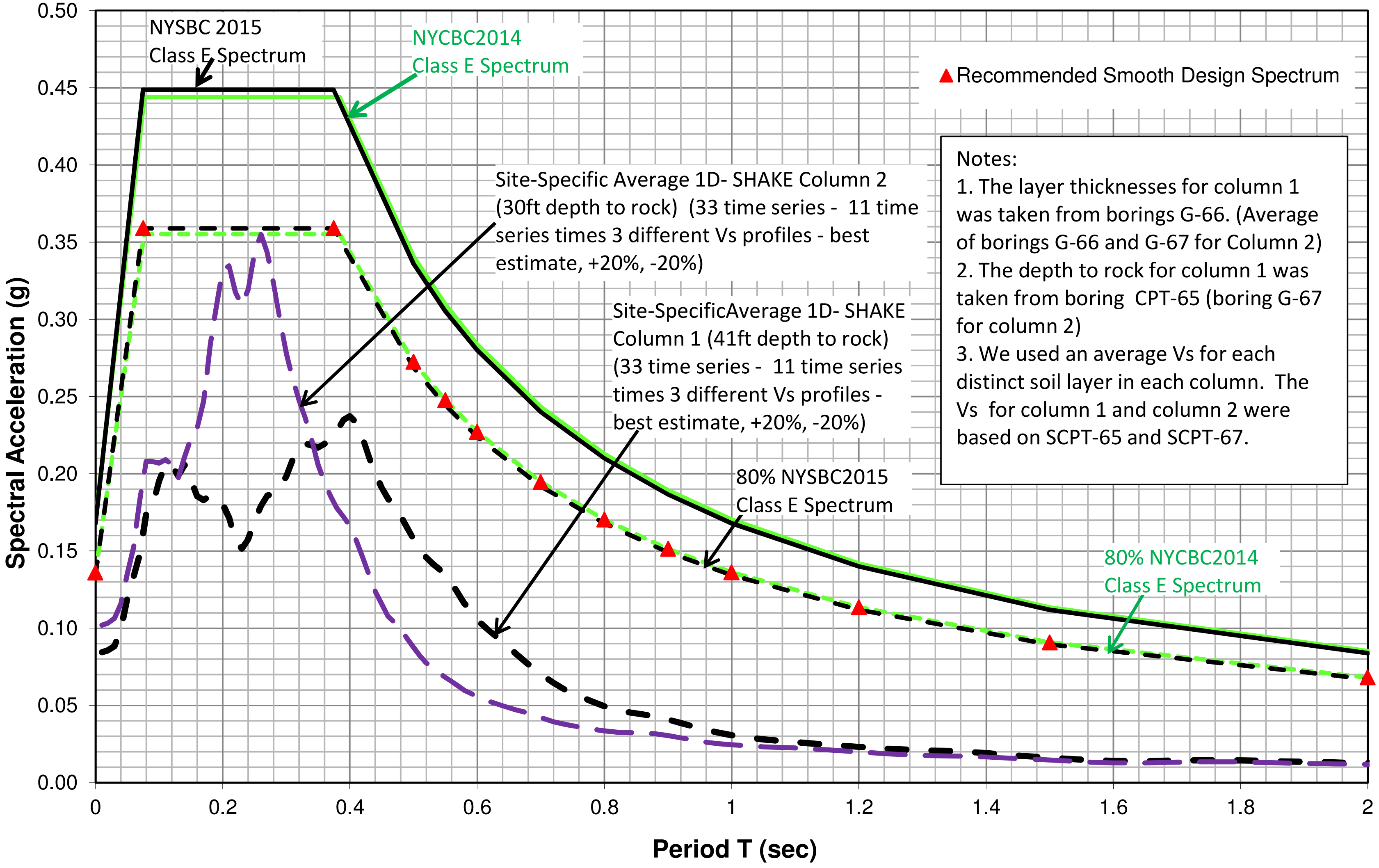
Zone 2 - Ground Surface Design Acceleration Response Spectra (ξ=5%)



Notes:
1. The layer thicknesses for column 1 was taken from borings G-66. (Average of borings G-66 and G-67 for Column 2)
2. The depth to rock for column 1 was taken from boring CPT-65 (boring G-67 for column 2)
3. We used an average Vs for each distinct soil layer in each column. The Vs for column 1 and column 2 were based on SCPT-65 and SCPT-67.

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HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
ZONE 2
SITE-SPECIFIC DESIGN RESPONSE SPECTRA

Project No.
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LY
Submission Date
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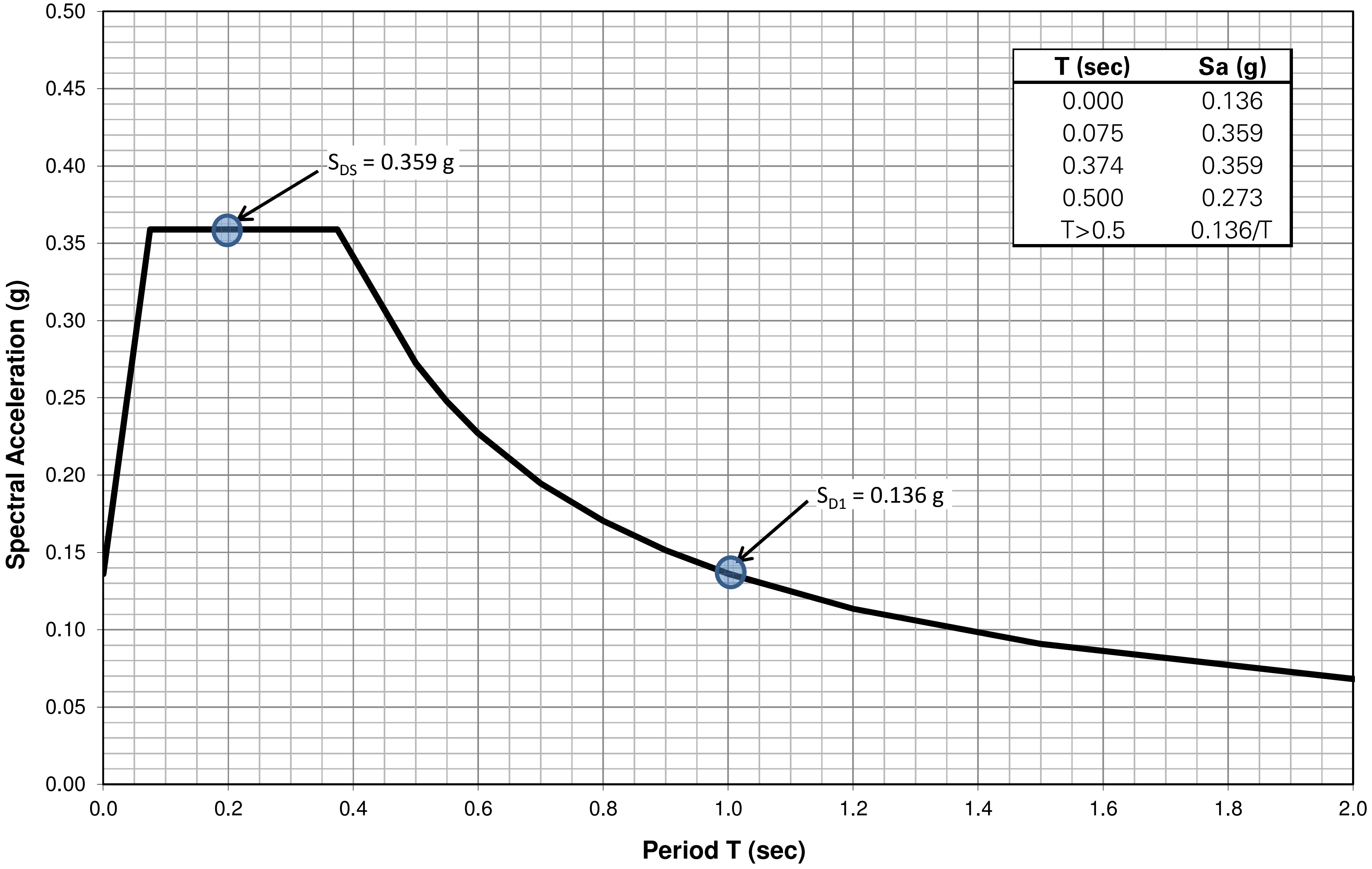
Drawing No.
B-3
Sheet 3 of 4

Zone 2 - Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
0.000	0.136
0.075	0.359
0.374	0.359
0.500	0.273
T>0.5	0.136/T

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MANHATTAN NEW YORK

Drawing Title
ZONE 2 RECOMMENDED SITE-SPECIFIC DESIGN RESPONSE SPECTRUM

Project No. 170444101
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Submission Date 4/29/2017

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Sheet 4 of 4

APPENDIX C

ZONE 3 SITE-SPECIFIC SEISMIC STUDY

We performed a site-specific seismic analysis for Zone 3 of the platform. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Zone 3 consist of fill, underlain by clay, silt, glacial till, decomposed rock and finally bedrock. The depth to bedrock varies from 80 to 115 feet increasing east to west. We selected two soil columns (C1 and C2) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table C-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table C-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

Column 1(C1) - Representative of west side of the zone Based on G-47 and SCPT-70			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	22	360 to 950	670
Clay	52	380 to 570	500
Clay/Silt	36	550 to 740	640
Glacial Till	5	1,100 to 1,310	1,200
Bedrock	N/A	9,000	9,000

Column 2(C2) - Representative of the east side of the zone Based on G-48 and SCPT-41			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	17	590 to 830	710
Organic Clay	10	380 to 580	510
Clay/Silt	50	310 to 660	510
Glacier Till/ Decomposed Rock	6	1,100 to 1,310	1,200
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 550 and 590 fps. The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

We evaluated the soil liquefaction potential using the peak ground accelerations (PGA) adjusted for site class effects per Table 1813.2.1 of 2014 NYCBC. Figure C-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Youd et al. (2001) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.33 g. (In accordance with ASCE 7-10 section 21.5.3, the PGA was taken as the higher value determined from: 1) 80 percent of PGA for Site Class E (i.e. 0.8 * 0.33g); and 2) the site-specific PGA (0.12 g) determined from total-stress analyses.);
- A magnitude scaling factor (MSF) of 2.2, as per the Youd et al. 2001 recommendations.

The Youd et al. (2001) liquefaction analysis indicated liquefaction potential around 10 feet and 80 feet below ground surface. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios are zero along the depth of the soil columns. The excess pore water pressure ratios estimated from DMOD2000 analyses are presented on Figure C-2. Based on our effective-stress analyses, there is enough margins towards liquefaction. Site Class remains as E.

We estimated about 0.1 to 0.2 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table C-2. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per the 2014 NYCBC) are presented on Figure C-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table C-2 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure C-4. The short-period and 1 second period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

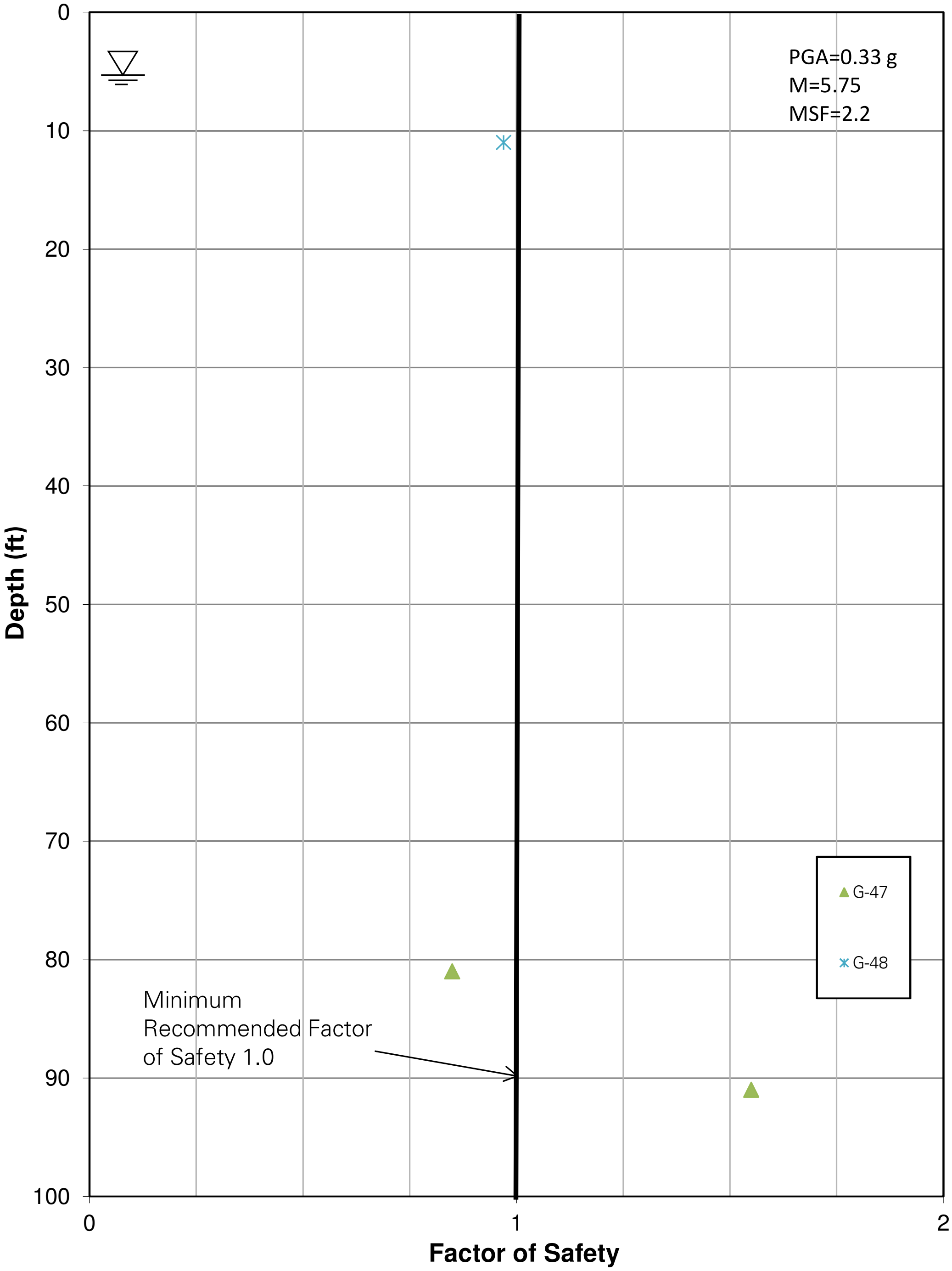
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category, regardless of the structure’s fundamental period of vibration. The results of the site-specific seismic study are listed in Table C-3:

Table C-3 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.09 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Zone 3 - Factor of Safety against Liquefaction
Simplified Procedure - Youd et al 2001



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ZONE 3 LIQUEFACTION ASSESSMENT (YOUD ET AL)

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4/29/2017

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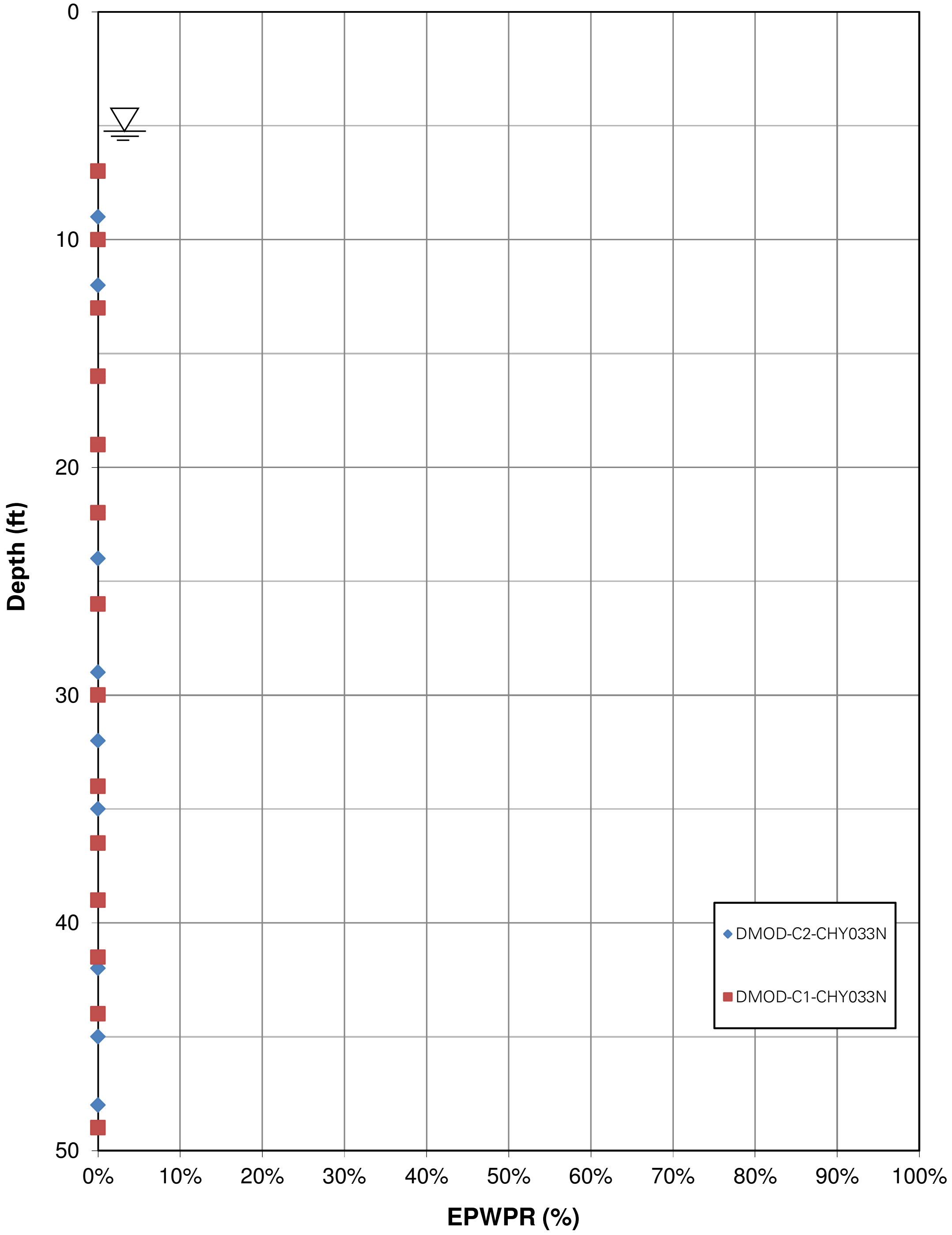
C-1

Sheet 1 of 4

Zone 3 - Estimated Excess Pore Water Pressure Ratio



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ZONE 3
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Submission Date 4/29/2017

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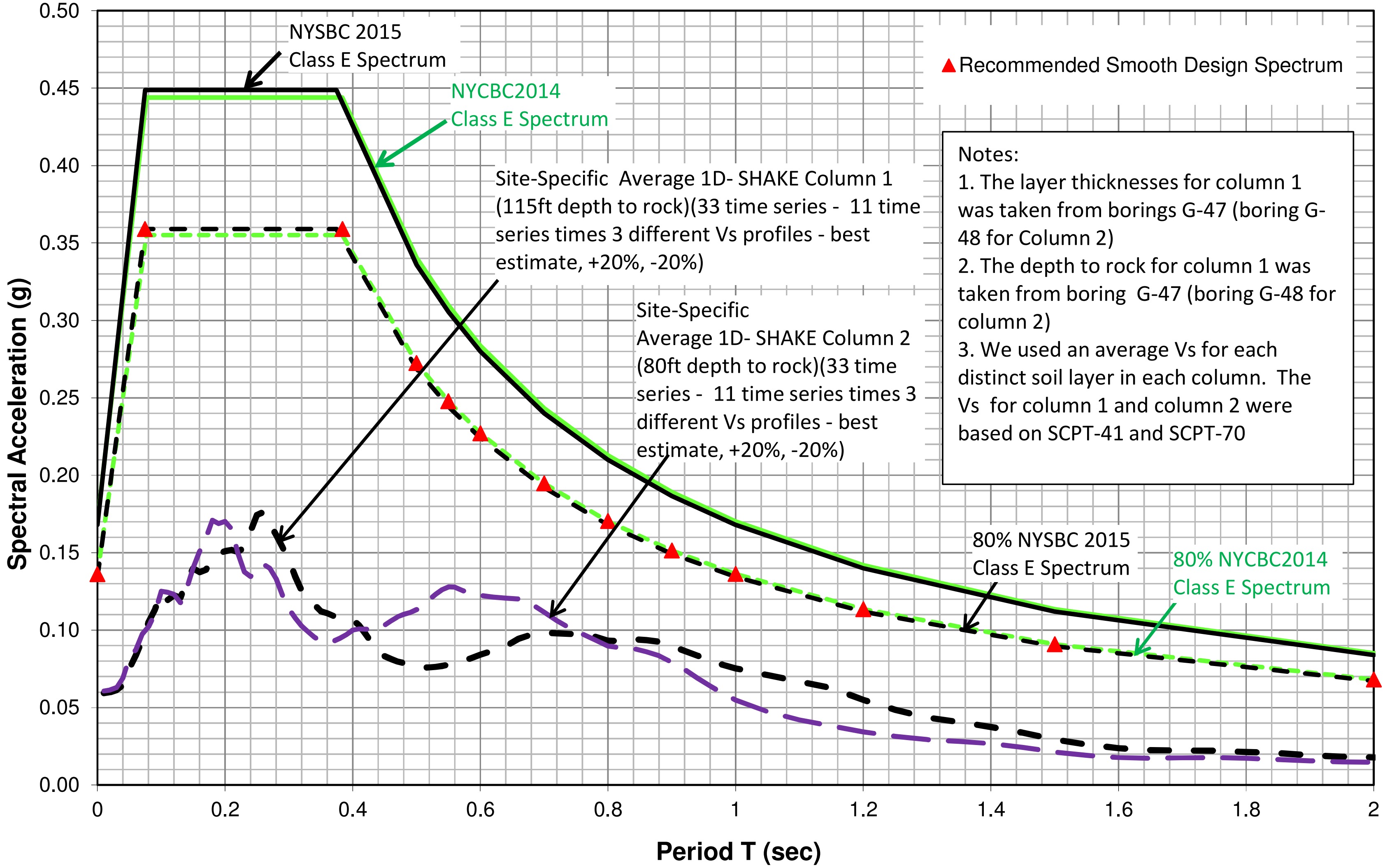
Sheet 2 of 4

Zone 3 - Ground Surface Design Acceleration Response Spectra (ξ=5%)



NYSBC 2015
Class E Spectrum

NYCBC2014
Class E Spectrum

Site-Specific Average 1D- SHAKE Column 1 (115ft depth to rock)(33 time series - 11 time series times 3 different Vs profiles - best estimate, +20%, -20%)

Site-Specific
Average 1D- SHAKE Column 2 (80ft depth to rock)(33 time series - 11 time series times 3 different Vs profiles - best estimate, +20%, -20%)

80% NYSBC 2015
Class E Spectrum

80% NYCBC2014
Class E Spectrum

Notes:
1. The layer thicknesses for column 1 was taken from borings G-47 (boring G-48 for Column 2)
2. The depth to rock for column 1 was taken from boring G-47 (boring G-48 for column 2)
3. We used an average Vs for each distinct soil layer in each column. The Vs for column 1 and column 2 were based on SCPT-41 and SCPT-70

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ZONE 3
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

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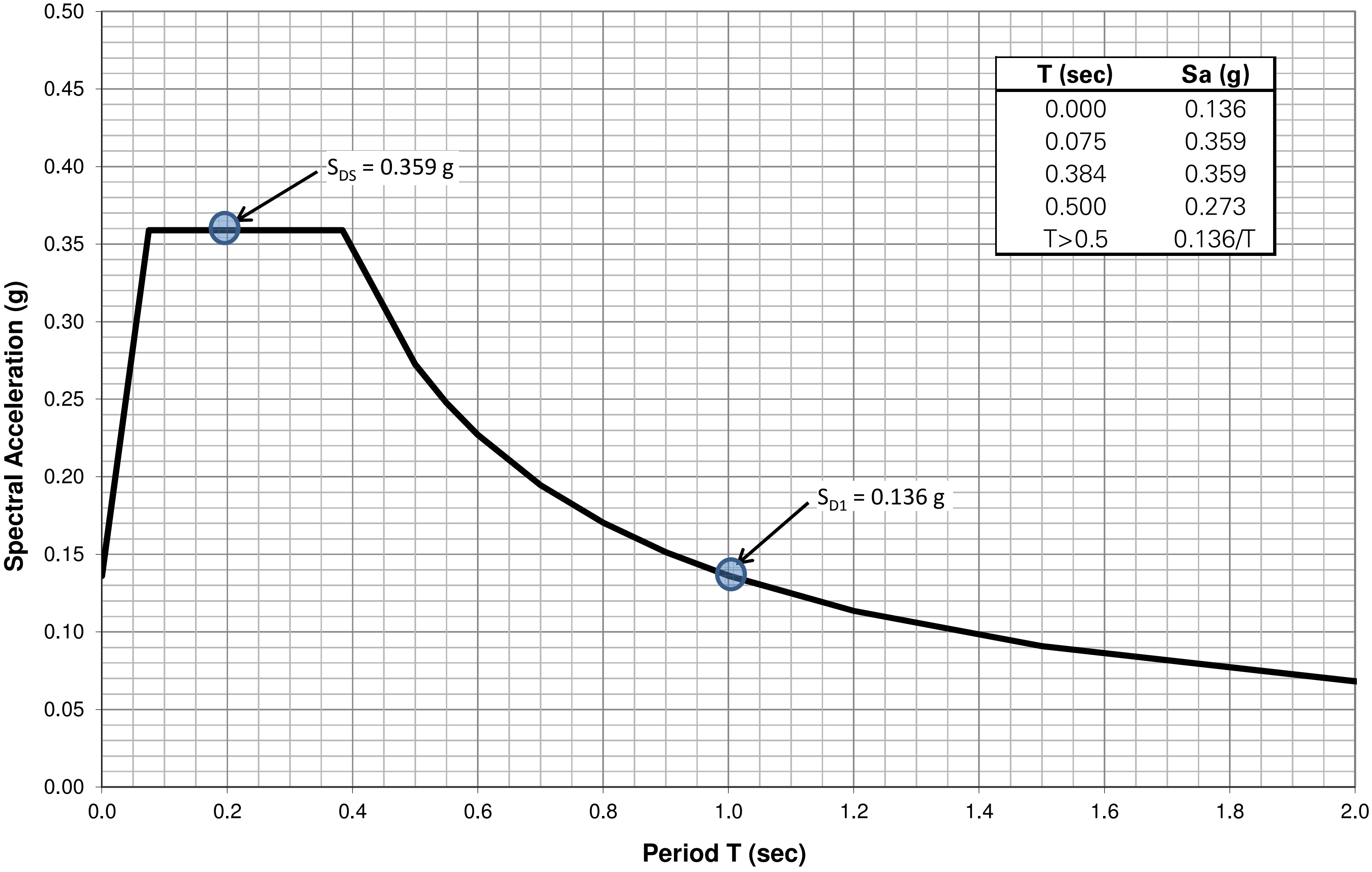
C-3

Sheet 3 of 4

Zone 3 - Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
0.000	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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ZONE 3 RECOMMENDED SITE-SPECIFIC DESIGN RESPONSE SPECTRUM

Project No. 170444101
Date 4/29/2017
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Drawn By LY
Submission Date 4/29/2017

Drawing No.
C-4

Sheet 4 of 4

APPENDIX D

ZONE 4 SITE-SPECIFIC SEISMIC STUDY

We performed a site-specific seismic analysis for Zone 4 of the platform. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Zone 4 consist of fill, underlain by clay, silt, glacial till, and finally bedrock. The depth to bedrock varies from 60 to 87 feet, increasing east to west. We selected two soil columns (C1 and C2) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table D-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table D-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

Column 1(C1) - Representative of west side of the zone Based on G-35 and SCPT-42			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	41	440 to 670	580
Clay/Silt	32	470 to 600	540
Glacial Till	2	1,200	1,200
Bedrock	2	9,000	9,000

Column 2(C2) - Representative of the east side of the zone Based on G-35 and SCPT-43			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	41	450 to 900	640
Clay/Silt	32	550 to 600	570
Glacial Till	6	1,200	1,200
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 550 and 640 fps with an average of 590 fps. The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure D-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Youd et al. (2001) procedure with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.264 g. (In accordance with ASCE 7-10 section 21.5.3, the PGA was taken as the higher value determined from: 1) 80 percent of PGA for Site Class E (i.e. 0.8 * 0.33g); and 2) the site-specific PGA (0.107 g) determined from total-stress analyses.);
- A magnitude scaling factor (MSF) of 2.2, as per the Youd et al. 2001 recommendations.

The Youd et al. (2001) liquefaction analysis indicated potential liquefaction at depths between 8 and 18 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as 50 percent at depths around 30 feet, corresponding to partial liquefaction (partial soil strength loss). Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. The excess pore water pressure ratios estimated from DMOD2000 analyses are presented in Figure D-2 and listed in Table D-2.

Table D-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
6 to 20	0% to 30%	30%
20 to 41	0% to 50%	50%
below 41	0%	0%

We estimated about 0.1 to 0.3 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table D-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure D-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table D-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented in Figure D-4. The short-period and 1 second period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

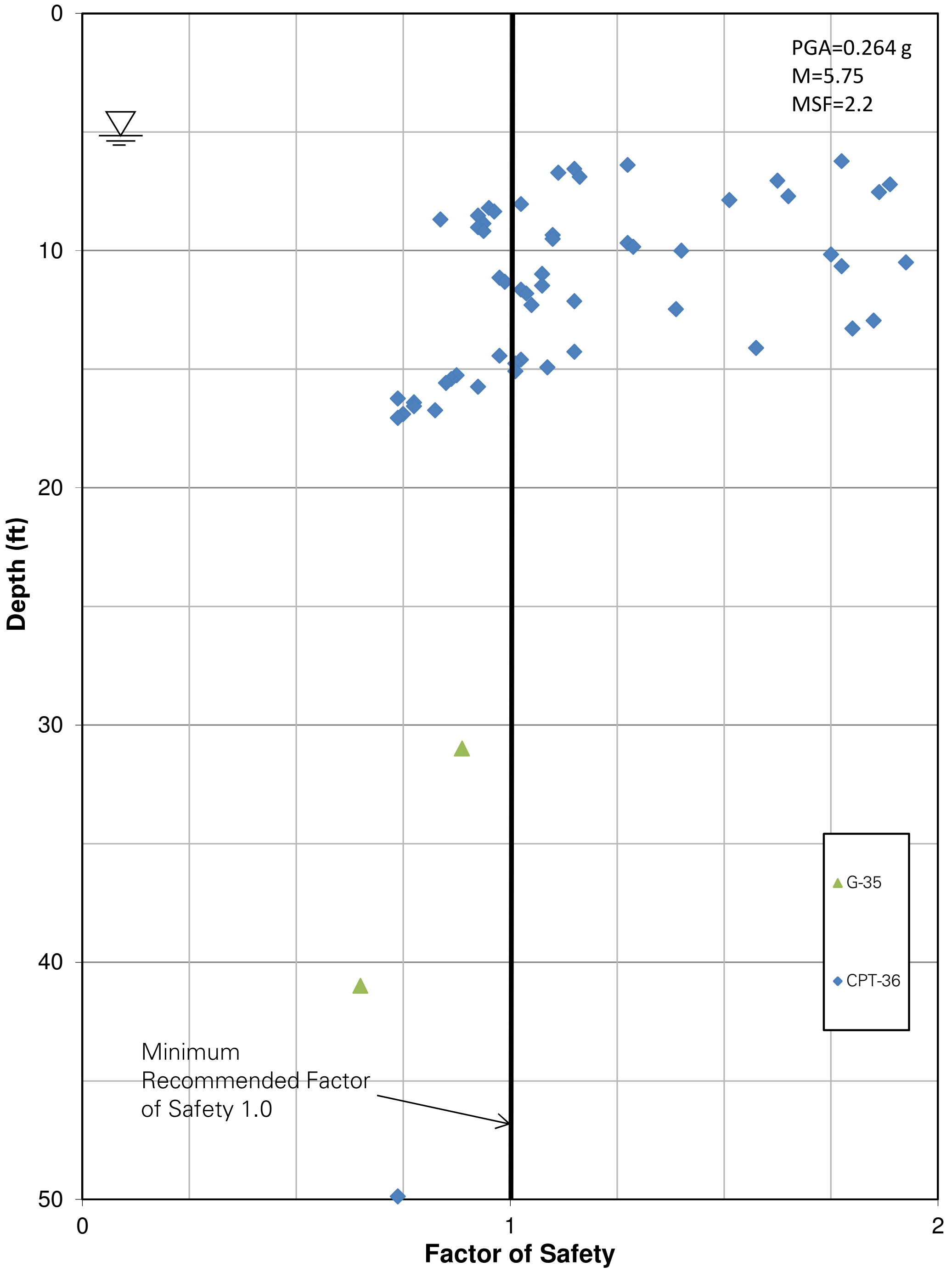
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table D-4 below.

Table D-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.107 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Zone 4 - Factor of Safety against Liquefaction
Simplified Procedure - Youd et al 2001



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(YOUD ET AL)

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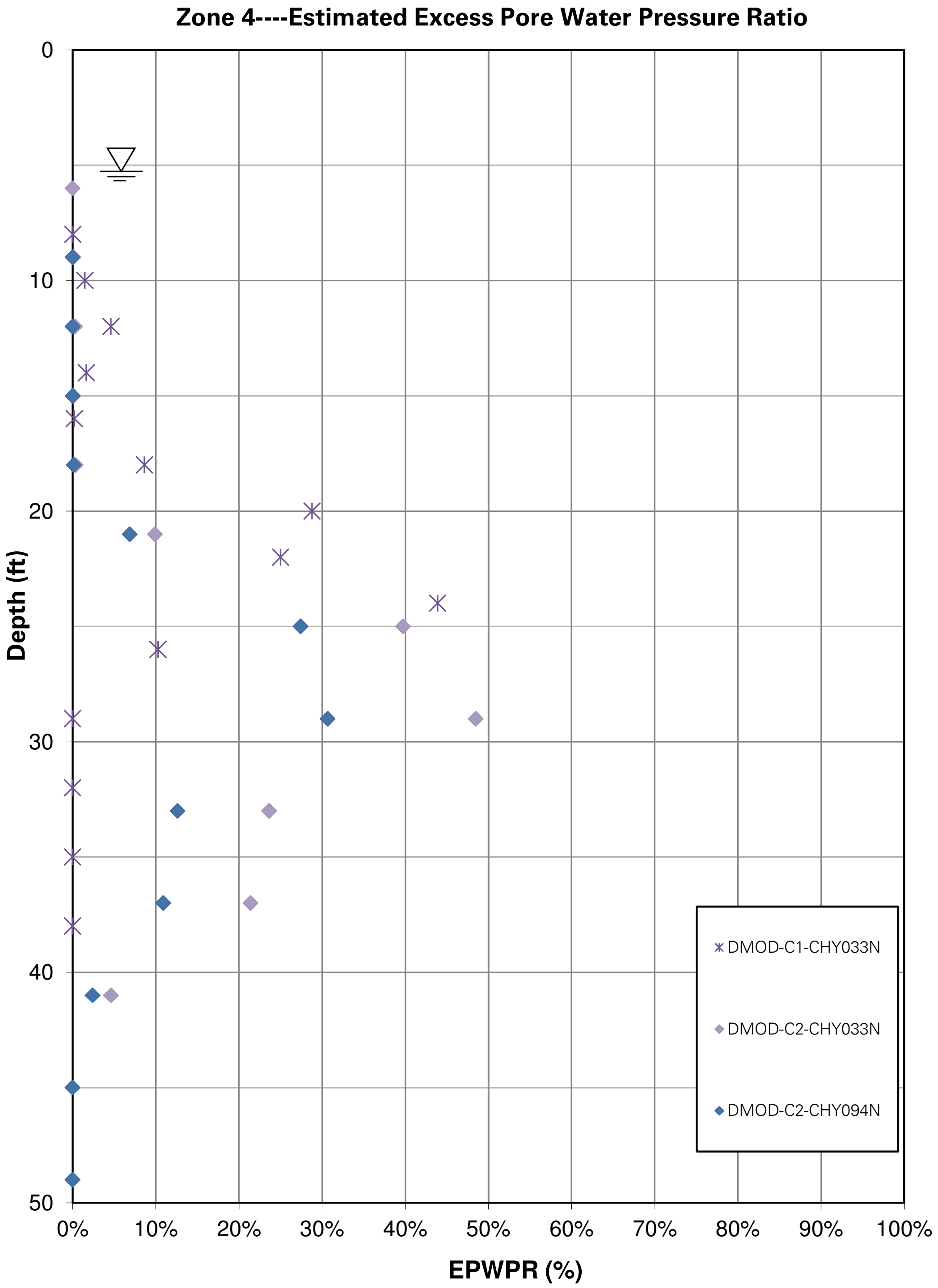
D-1

Sheet 1 of 4



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ZONE 4
DMOD2000 EPWPR

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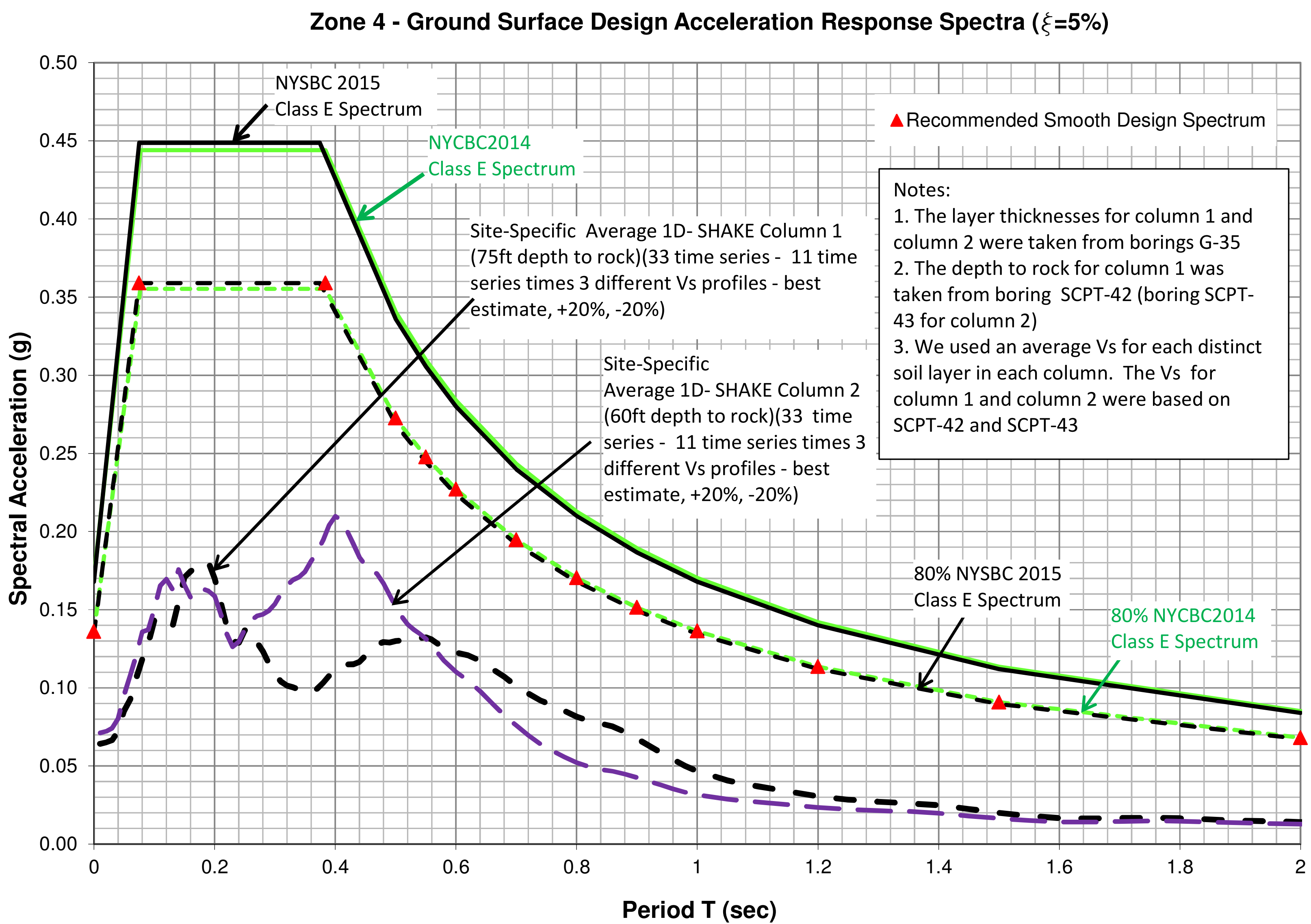
Drawn By	LY
Submission Date	4/29/2017
Drawing No.	D-2

Sheet 2 of 4



Notes:

1. The layer thicknesses for column 1 and column 2 were taken from borings G-35
2. The depth to rock for column 1 was taken from boring SCPT-42 (boring SCPT-43 for column 2)
3. We used an average Vs for each distinct soil layer in each column. The Vs for column 1 and column 2 were based on SCPT-42 and SCPT-43

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WEST RAIL YARD PLATFORM

HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

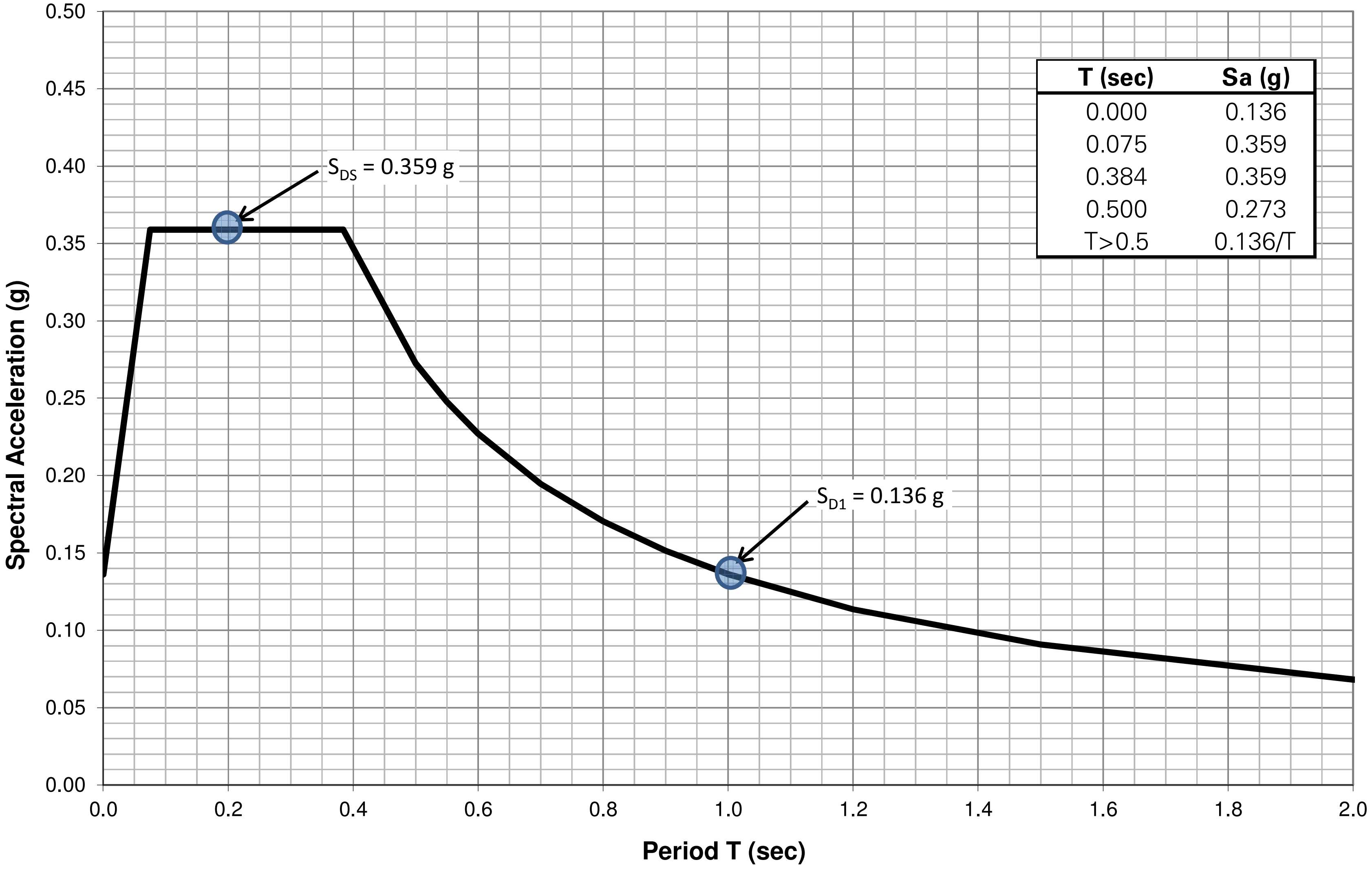
ZONE 4
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

Project No.	170444101
Date	4/29/2017
Scale	NTS
Drawn By	LY
Submission Date	4/29/2017

Drawing No.

D-3

Zone 4 - Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
0.000	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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Drawing Title
ZONE 4
RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No.	170444101
Date	4/29/2017
Scale	NTS
Drawn By	LY
Submission Date	4/29/2017
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Sheet 4 of 4

APPENDIX E

ZONE 5 SITE-SPECIFIC SEISMIC STUDY

We performed a site-specific seismic analysis for Zone 5 of the platform. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Zone 5 consist of fill, underlain by clay, silty sand, glacial till, and finally bedrock. The depth to bedrock varies from 33 to 54 feet, increasing east to west. We selected two soil columns (C1 and C2) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table E-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table E-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

Column 1(C1) - Representative of west side of the zone Based on G-30, G-37, G-49 and SCPT-44			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	26	530 to 780	650
Clay	25	430 to 590	510
Glacial Till	2	1,200	1,200
Bedrock	N/A	9,000	9,000

Column 2(C2) - Representative of the east side of the zone Based on G-31, G-50, CPT-38 and SCPT-45			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	16	450 to 500	470
Clay/Silt	16	330 to 620	430
Silty Sand	4	330 to 620	430
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 450 and 610 fps, with an average of 530 fps. The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure E-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Youd et al. (2001) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.264 g. (In accordance with ASCE 7-10 section 21.5.3, the PGA was taken as the higher value determined from: 1) 80 percent of PGA for Site Class E (i.e. 0.8 * 0.33g); and 2) the site-specific PGA (0.12 g) determined from total-stress analyses.);
- A magnitude scaling factor (MSF) of 2.2, as per the Youd et al. 2001 recommendations.

The Youd et al. (2001) liquefaction analysis indicated potential liquefaction at depths between 10 and 35 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as 45 percent at depths around 15 feet, corresponding to partial liquefaction (partial soil strength loss). Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. The excess pore water pressure ratios estimated from DMOD2000 analyses are presented in Figure E-2 and listed in Table E-2.

Table E-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
6 to 10	0% to 20%	20%
10 to 20	0% to 45%	45%
below 20	0% to 10%	0%

We estimated about 0.1 to 0.3 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table E-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per the 2014 ASCE 7-10) are presented in Figure E-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table E-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure E-4. The short-period and 1-second-period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

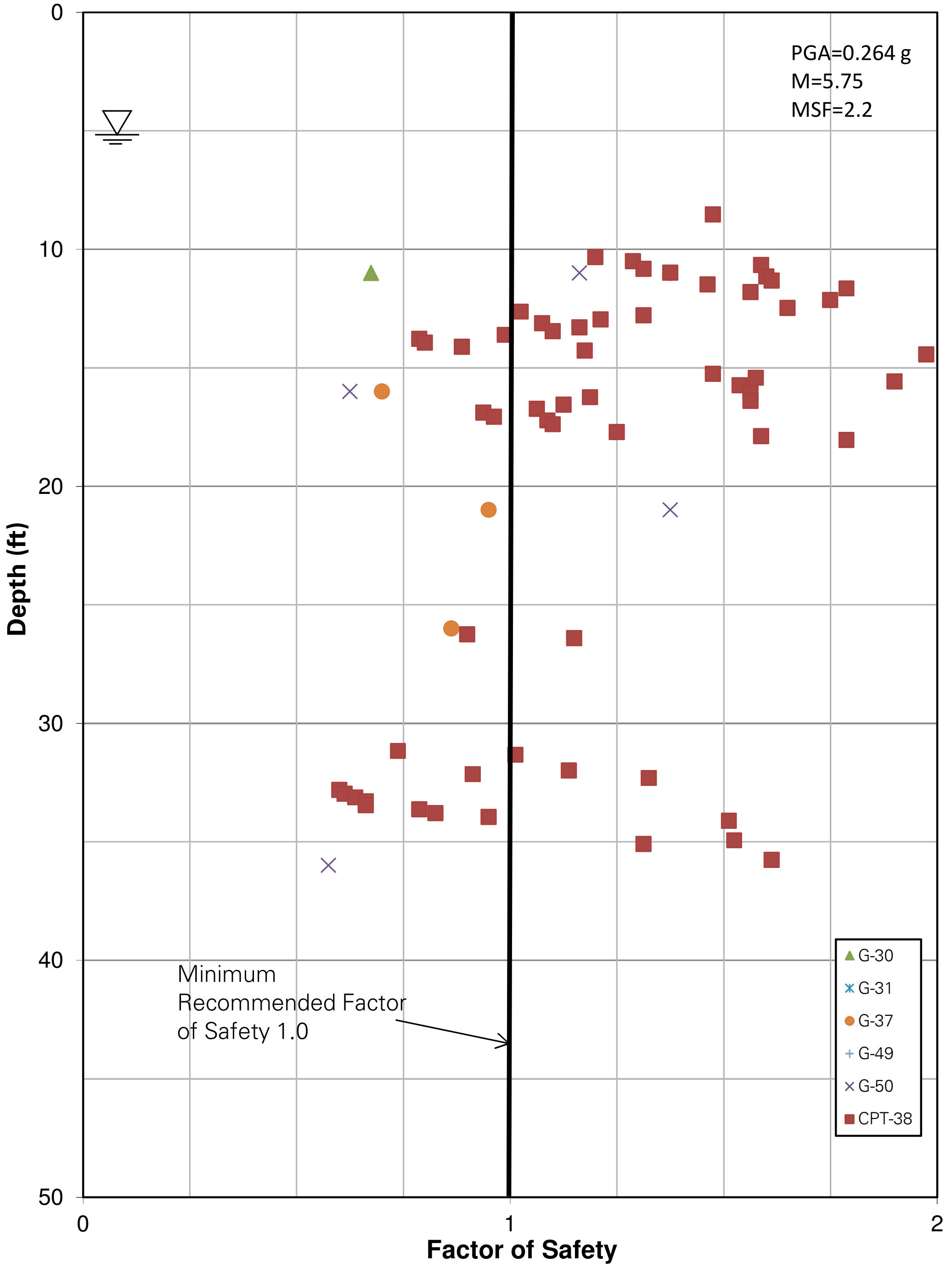
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table E-4.

Table E-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.12 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Zone 5 - Factor of Safety against Liquefaction
Simplified Procedure - Youd et al 2001



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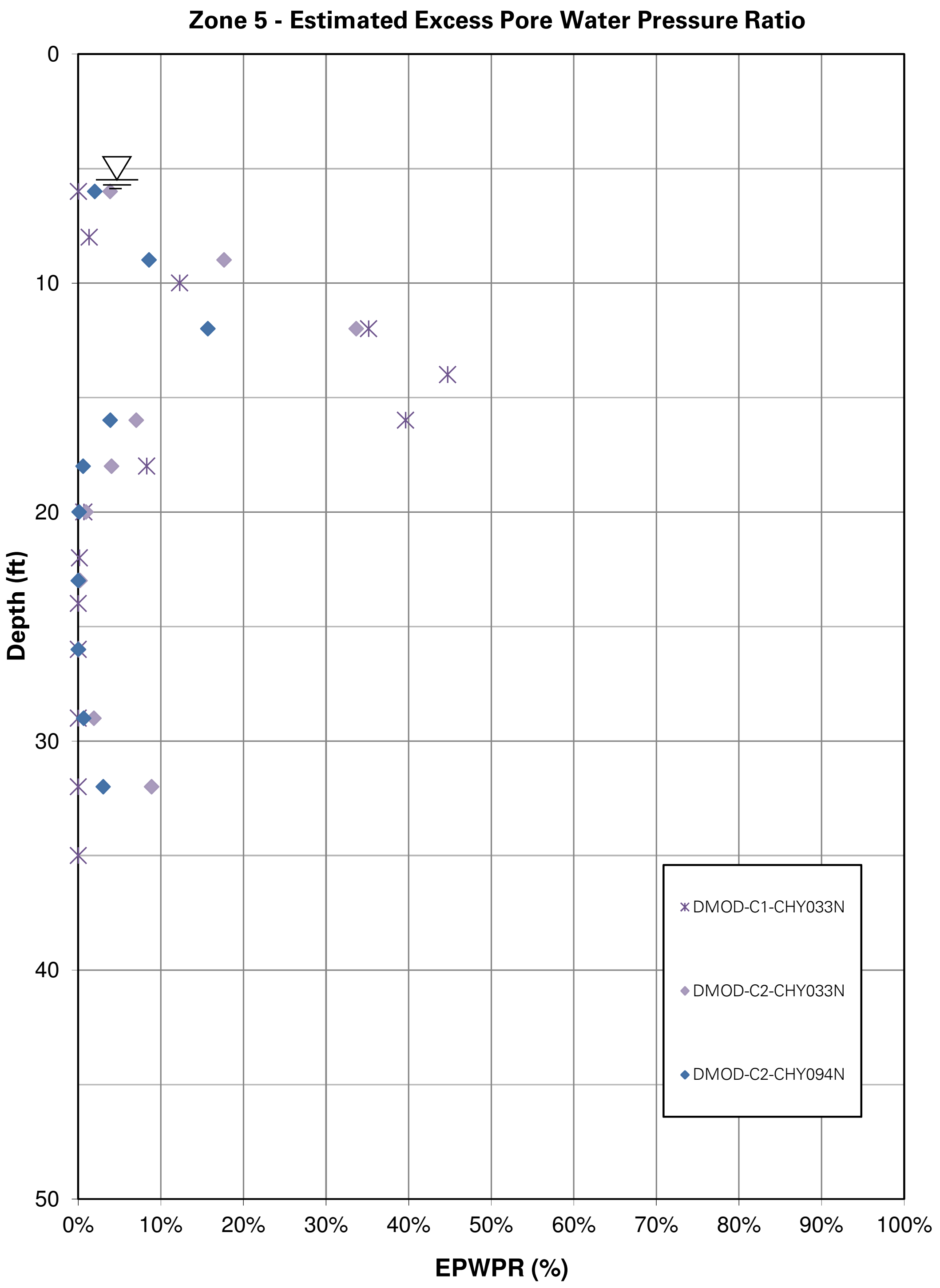
Project
WEST RAIL YARD PLATFORM
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
ZONE 5 LIQUEFACTION ASSESSMENT (YOUD ET AL)

Project No. 170444101
Date 4/29/2017
Scale NTS
Drawn By LY
Submission Date 4/29/2017

Drawing No. E-1

Sheet 1 of 4



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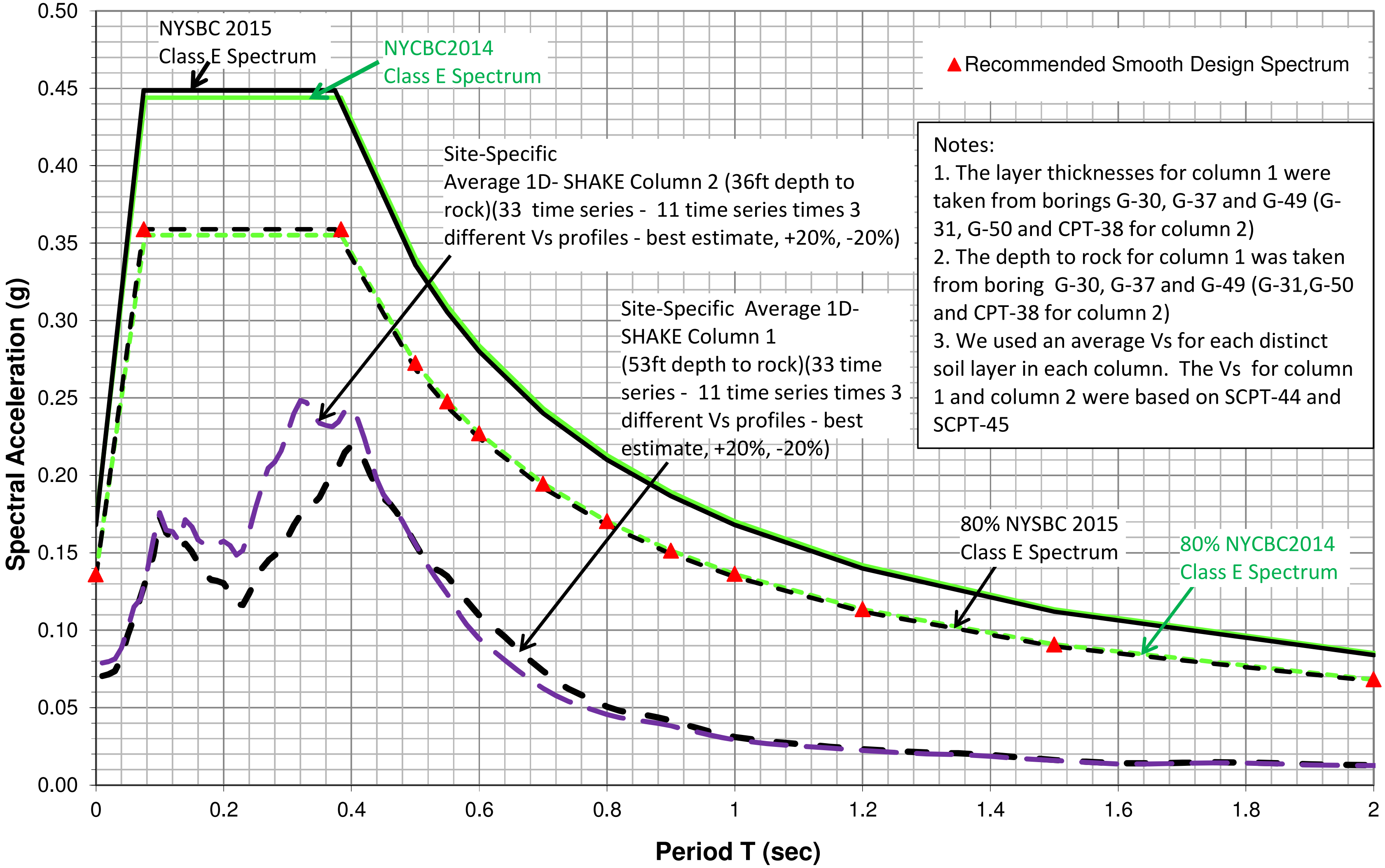
Drawing Title
ZONE 5
DMOD2000 EPWPR

Project No.	170444101
Date	4/29/2017
Scale	NTS
Drawn By	LY
Submission Date	4/29/2017
Drawing No.	E-2
	Sheet 2 of 4

Zone 5 - Ground Surface Design Acceleration Response Spectra (ξ=5%)



Notes:

1. The layer thicknesses for column 1 were taken from borings G-30, G-37 and G-49 (G-31, G-50 and CPT-38 for column 2)
2. The depth to rock for column 1 was taken from boring G-30, G-37 and G-49 (G-31,G-50 and CPT-38 for column 2)
3. We used an average Vs for each distinct soil layer in each column. The Vs for column 1 and column 2 were based on SCPT-44 and SCPT-45

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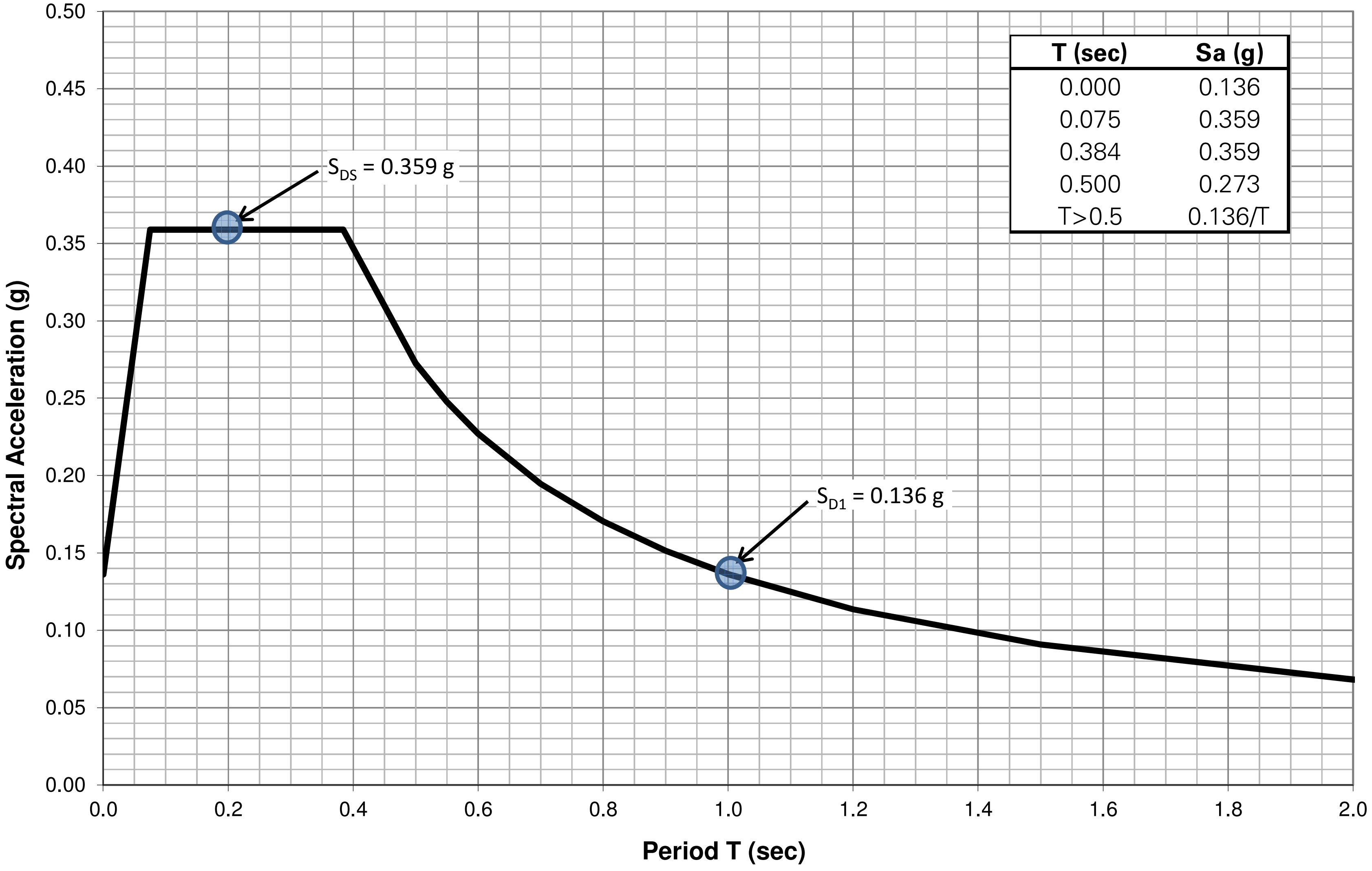
ZONE 5
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

Project No. 170444101
Date 4/29/2017
Scale NTS
Drawn By LY
Submission Date 4/29/2017

Drawing No.
E-3

Sheet 3 of 4

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



T (sec)	Sa (g)
0.000	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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ZONE 5
RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

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E-4

Sheet 4 of 4

APPENDIX F

ZONE 6 SITE-SPECIFIC SEISMIC STUDY

We performed a site-specific seismic analysis for Zone 6 of the platform. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Zone 6 consist of fill, underlain by clay, glacial till, and finally bedrock. The depth to bedrock varies from 26 to 34 feet east to west. We selected two soil columns (C1 and C2) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table F-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table F-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

Column 1(C1) - Representative of west side of the zone Based on G-39, G-51 and SCPT-46			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	26	440 to 490	440
Clay/Silt	25	440 to 490	470
Glacial Till	2	1,470	1,470
Bedrock	N/A	9,000	9,000

Column 2(C2) - Representative of the east side of the zone Based on G-52 and SCPT-46			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	16	440 to 490	440
Clay	16	440 to 490	470
Glacial Till	4	1,470	1,470
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{\mathrm{V}}_{\mathrm{s}}$) about 490 fps. The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure F-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Youd et al. (2001) procedure with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.264 g. (In accordance with ASCE 7-10 section 21.5.3, the PGA was taken as the higher value determined from: 1) 80 percent of PGA for Site Class E (i.e. 0.8 * 0.33g); and 2) the site-specific PGA (0.16 g) determined from total-stress analyses.);
- A magnitude scaling factor (MSF) of 2.2, as per the Youd et al. 2001 recommendations.

The Youd et al. (2001) liquefaction analysis indicated potential liquefaction at depths between 10 and 20 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as 50 percent at depths around 15 to 20 feet, corresponding to partial liquefaction (partial soil strength loss). Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. The excess pore water pressure ratios estimated from DMOD2000 analyses are presented in Figure F-2 and listed in Table F-2.

Table F-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
6 to 15	0% to 40%	40%
15 to 25	0% to 50%	50%
below 25	0%	0%

We estimated about 0.1 to 0.5 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table F-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure F-3. The red triangles show our recommended design acceleration-response spectrum.

Table F-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.136
0.075	0.409
0.384	0.409
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented in Figure F-4. The short-period and 1 second period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.409 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

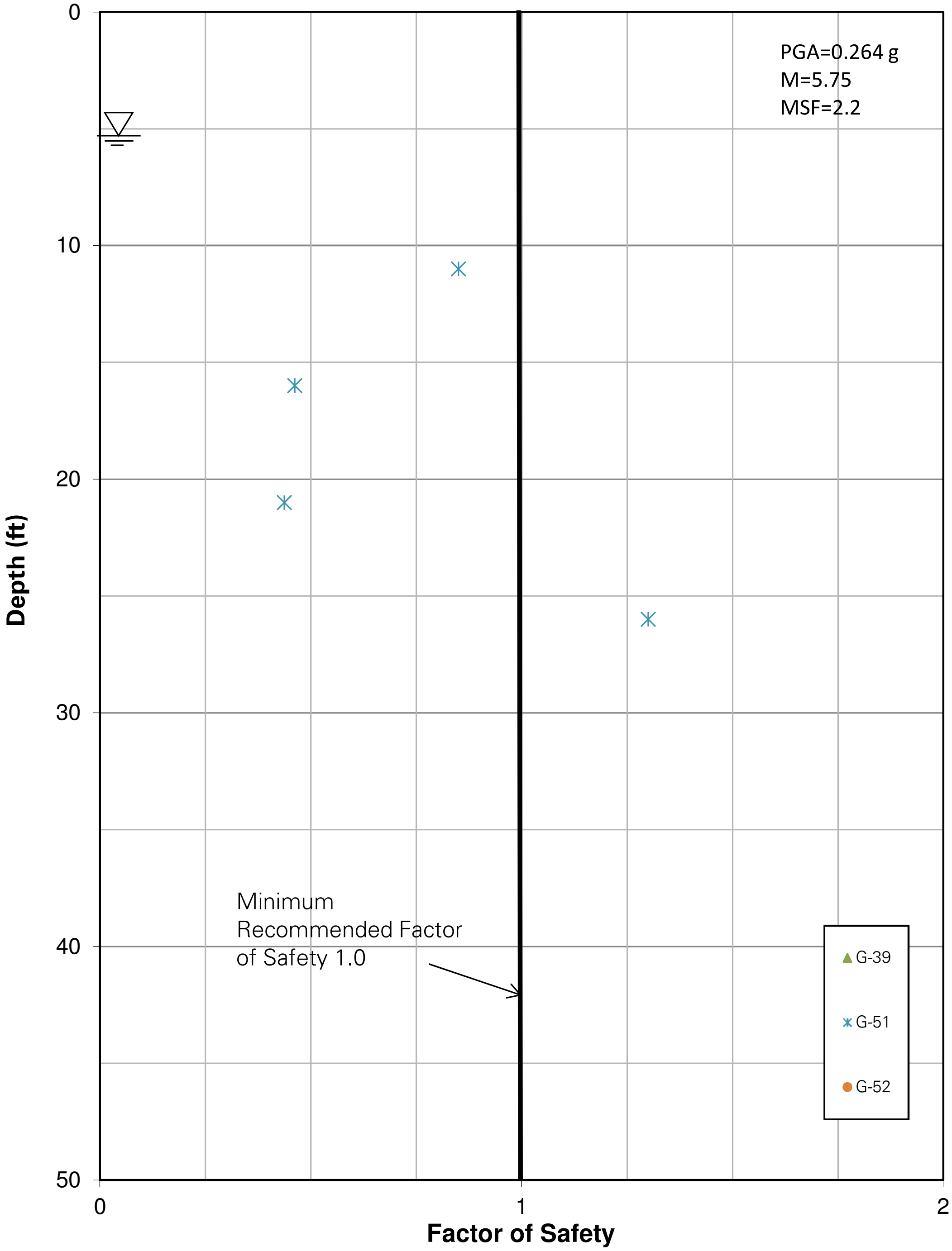
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table F-4.

Table F-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.16 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Zone 6 - Factor of Safety against Liquefaction
Simplified Procedure - Youd et al 2001



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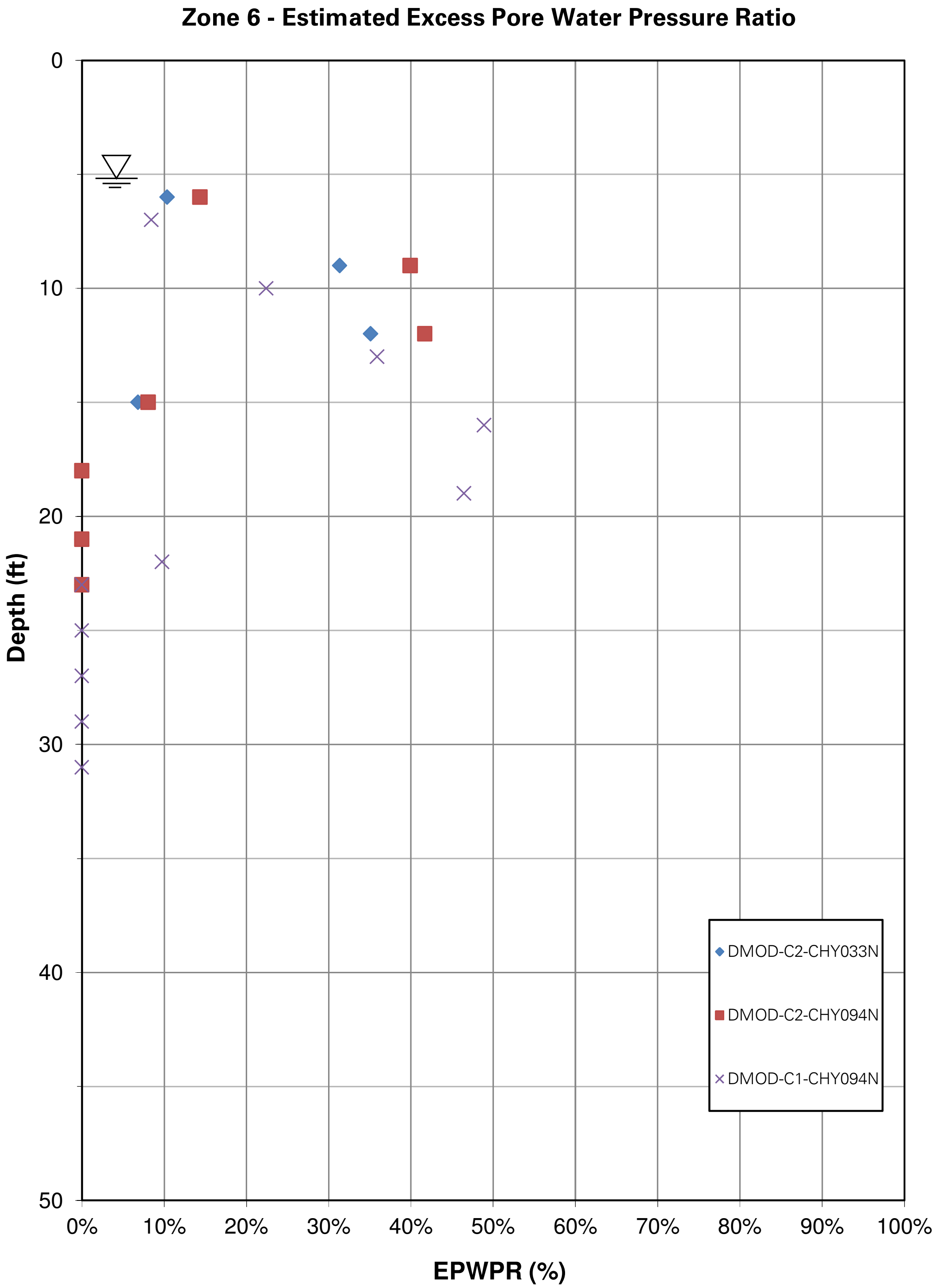
F-1
Sheet 1 of 4



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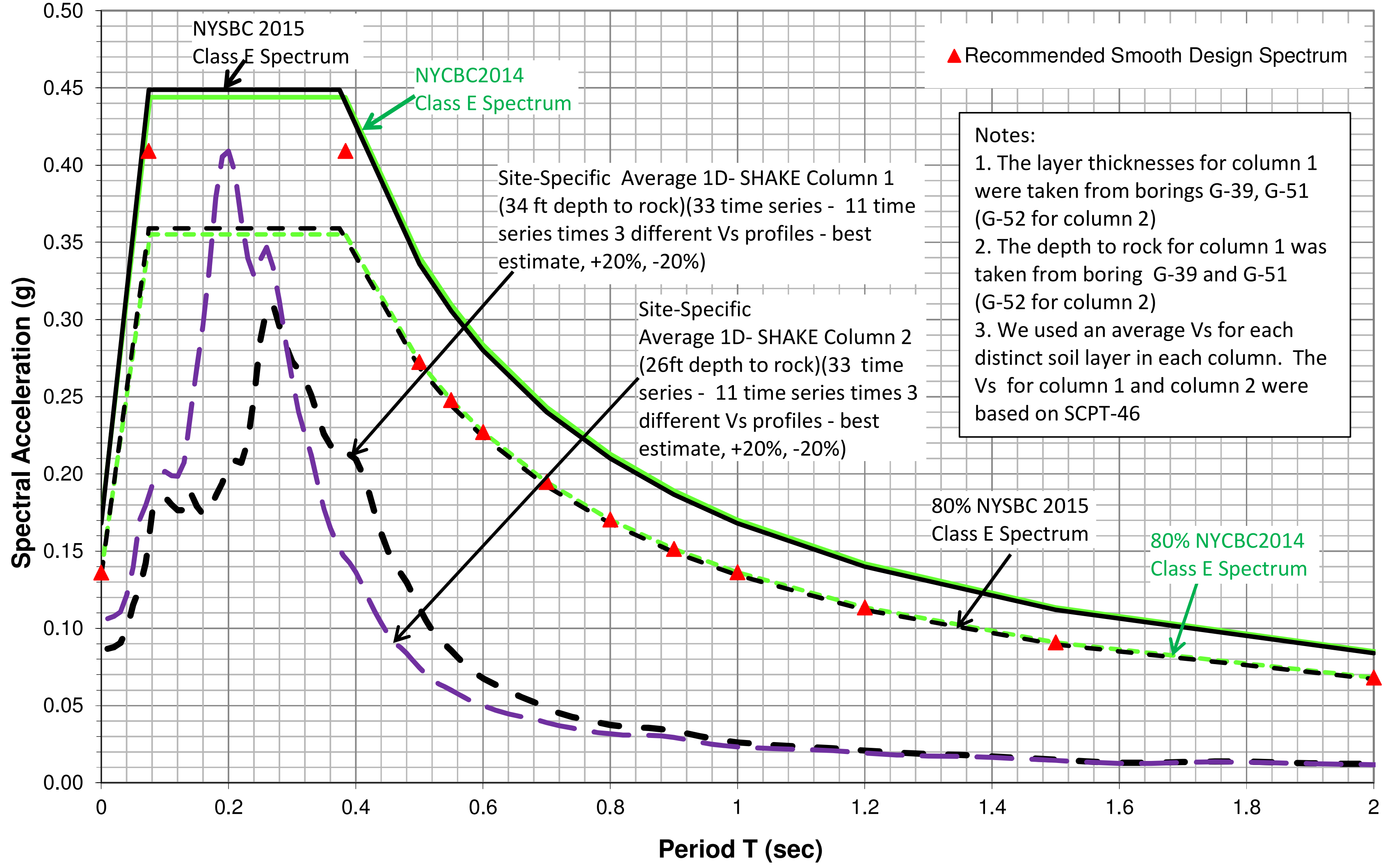
F-2

Sheet 2 of 4

Zone 6 - Ground Surface Design Acceleration Response Spectra (ξ=5%)



Notes:
1. The layer thicknesses for column 1 were taken from borings G-39, G-51 (G-52 for column 2)
2. The depth to rock for column 1 was taken from boring G-39 and G-51 (G-52 for column 2)
3. We used an average Vs for each distinct soil layer in each column. The Vs for column 1 and column 2 were based on SCPT-46

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MANHATTAN NEW YORK

Drawing Title
ZONE 6 SITE-SPECIFIC DESIGN RESPONSE SPECTRA

Project No. 170444101
Date 4/29/2017
Scale NTS
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Submission Date 4/29/2017

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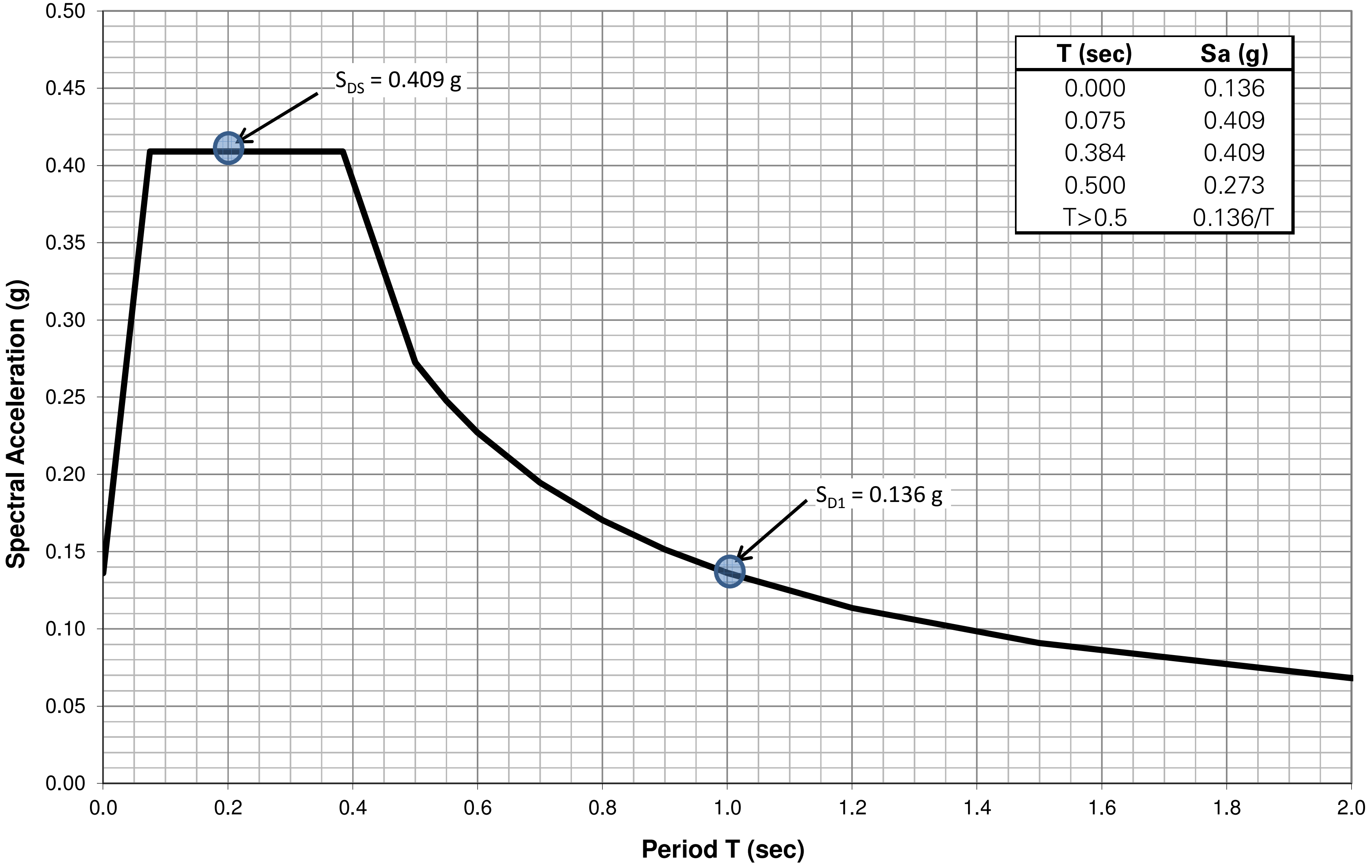
F-3

Sheet 3 of 4

Zone 6 - Recommended Surface Design Acceleration Response Spectrum (ξ=5%)



T (sec)	Sa (g)
0.000	0.136
0.075	0.409
0.384	0.409
0.500	0.273
T>0.5	0.136/T

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ZONE 6 RECOMMENDED SITE-SPECIFIC DESIGN RESPONSE SPECTRUM

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Sheet 4 of 4

Appendix J2 Geotechnical Report – Terra Firma

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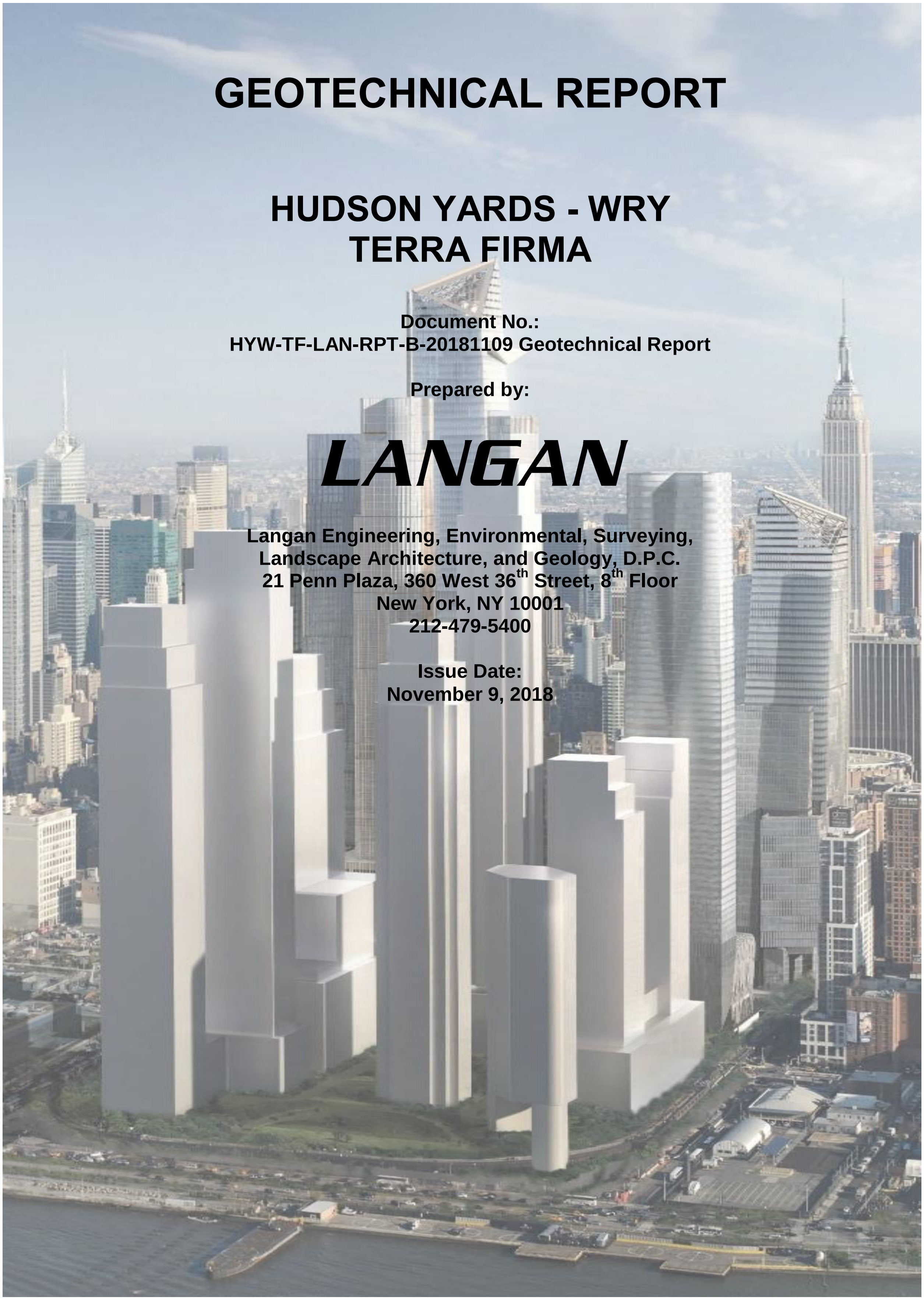

GEOTECHNICAL REPORT

HUDSON YARDS - WRY
TERRA FIRMA

Document No.:
HYW-TF-LAN-RPT-B-20181109 Geotechnical Report

Prepared by:

LANGAN

Langan Engineering, Environmental, Surveying,
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21 Penn Plaza, 360 West 36th Street, 8th Floor
New York, NY 10001
212-479-5400

Issue Date:
November 9, 2018

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 Introduction

This report presents the results of our geotechnical engineering study and provides recommendations for the design and construction of structures within the terra firma area of the West Rail Yard of Hudson Yards. All services were performed in general accordance with our 5 May 2017 proposal. 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. The historical drawings and data referenced in this report reference multiple datums; 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 “terra firma” (Block 676, Lot 1) and “platform” (Block 676, Lot 5) parcels. This report focuses solely on the terra firma site. Terra firma measures about 147,000 square feet and is bound by the LIRR South Access Road and the new platform parcel on the north, West 30th Street 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 terra firma site is occupied by several LIRR support facilities at the east end of the site, a laydown area for ongoing construction within Hudson Yards near the center of the site, and a Vehicle Processing Center (VPC) near the west end of the site. Surface cover predominantly consists of asphalt and concrete pavements. Numerous structures are located within and adjacent to the site as discussed herein.

Surface grade within the site varies from about el 7 ft at the west to about el 15 ft near the southeast corner of the site and generally slopes gently down to the west. Grade on the streets fronting the site generally slopes down to the west and south. West 30th Street slopes down from a high point of about el 19 ft at the intersection with Eleventh Avenue to about el 6 ft at the intersection with Twelfth Avenue. The Eleventh Avenue viaduct ramps up from about el 19 ft to about el 24 ft near the northeast corner of the site. Twelfth Avenue is relatively flat, varying from about el 5.5 to 6.5 ft along the site.

3 EXISTING STRUCTURES AND UTILITIES

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

3.1 Ancillary Structures

Several ancillary structures are within the site including temporary buildings, office trailers and metal storage containers. The central part of the site is currently used as a staging and storage area for the ongoing Hudson Yards East Rail Yard construction. There are several guard booths and Conex boxes in the VPC at the west end of the site.

3.2 LIRR Emergency Facilities Building

The LIRR Emergency Facilities building is near the northeast corner of the site. This building houses fire pumps, emergency generators, and electrical switchgear associated with the rail yard. A water storage tank is near the northwest corner of the building.

3.3 High Line (City of New York)

The High Line Park elevated rail line traverses along the south and west sides of the site. The structure parallels West 30th Street then arcs north, near the west end of the site. 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 supported by concrete piers bearing on rock along the eastern third of the site and timber friction piles with reinforced concrete pile caps for the remainder of the site. Historical drawings indicate the top of the pier and pile caps are at about el 3.5 to 5 ft.

The Highline slopes down from the east, with the top of deck varying from about 22 to 25 feet above grade. The Highline will be incorporated into the proposed redevelopment and must 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.

3.4 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 to the west side of Eleventh Avenue. The third segment of the tunnel is proposed to run from Eleventh Avenue to West 30th Street, beneath the terra firma site, and will be constructed using cut-and-cover construction. Segment 3 is expected to be constructed between 2019 and 2021. Future construction of Segment 4 contemplates mined tunnels running from bulkheads at the western end of Segment 3 to a ventilation shaft to be constructed to the southwest. Construction within terra firma will require coordination with the anticipated Amtrak construction.

3.5 Eleventh Avenue Viaduct

The Eleventh Avenue viaduct borders the east side of the site. Elevations range from about el 19 ft at West 30th Street to about el 24 ft at the northern site boundary, and the viaduct crowns at about el 34 ft north of the site. The viaduct generally consists of a steel-frame, a reinforced concrete deck, concrete piers supported on piles and an earthen fill abutment (foundations unknown) at the south end. The viaduct was reconstructed during development of the West Side Yards in the 1980s and the abutment was underpinned via jet grouting during construction of Segment 2 of the Gateway tunnel.

The viaduct and abutment will remain and must be protected during construction.

3.6 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. There is a concrete security wall on the site perimeter along Twelfth Avenue.

3.7 MTA No. 7 Line Extension

The MTA No. 7 Line is below Eleventh Avenue, and consists of two running tunnels (CC1 and CC2) and a cross passage (No. 3) next to terra firma.. The tunnels slope down from north to south at an inclination of about 0.5 percent. Invert elevations adjacent to the site vary from about el -104.5 to -106 ft and crown elevations vary from about el -84.5 to -86 ft. The No. 7 Line is about 17 to 18 feet east of the of terra firma, and cross passage No. 3 is about 7 feet south of terra firma.

The running tunnels were bored by a tunnel boring machine (TBM). The MTA No. 7 Line will remain and be must protected during construction. Construction within 200 feet of the No. 7 Line requires NYCT approval to obtain NYC DOB permits.

3.8 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 foundations for the terra firma structures.

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 West Rail Yard Platform

The proposed WRY redevelopment includes construction of a platform over the WRY (north of terra firma) 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 be residential. LIRR facilities and parking areas will occupy the platform level.
- Site 2: Located in the northeast part of the platform, Site 2 includes Tower 2 (46-stories). The commercial space will occupy the lower 18 floors with residential above. Retail space, a commercial lobby, a loading dock, 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 building will be residential with a retail component at the platform level. 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. Retail space will occupy the platform and “lobby” level with residential above.
- 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 to 32.5 ft, and will be supported by columns extending to ground level in the service corridors between tracks. The WRY platform is expected to be constructed between 2019 and 2021. Construction within terra firma will require coordination with the anticipated platform 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. Loads for the buildings have not been developed as of the time of this report.

5.1 Tower 5

Tower 5 will be on the west side of terra firma and will consist of a high-rise residential building spanning over the Highline. The tower will be supported by a core northeast of the Highline and two mega columns southwest of the Highline. A cellar is limited to the core area northeast of the Highline. Maintenance space will occupy the ground and platform levels, and a residential lobby will occupy the plaza level. The full tower footprint will span over the Highline above the plaza level.

Tower 5 will be designed in accordance with the 2014 New York City Building Code (NYCBC). The design team has not been selected.

5.2 Tower 6

Tower 6 will be on the east side of the site between the Highline and LIRR South Access Road and will consist of a high-rise building with residential, retail, and school spaces. The building will have a single cellar level for use as parking and utility space. Retail space, a school, maintenance facilities, and parking will occupy the ground level and extend under the Highline to provide frontage along West 30th Street. A portion of the school and additional parking will occupy the platform level. Portions of the school, retail space, and a residential lobby will occupy the plaza level. The tower will contain residential units.

Tower 6 will be constructed over, and will be partially supported by the Amtrak Gateway tunnel Segment 3 (to be constructed).

Tower 6 will be designed in accordance with the NYCBC. The design team has not been selected.

5.3 Terra Firma Platform

The proposed development includes construction of a two-level platform over part of terra firma outside of the towers, north of the Highline. Utility, HVAC, maintenance facilities will occupy the platform level. Public space and a school playground will occupy the upper, plaza level.

The terra firma platform will be designed in accordance with the NYCBC.

5.4 LIRR Building C

A two-story LIRR support building (“Building C”) will be constructed below the platform and between towers 5 and 6. Building C will have a single cellar level.

The LIRR building will be designed in accordance with the 2015 New York State Building Code (NYSBC) with applicable Uniform Code supplements through 2017.

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 site and should be anticipated during construction.

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

7 LOCAL GEOLOGY

7.1 Bedrock Geology

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. The original topography of Manhattan typically mimicked the contours of the underlying bedrock; although the current topography has been altered by urban development.

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. 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 traversed the site prior to historic 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 in Figure 10.

8 FEMA Flood Zone

The Federal Emergency Management Agency (FEMA) Primary Flood Insurance Rate Map (PFIRM), plate 3604970009G, shows the site is partially within Zone AE and shaded Zone X. The Zone 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 shaded Zone X designation corresponds to areas subject to inundation by 0.2% annual chance flood. The FEMA base flood elevation varies from el 11 to 12 ft within terra firma. 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, NYSBC, 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 for NYCBC job filings. Two feet of freeboard must be provided for filings made under the NYSBC in accordance with the 2016 Uniform Code Supplement (Section 1612.4.1). We understand that Related has elected to use a design flood of el 15 ft (3+ feet of freeboard).

We understand LIRR is designing a floodwall to protect the West Rail Yard. We recommend that LIRR be consulted to determine any special floodproofing requirements for Building C.

9 Subsurface Data

Subsurface data for the site was derived from numerous investigations performed within and adjacent to the site. 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 Test Caisson Borings (2017)

A geotechnical subsurface investigation was performed within terra firma before caisson load tests. This investigation included three geotechnical test borings and laboratory testing of collected samples.

9.1.1 Borings

The test caisson borings (identified as LB-1 through LB-3) were drilled by Craig Geotechnical Drilling Co., Inc. from 23 October to 3 November 2017 with a CME 75 truck-mounted drill rig. The borings were advanced to about 60 to 170 feet below grade.

Each boring was cleared of utilities using a vacuum truck. The borings were advanced through overburden using mud-rotary drilling techniques with tri-cone roller bits and drilling fluid consisting of a mixture of bentonite 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[2] and visual soil classifications were recorded by Langan's engineers. Soils were sampled using a 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.

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[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.

[2] 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 free falling from a height of 30 inches.

Rock core recovery (REC)[1] and rock-quality designation (RQD)[2] 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 Laboratory Testing

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

- Natural Water Content (21 tests) [ASTM D 2216]
- Liquid and Plastic (Atterberg) limits (21 tests) [ASTM D 4318]
- Organic Content (21 tests) [ASTM D 2974]
- Unconsolidated Undrained (UU) Triaxial Test (12 tests) [ASTM D 2850]

9.2 Proposed New York Sports and Convention Center (2004)

A geotechnical subsurface investigation was performed within the WRY for the proposed New York Sports and Convention Center (NYSCC) in 2004. This investigation included 29 geotechnical test borings and 24 cone penetration tests (CPT) in the WRY, with 14 test borings and five CPTs within terra firma. A laboratory test program was also conducted as part of the project.

9.2.1 Borings

The NYSCC borings (identified as G-#) were drilled within and adjacent to the WRY by Warren George Inc. from 11 October to 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 about 53 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 SPT was performed in general accordance with ASTM D1586. SPT N-values and visual soil classifications were recorded by Langan’s engineers. Soils were sampled using a 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.

The REC and RQD values 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.

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[1] Rock core recovery (REC) is defined as the length of all core pieces recovered divided by the total core run length.

[2] 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.

9.2.2 Cone Penetration Testing

Cone penetration testing (CPT) within terra firma included five seismic CPTs (identified as SCPT-#). All cone-penetration testing was performed in accordance with ASTM D3441, by ConeTec, Inc. from 11 October to 19 November 2004. All of the test locations were pre-drilled to depths of about 10 feet to clear for utilities. Where obstructions were encountered in the fill, the driller returned to the CPT location and performed additional pre-drilling through the fill to allow the CPT to proceed. The CPTs were pushed to refusal, encountered at from about 40 to 82 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 CPT cone measures penetration tip resistance, side friction, and pore water pressure at 5 cm (about 2 inch) intervals as well as shear-wave velocity; a total of 86 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.

9.2.3 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 full laboratory test results for the WRY (platform and terra firma) are included in Appendix C. The testing 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]

9.3 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 and the test caisson study. In general, the reported subsurface conditions correlate well with our 2017 and 2004 studies, 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
Amtrak Gateway Segment 3	Trans-Hudson Partnership	2017

10 SUBSURFACE CONDITIONS

The general subsurface stratigraphy at terra firma 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. A subsurface profile is attached as Figure 13.

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 13 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 about 1 to more than 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.

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

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

A stratum of organic clay and clay and silt underlies 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 to -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).

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

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 organics. 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 21 blows per foot. Values in excess of 10 blows per foot are likely attributed to inclusions of debris near the interface with the fill, or wood or sand lenses within the silt-clay layer.

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 -24 to -88 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 about 30 feet thick. N-values in the sand ranged from WOH to 27 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 about 2 to 8 feet. N-values in the glacial till varied were more than 100 blows per foot. The high SPT N-values were likely caused by the presence of gravel, cobbles, and boulders. The glacial till appears to be more prevalent on the west 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 -22 to -131 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 about 33 to 100 percent. Rock quality designations (RQD) varied from 17 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 observed in fractures in some of the 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 about el 3.9 ft to as low as el -1.5 ft, but are generally expected to vary from about el 0 to 2 ft. Groundwater is expected to be tidally influenced along the west side of the site because of the proximity to the Hudson River. In addition, groundwater is 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.

11 Index Load Tests

Design phase axial and lateral load tests were performed in January 2018 on test caissons in the east, center and west areas of terra firma. Three axial and three lateral tests were completed (one in each zone). The purpose of the tests was to determine caisson design parameters including rock socket allowable peripheral side shear and end bearing, and p-y springs for lateral analysis.

Our evaluation of the axial load tests is summarized in our technical memorandum dated 4 April 2018, included as Appendix E. The main conclusions from the axial tests were that an allowable peripheral side shear of 300 psi in compression is justifiable (higher than the NYCBC presumptive value of 200 psi for bedrock) and that end bearing should be ignored because the bottoms of the sockets will likely be difficult to clean.

Our evaluation of the lateral load tests is summarized in our technical memorandum dated 17 July 2018, included as Appendix F. The main conclusions from the lateral tests were that the lateral caisson response was primarily controlled by the historical fill (thickness and density) and the caissons are not sensitive to the underlying clay or depth to bedrock. The results of the load tests were used to calibrate software models for caisson design.

12 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).

12.1 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 because of the potential for liquefaction. The Site Class F designation 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. The study is presented as Appendix G.

Site-specific total and effective stress analyses were performed using the pertinent boring and CPT data for towers 5 and 6 shown in Figure 14. These analyses indicate the site’s design spectrum falls below the 80 percent of Site Class E envelope (minimum spectrum permitted by code) for both zones.

We understand the proposed structures at terra firma are 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 both zones. Seismic design parameters are presented in Table 3. The recommended design response spectra are presented in Figure 15.

Although a site-specific study was not performed for Building C, the results at towers 5 and 6 both yielded the code minimum design response spectrum; therefore, we also recommend the same spectrum for Building C.

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 recommended excess pore pressures for design range from 40 percent at Tower 6 to 65 percent at Tower 5, as discussed in the site-specific seismic study (Appendix G). As such, we recommend that the foundations be designed to accommodate reduced bearing and lateral resistance by corresponding reductions in shear strength.

Table 3: Seismic Design Parameters

Parameter	Design Value
Site Class	E
Spectral Acceleration at short periods, SDS	0.359 g
Spectral Acceleration at 1-sec period, SD1	0.136 g
Risk Category	III
Seismic Design Category, SDC	C

12.2 Design and Construction Considerations

12.2.1 Tower 5 and 6

The following bullets briefly summarize significant design and construction considerations for towers 5 and 6.

- The design and construction of towers 5 and 6 is subject to the requirements of the NYCBC.
- In addition to LIRR, the tower design and construction will be subject to review and approval of Amtrak (Gateway Tunnel), MTACC/NYCT (No. 7 Line subway), NYCDOT (Eleventh Avenue 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 to 12 ft. Areas of Tower 5 and 6 below design flood level (project chosen el 15 ft) must be floodproofed in accordance with the NYCBC and ASCE 24.
- Groundwater generally varies from about el -1.5 to 2 ft. Temporary dewatering will be necessary for construction of the cellars and installation of utilities, pile caps, tie-beams, etc.
- The subsurface conditions within the site are relatively poor and necessitate a deep foundation system for much of the proposed structure. Drilled caissons will generally be required to support the towers given the anticipated high axial and lateral loads. Lightly loaded retail structures below the Highline at Tower 6 may be supported by drilled mini-caissons.
- Segment 3 of the Amtrak Gateway tunnel will pass below Tower 6 and portions of Tower 6 are expected to bear directly atop the Gateway tunnel. The overbuild loads on the tunnel roof must not exceed the established allowable bearing pressures dictated by Amtrak. We understand that the tunnel will not accommodate lateral loads from Tower 6. Foundations outboard of the tunnel will be subject to Amtrak's project-specific requirements with respect transfer of loads, influence lines, and construction means and methods.
- Pre-production axial load tests indicate that an allowable peripheral side shear of 300 psi can be used for design of the caissons.
- The potential for excess pore pressure development during seismic events will reduce the lateral capacity of caissons at the site, with greater softening potential at Tower 5 (refer to Appendix G).

- Tie-beams between adjacent caissons are required because the site classifies as Seismic Design Category C. Excavations for tie-beams may require utility relocations, and support and protection of adjacent structures such as the Highline and the Eleventh Avenue viaduct abutment.
- Excavation will extend below groundwater and temporary construction dewatering will be required. Support of excavation systems should consider the need to mitigate groundwater pumping and reduce the potential for affecting groundwater and stress conditions in areas outside of the excavation. Therefore, we recommend a continuous wall system such as interlocking sheet piling, secant walls, or soil-mix walls, etc. to provide groundwater cutoff.
- Protection of adjacent structures will be necessary during construction, particularly the Highline, Gateway Tunnel and the Eleventh Avenue abutment. A detailed monitoring program is necessary to evaluate the performance of the SOE, adjacent structures, the ground, and existing tunnels during tower construction. The monitoring program will be subject to review and approval of Amtrak, MTACC/NYCT, LIRR, NYCDOT, and Friends of the Highline.
- Means and methods to construct caissons must mitigate potential for soil loss and disturbance.
- The rail yard north of the site will remain active during tower construction and will require close coordination with LIRR.
- Floor slabs and walls of permanent structures below the design flood elevation must be designed to resist hydrostatic pressures.
- Ground anchors may be required where sufficient dead load is not present to accommodate hydrostatic forces from either static groundwater or design flood conditions.

12.2.2 LIRR Building C

The following bullets briefly summarize significant design and construction considerations for the LIRR Building C.

- Design of LIRR Building C is subject to the requirements of the NYSBC with all applicable Uniform Code supplements.
- Drilled caissons, mini-caissons or driven piles are considered feasible for support the LIRR support buildings; however, we understand that a combination of caissons and mini-caissons are anticipated. Shallow foundations are not considered suitable given the poor soils and 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.
- Excavation will extend below the groundwater table and temporary construction dewatering will be required. The support of excavation system should consider the need to mitigate groundwater pumping and reduce the potential for affecting groundwater and stress conditions in areas outside of the excavation. Therefore, we recommend a continuous wall system such as interlocking sheet piling, secant walls, or soil-mix walls, etc to provide groundwater cutoff.
- Floor slabs and walls of permanent structures below the design flood elevation must be designed to resist hydrostatic pressures.
- Ground anchors may be required where sufficient dead load is not present to accommodate hydrostatic forces from either static groundwater or design flood conditions.

13 Design Recommendations

13.1 Drilled Caissons

We recommend that Tower 5, Tower 6, and Building C be supported by drilled caissons. Lightly loaded parts of Tower 6 (under the Highline) and Building C can be supported by smaller diameter mini-caissons. Note that NYSBC terminology varies from the NYCBC and that the NYSBC describes caissons as “socketed drilled shafts” and mini-caissons as “micropiles”. We will use the NYCBC nomenclature of “caissons” and “mini-caissons” herein.

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. We recommend that the caisson rock sockets be proportioned assuming an allowable peripheral bond stress of 300 pounds per square inch (psi) for compression and 100 psi for uplift. We recommend that end bearing be ignored because obtaining a suitably clean bottom will be difficult at the anticipated depths (as observed in the test caissons). The recommended design values assume rock meeting NYCBC Class 1c or better for rock socket sidewalls. 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).

Preliminary plans by MRCE indicate caissons and mini-caissons varying from 9-5/8 to 24-inch in diameter, with service loads up to about 980 kips, will support LIRR Building C. Caisson service loads and diameters for towers 5 and 6 have not been developed.

Caissons should be designed to accommodate the combined effects from axial loading and bending. Short caissons may be prone to develop a plastic hinge at the soil-rock interface. The shear capacity of such elements should be evaluated and where required, additional shear reinforcing should be provided or the casing should be seated deeper into rock. The effects of excess pore water pressure during seismic loading should be considered when evaluating the lateral capacity of the caissons by corresponding reductions in shear strength.

13.1.1 Caisson Load Tests

13.1.1.1 Axial Load Tests

As discussed prior, three pre-production axial load tests were performed to evaluate the potential for increasing the peripheral side shear in excess of the presumptive values identified in the NYCBC. Additional axial load tests will be required to meet the requirements of the NYCBC and substantiate the recommended 300-psi peripheral shear. We estimate that at least three additional tests will be required assuming that caissons can land within about 76,000 square feet of the site area. We recommend that the tests be distributed such that at least one test be performed within the footprint of each tower.

13.1.1.2 Lateral Load Tests

Although pre-production lateral load tests were perform as part of the design additional lateral load tests will be required for production caissons per the NYCBC. At least two lateral load tests are required for each caisson diameter and 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 use 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. Lateral load tests must be performed in accordance with ASTM D3966.

13.1.2 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.

13.1.3 Caisson and Mini-Caisson Drilling

Caisson installation methods must prevent loss of ground and minimize vibrations. Drilling of the caissons through soil 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 drilling fluid be maintained during drilling. Where required a mineral or polymer slurry should be provided to improve stability. In addition, we recommend the drill stem be kept a minimum of 1 foot inside the casing while drilling through overburden soils to minimize the potential for bottom heave or running-sand conditions. A concrete plug may be necessary to seal the casing to rock in areas with steeply sloping or fractured rock.

A down-the-hole hammer will be required to efficiently drill the rock socket. Caissons should be flushed using water or compressed air (or other approved methods) after completing rock socket drilling to remove all debris from the bottom of the rock socket. Thorough cleaning of the bottom of the rock socket is critical for caissons designed with end-bearing. As discussed above, because of the difficulty in achieving a clean bottom at the anticipated socket depths over 100 feet we recommend neglecting end bearing in the design.

Obstructions, such as remnant foundations or bulkheads, and debris in the historical fill, should be anticipated throughout the site. The Contractor must 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.

13.1.4 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 and 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.

13.1.5 Centralizers

All reinforcing steel must be centered within the caisson or mini-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.

13.1.6 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 duration of the pour. We recommend self-consolidating concretes.

13.1.7 Foundation Settlement

Caissons and mini-caisson settlement will generally be about equal to elastic shortening.

13.1.8 Minimum Clearances (Amtrak and MTA Tunnels)

Coordination with Amtrak and the MTA will be required to determine the minimum allowable clear distances (lateral and vertical) between caissons or mini-caissons and tunnels. Lateral clearances to the No. 7 Line subway are not expected to govern as the tunnels are greater than 10 feet beyond the east property line.

Finite element method (FEM) analyses will be necessary to demonstrate that the caissons do not negatively impact the tunnels and justify the vertical location of rock socket bond zones relative to the existing tunnels.

The bond zones for caissons adjacent to the Gateway tunnel must be located below a theoretic influence line starting at the tunnel invert and projecting outward 10 feet, upward vertically 10 feet, and then upward at an inclination of 1V:1H. Caissons adjacent to the No. 7 Line should be assumed to have bond zones starting at a minimum depth of 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 before drilling.

13.1.9 Plumbness Monitoring

We recommend that all caissons and mini-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).

13.1.10 Bond Breaker

Bond breakers may be necessary to prevent shedding loads onto the Gateway tunnel. The specific requirements for bond breakers should be determined by Amtrak, 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.

13.2 Floor Slabs

Floor slabs and sump pits should be designed as structural pressure slabs assuming hydrostatic uplift corresponding to the design flood elevation. 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.

13.3 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 4 should be used for the design of lateral earth pressure loads on restrained below grade walls.

Table 4: 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	Towers 5 and 6: Project Design Elevation, el 15 ft Building C: As directed by LIRR

13.4 Permanent Groundwater Control

We recommend that all walls and slabs of the towers 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., Sika Corporation, 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 before placing concrete.

14 Construction Recommendations

14.1 Excavations

Excavations will extend to about 15 to 20 feet below existing site grades for construction of the proposed cellars, with localized deeper pits. Additionally, 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.

Temporary excavation support should be installed as per the recommendations presented herein. Smaller excavations (e.g. utilities, etc.) may be benched or sloped in accordance with applicable OSHA standards where appropriate, or use trench boxes or other temporary excavation support.

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 Excavation Support

Temporary excavation support will be required for the excavation of the core at Tower 5 and the cellars at Tower 6 and Building C. The excavation will extend below the groundwater table and the excavation support should be designed as an interlocking system extending into the clay to provide groundwater cut-off, and reduce groundwater pumping and draw down outside of the excavation limits.

We anticipate that the excavation support system will be a combination of interlocking steel sheet piling with internal bracing at Building C and Tower 5 and a secant pile wall tied into the Gateway Tunnel excavation support system at Tower 6.

Temporary excavation support may be needed for 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 5and 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 foot below the groundwater table (el 2 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 for construction equipment). Lateral surcharge pressure can be reduced to zero at a depth of 15 feet below ground surface.
- Lateral pressures from adjacent structures should be determined using elastic methods and should be added to the above loads.

- Temporary construction loads such as cranes and other equipment are not considered herein and must be assessed on a case-by-case basis.

Table 5: 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

The basement excavations will extend below groundwater, which was generally observed between el 2 to -1 ft; therefore, temporary construction dewatering will be required in all excavations below el 2 ft. We anticipate that dewatering can be accomplished with a well-point dewatering system or a deep well system. The use of sumps and trench drains may be possible in localized areas provided that necessary draw-down is limited to less than about 4 feet.

Given the porous nature of the existing fill soils and underlying native sand soils and proximity to the Hudson River, significant flow rates should be expected. The contractor's dewatering system should be adequate for maintaining a dry subgrade during normal operating conditions. The sheet pile excavation support system should be driven into the clay to help reduce lateral water flow beneath and into the base of the excavation. Joint sealer should be applied to the joints during driving to reduce the potential for water flow through the joints.

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 discharge does not meet water quality standards dictated by the regulatory agencies having jurisdiction.

14.4 Soil Subgrades

Floor slab, pile cap, and grade beam 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” because of wet conditions.

After 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 under slabs and around foundation walls, tie-beams and pile caps. 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 before 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. Areas which cannot be densified by compaction and areas containing appreciable amounts of deleterious debris (i.e. wood, organics, etc.) should be removed as directed by the inspecting Geotechnical Engineer and replaced with structural fill, CLSM, or lean concrete. All fill placement and compaction work must be performed in the presence of the inspecting Geotechnical Engineer.

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). 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. 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 contractor and 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 Highline,
2. the Eleventh Avenue viaduct,
3. the Gateway Tunnel, and
4. the MTA No. 7 Line subway.

We recommend that a dialog be established with all governing agencies before 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 construction.

14.8 Preconstruction Conditions Documentation

We recommend that preconstruction conditions documentation be performed on any structures to remain, about one month prior to the start of construction. Each agency will likely require documentation of their facilities. This would most likely include Highline, Eleventh Avenue viaduct, Amtrak Gateway tunnel, 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 excavation 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 and groundwater control 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.

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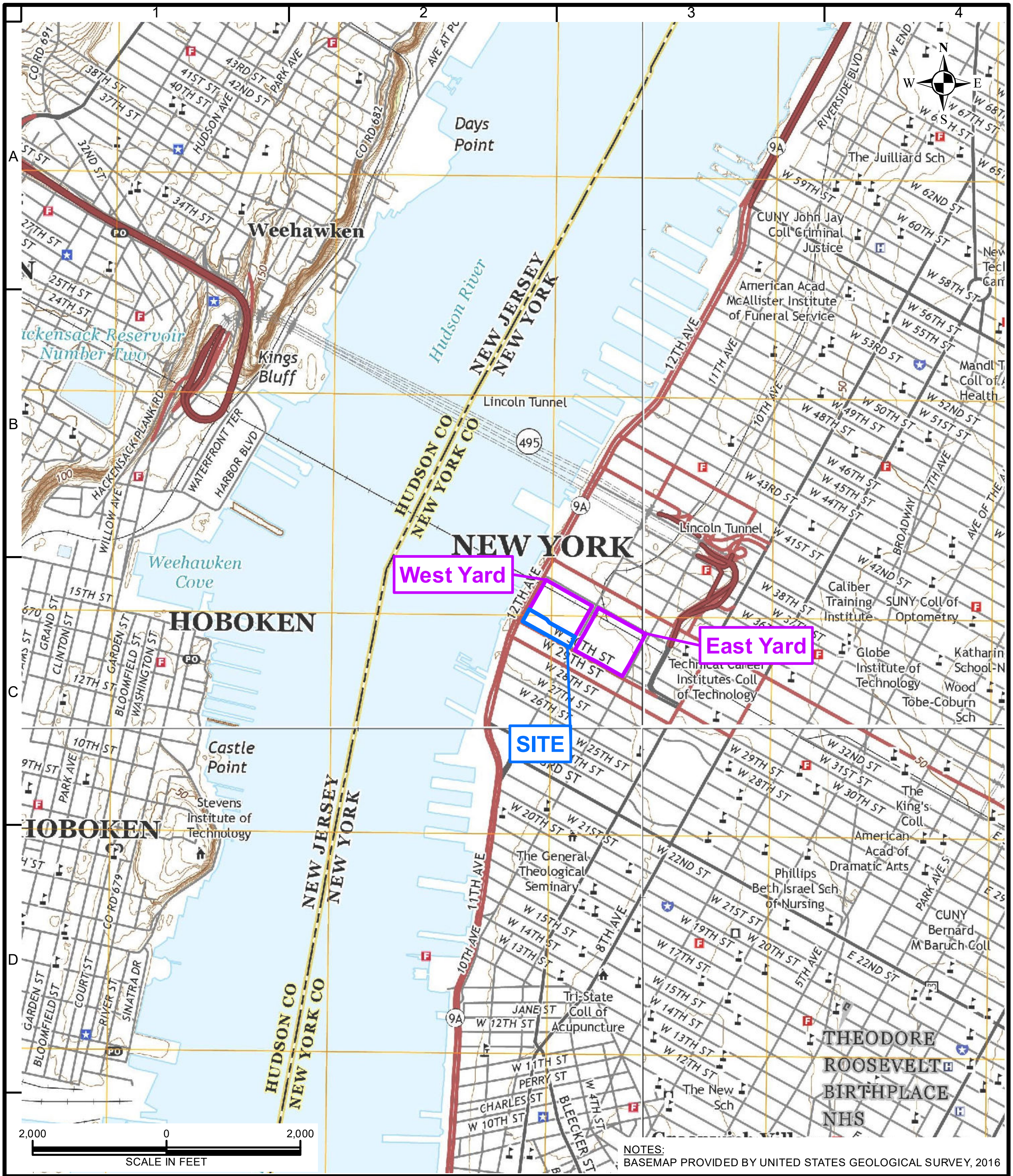
End of Report

FIGURES



NOTES:
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Langan International LLC
Collectively known as Langan

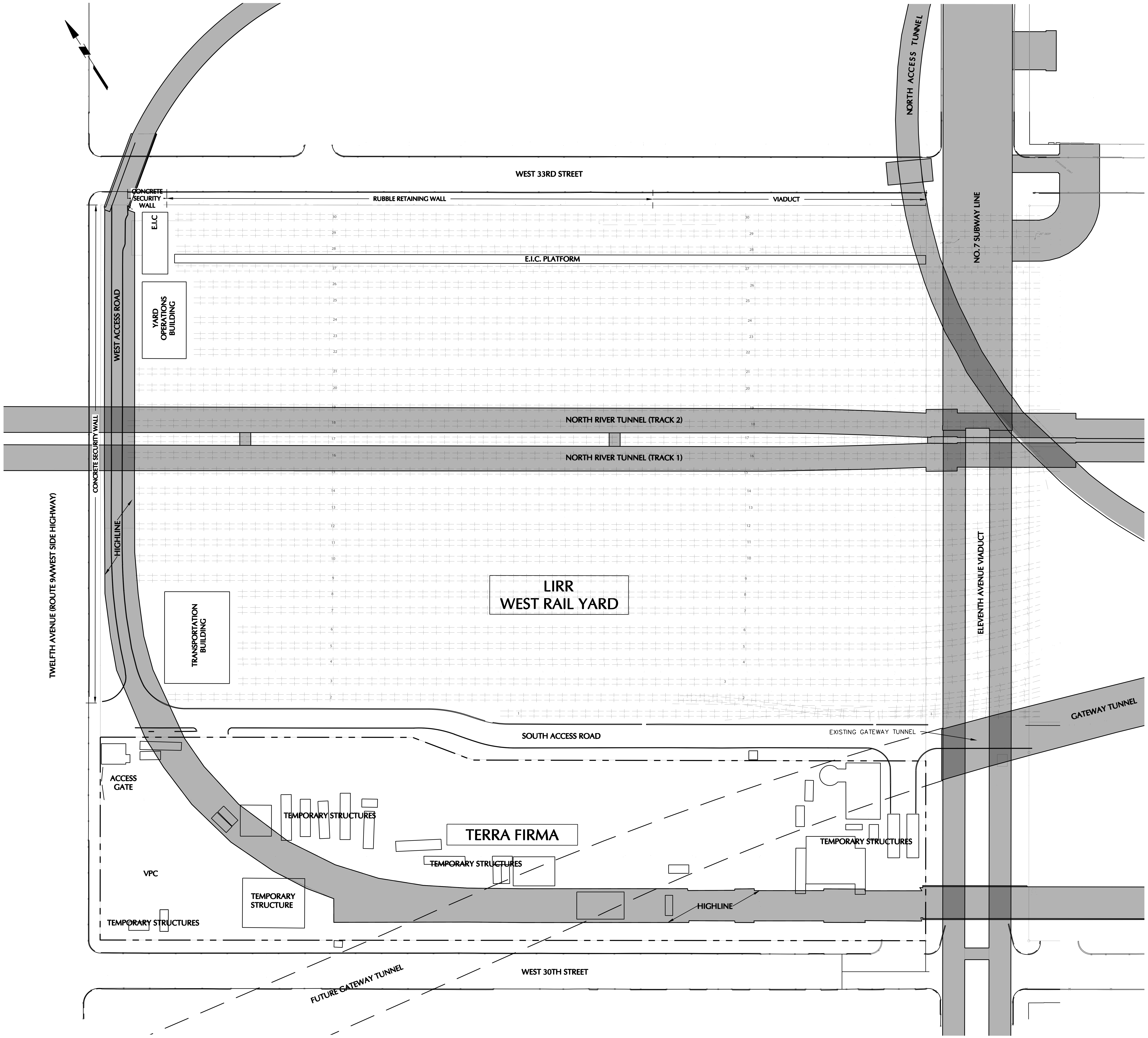
Project
WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
SITE LOCATION MAP

Project No.
170444101
Date
7/3/2018
Scale
1"=2000'
Drawn By
TKS
Submission Date
11/9/2018

Drawing
1
Sheet 1 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 1 - Site_Location_Map_Update.mxd



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING, LANDSCAPE ARCHITECTURE, AND GEOLOGY D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 15 JUNE 2018.
2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X-011, DATED 15 JUNE 2018.

LEGEND

— · — APPROXIMATE LIMITS OF PROPOSED TERRA FIRMA DEVELOPMENT

WARNING:
IT IS A VIOLATION OF THE NYS EDUCATION LAW ARTICLE 145 FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS ITEM IN ANY WAY.

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Project

WEST RAIL YARD
TERRA FIRMA

HUDSON YARD
MANHATTAN NEW YORK

Drawing Title

EXISTING
CONDITIONS PLAN

Project No. 170444101
Date 9/12/2018
Drawn By KM
Checked By MP
Drawing No. 2
Sheet 2 of 15

PROJECT NO. 170444101

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Geotechnical Report\Dwg 2. Existing Conditions Plan.dwg Date: 11/9/2018 Time: 09:09 User: jquintana 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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Project

WEST RAIL YARD
TERRA FIRMA

HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

HISTORICAL
SITE MAP
(W. BRIDGES, 1811)

Project No.
170444101

Date
7/3/2018

Scale
1"=1000'

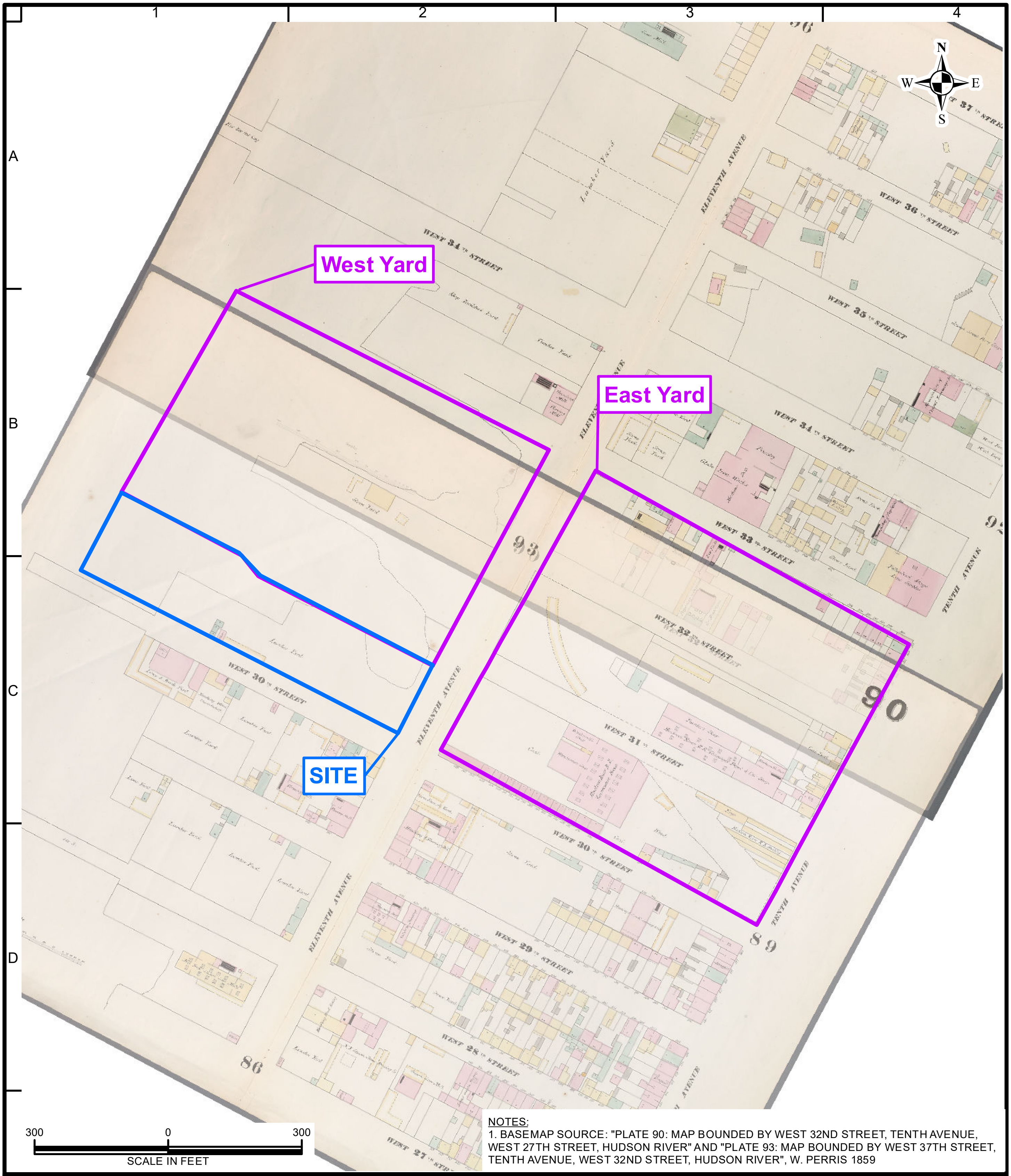
Drawn By
TKS

Submission Date
11/9/2018

Drawing
3

Sheet 3 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 3 - Historic Bridges Map_Update.mxd



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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WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS

MANHATTAN   NEW YORK

Drawing Title

HISTORICAL SITE MAP (Perris, 1859)

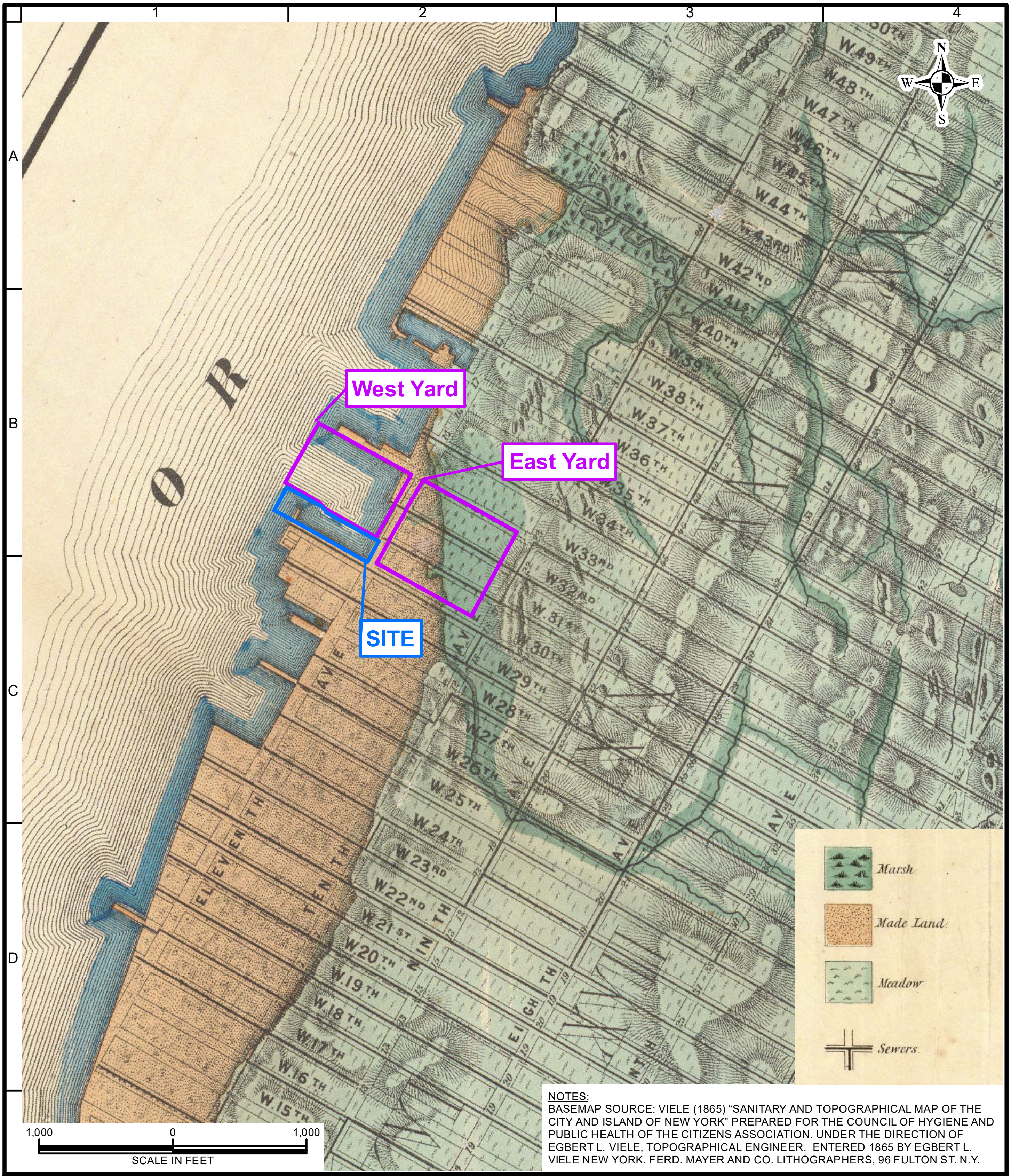
Project No.	170444101
Date	7/3/2018
Scale	1"=300'
Drawn By	TKS
Submission Date	11/9/2018

Drawing

4

Sheet 4 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 4 - 1859 W Perris_Update.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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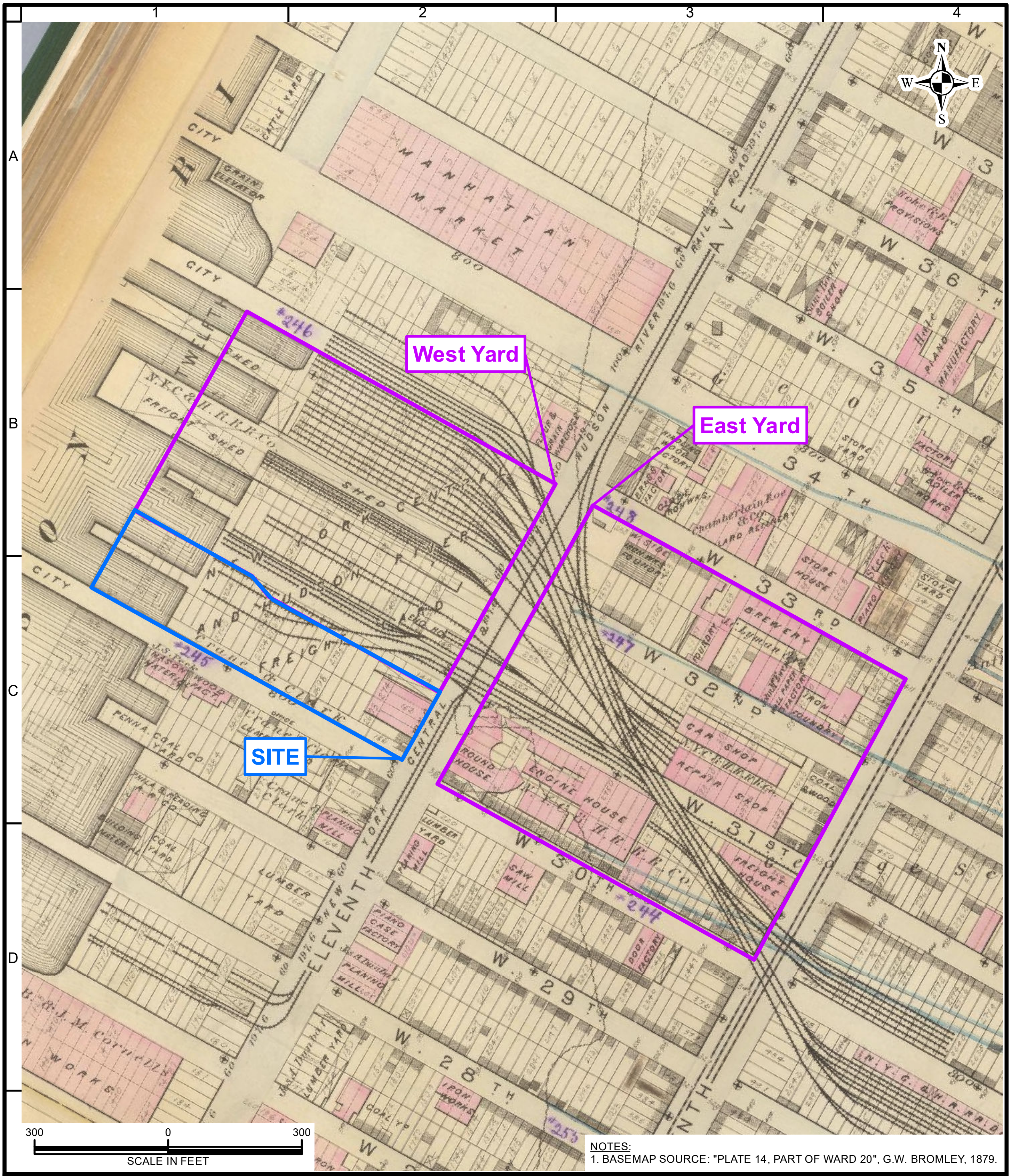
Project	WEST RAIL YARD TERRA FIRMA HUDSON YARDS MANHATTAN NEW YORK
Drawing Title	HISTORICAL SITE MAP (VIELE, 1865)
Project No.	170444101
Date	7/3/2018
Scale	1"=1000'
Drawn By	TKS
Submission Date	11/9/2018
Drawing	5
	Sheet 5 of 16

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 5 - Viele Map_Update.mxd



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

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WEST RAIL YARD
TERRA FIRMA

HUDSON YARDS

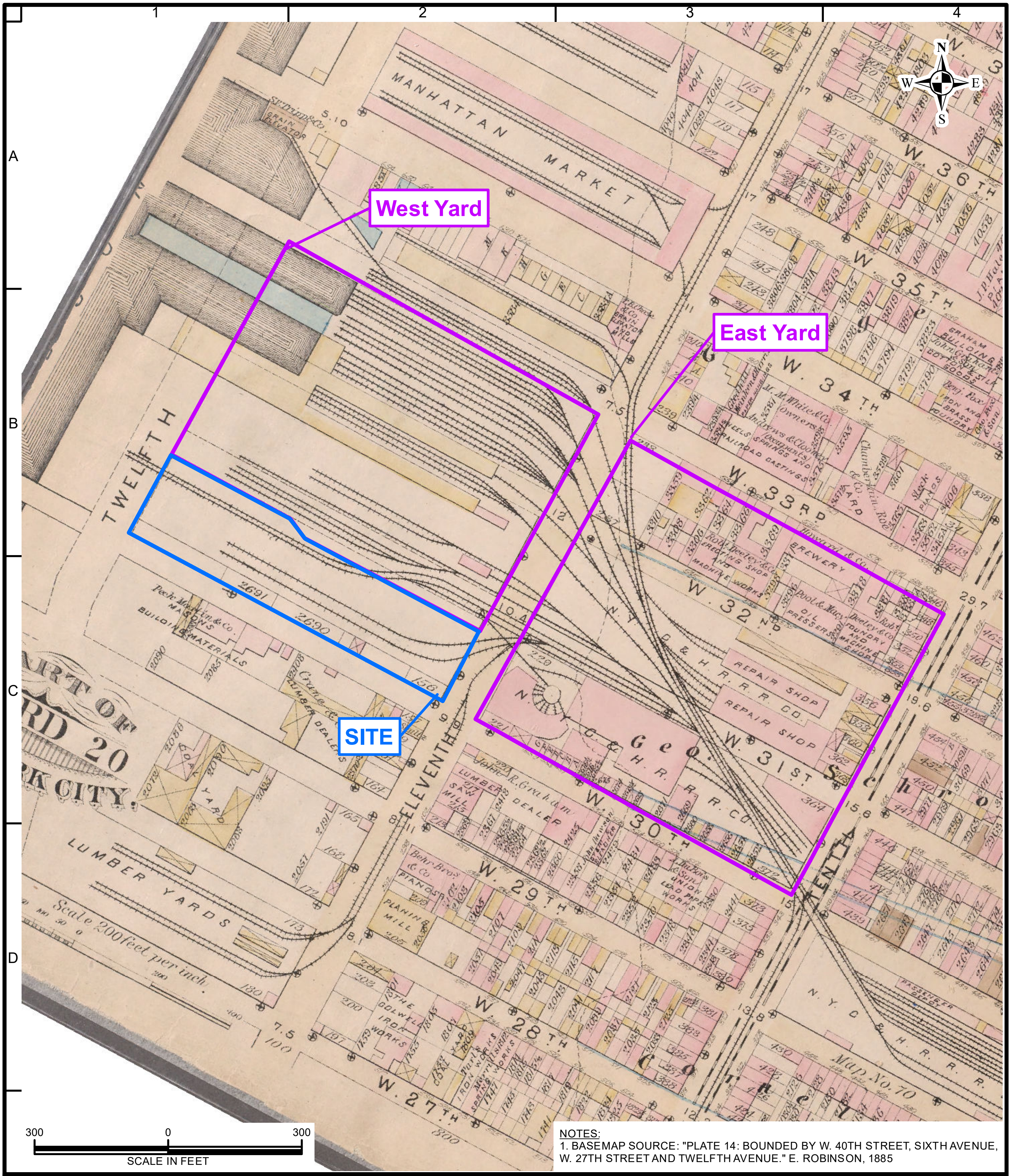
MANHATTAN NEW YORK

Drawing Title

HISTORICAL
SITE MAP
(BROMLEY, 1879)

Project No. 170444101	Drawing
Date 7/3/2018	6
Scale 1"=300'	
Drawn By TKS	
Submission Date 11/9/2018	Sheet 6 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 6 - 1879 Bromley_Update.mxd



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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WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

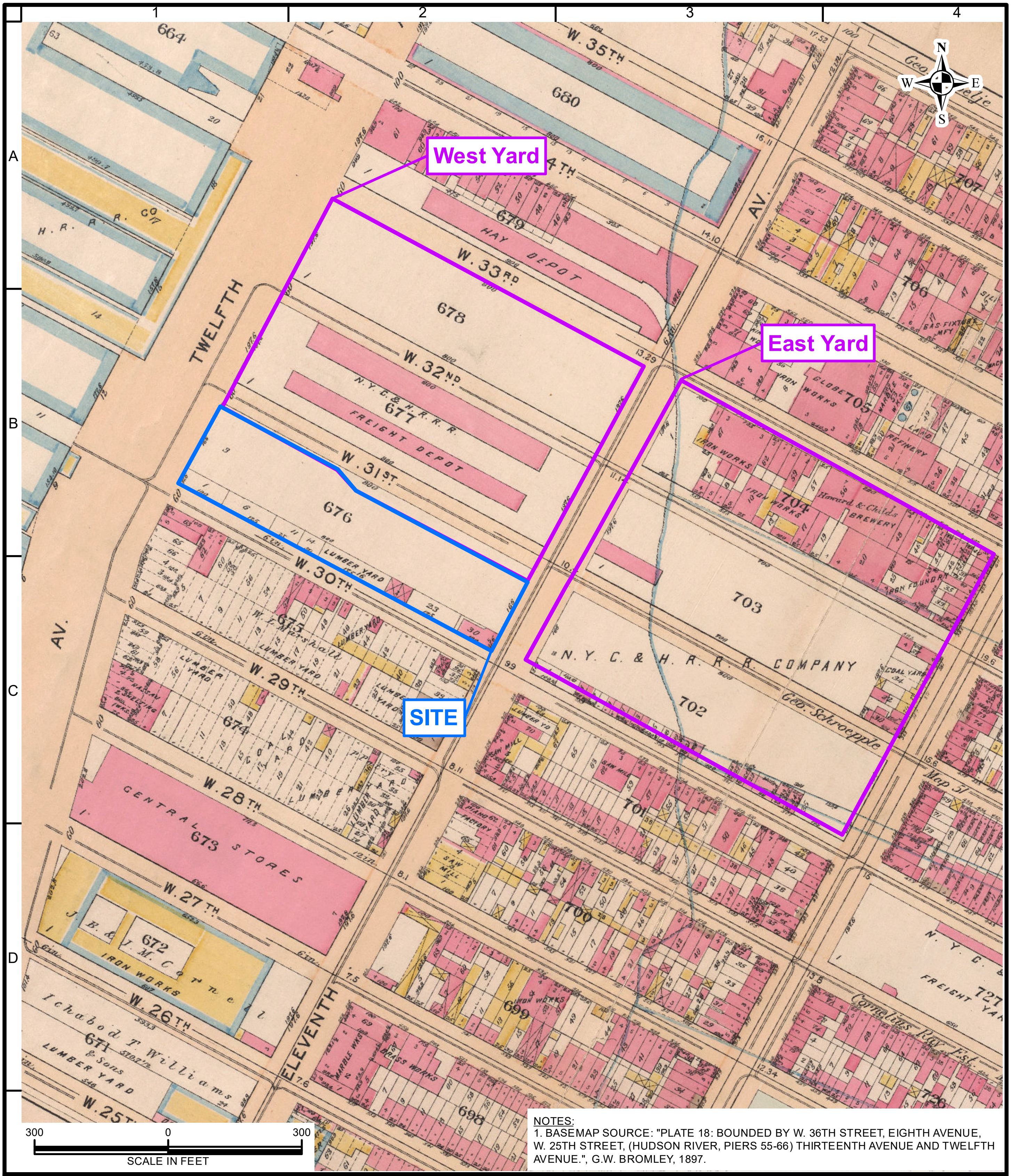
HISTORICAL
SITE MAP
(ROBINSON, 1885)

Project No.
170444101
Date
7/3/2018
Scale
1"=300'
Drawn By
TKS
Submission Date
11/9/2018

Drawing
7

Sheet 7 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 7 - 1885 Robinson_Update.mxd



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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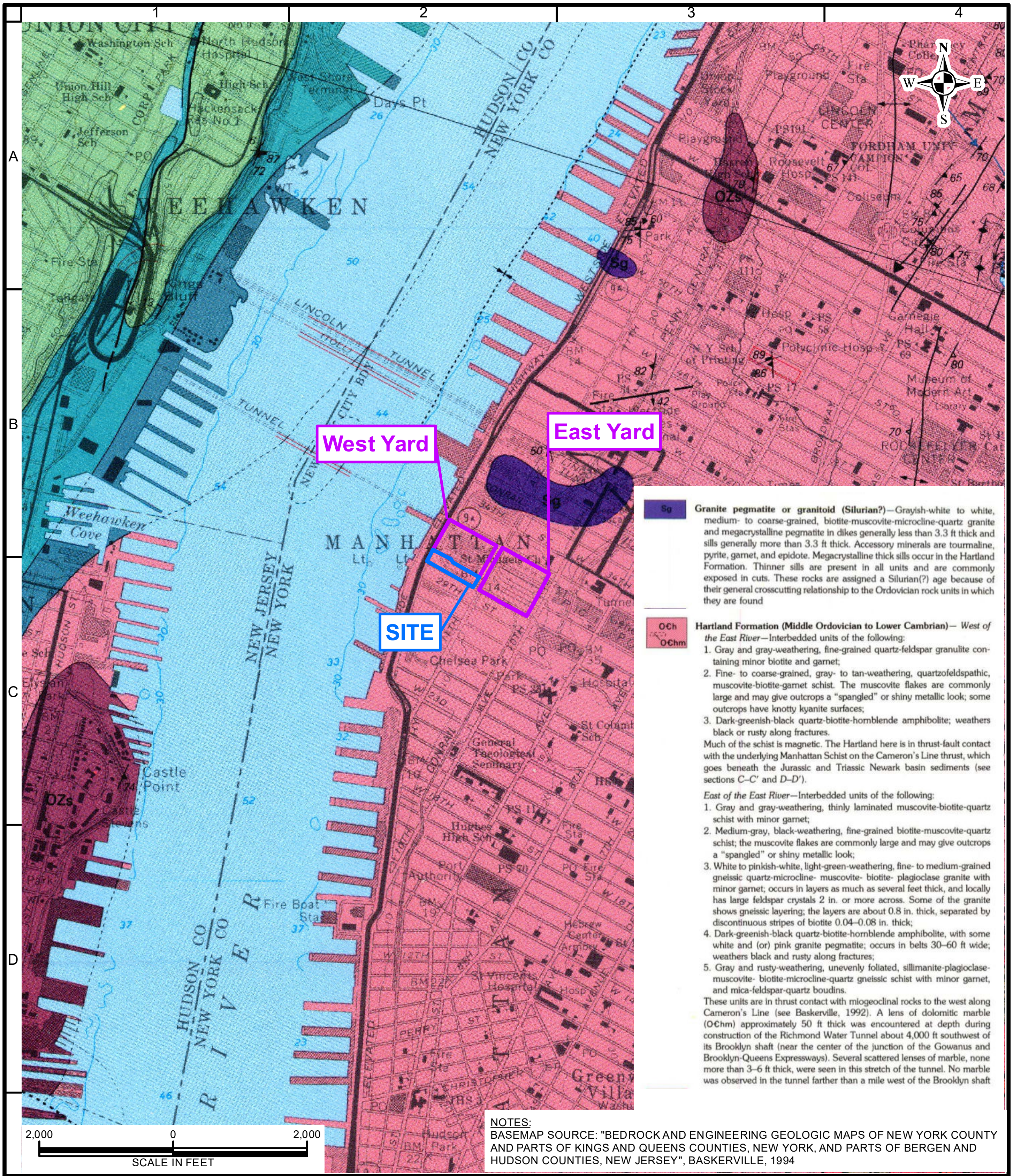
Project	WEST RAIL YARD TERRA FIRMA HUDSON YARDS MANHATTAN NEW YORK
Drawing Title	HISTORICAL SITE MAP (BROMLEY, 1897)
Project No.	170444101
Date	7/3/2018
Scale	1"=300'
Drawn By	TKS
Submission Date	11/9/2018
Drawing	8
	Sheet 8 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 8 - 1897 Current Shoreline_Update.mxd



Sg **Granite pegmatite or granitoid (Silurian?)**—Grayish-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

O€h / **O€hm** **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 (O€hm) 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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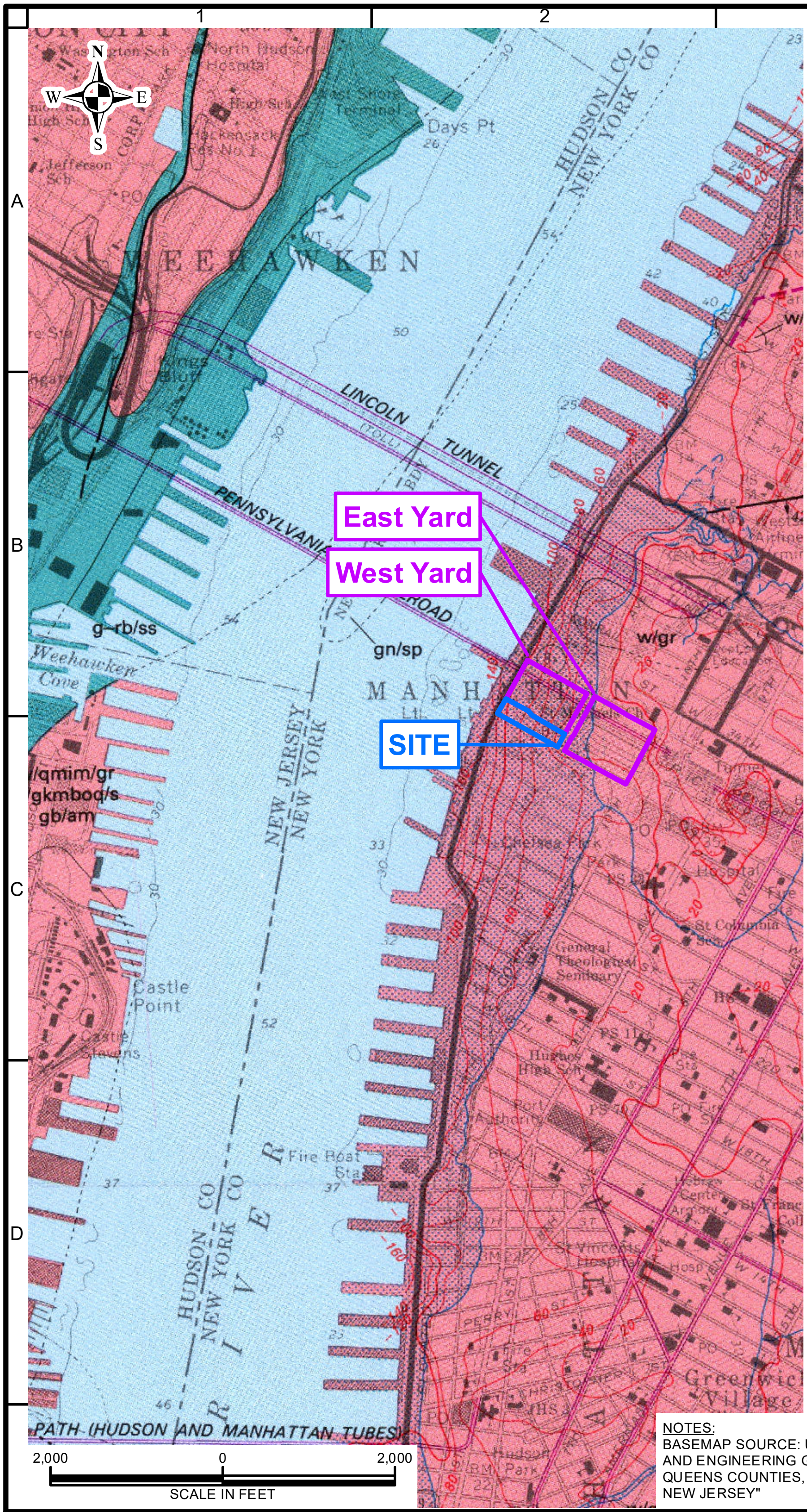
Project
WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
BEDROCK
GEOLOGY
MAP

Project No. 170444101
Date 7/3/2018
Scale 1"=2000'
Drawn By TKS
Submission Date 11/9/2018

Drawing
9
Sheet 9 of 15



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/mbp/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 (Fordham Gneiss, member C)
w/qmim/gr	White quartz-microcline-muscovite granite (Hartland Formation)
g/bmq/s	Gray biotite-muscovite-quartz schist (Hartland Formation)
g/mbq/s	Gray muscovite-biotite-quartz schist (Hartland Formation)
g/spm/s	Gray sillimanite-plagioclase-muscovite schist (Hartland Formation)
gb/am	Greenish-black amphibolite (Hartland Formation)
g/sgmi/g	Gray sillimanite-garnet-microcline gneiss (Ravenswood Granodiorite)
g/gps/g	Gray garnet-plagioclase-sillimanite gneiss (Hartland Formation, Pelham Bay Member)
g/spb/g	Gray sillimanite-plagioclase-biotite gneiss (Hartland Formation, Pelham Bay Member)
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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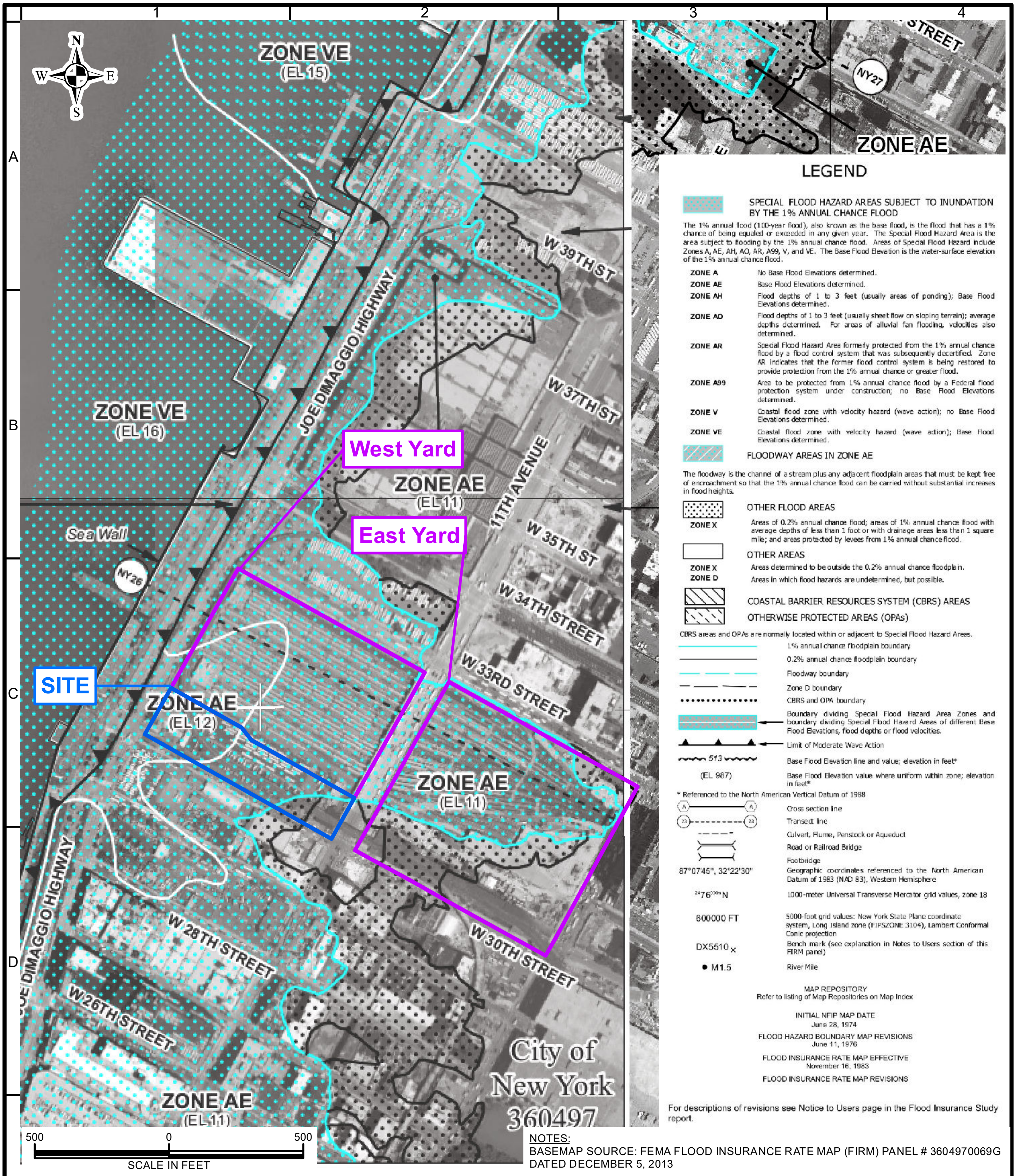
Project
WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
ENGINEERING
GEOLOGY
MAP

Project No. 170444101
Date 7/3/2018
Scale 1"=2000'
Drawn By TKS
Submission Date 11/9/2018

Drawing
10
Sheet 10 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 10 - Bedrock Geology Map_Update.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

A ── A	Cross section line
23 - - - 23	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
$^{24}76^{000m}$N	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

For descriptions of revisions see Notice to Users page in the Flood Insurance Study report.

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

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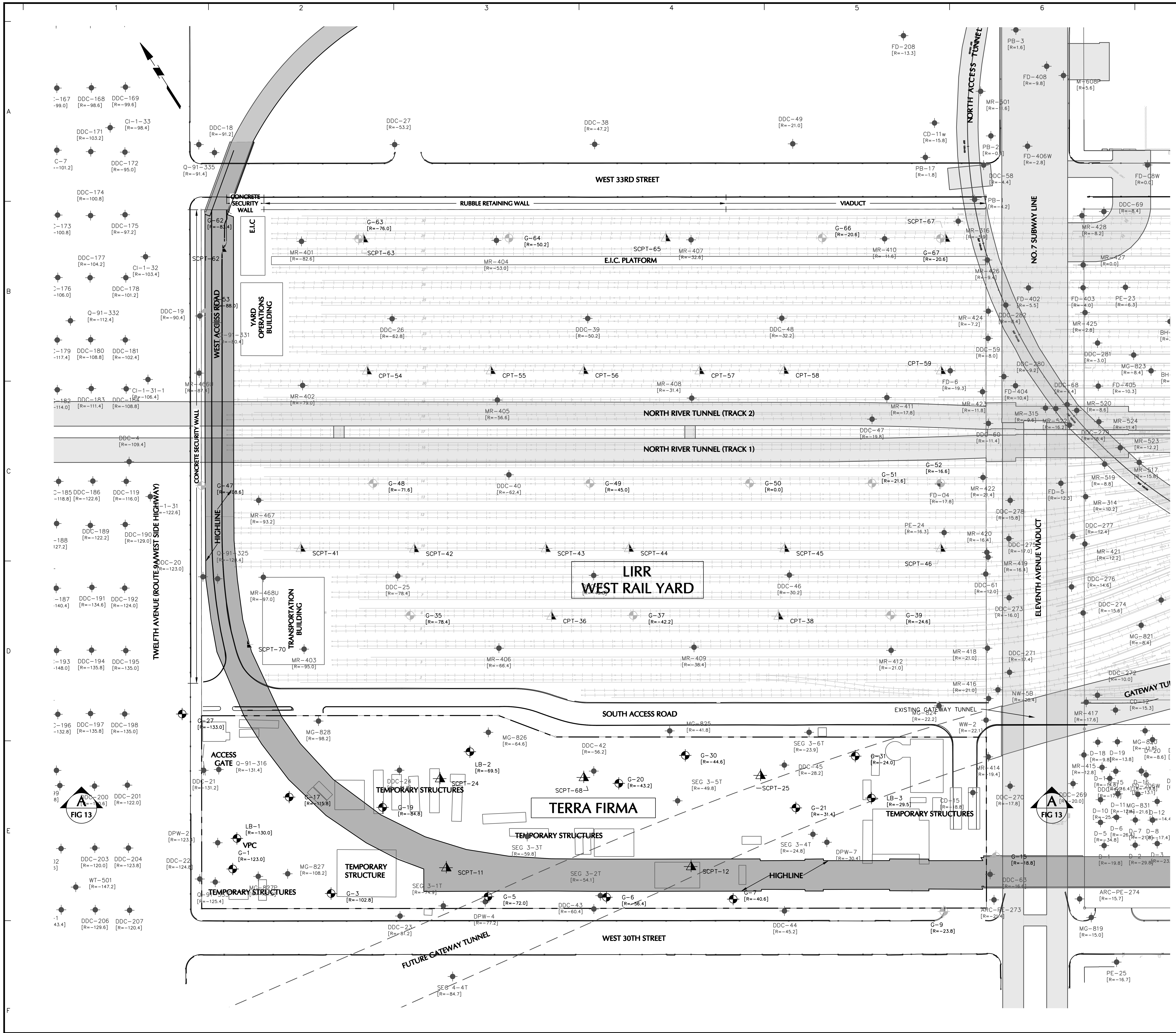
Project
WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
FEMA
PRELIMINARY
FLOOD INSURANCE
RATE MAP

Project No. 170444101	Drawing 11
Date 7/3/2018	
Scale 1"=500'	
Drawn By TKS	
Submission Date 11/9/2018	Sheet 11 of 15

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 11 - FEMA Map_Update.mxd



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING, LANDSCAPE ARCHITECTURE, AND GEOLOGY, D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 15 JUNE 2018.

2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X-011, DATED 15 JUNE 2018.

3. ELEVATIONS SHOWN HEREIN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) WHICH IS 1.676 FEET BELOW THE BOROUGH OF MANHATTAN DATUM (BPMD).

4. DATUM CONVERSIONS
   BPMD = NAVD88 – 1.676'
   NGVD29 = NAVD88 + 1.076'
   NYCT = NAVD88 + 98.423'
   PENN = NAVD88 + 298.351'

5. BORING, CPT AND TEST PIT LOCATIONS SHOULD BE CONSIDERED APPROXIMATE.

6. 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.

7. 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.

8. 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

⊕ LB-# ELEV (NAVD88)	LANGAN BORINGS 2017 APPROXIMATE ELEVATION (TOP OF ROCK)
⊕ 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 TERRA FIRMA DEVELOPMENT

LANGAN

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Project

WEST RAIL YARD TERRA FIRMA

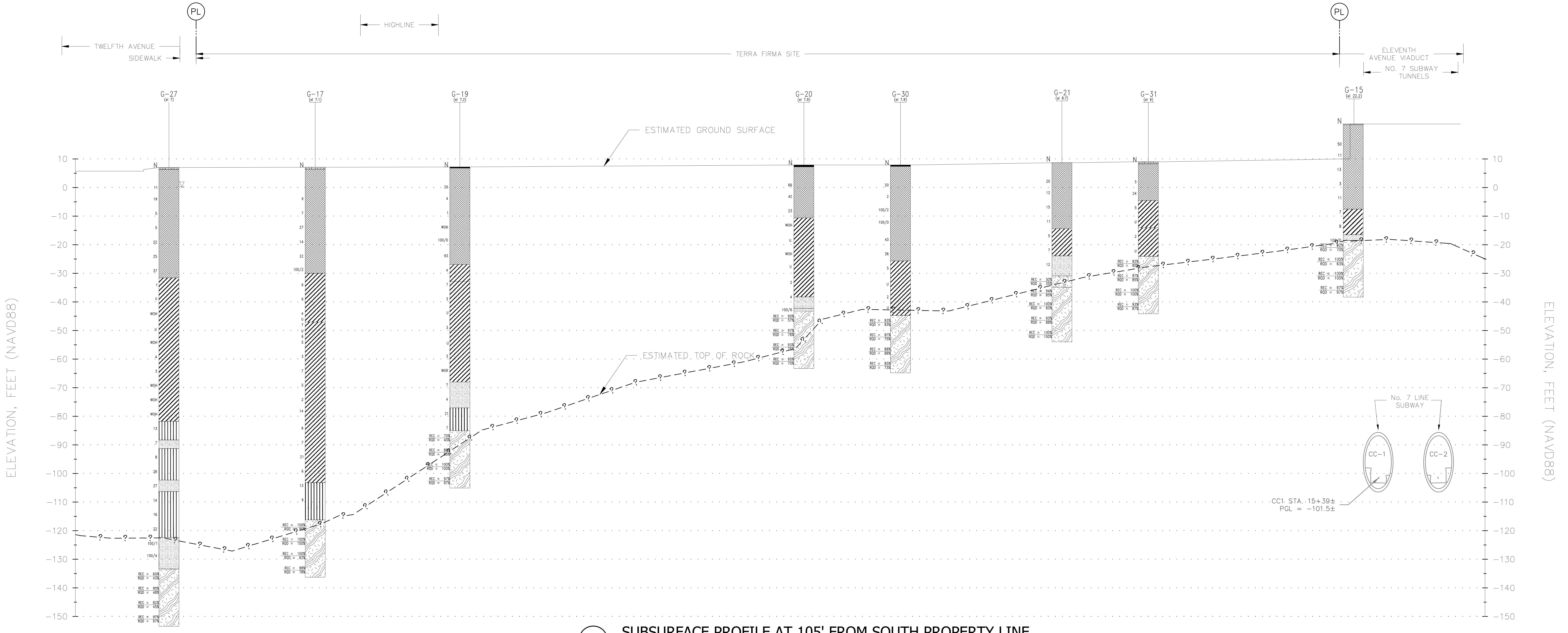
HUDSON YARD
MANHATTAN NEW YORK

Drawing Title

BORING AND CPT LOCATION PLAN

Project No. 170444101
Date 9/12/2018
Drawn By KM
Checked By MP
Drawing No. 12
Sheet 12 of 15

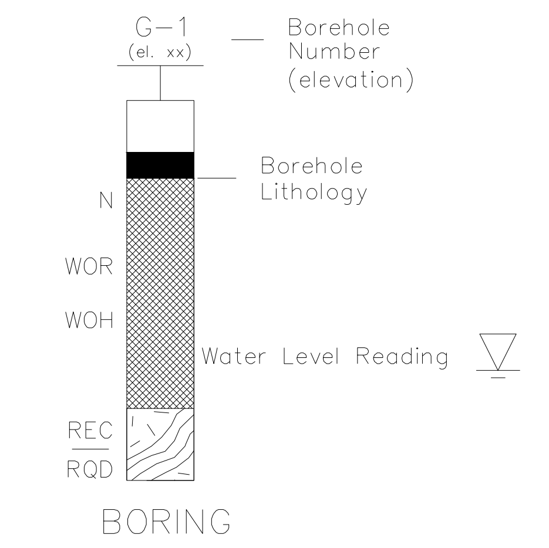
LANGAN
PROJECT NO. 170444101



(A) SUBSURFACE PROFILE AT 105' FROM SOUTH PROPERTY LINE

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

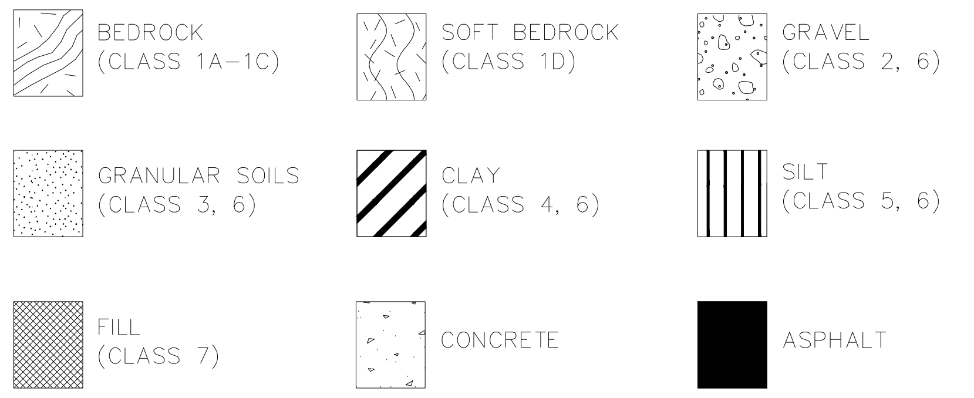
BORING KEY DIAGRAM



EXPLANATION OF BOREHOLE LITHOLOGY

N	STANDARD PENETRATION RESISTANCE; NUMBER OF BLOWS OF A 140 LB HAMMER FREE FALLING 30 INCH TO DRIVE A 2 INCH O.D. SPLIT SPOON SAMPLER 12 INCH, AFTER 6 INCH OF INITIAL PENETRATION.
WOR	2 FOOT 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	ROCK QUALITY DESIGNATION, (LENGTH OF ROCK 4 IN OR LONGER) / (LENGTH OF ROCK CORED) * 100%.

LITHOLOGY GRAPHICS



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 0.5 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 0.5 TSF.
- PEAT, ORGANIC SILT, ORGANIC CLAY, VARVED SILT.

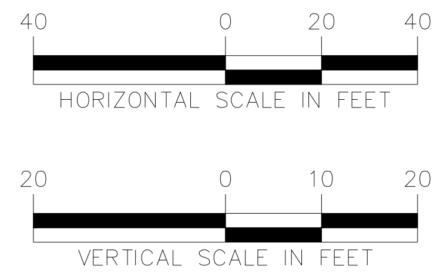
CLASS 7 – CONTROLLED AND UNCONTROLLED FILL
- ALL FILLS HAVING BEEN PLACED IN EITHER CONTROLLED OR UNCONTROLLED SETTINGS.

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.
7. THIS PROFILE REPRESENTS A GENERALIZED 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.



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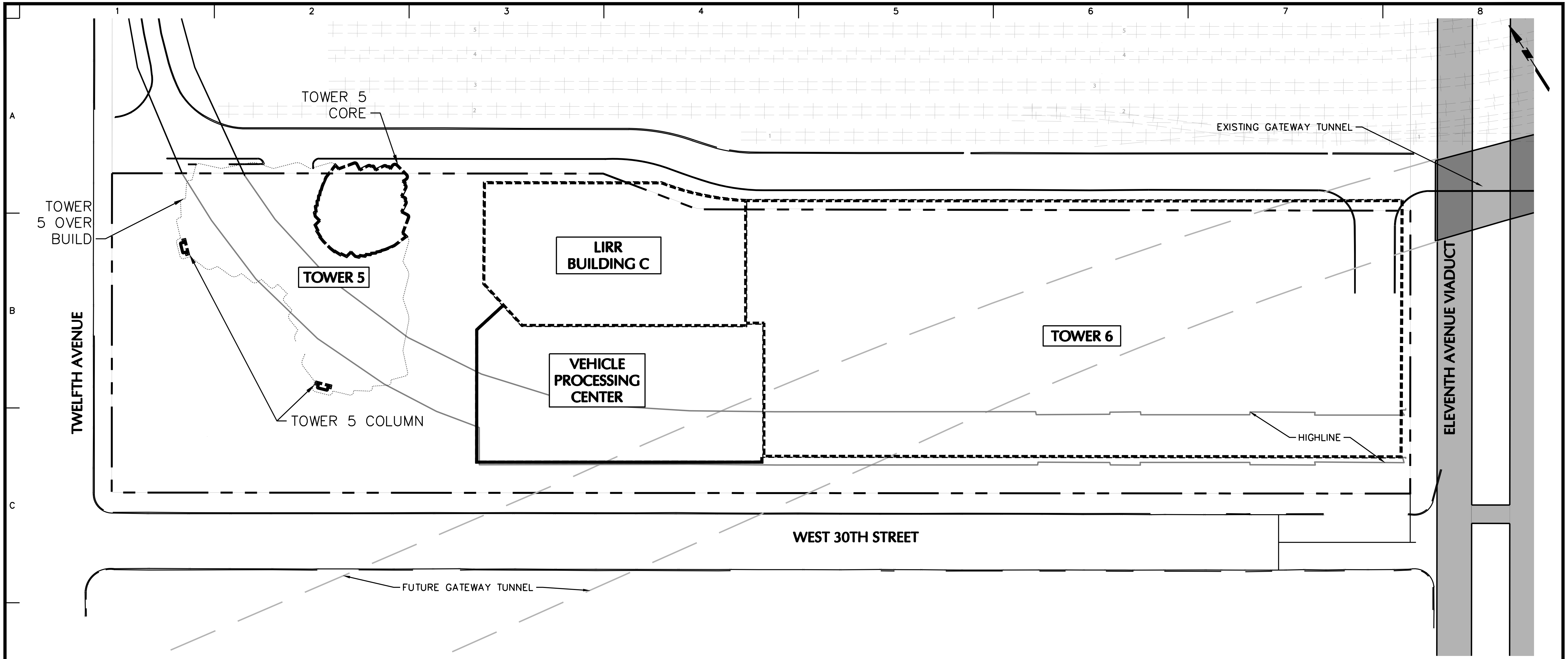
Project
WEST RAIL YARD
TERRA FIRMA
HUDSON YARD
MANHATTAN NEW YORK

Drawing Title
SUBSURFACE
PROFILE A

Project No. 170444101
Date 09/18/2018
Drawn By KM
Checked By MP

Drawing No.
13
Sheet 13 of 15

Filename: \\langan.com\data\NYC\data1\170444101\Cadd Data - 170444101\2D-DesignFiles\Geotechnical\WRY Report\1700444101-B-PF0102.dwg Date: 11/9/2018 Time: 09:23 User: jquintana Style Table: Langan.stb Layout: Section TF-A



NOTES

1. EXISTING INFORMATION TAKEN FROM TOPOGRAPHIC AND BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING, LANDSCAPE ARCHITECTURE AND GEOLOGY, D.P.C., DATED 4 APRIL 2004, AND LAST REVISED 15 JUNE 2018.

2. PROPOSED GATEWAY TUNNEL EXTENTS TAKEN FROM AMTRAK HUDSON YARDS PHASE II – WEST RAIL YARDS PROJECT LOCATION PLAN, X–011, DATED 15 JUNE 2018.

LEGEND

— - — PROPERTY LINE OF TERRA FIRMA

- - - - - APPROXIMATE LIMIT OF NEW STRUCTURE

WARNING: IT IS A VIOLATION OF THE NYS EDUCATION LAW ARTICLE 145 FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS ITEM IN ANY WAY.

60 0 20 40 60

SCALE IN FEET

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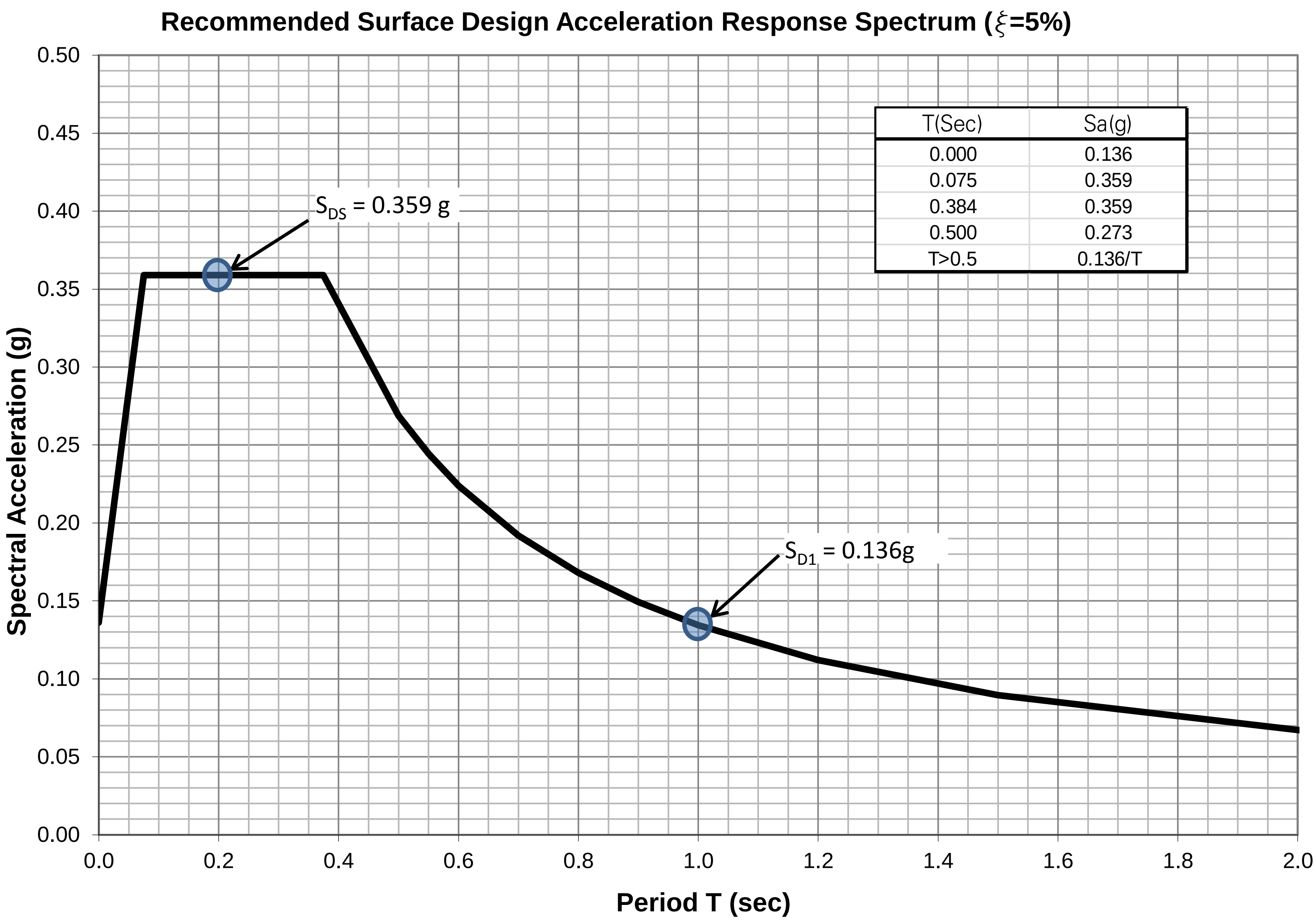
Project
WEST RAIL YARD
TERRA FIRMA
BLOCK No. 676, LOT No.1 & 5
MANHATTAN
NEW YORK **NEW YORK**

Drawing Title
PROPOSED STRUCTURES

Project No. 170444101
Date 10/03/2018
Drawn By JCQ
Checked By MP

Drawing No.
14
Sheet 14 of 15

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Geotechnical Report\Dwg 14.Seismic.dwg Date: 11/9/2018 Time: 09:06 User: jquintana Style Table: Langan.stb Layout: Fig 14 - 11x17



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

T(Sec)	Sa(g)
0.000	0.136
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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

Project

WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No. 170444103
Date 11/9/2018
Scale NTS
Drawn By LY
Submission Date 11/9/2018

Drawing No. 15

Sheet 15 of 15

APPENDIX A

2004 and 2017 Langan Boring Logs

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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 +6.4	6" Concrete		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
				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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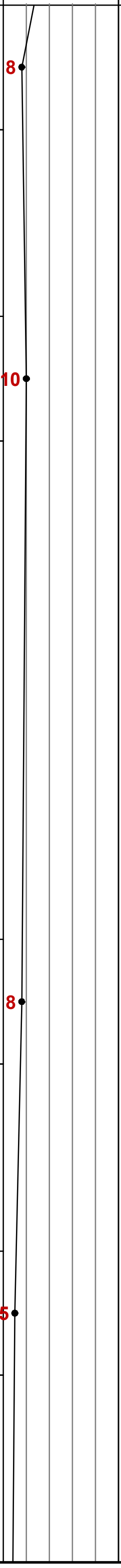
Log of Boring **G-1** Sheet 2 of 7

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

					Sample Data					
MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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.)
▨	-13.1	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	
▨				22						Drilling mud additive (revert) mixed with water Roller bit to 25'
▨		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	
▨				27						Spin 4" casing to 30' Casing breaks inside hole Missed sample 30 ft to 32 ft due to casing problem (break and retrieval) Rollerbit to 35'
▨		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	
▨				37						Rollerbit to 40'
▧	-33.1	S-6: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4c]		40	S-6	SS	22	3 3 2 3	5	q_u=0.5 tsf
▧				42						Rollerbit to 45'
▧				45						



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

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

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

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
			72						Rollerbit to 75'
	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
			77						Rollerbit to 80'
	S-14: Dark grey, silty CLAY (CL), trace shell fragments [NYCBC Class 4c]		80	S-14	SS	24	1 2 2 1	4	
			82						Rollerbit to 85'
	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		
			87						Rollerbit to 90'
-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	
			92						Rollerbit to 95'
-88.1			95						

\\LANGAN.COM\DATA\NY\DATA1\170444101\ENGINEERING DATA\GEOTECHNICAL\GINT\JETS STADIUM LOGS\LANGAN BORINGS.GPJ ... 3/28/2017 1:18:31 PM ... Report: Log - LANGAN

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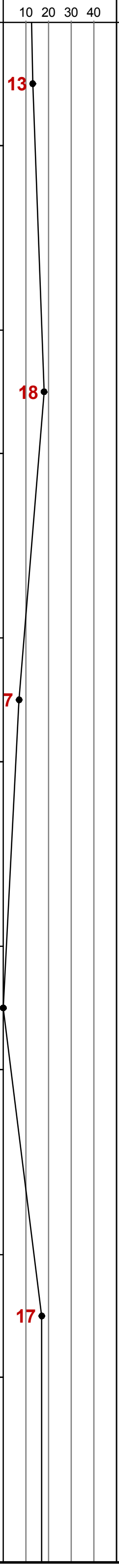
Log of Boring G-1 Sheet 5 of 7

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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	S-17	SS	20	3 3 10 13	13	
			97						Rollerbit to 100'
	S-18: Gray fine SAND (SM), some silt, trace shell fragments [NYCBC Class 3b]		100	S-18	SS	24	5 6 12 14	18	Spin 3" casing to 100'
			102						Rollerbit to 105'
	S-19: Grey, fine SAND (SM), some silt, trace fine gravel, trace shell fragments [NYCBC Class 6]		105	S-19	SS	10	3 3 4 7	7	
			107						Rollerbit to 110'
	S-20:NO RECOVERY. GRAVEL IN SPOON TIP.		110	S-20	SS	0	WOR WOR WOR WOR		
			112						Rollerbit to 115'
	S-21: Grey, fine SAND (SM), some silt, trace rock fragments [NYCBC Class 3b]		115	S-21	SS	1	6 8 9 15	17	
			117						Rollerbit to 120'
			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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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	S-24: Grey-brown, medium to fine SAND (SM), some silt, some fine gravel, trace rock fragments (Glacial Till) [NYCBC Class 3a]		124						
			125	S-23	SS	0	100/0"	100/0"	Rig chattering and hard drilling 124' to 125' (Boulder) Spin 3" casing to 125'
			126						
			127	S-24	SS	8	6 22 100/1"		Drill through boulder and spin casing to 128'
			128					100/1"	Top of rock at 130'
			129						
-123.1	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]		130						
		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	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	6	135						
		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						
		7	144						
			145						

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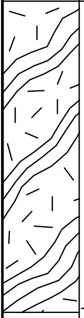
Log of Boring **G-1** Sheet 7 of 7

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	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	Sample Data N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	-138.1		7	145	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]	8	146	C-4	NX CORE BARREL	REC=42"/48" =88%	RQD=24"/48" =50%		
			8	147						
			7	148						
			8	149						
	-143.1	End of boring at 150'		150						Borehole backfilled with cuttings and surface patched upon completion
				151						
				152						
				153						
				154						
				155						
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				170						

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		

Elev. (ft)	Sample Description	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+22.2								
+22.0	3" Concrete Slab	0						Boring located on 11th Avenue sidewalk, about 67' north of 30th Street
		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'
	S-1: Dark brown, medium to fine SAND, some fine gravel, trace brick (Fill) [NYCBC Class 7]	6–8	S-1	SS	12	15 23 27 36	50	
		8–9						Rollerbit to 10' Install 4" casing to 9' Clean to 10' Mix revert
	S-2: Brick fragments, some silty sand (Fill) [NYCBC Class 7]	10–12	S-2	SS	3	4 5 6 4	11	
		12						Rollerbit to 15'
	S-3: Brown, medium to fine SAND, some silt, trace rock fragments (Fill) [NYCBC Class 7]	15–17	S-3	SS	6	10 8 5 6	13	
		17–18						Rollerbit to 20' Install 4" casing to 14' Clean to 20'
		20						

Project: Hudson Yards - WRY

Project No.: 170444101

Location: LIRR West Side Yard, Manhattan, NY

Elevation and Datum: Approx. 22.2 NAVD88

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	
			22						Push 4" casing to 19' Rollerbit to 25'
	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	
			27						Rollerbit to 30'
-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	
			32						Rollerbit to 35'
	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)
			37						Rollerbit to 40'
-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' Push 3" casing to 29', spin to 40'
-18.8	C-1: Grey, fractured mica SCHIST, Hard, slightly weathered joints, some iron stained joints, foliation dip: 40-60 degrees [NYCBC Class 1b]	2.5 5 4 4	41	C-1	NX CORE BARREL	REC=55"/60" =92%	RQD=42"/60" =70%		

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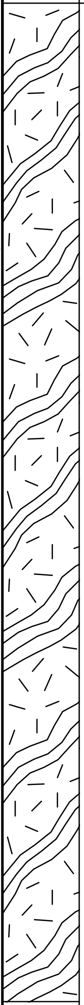
Log of Boring **G-15** Sheet 3 of 3

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					
		C-2: Grey, fractured mica SCHIST, hard, slightly weathered joints [NYCBC Class 1b] PEGMATITE from 46' to 46.3' and 49' to 49.8'	5 4 5.5 5.5 4.5	46 47 48 49 50	C-2	NX CORE BARREL	REC=60"/60" =100%	RQD=38"/60" =63%		
		C-3: Grey, slightly fractured mica SCHIST, hard, slightly weathered joints, foliation dip: 30-60 degrees [NYCBC Class 1a]	5 5 5.5 5 5.5	51 52 53 54 55	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
		C-4: Grey, sound mica SCHIST, hard, mechanical fractures along foliation, foliation dip: 50-60 degrees [NYCBC Class 1a]	5 5.5 5.5 5 5	56 57 58 59 60	C-4	NX CORE BARREL	REC=58"/60" =97%	RQD=58"/60" =97%		
	-38.8	End of boring at 61'		61 62 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-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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+7.1	9" Concrete		0						Boring located in northeast corner of NYDS gas station, about 95' east of 12th Avenue and 130' north of 30th Street
+6.4									
	Black, fine to coarse SAND and GRAVEL, some cobbles, trace brick, dry (Fill) [NYCBC Class 7]		3						qu (tsf) estimated from Pocket Penetrometer Rollerbit to 6' with water and no down pressure
			8						Drive 4" casing to 10' Rollerbit to 10'
	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	
			12						Rollerbit to 15'
	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	
			17						Drive 4" casing to 15' Rollerbit to 20'
			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) 10 20 30 40	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 – 22	S-3	SS	8	14 8 19 15	27	
▩				22						Drive 4" casing to 20' Rollerbit to 25'
▩		S-4: Black GRAVEL, some coarse to fine sand, some silt, trace fine gravel (Fill) [NYCBC Class 7]		25 – 27	S-4	SS	5	8 5 9 8	14	
▩				27						Drive 4" casing to 25' Rollerbit to 30'
▩				29						Rig chatter at 29'
▩		S-5: Black medium to fine SAND, some silt, rock fragments, trace wood (Fill) [NYCBC Class 7]		30 – 32	S-5	SS	8	15 11 11 7	22	
▩				32						Drive 4" casing to 30' Rollerbit to 35'
▩		S-6: No recovery		35	S-6	SS	0	44 100/2"	100/2"	
▩				36						Hard drilling - (1.5' boulder)
▨	-29.9			37						
▨		S-7: Black-grey, organic silty CLAY (OH), trace fine sand, trace wood [NYCBC Class 4c]		40 – 42	S-7	SS	24	2 2 4 4	6	
▨				42 – 45						Drive 4" casing to 40' Rollerbit to 45'

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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 Add revert to wash
			47						Rollerbit to 50'
	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
			52	U-1	UNDIST	24			Rollerbit to 52'
-46.9	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
			56	U-2	UNDIST	0			Rollerbit to 56'
	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
	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
			62						Rollerbit to 65'
	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
			67						Rollerbit to 70'
			70						

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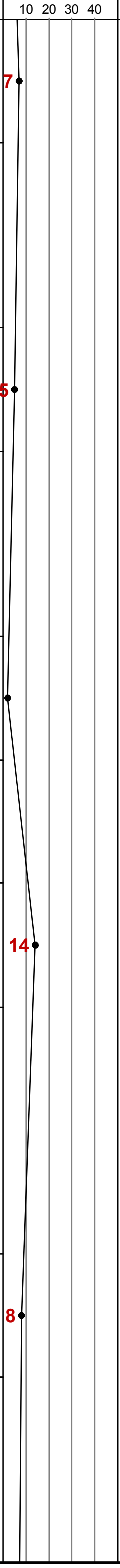
Log of Boring **G-17** Sheet 4 of 6

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



MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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-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
				72						Rollerbit to 75'
		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
				77						Rollerbit to 80'
		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		
				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]		84	S-17	SS	24	4 5 9 16	14	q_u=0.25 tsf
				86						Rollerbit to 90'
		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
				92						Rollerbit to 95'
				95						

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

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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
			97						Rollerbit to 100'
	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	
			102						Rollerbit to 105'
	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
			107						Rollerbit to 110
-102.9	S-22: Dark grey, clayey SILT (ML), trace fine sand, wood fragments [NYCBC Class 5b]		110	S-22	SS	24	6 5 8 10	13	
			112						Rollerbit to 115'
	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	
-111.9			119						Rig chatter at 119'
			120						

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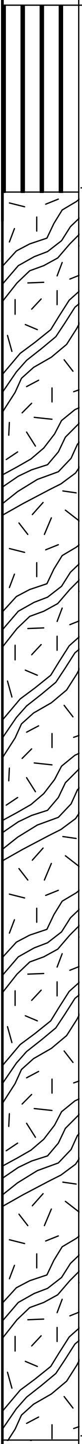
Log of Boring **G-17** Sheet 6 of 6

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



MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data 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						
	-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 6 5 7 8	123-128	C-1	NX2 CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		
		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 9 8 3 9	128-133	C-2	NX2 CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		Core barrel jammed at 132.25'
		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 9 10 10 10	133-138	C-3	NX2 CORE BARREL	REC=60"/60" =100%	RQD=37"/60" =62%		
		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 12 15 14	138-143	C-4	NX2 CORE BARREL	REC=59"/60" =98%	RQD=47"/60" =78%		Core barrel jammed at 141.75'
	-135.9	End of boring at 143'		143						Borehole backfilled with cuttings and surface patched upon completion
				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
Casing Hammer	Donut	Weight (lbs) 300	Drop (in) 30
Sampler	2" O.D. Split Spoon / 3" Shelby Tube	Water Level (ft.)	First ▽ / Completion ▼ / 24 HR. ▼
Sampler Hammer	Donut	Weight (lbs) 140	Drop (in) 30
Drilling Foreman	Robert Ware	Field Engineer	Stuart Knoop

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+7.2			0						Boring located in Greyhound, about 14' east of operations building and 12' south of trench drain
+6.8	5" Asphalt								
			2						"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'
	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	
			8						Rollerbit to 10'
	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	
			12						Rollerbit to 15'
	S-3: Dark brown, sandy SILT, some clay, trace gravel (Fill) [NYCBC Class 7]		15	S-3	SS	3	4 1 WOH 1		
			17						Rollerbit to 20'
			20						

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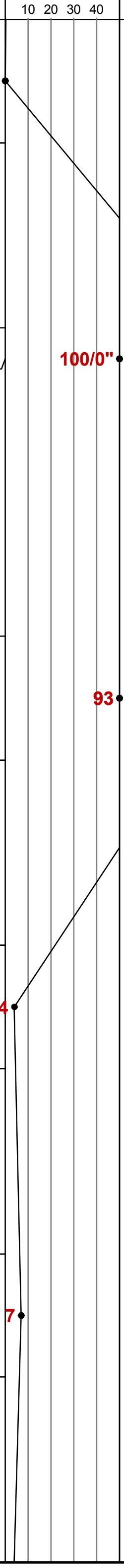
Log of Boring **G-19** Sheet 2 of 5

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

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		
			22						Rollerbit to 25'
	S-5: No recovery		25	S-5	SS	2	11 100/0"	100/0"	Cobble at 25.5'
			27						Rollerbit through cobble
			28						Spin 4" casing to 30' Rollerbit to 30'
	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	
			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 Organic Content = 5.9.% (burnoff) Spin 4" casing to 40' Rollerbit to 40'
-32.8	S-8: Dark grey, CLAY (CH), trace silt, trace shell fragments [NYCBC Class 4b]		40	S-8	SS	24	3 3 4 2	7	
			42						Rollerbit to 45'
			45						



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

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.)
-37.8	S-9: Dark grey, organic CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		45 – 47	S-9	SS	24	WOH 1 2 1	3	
			47						Rollerbit to 50'
			50 – 52	U-1	UNDIST	21			
			52						Rollerbit to 55'
	S-10: Dark grey, organic CLAY (CH), trace silt, trace shell fragments [NYCBC Class 6]		55 – 57	S-10	SS	24	WOH 1 2 1	3	
			57						Rollerbit to 60'
			60 – 62	U-2	UNDIST	24			WC=43.3 , LL=43 , PL=19
			62						Rollerbit to 65'
	S-11: Dark grey, organic clayey SILT (ML) with clay lenses, trace shell fragments [NYCBC Class 6]		65 – 67	S-11	SS	24	2 2 1 2	3	
			67 – 70						Rollerbit to 70'

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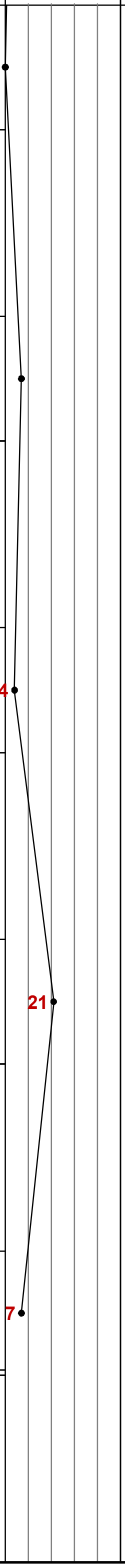
Log of Boring **G-19** Sheet 4 of 5

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

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Sample Data: Type	Sample Data: Recov. (in)	Sample Data: Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	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		
				72						Rollerbit to 75'
	-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		
				77						Rollerbit to 80'
		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	
				82						Rollerbit to 85'
	-76.8			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	
				87						Rollerbit to 90'
		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	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 5 5	92	C-1	NX CORE BARREL	REC=42"/60" =70%	RQD=26"/60" =43%		
				95						



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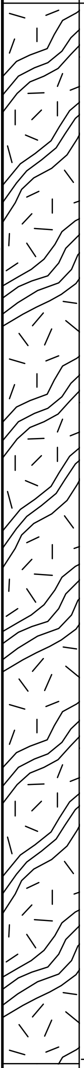
Log of Boring **G-19** Sheet 5 of 5

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



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

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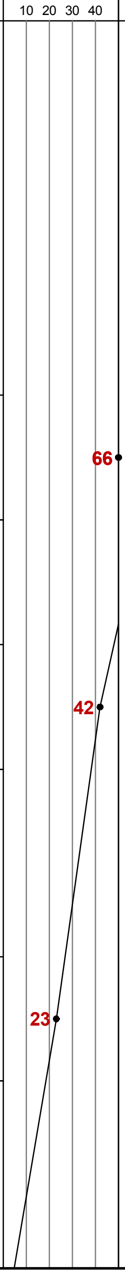
Log of Boring **G-20** Sheet 1 of 4

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	
Sampler Hammer Donut Weight (lbs) 140 Drop (in) 30	Field Engineer Stuart Knoop

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+7.9	8" Asphalt		0						Boring located in Greyhound parking, about 115' north of 30th Street and 450' east of 12th Avenue
+7.2			1						
			2						qu (tsf) estimated from Pocket Penetrometer
			4						Use rollerbit and water with no down pressure to 6'
	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	
			8						Spin 4" casing to 10' Rollerbit to 10'
	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	Petroleum odor
			12						Spin/push 4" casing to 15' Rollerbit to 15'
	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	
			17						Rollerbit to 20'
-10.6			18						Wash change to dark grey ~18'
			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

Elev. (ft)	Sample Description	Depth Scale	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: Dark grey, organic CLAY (OH) [NYCBC Class 6]	20	S-4	SS	18	WOH WOH WOH 1		q_u=0.25 tsf
		22						Push 4" casing to 20' Rollerbit to 25'
		25	U-1	UNDIST	21			
		27						Rollerbit to 30'
	S-5: Dark grey, organic silty CLAY (OH), some shell fragments [NYCBC Class 6]	30	S-5	SS	22	WOH WOH WOH WOH		
		32						Rollerbit to 35'
		35	U-2	UNDIST	24			
		37						Push 4" casing to 40' Rollerbit to 40'
	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
		42						Rollerbit to 45'
		45						

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

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

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 -38.1	S-7A: Dark grey, organic silty CLAY (OH), trace shell fragments [NYCBC Class 6]		45–46	S-7	SS	24	1 1 3 3	4	q_u=0.5 tsf Organic Content = 1.6.% (burnoff) Rollerbit to 50'
-42.1	S-7B: Dark grey, medium to fine SAND (SM), some silt, trace shell fragments [NYCBC Class 6]		46–50						
-43.1	S-8: Weathered rock (mica schist) [NYCBC Class 3a]		50–51	S-8	SS	6	100/6"	100/6"	Spin 3" casing to 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 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 3 6 6 6	51–56	C-1	NX CORE BARREL	REC=54"/60" =90%	RQD=34"/60" =57%		
	C-2: Green chlorite SCHIST, soft to moderately hard, very slightly weathered, fractures parallel, foliation at ~70 degrees [NYCBC Class 1b] Dark grey biotite-quartz-muscovite SCHIST (as above), hard	6 7 10 6 6	56–61	C-2	NX CORE BARREL	REC=58"/60" =97%	RQD=47"/60" =78%		
	C-3: Bluish grey quartz-muscovite SCHIST (as above), very hard [NYCBC Class 1b]	4 7 7 6 8	61–66	C-3	NX CORE BARREL	REC=56"/60" =93%	RQD=45"/60" =75%		
	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 5 7 6	66–70	C-4	NX CORE BARREL	REC=57"/60" =95%	RQD=42"/60" =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		5	70	C-4	■				
	-63.1	End of boring at 71'		71						Borehole backfilled with cuttings and surface patched upon completion
				72						
				73						
				74						
				75						
				76						
				77						
				78						
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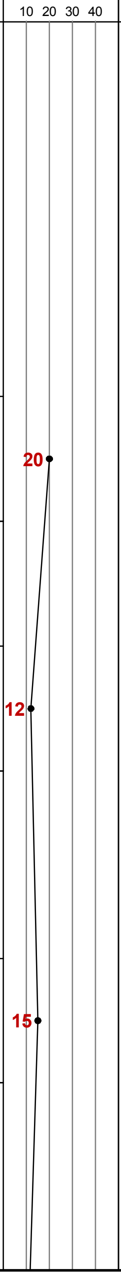
Log of Boring **G-21** Sheet 1 of 3

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



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

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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	
			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]		25	S-5	SS	20	3 2 3 3	5	
			27						Rollerbit to 27'
	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 "Organic Content = 4.6.% (burnoff) LL = 41 after burnoff (change of ~28%)"
			32						Rollerbit to 35'
-24.3	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	Weathered Rock		37						Rollerbit to 40' Hard drilling to 40' (very slow)
-31.3	C-1: No recovery - some dark gray medium to fine sand in core barrel [NYCBC Class 1d]	2 3 5 4	40	C-1	NX CORE BARREL	REC=24"/48" =50%	RQD=17"/48" =35%		No recovery from 40' to 42'
-35.3		4	44	C-2					Core barrel clogged at 44'
			45						

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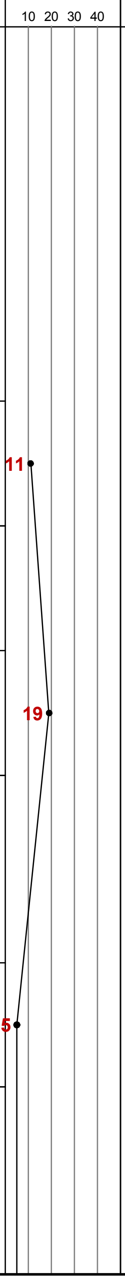
Project Hudson Yards - WRY	Project No. 170444101
Location LIRR West Side Yard, Manhattan, NY	Elevation and Datum Approx. 8.7 NAVD88

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.)
-36.3	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	45	C-2	NX CORE BARREL	REC=45"/48" =94%	RQD=41"/48" =85%		
		5	46						
		3	47						
		3	48	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=50"/60" =83%		
	C-3: Grey-black, biotite-quartz-garnet SCHIST, hard, foliation at ~60 degrees, fractures parallel to foliation, fresh fractures [NYCBC Class 1b]	4	49						
		3	50						
		4	51						
		4	52						
	Quartz vein from 53.4' to 54.8', very hard	5	53	C-4	NX CORE BARREL	REC=56"/60" =93%	RQD=53"/60" =88%		
	C-4: Grey-black, biotite-quartz-garnet SCHIST (as above) [NYCBC Class 1a]	4	54						
		5	55						
		5	56						
		5	57						
		4	58	C-5	NX CORE BARREL	REC=60"/60" =100%	RQD=60"/60" =100%		
	C-5: Grey-black, biotite-quartz-garnet SCHIST (as above) [NYCBC Class 1a]	4	59						
		4	60						
		4	61						
		3	62						
-54.3	End of boring at 63'		63						Borehole backfilled with cuttings and surface patched upon completion
			64						
			65						
			66						
			67						
			68						
			69						
			70						

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
Sampler	2" O.D. Split Spoon / 3" Shelby Tube	Drilling Foreman	Robert Ware
Sampler Hammer	Donut	Weight (lbs) 140	Drop (in) 30
Field Engineer	Stuart Knoop		

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.)
	+7.0	8" Concrete slab		0						Boring located on 12th Avenue sidewalk about 187' north of 30th Street
	+6.3			1						
				2						qu (tsf) estimated from Pocket Penetrometer
				3						Use 4 7/8" rollerbit to drill concrete slab
				4						Use rollerbit with water and no down pressure to drill to 6'
		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	
				8						Push 4" casing to 10' Rollerbit to 10'
		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	
				12						Rollerbit to 15'
		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	
				17						Rollerbit to 17'
				20						



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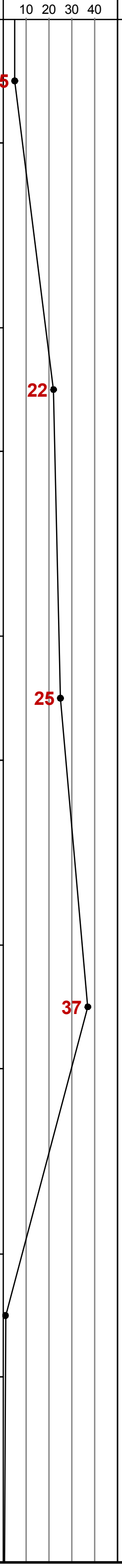
Log of Boring **G-27** Sheet 2 of 7

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

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	Rollerbit to 25'
	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	Rollerbit to 30'
	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	Organic Content = 1.2% (burnoff) Rollerbit to 35'
	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	Push 4" casing to 20' Rollerbit to 40'
-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 "Rollerbit to 45' Very soft drilling"
			45						



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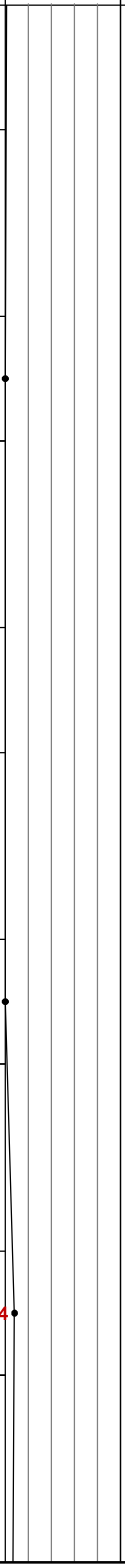
Log of Boring **G-27** Sheet 3 of 7

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

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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	U-1	UNDIST	20			WC=42.3 , LL=49 , PL=22 Organic Content = 4.2% (burnoff) Rollerbit to 50'
		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 Rollerbit to 55'
				55	U-2	UNDIST	13			q_u=0.5 tsf WC=50 , LL=21 , PL=29 Organic Content = 4.1% (burnoff) Rollerbit to 60'
		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 Rollerbit to 65'
		S-11: Dark grey, CLAY (CL), trace silt, trace fine sand [NYCBC Class 4c]		65	S-11	SS	24	WOH 2 2 3	4	q_u=0.75 tsf Rollerbit to 70'
				70						



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

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

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	Sample Data 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 71	S-12	SS	24	2 1 2 3	3	q_u=0.75 tsf WC=46.9 , LL=57 , PL=24
▨				72 73 74						Rollerbit to 75'
▨		S-13: Dark grey, CLAY (CH), trace silt, trace fine sand, trace shell fragments [NYCBC Class 6]		75 76	S-13	SS	24	1 WOH WOH WOH		q_u=0.5 tsf
▨				77 78 79						Rollerbit to 80'
▨		S-14: Dark grey, CLAY (CH), trace silt, trace fine sand, trace shell fragments [NYCBC Class 6]		80 81	S-14	SS	24	1 WOH WOH WOH		q_u=0.5 tsf
▨				82 83 84						Rollerbit to 85'
▨		S-15: Dark grey, CLAY (CL), some silt, trace fine sand, trace wood, trace shell fragments [NYCBC Class 6]		85 86	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)
▨				87 88						Rollerbit to 90'
▥	-81.5			89						
▥		S-16: Dark grey, sandy SILT (ML), some clay, trace shell fragments [NYCBC Class 5b]		90 91	S-16	SS	24	5 3 10 15	13	
▥				92 93 94						Rollerbit to 95'
▥	-88.0			95						

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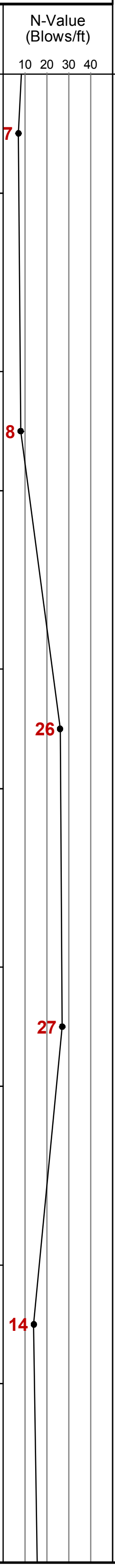
Log of Boring **G-27** Sheet 5 of 7

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	S-17	SS	24	2 0 7 7	7	
				97						Rollerbit to 100'
	-91.0			98						
		S-18: Dark grey, sandy SILT (ML), some clay, clay lenses, trace shell fragments [NYCBC Class 6]		100	S-18	SS	24	WOH 5 3 3	8	
				102						Rollerbit to 105'
		S-19: Dark grey, sandy SILT (ML), trace clay, trace rock fragments (schist), trace shell fragments [NYCBC Class 3b]		105	S-19	SS	24	WOH 11 15 16	26	
				107						Rollerbit to 110'
	-102.0			109						
		S-20: Dark grey, silty fine SAND (SM) [NYCBC Class 3b]		110	S-20	SS	24	10 12 15 19	27	
				112						Rollerbit to 115'
	-106.0			113						
		S-21: Dark grey, SILT (ML), some fine sand, trace clay [NYCBC Class 5b]		115	S-21	SS	18	6 6 8 8	14	
				117						Rollerbit to 120'
				120						



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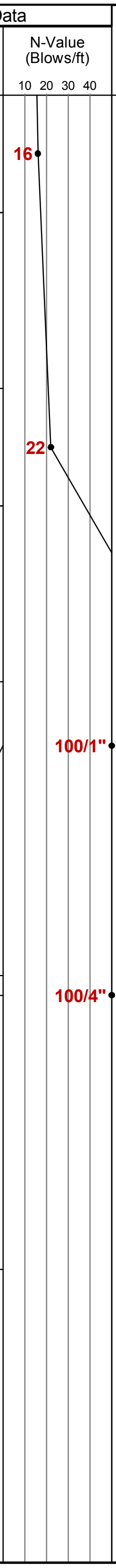
Log of Boring **G-27** Sheet 6 of 7

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

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	
			122						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			129						
	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	C-1	NQ CORE BARREL	REC=36"/60" =60%	RQD=26"/60" =43%		
			145						



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

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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 2 3 2	146 147 148 149	C-2	NQ CORE BARREL	REC=54"/60" =90%	RQD=29"/60" =48%		
	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]	2 7 5 17 7	150 151 152 153 154	C-3	NQ CORE BARREL	REC=49"/60" =82%	RQD=27"/60" =45%		
	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]	5 3 6 8 6	155 156 157 158 159	C-4	NQ CORE BARREL	REC=58"/60" =97%	RQD=58"/60" =97%		
-153.0	End of boring at 160'		160 161 162 163 164 165 166 167 168 169 170						Borehole backfilled with cuttings and surface patched upon completion

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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			
Sampler Hammer: Automatic / Weight (lbs): 140	Drop (in): 30	Field Engineer: Nipam Shah	

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.1	6" Concrete		0						Boring located in southeast corner of NYDS gas station, about 30' north of 30th Street and 12' west of wash building
	+6.6			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						
		S-1: Dark brown, fine to coarse SAND and GRAVEL, some cobbles, some brick, dry (Fill) [NYCBC Class 7]		10	S-1	SS	8	6 4 5 7	9	Drive 4" casing to a depth of 15' Strong organic odor.
				11						
				12						Rollerbit to 15'
				13						
				14						
		S-2: Dark brown, coarse to fine SAND, some coarse to fine gravel, some silt, trace brick fragments, wood (Fill) [NYCBC Class 7]		15	S-2	SS	10	2 3 1 1	4	Drilling mud additive mixed with water
				16						
				17						Rollerbit to 20'
				18						
				19						
	-12.9			20						

N-Value scale: 10 20 30 40

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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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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: 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	
			22						Rollerbit to 25'
	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'
			27						Rollerbit to 30'
			30	U-1	UNDIST	24	PUSH		
			32						Rollerbit to 35'
			35	U-2	UNDIST	18	PUSH		
			37						Rollerbit to 40'
-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
			42						Rollerbit to 45'
			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	Sample Data: Type	Sample Data: Recov. (in)	Sample Data: Penetr. resist BL/6in	Sample Data: 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 1	4	q_u=0.2 tsf
▨				47						Rollerbit to 50'
▨		S-7: Dark grey, CLAY (CH), trace silt, shell fragments [NYCBC Class 4c]		50	S-7	SS	24	1 2 2 2	4	q_u=0.25 tsf
▨				52						Rollerbit to 55'
▨		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
▨				57						Rollerbit to 60'
▨		S-9: Dark grey, silty CLAY (CH), some shell fragments [NYCBC Class 6]		60	S-9	SS	24	1 1 1 2	2	q_u=0.3 tsf
▨				62						Rollerbit to 65'
▨		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
▨				67						Rollerbit to 70'
▨				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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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-11: Dark grey, CLAY (CH), trace silt, trace shell fragments, trace rock fragments [NYCBC Class 6]		70	S-11	SS	24	WOH 1 2 2	3	q_u=0.19 tsf
			72						Rollerbit to 75'
	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
			77						Rollerbit to 80'
	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
			82						Rollerbit to 85'
-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		
			87						Rollerbit to 90'
	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
			92						Rollerbit to 95'
			95						

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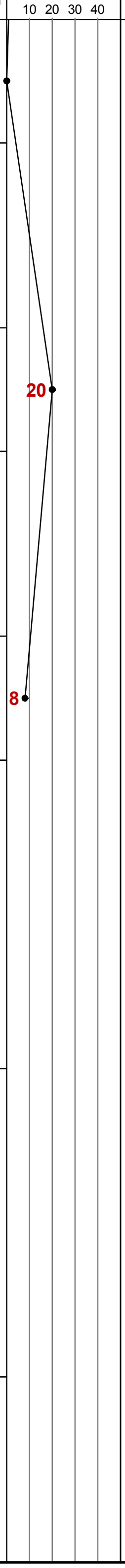
Log of Boring **G-3** Sheet 5 of 6

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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
			97						Rollerbit to 100'
	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
			102						Rollerbit to 105'
	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	
			107						Rollerbit to 110' Rig chatter between 109' and 110' Top of bedrock at 110' Spin 3" casing to a depth of 110'
-102.9			110						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' Loss of recovery possibly due to drilling out bottom 2'. (Highly weathered/ decomposed rock)
	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%		
			120						



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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data 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%		
		9	123						
		10	124						
		9	125						Core barrel jammed at 125' Drive 3" casing to a depth of 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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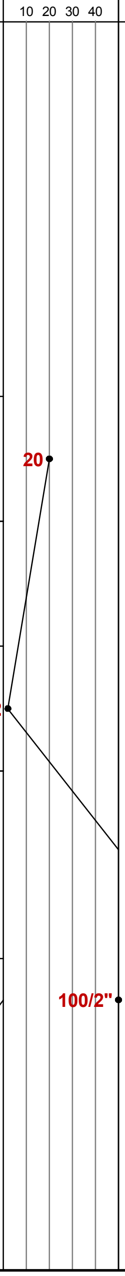
Log of Boring G-30 Sheet 1 of 4

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		

Elev. (ft)	Sample Description	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+7.9 +7.4	Asphalt Pavement	0						Boring located in Greyhound, about 500' east of 12th Avenue and 170' north of 30th Street
		2						qu (tsf) estimated from Pocket Penetrometer
		4						Rollerbit with water and no pressure to 6'
	S-1: Black, medium SAND, some rock fragments and gravel, trace brick fragments (Fill) [NYCBC Class 7]	6–8	S-1	SS	4	1 8 12 8	20	
		8						Install casing to 9'
	S-2: Black, medium to fine SAND, some clay, trace gravel and brick fragmets (Fill) [NYCBC Class 7]	10–12	S-2	SS	6	2 1 1 1	2	
		12						Install casing to 14' Rollerbit to 15'
		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"	
		16–20						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'



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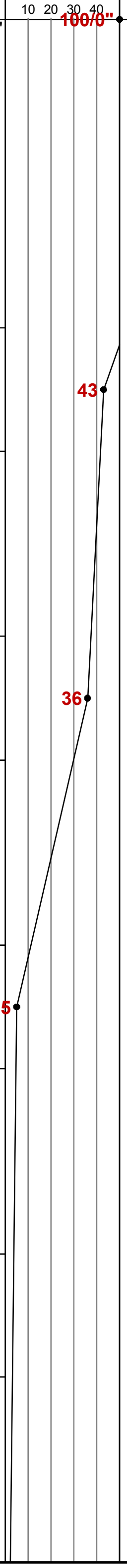
Log of Boring **G-30** Sheet 2 of 4

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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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'
			21						
			22						
			23						
			24						
	S-5: Gravel, trace brick fragments (Fill) [NYCBC Class 7]		25	S-5	SS	5	9 33 10 23	43	
			26						
			27						Rollerbit to 30' Hard drilling 27' to 29' Spin casing to 29' Clean to 30'
			28						
			29						
	S-6: Gravel, some brown, medium sand, trace clay (Fill) [NYCBC Class 7]		30	S-6	SS	4	6 19 17 14	36	
			31						
			32						Rollerbit to 35' Wash water color change ~33'
-25.6			33						
			34						
	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
			36						
			37						Spin casing to 34' Rollerbit to 40'
			38						
			39						
	Grey, silty CLAY (CH)		40	U-1	UNDIST	13			WC=51.5 , LL=52 , PL=19
			41						
			42						Rollerbit to 45'
			43						
			44						
			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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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.)
-37.1	S-8: Grey, silty CLAY (CL), some shell frag [NYCBC Class 6]		45	S-8	SS	24	3 1 1 1	2	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						
			52						
-44.6	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 Hudson Yards - WRY	Project No. 170444101
Location LIRR West Side Yard, Manhattan, NY	Elevation and Datum Approx. 7.9 NAVD88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data 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	(see above)	1 1.5 2	70 71 72	C-4	NX CORE BARREL				
	-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						Borehole backfilled with cuttings and surface patched upon completion

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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 / Date Finished	10/26/04 / 10/27/04
Drilling Equipment	DK-50 Track Rig	Completion Depth / Rock Depth	53 ft / 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) / Casing Depth (ft)	3"/4" Flush Joint Steel / 31	Water Level (ft.)	First ▽ / Completion ▼ / 24 HR. ▼
Casing Hammer / Weight (lbs) / Drop (in)	Donut / 300 / 30	Drilling Foreman	Robert Ware
Sampler	2" O.D. Split Spoon / 3" Shelby Tube		
Sampler Hammer / Weight (lbs) / Drop (in)	Donut / 140 / 30	Field Engineer	Juan Pinzon

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+9.0	8" Concrete Slab		0						Boring located in Greyhound, about 140' west of 11th Avenue and 170' north of 30th Street qu (tsf) estimated from Pocket Penetrometer
+8.3									
			4						Drill through concrete slab Rollerbit to 6' with water and no pressure
	S-1: Brown, coarse to medium SAND, some fine gravel and brick fragments (Fill) [NYCBC Class 7]		6	S-1	SS	4	2 2 1 4	3	Install casing to 9' Rollerbit to 10'
	S-2: Gravel, some brown medium to fine sand, trace brick fragments (Fill) [NYCBC Class 7]		10	S-2	SS	4	9 19 5 3	24	Mix Revert Rollerbit to 15ft
-4.5									
	S-3: Black, silty CLAY (CH-OH), some organics, wood [NYCBC Class 4c]		15	S-3	SS	11	6 1 4 4	5	q_u=0.25 tsf Install casing to 19ft Rollerbit to 20ft
			20						

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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	U-1	UNDIST	24			Rollerbit to 25 ftWC=66.2 , LL=83 , PL=30
				22						Organic Content = 5.7% (burnoff)
	-14.0			23						
		S-4: Grey, silty CLAY (CL), some shell frag [NYCBC Class 6]		25	S-4	SS	24	2 1 1 2	2	q_u=0.5 tsf Rollerbit to 30ft
		No Recovery		30	U-2	UNDIST	0			No recovery Tube's tip bent
				32						Rollerbit to 35ft Rollerbit refusal @ 33ft Install casing to 31ft Clean to 33ft Rock Coring Run #1 (33ft-38ft)
	-24.0	C-1: Grey, slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joints Foliation dip: 50 - 70 degrees. [NYCBC Class 1a]	4.5 5.5 5.5 5 5.5	33	C-1	NX CORE BARREL	REC=55"/60" =92%	RQD=51"/60" =85%		
		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 1.5 2.5 3 3	38	C-2	NX CORE BARREL	REC=58"/60" =97%	RQD=51"/60" =85%		Run #2 (38ft-43ft) Increase RPM (from previous Run)
		C-3: Grey slightly fractured MICA SCHIST, hard, slightly weathered, iron stained joint [NYCBC Class 1a]	4 3	43	C-3					Run #3 (43ft-48ft) Barrel stopped moving @ 43.5ft (Drilled for 50 min @ 43.5ft, change bit and continue
				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	Sample Data Type	Sample Data Recov. (in)	Sample Data Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	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%		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	C-4	NX CORE BARREL	REC=56"/60" =93%	RQD=52"/60" =87%		Run #4 (48ft-53ft)
			3	49						
			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						
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				67						
				68						
				69						
				70						

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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			
Sampler Hammer Automatic	Weight (lbs) 140 Drop (in) 30	Field Engineer Stephen Morse / Nipam Shah	

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 +7.4	6" Asphalt		0						Boring located in NYDS parking area, about 300' east of 12th Avenue and 27' north of 30th Street
▨				3						qu (tsf) estimated from Pocket Penetrometer
▨				4						Drill to 6' using rollerbit and water with no down pressure
▨		S-1: Brown-black, GRAVEL and SILT (Fill) [NYCBC Class 7]		6	S-1	SS	5	5 3 2 3	5	
▨				8						Push and drive 4" casing to 9'
▨				9						Rollerbit to 10'
▨		S-2: Brown-black, GRAVEL and SILT (Fill) [NYCBC Class 7]		10	S-2	SS	5	4 4 3 2	7	
▨				12						Drive 4" casing to 14' Rollerbit to 15'
▨		S-3: Brown-black, GRAVEL and SILT, some brick fragments (Fill) [NYCBC Class 7]		15	S-3	SS	3	6 4 3 5	7	
▨				17						Install 4" casing to 19' Rollerbit to 20'
▨				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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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	
			22						Install 4" casing to 24' Rollerbit to 25'
	S-5: Brown-grey, GRAVEL and SILT, some rock fragments (FILL) [NYCBC Class 7]		25	S-5	SS	4	5 4 4 4	8	
			27						Spin 4" casing to 30' Rollerbit to 30'
	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	
			32						Add revert to drilling fluid
			33						Rollerbit to 35'
	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	
			37						Rollerbit to 40' Reddish brown wash
	S-8: No recovery		40	S-8	SS	0	4 3 3 2	6	
			42						Rollerbit to 45'
-35.1			43						
			45						

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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) 10 20 30 40	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		47	U-1	UNDIST	15			Rollerbit to 47'
▨		S-10: Grey, organic silty CLAY (OH), some shell fragments, trace fine sand [NYCBC Class 6]		49	S-10	SS	8	2 1 2 3	3	q_u=0.1 tsf
▨		No recovery		51	U-2	UNDIST	0			Rollerbit to 51'
▨				53						Rollerbit to 55'
▨		No recovery		55	U-3	UNDIST	0			
▨		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
▨				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	
▥				62						Rollerbit to 65'
▥		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
▥				67						Rollerbit to 70'
▥				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

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data Number	Sample Data Type	Sample Data Recov. (in)	Sample Data 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 Rollerbit to 75'
	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	Hole caved in Spin 3" casing to 75' Rollerbit to 80'
-72.1	C-1: Grey, mica SCHIST, moderately weathered, sound, wide fracture spacing, strong rock, medium grained, slightly to moderately weathered [NYCBC Class 1b] highly weathered PEGMATITE between 83'-84'	5 5 5 4 4	80	C-1	NX CORE BARREL	REC=54"/60" =90%	RQD=45"/60" =75%		Rock encountered at 80'
	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 5 5 5 5	85	C-2	NX CORE BARREL	REC=56"/60" =93%	RQD=55"/60" =92%		
	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 4 3 5 5	90	C-3	NX CORE BARREL	REC=60"/60" =100%	RQD=50"/60" =83%		
			95						

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) -87.1	Sample Description	Coring (min)	Depth Scale	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.)
		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						Borehole backfilled with cuttings and surface patched upon completion
				101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120						

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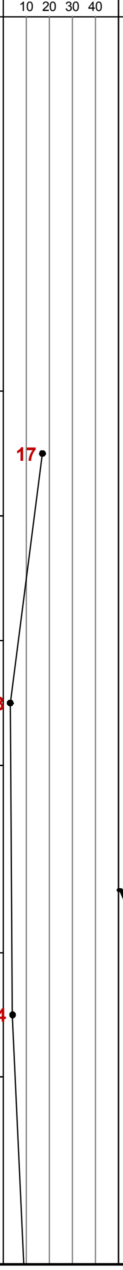
Log of Boring G-7 Sheet 1 of 3

Project: Hudson Yards - WRY
Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY
Elevation and Datum: Approx. 9.4 NAVD88
Drilling Company: Warren George, Inc.
Date Started: 10/12/04
Date Finished: 10/13/04
Drilling Equipment: Acker-11 Truck Rig
Completion Depth: 70 ft
Rock Depth: 50 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): 50
Water Level (ft.): First ▽; Completion ▼; 24 HR. ▼
Casing Hammer: Donut; Weight (lbs) 300; Drop (in) 30
Drilling Foreman: Corey Tirro
Sampler: 2" O.D. Split Spoon / 3" Shelby Tube
Field Engineer: Juan Pinzon / Clay Patterson
Sampler Hammer: Donut; Weight (lbs) 140; Drop (in) 30

Elev. (ft)	Sample Description	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
+9.4	8" Asphalt	0						Boring located in NYDS parking area, about 280' west of 11th Avenue and 25' north of 30th Street
+8.7								
		2						qu (tsf) estimated from Pocket Penetrometer
		3						Rollerbit with no pressure to 6'
		4						Push casing to 4' Clean to 6'
	S-1: Fine GRAVEL, brick fragments, some medium sand (Fill) [NYCBC Class 7]	6	S-1	SS	7	6 10 7 5	17	
		8						Hammer 4" casing to 9' Rollerbit to 10' Add Revert
	S-2: Brown, medium silty SAND, trace gravel (Fill) [NYCBC Class 7]	10	S-2	SS	8	2 1 2 1	3	
		12						Rollerbit to 15' Rig chatter
		13						Hole caves in when trying to take sample, hammer 4" casing to 14' Redrill to 15'
	S-3: Brown, medium silty SAND, trace fine gravel, rock fragments (Fill) [NYCBC Class 7]	15	S-3	SS	4	6 3 1 2	4	
		17						Rollerbit to 20'
		20						



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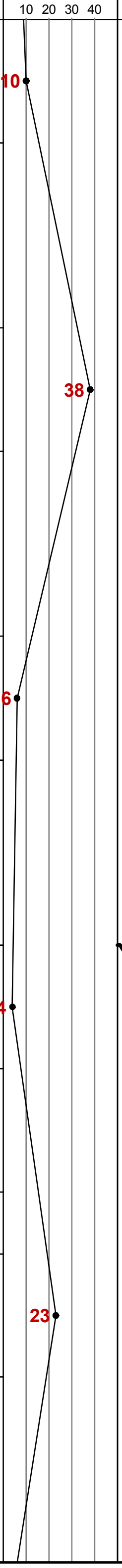
Log of Boring **G-7** Sheet 2 of 3

Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 9.4 NAVD88

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
-10.6	S-4: Brown, medium SAND, some fine gravel, some silt (Fill) [NYCBC Class 7]		20	S-4	SS	9	9 6 4 9	10	
			22						Rollerbit to 25' Rig chatter
	S-5: Brown-tan, coarse to medium SAND, rock fragments, some fine gravel (Fill) [NYCBC Class 7]		25	S-5	SS	3	6 22 16 25	38	
			27						Install casing to 24' Rollerbit to 30'
-20.6	S-6: Grey, organic silty CLAY (OH), trace shell fragments [NYCBC Class 4c]		30	S-6	SS	5	5 3 3 4	6	q_u=0.25 tsf
			32						Install casing to 29' Rollerbit to 35' Casing drops 6" Install casing to 34' Redrill to 35' q_u=0.5 tsf
	S-7: Grey, organic silty CLAY (OH), trace shell fragments [NYCBC Class 4c]		35	S-7	SS	19	5 1 3 3	4	
	No recovery		37	U-1	UNDIST	0			Rollerbit to 37
			39						Rollerbit to 40'
	S-8: No recovery		40	S-9	SS	0	11 12 11 13	23	
			42						Rollerbit to 45'
			45						



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

Project: Hudson Yards - WRY	Project No.: 170444101
Location: LIRR West Side Yard, Manhattan, NY	Elevation and Datum: Approx. 9.4 NAVD88

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
-35.6	S-9: Grey, organic silty CLAY (OH), some fine sand [NYCBC Class 6]		45	S-10	SS	20	WOH WOH 2 2		q_u=0.5 tsf WC=36.1 , LL=33 , PL=16 Organic Content = 3.4% (burnoff)
			46						
			47						Rollerbit to 50'
			48						Hard drilling 48' - 50'
			49						
-40.6			50	S-11	SS	0	100/0"	100/0"	Spoon bouncing at 50'
	C-1: Black-white banded mica SCHIST, slightly fractured, partially weathered [NYCBC Class 1b]	5 5 4 5 4	50 - 55	C-1	NX CORE BARREL	REC=51"/60" =85%	RQD=42"/60" =70%		Spin 3" casing to 50'
	C-2: Black-white banded mica SCHIST, slightly fractured, partially weathered [NYCBC Class 1b]	5 4 3 6 7	55 - 60	C-2	NX CORE BARREL	REC=51"/60" =85%	RQD=46"/60" =77%		
	C-3: Black-white banded mica SCHIST, one break, no weathering [NYCBC Class 1a]	6 6 4 5 6	60 - 65	C-3	NX CORE BARREL	REC=53"/60" =88%	RQD=53"/60" =88%		
	C-4: Black-white banded mica SCHIST, no fractures [NYCBC Class 1a]	5 6 6 6 10	65 - 70	C-4	NX CORE BARREL	REC=56"/60" =93%	RQD=56"/60" =93%		Borehole backfilled with cuttings and surface patched upon completion
-60.6	End of boring at 70'		70						

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Log of Boring **G-9** Sheet 1 of 3

Project	Hudson Yards - WRY	Project No.	170444101
Location	LIRR West Side Yard, Manhattan, NY	Elevation and Datum	Approx. 15.1 NAVD88
Drilling Company	Warren George, Inc.	Date Started / Date Finished	10/13/04 / 10/13/04
Drilling Equipment	DK-50 Track Rig	Completion Depth / Rock Depth	59 ft / 39 ft
Size and Type of Bit	3 7/8" Tri-Cone Rollerbit	Number of Samples	Disturbed 8 Undisturbed 0 Core 4
Casing Diameter (in) / Casing Depth (ft)	3"/4" Flush Joint Steel / 39	Water Level (ft.)	First ▽ Completion ▼ 24 HR. ▽
Casing Hammer / Weight (lbs) / Drop (in)	Donut / 300 / 30	Drilling Foreman	Robert Ware
Sampler	2" O.D. Split Spoon	Field Engineer	Clay Patterson
Sampler Hammer / Weight (lbs) / Drop (in)	Donut / 140 / 30		

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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.)
	+15.1									
▨	+14.6	6" Concrete Slab		0						
▨				1						Rollerbit through concrete Drill to 6' with water and no pressure on drill head
		Brown-black, medium to fine SAND, trace silt, trace brick, trace mica (Fill) [NYCBC Class 7]		2						
				3						Cuttings indicate Fill (sand and gravel)
				4						qu (tsf) obtained from Pocket Penetrometer
				5						
				6	S-1	SS	0	27 100/0"	100/0"	Install 4" casing to 5'
				7						
				8	S-2	SS	0	100/3"	100/3"	Rollerbit to 8' Lose of water at 8' Refusal at 8' - take sample
				9						
		S-3: Black-white-brown, coarse to medium SAND, trace brick (Fill) [NYCBC Class 7]		10	S-3	SS	4	100/5"	100/5"	Rollerbit to 10', hard drilling, cuttings indicate cobble Install 4" casing to 10' Rollerbit to 10'
				11						
				12						Rollerbit to 15' Hard drilling from 12' to 15'
				13						
				14						
		S-4: Black-white-brown, coarse to medium SAND, trace brick (Fill) [NYCBC Class 7]		15	S-4	SS	4	100/4"	100/4"	
				16						
				17						Rollerbit to 20' Hard drilling from 15' to 18'
				18						
				19						
				20						

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Log of Boring **G-9** Sheet 2 of 3

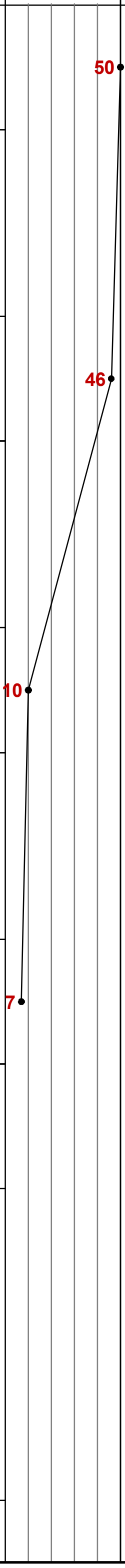
Project: Hudson Yards - WRY

Project No.: 170444101

Location: LIRR West Side Yard, Manhattan, NY

Elevation and Datum: Approx. 15.1 NAVD88

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data: Number	Sample Data: Type	Sample Data: Recov. (in)	Sample Data: Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
-4.9	S-5: Brown, coarse to fine SAND, some fine gravel, trace silt (Fill) [NYCBC Class 7]		20 - 22	S-5	SS	14	17 21 29 31	50	
			22 - 25						Rollerbit to 25' Cannot advance 4" casing past 10', spin 3" casing to 25'
	S-6: Brown, coarse to medium SAND, some fine gravel, trace silt (Fill) [NYCBC Class 7]		25 - 27	S-6	SS	8	14 19 27 26	46	
			27 - 30						Spin 3" casing to 30' Rollerbit to 30'
-13.4	S-7: Grey, organic CLAY (OH), trace medium to fine sand [NYCBC Class 4b]		30 - 32	S-7	SS	15	14 7 3 3	10	
			32 - 35						Spin 3" casing to 35' Rollerbit to 35'
	S-8: No recovery		35 - 37	S-8	SS	0	6 4 3 5	7	
			37 - 39						Rollerbit to 39' Refusal at 39' Spin 3" casing to 39'
-23.9	C-1: Black and white banded mica SCHIST, partially weathered, slightly fractured [NYCBC Class 1b]	4 5 5 6 5	39 - 44	C-1	NX CORE BARREL	REC=55"/60" =92%	RQD=48"/60" =80%		
		6	44 - 45	C-2					



Project	Project No.
Hudson Yards - WRY	170444101
Location	**Elevation and Datum**
LIRR West Side Yard, Manhattan, NY	Approx. 15.1 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.)
	-29.9	C-2: Black and white banded mica SCHIST, slightly weathered, slightly fractured [NYCBC Class 1a]	7 7 6 6	45 46 47 48	C-2	NX CORE BARREL	REC=57"/60" =95%	RQD=54"/60" =90%		
		C-3: Black and white banded mica SCHIST, slightly weathered, slightly fractured [NYCBC Class 1a]	6 5 5 6 7	49 50 51 52 53	C-3	NX CORE BARREL	REC=57"/60" =95%	RQD=53"/60" =88%		
		C-4: Black and white banded mica SCHIST, slightly weathered, slightly fractured [NYCBC Class 1a]	6 7 6 5 5	54 55 56 57 58	C-4	NX CORE BARREL	REC=60"/60" =100%	RQD=54"/60" =90%		
	-43.9	End of boring at 59'		59 60 61 62 63 64 65 66 67 68 69 70						Borehole backfilled with cuttings and surface patched upon completion

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Log of Boring **LB-1** Sheet 1 of 8

Project: Platform Test Caissons		Project No.: 170444101	
Location: Hudson Yards - West Rail Yard, Manhattan, NY		Elevation and Datum: Approx. 7 feet NAVD 88	
Drilling Company: Craig Geotechnical Drilling Co., Inc		Date Started: 10/23/17	Date Finished: 10/27/17
Drilling Equipment: CME75 Truck Rig		Completion Depth: 177 ft	Rock Depth: 137 ft
Size and Type of Bit: 3-7/8 inch Tricone Roller Bit		Number of Samples: Disturbed 27; Undisturbed 6; Core 40	
Casing Diameter (in): 4	Casing Depth (ft): 25	Water Level (ft.): First ▽ 9; Completion ▼; 24 HR. ▼	
Casing Hammer: Automatic; Weight (lbs): 140; Drop (in): 30		Drilling Foreman: Eric Delmeier	
Sampler: 2-inch-diameter split spoon; Shelby Tube; Macrocore		Field Engineer: Thomas Androutselis	
Sampler Hammer: Automatic; Weight (lbs): 140; Drop (in): 30			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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.)
■	+7.0 +6.5	About 6 inches asphalt		0						Clear for utilities for the upper 8.0ft. with vacuum truck on 10/20/17 Started Drilling at 10/23/2017 12:00 PM
▩				2						Push casing to 2.0ft., Drive casing to 5.0ft. (~100 blows)
▩		Brown to black silty fine SAND, some fine gravel, trace brick (from vacuum cuttings) [FILL] [NYC BC Class 7]		4						Drive casing to 10.0ft. (~160 blows)
▩				6						Drill to 8.0ft. without taking samples, Brown and black wash
▩		Brown to black silty fine SAND, trace fine gravel (wet) [FILL] [NYC BC Class 7]	▽	8	S-1	SS	12	8 7 4 4	11	PID reading=0
▩		Brown to black silty fine SAND, trace fine gravel (wet) [FILL] [NYC BC Class 7]		10	S-2	SS	15	8 5 9 12	14	PID reading=0
▩				12						Drive casing to 15.0ft. (~250 blows)
▩		Gray fine GRAVEL, some silty fine sand (wet) [FILL] [NYC BC Class 7]		15	S-3	SS	16	31 26 35 23	61	Drill to 15.0ft., Brown and black wash, Light rig chatter
▩				17						Drive casing to 20.0ft. (~83 blows)
▨	-11.0			18						Change in drilling at around 18.0ft., from light rig chatter to smooth drilling, probably start of clay layer
				20						

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 7 feet NAVD 88

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.)
	-13.0			20						
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		20–22	S-4	SS	24	WOH WOH WOH WOH		Drill to 20.0ft., Black wash, Smooth drilling
				22–25						Push casing to 25.0ft
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		25–27	S-5	SS	24	WOH WOH WOH WOH		Drill to 25.0ft., Black wash, Smooth drilling
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		27–29	U-1	ST	24			Push a Shelby tube at 27.0ft.
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		29–31	S-6	SS	24	WOH WOH WOH WOH		
				31–35						
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		35–37	S-7	SS	24	WOH WOH WOH WOH		Drill to 35.0ft., Black wash, Smooth drilling
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		37–39	U-2	ST	20			Push a Shelby tube at 37.0ft.
		Black high-plasticity CLAY with organics and lenses of olive greyish brown silt, trace shells (wet) [CH] [NYC BC Class 6]		39–41	S-8	SS	24	WOH WOH WOH WOH		
				41–45						Stopped Drilling for the day at 10/23/2017 2:42 PM

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Log of Boring **LB-1** Sheet 3 of 8

Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7 feet NAVD 88

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						Drill to 45.0ft., Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		45–47	S-9	SS	24	WOR WOR WOR WOR		
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		47–49	U-3	ST	24			Push a Shelby tube at 47.0ft.
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		49–51	S-10	SS	24	WOR WOR WOR WOR		
▨				51–55						Drill to 55.0ft.,Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		55–57	S-11	SS	24	WOR WOR WOR WOR		
▨		Dark gray low-plasticity CLAY and lenses of fine sand, some shells (wet) [CL] [NYC BC Class 6]		57–59	U-4	ST	24			Push a Shelby tube at 57.0ft.
▨		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		59–61	S-12	SS	24	WOR WOR WOR WOR		
▨				61–65						Drill to 65.0ft., Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		65–67	S-13	SS	24	WOR WOR WOR WOR		
▨				67–70						

LANGAN Log of Boring **LB-1** Sheet 4 of 8

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 7 feet NAVD 88

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	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		70	S-14	SS	24	WOH WOH WOH WOH		Drill to 70.0ft., Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		72	U-5	ST	24			Push a Shelby tube at 72.0ft.
▨		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		74	S-15	SS	24	WOH WOH WOH WOH		
▨				76						Drill to 80.0ft., Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		80	S-16	SS	24	WOH WOH WOH WOH		
▨				82						Drill to 85.0ft., Gray wash, Smooth drilling
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		85	S-17	SS	24	WOH WOH WOH WOH		
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		87	U-6	ST	22			Push a Shelby tube at 87.0ft.
▨		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		89	S-18	SS	20	WOH WOH WOH WOH		
▨				91						
				95						

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Log of Boring **LB-1** Sheet 5 of 8

Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7 feet NAVD 88

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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			95						Drill to 95.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells, trace wood (wet) [CL] [NYC BC Class 6]		95–97	S-19	SS	18	WOH WOH WOH 2		
			97–100						Drill to 100.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells, trace wood (wet) [CL] [NYC BC Class 6]		100–102	S-20	SS	22	WOH 2 2 3	4	
			102–105						Drill to 105.0ft., Gray wash, Smooth drilling . S-21 at 105ft
	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		105–107	S-21	SS	24	WOH 1 2 5	3	
			107–110						Drill to 110.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		110–112	S-22	SS	24	3 1 2 3	3	
			112–115						Drill to 115.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		115–117	S-23	SS	24	WOR WOR WOR WOR		
			117–120						

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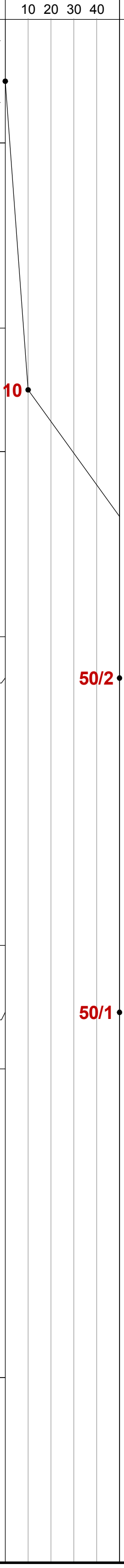
Log of Boring **LB-1** Sheet 6 of 8

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 7 feet NAVD 88

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			120						Drill to 120.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		120–122	S-24	SS	24	WOR WOR WOR WOR		
			122–125						Drill to 125.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand, some wood (wet) [CL] [NYC BC Class 6]		125–127	S-25	SS	24	WOH 4 6 8	10	
			127–129						Drill to 129.0ft., Gray wash, Smooth drilling, At around 129 ft heavy rig chatter
-122.0	Dark reddish brown SILT, some fine sand [ML] [completely decomposed rock] [NYC BC Class 1D] (wet)		129						
			130	S-26	SS	5	30 50/2	50/2	
			131–135						Drill to 135.0ft., Brown wash, Heavy rig chatter
	Gray and dark brown SILT, some fine sand [completely decomposed rock] [ML] [NYC BC Class 1D] (wet)		135–136	S-27	SS	12	45 60 50/1	50/1	
-130.0	Gray fine to coarse grained muscovite-biotite-garnet gneissic SCHIST, slightly weathered, close to moderate fracture spacing, fractures steeply dipping to shallow dipping [NYC BC Class 1B]	4:54 2:19 3:07 3:47 2:51	137–142	C-1	NX Core	REC=56"/60" =93%	RQD=37"/60" =62%		Start coring rock @137ft, C-1 at 137ft
	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, slightly weathered, close to moderate fracture spacing, fractures steeply dipping to shallow dipping [NYC BC Class 1B]	2:45 2:26 2:22	142–145	C-2	NX Core	REC=56"/60" =93%	RQD=44"/60" =73%		C-2 at 142ft



Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7 feet NAVD 88

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		2:05 2:34	145 146	C-2	NX Core				
-140.0	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, moderately weathered, very close to close fracture spacing, fractures near vertical to near horizontal, dark greenish and black quartz-biotite-hornblende amphibolite from 148' to 150', granulite intrusion at around 150' [NYC BC Class 1D]	2:25 2:48 2:36 3:03 2:44	147 148 149 150 151	C-3	NX Core	REC=60"/60" =100%	RQD=18"/60" =30%		C-3 at 147ft
-145.0	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, slightly weathered, close to moderate fracture spacing, fractures steeply dipping to shallow dipping [NYC BC Class 1C]	3:05 3:12 4:01 4:06 4:08	152 153 154 155 156	C-4	NX Core	REC=45"/60" =75%	RQD=26"/60" =43%		C-4 at 152ft
-150.0	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, moderately weathered, close fracture spacing, fractures near vertical to near horizontal [NYC BC Class 1D]	4:02 4:10 4:25 4:12 4:44	157 158 159 160 161	C-5	NX Core	REC=20"/60" =33%	RQD=10"/60" =17%		C-5 at 157ft
-155.0	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, slightly weathered, close to moderate fracture spacing, fractures steeply dipping [NYC BC Class 1C]	4:30 4:16 4:32 4:16 4:05	162 163 164 165 166	C-6	NX Core	REC=54"/60" =90%	RQD=29"/60" =48%		C-6 at 162ft
	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, slightly weathered, close to moderate fracture spacing, fractures steeply dipping [NYC BC Class 1B]	4:50 4:40 4:36	167 168 169 170	C-7	NX Core	REC=60"/60" =100%	RQD=42"/60" =70%		C-7 at 167ft

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Log of Boring **LB-1** Sheet 8 of 8

Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7 feet NAVD 88

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.)
-163.0	Gray fine to coarse grained muscovite-biotite-garnet SCHIST, slightly weathered, close to moderate fracture spacing, fractures shallow dipping [NYC BC Class 1B]		170						
		4:52		C-7	NX Core				
		4:25	171						
		4:45	172	C-8	NX Core	REC=58"/60" =97%	RQD=46"/60" =77%		C-8 at 172ft
		4:20	173						
		4:25	174						
		4:39	175						
		4:58	176						
-170.0			177						Bottom of boring at 177.0ft. Boring was backfilled and grouted.
			178						
			179						
			180						
			181						
			182						
			183						
			184						
			185						
			186						
			187						
			188						
			189						
			190						
			191						
			192						
			193						
			194						
			195						

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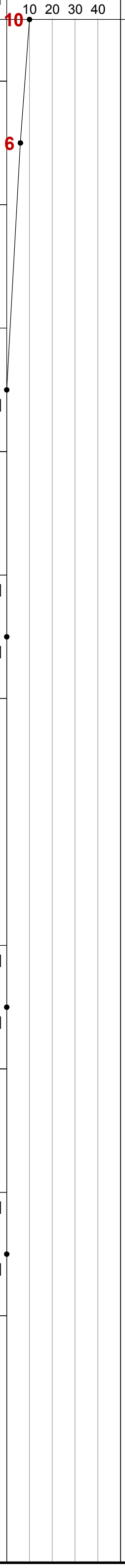
Log of Boring **LB-2** Sheet 1 of 5

Project	Platform Test Caissons			Project No.	170444101	
Location	Hudson Yards - West Rail Yard, Manhattan, NY			Elevation and Datum	Approx. 7.5 feet NAVD 88	
Drilling Company	Craig Geotechnical Drilling			Date Started	10/27/17	Date Finished 11/3/17
Drilling Equipment	CME75 Truck Rig			Completion Depth	117 ft	Rock Depth 77 ft
Size and Type of Bit	3-7/8 inch Tricone Roller Bit			Number of Samples	Disturbed 17	Undisturbed 5 / Core 40
Casing Diameter (in)	4	Casing Depth (ft)	77	Water Level (ft.)	First ▽ 9	Completion ▼ / 24 HR. ▽
Casing Hammer	Automatic	Weight (lbs) 140	Drop (in) 30	Drilling Foreman	Eric Delmeier	
Sampler	2-inch-diameter split spoon; Shelby Tube; Macrocore					
Sampler Hammer	Automatic	Weight (lbs) 140	Drop (in) 30	Field Engineer	Thomas Androutselis	

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
	+7.5			0						
■	+7.0	About 6 inches asphalt		0–0.5						Clear for utilities for the upper 8.0ft. with vacuum truck on 10/20/17 Started Drilling at 10/27/2017
▨		Black medium SAND, some fine gravel, trace brick (from vacuum cuttings) [FILL] [NYC BC Class 7]		0.5–8						Drive casing to 5.0ft. (~40 blows) Drive casing to 10.0ft. (~95 blows)
▨		Black silty fine SAND, trace fine gravel (wet) [FILL] [NYC BC Class 7]	▽	8–10	S-1	SS	8	3 4 4 2	8	Drill to 8.0ft. without taking any samples
▨		Black silty fine SAND, trace fine gravel (wet) [FILL] [NYC BC Class 7]		10–12	S-2	SS	10	2 2 4 7	6	
▨				12–15						
▨		Gray silty medium to fine SAND, some fine gravel (wet) [FILL] [NYC BC Class 7]		15–17	S-3	SS	8	3 2 2 3	4	Push casing to 15.0ft. Drill to 15.0ft., Gray wash, Smooth drilling
▨		Gray silty medium to fine SAND, some fine gravel (wet) [FILL] [NYC BC Class 7]		17–19	S-4	SS	6	3 4 4 4	8	
▨				19–20	S-5	SS	8	4 5	10	

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 7.5 feet NAVD 88

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Sample Data					Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
					Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	
	-12.5	Greenish brown fine SAND, some silt, trace fine gravel (wet) [FILL] [NYC BC Class 7]		20	S-5	SS	8	5 5	10	Push casing to 20.0ft., clean out the hole Drill to 15.0ft., Gray wash, Smooth drilling
		Greenish brown fine SAND, some silt, trace fine gravel, trace wood (wet) [FILL] [NYC BC Class 7]		21	S-6	SS	10	2 3 3 4	6	
				23						
	-17.5	Black high-plasticity CLAY with organics and lenses of olive greyish brown silt (wet) [CH] [NYC BC Class 6]		25	S-7	SS	18	1 WOH WOH WOH		Push casing to 25.0ft. Drill to 25.0, Gray wash, Smooth drilling
				27	U-1	ST	24			Push a Shelby tube at 27.0ft.
		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		29	S-8	SS	18	WOH WOH WOH WOH		
				31						
		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		35	S-9	SS	24	WOH WOH WOH WOH		Drill to 35.0, Gray wash, Smooth drilling
				37	U-2	ST	24			Push a Shelby tube at 37.0ft.
		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		39	S-10	SS	24	WOH WOH WOH WOH		
				41						
				45						



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Log of Boring **LB-2** Sheet 3 of 5

Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7.5 feet NAVD 88

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.)
▨	-37.5	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		45	S-11	SS	24	WOR WOR WOR WOR		Drill to 45.0ft., gray wash, smooth drilling
				47	U-3	ST	24			Push a Shelby tube at 47.0ft.
		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		49	S-12	SS	24	WOH WOH WOH WOH		
				51						Drill to 55.0ft., Gray wash, Smooth drilling
		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		55	S-13	SS	24	WOH WOH WOH WOH		
		No Recovery		57	U-4	ST	0			Push a Shelby tube at 57.0ft.
		Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		59	S-14	SS	24	WOR WOR WOR WOH		
				61						Drill to 65.0ft., Gray wash, Smooth drilling
		Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		65	S-15	SS	24	WOH WOH WOH WOH		
				67	U-5	ST	24			Push a Shelby tube at 67.0ft.
				69	S-16	SS	24	WOH WOH		
				70						

Project	Project No.
Platform Test Caissons	170444101
Location	**Elevation and Datum**
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 7.5 feet NAVD 88

Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft)	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
-62.5	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		70	S-16	SS	24	WOH WOH		
-64.5	Dark reddish brown SILT, some fine sand [ML] [completely decomposed rock] [NYC BC Class 1D] (wet)		72						
			75	S-17	SS	19	11 50/2	50/2	
-69.5	Gray gneissic SCHIST; slightly; moderate fracture spacing; fractures shallow dipping to near horizontal [NYC BC Class 1B]	4:20 4:16 4:34 4:28 4:49	77	C-1	NX Core	REC=54"/60" =90%	RQD=50"/60" =83%		Start coring rock at around 77.0ft C-1 at 77ft
	Gray gneissic SCHIST; slightly; moderate fracture spacing; fractures steeply dipping to near horizontal [NYC BC Class 1B]	4:25 4:10 4:56 4:28 4:37	82	C-2	NX Core	REC=56"/60" =93%	RQD=50"/60" =83%		C-2 at 82ft
	Gray gneissic SCHIST; fresh; moderate to wide fracture spacing; fractures moderately dipping [NYC BC Class 1A]	2:40 2:45 3:01 2:25 2:35	87	C-3	NX Core	REC=53"/60" =88%	RQD=53"/60" =88%		C-3 at 87ft
	Gray gneissic SCHIST; moderately to highly weathered (from 94'-97'); close to moderate fracture spacing; fractures near vertical to near horizontal [NYC BC Class 1B]	2:02 1:47 2:20	92	C-4	NX Core	REC=49"/60" =82%	RQD=37"/60" =62%		C-4 at 92ft
			95						

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

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 7.5 feet NAVD 88

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.)
-87.5		1:55 2:02	95 96	C-4	NX Core				
	Gray gneissic SCHIST; slightly to moderately; close fracture spacing; fractures near vertical to near horizontal [NYC BC Class 1C]	2:05 1:50 1:45 2:03 2:10	97 98 99 100 101	C-5	NX Core	REC=50"/60" =83%	RQD=27"/60" =45%		C-5 at 97ft Push casing to 77 feet, Clean out the hole
	Gray gneissic SCHIST; slightly to moderately; close to moderate fracture spacing; fractures steeply dipping to near horizontal [NYC BC Class 1B]	2:08 1:56 1:33 1:42 2:06	102 103 104 105 106	C-6	NX Core	REC=45"/60" =75%	RQD=36"/60" =60%		C-6 at 102ft
-99.5	Gray gneissic SCHIST; moderately; close fracture spacing; fractures steeply dipping to near horizontal [NYC BC Class 1D]	3:20 3:45 3:12 3:16 3:39	107 108 109 110 111	C-7	NX Core	REC=40"/60" =67%	RQD=16"/60" =27%		C-7 at 107ft
-104.5	Gray gneissic SCHIST; fresh; close to wide fracture spacing; fractures moderately dipping to near horizontal [NYC BC Class 1B]	3:25 3:45 3:48 3:36 3:57	112 113 114 115 116	C-8	NX Core	REC=50"/60" =83%	RQD=50"/60" =83%		C-8 at 112ft
-109.5			117 118 119 120						Bottom of boring at 11/3/2017 Boring was backfilled and grouted

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Log of Boring **LB-3** Sheet 1 of 3

Project Platform Test Caissons		Project No. 170444101	
Location Hudson Yards - West Rail Yard, Manhattan, NY		Elevation and Datum Approx. 8.5 feet NAVD 88	
Drilling Company Craig Geotechnical Drilling		Date Started 11/2/17	Date Finished 11/3/17
Drilling Equipment CME75 Truck Rig		Completion Depth 68 ft	Rock Depth 38 ft
Size and Type of Bit 3-7/8 inch Tricone Roller Bit		Number of Samples: Disturbed 7; Undisturbed 2; Core 30	
Casing Diameter (in) 4	Casing Depth (ft) 38	Water Level (ft.): First ▽ 8.5; Completion ▼; 24 HR. ▼	
Casing Hammer Automatic; Weight (lbs) 140; Drop (in) 30		Drilling Foreman Eric Delmeier	
Sampler 2-inch-diameter split spoon; Shelby Tube; Macrocore		Field Engineer Thomas Androutselis	
Sampler Hammer Automatic; Weight (lbs) 140; Drop (in) 30			

MATERIAL SYMBOL	Elev. (ft)	Sample Description	Coring (min)	Depth Scale	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.)
■	+8.5	About 6 inches asphalt		0						Clear for utilities for the upper 8.0ft. with vacuum truck on 10/20/17 Started drilling at 11/2/2017
▩	+8.0	Black medium to coarse SAND, some fine gravel, trace brick (from vacuum cuttings) [FILL] [NYC BC Class 7]		4						Push casing to 5.0ft. Drive casing to 10.0ft. (~120 blows)
		▽ No Recovery		8	S-1	SS	0	5 3 1 1	4	Drill to 8.0ft., Gray and black wash, Smooth drilling. S-1 at 8ft
		Gray fine GRAVEL and SAND, trace silt (wet) [FILL] [NYC BC Class 7]		10	S-2	SS	6	3 2 1 1	3	Push casing to 15.0ft
				14						Drill to 15.0ft., Gray and black wash, Smooth drilling
		Gray medium to coarse SAND, some gravel, trace silt (wet) [FILL] [NYC BC Class 7]		15	S-3	SS	8	3 6 7 2	13	Push casing to 20.0ft
▨	-9.5			18						Change in drilling at around 18.0 ft., probably start of clay layer
				20						

Project Platform Test Caissons	Project No. 170444101
Location Hudson Yards - West Rail Yard, Manhattan, NY	Elevation and Datum Approx. 8.5 feet NAVD 88

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.)
-11.5	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		20–22	S-4	SS	16	WOH WOH WOH WOH		Drill to 20.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand (wet) [CL] [NYC BC Class 6]		22–24	U-1	ST	24			Push a Shelby tube at 22.0ft.
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		24–26	S-5	SS	24	WOH WOH WOH WOH		Push casing to 30.0ft
			26–30						Drill to 30.0ft., Gray wash, Smooth drilling
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		30–32	S-6	SS	24	WOH WOH WOH WOH		
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		32–34	U-2	ST	24			Push a Shelby tube at 32.0ft.
	Dark gray low-plasticity CLAY and lenses of fine sand, trace shells (wet) [CL] [NYC BC Class 6]		34–36	S-7	SS	24	WOH WOH WOH WOH		
			36–38						Push casing to 37.0ft., Drive casing to 38.0ft (~80 blows). Drill to 38.0ft., Gray wash, Smooth drilling Start coring rock at around 38.0ft
-29.5	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures near vertical to near horizontal; pegmatite intrusions from 39.5 to 40.0ft. [NYC BC Class 1B]	1:38 1:59 2:59 3:09 3:41	38–43	C-1	NX Core	REC=57"/60" =95%	RQD=48"/60" =80%		C-1 at 38ft
		1:50 2:48	43–45	C-2	NX Core				C-2 at 43ft

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Log of Boring **LB-3** Sheet 3 of 3

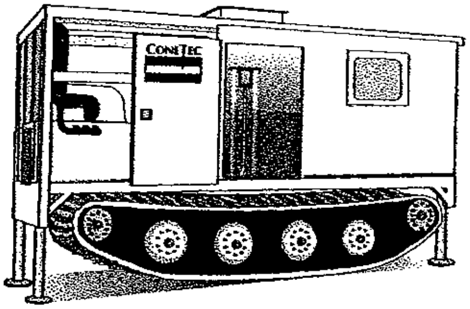
Project	Project No.
Platform Test Caissons	170444101

Location	Elevation and Datum
Hudson Yards - West Rail Yard, Manhattan, NY	Approx. 8.5 feet NAVD 88

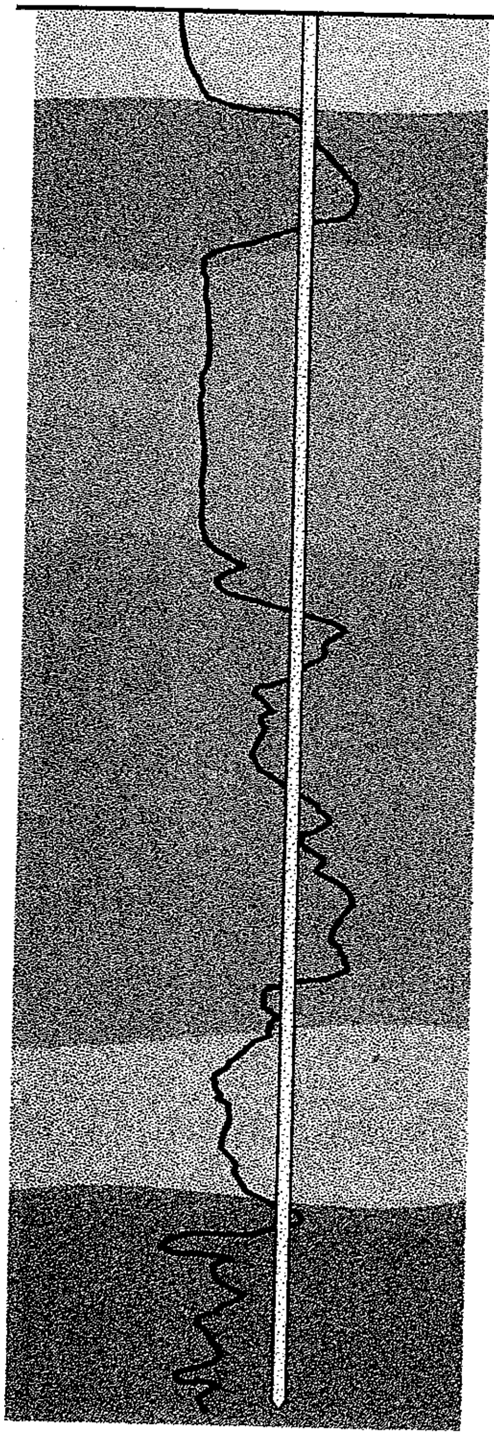
Elev. (ft)	Sample Description	Coring (min)	Depth Scale	Number	Type	Recov. (in)	Penetr. resist BL/6in	N-Value (Blows/ft) 10 20 30 40	Remarks (Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.)
-36.5	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures steeply dipping [NYC BC Class 1A]	3:23 2:58 7:25	45 46 47	C-2	NX Core	REC=57"/60" =95%	RQD=53"/60" =88%		
	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures steeply dipping; pegmatite intrusions from 52.0 to 52.5 ft. [NYC BC Class 1B]	3:24 4:26 4:48 5:36 7:24	48 49 50 51 52	C-3	NX Core	REC=55"/60" =92%	RQD=45"/60" =75%		C-3 at 48ft
	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures steeply dipping to shallow dipping [NYC BC Class 1A]	3:21 6:58 8:13 6:18 6:08	53 54 55 56 57	C-4	NX Core	REC=60"/60" =100%	RQD=53"/60" =88%		C-4 at 53ft
	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures shallow dipping to near horizontal [NYC BC Class 1B]	6:26 6:39 7:12 7:25 7:20	58 59 60 61 62	C-5	NX Core	REC=52"/60" =87%	RQD=46"/60" =77%		C-5 at 58ft
	Gray gneissic SCHIST; slightly weathered; close to moderate fracture spacing; fractures near horizontal [NYC BC Class 1A]	6:04 6:32 7:46 6:22 6:53	63 64 65 66 67	C-6	NX Core	REC=55"/60" =92%	RQD=53"/60" =88%		C-6 at 63ft
-59.5			68 69 70						Bottom of boring at 68.0 ft. Boring was backfilled and grouted.

APPENDIX B

2004 CPT Report



Geotechnical and Environmental In Situ Testing Contractors



ConeTec Field Report

Presentation of CPTU Test Results for:

Proposed Jets Stadium Manhattan, New York

Presented to:	Langan Engineering
Date:	December 7, 2004
Presented by:	ConeTec, Inc. 436 Commerce Lane, Unit C West Berlin, NJ (856) 767-8600

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FIGURES

APPENDICES

2.0 FIELD EQUIPMENT AND PROCEDURES

2.1 CONE PENETRATION TESTING

The cone penetrometer tests were carried out using an integrated electronic piezo cone manufactured by ConeTec in Vancouver, Canada. The piezo cone used was a compression model cone penetrometer with a 15 cm^2 tip and a 225 cm^2 friction sleeve. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85. The piezo cone dimensions and the operating procedure were in accordance with ASTM Standard D-3441. A diagram of the cone penetrometer used for this project is shown as Figure 1.

Pore pressure filter elements, made of porous plastic, were saturated under a vacuum using glycerin as the saturating fluid. The pore pressure element was six millimeters thick and was located immediately behind the tip (the U_2 location) for all soundings.

The cone was advanced using a 25-ton, unitized, truck-mounted cone penetration rig with high rail capabilities. The following data were recorded onto magnetic media every five centimeters (approximately every two inches) as the cone was advanced into the ground:

- Tip Resistance (Qc)
- Sleeve Friction (Fs)
- Dynamic Pore Pressure (Ut)

The field data recorded is included on the attached diskette (appendix E).

The principal objective of this project was to profile the soils and obtain shear wave velocity measurements.

Before each sounding a complete set of analog baseline readings are taken with a multimeter and compared with the digitized value on the computer screen. This provides a check on the analog to digital conversion board.

Evaluation of the analog baselines is key to consistent readings. The baseline data should be stable and should not wander excessively during the course of a sounding. Baseline data can be used to apply corrections to the cone data where necessary. For this project, the baseline shift from sounding to sounding was small, typically less than 0.1% of full scale, and no data corrections were applied.

During seismic testing, the seismic signals were recorded using a geophone mounted in the cone as shown in Figure 1 and an up-hole digital oscilloscope. A sledge hammer hit against a beam was used for the seismic source. Normal reaction for the beam was provided by the dead weight of the rig placed upon the beam. A schematic of the shear wave testing configuration is shown in Figure 2.

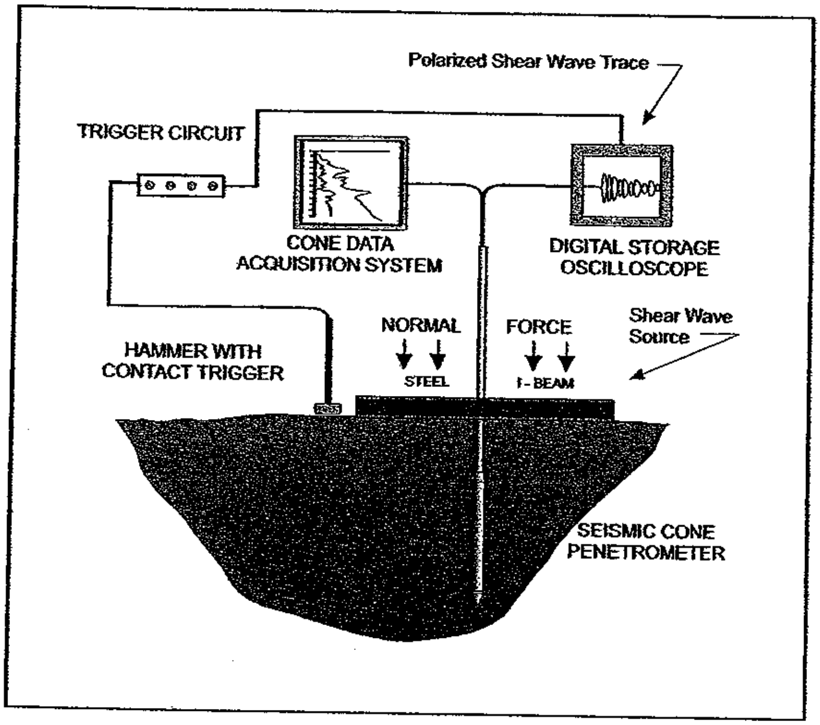


FIGURE 2 - SCHEMATIC OF SHEAR WAVE TESTING CONFIGURATION

2.2 PORE PRESSURE DISSIPATION TESTS

When cone penetration is stopped, the piezo cone essentially becomes a piezometer. While stopped, pore water pressures are automatically recorded at five-second intervals and the readings are stored in a dissipation file (.ppd). Dissipation data can then be plotted onto a dissipation curve consisting of pore water pressure (U) verses time (t). The shapes of dissipation curves are very useful in evaluating soil type, drainage and in situ static water level.

A flat curve that stabilizes quickly (i.e. less than 30 seconds) is typical of a free draining sand. In this case, the final measured pore water pressure is the static in situ water pressure.

Soils that generate excess dynamic pore water pressure during penetration will dissipate this excess pressure when penetration stops. The shape of the dissipation curve and the time of dissipation can be used to estimate C_h, the coefficient of consolidation that can in turn be used to calculate K_h, the horizontal permeability.

Figure 3 shows some idealized shapes of various pore water pressure dissipation curves. The reader is referred Robertson et. al., 1990 to reference dissipation test data analytical techniques.

3.0 CONE PENETRATION TEST DATA AND INTERPRETATION

3.1 ANALYSIS OF PIEZOCONE DATA - GENERAL

A total of 24 CPT soundings involving 1,378.10 feet of testing, were completed.

The interpretation of cone data is based on the relationship between cone bearing, Qc, sleeve friction, Fs, and penetration pore water pressure, U. The friction ratio, Rf , (sleeve friction divided by cone bearing) is a calculated parameter which is used to infer soil behavior type. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

The interpretation of soils encountered on this project was carried out using correlations developed by Robertson et al., 1986. It should be noted that it is not always possible to clearly identify a soil type based on Qc, Fs and Ut. Occasionally soils will fall within different soil categories on the classification charts. In these situations, experience and judgment and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type. Computer tabulations of the interpreted soil types along with certain other geotechnical parameters for each cone hole is presented in Appendix B.

Each of the parameters measured in the sounding is discussed briefly below. A detailed explanation of CPTU testing and interpretation of the results can be found in "Guidelines for Geotechnical Design Using CPT and CPTU" by P. K. Robertson and R. G. Campanella, listed in the references.

TIP RESISTANCE (Q_c): The resistance to penetration, measured at the cone tip, provides an accurate profile of subsurface strata. The recorded tip resistance is a composite of the penetration resistance of the soils located five to ten cone diameters (7 to 14 inches) in front of and behind the tip. The actual resistance "sensed" by the tip depends on the soil properties and on the relative stiffness of the layers encountered. Tip resistance is often corrected for pore pressure effects when testing in soft saturated cohesive soils.

For this project the correction was made and the tip resistance shown, Q_t is the corrected tip resistance.

The correction used is: $Q_t = Q_c + (1-a)U$

Where:
Q_t = corrected tip resistance
Q_c = measured tip resistance
a = net area ratio for cone (0.85 for this project)
U = dynamic pore water pressure measured behind tip

3.4 SHEAR WAVE VELOCITY MEASUREMENTS

Shear wave velocity measurements were conducted in sixteen of the CPT soundings at one-meter intervals. A tabular summary of the results and shear wave velocity plots are presented in Appendix C.

3.5 CPTSUMM DATA PROCESSING

The electronic data files were processed using the program CPTSUMM. CPTSUMM is a program developed by ConeTec to calculate common engineering parameters from CPT data. The processed data files are attached in Appendix B. The files are also included on the data disk. The calculations used are summarized in the table at the front of the Appendix. Each calculation is derived according to the referenced article. The water table used was an estimate derived from the dissipation data.

3.6 DATA DISK

One data disk is included in Appendix E. The disk includes all of the CPT, dynamic and static pore water pressure, and CPTSUMM data.

CONETEC

TABLE 1 - SUMMARY OF CPTU SOUNDINGS

Job No.: 04-797
Location: Jets Stadium - Manhattan, New York
Client: Langan Engineering
Date: October 11, 18, 19, November 11, 12, 13, 15, 16, 17, 18, 19, 2004

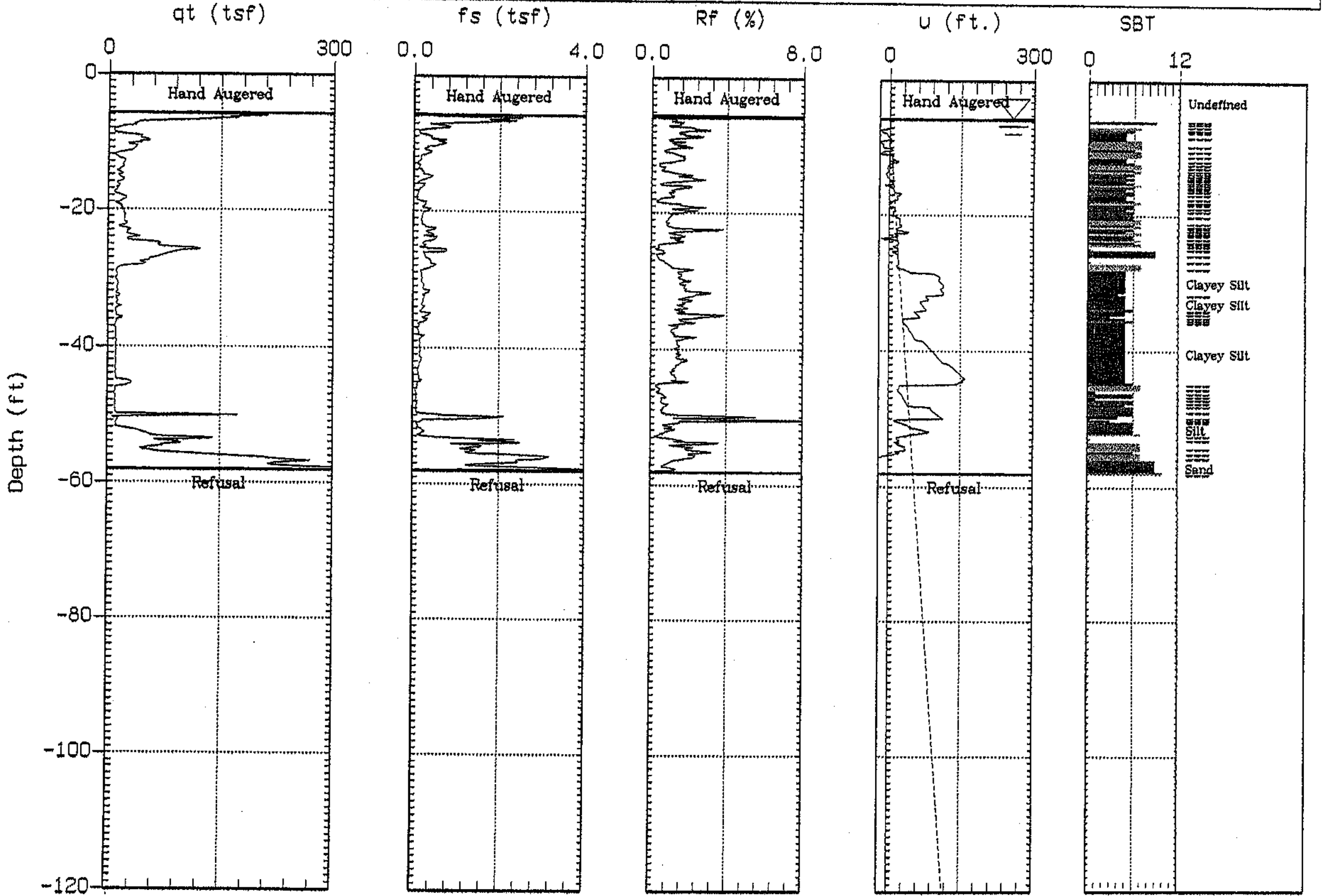
Date	CPTU Sounding	File Name	Total Depth (ft)	Seismic Tests	Comments
October 11, 2004	SCPT-11	797cp11.cor	83.99	24	
October 18, 2004	SCPT-12	797cp012.cor	58.07	16	
October 18, 2004	SCPT-24	797cp024.cor	76.28	22	
October 19, 2004	SCPT-25	797cp025.cor	39.53	11	
November 17, 2004	CPT-36	797cp36.cor	60.69	0	
November 18, 2004	CPT-38	797cp38.cor	36.09	0	
November 16, 2004	SCPT-41	797cp41.cor	102.85	29	
November 16, 2004	SCPT-42	797cp42.cor	74.97	21	combined 42 & 42A
November 17, 2004	SCPT-43	797cp43.cor	58.89	17	combined 43 & 43A
November 17, 2004	SCPT-44	797cp44.cor	42.98	10	combined 44 & 44A
November 17, 2004	SCPT-45	797cp45.cor	30.68	7	
November 17, 2004	SCPT-46	797cp46.cor	22.31	5	
November 13, 2004	CPT-54	797cp54.cor	77.75	0	
November 13, 2004	CPT-55	797cp55.cor	58.89	0	
November 15, 2004	CPT-56	797cp56.cor	46.42	0	
November 15, 2004	CPT-57	797cp57.cor	46.10	0	
November 15, 2004	CPT-58	797cp58.cor	36.42	0	
November 16, 2004	CPT-59	797cp59.cor	23.46	0	
November 19, 2004	SCPT-62	797cp62.cor	95.47	29	
November 11, 2004	SCPT-63	797cp63.cor	76.44	21	
November 12, 2004	SCPT-65	797cp65.cor	42.81	11	
November 12, 2004	SCPT-67	797cp67.cor	12.96	2	
October 19, 2004	SCPT-68	797cp068.cor	62.99	18	
November 18, 2004	SCPT-70	797cp70.cor	111.06	34	
Totals:	**24 holes**	**24 files**	**1378.10**	**277**	

CONETEC

Langan Engineering

Site:SCPT-12
Location:Jets Stadium

Cone:20 Ton AD139
Date:10:18:04 08:20



Max. Depth: 58.07 (ft)
Depth Inc.: 0.164 (ft)

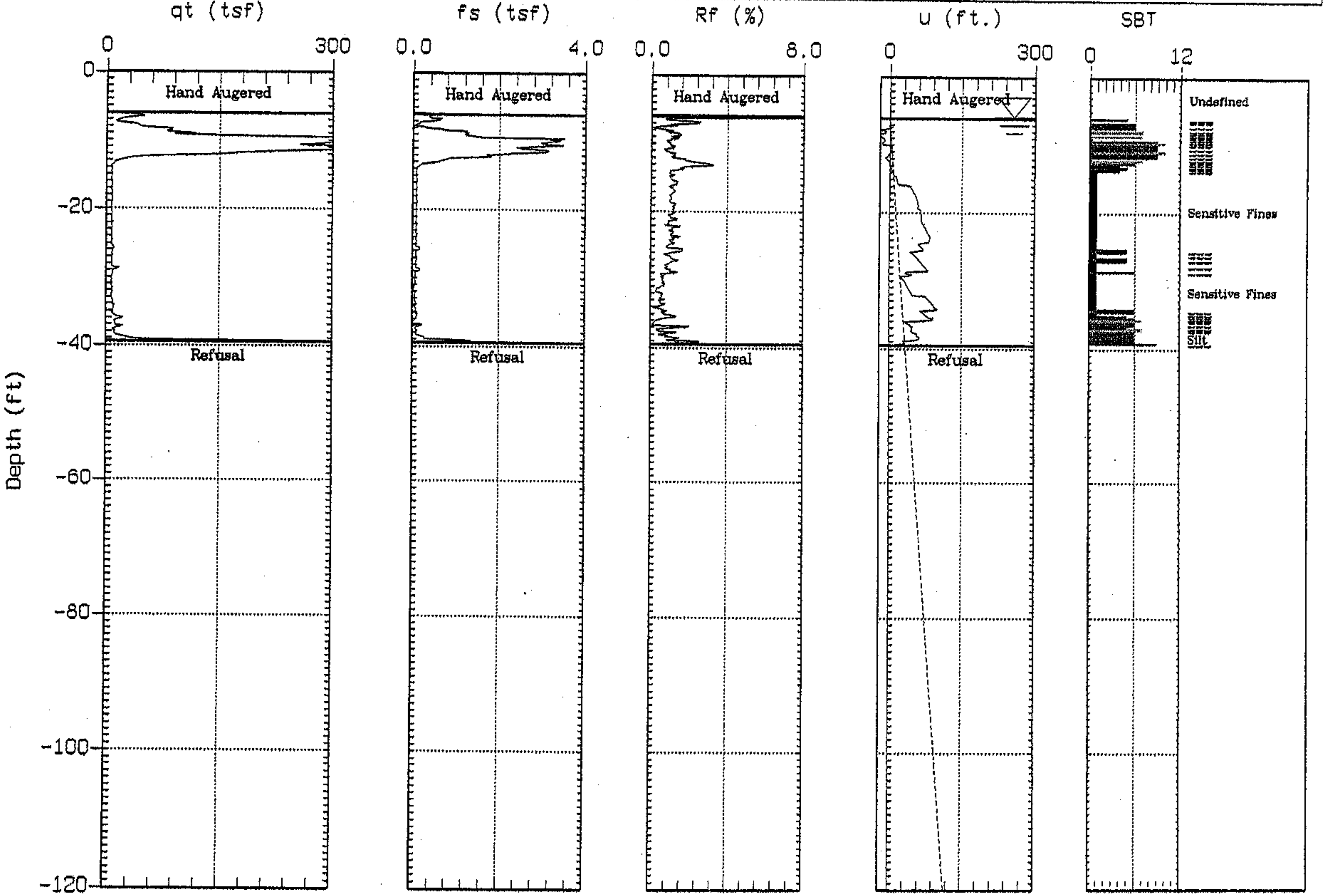
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-25
Location:Jets Stadium

Cone:20 Ton AD139
Date:10:19:04 08:09



Max. Depth: 39.53 (ft)
Depth Inc.: 0.164 (ft)

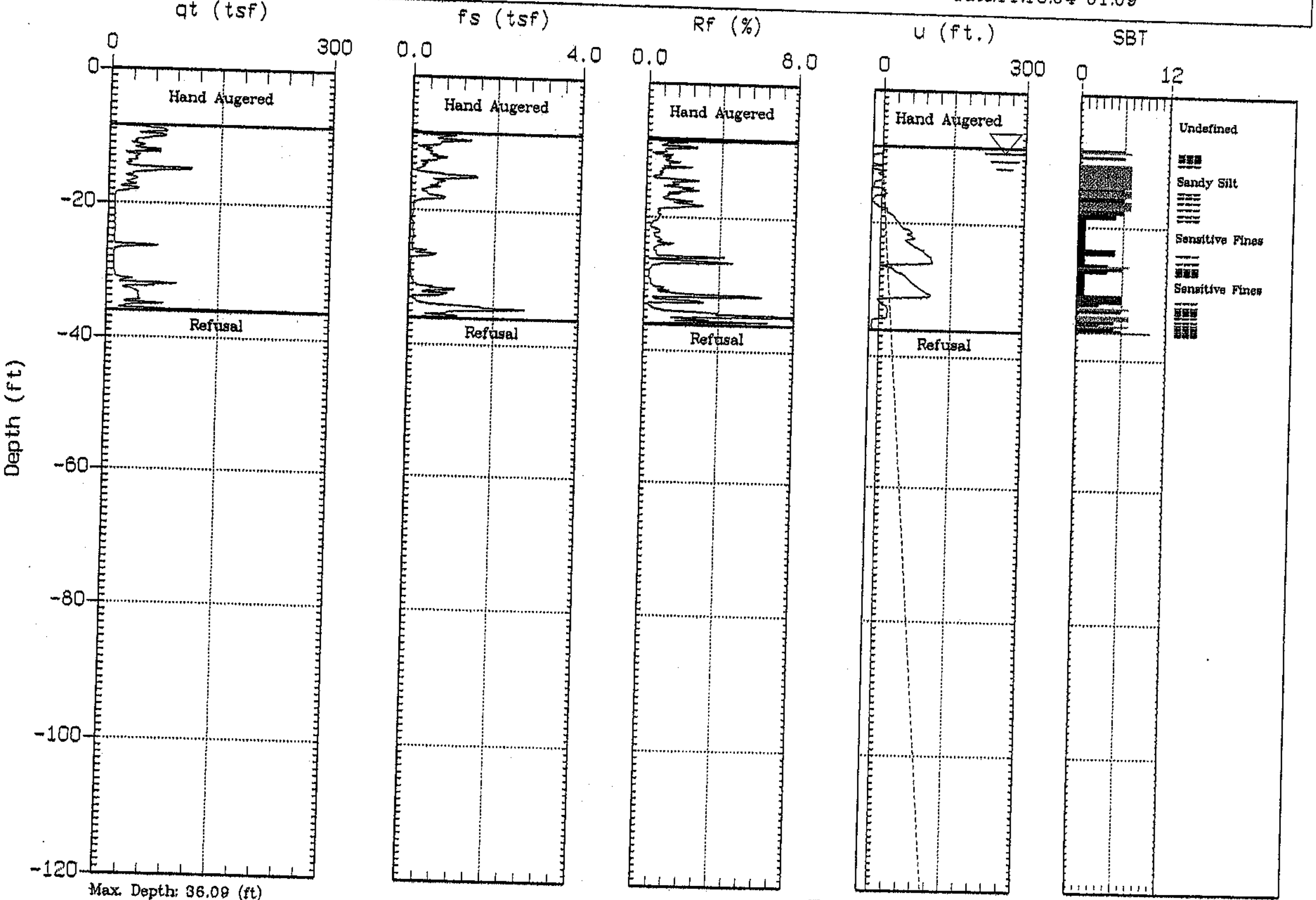
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:CPT-38
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:18:04 01:09



Max. Depth: 36.09 (ft)
Depth Inc.: 0.164 (ft)

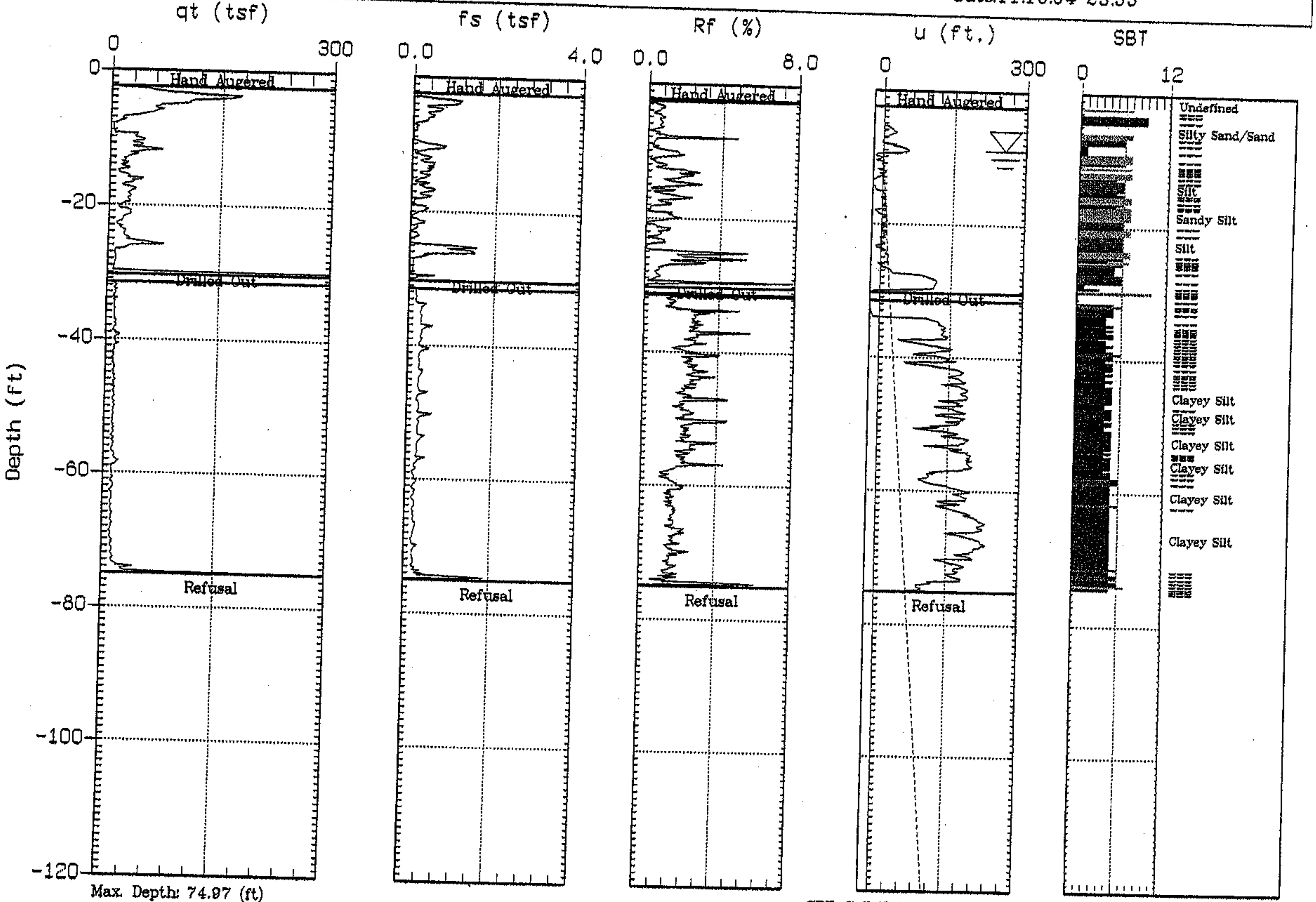
SBT: Soil Behavior Type (Robertson 1990)
▽ Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-42
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:16:04 23:55



Max. Depth: 74.97 (ft)
Depth Inc.: 0.164 (ft)

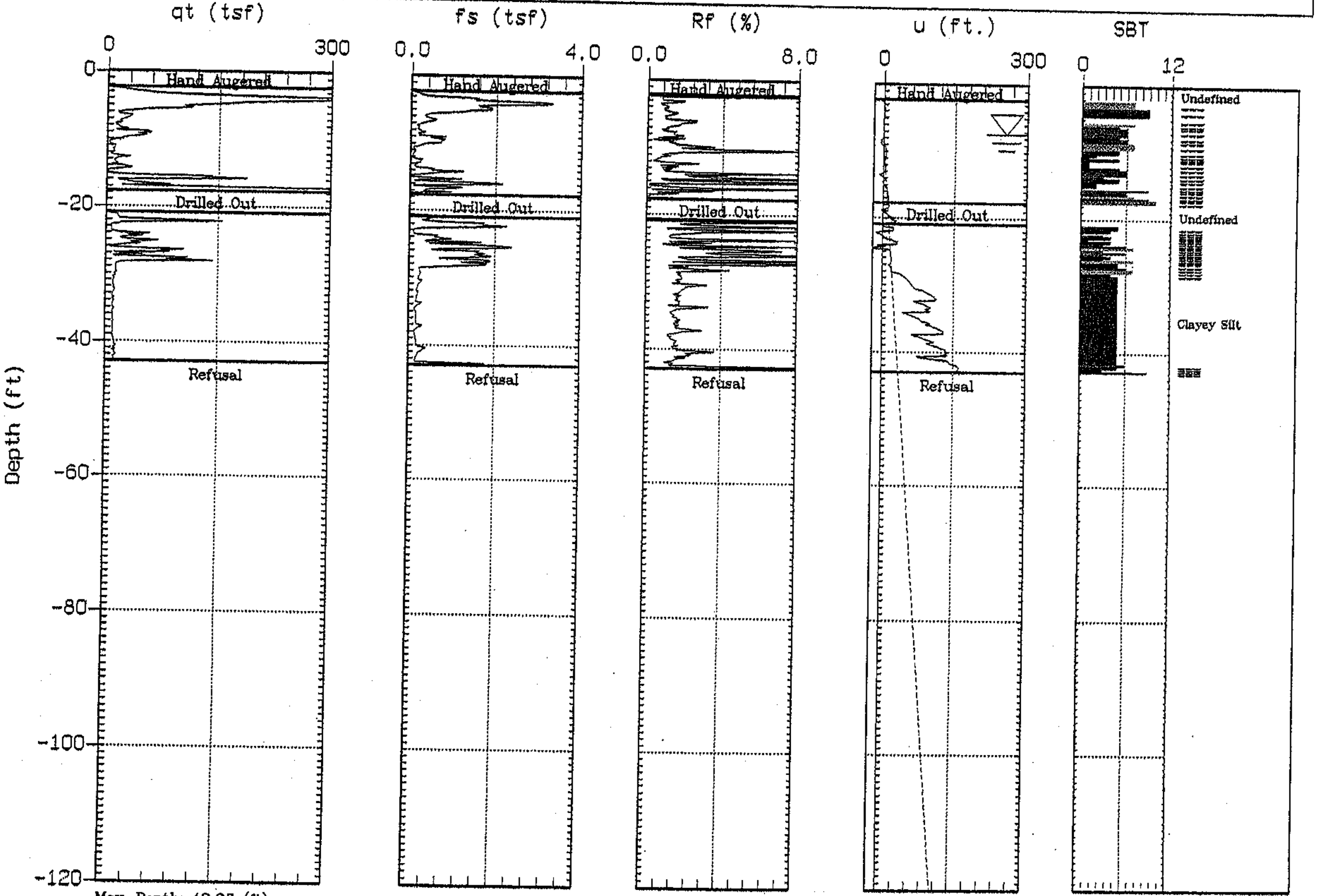
SBT: Soil Behavior Type (Robertson 1990)
▽ Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-44
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:17:04 01:42



Max. Depth: 42.98 (ft)
Depth Inc.: 0.164 (ft)

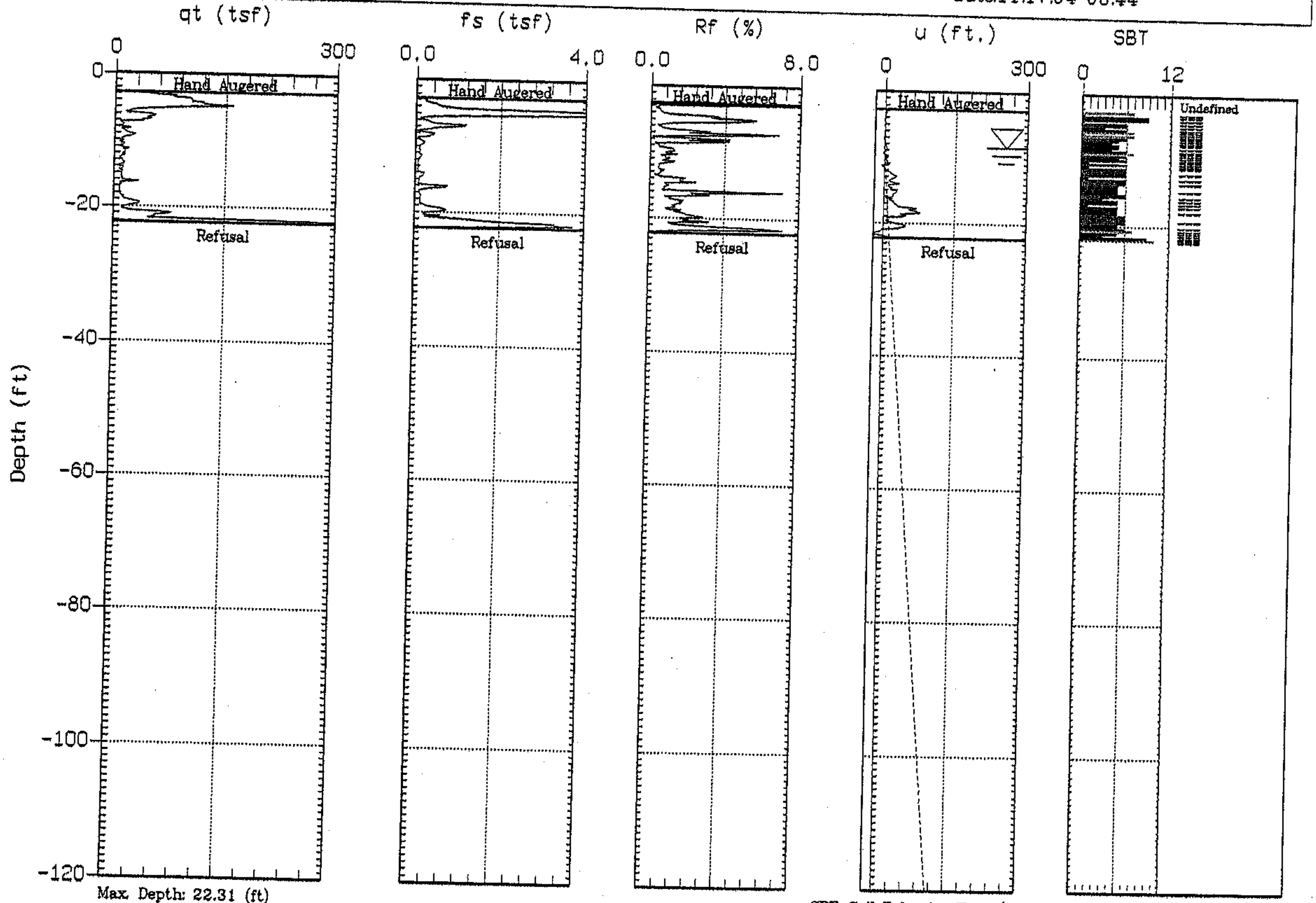
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-46
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:17:04 03:44



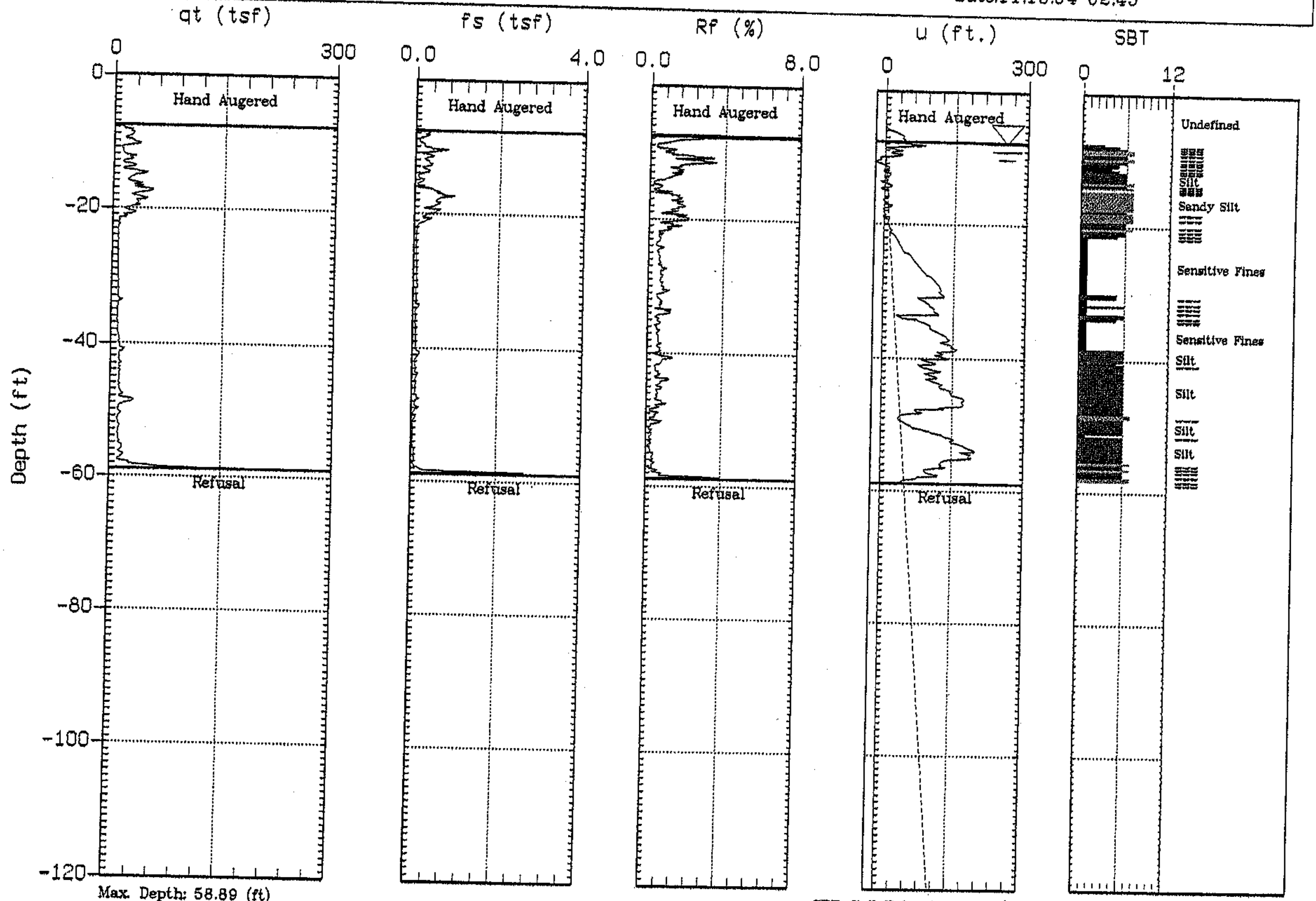
Max. Depth: 22.31 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
▽ Estimated Phreatic Surface

Langan Engineering

Site:CPT-55
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:13:04 02:45



Max. Depth: 58.89 (ft)
Depth Inc.: 0.164 (ft)

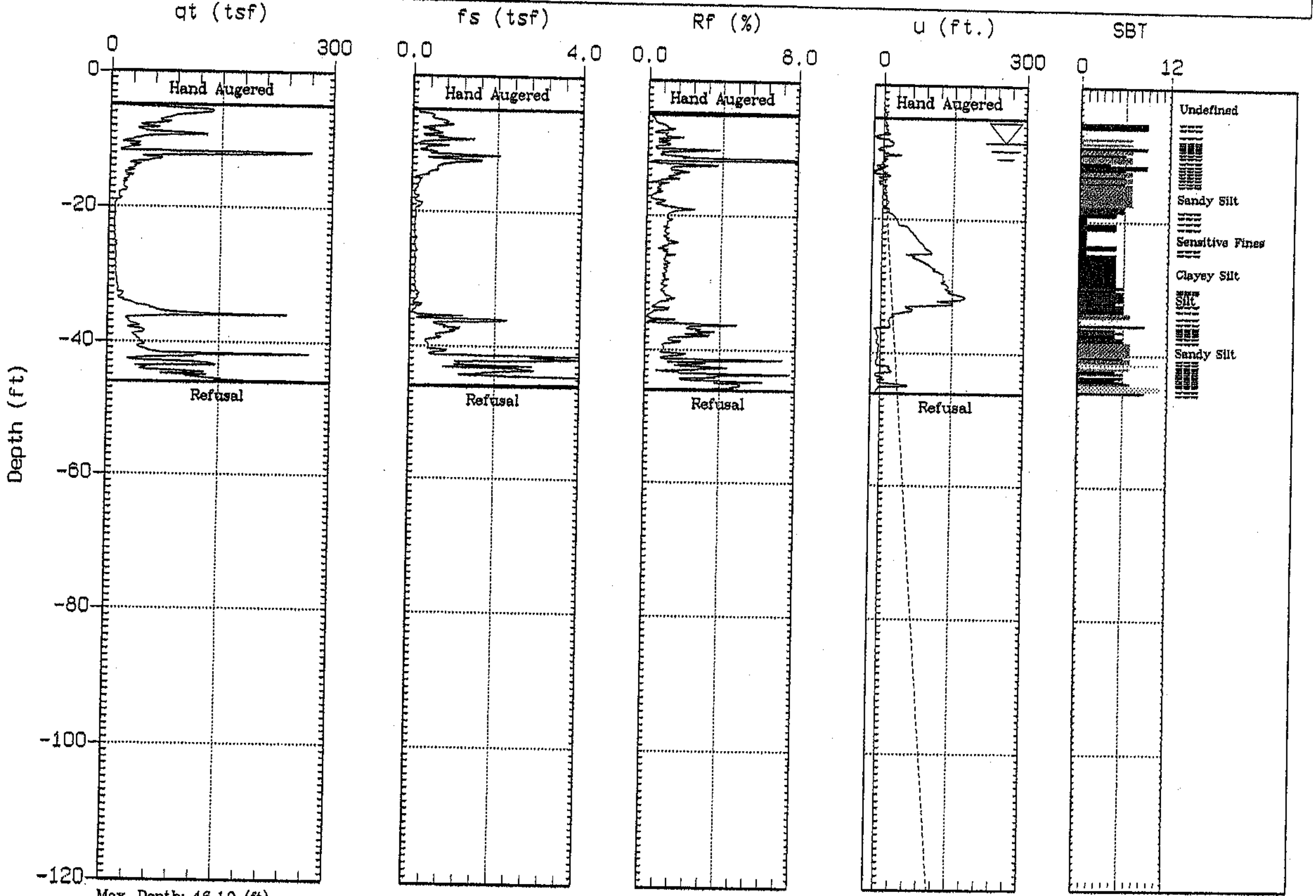
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:CPT-57
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:15:04 21:19



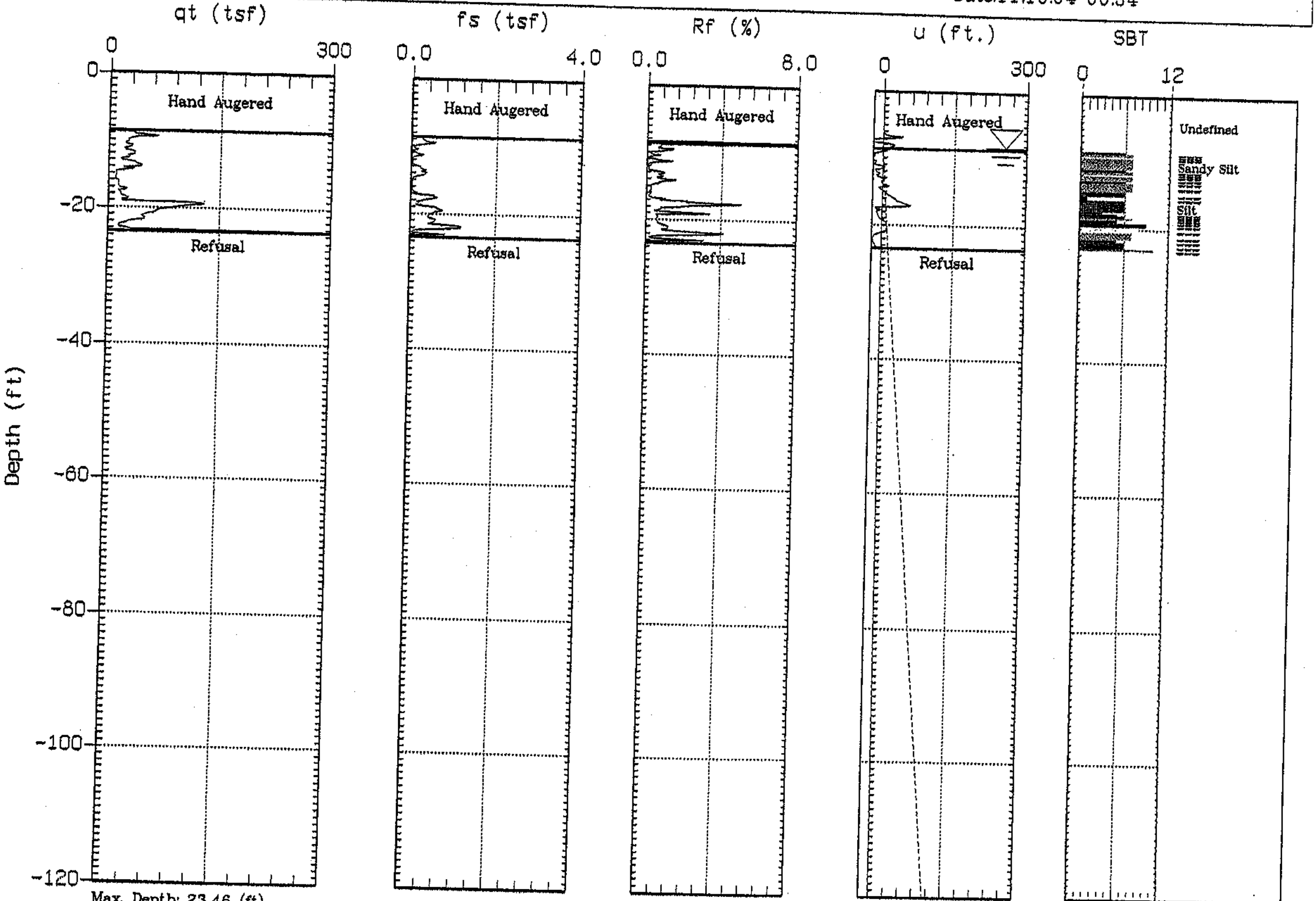
Max. Depth: 46.10 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
≚ Estimated Phreatic Surface

Langan Engineering

Site:CPT-59
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:16:04 00:34



Max. Depth: 23.46 (ft)
Depth Inc.: 0.164 (ft)

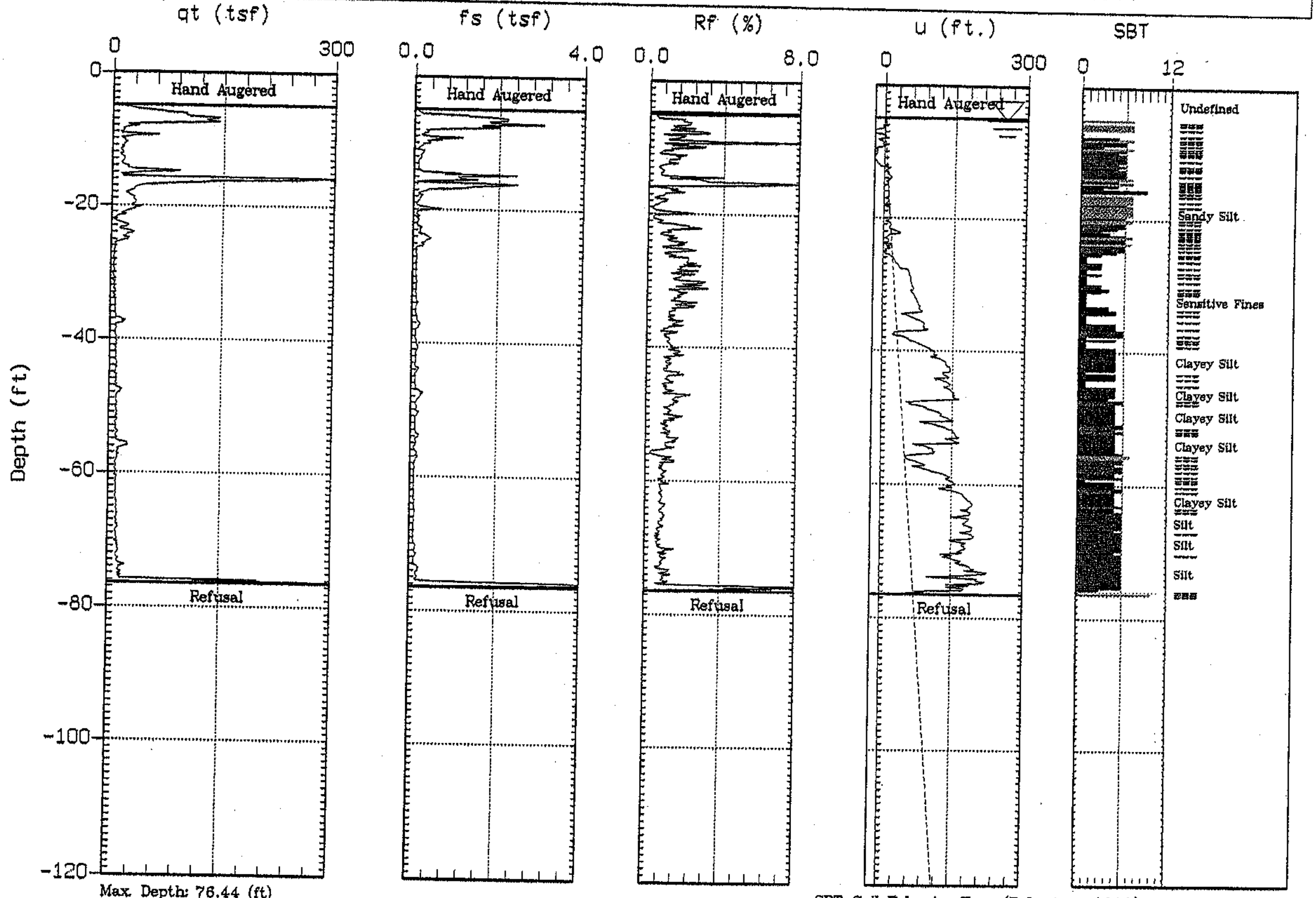
SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-63
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:11:04 23:52



Max. Depth: 76.44 (ft)
Depth Inc.: 0.164 (ft)

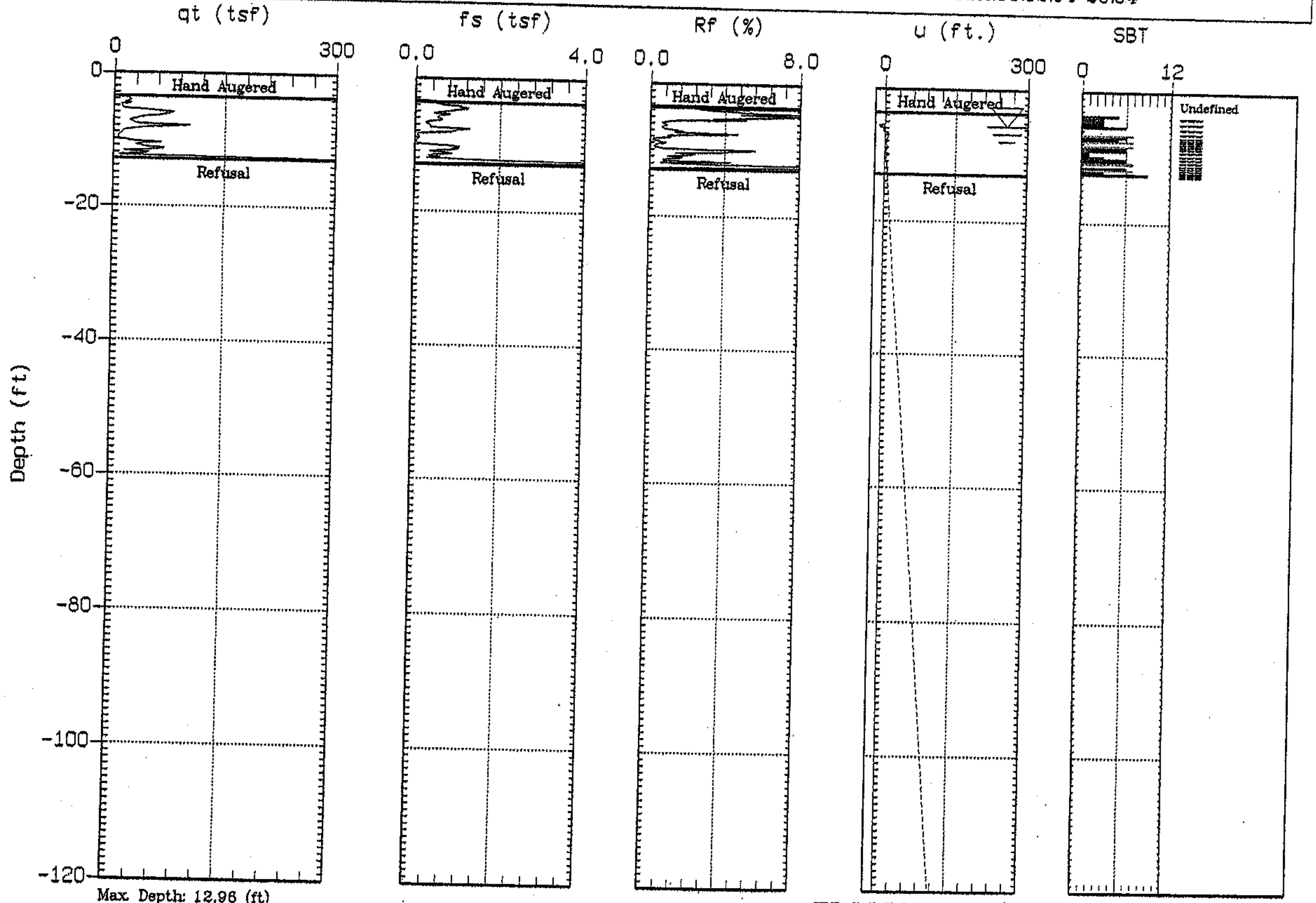
SBT: Soil Behavior Type (Robertson 1990)
⊽ Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-67
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:12:04 23:34



Max. Depth: 12.96 (ft)
Depth Inc.: 0.164 (ft)

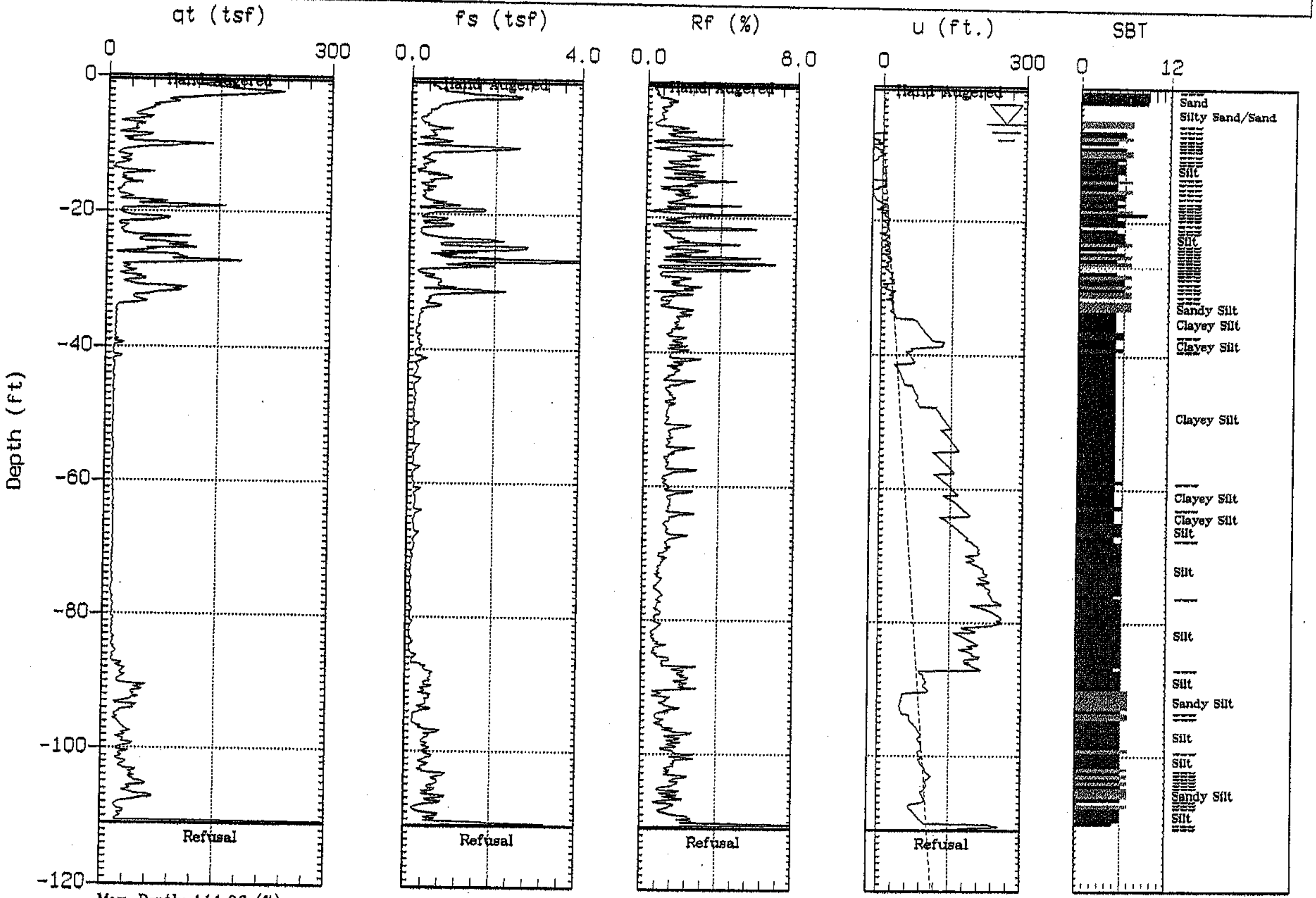
SBT: Soil Behavior Type (Robertson 1990)
▽ Estimated Phreatic Surface

CONETEC

Langan Engineering

Site:SCPT-70
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:18:04 21:06



Max. Depth: 111.06 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)
Estimated Phreatic Surface

FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-11

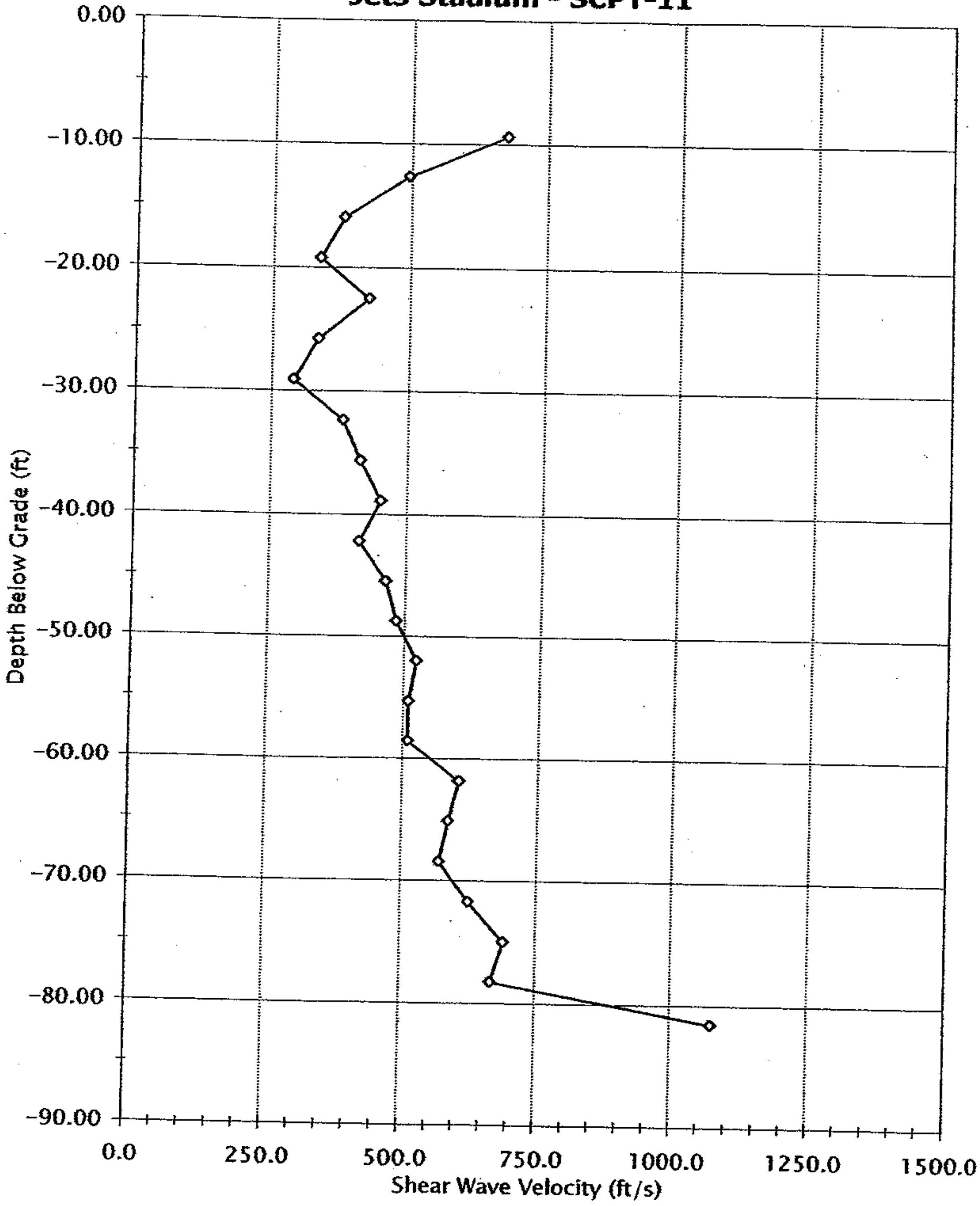


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-12

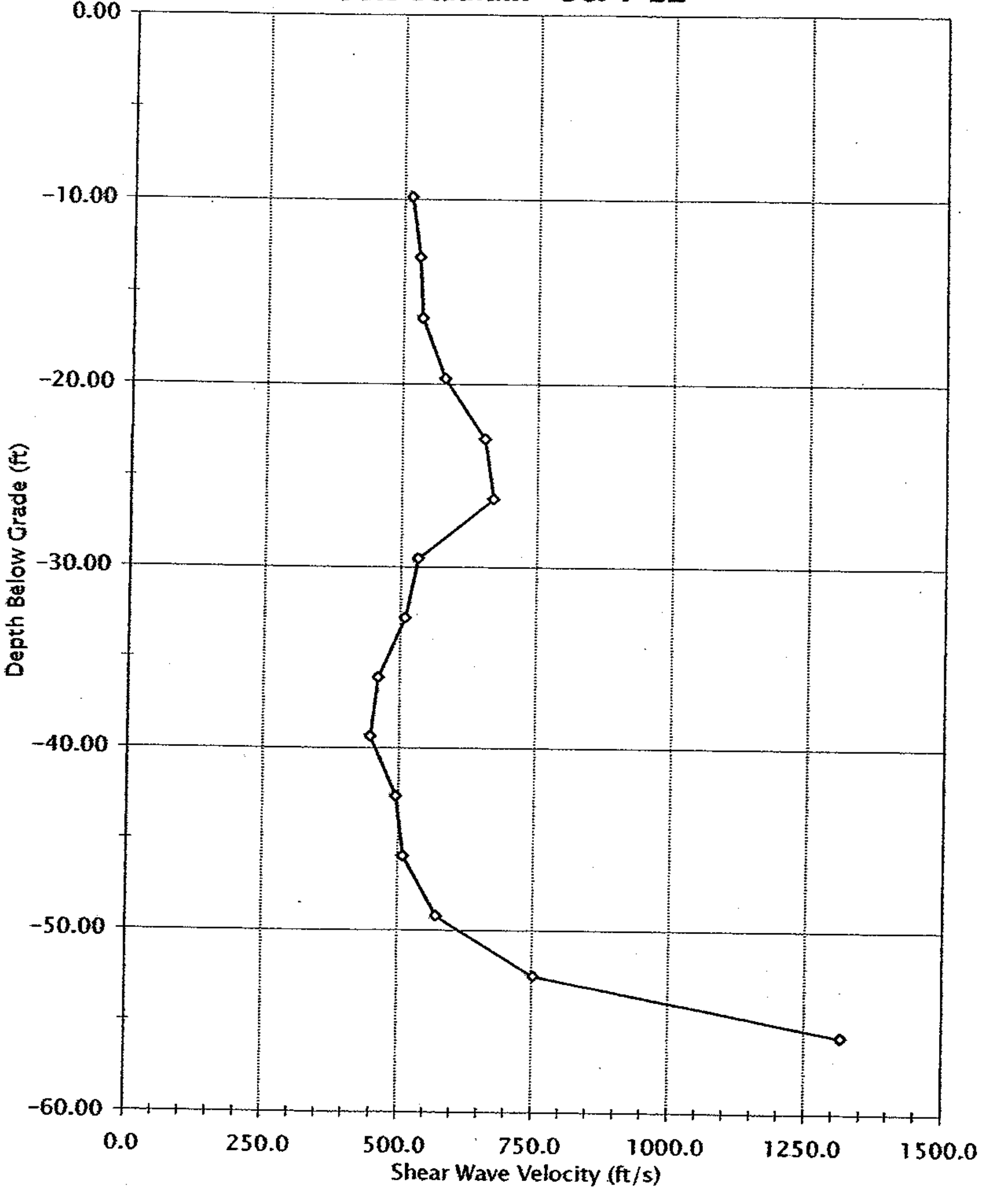


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-24

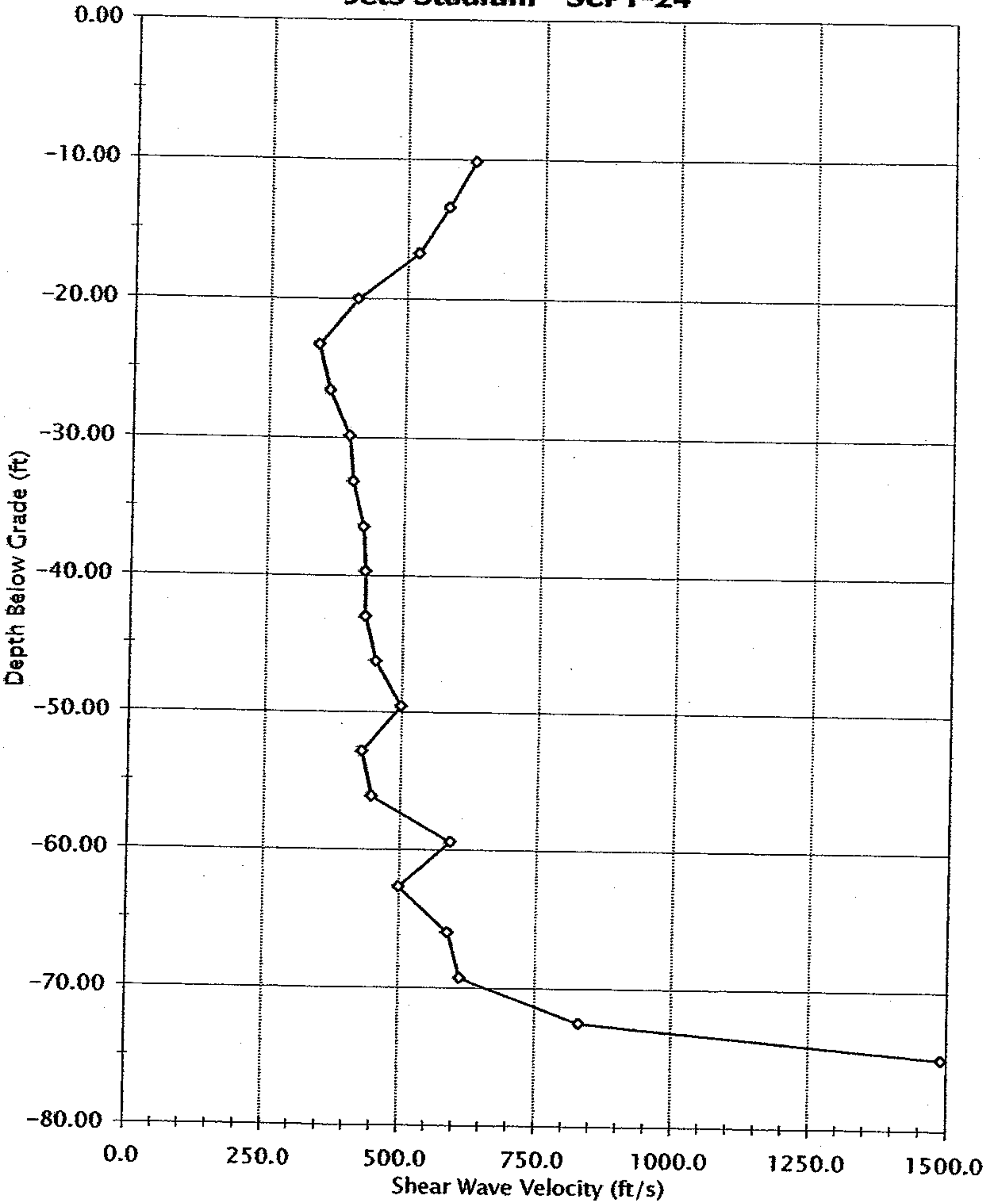


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-25

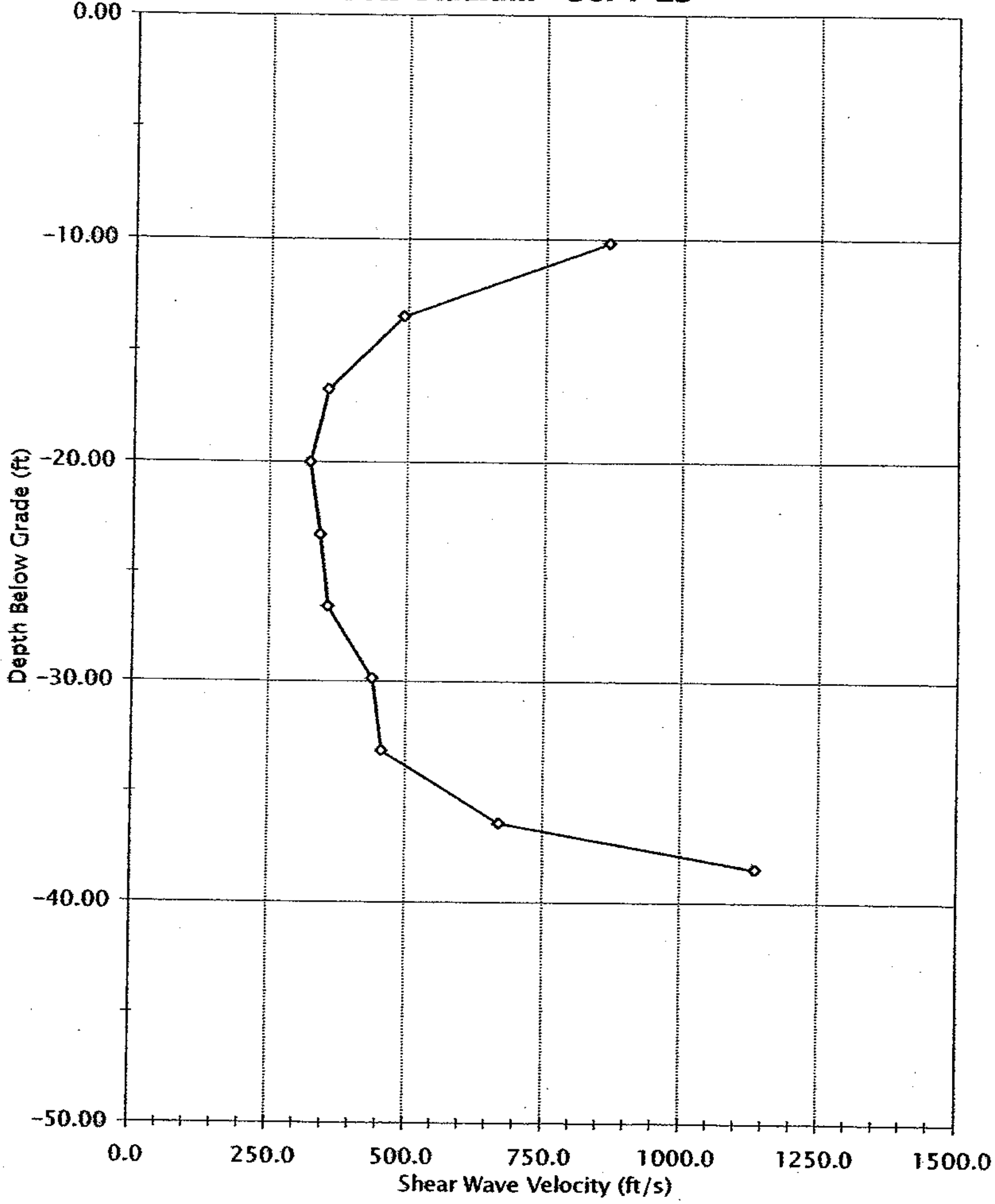
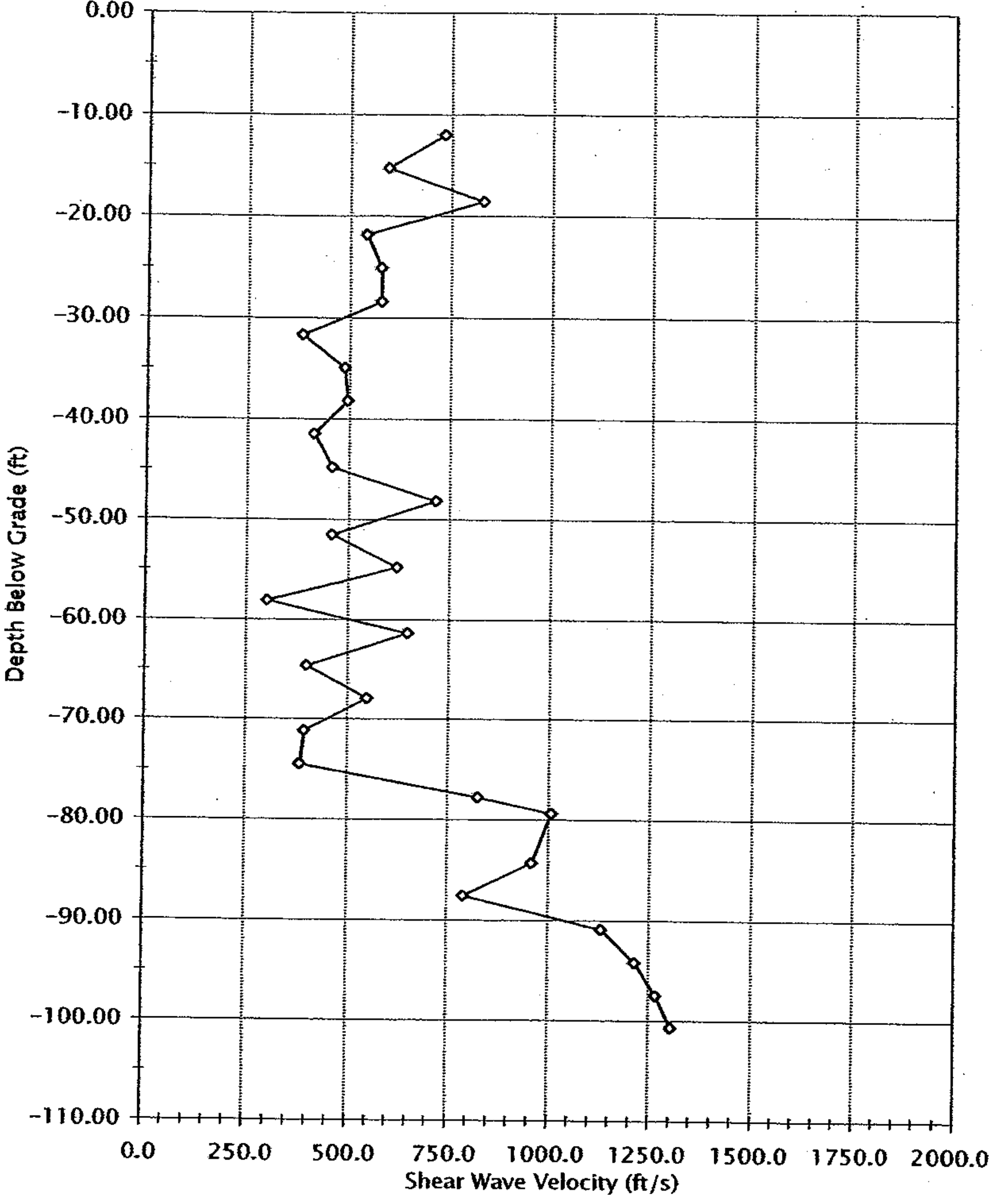


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-41



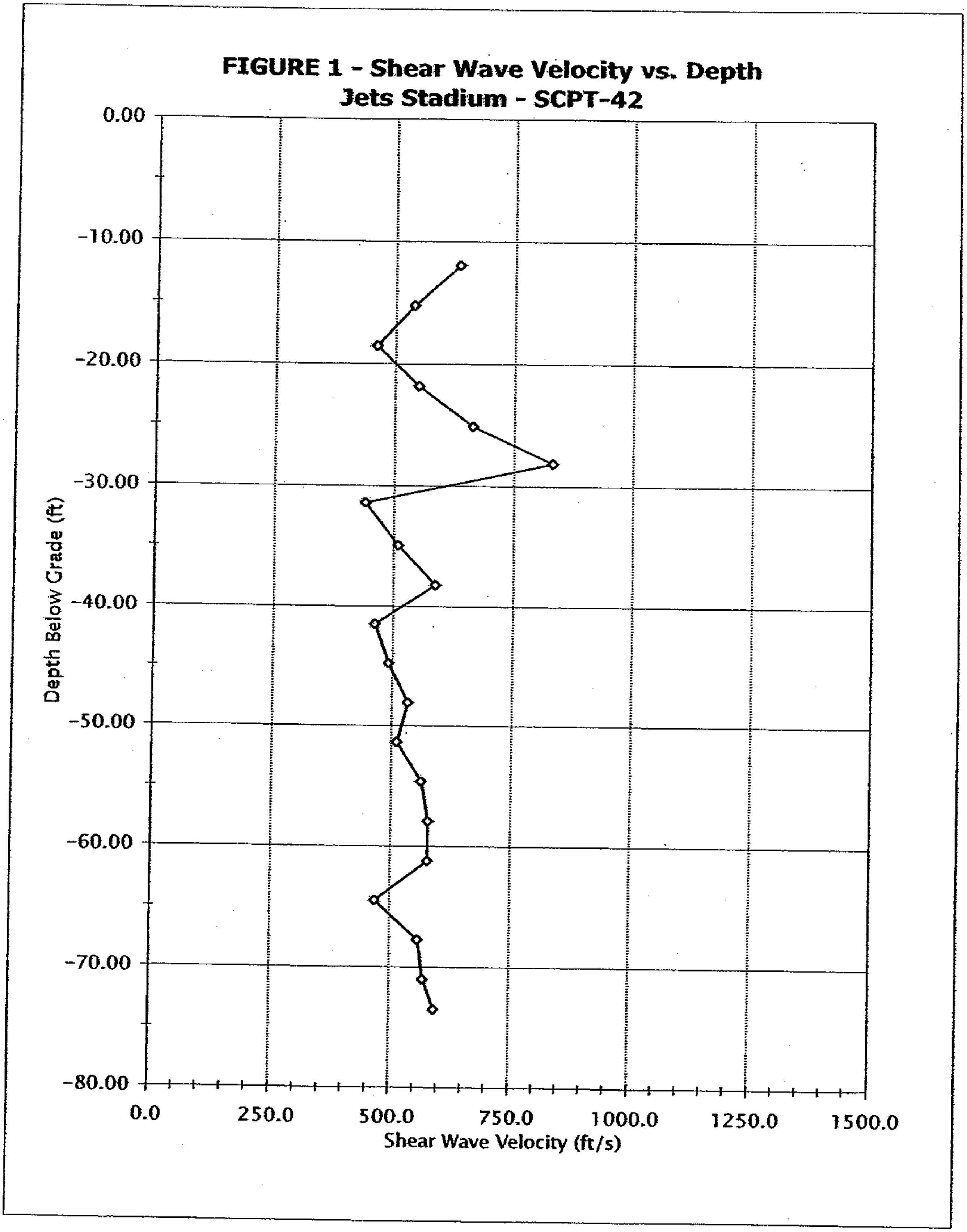


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-42

FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-43

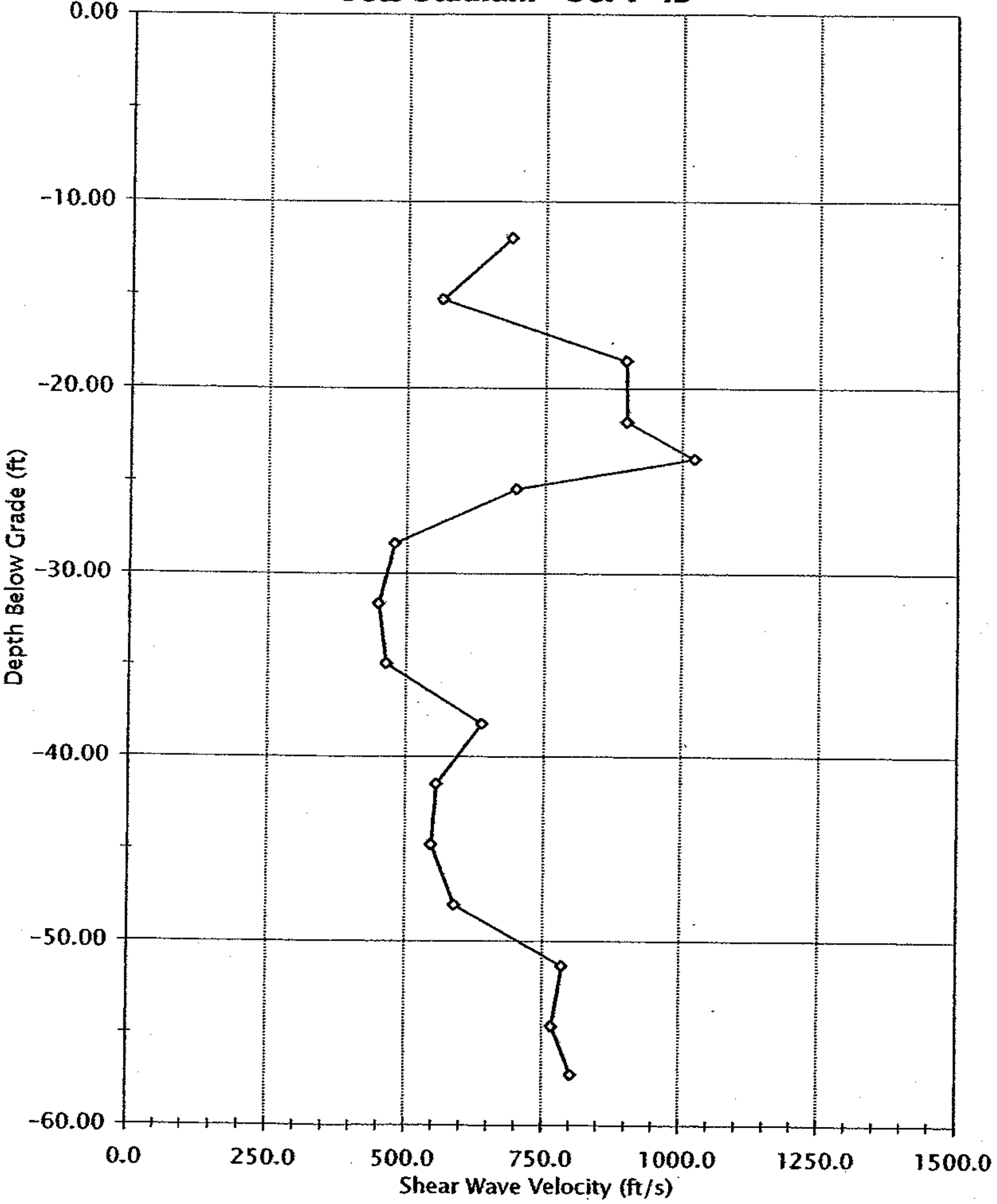


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-44

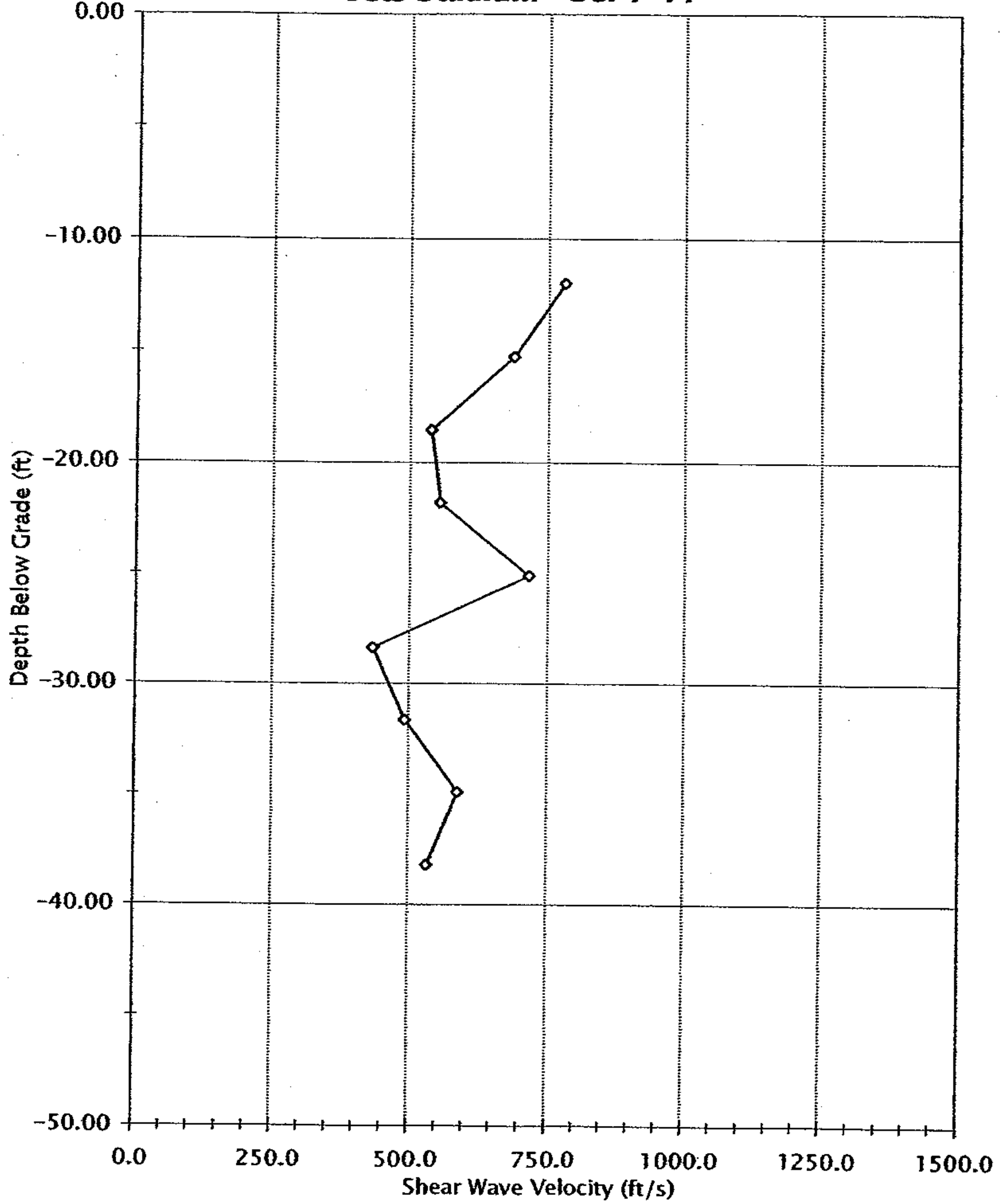


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-45

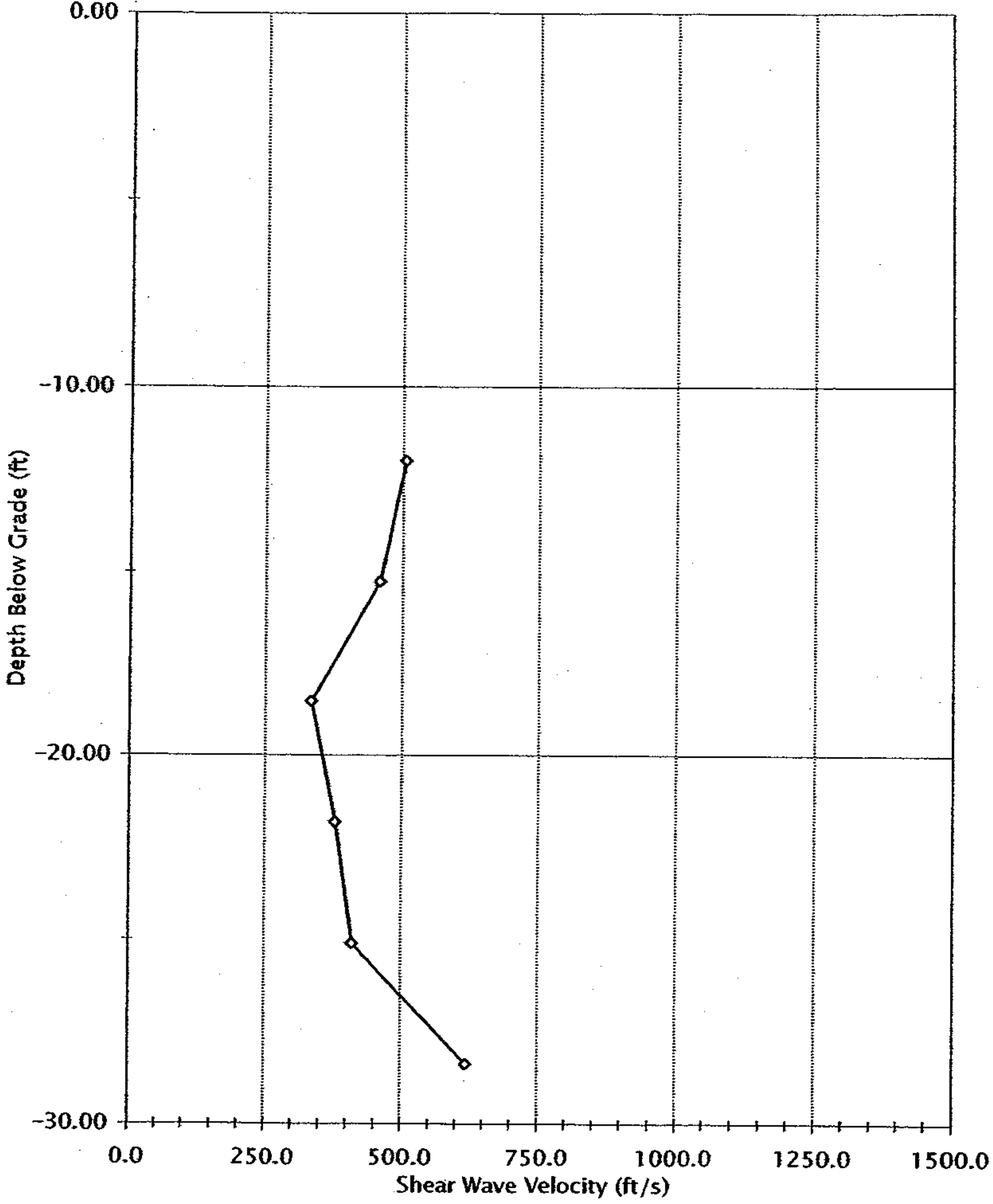


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-46

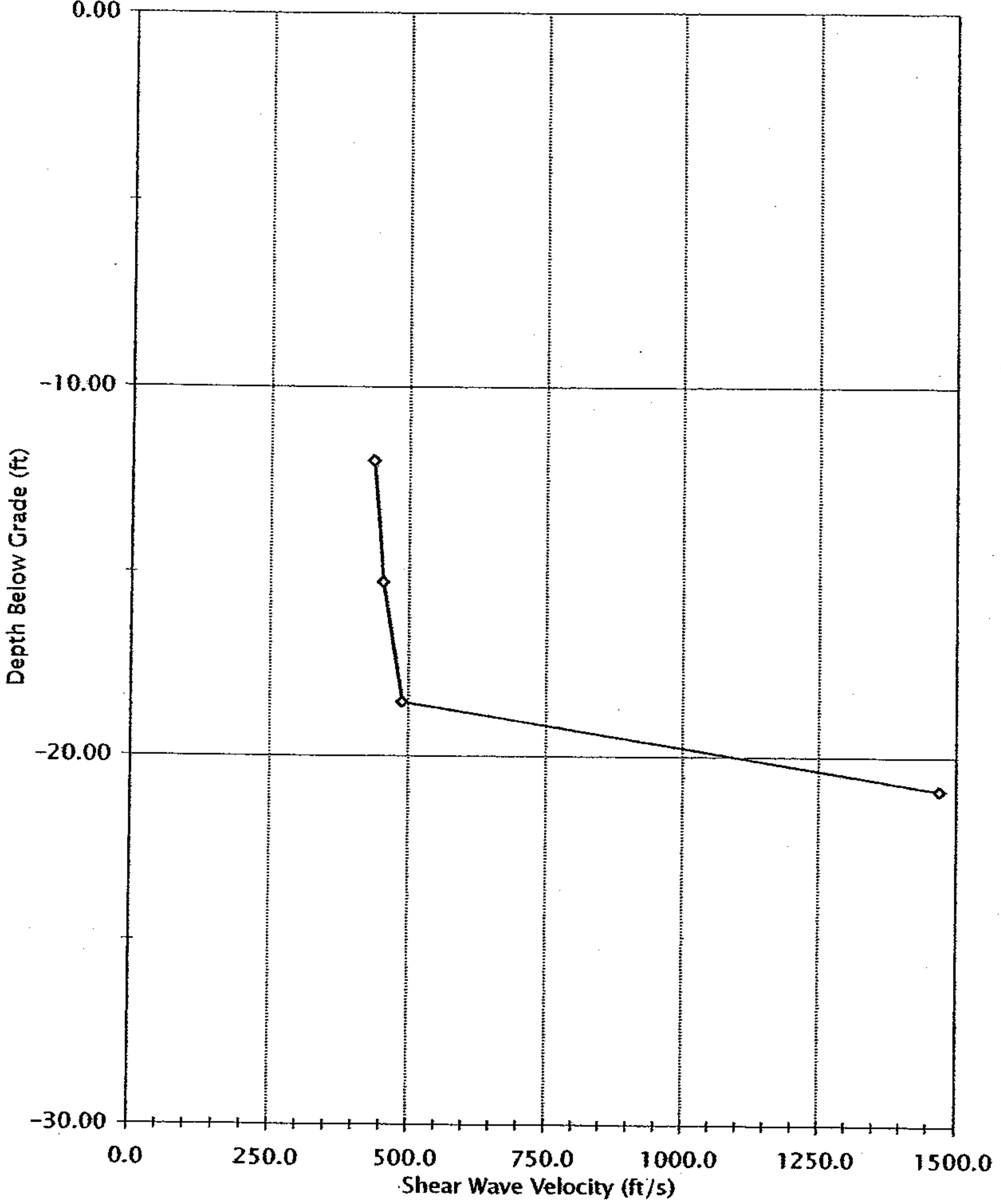
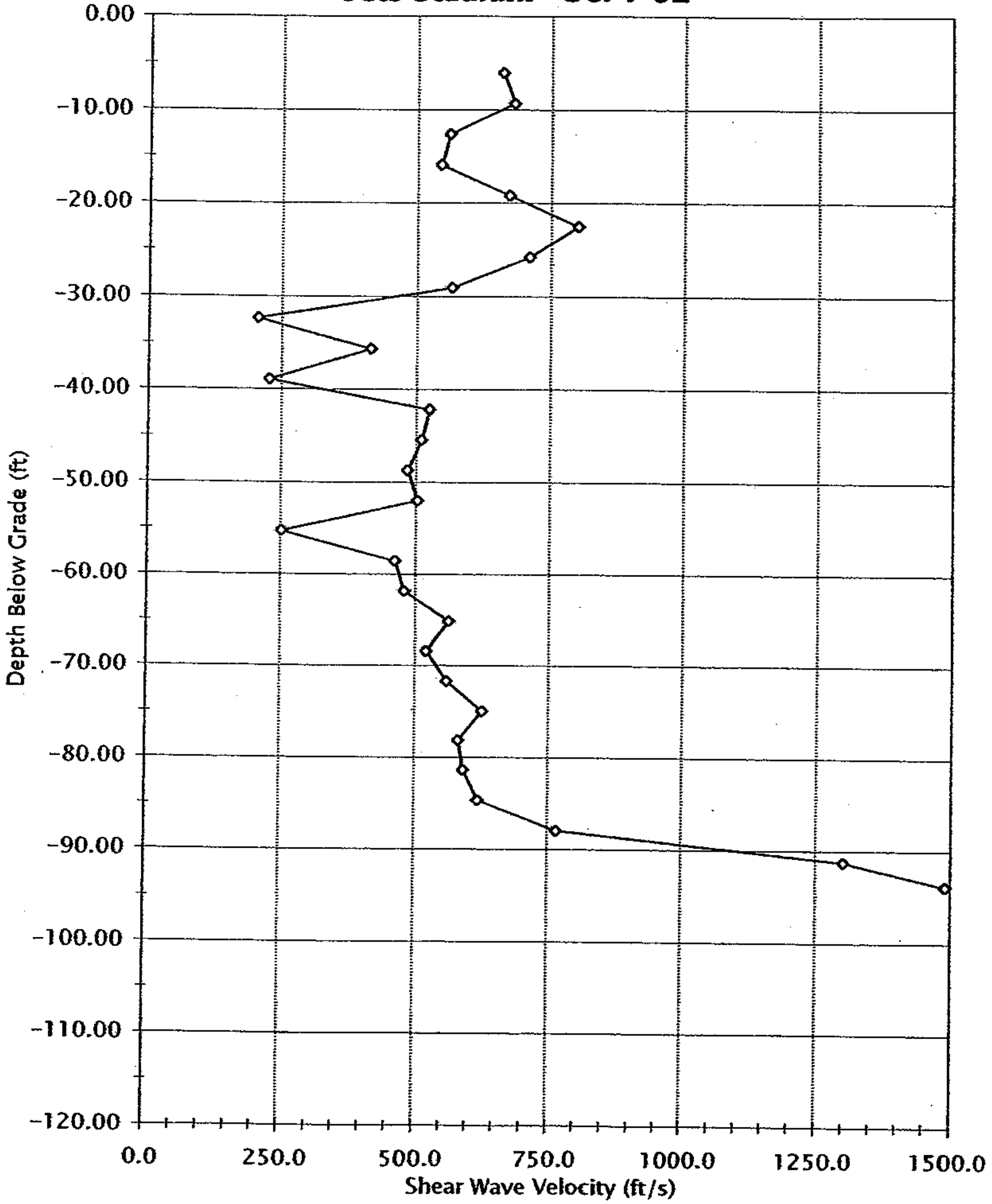


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-62



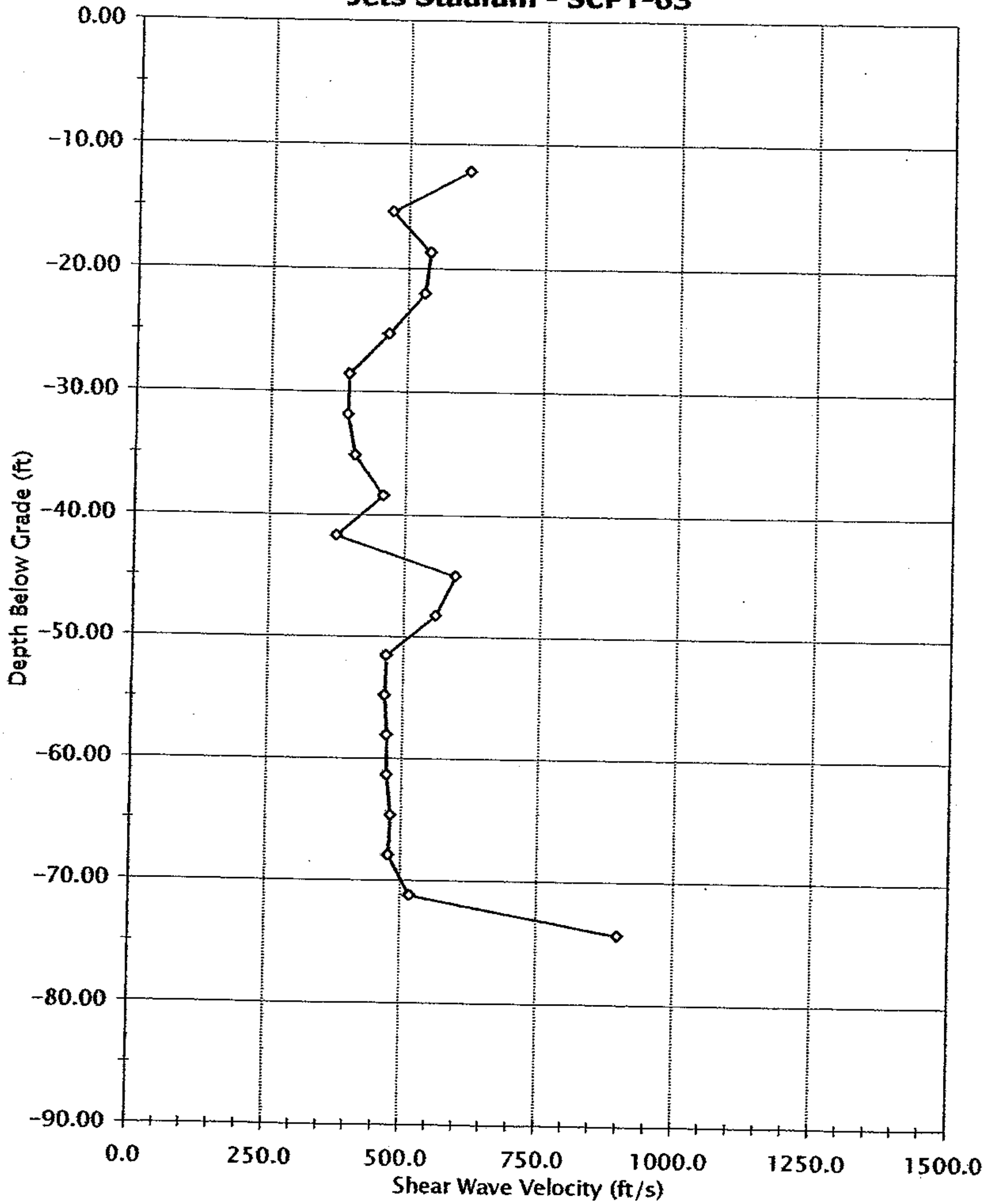


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-63

FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-65

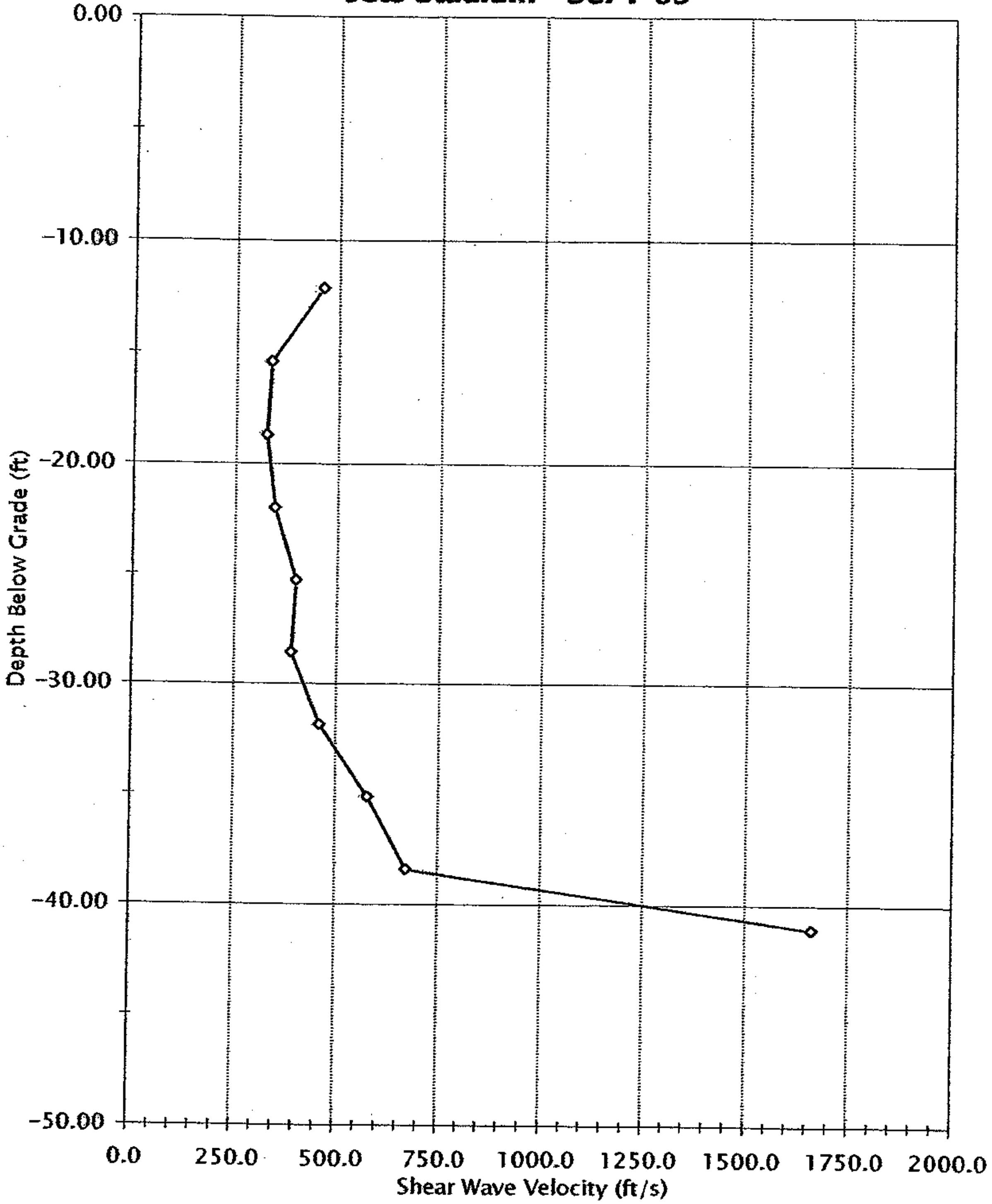


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-67

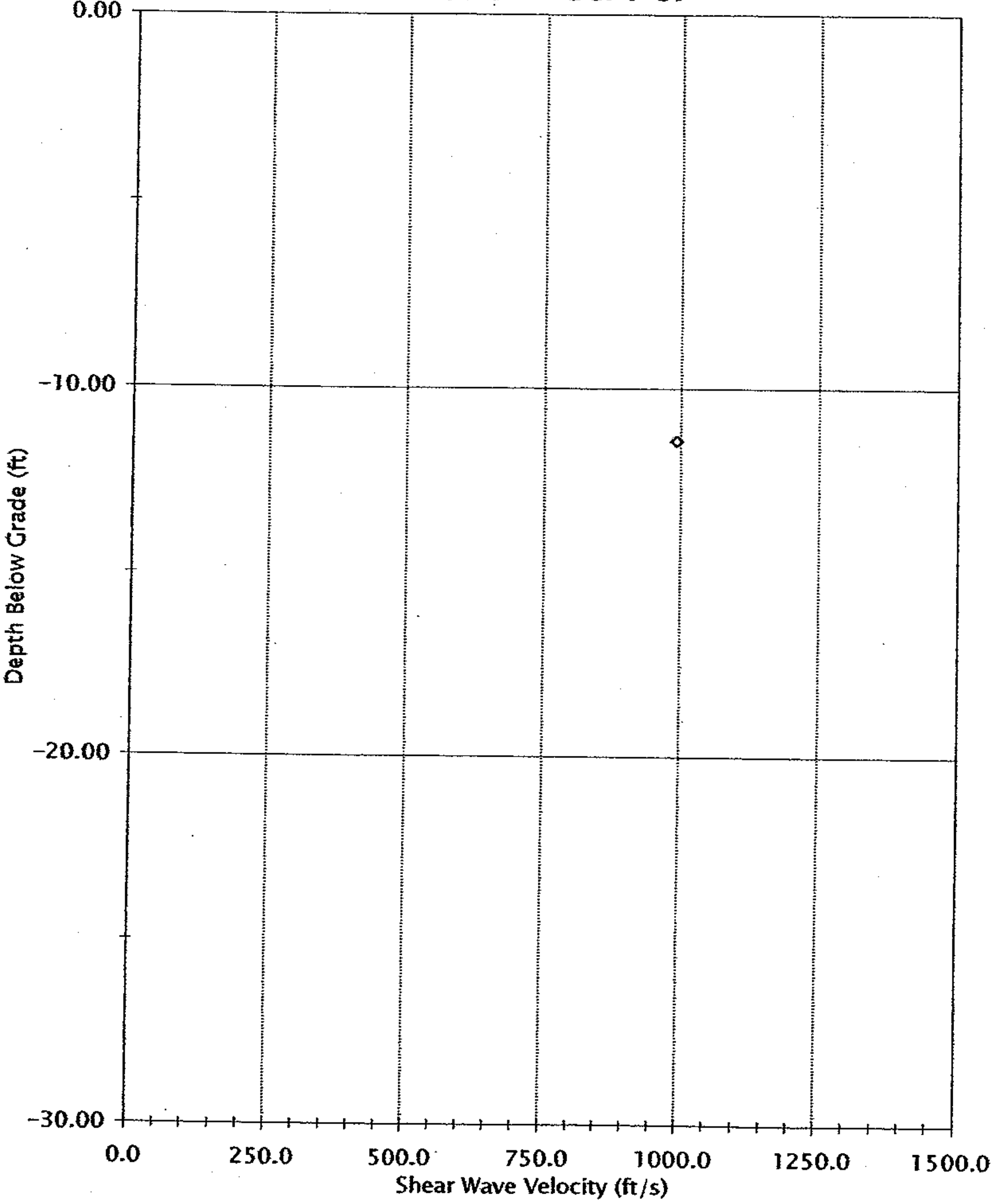


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-68

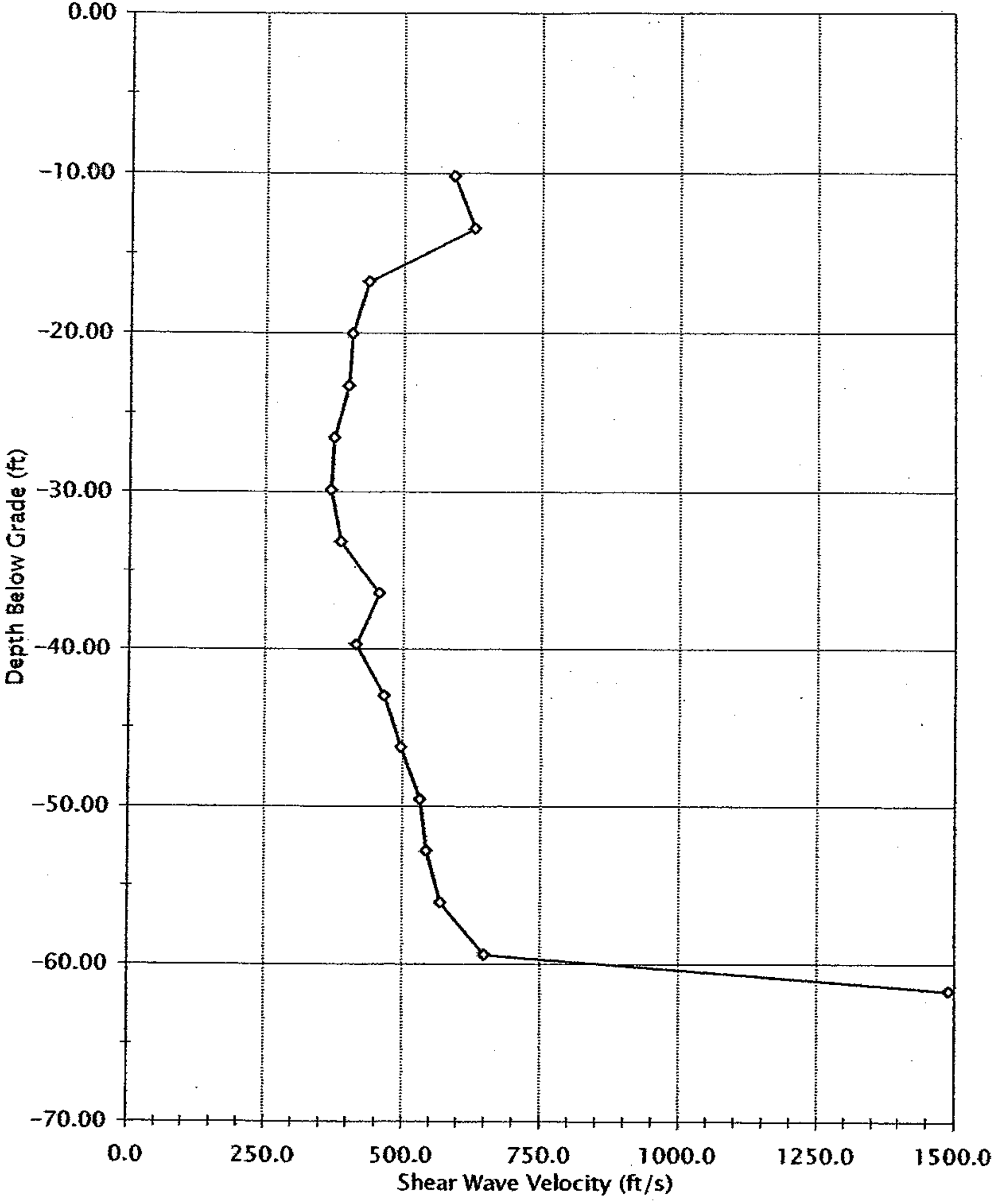
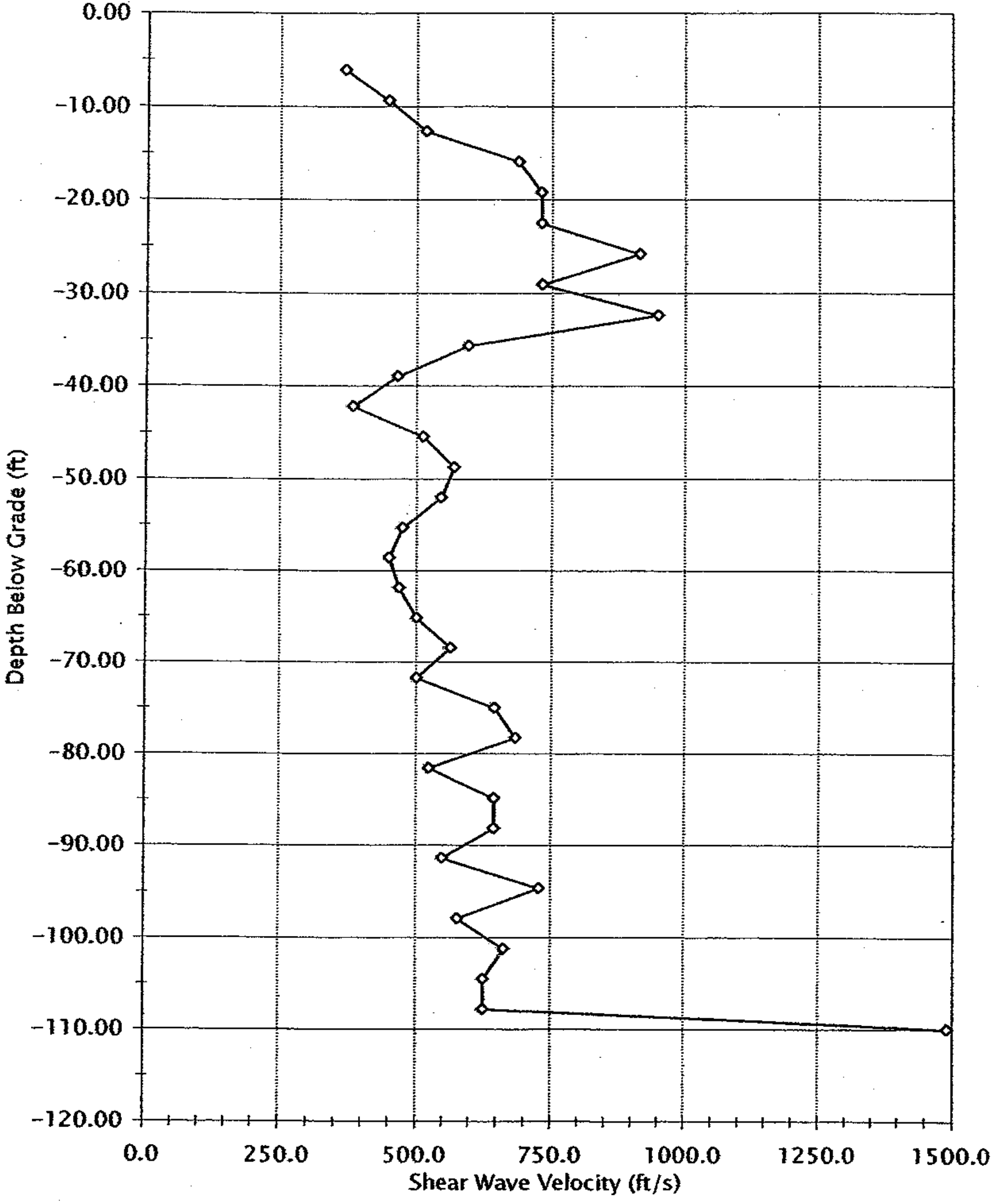


FIGURE 1 - Shear Wave Velocity vs. Depth
Jets Stadium - SCPT-70

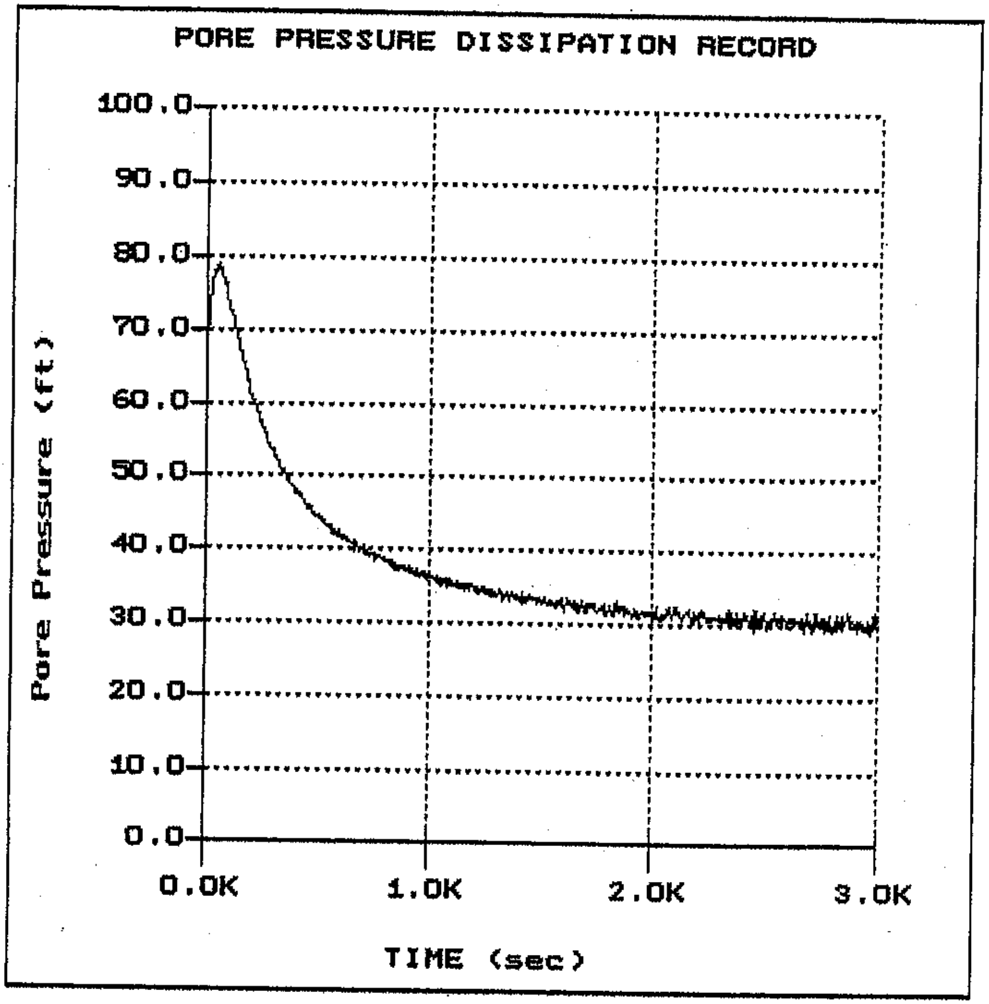


Langan

Hole:SCPT-12
Location:Jets Stadium

Cone:20 Ton AD139
Date:10:18:04 08:20

File: 797CP012.PPD
Depth (m): 10.70
(ft): 35.10
Duration : 3000.0s
U-min: 28.67 2970.0s
U-max: 78.75 55.0s

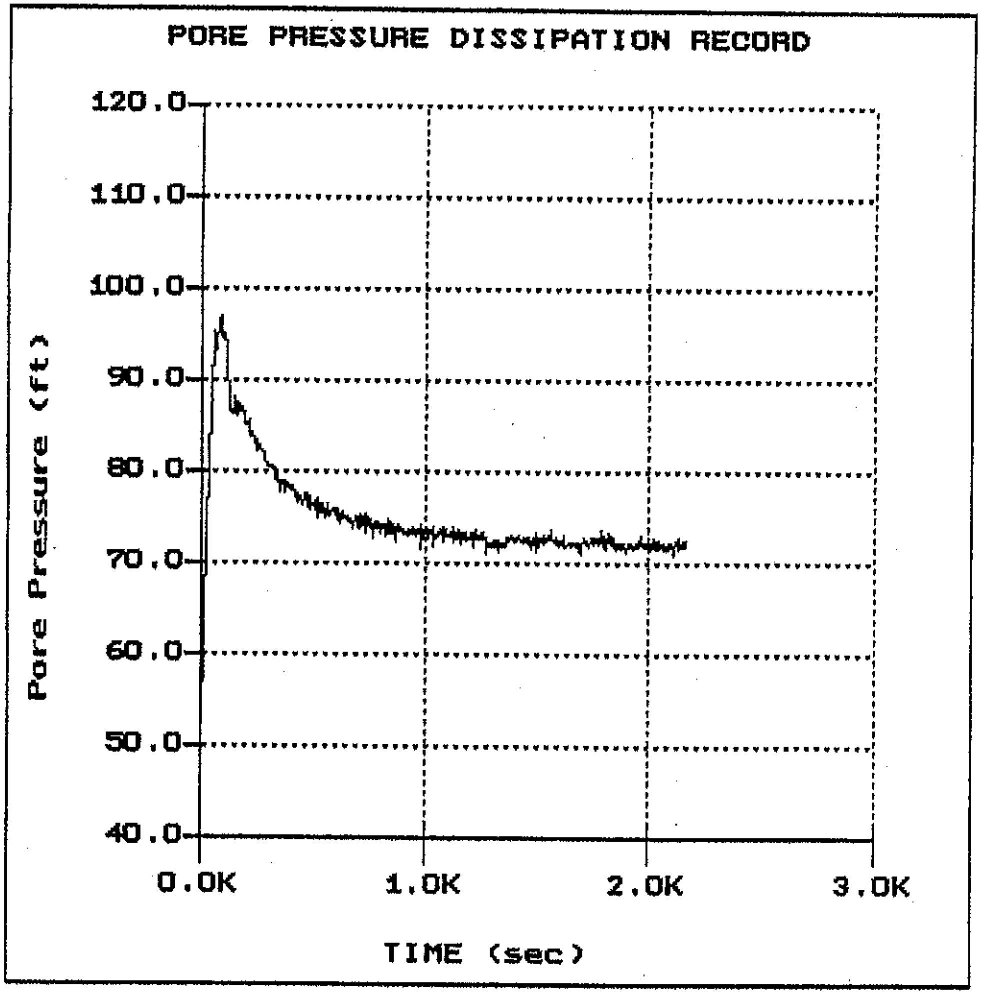


Langan

Hole:SCPT-24
Location:Jets Stadium

Cone:20 Ton AD139
Date:10:18:04 10:53

File: 797CP024.PPD
Depth (m): 23.25
(ft): 76.28
Duration : 2160.0s
U-min: 47.63 0.0s
U-max: 96.81 85.0s

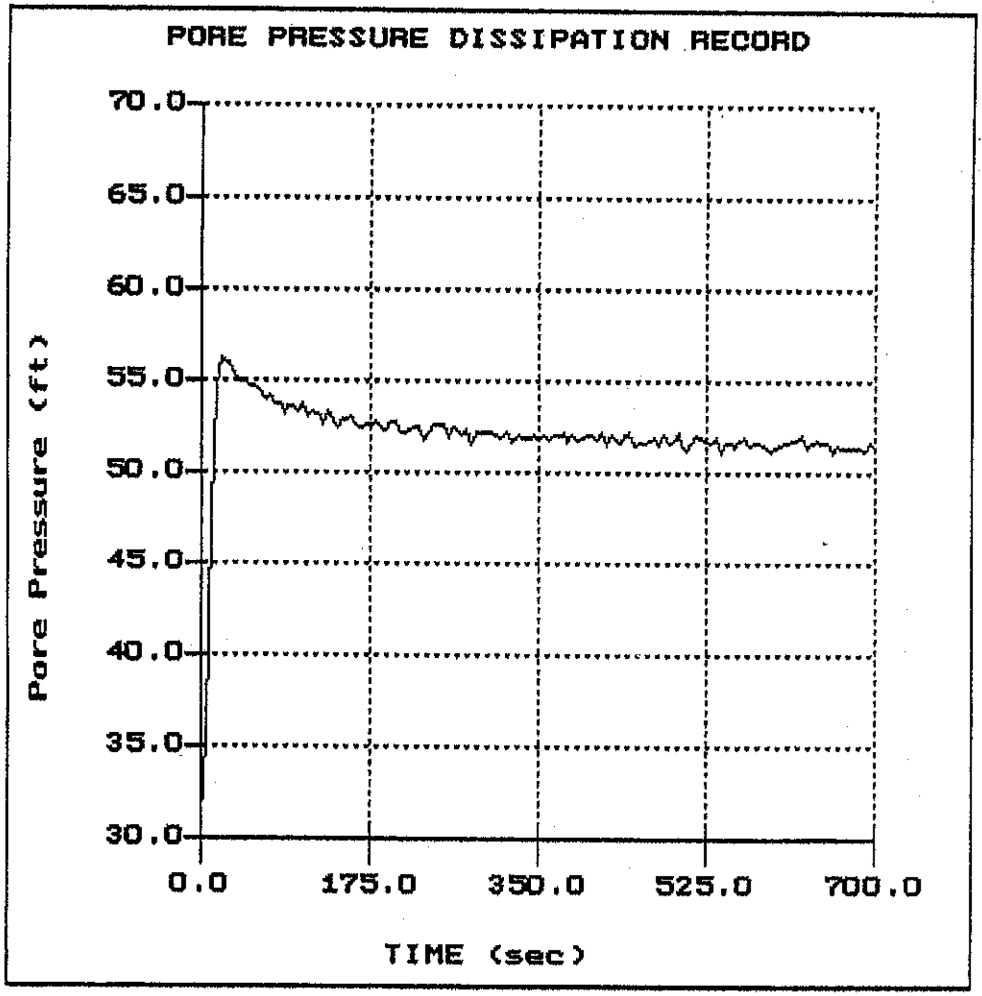

PORE PRESSURE DISSIPATION RECORD

Langan

Hole:CPT-36
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:17:04 23:20

File: 797CP36.PPD
Depth (m): 18.50
(ft): 60.70
Duration : 700.0s
U-min: 30.88 0.0s
U-max: 56.31 20.0s

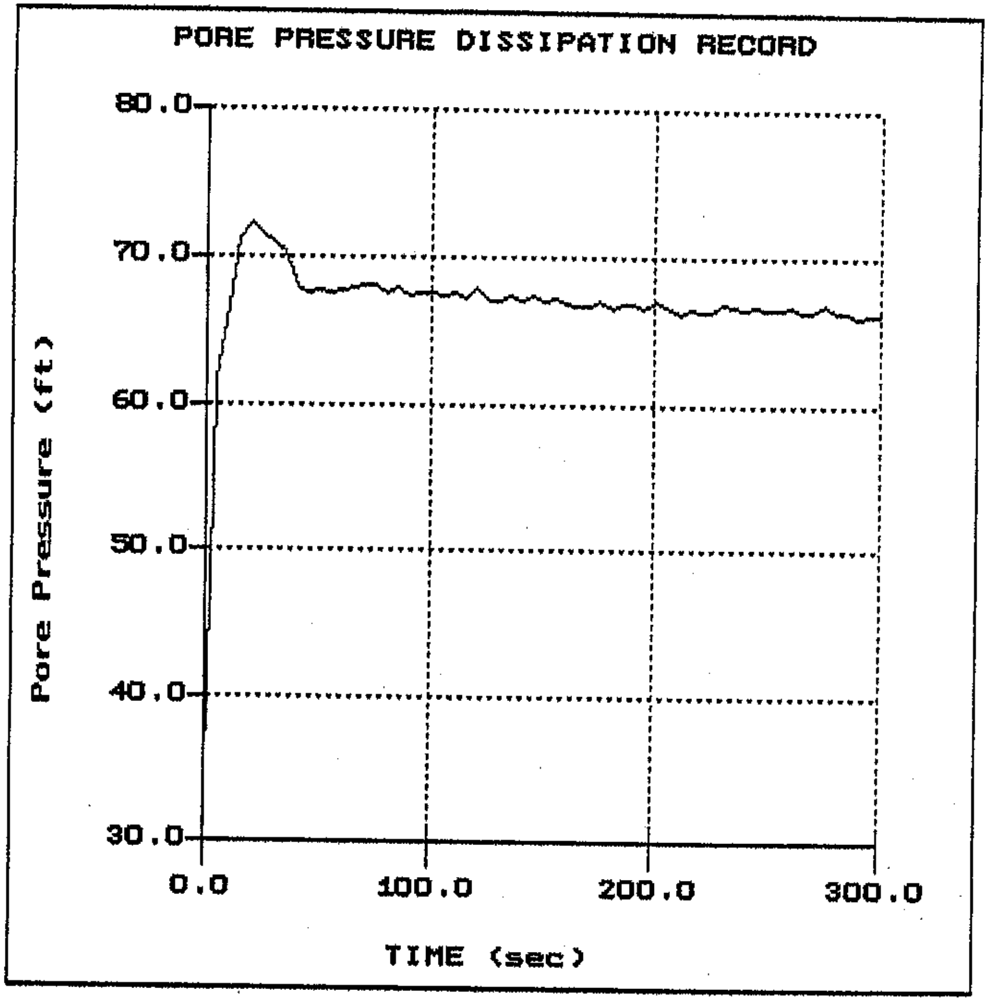


Langan

Hole:SCPT-42
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:16:04 23:55

File: 797CP42.PPD
Depth (m): 22.85
(ft): 74.97
Duration : 300.0s
U-min: 33.98 0.0s
U-max: 72.22 20.0s



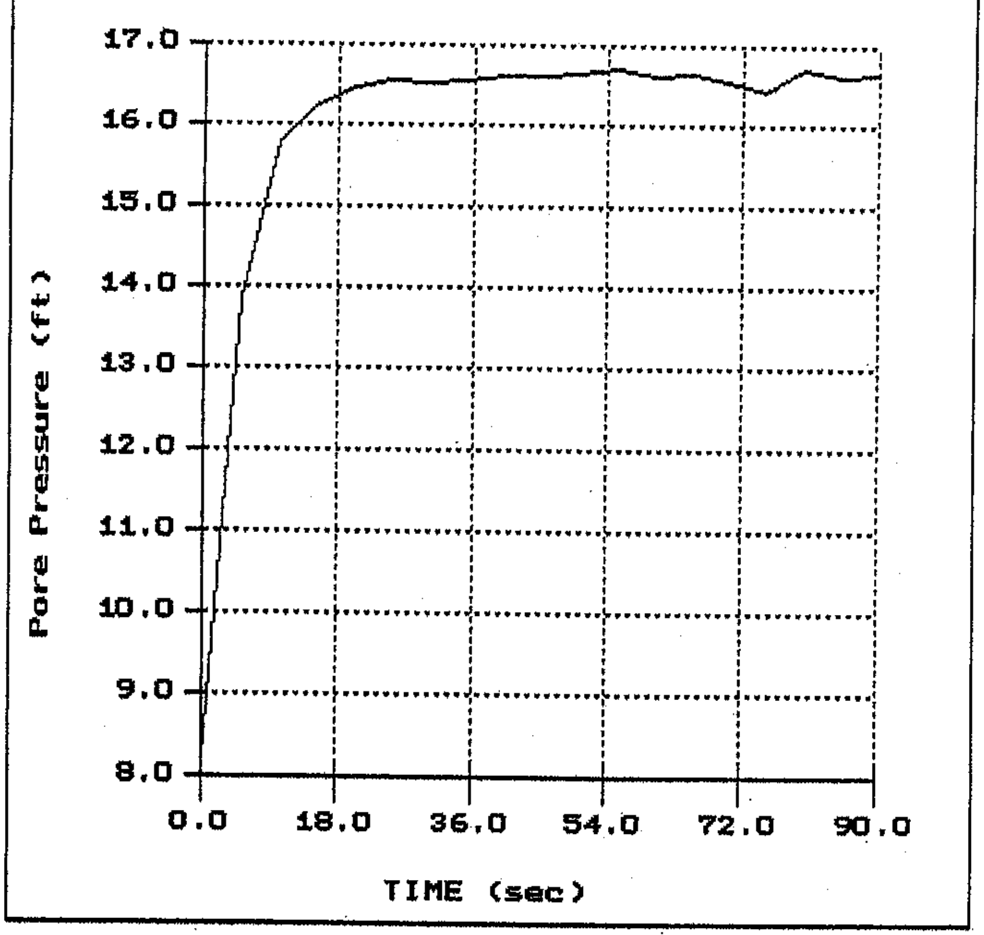
Langan

Hole:SCPT-44
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:17:04 01:42

File: 797CP44.PPD
Depth (m): 7.35
(ft): 24.11
Duration : 90.0s
U-min: 8.17 0.0s
U-max: 16.71 80.0s

PORE PRESSURE DISSIPATION RECORD



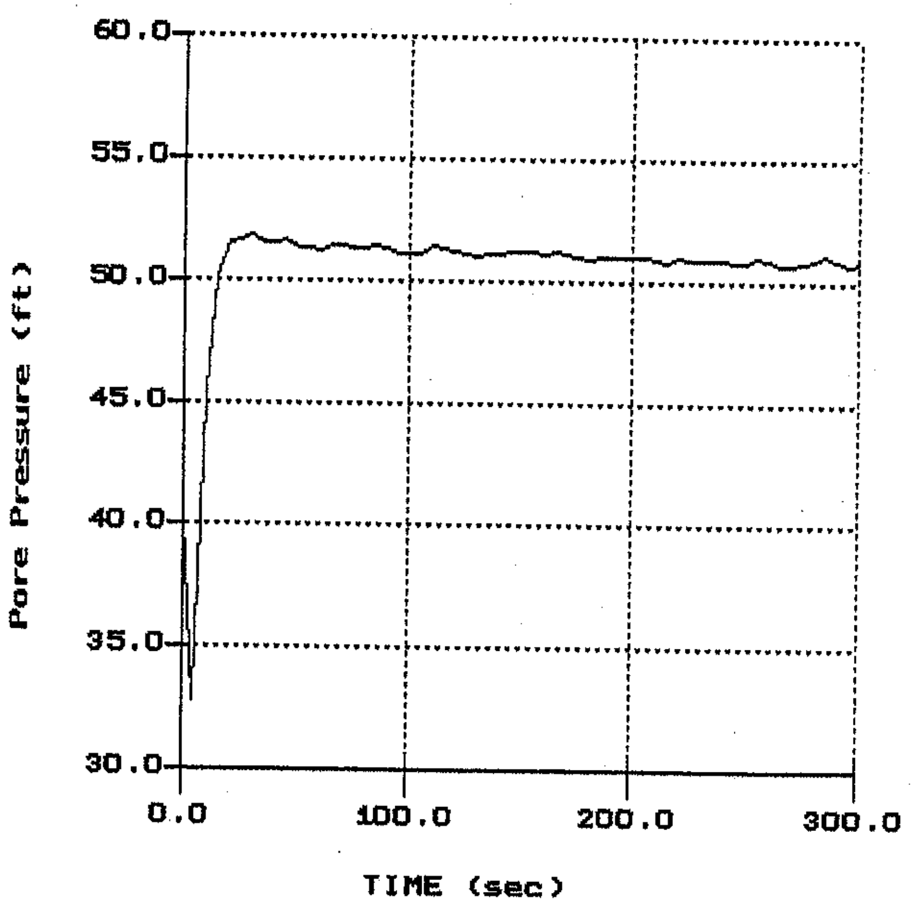
Langan

Hole:CPT-55
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:13:04 02:45

File: 797CP55.PPD
Depth (m): 17.95
(ft): 58.89
Duration : 300.0s
U-min: 32.80 5.0s
U-max: 51.86 30.0s

PORE PRESSURE DISSIPATION RECORD

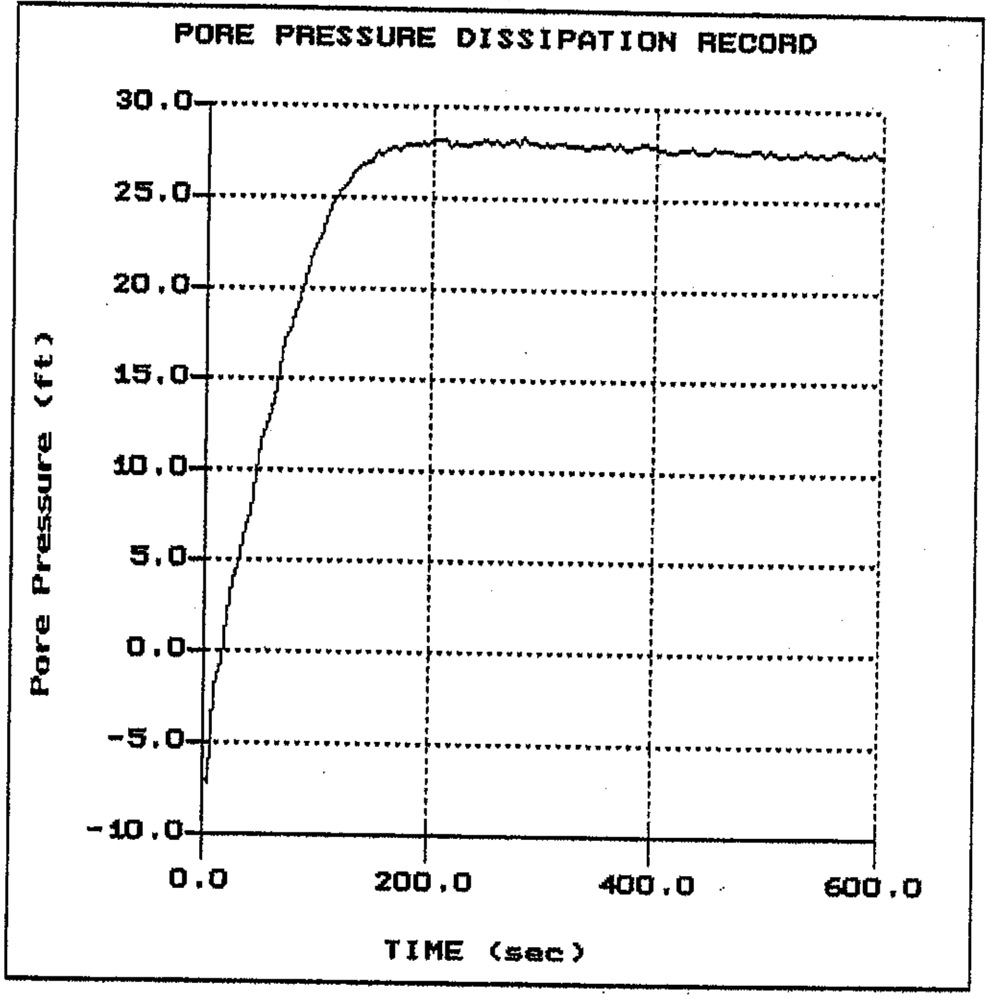


Langan

Hole:CPT-58
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:15:04 22:14

File: 797CP58.PPD
Depth (m): 11.10
(ft): 36.42
Duration : 600.0s
U-min: -7.27 5.0s
U-max: 28.30 280.0s

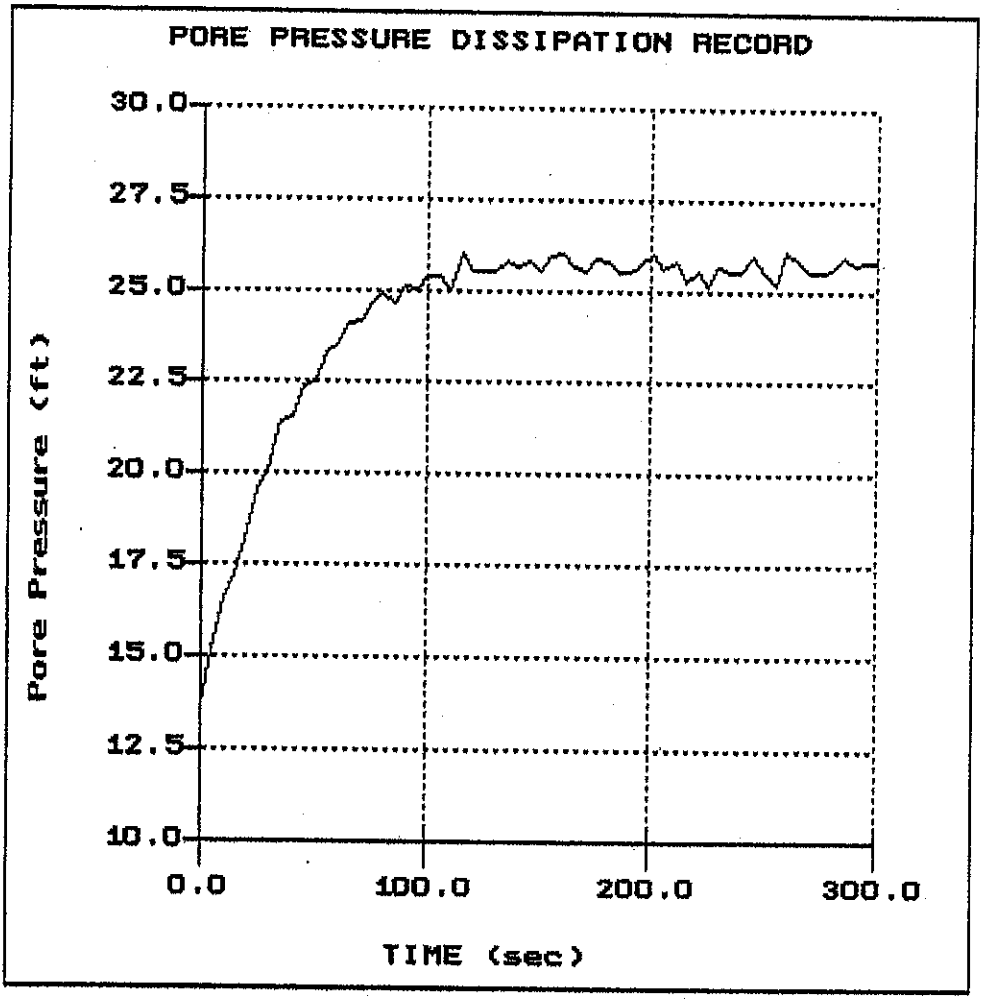


Langan

Hole:SCPT-65
Location:Jets Stadium

Cone:20 Ton AD165
Date:11:12:04 01:59

File: 797CP65.PPD
Depth (m): 10.70
(ft): 35.10
Duration : 300.0s
U-min: 13.66 0.0s
U-max: 26.14 260.0s

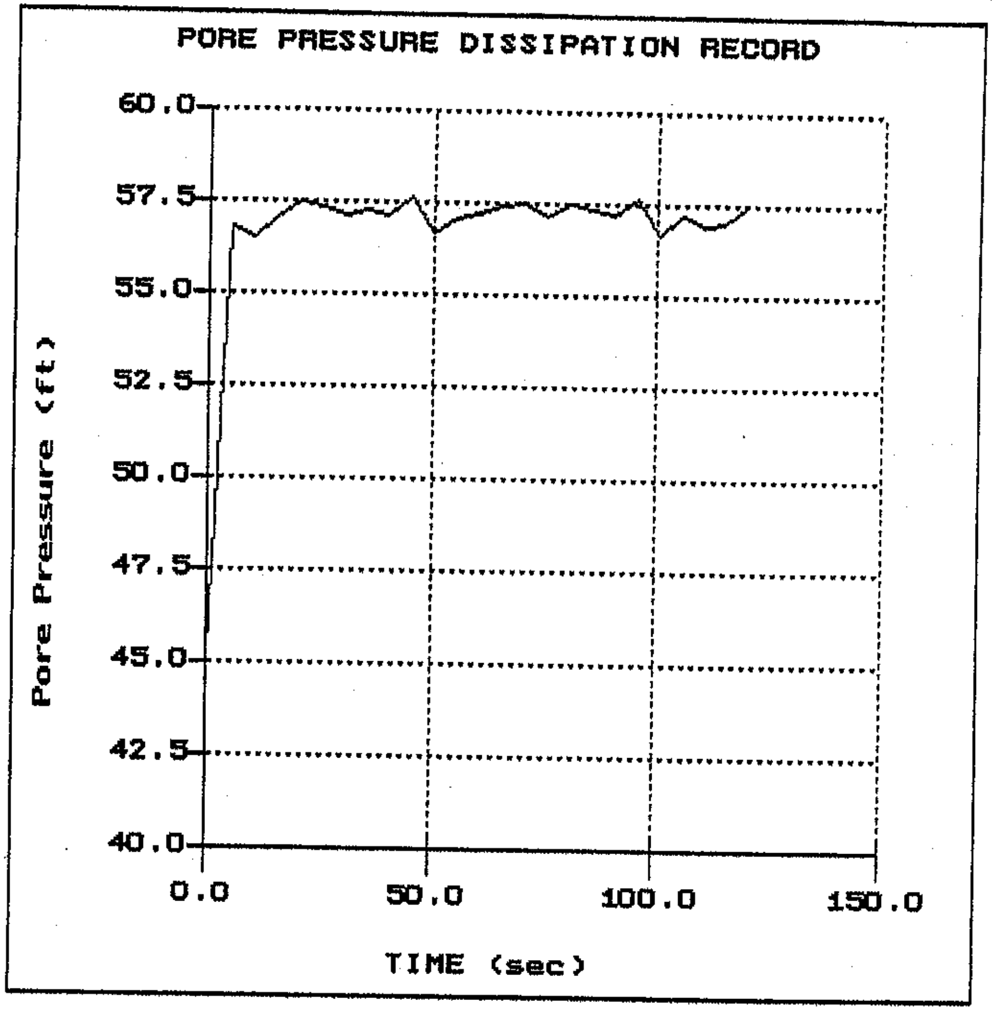


Langan

Hole:SCPT-68
Location:Jets Stadium

Cone:20 Ton AD139
Date:10:19:04 11:39

File: 797CP068.PPD
Depth (m): 19.20
(ft): 62.99
Duration : 120.0s
U-min: 45.10 0.0s
U-max: 57.63 95.0s



APPENDIX C

2004 and 2017 Laboratory Data

RSA GEOLAB, LLC

1017 Greeley Avenue North
Union, New Jersey 07083
908-964-0786 (P)
www.RSAgeolab.com

Letter of Transmittal

Date: 11-8-17	Job No.: 869	Lab Log: 17-335

Attention: Michael Paquette
Langan Engineering
360 West 31st Street, 8th Floor
New York, NY 10001

CC: Thomas Androutselis

Re: Hudson Yards

Sample(s) ID: **LB-1 27-29', LB-1 37-39', LB-1 47-49', LB-1 57-59', LB-1 72-74', LB-1 87-89'**

Dear Mr. Paquette,

Please find attached results for the samples referenced above. The following lab testing was performed:

- ASTM D2216 Moisture Content
- ASTM D2974 Organic Content
- ASTM D4318 Atterberg Limits (w/LL on oven dried material)
- ASTM D2850 Unconsolidated Undrained Triaxial Shear (10 psi)
- Log & Photograph of tubes

Regards,
RSA Geolab, LLC

Remarks: If you have any questions, please call 908-964-0786.

Signed: ______________________
Dr. Raza S. Ahmed
President RSA Geolab, LLC

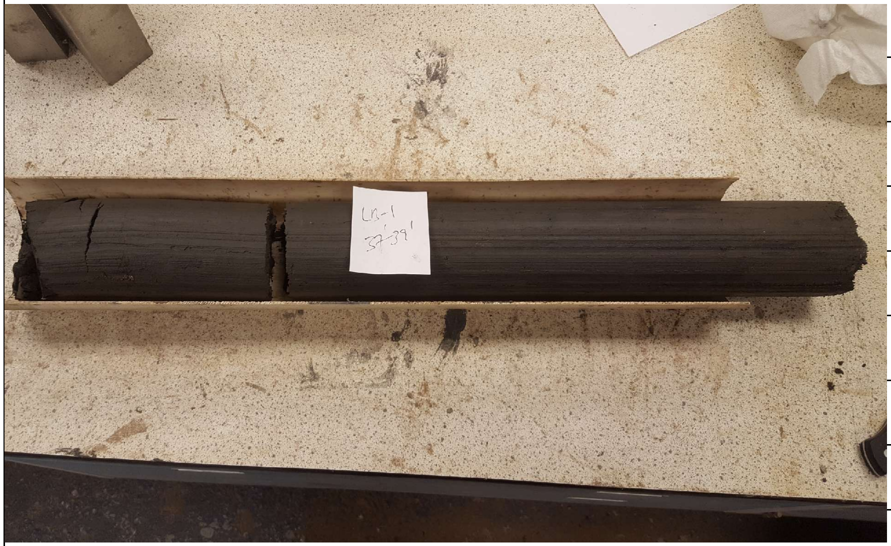
RSA Geolab, LLC

LOG OF UNDISTURBED SOIL SAMPLERS

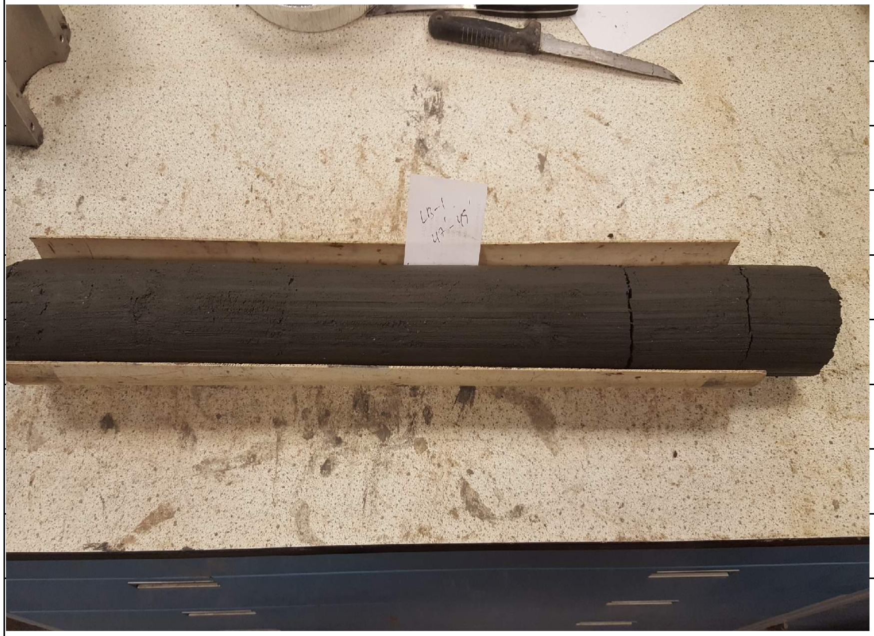
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-1 27-29’	Recovery: 22.5”
Date: 11-1-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (-), cmf Sand, trace f Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-1 37-39’	Recovery: 24”
Date: 11-1-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Gray Clay & Silt little (+), cmf Sand, trace mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-1 47-49’	Recovery: 26”
Date: 11-1-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC

LOG OF UNDISTURBED SOIL SAMPLERS

Project: Hudson Yards

Project Number: 869

Client: Langan Engineering

Diameter: 2.8”

Sample: LB-1 57-59’

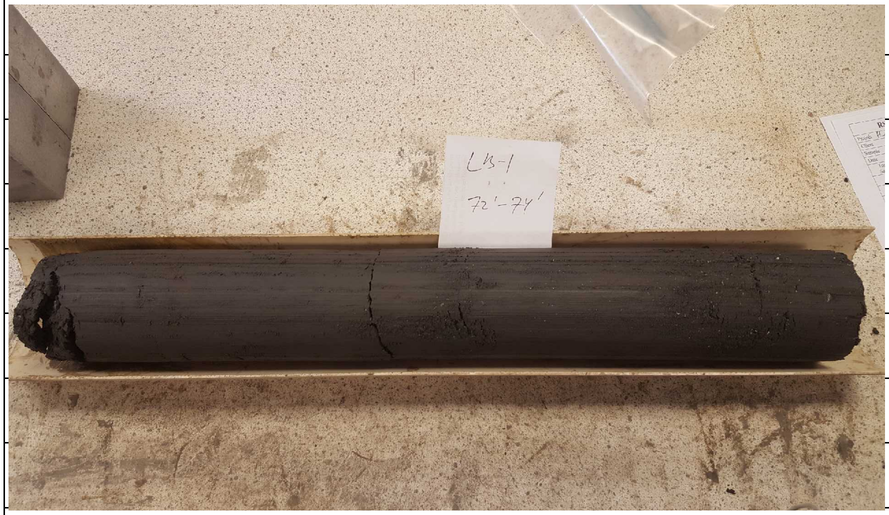
Recovery: 21”

Date: 11-1-17

Remarks:

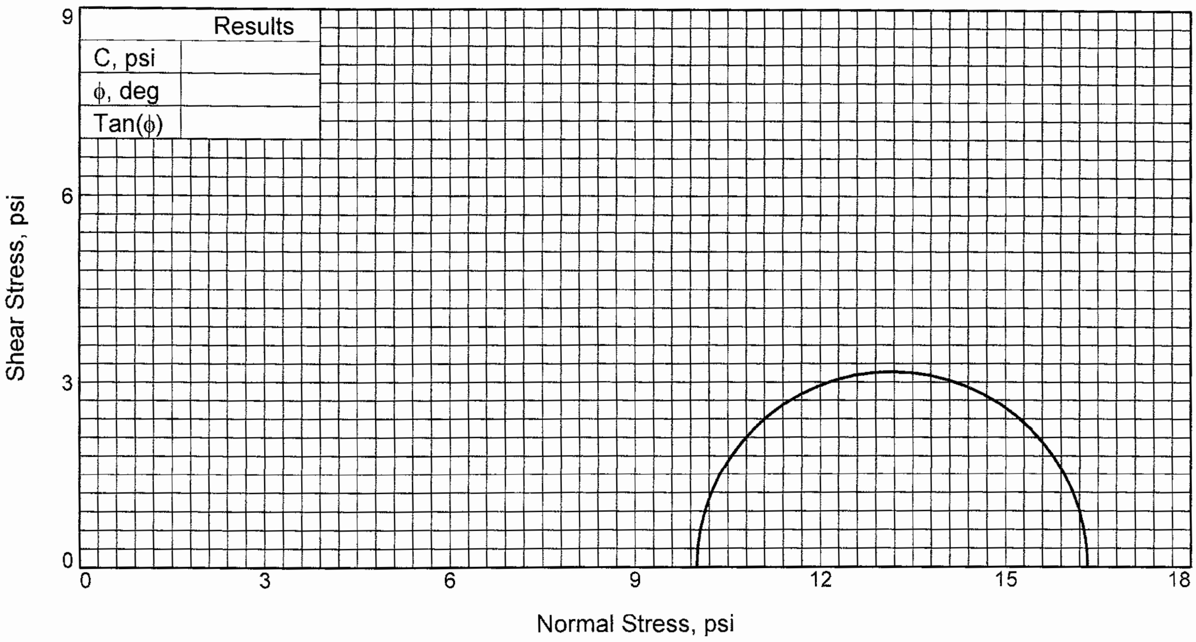
Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

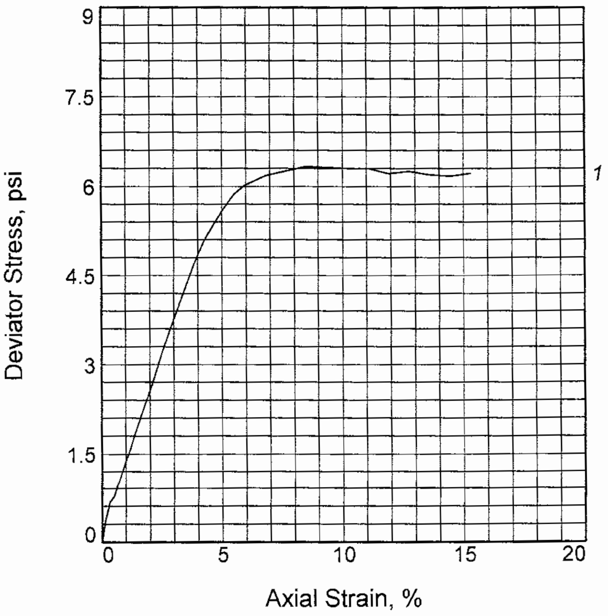
RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-1 72-74’	Recovery: 19.5”
Date: 11-1-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-1 87-89’	Recovery: 26”
Date: 11-1-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (+), cmf Sand, trace f Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			





Sample No.		1
Initial	Water Content, %	71.3
	Dry Density, pcf	56.7
	Saturation, %	101.9
	Void Ratio	1.7510
	Diameter, in.	2.79
	Height, in.	5.88
At Test	Water Content, %	70.0
	Dry Density, pcf	56.7
	Saturation, %	100.0
	Void Ratio	1.7510
	Diameter, in.	2.79
	Height, in.	5.88
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		6.3
Ult. Stress, psi		
σ_1 Failure, psi		16.3
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little (-), cmf Sand, trace f Gravel, odorous, organics (sea shells) (visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.10

Figure ________

Client: Langan Engineering

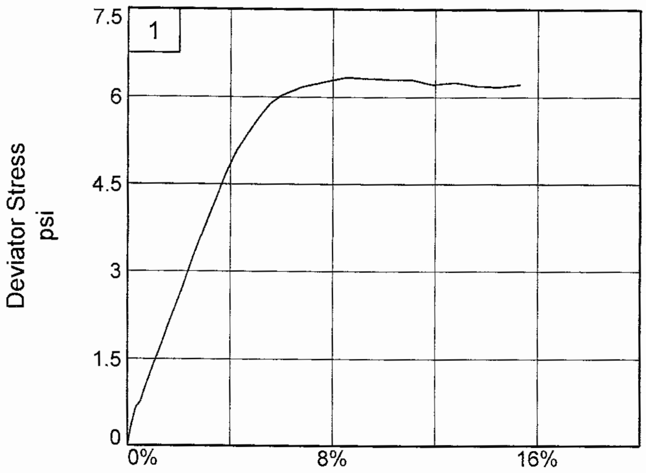
Project: Hudson Yards

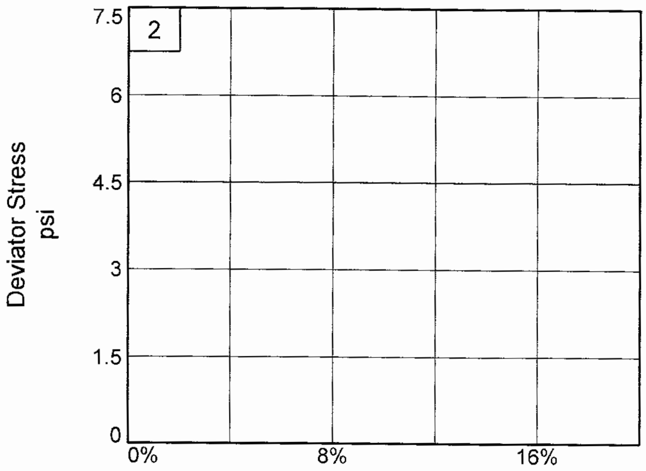
Sample Number: LB-1 27-29'

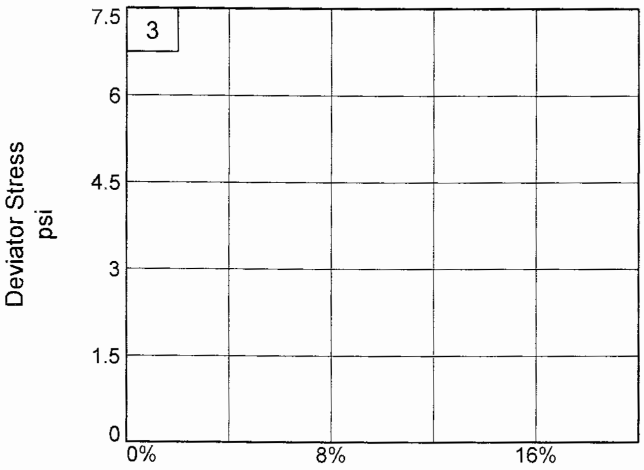
Proj. No.: 869 **Date Sampled:** 11-8-17

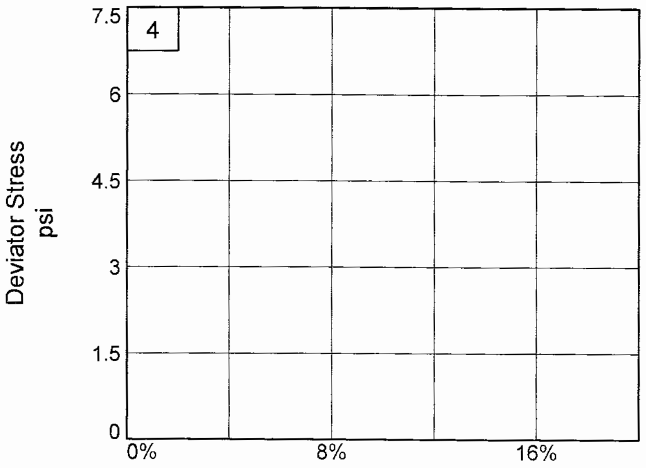
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

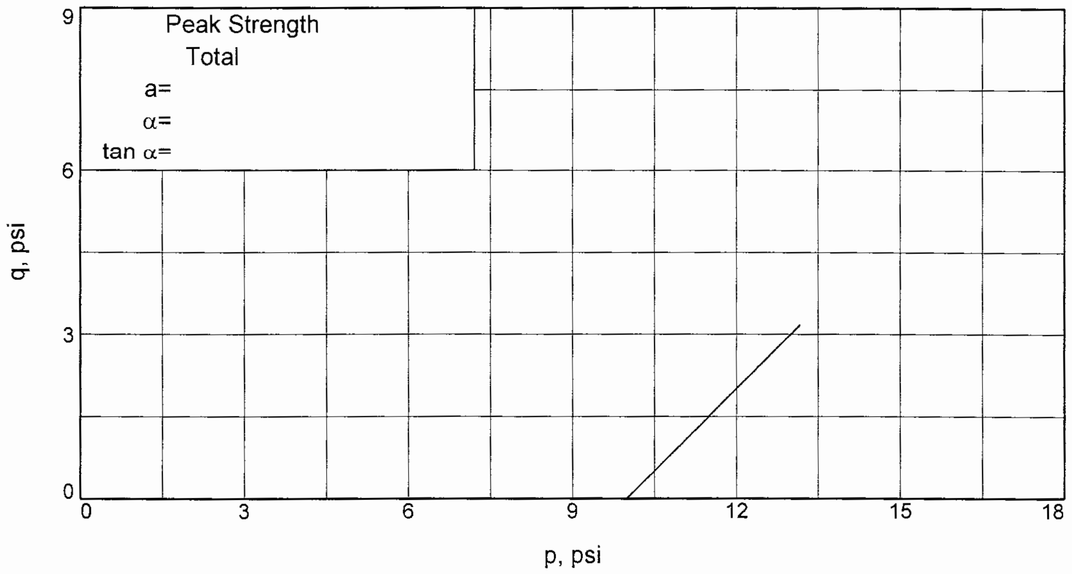
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-1 27-29'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/3/2017
11:52 AM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 27-29'
Description: Dark Gray Clay & Silt little (-), cmf Sand, trace f Gravel, odorous, organics (sea shells) (visual)
Remarks: H/D = 2.10
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

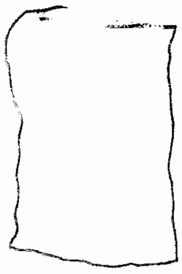
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	919.100		919.100
Moisture content: Dry soil+tare, gms.	536.400		536.400
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	71.3	70.0	71.3
Moist specimen weight, gms.	919.1		
Diameter, in.	2.79	2.79	
Area, in.^{2}	6.13	6.13	
Height, in.	5.88	5.88	
Net decrease in height, in.		0.00	
Wet density, pcf	97.2	96.5	
Dry density, pcf	56.7	56.7	
Void ratio	1.7510	1.7510	
Saturation, %	101.9	100.0	

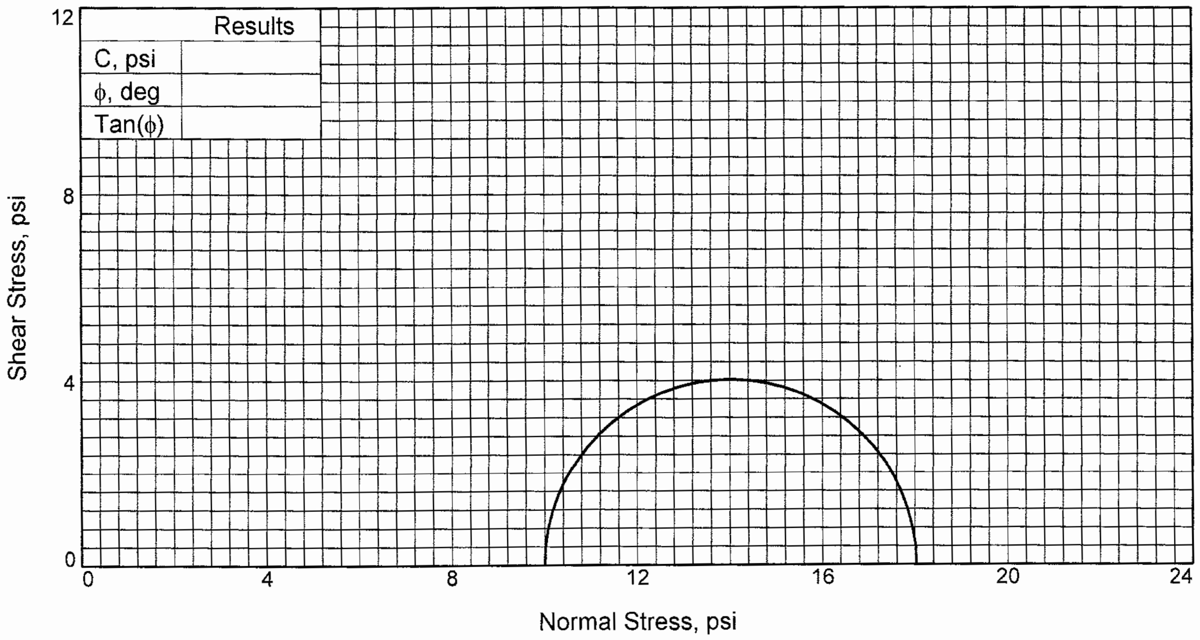
Test Readings for Specimen No. 1

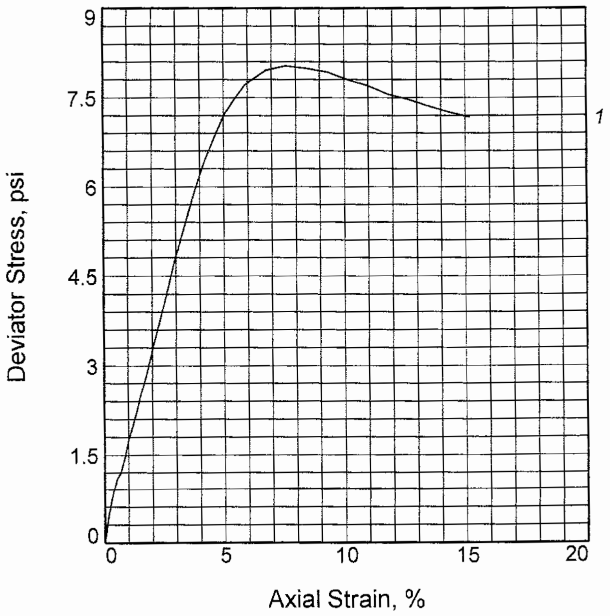
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 6.33 psi **at reading no.** 23

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	4.600	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	6.900	2.3	0.2	0.37	10.00	10.37	1.04	10.19	0.19
2	0.0200	8.700	4.1	0.3	0.67	10.00	10.67	1.07	10.33	0.33
3	0.0300	9.300	4.7	0.5	0.76	10.00	10.76	1.08	10.38	0.38
4	0.0400	10.700	6.1	0.7	0.99	10.00	10.99	1.10	10.49	0.49
5	0.0500	12.000	7.4	0.9	1.20	10.00	11.20	1.12	10.60	0.60
6	0.0600	13.300	8.7	1.0	1.41	10.00	11.41	1.14	10.70	0.70
7	0.0700	14.500	9.9	1.2	1.60	10.00	11.60	1.16	10.80	0.80
8	0.0800	15.800	11.2	1.4	1.80	10.00	11.80	1.18	10.90	0.90
9	0.0900	17.100	12.5	1.5	2.01	10.00	12.01	1.20	11.00	1.00
10	0.1000	18.400	13.8	1.7	2.21	10.00	12.21	1.22	11.11	1.11
11	0.1250	21.500	16.9	2.1	2.70	10.00	12.70	1.27	11.35	1.35
12	0.1500	25.000	20.4	2.6	3.24	10.00	13.24	1.32	11.62	1.62
13	0.1750	28.200	23.6	3.0	3.74	10.00	13.74	1.37	11.87	1.87
14	0.2000	31.300	26.7	3.4	4.21	10.00	14.21	1.42	12.10	2.10
15	0.2250	34.400	29.8	3.8	4.68	10.00	14.68	1.47	12.34	2.34
16	0.2500	37.100	32.5	4.3	5.08	10.00	15.08	1.51	12.54	2.54
17	0.2750	39.100	34.5	4.7	5.37	10.00	15.37	1.54	12.68	2.68
18	0.3000	41.000	36.4	5.1	5.64	10.00	15.64	1.56	12.82	2.82
19	0.3250	42.700	38.1	5.5	5.87	10.00	15.87	1.59	12.94	2.94
20	0.3500	43.800	39.2	6.0	6.02	10.00	16.02	1.60	13.01	3.01
21	0.4000	45.200	40.6	6.8	6.18	10.00	16.18	1.62	13.09	3.09
22	0.4500	46.100	41.5	7.7	6.26	10.00	16.26	1.63	13.13	3.13
23	0.5000	47.000	42.4	8.5	6.33	10.00	16.33	1.63	13.17	3.17
24	0.5500	47.300	42.7	9.4	6.32	10.00	16.32	1.63	13.16	3.16
25	0.6000	47.600	43.0	10.2	6.30	10.00	16.30	1.63	13.15	3.15
26	0.6500	48.000	43.4	11.1	6.30	10.00	16.30	1.63	13.15	3.15
27	0.7000	47.800	43.2	11.9	6.21	10.00	16.21	1.62	13.11	3.11
28	0.7500	48.500	43.9	12.8	6.25	10.00	16.25	1.63	13.13	3.13
29	0.8000	48.500	43.9	13.6	6.19	10.00	16.19	1.62	13.10	3.10
30	0.8500	48.800	44.2	14.5	6.17	10.00	16.17	1.62	13.09	3.09
31	0.9000	49.600	45.0	15.3	6.22	10.00	16.22	1.62	13.11	3.11







Sample No.		1
Initial	Water Content, %	60.3
	Dry Density, pcf	64.1
	Saturation, %	105.2
	Void Ratio	1.4331
	Diameter, in.	2.82
	Height, in.	5.92
At Test	Water Content, %	57.3
	Dry Density, pcf	64.1
	Saturation, %	100.0
	Void Ratio	1.4331
	Diameter, in.	2.82
	Height, in.	5.92
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		8.0
Ult. Stress, psi		
σ_1 Failure, psi		18.0
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained
Sample Type: ASTM D2850
Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells) (visual)

Assumed Specific Gravity= 2.5
Remarks: H/D = 2.10

Figure ________

Client: Langan Engineering

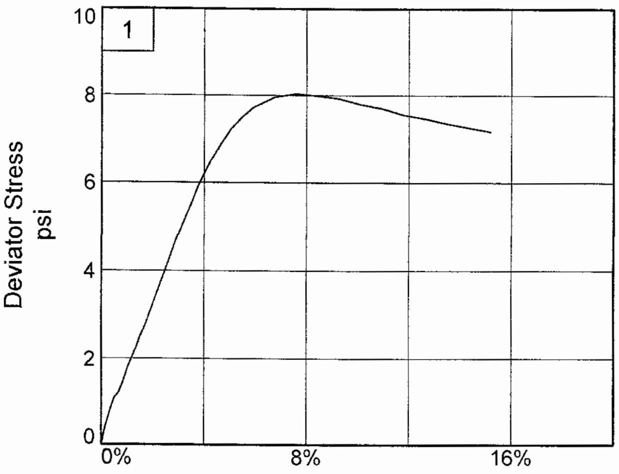
Project: Hudson Yards

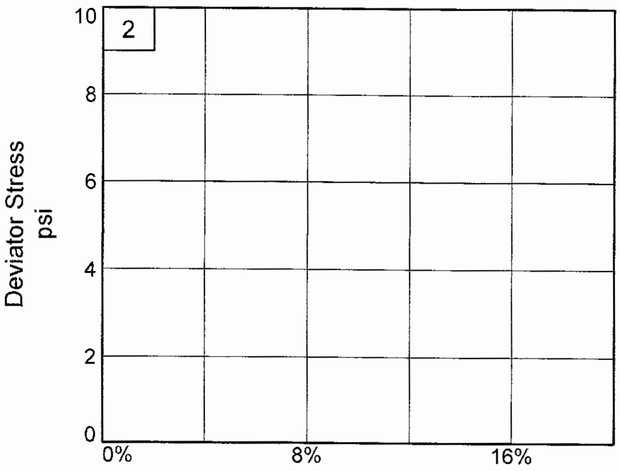
Sample Number: LB-1 37-39'

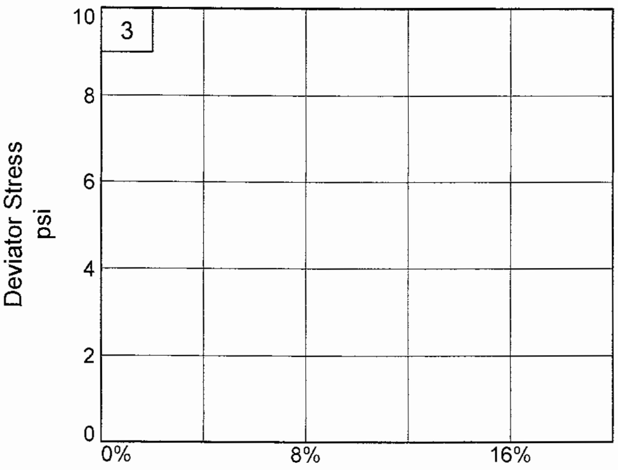
Proj. No.: 869 **Date Sampled:** 11-8-17

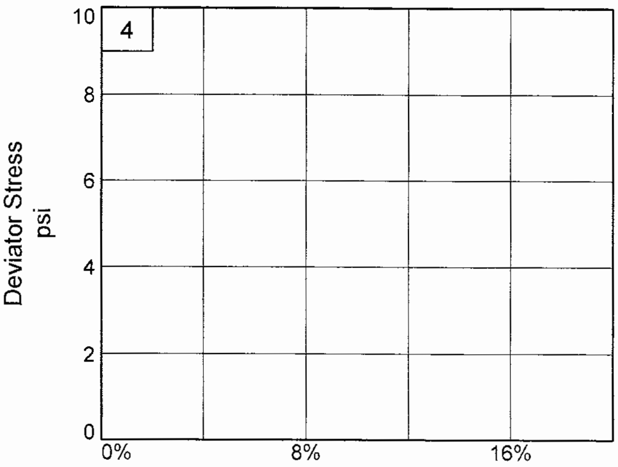
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

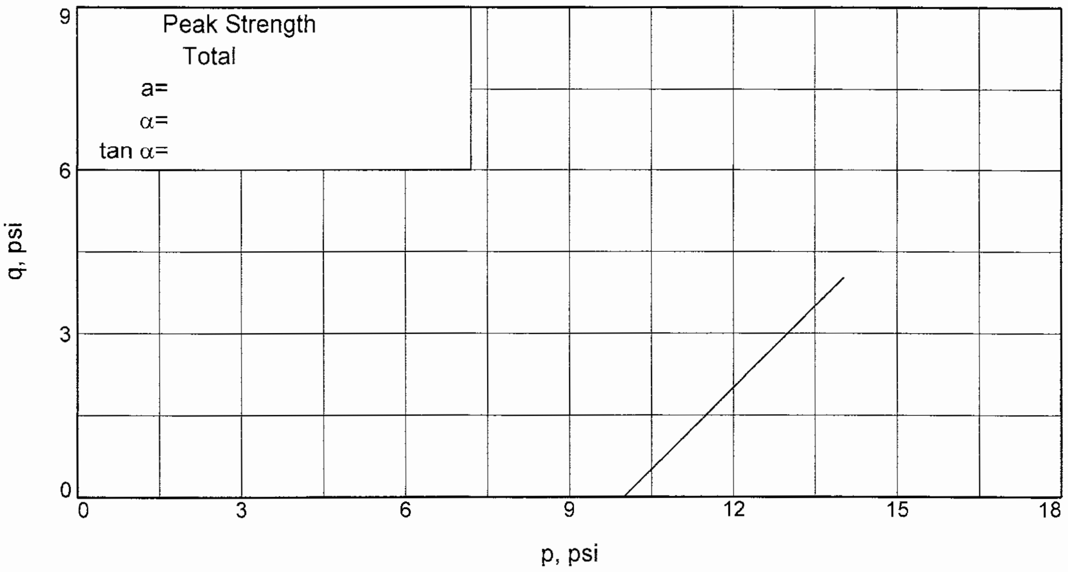
Tested By: EE **Checked By:** KP











Client: Langan Engineering

Project: Hudson Yards

Sample Number: LB-1 37-39'

Project No.: 869

Figure ________

RSA Geolab

Tested By: EE

Checked By: KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/3/2017
11:51 AM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 37-39'
Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells) (visual)
Remarks: H/D = 2.10
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

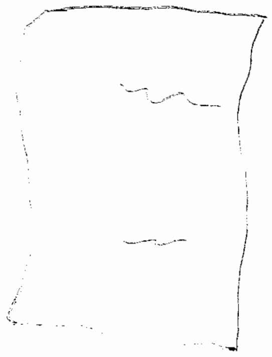
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	998.600		998.600
Moisture content: Dry soil+tare, gms.	622.900		622.900
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	60.3	57.3	60.3
Moist specimen weight, gms.	998.6		
Diameter, in.	2.82	2.82	
Area, in.²	6.25	6.25	
Height, in.	5.92	5.92	
Net decrease in height, in.		0.00	
Wet density, pcf	102.8	100.9	
Dry density, pcf	64.1	64.1	
Void ratio	1.4331	1.4331	
Saturation, %	105.2	100.0	

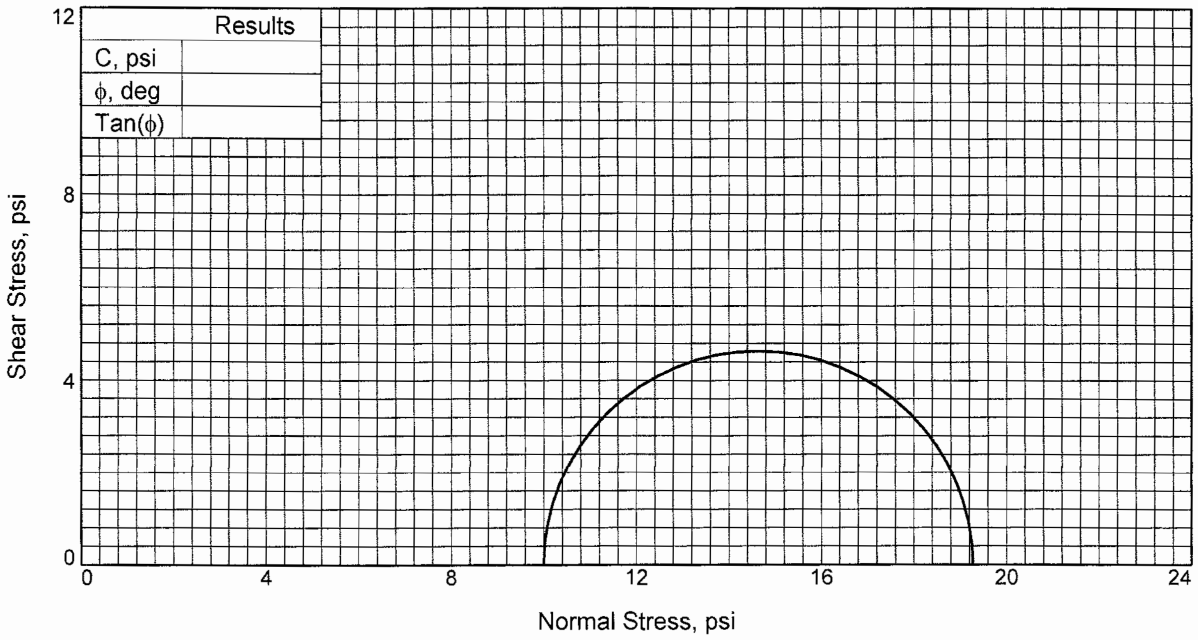
Test Readings for Specimen No. 1

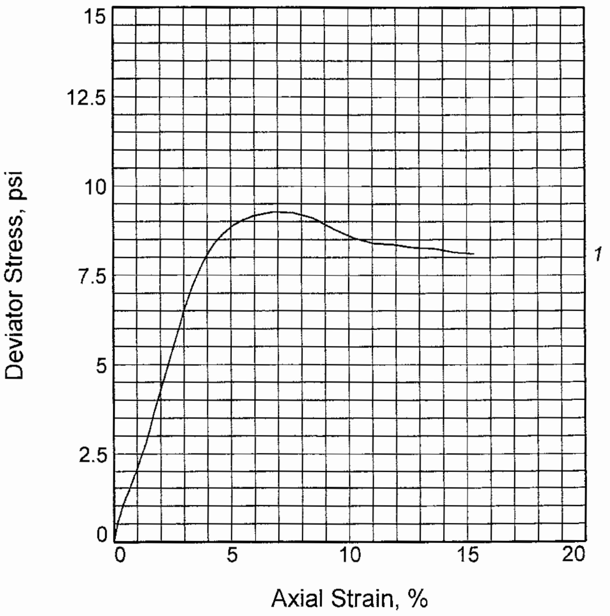
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 8.03 psi **at reading no.** 22

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	3.200	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	5.900	2.7	0.2	0.43	10.00	10.43	1.04	10.22	0.22
2	0.0200	8.200	5.0	0.3	0.80	10.00	10.80	1.08	10.40	0.40
3	0.0300	10.000	6.8	0.5	1.08	10.00	11.08	1.11	10.54	0.54
4	0.0400	10.800	7.6	0.7	1.21	10.00	11.21	1.12	10.60	0.60
5	0.0500	12.300	9.1	0.8	1.44	10.00	11.44	1.14	10.72	0.72
6	0.0600	14.300	11.1	1.0	1.76	10.00	11.76	1.18	10.88	0.88
7	0.0700	15.800	12.6	1.2	1.99	10.00	11.99	1.20	11.00	1.00
8	0.0800	17.400	14.2	1.4	2.24	10.00	12.24	1.22	11.12	1.12
9	0.0900	19.100	15.9	1.5	2.51	10.00	12.51	1.25	11.25	1.25
10	0.1000	20.500	17.3	1.7	2.72	10.00	12.72	1.27	11.36	1.36
11	0.1250	25.000	21.8	2.1	3.42	10.00	13.42	1.34	11.71	1.71
12	0.1500	29.300	26.1	2.5	4.07	10.00	14.07	1.41	12.04	2.04
13	0.1750	33.900	30.7	3.0	4.77	10.00	14.77	1.48	12.39	2.39
14	0.2000	37.800	34.6	3.4	5.35	10.00	15.35	1.54	12.68	2.68
15	0.2250	41.800	38.6	3.8	5.95	10.00	15.95	1.59	12.97	2.97
16	0.2500	45.200	42.0	4.2	6.44	10.00	16.44	1.64	13.22	3.22
17	0.2750	48.100	44.9	4.6	6.86	10.00	16.86	1.69	13.43	3.43
18	0.3000	50.800	47.6	5.1	7.24	10.00	17.24	1.72	13.62	3.62
19	0.3250	52.700	49.5	5.5	7.49	10.00	17.49	1.75	13.75	3.75
20	0.3500	54.400	51.2	5.9	7.71	10.00	17.71	1.77	13.86	3.86
21	0.4000	56.500	53.3	6.8	7.96	10.00	17.96	1.80	13.98	3.98
22	0.4500	57.500	54.3	7.6	8.03	10.00	18.03	1.80	14.02	4.02
23	0.5000	57.700	54.5	8.4	7.99	10.00	17.99	1.80	13.99	3.99
24	0.5500	57.800	54.6	9.3	7.93	10.00	17.93	1.79	13.97	3.97
25	0.6000	57.400	54.2	10.1	7.80	10.00	17.80	1.78	13.90	3.90
26	0.6500	57.200	54.0	11.0	7.70	10.00	17.70	1.77	13.85	3.85
27	0.7000	56.700	53.5	11.8	7.55	10.00	17.55	1.76	13.78	3.78
28	0.7500	56.600	53.4	12.7	7.47	10.00	17.47	1.75	13.73	3.73
29	0.8000	56.300	53.1	13.5	7.35	10.00	17.35	1.74	13.68	3.68
30	0.8500	56.100	52.9	14.4	7.25	10.00	17.25	1.73	13.63	3.63
31	0.9000	56.000	52.8	15.2	7.17	10.00	17.17	1.72	13.58	3.58







Sample No.		1
Initial	Water Content, %	51.6
	Dry Density, pcf	69.3
	Saturation, %	103.2
	Void Ratio	1.2513
	Diameter, in.	2.87
	Height, in.	5.88
At Test	Water Content, %	50.1
	Dry Density, pcf	69.3
	Saturation, %	100.0
	Void Ratio	1.2513
	Diameter, in.	2.87
	Height, in.	5.88
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		9.3
Ult. Stress, psi		
σ_1 Failure, psi		19.3
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.05

Figure ________

Client: Langan Engineering

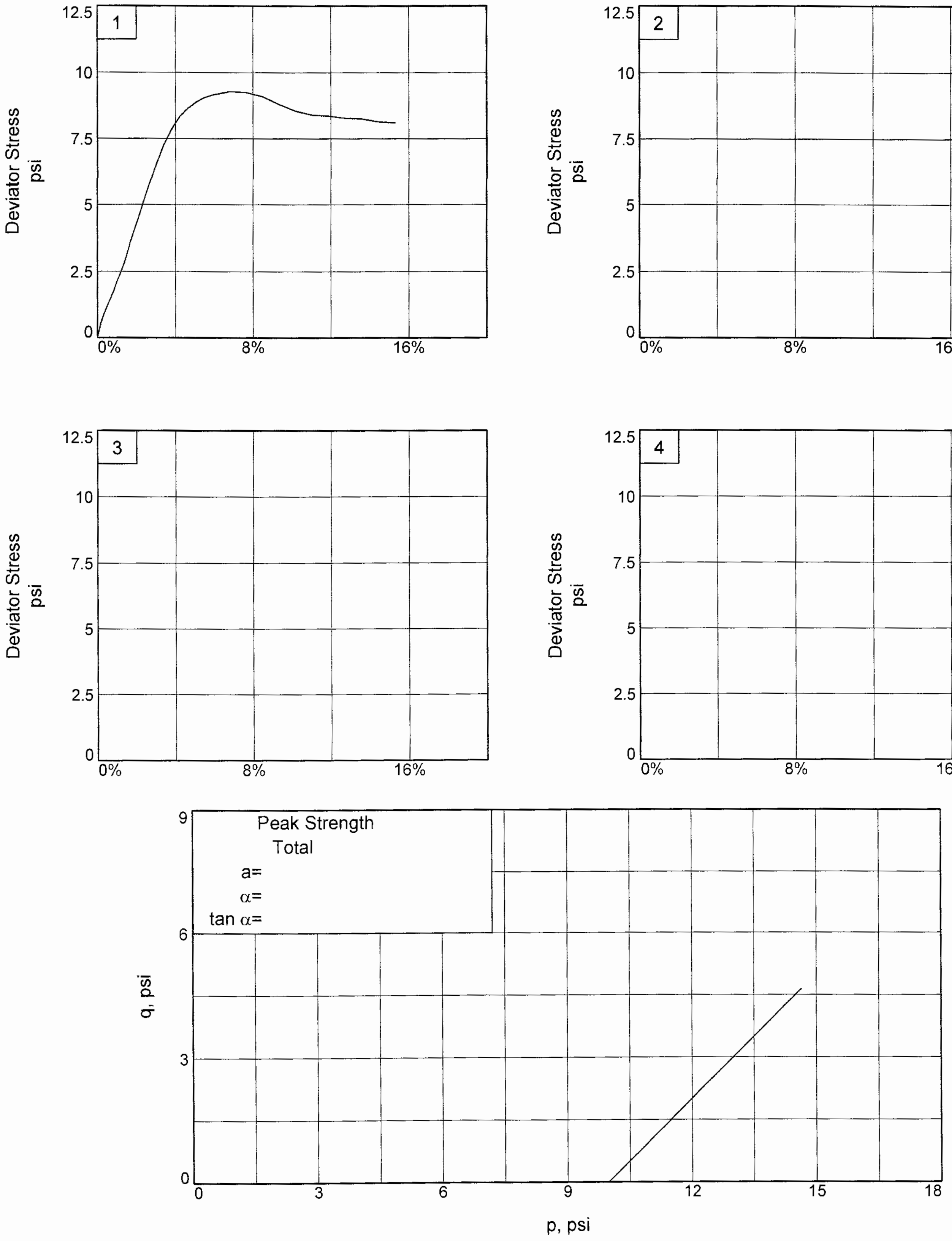
Project: Hudson Yards

Sample Number: LB-1 47-49'

Proj. No.: 869 **Date Sampled:** 11-8-17

TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

Tested By: EE **Checked By:** KP



Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-1 47-49'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/3/2017
12:19 PM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 47-49'
Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.05
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

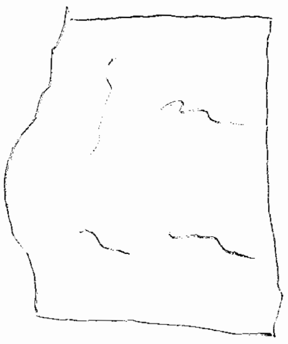
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1046.900		1046.900
Moisture content: Dry soil+tare, gms.	690.400		690.400
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	51.6	50.1	51.6
Moist specimen weight, gms.	1046.9		
Diameter, in.	2.87	2.87	
Area, in.^{2}	6.45	6.45	
Height, in.	5.88	5.88	
Net decrease in height, in.		0.00	
Wet density, pcf	105.1	104.0	
Dry density, pcf	69.3	69.3	
Void ratio	1.2513	1.2513	
Saturation, %	103.2	100.0	

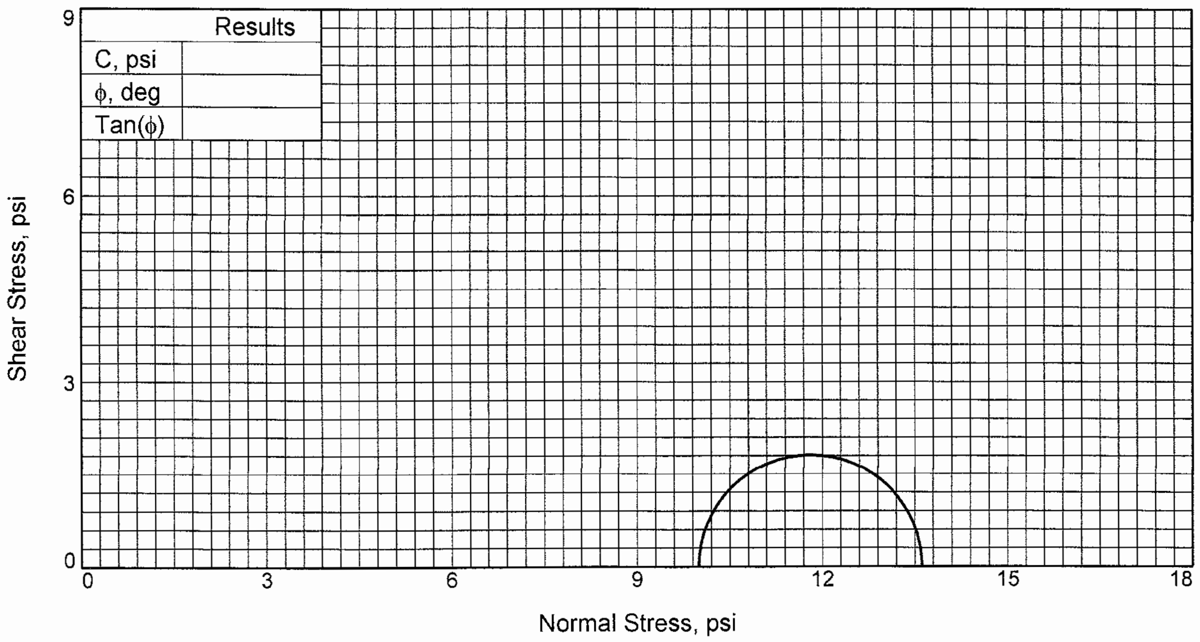
Test Readings for Specimen No. 1

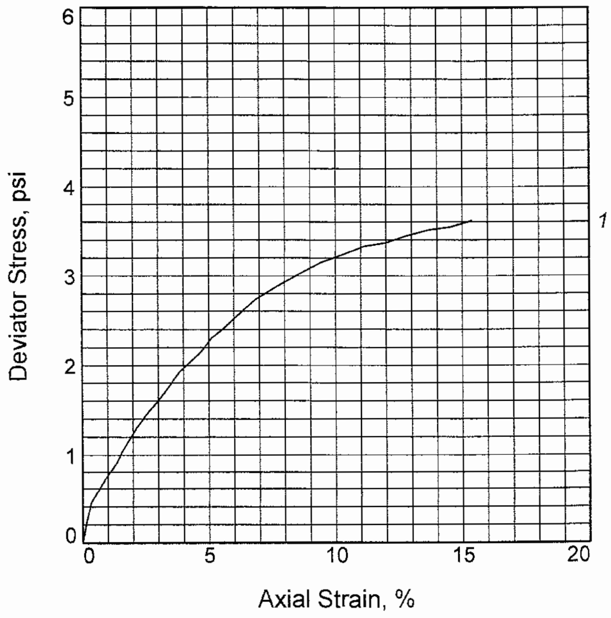
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 9.27 psi **at reading no.** 21

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	2.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	5.800	3.4	0.2	0.53	10.00	10.53	1.05	10.26	0.26
2	0.0200	8.300	5.9	0.3	0.91	10.00	10.91	1.09	10.46	0.46
3	0.0300	10.300	7.9	0.5	1.22	10.00	11.22	1.12	10.61	0.61
4	0.0400	12.100	9.7	0.7	1.49	10.00	11.49	1.15	10.75	0.75
5	0.0500	14.100	11.7	0.9	1.80	10.00	11.80	1.18	10.90	0.90
6	0.0600	16.300	13.9	1.0	2.13	10.00	12.13	1.21	11.07	1.07
7	0.0700	18.400	16.0	1.2	2.45	10.00	12.45	1.25	11.23	1.23
8	0.0800	20.600	18.2	1.4	2.78	10.00	12.78	1.28	11.39	1.39
9	0.0900	23.100	20.7	1.5	3.16	10.00	13.16	1.32	11.58	1.58
10	0.1000	26.200	23.8	1.7	3.63	10.00	13.63	1.36	11.81	1.81
11	0.1250	32.300	29.9	2.1	4.54	10.00	14.54	1.45	12.27	2.27
12	0.1500	38.900	36.5	2.6	5.51	10.00	15.51	1.55	12.76	2.76
13	0.1750	45.300	42.9	3.0	6.45	10.00	16.45	1.65	13.23	3.23
14	0.2000	50.800	48.4	3.4	7.25	10.00	17.25	1.72	13.62	3.62
15	0.2250	55.200	52.8	3.8	7.87	10.00	17.87	1.79	13.94	3.94
16	0.2500	58.700	56.3	4.3	8.36	10.00	18.36	1.84	14.18	4.18
17	0.2750	61.000	58.6	4.7	8.66	10.00	18.66	1.87	14.33	4.33
18	0.3000	62.900	60.5	5.1	8.90	10.00	18.90	1.89	14.45	4.45
19	0.3250	64.200	61.8	5.5	9.05	10.00	19.05	1.91	14.53	4.53
20	0.3500	65.200	62.8	6.0	9.16	10.00	19.16	1.92	14.58	4.58
21	0.4000	66.600	64.2	6.8	9.27	10.00	19.27	1.93	14.64	4.64
22	0.4500	67.000	64.6	7.7	9.25	10.00	19.25	1.92	14.62	4.62
23	0.5000	66.500	64.1	8.5	9.09	10.00	19.09	1.91	14.55	4.55
24	0.5500	65.000	62.6	9.4	8.80	10.00	18.80	1.88	14.40	4.40
25	0.6000	63.800	61.4	10.2	8.55	10.00	18.55	1.85	14.27	4.27
26	0.6500	63.300	60.9	11.1	8.40	10.00	18.40	1.84	14.20	4.20
27	0.7000	63.600	61.2	11.9	8.36	10.00	18.36	1.84	14.18	4.18
28	0.7500	63.600	61.2	12.8	8.28	10.00	18.28	1.83	14.14	4.14
29	0.8000	64.000	61.6	13.6	8.25	10.00	18.25	1.82	14.12	4.12
30	0.8500	63.800	61.4	14.5	8.14	10.00	18.14	1.81	14.07	4.07
31	0.9000	64.100	61.7	15.3	8.10	10.00	18.10	1.81	14.05	4.05







Sample No.		1
Initial	Water Content, %	56.1
	Dry Density, pcf	67.9
	Saturation, %	108.1
	Void Ratio	1.2976
	Diameter, in.	2.82
	Height, in.	5.85
At Test	Water Content, %	51.9
	Dry Density, pcf	67.9
	Saturation, %	100.0
	Void Ratio	1.2976
	Diameter, in.	2.82
	Height, in.	5.85
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		3.6
Ult. Stress, psi		
σ_1 Failure, psi		13.6
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.07

Figure ________

Client: Langan Engineering

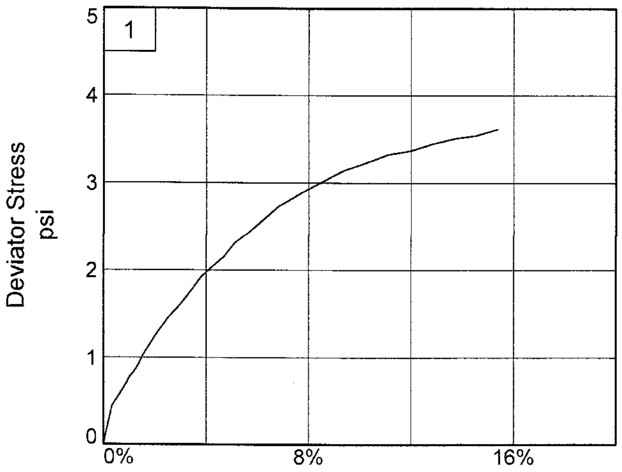
Project: Hudson Yards

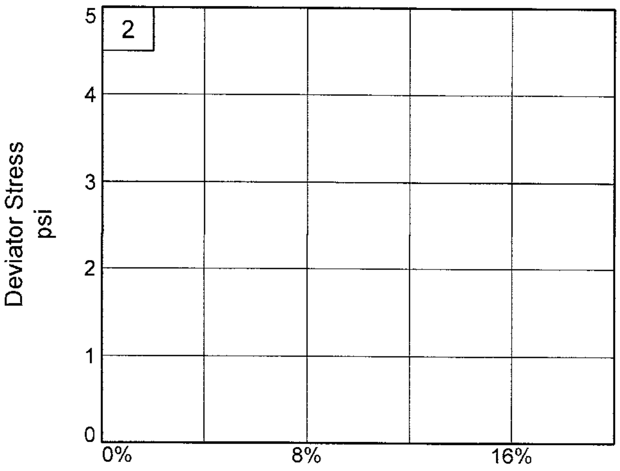
Sample Number: LB-1 57-59'

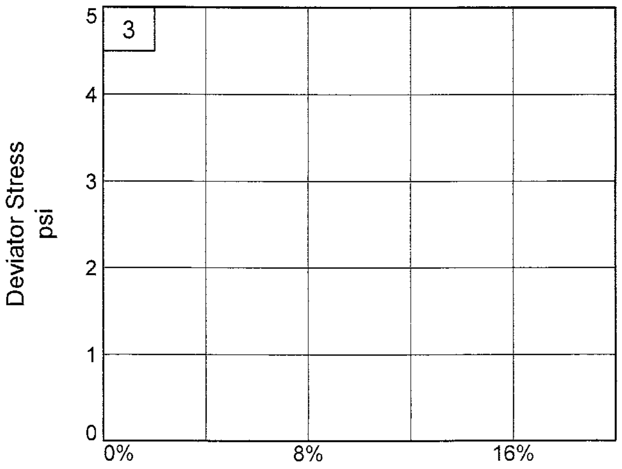
Proj. No.: 869 **Date Sampled:** 11-8-17

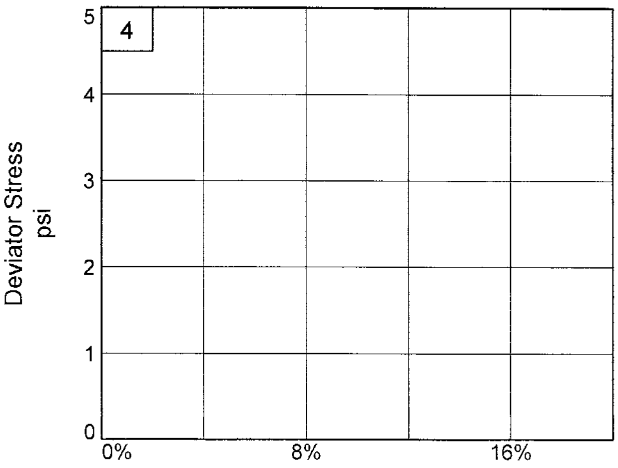
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

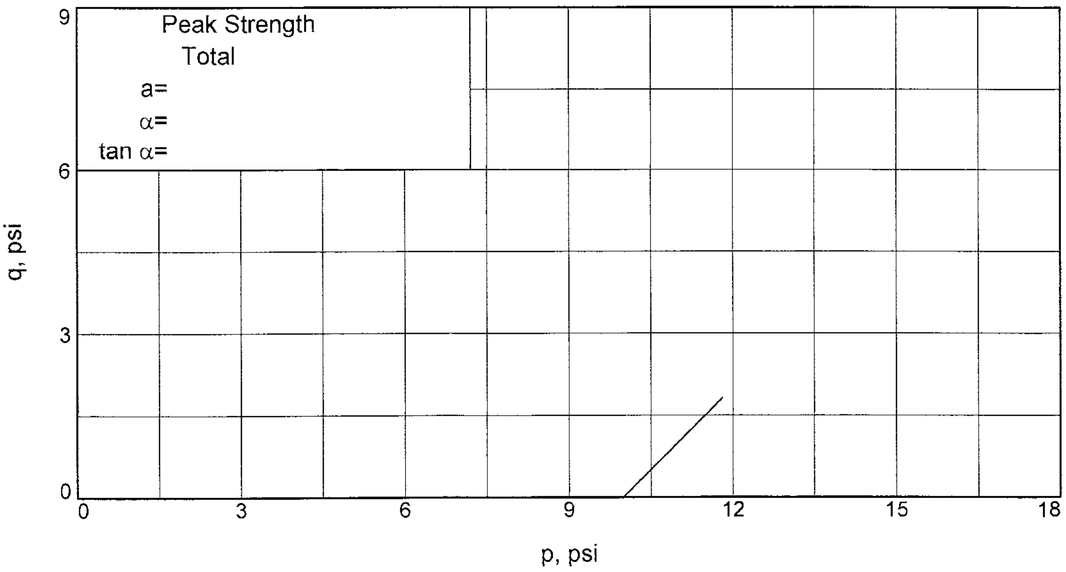
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-1 57-59'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE

Checked By: KP

TRIAXIAL COMPRESSION TEST

Unconsolidated Undrained

11/3/2017
12:30 PM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 57-59'
Description: Dark Gray Clay & silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.07
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

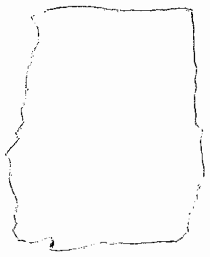
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1016.900		1016.900
Moisture content: Dry soil+tare, gms.	651.500		651.500
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	56.1	51.9	56.1
Moist specimen weight, gms.	1016.9		
Diameter, in.	2.82	2.82	
Area, in.^{2}	6.25	6.25	
Height, in.	5.85	5.85	
Net decrease in height, in.		0.00	
Wet density, pcf	106.0	103.2	
Dry density, pcf	67.9	67.9	
Void ratio	1.2976	1.2976	
Saturation, %	108.1	100.0	

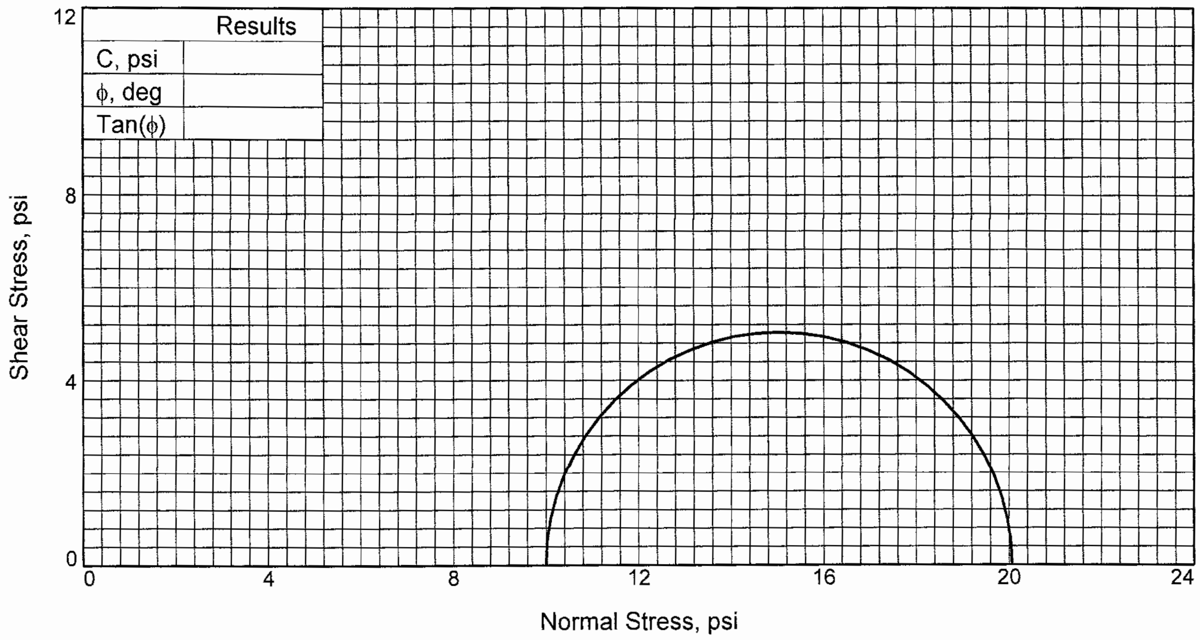
Test Readings for Specimen No. 1

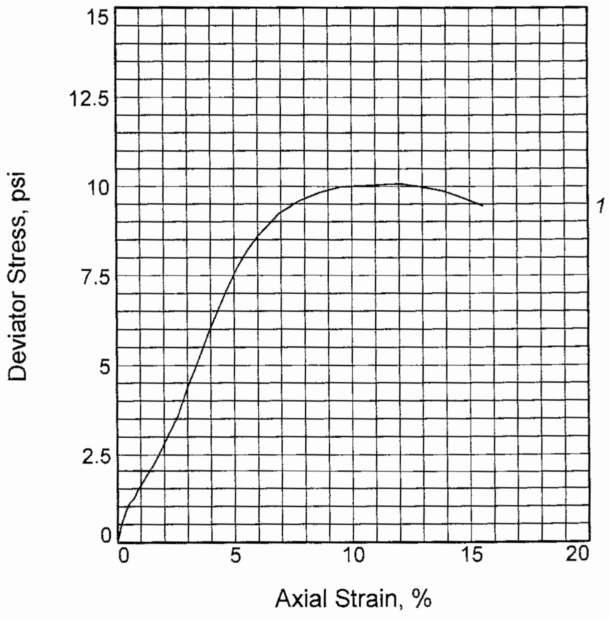
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 3.62 psi **at reading no.** 31

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	1.900	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	3.400	1.5	0.2	0.24	10.00	10.24	1.02	10.12	0.12
2	0.0200	4.700	2.8	0.3	0.45	10.00	10.45	1.04	10.22	0.22
3	0.0300	5.200	3.3	0.5	0.53	10.00	10.53	1.05	10.26	0.26
4	0.0400	5.700	3.8	0.7	0.60	10.00	10.60	1.06	10.30	0.30
5	0.0500	6.200	4.3	0.9	0.68	10.00	10.68	1.07	10.34	0.34
6	0.0600	6.800	4.9	1.0	0.78	10.00	10.78	1.08	10.39	0.39
7	0.0700	7.200	5.3	1.2	0.84	10.00	10.84	1.08	10.42	0.42
8	0.0800	7.700	5.8	1.4	0.92	10.00	10.92	1.09	10.46	0.46
9	0.0900	8.400	6.5	1.5	1.02	10.00	11.02	1.10	10.51	0.51
10	0.1000	8.900	7.0	1.7	1.10	10.00	11.10	1.11	10.55	0.55
11	0.1250	10.200	8.3	2.1	1.30	10.00	11.30	1.13	10.65	0.65
12	0.1500	11.300	9.4	2.6	1.47	10.00	11.47	1.15	10.73	0.73
13	0.1750	12.200	10.3	3.0	1.60	10.00	11.60	1.16	10.80	0.80
14	0.2000	13.300	11.4	3.4	1.76	10.00	11.76	1.18	10.88	0.88
15	0.2250	14.400	12.5	3.8	1.92	10.00	11.92	1.19	10.96	0.96
16	0.2500	15.200	13.3	4.3	2.04	10.00	12.04	1.20	11.02	1.02
17	0.2750	16.000	14.1	4.7	2.15	10.00	12.15	1.22	11.08	1.08
18	0.3000	17.100	15.2	5.1	2.31	10.00	12.31	1.23	11.15	1.15
19	0.3250	17.800	15.9	5.6	2.40	10.00	12.40	1.24	11.20	1.20
20	0.3500	18.600	16.7	6.0	2.51	10.00	12.51	1.25	11.26	1.26
21	0.4000	20.200	18.3	6.8	2.73	10.00	12.73	1.27	11.36	1.36
22	0.4500	21.400	19.5	7.7	2.88	10.00	12.88	1.29	11.44	1.44
23	0.5000	22.500	20.6	8.5	3.02	10.00	13.02	1.30	11.51	1.51
24	0.5500	23.600	21.7	9.4	3.15	10.00	13.15	1.31	11.57	1.57
25	0.6000	24.400	22.5	10.3	3.23	10.00	13.23	1.32	11.62	1.62
26	0.6500	25.300	23.4	11.1	3.33	10.00	13.33	1.33	11.67	1.67
27	0.7000	25.800	23.9	12.0	3.37	10.00	13.37	1.34	11.68	1.68
28	0.7500	26.600	24.7	12.8	3.45	10.00	13.45	1.34	11.72	1.72
29	0.8000	27.300	25.4	13.7	3.51	10.00	13.51	1.35	11.76	1.76
30	0.8500	27.800	25.9	14.5	3.54	10.00	13.54	1.35	11.77	1.77
31	0.9000	28.600	26.7	15.4	3.62	10.00	13.62	1.36	11.81	1.81







Sample No.		1
Initial	Water Content, %	41.0
	Dry Density, pcf	80.4
	Saturation, %	108.8
	Void Ratio	0.9422
	Diameter, in.	2.85
	Height, in.	5.79
At Test	Water Content, %	37.7
	Dry Density, pcf	80.4
	Saturation, %	100.0
	Void Ratio	0.9422
	Diameter, in.	2.85
	Height, in.	5.79
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		10.1
Ult. Stress, psi		
σ_1 Failure, psi		20.1
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.03

Figure ______

Client: Langan Engineering

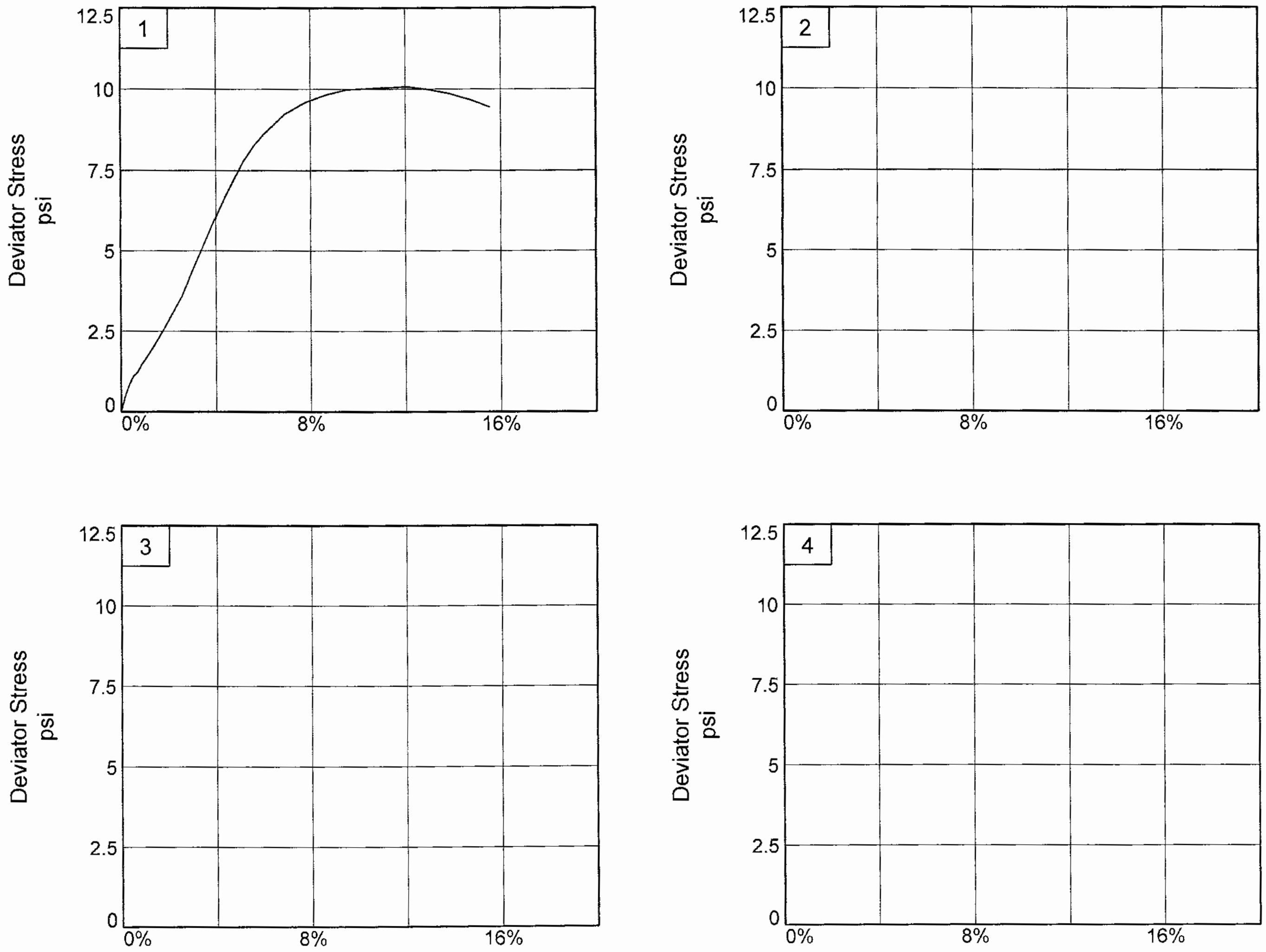
Project: Hudson Yards

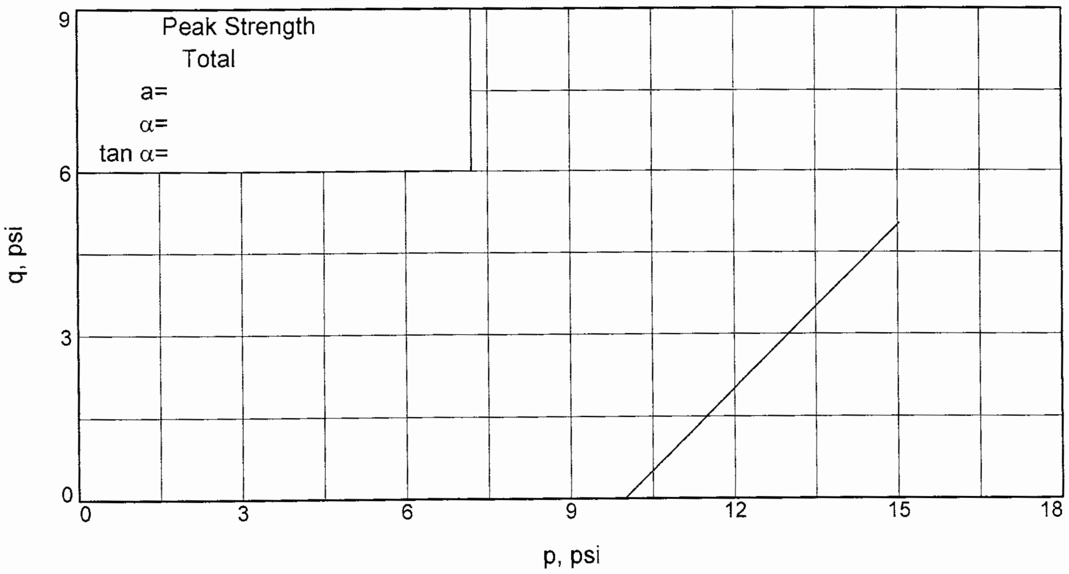
Sample Number: LB-1 72-74'

Proj. No.: 869 **Date Sampled:** 11-8-17

TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

Tested By: EE **Checked By:** KP





Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-1 72-74'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST

Unconsolidated Undrained

11/3/2017
12:41 PM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 72-74'
Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.03
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

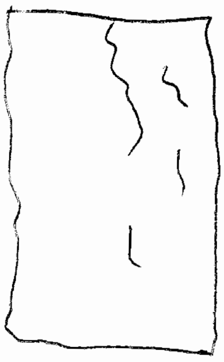
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1094.300		1094.300
Moisture content: Dry soil+tare, gms.	776.000		776.000
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	41.0	37.7	41.0
Moist specimen weight, gms.	1094.3		
Diameter, in.	2.85	2.85	
Area, in.²	6.36	6.36	
Height, in.	5.79	5.79	
Net decrease in height, in.		0.00	
Wet density, pcf	113.3	110.6	
Dry density, pcf	80.4	80.4	
Void ratio	0.9422	0.9422	
Saturation, %	108.8	100.0	

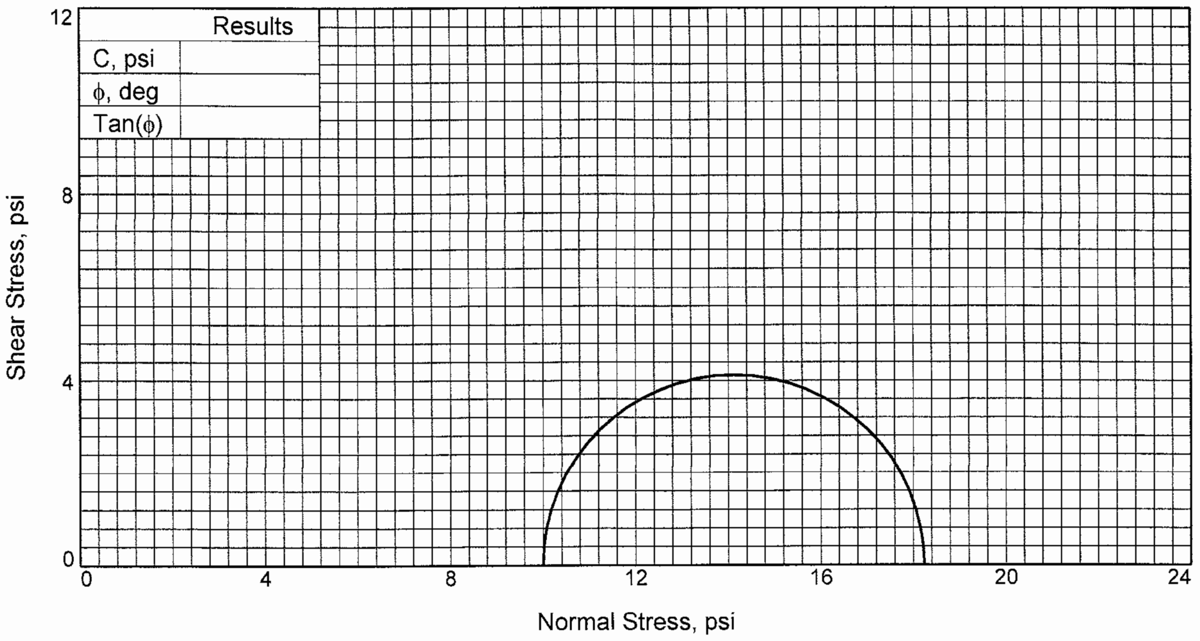
Test Readings for Specimen No. 1

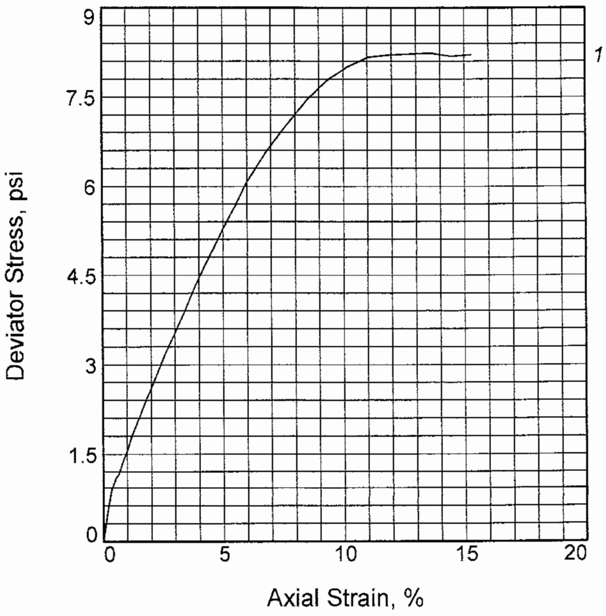
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 10.07 psi **at reading no.** 27

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	3.000	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	6.000	3.0	0.2	0.47	10.00	10.47	1.05	10.24	0.24
2	0.0200	8.300	5.3	0.3	0.83	10.00	10.83	1.08	10.42	0.42
3	0.0300	10.000	7.0	0.5	1.10	10.00	11.10	1.11	10.55	0.55
4	0.0400	10.800	7.8	0.7	1.22	10.00	11.22	1.12	10.61	0.61
5	0.0500	12.300	9.3	0.9	1.45	10.00	11.45	1.15	10.73	0.73
6	0.0600	13.500	10.5	1.0	1.63	10.00	11.63	1.16	10.82	0.82
7	0.0700	14.800	11.8	1.2	1.83	10.00	11.83	1.18	10.92	0.92
8	0.0800	16.000	13.0	1.4	2.02	10.00	12.02	1.20	11.01	1.01
9	0.0900	17.400	14.4	1.6	2.23	10.00	12.23	1.22	11.11	1.11
10	0.1000	18.800	15.8	1.7	2.44	10.00	12.44	1.24	11.22	1.22
11	0.1250	22.700	19.7	2.2	3.03	10.00	13.03	1.30	11.52	1.52
12	0.1500	26.500	23.5	2.6	3.60	10.00	13.60	1.36	11.80	1.80
13	0.1750	31.800	28.8	3.0	4.39	10.00	14.39	1.44	12.20	2.20
14	0.2000	36.600	33.6	3.5	5.10	10.00	15.10	1.51	12.55	2.55
15	0.2250	41.800	38.8	3.9	5.87	10.00	15.87	1.59	12.93	2.93
16	0.2500	46.500	43.5	4.3	6.55	10.00	16.55	1.65	13.27	3.27
17	0.2750	51.000	48.0	4.8	7.19	10.00	17.19	1.72	13.60	3.60
18	0.3000	55.200	52.2	5.2	7.79	10.00	17.79	1.78	13.89	3.89
19	0.3250	58.600	55.6	5.6	8.26	10.00	18.26	1.83	14.13	4.13
20	0.3500	61.400	58.4	6.0	8.63	10.00	18.63	1.86	14.32	4.32
21	0.4000	66.000	63.0	6.9	9.23	10.00	19.23	1.92	14.61	4.61
22	0.4500	69.100	66.1	7.8	9.59	10.00	19.59	1.96	14.79	4.79
23	0.5000	71.300	68.3	8.6	9.82	10.00	19.82	1.98	14.91	4.91
24	0.5500	73.100	70.1	9.5	9.98	10.00	19.98	2.00	14.99	4.99
25	0.6000	74.000	71.0	10.4	10.01	10.00	20.01	2.00	15.01	5.01
26	0.6500	74.900	71.9	11.2	10.04	10.00	20.04	2.00	15.02	5.02
27	0.7000	75.800	72.8	12.1	10.07	10.00	20.07	2.01	15.03	5.03
28	0.7500	75.900	72.9	13.0	9.98	10.00	19.98	2.00	14.99	4.99
29	0.8000	75.800	72.8	13.8	9.87	10.00	19.87	1.99	14.93	4.93
30	0.8500	75.100	72.1	14.7	9.68	10.00	19.68	1.97	14.84	4.84
31	0.9000	74.100	71.1	15.6	9.45	10.00	19.45	1.94	14.72	4.72







Sample No.		1
Initial	Water Content, %	40.3
	Dry Density, pcf	82.9
	Saturation, %	114.3
	Void Ratio	0.8815
	Diameter, in.	2.83
	Height, in.	5.89
At Test	Water Content, %	35.3
	Dry Density, pcf	82.9
	Saturation, %	100.0
	Void Ratio	0.8815
	Diameter, in.	2.83
	Height, in.	5.89
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		8.2
Ult. Stress, psi		
σ_1 Failure, psi		18.2
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little (+), cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.08

Figure ________

Client: Langan Engineering

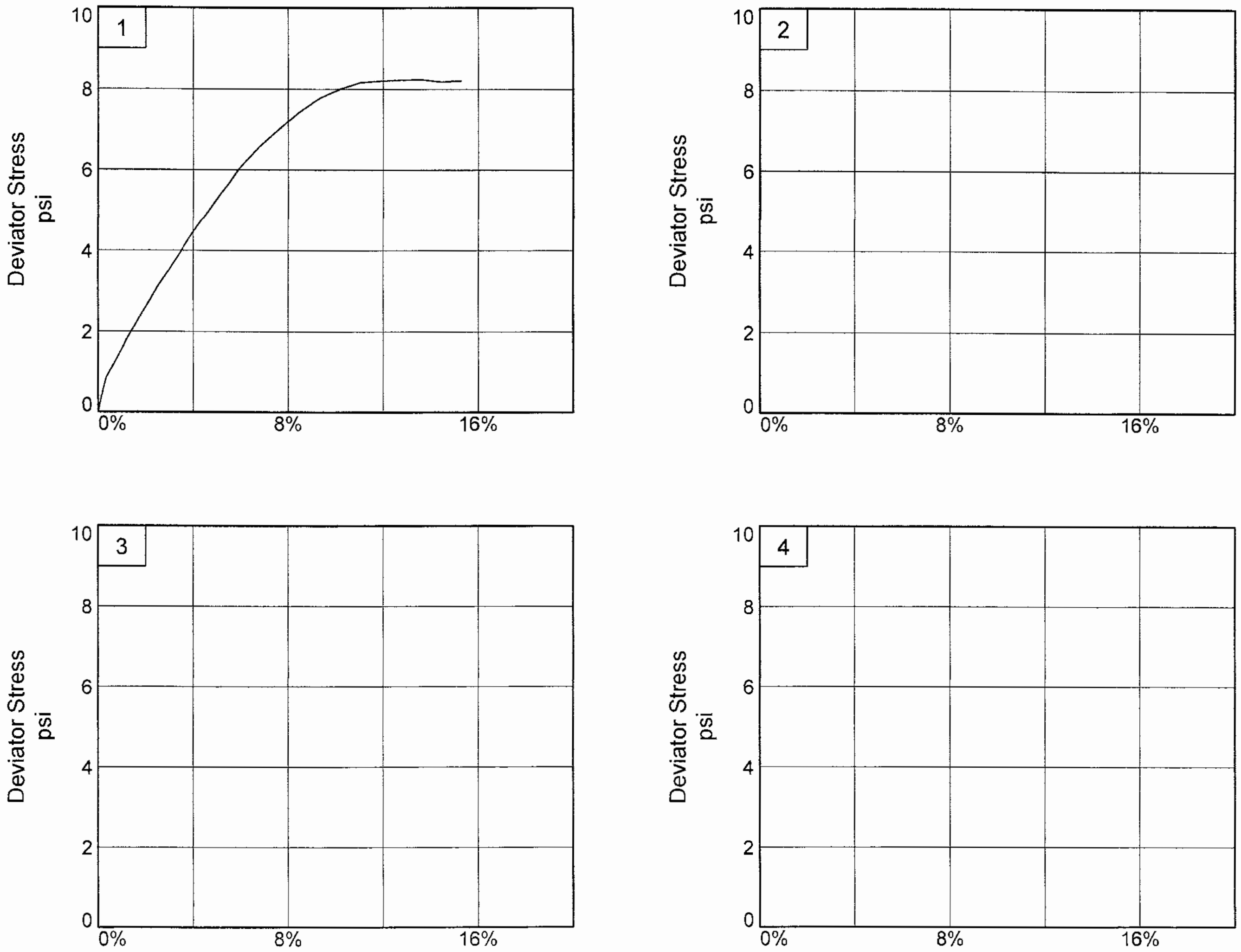
Project: Hudson Yards

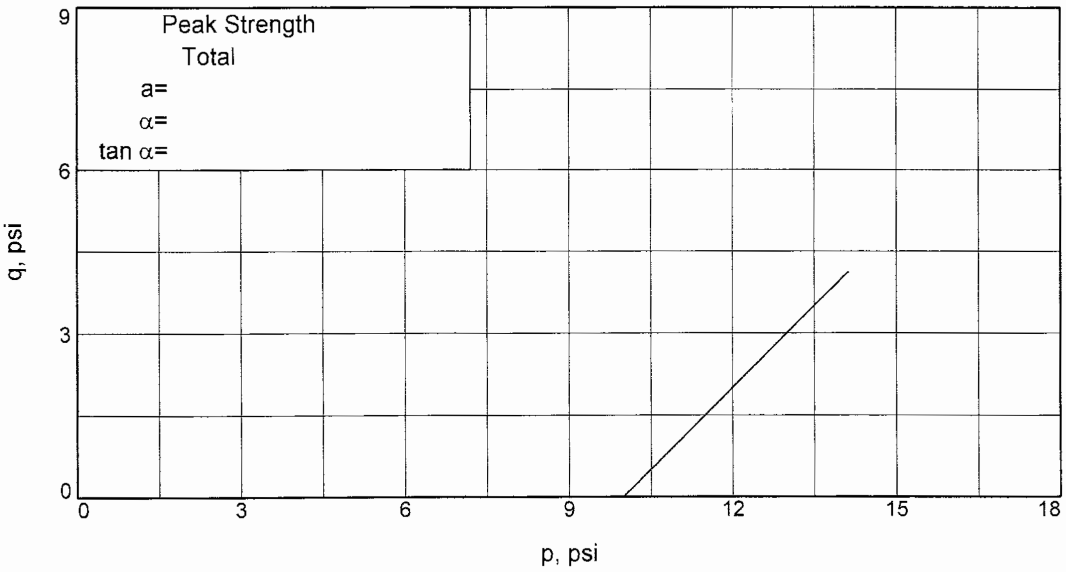
Sample Number: LB-1 87-89'

Proj. No.: 869 **Date Sampled:** 11-8-17

TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

Tested By: EE **Checked By:** KP





Client: Langan Engineering

Project: Hudson Yards

Sample Number: LB-1 87-89'

Project No.: 869

Figure ________

RSA Geolab

Tested By: EE

Checked By: KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/3/2017
12:46 PM

Date: 11-8-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-1 87-89'
Description: Dark Gray Clay & Silt little (+), cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.08
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

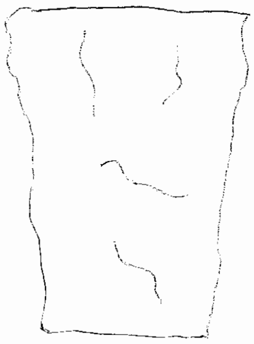
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1132.300		1132.300
Moisture content: Dry soil+tare, gms.	807.000		807.000
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	40.3	35.3	40.3
Moist specimen weight, gms.	1132.3		
Diameter, in.	2.83	2.83	
Area, in.^{2}	6.29	6.29	
Height, in.	5.89	5.89	
Net decrease in height, in.		0.00	
Wet density, pcf	116.4	112.2	
Dry density, pcf	82.9	82.9	
Void ratio	0.8815	0.8815	
Saturation, %	114.3	100.0	

Test Readings for Specimen No. 1

Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 8.24 psi **at reading no.** 29

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	1.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	4.100	2.7	0.2	0.43	10.00	10.43	1.04	10.21	0.21
2	0.0200	6.800	5.4	0.3	0.85	10.00	10.85	1.09	10.43	0.43
3	0.0300	8.000	6.6	0.5	1.04	10.00	11.04	1.10	10.52	0.52
4	0.0400	9.000	7.6	0.7	1.20	10.00	11.20	1.12	10.60	0.60
5	0.0500	10.300	8.9	0.8	1.40	10.00	11.40	1.14	10.70	0.70
6	0.0600	11.400	10.0	1.0	1.57	10.00	11.57	1.16	10.79	0.79
7	0.0700	12.800	11.4	1.2	1.79	10.00	11.79	1.18	10.89	0.89
8	0.0800	13.900	12.5	1.4	1.96	10.00	11.96	1.20	10.98	0.98
9	0.0900	15.000	13.6	1.5	2.13	10.00	12.13	1.21	11.06	1.06
10	0.1000	16.200	14.8	1.7	2.31	10.00	12.31	1.23	11.16	1.16
11	0.1250	18.900	17.5	2.1	2.72	10.00	12.72	1.27	11.36	1.36
12	0.1500	21.700	20.3	2.5	3.14	10.00	13.14	1.31	11.57	1.57
13	0.1750	24.100	22.7	3.0	3.50	10.00	13.50	1.35	11.75	1.75
14	0.2000	26.700	25.3	3.4	3.88	10.00	13.88	1.39	11.94	1.94
15	0.2250	29.500	28.1	3.8	4.29	10.00	14.29	1.43	12.15	2.15
16	0.2500	32.000	30.6	4.2	4.65	10.00	14.65	1.47	12.33	2.33
17	0.2750	34.400	33.0	4.7	5.00	10.00	15.00	1.50	12.50	2.50
18	0.3000	36.900	35.5	5.1	5.35	10.00	15.35	1.54	12.68	2.68
19	0.3250	39.200	37.8	5.5	5.67	10.00	15.67	1.57	12.84	2.84
20	0.3500	41.800	40.4	5.9	6.04	10.00	16.04	1.60	13.02	3.02
21	0.4000	45.800	44.4	6.8	6.57	10.00	16.57	1.66	13.29	3.29
22	0.4500	49.300	47.9	7.6	7.03	10.00	17.03	1.70	13.51	3.51
23	0.5000	52.600	51.2	8.5	7.44	10.00	17.44	1.74	13.72	3.72
24	0.5500	55.400	54.0	9.3	7.78	10.00	17.78	1.78	13.89	3.89
25	0.6000	57.500	56.1	10.2	8.00	10.00	18.00	1.80	14.00	4.00
26	0.6500	59.200	57.8	11.0	8.17	10.00	18.17	1.82	14.08	4.08
27	0.7000	60.000	58.6	11.9	8.20	10.00	18.20	1.82	14.10	4.10
28	0.7500	60.700	59.3	12.7	8.22	10.00	18.22	1.82	14.11	4.11
29	0.8000	61.400	60.0	13.6	8.24	10.00	18.24	1.82	14.12	4.12
30	0.8500	61.600	60.2	14.4	8.18	10.00	18.18	1.82	14.09	4.09
31	0.9000	62.400	61.0	15.3	8.21	10.00	18.21	1.82	14.10	4.10



LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

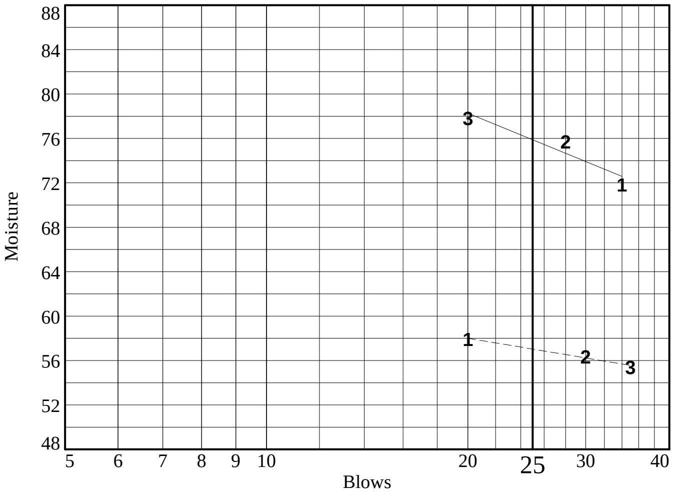
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 27-29'
Material Description: Dark Gray Clay & Silt little (-), cmf Sand, trace f Gravel, odorous, organics (sea shells) (visual)
Tested by: RP **Checked by:** KP
Testing Remarks: 11-8-17

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	19.36	20.47	20.52			
Dry+Tare	11.94	12.35	12.25			
Tare	1.62	1.63	1.63			
# Blows	34	28	20			
Moisture	71.9	75.7	77.9			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	17.48	16.30	18.65			
Dry+Tare	11.58	10.93	12.48			
Tare	1.40	1.41	1.35			
# Blows	20	30	35			
Moisture	58.0	56.4	55.4			



Liquid Limit= 76
Liquid Limit (organics)= 57
Plastic Limit= 40
Plasticity Index= 36

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	7.58	7.62			
Dry+Tare	5.86	5.90			
Tare	1.57	1.56			
Moisture	40.1	39.6			

RSA Geolab

MOISTURE CONTENT (ASTM D2216)/
LOSS ON IGNITION (ASTM D2974)

Project: Hudson Yards

Project #: 869

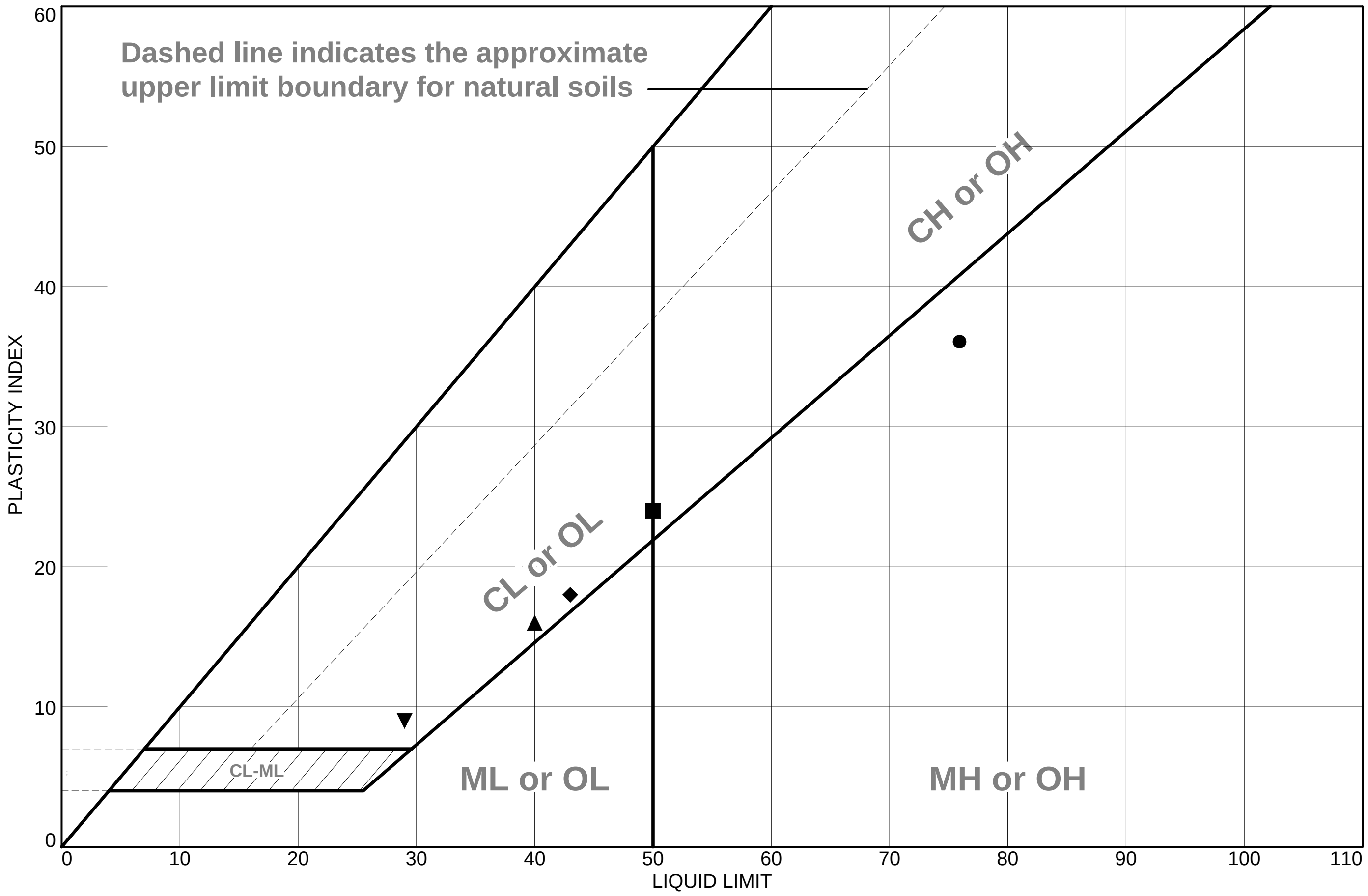
Client: Langan Engineering

Date: 11-8-17

HOLE #/ SAMPLE #	LB-1 27-29'	LB-1 37-39'	LB-1 47-49'	LB-1 57-59'	LB-1 72-74'	LB-1 87-89'
DEPTH						
WET WGT. + TARE (gm	334.9	337.6	393.5	438.4	350.5	433.1
DRY WGT. + TARE (gm	211.3	212.0	259.6	290.8	254.6	313.5
WGT. WATER (gms.)	123.6	125.6	133.9	147.6	95.9	119.6
TARE (gms.)	7.6	7.7	7.7	7.8	7.9	7.8
DRY WGT. (gms.)	203.7	204.3	251.9	283.0	246.7	305.7
MOISTURE CONTENT (%)	**60.7**	**61.5**	**53.2**	**52.2**	**38.9**	**39.1**
OVEN DRIED SAMPLE + TARE (gms.)	63.07	61.12	103.50	105.70	103.94	109.26
AFTER IGNITION SAMPLE + TARE (gms.)	60.96	59.29	100.71	103.99	102.17	107.63
LOSS ON IGNITION (gms.)	2.11	1.83	2.79	1.71	1.77	1.63
TARE (gms.)	31.23	26.97	52.11	57.23	52.10	57.23
INITIAL WGT. OF OVEN DRIED SAMPLE (gms.)	31.84	34.15	51.39	48.47	51.84	52.03
LOSS ON IGNITION (%)	**6.63**	**5.36**	**5.43**	**3.53**	**3.41**	**3.13**

Performed by: EE Entered by: KH Checked by: KP

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Clay & Silt little (-), cmf Sand, trace f Gravel, odorous, organics (sea shells) (visual)	76	40	36			
■	Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells) (visual)	50	26	24			
▲	Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)	40	24	16			
◆	Dark Gray Clay & silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)	43	25	18			
▼	Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)	29	20	9			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

●**Sample Number:** LB-1 27-29'
■**Sample Number:** LB-1 37-39'
▲**Sample Number:** LB-1 47-49'
◆**Sample Number:** LB-1 57-59'
▼**Sample Number:** LB-1 72-74'

Remarks:
●11-8-17

RSA Geolab

Union, New Jersey

Figure

Tested By: RP **Checked By:** KP

LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

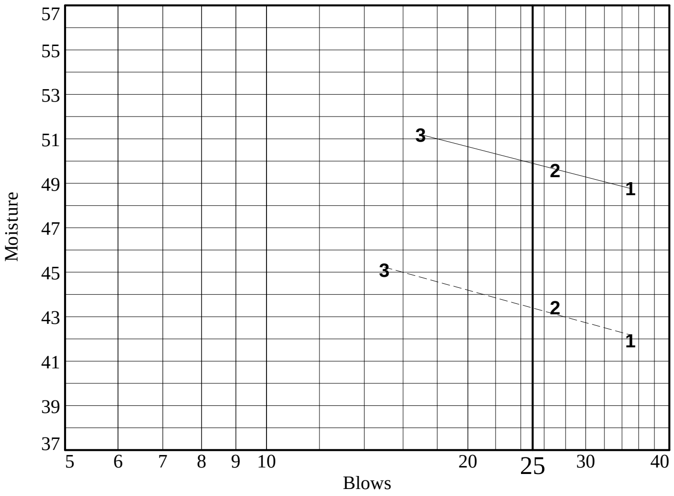
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 37-39'
Material Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells) (visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	18.24	18.70	18.53			
Dry+Tare	12.79	13.04	12.80			
Tare	1.62	1.63	1.61			
# Blows	35	27	17			
Moisture	48.8	49.6	51.2			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	20.45	20.04	21.20			
Dry+Tare	14.82	14.38	15.04			
Tare	1.40	1.35	1.39			
# Blows	35	27	15			
Moisture	42.0	43.4	45.1			



Liquid Limit= 50
Liquid Limit (organics)= 43
Plastic Limit= 26
Plasticity Index= 24

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	6.75	6.64			
Dry+Tare	5.68	5.58			
Tare	1.56	1.55			
Moisture	26.0	26.3			

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LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

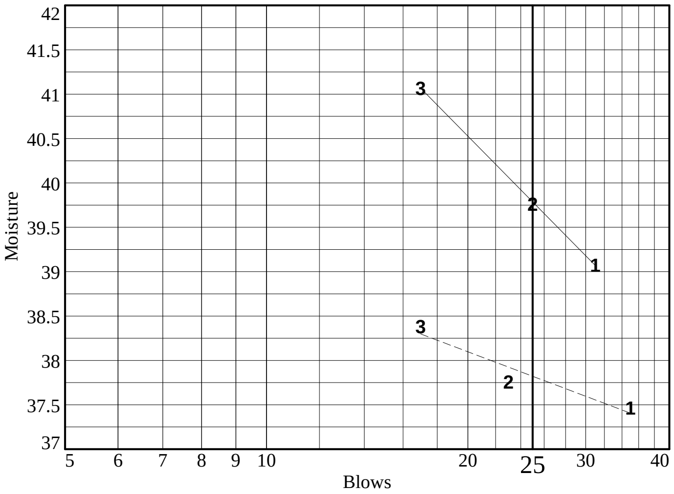
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 47-49'
Material Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	19.30	16.97	17.68			
Dry+Tare	14.27	12.54	12.94			
Tare	1.40	1.40	1.40			
# Blows	31	25	17			
Moisture	39.1	39.8	41.1			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	20.46	20.26	19.63			
Dry+Tare	15.27	15.09	14.57			
Tare	1.42	1.40	1.39			
# Blows	35	23	17			
Moisture	37.5	37.8	38.4			



Liquid Limit= 40
Liquid Limit (organics)= 38
Plastic Limit= 24
Plasticity Index= 16

Plastic Limit Data

Run No.	1	2	3	4
Wet+Tare	8.13	7.19		
Dry+Tare	6.85	6.10		
Tare	1.45	1.45		
Moisture	23.7	23.4		

LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

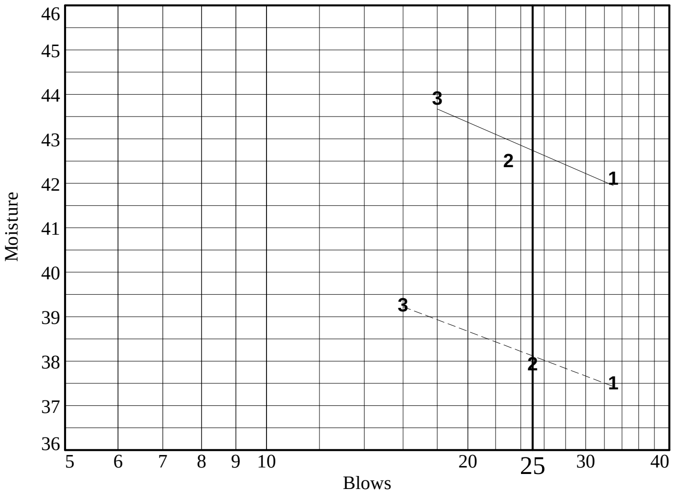
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 57-59'
Material Description: Dark Gray Clay & silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	20.30	21.85	20.57			
Dry+Tare	14.68	15.73	14.70			
Tare	1.34	1.34	1.34			
# Blows	33	23	18			
Moisture	42.1	42.5	43.9			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	20.34	20.60	20.44			
Dry+Tare	15.18	15.32	15.05			
Tare	1.43	1.41	1.33			
# Blows	33	25	16			
Moisture	37.5	38.0	39.3			



Liquid Limit= 43
Liquid Limit (organics)= 38
Plastic Limit= 25
Plasticity Index= 18

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.33	8.38			
Dry+Tare	6.93	6.98			
Tare	1.31	1.31			
Moisture	24.9	24.7			

LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

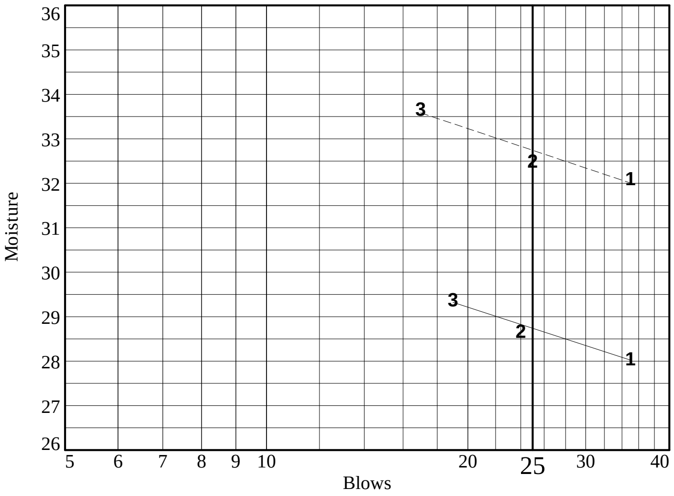
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 72-74'
Material Description: Dark Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	19.24	19.76	18.96			
Dry+Tare	15.38	15.72	15.02			
Tare	1.63	1.64	1.62			
# Blows	35	24	19			
Moisture	28.1	28.7	29.4			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	19.30	18.68	18.89			
Dry+Tare	14.95	14.44	14.49			
Tare	1.41	1.40	1.43			
# Blows	35	25	17			
Moisture	32.1	32.5	33.7			

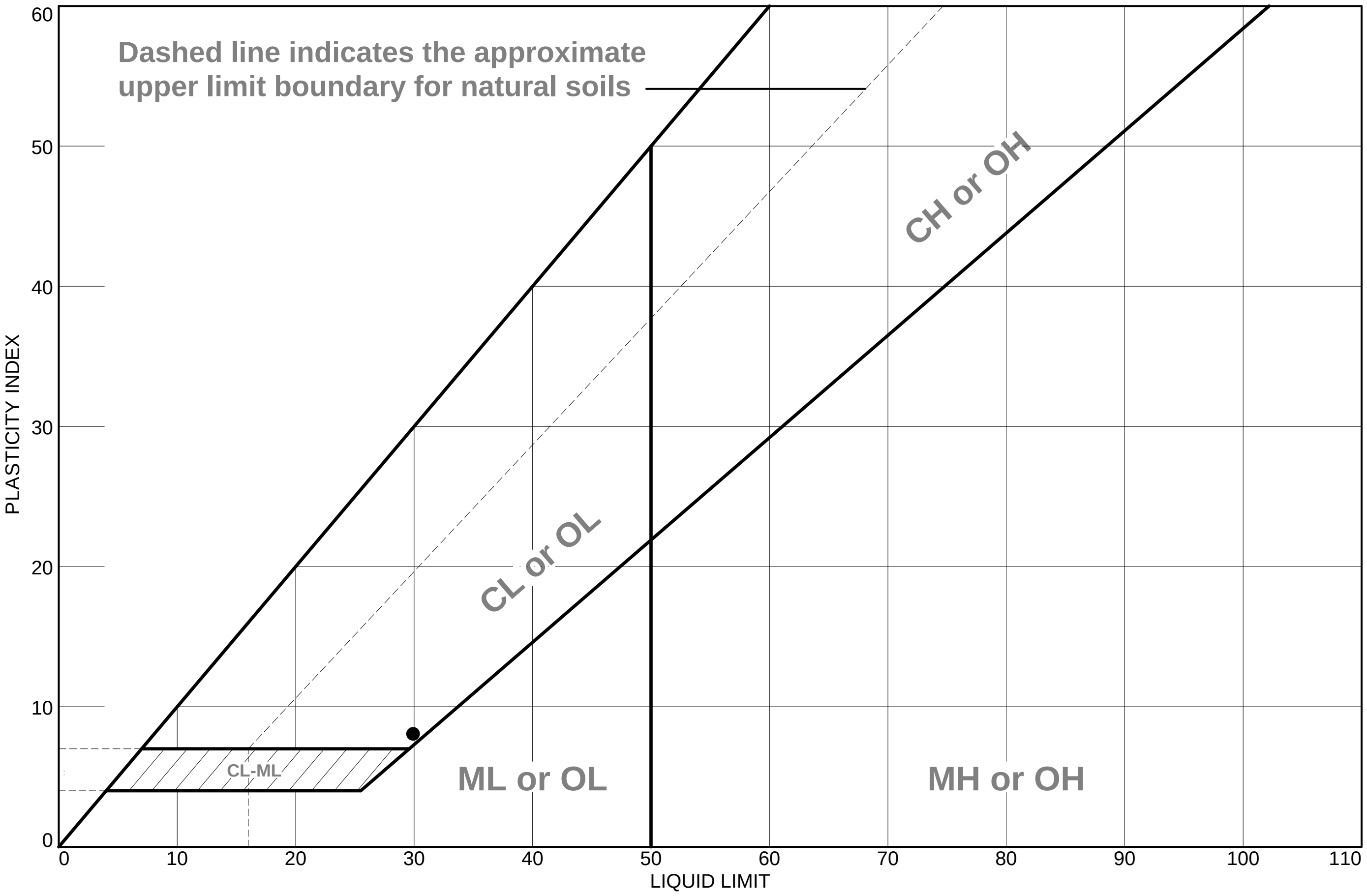


Liquid Limit= 29
Liquid Limit (organics)= 33
Plastic Limit= 20
Plasticity Index= 9

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	9.05	8.82			
Dry+Tare	7.78	7.59			
Tare	1.58	1.56			
Moisture	20.5	20.4			

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Clay & Silt little (+), cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)	30	22	8			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

● **Sample Number:** LB-1 87-89'

Remarks:

●11-8-17

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Union, New Jersey

Figure

Tested By: RP **Checked By:** KP

LIQUID AND PLASTIC LIMIT TEST DATA

11/8/2017

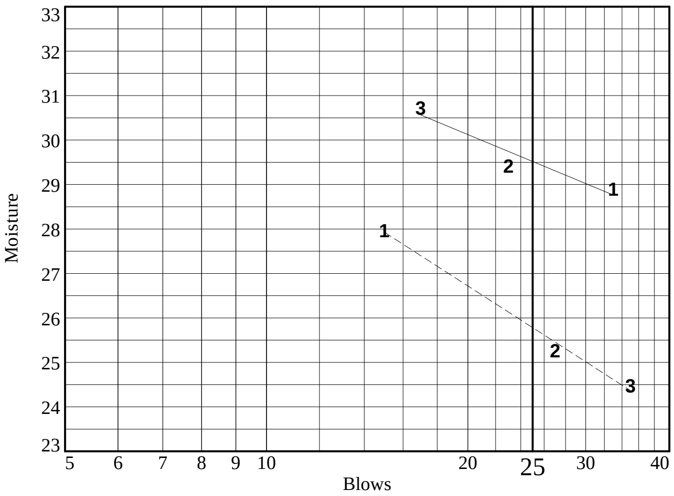
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-1 87-89'
Material Description: Dark Gray Clay & Silt little (+), cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)
Tested by: RP **Checked by:** KP
Testing Remarks: 11-8-17

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	19.36	19.30	17.71			
Dry+Tare	15.33	15.23	13.88			
Tare	1.39	1.40	1.42			
# Blows	33	23	17			
Moisture	28.9	29.4	30.7			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	18.45	19.21	19.70			
Dry+Tare	14.72	15.62	16.11			
Tare	1.39	1.42	1.45			
# Blows	15	27	35			
Moisture	28.0	25.3	24.5			



Liquid Limit= 30
Liquid Limit (organics)= 26
Plastic Limit= 22
Plasticity Index= 8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	7.25	8.23			
Dry+Tare	6.19	6.97			
Tare	1.42	1.36			
Moisture	22.2	22.5			

RSA GEOLAB, LLC

1017 Greeley Avenue North
Union, New Jersey 07083
908-964-0786 (P)
www.RSAgeolab.com

Letter of Transmittal

Date: 11-17-17 Job No.: 869 Lab Log: 17-359

Attention: Michael Paquette
Langan Engineering
360 West 31st Street, 8th Floor
New York, NY 10001

CC: Thomas Androutselis

Re: Hudson Yards

Sample(s) ID: **LB-1 S-4 20-22’, LB-1 S-13 65-67, LB-1 S-16 80-82’, LB-1 S-19 95-97’, LB-1 S-23 113-120’, LB-2 S-7 25-27’, LB-2 S-13 55-57’, LB-3 S-4 20-22’, LB-3 S-6 30-32’**

Dear Mr. Paquette,

Please find attached results for the samples referenced above. The following lab testing was performed:

- ASTM D2216 Moisture Content
- ASTM D4318 Atterberg Limit

Regards,
RSA Geolab, LLC

Remarks: <u>If you have any questions, please call 908-964-0786.</u>

Signed: ____________________
Dr. Raza S. Ahmed
President RSA Geolab, LLC

RSA’s Geolab’s Geotechnical Laboratory testing was performed and results reported in accordance with ASTM standards and accepted industry standards. No other representations or warranties either express or implied are given. RSA Geolab, LLC neither accepts responsibility for nor makes claim to the final use and purpose of the material tested.
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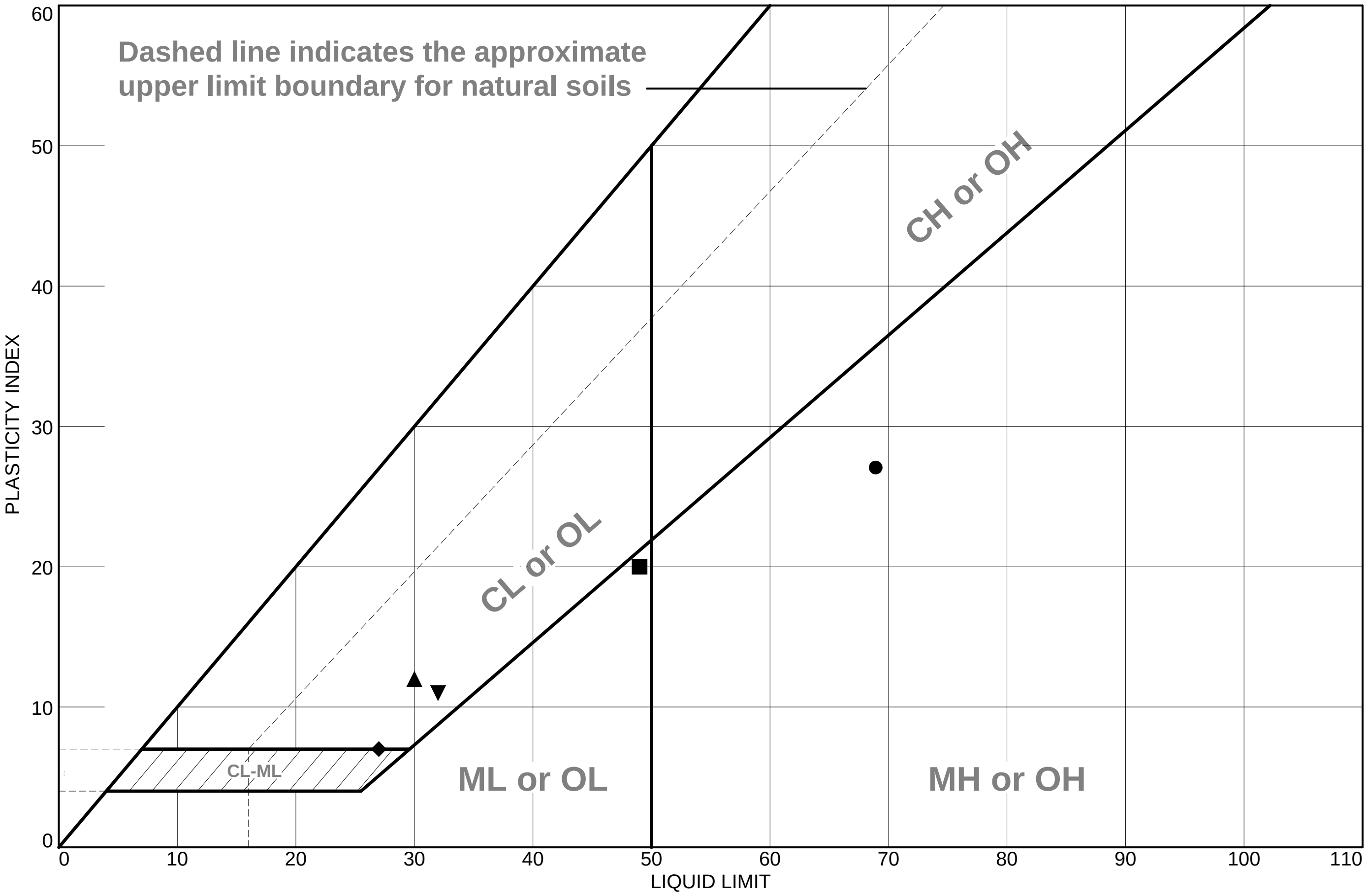
LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		69	42	27			
■		49	29	20			
▲		30	18	12			
◆		27	20	7			
▼		32	21	11			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

●**Sample Number:** LB-1 S-4 20-22'
■**Sample Number:** LB-1 S-13 65-67'
▲**Sample Number:** LB-1 S-16 80-82'
◆**Sample Number:** LB-1 S-19 95-97'
▼**Sample Number:** LB-1 S-23 113-120'

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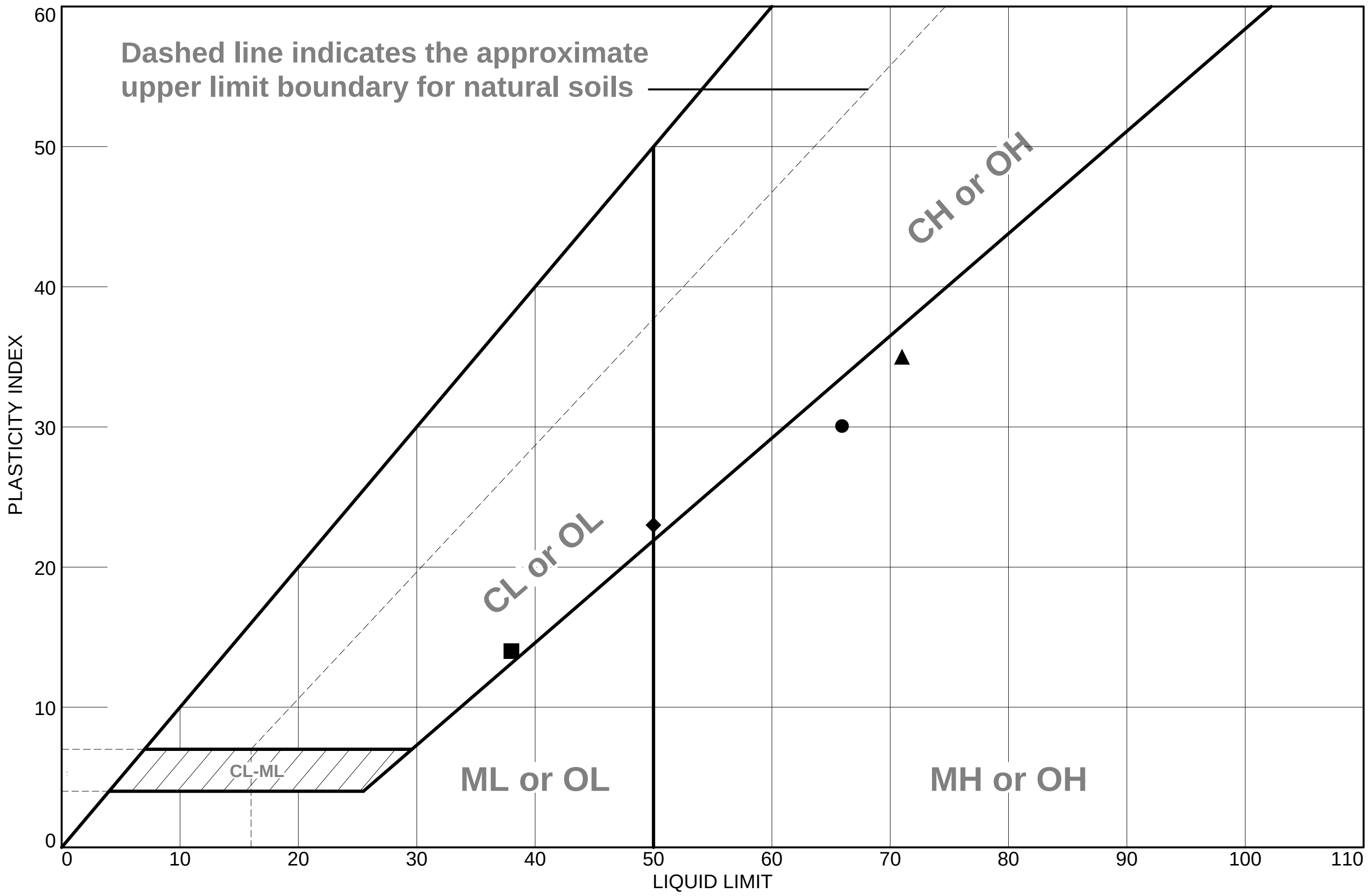
Union, New Jersey

Remarks:
●11-17-17

Figure

Tested By: RP **Checked By:** KP

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		66	36	30			
■		38	24	14			
▲		71	36	35			
◆		50	27	23			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

●**Sample Number:** LB-2 S-7 25-27'
■**Sample Number:** LB-2 S-13 55-57'
▲**Sample Number:** LB-3 S-4 20-22'
◆**Sample Number:** LB-3 S-6 30-32'

RSA Geolab

Union, New Jersey

Remarks:
●11-17-17

Figure

Tested By: RP **Checked By:** KP

RSA Geolab	MOISTURE CONTENTS TEST METHOD ASTM D-2216

CLIENT:	Langan Engineering and Environmental Services	DATE:	17-Nov-17
PROJECT:	Hudson Yards	PROJECT #	869

HOLE #/ SAMPLE #	LB-1 S-4	LB-1 S-13	LB-1 S-16	LB-1 S-19	LB-1 S-23
DEPTH	20-22'	65-67'	80-82'	95-97'	113-120'
WET WGT. + tare (gms.)	57.16	52.53	54.60	50.21	56.07
DRY WGT. + tare (gms.)	35.72	37.58	42.98	37.95	41.78
WGT. WATER (gms.)	21.44	14.95	11.62	12.26	14.29
TARE (gms.)	7.61	7.57	7.56	7.57	7.52
DRY WGT. (gms.)	28.11	30.01	35.42	30.38	34.26
MOISTURE CONTENT	76.3%	49.8%	32.8%	40.4%	41.7%

HOLE #/ SAMPLE #	LB-2 S-7	LB-2 S-13	LB-3 S-4	LB-3 S-6	
DEPTH	25-27'	55-57'	20-22'	30-32'	
WET WGT. + tare (gms.)	52.68	51.26	60.65	57.92	
DRY WGT. + tare (gms.)	34.41	37.37	39.68	40.89	
WGT. WATER (gms.)	18.27	13.89	20.97	17.03	0.00
TARE (gms.)	7.55	7.54	7.53	7.54	
DRY WGT. (gms.)	26.86	29.83	32.15	33.35	0.00
MOISTURE CONTENT	68.0%	46.6%	65.2%	51.1%	

Performed by: EE Entered by: KH Checked by: KP

RSA GEOLAB, LLC

1017 Greeley Avenue North
Union, New Jersey 07083
908-964-0786 (P)
www.RSAgeolab.com

Letter of Transmittal

Date: 11-20-17 Job No.: 869 Lab Log: 17-358

Attention: Michael Paquette
Langan Engineering
360 West 31st Street, 8th Floor
New York, NY 10001

CC: Thomas Androutselis

Re: Hudson Yards

Sample(s) ID: **LB-2 27-29’, LB-2 37-39’, LB-2 47-49’, LB-2 67-69’, LB-3 22-24’, LB-3 32-34’**

Dear Mr. Paquette,

Please find attached results for the samples referenced above. The following lab testing was performed:

- ASTM D2216 Moisture Content
- ASTM D2974 Organic Content
- ASTM D4318 Atterberg Limits (w/LL on oven dried material)
- ASTM D2850 Unconsolidated Undrained Triaxial Shear (10 psi)
- Log & Photograph of tubes

Regards,
RSA Geolab, LLC

Remarks: If you have any questions, please call 908-964-0786.

Signed:

Dr. Raza S. Ahmed
President RSA Geolab, LLC

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-2 27-29’	Recovery: 20”
Date: 11-14-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Light Gray, Dark Gray Clay & Silt little (+), cmf Sand, little (-)	
	20	cmf Gravel,Odorous, organics (sea shells) (visual)	
	19		
	18		
	17	 LB-2 (27'-29')	
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-2 37-39’	Recovery: 20”
Date: 11-14-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Gray Clay & Silt little (+), cmf Sand, trace (+) mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-2 47-49’	Recovery: 22”
Date: 11-14-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Gray Clay & Silt little (+), cmf Sand, trace mf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC

LOG OF UNDISTURBED SOIL SAMPLERS

Project: Hudson Yards

Project Number: 869

Client: Langan Engineering

Diameter: 2.8”

Sample: LB-2 67-69’

Recovery: 26”

Date: 11-14-17

Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little, cmf Sand, trace f Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC

LOG OF UNDISTURBED SOIL SAMPLERS

Project: Hudson Yards
Project Number: 869
Client: Langan Engineering
Diameter: 2.8”
Sample: LB-3 22-24’
Recovery: 26”
Date: 11-14-17
Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Gray Clay & Silt little, cmf Sand, trace f Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab, LLC	LOG OF UNDISTURBED SOIL SAMPLERS
Project: Hudson Yards	Project Number: 869
Client: Langan Engineering	Diameter: 2.8”
Sample: LB-3 32-34’	Recovery: 22”
Date: 11-14-17	Remarks:

Top of Sample	Inches		Type of Test
	22		
	21	Dark Gray Clay & Silt little (+), cmf Sand, trace (+) cmf Gravel	
	20	Odorous, organics (sea shells) (visual)	
	19		
	18		
	17		
	16		
	15		
	14		
	13		
	12		
	11		
	10		
	9		Atterberg
	8		Moisture &
	7		Organic Cont.
	6		
	5		UU
	4		
	3		
	2		
	1		
	0		
Bottom of Sample			

RSA Geolab

MOISTURE CONTENT (ASTM D2216)/
LOSS ON IGNITION (ASTM D2974)

Project: Hudson Yards

Project #: 869

Client: Langan Engineering

Date: 11-20-17

HOLE #/ SAMPLE #	LB-2 27-29'	LB-2 37-39'	LB-2 47-49'	LB-2 67-69'	LB-3 22-24'	LB-2 32-34'
DEPTH						
WET WGT. + TARE (gm	492.6	351.8	395.2	384.0	338.2	349.7
DRY WGT. + TARE (gm	340.6	218.8	250.7	288.7	201.3	227.5
WGT. WATER (gms.)	152.0	133.0	144.5	95.3	136.9	122.2
TARE (gms.)	7.6	7.6	7.6	7.6	7.6	7.6
DRY WGT. (gms.)	333.0	211.2	243.1	281.1	193.7	219.9
MOISTURE CONTENT (%)	**45.6**	**63.0**	**59.4**	**33.9**	**70.7**	**55.6**
OVEN DRIED SAMPLE + TARE (gms.)	107.25	102.56	103.09	70.18	59.02	107.62
AFTER IGNITION SAMPLE + TARE (gms.)	104.45	99.25	100.85	69.10	56.54	105.28
LOSS ON IGNITION (gms.)	2.80	3.31	2.24	1.08	2.48	2.34
TARE (gms.)	57.23	52.11	52.12	31.23	26.97	57.22
INITIAL WGT. OF OVEN DRIED SAMPLE (gms.)	50.02	50.45	50.97	38.95	32.05	50.40
LOSS ON IGNITION (%)	**5.60**	**6.56**	**4.39**	**2.77**	**7.74**	**4.64**

Performed by: EE

Entered by: KH

Checked by: KP

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

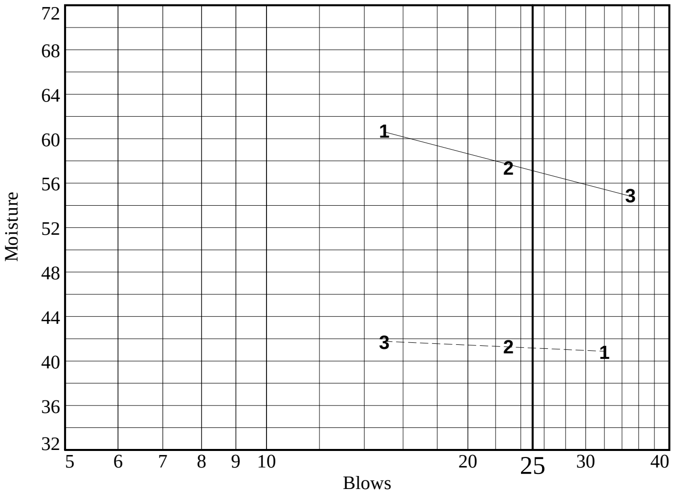
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-2 27-29'
Material Description: Light Gray, Dark Gray Clay & Silt little (+), cmf Sand, little (-) cmf Gravel, odorous, organics (sea shells)(visual)
Tested by: RP **Checked by:** KP
Testing Remarks: 11-20-17

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	16.90	17.10	18.59			
Dry+Tare	11.05	11.37	12.50			
Tare	1.42	1.39	1.42			
# Blows	15	23	35			
Moisture	60.7	57.4	55.0			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	16.59	16.43	16.45			
Dry+Tare	12.20	12.04	12.00			
Tare	1.45	1.42	1.34			
# Blows	32	23	15			
Moisture	40.8	41.3	41.7			



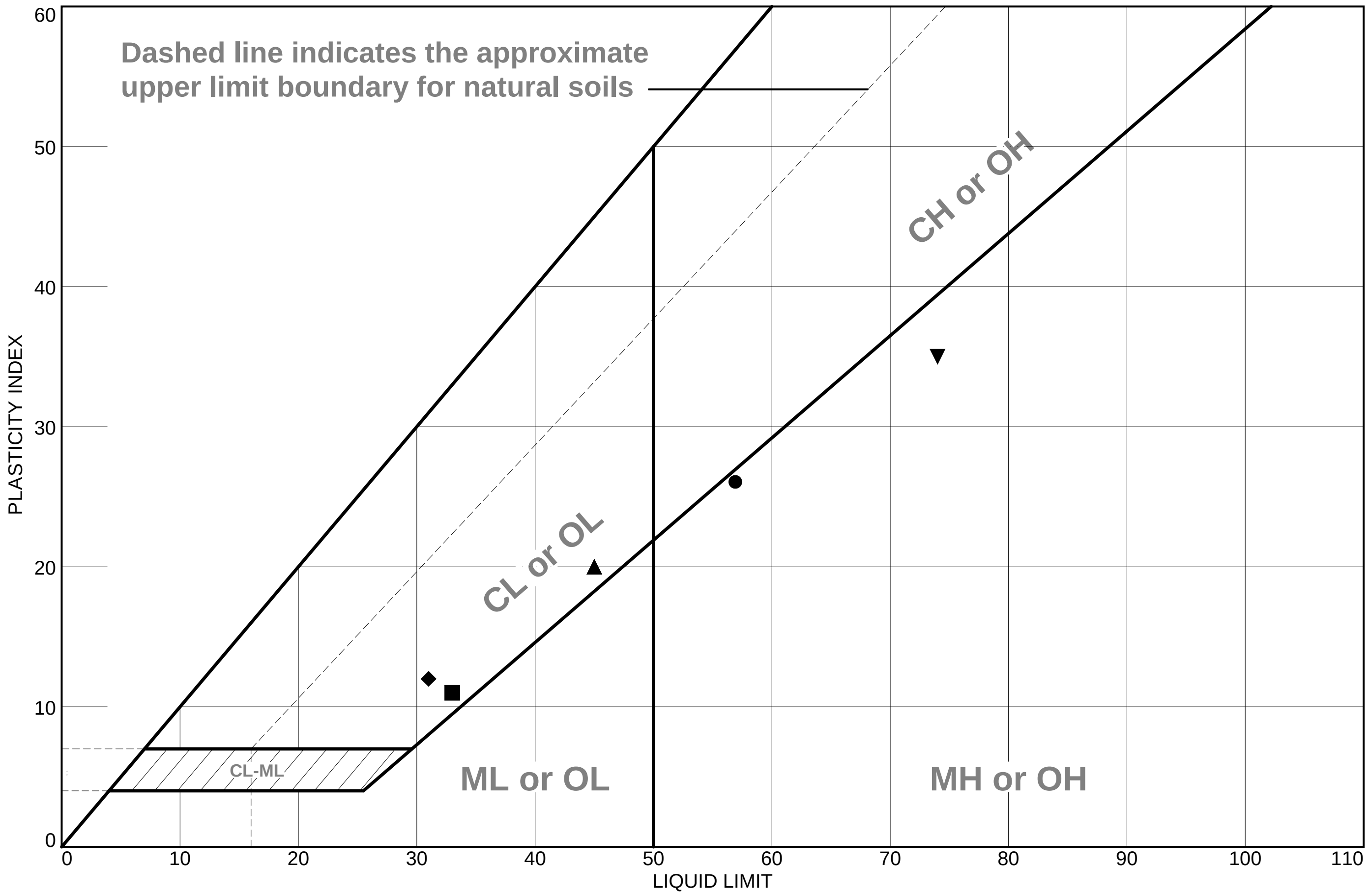
Liquid Limit= 57
Liquid Limit (organics)= 41
Plastic Limit= 31
Plasticity Index= 26

RSA Geolab

Plastic Limit Data

Run No.	**1**	**2**	**3**	**4**	
Wet+Tare	6.03	6.18			
Dry+Tare	4.92	5.09			
Tare	1.37	1.43			
Moisture	31.3	29.8			

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Light Gray, Dark Gray Clay & Silt little (+), cmf Sand, little (-) cmf Gravel, odorous, organics (sea shells)(visual)	57	31	26			
■	Gray Clay & Silt little (+), cmf Sand, trace (+) mf Gravel, odorous, organics (sea shells)(visual)	33	22	11			
▲	Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)	45	25	20			
◆	Dark Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)	31	19	12			
▼	Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)	74	39	35			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

●**Sample Number:** LB-2 27-29'
■**Sample Number:** LB-2 37-39'
▲**Sample Number:** LB-2 47-49'
◆**Sample Number:** LB-2 67-69'
▼**Sample Number:** LB-3 22-24'

Remarks:
●11-20-17

RSA Geolab

Union, New Jersey

Figure

Tested By: RP **Checked By:** KP

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

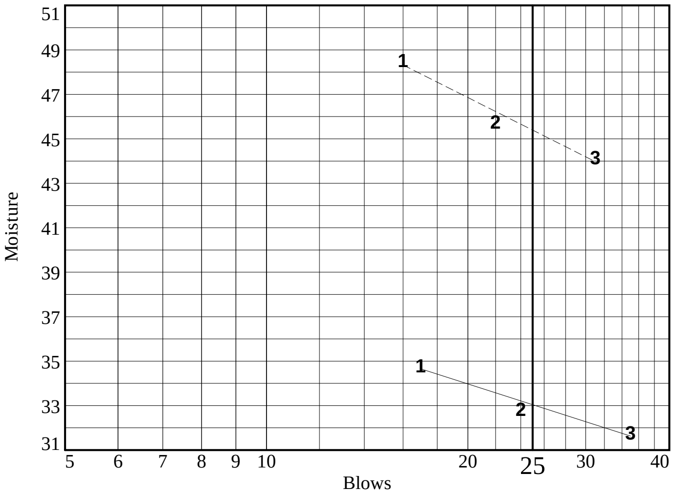
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-2 37-39'
Material Description: Gray Clay & Silt little (+), cmf Sand, trace (+) mf Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	16.93	18.52	17.76			
Dry+Tare	12.91	14.27	13.83			
Tare	1.37	1.34	1.47			
# Blows	17	24	35			
Moisture	34.8	32.9	31.8			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	18.36	17.63	18.99			
Dry+Tare	12.83	12.52	13.59			
Tare	1.44	1.36	1.37			
# Blows	16	22	31			
Moisture	48.6	45.8	44.2			



Liquid Limit= 33
Liquid Limit (organics)= 45
Plastic Limit= 22
Plasticity Index= 11

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.54	7.81			
Dry+Tare	7.26	6.67			
Tare	1.34	1.36			
Moisture	21.6	21.5			

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

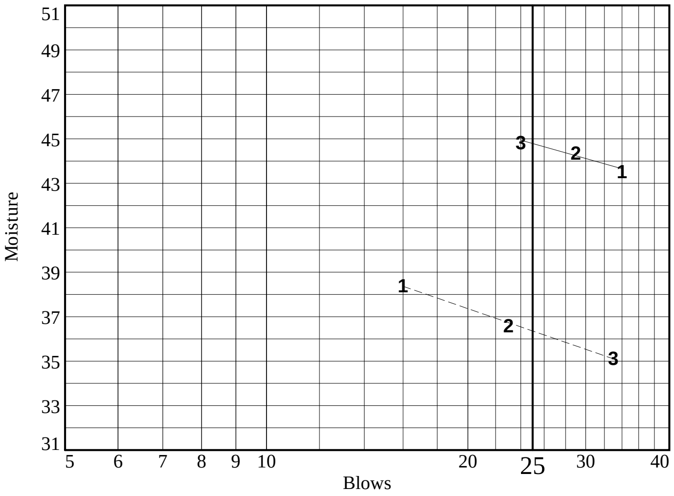
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-2 47-49'
Material Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	17.89	16.39	18.67			
Dry+Tare	12.88	11.79	13.34			
Tare	1.38	1.43	1.46			
# Blows	34	29	24			
Moisture	43.6	44.4	44.9			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	16.51	18.11	16.28			
Dry+Tare	12.33	13.63	12.42			
Tare	1.45	1.40	1.44			
# Blows	16	23	33			
Moisture	38.4	36.6	35.2			



Liquid Limit= 45
Liquid Limit (organics)= 36
Plastic Limit= 25
Plasticity Index= 20

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.13	8.58			
Dry+Tare	6.77	7.12			
Tare	1.35	1.35			
Moisture	25.1	25.3			

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

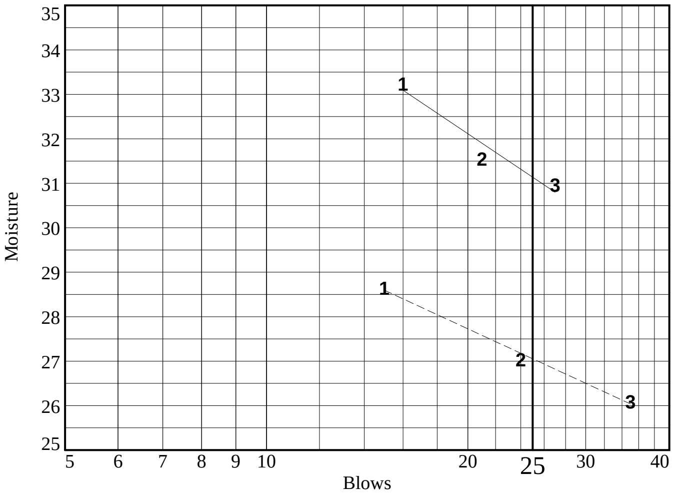
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-2 67-69'
Material Description: Dark Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	18.14	17.31	16.69			
Dry+Tare	14.00	13.50	13.06			
Tare	1.55	1.43	1.34			
# Blows	16	21	27			
Moisture	33.3	31.6	31.0			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	17.23	17.36	19.00			
Dry+Tare	13.70	13.96	15.35			
Tare	1.38	1.39	1.37			
# Blows	15	24	35			
Moisture	28.7	27.0	26.1			



Liquid Limit= 31
Liquid Limit (organics)= 27
Plastic Limit= 19
Plasticity Index= 12

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	8.09	8.38			
Dry+Tare	6.99	7.24			
Tare	1.31	1.42			
Moisture	19.4	19.6			

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

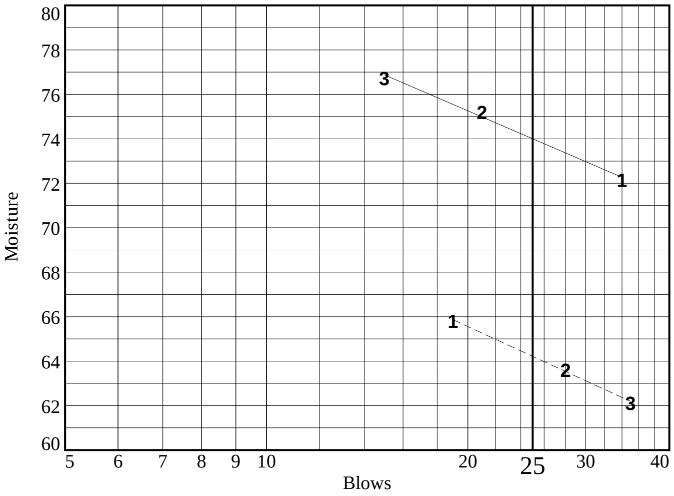
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-3 22-24'
Material Description: Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	17.12	17.51	16.60			
Dry+Tare	10.61	10.62	10.00			
Tare	1.59	1.46	1.40			
# Blows	34	21	15			
Moisture	72.2	75.2	76.7			

Organics Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	16.86	16.89	17.14			
Dry+Tare	10.83	10.96	11.20			
Tare	1.67	1.64	1.64			
# Blows	19	28	35			
Moisture	65.8	63.6	62.1			

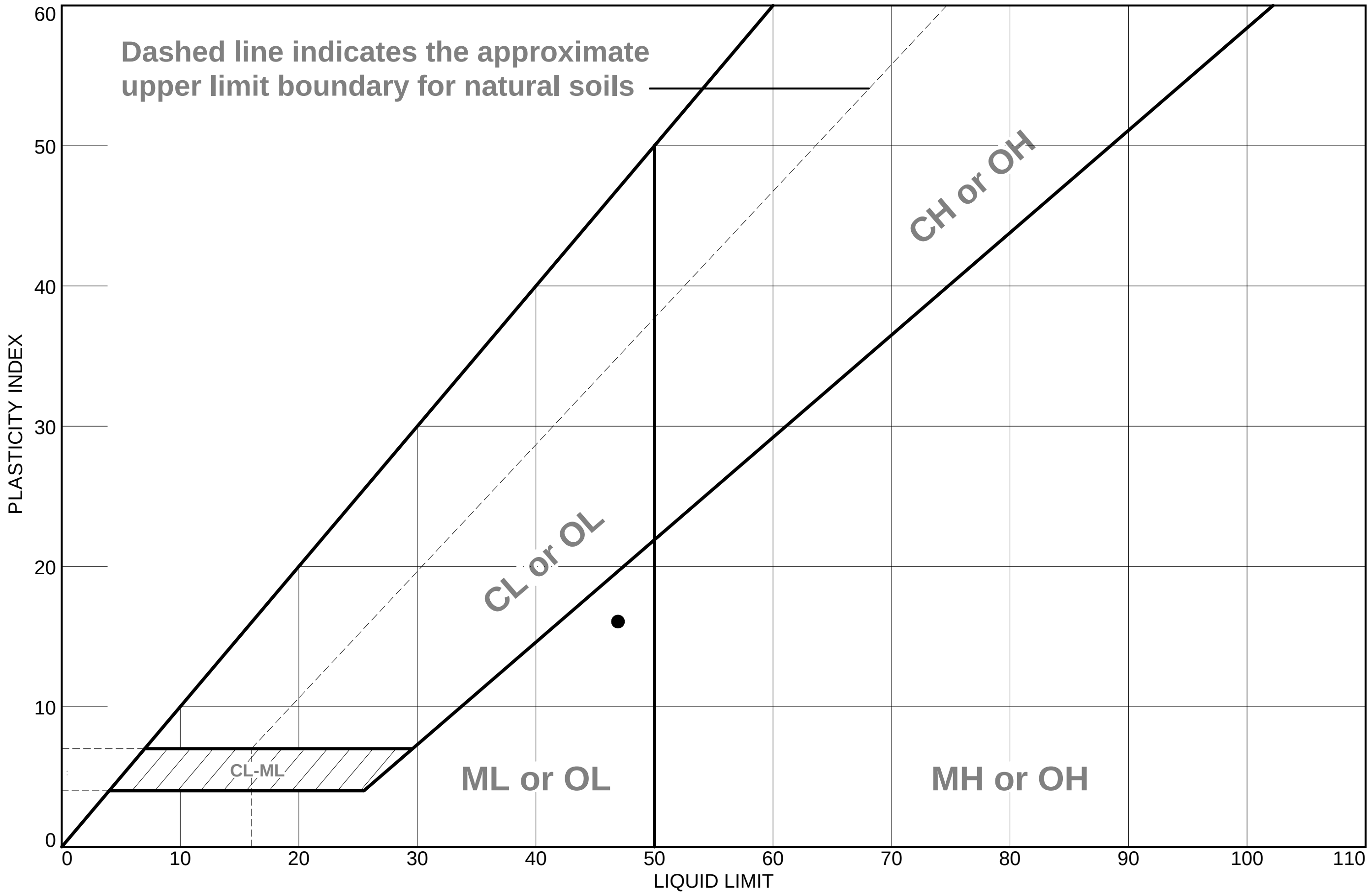


Liquid Limit= 74
Liquid Limit (organics)= 64
Plastic Limit= 39
Plasticity Index= 35

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	9.18	8.33			
Dry+Tare	7.00	6.40			
Tare	1.40	1.45			
Moisture	38.9	39.0			

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark Gray Clay & Silt little (+), cmf Sand, trace (+) cmf Gravel, odorous, organics (sea shells)(visual)	47	31	16			

Project No. 869 **Client:** Langan Engineering

Project: Hudson Yards

●**Sample Number:** LB-3 32-34'

Remarks:
●11-20-17

RSA Geolab

Union, New Jersey

Figure

Tested By: RP **Checked By:** KP

LIQUID AND PLASTIC LIMIT TEST DATA

11/20/2017

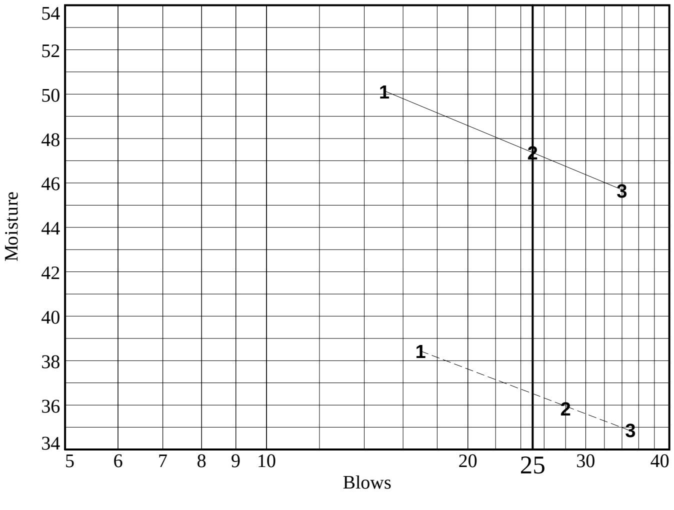
Client: Langan Engineering
Project: Hudson Yards
Project Number: 869
Sample Number: LB-3 32-34'
Material Description: Dark Gray Clay & Silt little (+), cmf Sand, trace (+) cmf Gravel, odorous, organics (sea shells)(visual)
Tested by: RP **Checked by:** KP
Testing Remarks: 11-20-17

Liquid Limit Data

Run No.	**1**	**2**	**3**	**4**	**5**	**6**
Wet+Tare	17.26	17.73	17.11			
Dry+Tare	11.97	12.48	12.19			
Tare	1.42	1.40	1.42			
# Blows	15	25	34			
Moisture	50.1	47.4	45.7			

Organics Liquid Limit Data

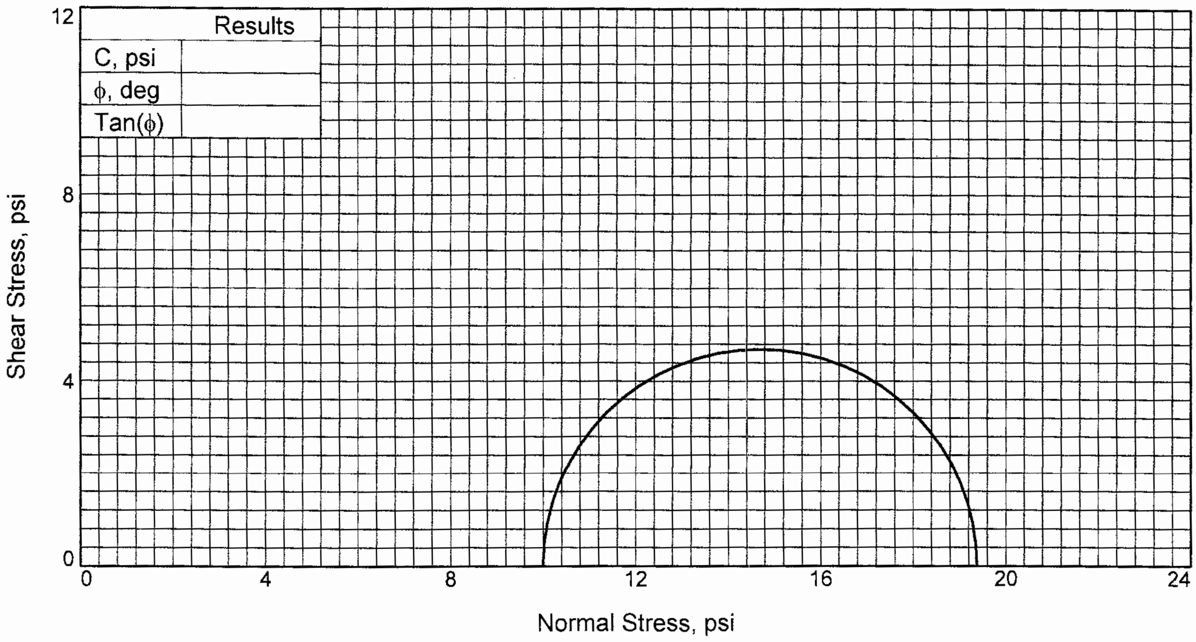
Run No.	**1**	**2**	**3**	**4**	**5**	**6**
Wet+Tare	17.72	17.84	19.23			
Dry+Tare	13.19	13.50	14.62			
Tare	1.41	1.40	1.41			
# Blows	17	28	35			
Moisture	38.5	35.9	34.9			

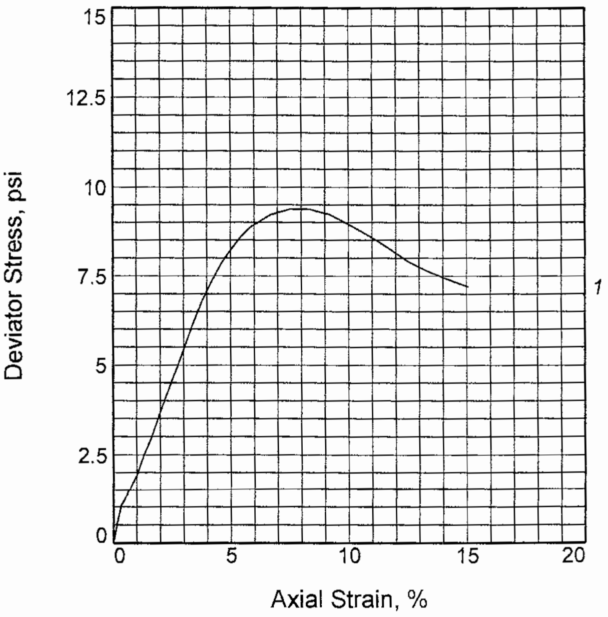


Liquid Limit= 47
Liquid Limit (organics)= 37
Plastic Limit= 31
Plasticity Index= 16

Plastic Limit Data

Run No.	**1**	**2**	**3**	**4**	
Wet+Tare	8.39	8.37			
Dry+Tare	6.73	6.71			
Tare	1.36	1.41			
Moisture	30.9	31.3			





Sample No.		1
Initial	Water Content, %	71.1
	Dry Density, pcf	57.1
	Saturation, %	97.5
	Void Ratio	2.0045
	Diameter, in.	2.81
	Height, in.	5.97
At Test	Water Content, %	72.9
	Dry Density, pcf	57.1
	Saturation, %	100.0
	Void Ratio	2.0045
	Diameter, in.	2.81
	Height, in.	5.97
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		9.4
Ult. Stress, psi		
σ_1 Failure, psi		19.4
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Light Gray, Dark Gray Clay & Silt little (+), cmf Sand, little (-) cmf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.75

Remarks: H/D = 2.13

Figure ________

Client: Langan Engineering

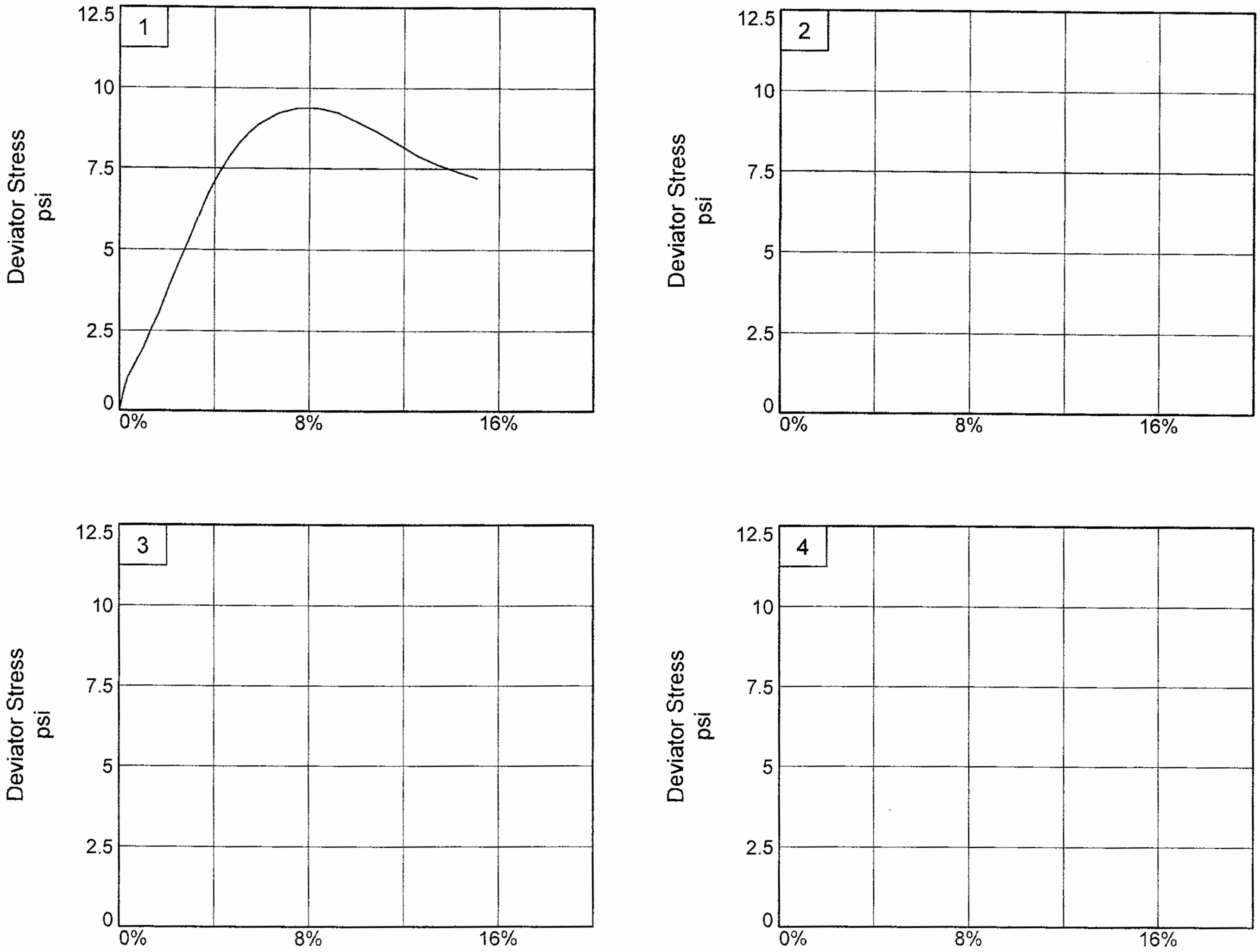
Project: Hudson Yards

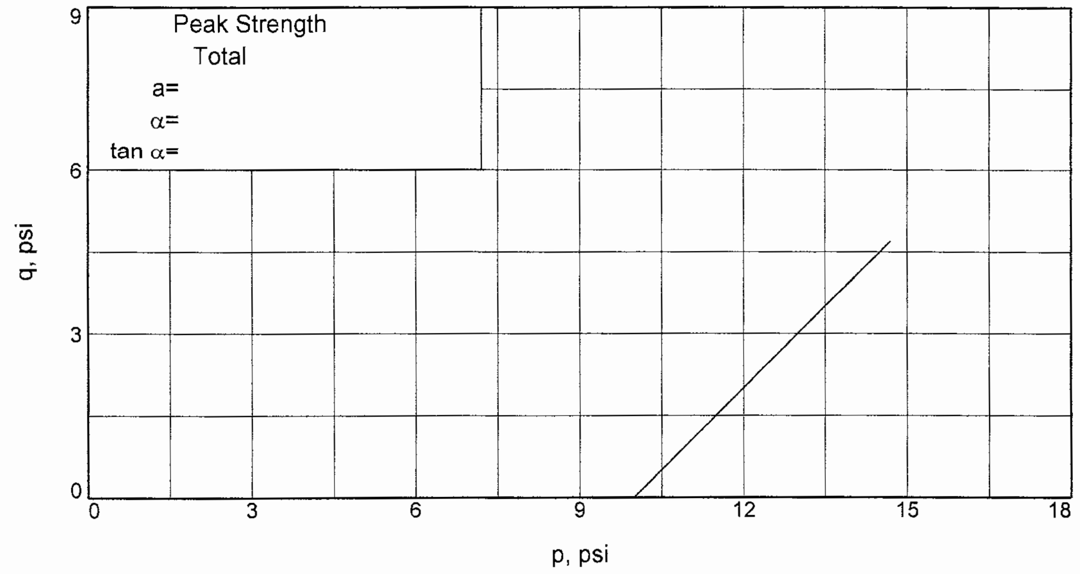
Sample Number: LB-2 27-29'

Proj. No.: 869 **Date Sampled:** 11-17-17

TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

Tested By: EE **Checked By:** KP





Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-2 27-29'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

Date: 11-17-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-2 27-29'
Description: Light Gray, Dark Gray Clay & Silt little (+), cmf Sand, little (-) cmf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.13
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.75 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

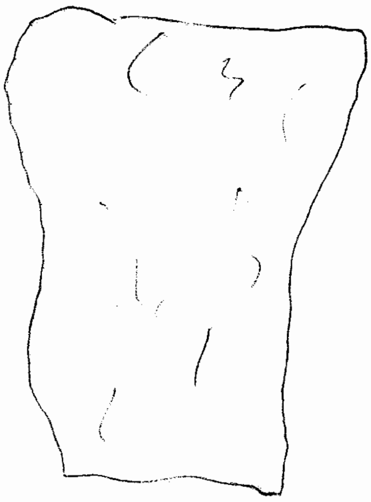
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	950.500		950.500
Moisture content: Dry soil+tare, gms.	555.600		555.600
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	71.1	72.9	71.1
Moist specimen weight, gms.	950.5		
Diameter, in.	2.81	2.81	
Area, in.^{2}	6.20	6.20	
Height, in.	5.97	5.97	
Net decrease in height, in.		0.00	
Wet density, pcf	97.8	98.8	
Dry density, pcf	57.1	57.1	
Void ratio	2.0045	2.0045	
Saturation, %	97.5	100.0	

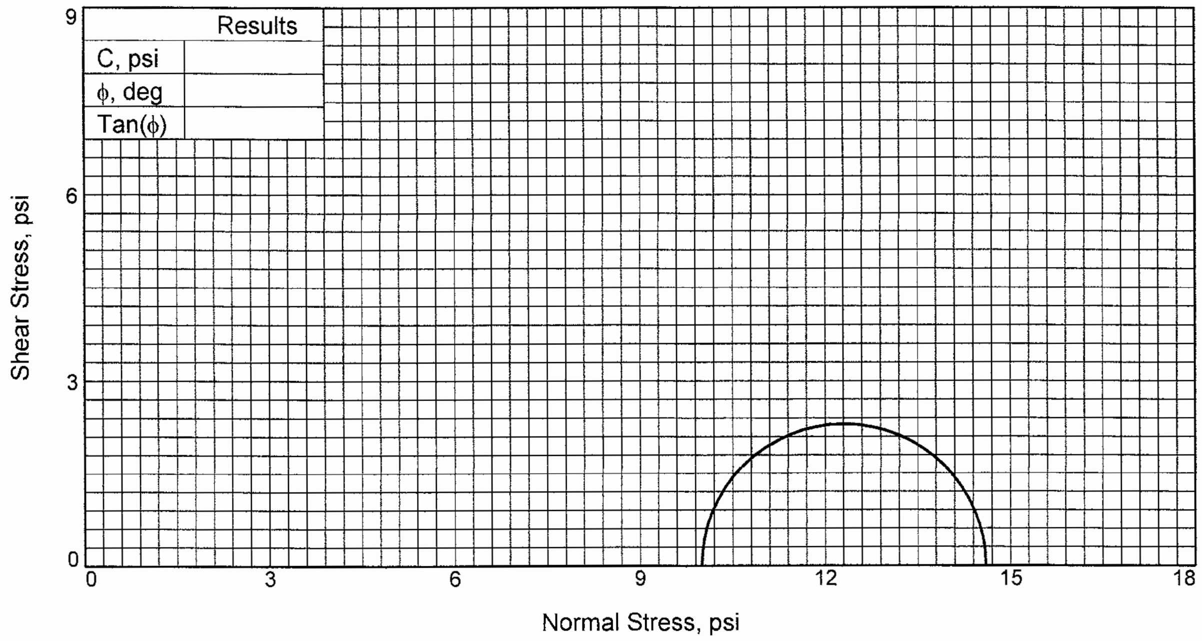
Test Readings for Specimen No. 1

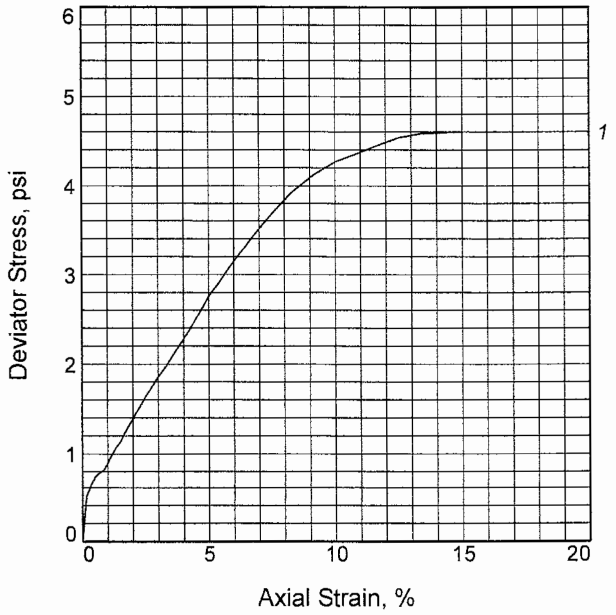
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 9.38 psi **at reading no.** 22

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	3.100	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	6.400	3.3	0.2	0.53	10.00	10.53	1.05	10.27	0.27
2	0.0200	9.500	6.4	0.3	1.03	10.00	11.03	1.10	10.51	0.51
3	0.0300	10.800	7.7	0.5	1.24	10.00	11.24	1.12	10.62	0.62
4	0.0400	12.300	9.2	0.7	1.47	10.00	11.47	1.15	10.74	0.74
5	0.0500	13.800	10.7	0.8	1.71	10.00	11.71	1.17	10.86	0.86
6	0.0600	15.200	12.1	1.0	1.93	10.00	11.93	1.19	10.97	0.97
7	0.0700	17.200	14.1	1.2	2.25	10.00	12.25	1.22	11.12	1.12
8	0.0800	19.100	16.0	1.3	2.55	10.00	12.55	1.25	11.27	1.27
9	0.0900	20.700	17.6	1.5	2.80	10.00	12.80	1.28	11.40	1.40
10	0.1000	22.400	19.3	1.7	3.06	10.00	13.06	1.31	11.53	1.53
11	0.1250	27.500	24.4	2.1	3.85	10.00	13.85	1.39	11.93	1.93
12	0.1500	32.400	29.3	2.5	4.61	10.00	14.61	1.46	12.30	2.30
13	0.1750	36.900	33.8	2.9	5.29	10.00	15.29	1.53	12.65	2.65
14	0.2000	42.000	38.9	3.3	6.06	10.00	16.06	1.61	13.03	3.03
15	0.2250	46.700	43.6	3.8	6.77	10.00	16.77	1.68	13.38	3.38
16	0.2500	50.600	47.5	4.2	7.34	10.00	17.34	1.73	13.67	3.67
17	0.2750	54.100	51.0	4.6	7.85	10.00	17.85	1.78	13.92	3.92
18	0.3000	57.000	53.9	5.0	8.25	10.00	18.25	1.83	14.13	4.13
19	0.3250	59.500	56.4	5.4	8.60	10.00	18.60	1.86	14.30	4.30
20	0.3500	61.500	58.4	5.9	8.87	10.00	18.87	1.89	14.43	4.43
21	0.4000	64.400	61.3	6.7	9.22	10.00	19.22	1.92	14.61	4.61
22	0.4500	66.000	62.9	7.5	9.38	10.00	19.38	1.94	14.69	4.69
23	0.5000	66.500	63.4	8.4	9.37	10.00	19.37	1.94	14.68	4.68
24	0.5500	66.100	63.0	9.2	9.22	10.00	19.22	1.92	14.61	4.61
25	0.6000	64.700	61.6	10.0	8.94	10.00	18.94	1.89	14.47	4.47
26	0.6500	63.100	60.0	10.9	8.62	10.00	18.62	1.86	14.31	4.31
27	0.7000	61.200	58.1	11.7	8.27	10.00	18.27	1.83	14.14	4.14
28	0.7500	59.100	56.0	12.6	7.90	10.00	17.90	1.79	13.95	3.95
29	0.8000	57.700	54.6	13.4	7.63	10.00	17.63	1.76	13.81	3.81
30	0.8500	56.600	53.5	14.2	7.40	10.00	17.40	1.74	13.70	3.70
31	0.9000	55.700	52.6	15.1	7.20	10.00	17.20	1.72	13.60	3.60







Sample No.		1
Initial	Water Content, %	58.4
	Dry Density, pcf	67.0
	Saturation, %	110.0
	Void Ratio	1.3288
	Diameter, in.	2.78
	Height, in.	6.00
At Test	Water Content, %	53.2
	Dry Density, pcf	67.0
	Saturation, %	100.0
	Void Ratio	1.3288
	Diameter, in.	2.78
	Height, in.	6.00
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		4.6
Ult. Stress, psi		
σ_1 Failure, psi		14.6
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Gray Clay & Silt little (+), cmf Sand, trace (+) mf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.16

Figure ________

Client: Langan Engineering

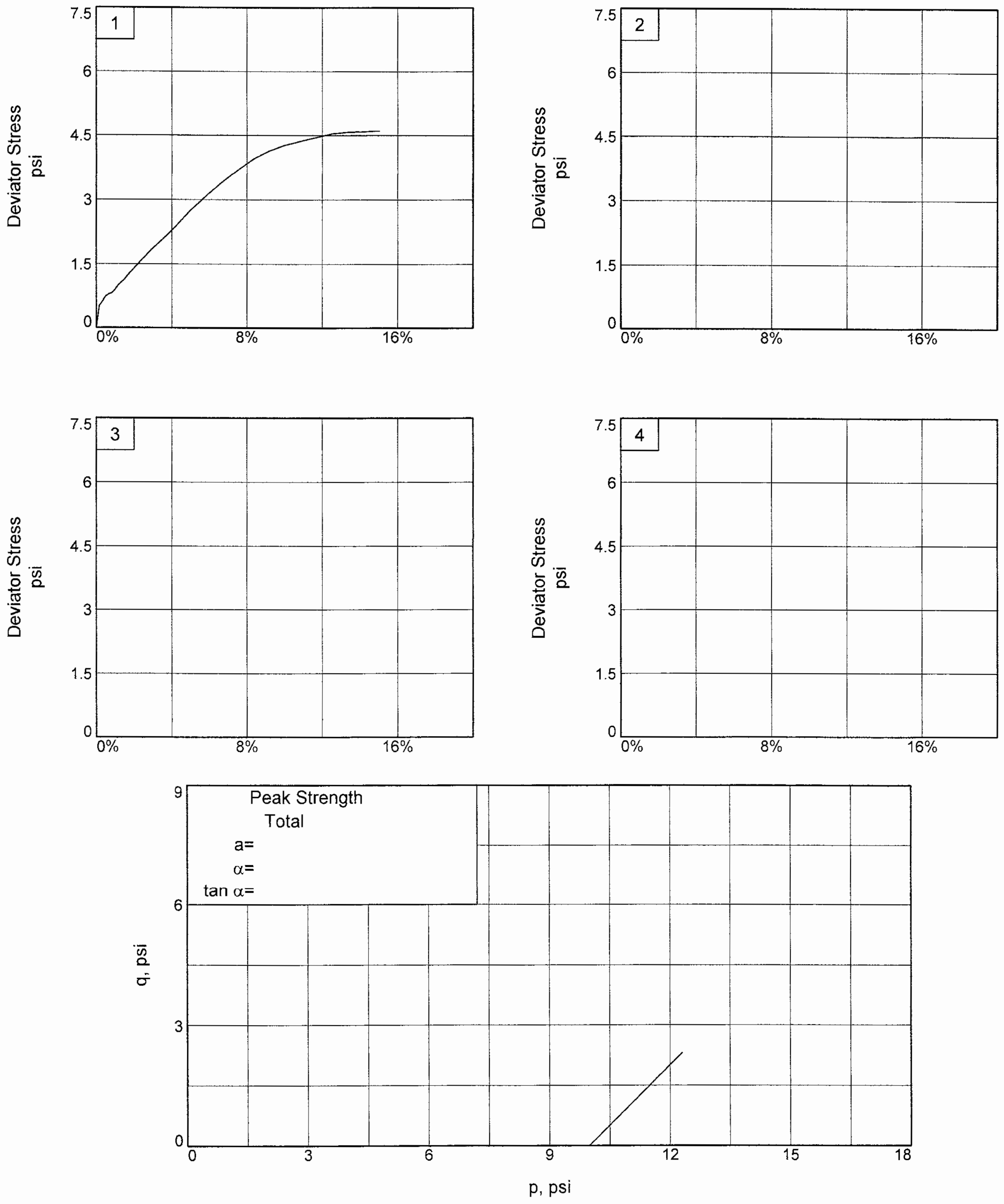
Project: Hudson Yards

Sample Number: LB-2 37-39'

Proj. No.: 869 **Date Sampled:** 11-17-17

TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

Tested By: EE **Checked By:** KP



Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-2 37-39'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE

Checked By: KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/17/2017
10:48 AM

Date: 11-17-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-2 37-39'
Description: Gray Clay & Silt little (+), cmf Sand, trace (+) mf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.16
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

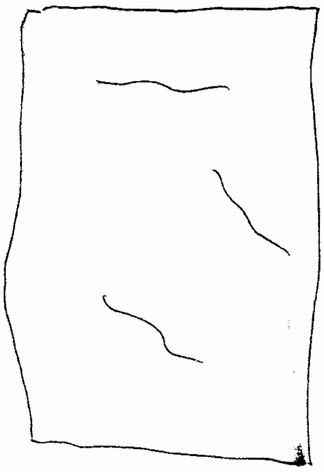
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1015.000		1015.000
Moisture content: Dry soil+tare, gms.	640.600		640.600
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	58.4	53.2	58.4
Moist specimen weight, gms.	1015.0		
Diameter, in.	2.78	2.78	
Area, in.^{2}	6.07	6.07	
Height, in.	6.00	6.00	
Net decrease in height, in.		0.00	
Wet density, pcf	106.2	102.6	
Dry density, pcf	67.0	67.0	
Void ratio	1.3288	1.3288	
Saturation, %	110.0	100.0	

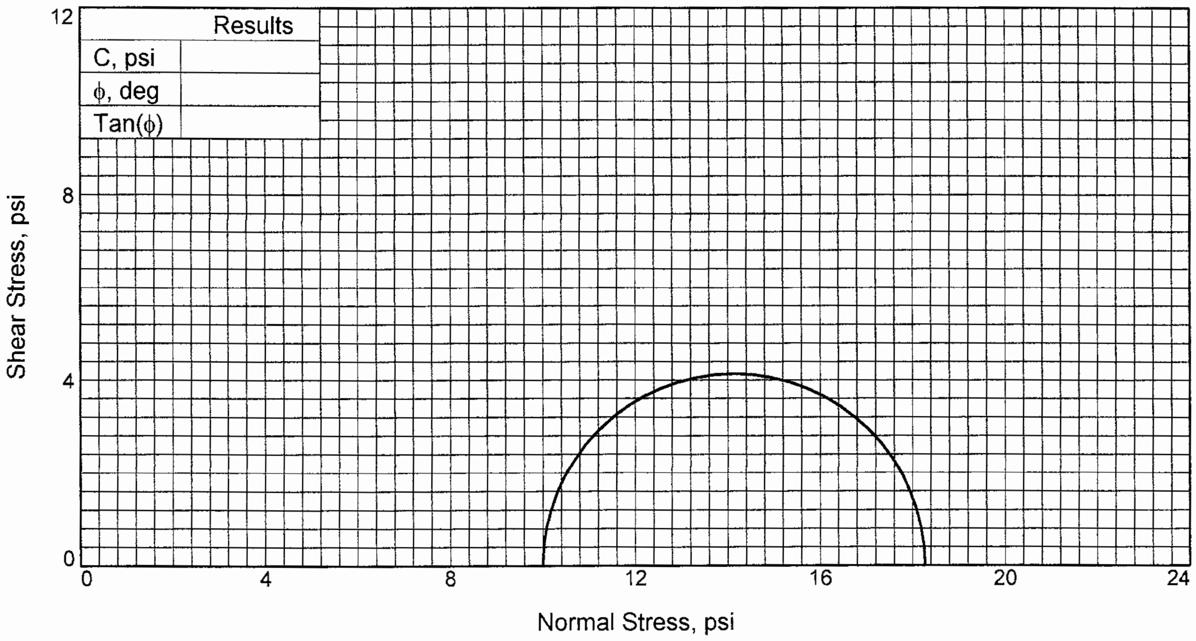
Test Readings for Specimen No. 1

Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 4.60 psi **at reading no.** 31

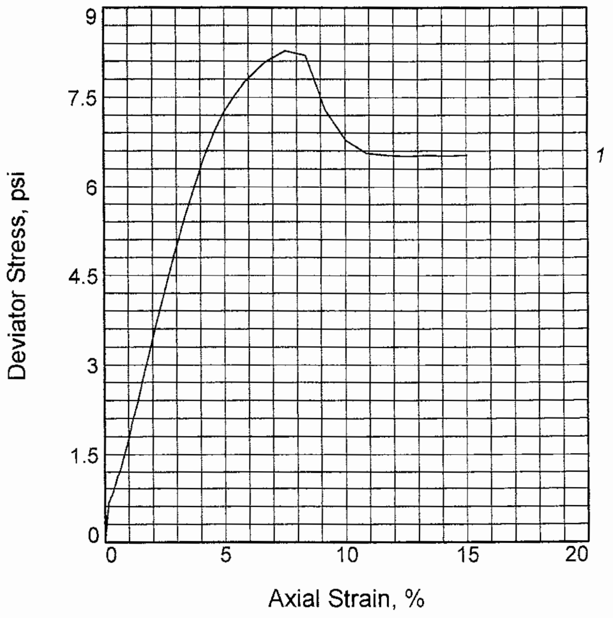
Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	2.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	5.500	3.1	0.2	0.51	10.00	10.51	1.05	10.25	0.25
2	0.0200	6.200	3.8	0.3	0.62	10.00	10.62	1.06	10.31	0.31
3	0.0300	6.900	4.5	0.5	0.74	10.00	10.74	1.07	10.37	0.37
4	0.0400	7.200	4.8	0.7	0.78	10.00	10.78	1.08	10.39	0.39
5	0.0500	7.400	5.0	0.8	0.82	10.00	10.82	1.08	10.41	0.41
6	0.0600	7.900	5.5	1.0	0.90	10.00	10.90	1.09	10.45	0.45
7	0.0700	8.500	6.1	1.2	0.99	10.00	10.99	1.10	10.50	0.50
8	0.0800	9.000	6.6	1.3	1.07	10.00	11.07	1.11	10.54	0.54
9	0.0900	9.400	7.0	1.5	1.14	10.00	11.14	1.11	10.57	0.57
10	0.1000	10.000	7.6	1.7	1.23	10.00	11.23	1.12	10.62	0.62
11	0.1250	11.300	8.9	2.1	1.43	10.00	11.43	1.14	10.72	0.72
12	0.1500	12.600	10.2	2.5	1.64	10.00	11.64	1.16	10.82	0.82
13	0.1750	13.800	11.4	2.9	1.82	10.00	11.82	1.18	10.91	0.91
14	0.2000	14.900	12.5	3.3	1.99	10.00	11.99	1.20	10.99	0.99
15	0.2250	16.100	13.7	3.8	2.17	10.00	12.17	1.22	11.09	1.09
16	0.2500	17.300	14.9	4.2	2.35	10.00	12.35	1.24	11.18	1.18
17	0.2750	18.600	16.2	4.6	2.54	10.00	12.54	1.25	11.27	1.27
18	0.3000	20.000	17.6	5.0	2.75	10.00	12.75	1.28	11.38	1.38
19	0.3250	21.100	18.7	5.4	2.91	10.00	12.91	1.29	11.46	1.46
20	0.3500	22.300	19.9	5.8	3.08	10.00	13.08	1.31	11.54	1.54
21	0.4000	24.500	22.1	6.7	3.40	10.00	13.40	1.34	11.70	1.70
22	0.4500	26.600	24.2	7.5	3.68	10.00	13.68	1.37	11.84	1.84
23	0.5000	28.500	26.1	8.3	3.94	10.00	13.94	1.39	11.97	1.97
24	0.5500	30.000	27.6	9.2	4.13	10.00	14.13	1.41	12.06	2.06
25	0.6000	31.200	28.8	10.0	4.27	10.00	14.27	1.43	12.13	2.13
26	0.6500	32.100	29.7	10.8	4.36	10.00	14.36	1.44	12.18	2.18
27	0.7000	33.000	30.6	11.7	4.45	10.00	14.45	1.44	12.22	2.22
28	0.7500	33.900	31.5	12.5	4.54	10.00	14.54	1.45	12.27	2.27
29	0.8000	34.500	32.1	13.3	4.58	10.00	14.58	1.46	12.29	2.29
30	0.8500	34.900	32.5	14.2	4.59	10.00	14.59	1.46	12.30	2.30
31	0.9000	35.300	32.9	15.0	4.60	10.00	14.60	1.46	12.30	2.30





Results	
C, psi	
φ, deg	
Tan(φ)	



	Sample No.	1
Initial	Water Content, %	52.8
	Dry Density, pcf	68.0
	Saturation, %	102.1
	Void Ratio	1.2939
	Diameter, in.	2.85
	Height, in.	5.98
At Test	Water Content, %	51.8
	Dry Density, pcf	68.0
	Saturation, %	100.0
	Void Ratio	1.2939
	Diameter, in.	2.85
	Height, in.	5.98
	Strain rate, in./min.	0.050
	Back Pressure, psi	0.0
	Cell Pressure, psi	10.0
	Fail. Stress, psi	8.3
	Ult. Stress, psi	
	σ_1 Failure, psi	18.3
	σ_3 Failure, psi	10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.10

Figure ______

Client: Langan Engineering

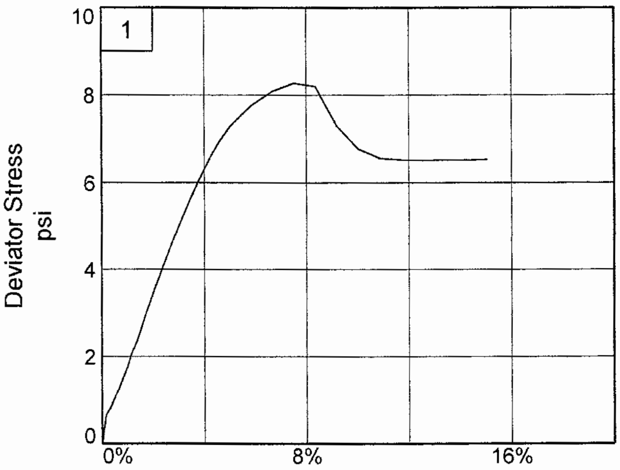
Project: Hudson Yards

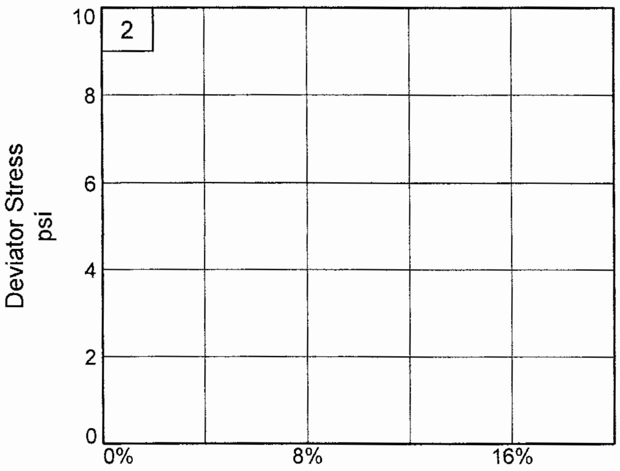
Sample Number: LB-2 47-49'

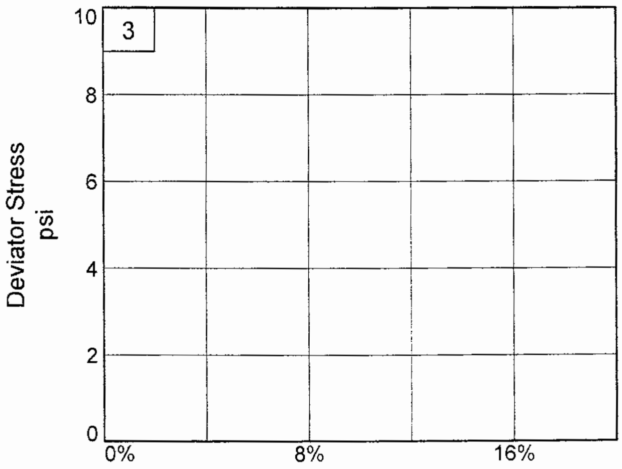
Proj. No.: 869 **Date Sampled:** 11-17-17

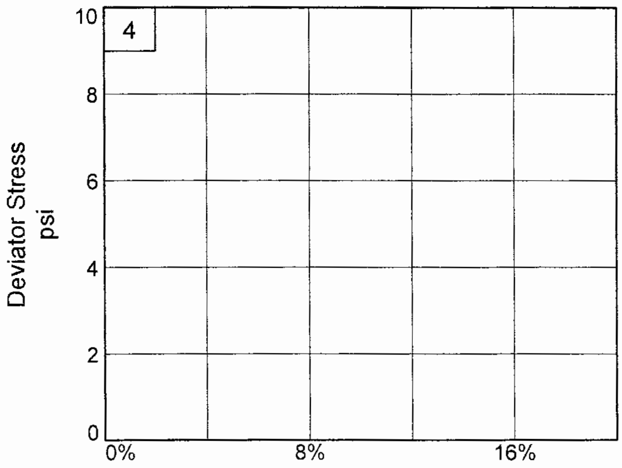
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

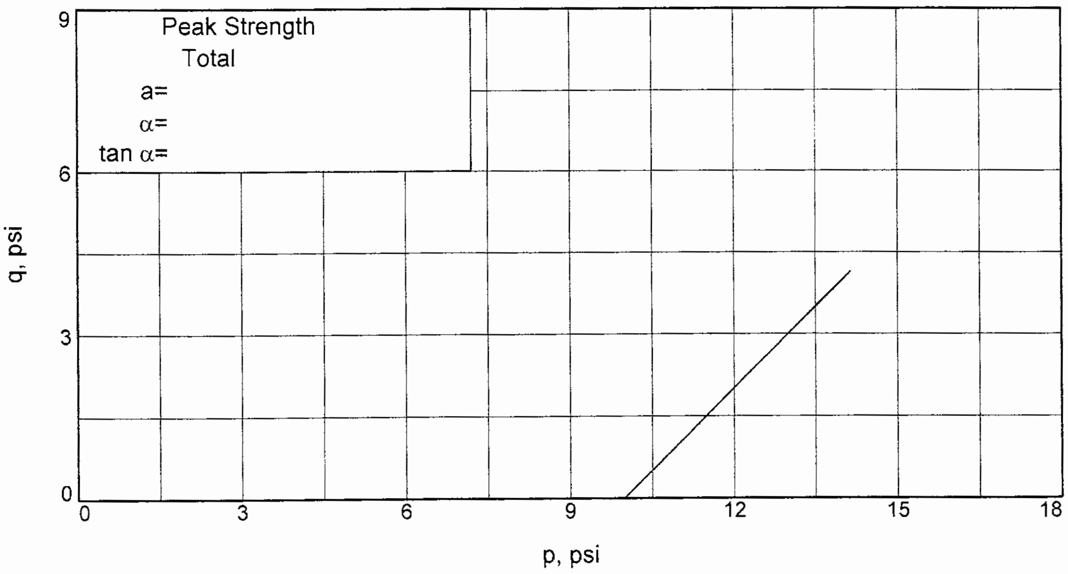
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-2 47-49'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/17/2017
10:56 AM

Date: 11-17-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-2 47-49'
Description: Gray Clay & Silt little (+), cmf Sand, trace mf Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.10
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

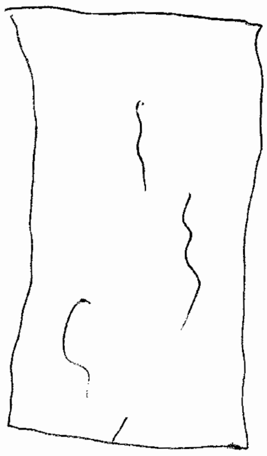
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1042.100		1042.100
Moisture content: Dry soil+tare, gms.	681.800		681.800
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	52.8	51.8	52.8
Moist specimen weight, gms.	1042.1		
Diameter, in.	2.85	2.85	
Area, in.^{2}	6.38	6.38	
Height, in.	5.98	5.98	
Net decrease in height, in.		0.00	
Wet density, pcf	104.0	103.3	
Dry density, pcf	68.0	68.0	
Void ratio	1.2939	1.2939	
Saturation, %	102.1	100.0	

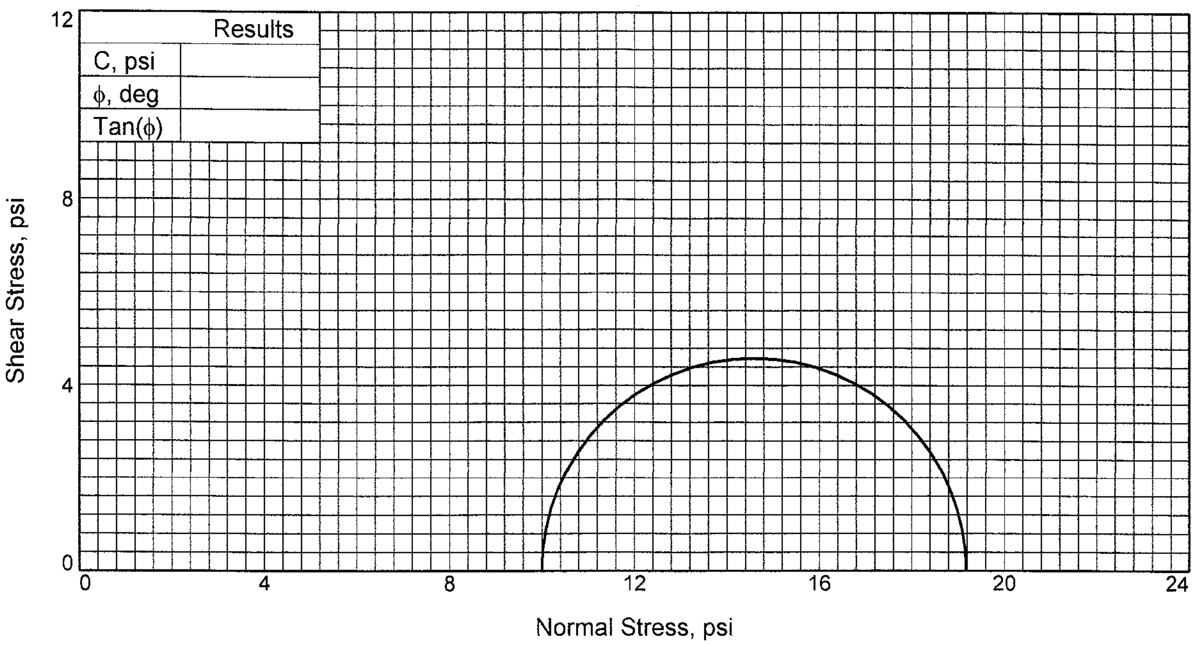
Test Readings for Specimen No. 1

Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 8.27 psi **at reading no.** 22

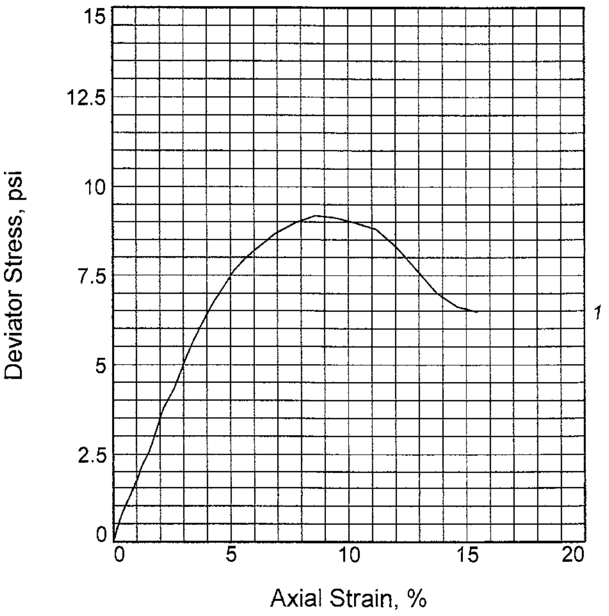
Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	10.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	14.600	4.2	0.2	0.66	10.00	10.66	1.07	10.33	0.33
2	0.0200	15.700	5.3	0.3	0.83	10.00	10.83	1.08	10.41	0.41
3	0.0300	17.200	6.8	0.5	1.06	10.00	11.06	1.11	10.53	0.53
4	0.0400	18.500	8.1	0.7	1.26	10.00	11.26	1.13	10.63	0.63
5	0.0500	20.200	9.8	0.8	1.52	10.00	11.52	1.15	10.76	0.76
6	0.0600	21.700	11.3	1.0	1.75	10.00	11.75	1.18	10.88	0.88
7	0.0700	23.800	13.4	1.2	2.07	10.00	12.07	1.21	11.04	1.04
8	0.0800	25.300	14.9	1.3	2.30	10.00	12.30	1.23	11.15	1.15
9	0.0900	27.100	16.7	1.5	2.58	10.00	12.58	1.26	11.29	1.29
10	0.1000	29.200	18.8	1.7	2.90	10.00	12.90	1.29	11.45	1.45
11	0.1250	33.800	23.4	2.1	3.59	10.00	13.59	1.36	11.79	1.79
12	0.1500	38.100	27.7	2.5	4.23	10.00	14.23	1.42	12.12	2.12
13	0.1750	42.600	32.2	2.9	4.90	10.00	14.90	1.49	12.45	2.45
14	0.2000	46.500	36.1	3.3	5.47	10.00	15.47	1.55	12.73	2.73
15	0.2250	50.300	39.9	3.8	6.01	10.00	16.01	1.60	13.01	3.01
16	0.2500	53.800	43.4	4.2	6.51	10.00	16.51	1.65	13.26	3.26
17	0.2750	56.800	46.4	4.6	6.93	10.00	16.93	1.69	13.47	3.47
18	0.3000	59.300	48.9	5.0	7.28	10.00	17.28	1.73	13.64	3.64
19	0.3250	61.200	50.8	5.4	7.53	10.00	17.53	1.75	13.76	3.76
20	0.3500	63.000	52.6	5.9	7.76	10.00	17.76	1.78	13.88	3.88
21	0.4000	65.700	55.3	6.7	8.08	10.00	18.08	1.81	14.04	4.04
22	0.4500	67.500	57.1	7.5	8.27	10.00	18.27	1.83	14.14	4.14
23	0.5000	67.500	57.1	8.4	8.20	10.00	18.20	1.82	14.10	4.10
24	0.5500	61.600	51.2	9.2	7.28	10.00	17.28	1.73	13.64	3.64
25	0.6000	58.500	48.1	10.0	6.78	10.00	16.78	1.68	13.39	3.39
26	0.6500	57.400	47.0	10.9	6.56	10.00	16.56	1.66	13.28	3.28
27	0.7000	57.600	47.2	11.7	6.53	10.00	16.53	1.65	13.26	3.26
28	0.7500	57.900	47.5	12.5	6.51	10.00	16.51	1.65	13.25	3.25
29	0.8000	58.500	48.1	13.4	6.53	10.00	16.53	1.65	13.26	3.26
30	0.8500	58.900	48.5	14.2	6.52	10.00	16.52	1.65	13.26	3.26
31	0.9000	59.500	49.1	15.1	6.53	10.00	16.53	1.65	13.27	3.27





Results	
C, psi	
ϕ, deg	
Tan(ϕ)	



	Sample No.	1
Initial	Water Content, %	33.3
	Dry Density, pcf	90.0
	Saturation, %	113.4
	Void Ratio	0.7347
	Diameter, in.	2.84
	Height, in.	5.82
At Test	Water Content, %	29.4
	Dry Density, pcf	90.0
	Saturation, %	100.0
	Void Ratio	0.7347
	Diameter, in.	2.84
	Height, in.	5.82
	Strain rate, in./min.	0.050
	Back Pressure, psi	0.0
	Cell Pressure, psi	10.0
	Fail. Stress, psi	9.2
	Ult. Stress, psi	
	σ_1 Failure, psi	19.2
	σ_3 Failure, psi	10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.05

Figure ________

Client: Langan Engineering

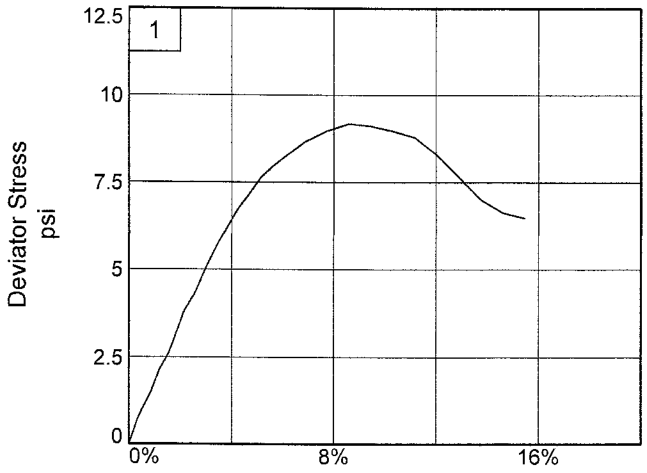
Project: Hudson Yards

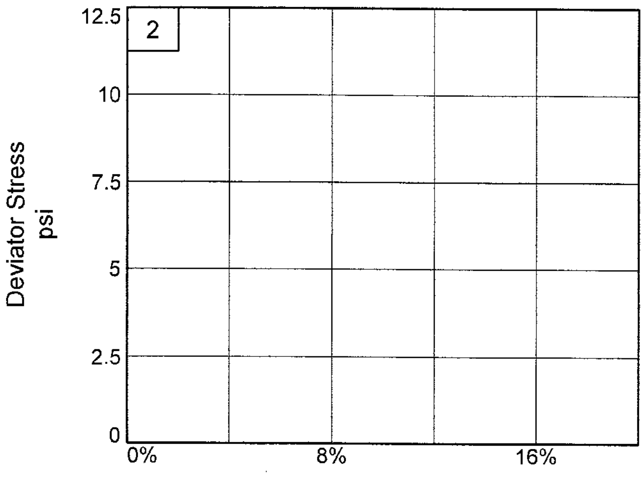
Sample Number: LB-2 67-69'

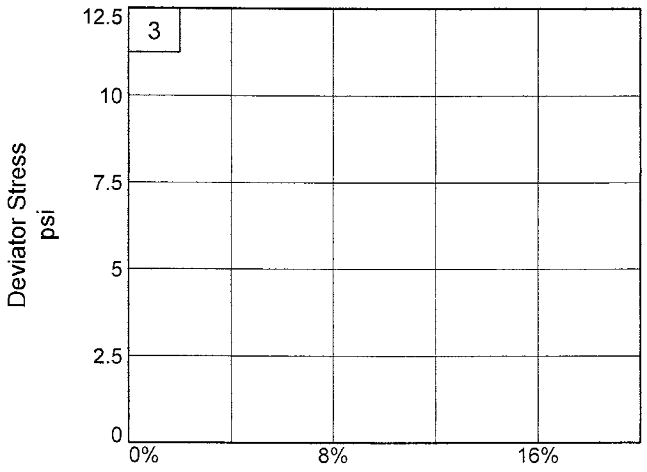
Proj. No.: 869 **Date Sampled:** 11-17-17

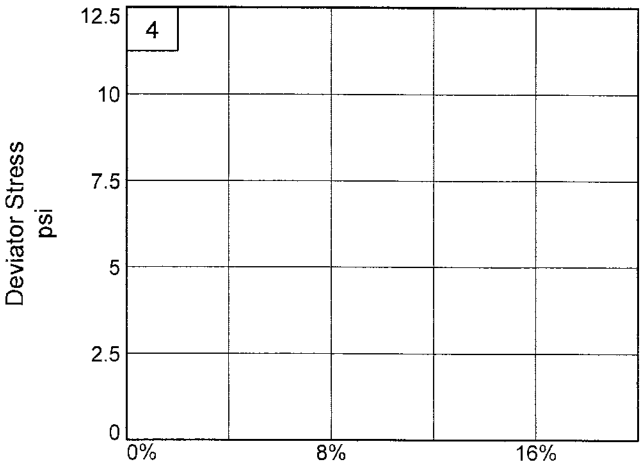
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

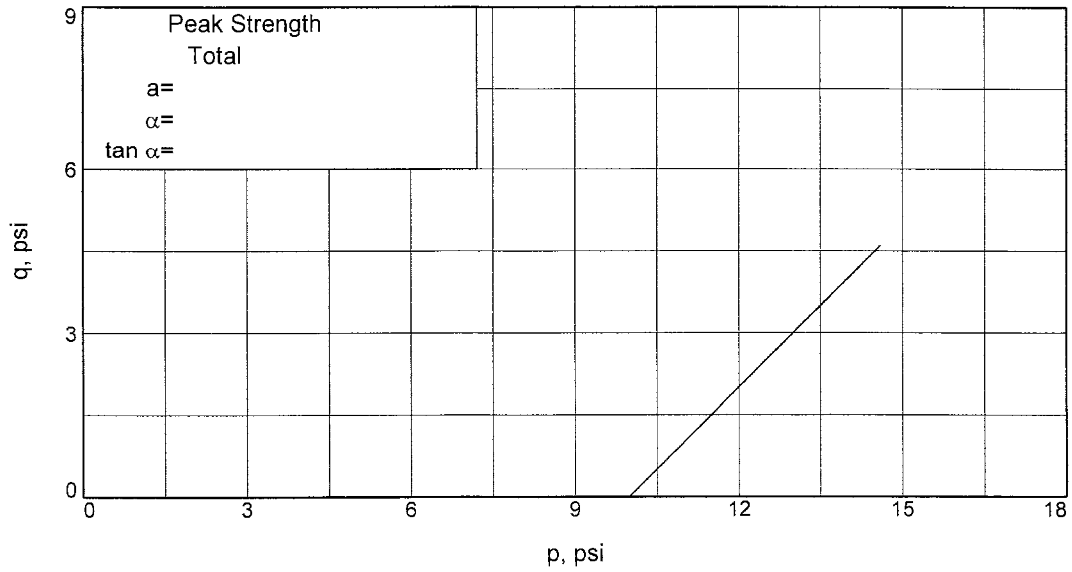
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-2 67-69'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST
Unconsolidated Undrained

11/17/2017
11:03 AM

Date: 11-17-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-2 67-69'
Description: Dark Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.05
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

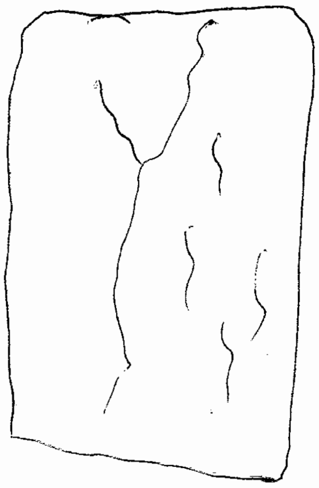
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1162.000		1162.000
Moisture content: Dry soil+tare, gms.	871.600		871.600
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	33.3	29.4	33.3
Moist specimen weight, gms.	1162.0		
Diameter, in.	2.84	2.84	
Area, in.^{2}	6.34	6.34	
Height, in.	5.82	5.82	
Net decrease in height, in.		0.00	
Wet density, pcf	119.9	116.4	
Dry density, pcf	90.0	90.0	
Void ratio	0.7347	0.7347	
Saturation, %	113.4	100.0	

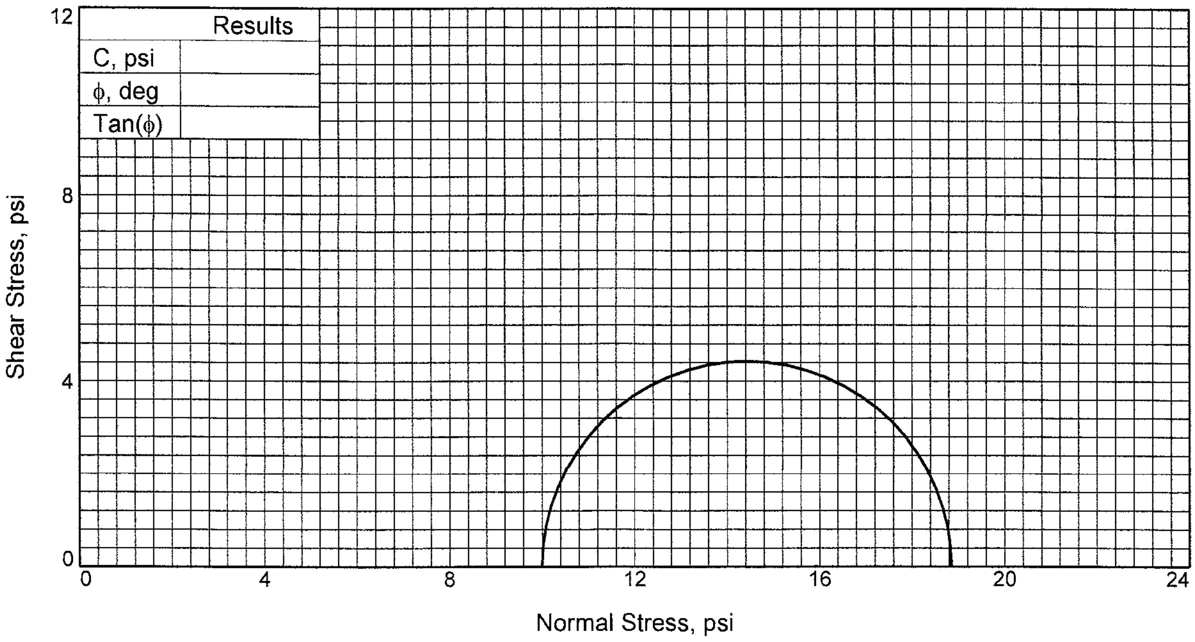
Test Readings for Specimen No. 1

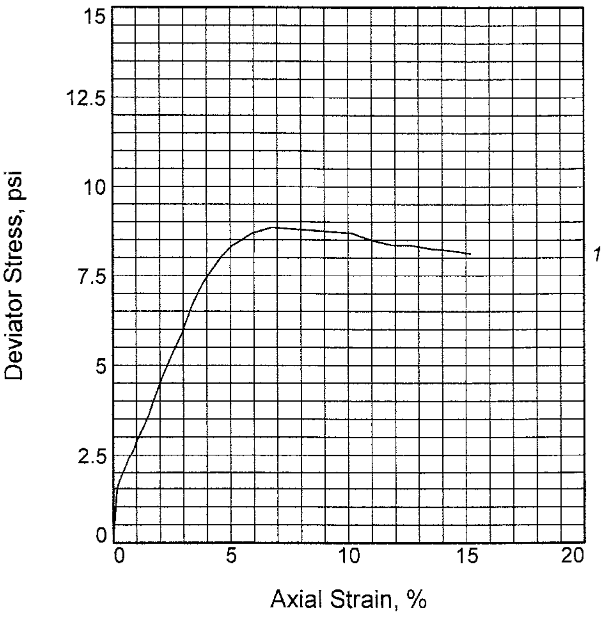
Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 9.18 psi **at reading no.** 23

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	3.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	5.700	2.3	0.2	0.36	10.00	10.36	1.04	10.18	0.18
2	0.0200	8.000	4.6	0.3	0.72	10.00	10.72	1.07	10.36	0.36
3	0.0300	9.800	6.4	0.5	1.00	10.00	11.00	1.10	10.50	0.50
4	0.0400	11.300	7.9	0.7	1.24	10.00	11.24	1.12	10.62	0.62
5	0.0500	13.000	9.6	0.9	1.50	10.00	11.50	1.15	10.75	0.75
6	0.0600	15.000	11.6	1.0	1.81	10.00	11.81	1.18	10.90	0.90
7	0.0700	17.100	13.7	1.2	2.13	10.00	12.13	1.21	11.07	1.07
8	0.0800	18.600	15.2	1.4	2.36	10.00	12.36	1.24	11.18	1.18
9	0.0900	20.200	16.8	1.5	2.61	10.00	12.61	1.26	11.30	1.30
10	0.1000	22.200	18.8	1.7	2.91	10.00	12.91	1.29	11.46	1.46
11	0.1250	28.000	24.6	2.1	3.79	10.00	13.79	1.38	11.90	1.90
12	0.1500	31.500	28.1	2.6	4.32	10.00	14.32	1.43	12.16	2.16
13	0.1750	36.200	32.8	3.0	5.02	10.00	15.02	1.50	12.51	2.51
14	0.2000	40.700	37.3	3.4	5.68	10.00	15.68	1.57	12.84	2.84
15	0.2250	44.600	41.2	3.9	6.24	10.00	16.24	1.62	13.12	3.12
16	0.2500	48.200	44.8	4.3	6.76	10.00	16.76	1.68	13.38	3.38
17	0.2750	51.300	47.9	4.7	7.19	10.00	17.19	1.72	13.60	3.60
18	0.3000	54.500	51.1	5.2	7.64	10.00	17.64	1.76	13.82	3.82
19	0.3250	56.700	53.3	5.6	7.93	10.00	17.93	1.79	13.97	3.97
20	0.3500	58.700	55.3	6.0	8.19	10.00	18.19	1.82	14.10	4.10
21	0.4000	62.400	59.0	6.9	8.66	10.00	18.66	1.87	14.33	4.33
22	0.4500	65.100	61.7	7.7	8.97	10.00	18.97	1.90	14.49	4.49
23	0.5000	67.100	63.7	8.6	9.18	10.00	19.18	1.92	14.59	4.59
24	0.5500	67.300	63.9	9.5	9.12	10.00	19.12	1.91	14.56	4.56
25	0.6000	66.900	63.5	10.3	8.98	10.00	18.98	1.90	14.49	4.49
26	0.6500	66.200	62.8	11.2	8.79	10.00	18.79	1.88	14.40	4.40
27	0.7000	63.200	59.8	12.0	8.29	10.00	18.29	1.83	14.15	4.15
28	0.7500	59.200	55.8	12.9	7.66	10.00	17.66	1.77	13.83	3.83
29	0.8000	54.900	51.5	13.8	7.00	10.00	17.00	1.70	13.50	3.50
30	0.8500	52.600	49.2	14.6	6.62	10.00	16.62	1.66	13.31	3.31
31	0.9000	52.000	48.6	15.5	6.48	10.00	16.48	1.65	13.24	3.24







Sample No.		1
Initial	Water Content, %	61.7
	Dry Density, pcf	63.0
	Saturation, %	104.2
	Void Ratio	1.4788
	Diameter, in.	2.82
	Height, in.	5.92
At Test	Water Content, %	59.2
	Dry Density, pcf	63.0
	Saturation, %	100.0
	Void Ratio	1.4788
	Diameter, in.	2.82
	Height, in.	5.92
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		8.9
Ult. Stress, psi		
σ_1 Failure, psi		18.9
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.10

Figure ________

Client: Langan Engineering

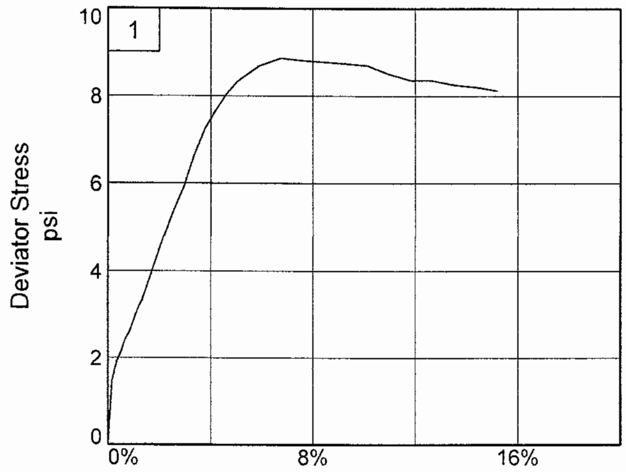
Project: Hudson Yards

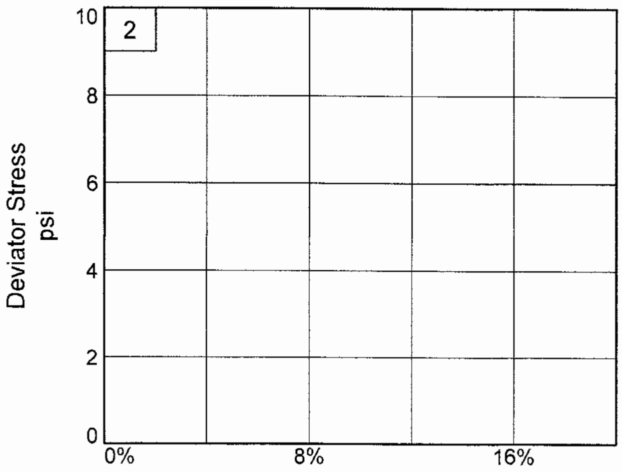
Sample Number: LB-3 22-24'

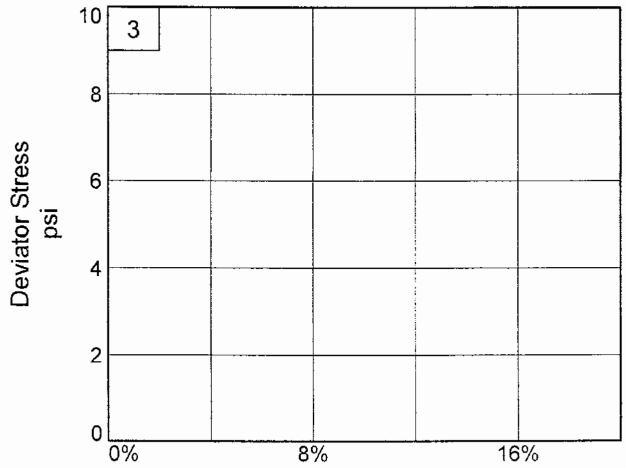
Proj. No.: 869 **Date Sampled:** 11-17-17

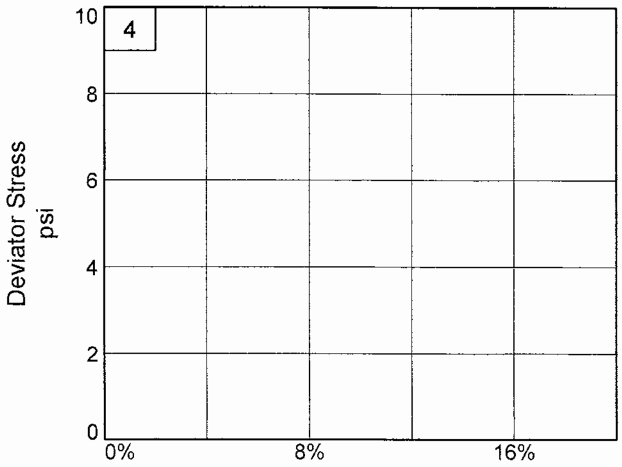
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

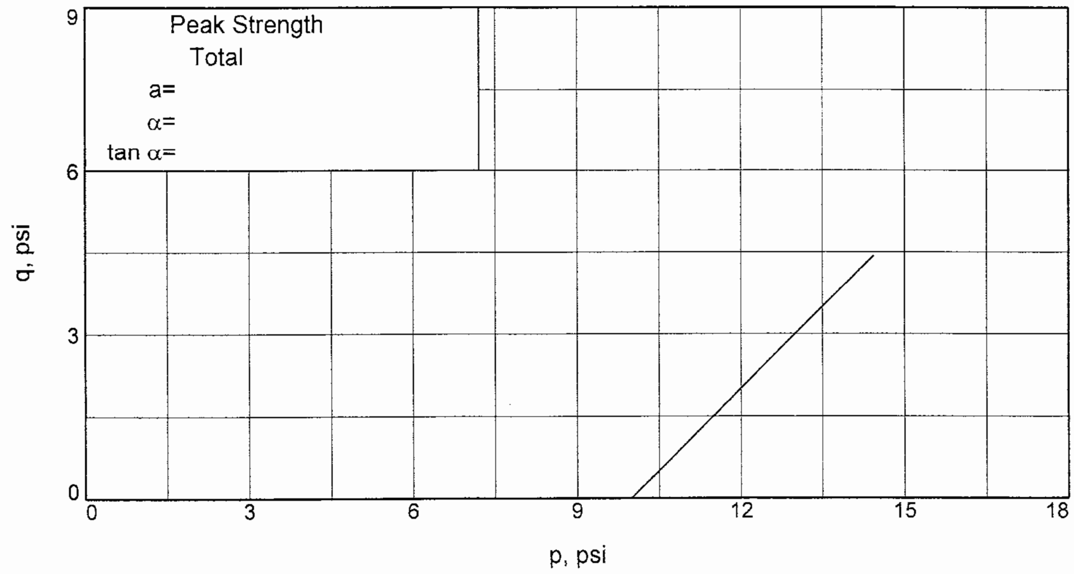
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-3 22-24'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE **Checked By:** KP

TRIAXIAL COMPRESSION TEST

Unconsolidated Undrained

11/17/2017
11:09 AM

Date: 11-17-17
Client: Langan Engineering
Project: Hudson Yards
Project No.: 869
Sample Number: LB-3 22-24'
Description: Gray Clay & Silt little, cmf Sand, trace f Gravel, odorous, organics (sea shells)(visual)
Remarks: H/D = 2.10
Type of Sample: ASTM D2850
Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**
Test Method: COE uniform strain

Parameters for Specimen No. 1

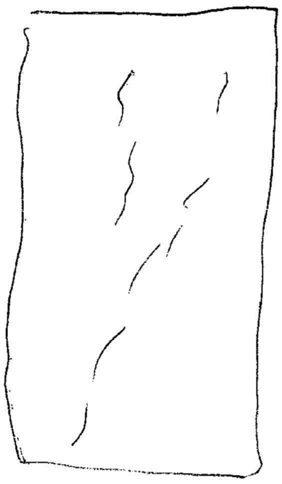
Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	988.400		988.400
Moisture content: Dry soil+tare, gms.	611.400		611.400
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	61.7	59.2	61.7
Moist specimen weight, gms.	988.4		
Diameter, in.	2.82	2.82	
Area, in.^{2}	6.25	6.25	
Height, in.	5.92	5.92	
Net decrease in height, in.		0.00	
Wet density, pcf	101.8	100.2	
Dry density, pcf	63.0	63.0	
Void ratio	1.4788	1.4788	
Saturation, %	104.2	100.0	

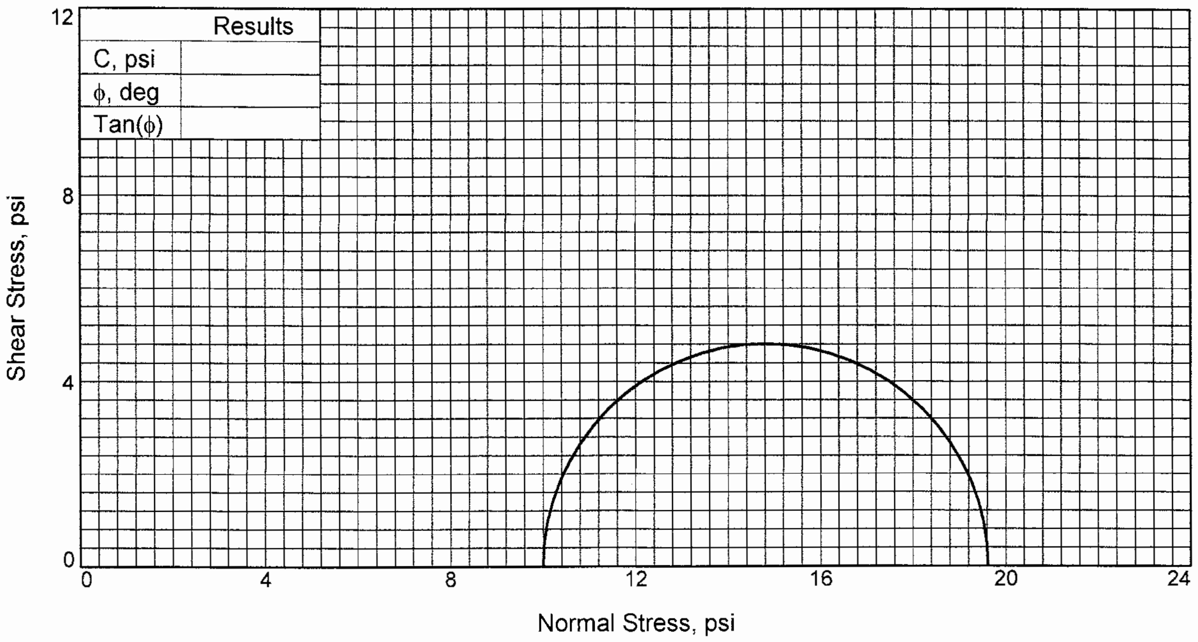
Test Readings for Specimen No. 1

Cell pressure = 10.00 psi
Back pressure = 0.00 psi
Strain rate, in./min. = 0.050
Fail. Stress = 8.85 psi **at reading no.** 21

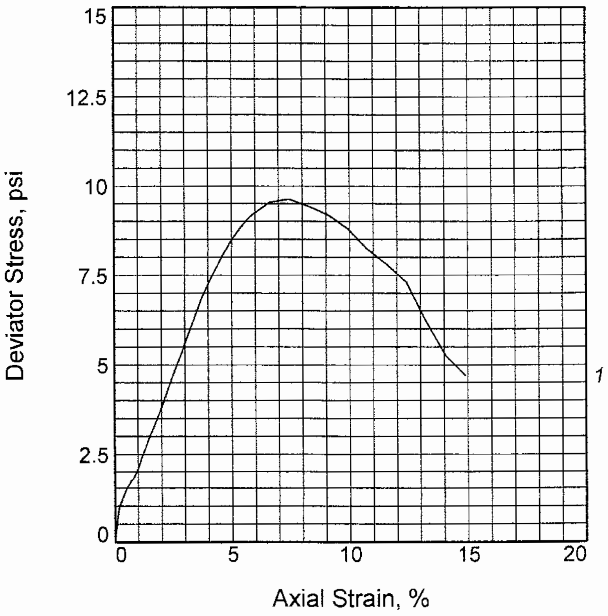
Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	4.400	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	13.600	9.2	0.2	1.47	10.00	11.47	1.15	10.74	0.74
2	0.0200	16.300	11.9	0.3	1.90	10.00	11.90	1.19	10.95	0.95
3	0.0300	17.700	13.3	0.5	2.12	10.00	12.12	1.21	11.06	1.06
4	0.0400	19.600	15.2	0.7	2.42	10.00	12.42	1.24	11.21	1.21
5	0.0500	20.700	16.3	0.8	2.59	10.00	12.59	1.26	11.29	1.29
6	0.0600	22.600	18.2	1.0	2.88	10.00	12.88	1.29	11.44	1.44
7	0.0700	24.200	19.8	1.2	3.13	10.00	13.13	1.31	11.57	1.57
8	0.0800	25.600	21.2	1.4	3.35	10.00	13.35	1.33	11.67	1.67
9	0.0900	27.400	23.0	1.5	3.63	10.00	13.63	1.36	11.81	1.81
10	0.1000	29.500	25.1	1.7	3.95	10.00	13.95	1.40	11.98	1.98
11	0.1250	34.300	29.9	2.1	4.69	10.00	14.69	1.47	12.34	2.34
12	0.1500	38.500	34.1	2.5	5.32	10.00	15.32	1.53	12.66	2.66
13	0.1750	42.400	38.0	3.0	5.90	10.00	15.90	1.59	12.95	2.95
14	0.2000	47.500	43.1	3.4	6.67	10.00	16.67	1.67	13.33	3.33
15	0.2250	51.500	47.1	3.8	7.25	10.00	17.25	1.73	13.63	3.63
16	0.2500	54.400	50.0	4.2	7.67	10.00	17.67	1.77	13.83	3.83
17	0.2750	57.100	52.7	4.6	8.05	10.00	18.05	1.80	14.02	4.02
18	0.3000	59.200	54.8	5.1	8.33	10.00	18.33	1.83	14.16	4.16
19	0.3250	60.600	56.2	5.5	8.50	10.00	18.50	1.85	14.25	4.25
20	0.3500	62.000	57.6	5.9	8.68	10.00	18.68	1.87	14.34	4.34
21	0.4000	63.700	59.3	6.8	8.85	10.00	18.85	1.89	14.43	4.43
22	0.4500	63.900	59.5	7.6	8.80	10.00	18.80	1.88	14.40	4.40
23	0.5000	64.200	59.8	8.4	8.77	10.00	18.77	1.88	14.38	4.38
24	0.5500	64.500	60.1	9.3	8.73	10.00	18.73	1.87	14.36	4.36
25	0.6000	64.800	60.4	10.1	8.69	10.00	18.69	1.87	14.35	4.35
26	0.6500	64.000	59.6	11.0	8.50	10.00	18.50	1.85	14.25	4.25
27	0.7000	63.600	59.2	11.8	8.36	10.00	18.36	1.84	14.18	4.18
28	0.7500	64.100	59.7	12.7	8.35	10.00	18.35	1.83	14.17	4.17
29	0.8000	64.000	59.6	13.5	8.25	10.00	18.25	1.83	14.13	4.13
30	0.8500	64.200	59.8	14.4	8.20	10.00	18.20	1.82	14.10	4.10
31	0.9000	64.200	59.8	15.2	8.12	10.00	18.12	1.81	14.06	4.06





Results	
C, psi	
ϕ, deg	
Tan(ϕ)	



Sample No.		1
Initial	Water Content, %	52.3
	Dry Density, pcf	67.8
	Saturation, %	100.5
	Void Ratio	1.3017
	Diameter, in.	2.88
	Height, in.	6.04
At Test	Water Content, %	52.1
	Dry Density, pcf	67.8
	Saturation, %	100.0
	Void Ratio	1.3017
	Diameter, in.	2.88
	Height, in.	6.04
Strain rate, in./min.		0.050
Back Pressure, psi		0.0
Cell Pressure, psi		10.0
Fail. Stress, psi		9.6
Ult. Stress, psi		
σ_1 Failure, psi		19.6
σ_3 Failure, psi		10.0

Type of Test:
Unconsolidated Undrained

Sample Type: ASTM D2850

Description: Dark Gray Clay & Silt little (+), cmf Sand, trace (+) cmf Gravel, odorous, organics (sea shells)(visual)

Assumed Specific Gravity= 2.5

Remarks: H/D = 2.10

Figure ________

Client: Langan Engineering

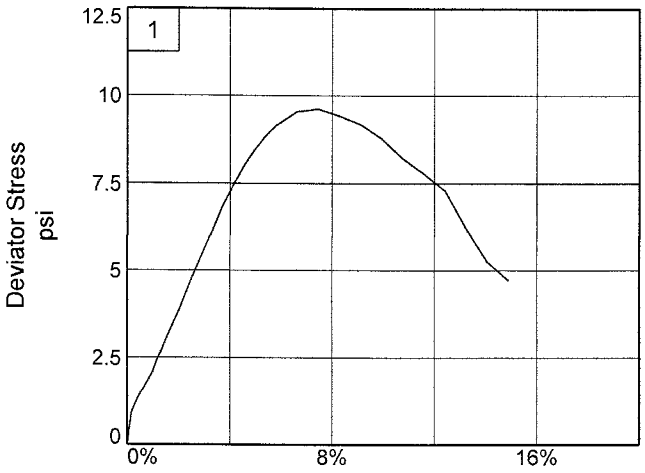
Project: Hudson Yards

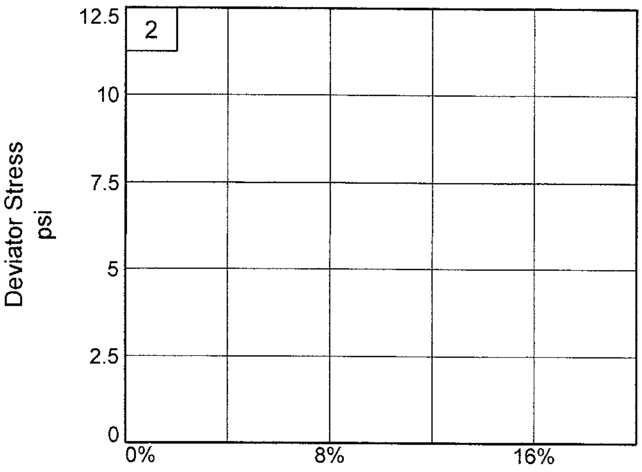
Sample Number: LB-3 32-34'

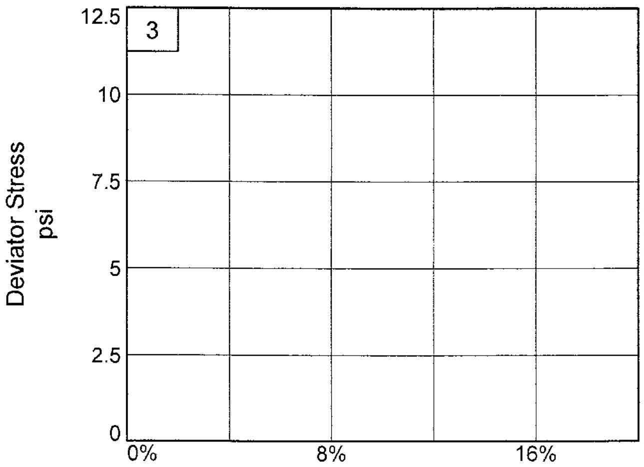
Proj. No.: 869 **Date Sampled:** 11-17-17

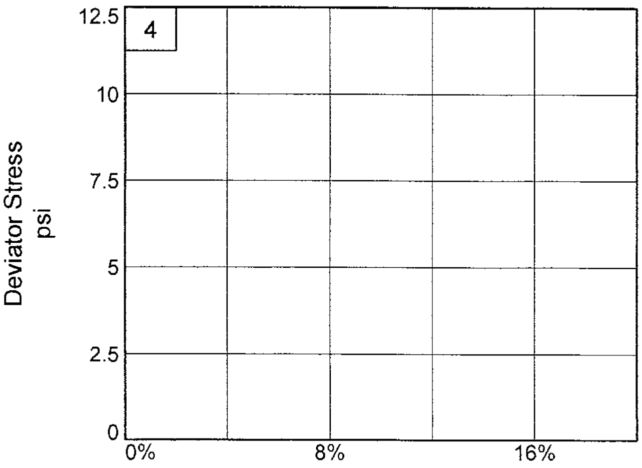
TRIAXIAL SHEAR TEST REPORT
RSA Geolab
Union, New Jersey

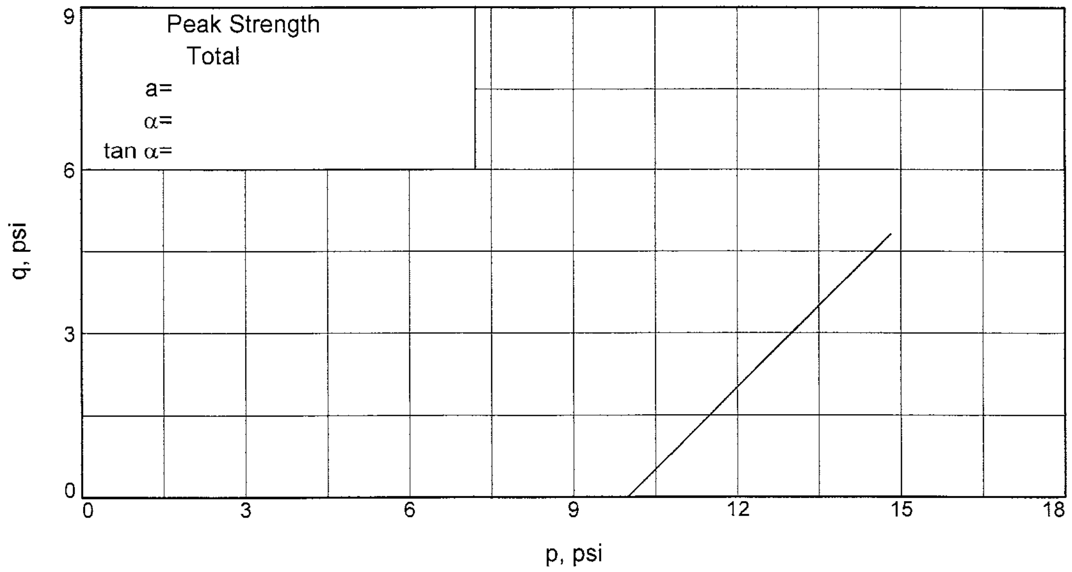
Tested By: EE **Checked By:** KP











Client: Langan Engineering
Project: Hudson Yards
Sample Number: LB-3 32-34'
Project No.: 869

Figure ________

RSA Geolab

Tested By: EE

Checked By: KP

TRIAXIAL COMPRESSION TEST

Unconsolidated Undrained

11/17/2017
11:15 AM

Date: 11-17-17

Client: Langan Engineering

Project: Hudson Yards

Project No.: 869

Sample Number: LB-3 32-34'

Description: Dark Gray Clay & Silt little (+), cmf Sand, trace (+) cmf Gravel, odorous, organics (sea shells)(visual)

Remarks: H/D = 2.10

Type of Sample: ASTM D2850

Assumed Specific Gravity=2.5 **LL=** **PL=** **PI=**

Test Method: COE uniform strain

Parameters for Specimen No. 1

Specimen Parameter	Initial	Saturated	Final
Moisture content: Moist soil+tare, gms.	1067.400		1067.400
Moisture content: Dry soil+tare, gms.	700.800		700.800
Moisture content: Tare, gms.	0.000		0.000
Moisture, %	52.3	52.1	52.3
Moist specimen weight, gms.	1067.4		
Diameter, in.	2.88	2.88	
Area, in.^{2}	6.51	6.51	
Height, in.	6.04	6.04	
Net decrease in height, in.		0.00	
Wet density, pcf	103.3	103.1	
Dry density, pcf	67.8	67.8	
Void ratio	1.3017	1.3017	
Saturation, %	100.5	100.0	

Test Readings for Specimen No. 1

Cell pressure = 10.00 psi

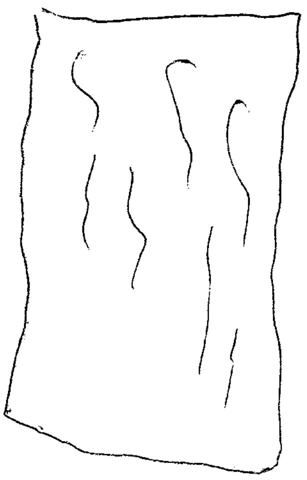
Back pressure = 0.00 psi

Strain rate, in./min. = 0.050

Fail. Stress = 9.62 psi **at reading no.** 22

Test Readings for Specimen No. 1

No.	Def. Dial in.	Load Dial	Load lbs.	Strain %	Deviator Stress psi	Minor Princ. Stress psi	Major Princ. Stress psi	1:3 Ratio	P psi	Q psi
0	0.0000	4.900	0.0	0.0	0.00	10.00	10.00	1.00	10.00	0.00
1	0.0100	10.800	5.9	0.2	0.90	10.00	10.90	1.09	10.45	0.45
2	0.0200	12.800	7.9	0.3	1.21	10.00	11.21	1.12	10.60	0.60
3	0.0300	14.500	9.6	0.5	1.47	10.00	11.47	1.15	10.73	0.73
4	0.0400	15.700	10.8	0.7	1.65	10.00	11.65	1.16	10.82	0.82
5	0.0500	17.100	12.2	0.8	1.86	10.00	11.86	1.19	10.93	0.93
6	0.0600	18.600	13.7	1.0	2.08	10.00	12.08	1.21	11.04	1.04
7	0.0700	20.800	15.9	1.2	2.41	10.00	12.41	1.24	11.21	1.21
8	0.0800	22.600	17.7	1.3	2.68	10.00	12.68	1.27	11.34	1.34
9	0.0900	24.600	19.7	1.5	2.98	10.00	12.98	1.30	11.49	1.49
10	0.1000	26.400	21.5	1.7	3.25	10.00	13.25	1.32	11.62	1.62
11	0.1250	31.000	26.1	2.1	3.92	10.00	13.92	1.39	11.96	1.96
12	0.1500	36.200	31.3	2.5	4.69	10.00	14.69	1.47	12.34	2.34
13	0.1750	41.100	36.2	2.9	5.40	10.00	15.40	1.54	12.70	2.70
14	0.2000	46.100	41.2	3.3	6.12	10.00	16.12	1.61	13.06	3.06
15	0.2250	51.300	46.4	3.7	6.86	10.00	16.86	1.69	13.43	3.43
16	0.2500	55.400	50.5	4.1	7.43	10.00	17.43	1.74	13.72	3.72
17	0.2750	59.300	54.4	4.5	7.97	10.00	17.97	1.80	13.99	3.99
18	0.3000	62.800	57.9	5.0	8.45	10.00	18.45	1.84	14.22	4.22
19	0.3250	65.700	60.8	5.4	8.83	10.00	18.83	1.88	14.42	4.42
20	0.3500	68.100	63.2	5.8	9.14	10.00	19.14	1.91	14.57	4.57
21	0.4000	71.400	66.5	6.6	9.53	10.00	19.53	1.95	14.77	4.77
22	0.4500	72.600	67.7	7.4	9.62	10.00	19.62	1.96	14.81	4.81
23	0.5000	71.800	66.9	8.3	9.42	10.00	19.42	1.94	14.71	4.71
24	0.5500	70.700	65.8	9.1	9.18	10.00	19.18	1.92	14.59	4.59
25	0.6000	68.500	63.6	9.9	8.79	10.00	18.79	1.88	14.40	4.40
26	0.6500	64.900	60.0	10.8	8.22	10.00	18.22	1.82	14.11	4.11
27	0.7000	62.300	57.4	11.6	7.79	10.00	17.79	1.78	13.90	3.90
28	0.7500	59.200	54.3	12.4	7.30	10.00	17.30	1.73	13.65	3.65
29	0.8000	51.500	46.6	13.2	6.21	10.00	16.21	1.62	13.10	3.10
30	0.8500	44.700	39.8	14.1	5.25	10.00	15.25	1.53	12.63	2.63
31	0.9000	40.900	36.0	14.9	4.70	10.00	14.70	1.47	12.35	2.35



Project No.: 31737700-458 File: Indx1.xls

Langan #35578403
New York Sports and Convention Center
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARK
															INITIAL CONDITIONS		
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	TOTAL UNIT WEIGHT (pcf)	Type Test @ STRESS (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	VOID RATIO	SATUR-ATION	
G-6	S-9	45-47	49.3	56	24	32	CH			3.8							
G-6	S-11	55-57	65.5	45	20	25	CL			3.3							
G-6	S-12	60-62	30.1	25	20	5	CL-ML										
G-7	S-10	45-47	36.1	33	16	17	CL			3.4							
G-9	S-7	30-32	43.3	63	25	38	CH-OH			5.2							
G-9	S-7	30-32		43	25	18	CH-OH										oven dried
G-15	S-7	35-37	59.1	64	26	38	CH			4.4							
G-17	U-2	82-84									120.3						
G-17	U-2	82.15	48.7														
G-17	U-2	82.65	34.9														
G-17	U-2	83.15	27.5														
G-17	U-2C	83.4	27.1	27	14	13	SC				122.6	UU@1.15	0.9	15.2			UU005c
G-19	S-7	35-37	57.7	77	28	49	CH-OH			5.9							
G-19	U-2	60-62									107.3						
G-19	U-2	60.35	61.4														
G-19	U-2	60.9	43.6														
G-19	U-2	61.45	48.2														
G-19	U-2C	61.7	43.3	43	19	24	CL				110.7	UU@0.94	1.0	11.5			UU342e
G-19	S-16	90-95	42.1	52	20	32	CH			4.2							
G-20	U-1	25-27										UU					missing
G-20	S-7	45-47	25.1	np	np	np	ML			1.6							
G-21	S-6	30-32	53.0	57	22	35	CH-OH			4.6							
G-21	S-6	30-32		41	21	20	CH-OH										oven dried

Prepared by: RV Reviewed by: Date: 01/10/2005

Langan #35578403
New York Sports and Convention Center
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARKS
															INITIAL CONDITIONS		
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	TOTAL UNIT WEIGHT (pcf)	Type Test @ STRESS (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	VOID RATIO	SATUR-ATION	
G-27	S-6	30-32	9.3	np	np	np	ML			1.2							
G-27	U-1	45-47									104.9						
G-27	U-1	45.6	52.3														
G-27	U-1	46.15	50.4														
G-27	U-1C	46.4	42.3	49	22	27	CL			4.2	111.1				1.159	98	C04255
G-27	U-2	55-57									102.3						
G-27	U-2	55.55	53.7														
G-27	U-2B	55.8	50.1	50	21	29	CH			4.1	106.5	UU@0.94	1.0	6.7			UU342f
G-27	S-10	60-62	41.9	49	23	26	CL										
G-27	S-12	70-72	46.9	57	24	33	CH										
G-27	S-15	85-87	36.3	37	18	19	CL			2.9							
G-27	S-23	125-127	43.6	64	27	37	CH-OH			9.1							
G-30	U-1	40-42									104.7						
G-30	U-1	40.6	42.4														
G-30	U-1B	40.85	51.5	52	19	33	CH				106.9	CIU@0.79	0.6	7.3			T2438
G-30	U-2	50-52									124.4						
G-30	U-2	50.3	26.3														
G-30	U-2B	50.55	23.7	22	16	6	CL-ML				129.1	UU@0.94	0.8	15.1			UU342d
G-31	U-1	20-22									97.1						
G-31	U-1	20.35	64.9														
G-31	U-1	20.9	65.2														
G-31	U-1B	21.15	63.8				CH-OH	99.0	35		100.3	UU@0.58	0.7	8.2			UU343e
G-31	U-1	21.45	57.0														
G-31	U-1C	21.7	66.2	83	30	53	CH-OH			5.7	99.6				1.728	100	C04252

Prepared by: RV Reviewed by: CWG Date: 01/10/2005

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Langan #35578403
New York Sports and Convention Center
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									STRENGTH			CONSOL. INITIAL CONDITIONS		REMARKS
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	TOTAL UNIT WEIGHT (pcf)	Type Test @ STRESS (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	VOID RATIO	SATUR-ATION	
G-37	S-1	10-12	22.8				SM	29.3									
G-37	S-2	15-17	25.5				SM	19.7									
G-37	S-3	20-22	15.7				SM	43.2									
G-37	S-5	30-32	58.6	69	27	42	CH-OH			4.4							
G-37	S-6	35-37	50.6	62	23	39	CH-OH			4.6							
G-37	S-6	35-37		43	21	22	CH-OH										oven dried
G-37	S-8	45-47	26.8	34	17	17	CL			2.0							
G-39	S-4	25-27	44.9	64	24	40	CH-OH			3.9							
G-39	S-5	30-32	10.5				SM	20.8									
G-48	U-2	25-27									94.0						
G-48	U-2	25.3	72.4														
G-48	U-2	25.85	79.8														
G-48	U-2B	26.1	69.4	80	29	51	CH-OH			6.5	100.3	CIU@0.50	0.3	9.3			T2439
G-48	U-2	26.4	66.8														
G-48	U-3	60-62									114.6						
G-48	U-3	60.25	52.0														
G-48	U-3	60.8	33.7														
G-48	U-3B	61.05	30.8				CL				120.7	UU@0.86	0.9	15.1			UU342c
G-48	U-3	61.35	30.7														
G-48	U-3C	61.6	37.8	33	17	16	CL				116.1				1.022	101	C04250
G-49	S-4	25-27	72.5	80	29	51	CH-OH			6.2							
G-49	U-1	30-32									102.1						
G-49	U-1	30.5	42.5														
G-49	U-1	31.05	57.5														
G-49	U-1C	31.3	56.6				CH-OH				103.7	UU@0.58	0.7	8.1			UU343b
G-49	U-1	31.6	54.7														
G-49	U-1D	31.85	60.4	67	25	42	CH-OH				102.7				1.584	101	C04251
G-49	S-6	35-37	50.4	63	24	39	CH-OH			3.8							
G-49	S-8	45-47	22.6	23	13	10	CL										

Prepared by: RV Reviewed by: Date: 01/10/2005

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Langan #35578403
New York Sports and Convention Center
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARKS
															INITIAL CONDITIONS		
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	TOTAL UNIT WEIGHT (pcf)	Type Test @ STRESS (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	VOID RATIO	SATUR-ATION	
G-50	S-4	25-27	55.0	66	26	40	CH-OH			4.5							
G-50	S-6	35-37	18.6	np	np	np	SM			1.0							
G-50	S-6	35-37															
															np - oven dried not performed		
G-52	S-2	16-18	52.7	71	30	41	CH	83.3	24	4.9							
G-52	S-3	20-22	17.2	21	14	7	CL-ML										
G-62	S-7	40-42	51.8	52	21	31	CH			3.6							
G-62	U-1	45-47									102.1						
G-62	U-1	45.35	57.9														
G-62	U-1	45.85	56.3														
G-62	U-1	46.25	50.5														
G-62	U-1C	46.5	49.5	60	22	38	CH-OH				105.1	UU@0.86	0.8	8.5			UU005a
G-62	S-9	55-57	54.3	58	24	34	CH-OH			4.2							
G-62	U-2	60-62									107.9						
G-62	U-2	60.55	53.5														
G-62	U-2	61.05	32.3														
G-62	U-2	61.4	37.3														
G-62	U-2C	61.7	34.1	30	16	14	CL				118.5	UU@1.01	0.6	15.1			UU005b
G-62	S-11	70-72	28.5	28	15	13	CL										
G-62	S-14	85-87	32.4	34	16	18	CL										
G-63	S-3	20-22	86.0	91	33	58	CH-OH			7.0							
G-63	S-5	30-32	83.7	98	32	66	CH-OH			8.1							
G-63	S-7	40-42	65.1														
G-63	S-10	55-57	42.7	32	17	15	CL										
G-63	S-12	65-67	33.7							2.6							
G-63	S-13	70-72	34.6	33	17	16	CL			2.4							
G-63	S-15	80-82					SM	39.8	8								

Prepared by: RV Reviewed by: Date: 01/10/2005

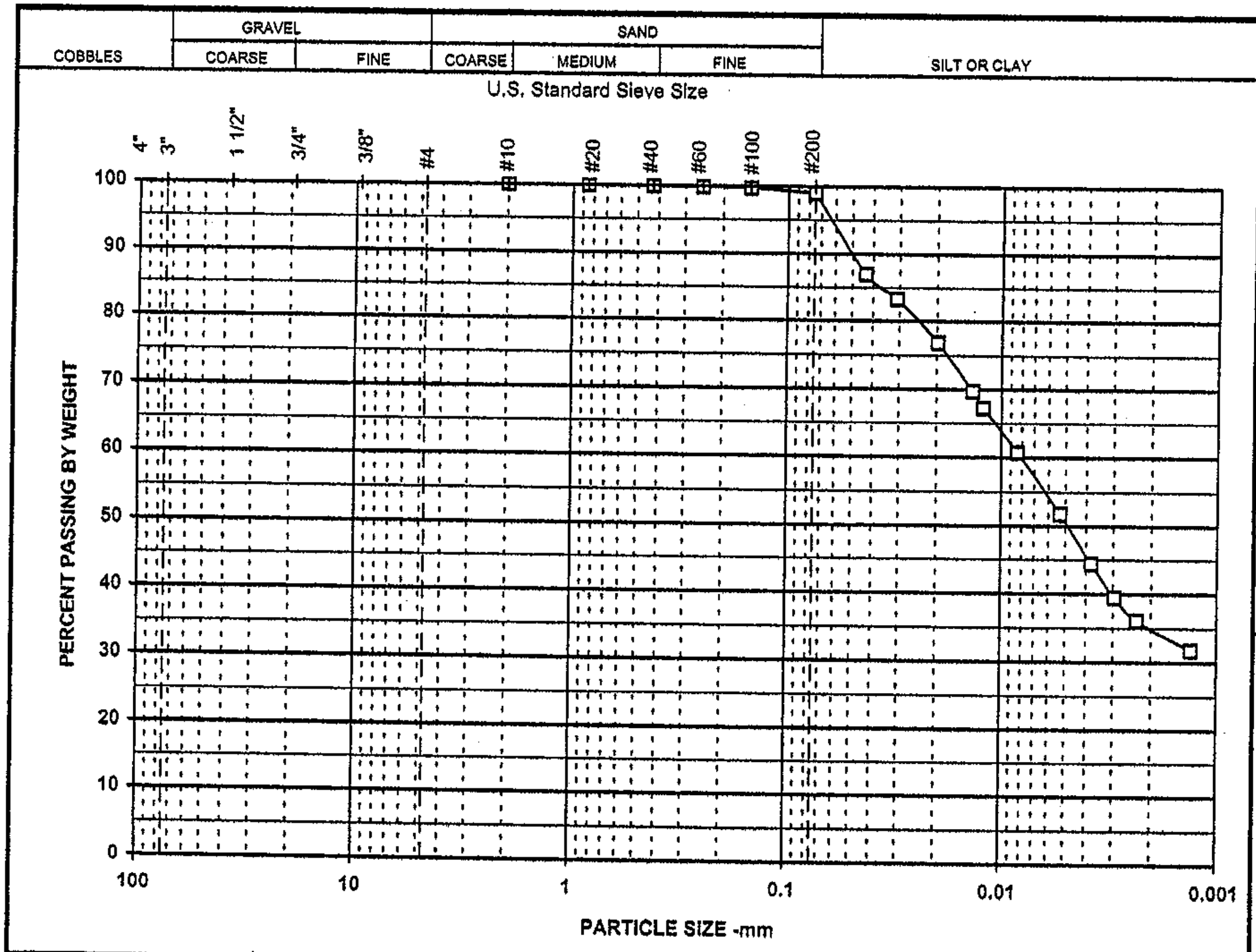
Project No.: 31737700-458 File: Indx1.xls

Langan #35578403
New York Sports and Convention Center
LABORATORY TESTING DATA SUMMARY

BORING	SAMPLE	DEPTH	IDENTIFICATION TESTS									STRENGTH			CONSOL.		REMARKS
NO.	NO.	(ft)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDRO. % MINUS 2 µm (%)	ORGANIC CONTENT (burnoff) (%)	TOTAL UNIT WEIGHT (pcf)	Type Test @ STRESS (tsf)	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	INITIAL CONDITIONS VOID RATIO	INITIAL CONDITIONS SATUR-ATION	
G-64	S-3	20-22	26.3							1.9							
G-64	U-1	25-27															*no test
G-64	S-6	30-32	58.9														
G-64	U-2	40-42									104.8						
G-64	U-2	40.55	53.6														
G-64	U-2	41.1	53.6														
G-64	U-2C	41.35	46.4				CL	83.5	19	3.6	108.1	UU@0.65	0.9	6.9			UU343a
G-64	U-2	41.65	34.2														
G-64	S-9	42-44	42.6	51	20	31	CH			2.9							
G-66	S-3	20-22	49.6	66	28	38	CH-OH			4.3							
G-66	S-4	25-27					SM	16.5	5								

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.

Prepared by: RV Reviewed by: Date: 01/10/2005



SYMBOL	DESCRIPTION AND REMARKS
☐	gray ORGANIC CLAY, trace f. sand.
■	
○	

Symbol	☐	■	○
Boring	G-31		
Sample	U-1		
Spec	B		
Depth	21.15		
% +3"			
% Gravel			
% SAND	1.0		
% FINES	99.0		
% -2μ	35		
Cc			
Cu			
LL			
PL			
PI			
USCS	CH-OH		
w (%)			

Particle Size (Sieve #)	PERCENT FINER		
	☐	■	○
4"			
3"			
1 1/2"			
3/4"			
3/8"			
4			
10			
20	100.0		
40	99.9		
60	99.8		
100	99.7		
200	99.0		

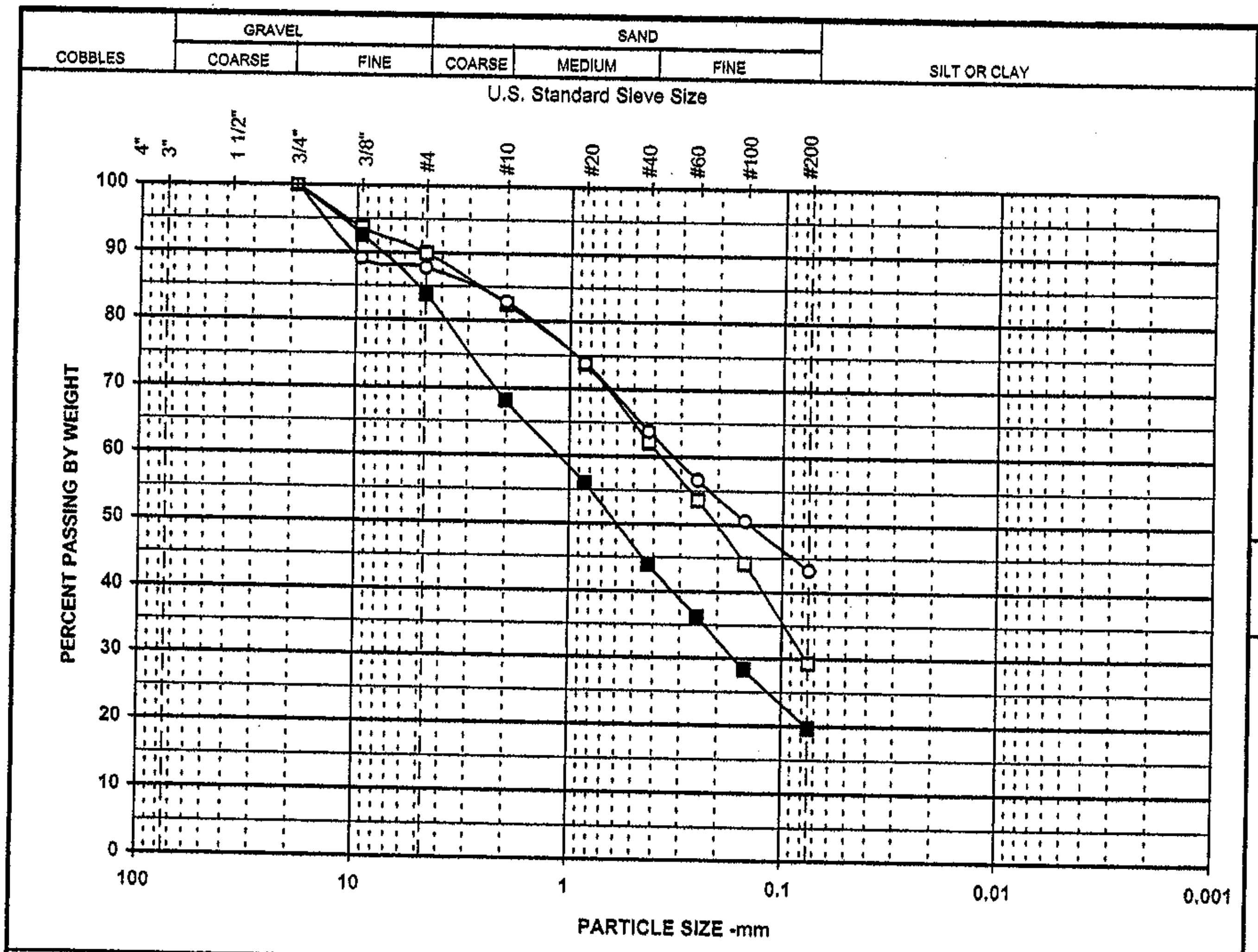
PARTICLE SIZE DISTRIBUTION

Langan #5578403

Project No. 31737700-458	January 2005	Figure

Geotesting Services, Inc.

siev1d.xls 01/05/2005



Symbol	☐	■	○
Boring	G-37	G-37	G-37
Sample	S-1	S-2	S-3
Spec			
Depth	10-12	15-17	20-22
% +3"			
% Gravel	10.1	16.2	12.2
% SAND	60.6	64.1	44.6
% FINES	29.3	19.7	43.2
% -2µ			
Cc			
Cu			
LL			
PL			
PI			
USCS	SM	SM	SM
w (%)	22.8	25.5	15.7

Particle Size (Sieve #)	PERCENT FINER ☐	■	○
4"			
3"			
1 1/2"			
3/4"	100.0	100.0	100.0
3/8"	93.6	92.5	89.1
4	89.9	83.8	87.8
10	82.4	68.1	82.7
20	73.8	56.0	73.8
40	62.1	44.0	63.7
60	53.6	36.2	56.5
100	44.2	28.3	50.5
200	29.3	19.7	43.2

SYMBOL	DESCRIPTION AND REMARKS
☐	brown c-f SAND, some silt, trace f. gravel.
■	brown-black c-f SAND, some f. gravel, silt.
○	brown silty c-f SAND, some f. gravel.

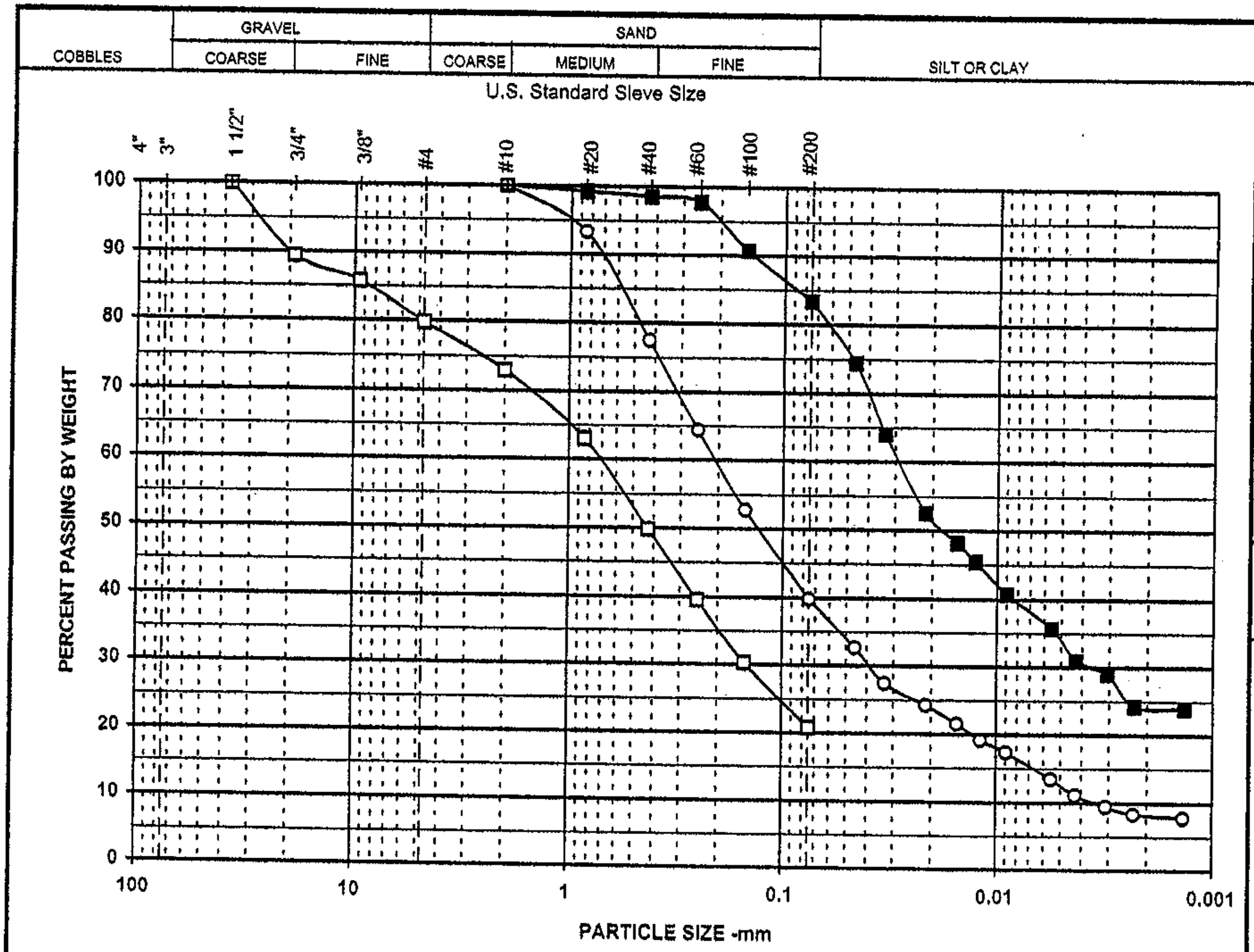
PARTICLE SIZE DISTRIBUTION

Langan #5578403

Project No.		
31737700-458	December 2004	Figure

Geotesting Services, Inc.

siev1a.xls 12/07/2004



SYMBOL	DESCRIPTION AND REMARKS
☐	reddish brown c-f SAND, some gravel, silt.
■	reddish brown CLAY, some f. sand, trace m. sand.
○	brown silty m-f SAND.

Symbol	☐	■	○
Boring	G-39	G-52	G-63
Sample	S-5	S-2	S-15
Spec			
Depth	30-32	16-18	80-82
% +3"			
% Gravel	20.2		
% SAND	59.0	16.7	60.2
% FINES	20.8	83.3	39.8
% -2μ		24	8
Cc			
Cu			
LL		71	
PL		30	
PI		41	
USCS	SM	CH	SM
w (%)	10.5		

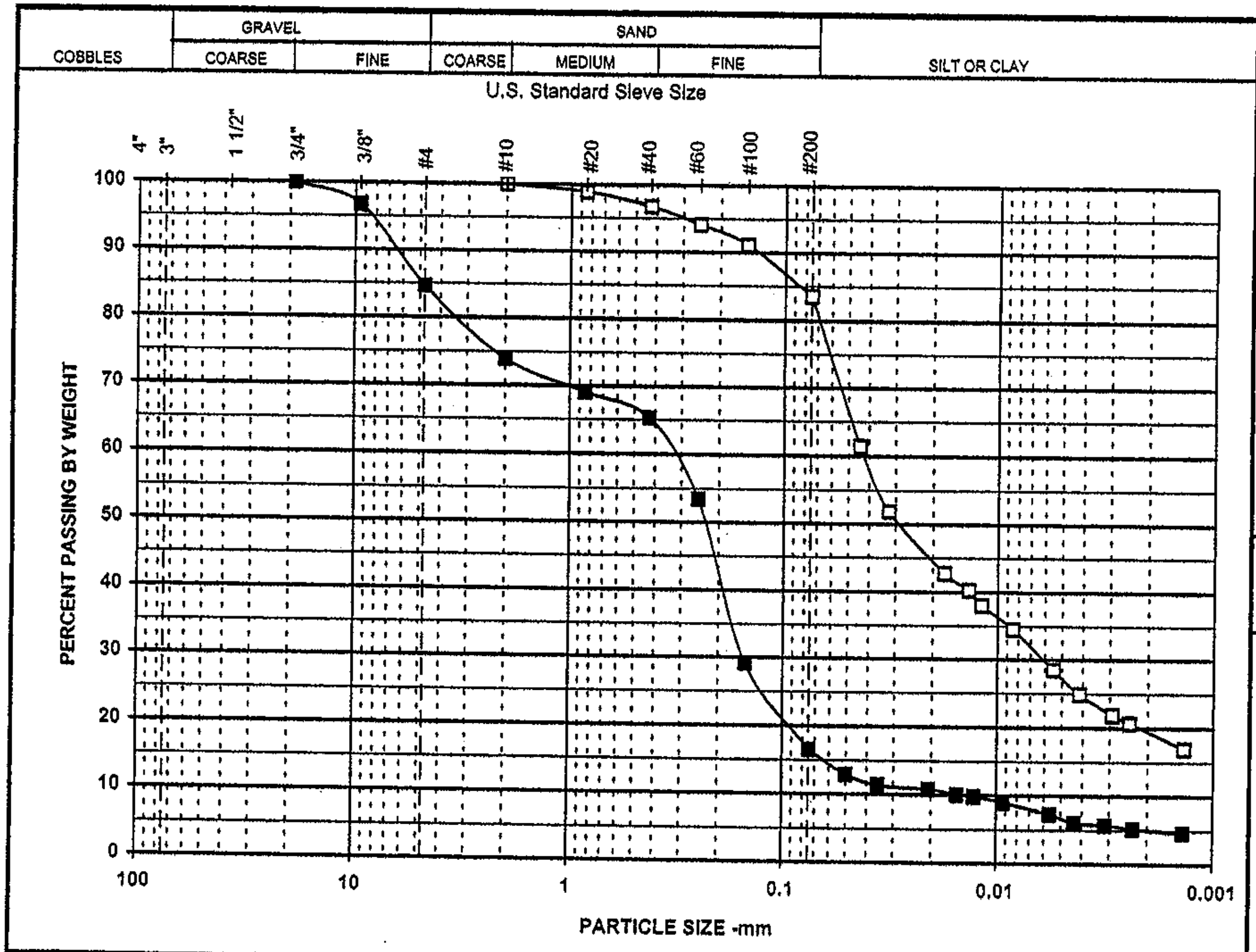
Particle Size	PERCENT FINER		
(Sieve #)	☐	■	○
4"			
3"			
1 1/2"	100.0		
3/4"	89.4		
3/8"	85.7		
4	79.8		
10	73.0	100.0	100.0
20	63.0	99.2	93.3
40	49.8	98.6	77.5
60	39.5	97.8	64.3
100	30.3	90.7	52.7
200	20.8	83.3	39.8

PARTICLE SIZE DISTRIBUTION
Langan #5578403

Project No. 31737700-458	December 2004	Figure

Geotesting Services, Inc.

siev1b.xls 12/09/2004



Symbol	□	■	○
Boring	G-64	G-66	
Sample	U-2	S-4	
Spec	C		
Depth	41.35	25-27	
% +3"			
% Gravel		15.4	
% SAND	16.5	68.1	
% FINES	83.5	16.5	
% -2μ	19	5	
Cc			
Cu			
LL			
PL			
PI			
USCS	CL-OL	SM	
w (%)			

Particle Size (Sieve #)	PERCENT FINER □	■	○
4"			
3"			
1 1/2"			
3/4"		100.0	
3/8"		96.7	
4		84.6	
10	100.0	73.9	
20	98.9	69.0	
40	96.8	65.3	
60	94.1	53.4	
100	91.1	29.2	
200	83.5	16.5	

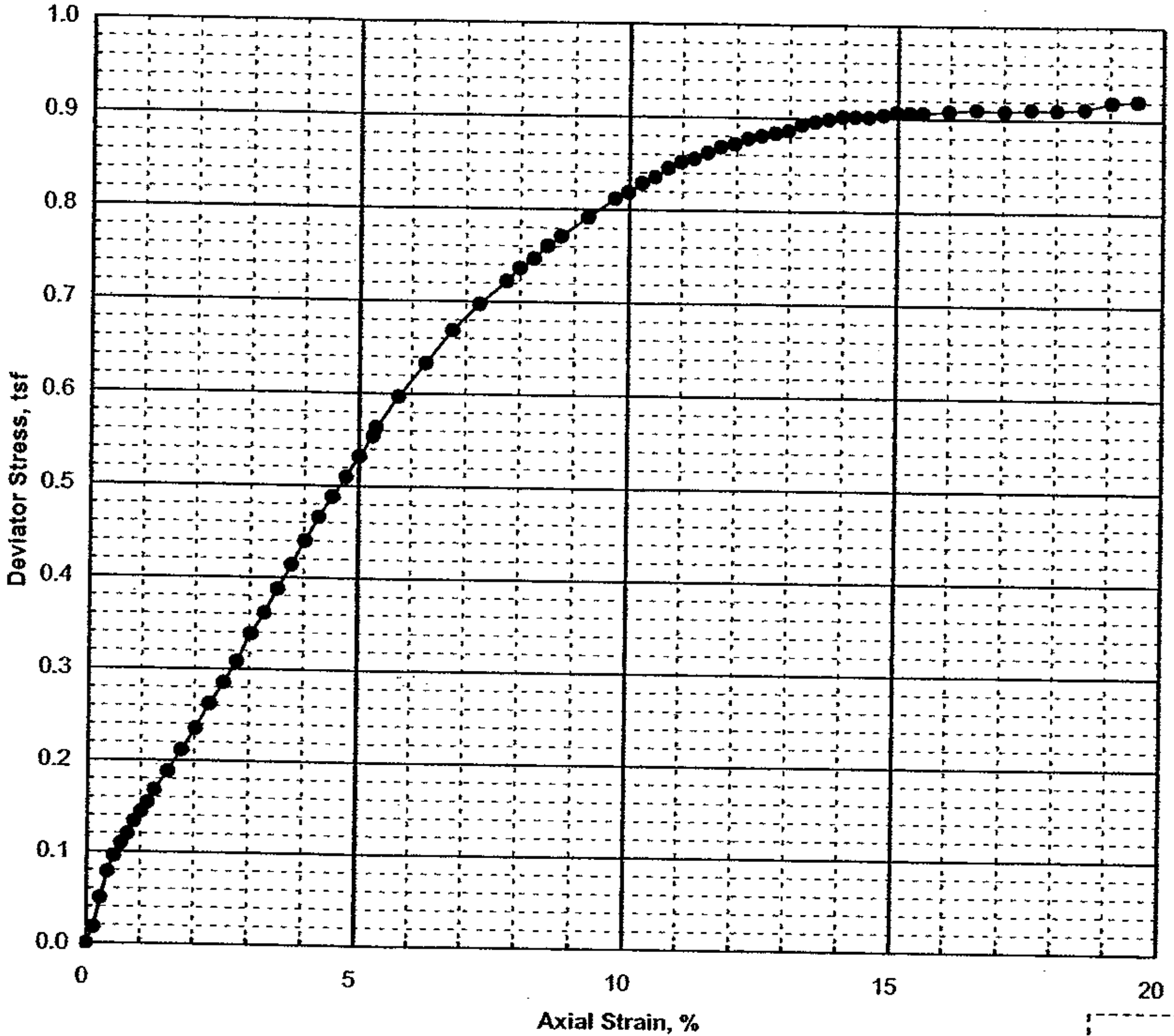
SYMBOL	DESCRIPTION AND REMARKS
□	gray ORGANIC silty CLAY, some m-f sand.
■	brown c-f SAND, some f. gravel, silt.
○	

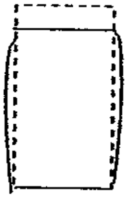
PARTICLE SIZE DISTRIBUTION
Langan #5578403

Project No. 31737700-458	January 2005	Figure

Geotesting Services, Inc.

siev1c.xls 01/05/2005




FAILURE SKETCH

Specimen Information

Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
27.1	27	13	5.977	2.871	122.6	96.5

SC, gray silty clayey, f. SAND, trace m-f sand; shell fragments and organic mat'l noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
1.15	0.25	0.91	15.2	0.75

Project No.
31737700-458

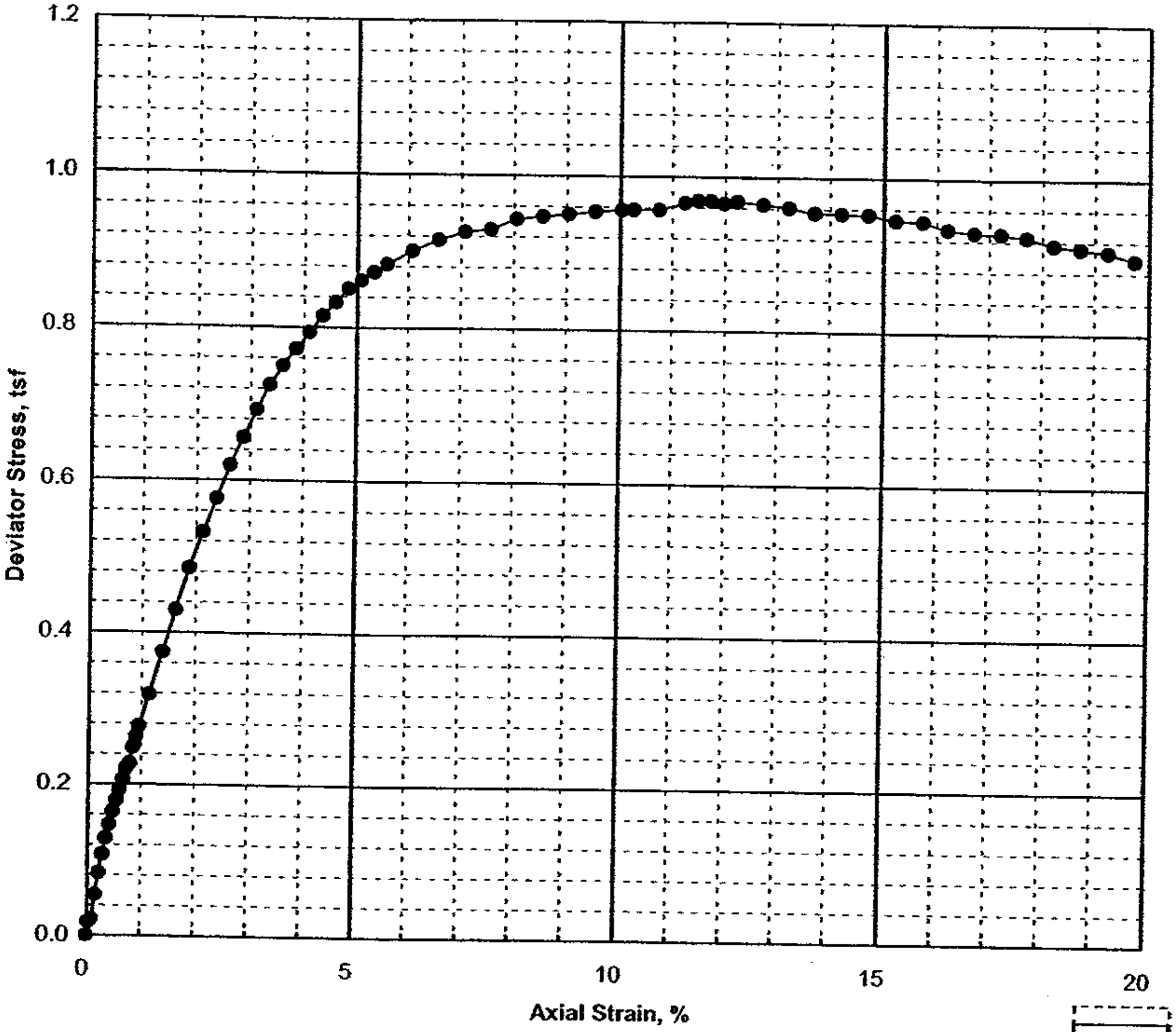
New York Sports and Convention Center

Geotesting Services, Inc.

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Boring No.: G-17 Sample No.: U-2C
Depth (ft): 83.4

January 2005



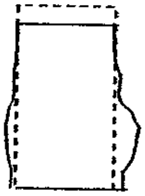
Specimen Information

Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
43.3	43	24	6.007	2.865	110.7	77.3

CL, gray CLAY, trace f. sand; silt lenses and organic mat'l noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.94	0.17	0.97	11.5	0.74



FAILURE SKETCH

Project No.
31737700-458

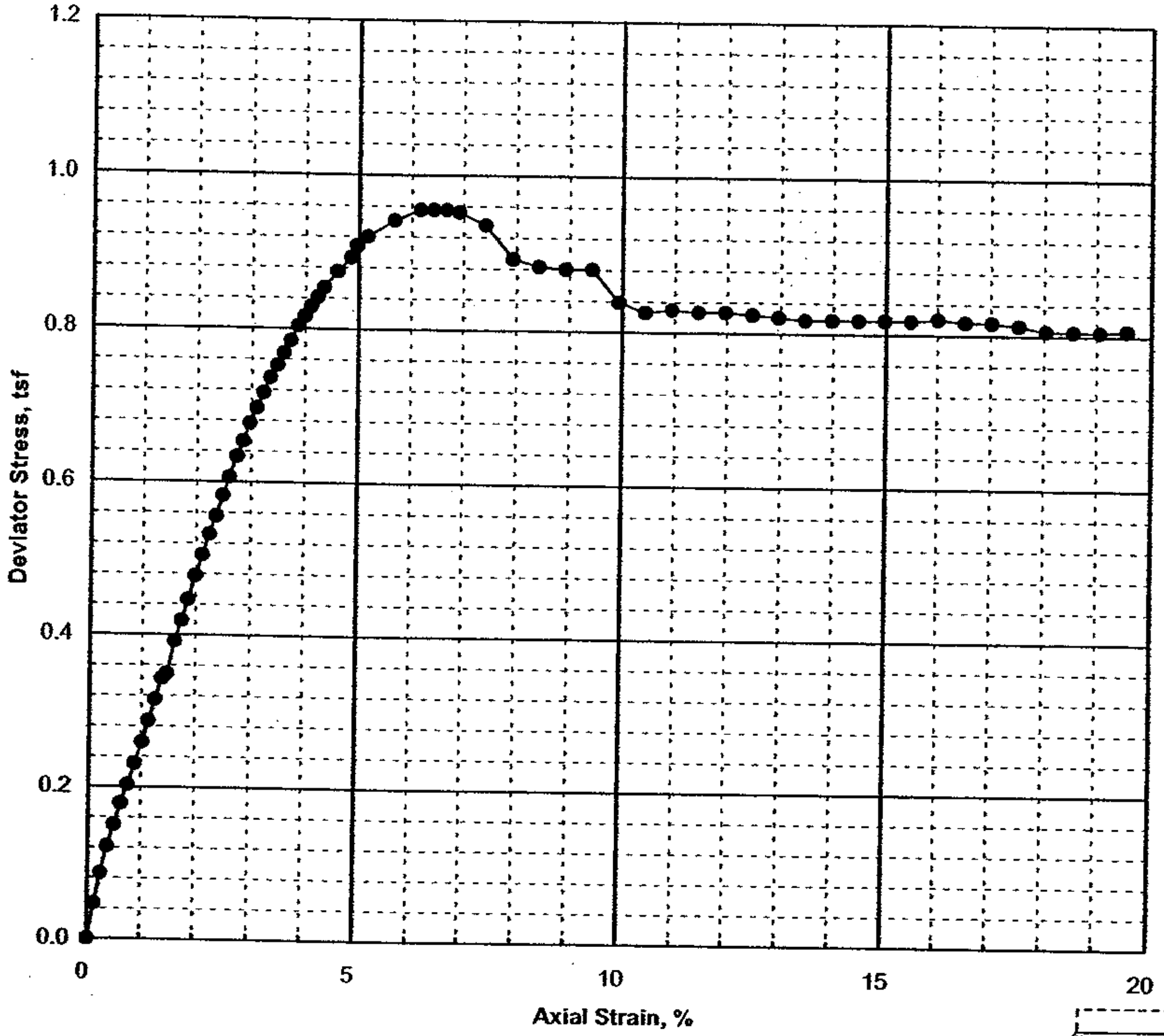
New York Sports and Convention Center

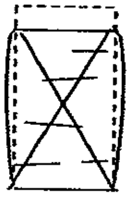
Geotesting Services, Inc.

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Boring No.: G-19 Sample No.: U-2C
Depth (ft): 61.7

January 2005




FAILURE SKETCH

Specimen Information

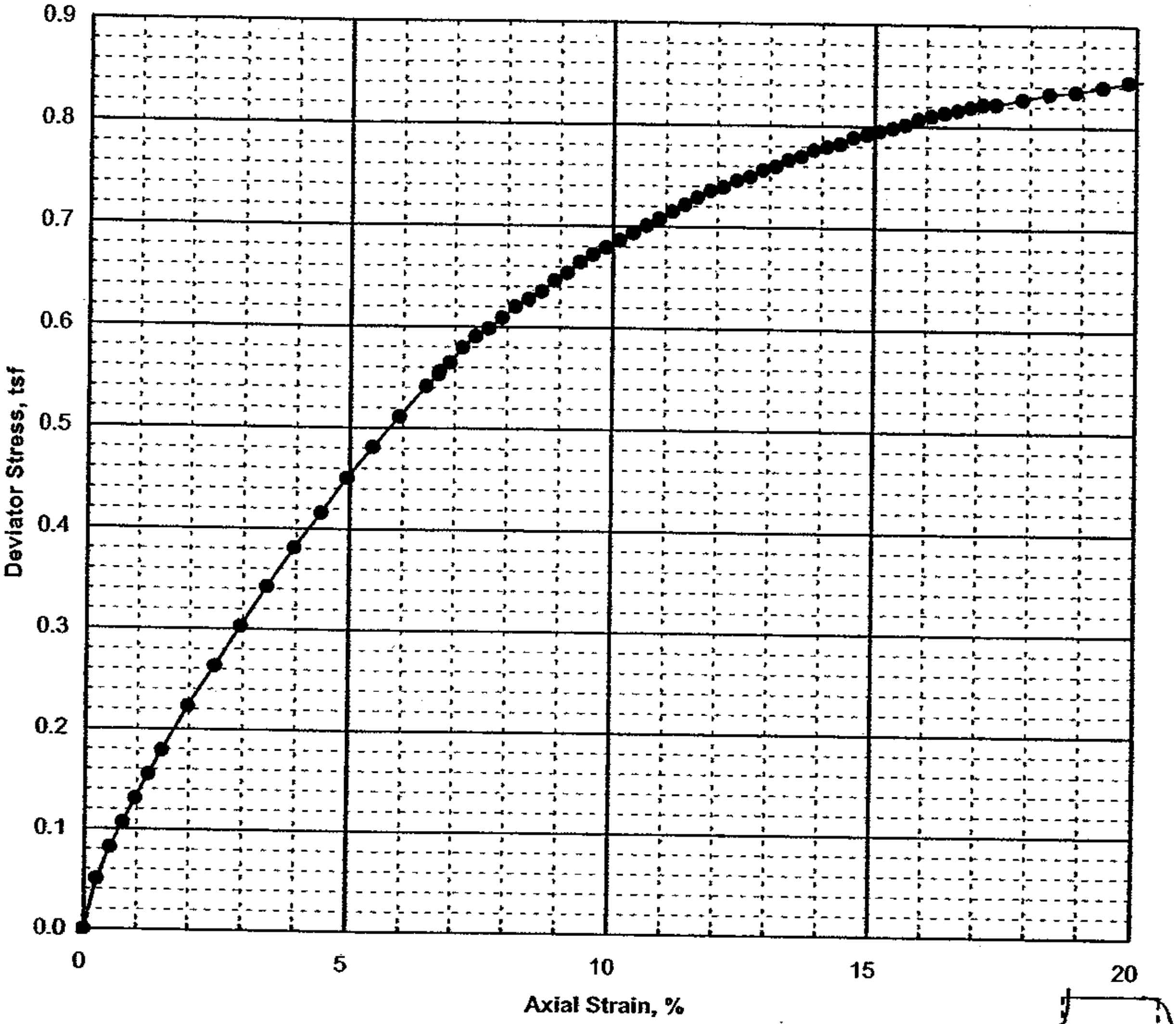
Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
50.1	50	29	5.963	2.864	106.5	71.0

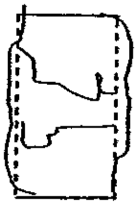
CH, gray VARVED CLAY, trace f. sand.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.94	0.17	0.96	6.7	0.75

Project No. 31737700-458	New York Sports and Convention Center	UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST Boring No.: G-27 Sample No.: U-2B Depth (ft): 55.8	January 2005
Geotesting Services, Inc.			





FAILURE SKETCH

Specimen Information

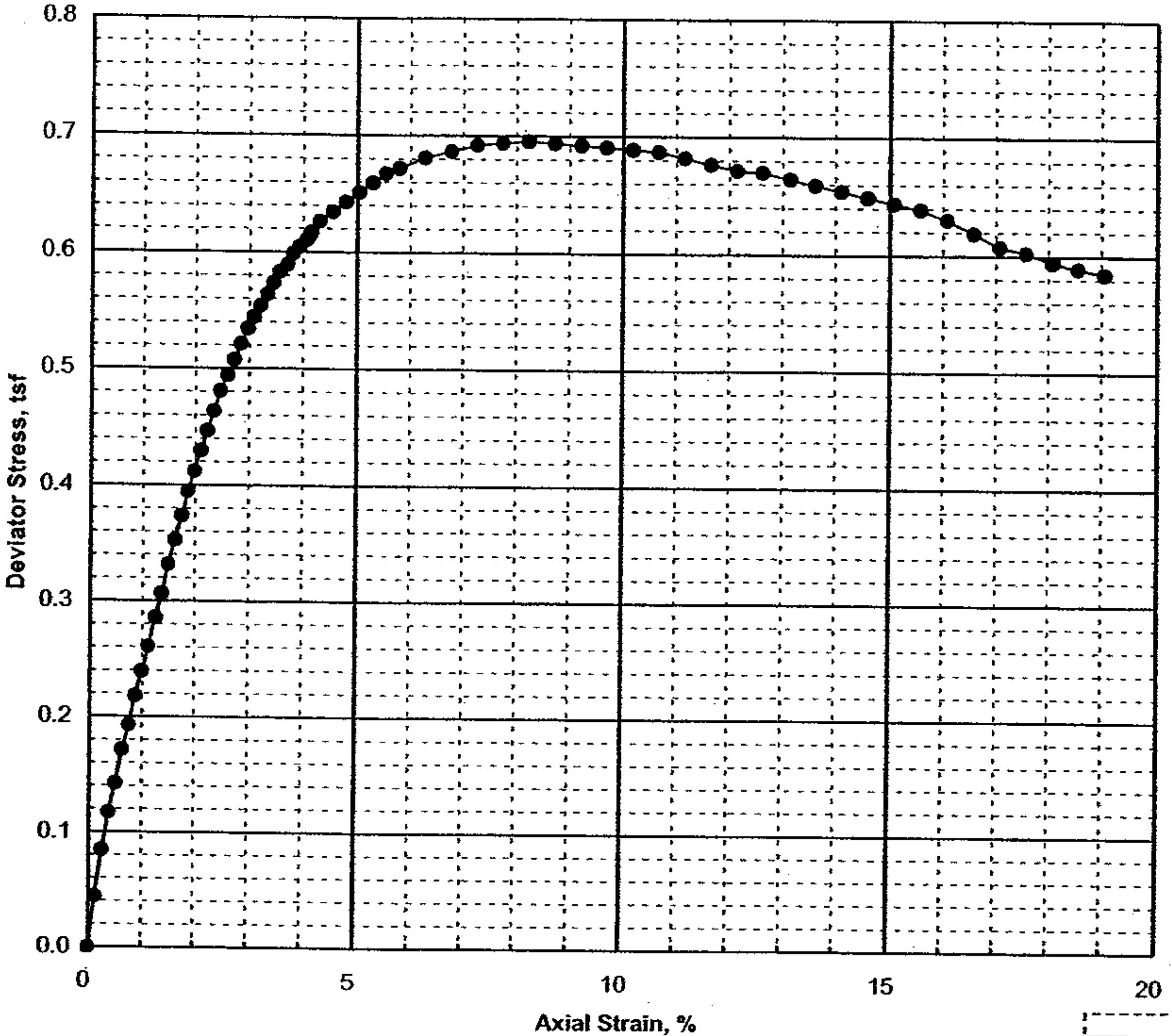
Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
23.7	22	6	5.983	2.855	129.1	104.3

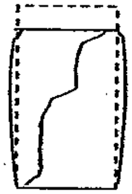
CL-ML, gray sandy silty CLAY, trace f. gravel.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.94	0.07	0.80	15.1	0.73

Project No. 31737700-458	**New York Sports and Convention Center**	**UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST** Boring No.: G-30 Sample No.: U-2B Depth (ft): 50.55	
Geotesting Services, Inc.			January 2005





FAILURE SKETCH

Specimen Information

Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
63.8			6.034	2.831	100.3	61.3

CH-OH, gray ORGANIC CLAY, trace f. sand.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.58	0.12	0.70	8.2	0.74

Project No.
31737700-458

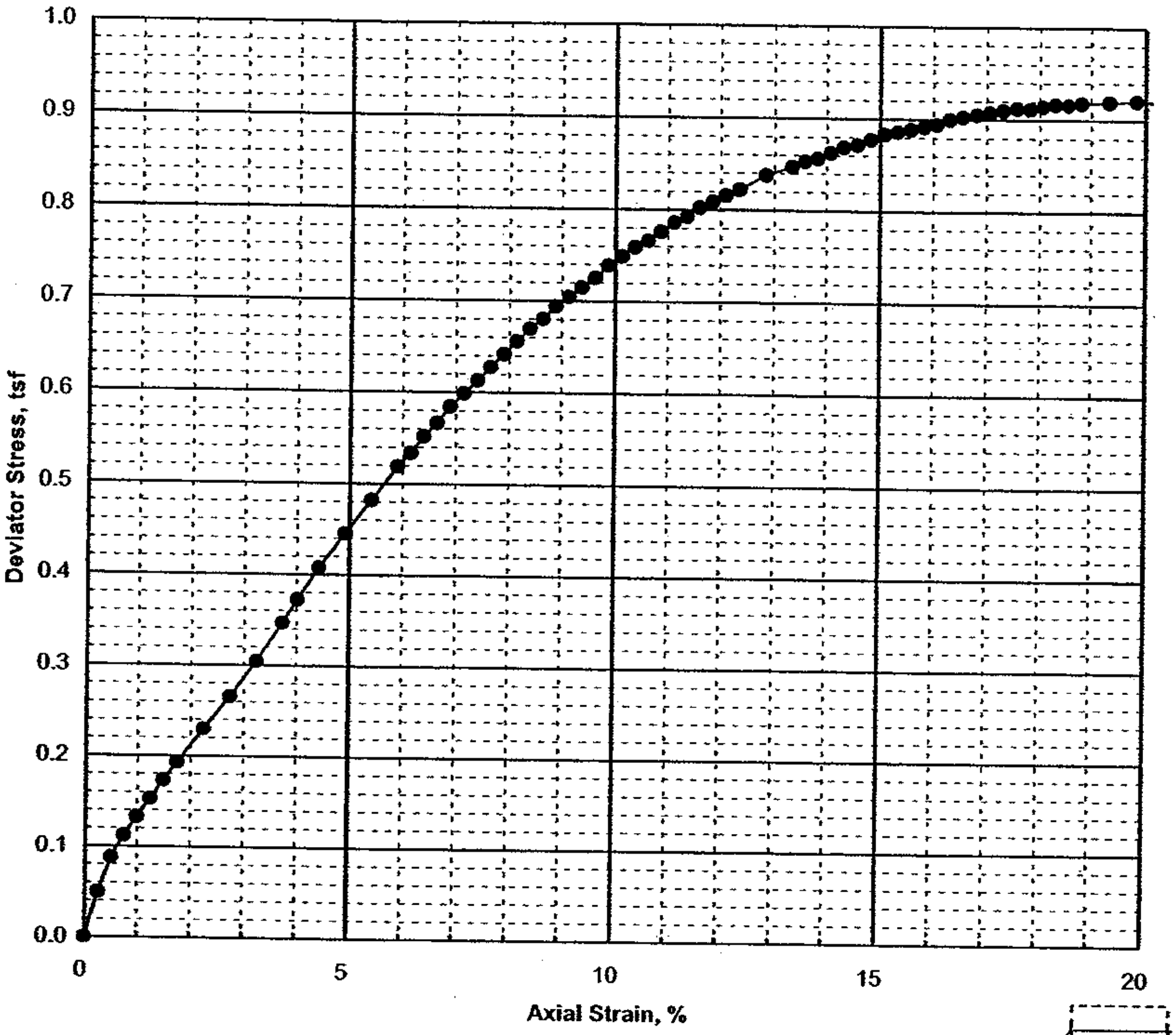
New York Sports and Convention Center

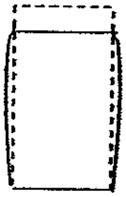
Geotesting Services, Inc.

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Boring No.: G-31 Sample No.: U-1B
Depth (ft): 21.15

January 2005





FAILURE SKETCH

Specimen Information

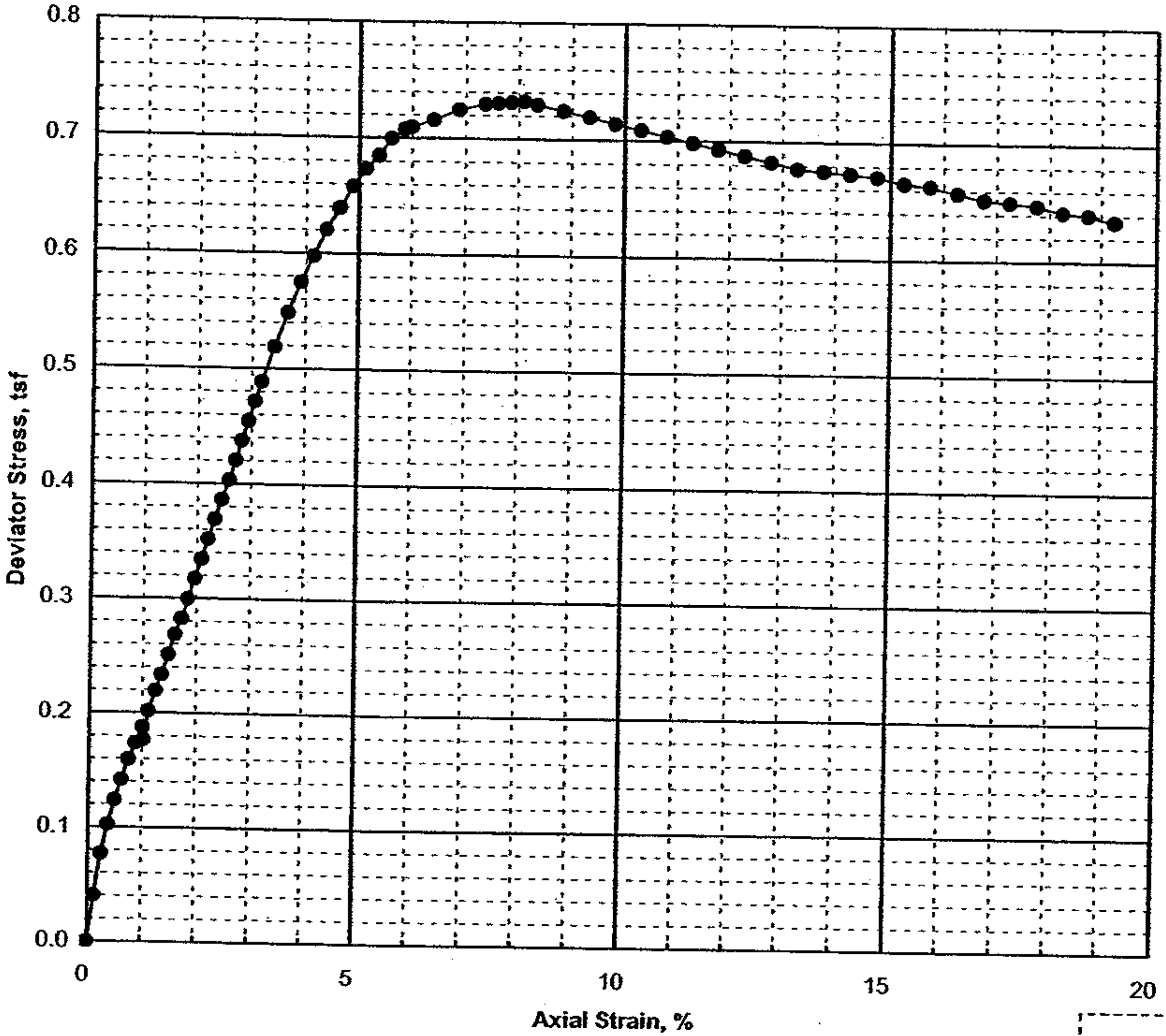
Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
30.8			6.009	2.875	120.7	92.3

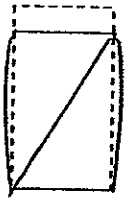
CL, gray silty CLAY, trace f. sand; shell fragments and organic mat'l noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.86	0.18	0.88	15.1	0.74

Project No. 31737700-458	New York Sports and Convention Center	UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST Boring No.: G-48 Sample No.: U-3B Depth (ft): 61.05	January 2005
Geotesting Services, Inc.			




FAILURE SKETCH

Specimen Information

Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
56.6			6.022	2.833	103.7	66.3

CH-OH, gray ORGANIC CLAY, trace f. sand; shell fragments noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.58	0.08	0.73	8.1	0.73

Project No.
31737700-458

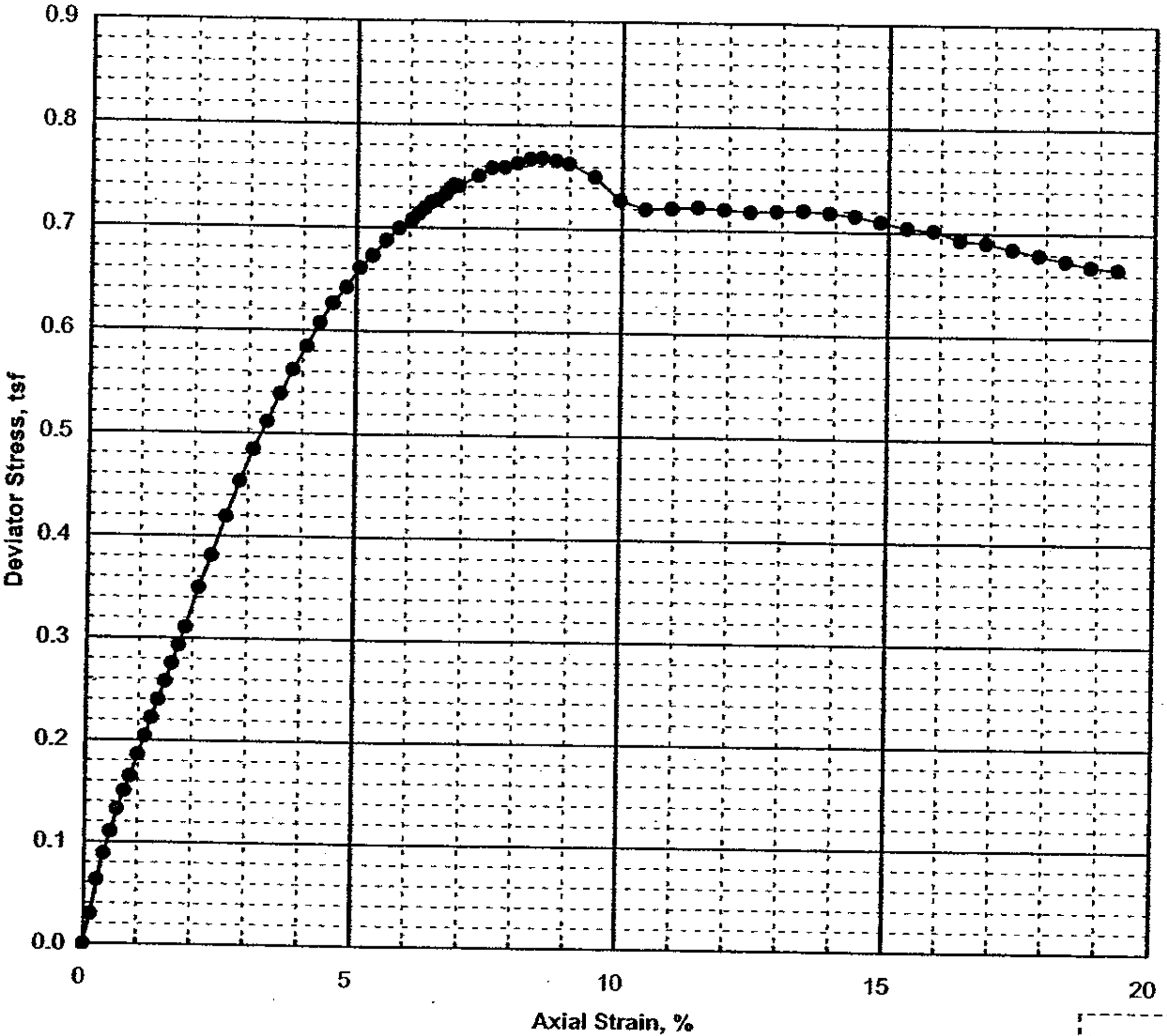
New York Sports and Convention Center

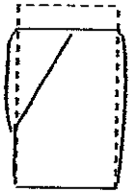
Geotesting Services, Inc.

UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST

Boring No.: G-49 Sample No.: U-1C
Depth (ft): 31.3

January 2005





FAILURE SKETCH

Specimen Information

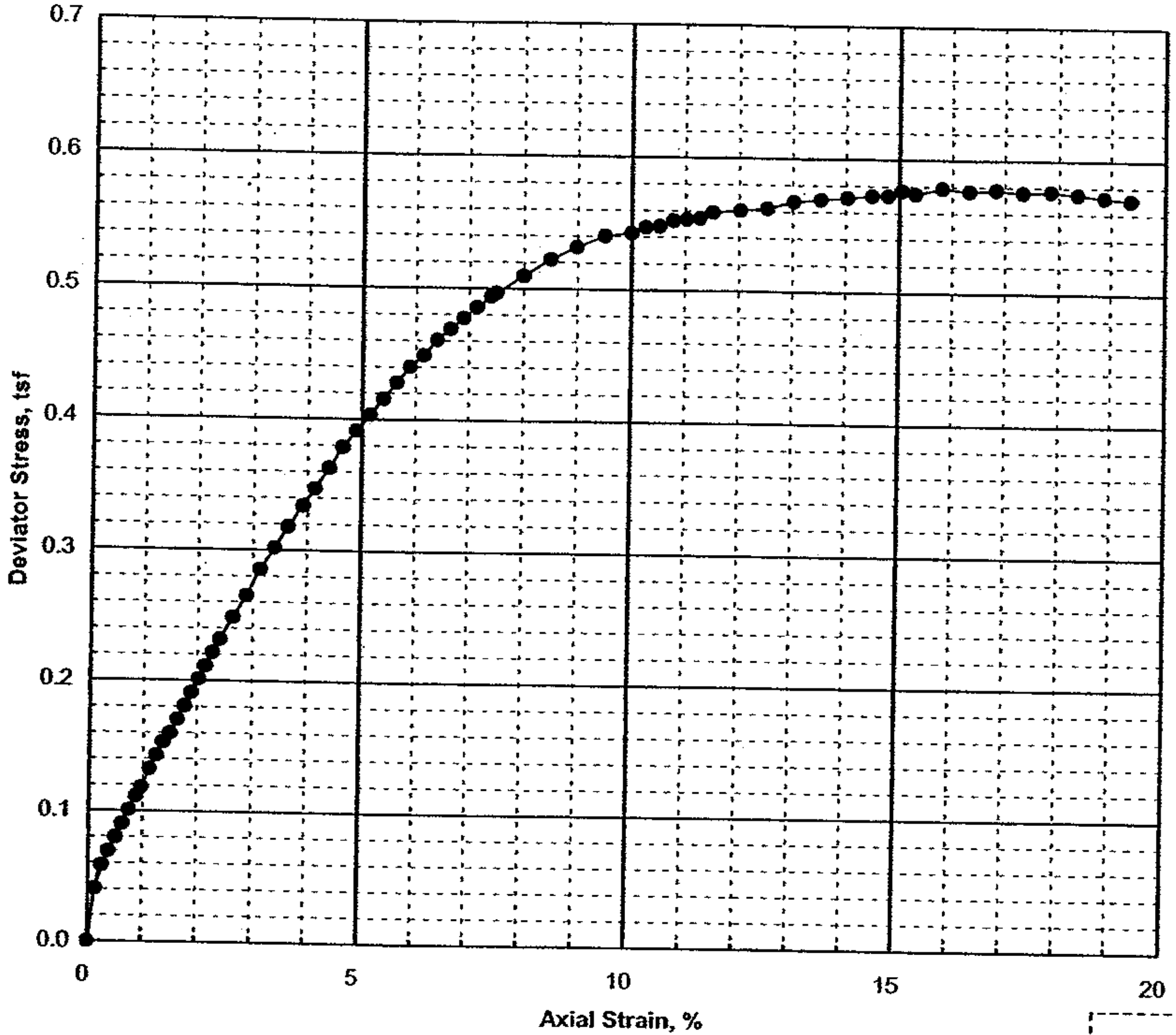
Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
49.5	60	38	6.007	2.816	105.1	70.3

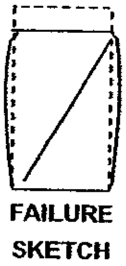
CH-OH, gray ORGANIC VARVED CLAY, trace f. sand.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.86	0.12	0.77	8.5	0.74

Project No. 31737700-458	New York Sports and Convention Center	**UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST** Boring No.: G-62 Sample No.: U-1C Depth (ft): 46.5	January 2005
Geotesting Services, Inc.			





Specimen Information

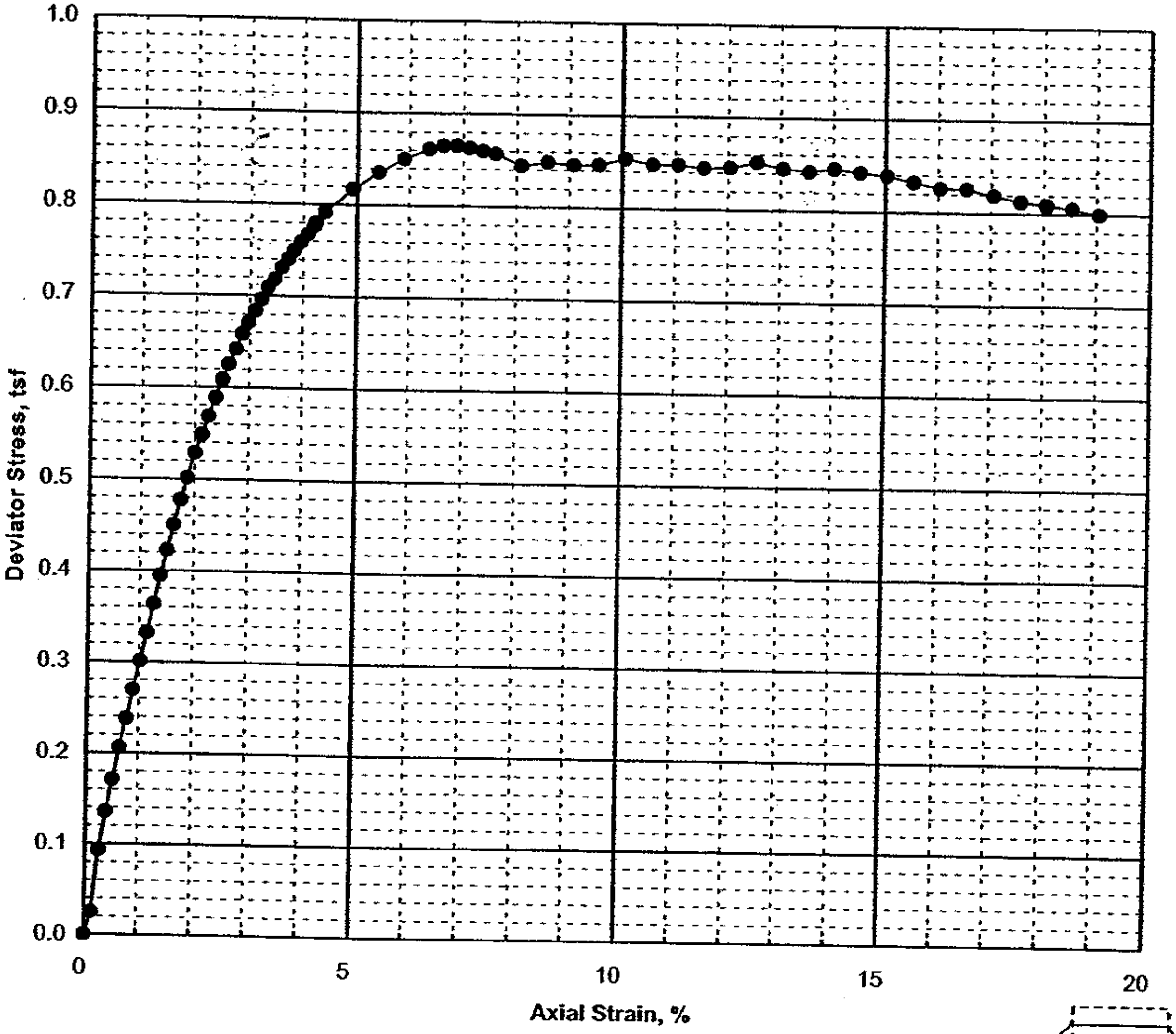
Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
34.1	30	14	5.843	2.835	118.5	88.4

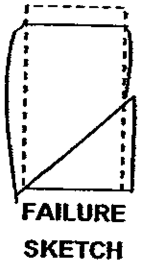
CL, gray silty CLAY, trace f. sand; numerous shell fragments noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
1.01	0.14	0.58	15.1	0.76

Project No. 31737700-458	New York Sports and Convention Center	UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST Boring No.: G-62 Sample No.: U-2C Depth (ft): 61.7	
Geotesting Services, Inc.			January 2005





Specimen Information

Water Content (%)	LL	PI	Length (inch)	Diameter (inch)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)
46.4			6.011	2.870	108.1	73.8

CL, gray silty CLAY, some m-f sand; shell fragments noted.

Test Summary

Cell Pressure (tsf)	Axial Strain during confinement (%)	Compressive Strength (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.65	0.22	0.87	6.9	0.74

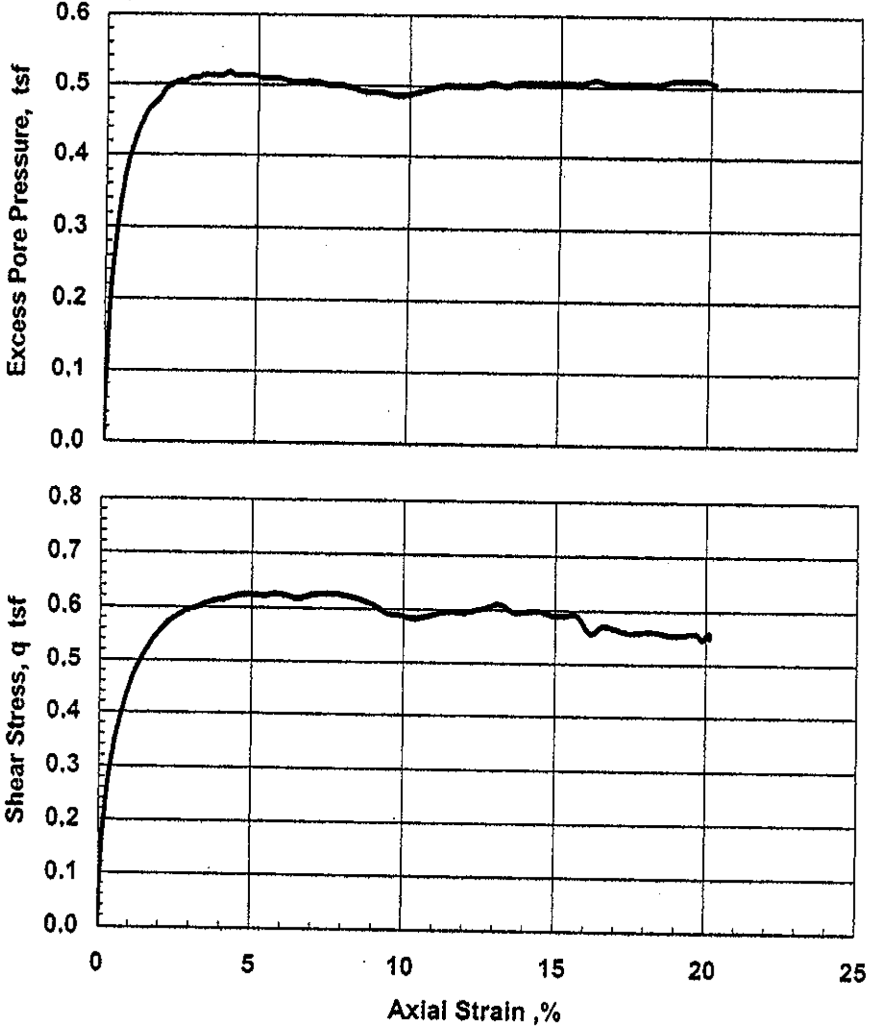
Project No.
31737700-458

New York Sports
and Convention Center

Geotesting Services, Inc.

UNCONSOLIDATED-UNDRAINED
TRIAXIAL COMPRESSION TEST
Boring No.: G-64 Sample No.: U-2C
Depth (ft): 41.35

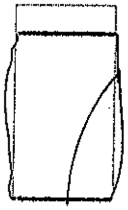
January 2005



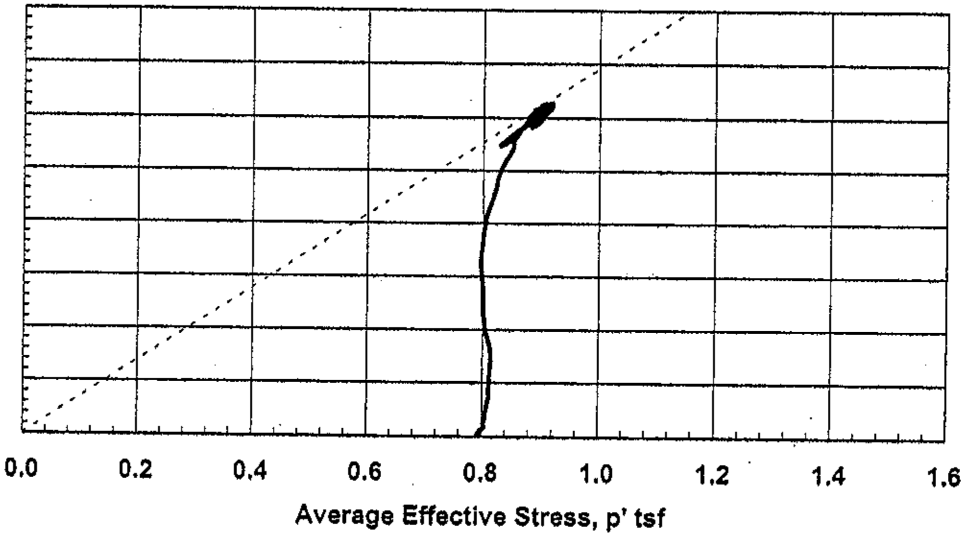
SAMPLE INFORMATION
Boring: G-30 Sample: U-1B Depth: 40.85ft
Type: Undisturbed
Description: CH-OH, gray ORGANIC VARVED CLAY, trace f. sand.
LL = 52 PL = 19 PI = 33

SPECIMEN INFORMATION (Initial)
Height: 6.02 Inch Diameter: 2.86 inch Area: 6.41 in²
Water Content: 51.5 % Total Unit Weight: 106.9 pcf

TEST SUMMARY
Consolidation Stresses: 0.79 tsf vertical, 0.79 tsf lateral
Water Content: 48.6 % Total Unit Weight: 108.0 pcf
B Coefficient: 98 Strain Rate: 0.017 %/min
Peak Shear Strength: 0.63 tsf @ 7.3 % Strain
Peak Effective Friction Angle: 43.8°


Failure Sketch

REMARKS:



Test by: DT

Checked by: CMO

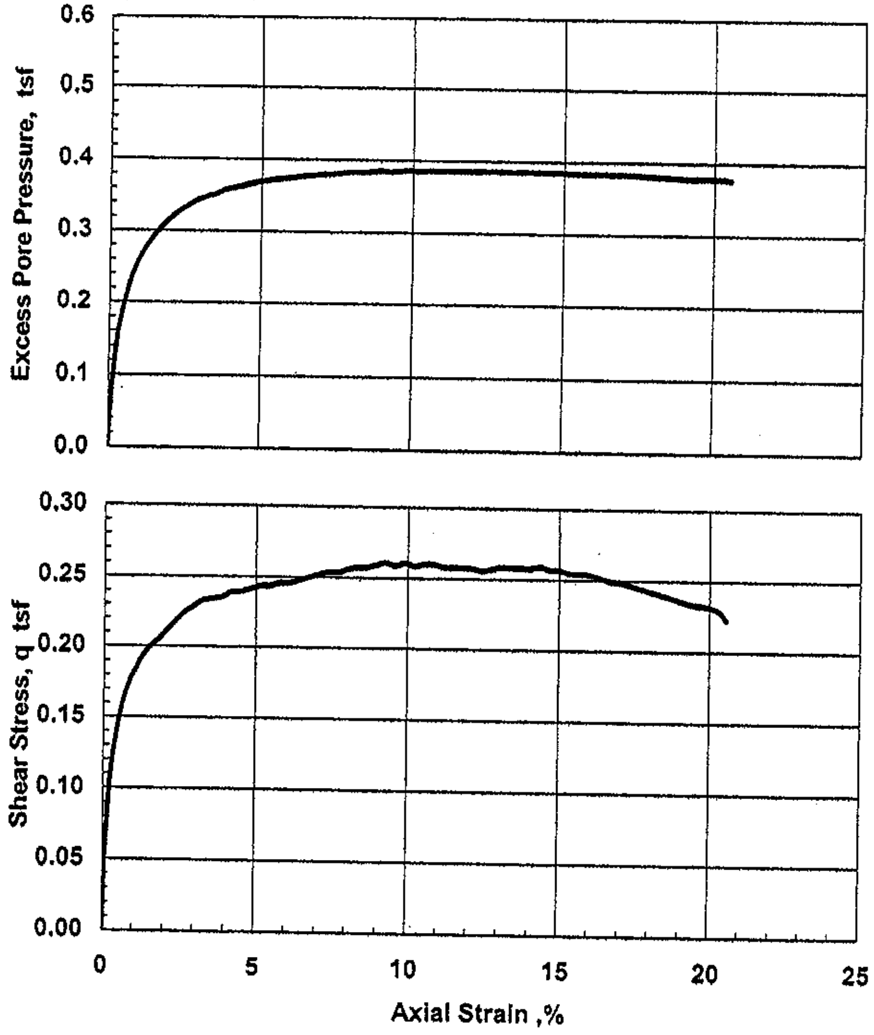
Project No.
31737700-458

New York Sports
and Convention Center

Geotesting Services, Inc.

CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION
with Pore Pressure Measurements
Boring G-30 Sample U-1B

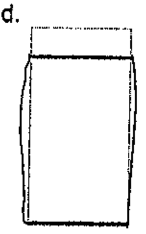
January-05



SAMPLE INFORMATION
Boring: G-48 Sample: U-2B Depth: 26.1ft
Type: Undisturbed
Description: CH-OH, gray ORGANIC CLAY, trace f. sand; silt layers noted.
LL = 80 PL = 29 PI = 51

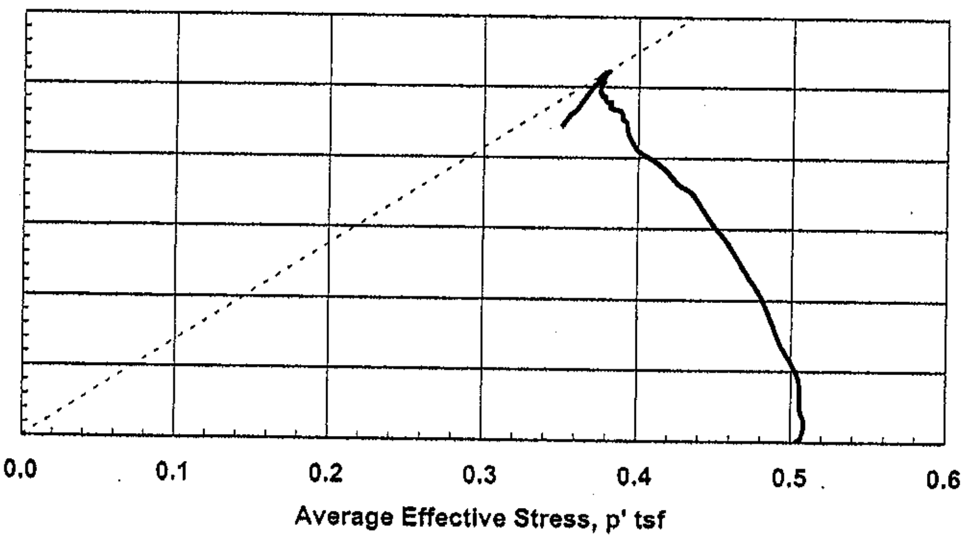
SPECIMEN INFORMATION (Initial)
Height: 6.01 inch Diameter: 2.78 inch Area: 6.07 in²
Water Content: 69.4 % Total Unit Weight: 100.3 pcf

TEST SUMMARY
Consolidation Stresses: 0.50 tsf vertical, 0.50 tsf lateral
Water Content: 60.5 % Total Unit Weight: 102.9 pcf
B Coefficient: 99.5 Strain Rate: 0.018 %/min
Peak Shear Strength: 0.26 tsf @ 9.3 % Strain
Peak Effective Friction Angle: 43.5°



Failure Sketch

REMARKS:



Test by: DT
Checked by: UWB

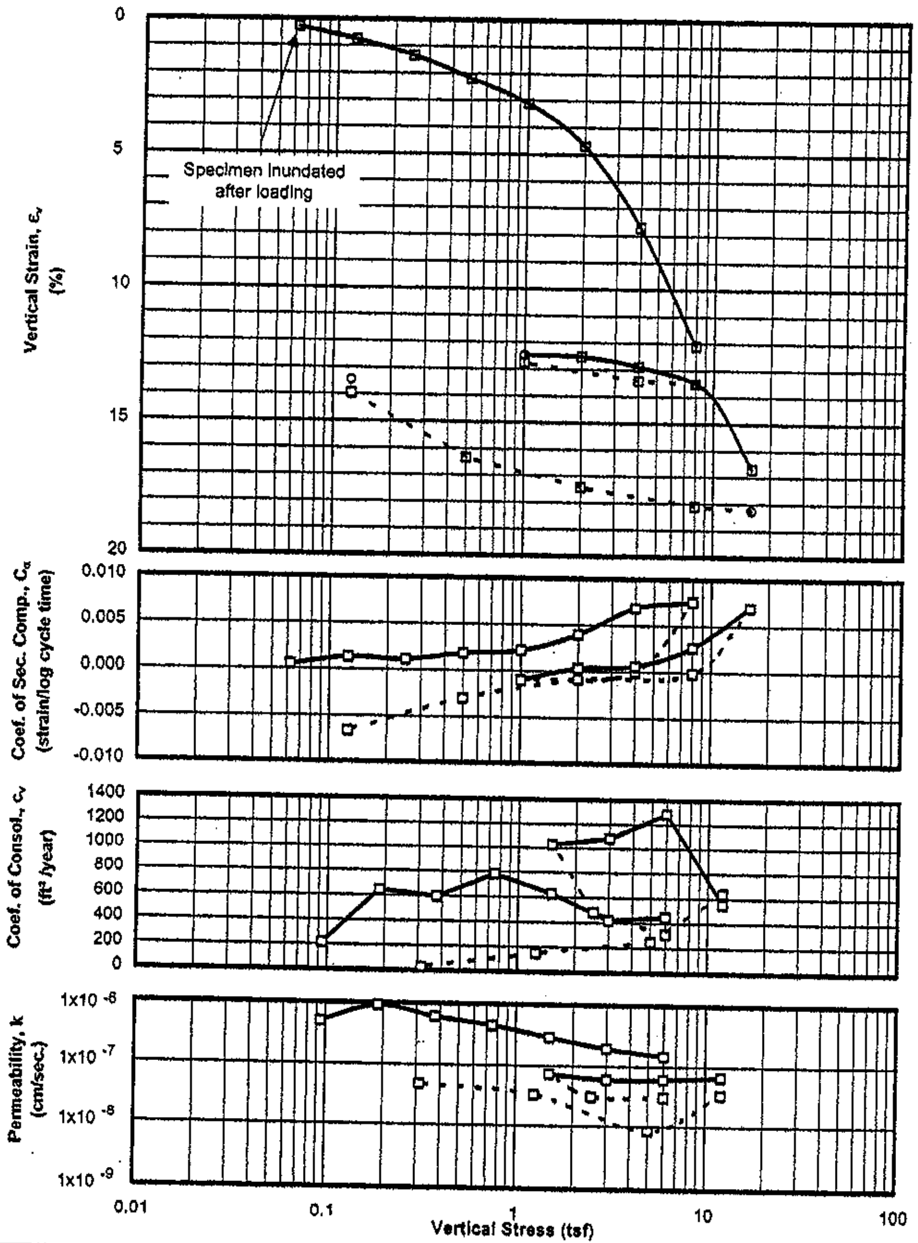
Project No.
31737700-458

New York Sports
and Convention Center

Geotesting Services, Inc.

CONSOLIDATED UNDRAINED
TRIAXIAL COMPRESSION
with Pore Pressure Measurements
Boring G-48 Sample U-2B

January-05



SAMPLE INFORMATION

Boring:	G-27
Sample:	U-1C
Depth:	46.40 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	CL, gray CLAY, trace f. sand; numerous shell fragments noted, LL = 49, PL = 22, PI = 27

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.63	inch
Diameter:	2.50	inch
Initial water content:	42.3	%
Initial total unit weight:	111.1	pcf
Initial dry unit weight:	78.1	pcf
Initial void ratio:	1.159	
Initial degree of saturation:	98	%
Final water content:	37.7	%
Final total unit weight:	115.1	pcf
Final dry unit weight:	83.6	pcf
Final void ratio:	1.016	
Final degree of saturation:	100	% (assumed specific gravity = 2.70)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	2.9 (Range: 2.5 to 3.2)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.149
Compression Index (void ratio per log cycle stress):	0.322
Swell Ratio (strain per log cycle stress):	0.011
Swell Index (void ratio per log cycle stress):	0.024
Recompression Ratio (strain per log cycle stress):	0.012
Recompression Index (void ratio per log cycle stress):	0.026
Remarks:	

LEGEND: ☐ End of primary ○ End of Stage ———— Loading -------- Unloading

Test Date: 12/9/04 Tested By: RV Checked By: CWS

Langan #35578403	New York Sports and Convention Center	ONE DIMENSIONAL CONSOLIDATION TEST Boring: G-27 Depth: 46.40 feet
Geotesting Services, Inc.	Project No. 31737700-458	January 2005 Fig.

GSI Analysis File: Conv30.xls

C04255.xls

01/06/2005

PROJECT: New York Sports and Convention Center
PROJECT NO.: 31737700-458
BORING: G-27
SAMPLE: U-1C
TEST: C04255
DEPTH, feet: 46.4
BY: RV
TEST DATE: 12/09/2004

Initial height: 0.635 inch
Initial water content: 42.3 %
Initial dry density: 78.1 pcf
Initial total density: 111.1 pcf
Initial saturation: 98 %
Initial void ratio: 1.159

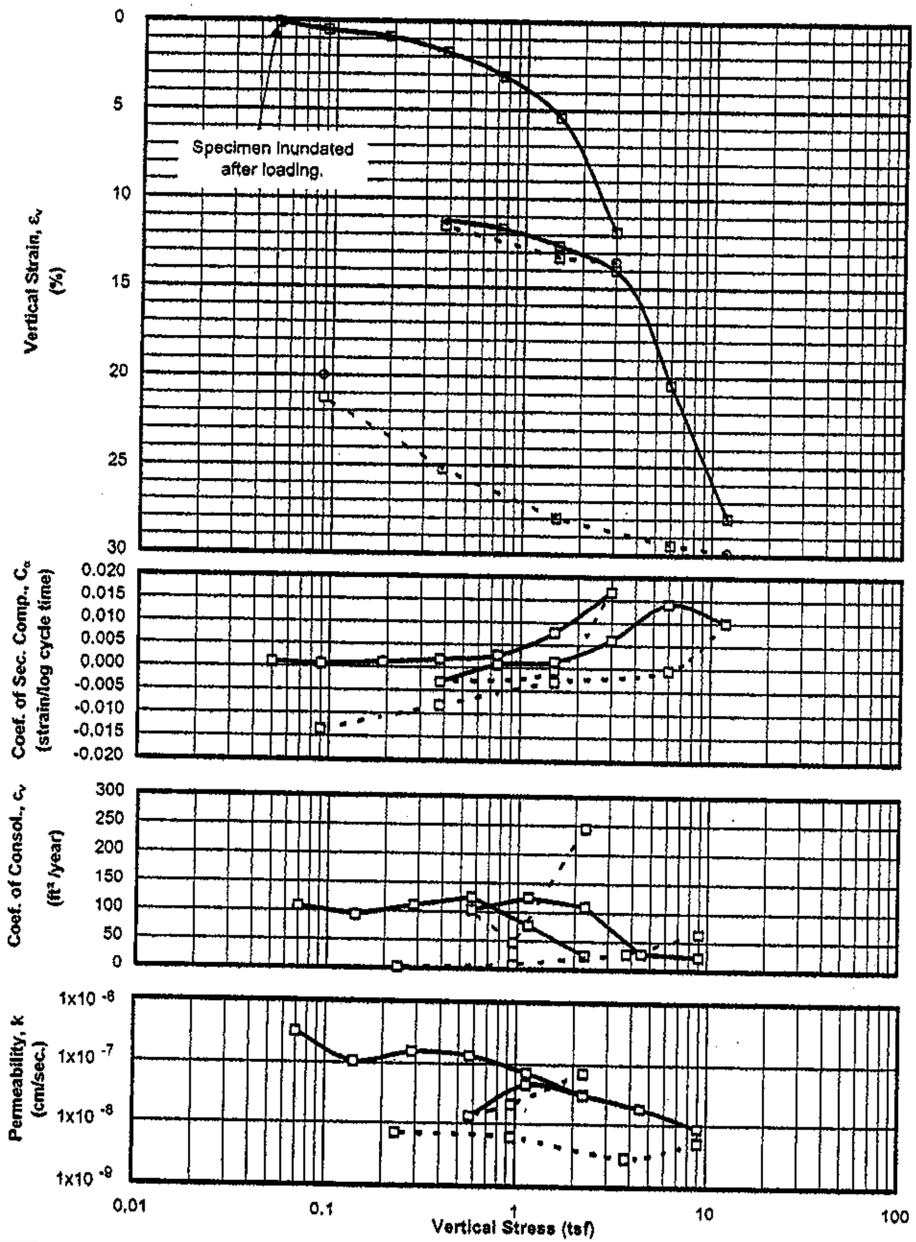
Final height: 0.593 inch
Final water content: 37.7 %
Final dry density: 83.6 pcf
Final total density: 115.1 pcf
Final saturation: 100 %
Final void ratio: 1.016
Final strain: 6.6 %

EQUIPMENT:
Load Frame No.: 4
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CL, gray CLAY, trace f. sand;
numerous shell fragments noted.

G	LL	PL	PI
2.7	49	22	27

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0018	0.290	1.153	0.299	1.152	186.14	0.0005	21.56	2.60E-07
2	0.125	0.0049	0.770	1.142	1.075	1.136	211.17	0.0013	13.01	4.90E-07
3	0.250	0.0086	1.357	1.130	1.581	1.125	643.01	0.0011	21.32	9.10E-07
4	0.500	0.0140	2.204	1.111	2.576	1.103	593.76	0.0018	29.52	6.07E-07
5	1.00	0.0199	3.141	1.091	3.636	1.080	780.56	0.0022	53.35	4.41E-07
6	2.00	0.0297	4.675	1.058	5.516	1.040	626.94	0.0039	65.18	2.90E-07
7	4.00	0.0491	7.734	0.992	9.058	0.963	415.93	0.0069	65.39	1.92E-07
8	8.00	0.0768	12.103	0.898	13.522	0.867	445.28	0.0076	91.55	1.47E-07
9	4.00	0.0851	13.409	0.869	13.402	0.870	310.77	-0.0001	306.24	3.06E-08
10	1.00	0.0810	12.762	0.883	12.484	0.889	479.60	-0.0010	463.63	3.12E-08
11	2.00	0.0795	12.526	0.888	12.617	0.887	1027.25	0.0003	424.48	7.30E-08
12	4.00	0.0818	12.892	0.881	13.129	0.875	1079.08	0.0006	546.40	5.96E-08
13	8.00	0.0858	13.513	0.867	14.562	0.845	1283.66	0.0026	644.31	6.01E-08
14	16.0	0.1060	16.703	0.798	18.246	0.765	551.18	0.0070	250.79	6.63E-08
15	8.00	0.1149	18.108	0.768	18.069	0.769	636.91	-0.0002	569.51	3.37E-08
16	2.00	0.1106	17.432	0.783	17.297	0.785	246.02	-0.0009	887.59	8.36E-09
17	0.500	0.1038	16.349	0.806	15.925	0.815	150.82	-0.0030	138.52	3.28E-08
18	0.125	0.0886	13.965	0.857	13.469	0.868	24.61	-0.0067	15.73	4.72E-08



SAMPLE INFORMATION

Boring:	G-31
Sample:	U-1C
Depth:	21.70 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	CH-OH, gray ORGANIC CLAY, trace f. sand.

LL = 83, PL = 30, PI = 53

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.62	inch
Diameter:	2.50	inch
Initial water content:	66.2	%
Initial total unit weight:	99.6	pcf
Initial dry unit weight:	60.0	pcf
Initial void ratio:	1.728	
Initial degree of saturation:	100	%
Final water content:	51.2	%
Final total unit weight:	105.5	pcf
Final dry unit weight:	69.8	pcf
Final void ratio:	1.344	
Final degree of saturation:	100	% (assumed specific gravity = 2.62)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	1.8 (Range: 1.6 to 1.9)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.286
Compression Index (void ratio per log cycle stress):	0.780
Swell Ratio (strain per log cycle stress):	0.029
Swell Index (void ratio per log cycle stress):	0.079
Recompression Ratio (strain per log cycle stress):	0.031
Recompression Index (void ratio per log cycle stress):	0.085
Remarks:	

LEGEND: ☐ End of primary ○ End of Stage ——— Loading - - - - - - - Unloading

Test Date: 12/8/04 Tested By: RV Checked By: MS

Langan #35578403	New York Sports and Convention Center	ONE DIMENSIONAL CONSOLIDATION TEST Boring: G-31 Depth: 21.70 feet
Geotesting Services, Inc.	Project No. 31737700-458	January 2005 Fig.

PROJECT: New York Sports and Convention Center
PROJECT NO.: 31737700-458
BORING: G-31
SAMPLE: U-1C
TEST: C04252
DEPTH, feet: 21.7
BY: RV
TEST DATE: 12/08/2004

Initial height: 0.623 inch
Initial water content: 66.2 %
Initial dry density: 60.0 pcf
Initial total density: 99.6 pcf
Initial saturation: 100 %
Initial void ratio: 1.728

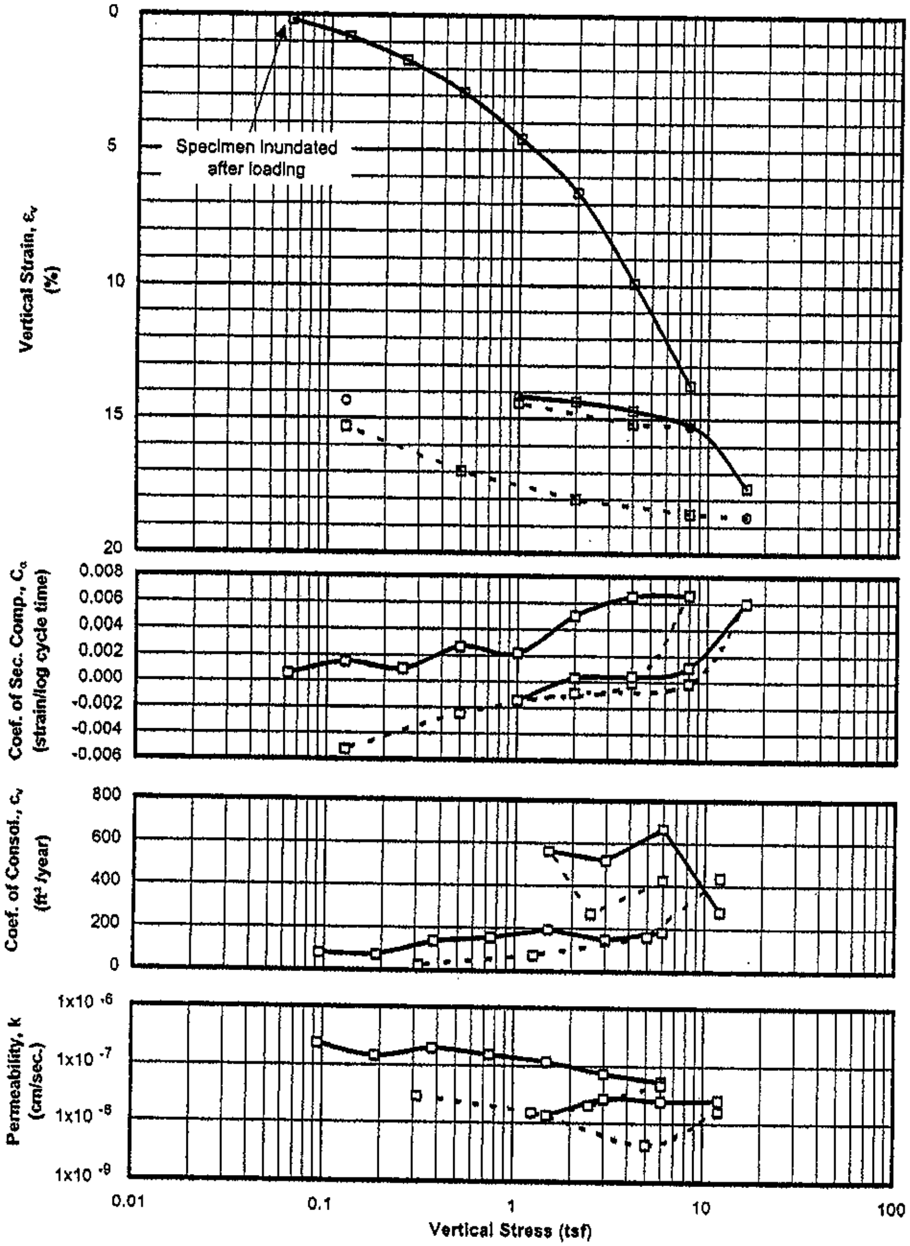
Final height: 0.534 inch
Final water content: 51.2 %
Final dry density: 69.8 pcf
Final total density: 105.5 pcf
Final saturation: 100 %
Final void ratio: 1.344
Final strain: 14.3 %

EQUIPMENT:
Load Frame No.: 2
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH-OH, gray ORGANIC CLAY, trace f. sand.

G	LL	PL	PI
2.62	83	30	53

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.050	0.0007	0.114	1.725	0.131	1.724	589.25	0.0009	43.87	4.05E-07
2	0.090	0.0032	0.510	1.714	0.569	1.712	107.32	0.0006	10.10	3.21E-07
3	0.190	0.0055	0.887	1.704	1.068	1.699	93.44	0.0010	26.55	1.06E-07
4	0.380	0.0111	1.776	1.680	1.984	1.674	110.39	0.0017	21.38	1.56E-07
5	0.760	0.0195	3.136	1.642	3.511	1.632	125.18	0.0026	27.93	1.35E-07
6	1.51	0.0337	5.417	1.580	6.276	1.557	77.39	0.0077	32.89	7.10E-08
7	3.00	0.0737	11.841	1.405	13.527	1.359	24.27	0.0167	23.19	3.16E-08
8	1.51	0.0828	13.287	1.366	13.185	1.368	244.34	-0.0006	103.01	7.16E-08
9	0.380	0.0719	11.546	1.413	11.225	1.422	46.12	-0.0033	64.88	2.14E-08
10	0.760	0.0729	11.708	1.409	11.803	1.406	103.33	0.0006	234.24	1.33E-08
11	1.51	0.0787	12.633	1.383	12.793	1.379	124.82	0.0012	81.09	4.64E-08
12	3.00	0.0873	14.016	1.346	14.737	1.326	109.64	0.0061	107.71	3.07E-08
13	6.00	0.1273	20.444	1.170	22.880	1.104	28.51	0.0141	46.67	1.84E-08
14	12.0	0.1740	27.932	0.966	29.895	0.912	22.78	0.0100	80.12	8.58E-09
15	6.00	0.1836	29.474	0.924	29.349	0.927	63.54	-0.0005	389.14	4.93E-09
16	1.51	0.1742	27.977	0.965	27.681	0.973	28.08	-0.0031	299.86	2.83E-09
17	0.380	0.1569	25.196	1.041	24.451	1.061	7.83	-0.0083	40.64	5.81E-09
18	0.090	0.1324	21.260	1.148	19.985	1.183	1.64	-0.0136	7.37	6.71E-09



SAMPLE INFORMATION

Boring:	G-48
Sample:	U-3C
Depth:	61.60 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	CL, gray silty CLAY, trace f. sand; shell fragments and organic mat'l noted. LL = 33, PL = 17, PI = 16

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.63	inch
Diameter:	2.50	inch
Initial water content:	37.8	%
Initial total unit weight:	116.1	pcf
Initial dry unit weight:	84.3	pcf
Initial void ratio:	1.022	
Initial degree of saturation:	101	%
Final water content:	30.6	%
Final total unit weight:	121.3	pcf
Final dry unit weight:	92.9	pcf
Final void ratio:	0.834	
Final degree of saturation:	100	% (assumed specific gravity = 2.73)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	2.2 (Range: 2.0 to 2.4)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.127
Compression Index (void ratio per log cycle stress):	0.257
Swell Ratio (strain per log cycle stress):	0.013
Swell Index (void ratio per log cycle stress):	0.026
Recompression Ratio (strain per log cycle stress):	0.014
Recompression Index (void ratio per log cycle stress):	0.028
Remarks:	

LEGEND: ☐ End of primary ○ End of Stage ——— Loading -------- Unloading

Test Date: 12/8/04 Tested By: RV Checked By:

Langan #35578403	New York Sports and Convention Center	ONE DIMENSIONAL CONSOLIDATION TEST Boring: G-48 Depth: 61.60 feet
Geotesting Services, Inc.	Project No. 31737700-458	January 2005 Fig.

GSI Analysis File: Conv30.xls

C04250.xls

01/06/2005

PROJECT: New York Sports and Convention Center
PROJECT NO.: 31737700-458
BORING: G-48
SAMPLE: U-3C
TEST: C04250
DEPTH, feet: 61.6
BY: RV
TEST DATE: 12/08/2004

Initial height: 0.625 inch
Initial water content: 37.8 %
Initial dry density: 84.3 pcf
Initial total density: 116.1 pcf
Initial saturation: 101 %
Initial void ratio: 1.022

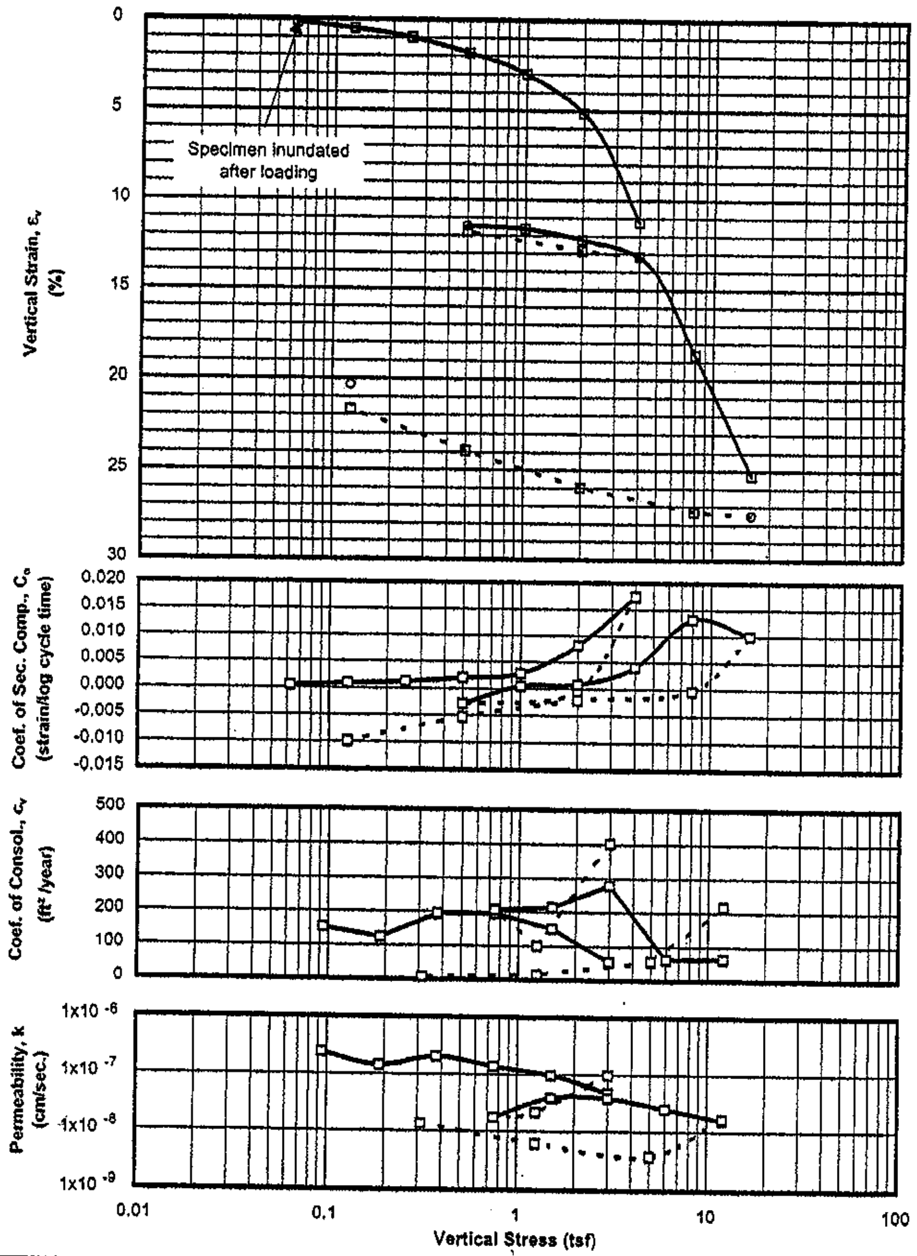
Final height: 0.567 inch
Final water content: 30.6 %
Final dry density: 92.9 pcf
Final total density: 121.3 pcf
Final saturation: 100 %
Final void ratio: 0.834
Final strain: 9.3 %

EQUIPMENT:
Load Frame No.: 5
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CL, gray silty CLAY, trace f. sand; shell fragments and organic mat'l noted.

G	LL	PL	PI
2.73	33	17	16

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeablity (cm/sec)
1	0.063	0.0011	0.176	1.019	0.297	1.016	77.29	0.0005	35.47	6.57E-08
2	0.125	0.0051	0.811	1.006	1.086	1.000	77.21	0.0014	9.84	2.37E-07
3	0.250	0.0106	1.690	0.988	1.774	0.986	69.00	0.0009	14.23	1.46E-07
4	0.500	0.0181	2.895	0.964	3.186	0.958	135.66	0.0026	20.73	1.97E-07
5	1.00	0.0286	4.582	0.930	4.867	0.924	151.83	0.0022	29.65	1.54E-07
6	2.00	0.0412	6.586	0.889	7.260	0.876	192.66	0.0050	49.90	1.16E-07
7	4.00	0.0619	9.911	0.822	10.817	0.804	145.79	0.0065	60.15	7.31E-08
8	8.00	0.0858	13.725	0.745	15.284	0.713	183.17	0.0066	104.87	5.27E-08
9	4.00	0.0949	15.186	0.715	15.177	0.715	423.40	-0.0001	273.78	4.67E-08
10	1.00	0.0902	14.427	0.731	14.180	0.736	265.71	-0.0015	395.40	2.03E-08
11	2.00	0.0897	14.349	0.732	14.425	0.731	558.65	0.0003	1273.05	1.32E-08
12	4.00	0.0918	14.687	0.725	14.773	0.724	516.16	0.0004	591.47	2.63E-08
13	8.00	0.0948	15.168	0.716	15.424	0.710	667.66	0.0011	831.17	2.42E-08
14	16.0	0.1099	17.577	0.667	18.655	0.645	277.02	0.0060	332.11	2.52E-08
15	8.00	0.1159	18.540	0.647	18.496	0.648	434.71	-0.0001	831.16	1.58E-08
16	2.00	0.1125	18.002	0.658	17.809	0.662	159.57	-0.0009	1116.97	4.31E-09
17	0.500	0.1060	16.961	0.679	16.390	0.691	71.14	-0.0025	143.97	1.49E-08
18	0.125	0.0958	15.325	0.712	14.350	0.732	21.69	-0.0053	22.93	2.85E-08



SAMPLE INFORMATION

Boring:	G-49
Sample:	U-1D
Depth:	31.85 feet
Elevation:	
Type:	3-inch thin wall tube
Description:	CH-OH gray ORGANIC silty CLAY, trace f. sand; silt lenses and shell fragments. LL = 67, PL = 25, PI = 42

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.62	inch
Diameter:	2.50	inch
Initial water content:	60.4	%
Initial total unit weight:	102.7	pcf
Initial dry unit weight:	64.0	pcf
Initial void ratio:	1.584	
Initial degree of saturation:	101	%
Final water content:	47.0	%
Final total unit weight:	108.3	pcf
Final dry unit weight:	73.7	pcf
Final void ratio:	1.244	
Final degree of saturation:	100	% (assumed specific gravity = 2.65)

TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	2.1 (Range: 2.0 to 2.3)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.233
Compression Index (void ratio per log cycle stress):	0.602
Swell Ratio (strain per log cycle stress):	0.018
Swell Index (void ratio per log cycle stress):	0.047
Recompression Ratio (strain per log cycle stress):	0.020
Recompression Index (void ratio per log cycle stress):	0.052
Remarks:	

LEGEND: ☐ End of primary ○ End of Stage ———— Loading -------- Unloading

Test Date: 12/8/04 Tested By: RV Checked By: CMB

Langan #35578403	New York Sports and Convention Center	ONE DIMENSIONAL CONSOLIDATION TEST Boring: G-49 Depth: 31.85 feet
Geotesting Services, Inc.	Project No. 31737700-458	January 2005 Fig.

GSI Analysis File: Conv30.xls

C04251.xls

01/06/2005

PROJECT: New York Sports and Convention Center
PROJECT NO.: 31737700-458
BORING: G-49
SAMPLE: U-1D
TEST: C04251
DEPTH, feet: 31.85
BY: RV
TEST DATE: 12/08/2004

Initial height: 0.624 inch
Initial water content: 60.4 %
Initial dry density: 64.0 pcf
Initial total density: 102.7 pcf
Initial saturation: 101 %
Initial void ratio: 1.584

Final height: 0.542 inch
Final water content: 47.0 %
Final dry density: 73.7 pcf
Final total density: 108.3 pcf
Final saturation: 100 %
Final void ratio: 1.244
Final strain: 13.1 %

EQUIPMENT:
Load Frame No.: 6
Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: CH-OH gray ORGANIC silty CLAY, trace f. sand; silt lenses and shell fragments.

G	LL	PL	PI
2.65	67	25	42

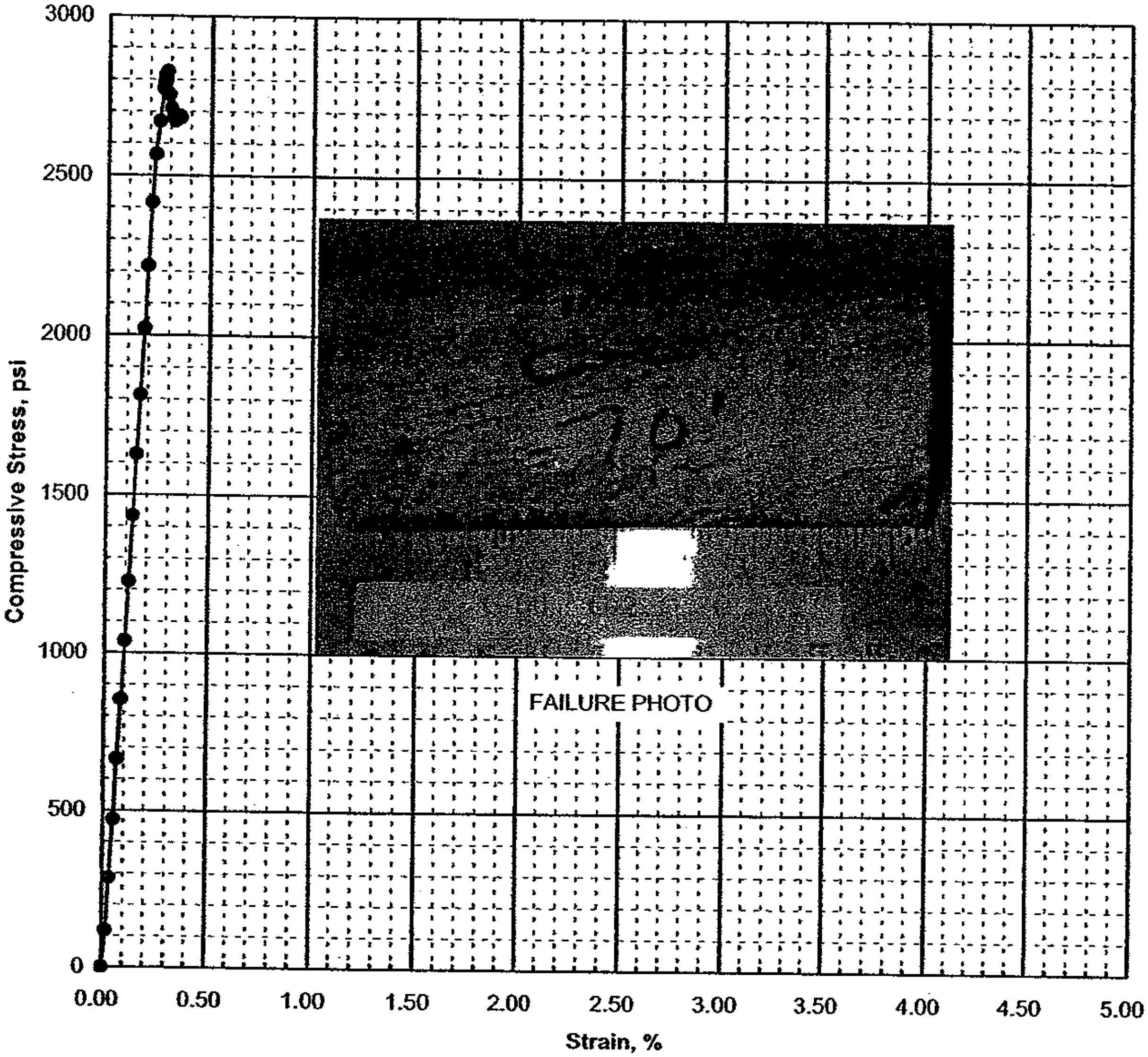
Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0011	0.181	1.579	0.253	1.577	260.21	0.0004	34.46	2.28E-07
2	0.125	0.0032	0.510	1.571	0.715	1.565	151.88	0.0008	19.02	2.41E-07
3	0.250	0.0062	0.987	1.558	1.163	1.554	122.97	0.0012	26.21	1.42E-07
4	0.500	0.0116	1.852	1.536	2.191	1.527	194.29	0.0019	28.89	2.03E-07
5	1.00	0.0189	3.023	1.506	3.411	1.496	195.32	0.0028	42.71	1.38E-07
6	2.00	0.0321	5.139	1.451	6.213	1.423	151.42	0.0082	47.26	9.67E-08
7	4.00	0.0703	11.255	1.293	13.149	1.244	52.85	0.0175	32.70	4.88E-08
8	2.00	0.0803	12.865	1.251	12.770	1.254	401.95	-0.0004	124.27	9.76E-08
9	0.500	0.0736	11.790	1.279	11.487	1.287	100.43	-0.0028	139.55	2.17E-08
10	1.00	0.0727	11.649	1.283	11.716	1.281	205.75	0.0004	354.62	1.75E-08
11	2.00	0.0765	12.251	1.267	12.410	1.263	213.47	0.0008	166.11	3.88E-08
12	4.00	0.0822	13.173	1.243	14.023	1.221	278.08	0.0041	216.77	3.87E-08
13	8.00	0.1165	18.660	1.102	20.336	1.058	61.30	0.0132	72.91	2.54E-08
14	16.0	0.1576	25.256	0.931	27.526	0.873	63.38	0.0101	121.28	1.58E-08
15	8.00	0.1705	27.317	0.878	27.215	0.881	217.24	-0.0004	388.21	1.69E-08
16	2.00	0.1621	25.975	0.913	25.547	0.924	55.34	-0.0021	447.01	3.73E-09
17	0.500	0.1494	23.936	0.965	23.111	0.987	14.76	-0.0053	73.59	6.05E-09
18	0.125	0.1355	21.703	1.023	20.341	1.058	7.46	-0.0099	16.79	1.34E-08

Project No.: 31737700-458 File: Rocksum1.xls

Langan #35578403
New York Sports and Convention Center
SUMMARY OF ROCK TESTING

BORING NO.	RUN NO.	DEPTH (ft)	WATER CONTENT (%)	TOTAL UNIT WGT. (pcf)	DRY UNIT WGT. (pcf)	UNCONFINED COMPRESSIVE STRENGTH (psi)	AXIAL STRAIN @ FAILURE (%)
G-6	C-2	70	0.2	171	171	2830	0.28
G-7	C-3	61	0.1	174	174	5580	0.21
G-7	C-3 (2)	61	0.0	173	173	3050	0.19
G-15	C-3	52	0.1	173	173	3690	0.19
G-27	C-4A	156	0.2	165	165	17960	0.40
G-27	C-4B	156	0.1	169	169	3830	0.19
G-30	C-2	60	0.1	172	172	4190	0.21
G-35	C-3	98	0.3	176	176	7040	0.30
G-35	C-9	128	0.1	172	172	7190	0.21
G-48	C-2	86	0.1	172	172	2810	0.14
G-62	C-2A	97	0.1	162	162	18300	0.50
G-62	C-2B	97	0.2	164	164	13130	0.39
G-63	C-4	100	0.2	169	169	3390	0.16

Prepared by: RV Reviewed by: Date: 01/06/2005



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.17	171	171	4.291	1.981

gray mica schist

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

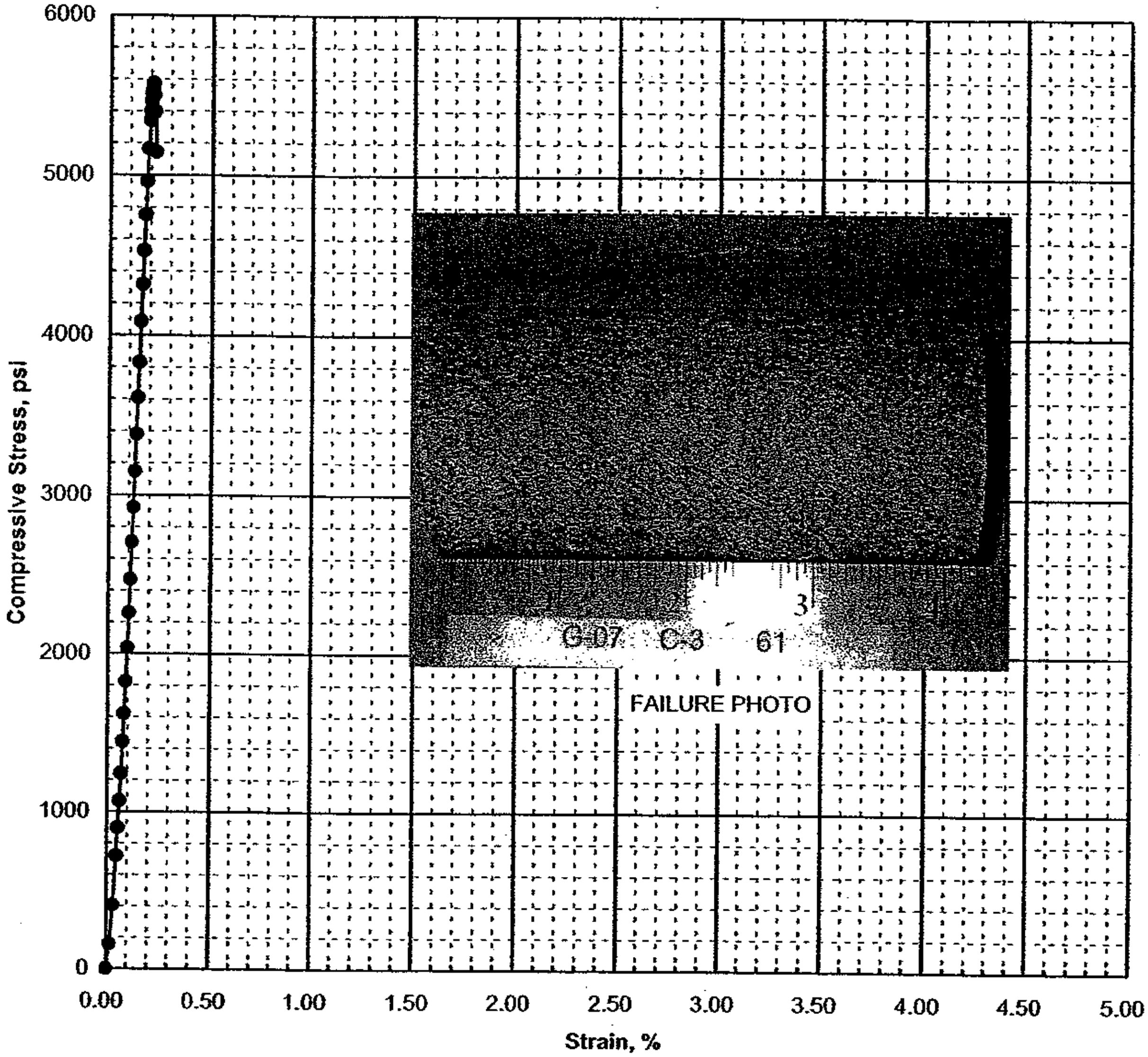
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.17	0.28	2830

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-6 Sample: C-2
Depth 70 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.05	174	174	4.269	2.000

gray micaceous schist

Specimen meets ASTM D4543 shape tolerances

Tested by: DT

Test Date: Dec-21-04

Test Summary

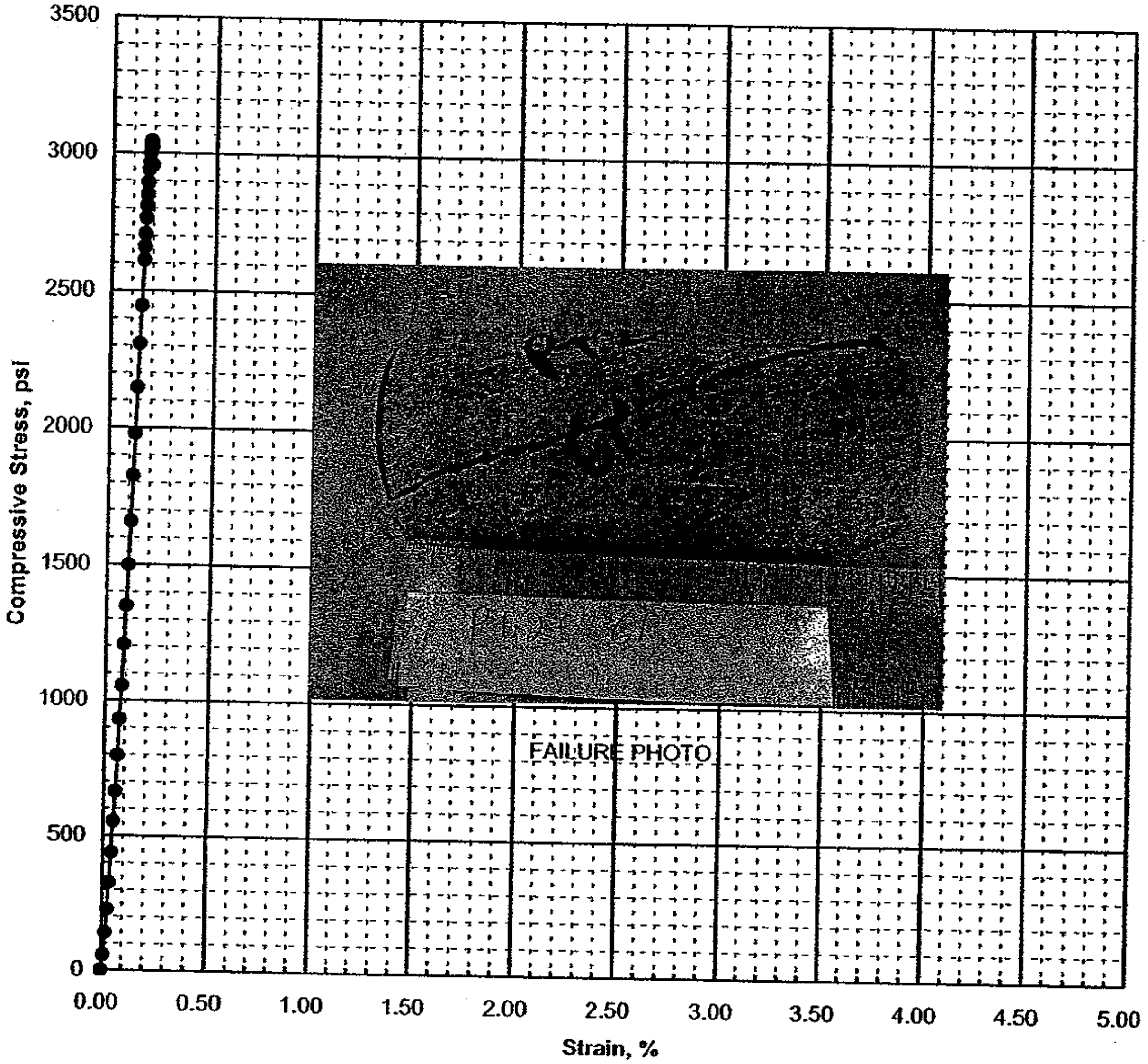
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.15	0.21	5580

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-7 Sample: C-3
Depth 61 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.02	173	173	4.214	2.000

gray fine grained gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.16	0.19	3050

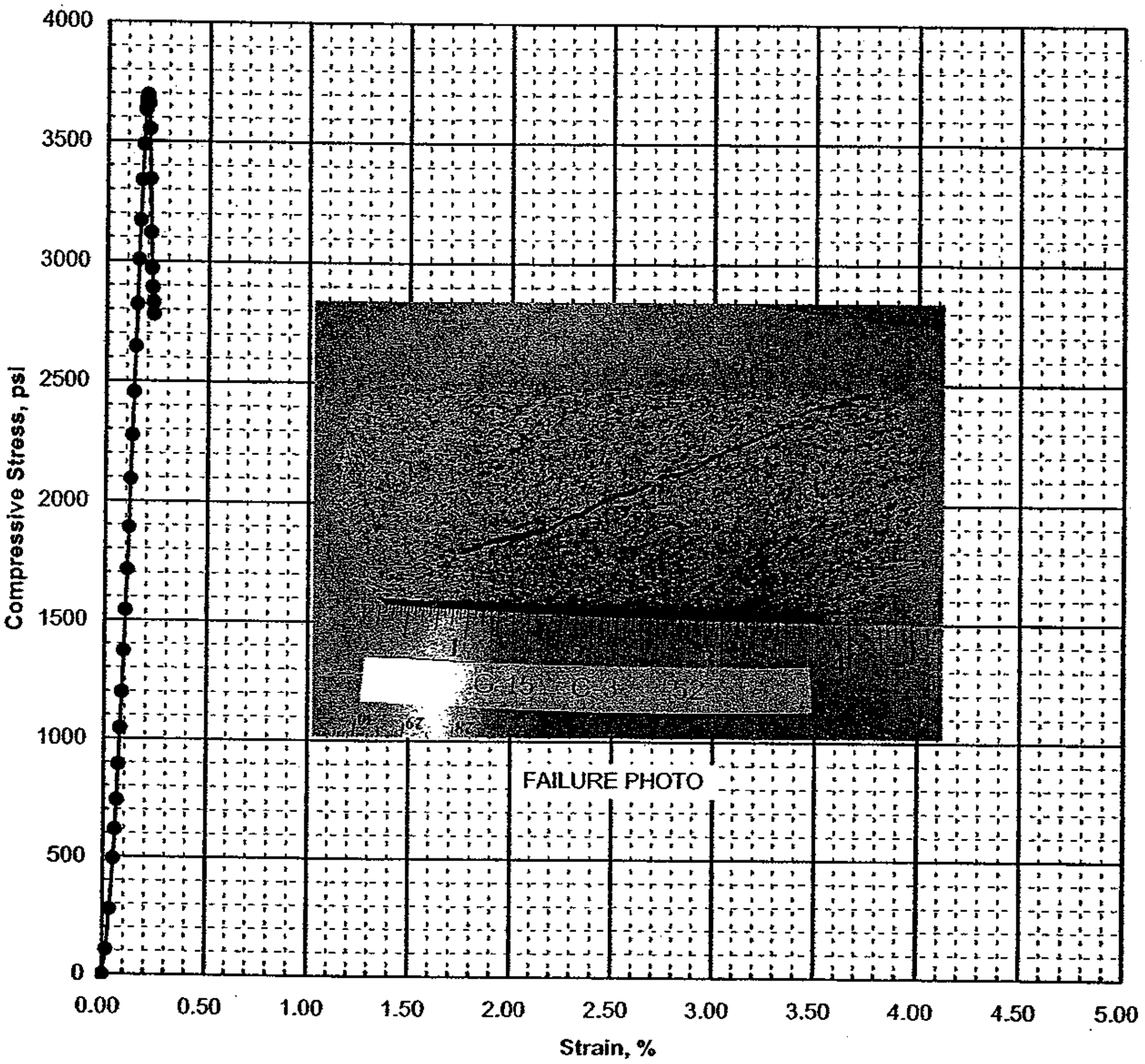
Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST

Boring: G-7 Sample: C-3 (2)
Depth 61 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.10	173	173	4.355	1.975

gray granitiferous gneiss

Specimen does not meet ASTM D4543 shape tolerances

Test Summary

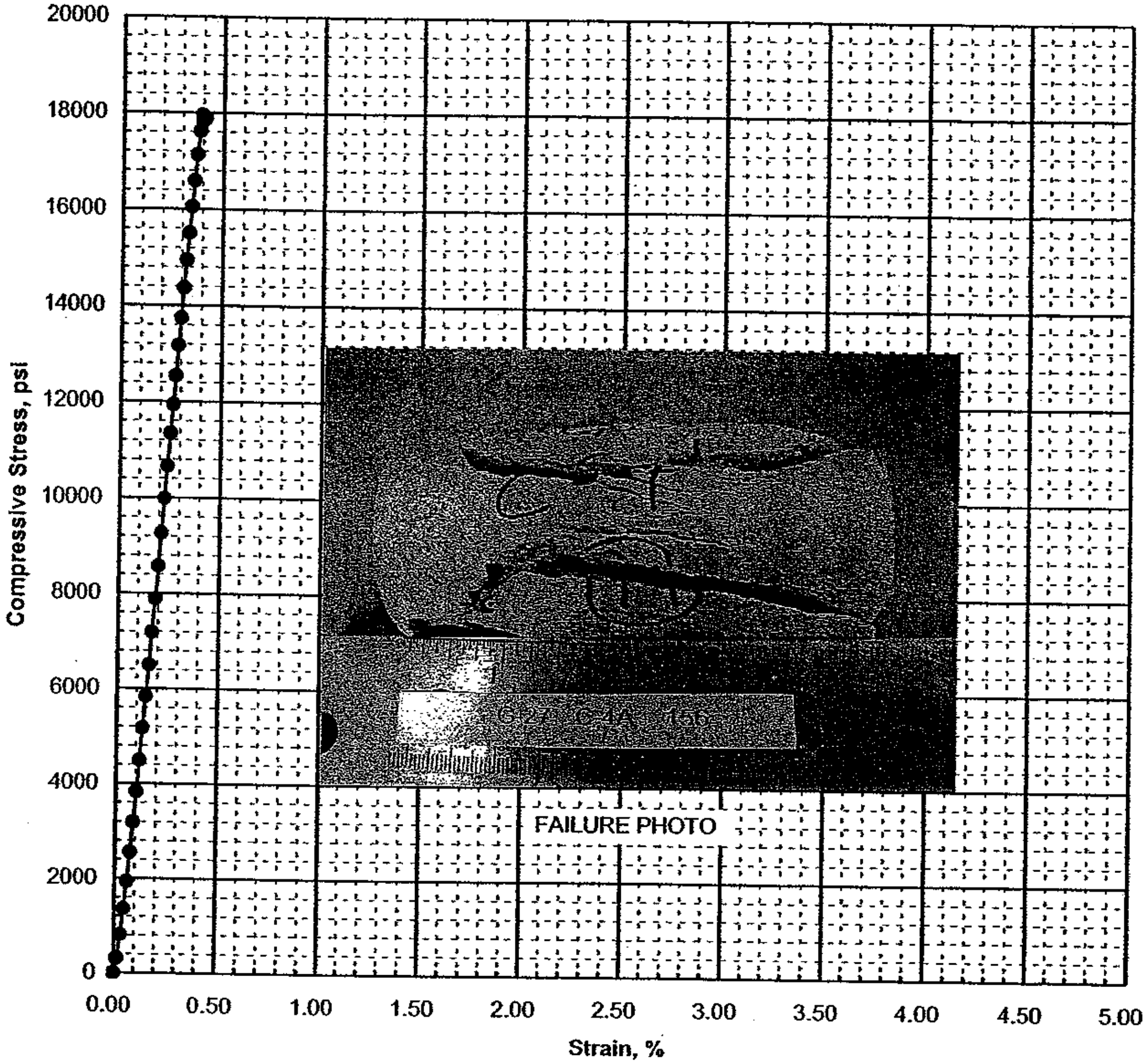
Tested by: DT

Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.16	0.19	3690

Project No.	Langan #35578403 New York Sports and Convention Center	COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST Boring: G-15 Sample: C-3 Depth 52 ft.
31737700-458		

Geotesting Services, Inc.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.21	165	165	4.261	1.982

white fine grained schist

Specimen meets ASTM D4543 shape tolerances

Test Summary

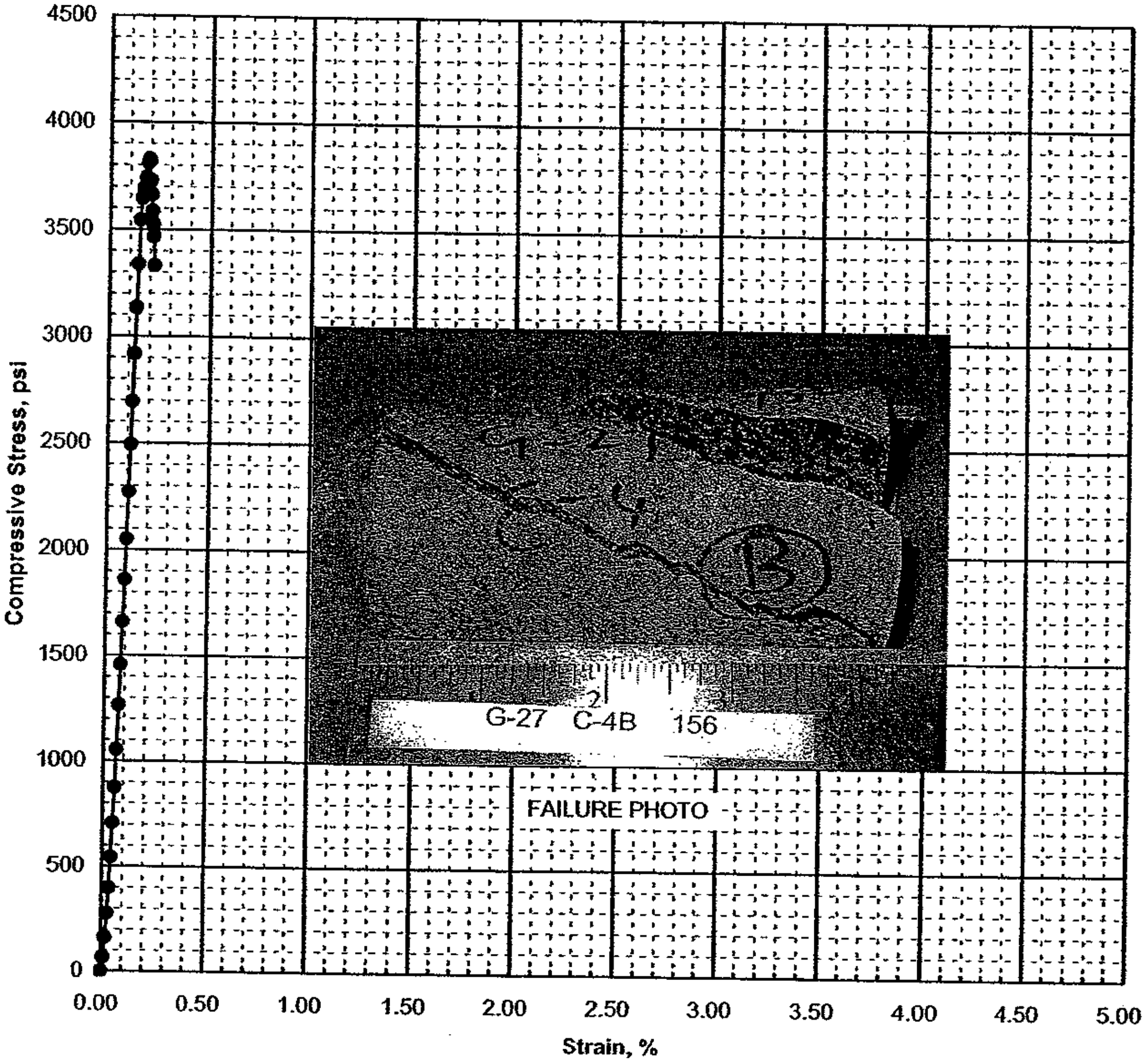
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.12	0.40	17960

Tested by: DT

Test Date: Dec-21-04

Project No. 31737700-458	Langan #35578403 New York Sports and Convention Center	COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST Boring: G-27 Sample: C-4A Depth 156 ft.

Geotesting Services, Inc.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.12	169	169	4.142	1.984

gray micaceous schist

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

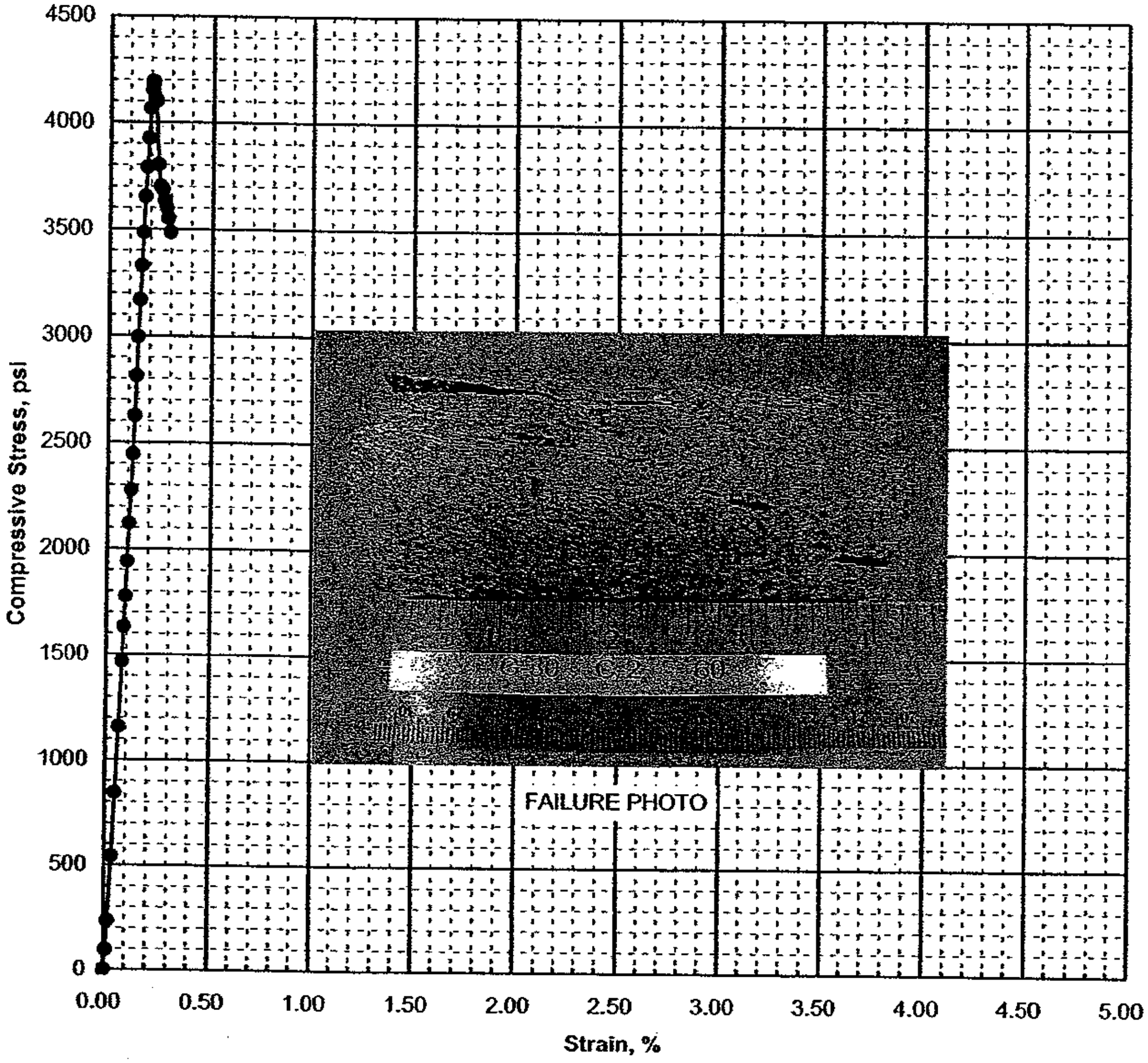
Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.16	0.19	3830

Project No. 31737700-458	Langan #35578403 New York Sports and Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-27 Sample: C-4B
Depth 156 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.09	172	172	4.204	1.974

gray granitiferous gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

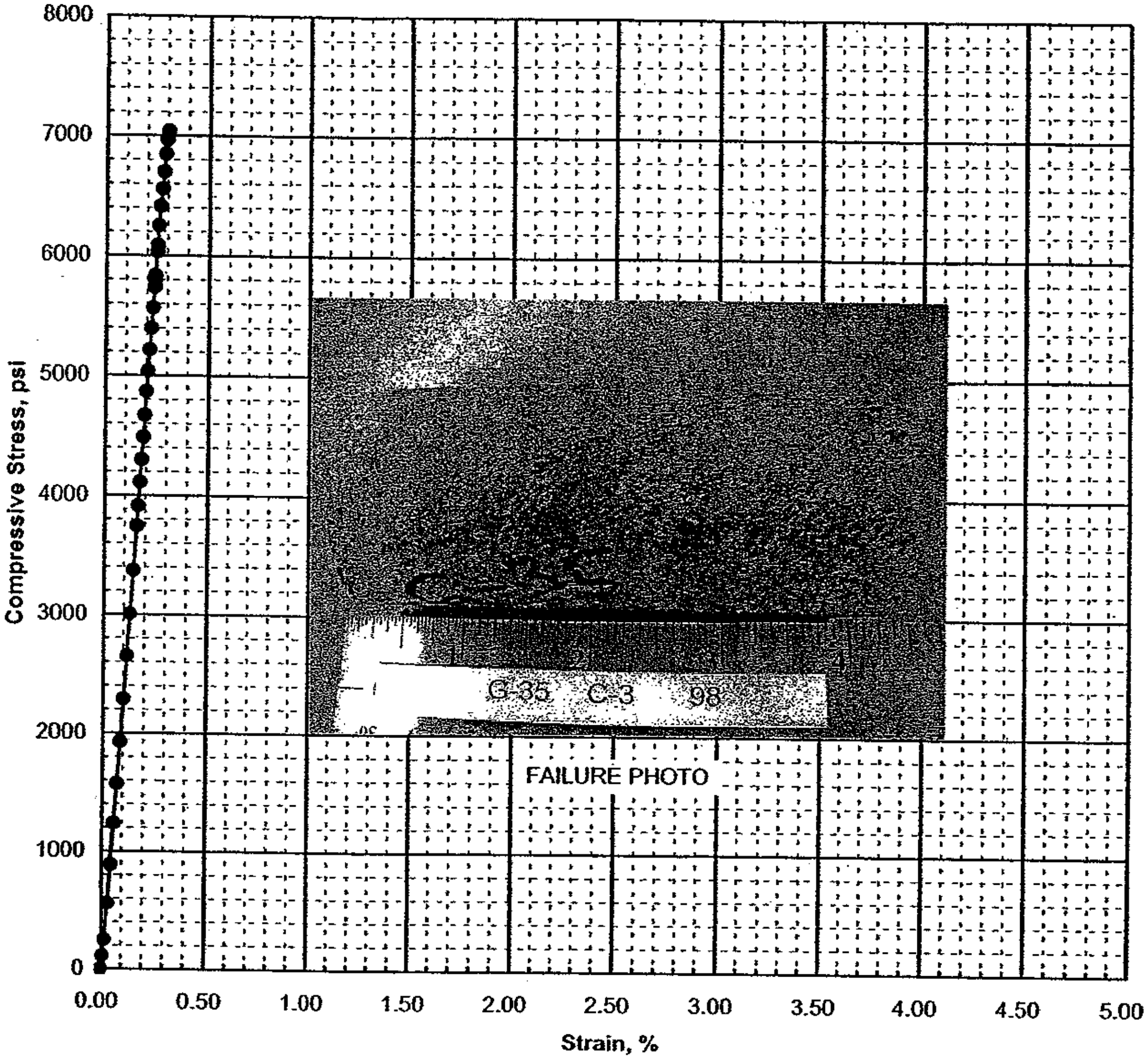
Tested by: DT

Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.17	0.21	4190

Project No. 31737700-458	Langan #35578403 New York Sports and Convention Center	**COMPRESSIVE STRESS VS STRAIN UNCONFINED COMPRESSIVE STRENGTH TEST** **Boring: G-30 Sample: C-2** **Depth 60 ft.**

Geotesting Services, Inc.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.31	176	176	4.329	1.981

blue-gray gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

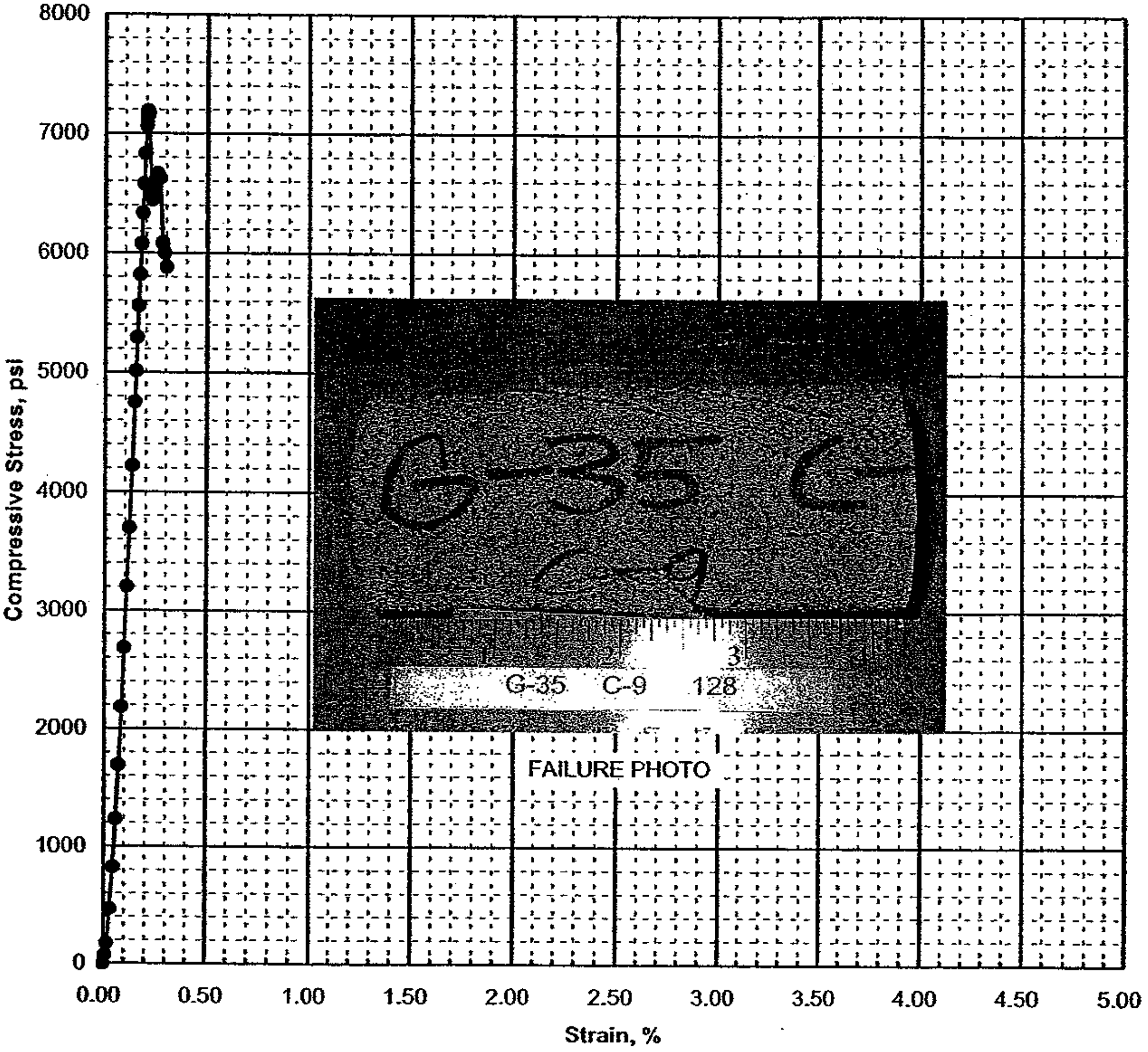
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.14	0.30	7040

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-35 Sample: C-3
Depth 98 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.08	172	172	4.320	1.986

gray granitiferous gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.15	0.21	7190

Project No.
31737700-458

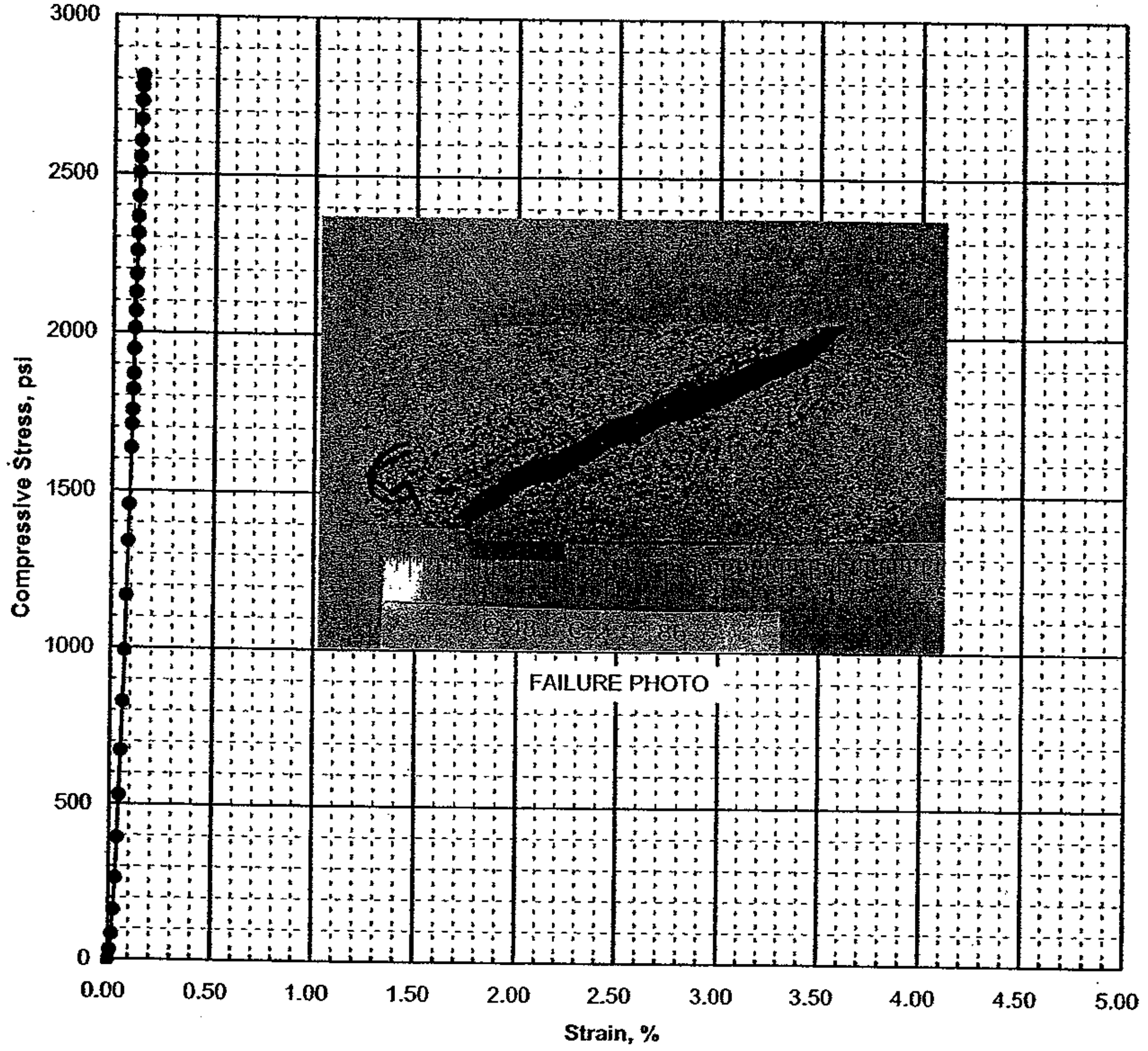
Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-35 Sample: C-9
Depth 128 ft.

GSI Analysis File: UCrockv5.XLS (01/04)

01/06/2005
UCG35-C9-128.xls



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.10	172	172	4.451	1.988

gray granitiferous gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

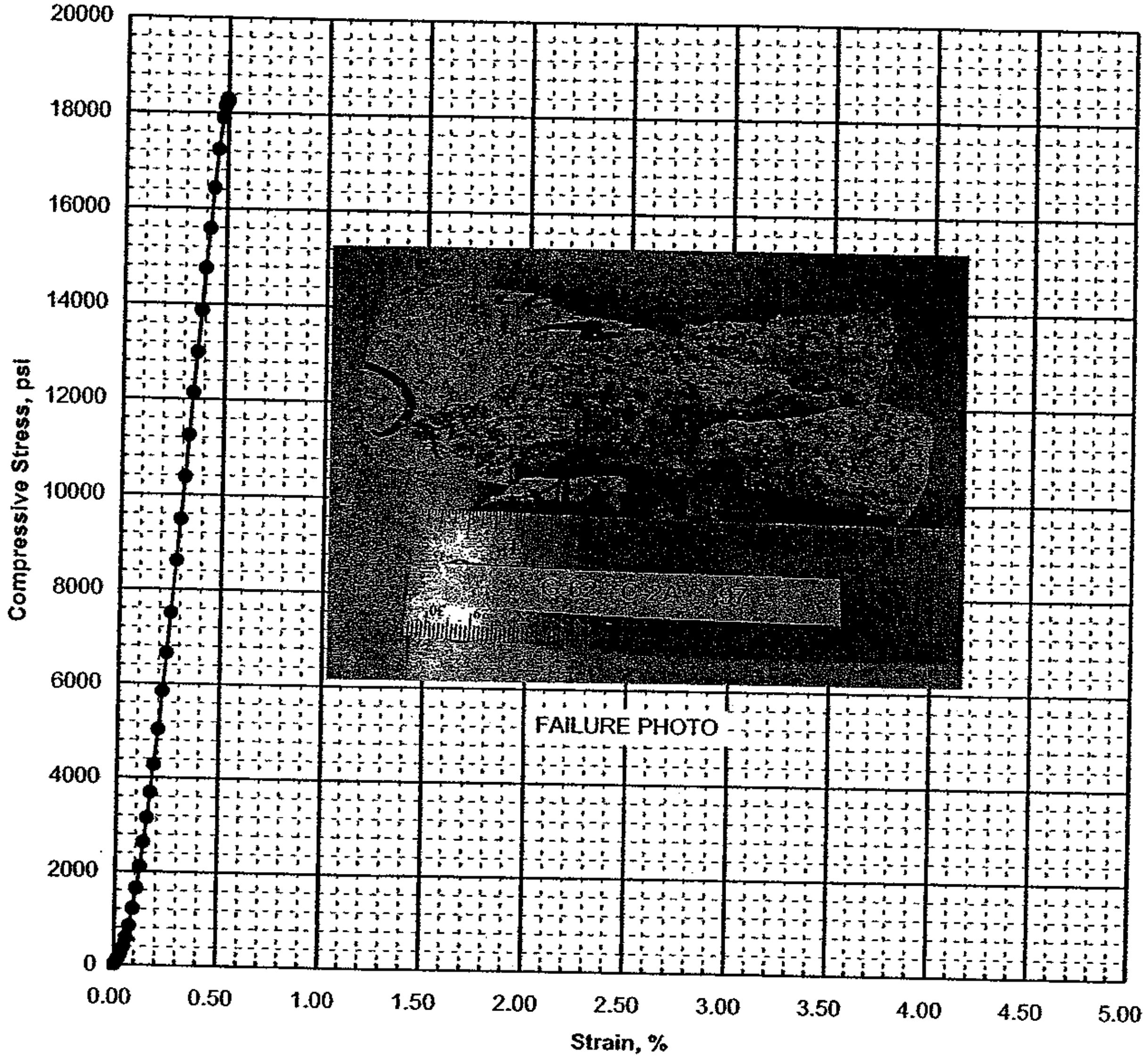
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.15	0.14	2810

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-48 Sample: C-2
Depth 86 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.12	162	162	4.276	1.989

pink pegmatite

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

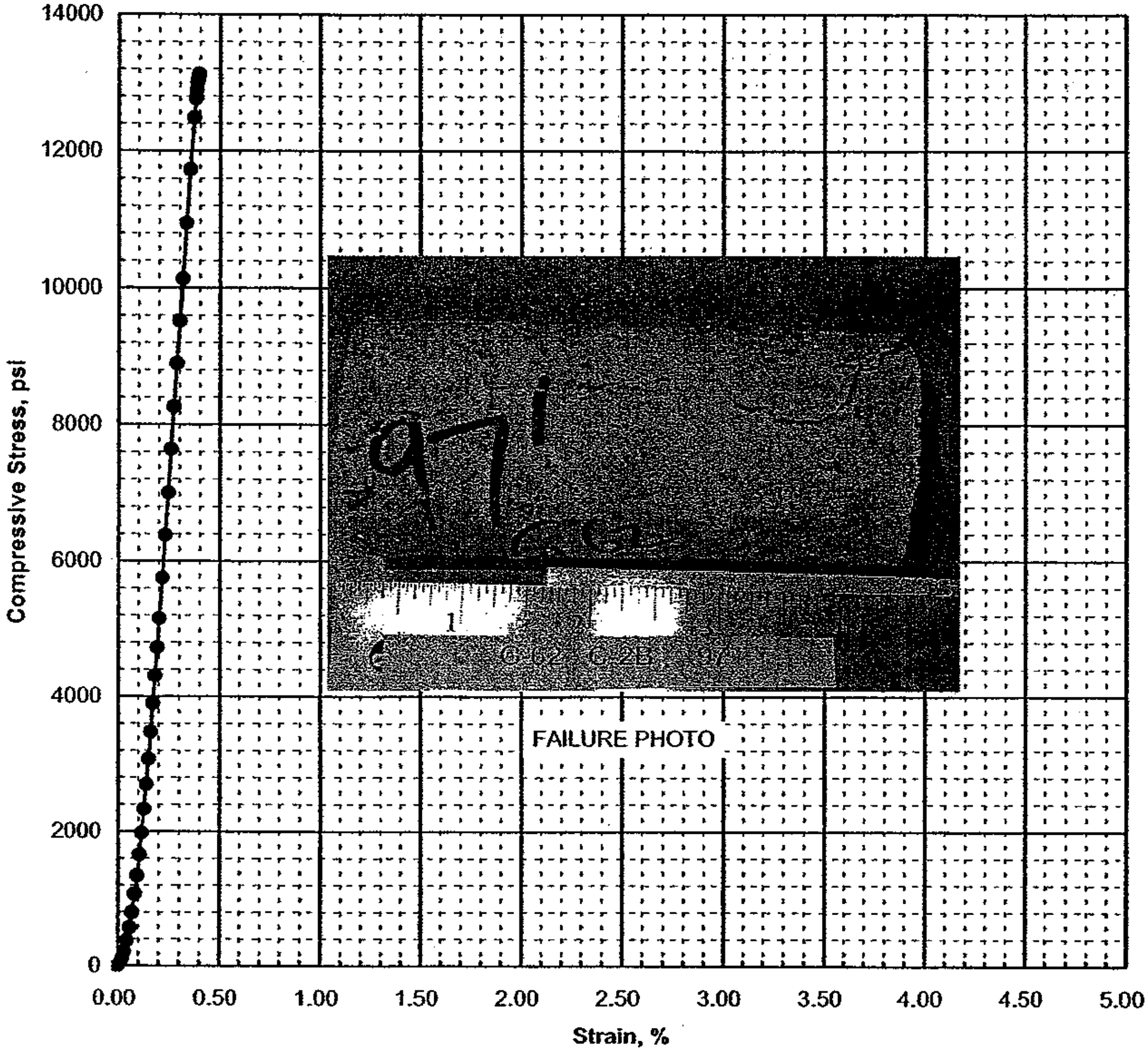
Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.13	0.50	18300

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-62 Sample: C-2A
Depth 97 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.16	164	164	4.329	1.989

white-gray pegmatite

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

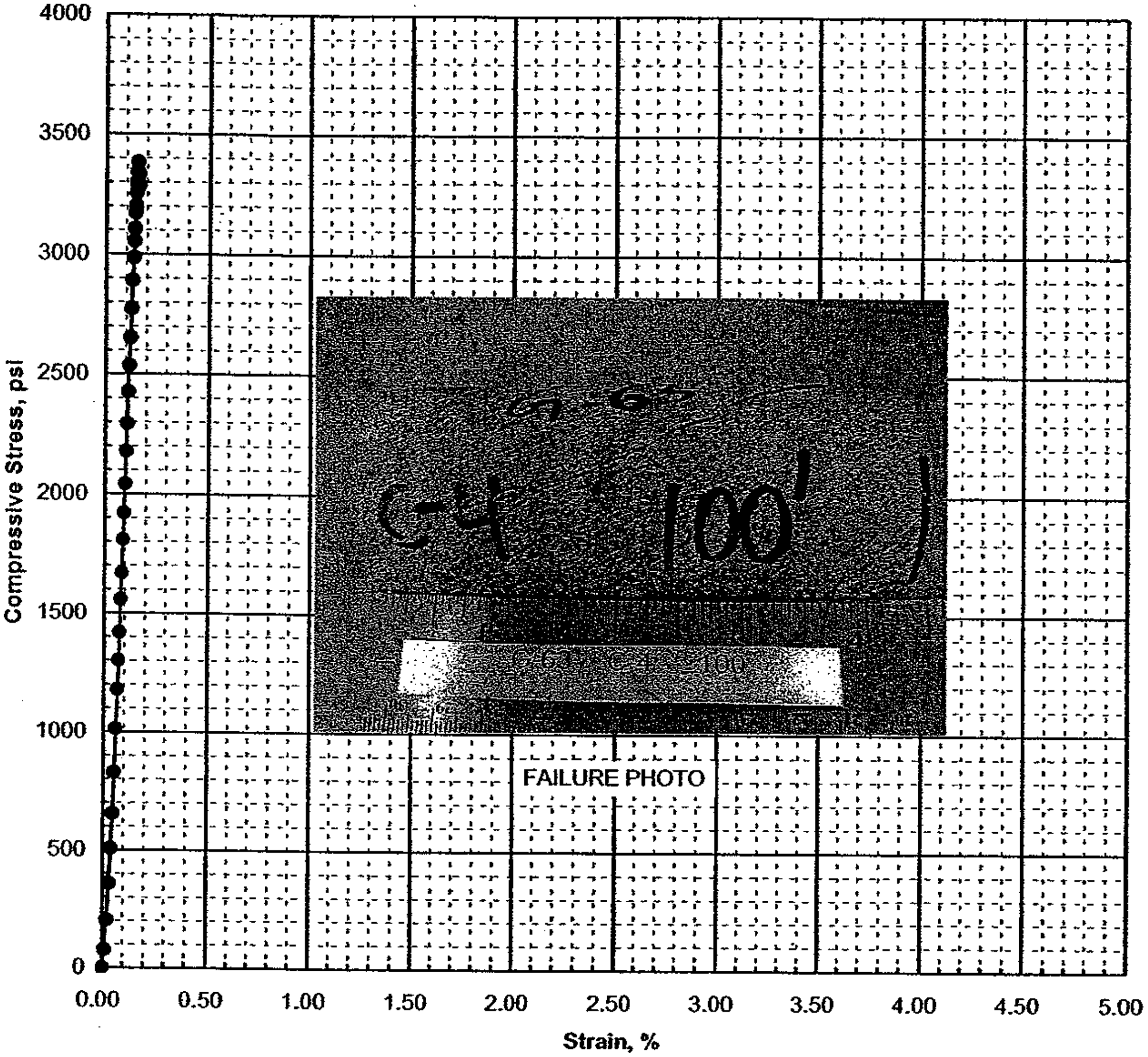
Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.13	0.39	13130

Project No. 31737700-458	Langan #35578403 New York Sports and Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-62 Sample: C-2B
Depth 97 ft.



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	Length (inch)	Diameter (inch)
0.18	169	169	4.364	1.985

gray gneiss

Specimen meets ASTM D4543 shape tolerances

Test Summary

Tested by: DT

Test Date: Dec-21-04

Strain Rate (%/min)	Strain to Peak (%)	q_u (psi)
0.15	0.16	3390

Project No.
31737700-458

Langan #35578403
New York Sports and
Convention Center

Geotesting Services, Inc.

COMPRESSIVE STRESS VS STRAIN
UNCONFINED COMPRESSIVE
STRENGTH TEST
Boring: G-63 Sample: C-4
Depth 100 ft.

APPENDIX D

Borings by Others (Various)

Parsons
Brinckerhoff
Quade &
Douglas, Inc.

BORING LOG

BORING NUMBER: **CD-15**
SHEET NUMBER: **1** of **2**

PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**
CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME 75**

LOCATION: **LIRR (West Side Yard)**
COORD. N: **213,874.0** E: **983,206.0**
STN. NO.: OFFSET:
SURFACE ELEV.: **108.0 feet**
DATUM:
START DATE: **6/2/03** TIME: **8:00 am**
FINISH DATE: **6/6/03** TIME: **4:00 pm**

	Casing	Split Spoon	Shelby Tube	Piston	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ⧅	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	2.938"		2"
O.D.	4.5"	2"	3"	3"		3"
Length		24"	24"	24"		
Hammer Wt.	300 lbs	140 lbs	Drill Rod Size		NWJ	
Hammer Fall	24"	30"	I.D. (O.D.)		2.937" (2.938")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft) CORING (Min./ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
						0.0 - 6.0		Hand		Auger			Hand Augered Material: 0' to 1' - Concrete 1' to 4' - Light brown, yellowish Sand with little Gravel 4' to 6' - Dark brown, coarse to fine grained Sand, some coarse to medium Gravel, trace organics
5													
			S	1	■	6.0 - 8.0	WOH	WOH	WOH	1	12		Brown, c-f SAND, some m-f Gravel, little Silt, very loose, moist.
10			S	2	■	10.0 - 12.0	2	3	1	2	20		S-2A (10") same as above. S-2B (10") Dark brown to black, m-f SAND, little f-Gravel, small pieces of brick, organics, very loose.
15			S	3	■	15.0 - 17.0	4	3	3	6	20		S-3A (12") Brown, black and light green c-f SAND, trace c-f Gravel, little Silty Clay, loose. S-3B (8") Light gray SILT, trace m-f Sand, loose.
20			S	4	■	20.0 - 22.0	2	2	2	3	19		Dark brown Silty CLAY, little m-f Sand, high PI, moist.
					■								S-5A (18") Same as above.

Parsons
Brinckerhoff
Quade &
Douglas, Inc.

BORING LOG
(continued)

BORING NUMBER: **CD-15**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft) CORING (Min./ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS	
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)		
							CORING						
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.	
			S	5		24.0 - 26.0	3	2	3	4	24		S-5B (6") Gray m-f SAND, some Silt, loose, dry.
			S	6		26.0 - 28.0	2	3	1	6	22		S-6A (11") Gray m-f SAND, some Silt, very loose, trace Gravel, very loose. S-6B (11") Reddish SILT, m-f Sand, very loose, dry.
												28.5	Roller bit refusal and begin coring at 28.5'.
30													
35													
40													
45													
50													
55													

Parsons
Brinckerhoff
Quade &
Douglas, Inc.

CORING LOG

BORING NUMBER: **CD-15**
SHEET NUMBER: **1** of **4**
PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**
CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**
DRILLING METHOD: **Diamond drilling with double core barrel**
RIG TYPE: **CME 75**

LOCATION: **LIRR (West Side Yard)**
COORD. **N: 213,874.0** **E: 983,206.0**
STN. NO.: OFFSET:
SURFACE ELEV.: **108.0 feet**
DATUM:
START DATE: **6/2/03** TIME: **8:00 am**
FINISH DATE: **6/6/03** TIME: **4:00 pm**

CORE BARREL DATA:	**NOTES:**
TYPE: NX	
CORE SIZE: 2"	
O.D.: 3"	
I.D.: 2"	
CASING SIZE: 4" (4.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH
30		C-1 28.5 - 32.0	42	100	69	Dark gray SCHIST, slightly weathered, slightly fractured, strong rock, coarse to fine grained Intercalated with light gray fine-medium grained GRANOFELS, faintly foliated (about 80% of rock is Granofels) -Yellow rusted joints @ 28.7' (reddish), 27.3' and 29.6'; 28.5' - 28.6'- quartz vein. -No wall contact at 31.8'	II	R4
35 40		C-2 32.0 - 41.3	112	100	96	Intercalated dark gray SCHIST and light gray fine fine-medium grained, light gray GRANOFELS, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained -Rusty coated joint walls: 34.2' - reddish with Pyrite joint, 36.5' - green with Pyrite joint, 37.9' - reddish joint	II	R4
45 50		C-3 41.3 - 51.2	119	100	97	Gray SCHIST, slightly weathered, sound, moderate to wide fracture spacing, strong rock, coarse to fine grained Except 43.8' to 45.4", light gray-white PEGMATITE -Garnets 1/8" along the run - Reddish coated joint walls at 42.0', 43.7', 47.2', 48.3'	II	R4
						Gray SCHIST, slightly weathered, sound, wide to very wide fracture spacing, strong rock, coarse to fine grained	II	R4

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
40	1.5	2	28.6
70	1.5	2	28.7
30	1.5	2	29.1
35	1.5	2	29.3
*50	1.5	1	29.6
60_{MB}	-	-	30
30_{MB}	-	-	30.5
55	1.5	2	31.1
40	4	1	31.3
0_{MB}	-	-	31.8
90	1.5	1	31.9
0_{MB}	Roller	Bit	32
*40_{MB}	-	-	32.8
*55_{MB}	-	-	33.5
25	3	1	34.2
*40_{MB}	-	-	35.1
0	3.0	1	36.2
*60	1.5	1	36.6
45_{MB}	-	-	36.9
*60	1.5	2	37.3
60-10	1.5	2	37.9
30	1.5	1	39.9
*60	1.5	1	40.5
*60_{MB}	-	-	40.9
35_{MB}	-	-	41.3
*70	1.5	1	41.8
40	3	2	42
40_{MB}	-	-	43.1
90_{MB}	-	-	43.3
60_{MB}	-	-	43.5
0	1.5	1.0	43.7
50_{MB}	-	-	43.8
0_{MB}	-	-	44.5
20	1.5	2	45.4
20	1.5	2	45.5
*50_{MB}	-	-	46
*40_{MB}	-	-	46.7
*40	1.5	1.0	47.2
55	1.5	1.0	48.3
*70_{MB}	-	-	49.1
*70_{MB}	-	-	49.5

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Brinckerhoff
Quade &
Douglas, Inc.

CORING LOG
(continued)

BORING NUMBER: **CD-15**
SHEET NUMBER: **2** of **4**
PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
		C-4 51.2 - 61.2	120	100	100	-Garnets 1/8" along the run			0_{MB}	-	-	49.9
									40_{MB}	-	-	50.6
55									40	1.5	2	51
									0	1.0	2	51.2
									$*70_{MB}$	-	-	52.2
									0_{MB}	-	-	53.8
									$*60_{MB}$	-	-	54.8
									10_{MB}	-	-	55.2
									40	1.5	2.0	55.4
									20_{MB}	-	-	55.8
60									40_{MB}	-	-	56.4
									$*60_{MB}$	-	-	57.2
									$*60_{MB}$	-	-	57.8
		C-5 61.2 - 71.2	120	100	91	Gray SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained Except 69.8' to 71.2' - light gray-white PEGMATITE -Slight rusty coating and greenish gray discoloration on joints at 70' and 71.2' -Possible micro-shear along foliation from 69' to 70'	II	R4	$*65_{MB}$	-	-	58.6
									$*80_{MB}$	-	-	59.9
									$*70_{MB}$	-	-	60.6
									$*70_{MB}$	-	-	61.2
									65_{MB}	-	-	61.4
65									35_{MB}	-	-	62.2
									$*70_{MB}$	-	-	62.6
									$60\text{-}90_{MB}$	-	-	64
									40_{MB}	-	-	65.5
									*60	1.5	3.0	67
									0	1.5	3.0	67.2
									*65	1.5	3.0	67.4
									0_{MB}	-	-	68.5
70									55_{MB}	-	-	69.7
									35	1.5	2	69.9
		C-6 71.2 - 81.2	120	100	95	Gray SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained, wavy foliation -Garnets 1/8" along the run -Rusted Joints: 71.7' and 71.9' - green stains 77.7' and 77.8' - yellow stains -Possible micro-shears along foliation from 71.2' to 71.7' and from 81' to 81.2' -GRANOFELS from 79.4' to 79.7' and 80.3' to 81'	II	R4	*75	1.5	1.0	70
									30_{MB}	-	-	70.1
									65_{MB}	-	-	70.3
									70	1.5	1.0	71.2
									*50	1.5	1.0	71.7
									*60	1.5	1.0	72.7
75									10_{MB}	-	-	73.5
									$0\text{-}50_{MB}$	-	-	75.4
									*70	1.5	1.0	76.3
									35_{MB}	-	-	76.8
									$*55_{MB}$	-	-	77
									20	1.5	2	77.2
									50	1.5	1.0	77.7
									85	1.5	1.0	77.8
80									50	1.5	2.0	77.9
									40_{MB}	-	-	78.4
		C-7 81.2 - 90.5	112	100	98	Gray SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained, wavy foliation	II	R4	$*40_{MB}$	-	-	79.9
									$*60_{MB}$	-	-	81.2
									30-40	1.5	1.0	84
85									0	1.5	2.0	84.2
									40_{MB}	-	-	84.6
									20_{MB}	-	-	84.9
									$*60_{MB}$	-	-	85.3
									$0\text{-}30_{MB}$	-	-	85.7

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CORING LOG
(continued)

BORING NUMBER: **CD-15**
SHEET NUMBER: **3** of **4**
PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
									0	1.5	1.0	88.3
90									*65	1.5	1.0	89.3
									45	1.5	1.0	90
						Gray SCHIST, unweathered, sound, very wide fracture spacing, strong rock, coarse to fine grained -PEGMATITE Material from 98.3' to 98.7' congruent to foliation -Possible micro-shears at 98.2' to 98.3'	I	R4	30_{MB}	-	-	90.5
									*65_{MB}	-	-	90.9
									*65_{MB}	-	-	93
95		C-8 90.5 - 100.0	114	100	100							
									*50_{MB}	-	-	95.3
									40_{MB}	-	-	95.8
									70_{MB}	-	-	96.3
									40_{MB}	-	-	96.5
									20_{MB}	-	-	98.2
100						Gray SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained (100'-103.8'), except PEGMATITE material from 101.1' to 101.5' congruent with wavy foliation	II	R4	60_{MB}	-	-	100
									0_{MB}	-	-	101.3
									*50_{MB}	-	-	101.7
									*40	1.5	1.0	102.5
									*30	1.5	2.0	103.1
						Light gray PEGMATITE, unweathered, very wide fracture spacing, sound, very strong, medium to fine grained (103.8'-109.6') -Core barrel jammed from 108.5' to 109.6'. Rock damaged.	I	R5	*30	1.5	1.0	103.4
									*30	1.5	1.0	103.6
105		C-9 100.0 - 109.6	115	100	92				50	1.5	1.0	103.8
									10_{MB}	-	-	104.8
									30_{MB}	-	-	106.1
110						Light gray-white PEGMATITE, unweathered, very wide fracture spacing, sound, very strong, medium to fine grained (109.6'-112',113.4'-116' and 116.4'-117.1')	I	R5				
						Gray SCHIST, unweathered, sound, wide fracture spacing, strong rock, coarse to fine grained (112'-113.4'), (116'-116.4'), (117.1'-118.8')	I	R4	*65_{MB}	-	-	112
		C-10 109.6 - 118.8	110	100	100				0_{MB}	-	-	113.3
									40_{MB}	-	-	113.8
115									60_{MB}	-	-	114.3
									50_{MB}	-	-	116.8
									20_{MB}	-	-	117.9
									55_{MB}	-	-	118.4
						Gray SCHIST, slightly weathered, sound, wide fracture spacing, strong rock, coarse to fine grained. Foliation is + or - 65 degrees along the run.	II	R4	30_{MB}	-	-	118.8
									*60_{MB}	-	-	119.5
120									10_{MB}	-	-	120.2
		C-11 118.8 - 125.0	74	100	100				*70_{MB}	-	-	121.4

Parsons
Brinckerhoff
Quade &
Douglas, Inc.
100 YEARS ®

CORING LOG
(continued)

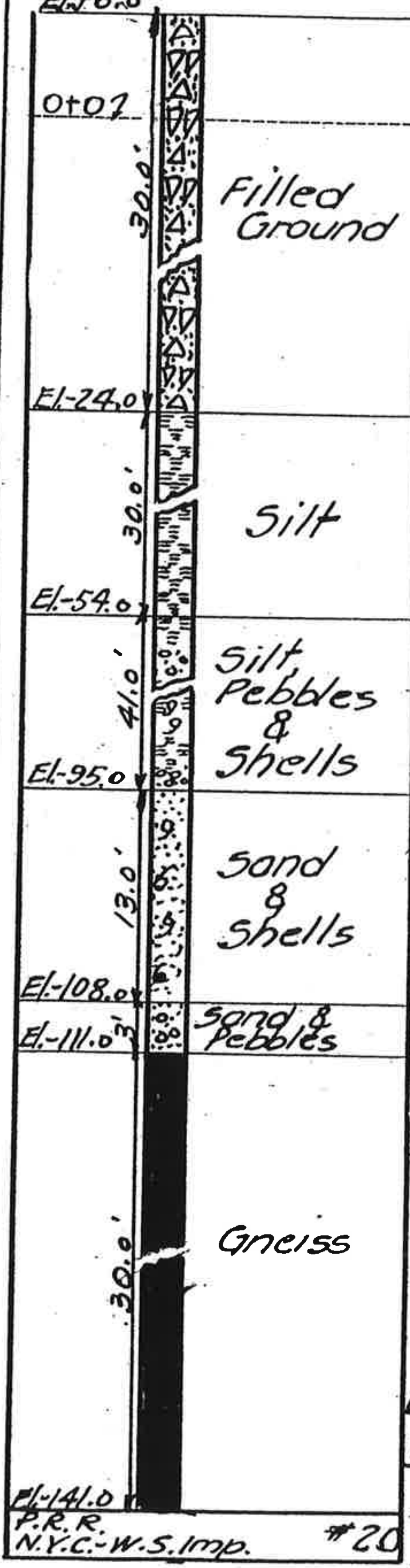
BORING NUMBER: **CD-15**
SHEET NUMBER: **4** of **4**
PROJECT NUMBER: **26553A**

PROJECT: **No 7 Subway line Extension**
LOCATION: **Manhattan**
CLIENT: **MTA**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **M. Blejuwas**
INSPECTOR: **A. Zabala**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	DISCONTINUITY DATA Jr	DISCONTINUITY DATA Ja	DISCONTINUITY DATA DEPTH (feet)
									20_{MB}	-	-	123.7
									$*65_{\text{MB}}$	-	-	124.4
125						E.O.B. at 125'.			10_{MB}	-	-	125
130												
135												
140												
145												
150												
155												

#4



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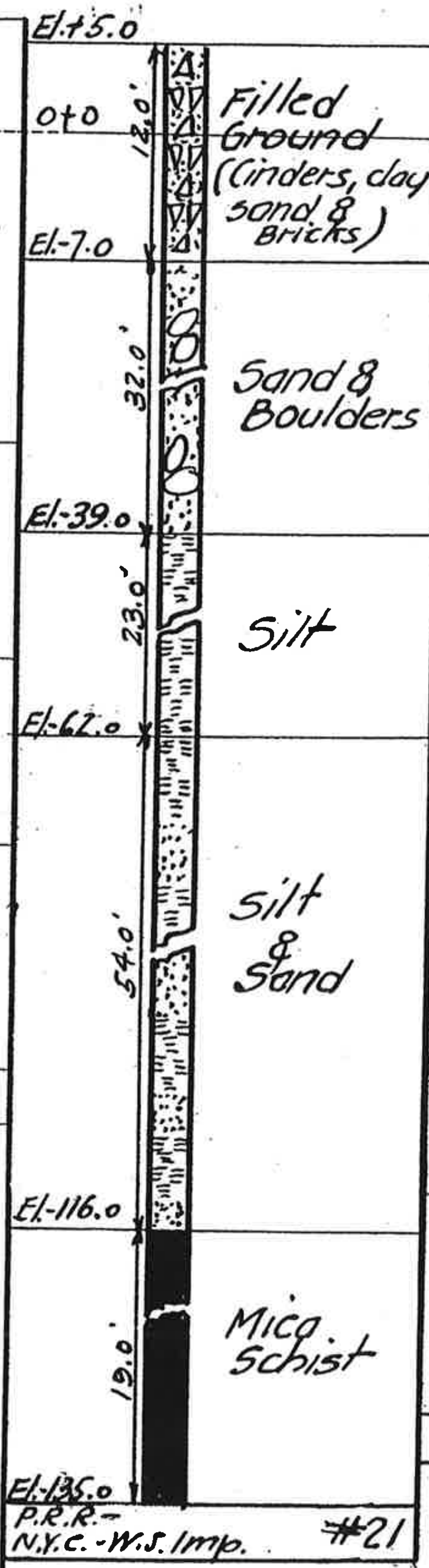

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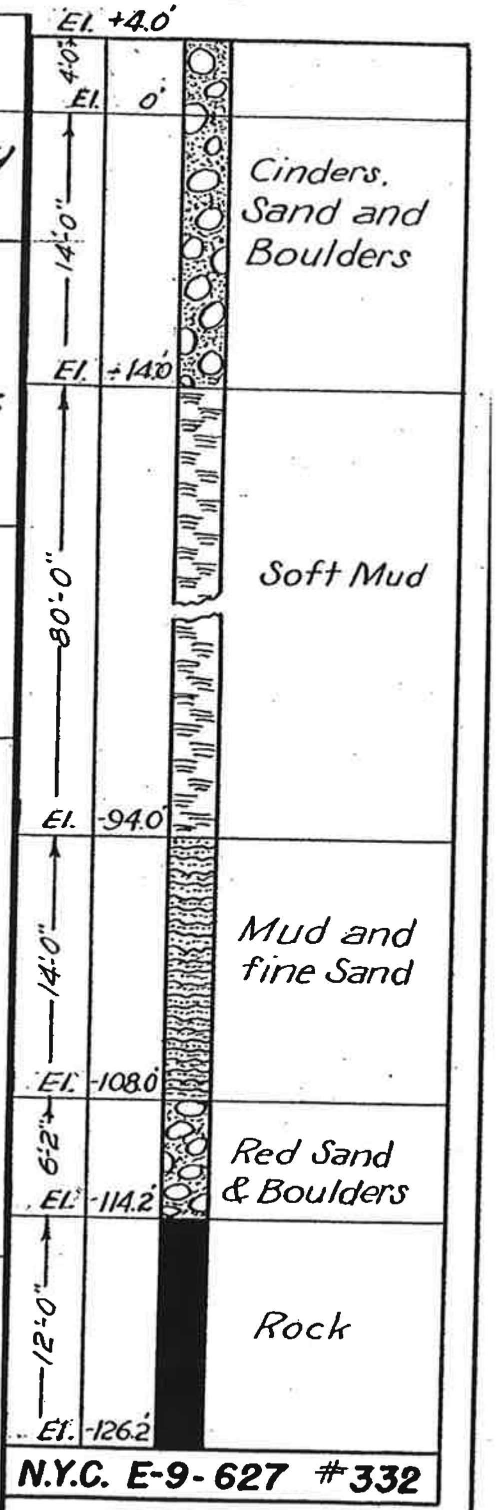
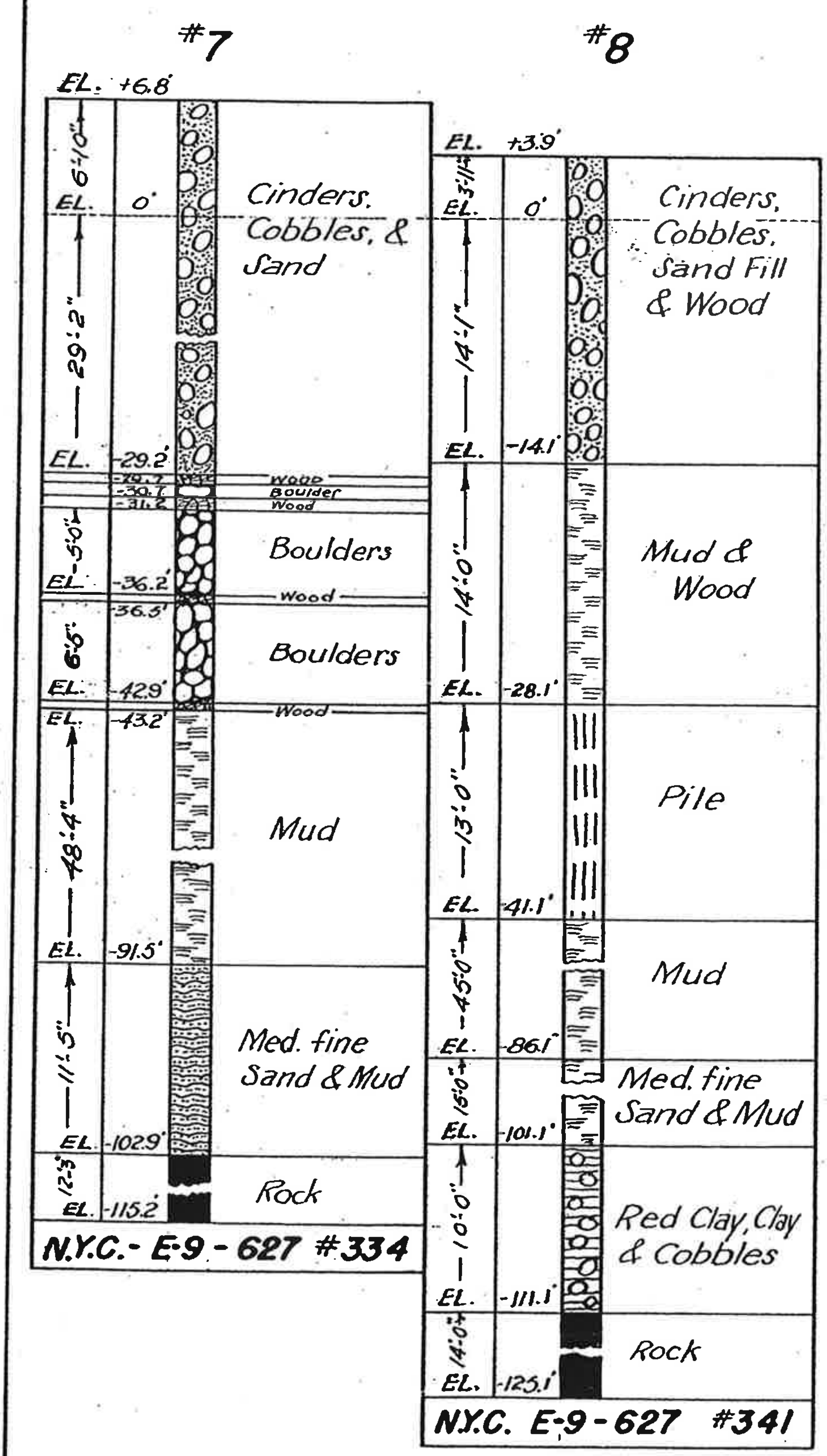


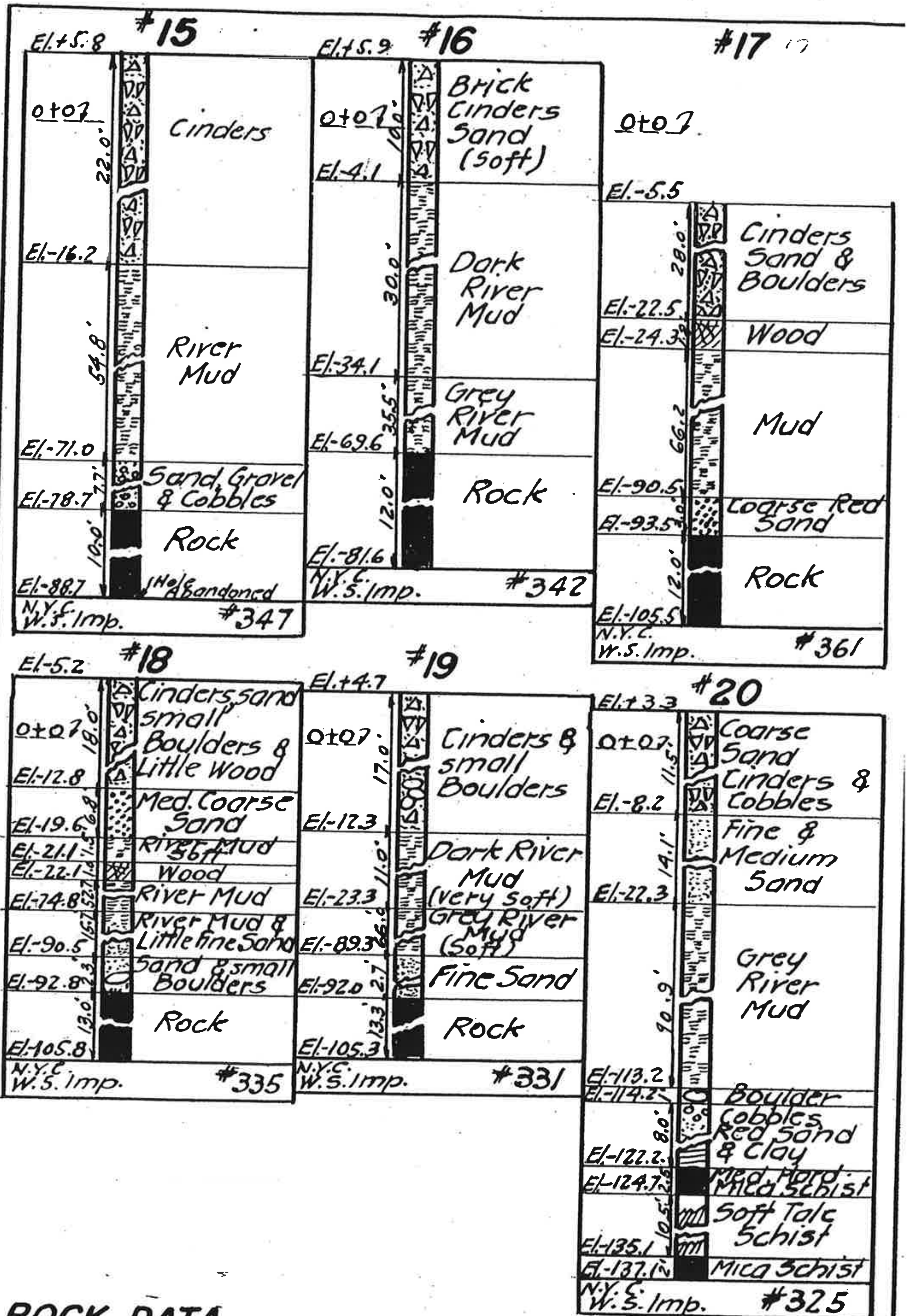
ROCK DATA

VOL.2 SHEET 10



ROCK DATA

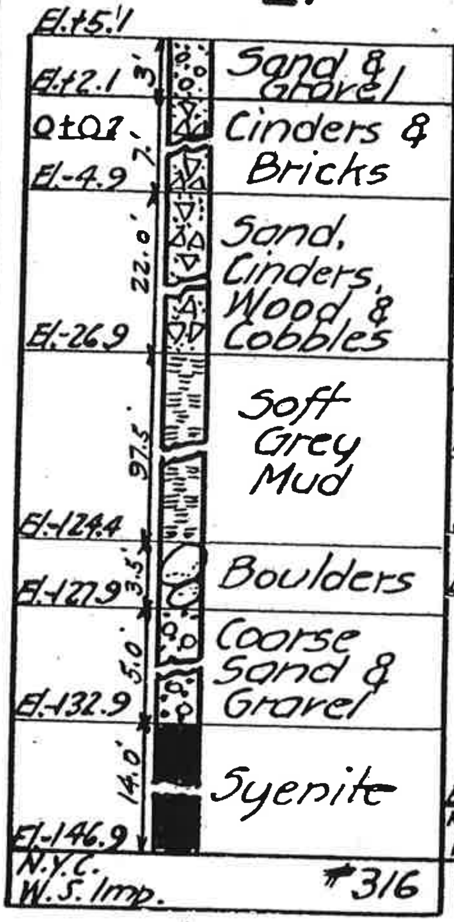
VOL.2 SHEET 10



ROCK DATA

VOL 2 SH 10

#21



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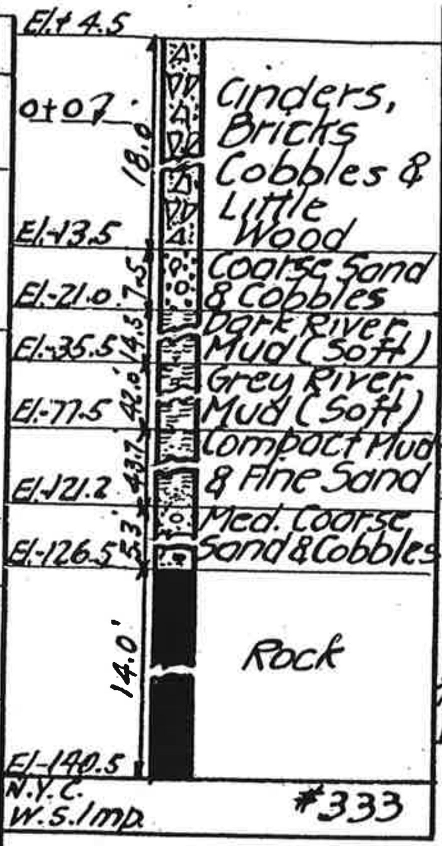

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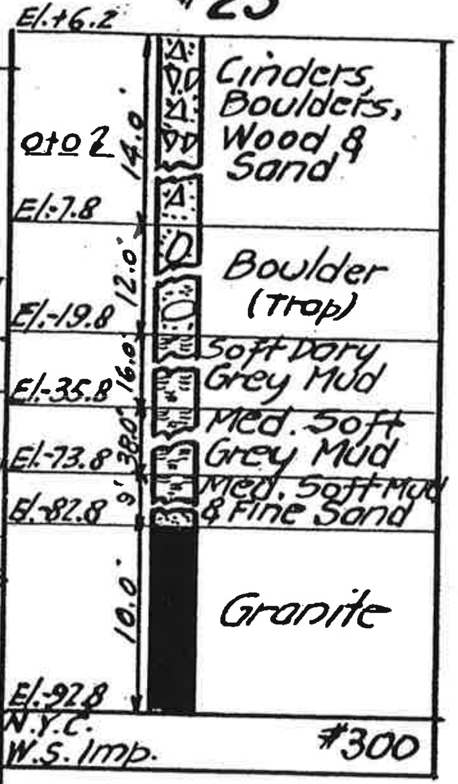

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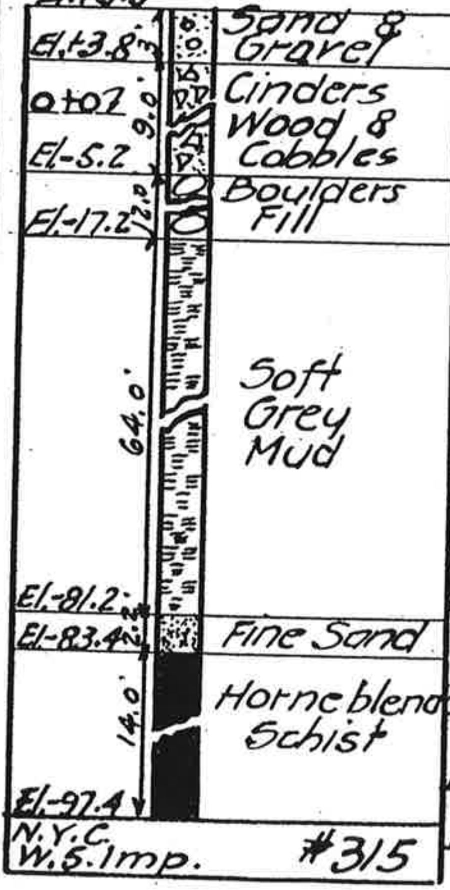

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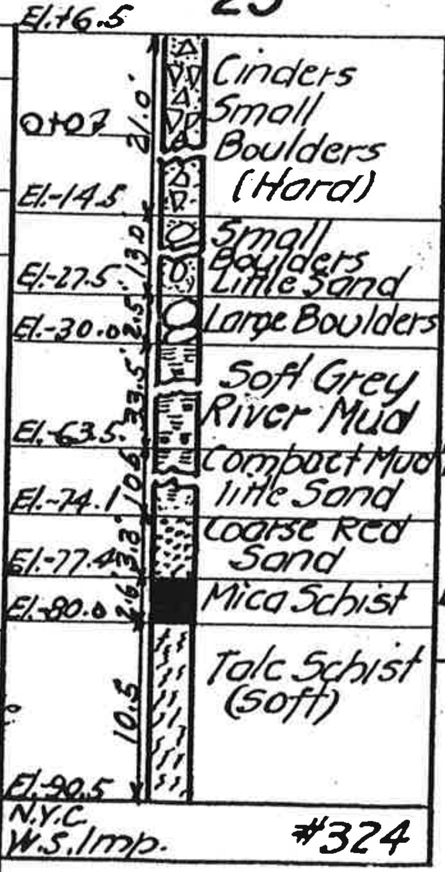

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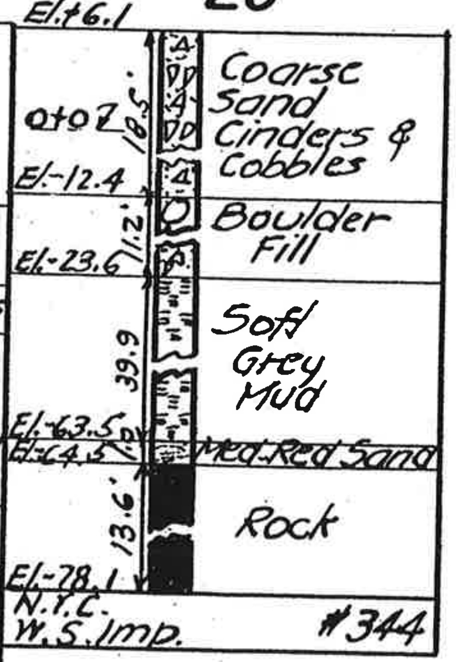

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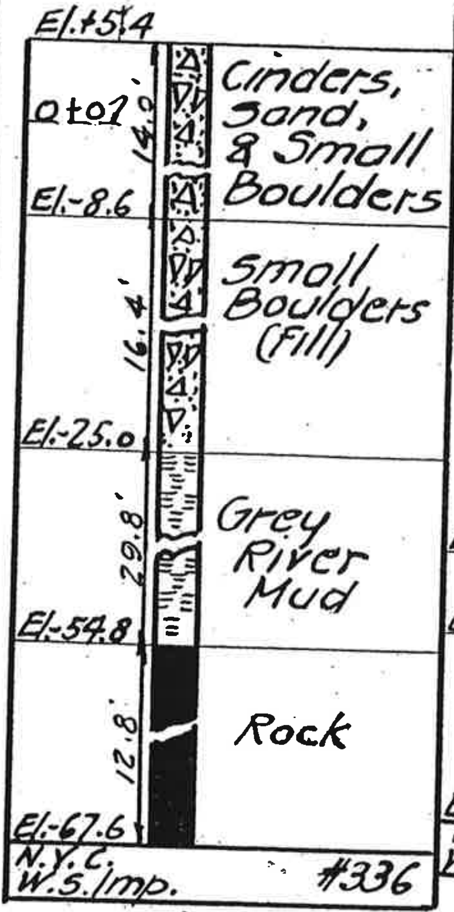

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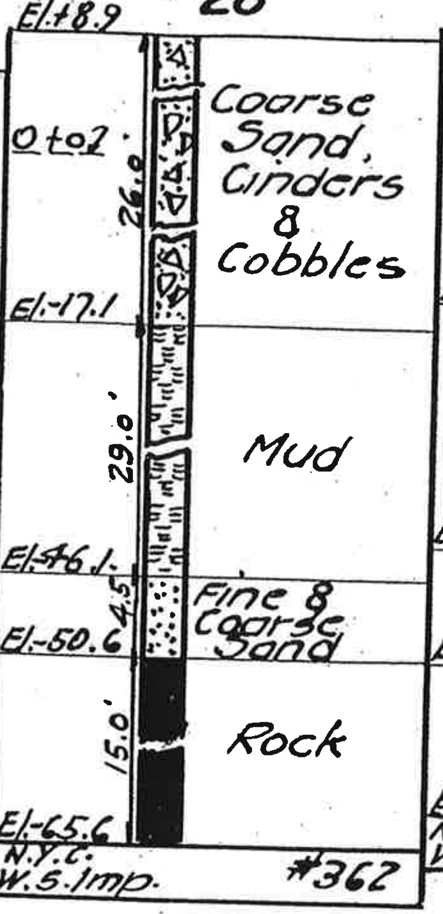

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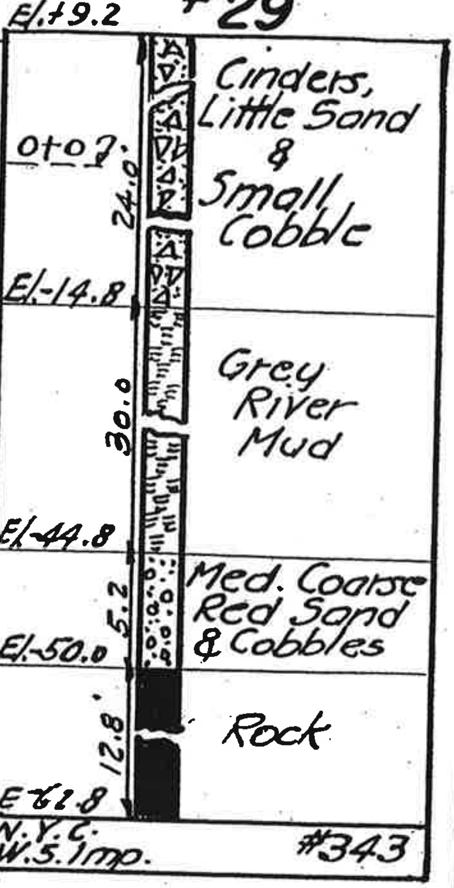

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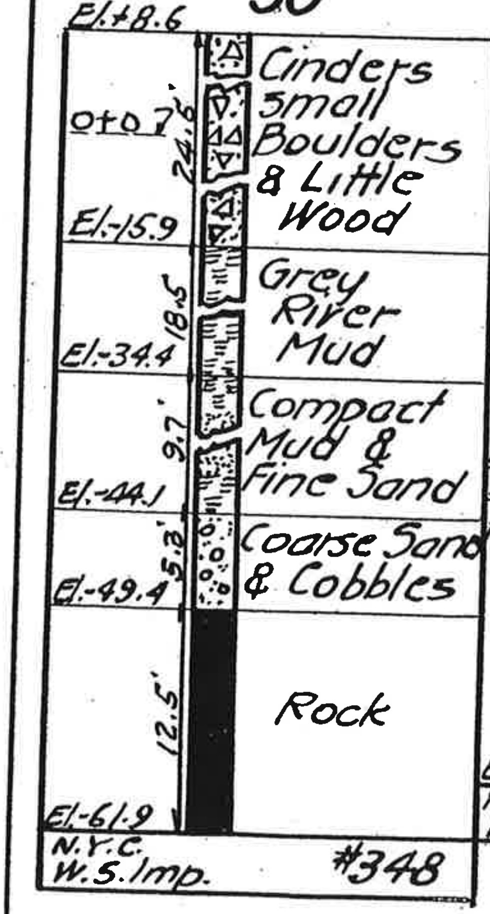

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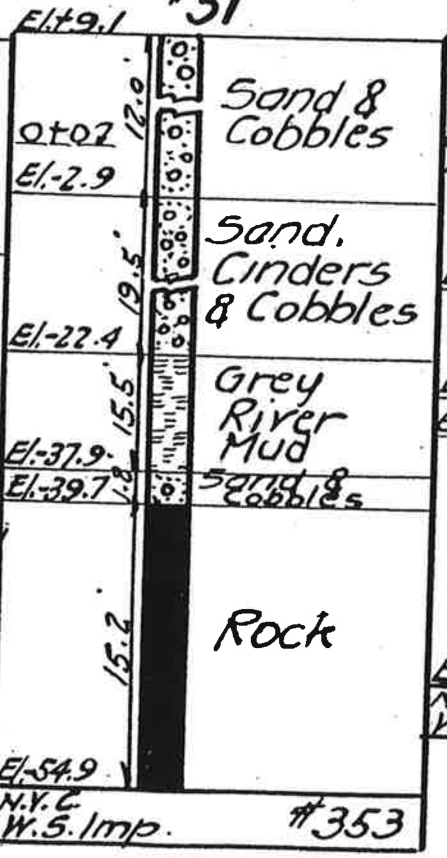
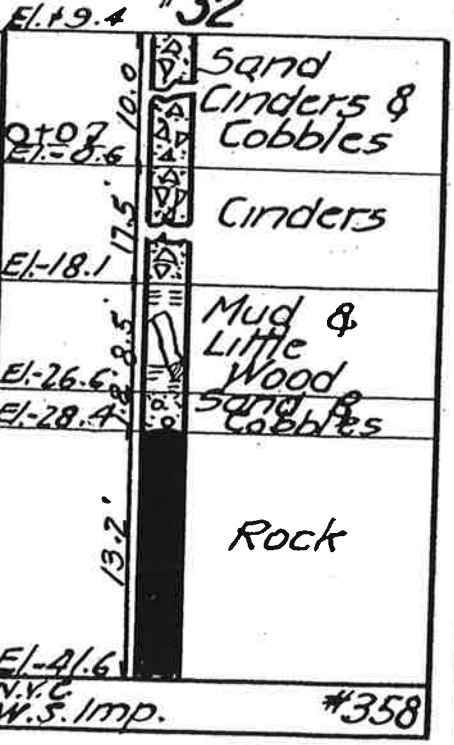


#32



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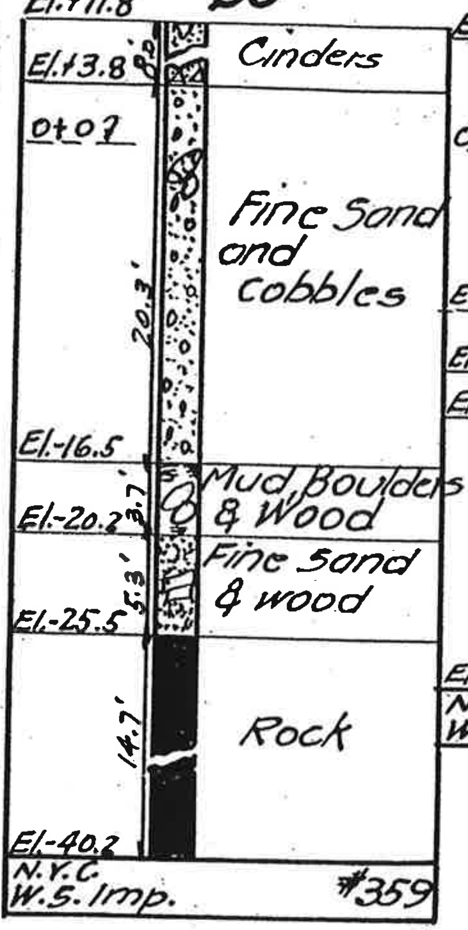
#33



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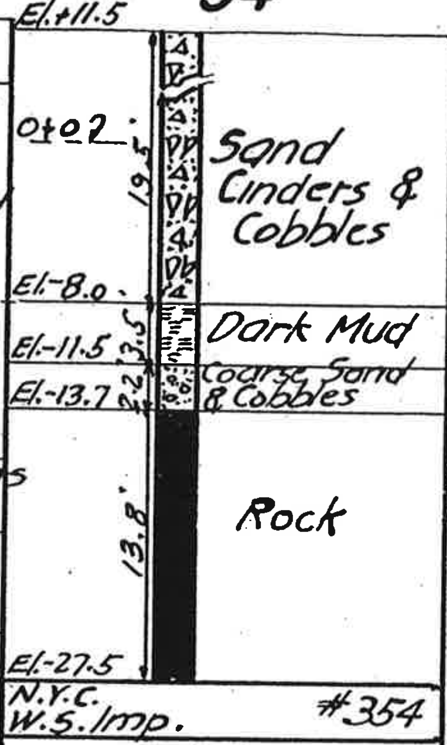

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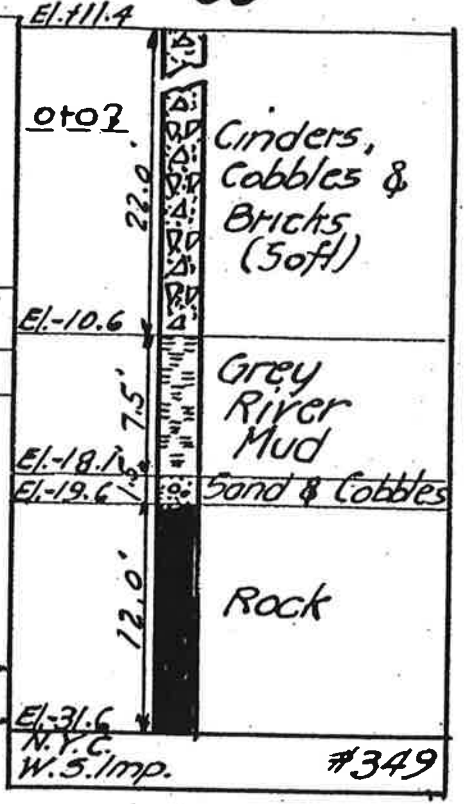

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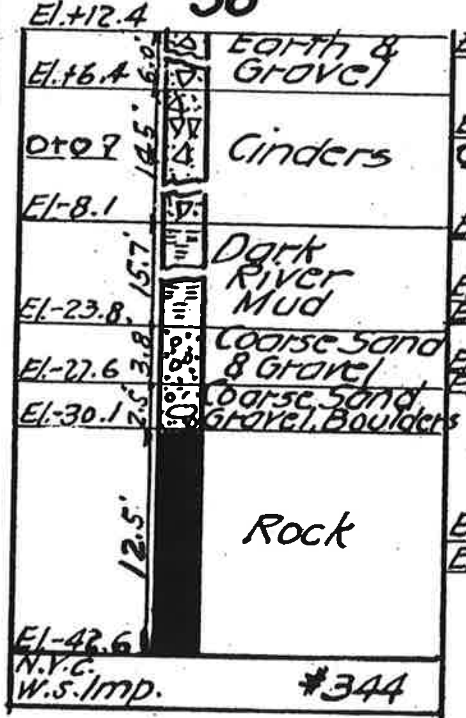
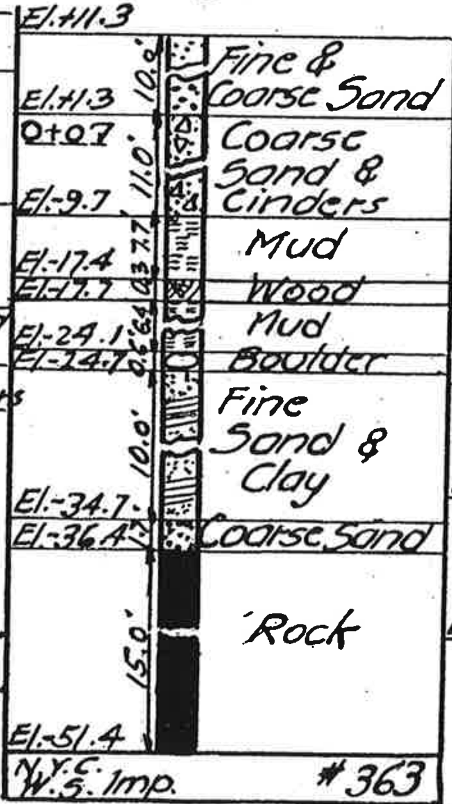


#37



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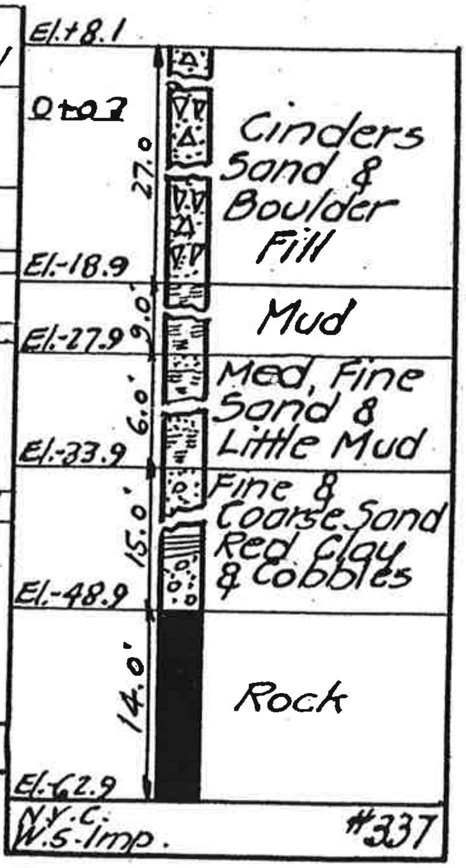
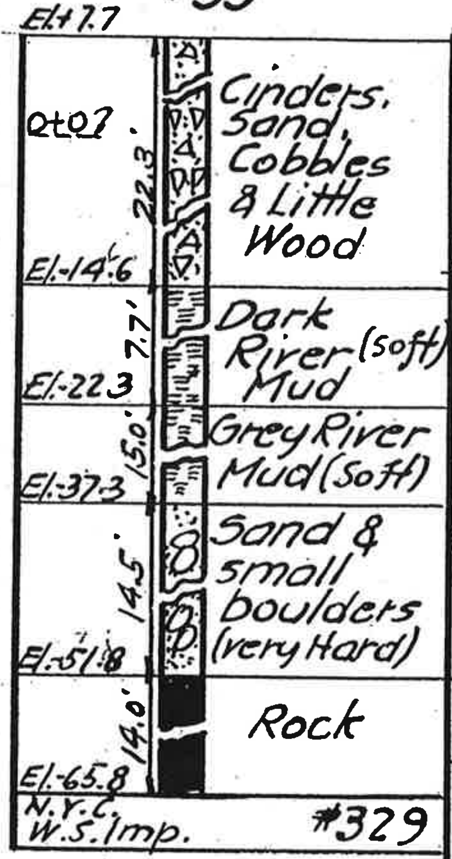
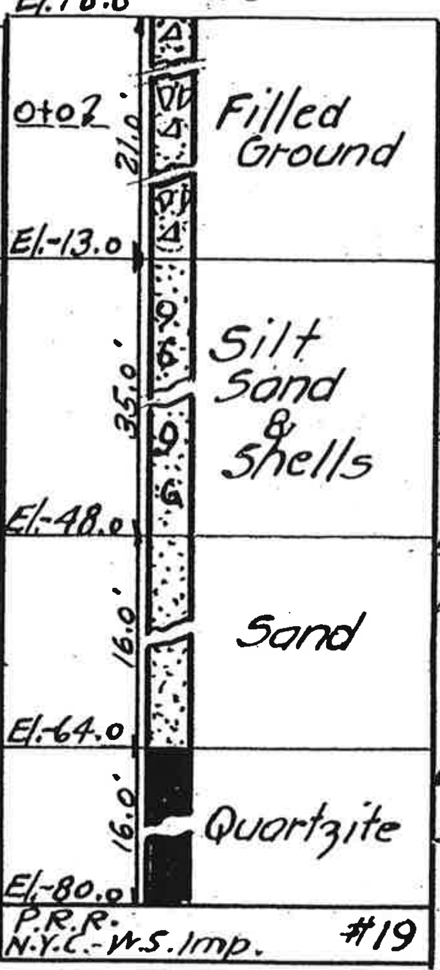


#39



#40



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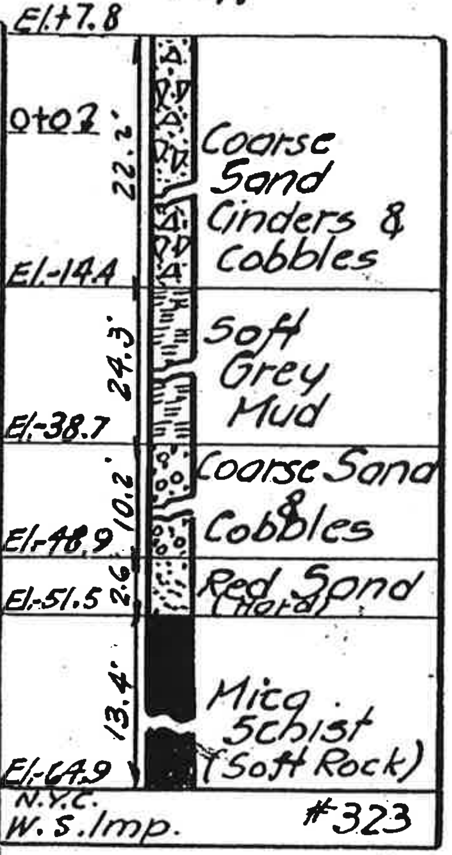
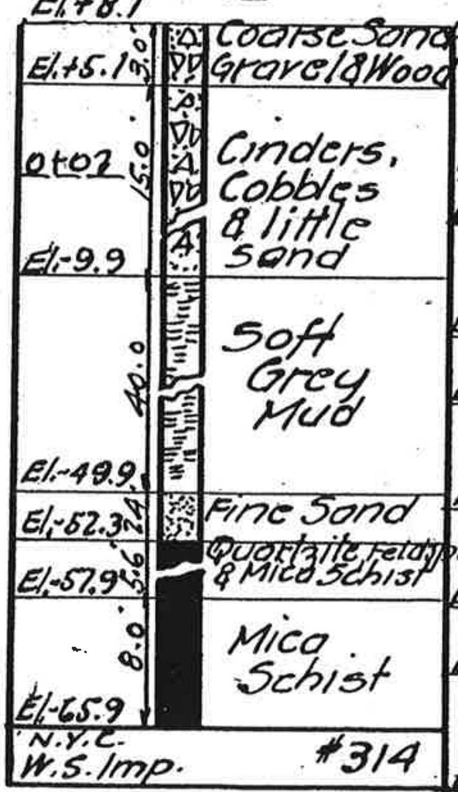


#42



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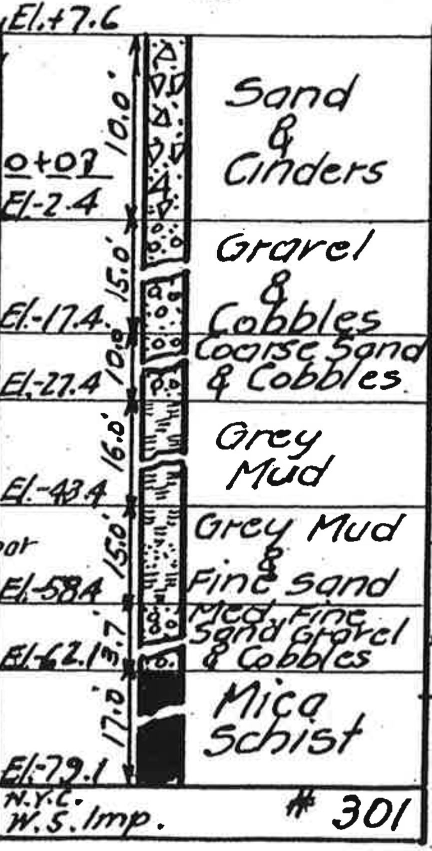
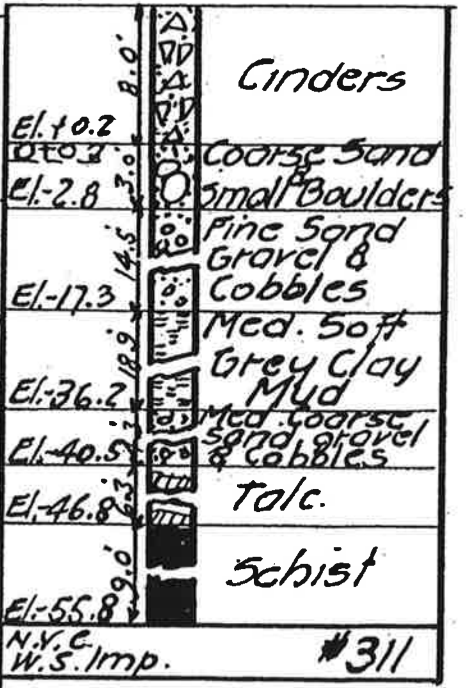
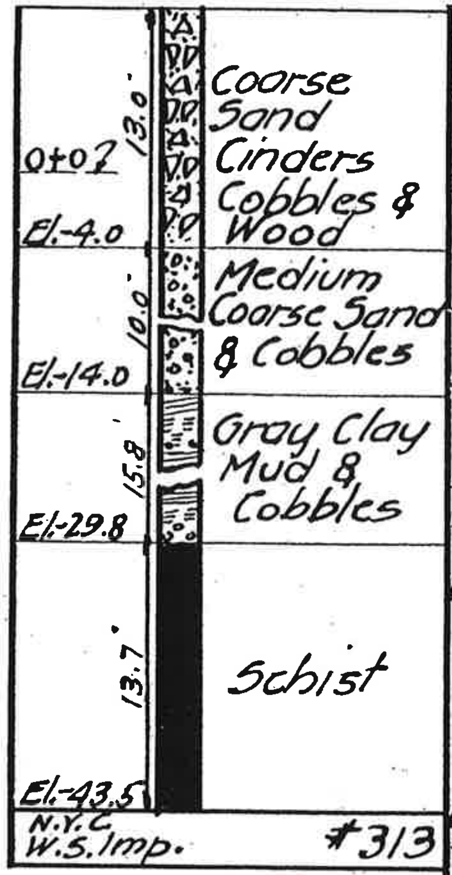


#44



ROCK DATA

#45



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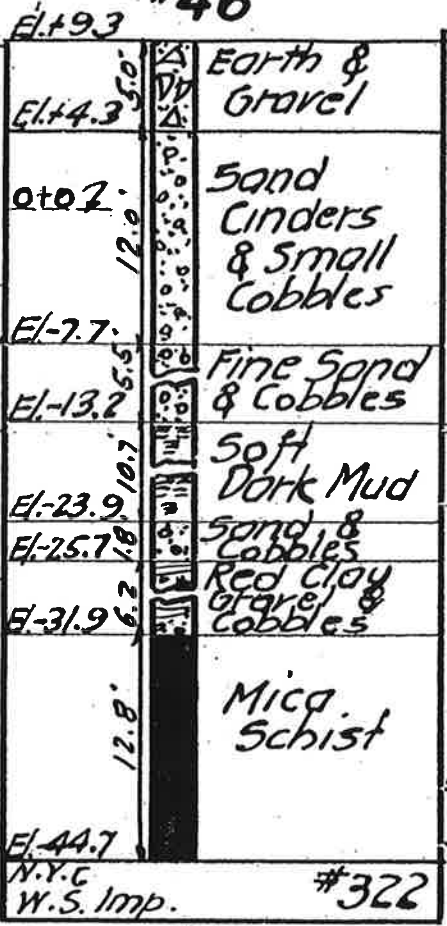
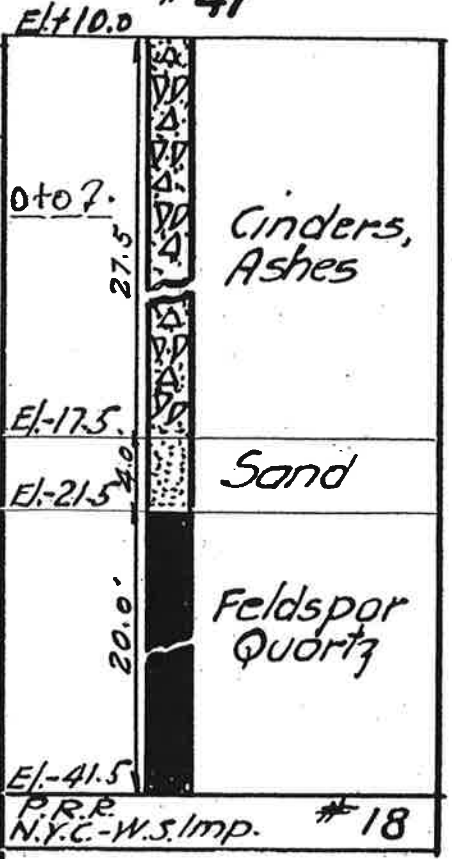


#47



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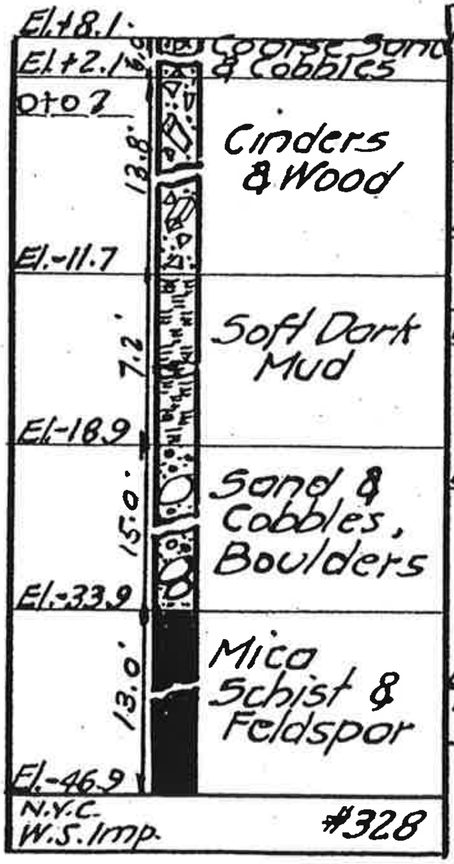

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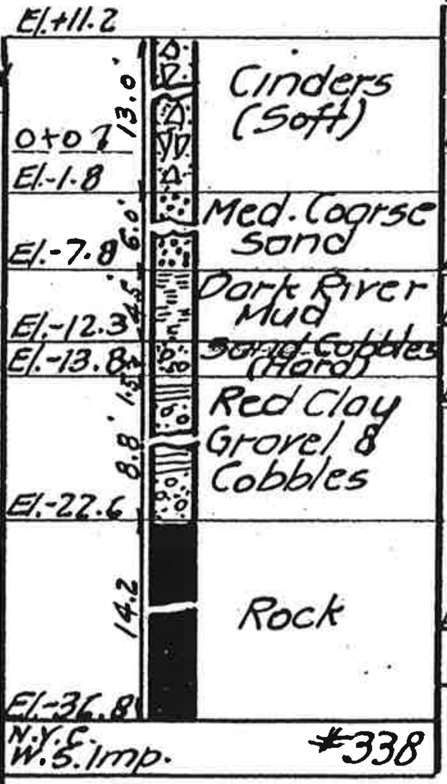

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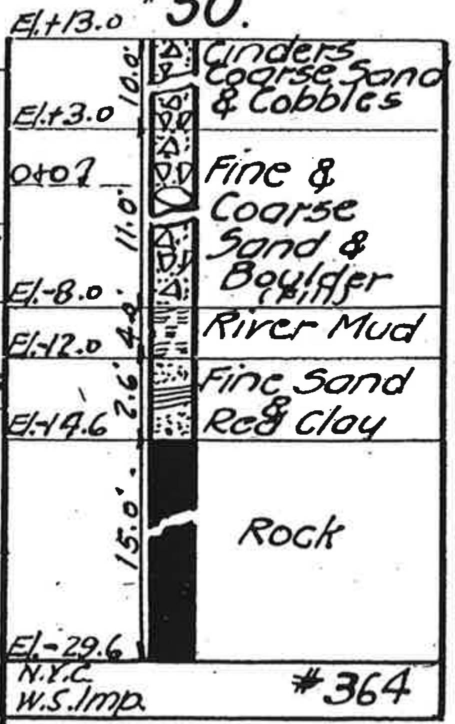

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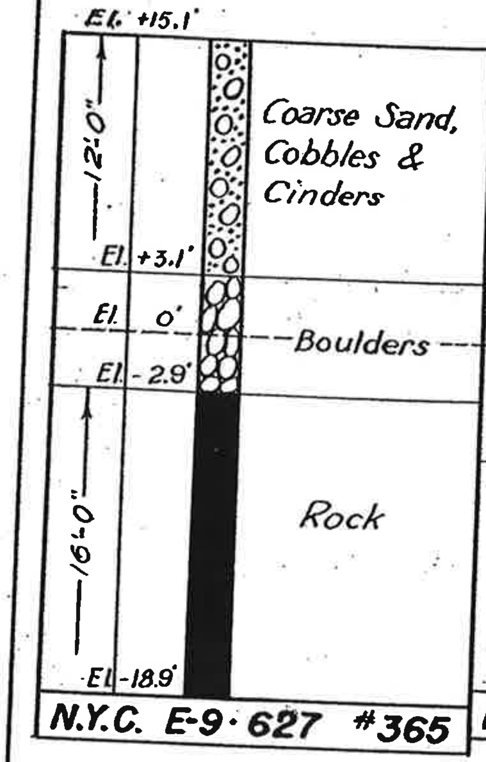
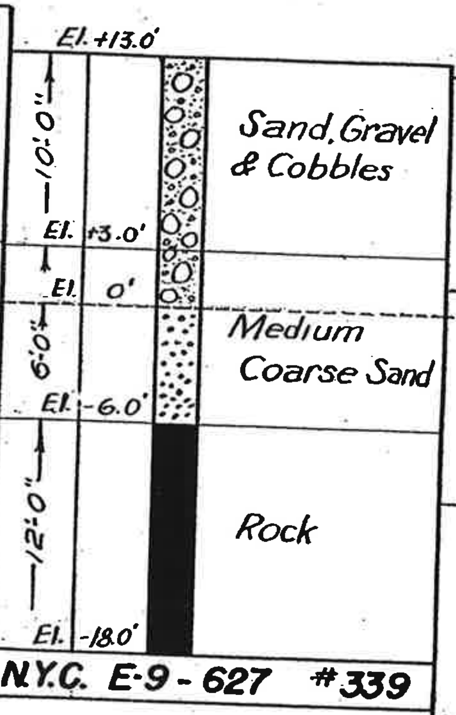
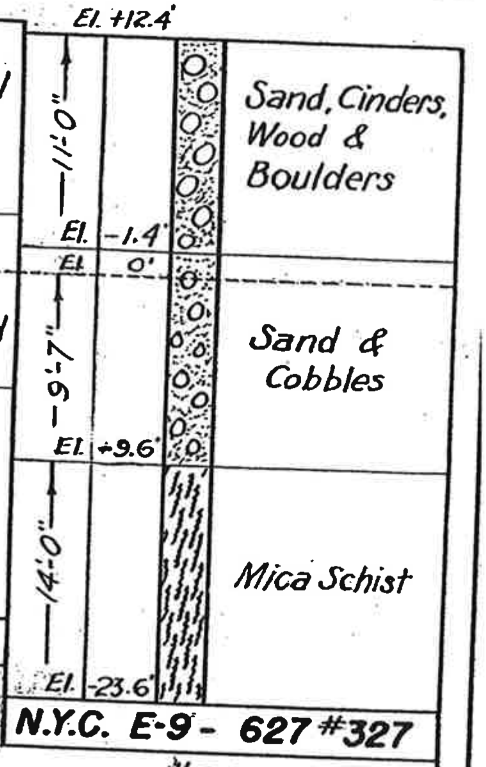


#58



#59



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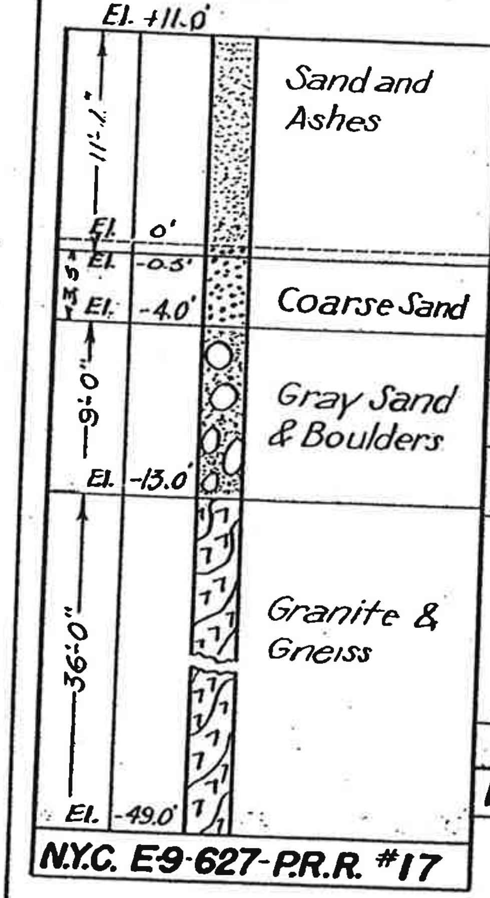
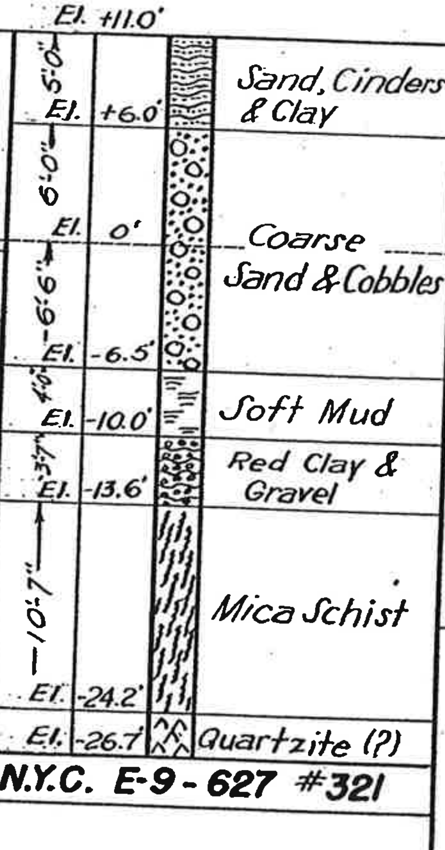
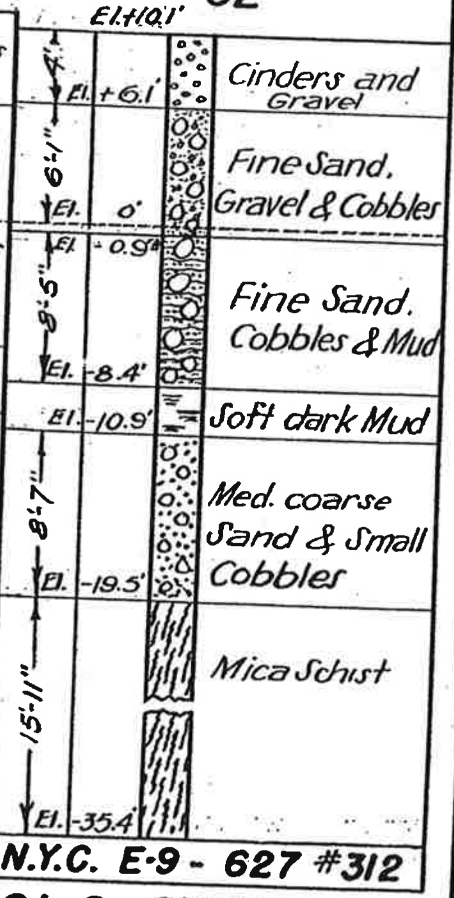


#61



#62



ROCK DATA

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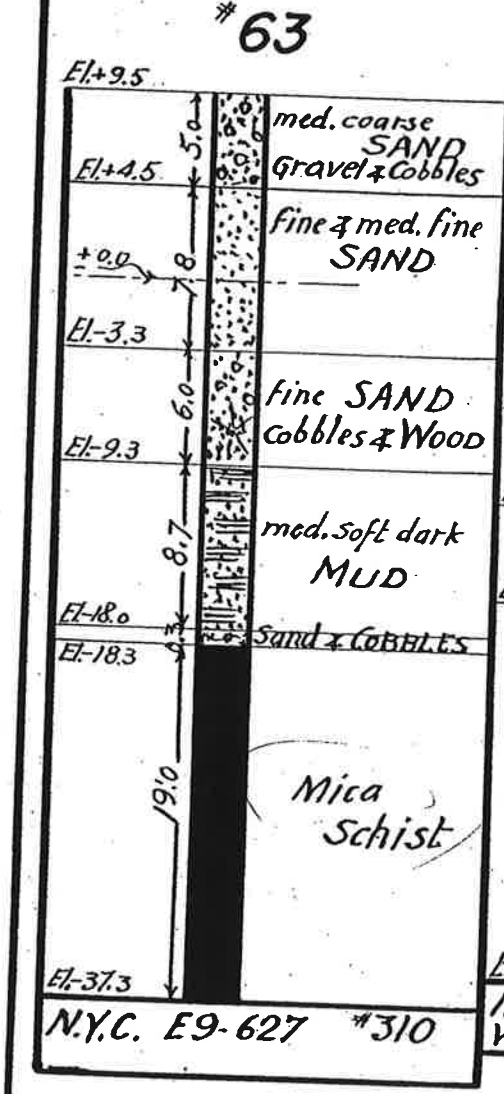
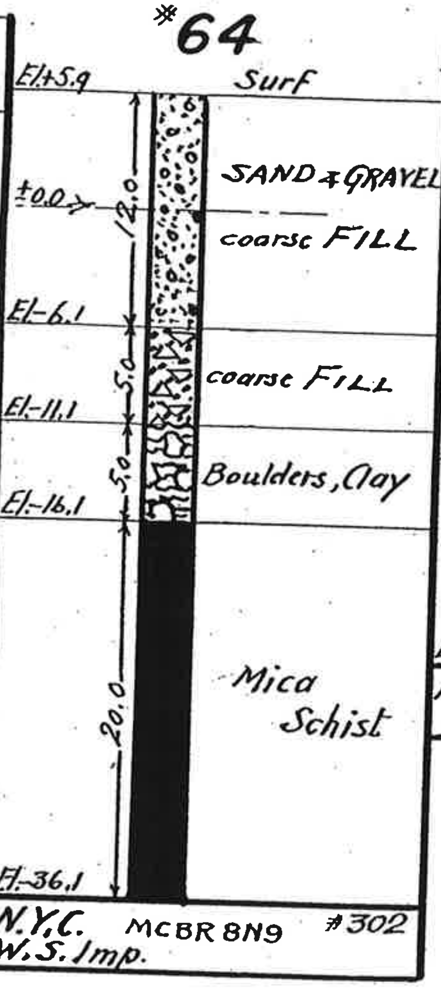
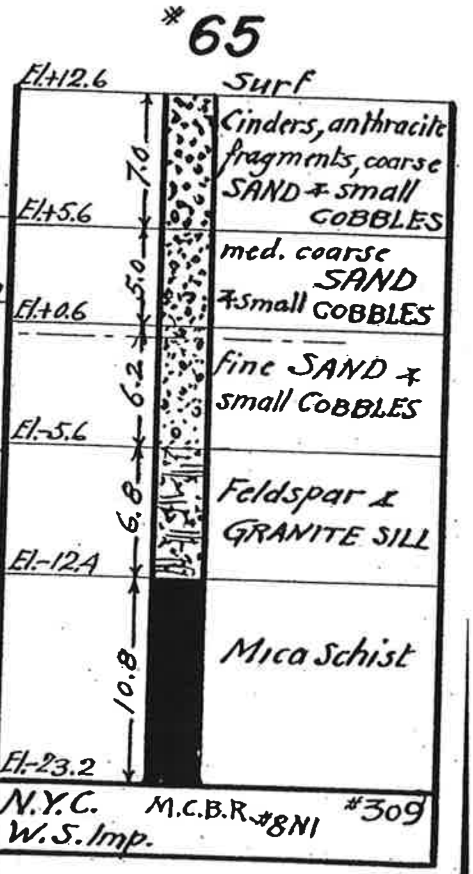
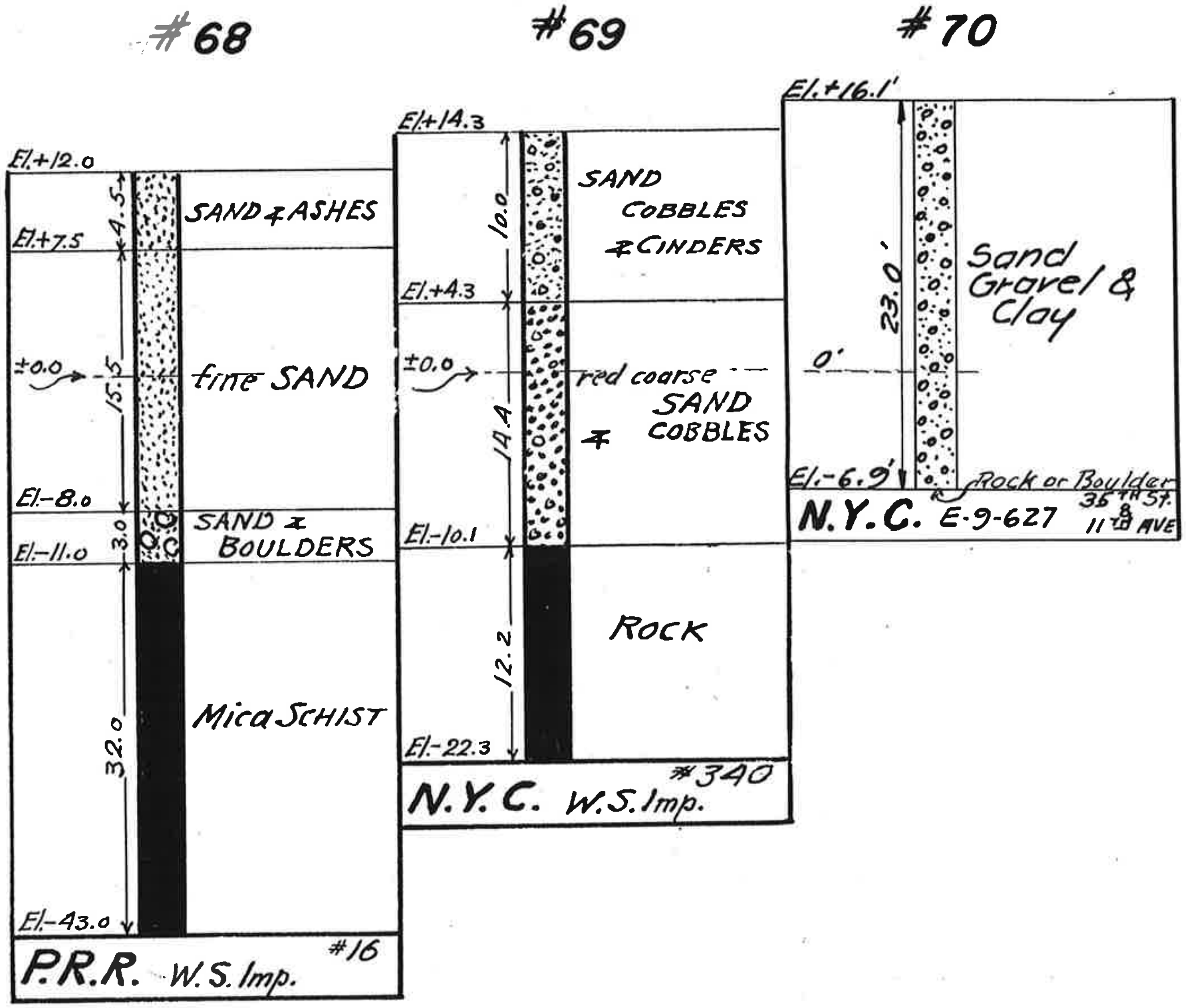






ROCK DATA VOL. 2, SHEET 10



ROCK DATA

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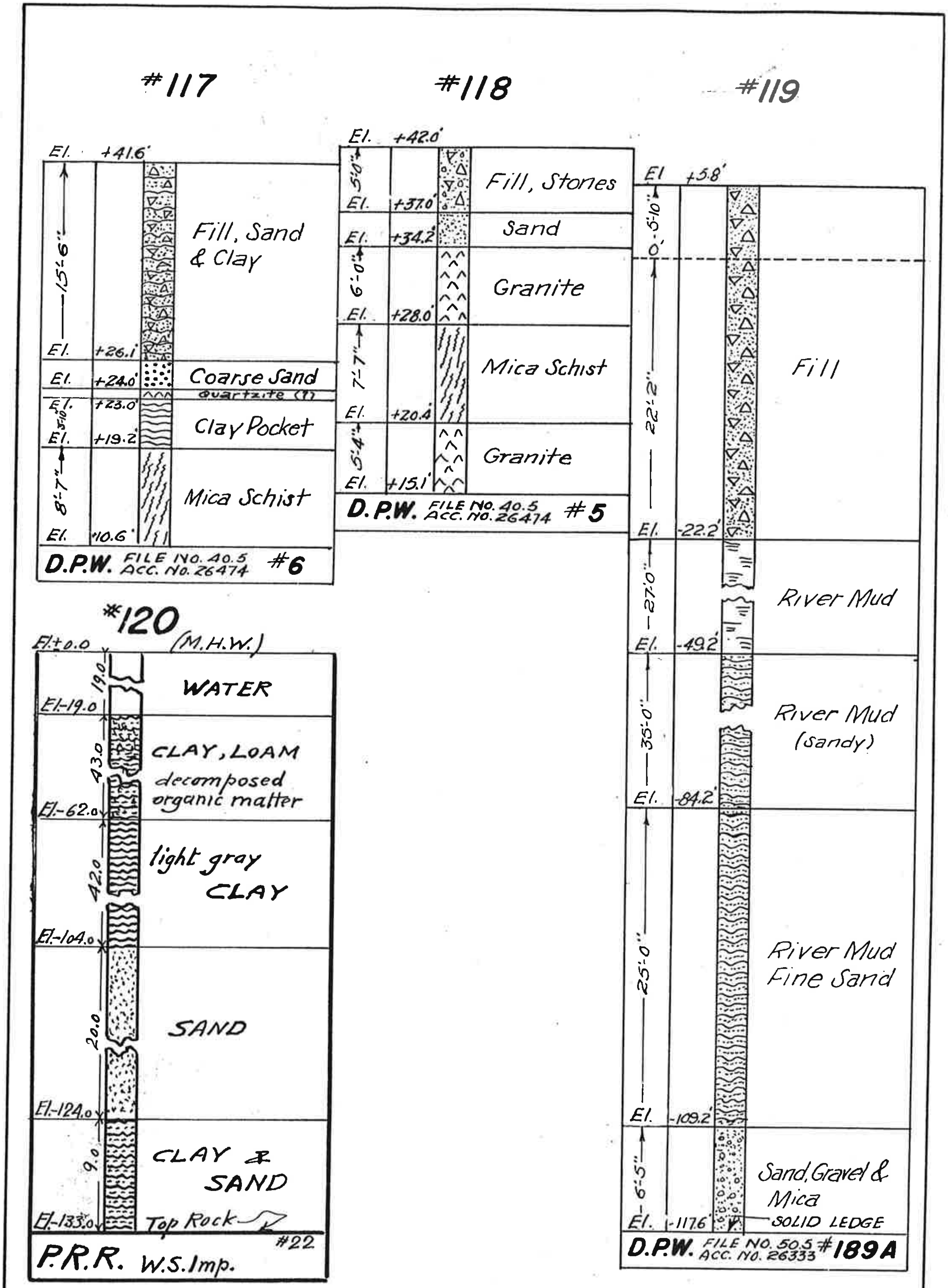
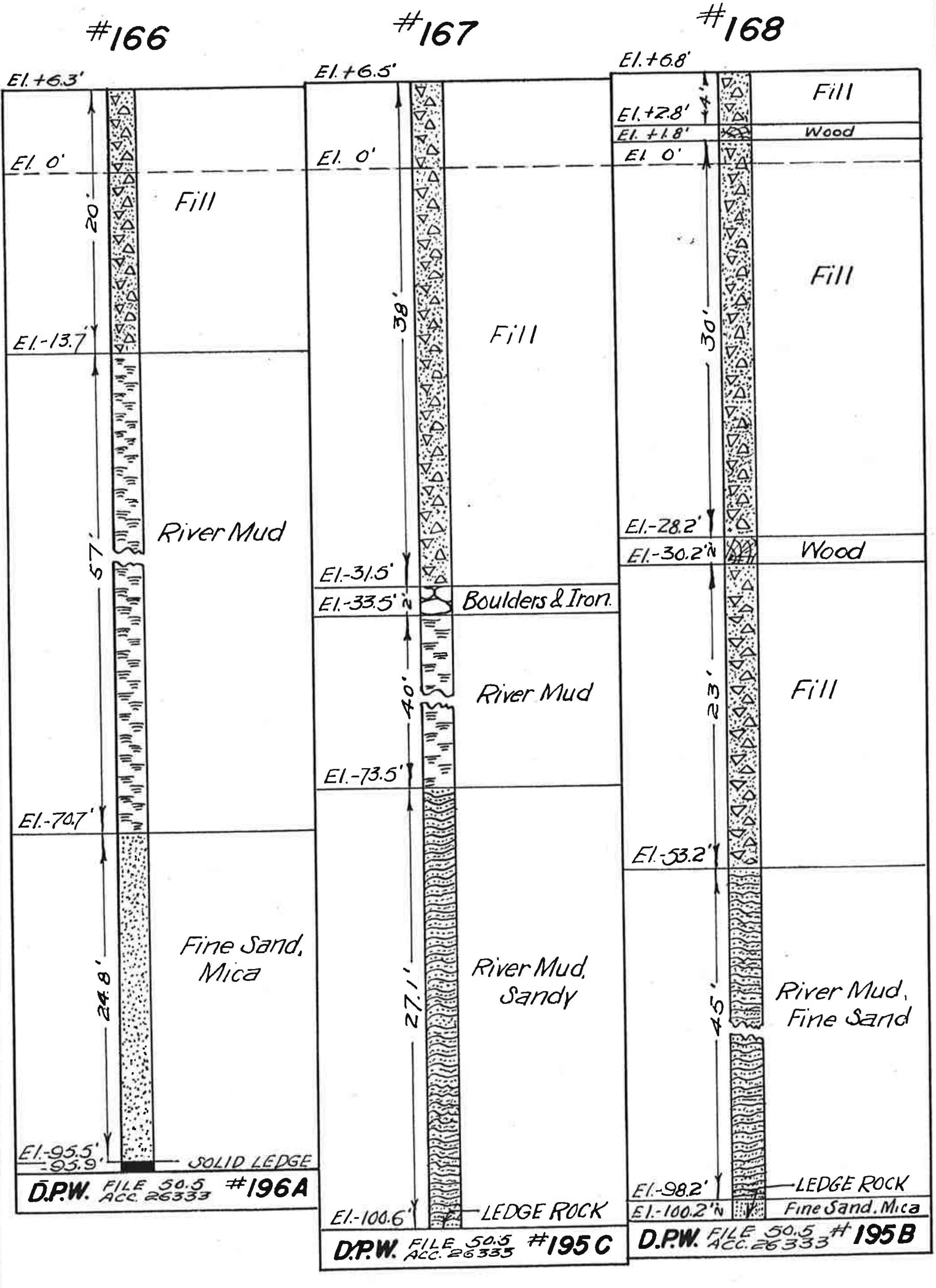
Ch. B. 11-19-34

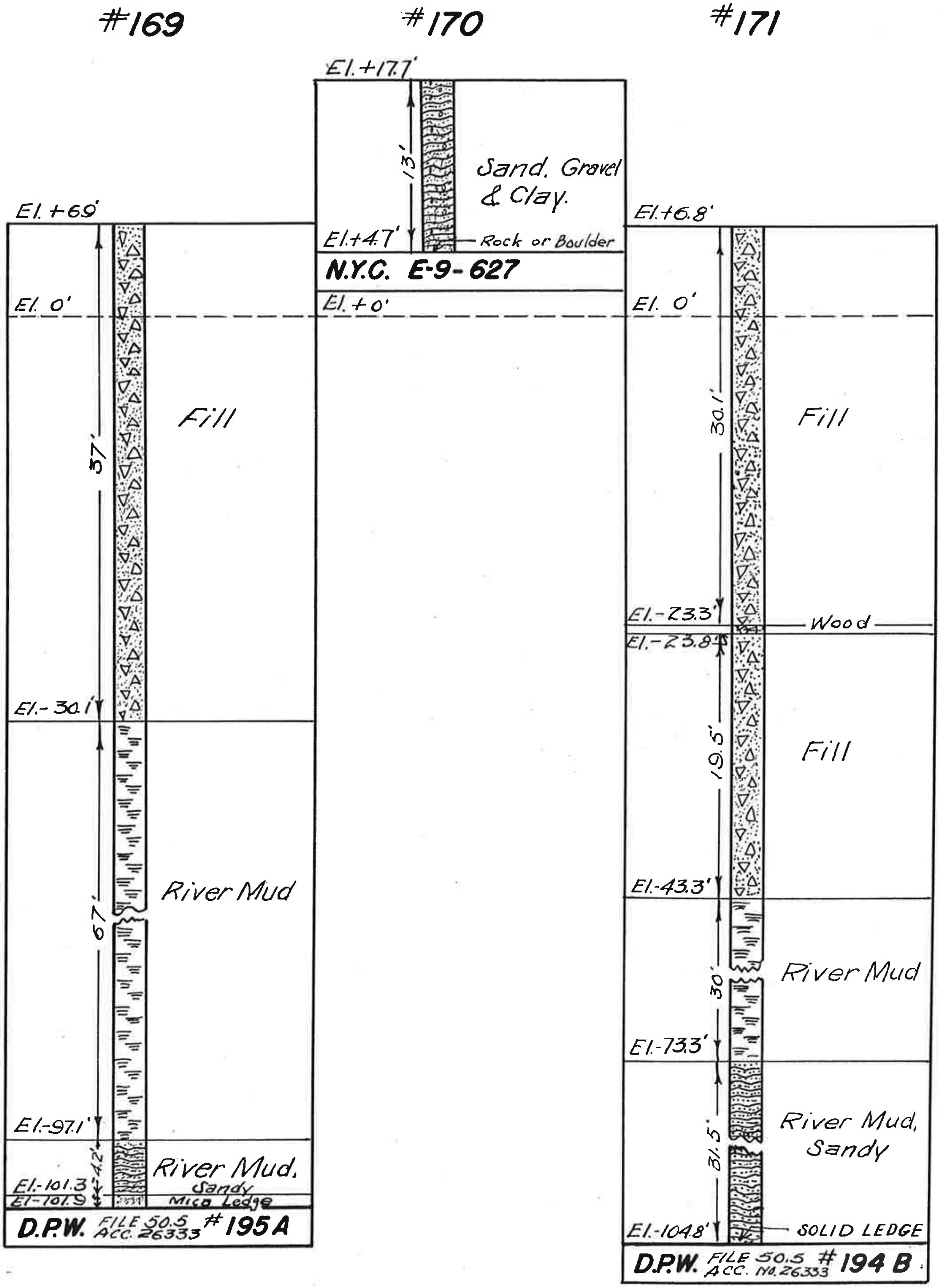

#117
El. +41.6'
15'-6"
Fill, Sand & Clay
El. +26.1'
El. +24.0'
Coarse Sand
Quartzite (?)
El. +23.0'
5'-10"
Clay Pocket
El. +19.2'
8'-7"
Mica Schist
El. +10.6'
D.P.W. FILE NO. 40.5 ACC. NO. 26474 #6
#118
El. +42.0'
5'-0"
Fill, Stones
El. +37.0'
Sand
El. +34.2'
6'-0"
Granite
El. +28.0'
7'-7"
Mica Schist
El. +20.4'
5'-4"
Granite
El. +15.1'
D.P.W. FILE NO. 40.5 ACC. NO. 26474 #5
#119
El. +5.8'
0'-5'-10"
22'-2"
Fill
El. -22.2'
27'-0"
River Mud
El. -49.2'
35'-0"
River Mud (sandy)
El. -84.2'
25'-0"
River Mud Fine Sand
El. -109.2'
6'-5"
Sand, Gravel & Mica
El. -117.6'
SOLID LEDGE
D.P.W. FILE NO. 50.5 ACC. NO. 26333 #189A
#120
El. ±0.0
(M.H.W.)
19.0
WATER
El. -19.0
43.0
CLAY, LOAM decomposed organic matter
El. -62.0
42.0
light gray CLAY
El. -104.0
20.0
SAND
El. -124.0
9.0
CLAY & SAND
El. -133.0
Top Rock
#22
P.R.R. W.S.Imp.

ROCK DATA



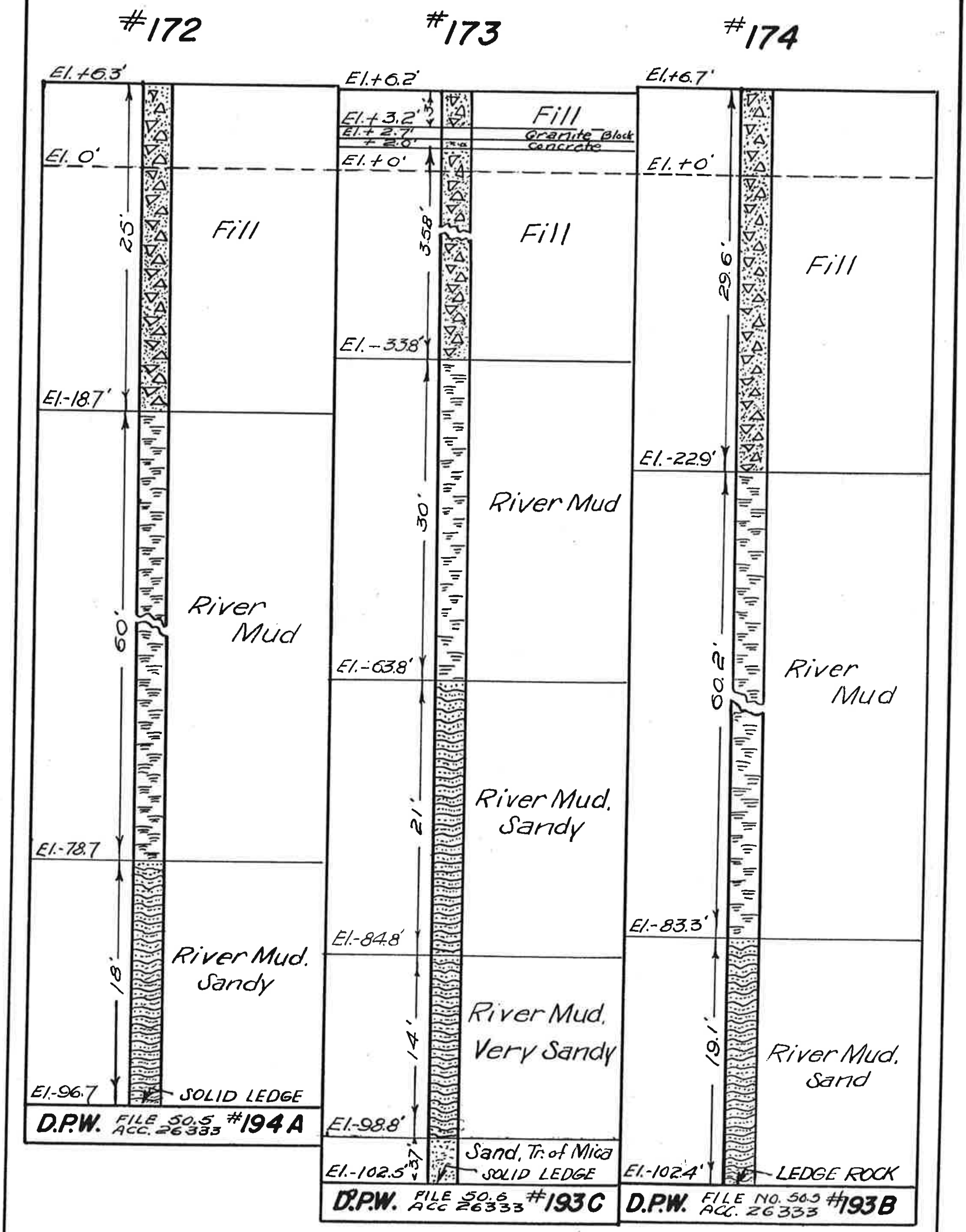
ROCK DATA

VOL. 2 SHEET 10

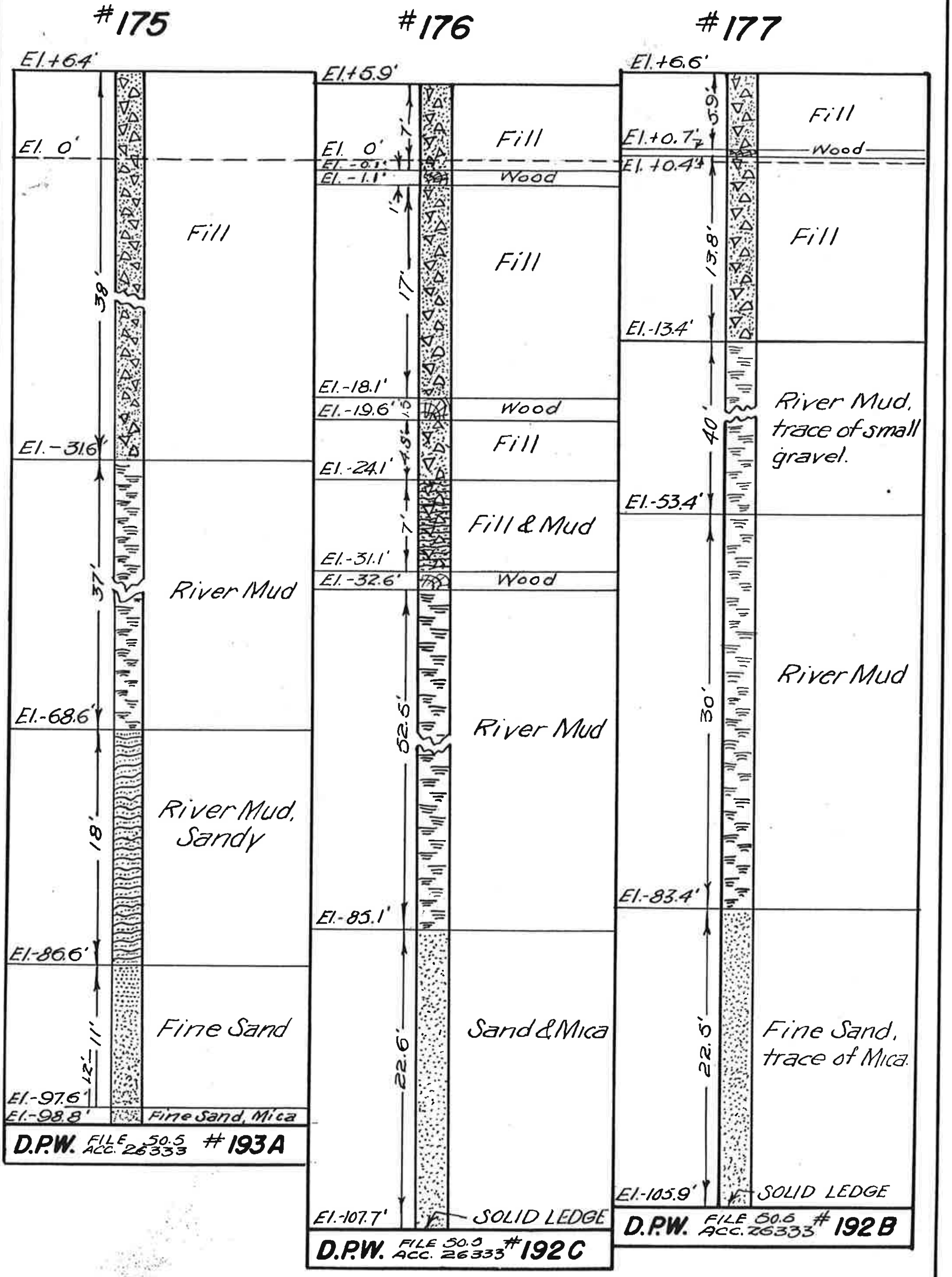


ROCK DATA

VOL. 2 SHEET 10

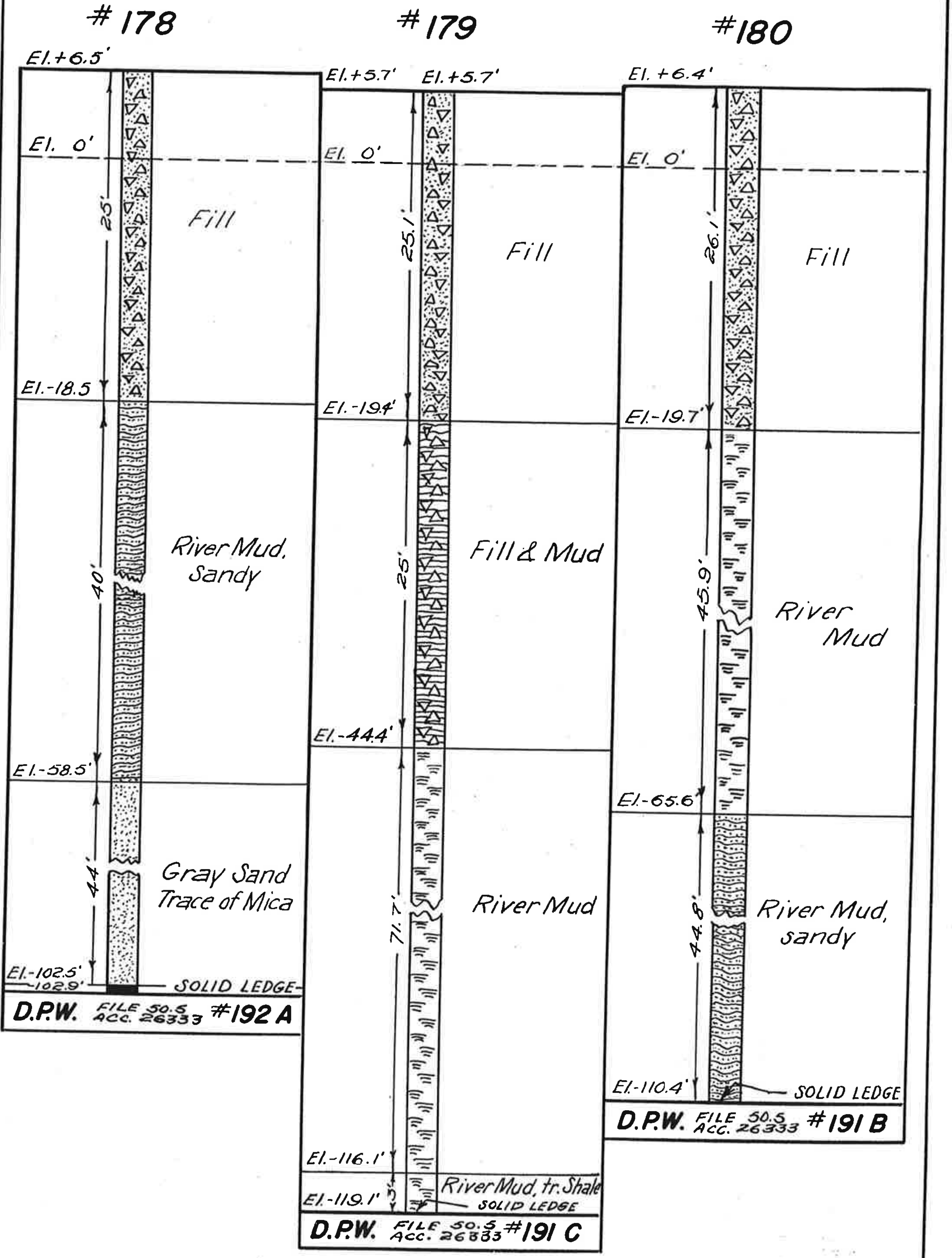

#172
El.+6.3'
El. 0'
25'
Fill
El.-18.7'
60'
River Mud
El.-78.7
18'
River Mud. Sandy
El.-96.7
SOLID LEDGE
D.P.W. FILE 50.5 ACC. 26333 #194 A
#173
El.+6.2'
3'
El.+3.2'
El.+2.7'
+2.0'
Fill
Granite Block
Concrete
El.+0'
35.8'
Fill
El.-33.8'
30'
River Mud
El.-63.8'
21'
River Mud. Sandy
El.-84.8'
14'
River Mud. Very Sandy
El.-98.8'
3.7'
Sand, Tr. of Mica
El.-102.5'
SOLID LEDGE
D.P.W. FILE 50.6 ACC 26333 #193C
#174
El.+6.7'
El.+0'
29.6'
Fill
El.-22.9'
60.2'
River Mud
El.-83.3'
19.1'
River Mud. Sand
El.-102.4'
LEDGE ROCK
D.P.W. FILE NO. 50.5 ACC. 26333 #193B

ROCK DATA



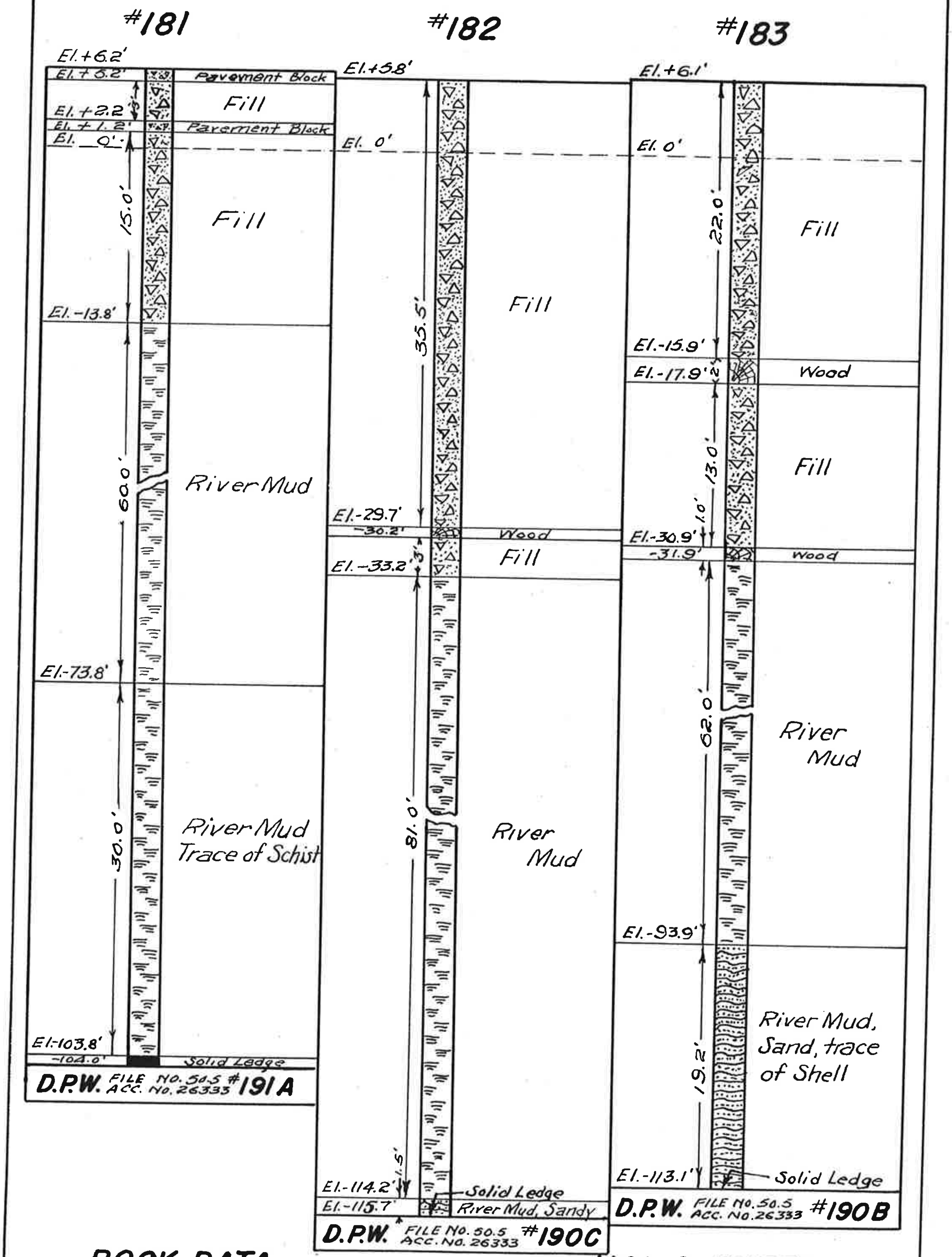
ROCK DATA

VOL.2 SHEET 10



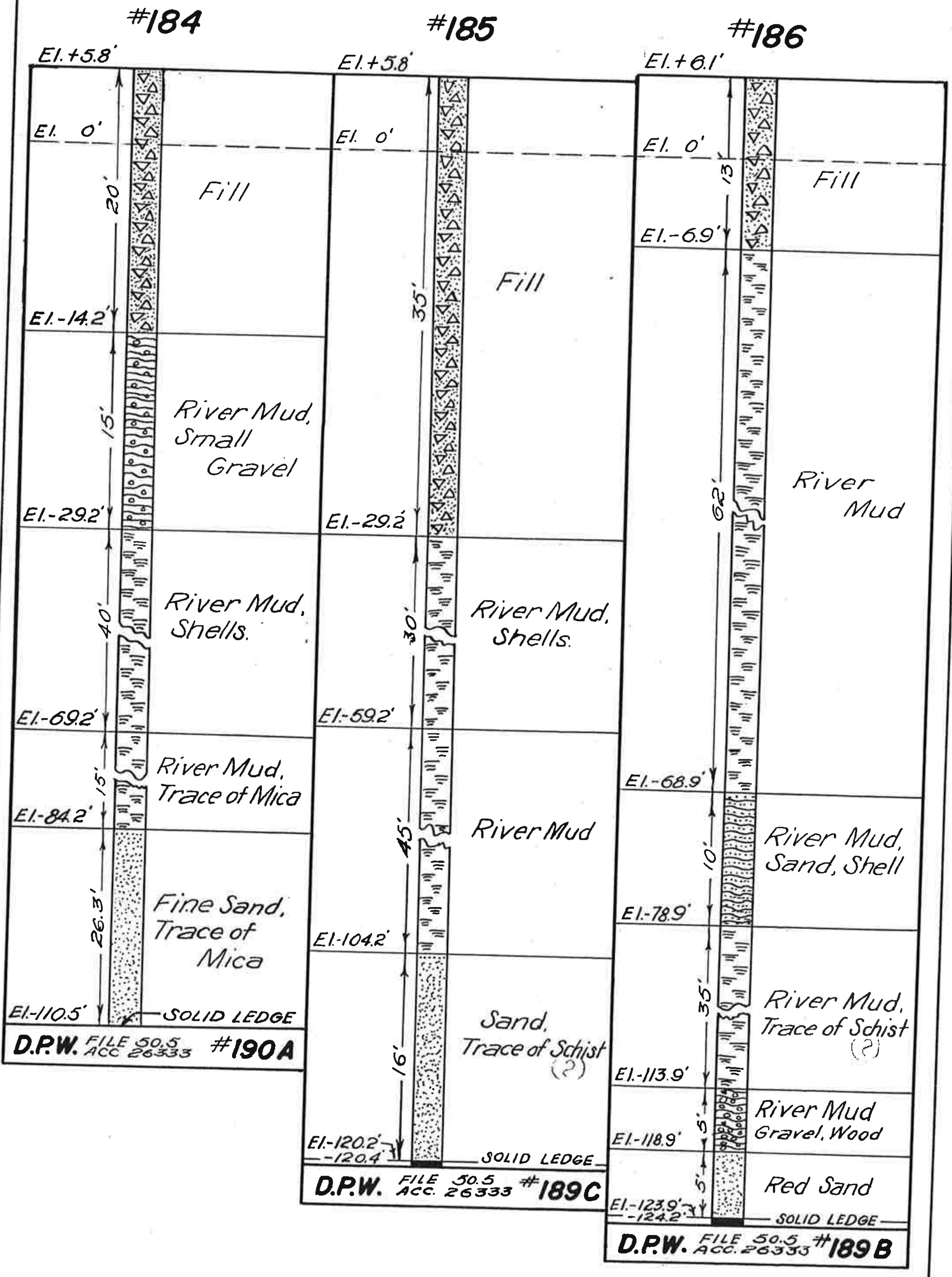
ROCK DATA

VOL.2 SHEET 10



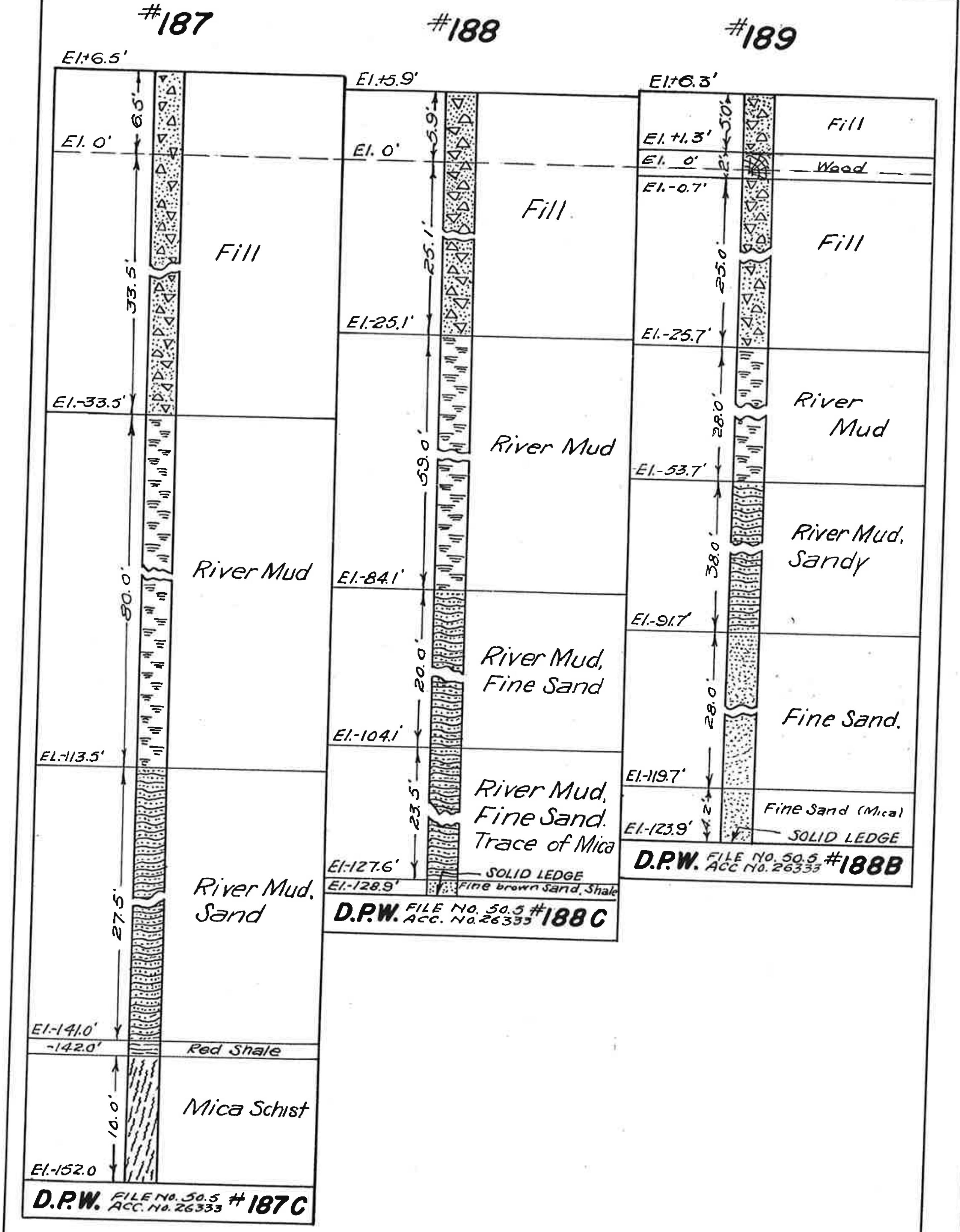
ROCK DATA

VOL. 2 SHEET 10



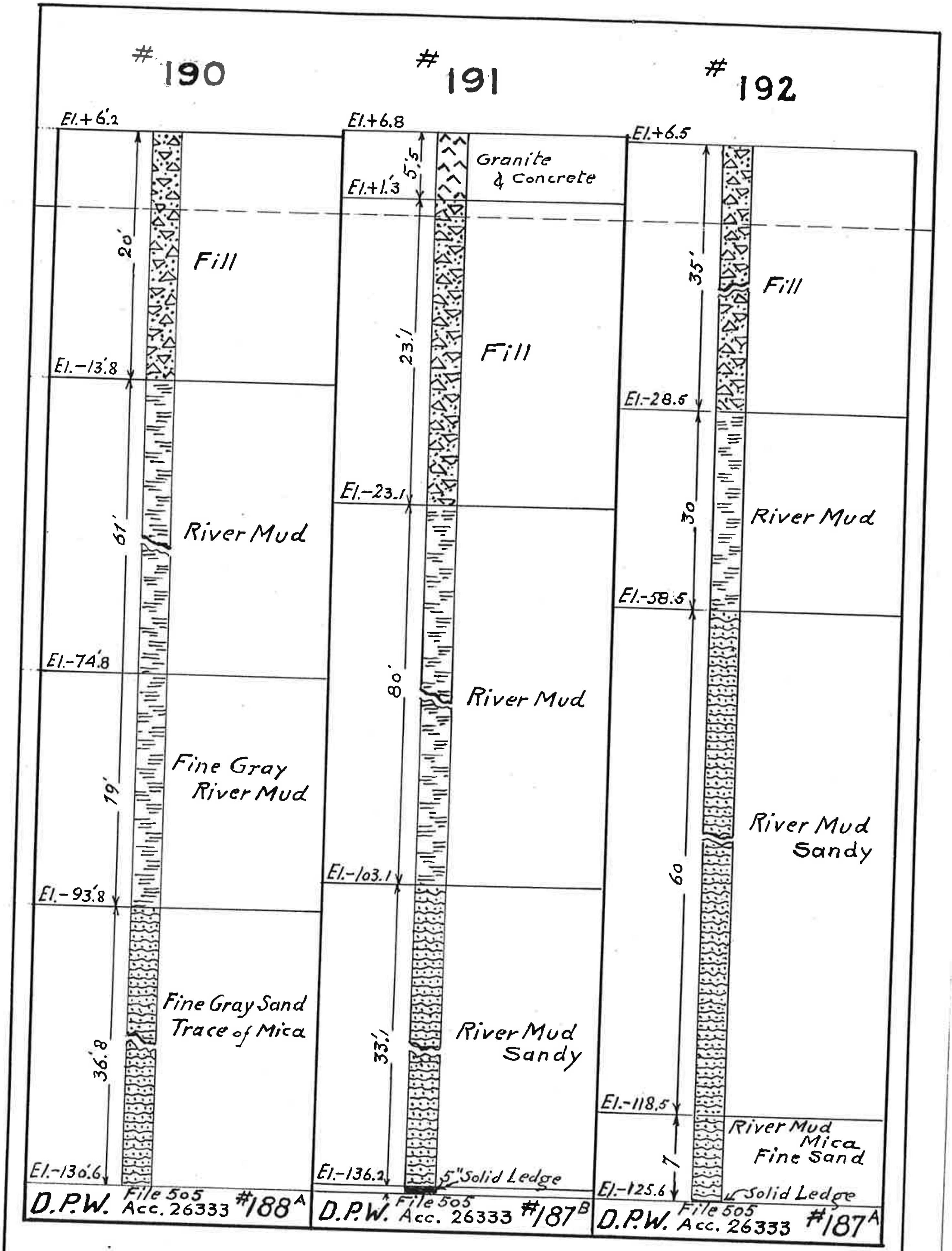
ROCK DATA

VOL.2 SHEET 10

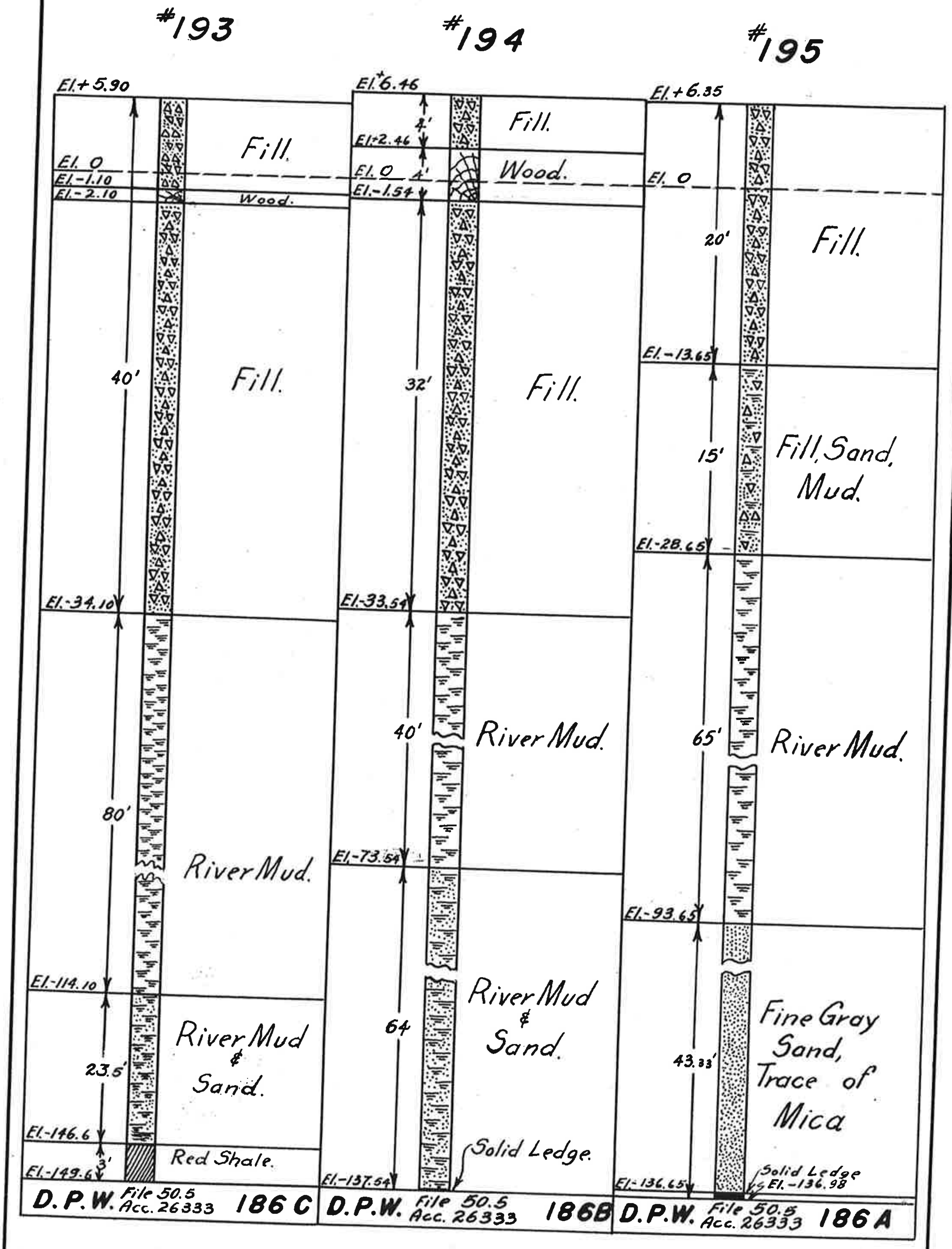


ROCK DATA

VOL. 2 SHEET 10


#190
El.+6.2
20'
Fill
El.-13.8
61'
River Mud
El.-74.8
19'
Fine Gray River Mud
El.-93.8
36.8
Fine Gray Sand Trace of Mica
El.-130.6
D.P.W. File 505 Acc. 26333 #188A
#191
El.+6.8
5.5
Granite & Concrete
El.+1.3
23.1
Fill
El.-23.1
80'
River Mud
El.-103.1
33.1
River Mud Sandy
El.-136.2
5" Solid Ledge
D.P.W. File 505 Acc. 26333 #187B
#192
El.+6.5
35'
Fill
El.-28.6
30
River Mud
El.-58.5
60
River Mud Sandy
El.-118.5
7
River Mud Mica Fine Sand
El.-125.6
Solid Ledge
D.P.W. File 505 Acc. 26333 #187A

ROCK DATA



ROCK DATA

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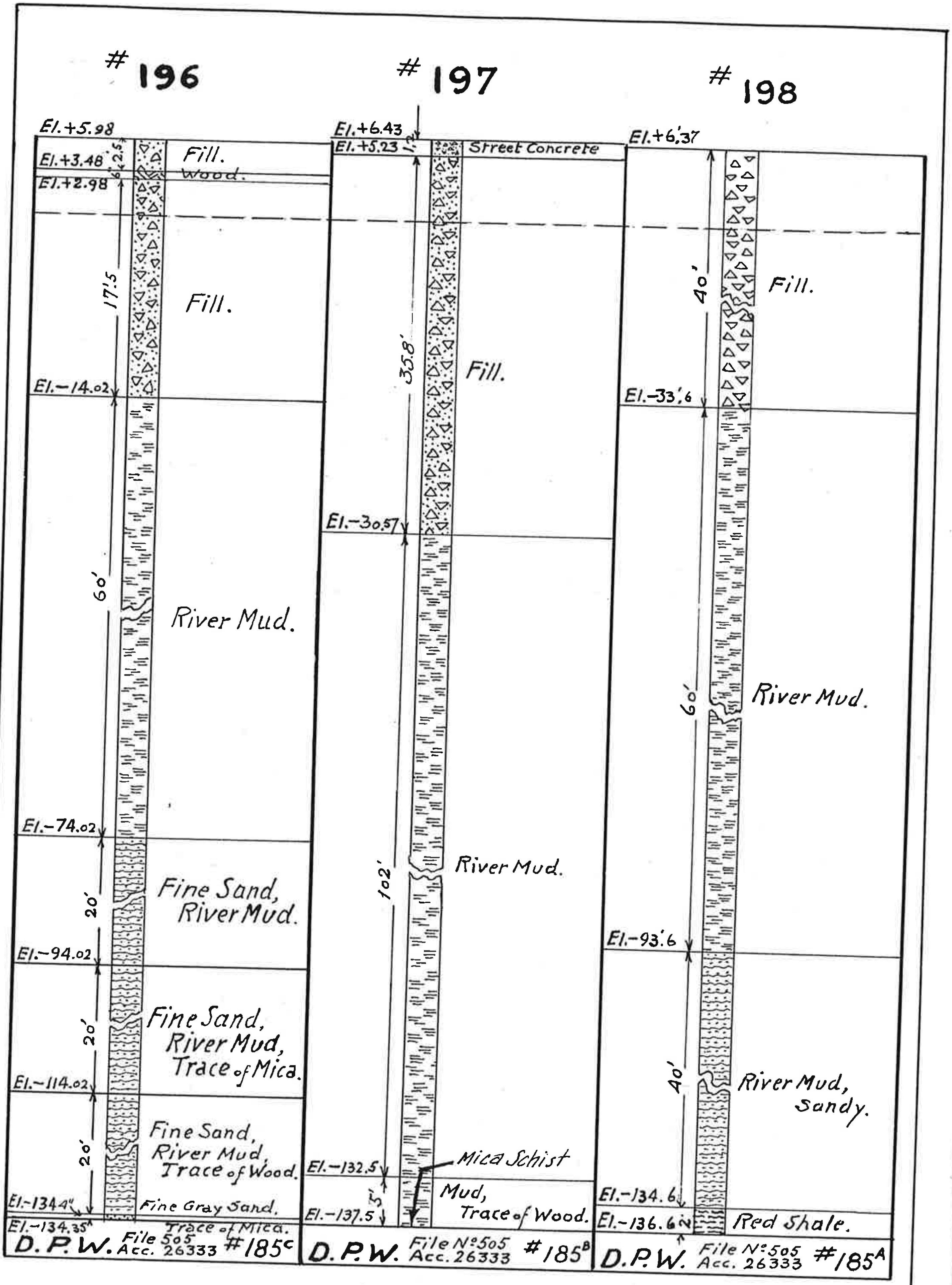
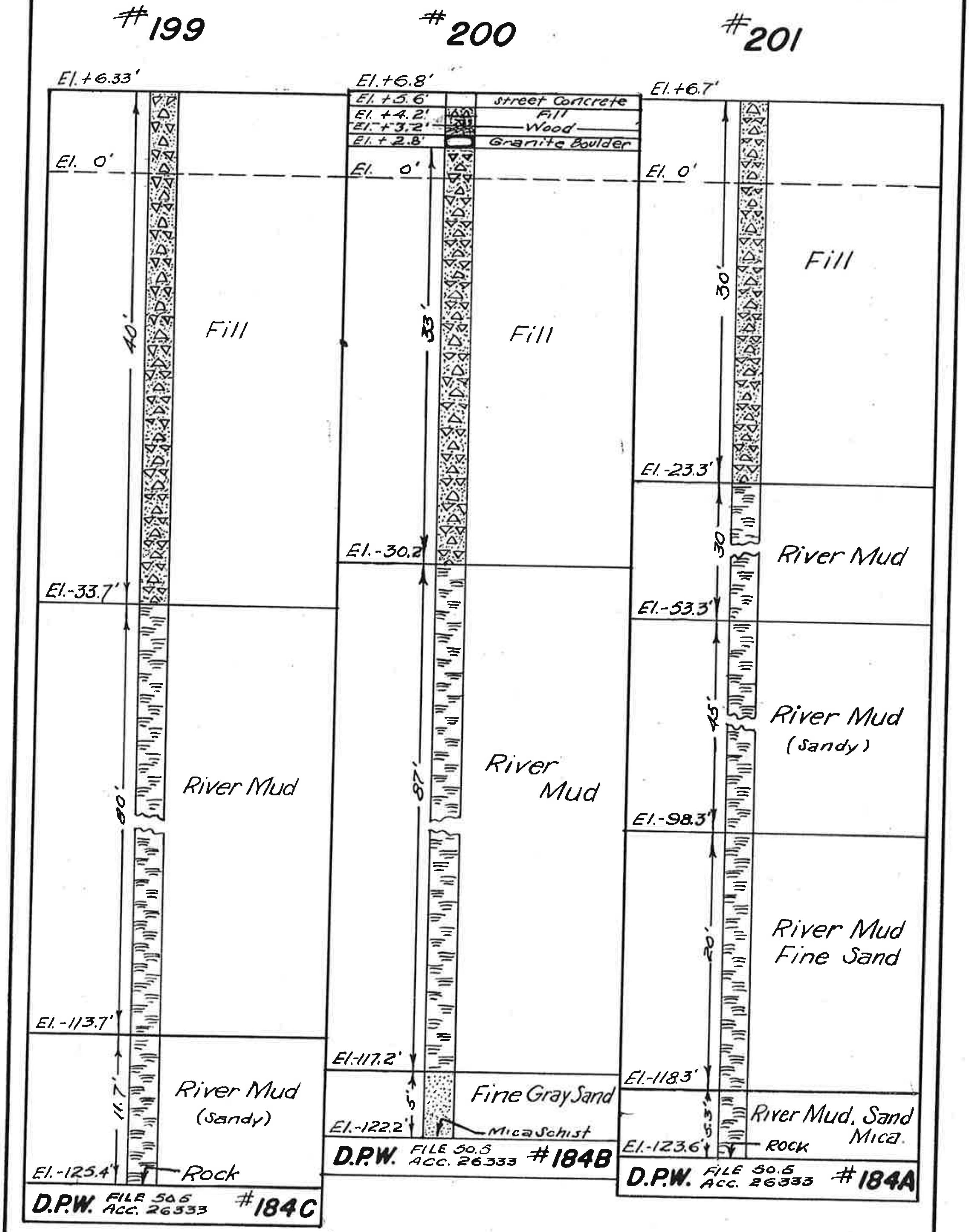
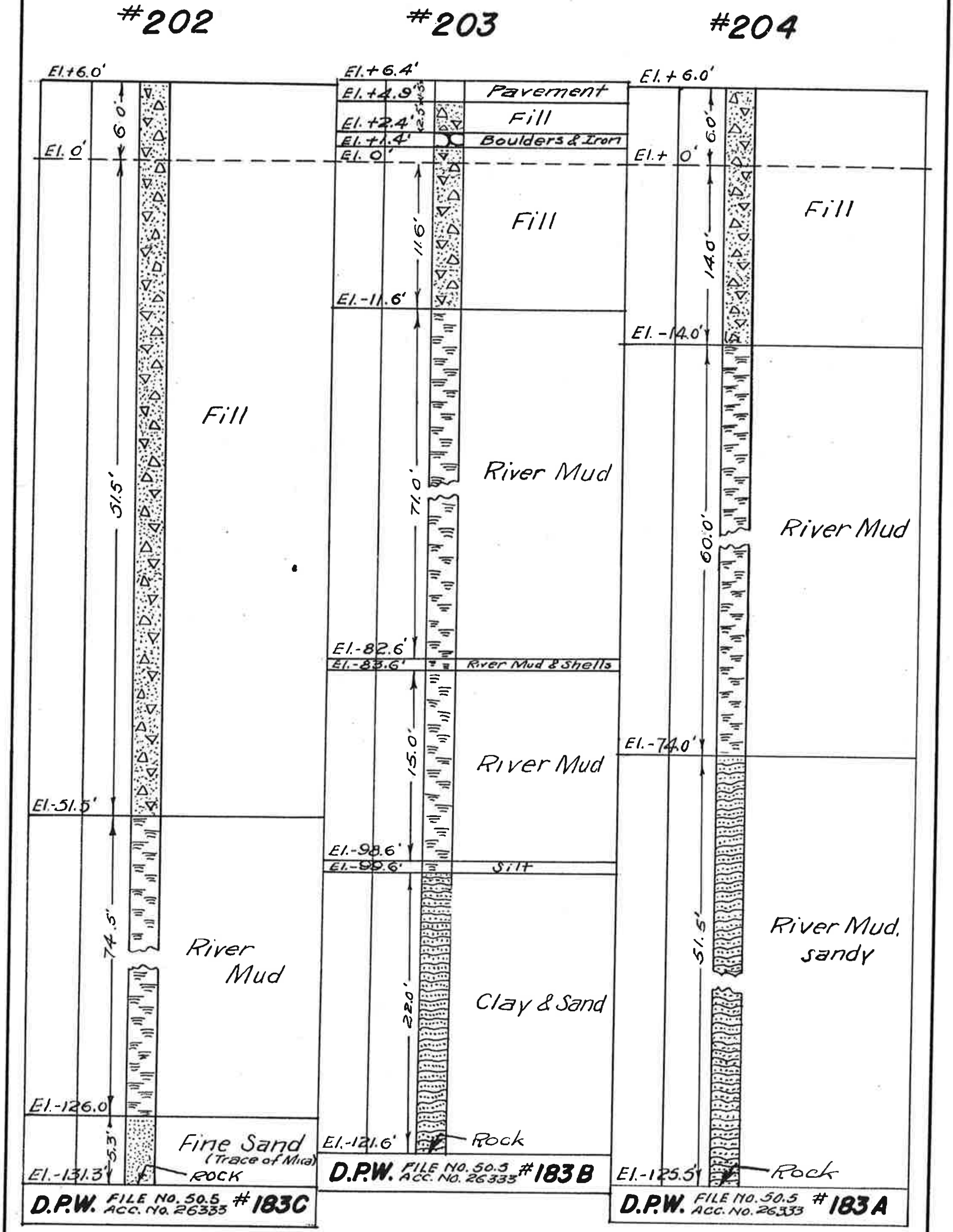


ROCK DATA

VOL.2 SHEET 10

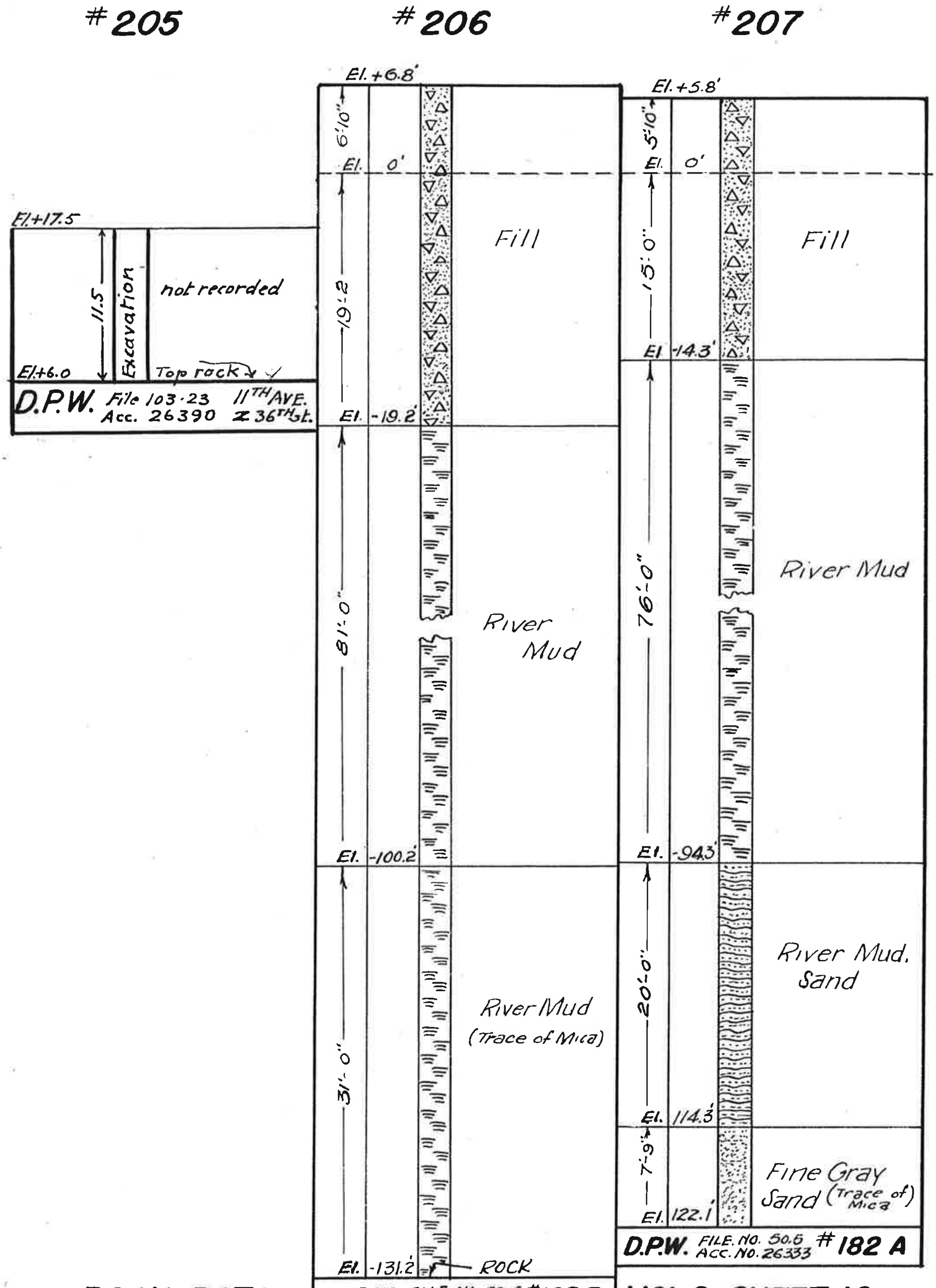

#199
El. +6.33'
El. 0'
40'
Fill
El. -33.7'
80'
River Mud
El. -113.7'
11.7'
River Mud
(Sandy)
El. -125.4'
Rock
D.P.W. FILE 50.6 ACC. 26333 #184C
#200
El. +6.8'
El. +5.6' Street Concrete
El. +4.2' Fill
El. +3.2' Wood
El. +2.8' Granite Boulder
El. 0'
33'
Fill
El. -30.2'
87'
River Mud
El. -117.2'
5'
Fine Gray Sand
El. -122.2'
Mica Schist
D.P.W. FILE 50.5 ACC. 26333 #184B
#201
El. +6.7'
El. 0'
30'
Fill
El. -23.3'
30
River Mud
El. -53.3'
45'
River Mud
(Sandy)
El. -98.3'
20'
River Mud
Fine Sand
El. -118.3'
5.3'
River Mud, Sand
Mica
El. -123.6'
Rock
D.P.W. FILE 50.6 ACC. 26333 #184A

ROCK DATA



ROCK DATA

VOL. 2 SHEET 10



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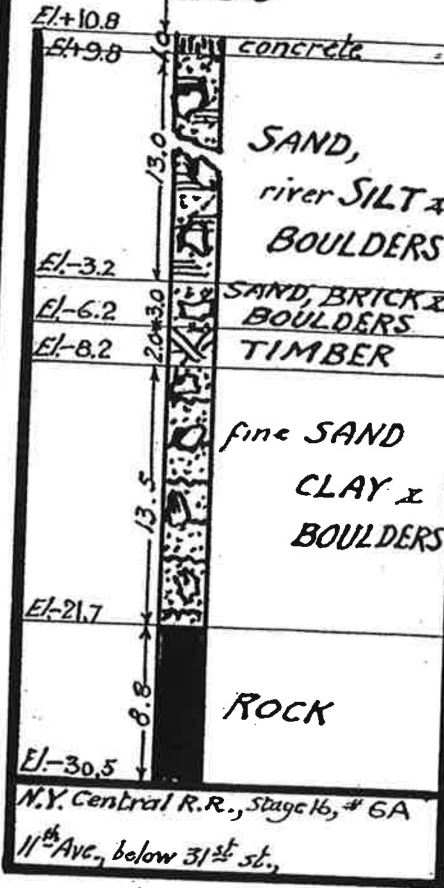
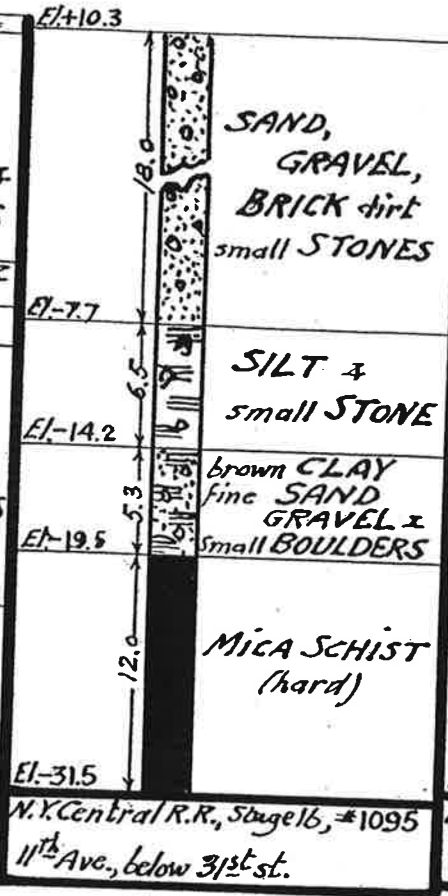
\#269



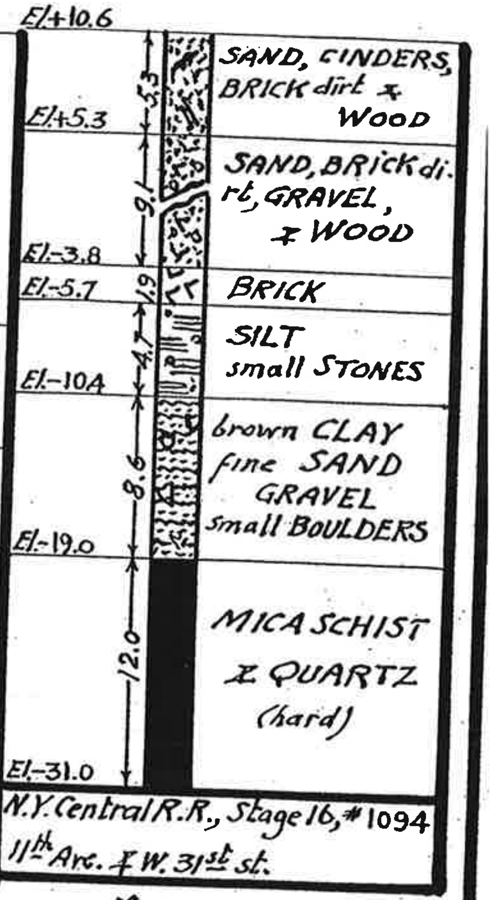
N.Y. Central R.R., Stage 16, # 6A
11th Ave., below 31st st.

\#270



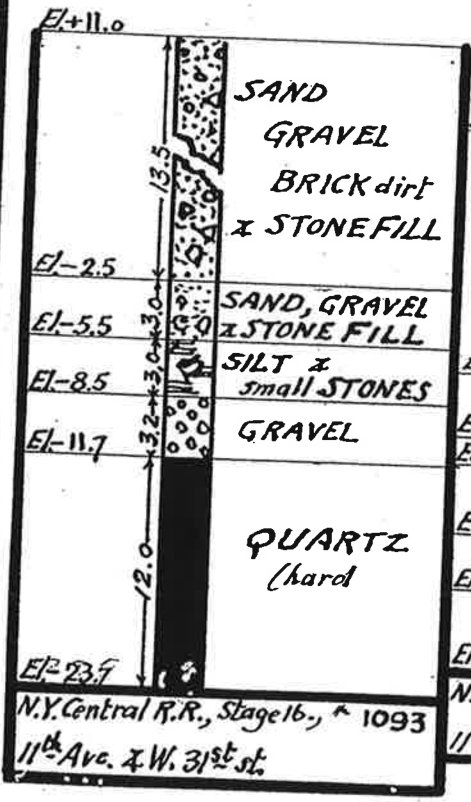
N.Y. Central R.R., Stage 16, #1095
11th Ave., below 31st st.

\#271



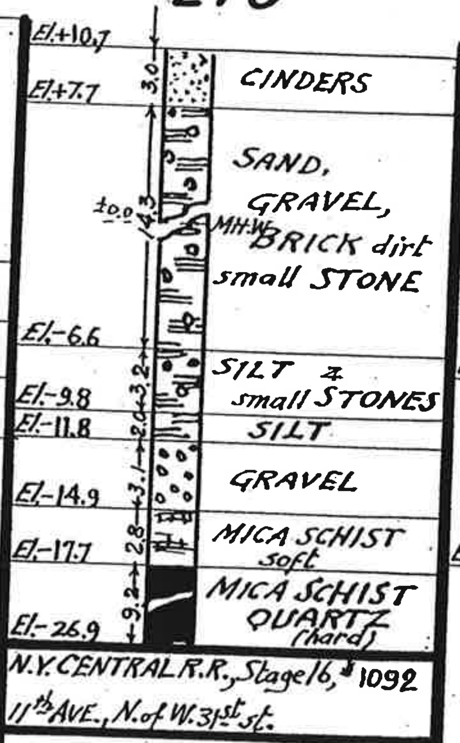
N.Y. Central R.R., Stage 16, #1094
11th Ave. & W. 31st st.

\#272



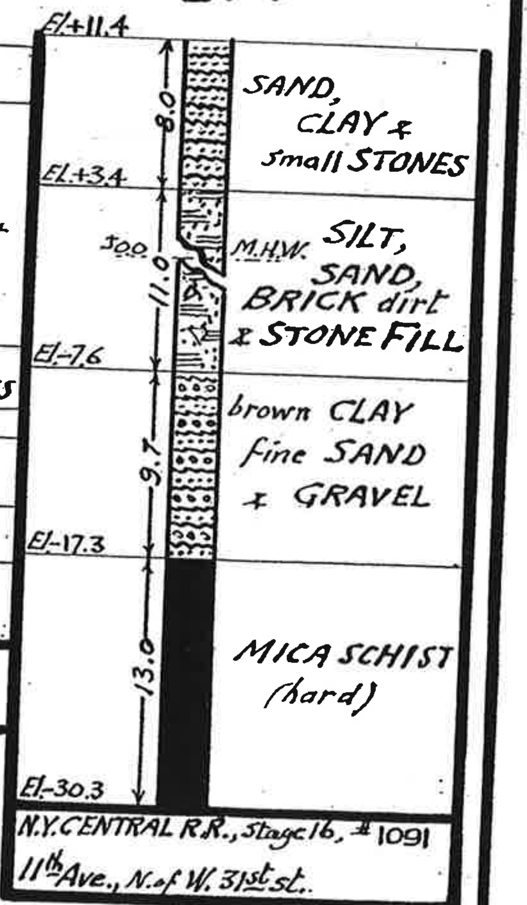
N.Y. Central R.R., Stage 16., # 1093
11th Ave. & W. 31st st.

\#273



N.Y. CENTRAL R.R., Stage 16, # 1092
11th AVE., N. of W. 31st st.

\#274



N.Y. CENTRAL R.R., Stage 16, # 1091
11th Ave., N. of W. 31st st.

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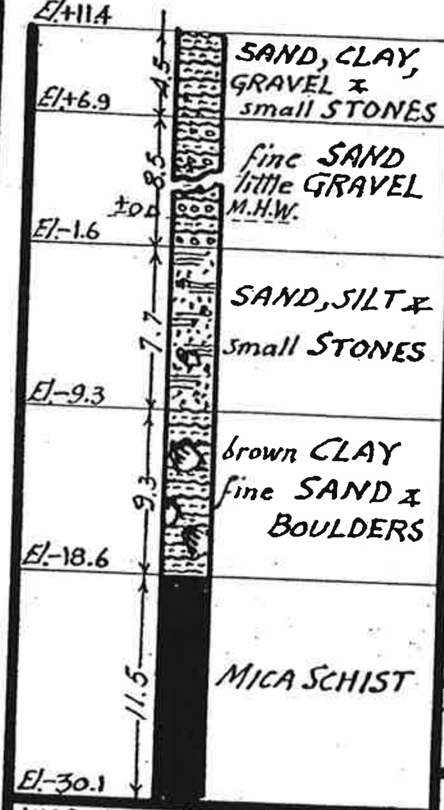
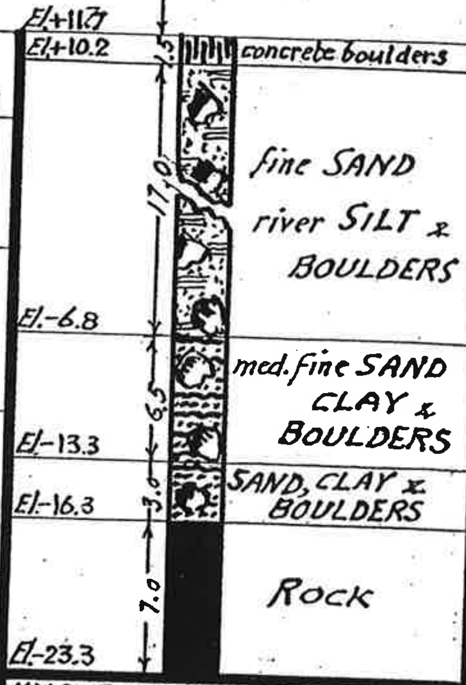
#275



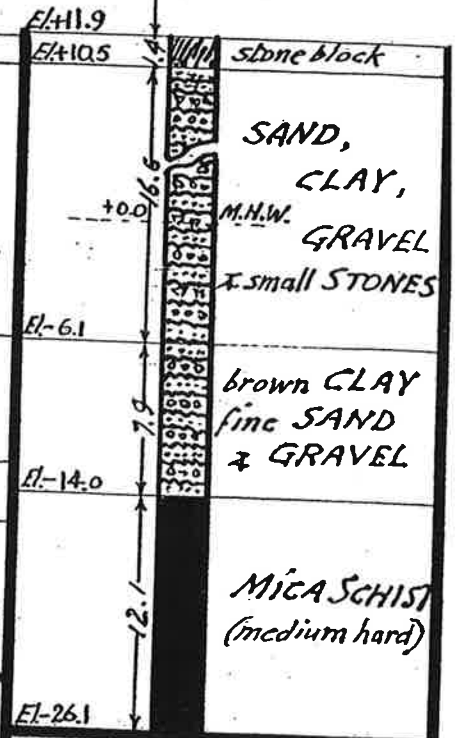
N.Y. Central R.R., Stage #16, #1090
11th Ave., bet. W. 31st & 32nd sts.

#276



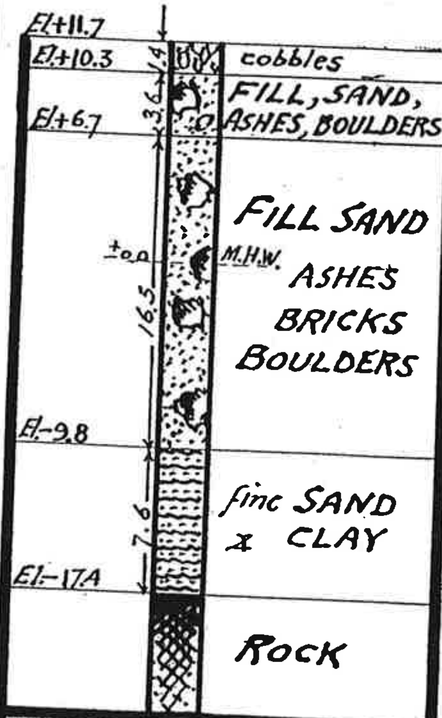
N.Y. CENTRAL R.R., Stage #16, #9A
11th Ave., bet. 31st & 32nd sts.

#277



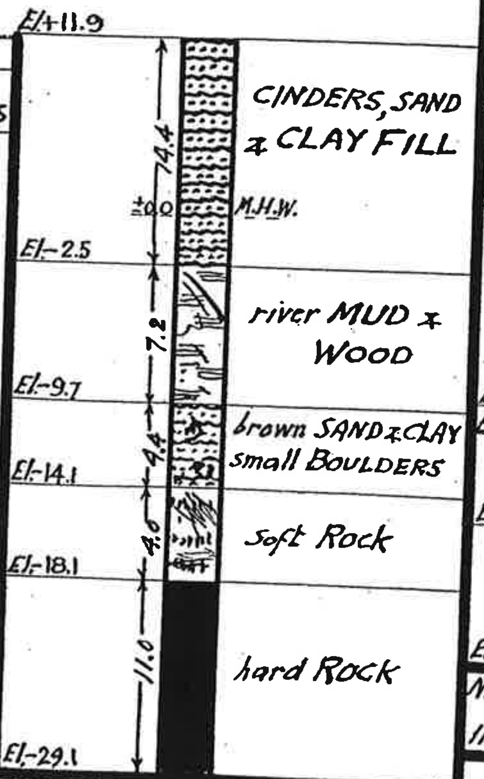
N.Y. Central R.R., Stage #16, #1096
11th Ave., below W. 32nd st.

#278



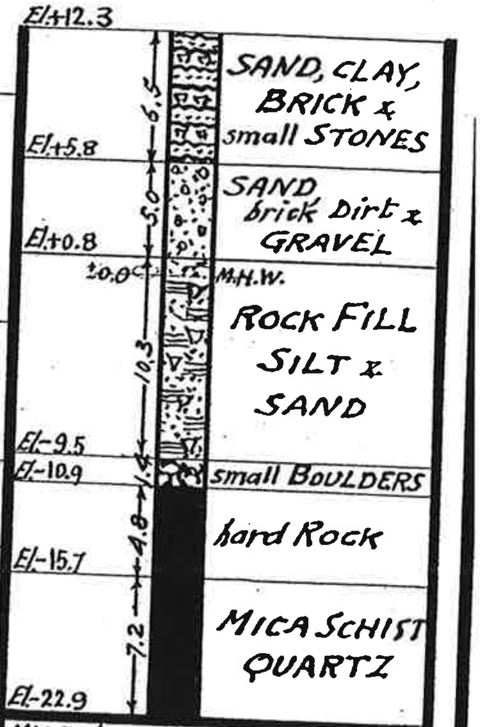
N.Y. Central R.R., Stage #16, #11A
11th Ave., below S.W. corner W. 32nd st.

#279



N.Y. Central R.R., Stage #16, #1088
11th Ave., N.E. corner W. 32nd st.

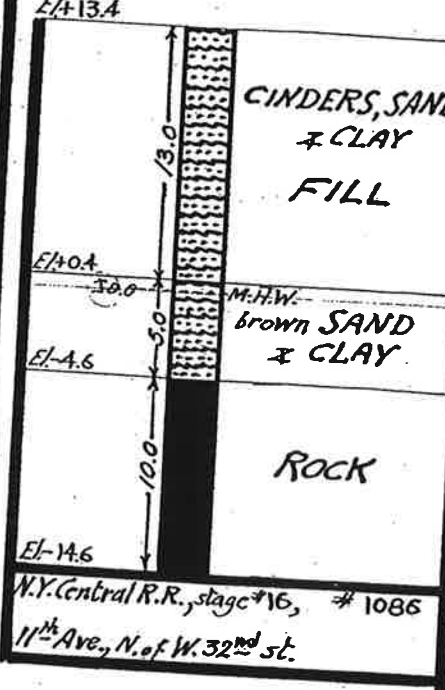
#280



N.Y. Central R.R., Stage 16, #1089
11th Ave., above W. 32nd st.

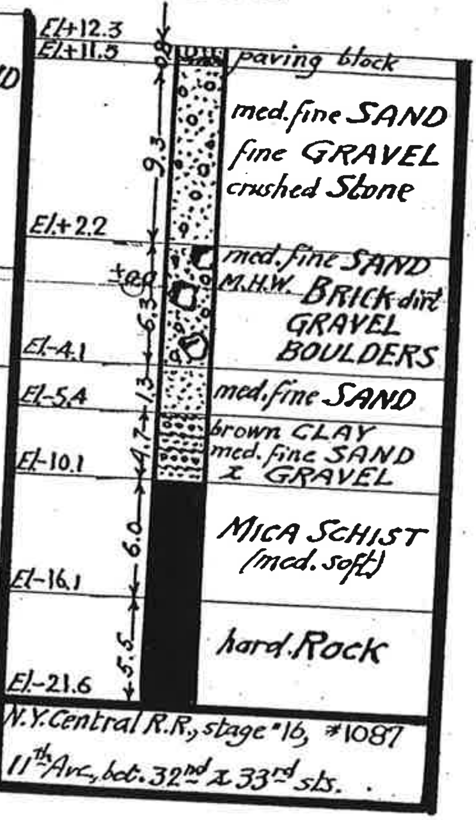
ROCK DATA

#281



N.Y. Central R.R., stage #16, #1086
11th Ave., N. of W. 32nd st.

#282



N.Y. Central R.R., stage #16, #1087
11th Ave., bet. 32nd & 33rd sts.

ROCK DATA

MJS 2-11-42

VOL. 2, SHEET 10

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

SHEET 1 of 2
BORING NO. MG-824
FILE NO. 4840

BORING LOG

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +5.7
COORDINATES: N 192491.8 E 1998852.4
DATUM: Manhattan
BORING LOCATION: MTA Yard, Ramps
DATE STARTED: 04/07/82
INSPECTOR: Y.K. Chan (MRJD)
DATE COMP.: 04/08/82
CONTRACTOR: Warren George, Inc.
DRILLER: J. Farrell
HELPER: G. Mccartar
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 5.0 FT.; DIA. 3 IN. FROM 0.0 TO 29.5 FT.
DRILLING MUD UTILIZED: MUD TYPE Quick-Gel
ROTARY BIT DIA. 3 7/8 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D–SAMPLER: Split Spoon, 2" O.D.
DRILL ROD NW
U–SAMPLER: DIA. IN.: TYPE
CORE BIT Diamond, NX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U–TUBES – NO. OF VANE TESTS – DEPTH TO ROCK 27.7 FT. DEPTH TO COMP. 39.5 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/08/82	0730	20.0	5.0	0.0		Overnight – mud in hole.
04/08/82	1120	39.5	29.5	5.0		At completion. Water in hole.

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
1300	10	1D	0.0	6-8	Dark brown f-c sandy gravel, some silt, trace glass (Fill) (GM)	Loose Med cpt dk brn, f-c sand & gvl, sm silt, tr brick, glass (Fill)	0	W = Water content in %
	15		2.0	9-8				
Sunny, Windy	17							
	31							
	17						5	
	LOWERED	NR	5.5	6-8				
			7.5	5-6				
		2D	7.5	9-9	Dark brown f-c sand, sm silt, trace brick (Fill) (SM)			
			9.5	16-13				
04/07/82		NR	10.0	3-3			10	
			12.0	3-4		12.0		
		3D	12.0	5-3	Black organic clayey m-f sand (Fill)(SC)	3D (Fill)		
			14.0	4-6				
		4D	15.0	1-1	Medium dark gray organic silty clay, tr fine sand, decomposed wood (OH)	15.0	15	W = 72
1530			17.0	1-1		4D, trace vegetation		
0700								
Sunny		5D	20.0	1/12"	Do 4D, trace vegetation (OH)		20	W = 57
			22.0	2-2				
						24.0		
04/08/82		6D	25.0	6-5	Red-brn silty f-m sand, sm silty clay layers, tr gravel, mica (SM)	6D Med cpt	25	
			27.0	5-6		27.5		Decomposed rock fgmts, in wash at 27.5'.
						Dec. Rock	30	

BORING NO. MG-824

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

SHEET 2 of 2
BORING NO. MG-824
FILE NO. 4840

BORING LOG

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
Sunny		1C	29.5	Rec=98%	Green to light gray hornblende mica schist, tr quartz veins & mica schist, jtd, UnWExJts.	1C	30	
			34.5	RQD=84%		34.5		
04/08/82		2C	34.5	Rec=96%	Light gray mica schist, trace quartz inclusions, mdjtd, UnWExJts	2C	35	
			39.5	RQD=84%		39.5		
1200							40	
							45	
							50	
							55	
							60	
							65	
							70	
							75	
							80	
							85	

BORING NO. MG-824

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 1 of 2
BORING NO. MG-825
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +6.2
COORDINATES: N 192600.2 E 1998598.9
DATUM: Manhattan
BORING LOCATION: MTA Yard, MABSTOA Garage
DATE STARTED: 04/02/82
INSPECTOR: B. Mukherjee
DATE COMP.: 04/05/82
CONTRACTOR: Warren George, Inc.
DRILLER: J. Stevenson
HELPER: C. Soto
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 35.0 FT.; DIA. 3 IN. FROM 0.0 TO 49.5 FT.
DRILLING MUD UTILIZED: MUD TYPE Zeogel
ROTARY BIT DIA. 3 3/4, 2 15/16 IN
SAMPLING EQUIPMENT, (TYPE & SIZE)
D-SAMPLER: Split Spoon, 2" O.D.
DRILL ROD BW
U-SAMPLER: DIA. IN.: TYPE
CORE BIT Diamond, BX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U-TUBES -- NO. OF VANE TESTS - DEPTH TO ROCK 49.5 FT. DEPTH TO COMP. 68.0 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/05/82	0715	60.0	49.5	3.0		Over weekend
04/05/82	1430	68.0	49.5	4.9		At completion of rock coring
04/05/82	1440	68.0	35.0	9.0		
04/05/82	1500	68.0	20.0	4.5		
04/05/82	1510	-	0.0	5.2		

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
0700	-	1D	0.5	12-12	Dk gry c-f cinders, sm silt (Fill) (SM)	*	0	*Asphalt W = Water content in %
	16		2.5	8-9		0.3		
	14					Loose to compact, dark gray fine to coarse sand, some cinders, silt, trace gravel, rock fragments. (Fill)		
	31							
	32							
	14	2D	5.0	7-4	Dk gray c-f cinders, some organic silt (Fill) (SM)		5	
	11		7.0	4-5				
	14							
	13							
	18							
	11	3D	10.0	2-1	Gray fine sand, sm organic silt (Fill) (SM)		10	
	16		12.0	1-2				Lost all drilling water at 12.0'.
	82							
	87							
Sunny	45							
	28	4D	15.0	12-11	Dk gray c-f sand, sm silt, gvl (Fill) (SM)		15	
	30		17.0	30-32				
	62							
04/02/82	45							
	46							
	30	NR	20.0	15-21			20	
	56		22.0	6-3				
	42	5D	22.0	5-12	Gry mic silty f-c sand, some rock fragments (Fill) (SM)			
	44		24.0	17-20				
	48							
	26	6D	25.0	14-1.9	Gray mic f-c sand, sm silt (Fill) (SM)		25	
	51		27.0	3-21				
	113							
	276							
	82						30	

BORING NO. MG-825

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 2 of 2
BORING NO. MG-825
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
	46	7D	30.0	WR/12"	Top: Soft blk org silty clay, tr mica (OH) Bot: Med gry org silty clay, sm shells, fine sand (OH)	*	30*	*7D Top Top: W = 52 Bot: W =55
	30		32.0	4-4		31.0		
	39					Med gry org silty clay, some shells, trace fine sand, fine sand partings, vegetation		
	36							
	39							
		8D	35.0	1-1	Medium gray organic silty clay, some shells, trace fine sand (OH)		35	W = 48
	M		37.0	2-2				
	U							
	D							
	U	9D	40.0	1/12"	Med gry org silty clay, tr fine sand partings, veg (OH)		40	W = 53
	S		42.0	2-2				
	E							
	D							
Sunny		10D	45.0	WH -1	Top: Do 9D (OH) Bot: Gray f-m sand, sm organic silt, trace peat, shells (SM)		45	Top: W = 34
			47.0	1-2		46.0		
						10D Bottom		
		1C	50.0	Rec=94%	Lt gry to white granitic pegmatite, cljtd, UnW to SlW		50	
			55.0	RQD=46%		49.5		
04/02/82						Light gray to white granitic pegmatite, trace quartzite, jtd, UnW to SlW		
		2C	55.0	Rec=98%	Do 1C		55	New diamond bit at 55.0'.
			60.0	RQD=26%				
1530								
0700		3C	60.0	Rec=93%	Do 2C, trace quartzite		60	Core barrel blocked at 63.0'
			63.0	RQD=50%				
		4C	63.0	Rec=98%	Lt gray to white quartzite and granitic gneiss, jtd, UnW			
04/05/82 Sunny			68.0	RQD=84%				
							65	
1530								
						68.0		
							70	
							75	
							80	
							85	

BORING NO. MG-825

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 1 of 2
BORING NO. MG-826
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +5.7
COORDINATES: N 192690.5 E 1998436.2
DATUM: Manhattan
BORING LOCATION: MTA Yard, MABSTOA Garage
DATE STARTED: 04/01/82
INSPECTOR: Y. K. Chan
DATE COMP.: 04/02/82
CONTRACTOR: Warren George, Inc.
DRILLER: J. Farrell
HELPER: G. McCartar
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 11.0 FT.; DIA. 3 IN. FROM 0.0 TO 71.0 FT.
DRILLING MUD UTILIZED: MUD TYPE Quick Gel
ROTARY BIT DIA. 3 7/8 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D–SAMPLER: Split Spoon, 2" O.D.
DRILL ROD NW
U–SAMPLER: DIA. IN.; TYPE
CORE BIT Diamond, NX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U–TUBES -- NO. OF VANE TESTS --- DEPTH TO ROCK 69.0 FT. DEPTH TO COMP. 82.0 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/02/82	0710	82.0	71.0	6.2		Overnight
04/02/82	0815	82.0	0.0	6.9		

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
0700	-					* 0.3	0	*Asphalt W = Water content in %
		1D	1.0	23-16	Gray c-f sand, sm gravel, trace silt (Fill)(SP)	Loose to compact gry to blk f-c sand, sm silt, tr gvl, sls, dec wood (Fill)		
			3.0	14-11				
		2D	5.0	6-8	Gray silty fine to medium sand (Fill)(SM)		5	
			7.0	7-7				
Sunny		*NR	10.0	7-5			10	**Tried for sample twice. No recovery.
			12.0	3-3				
		3D	12.0	3-3	Black c-f sand, sm silt, tr gravel (Fill)(SM)			
			14.0	13-17				
04/01/82		4D	15.0	3-3	Blk f-c sand, sm silt, tr gvl decomposed wood, sls(Fill) (SM)		15	
			17.0	3-3				
		5D	20.0	6-3	Gray-brn clayey fine to medium sand, trace gravel (Fill)(SC)		20	Color of mud was black at 23.0'.
			22.0	3-4		23.0		
		6D	25.0	2-2	Soft black organic silty clay, trace fine sand (OH)	6D	25	W = 72 *Soft-med,dk gry org silty clay, tr f sa, f sa seams,sls, veg.
			27.0	3-3		28.0 *	30	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 2 of 2
BORING NO. MG-826
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		7D	30.0	WH/12"	Soft dark gray organic silty clay, tr fine sand seams (OH)	Soft to medium dark gray organic silty clay, tr fine sand seams, shells, vegetation.	30	W = 69
	M		32.0	2-3				
	U							
	D							
	U	8D	35.0	WH-1	Do 7D, trace shells, veg (OH)		35	W = 46
	S		37.0	1-2				
	E							
	D							
		9D	40.0	1/12"	Do 8D (OH)		40	W = 52
			42.0	WH/12"				
		10D	45.0	2-2	Do 8D (OH)		45	W = 52
			47.0	2-2				
		11D	50.0	1-2	Medium dark gray organic silty clay, trace fine sand (OH)		50	W = 57
			52.0	2-3				
		12D	55.0	WR/24"	Do 11D, some fine sand, trace shells (OH)		55	W = 35
			57.0					
04/01/82		13D	60.0	WH/12"	Medium dark gray organic silty clay, tr fine sand, shells, veg (OH)		60	W = 41
			62.0	3-3				
		14D	65.0	WH/18"	Medium dark gray organic silty clay, tr fine sand, veg (OH)		65	W = 33
			67.0	3				
						69.0 *	70	Telescoped 3" casing inside 4" casing to 72.0' *Possible decomposed rock
		1C	72.0	Rec=98%	Top: Gray garnet mica schist, jtd, UnWExJts Bot: White quartzite, mdjtd. UnW.	72.0 Gry grt mica schist to wht quartzite, jtd to mdjtd,UnWExJts		
			77.0	RQD=88%			75	Mica schist is very micaceous.
		2C	77.0	Rec=98%	Top: White quartzite, mdjtd, UnW Bottom: Gray garnet mica schist, mdjtd, UnWExJts			
			82.0	RQD=96%			80	
1530						82.0	85	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 1 of 3
BORING NO. MG-827
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +5.5
COORDINATES: N 192663.3 E 1998186.4
DATUM: Manhattan
BORING LOCATION: MTA Yard, Ramps
DATE STARTED: 04/07/82
INSPECTOR: B. Mukherjee (MRJD)
DATE COMP.: 04/09/82
CONTRACTOR: Warren George, Inc.
DRILLER: J Stevenson
HELPER: C. Soto
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 40.0 FT.; DIA. 3 IN. FROM 0.0 TO 115.3 FT.
DRILLING MUD UTILIZED: MUD TYPE
ROTARY BIT DIA. 3 3/4 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D–SAMPLER: Split Spoon, 2" O.D.
DRILL ROD BW
U–SAMPLER: DIA. IN.: TYPE
CORE BIT Diamond, NX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U–TUBES – NO. OF VANE TESTS – DEPTH TO ROCK 115.3 FT. DEPTH TO COMP. 135.0 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/08/82	0730	62.0	40.0	4.6		Overnight
04/09/82	0715	115.3	115.3	6.0		
04/09/82	1430	135.0	115.3	2.0		At completion at rock coring
04/12/82	0730	–	15.0	5.7		Over the weekend
04/12/82	0800	–	0.0	5.0		

DAILY PROGRESS	CASING BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		NO.	DEPTH	BLOWS/6"				
0830	—	1D	0.75	32-19	Brown cinders, sm c-f sand, silt, tr gravel (Fill) (SM)	* 0.2	-0	*Asphalt W = Water content in %
04/07/82 Partly Cloudy, Cold	28		2.75	10-30		Medium compact to loose gray-brown silty fine to coarse sand, trace gravel, cinders, brick, mica (Fill)		
	48							
	37							
	56							
	31	2D	5.0	9-16	Gry-brn silty f-m sand, tr gvl cndrs, brick, mica (Fill) (SM)		5	
	27		7.0	9-10				
	34							
	21							
	13							
	29	3D	10.0	11-17	Top: 18" Do 2D (Fill) (SM) Bot: 6" Red-brn silt, sm fine sand (Fill) (ML)		10	
	25		12.0	12-8				
	38							
	29							
	17							
	15	4D	15.0	1-3	Dark gray c-f sand, sm gravel, silt, tr cndrs, mica (Fill)(SM)		15	
	15		17.0	3-5				
	16							
	18							
	16							
	*19	5D	20.0	WR-13	Med black organic silty clay, tr fine sand, wood, bricks (OH)	20.0 5D Medium	20	W = 58 *20.0'-25.0' drilled ahead of casing.
	18		22.0	9-6				
	12							
	26							
	27							
	28	6D	25.0	30-19	Gray-brn mic silty f-m sand, sm rock fragments (SM)	25.0 6D Med compact (Fill)	25	6D rock fgmts are decomposed mica schist. (Fill)
	43		27.0	12-13				
	80							
	69							
	90						30	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 2 of 3
BORING NO. MG-827
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		NO.	DEPTH	BLOWS/6"				
04/07/82 Partly Cloudy, Cold	44	NR	30.0	100/4"		Same as above	30	
	22		30.3					
	32							
	34							
	35							
	* 42	7D	35.0	10-14	Stiff black organic clay, trace vegetation (OH)	35.0 Stiff blk org clay	35	W = 64 *35.0'-40.0' drilled ahead of casing.
	26		37.0	8-9				
	26							
	25							
	25							
	LOWERED 3"DIA	8D	40.0	1-1	Medium gray organic silty clay, trace shells (OH)	40.0 Medium gray organic silty clay, trace fine sand partings, shells	40	W = 69
			42.0	2-4				
		9D	45.0	1-1	Medium gray organic silty clay, trace shells (OH)		45	W = 53
			47.0	1-1				
		10D	50.0	1-1	Do 9D, some fine sand (OH)		50	W = 47
			52.0	1-1				
		11D	55.0	1-1	Medium gray organic silty clay, trace shells (OH)		55	W = 47
			57.0	2-2				
1530		12D	60.0	2-2	Do 11D (OH)		60	W = 53
0700			62.0	3-4				
04/08/82 Sunny								
		13D	65.0	1-WH	Medium gray organic silty clay, tr shells, fine sand partings (OH)		65	W = 57
			67.0	WH-1				
		14D	70.0	WH-1	Do 13D (OH)		70	W = 34
			72.0	1-2				
		15D	75.0	1-1	Do 13D (OH)		75	W = 50
			77.0	2-2				
		16D	80.0	2-3	Do 13D (OH)		80	W = 39
			82.0	4-2				
							85	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 3 of 3
BORING NO. MG-827
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
Sunny 04/08/82		17D	85.0 87.0	2-2 6-5	Medium gray organic silty clay, some fine sand (OH)	Medium gray organic silty clay, tr to sm fine sand, tr fine sand partings, peat	85	W = 59
		18D	90.0 92.0	WH-6 3-2	Medium gray organic silty clay, trace fine sand partings (OH)		90	W = 39
		19D	95.0 97.0	WH-1 5-9	Medium gray organic silty clay, some fine sand (OH)		95	W = 40
		20D	100.0 102.0	WR-2 2-11	Medium gray organic silty clay, trace fine sand partings, peat (OH)		100	W = 45
		21D	105.0 107.0	5-11 16-16	Medium gray organic silt, sm fine sand and clay (OL)		105	W = 32
		22D	110.0 112.0	2-5 7-10	Stiff gray organic clay, some peat, trace decomposed wood (OH)		110	W = 52 W = 73 (Peat portion of the sample)
1500								
0700		23D	115.0 115.3	100/4"	Light gray micaceous f-m sand, tr c sand, silt (SP)*	115.0 Dec Rock	115	* Decomposed mica schist.
		1C	116.0 121.0	Rec=88% RQD=12%	Light gray garnet mica schist, broken, SlW to HiW	118.0 Lt gry mica schist & grt mica schist, mic quartzite, tr qtz veins, bkn to mdjt, UnWExJts		
Cloudy. 04/09/82		2C	121.0 125.0	Rec=82% RQD=25%	Light gray garnet mica schist, trace quartz veins, cljtd, UnWExJts.		120	Run #2C Core barrel blocked.
		3C	125.0 130.0	Rec=92% RQD=30%	Top: Light gray mica schist, tr quartz veins, broken, UnWExJts Bot: White mic quartzite, cljtd, UnWExJts		125	
		4C	130.0 135.0	Rec=100% RQD=88%	Light gray mica schist & mic quartzite, mdjtd, UnWExJts		130	
1430						135.0	135	
							140	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 1 of 2
BORING NO. MG-827P
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +5.5
COORDINATES: N 192674 E 1998158
DATUM: Manhattan
BORING LOCATION: MTA Yard, MABSTOA Garage
DATE STARTED: 04/12/82
INSPECTOR: B. Mukherjee (MRJD)
DATE COMP.: 04/12/82
CONTRACTOR: Warren George, Inc.
DRILLER: J. Stevenson
HELPER: C. Soto
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 20.0 FT.; DIA. IN. FROM TO FT.
DRILLING MUD UTILIZED: MUD TYPE
ROTARY BIT DIA. 3 3/4 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D–SAMPLER: Split Spoon, 2" O.D.
DRILL ROD BW
U–SAMPLER: DIA. IN.: TYPE
CORE BIT
CORE BARREL
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☐ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U–TUBES – NO. OF VANE TESTS – DEPTH TO ROCK – FT. DEPTH TO COMP. – FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/12/82	1000	20.0	20.0	2.0		
04/12/82	1300	15.5	15.0	3.9		Inside piezometer

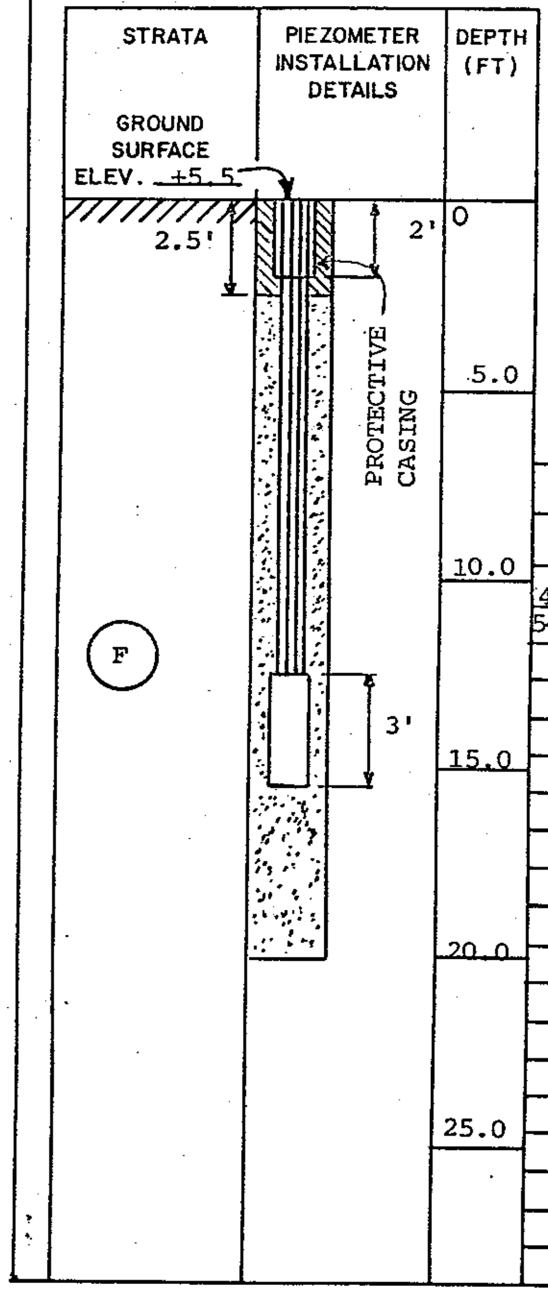
DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
0700	13					(Fill)	0	
Partly Sunny 04/12/82	18							
	16							
	34							
	12							
	20						5	
	110							
	88							
	19							
	10						10	
	25							
	20							
	20							
	18							
	12							
	11	1D	15.0	3-3	Gray-brown medium to fine sand, trace gravel (Fill)(SP)		15	
	11		17.0	4-5				
	13							
	12							
1300	12							
						20.0	20	
							25	
							30	

SHEET 2 OF 2
FILE NO. 4840
SUBCODE SMBST

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
CONSULTING ENGINEERS

PIEZOMETER RECORD

PROJECT WEST SIDE HIGHWAY - CONTRACT 5
PIEZOMETER NO. MG-827 P
LOCATION MABSTOA GARAGE
PIEZOMETER LOCATION 12th AVE & W 30th STREET
DATE OF INSTALLATION 4-12-82
☐ SEE SKETCH ON BACK
RES. ENG. B. Mukherjee



PIEZOMETER TYPE DOUBLE TUBE POROUS PLASTIC

INTAKE POINT
depth to bottom, ft= 15.5
depth to top, ft= 12.5
length, ft= 3' =L
diameter, in = 1.5, ft= 0.125 =2R

STANDPIPE/RISER (DOUBLE TUBE)
elevation of rim, ft= +5.5
diameter, in = 3/8, ft= 0.031 =2r

READING TIME		DEPTH - RIM TO WATER	ELEVATION OF WATER	REMARKS
DATE	CLOCK			
4-12-82	1300	3.9	1.6	High Tide 1220
5-10-82	1503	4.7	0.8	High Tide 1115

░ Sand
▨ Bentonite
△ Gravel
▧ Grout

GROUND SURFACE ELEV. +5.5

PIEZOMETER NO. MG-827P

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 1 of 3
BORING NO. MG-828
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +5.3
COORDINATES: N 192784.1 E 1998289.0
DATUM: Manhattan
BORING LOCATION: MTA Yard, Ramp
DATE STARTED: 04/02/82
INSPECTOR: Y. K. Chan (MRJD)
DATE COMP.: 04/07/82
CONTRACTOR: Warren George, Inc.
DRILLER: J Farrell
HELPER: Mr. G. McCartar
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 10.0 FT.; DIA. 3 IN. FROM 0.0 TO 105.0 FT.
DRILLING MUD UTILIZED: MUD TYPE Quick Gel
ROTARY BIT DIA. 3 7/8 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D-SAMPLER: Split Spoon, 2" O.D.
DRILL ROD NW
U-SAMPLER: DIA. IN.: TYPE
CORE BIT Diamond, NX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U-TUBES – NO. OF VANE TESTS – DEPTH TO ROCK 103.0 FT. DEPTH TO COMP. 115.0 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/05/82	0750	57.0	10.0	4.4		Over weekend with drilling mud inside the hole
04/07/82	0800	105.0	105.0	4.5		At start of drilling w/water inside the hole
04/07/82	1045	115.0	10.0	4.5		

DAILY PROGRESS	CASING BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		NO.	DEPTH	BLOWS/6"				
0830 04/02/82 Sunny, Windy	–					* 0.3	0	*Asphalt
	21	1D	0.5	10-8	Dark gray c-f sand, sm cinders,	Medium compact dark gray to brown coarse to fine sand, some cinders, gravel, trace silt (Fill)		W = Water
	17		2.5	6-5	silt, tr gvl (Fill)(SM)			content in %
	22							
	13							
	21	2D	5.0	22-17	Black c-f sandy gravel, trace		5	
	30		7.0	6-13	silt (Fill)(GP)			
	26							
	30							
	28							
		3D	10.0	17-13	Dark brown c-f sand, some		10	
			12.0	9-5	cinders, trace gvl (Fill)(SP)			
		**NR	15.0	5-3			15	**Attempted
			17.0	1-3				sample twice.
		4D	17.0	5-5	Black c-f sand, sm cndrs, tr			No recovery.
			19.0	8-9	silt, gvl (Fill)(SP)			Sample 4D is probably wash.
		5D	20.0	4-1	Black c-f sand, sm cndrs, tr		20	
			22.0	2-4	organic silty clay, gravel			
					(Fill)(SP)			
						23.0 Med blk org siltyclay, tr fsa, wood, veg		
		6D	25.0	2-1	Medium black organic silty clay,		25	W = 71
			27.0	1-2	trace fine sand, veg, wood (OH)			
							30	

BORING LOG

SHEET 2 of 3
BORING NO. MG 828
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
04/02/82 Sunny		7D	30.0 32.0	1-WH 2-2	Med dark gray organic silty clay, tr fine sand, sls (OH)	Medium dark gray organic silty clay, trace fine sand, fine sand partings, shells	30	W = 62
		8D	35.0 37.0	1-WH 1-2	Do 7D, trace veg. (OH)		35	W = 69
		9D	40.0 42.0	5-4 1-1	Do 7D (OH)		40	
		10D	45.0 47.0	1-WH 3-4	Do 7D, tr fine sand partings (OH)		45	W = 53
		11D	50.0 52.0	1-WH 5-4	Do 7D, tr fine sand partings (OH)		50	W = 54
1500 0700		12D	55.0 57.0	WR - WH 2-4	Do 7D, tr fine sand partings (OH)		55	W = 53
		13D	60.0 62.0	2-3 5-7	Do 7D, tr fine sand partings (OH)		60	
04/05/82 Sunny, Windy		NR	65.0 67.0	9-7 7-10			65	
		14D	67.0 69.0	7-2 5-4	Med dk org silty clay, sm fine sand, tr sls, gvl, veg (OH)			W = 36
		15D	70.0 72.0	WR/24"	Med dk gray org silty clay, tr fine sand, sls (OH)		70	W = 39
		16D	75.0 77.0	WR/24"	Do 15D, tr fine sand partings (OH)		75	W = 34
		17D	80.0 82.0	WR - 1 6-9	Med dk gray org silty clay, tr m-f sand, fine sand partings, shells (OH)		80	W = 41
							85	

BORING LOG

SHEET 3 of 3
BORING NO. MG-828
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO.	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
04/05/82 Sunny, Windy		NR	85.0 87.0	5-12 11-14		Med dk gry org si cl, sm m-f sa tr shells	85	
		18D	87.0 89.0	9-6 11-14	Med dark gray organic silty clay, sm m-f sand, tr shells (OH)			
		19D	90.0 92.0	WR - 6 6-9	Med dark gray organic silty clay, some m-f sandy silt lyrs (OH)		90	W = 43
		20D	95.0 97.0	11-18 22-25	Dark gray silty fine to medium sand, tr mica (SM)	93.0 Cpt dk gry si f-m sa tr mica	95	3" dia casing was placed inside hole.
		21D	100.0 102.0	2-6 8-11	Stiff dark gray organic silty clay, tr f-m sand, veg (OH)	99.0 21D	100	W = 53
1530 0700						103.0 *		
04/07/82 Windy		1C	105.0 110.0	Rec=100% RQD=84%	Light gray garnet mica schist, jtd, UnWExJts	105.0 Light gry garnet mica schist, jtd UnWExJts	105	*Possible decomposed rock.
		2C	110.0 115.0	Rec=96% RQD=80%	Do 1C		110	Highly micaceous rock.
1130						115.0	115	
							120	
							125	
							130	
							135	
							140	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 1 of 2
BORING NO. MG-831
FILE NO. 4840

PROJECT: WEST SIDE HIGHWAY
DOT. CONTR. NO.: D 250002
ELEVATION: +10.8
COORDINATES: N 192313.3 E 1998985.3
DATUM: Manhattan
BORING LOCATION: MTA Yard, MABSTOA Garage
DATE STARTED: 04/09/82
INSPECTOR: Y.K. Chan (MRJD)
DATE COMP.: 04/12/82
CONTRACTOR: Warren George, Inc.
DRILLER: J. Farrell
HELPER: G McCartar
TYPE OF RIG: TRUCK ☒ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING: DIA. 4 IN. FROM 0.0 TO 5.0 FT.; DIA. 3 IN. FROM 0.0 TO 33.5 FT.
DRILLING MUD UTILIZED: MUD TYPE Quick-Gel
ROTARY BIT DIA. 3 7/8 IN.
SAMPLING EQUIPMENT, (TYPE & SIZE)
D-SAMPLER: Split Spoon, 2" O.D.
DRILL ROD NW
U-SAMPLER: DIA. IN.: TYPE
CORE BIT Diamond, NX
CORE BARREL Double Barrel
FEED DURING CORING: MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER: WEIGHT (LBS) 140 AVG. FALL 30 IN.
CASING HAMMER: WEIGHT (LBS) 300 AVG. FALL 18 IN.
NO. OF U–TUBES – NO. OF VANE TESTS – DEPTH TO ROCK 33.0 FT. DEPTH TO COMP. 44.0 FT.

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
04/12/82	0800	27.0	5.0	5.8		Over weekend. Drilling mud in hole
04/12/82	1410	44.0	5.0	11.5		At completion Water in hole
04/12/82	1445	44.0	0.0	7.5		

DAILY PROGRESS	CASING BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		NO.	DEPTH	BLOWS/6"				
1215		1D	0.5	12-11	Dark brown f-c sand, sm silt, gravel, cinders (Fill) (SM)	0.*	0	*Concrete W = Water content in %
	4		2.5	6-4				
	8							
	7							
	6							
		2D	5.0	4-3	Gray-brown f-m sand, sm silt, tr decomposed wood (Fill)(SM)	Med cpt to loose dark brn f-c sand, sm silt, tr gvl, cndrs, (Fill) decomposed wood	5	
	LOWERED		7.0	3-3				
		3D	10.0	7-1	Gray-brown f-m sand, sm silt, tr gravel (Fill)(SM)		10	
Snow			12.0	12-15				
04/09/82		4D	15.0	4-4	Top: Do 3D (Fill)(SM) Bot: Soft black organic silty clay, tr fine sand (OH)		15	4D Bot: W = 58
			17.0	4-2		16.5 4D Bottom		
		NR	20.0	7-14		20.0	20	
			22.0	17-23				
		5D	22.0	29-29	Brown silty f-m sand, tr gravel (SM)	Cpt red-brn f-c sand, sm silt, gravel		
			24.0	38-44				
		6D	25.0	28-36	Red-brown f-c sand, sm silt, gravel (SM)		25	
			27.0	32-41				
							30	

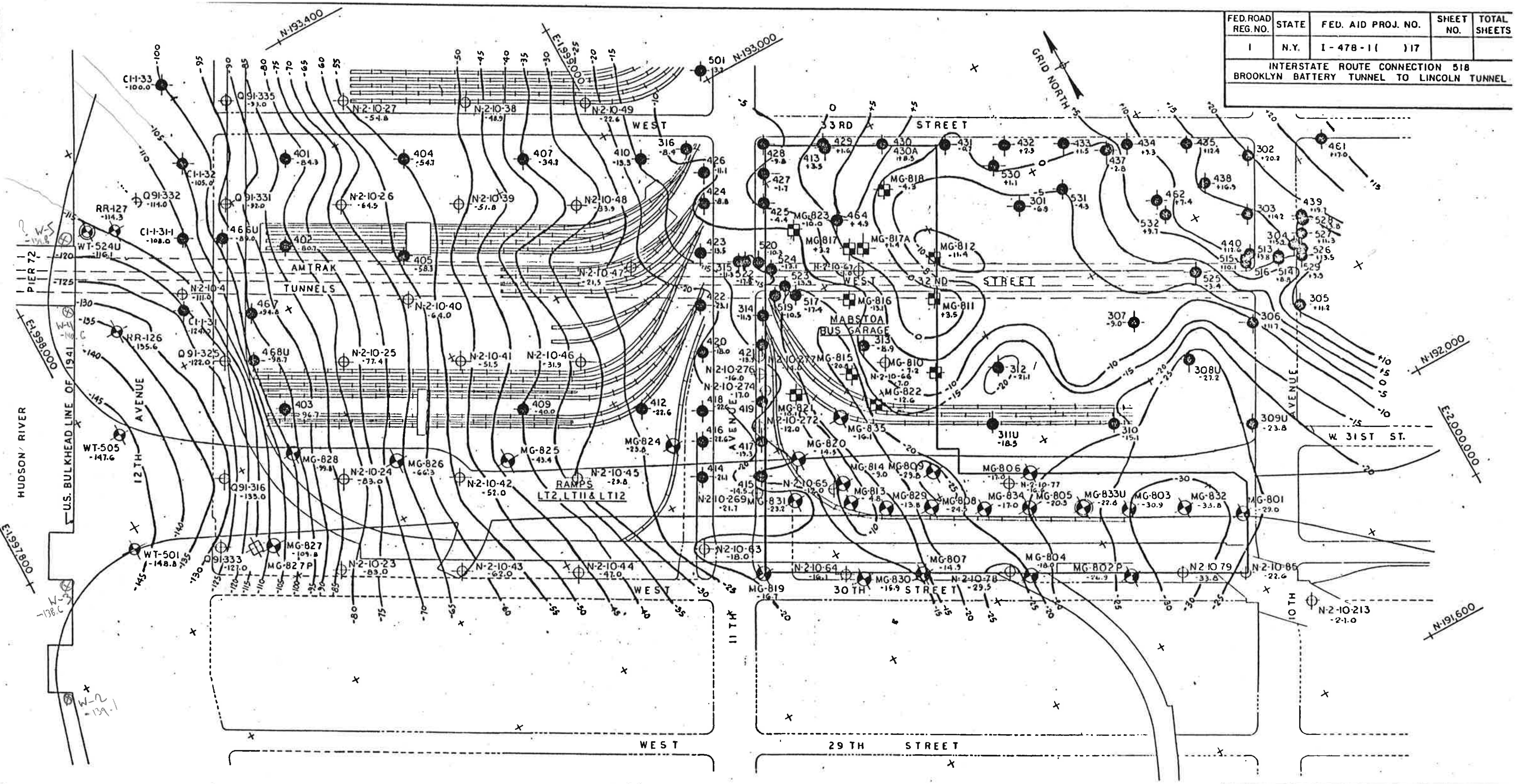
MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD–CLYDE CONSULTANTS, INC.
BORING LOG

SHEET 2 of 2
BORING NO. MG-831
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE			SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		NO.	DEPTH	BLOWS/6"				
		7D	30.0	24-36	Brown f-c sand, sm silt, gravel (SM)	7D V cpt	30	
			32.0	62-37				
						33.0 *		*Decomposed rock
Sunny		1C	34.0	Rec=98%	Light gray-white micaceous quartzite blocky, UnW	34.0	35	Core barrel was blocked at 35.5.
			39.0	RQD=98%		Lt gry mica schist quartzite mass, UnW		
04/12/82		2C	39.0	Rec=100%	Do 1C		40	
			44.0	RQD=96%				
1530						44.0	45	
							50	
							55	
							60	
							65	
							70	
							75	
							80	
							85	

FED. ROAD REG. NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
1	N.Y.	I-478-1( )17		

INTERSTATE ROUTE CONNECTION 518
BROOKLYN BATTERY TUNNEL TO LINCOLN TUNNEL



NOTES

1. For General Notes see Figure No. 3.1.
2. Contours shown are necessary interpolations between borings and may not represent actual subsurface conditions.
3. 400 series borings shown on Figure No. 3.1 but not shown on this drawing did not define bedrock and were not used for contouring.

LEGEND

- Borings made in 1982 under Westway Boring Contracts Nos. 2, 4 & 5.
- MG series borings made by others for MABSTOA Garage.
- Previously made borings providing reliable, detailed information.
- Previously made borings providing limited information.

A - Elevation of top of bedrock.

- Piezometer installed in 1982. (Does not extend to bedrock.)

GRAPHIC SCALE
0 40' 80' 160'

FIGURE NO. 4.6

INTERSTATE ROUTE CONNECTION 518
WEST SIDE HIGHWAY PROJECT

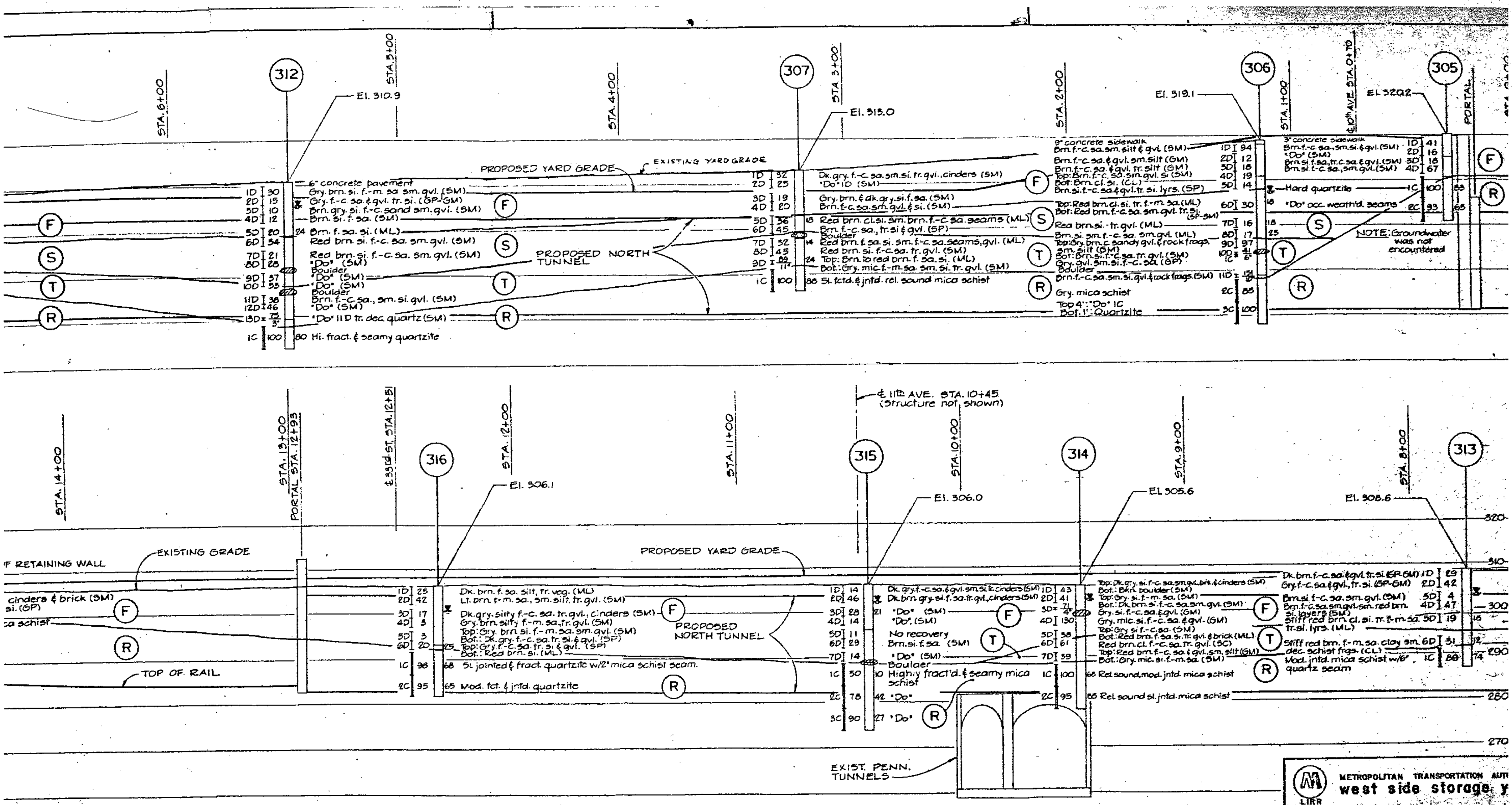
CONTOURS OF BEDROCK SURFACE

MABSTOA GARAGE

DRAWING NO.	DATE	SCALE	SHEET NO.
C-MG-1		GRAPHIC	

MUESER · RUTLEDGE · JOHNSTON & DESIMONE
WOODWARD – CLYDE CONSULTANTS, INC.

DATE
REVIEWED BY
DATE
CHECKED BY
DATE
DESIGNED BY
IN CHARGE OF



SECTION C-C

RATA DESCRIPTIONS

se to compact grey-brown
oarse sand and gravel, some silt with
brick and concrete.

Silt: Medium compact to compact red-brown
layey silt with layers of silty fine sand to
e to coarse sand, some gravel.

ill: Very compact red-brown silty fine to coarse
me gravel with boulders.

k: Moderately jointed and fractured
hist with quartzite seams.

NOTE: For Boring Legend, General Notes and Soil Sample Abbreviations see Drawing No. 05-1. Tunnel and existing structure profiles were taken from SSV & K's Drawing titled North-Connection Plan.

GRAPHIC SCALE
HORIZONTAL 0 20' 40' 60'
VERTICAL 0 10' 20' 40'

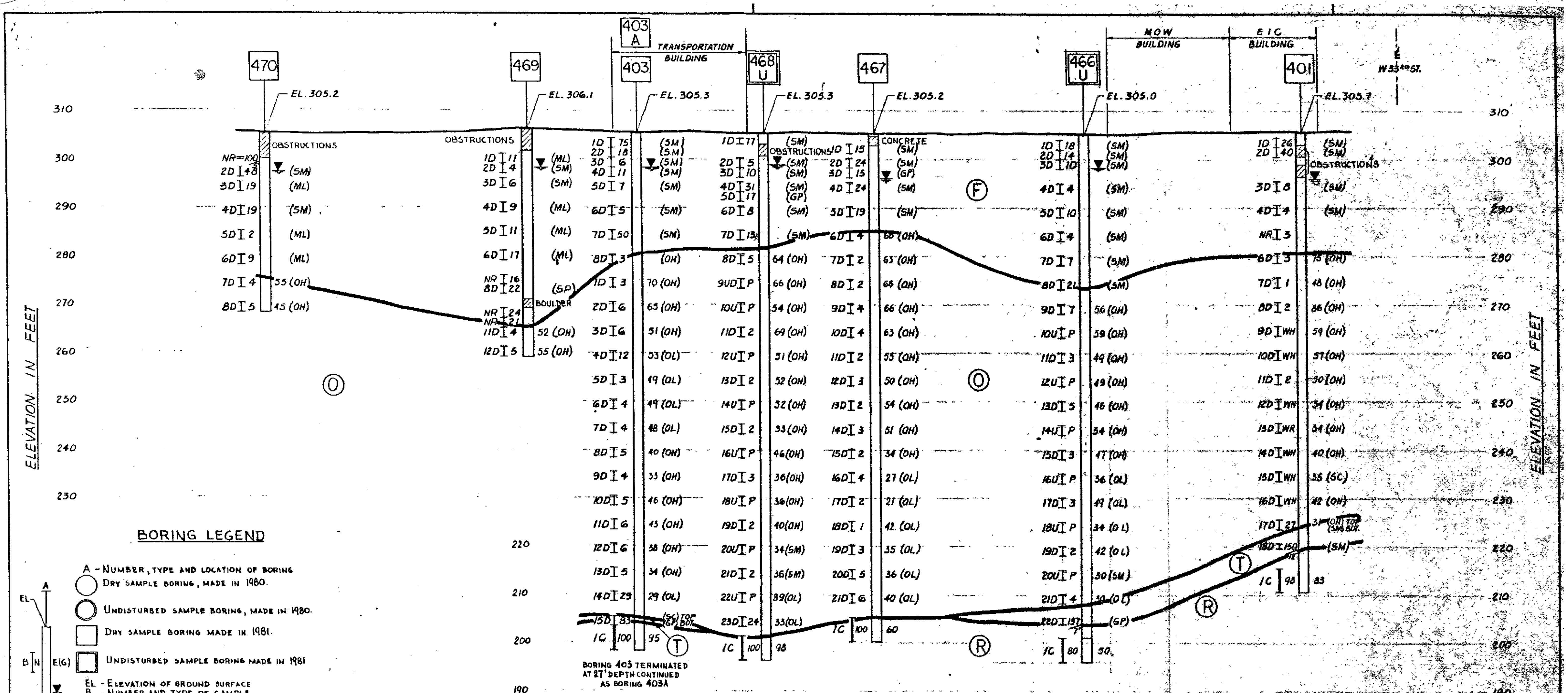
METROPOLITAN TRANSPORTATION AUT
LIRR
west side storage y

SEELYE STEVENSON VALUE & KNECH
NEW YORK, N.Y.

MUESER RUTLEDGE JOHNSTON & DES
CONSULTING ENGINEERS
415 MADISON AVE., NEW YORK N. Y. 1001

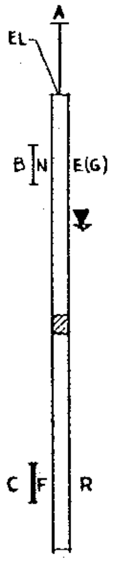
SCALE GRAPHIC	MADE BY J.V.	DATE 5-11-80
	CHKD BY J.F.G.	DATE 6-11-80

GEOLOGIC SECTION C-C



SECTION D-D

BORING LEGEND



A - NUMBER, TYPE AND LOCATION OF BORING

○ DRY SAMPLE BORING, MADE IN 1980.

◎ UNDISTURBED SAMPLE BORING, MADE IN 1980.

□ DRY SAMPLE BORING MADE IN 1981.

▣ UNDISTURBED SAMPLE BORING MADE IN 1981

EL - ELEVATION OF GROUND SURFACE
B - NUMBER AND TYPE OF SAMPLE
  D - DRY SAMPLE TAKEN WITH 2" O.D SPLIT SPOON
  U - UNDISTURBED SAMPLE TAKEN WITH 3" O.D PISTON TYPE SAMPLER.
  UD - UNDISTURBED SAMPLE EXTRUDED IN FIELD AND PLACED IN JAR DUE TO POOR RECOVERY.
  NR - NO RECOVERY
I - LOCATION AND LENGTH OF SAMPLE
N - STANDARD PENETRATION RESISTANCE - NUMBER OF BLOWS FROM 140LB. HAMMER FREE FALLING 30" REQUIRED TO DRIVE 2" O.D. SPLIT SPOON SAMPLER ONE FOOT UNLESS A SPECIFIC PENETRATION IS INDICATED
  P - PRESSED OR PUSHED SAMPLE.
  WR - SAMPLER ADVANCED UNDER WEIGHT OF RODS
  WH - SAMPLER ADVANCED UNDER WEIGHT OF RODS AND HAMMER
▨ BOULDER OR OBSTRUCTION
E - AVERAGE NATURAL WATER CONTENT OF SAMPLE IN PERCENT OF DRY WEIGHT.
▼ GROUND WATER LEVEL OBSERVED IN LAND BORINGS. (IMMEDIATELY AFTER COMPLETION OF BORING)
C - ROCK CORE
Ⅱ - LENGTH OF CORE RUN.
F - LENGTH OF CORE RECOVERED EXPRESSED AS A PERCENT OF THE LENGTH OF CORE RUN
R - ROCK QUALITY DESIGNATION - LENGTH OF RECOVERED CORE CONSISTING OF PIECES 4" OR MORE IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF CORE RUN
G - UNIFIED SOIL CLASSIFICATION SYMBOL

GENERAL NOTES

1. 400 SERIES BORINGS WERE MADE BY WARREN GEORGE, INC BETWEEN APRIL 13 AND JUNE 5, 1981 UNDER THE CONTINUOUS INSPECTION OF MUESER, RUTLEDGE, JOHNSTON AND DE SIMONE
2. 300 SERIES BORINGS WERE MADE BY WARREN GEORGE, INC BETWEEN MAY 5 AND 22, 1980 UNDER THE CONTINUOUS INSPECTION OF MUESER, RUTLEDGE, JOHNSTON AND DE SIMONE.
3. CLASSIFICATIONS SHOWN WERE MADE BY MUESER, RUTLEDGE, JOHNSTON AND DE SIMONE AND MAY NOT AGREE WITH THE DRILLERS' CLASSIFICATIONS.
4. STRATIFICATIONS SHOWN ARE NECESSARY INTERPOLATIONS BETWEEN BORINGS AND MAY OR MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS
5. ELEVATIONS REFER TO L I R R DATUM, ON WHICH ELEVATION 300 IS EQUAL TO ELEVATION -0.025 ON THE BOROUGH OF MANHATTAN DATUM.
6. LOCATIONS AND GROUND SURFACE ELEVATIONS OF BORINGS WERE DETERMINED BY SEELYE, STEVENSON, VALUE AND KNECHT, INC.

GENERAL STRATA DESCRIPTIONS

Ⓕ - FILL: LOOSE TO COMPACT GRAY-BROWN FINE TO COARSE SAND AND GRAVEL, SOME SILT WITH CINDERS, BRICK AND CONCRETE.

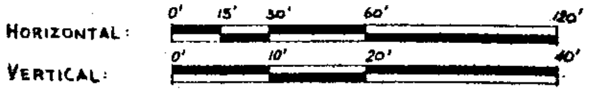
Ⓞ - ORGANIC: SOFT TO MEDIUM DARK GRAY ORGANIC SILTY CLAY TO CLAYEY SILT WITH FINE SAND SEAMS.

Ⓢ - SAND AND SILT: MEDIUM COMPACT TO COMPACT RED-BROWN SILT OR CLAYEY SILT WITH LAYERS OF SILTY FINE SAND TO SILTY FINE TO COARSE SAND, SOME GRAVEL.

Ⓣ - GLACIAL TILL: VERY COMPACT RED-BROWN SILTY FINE TO COARSE SAND, SOME GRAVEL WITH BOULDERS.

Ⓡ - BEDROCK: MODERATELY JOINTED AND FRACTURED MICA SCHIST WITH QUARTZITE SEAMS.

GRAPHIC SCALES



SEELYE STEVENSON VALUE & KNECHT, INC.
ENGINEERS & PLANNERS
99 PARK AVENUE NEW YORK, N.Y. 10016

MUESER-RUTLEDGE-JOHNSTON & DESIMONE
CONSULTING ENGINEERS
415 MADISON AVE., NEW YORK, N.Y. 10017

L.I.R.R.
LONG
ISLAND
RAIL ROAD

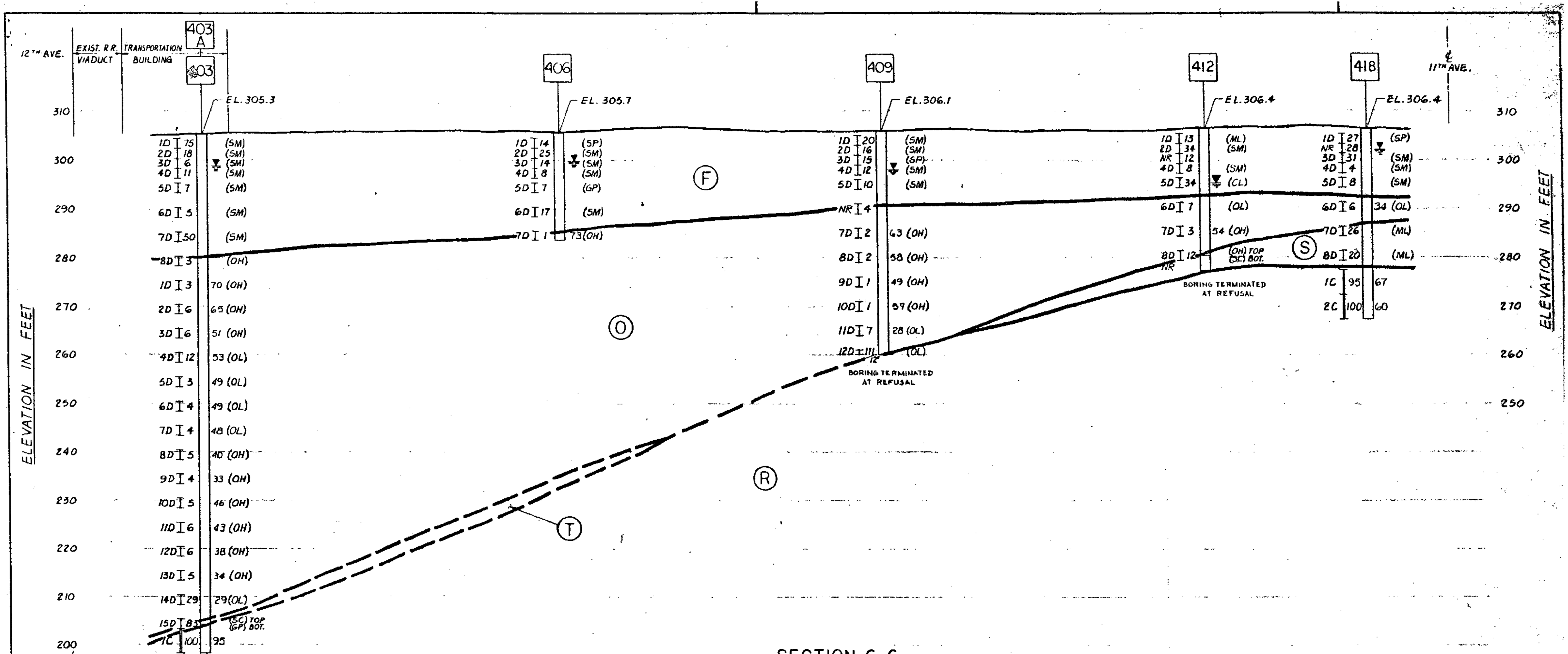
M
Metropolitan
Transportation
Authority

REV. NO.	DESCRIPTION	DATE

WEST SIDE STORAGE YARD COMPLEX

GEOLOGIC SECTION D-D

CONTRACT NO 5385
DATE JULY 16, 1981
SCALE GRAPHIC
DRAWING NO GS-3
SHEET 5 OF 12



SECTION G-G

Boring 403 terminated at 27' depth continued as Boring 403A

GENERAL STRATA DESCRIPTIONS

Ⓕ – FILL: LOOSE TO COMPACT GRAY-BROWN FINE TO COARSE SAND AND GRAVEL, SOME SILT WITH CINDERS, BRICK AND CONCRETE.

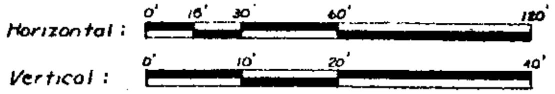
Ⓞ – ORGANIC: SOFT TO MEDIUM DARK GRAY ORGANIC SILTY CLAY TO CLAYEY SILT WITH FINE SAND SEAMS.

Ⓢ – SAND AND SILT: MEDIUM COMPACT TO COMPACT RED-BROWN SILT OR CLAYEY SILT WITH LAYERS OF SILTY FINE SAND TO SILTY FINE TO COARSE SAND, SOME GRAVEL.

Ⓣ – GLACIAL TILL: VERY COMPACT RED-BROWN SILTY FINE TO COARSE SAND, SOME GRAVEL WITH BOULDERS.

Ⓡ – BEDROCK: MODERATELY JOINTED AND FRACTURED MICA SCHIST WITH QUARTZITE SEAMS.

GRAPHIC SCALES



REV NO	DESCRIPTION	DATE

SEELYE STEVENSON VALUE & KNECHT, INC.
ENGINEERS & PLANNERS
99 PARK AVENUE NEW YORK, N.Y. 10016

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
CONSULTING ENGINEERS
415 MADISON AVE., NEW YORK, N.Y. 10017

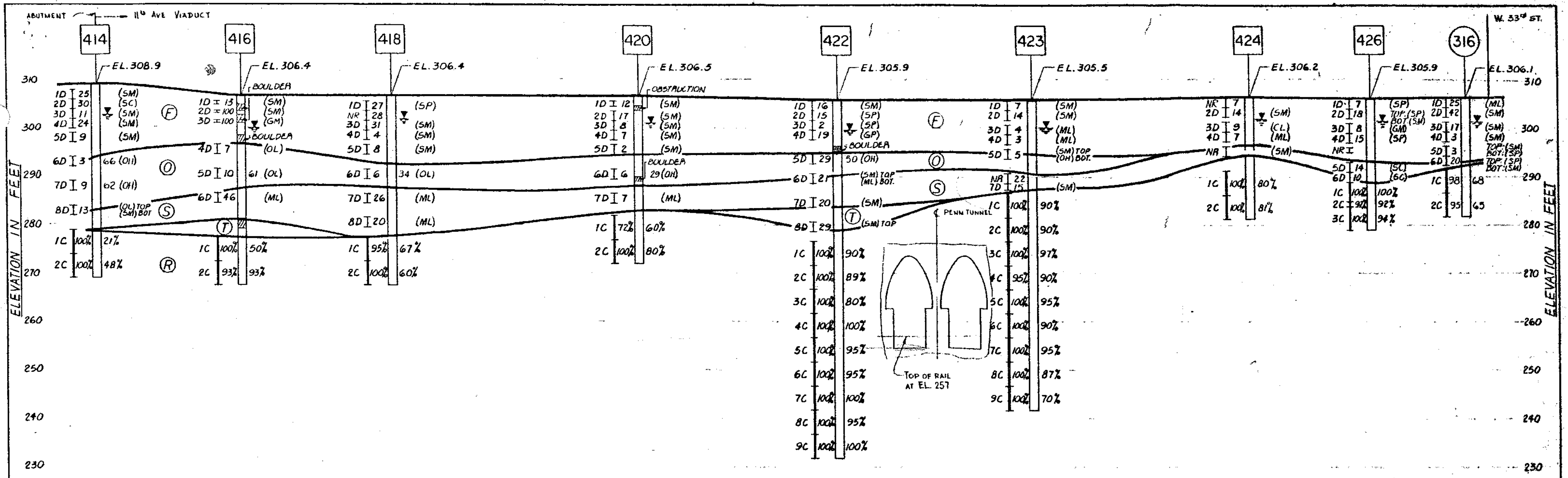
L.I.R.R.
LONG
ISLAND
RAIL ROAD

M
Metropolitan
Transportation
Authority

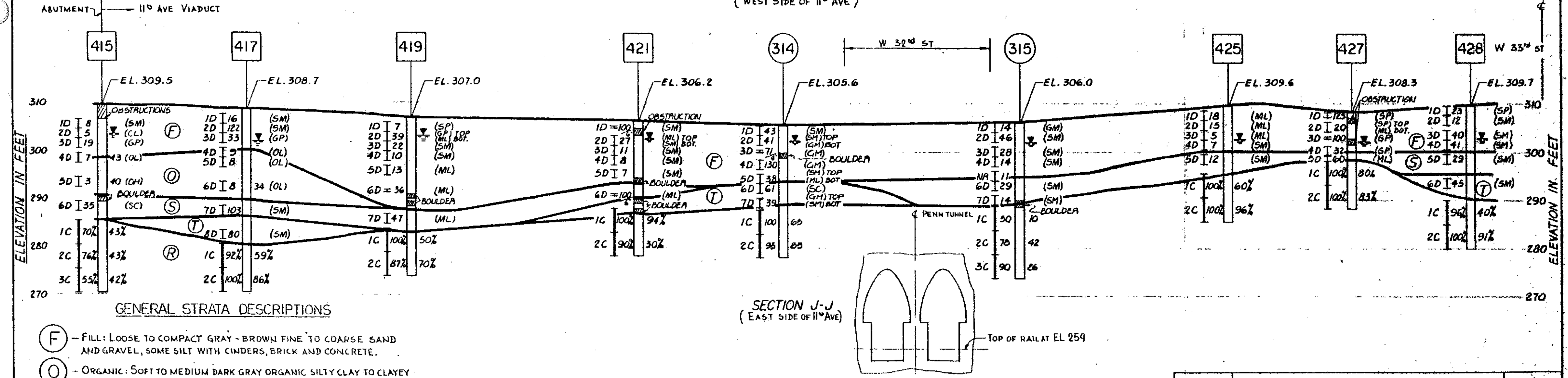
WEST SIDE STORAGE YARD COMPLEX

GEOLOGIC SECTION G-G

CONTRACT NO 5385
DATE JULY, 16, 1981
SCALE GRAPHIC
DRAWING NO. GS-6
SHEET 8 OF 12



SECTION H-H
(WEST SIDE OF 11th AVE)



SECTION J-J
(EAST SIDE OF 11th AVE)

GENERAL STRATA DESCRIPTIONS

Ⓕ – FILL: LOOSE TO COMPACT GRAY - BROWN FINE TO COARSE SAND AND GRAVEL, SOME SILT WITH CINDERS, BRICK AND CONCRETE.

Ⓞ – ORGANIC: SOFT TO MEDIUM DARK GRAY ORGANIC SILTY CLAY TO CLAYEY SILT WITH FINE SAND SEAMS.

Ⓢ – SAND AND SILT: MEDIUM COMPACT TO COMPACT RED-BROWN SILT OR CLAYEY SILT WITH LAYERS OF SILTY FINE SAND TO SILTY FINE TO COARSE SAND, SOME GRAVEL.

Ⓣ – GLACIAL TILL: VERY COMPACT RED-BROWN SILTY FINE TO COARSE SAND, SOME GRAVEL WITH BOULDERS.

Ⓡ – BEDROCK: MODERATELY JOINTED AND FRACTURED MICA SCHIST WITH QUARTZITE SEAMS.

HORIZONTAL 0' 20' 40'

VERTICAL 0' 10' 20'

SEELYE STEVENSON VALUE & KNECHT, INC.
ENGINEERS & PLANNERS
99 PARK AVENUE NEW YORK, N.Y. 10016

MUESER-RUTLEDGE-JOHNSTON & DESIMONE
CONSULTING ENGINEERS
415 MADISON AVE., NEW YORK, N.Y. 10017

L.I.R.R.
LONG ISLAND RAIL ROAD

Metropolitan Transportation Authority

REV NO	DESCRIPTION	DATE

WEST SIDE STORAGE YARD COMPLEX
11TH AVENUE VIADUCT
SUBSURFACE PROFILES
GEOLOGIC SECTION H-H & J-J

CONTRACT NO 5385
DATE JULY 16, 1981
SCALE GRAPHIC
DRAWING NO GS-7
SHEET 9 of 12

JOB LOCATION: AMTRAK North Access Connection Tunnel New York City	**WARREN GEORGE. INC.** FOOT OF JERSEY AVENUE P. O. BOX 413 JERSEY CITY, N.J. 07303 FOR: Parsons Brinckerhoff	SHEET 1 OF 1 LOCATION New York City HOLE NO. B-1 N 19921.73 W 15120.80

DEPTH ______ FT. ____ FT. CASING OUT DATE: ______

DEPTH ______ FT. ALL CASING OUT DATE: ______

DATE, START: 9/2/86

DATE, FINISH: 9/13/86

GROUND ELEVATION 306.7

GROUND WATER ELEVATION 299.4

CASING O.D. NW I.D. ______

SAMPLER O.D. 2" I.D. 1-3/8"

DIAMOND BIT SIZE NX

WEIGHT OF HAMMER 300-140 LBS.

INSIDE LENGTH OF SAMPLER 24 IN.

HAMMER FALL

CASING 24" SAMPLER 30"

DEPTH BELOW SURFACE	CASING BLOWS PER FOOT	SAMPLE NUMBER	SAMPLE DEPTHS ELEV. / FEET	SAMPLE RECOVERY	BLOWS PER 6" ON SAMPLER			DENSITY OR CONSIST. MOISTURE	PROFILE CHANGE DEPTH	FIELD IDENTIFICATION OF SOILS REMARKS
					0-6	6-12	12-18			
0		SS-1	0'-1.1'	4"	5-	15-	50/1"		SS-1	Brown Sandy medium to coarse GRAVEL, very dense dry (FILL+BALLAST)
		SS-2	5'-6'	3"	3-	3-	50/0"		SS-2	Brown medium to fine SAND, some Gravel, little Clay very dense ~~wet~~ (fill)
10		SS-3	10'-12'	10"	5-	10-	10-4		0'-12.5' SS-3	Gray coarse to fine SAND, little fine Gravel, trace Silt, medium dense, very moist
									12.5'-13'	Soft rock
		R1	13'-18'	4.75'	RQD=84%				13'-35'	Manhattan Schist Formation, dark gray Mica Schist. 13.0'-13.5',Highly to moderately weathered low to moderate hardness
		R2	18'-19.5'	1.1'	RQD=53%					
20										13.5'-35.0' Slightly weathered, moderate hardness, close to wide fracture spacing.
		R3	19.5'-24.8'	5.3'	RQD=100%					
30		R4	24.8'-30'	5.2'	RQD=100%					
		R5	30'-35'	4.9'	RQD=84%					Note: Pressure test at 14.0'-19.6', 1 gpm at 24 psi, Piezometer installed at 23'
40										

Soils Engineer: ______

Drilling Inspector: Peter Tani

Driller: Greg Marney

Helper: Norman Burgess

JOB LOCATION: AMTRAK North Access Connection Tunnel New York City	**WARREN GEORGE, INC.** FOOT OF JERSEY AVENUE P. O. BOX 413 JERSEY CITY, N.J. 07303 FOR: Parsons Brinckerhoff	SHEET 1 OF 1 LOCATION New York City HOLE NO. B-2 N 19986.60 W 15104.10

DEPTH ______ FT. ____ FT. CASING OUT DATE: ______

DEPTH ______ FT. ALL CASING OUT DATE: ______

DATE, START: 9/10/86

DATE, FINISH: 9/10/86

GROUND ELEVATION 306.2

GROUND WATER ELEVATION 301.3

CASING O.D. NW I.D. ______

SAMPLER O.D. 2" I.D. 1-3/8"

DIAMOND BIT SIZE NX

WEIGHT OF HAMMER 300-140 LBS.

INSIDE LENGTH OF SAMPLER 24 IN.

HAMMER FALL

CASING 24" SAMPLER 30"

TH BE. OW SURFACE	CASING BLOWS PER FOOT	SAMPLE NUMBER	SAMPLE DEPTHS ELEV. / FEET	SAMPLE RECOVERY	BLOWS PER 6" ON SAMPLER			DENSITY OR CONSIST. MOISTURE	PROFILE CHANGE DEPTH	FIELD IDENTIFICATION OF SOILS REMARKS
					0-6	6-12	12-18			
0									0'-8.5'	SS-1 Black brown coarse/fine SAND and coarse/medium GRAVEL, little CLay, slightly moist, very slightly plastic, very stiff, (Fill & Ballast)
		SS-1	0'-2'	11"	4-	13-	15-26			
		SS-2	5'-7'	4"	3-	5-	7-14			
									SS-2	Black brown coarse/medium GRAVEL, some medium/fine Sand, wet, stiff(Fill & Ball ast)
10										
									8.5'-9'	Decomposed rock
		R1	9'-14'	4.6'	RQD=92%					
									9'-29'	Manhattan Schist Formation, light gray quartz pegmatite coarse to medium-grained, slightly weathered, hard to very hard moderately close to wide fracture spacing
		R2	14'-19'	4.9'	RQD=91%					
20										
		R3	19'-24'	5'	RQD=100%					
		R4	24'-29'	5'	RQD=94%					
30										Note: Pressure test at 10.1'-15.7' no take at 30 psi
40										

Soils Engineer: ______

Drilling Inspector: Peter Tani

Driller: Greg Marney

Helper: NOrman Burgess

JOB LOCATION:
AMTRAK North Access
Connection Tunnel
New York City

WARREN GEORGE, INC.

FOOT OF JERSEY AVENUE
P. O. BOX 413
JERSEY CITY, N.J. 07303

FOR: Parsons Brinckerhoff

SHEET 1 OF 1
LOCATION New York City
HOLE NO. B-3
N-20094.56
W 15078.41

EPTH ______ FT. ____ FT. CASING OUT DATE: ______
DEPTH ______ FT. ALL CASING OUT DATE: ______

DATE, START: 9/11/86
DATE, FINISH: 9/11/86

GROUND ELEVATION 306.3
GROUND WATER ELEVATION 300.5

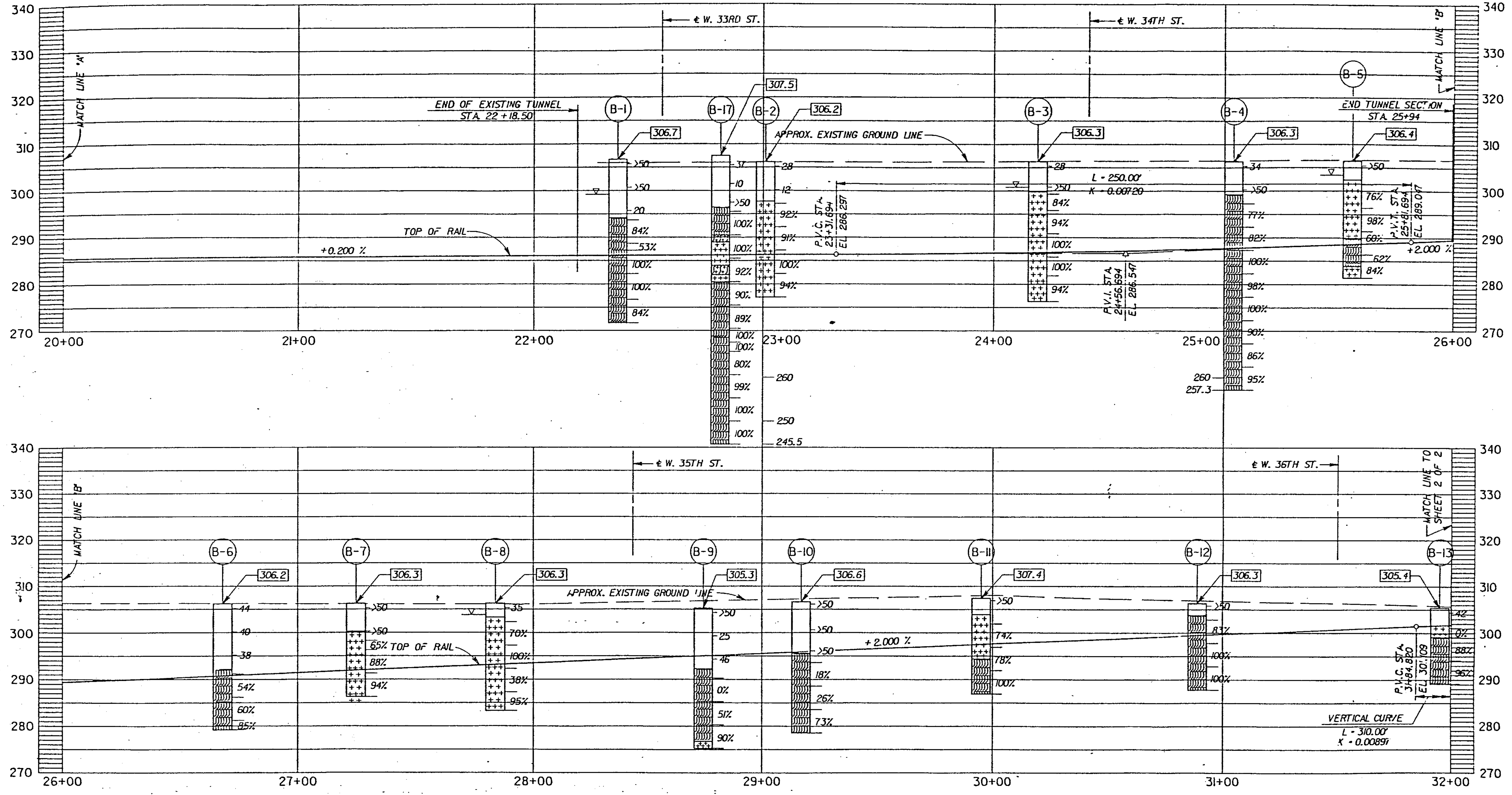
ASING O.D. NW I.D. ______
AMPLER O.D. 2" I.D. 1-3/8"
DIAMOND BIT SIZE NX

WEIGHT OF HAMMER 300-140 LBS.
INSIDE LENGTH OF SAMPLER 24 IN.

HAMMER FALL
CASING 24" SAMPLER 30"

PTH W SURFACE	CASING BLOWS PER FOOT	SAMPLE NUMBER	SAMPLE DEPTHS ELEV. / FEET	SAMPLE RECOVERY	BLOWS PER 6" ON SAMPLER 0-6	6-12	12-18	DENSITY OR CONSIST. MOISTURE	PROFILE CHANGE DEPTH	FIELD IDENTIFICATION OF SOILS. REMARKS
		SS-1	0'-2'	1"	12-	14-	14-8		SS-1:	Light brown coarse GRAVEL, and SILT, dry, medium dense (Ballast & Fill)
		SS-2	5'-6.25'	13"	11-	19-	28/3"		0'-6.25'	
									SS-2	Light brown SILT, little coarse/medium Sand, trace Gravel, Wet, Dense, decomposed Rock
		R1	6.5'-10'	3'	RQD=84%					
									6.25'-30'	
		R2	10'-15'	4.8'	RQD=94%					
		R3	15'-20.3'	5.3'	RQD=100%					
										Manhattan Schist Formation, Light gray quartz pegmatite, slightly weathered, hard to very hard, moderately close fracture spacing
		R4	20/3'-24.2'	3.9'	RQD=100%					
		R5	24.2'-30'	5.7'	RQD=97%					
										Note: Pressure test at 14.4'-20.0' 4.5 gpm at 20 psi Piezometer installed at 30'

ils Engineer: ______
Drilling Inspector: Peter Tani
Driller: Greg Marney
Helper: Norman Burgess



LEGEND:

OVERBURDEN

☐ TRACK BEDDING AND FILL MATERIALS. GENERALLY CONSISTING OF MEDIUM TO VERY DENSE COARSE TO FINE SAND & GRAVEL

BEDROCK (MANHATTAN SCHIST FORMATION)

▤ MICA SCHIST

⊞ QUARTZ PEGMATITE INTRUSIONS

▨ SCHIST/PEGMATITE TRANSITION ZONE

IN OVERBURDEN, NUMBERS GIVEN ARE STANDARD PENETRATION TEST N-VALUES. IN BEDROCK, NUMBERS GIVEN ARE ROCK QUALITY DESIGNATION (RQD) INDEX VALUES.

▽ WATER LEVEL READING TAKEN IN OBSERVATION WELL.

HORIZONTAL

0 20 40 60

GRAPHIC SCALE (FEET)

VERTICAL

0 10 20 30

GRAPHIC SCALE (FEET)

NORTH ACCESS TUNNEL

WEST 33RD STREET TO WEST 38TH STREET

SUBSURFACE INFORMATION

FIGURE 1

THE PARTNERSHIP **BORING LOG**	BORING NUMBER: **PE-273** SHEET NUMBER: **1** of **2** PROJECT NUMBER: **19499B**
PROJECT: **Trans-Hudson Express (THE) Project** LOCATION: **New York, New York** CLIENT: **NJ Transit** CONTRACTOR: **Jersey Boring & Drilling**	LOCATION: **11th Ave at 30th St, NW corner** COORD.: **N: 699,757.3 E: 629,565.0** SURFACE ELEV.: **318.5 feet**
DRILLER: **J. Kurzynowski** INSPECTOR: **R. Sidorski/M. Tekin**	DATUM: **Horizontal: NJ State Plane** **Vertical: NYCT datum-200 ft**
DRILLING METHOD: **Rotary Wash; Diamond Coring** RIG TYPE: **CME-75, Truck-mounted, Automatic Safety Hammer**	START DATE: **4/15/08** TIME: **7:00 am** FINISH DATE: **4/18/08** TIME: **11:00 am**

	Casing	Split Spoon	Shelby Tube	Piston	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ▧	G ☒	C ▤
I.D.	4"	1.375"	2.938"	2.938"		1.875"
O.D.	4.5"	2"	3"	3"		3"
Length	60"	24"	24"	24"		120"
Hammer Wt.	300 lbs.	140 lbs.	Drill Rod Size		NWJ	
Hammer Fall	24"	30"	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 0.5 0.5 - 6.0						Hand augered from 0.0' to 6.0'. 0-0.5': Asphalt 0.5-6.0': Brown, c-f SAND, trace m-f Gravel, trace Silt, brick & concrete pieces. (FILL)
5												
			S	2	■	6.0 - 8.0	7	7	5	2	12	Brown, c-f SAND, trace (+) m-f Gravel, trace Silt, concrete. (FILL)
			S	3	■	8.0 - 10.0	3	5	5	4	6	Brown, c-f SAND, little m-f Gravel, trace Silt. (FILL)
10			S	4	■	10.0 - 12.0	2	4	29	71	5	Black and white, c-f GRAVEL, some c-f Sand, trace Silt with mica. (GP)
15			S	5	■	15.0 - 17.0	2	2	6	3	8	Brown, SILT, some f Sand, trace c-f Gravel. (ML)

THE PARTNERSHIP

BORING LOG
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)	
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			S	6	■	20.0 - 22.0	1	WOH	WOH	20	4	Red & gray, c-f SAND, some c-f Gravel, trace (+) Silt. (SP)
25			S	7	■	25.0 - 27.0	24	9	11	15	11	Red brown, c-f SAND, some m-f Gravel, trace Silt. (SP)
30			S	8	■	30.0 - 32.0	2	1	1	2	18	Dark gray, CLAY & SILT, trace f Sand with marine shells. (CL)
35			S	9	■	35.0 - 37.0	WOH	1	2	9	4	Dark gray, c-f GRAVEL, trace Silt . (GP) Note: Gravel is stuck in tip. Hard drilling at 39.0'.
40			S	10	■	40.0 - 40.3	100/3"				3	Dark gray, m-f SAND, little m-f Gravel, trace Silt with mica. (SM) (Decomposed Rock)
												41.5'
												Roller-bit to 41.5' depth and start rock coring.

THE PARTNERSHIP CORING LOG

BORING NUMBER: **PE-273**
SHEET NUMBER: **1** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **New York, New York**
CLIENT: **NJ Transit**
CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**
DRILLING METHOD: **Rotary Wash; Diamond Coring**
RIG TYPE: **CME-75, Truck-mounted, Automatic Safety Hammer**

LOCATION: **11th Ave at 30th St, NW corner**
COORD.: **N: 699,757.3 E: 629,565.0**
SURFACE ELEV.:**318.5 feet**
DATUM: **Horizontal: NJ State Plane**
Vertical: NYCT datum-200 ft
START DATE: **4/15/08** TIME: **7:00 am**
FINISH DATE: **4/18/08** TIME: **11:00 am**

CORE BARREL DATA:	NOTES:
TYPE: Double Barrel, solid inner barrel with wireline	
CORE SIZE: NQ	
O.D.: 3"	
I.D.: 1.875"	
CASING SIZE: 4" (4.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
45	4	C-1 41.5 - 46.6	61	100	70	C-1: 41.5-45.8': Dark gray SCHIST; f-c grains of biotite, quartz, muscovite, feldspar, and sparse garnet; close to moderate fracture spacing, except extremely close at 42.3-42.4'; slightly weathered; medium strong to strong; distinct wavy and crenulated schistosity dips 50-80 deg; orange iron staining on some fracture surfaces; no rock wall contact at horizontal fracture at 44.1'; 1/2-inch thick quartz-feldspar pegmatites; parallel to schistosity at 43.6', 44.4', and 44.6'.	II	R3/R4	*70 30 30 *60 *80 *50 0 5 *70	2.0 2.0 2.0 2.0 1.5 2.0 1.0 2.0 1.5	2.0 2.0 2.0 2.0 1.0 1.0 6.0 2.0 1.0	41.5 42.3 42.4 42.8 43.4 43.6 44.1 44.6 44.8
						45.8-46.3': Medium gray GRANITE; medium grains of mostly quartz, with some muscovite and white feldspar; moderate fracture spacing; unweathered; strong; upper contact is parallel to foliation in schist.	I	R4	15 10 *70	3.0 3.0 1.5	2.0 2.0 1.0	45.4 45.6 46.3
50 55	5	C-2 46.6 - 56.1	114	100	95	C-2: Dark gray SCHIST, with interlayered medium to light gray to light red GRANITE; alternating schist and granite bands are 1/4" to 8" thick; schist has f-c grains of biotite, quartz, muscovite, feldspar, and sparse garnet; granite has f-m grains of quartz, feldspar, and muscovite, with hematite at 53.8-54.3' and 55.7-56.1'; moderate to wide fracture spacing, except close at 55.6-56.1'; unweathered to slightly weathered; strong; schist has distinct planar schistosity dipping 50-70 deg; schist-granite contacts are intact and parallel to schistosity; pure QUARTZ at 55.5-55.6'; pink PEGMATITE at 51.0-51.1'.	I/II	R4	*70 25 *70 *50 *50 30 30 *50	1.5 3.0 2.0 1.5 1.0 1.0 3.0 2.0	1.0 1.0 1.0 1.0 1.0 6.0 1.0 1.0	47 49.7 51.2 53.3 54.6 54.8 55.5 55.6
						C-3: 56.1-61.0': Light red to light gray GRANITE	I	R4				

THE PARTNERSHIP **CORING LOG**
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **2** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
	5	C-3 56.1 - 66.0	119	100	97	with interlayered dark gray SCHIST; alternating granite and schist bands are 1/4" to 10" thick; granite has f-m grains of quartz, feldspar, muscovite, and sparse garnet, with hematite at 56.1-59.0'; schist has f-c grains of biotite, quartz, muscovite, and feldspar; moderate to wide fracture spacing; unweathered; strong; distinct planar schistosity in schist dips 50-60 deg; granite-schist contacts are intact and parallel to schistosity.	II	R4	20	1.0	6.0	56
									25	1.5	1.0	56.1
									0	MB	MB	59.4
60						61.0-66.0': Dark gray SCHIST; f-c grains of biotite, quartz, muscovite, and feldspar; moderate fracture spacing; slightly weathered; strong; distinct wavy and crenulated schistosity dips 60-80 deg; no rock wall contact at 60 deg foliation fracture at 62.0', with smooth, polished surfaces and thin coating of brown clay; light gray granite intrusion along foliation at 63.3-63.8'; black, f-grained, and biotite-rich at 65.4-66.0'.			20	2.0	2.0	60
									*50	1.5	2.0	61.3
									60	1.0	6.0	62
									40	MB	MB	63.4
									10	MB	MB	64.4
65									*60	1.5	1.0	65
									60	1.0	1.0	65.6
	5	C-4 66.0 - 76.0	118	98	86	C-4: Dark to medium gray SCHIST; f-c grains of quartz, biotite, muscovite, feldspar, and scattered garnets, up to 1/8" across; close to wide fracture spacing, except extremely close at 70.6-71.0'; slightly weathered; strong; wavy to crenulated schistosity dips 60-80 deg; strike-slip slickensides on 70 deg foliation fracture at 70.9', with thin (<0.1") coating of brown clay; near-vertical cross foliation fracture at 70.0-70.8' has thin coating of gray clay; thin brown clay coating also on smooth 70 deg foliation fracture at 71.0'; calcite coatings on fractures at 72.4-74.3'; orange iron staining on fractures at 75.3-76.0'; white near-vertical hairline veins of calcite, partly weathered out, at 72.4-76.0'; medium gray GRANITE at 71.0-72.4', with medium grains of quartz, feldspar, and muscovite and faint near-vertical banding; upper and lower granite contacts are along smooth foliation fractures.	II	R4	*60	MB	MB	66
									5	2.0	1.0	66.5
									20	2.0	1.0	66.8
									35	2.0	1.0	67.3
70									80	1.5	4.0	70
									90	1.5	4.0	70.2
									85	1.5	4.0	70.8
									*70	0.5	4.0	70.9
									*70	1.0	4.0	71
									*60	2.0	1.0	72.4
									*60	1.0	1.0	73
									90	3.0	2.0	74.3
75									60	3.0	1.0	74.35

THE PARTNERSHIP CORING LOG
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **3** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
									10	3.0	2.0	74.4
									20	3.0	2.0	75.3
	5	C-5 76.0 - 86.1	121	100	100	C-5: Medium to dark gray SCHIST; f-m grains of biotite, muscovite, quartz, feldspar, calcite, and garnets up to 1/4" across; moderate to wide fracture spacing; slightly weathered; strong; crenulated schistosity dips 50-70 deg; enriched in biotite at 82.1-82.3'; pure QUARTZ at 80.6-80.8'; scattered hairline calcite veins parallel to foliation; all fractures are along foliation, most with thin (<(0.1") calcite coatings.	II	R4	80	1.5	1.0	76
									*60	1.5	1.0	78.4
									30	2.0	2.0	79.3
80												
									*50	1.5	2.0	80.5
									*50	MB	MB	80.8
									20	3.0	1.0	81.6
									*50	1.0	1.0	82.2
									*50	1.5	1.0	84.5
85												
									*50	2.0	2.0	85.3
									*70	2.0	1.0	85.7
	5	C-6 86.1 - 96.1	120	100	100	C-6: Medium to dark gray SCHIST; f-m grains of biotite, quartz, muscovite, feldspar, calcite, and scattered garnets, up to 1/4" across; rock is f-c grained below 90.7'; moderate fracture spacing; unweathered; strong; planar to crenulated schistosity dips 50-80 deg, becoming near-vertical below 93.6'; contorted quartz-feldspar band, 1/2" thick, at 89.2'; thin (<0.1") calcite coatings on most fractures; scattered hairline veins of white calcite parallel to schistosity; core sides are slightly bulging at 92.0-93.5'.	I	R4	30	2.0	1.0	86.9
									*60	1.0	1.0	88.6
90												
									*50	1.0	1.0	90.2
									10	3.0	1.0	91.9
									*60	1.5	2.0	93.6

CORING LOG
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **4** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
95												
									15	MB	MB	95.1
									20	3.0	1.0	95.6
	5	C-7 96.1 - 105.8	116	100	95	C-7: Dark gray SCHIST; f-c grains of biotite, muscovite, quartz, feldspar, calcite, and many garnets, up to 1/4" across; moderate to wide fracture spacing, except close at 105.1-105.8'; unweathered; strong; crenulated schistosity dips 50-80 deg, near-vertical at 96.1-97.2'; thin (<0.1") calcite coatings on some foliation fractures; no rock wall contact at near-horizontal fractures at 100.9', with rough, unweathered fracture surfaces.	I	R4	50	MB	MB	96.1
									30	3.0	1.0	98.1
									40	MB	MB	99.7
100												
									*60	1.0	1.0	100.2
									10	1.0	6.0	100.9
									*60	1.5	1.0	103.6
									0	2.0	1.0	104.7
105												
									*60	1.5	1.0	105.1
									*50	2.0	1.0	105.4
	5	C-8 105.8 - 115.4	115	100	93	C-8: Dark to medium gray SCHIST; f-m grains of muscovite, biotite, quartz, feldspar, calcite, and scattered garnets, up to 1/4" across; close to moderate fracture spacing; unweathered; strong; planar to crenulated schistosity dips 50-70 deg; thin (0.1") calcite coatings on many fractures; medium gray, pure QUARTZ at 112.9-114.1'.	I	R4	40	2.0	1.0	105.8
									*60	1.0	1.0	107.2
									*60	2.0	1.0	107.7
									40	2.0	1.0	108.6
									*70	1.5	1.0	109.2
									*70	2.0	1.0	109.3
									35	2.0	1.0	109.9
110												
									*50	1.5	1.0	110.1
									15	3.0	1.0	111.3
									0	2.0	1.0	112.1

THE PARTNERSHIP **CORING LOG**
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **5** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH
115								
120 125	5	C-9 115.4 - 125.4	120	100	94	C-9: 115.4-121.3' and 124.0-125.4': Medium to dark gray SCHIST; f--m grains of quartz, biotite, muscovite, feldspar, calcite, and sparse garnet; close to moderate fracture spacing, except two very close foliation fractures at 121.1-121.3'; unweathered; strong; indistinct schistosity is wavy to crenulated, dips 60-80 deg; calcite coatings on many fracture surfaces; QUARTZ band parallel to schistosity at 124.9-125.35'; core sides bulging at 119.5-120.4'. 121.3-124.0': Light gray GRANITE; indistinct f-m grains of quartz, feldspar, and muscovite, with some pink orthoclase; moderate fracture spacing; unweathered; strong; faint near-vertical banding; near-vertical inclusion of dark gray schist at 122.5-123.0'.	I	R4
130	5	C-10 125.4 - 135.7	124	100	81	C-10: 125.4-132.4': Black and white pinstriped SCHIST; f-m grains of biotite, amphibole (?), quartz, feldspar, and calcite; close to moderate fracture spacing; slightly weathered; strong; distinct planar schistosity and wavy banding dip 70-90 deg; planar bands of white calcite and quartz parallel to schistosity are hairline to 1/2" thick; some contorted bands of quartz-feldspar; thin (<0.1") coating of gray clay on 80 deg foliation fracture at 128.4'; calcite on most fracture surfaces. 132.4-135.7': Light gray GRANITE; m grains of feldspar, quartz, muscovite, and sparse garnet; close to moderate fracture spacing, except extremely close at 135.0-135.6' (may be mechanical); unweathered; very strong; calcite on some fracture surfaces inclusion of dark gray schist at 133.1-133.4'.	II	R4

DISCONTINUITY DATA			
ANGLE (deg)	Jr	Ja	DEPTH (feet)
*50	1.0	1.0	112.2
*60	1.5	1.0	112.8
10	3.0	1.0	114.1
*40	1.5	1.0	114.2
30	3.0	1.0	115.4
40	2.0	1.0	116.1
30	3.0	1.0	116.6
0	MB	MB	117
*70	1.5	1.0	117.3
5	3.0	1.0	118.4
*60	1.5	1.0	120.5
*70	1.5	1.0	121.1
*80	1.0	1.0	121.3
90	2.0	1.0	122.5
50	1.5	1.0	122.55
*65	1.0	1.0	122.7
40	2.0	1.0	125.4
10	MB	MB	126.1
50	2.0	1.0	126.5
30	3.0	1.0	127
20	3.0	2.0	127.5
*80	1.5	4.0	128.4
5	3.0	2.0	128.6
30	3.0	2.0	129.7
30	3.0	1.0	130.3
10	3.0	1.0	130.7

CORING LOG
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **6** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
									*80	1.5	4.0	131.2
									10	3.0	1.0	131.3
							I	R5	5	2.0	2.0	131.4
									*90	2.0	2.0	131.6
									50	2.0	2.0	131.8
									80	1.5	2.0	132
									60	1.0	1.0	133.1
									40	2.0	1.0	133.9
									40	2.0	1.0	134.4
135									20	2.0	1.0	134.8
									30	2.0	1.0	135.1
						C-11: 135.7-141.5': Light gray GRANITE; f-m grains of feldspar, quartz, muscovite, and garnet; close to moderate fracture spacing, except very close low-angle fractures at 139.5-139.9'; unweathered to slightly weathered; very strong; becoming f-grained below 139.9', with faint banding dipping 50 deg; slight iron stains on fracture surfaces at 139.5-139.7' and at lower contact at 141.5'; calcite on some fracture surfaces; black schist inclusion at 136.3-136.9'.	I/II	R5	60	3.0	1.0	135.3
									90	3.0	1.0	135.5
									10	2.0	1.0	135.7
									50	2.0	1.0	135.8
									30	1.5	1.0	137.2
									10	1.5	1.0	137.6
									5	2.0	1.0	138.3
						141.5-145.6': Black to dark gray SCHIST; f-m grains of biotite, quartz, feldspar, and muscovite; close to moderate fracture spacing; unweathered to slightly weathered; strong; planar schistosity dip 50 deg; calcite on all fracture surfaces; no rock wall contact and softened biotite on horizontal fracture at upper contact with granite; pure QUARTZ at 142.7-143.2'.			10	1.5	1.0	139.5
140									5	1.5	1.0	139.6
		C-11 135.7 - 145.6	119	100	94				10	1.5	1.0	139.7
									15	2.0	1.0	139.9
	4								50	MB	MB	140.5
							I/II	R4	0	1.0	6.0	141.5
									*50	1.0	1.0	142.4
									*40	MB	MB	143.9
									*50	1.5	1.0	144.6
145									*50	MB	MB	144.9
						C-12: Medium to dark gray SCHIST; f-m grains of quartz, biotite, feldspar, muscovite, calcite, and scattered garnets, up to 1/8" across; moderate fracture spacing, except very close foliation fractures at 150.1-150.7'; unweathered; strong; planar schistosity dips 50-60 deg; calcite on most fracture surfaces; pure QUARTZ at 149.0-149.7' and 155.1-155.5', light gray APLITE at 149.8-149.9', 150.1-150.3', and 148.1-148.5, with some orange potassium feldspar.	I	R4	*50	1.0	1.0	145.7
									55	1.5	1.0	146.4
									*50	1.0	1.0	147.8
									*60	1.5	1.0	148.5
150									*40	1.0	1.0	149.8

PARTNERSHIP CORING GDR (FINAL) 00 EPE ALL PACKAGES 4-30-08.GPJ THE PARTNERSHIP EPE (FINAL) 10-24-08.GLB 10/24/08

BORING NUMBER: **PE-273**
SHEET NUMBER: 7 of 9
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
155		C-12 145.6 - 155.6	120	100	94				*50 *50 *50 *50 *60 0 *60 *50 45	1.5 1.5 1.5 1.0 1.0 3.0 1.0 1.5 2.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	150.1 150.3 150.5 150.7 152.3 152.9 154 155.1 155.2
160 165	5	C-13 155.6 - 165.6	120	100	97	C-13: Medium to dark gray SCHIST; f-c grains of quartz, biotite, muscovite, feldspar, calcite, and scattered garnets, up to 1/4" across; moderate fracture spacing, except for two extremely close foliation fractures at 165.4-165.45'; unweathered; strong; planar to slightly crenulated schistosity dips 50-60 deg; most fractures are along schistosity; calcite on most fracture surfaces; irregular white granitic intrusions, 1" thick and near-vertical, at 160.0', 161.3', and 162.1'; 1/2" of adjacent schist is enriched in biotite.	I	R4	15 30 *70 *50 *60 *50 *50	2.0 2.0 1.0 1.5 1.5 1.0 1.0	1.0 1.0 1.0 1.0 1.0 1.0 1.0	155.6 157.5 159.1 160.6 161.4 163.3 164.2
						C-14: Medium gray SCHIST; f-m grains of muscovite, biotite, quartz, feldspar, and scattered garnets, up to 1/8" across; very close to moderate fracture spacing, except extremely close at 172.8-172.9' and 175.2-175.6'; slightly weathered; medium strong to strong; distinct wavy to planar schistosity dips 50-70 deg; clay and softened mica on fractures at 167.9', 172.9' and 173.1'.	II	R3/R4	*50 *50 *50 *60 *50 *60 15 *50 *70	1.0 1.0 1.5 1.0 1.0 1.0 3.0 1.0 1.0	1.0 1.0 1.0 1.0 1.0 MB 1.0 4.0 4.0	165.4 165.45 165.6 166.4 167 167.05 167.5 167.9 168.2

THE PARTNERSHIP

CORING LOG
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **8** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
		C-14 165.6 - 175.6	120	100	72	169.9-172.6': Rock is gneissic, with irregular bands of quartz and orange potassium-feldspar; core surfaces is pitted; no rock wall contact at 170.8'; hard, green epidote (?) on weathered fracture surfaces at 170.8' and 171.6'.			*70	1.5	1.0	169.1
									*60	1.5	4.0	169.3
									*50	1.0	1.0	169.5
170									30	2.0	2.0	170.05
									15	3.0	1.0	170.2
									10	1.0	6.0	170.8
									15	3.0	1.0	171
									*60	2.0	2.0	171.5
									20	3.0	2.0	171.6
									*40	1.5	1.0	172
									*50	1.5	2.0	172.8
									80	2.0	4.0	172.9
									*50	1.5	1.0	173
									80	3.0	4.0	173.1
									10	3.0	1.0	173.4
175									0	MB	MB	174.6
									*50	1.5	1.0	175.2
		C-15 175.6 - 185.3	116	100	89	C-15: 175.6-181.6': Dark gray SCHIST; f-m grains of biotite, muscovite, quartz, feldspar, and garnet; close to moderate fracture spacing, except for 2 extremely close intersecting high-angle fractures at 179.8-180.0'; slightly weathered; strong; planar to crenulated schistosity dips 50-70 deg; high angle cross-foliation fractures at 178.9-179.8 have orange and red iron staining, softened mica, and sandy clay coatings; softened mica on some foliation fractures; calcite on fracture surfaces at 176.8-178.1'.	II	R4	*50	1.0	1.0	175.3
									*50	1.5	1.0	175.35
									*40	2.0	1.0	175.5
									*50	1.5	1.0	175.6
									20	3.0	2.0	175.7
									*50	1.5	1.0	176.8
									*30	1.0	1.0	177.9
									*60	1.0	1.0	178.3
									25	3.0	2.0	178.6
									90	2.0	4.0	178.9
									40	3.0	1.0	179.2
180						181.6-183.4': Light gray GRANITE; f-c grains of white and pink feldspar, quartz, and muscovite; moderate fracture spacing; unweathered; very strong; healed hairline fracture dips 70 deg.			80	2.0	4.0	179.8
									*70	1.5	1.0	180
									60	2.0	4.0	180.3
									15	3.0	2.0	180.9
						183.4-185.3': Medium gray, pure QUARTZ; close to moderate fracture spacing; unweathered; very strong; few small (<0.1") inclusions of white feldspar.	II	R5	20	2.0	1.0	181.6
							I	R5				
									20	1.5	1.0	183.8
185									20	3.0	1.0	184.6
						C-16: 185.3-185.5': Medium gray QUARTZ, as above.	II	R4	10	1.5	1.0	185.1
									40	3.0	1.0	185.3
									*40	3.0	2.0	185.6
						185.5-188.0': Light gray GRANITE; f-c grains of feldspar, quartz, and muscovite; close to moderate fracture spacing; slightly weathered; strong; coarse			80	2.0	1.0	185.9
									30	1.5	1.0	186
									90	3.0	2.0	186.5
									70	3.0	1.0	186.9

THE PARTNERSHIP **CORING LOG**
(continued)

BORING NUMBER: **PE-273**
SHEET NUMBER: **9** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NW corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **R. Sidorski/M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
						grained at 186.1-187.4', with muscovite seams dipping 30 deg spaced 1/8" to 1/2" apart; vertical fracture at 186.5' has rough, orange iron-stained surface.	I/II	R4	*60	1.5	1.0	188
									*50	1.0	1.0	188.7
									*45	1.5	1.0	189
190		C-16 185.3 - 195.2	119	100	82	188.0-195.2': Dark gray SCHIST; f-m grains of biotite, muscovite, quartz, feldspar, calcite, and sparse garnet; close to moderate fracture spacing, except very close at 194.6-195.2'; unweathered to slightly weathered; strong; planar to wavy schistosity dips 50-60 deg; most fractures along foliation, many with calcite on surface; light gray granitic intrusions at 189.5-190.0', 190.5-190.8', 191.2-191.5', and 192.3-192.9'; schistosity is contorted around granite contacts.			50	3.0	1.0	189.8
									*60	1.0	2.0	191.7
									*60	1.0	1.0	192.4
									*50	1.0	1.0	193.5
									*50	1.0	1.0	194.2
195									*50	1.0	1.0	194.6
									30	3.0	1.0	194.7
						End of Boring at 195.2'			40	3.0	1.0	195
									40	2.0	1.0	195.2
200												
205												

THE PARTNERSHIP BORING LOG

BORING NUMBER: **PE-274**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **19499B**

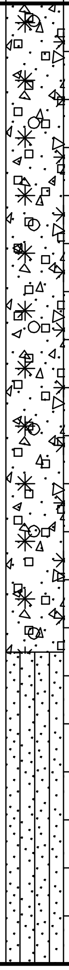
PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **New York, New York**
CLIENT: **NJ Transit**
CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**
DRILLING METHOD: **Rotary Wash; Diamond Coring**
RIG TYPE: **CME-75, Truck-mounted, Automatic Safety Hammer**

LOCATION: **11th Ave at 30th St, NE corner**
COORD.: **N: 699,717.1 E: 629,641.9**
SURFACE ELEV.: **318.6 feet**
DATUM: **Horizontal: NJ State Plane**
Vertical: NYCT datum-200 ft
START DATE: **4/15/08** TIME: **10:00 am**
FINISH DATE: **4/24/08** TIME: **11:30 am**

	Casing	Split Spoon	Shelby Tube	Piston	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ⧄	G ☒	C ▤
I.D.	4"	1.375"	2.938"	2.938"		1.875"
O.D.	4.5"	2"	3"	3"		3"
Length	60"	24"	24"	24"		120"
Hammer Wt.	300 lbs.	140 lbs.	Drill Rod Size		NWJ	
Hammer Fall	24"	30"	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
4/22/08	7:00 am	19.5	35.0	115.1
4/24/08	7:00 am	19.0	35.0	166.1



DEPTH (feet)	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	FIELD CLASSIFICATION AND REMARKS
					0.0 - 6.0						Hand-augered from 0.0' to 6.0'. 0-0.5': Concrete 0.5-6.0': Brown, c-f SAND, little c-f Gravel, little Silt, occasional black pebble. (FILL)
5											
		S	1	■	6.0 - 8.0	3	3	4	4	3	Black brown, c-f SAND, little m-f Gravel, little (-) organic silt. (FILL)
		S	2	■	8.0 - 10.0	7	9	14	12	4	Black brown, c-f SAND, little m-f Gravel, little (-) organic silt, with brick fragments. (FILL)
10		S	3	■	10.0 - 12.0	9	13	16	17	4	Dark brown, c-f SAND, and c-f Gravel, little Silt, with brick fragments. (FILL)
15		S	4	■	15.0 - 17.0	3	3	3	3	6	Gray brown, c-f SAND, and Silt, trace (+) m-f Gravel, micaceous. (SM)

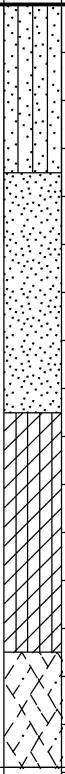
THE PARTNERSHIP

BORING LOG
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**



DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %		FIELD CLASSIFICATION AND REMARKS
			S	5	■	20.0 - 22.0	4	29	16	22	6		Gray, c-f SAND, some (+) m-f Gravel, some Silt, micaceous. (SM)
25			S	6	■	25.0 - 27.0	14	10	6	8	6		Gray brown, c-f SAND, some (+) c-f Gravel, trace (+) Silt, wet. (SP)
30			S	7	■	30.0 - 32.0	5	4	6	8	22		Gray, SILT & CLAY, trace (+) f Sand. (ML)
35			S	8	■	35.0 - 35.3	100/4"				4	35.9'	Gray, c-f SAND, trace Silt . (Decomposed Schist)
													Note: Start rock coring at 35.9' depth.
40													

THE PARTNERSHIP CORING LOG

BORING NUMBER: **PE-274**
SHEET NUMBER: **1** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **New York, New York**
CLIENT: **NJ Transit**
CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**
DRILLING METHOD: **Rotary Wash; Diamond Coring**
RIG TYPE: **CME-75, Truck-mounted, Automatic Safety Hammer**

LOCATION: **11th Ave at 30th St, NE corner**
COORD.: **N: 699,717.1 E: 629,641.9**
SURFACE ELEV.:**318.6 feet**
DATUM: **Horizontal: NJ State Plane**
Vertical: NYCT datum-200 ft
START DATE: **4/15/08** TIME: **10:00 am**
FINISH DATE: **4/24/08** TIME: **11:30 am**

CORE BARREL DATA:	**NOTES:**
TYPE: Double Barrel, solid inner barrel with wireline	
CORE SIZE: NQ	
O.D.: 3"	
I.D.: 1.875"	
CASING SIZE: 4" (4.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
4/22/08	7:00 am	19.5	35.0	115.1
4/24/08	7:00 am	19.0	35.0	166.1

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH
40	4	C-1 35.9 - 43.4	90	100	59	C-1, 35.9-37.6' and 38.5-40.7': Light gray to medium gray PEGMATITE; medium to coarse grains of quartz, white feldspar, muscovite, and biotite; close to moderate fracture spacing; slightly weathered; medium strong; irregular seams of mica throughout; orange iron-staining above 37.6'; schist inclusion at 36.8-37.0'. 37.6-38.5' and 40.7-43.5': Dark gray to brown SCHIST; fine to medium grains of biotite, muscovite, quartz, feldspar, and scattered garnets, up to 1/8" across; very close to moderate fracture spacing, except extremely close at 43.1-43.5'; slightly weathered, except moderately weathered at 41.8-42.5'; medium strong, except weak at 41.8-42.5'; distinct wavy to laminated schistosity dips 50-75 degrees; orange iron staining at 41.8-43.0', with thin (<0.1") coatings of softened mica and gray clay on fracture surfaces.	II III II	R3 R2 R3
45	4	C-2 43.5 - 45.3	21	100	57	C-2: 43.5-44.4': Tan to light gray PEGMATITE; coarse grains of quartz, white feldspar, and muscovite, with gray schist inclusions; close fracture spacing; slightly weathered; medium strong; orange iron staining throughout, with healed hairline fractures. 44.4-45.2': Dark gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar, scattered garnets, up to 1/8" across; close fracture spacing; slightly weathered; medium strong; distinct wavy to crenulated schistosity dips 60-75 degrees.	II II	R3 R3/R4
50	5	C-3 45.2 - 55.1	118	99	91	C-3: Dark gray to medium gray SCHIST; fine to coarse grains of muscovite, biotite, quartz, feldspar, and scattered garnets, up to 1/8" across; close to moderate fracture spacing; slightly weathered; medium strong to strong; distinct crenulated schistosity dips 50-80 degrees; medium gray to tan PEGMATITE; with muscovite seams, at 47.5-48.8'; no rock wall contact, with increased weathering at fractures at 48.7' and 48.8'; clay and softened mica		

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
*45	2.0	2.0	36.1
70	3.0	2.0	36.5
*20	1.5	2.0	36.7
*60	1.5	1.0	37
20	3.0	2.0	37.2
*40	2.0	2.0	37.5
*70	2.0	4.0	37.8
*50	1.5	2.0	38.4
*5	2.0	1.0	38.7
*40	1.5	1.0	39.5
15	2.0	1.0	40
*60	MB	MB	40.7
15	1.5	1.0	41
*50	1.0	4.0	41.8
*60	1.0	4.0	41.9
*60	1.5	4.0	42.2
*70	2.0	2.0	42.5
30	2.0	2.0	42.55
*75	1.5	4.0	42.6
5	3.0	2.0	42.9
*60	2.0	1.0	43.2
*60	1.5	1.0	43.5
*60	2.0	2.0	43.8
80	1.5	2.0	43.9
50	2.0	2.0	44
85	3.0	1.0	44.3
*60	1.5	1.0	44.7
85	3.0	1.0	45
30	3.0	1.0	45.1
45	3.0	1.0	45.2
50	3.0	1.0	45.8
*60	1.5	1.0	45.9
30	2.0	2.0	47.2
30	3.0	2.0	47.9
*50	1.5	2.0	48.3
10	1.0	6.0	48.4
10	3.0	3.0	48.5
40	2.0	2.0	48.6

THE PARTNERSHIP CORING LOG
(continued)

BORING NUMBER: **PE-274**

SHEET NUMBER: **2** of **9**

PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**

LOCATION: **11th Ave at 30th St, NE corner**

CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**

DRILLER: **J. Kurzynowski**

INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
						on 50 degree fractures at 51.3' and 51.8'; quartz vein along schistosity at 50.1-50.2'.			0	MB	MB	48.7
									30	1.0	6.0	48.8
									*60	1.5	4.0	49.3
									*60	1.5	2.0	49.7
									*50	1.0	3.0	50.1
									50	2.0	4.0	51.3
									*60	1.5	4.0	51.8
									*60	2.0	1.0	53.8
55									*60	1.5	2.0	54.6
	5	C-4 55.1 - 65.1	120	100	97	C-4: Dark gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar, and many garnets, up to 1/4" across; close to moderate fracture spacing; unweathered to slightly weathered; strong; crenulated to wavy schistosity dips 40-80 degrees; no rock wall contact at near horizontal fracture at 55.5'; softened mica along foliation fractures at 62.6' and 64.7'; ptygmatically folded bands of quartz-feldspar ~1/2" thick, at 60.1-60.5'; slightly bulging core sides throughout; pure QUARTZ at 57.7-58.2' and 62.6-64.6'; lower quartz has 1/8" seams of black mafic minerals and adjacent yellow metallic mineral (gold?).	I/II	R4	60	2.0	1.0	55.1
									*70	2.0	1.0	55.4
									10	1.0	6.0	55.5
									30	3.0	1.0	56.6
									15	2.0	2.0	57.8
									*40	1.0	2.0	58.2
									*60	1.5	1.0	58.8
60									*60	2.0	1.0	59.7
									*60	1.5	1.0	60.2
									*50	1.5	2.0	61.3
									*55	1.0	2.0	62.2
									20	3.0	1.0	62.3
									*50	1.0	4.0	62.6
									0	2.0	1.0	63.1
65									*50	1.0	4.0	64.7
						C-5: Dark gray SCHIST; fine to coarse grains of muscovite, biotite, quartz, feldspar, and scattered garnets, up to 1/8" across; close to moderate fracture spacing, except very close at 69.7-69.8' and 71.6-71.7'; unweathered to slightly weathered; strong; distinct crenulated to wavy schistosity dips 50-80 degrees; softened mica on foliation fractures at 69.7' and 69.8'; thin (<0.1") calcite coatings on foliation fractures at 73.1', 73.6' and 75.1'.	I/II	R4	0	3.0	2.0	65.1
									20	2.0	1.0	65.5
									20	1.0	6.0	65.6
									*60	2.0	1.0	66
									15	3.0	1.0	67.3
									20	3.0	2.0	67.9
									30	3.0	1.0	68.4

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
70	4	C-5 65.1 - 75.5	120	96	90				*60	1.5	4.0	69.7
									*60	1.5	4.0	69.8
									*50	1.5	2.0	70.8
									40	3.0	1.0	71.6
									40	3.0	2.0	71.7
									*60	1.5	2.0	73.1
75									*60	1.0	2.0	74.6
									*60	1.0	2.0	75.1
	4	C-6 75.5 - 85.5	120	100	100	C-6: Dark gray to medium gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar, and scattered garnets, up to 1/4" across; moderate to wide fracture spacing; unweathered, except slightly weathered at 81.0-81.2'; strong; foliation defined by distinct crenulated schistosity and few 1/2" thick contorted bands of quartz-feldspar; orange iron staining at 81.0'; calcite coatings on all foliation fractures; core sides slightly bulging at 77.0-80.5'.	I/II	R4	*60	1.5	1.0	78
									*60	1.5	1.0	79
80									50	2.0	1.0	79.7
									60	MB	MB	80.5
									50	MB	MB	80.7
									30	3.0	2.0	81
									*50	2.0	1.0	83.5
85												
						C-7: Dark gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar and many garnets, up to 1/4" across; moderate to wide fracture spacing, except very close at 91.7-92.0', 94.0- 94.2' and 94.8-95.6'; unweathered, except slightly weathered at 94.8-95.5'; strong; wavy to crenulated schistosity and scattered contorted quartz bands dip 60-75 degrees; thin (<0.1") calcite coatings on	I	R4	*60	2.0	2.0	85.5
									40	2.0	1.0	85.9
									50	3.0	1.0	87

PARTNERSHIP CORING GDR (FINAL) 00 EPE ALL PACKAGES 4-30-08.GPJ THE PARTNERSHIP EPE (FINAL) 10-24-08.GLB 10/24/08

THE PARTNERSHIP CORING LOG
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **4** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
						foliation fractures at 89.0', 90.5', and 91.8'; no rock wall contact at weathered low-angle fracture at 95.2'.			*50	1.0	1.0	89
90	4	C-7 85.5 - 95.5	120	100	93				*55 0 *60	1.0 3.0 1.0	1.0 1.0 1.0	89.9 90 90.5
									*60	1.5	1.0	91.8
									*60	2.0	1.0	93.8
95							II	R4	*60 *70	2.0 1.5	1.0 2.0	94.8 95.1
						C-8: 95.5-99.1': Dark gray SCHIST; fine to medium grains of biotite, muscovite, quartz, feldspar; moderate to wide fracture spacing; unweathered; strong; wavy to crenulated schistosity dips 60-80 degrees; calcite coating on foliation fracture at 96.1'; pure QUARTZ at 98.8-99.0'. 99.1-104.7': Medium gray to light gray GRANITE; fine to medium grains of feldspar, quartz, and muscovite; wide fracture spacing; unweathered, except slightly weathered at horizontal fractures at 101.6' and 101.9'; very strong; faint near vertical banding; trace QUARTZ at 101.6-101.9', with no contact at horizontal fractures at upper and lower contacts.	I	R4	*70 10 *60 *80	2.0 1.0 2.0 2.0	1.0 6.0 2.0 1.0	95.15 95.2 95.5 96.1
									*60	1.5	2.0	98.4
							I/II	R5	*60	1.5	1.0	99.1
100	4	C-8 95.5 - 104.7	110	100	96							
									0 0	1.0 1.0	6.0 6.0	101.6 101.9
									15	MB	MB	103.9
105						C-9: 104.7-111.5': Light gray GRANITE; medium grains of feldspar, quartz, and muscovite; moderate to wide fracture spacing; unweathered, except slightly weathered at 40 degree fracture at 107.0'; strong to very strong; faint banding and thin (<0.1") muscovite seams at 107.8-109.6' are near vertical;	I/II	R4/R5	40	2.0	1.0	104.7

THE PARTNERSHIP CORING LOG
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **5** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

									DISCONTINUITY DATA			
DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	ANGLE (deg)	Jr	Ja	DEPTH (feet)
	4	C-9 104.7 - 111.5	81	100	100	pure QUARTZ at 107.0-107.5', 108.1-108.4', and 110.9-111.5'; dark gray SCHIST inclusion at 110.2-110.9', with medium grains of biotite, other mafic minerals, muscovite, quartz, and feldspar; iron staining at horizontal fracture at 110.3'.			40	3.0	2.0	107
									0	MB	MB	108.3
									*80	1.0	4.0	108.9
									20	MB	MB	109
110												
									0	3.0	2.0	110.3
									20	3.0	1.0	110.9
	4	C-10 111.5 - 115.5	48	100	100	C-10: 111.5-112.9': Medium gray QUARTZ, with biotite schist and feldspar pegmatite inclusions; moderate fracture spacing; unweathered; strong. 112.9-115.5': Dark gray to black SCHIST; fine to medium grains of biotite, muscovite, quartz, and feldspar; moderate fracture spacing, unweathered; strong; planar schistosity dips 60 degrees; all fractures have thin (<0.1") calcite coatings.	I	R4	*50	1.5	1.0	111.5
									*50	3.0	1.0	112.9
									*60	1.0	1.0	114
115									*50	1.5	1.0	114.7
	4	C-11 115.5 - 125.3	117	100	100	C-11: Dark gray SCHIST; fine to medium grains of biotite, muscovite, quartz, and feldspar; wide fracture spacing; unweathered, except slightly weathered at near vertical fracture at 122.0'; strong; faint wavy schistosity dips 60-90 degrees; orange iron staining on rough, near vertical cross-foliation fracture at 122.0'; contorted intrusions of light gray GRANITE at 116.5-117.0', 119.3-120.7' and 123.1-124.2'; schistosity parallels contorted contacts.	I/II	R4	*60	1.5	1.0	115.5
									30	MB	MB	117
120												
									20	2.0	1.0	120.6
									85	2.0	2.0	122
125									*60	1.5	1.0	124.6
						C-12: Dark gay to black SCHIST; fine to medium	I	R4	20	3.0	1.0	125.3

PARTNERSHIP CORING GDR (FINAL) 00 EPE ALL PACKAGES 4-30-08.GPJ THE PARTNERSHIP EPE (FINAL) 10-24-08.GLB 10/24/08

THE PARTNERSHIP CORING LOG
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **6** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
130 135	5	C-12 125.3 - 135.3	120	100	100	grains of biotite, muscovite, quartz, feldspar, and sparse garnets, up to 1/8" across; wide fracture spacing; unweathered; strong; faint, wavy schistosity dips 60-90 degrees; pure QUARTZ, with vertical contacts at 125.3-126.0'; light gray GRANITE, with near-vertical muscovite seams, with vertical contacts along schistosity at 126.5-129.0'.			*60 45 *80	1.5 3.0 2.0	1.0 1.0 2.0	126.5 130.2 134.6
140	4	C-13 135.3 - 145.4	121	100	93	C-13: Dark gray SCHIST; fine to medium grains of biotite, muscovite, quartz, feldspar, and sparse medium grained garnet; close to moderate fracture spacing; unweathered to slightly weathered; strong; indistinct schistosity dips 60-90 degrees; contorted 1/2" band of quartz-feldspar at 142.4-142.6', parallel to schistosity; no rock wall contact and orange iron staining at low-angle fracture at 136.6'; thin (<0.1") calcite coating on foliation fracture at 142.8'; softened mica on smooth foliation fracture at 143.9'.	I/II	R4	0 30 20 10 40 30 *50 *60 40 *50 *70	2.0 3.0 1.0 1.0 MB 3.0 2.0 2.0 3.0 1.5 1.0	1.0 1.0 6.0 6.0 MB 1.0 1.0 1.0 1.0 2.0 4.0	135.3 135.6 136.6 137.5 138.9 139.9 141 142.8 143.1 143.7 143.9

THE PARTNERSHIP **CORING LOG**
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: 7 of 9

PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**

LOCATION: **11th Ave at 30th St, NE corner**

CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**

DRILLER: **J. Kurzynowski**

INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH
145								
	6	C-14 145.4 - 146.9	17	94	22	C-14: 145.4-146.0': Light gray GRANITE; medium grains of quartz, feldspar, and muscovite; closely fractured; slightly weathered; strong; healed hairline fractures dip 70 degrees.	II/III	R2/R3
	6	C-15 146.9 - 150.4	35	83	60	146.0-146.9': Dark gray SCHIST; fine to medium grains of biotite and other mafic minerals, quartz, muscovite and feldspar; very close to extremely close fracture spacing; slightly weathered at 146.0-146.9'; moderately weathered at 146.2-146.9'; weak to medium strong; softened mica on foliation fractures below 146.0'; irregular, broken pieces are pitted and weathered.	III II	R2/R3 R4
150	4	C-16 150.4 - 156.1	68	100	100	C-15: 146.9-147.8': Dark gray SCHIST; as above, except extremely close fracture spacing throughout; moderately weathered; some overdrilled pieces; recovery loss likely at 146.9-147.6'; 147.8-150.4': Dark gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar; many garnets, up to 1/2" across; close to moderate fracture spacing; slightly weathered; strong; crenulated schistosity dips 60-80 degrees. C-16: Dark gray to medium gray SCHIST; fine to coarse grains of biotite, muscovite, quartz, feldspar, sparse calcite, and many garnets, up to 3/8" across; moderate fracture spacing; slightly weathered; strong; distinct crenulated schistosity dips 60-70 degrees; calcite coating on foliation fracture at 153.0'.	II	R4
155								
160	4	C-17 156.1 - 166.1	120	100	91	C-17: 156.1-158.6': Dark to medium gray SCHIST; as above, except close fracture spacing and extremely close foliation fractures at 157.6-157.8'. 158.6-164.2': Black to dark green AMPHIBOLITE; fine to medium grains of hornblende, quartz, biotite, and sparse calcite; close to wide fracture spacing; unweathered to slightly weathered; very strong; faint schistosity and quartz bands dip ~ 50 degrees; biotite-rich at 160.2-160.7', where core sides are slightly bulging; calcite on most fracture surfaces; extremely dense. 164.2-166.1': Dark to medium gray SCHIST; fine to medium grains of biotite, muscovite, quartz, and feldspar; moderate fracture spacing; unweathered; strong; distinct crenulated schistosity dips 60 degrees.	II I/II	R4 R5

DISCONTINUITY DATA			
ANGLE (deg)	Jr	Ja	DEPTH (feet)
*60	1.0	1.0	144.2
60	1.0	2.0	144.7
*40	1.5	1.0	145.3
40	2.0	1.0	145.4
*70	2.0	1.0	145.8
*60	1.0	4.0	146.1
*60	1.0	4.0	146.2
10	3.0	2.0	146.3
80	1.5	2.0	146.4
0	1.5	3.0	146.5
*50	1.0	2.0	146.55
75	1.5	2.0	146.6
15	2.0	2.0	146.65
10	3.0	2.0	146.7
*60	1.0	2.0	146.8
20	2.0	2.0	147.6
75	2.0	2.0	147.65
15	2.0	2.0	147.68
*60	1.5	1.0	147.7
10	2.0	2.0	147.72
*70	2.0	4.0	148.1
15	2.0	2.0	148.15
20	3.0	2.0	149.9
*60	1.5	1.0	150.1
*70	2.0	4.0	150.4
*65	MB	MB	151.4
*65	1.5	1.0	151.7
*60	1.5	2.0	153
30	3.0	1.0	156.1
*60	1.5	1.0	156.8
20	3.0	2.0	157.4
45	2.0	2.0	157.6
*50	1.5	4.0	157.65
*60	1.5	1.0	157.8
*50	1.0	2.0	158.2
*30	1.5	1.0	158.7
40	1.5	1.0	159
30	2.0	1.0	160
*50	1.5	1.0	160.3
20	2.0	1.0	160.7

THE PARTNERSHIP

CORING LOG
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **8** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
							I	R4	0	2.0	1.0	164.2
165									*50	1.5	2.0	164.7
									*50	1.5	1.0	165.3
									*50	2.0	1.0	165.9
	4	C-18 166.1 - 175.4	112	100	89	C-18: 166.1-170.8': Dark gray SCHIST; as above; near vertical healed hairline fractures have orange, weathered calcite fillings. 170.8-172.0': Black and white pinstriped HORNBLENDE-BIOTITE-SCHIST; fine to medium grains of hornblende, biotite, quartz, and thin (<0.1" bands of calcite; moderate fracture spacing; unweathered; very strong; distinct planar schistosity and banding dip 60-70 degrees; very dense. 172.0 ft to 175.4 ft: Dark to medium gray SCHIST; fine to medium grains of biotite, muscovite, quartz, feldspar, and sparse garnets, up to 1/4" across; moderate fracture spacing; unweathered to slightly weathered; strong; wavy schistosity dips 70-80 degrees; calcite coatings on most fracture surfaces; pure, medium gray QUARTZ at 174.2-175.0', with yellow metallic flakes (pyrite ?) on fracture surface at 174.9'.	I	R4	50	2.0	2.0	166.1
									*60	1.5	4.0	166.8
									*60	1.0	2.0	167.2
									*70	1.5	2.0	168.2
170									20	MB	MB	169.8
							I	R5	*70	1.5	1.0	170.6
									*70	1.5	1.0	170.8
							I/II	R4				
									*70	2.0	2.0	172.7
									*50	2.0	1.0	174.1
									*40	1.5	1.0	174.3
175									5	3.0	1.0	174.9
	6	C-19 175.4 - 179.1	44	100	23	C-19, Dark gray SCHIST; fine to coarse grains of biotite, quartz, muscovite, feldspar, and medium grained garnet; close to moderate fracture spacing, except very close to extremely close at 175.7-179.1'; slightly weathered, except moderately weathered along fractures at 175.7-179.1'; strong, except weak to medium strong at 175.7-179.1'; foliation defined by distinct wavy schistosity and wavy bands and nodules of quartz; strike-slip slickensides on 80 degree foliation fracture at 177.1'; thick (>0.1") coatings of gray clay and calcite on all fractures at 177.1-179.1', most of which are along foliation.	II	R4	*70	2.0	1.0	175.2
							III	R2/R3	*70	1.0	1.0	175.3
									20	4.0	1.0	175.4
									*50	4.0	4.0	176.3
									*70	1.0	2.0	176.8
									*80	0.5	4.0	177.1
									30	3.0	4.0	177.5
									*70	1.0	4.0	177.6
									*70	1.5	4.0	177.7
									*70	1.0	4.0	177.9
							II	R3/R4	*60	1.0	4.0	178
									*70	1.5	4.0	178.3
180	5					C-20: Dark to medium gray SCHIST; fine to medium grains of muscovite, biotite, quartz, feldspar, and calcite; close to moderate fracture spacing, except very close foliation fractures at 185.0-185.1'; slightly weathered; medium strong to strong; distinct planar schistosity dips 60-70 degrees; calcite coatings on			50	2.0	2.0	178.6
									*70	1.0	4.0	179
									*70	1.0	4.0	179.05
									30	2.0	3.0	179.1
									*70	1.0	4.0	179.9
									0	3.0	2.0	180.5

THE PARTNERSHIP **CORING LOG**
(continued)

BORING NUMBER: **PE-274**
SHEET NUMBER: **9** of **9**
PROJECT NUMBER: **19499B**

PROJECT: **Trans-Hudson Express (THE) Project**
LOCATION: **11th Ave at 30th St, NE corner**
CLIENT: **NJ Transit**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **J. Kurzynowski**
INSPECTOR: **M. Tekin**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
185	4	C-20 179.1 - 185.7	79	100	89	almost all fractures; silt coatings on horizontal fractures at 180.5' and 184.3'; pitted horizontal healed hairline fracture at 184.35'.			*70 15 20 0 *70	1.0 1.5 MB 2.0 1.0	2.0 2.0 MB 3.0 4.0	180.7 181 182.8 184.3 185
190 195	5	C-21 185.7 - 195.8	121	100	94	C-21: 185.7-186.4': Dark gray SCHIST, as above. 186.4-191.2': Light to medium gray GRANITE; fine to medium grains of quartz, feldspar, muscovite, and sparse medium grained garnet; moderate fracture spacing; unweathered; very strong; faint banding dips 50 degrees; quartz-feldspar PEGMATITE at 187.4 ft, 187.8 ft, 190.0-190.3', and 190.7-191.1';; dark gray schist at 188.1-188.6'. 191.2-194.0': Dark to medium gray SCHIST; fine to medium grains of biotite, muscovite, quartz, and feldspar; wide fracture spacing; slightly weathered; strong; distinct planar schistosity dips 50 degrees. 194.1-195.8': Light gray GRANITE, as above except close to moderate fracture spacing; slightly weathered; strong; schist inclusion at 195.3-195.6'; very close horizontal fractures at 194.8-194.9' have orange iron staining and silt coatings.	II I II	R3/R4 R5 R4	*70 *60 *60 *60 *60 *50 10 *50 *50 45 0 5 0 10 80 15	2.0 1.0 1.0 1.0 1.0 1.0 MB 1.0 1.0 3.0 1.5 1.5 2.0 2.0 3.0 2.0	4.0 2.0 1.0 1.0 4.0 1.0 MB 1.0 1.0 1.0 3.0 3.0 1.0 1.0 1.0 1.0	185.1 185.5 185.7 185.8 185.9 186.4 186.7 188.1 191.4 194.1 194.8 194.9 195.4 195.5 195.7 195.8
200						End of Boring at 195.8'						

PARTNERSHIP CORING GDR (FINAL) 00 EPE ALL PACKAGES 4-30-08.GPJ THE PARTNERSHIP EPE (FINAL) 10-24-08.GLB 10/24/08

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

BORING NUMBER: **SEG-3-1T**
SHEET NUMBER: **1** of **3**
PROJECT NUMBER: **4016879**

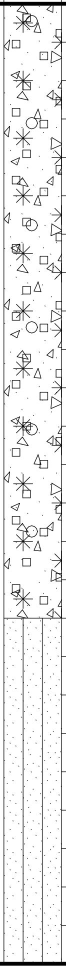
PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. **N: 1,915,821.2 E: 14,802,907.7**
STN. NO.: OFFSET:
SURFACE ELEV.: **306.5 feet**
DATUM:
START DATE: **8/24/15** TIME: **1:00 pm**
FINISH DATE: **8/26/15** TIME: **2:30 pm**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ⧄	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"	"	2.155"
O.D.	4.5"	2"	3"	"	"	2.98"
Length	65	24"	30"	"	"	60"
Hammer Wt.	140 lb lbs	140 lbs	Drill Rod Size		NW	
Hammer Fall	30" in.	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
8/26/2015	7:15:00 AM	10.9	65	70

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 6.0							Excavated top 6' soil to clear utilities. Mud at 3' to 4'.
5													
			S	1	■	6.0 - 8.0	2	1	1	1	8		S-1: Dark brown medium to fine SAND, trace medium to fine Gravel, very loose, moist-Fill.
			S	2	■	8.0 - 10.0	2	8	14	5	24		S-2: Brown coarse to fine SAND,some medium to fine Gravel, little Silt,medium dense, moist (SM)-Fill.
10			S	3	■	10.0 - 12.0	5	6	6	4	10		S-3: Brown medium to fine SAND, some medium to fine Gravel, trace Silt, medium dense, moist-Fill.
15			S	4	■	15.0 - 17.0	5	3	2	2	0		S-4: No Recovery.
20			S	5	■	20.0 - 22.0	6	3	5	8	9		S-5: Brown coarse to fine SAND, little medium to fine Gravel, little Silt, loose, wet (SM).

TEST BOREING SEG 3 BORING LOGS SOIL.GPJ CANARSIE-LIB.GLB - COPY.GLB 2/29/16

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-1T**
SHEET NUMBER: **2** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	6	■	25.0 - 27.0	5	11	10	7	0		S-6: No Recovery.
30			S	7	■	30.0 - 32.0	5	3	4	5	13		S-7: Brown coarse to fine SAND, little Silt, trace medium to fine Gravel, loose, wet (SM).
35			S	8	■	35.0 - 37.0	2	7	8	6	11		S-8A: 35' to 35.7': Same as above; S-8B: 35.7' to 37': Dark gray Clayey SILT, stiff, wet (ML).
40			S	9	■	40.0 - 42.0	8	4	3	4	0		S-9: No Recovery.
45			S	10	■	45.0 - 47.0	3	3	2	4	24		S-10: Gray Fat CLAY, trace fine Gravel, medium stiff, wet (CH).
50			S	11	■	50.0 - 52.0	3	2	2	2	11		S-11: Gray Fat CLAY, soft, wet (CH). Spoon is getting jammed and rods are getting jammed which hold back sampling efficiency.
55			S	12	■	55.0 - 57.0	2	2	3	2	2		S-12 Gray Fat CLAY and Organic CLAY, trace medium to fine Gravel, medium stiff, wet (CH-OH).

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG

(continued)

BORING NUMBER: **SEG-3-1T**

SHEET NUMBER: **3** of **3**

PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**

LOCATION: **30th St., 11th Ave., New York, NY**

CLIENT: **AMTRAK**

CONTRACTOR: **ADT**

DRILLER: **Dominick Pepe, George Raymond**

INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	13		60.0 - 62.0	WOH	WOH	WOH	WOH	22		S-13: Gray Fat CLAY, frequent marine material, very soft, wet (CH).
65			S	14		65.0 - 67.0	WOR	WOR	WOR	WOR	18		S-14: Same as above.
70			S	15		70.0 - 72.0	WOR	WOH	WOH	2	0		S-15: No Recovery.
75			S	16		75.0 - 77.0	WOR	WOH	WOH	1	20		S-16: Gray Silty CLAY, frequent marine material, very soft, wet (CL).
80			S	17		80.0 - 81.3	40	35	50/4"	-	0		S-17: No Recovery.
													End of soil at 83' bgs. Start rock coring at 83' bgs.
85													
90													

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG

BORING NUMBER: **SEG-3-1T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/24/15** TIME: **1:00 pm**
FINISH DATE: **8/26/15** TIME: **2:30 pm**

CORE BARREL DATA:	**NOTES:**
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
85		C-1 83.0 - 88.0	53	88	68	C-1: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong, close to moderate fracture spacing, schistosity dips 55° to 65°, recovery loss assumed at 85.1'-85.7', granitic band at 84.1'-84.3'.	II	R3	0_{MB} *60_{MB} *60_{MB} *60_{MB} 10_{MB} 80_{MB} 10_{MB} 10_{MB}	- 1 1 1 1 1 1 1	- 1 1 3 6 6 6 6	83 83.4 84.1 84.3 85 85.05 85.1 85.7
90		C-2 88.0 - 93.0	60	100	87	C-2: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong, close to moderate fracture spacing, granitic bands at 88.7'-88.9', and 89.2' to 89.3', schistosity dips 60° to 65°.	II	R3	*65_{MB} 15_{MB} *55_{MB} 20_{MB} *60_{MB} *60_{MB} 15_{MB} *60_{MB}	1.5 2 1 3 1.5 1 1.5 1.5	2 2 1 2 1 1 1 1	86.65 86.95 87.7 88 88.3 89.5 90.4 91.5
95		C-3 93.0 - 98.0	60	100	93	C-3: Gray gneissic SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, medium strong, moderate to wide fracture spacing except very close fracture spacing at 93.3' to 93.45' and 97.8' to 98', schistosity and gneissic bandings dip 70° to 80°, indistinct schistosity band at 95.7', granitic band at 95.7' to 96.3'.	II	R3	*65_{MB} 10_{MB} 60_{MB} 10_{MB}	1 3 1.5 2	1 2 2 2	92.7 93 96.3 96.45
100		C-4 98.0 - 103.0	60	100	95	C-4: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, medium strong, close to moderate fracture spacing except extremely close to very close fracture spacing at 102.15' to 102.3', schistosity dips 65° to 70°.	II	R3	10_{MB} 15_{MB} *70_{MB} 10_{MB} *70_{MB} *70_{MB} *65_{MB}	2 1.5 1 1.5 1.5 1 1	2 2 1 2 2 1 1	97.8 98 98.6 100.35 101 101.7 102.15
105		C-5 103.0 - 108.0	58	97	85	C-5: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, medium strong to strong, close to moderate fracture spacing except extremely close to very close fracture spacing at 106.3' to 106.5', schistosity dips 60° to 65°, quartz band at 106' to 106.4', loss of recovery assumed at 106.4' to 106.6', multiple healed fractures.	II	R3/R4	*70_{MB} 10_{MB} 10_{MB} *60_{MB} 30_{MB} 10_{MB} 80_{MB}	1 2 3 1 3 3 1	1 1 2 1 2 1 2	102.2 102.3 103 104.4 105.55 106.3 106.4

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG

(continued)

BORING NUMBER: **SEG-3-1T**

SHEET NUMBER: **2** of **2**

PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**

LOCATION: **30th St., 11th Ave., New York, NY**

CLIENT: **AMTRAK**

CONTRACTOR: **ADT**

DRILLER: **Dominick Pepe, George Raymond**

INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
110		C-6 108.0 - 109.9	23	100	100	C-6: Gray gneissic SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, strong, moderate fracture spacing, schistosity dips 65° to 70°. End of boring at 109.9' bgs.	II	R4	*60_{MB} 85_{MB} 65_{MB} *60_{MB} 40_{MB}	1 3 3 3 3	2 2 1 2 2	106.6 107 107.6 108 109.9
115												
120												
125												
130												
135												
140												

PB CORING LOG HUDSON YARD ROCK.GPJ CANARSIE-LIB.GLB - COPY.GLB 10/25/15

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

BORING NUMBER: **SEG-3-2T**
SHEET NUMBER: **1** of **3**

PROJECT NUMBER: **4016879**

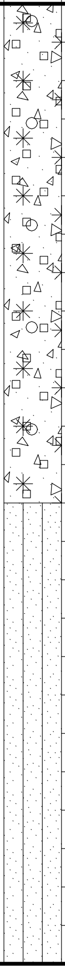
PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. **N: 1,915,957.9 E: 14,802,845.3**
STN. NO.: OFFSET:
SURFACE ELEV.: **307.3 feet**
DATUM:
START DATE: **8/10/15** TIME: **11:00 am**
FINISH DATE: **8/15/15** TIME: **10:30 am**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ▧	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"	"	2.155"
O.D.	4.5"	2"	3"	"	"	2.98"
Length	60	24"	30"	"	"	60"
Hammer Wt.	140 lb lbs	140 lbs	Drill Rod Size		NW	
Hammer Fall	30" in.	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)



DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 5.0							Excavated top 5' soil to clear utilities.
5			S	1	■	5.0 - 7.0	3	3	3	4	8		S-1: Brown and red brown coarse to fine SAND, some medium to fine Gravel, some Silt, loose, moist (SM)-Fill.
			S	2	■	7.0 - 9.0	7	7	4	4	3		S-2: Same as above.
			S	3	■	9.0 - 11.0	2	11	3	4	0		S-3: No Recovery.
10													
15			S	4	■	15.0 - 17.0	3	7	4	4	1		S-4: Dark brown coarse to fine SAND, little Silt, trace fine Gravel, medium dense, wet (SM).
20			S	5	■	20.0 - 22.0	5	8	10	6	0		S-5: No Recovery. Gravel jammed at spoon tip.

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-2T**
SHEET NUMBER: **2** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	6	■	25.0 - 27.0	11	7	9	7	0		S-6: No Recovery.
			S	7	■	27.0 - 29.0	12	7	4	6	3		S-7: Brown coarse to fine SAND, trace medium to fine Gravel, little Silt, medium dense, wet (SM).
30			S	8	■	30.0 - 32.0	6	10	11	10	9		S-8: Brown coarse to fine SAND, little Silt, some medium to fine Gravel, medium dense, wet (SM).
35			S	9	■	35.0 - 37.0	21	8	9	18	3		S-9: Same as above.
40			S	10	■	40.0 - 42.0	6	7	8	8	21		S-10: Gray Fat CLAY, trace medium to fine Sand, frequent marine material, stiff, wet (CH).
45			S	11	■	45.0 - 47.0	WOH	WOH	WOH	2	23		S-11: Gray Fat CLAY, trace medium to fine Sand, frequent marine material, very soft, wet (CH).
50			S	12	■	50.0 - 52.0	WOR	WOH	WOH	WOH	23		S-12: Gray Silty CLAY, trace medium to fine Sand, frequent marine material, very soft, wet (CL).
55			S	13	■	55.0 - 57.0	WOR	WOH	WOH	3	24		S-13: Gray fine SAND, some Clayey Silt, frequent marine material, very soft, wet (SM).

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-2T**
SHEET NUMBER: **3** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)	
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.
			S	14	■	60.0 - 61.8	6	8	7	60/4"	8	S-14: Brown coarse to fine SAND, some coarse to fine Gravel, some Silt, medium dense, wet (SM) - Decomposed SCHIST.
												End of soil at 63' bgs. Start rock coring at 63' bgs.
65												
70												
75												
80												
85												
90												

TEST BOREING SEG 3 BORING LOGS SOIL.GPJ CANARSIE-LIB.GLB - COPY.GLB 2/29/16

The Gateway Trans-Hudson Partnership
AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG

BORING NUMBER: **SEG-3-2T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/10/15** TIME: **11:00 am**
FINISH DATE: **8/15/15** TIME: **10:30 am**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size)

* - Denotes discontinuity along foliation

MB - Denotes mechanical break

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS	WEATHERING	STRENGTH
		C-1 63.0 - 65.0	20	83	46	C-1: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite, garnet and chlorite, slightly to moderately weathered, medium strong, very close to close fracture spacing, schistosity dips 65° to 75°, recovery loss assumed at 64.7'-65.7'.	II/III	R3
65		C-2 65.0 - 70.0	56	93	52	C-2: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite, garnet and chlorite, slightly to moderately weathered from 65' to 66.9', slightly weathered from 66.9' to 70', medium strong, very close to moderate fracture spacing, schistosity dips 70° to 85°, recovery loss assumed at 65'-65.3'.	II/III	R3
70		C-3 70.0 - 75.0	60	100	93	C-3: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite, garnet and chlorite, slightly weathered, medium strong, very close to moderate fracture spacing, schistosity dips 75°, quartz band at 73.8' to 74.6'.	II	R3
75		C-4 75.0 - 80.0	60	100	88	C-4: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, moderate to wide fracture spacing except close fracture spacing at 75' to 75.4', schistosity dips 75° to 85°.	II	R4
80		C-5 80.0 - 85.0	60	100	100	C-5: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered to fresh, strong, wide fracture spacing except close fracture spacing at 84.4' to 85', schistosity dips 70° to 85°.	II/I	R4
85		C-6 85.0 - 89.8	58	100	100	C-6: Gray SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered to fresh, strong, wide fracture spacing, schistosity dips 70° to 85°.	I	R4

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
0_{MB}	-	-	63
55_{MB}	3	2	63.5
0_{MB}	10	2	63.95
*80_{MB}	1.5	4	64.3
50_{MB}	3	2	64.6
10_{MB}	1	6	64.7
20_{MB}	1	6	65.3
*70_{MB}	1	6	65.6
30_{MB}	1	6	65.85
10_{MB}	1.5	3	66.9
*85_{MB}	1.5	3	67.1
50_{MB}	3	2	67.3
30_{MB}	3	2	68.25
30_{MB}	3	2	68.5
*80_{MB}	1	2	68.55
10_{MB}	3	2	68.75
*80_{MB}	1	2	68.9
50_{MB}	3	2	69.1
10_{MB}	1	2	69.7
20_{MB}	3	1	69.8
*85_{MB}	1	1	69.9
45_{MB}	3	1	70
*75_{MB}	1.5	2	70.1
10_{MB}	3	2	70.6
10_{MB}	1.5	2	71.25
*75_{MB}	1	1	72
10_{MB}	1.5	2	72.15
25_{MB}	3	2	73.15
20_{MB}	3	1	73.5
15_{MB}	1.5	1	74
20_{MB}	1	1	74.1
20_{MB}	3	1	75
*85_{MB}	1	2	75.4
30_{MB}	3	2	77.6
15_{MB}	3	1	78.5
25_{MB}	3	1	80
15_{MB}	3	1	84.4
10_{MB}	3	1	85

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG
(continued)

BORING NUMBER: **SEG-3-2T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
90						End of boring at 89.8' bgs.			40_{MB}	3	2	89.8
95												
100												
105												
110												
115												
120												

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

BORING NUMBER: **SEG-3-3T**
SHEET NUMBER: **1** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**

DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. N: **1,915,923.2** E: **14,802,927.9**
STN. NO.: OFFSET:
SURFACE ELEV.: **306.6 feet**
DATUM:
START DATE: **8/19/15** TIME: **2:00 pm**
FINISH DATE: **8/24/15** TIME: **12:00 pm**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ⧅	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"	"	2.155"
O.D.	4.5"	2"	3"	"	"	2.98"
Length	68	24"	30"	"	"	60"
Hammer Wt.	140 lb lbs	140 lbs	Drill Rod Size		NW	
Hammer Fall	30" in.	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
8/24/2015	7:10:00 AM	8.5	68	93

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 6.0							Excavated top 6' soil to clear utilities. Mud from 0' to 6'.
5													
			S	1	■	6.0 - 8.0	5	3	3	3	10		S-1: Black coarse to fine SAND, some medium to fine Gravel, loose, moist (Fill).
			S	2	■	8.0 - 10.0	7	5	3	2	10		S-2: Black coarse to fine SAND, some medium to fine Gravel, loose, moist (Fill).
10			S	3	■	10.0 - 12.0	3	3	3	1	7		S-3: Black coarse to fine SAND, some medium to fine Gravel, loose, moist (Fill).
15			S	4	■	15.0 - 17.0	1	WOH	1	1	16		S-4: Black Clayey SILT, trace fine Sand, trace fine Gravel, very soft, wet (ML)-Fill.
20			S	5	■	20.0 - 22.0	4	4	4	4	0		S-5: No Recovery.

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-3T**
SHEET NUMBER: **2** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS	
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)		
							CORING						
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.	
	▨		S	6	■	25.0 - 27.0	3	4	3	5	5		S-6: Brown coarse to fine SAND, some medium to fine Gravel, little Silt, loose, wet (SM).
30	▨		S	7	■	30.0 - 32.0	2	3	2	3	0		S-7: No Recovery.
35	▨		S	8	■	35.0 - 37.0	WOH	WOH	WOH	WOH	21		S-8: Gray Fat CLAY, occasional marine material, very soft, wet (CH).
40	▨		S	9	■	40.0 - 42.0	WOR	WOH	WOH	WOH	18		S-9: Gray Fat CLAY, trace fine Sand, trace fine Gravel, very soft, wet (CH).
45	▨		S	10	■	45.0 - 47.0	WOR	WOH	WOH	WOH	24		S-10: Gray Fat CLAY, occasional marine material, very soft, wet (CH).
50	▨		S	11	■	50.0 - 52.0	1	1	WOH	WOH	24		S-11: Same as above.
55	▨		S	12	■	55.0 - 57.0	2	1	WOH	WOH	24		S-12: Gray Fat CLAY, some medium to fine Sand, occasional marine material, very soft, wet (CH).

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

(continued)

BORING NUMBER: **SEG-3-3T**
SHEET NUMBER: **3** of **3**

PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS	
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)		
							CORING						
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.	
	▨		S	13	■	60.0 - 62.0	2	2	2	3	10		S-13: Gray Fat CLAY, occasional marine material, soft, wet (CH).
65	▥		S	14	■	65.0 - 66.1	WOR	5	50/1	-	13		S-14: Gray Clayey SILT, some medium to fine Sand, frequent decomposed SCHIST, hard, wet (ML).
													End of soil at 68' bgs. Start rock coring at 68'.
70													
75													
80													
85													
90													

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG

BORING NUMBER: **SEG-3-3T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/19/15** TIME: **2:00 pm**
FINISH DATE: **8/24/15** TIME: **12:00 pm**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
70		C-1 68.0 - 73.0	58	97	72	C-1: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong, extremely close to moderate fracture spacing, schistosity dips 70° to 80°, pyrite on multiple fractures, recovery loss assumed at 72.8'-73'.	II	R3	10_{MB} *80_{MB} *75_{MB} *80_{MB} *75_{MB} *80_{MB} *80_{MB} 10_{MB} 85_{MB} 10_{MB}	- 1.5 1.5 1.5 1.5 1 1 1 1 1	- 3 2 2 1 1 2 6 6 6	68 68.7 69.6 70.3 71.3 72.2 72.55 72.65 72.7 72.8
75		C-2 73.0 - 78.0	57	95	92	C-2: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong, moderate fracture spacing except very close to close fracture spacing at 77.8' to 78', schistosity dips 70° to 80°.	II	R3	15_{MB} 30_{MB} *75_{MB} 40_{MB}	1 1.5 1 3	6 1 1 2	73.25 75.2 77.15 77.8
80		C-3 78.0 - 83.0	60	100	100	C-3: 78' to 81.35': Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, wide fracture spacing schistosity dips 70° to 80°; 81.35' to 83': Light gray-green Muscovite GRANITE, coarse to fine grains of quartz, feldspar, muscovite, epidote (?) and garnet, slightly weathered, strong, close to moderate fracture spacing, high-angle healed fractures.	II	R4	20_{MB} 60_{MB} 75_{MB}	3 1.5 3	2 2 1	78 81.35 82.4
85		C-4 83.0 - 88.0	60	100	82	C-4: 83' to 85': Light gray-green Muscovite GRANITE, coarse to fine grains of quartz, feldspar, muscovite, epidote (?) and garnet, slightly weathered, strong, close to moderate fracture spacing; 85' to 88': Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong to strong, very close to moderate fracture spacing, schistosity dips 60° to 75°.	II	R3/R4	10_{MB} 70_{MB} *70_{MB} 10_{MB} 45_{MB} 50_{MB}	3 1 1 3 1.5 1.5	2 2 2 2 2 2	83 84.6 85 85.96 86.05 86.4
90		C-5 88.0 - 93.0	60	100	75	C-5: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong to strong, very close to moderate fracture spacing, schistosity dips 65° to 75°.	II	R3/R4	20_{MB} 60_{MB} 40_{MB} *75_{MB} *70_{MB} *65_{MB} *65_{MB}	3 1.5 3 1 1 1 1	1 1 1 2 1 1 1	88 89 89.45 89.55 90.1 90.6 91

The Gateway
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AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG
(continued)

BORING NUMBER: **SEG-3-3T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
						End of boring at 93' bgs.			*70_{MB} 30_{MB}	1 3	1 1	91.6 93
95												
100												
105												
110												
115												
120												
125												

The Gateway Trans-Hudson Partnership
AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

BORING NUMBER: **SEG-3-4T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

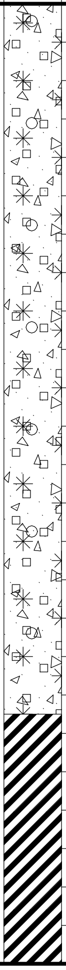
PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. **N: 1,916,164.6 E: 14,802,800.5**
STN. NO.: OFFSET:
SURFACE ELEV.: **308.6 feet**
DATUM:
START DATE: **8/13/15** TIME: **11:00 am**
FINISH DATE: **8/19/15** TIME: **2:00 pm**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ▧	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"		2.155"
O.D.	4.5"	3"	3"	"		2.98"
Length	35	24"	30"	"		60"
Hammer Wt.	140 lb	140 lbs	Drill Rod Size		NW	
Hammer Fall	30"	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
8/17/2015	9:00:00 AM	11.5	35	35
8/18/2015	10:00:00 AM	11	35	35
8/19/2015	7:00:00 AM	9.3	35	35



DEPTH (feet)	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	FIELD CLASSIFICATION AND REMARKS (Depth Elev.)
		G	1	☒	0.0 - 6.0						Excavated top 6' soil to clear utilities.
5											
		S	1	■	6.0 - 8.0	9	9	8	5	16	S-1: Brown, green and dark brown coarse to fine SAND, and Silt, little coarse to fine Gravel, medium dense, moist (SM)-Fill.
		S	2	■	8.0 - 10.0	5	8	11	8	10	S-2: Same as above.
10		S	3	■	10.0 - 12.0	3	2	1	3	1	S-3: Brown and green coarse to fine SAND, trace Silt, very loose, moist (SP)-Fill.
15		S	4	■	15.0 - 17.0	1	1	1	2	15	S-4: Brown medium to fine SAND, trace Silt, very loose, moist (SP)-Fill.
20		S	5	■	20.0 - 22.0	1	1	1	2	17	S-5: Gray Fat CLAY, some fine Sand, trace fine Gravel, very soft wet (CH)

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-4T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)						FIELD CLASSIFICATION AND REMARKS
							0/6	6/12	12/18	18/24	REC. (in.)		
							CORING						
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.	
	▨		S	6	■	25.0 - 27.0	WOH	WOH	WOH	2	23		S-6: Dark green-gray Fat CLAY, some fine Sand, trace fine Gravel, very loose, wet (CH).
30	▥		S	7	■	30.0 - 32.0	WOH	1	1	1	5		S-7: Dark gray Clayey SILT, trace fine Sand, occasional marine material, very soft, wet (ML).
													End of soil at 35' bgs. Start rock coring at 35' bgs.
35													
40													
45													
50													
55													

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

CORING LOG

BORING NUMBER: **SEG-3-4T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/13/15** TIME: **11:00 am**
FINISH DATE: **8/19/15** TIME: **2:00 pm**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
		C-1 35.3 - 40.0	57	100	91	C-1: Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, medium strong, very close to moderate fracture spacing, schistosity dips 60° to 65°, occasional banding parallel to schistosity.	II	R4	0_{MB}	-	-	35.25
									$*65_{MB}$	1	2	36.3
									$*65_{MB}$	1	2	36.7
									$*60_{MB}$	1	1	37.5
									$*65_{MB}$	1	2	38
									$*60_{MB}$	1	2	38.9
40									$*60_{MB}$	1	2	39
		C-2 40.0 - 45.0	58	97	83	C-2: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, close to moderate fracture spacing, schistosity dips 55° to 65°, occasional banding parallel to foliation.	II	R4	$*60_{MB}$	1	2	39.5
									$*60_{MB}$	1	2	39.9
									$*60_{MB}$	1	1	40
									$*60_{MB}$	1	1	40.7
									$*60_{MB}$	1	2	41.5
									$*60_{MB}$	1.5	2	41.85
									$*65_{MB}$	1	2	42.8
									$*55_{MB}$	1	2	43.5
45		C-3 45.0 - 50.0	59	98	58	C-3: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, very close to moderate fracture spacing.	II	R4	$*55_{MB}$	1	2	44
									$*55_{MB}$	1	2	44.2
									$*55_{MB}$	1.5	2	44.6
									$*60_{MB}$	1	4	45
									$*60_{MB}$	1.5	4	45.25
									$*60_{MB}$	1	2	45.5
									$*50_{MB}$	1	2	46.7
									$*55_{MB}$	1	1	47
50		C-4 50.0 - 54.9	59	100	92	C-4: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, close to moderate fracture spacing, schistosity dips 50° to 65°.	II	R4	$*60_{MB}$	1	1	47.35
									$*65_{MB}$	1	1	47.6
									$*65_{MB}$	1	1	47.8
									$*65_{MB}$	1	1	47.9
									$*65_{MB}$	1.5	2	47.95
									30_{MB}	1	6	48
									30_{MB}	1.5	2	48.9
									35_{MB}	3	1	49
55									$*65_{MB}$	1	1	50.8
		C-5 54.9 - 59.9	59	98	68	C-5: 54.9' to 57.7': Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, close to moderate fracture spacing, schistosity dips 55° to 60°; 57.7' to 58.6': QUARTZ, fresh, strong, moderate fracture spacing; 58.6' to 59.9': Gray Garnet-Mica SCHIST, medium to fine grains of quartz, feldspar, biotite, muscovite and	I/II	R4	20_{MB}	1.5	1	51.2
									$*50_{MB}$	1.5	2	52.9
									65_{MB}	3	2	53.2
									45_{MB}	-	-	54.3
									$*60_{MB}$	1	2	54.9
									20_{MB}	1.5	1	55.2
									$*55_{MB}$	1.5	2	55.5
60									35_{MB}	1	1	56.5

CORING LOG
(continued)

BORING NUMBER: **SEG-3-4T**

SHEET NUMBER: **2** of **2**

PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**

LOCATION: **30th St., 11th Ave., New York, NY**

CLIENT: **AMTRAK**

CONTRACTOR: **ADT**

DRILLER: **Dominick Pepe, George Raymond**

INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH
						garnet, slightly weathered, strong, very close to moderate fracture spacing, schistosity dips 55° to 60°.		
		C-6 59.9 - 64.9	60	100	93	C-6: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, close to moderate fracture spacing, schistosity dips 55° to 60°, quartz band at 64.1' to 64.35'.	II	R4
65		C-7 64.9 - 69.9	59	98	88	C-7: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, moderate to wide fracture spacing except close fracture spacing at 69.6' to 69.9', schistosity dips 60° to 70°.	II	R4
70		C-8 69.9 - 74.9	58	97	93	C-8: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong to strong, very close to moderate fracture spacing, schistosity dips 65°, muscovite granite bands at 70.9' to 71.8', and 73.55' to 73.75' with coarse to fine grains of quartz, feldspar, muscovite and garnet.	II	R3/R4
75		C-9 74.9 - 79.9	55	92	60	C-9: Gray Garnet-Mica SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, medium strong, very close to moderate fracture spacing, schistosity dips 65° to 70°, loss of recovery assumed at 74.9' to 75.35'.	II	R3
80						End of boring at 79.9' bgs.		
85								
90								
95								

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
40_{MB}	1	2	56.7
*55_{MB}	1	1	57
60_{MB}	3	2	57.5
10_{MB}	1.5	1	58.1
30_{MB}	1	2	58.9
15_{MB}	1.5	2	59.05
55_{MB}	1.5	1	59.9
50_{MB}	1.5	1	60.4
*60_{MB}	1	2	61.7
10_{MB}	3	2	63.7
*55_{MB}	1	2	64.1
55_{MB}	3	2	64.9
30_{MB}	3	1	67.55
*70_{MB}	1.5	2	69.5
10_{MB}	1	6	69.8
10_{MB}	1	6	70.1
25_{MB}	3	2	70.25
*65_{MB}	1	2	70.7
40_{MB}	3	1	71.5
40_{MB}	1.5	1	72.15
40_{MB}	1.5	1	72.6
40_{MB}	1.5	1	73.25
*65_{MB}	1	3	74.3
*65_{MB}	1	6	74.35
*65_{MB}	1	2	74.4
35_{MB}	1	6	74.9
*65_{MB}	1	1	77
*65_{MB}	1	2	77.35
30_{MB}	3	2	77.7
30_{MB}	3	1	78.55
35_{MB}	3	2	79.4
10_{MB}	1.5	2	79.6
30_{MB}	3	2	79.9

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG

BORING NUMBER: **SEG-3-5T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

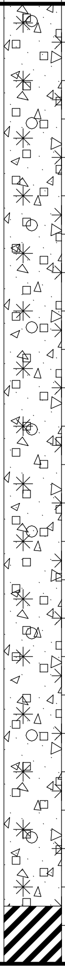
PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. **N: 1,916,066.0 E: 14,802,889.8**
STN. NO.: OFFSET:
SURFACE ELEV.: **306.6 feet**
DATUM:
START DATE: **8/28/15** TIME: **2:00 pm**
FINISH DATE: **8/30/15** TIME: **2:00 pm**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ▧	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"		2.155"
O.D.	4.5"	3"	3"	"		2.98"
Length	35	24"	30"	"		60"
Hammer Wt.	140 lb	140 lbs	Drill Rod Size		NW	
Hammer Fall	30"	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 6.0							Excavated top 6' soil to clear utilities.
5													
			S	1	■	6.0 - 8.0	2	6	4	4	7		S-1: Gray medium to fine SAND, trace medium to fine Gravel, loose, moist-Fill.
			S	2	■	8.0 - 10.0	10	8	9	14	1		S-2: Gray coarse to fine GRAVEL, medium dense, moist-Fill.
10			S	3	■	10.0 - 12.0	15	10	8	9	9		S-3: Gray Coarse to fine SAND, and Silt, some coarse to fine Gravel, medium dense, moist (SM)-Fill.
15			S	4	■	15.0 - 17.0	1	2	5	2	6		S-4: Brown medium to fine SAND, loose, moist-Fill.
20			S	5	■	20.0 - 22.0	WOH	1	1	1	1		S-5: Brown medium to fine SAND, little coarse to fine Gravel, very loose, wet-Fill.

PB BORINGS 2 SEG 3 BORING LOGS SOIL.GPJ CANARSIE-LIB.GLB - COPY.GLB 2/21/16

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG
(continued)

BORING NUMBER: **SEG-3-5T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 / CORING RUN (in.)	6/12 / REC. (in.)	12/18 / REC. %	18/24 / L>4" (in.)	REC. (in.) / RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	6		25.0 - 27.0	WOH	1	1	3	24		S-6: Dark gray Fat CLAY and Organic CLAY, very soft, wet (CH-OH).
30			S	7		30.0 - 32.0	1	1	WOH	1	24		S-7: Dark gray Fat CLAY and Organic CLAY, occasional marine material, very soft, wet (CH-OH).
35			S	8		35.0 - 37.0	2	1	1	1	20		S-8: Dark gray Fat CLAY and Organic CLAY, occasional marine material, very soft, wet (CH-OH).
40			S	9		40.0 - 42.0	WOH	1	WOH	1	23		S-9: Brown medium to fine SAND, and Clayey Silt, occasional marine material, very loose, wet (SM).
45			S	10		45.0 - 47.0	WOH	1	1	6	20		S-10: Same as above.
50			S	11		50.0 - 52.0	15	9	19	17	4		S-11: Dark brown coarse to fine GRAVEL, and coarse to fine Sand, little Silt, medium dense, wet (GM).
55			S	12		55.0 - 57.0	24	24	21	13	4		S-12: Dark brown medium to fine SAND, some medium to fine Gravel, dense, wet (SP).
													End of soil at 58' bgs. Start rock coring at 58' bgs.

PB BORINGS 2 SEG 3 BORING LOGS SOIL.GPJ CANARSIE-LIB.GLB - COPY.GLB 2/21/16

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

CORING LOG

BORING NUMBER: **SEG-3-5T**
SHEET NUMBER: **1** of **1**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/28/15** TIME: **2:00 pm**
FINISH DATE: **8/30/15** TIME: **2:00 pm**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH
60		C-1 58.0 - 63.0	53	88	55	C-1: Light gray to pink intermixed PEGMATITE and Muscovite GRANITE, coarse to fine grains of quartz, feldspar, muscovite and sparse biotite, slightly weathered, medium strong to strong, very close to moderate fracture spacing except wide fracture spacing at 61' to 63'.	II	R3/R4
65		C-2 63.0 - 68.0	60	100	83	C-2: Light gray to pink intermixed PEGMATITE and Muscovite GRANITE, coarse to fine grains of quartz, feldspar, muscovite and sparse biotite, slightly weathered, strong, close to moderate fracture spacing.	II	R4
70		C-3 68.0 - 72.7	56	100	88	C-3: Light gray Muscovite GRANITE, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse biotite, fresh to slightly weathered, strong, close to moderate fracture spacing.	I/II	R4
75		C-4 72.7 - 77.8	61	100	74	C-4: Light gray Muscovite GRANITE with PEGMATITE lenses, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse biotite, fresh to slightly weathered, strong, very close to moderate fracture spacing.	I/II	R4
80		C-5 77.8 - 82.4	55	100	100	C-5: Light gray Muscovite GRANITE with PEGMATITE lenses, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse biotite, fresh, strong, wide fracture spacing.	I	R4
						End of boring at 82.4' bgs.		

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
0_{MB}	-	-	58
10_{MB}	3	1	58.35
10_{MB}	3	2	58.75
85_{MB}	1	2	58.85
10_{MB}	1.5	2	59
10_{MB}	1.5	2	59.1
85_{MB}	1.5	2	59.2
60_{MB}	1	6	59.4
60_{MB}	3	3	60.1
55_{MB}	1.5	2	60.5
25_{MB}	3	2	61
10_{MB}	1.5	1	63
15_{MB}	1.5	1	64.3
20_{MB}	1	1	64.5
10_{MB}	1.5	2	65.6
25_{MB}	1.5	2	65.8
85_{MB}	1.5	2	66
10_{MB}	1.5	1	66.9
10_{MB}	1.5	1	68
10_{MB}	1	1	69.6
0_{MB}	1	1	70.2
10_{MB}	1	1	70.7
80_{MB}	1.5	2	71
20_{MB}	1	1	71.6
5_{MB}	1	1	72.1
15_{MB}	1.5	1	72.6
10_{MB}	1.5	2	73.2
80_{MB}	1	2	73.4
10_{MB}	1.5	2	73.45
80_{MB}	1	2	73.55
15_{MB}	1.5	1	73.7
80_{MB}	1	2	73.8
10_{MB}	1.5	2	73.9
45_{MB}	3	2	74.1
80_{MB}	1.5	2	74.4
10_{MB}	1	1	74.9
10_{MB}	1	1	76.4
30_{MB}	1.5	1	77.8
25_{MB}	1.5	1	82.4

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

BORING LOG

BORING NUMBER: **SEG-3-6T**	SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**	

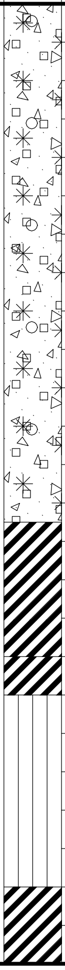
PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 11th Ave., New York, NY**
COORD. N: **1,916,207.5** E: **14,802,887.9**
STN. NO.: OFFSET:
SURFACE ELEV.: **307.5 feet**
DATUM:
START DATE: **8/26/15** TIME: **4:00 pm**
FINISH DATE: **8/28/15** TIME: **12:00 pm**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ⧅	G ☒	C ⊟
I.D.	4"	1.375"	2.938"	"		2.155"
O.D.	4.5"	3"	3"	"		2.98"
Length	35	24"	30"	"		60"
Hammer Wt.	140 lb	140 lbs	Drill Rod Size	NW		
Hammer Fall	30"	30 in.	I.D. (O.D.)	2.25" (2.625")		

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
8/28/2015	7:10:00 AM	9.7	33	83



DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 6.0							Excavated top 6' soil to clear utilities. Mud at around 2'.
5													
			S	1	■	6.0 - 8.0	4	5	2	2	13		S-1: Black coarse to fine SAND, loose, moist-Fill.
			S	2	■	8.0 - 10.0	4	10	9	10	13		S-2: Brown coarse to fine GRAVEL, some coarse to fine Sand, trace Silt, medium dense, moist (GW)-Fill.
10			S	3	■	10.0 - 12.0	6	6	10	9	22		S-3: Brown medium to fine SAND, trace fine Gravel, medium dense, moist-Fill.
15			S	4	■	15.0 - 17.0	WOH	WOH	1	1	22		S-4: Gray Fat CLAY, very soft, wet (CH).
			U	1	▯	17.0 - 19.0					8		Shelby Tube.
			S	5	■	19.0 - 21.0	WOR	WOH	WOH	WOH	17		S-5: Gray Clayey SILT, very soft, wet (ML).
20													

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV 100 Years

BORING LOG

(continued)

BORING NUMBER: **SEG-3-6T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS	
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6 CORING RUN (in.)	6/12 CORING REC. (in.)	12/18 CORING REC. %	18/24 CORING L>4" (in.)	REC. (in.) CORING RQD %	Depth Elev.	
	▨		S	6	■	25.0 - 27.0	WOH	WOH	WOH	WOH	24		S-6: Gray Fat CLAY, occasional marine material, very soft, wet (CH).
30			S	7	■	30.0 - 31.0	WOH	WOH	60/0	-	4		S-7: Gray Clayey SILT, very soft, wet (ML).
													End of soil at 33' bgs. Start rock coring from 33' bgs.
35													
40													
45													
50													
55													

The Gateway
Trans-Hudson
Partnership

AECOM PARSONS BRINCKERHOFF STV

CORING LOG

BORING NUMBER: **SEG-3-6T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30 St., 11 Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **8/26/15** TIME: **4:00 pm**
FINISH DATE: **8/28/15** TIME: **12:00 pm**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NQ	
O.D.: 2.98"	
I.D.: 1.875"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH
35		C-1 33.0 - 38.0	56	93	78	C-1: 33' to 33.5' and 35' to 38': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet, slightly weathered, medium strong, very close to moderate fracture spacing, schistosity dips 50° to 65°, recovery loss assumed at 33' to 33.3'; 33.5' to 35': Light gray, white and pink Muscovite GRANITE; gneissic towards the bottom, coarse to fine grains of quartz, feldspar, biotite and muscovite, slightly weathered, strong, moderate fracture spacing.	II	R3/R4
40		C-2 38.0 - 43.0	60	100	98	C-2: 38' to 42.05': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite and muscovite, slightly weathered, medium strong, moderate fracture spacing except extremely close fracture spacing at 38.7' to 38.75'; 42.05' to 43': Gray QUARTZ, coarse to fine grains of quartz, fresh, very strong, close fracture spacing.	I/II	R3/R5
45		C-3 43.0 - 48.0	58	97	97	C-3: 43' to 43.95': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite and muscovite, slightly weathered, medium strong, moderate fracture spacing except extremely close fracture spacing at 43' to 43.15', schistosity dips 60°; 43.95' to 48': Light gray-green to pink Muscovite GRANITE, medium to fine grains of quartz, feldspar, muscovite and sparse garnet, in some areas coarse grained, fresh, strong, moderate to wide fracture spacing, healed fractures dipping 55°.	II	R3
50		C-4 48.0 - 53.0	60	100	97	C-4: 48' to 50': Light gray-green to pink Muscovite GRANITE, medium to fine grains of quartz, feldspar, muscovite and sparse garnet, in some areas coarse grained, fresh, strong, wide fracture spacing; 50' to 53': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite and muscovite, slightly weathered, strong, moderate fracture spacing except extremely close fracture spacing at 50' to 50.1', schistosity dips 55° to 65°.	I/II	R4
55		C-5 53.0 - 58.0	59	98	67	C-5: Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite and muscovite, slightly weathered, medium strong, very close to moderate fracture spacing, schistosity dips 55°, quartz-feldspar band at 56.8' to 57.3'.	II	R3

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
0$_{MB}$	1	6	33.3
*55$_{MB}$	1	1	33.4
*50$_{MB}$	1.5	2	33.5
40$_{MB}$	1.5	2	34.3
*60$_{MB}$	1.5	2	35
*55$_{MB}$	1.5	2	35.3
*60$_{MB}$	1	3	35.9
*60$_{MB}$	1	2	36
*60$_{MB}$	1	2	37.3
*60$_{MB}$	1	1	38
*60$_{MB}$	1	2	38.7
*60$_{MB}$	1	2	38.75
*60$_{MB}$	1	1	39.6
20$_{MB}$	3	1	40.7
30$_{MB}$	1.5	1	42.05
30$_{MB}$	1	1	42.5
30$_{MB}$	1.5	1	43
30$_{MB}$	1	6	43.1
30	1.5	2	43.15
40$_{MB}$	1	6	43.95
30$_{MB}$	1	6	44
25$_{MB}$	1.5	1	45.5
15$_{MB}$	1.5	1	48
10$_{MB}$	1.5	2	50
*55$_{MB}$	1	2	50.1
*65$_{MB}$	1.5	1	51.4
*60$_{MB}$	1	2	52.2
30$_{MB}$	1	6	53
*65$_{MB}$	1	2	53.1
"55$_{MB}$	1	1	53.9
20$_{MB}$	2	2	54.45
*65$_{MB}$	1	1	54.8
85$_{MB}$	3	2	56.1
*65$_{MB}$	1.5	4	57.2

The Gateway Trans-Hudson Partnership

AECOM PARSONS BRINCKERHOFF STV

CORING LOG

(continued)

BORING NUMBER: **SEG-3-6T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **AMTRAK Hudson Yards**
LOCATION: **30th St., 11th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe, George Raymond**
INSPECTOR: **Juan Zapata Jr.**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH
60		C-6 58.0 - 63.0	58	97	92	C-6: Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet with quartz and feldspar lenses up to 1" thick, slightly weathered, medium strong, moderate fracture spacing except close fracture spacing at 58' to 58.5'.	II	R3
65		C-7 63.0 - 68.0	60	100	77	C-7: Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet with quartz and feldspar lenses up to 1" thick, slightly weathered, medium strong except medium strong to weak at 65.4' to 65.8', very close to moderate fracture spacing except extremely close fracture spacing at 65.6' to 65.8', schistosity dips 65° to 70°.	II	R2/R3
70		C-8 68.0 - 73.0	59	98	90	C-8: 68' to 72.5': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and sparse garnet with quartz and feldspar lenses up to 1" thick, slightly weathered, medium strong, moderate to wide fracture spacing except close fracture spacing at 68' to 68.4', schistosity dips 65° to 75°, quartz bands at 71.9' to 72.5'; 72.5' to 73': Light gray-Muscovite GRANITE, medium to fine grains of quartz, feldspar, muscovite and sparse garnet, slightly weathered, strong, close fracture spacing.	II I/II	R3/R4 R4
75		C-9 73.0 - 78.0	59	98	93	C-9: 73' to 76.2': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong. wide fracture spacing except very close fracture spacing at 76' to 76.2', schistosity dips 45° to 50°; granitic band at 73.2' to 73.5'. 76.2' to 78': Light green-gray Muscovite GRANITE, coarse to fine grained quartz, feldspar, muscovite, epidote (?), chlorite and sparse garnet, slightly weathered to fresh, strong, close to moderate fracture spacing.	I/II	R4
80		C-10 78.0 - 83.0	60	100	100	C-10: 78' to 78.8': Light green-gray Muscovite GRANITE, coarse to fine grained quartz, feldspar, muscovite, epidote (?), chlorite and sparse garnet, slightly weathered to fresh, strong, moderate fracture spacing; 78.8' to 83': Gray SCHIST, coarse to fine grains of quartz, feldspar, biotite, muscovite and garnet, slightly weathered, strong, close to wide fracture spacing, schistosity dips 70° to 75°. End of boring at 83' bgs.		
85								
90								

DISCONTINUITY DATA

ANGLE (deg)	Jr	Ja	DEPTH (feet)
10_{MB}	1.5	2	57.35
10_{MB}	1.5	2	57.5
*65_{MB}	1.5	4	57.6
85_{MB}	3	2	57.8
30_{MB}	1	6	58
20_{MB}	1	6	58.2
75_{MB}	2	2	58.5
*60_{MB}	1.5	2	59.6
65_{MB}	1.5	2	61.2
30_{MB}	1.5	2	63
55_{MB}	1.5	2	63.3
65_{MB}	3	2	64.9
10_{MB}	1	6	65.4
10_{MB}	1	6	65.6
30_{MB}	1	6	65.65
40_{MB}	1	6	65.7
40_{MB}	1.5	2	65.75
25_{MB}	1.5	2	66
50_{MB}	3	2	67.8
20_{MB}	2	1	68
40_{MB}	1	6	68.1
0_{MB}	15	2	68.4
50_{MB}	1.5	1	70.8
40_{MB}	1.5	1	72.5
50_{MB}	3	1	73

PARSONS BRINCKERHOFF

BORING LOG

BORING NUMBER: **SEG 4-4T**
SHEET NUMBER: **1** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **Hudson Yards Phase II**
LOCATION: **30th St., 12th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe**
INSPECTOR: **Brian Connolly/Juan Zapata**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION: **30th St., 12th Ave., New York, NY**
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **3/19/15** TIME: **9:00 am**
FINISH DATE: **3/24/15** TIME: **10:00 am**

	Casing	Split Spoon	Shelby Tube	Pitcher	Grab	Core Barrel
Type/Symbol	HW	S ■	U ▯	P ▧	G ☒	C ⊟
I.D.	4"	1.375"	2.938	"		2.155"
O.D.	4.5"	2"	3	"		2.98"
Length	94	24"	30	"		60"
Hammer Wt.	140 lb	140 lbs	Drill Rod Size		NW	
Hammer Fall	30"	30 in.	I.D. (O.D.)		2.25" (2.625")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
3/23/2015	7:26:00 AM	11.1	35	93
4/7/2015	7:23:00 AM	8	94	133

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			G	1	☒	0.0 - 6.0							Hand augered to 6'. 0-0.5': Asphalt. 0.5'-5.5': Brown SAND, some Silt, frequent brick fragments, occasional fabric, occasional wood fragments (Fill). 5.5'-6.0': Brick fragments (Fill).
5													
			S	1	■	6.0 - 8.0	76	3	3	3	12		S-1: Brown and gray SAND, some Silt, frequent brick fragments, occasional fabric, occasional wood fragments, loose, moist (Fill). Note: Brick layer at first 6".
			S	2	■	8.0 - 10.0	5	4	4	2	4		S-2: Brown and black SAND, some Silt, frequent brick fragments, occasional wood fragments, loose, moist (Fill).
10			S	3	■	10.0 - 12.0	5	2	5	6	4		S-3: Brown fine GRAVEL, and fine to coarse Sand, trace Silt, frequent brick fragments, occasional wood fragments, loose, moist (Fill).
15			S	4	■	15.0 - 17.0	WOH	WOH	WOH	WOH	14		S-4: Brown SILT, some Sand, very soft, moist (ML).
20			S	5	■	20.0 - 22.0	WOH	WOH	WOH	WOH	24		S-5: Gray and brown Silty CLAY, trace fine Sand, very soft, wet (CL).
			U	1	▯	22.0 - 24.0							U-1: Shelby tube.
			S	6	■	24.0 - 26.0	WOH	WOH	WOH	WOH	20		

PARSONS BRINCKERHOFF

BORING LOG

(continued)

BORING NUMBER: **SEG 4-4T**

SHEET NUMBER: **2** of **3**

PROJECT NUMBER: **4016879**

PROJECT: **Hudson Yards Phase II**

LOCATION: **30th St., 12th Ave., New York, NY**

CLIENT: **AMTRAK**

CONTRACTOR: **ADT**

DRILLER: **Dominick Pepe**

INSPECTOR: **Brian Connolly/Juan Zapata**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
					■								S-6: Gray and brown Silty CLAY, trace fine Sand, very soft, wet (CL).
30			S	7	■	30.0 - 32.0	WOH	WOH	WOH	WOH	20		S-7: Dark gray Clayey SILT, trace fine Sand, very soft, wet (CL).
35			S	8	■	35.0 - 37.0	WOH	WOH	WOH	WOH	24		S-8: Dark gray Silty CLAY, trace fine Sand, frequent decomposed marine material, very soft, wet (CH/OH).
40			S	9	■	40.0 - 42.0	WOH	WOH	WOH	WOH	24		S-9: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).
45			S	10	■	45.0 - 47.0	WOH	WOH	WOH	WOH	24		S-10: Dark gray Silty CLAY, little fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).
50			S	11	■	50.0 - 52.0	WOH	WOH	WOH	2	22		S-11: Dark gray Silty CLAY, little fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).
55			S	12	■	55.0 - 57.0	WOH	WOH	WOH	WOH	24		S-12: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).

PARSONS BRINCKERHOFF BORING LOG
(continued)

BORING NUMBER: **SEG 4-4T**
SHEET NUMBER: **3** of **3**
PROJECT NUMBER: **4016879**

PROJECT: **Hudson Yards Phase II**
LOCATION: **30th St., 12th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe**
INSPECTOR: **Brian Connolly/Juan Zapata**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	13	■	60.0 - 62.0	WOH	WOH	WOH	WOH	24		S-13: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).
65			S	14	■	65.0 - 67.0	WOH	WOH	WOH	WOH	24		S-14: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CH/OH).
70			S	15	■	70.0 - 72.0	WOH	WOH	WOH	WOH	24		S-15: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CL/OL).
75			S	16	■	75.0 - 77.0	WOH	WOH	WOH	WOH	21		S-16: Dark gray Silty CLAY, trace fine Sand, occasional decomposed marine material, very soft, wet (CL/OL).
80			S	17	■	80.0 - 82.0	1	2	2	7	24		S-17: Dark gray Silty CLAY, trace fine Sand, medium stiff, wet (CL-ML).
85			S	18	■	85.0 - 87.0	2	6	6	9	0		S-18: No recovery.
90			S	19	■	90.0 - 90.5	100/6"				3		S-19: Dark gray to black fine to coarse SAND, and fine to coarse Gravel, very dense, moist (Completely weathered bedrock).
													End of boring at 93'.

PARSONS BRINCKERHOFF CORING LOG

BORING NUMBER: **SEG 4-4T**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **Hudson Yards Phase II**
LOCATION: **30th St., 12th Ave., New York, NY**
CLIENT: **AMTRAK**
CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe**
INSPECTOR: **Brian Connecy/Juan Zapata**
DRILLING METHOD: MUD ROTARY
RIG TYPE: **CME-75 (truck mounted), Automatic Hammer**

LOCATION:
COORD.
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **3/19/15** TIME: **9:00 am**
FINISH DATE: **3/24/15** TIME: **10:00 am**

CORE BARREL DATA:	NOTES:
TYPE: Double Tube Swivel	
CORE SIZE: NX	
O.D.: 2.98"	
I.D.: 2.16"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
95		C-1 93.0 - 98.0	56	93	80	C-1: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, very close to moderate fracture spacing, foliation dips 25°-70°, rock tends to break along foliation, quartz and feldspar band from 96.6'-96.9'.						
100		C-2 98.0 - 103.0	60	100	92	C-2: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, very close to wide fracture spacing, foliation dips generally 70°, rock tends to break along foliation, quartz and feldspar bands up to 2" thick.						
105		C-3 103.0 - 108.0	59	98	92	C-3: 103'-103.7' & 105.7'- 108.0': Light gray and gray garnet-biotite-muscovite SCHIST, medium grained, fresh, medium strong, close to moderate fracture spacing except extremely close fracture spacing at 106.1'-106.25'. 103.7'-105.7': Light brown granitic GNEISS, fresh, strong, moderate fracture spacing.						
110		C-4 108.0 - 113.0	60	100	97	C-4: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, close to wide fracture spacing, foliation dips 65°-75°, rock tends to break along foliation.						
115		C-5 113.0 - 118.0	60	99	90	C-5: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, close to moderate fracture spacing, foliation dips 60°-65°, rock tends to break along foliation.						

PARSONS BRINCKERHOFF

CORING LOG
(continued)

BORING NUMBER: **SEG 4-4T**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **4016879**

PROJECT: **Hudson Yards Phase II**
LOCATION: **30th St., 12th Ave., New York, NY**
CLIENT: **AMTRAK**

CONTRACTOR: **ADT**
DRILLER: **Dominick Pepe**
INSPECTOR: **Brian Connecy/Juan Zapata**

DEPTH (feet)	CORING RATE (ft/min)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size) * - Denotes discontinuity along foliation MB - Denotes mechanical break	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
120		C-6 118.0 - 123.0	60	100	85	C-6: Gray SCHIST, medium to coarse grained, slightly weathered to fresh, medium strong, close to moderate fracture spacing except at 122.0'-122.35', foliation dips 60°-65°, rock tends to break along foliation planes.						
125		C-7 123.0 - 128.0	60	100	86	C-7: Gray and light gray garnet-biotite-muscovite SCHIST, medium to coarse grained, fresh, medium strong, very close to moderate fractrue spacing, foliation dips 50°-65°, rock tends to break along foliation planes, 1-1/4' thick quartz band at 124'.						
130		C-8 128.0 - 133.0	60	100	97	C-8: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, close to moderate fractrue spacing, foliation dips 45°-65°, rock tends to break along foliation planes.						
135		C-9 133.0 - 138.0	60	100	72	C-9: Gray SCHIST, medium to coarse grained, fresh, medium strong to strong, close to moderate fractrue spacing, foliation dips 45°-65°, rock tends to break along foliation planes, frequent quartz and feldspar bands and lenses up to 1" thick.						
140		C-10 138.0 - 141.0	35	97	75	C-10: Dark to light gray garnet-biotite-muscovite SCHIST, medium to coarse grained, fresh, medium strong, very close to moderate fractrue spacing, pegmatite band at 138.95'-139.75', foliation where observed, dips 45°-65°(centered in places). End of coring at 141'.						
145												
150												

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Quade &
Douglas, Inc.

BORING LOG

BORING NUMBER: **NW-5B**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**
CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **Baris Imamoglu**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **DK 525 (diesel fueled track rig)**

LOCATION: **Under 11th Ave. overpass, betw. 30th and 33th St., NYC**
COORD. **not surveyed**
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **1/16/15** TIME: **10:30 am**
FINISH DATE: **1/16/15** TIME: **2:30 pm**

	Casing	Split Spoon	Shelby Tube	Piston	Grab	Core Barrel
Type/Symbol		S ■	U ◫	P ⧅	G ☒	C ⊟
I.D.	3"	1.375"				2.16"
O.D.	3.5"	2"				2.98"
Length		24"				5'
Hammer Wt.	N/A	140 lbs	Drill Rod Size		N	
Hammer Fall	N/A	30 in.	I.D. (O.D.)		2" (2.375")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
1/9/15	6:20 pm	5.6	10.0	10.0
1/19/15	10:15 am	6.0	44.0	58.2

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
													Cleared for utilities with by hand/vactron to 10' bgs.
5						0.0 - 10.0							
10													No Recovery.
			S	1	■	10.0 - 12.0	41	41	50	40	0		
			S	2	■	12.0 - 14.0	10	16	9	7	3		S-2A: Gray Silty CLAY at top 1", stiff, moist (CL). S-2B: Gray to grayish brown, fine to coarse SAND, some fine gravel, little silt, medium dense, moist (SM) at bottom 2" (at tip of split spoon).
15			S	3	■	15.0 - 17.0	2	3	5	7	24		S-3 Gray CLAY, soft, moist (CL). 19': possible boulder.
20			S	4	■	20.0 - 22.0	8	9	13	12	12		S-4 Brown to light grayish brown SILT, stiff, moist (ML).

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BORING LOG
(continued)

BORING NUMBER: **NW-5B**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**

CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **Baris Imamoglu**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE SYMBOL	SAMPLE DEPTH (feet)	SOIL (Blows/6 in.) 0/6 CORING RUN (in.)	6/12 REC. (in.)	12/18 REC. %	18/24 L>4" (in.)	REC. (in.) RQD %	Depth Elev.	FIELD CLASSIFICATION AND REMARKS
			S	5	■	25.0 - 27.0	24	30	27	29	16		S-5 Reddish brown fine to coarse SAND, and silt, trace fine gravel; medium dense, moist (SM).
30			S	6	■	30.0 - 31.3	43	78	100/3"	-	14		S-6 Brown to reddish brown, fine to coarse SAND, some(+) fine to coarse gravel, trace silt, some rock fragments; very dense, moist (SP).
												End of Boring at 32.0'	
35													
40													
45													
50													
55													

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Douglas, Inc.

CORING LOG

BORING NUMBER: **NW-5B**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**
CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **Baris Imamoglu**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **DK 525 (diesel fueled track rig)**

LOCATION: **Under 11th Ave. overpass, betw. 30th and 33th St., NYC**
COORD. **not surveyed**
STN. NO.: OFFSET:
SURFACE ELEV.:
DATUM:
START DATE: **1/16/15** TIME: **7:00 am**
FINISH DATE: **1/19/15** TIME: **11:10 am**

CORE BARREL DATA:
TYPE: Double Tube Swivel
CORE SIZE: NX
O.D.: 2.98"
I.D.: 2.16"
CASING SIZE: 3" (3.5")

NOTES:

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
1/9/15	6:20 pm	5.6	10.0	10.0
1/19/15	10:15 am	6.0	44.0	58.2

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size)	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
35		C-1 34.0 - 38.2	9	18	11	C-1 Light brown and light gray, fine to medium grained gneissic GRANITE; fresh to highly weathered, extremely weak to strong, very close to close fracture spacing. 41" recovery loss assumed at top of run between 34' and 37.5', top of rock assumed at 37.5' bgs.	IV/I	R0/R4				
40		C-2 38.2 - 43.2	60	100	100	C-2 Light brown and light gray, fine to medium grained gneissic GRANITE; fresh to slightly weathered, strong to very strong, close to moderate fracture spacing, except at 39.55' to 39.8': extremely close fracture spacing. Numerous 0°-30° joints, slightly rough and planar to irregular with fresh to slightly weathered surfaces, slight FeOx coating; one 90° joint at 39.2' to 39.55', slightly rough and planar with slight FeOx coating; one 80° joint at 42.85' to 43.2', rough and undulating, heavy FeOx and silty fine to medium sand infill.	I/II	R4/R5				
45		C-3 43.2 - 48.2	56	94	90	C-3 Light gray, fine to coarse grained gneissic GRANITE with Quartz and Feldspar PEGMATITE bands and lenses; fresh , very strong to strong, moderate to very close fracture spacing. Five 0°-50° joints, slightly rough and wavy to planar with fresh surfaces, one with silt coating.	I	R5/R4				
50		C-4 48.2 - 53.2	60	100	60	C-4 Light gray, fine to coarse grained gneissic GRANITE with Quartz and Feldspar PEGMATITE bands and lenses, interlayered with SCHIST; fresh , very strong to strong, moderate to very close fracture spacing. SCHIST is slightly to moderately weathered, medium strong to weak. Prominent 70°-90° joint between 48.7' and 49.95', smooth and undulating with moderately weathered surfaces. Extremely close fracture spacing between 48.6' and 48.7'. Four 0°-70° joints, smooth to slightly rough, planar to wavy with slightly to moderately weathered surfaces, few with clayey sand infill and FeOx coating.	I/III	R5/R2				
55		C-5 53.2 - 58.2	48	79	64	C-5 53.2'-56': Dark gray to gray, fine to coarse grained schistose GNEISS; fresh, strong, moderate to close fracture spacing except at 53.2' to 53.35': slightly weathered, medium strong, very close fracture spacing. One 60° foliation joint, smooth and	I/II	R3/R5				

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CORING LOG
(continued)

BORING NUMBER: **NW-5B**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**

CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **Baris Imamoglu**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size)	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
60						slightly undulating. Four 0°-30° cross joints, smooth to slightly rough, planar to wavy with fresh surfaces. 56'-58.16': Light gray to light brown, Quartz and Feldspar PEGMATITE; fresh, very strong, moderate fracture spacing. No joints. End of coring at 58.2' bgs.						
65												
70												
75												
80												
85												
90												

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BORING LOG

BORING NUMBER: **WW-2**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**
CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **L. Sepulveda**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **DK 525 (diesel fueled track rig)**

LOCATION: **Under 11th Ave. overpass, betw. 30th and 33th St., NYC**
COORD. **not surveyed**
STN. NO.: OFFSET:
SURFACE ELEV.: **306.3 feet**
DATUM:
START DATE: **12/23/14** TIME: **7:30 pm**
FINISH DATE: **12/26/14** TIME: **10:30 am**

	Casing	Split Spoon	Shelby Tube	Piston	Grab	Core Barrel
Type/Symbol		S ■	U ▯	P ⧄	G ☒	C ⊟
I.D.	3"	1.375"				2.16"
O.D.	3.5"	2"				2.98"
Length		24"				5'
Hammer Wt.	N/A	140 lbs	Drill Rod Size		N	
Hammer Fall	N/A	30 in.	I.D. (O.D.)		2" (2.375")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
12/22/14	7:55 am	6.7	9.0	9.0
12/22/14	7:00 pm	6.6	9.0	9.0

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS
							0/6	6/12	12/18	18/24	REC. (in.)	
							CORING					
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.
5												
10			S	1	■	9.0 - 11.0	16	3	4	4	13	S-1 Top 5": Gray fine to medium SAND, some silt, trace fine gravel, wet (SM). Bottom 8": Red brown SILT, little(+) fine sand, interlayered with gray fine sand, some(+) silt, trace(-) fine to medium gravel (ML). Note: Drove casing to 14'.
15			S	2	■	14.0 - 16.0	18	12	15	17	0	S-2 No recovery due to coarse GRAVEL lodged in tip.
			S	3	■	16.0 - 18.0	2	6	8	9	6	S-3 Dark gray SILT, little clay, trace(+) fine sand, trace shell fragments (ML). PP up to 0.25 tsf.
			S	4	■	19.0 - 19.4	100/5"	-	-	-	2	S-4 Dark gray CLAY, little silt, some fine sand, trace shell fragments, wet (CL). Note: Rolled on it without advancement, telescoped 3-inch casing and set at depth 19.5' 19.4-20.5' Boulder (2.75 mins/ft).
20												
			S	5	■	21.5 - 23.5	12	14	19	20	10	S-5 Brown fine SAND, some silt, dense, wet, micaceous (SM).

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BORING LOG
(continued)

BORING NUMBER: **WW-2**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**

CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **L. Sepulveda**

DEPTH (feet)	GRAPHIC LOG	CASING (Blows/ft)	SAMPLE				SOIL (Blows/6 in.)					FIELD CLASSIFICATION AND REMARKS	
			TYPE	NUMBER	SYMBOL	DEPTH (feet)	0/6	6/12	12/18	18/24	REC. (in.)		
							CORING						
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	Depth Elev.	
			S	6	■	25.0 - 26.0	12	50/6"	-	-	12		S-6 Brown SILT, little fine to coarse sand, very dense, moist, slightly micaceous (ML). Start coring at 30' bgs.
30												End of Boring at 30.0'	
35													
40													
45													
50													
55													

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CORING LOG

BORING NUMBER: **WW-2**
SHEET NUMBER: **1** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**
CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **L. Sepulveda**
DRILLING METHOD: **Rotary Wash**
RIG TYPE: **DK 525 (diesel fueled track rig)**

LOCATION: **Under 11th Ave. overpass, betw. 30th and 33th St., NYC**
COORD. **not surveyed**
STN. NO.: OFFSET:
SURFACE ELEV.: **306.3 feet**
DATUM:
START DATE: **12/23/14** TIME: **7:30 pm**
FINISH DATE: **12/26/14** TIME: **10:30 am**

CORE BARREL DATA:	**NOTES:**
TYPE: Double Tube Swivel	
CORE SIZE: NX	
O.D.: 2.98"	
I.D.: 2.16"	
CASING SIZE: 3" (3.5")	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
12/22/14	7:55 am	6.7	9.0	9.0
12/22/14	7:00 pm	6.6	9.0	9.0

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size)	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
		C-1 30.0 - 34.2	39	78	46	C-1 Gray and white, fine to coarse grained SCHIST; moderately weathered, medium strong to strong, close to moderate fracture spacing. 30'-30.2': coarse gravel sized rock fragments.	III	R4				
35		C-2 34.2 - 39.2	59	98	80	C-2 Gray and white, fine to coarse grained SCHIST; slightly weathered, strong, very close to moderate fracture spacing.	II	R4				
40		C-3 39.2 - 44.2	57	95	95	C-3 Gray and white, fine to coarse grained SCHIST; fresh, strong, close to moderate fracture spacing.	I	R4				
45		C-4 44.2 - 49.2	51	85	85	C-4 Dark gray, medium to coarse grained SCHIST; fresh, strong, moderate to wide fracture spacing.	I	R4				
50		C-5 49.2 - 54.2	56	93	93	C-5 Dark gray, medium to coarse grained SCHIST; fresh, strong, moderate fracture spacing.	I	R4				
						C-6 Dark gray, medium to coarse grained SCHIST;	I/II	R4				

55TH STREET CORING LOG (PB) NEW GATEWAY.GPJ 148TH STREET YARD FENCE LOGS.GLB 1/23/15

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CORING LOG
(continued)

BORING NUMBER: **WW-2**
SHEET NUMBER: **2** of **2**
PROJECT NUMBER: **187625A**

PROJECT: **Gateway, Phase II**
LOCATION: **Hudson Yards, New York, NY**
CLIENT: **TPC**

CONTRACTOR: **WGI**
DRILLER: **C. Moreira**
INSPECTOR: **L. Sepulveda**

DEPTH (feet)	CORING RATE (min/ft)	CORE RUN NO. AND DEPTH (ft)	RECOVERY (in)	RECOVERY (%)	RQD (%)	DESCRIPTION AND REMARKS (Lithology, Structure, Weathering, Continuity, Strength, Color, Grain Size)	WEATHERING	STRENGTH	DISCONTINUITY DATA			
									ANGLE (deg)	Jr	Ja	DEPTH (feet)
		C-6 54.2 - 59.2	56	93	80	fresh to slightly weathered, strong, close to moderate fracture spacing.						
60						End of coring at 59.2'.						
65												
70												
75												
80												
85												

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD—CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 1 of 4
BORING NO. WT-501
FILE NO. 4840

PROJECT WEST SIDE HIGHWAY
DOT CONTR NO D 96416
COORDINATE N 192,777.0 E 1,997,988.5
LOCATION West Street at 30th Street
INSPECTOR G. Cardinez (WCC)
CONTRACTOR Warren George, Inc.
DRILLER S. Muh
HELPER F. Gaughan, M. Smith
ELEVATION + 5.2
DATUM Manhattan
DATE STARTED 11/05/80
DATE COMP. 11/10/80
TYPE OF RIG TRUCK ☐ SKID ☐ BARGE MOUNTED ☐ TRIPOD ☐ OTHER ☐
CASING DIA 5 IN. FROM 0.0 TO 15.0 FT. DIA. 3 IN. FROM 0.0 TO 154.0 FT.
DRILLING MUD UTILIZED MUD TYPE Quick Gel
ROTARY BIT DIA 3-3/4;4-7/4 IN.
SAMPLING EQUIPMENT (TYPE & SIZE)
D-SAMPLER: Split Spoon, 2" O.D.
DRILL ROD N
U-SAMPLER DIA - IN TYPE -
CORE BIT Diamond, NX
CORE BARREL Double Tube
FEED DURING CORING MECHANICAL ☐ HYDRAULIC ☒ OTHER ☐
SAMPLER HAMMER WEIGHT (LBS) 140 AVG FALL 30 IN
CASING HAMMER WEIGHT (LBS) 300 AVG FALL 18 IN
NO OF U-TUBES 0 NO OF VANE TESTS 0 DEPTH TO ROCK 154.0 FT DEPTH TO COMP 170.5 FT

WATER LEVEL OBSERVATIONS

DATE	TIME	DEPTH OF HOLE	DEPTH OF CASING	DEPTH TO WATER	ELEVATION OF TIDE	CONDITIONS OF OBSERVATION
11/10/80	1120	170.5	153	13.2	-0.1	20 minutes after coring
11/10/80	1130	170.5	-	6.11	-0.1	After casing was pulled out

DAILY PROGRESS	CASING BLOWS	SAMPLE NO	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
1000	O					*		W = Water content in %
	N				Concrete	**		qu = pocket penetrometer strength in tsf
	*	NR		50/0"		1.8		
	**				Boulder			
	2					4.5		
	0	1D	5.0	45 - 24	Coal, some gravel, bricks, black silt, mica	Soft, gray organic silty clay, organic silty and medium to fine sand, trace gravel, coal, brick (Fill)	5	* Asphalt ** Belgium block
	4		7.0	14 - 21				
	37							
	38							
	198							
11/05/80 Partly sunny, cool	23	2D	10.0	12 - 7	Medium, gray clayey silt, trace medium sand, veg lenses, organics (ML)		10	W = 22
	37		12.0	9 - 11				
	34							
	25							
	26							
		3D	15.0	8 - 3	Soft, gray silty clay, trace gvl fine sand, mica, organics (CL)		15	W = 24 Use of drilling mud at 15'
			17.0	3 - 3				
		4D	20.0	12 - 8	Gray silty fine to medium sand, trace gvl, coal, wd, brick (SM)		20	Use of drilling mud at 15' Attempted spoon at 2' - refusal
			22.0	5 - 2				
		NR	25.0	5 - 4			25	
			27.0	4 - 9				
		5D	27.0	5 - 4	Soft, gray silt, some fine sand, trace gravel, organic (ML)			W = 20
			29.0	4 - 9				
		6D	30.0	27 - 12	Coal, trace glass, medium to fine sand, shells	Same as above	30	
			32.0	9 - 5				
		7D	35.5	4 - 3	Soft, black organic silty clay, some wood layers, shells, fine sand (OH)		35	W = 52
			37.5	3 - 5		37.0		
		8D	40.0	WR/24"	Soft, black organic silty clay, trace shells, fine sand (OH)	Soft, black org silty clay, tr shells, f sand	40	W = 54
			42.0					* Driller overdrove spoon 6"
		9D*	45.0	4 - 1	Top: DO 8D (OH)		45	W = 65 Top
1530 0700			47.0	1 - 4	Bot: Medium, gray organic silty clay, sm f sand partings, seams, trace shells (OH)	46.0		W = 50 Bot
		10D	50.0	4 - 4	Medium, gray organic silty clay, trace f sand pockets, partings, shells (OH)	Medium to stiff, gray organic silty clay, some fine sand layers, seams, lenses, trace shells, vegetation	50	W = 47 qu = 0.5
			52.0	4 - 5				
		11D	55.0	2 - 2	Medium, gray organic silty clay, trace fine sand, shells (OH)		55	W = 48
			57.0	1 - 1				
		12D	60.0	3 - 3	DO 11D, stiff (OH)		60	W = 50 qu = 1.0
			62.0	3 - 7				
11/06/80 Sunny, cool		13D	65.0	WR/24"	Stiff, dark gray organic silty clay, trace f sand, shells (OH)		65	W = 43 qu = 1.0
			67.0					
		14D	70.0	3 - 3	DO 13D, trace fine sand partings (OH)		70	W = 51 qu = 0.5
			72.0	4 - 5				
		15D	75.0	1 - 1	DO 13D (OH)		75	W = 55 qu = 1.0
			77.0	1 - 1				
		16D	80.0	1 - 2	DO 13D, dark grey (OH)		80	W = 46 qu = 1.0
			82.0	1 - 4				
							85	

MUESER, RUTLEDGE, JOHNSTON & DESIMONE
WOODWARD—CLYDE CONSULTANTS, INC.

BORING LOG

SHEET 3 of 4
BORING NO. WT-501
FILE NO. 4840

DAILY PROGRESS	CASING BLOWS	SAMPLE NO	SAMPLE DEPTH	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION	STRATA	DEPTH (FT)	REMARKS
		17D	85.0	WR/12"	Medium, dark gray organic silty clay, tr f sand, shells (OH)		85	W = 33 qu = 0.75
			87.0	1 - 1				
		18D	90.0	4 - 2	Medium, dark gray organic silty clay, sm f sand, f sand seams, lenses, tr shells, mica (OH)		90	W = 40 qu =0.75
			92.0	2 - 4				
		19D	95.0	2 - 4	DO 18D (OH)	Same as above	95	W = 39 qu = 0.75
			97.0	9 - 11				
		20D	100.0	3 - 6	DO 18D (OH)		100	W = 34 qu = 0.75
			102.0	10 - 20				
		21D	105.0	4 - 4	Medium, dark gray organic silty clay, some f sand, tr shells (OH)		105	W = 33 qu = 0.5
			107.0	5 - 6				
		22D	110.0	21 - 16	Gray silty fine sand, trace clay, mica (SM)	110.0	110	
			112.0	21 - 24				
11/06/80		23D	115.0	8 - 8	Gray silty fine sand, some clay layers, trace vegetation, mica (SM)	Med cpt to cpt, gray silty f sa, tr cl, veg, mica	115	
			117.0	10 - 12				
		24D	120.0	10 - 12	Stiff, grey silty clay, trace fine sand seams, f sand pkts, vegetation, mica (CL)	120.0	120	W = 33
			122.0	15 - 17				
		25D	125.0	1 - 2	DO 24D (CL)	Medium to stiff, gray silty clay, trace fine sand seams, pockets & partings	125	W = 37
			127.0	10 - 8				
1530 0700		26D	130.0	WR/6"-9	Stiff, gray silty clay, some f sand seams, lenses (CL)		130	W = 39 qu = 0.5
			132.0	13-17				
11/07/80 Sunny, cool		27D	135.0	5 - 7	Medium, gray clayey silt, trace fine sand pockets, veg (ML)		135	W = 38 qu = 0.75
			137.0	9 - 10				
		28D	140.0	5 - 5	Stiff, gray clay, trace mica (CL)	Same as above	140	W = 36 qu = 1.0
			142.0	5 - 8		145.0		Hard drilling @ 145.8 to 146.8 possible cobbles or boulders
11/07/80		29D	145.0	25 -	Red-brown silty fine to coarse sa, sm gravel, mica (SM)	V cpt, red-brown silty f-c sand, sm gvl, tr mica	145	
			145.8	100/4"				
		30D	150.0	19 - 23	Red-brn silty fine to coarse sand, sm gvl, trace clay (SM)		150	
			151.8	50-50/1"		154.0		
		1C	155.5	Rec=81%	Gray slw mica schist, broken	Light gray slw to Unw mica schist, broken to sljtd	155	
			160.5	RQD=20%				
1530 0700		2C	160.5	Rec=60%	Gray slw mica schist, broken		160	
			165.5	RQD=12%				
11/10/80 Partly sunny, cool		3C	165.5	Rec=96%	Light gray Unw mica schist, sljtd		165	
			170.5	RQD=58%				
1100						170.5	170	
							175	
							180	
							185	
							190	
							195	

APPENDIX E

Axial Load Test Memo

LANGAN

Technical Memorandum

Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.
21 Penn Plaza, 360 West 31st Street, 8th Floor New York, NY 10001 T: 212.479.5400 F: 212.479.5444

To: Dave Pereira, Jim Strobel, Mark Townsend – Related

From: Michael Paquette, Saul Shapiro, Marc Gallagher

Info: Sitotaw Fantaye, Aleksandr Krutovskiy – MRCE
Dan Weaver, Robin Fitzgerald-Green – KPF

Date: 4 April 2018

Re: Updated Caisson Design Parameters - WRY Platform
Hudson Yards-West Rail Yards, Manhattan, New York
Langan Project No.: 170444101

This memorandum updates our recommended geotechnical design parameters for the WRY Platform caissons. The design parameters consider the results of three recently completed Osterberg Cell (O-cell) load tests performed in Terra Firma. The tests were located in the eastern, central and western parts of Terra Firma (Figure 1) to capture the variable depth to bedrock. Details and results of the load tests are included in LoadTest Inc.'s reports provided by East Coast Drilling and Related.

DESIGN PARAMETERS

We recommend the following geotechnical parameters for design of caissons for the WRY. Because the compressive side shear value exceeds the NYC Building Code maximum allowable value, a variance (CCD1) will be required:

- Allowable side shear:
  - Compression = 300 psi
  - Tension = 100 psi
- Allowable end bearing:
  - 80 ksf basic value per NYC Building Code*
  - 10% increase per foot up to 160 ksf maximum @ 10-foot embedment

*This end-bearing value assumes that the bottom of the sockets will be clean of sediment and will be at least Building Code Class 1b rock. We anticipate that cleaning the sockets will be difficult, especially on the west half of the site where the caissons will be over 100 feet deep. Where the contractor cannot achieve a clean bottom or where the video inspection cannot verify the bottom, the contractor could lengthen the rock sockets so the caissons rely on side shear only. The required overdrill length would vary from about 0.5 to 1 times the diameter of the socket as determined by:

$$\mathbf{L_{over-drill} = (0.0463x + 0.463)D \leq D}$$

where: $L_{over\text{-}drill}$ = Length of over-drilling (feet)
x = embedment below top of rock (feet)
D = Rock socket diameter (feet)

INCREASED SIDE SHEAR DISCUSSION

The O-cell load tests proved a significantly higher shear capacity than the Building Code presumptive value. The tests reached maximum side shear values varying from about 850 to 880 pounds per square inch (psi) at movements of about 0.09 to 0.33 inch (Figure 2). The maximum capacity of the load cells (jacks) was reached before the ultimate skin friction was reached in all three tests; however, as shown in Figure 2, the slope of the skin friction curve noticeably decreases at around 550 to 700 psi in all three tests.

The response of Test 1 (western test) was stiffer (less movement) than the other two tests—this test caisson was constructed in an area of known granite intrusions (refer to Langan 2005 boring G-17). The test caisson was observed to have slower drilling and the rock quality was better as shown during video inspection.

We recommend using an allowable side shear of 300 psi in compression to remain within the elastic portion of the stress-strain response and to account for variability in bedrock quality. At 300 psi, the corresponding deflection reported during the tests was about 1/100 of an inch.

We recommend using an allowable skin friction of 100 psi in tension (per geotechnical report). The capacity in tension is more influenced by rock mass conditions rather than grout-to-rock bond, particularly near the top of the bedrock surface.

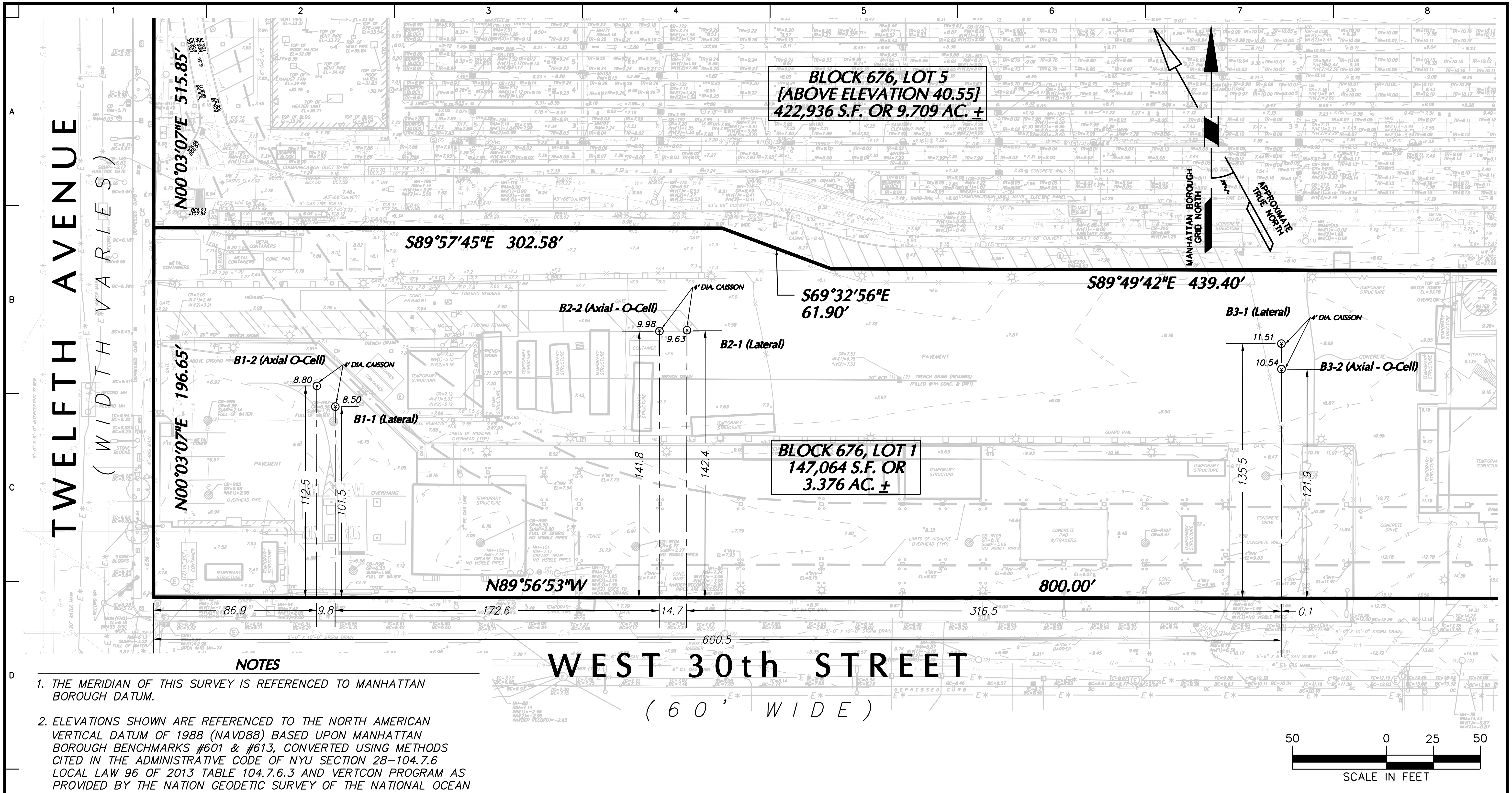
END BEARING DISCUSSION

The three load tests reached maximum end bearing values varying from about 750 to 800 kips per square foot (ksf) before the jack limit was reached. While this is substantially higher than the recommended design value, the tests indicate a caisson would settle 0.25 to 1.25 inches to reach the capacity (Figure 2). The test caissons likely had "soft bottoms" or poor-quality grout below the O-cell, as evidenced by the movement at the beginning of the test (left side of curve), particularly in Tests 2 and 3 (Figure 2).

We believe trying to eliminate "soft bottoms" by cleaning the socket bottoms will be difficult, especially on the side west of the site where proposed caissons depths are over 100 feet. Verification of hard bottoms via video inspection will also be difficult because of murky water, possibly necessitating use of a shaft inspection device (SID) to measure the sediment on the bottom. Note that the caisson construction will be more challenging than the East Rail Yard, where the shafts (1) were shallow, (2) could be vacuum-cleaned, and (3) could be dewatered for video inspection to confirm the clean bottom.

The inability to adequately clean and inspect socket bottoms, particularly in larger diameter caissons, can lead to significant additional time spent cleaning and inspecting the sockets. We believe that ignoring end bearing (design for side shear only) and drilling a few feet of additional rock socket in each caisson would likely be faster and less risky than trying to clean and confirm the bottom. The pros and cons of using a side-shear-only design approach to limit delays related to cleaning should be discussed with the foundation contractor to determine the most cost-effective approach. Field changes could also be made to adjust lengths on a case-by-case basis.

If you have any questions or require any additional information, please contact us.



NOTES

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2. ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88) BASED UPON MANHATTAN BOROUGH BENCHMARKS #601 & #613, CONVERTED USING METHODS CITED IN THE ADMINISTRATIVE CODE OF NYU SECTION 28-104.7.6 LOCAL LAW 96 OF 2013 TABLE 104.7.6.3 AND VERTCON PROGRAM AS PROVIDED BY THE NATION GEODETIC SURVEY OF THE NATIONAL OCEAN SERVICE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION.

3. PLANIMETRIC INFORMATION SHOWN HEREON HAS BEEN OBTAINED FROM GROUND SURVEYS BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEYING AND LANDSCAPE ARCHITECTURE, D.P.C., ON MARCH 26, 2018.

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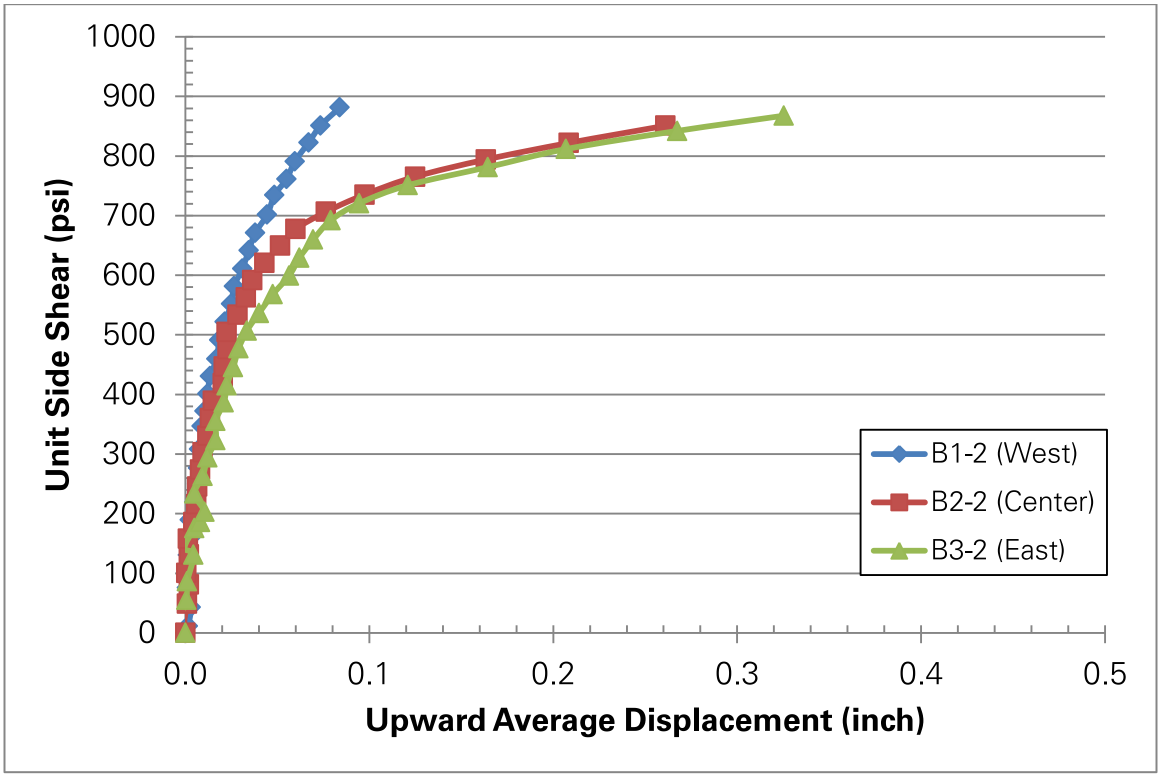
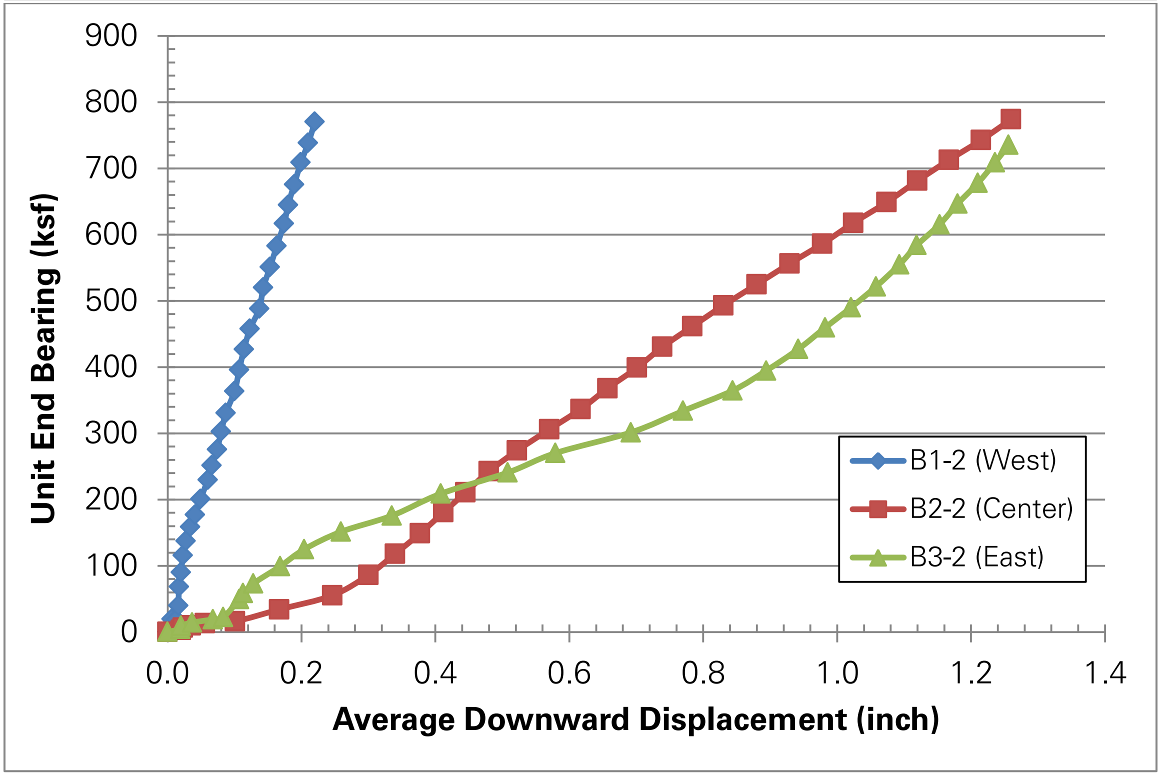
Project
HUDSON YARDS
WEST RAIL YARD
TERRAFIRMA
BLOCK No. 676, LOT No. 1
BOROUGH OF MANHATTAN
NEW YORK NEW YORK

Drawing Title
CAISSON
LOCATION
PLAN

Project No. 170444101
Date 03/28/2018
Scale 1"=50'
Drawn By TO
Checked By PF
Submission Date 04/04/2018

Drawing No. 1
Sheet 1 of 2





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Project	Drawing Title	Project No.	Drawing No.
HUDSON YARDS WEST RAIL YARDS	Unit Side Shear and Unit End Bearing	170444101	2
		Date 4 April 2018	
		Scale AS SHOWN	
		Drawn By MP	
MANHATTAN NEW YORK		Submission Date 4 April 2018	Sheet 2 of 2

APPENDIX F

Lateral Load Test Memo

LANGAN

Technical Memorandum

Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C.
21 Penn Plaza, 360 West 31st Street, 8th Floor New York, NY 10001 T: 212.479.5400 F: 212.479.5444

To: Dave Pereira, Jim Strobel, Mark Townsend – Related

From: Michael Paquette, Saul Shapiro, Marc Gallagher

Info: Sitotaw Fantaye, Aleksandr Krutovskiy – MRCE
Dan Weaver, Robin Fitzgerald-Green – KPF

Date: 17 July 2018

Re: Updated Caisson Design Parameters – Lateral Loads
Hudson Yards-West Rail Yards, Manhattan, New York
Langan Project No.: 170444101

This memorandum updates our recommended geotechnical design parameters for WRY Platform caissons. The design parameters consider the results of three lateral load tests performed in Terra Firma. The tests were in the eastern, central and western parts of Terra Firma (Figure 1) to evaluate how the variable depth to bedrock and thickness of the fill impact the caisson lateral response. Details and results of the load tests are included in LoadTest Inc.'s reports provided by East Coast Drilling.

LATERAL LOAD TEST DATA

We evaluated the caisson lateral response using strain gage and inclinometer data provided by LoadTest. The following key considerations were used to develop our recommended design parameters:

1. We excluded data from the upper 5 feet of the test caissons because this zone was excavated to clear for utilities and then backfilled with imported soil and therefore does not represent the historical fill.

2. We modeled the lateral caisson response using the p-y (mobilized soil reaction-deflection) procedure where the soil and rock are modeled as a series of discrete resistances (springs) with nonlinear behavior.

3. We evaluated both the strain gauge and inclinometer data and determined that the inclinometer gave more reliable readings. There were multiple instances in the strain gauge data where the force couple between the leading (loaded) and trailing faces of the caisson were not reliable (i.e. the data had erroneous spikes and valleys that could not be used to create a meaningful induced moment profile). The inclinometers produced a more accurate moment profile and were used to develop p-y curves.

4. Load Test 2 (center of the site) had incomplete inclinometer readings because of recording errors and erroneous strain gauge readings; therefore, p-y curves were not developed for this load test; however, the top load versus deflection was compared to the other two tests.

5. We used the inclinometer measurements along the length of the caisson to develop profiles of moment versus depth and mobilized soil reaction versus depth for each load increment. The mobilized soil reaction values at each load increment are combined to produce p-y curves at each inclinometer interval.

6. The p-y curves were relatively "noisy", possibly from the heterogeneous nature of the historical fill. We determined soil properties using published p-y curves to fit the site-specific p-y data. The predicted caisson top load versus deflection developed using our modeled parameters (Figure 2) provide a reasonable approximation of the load test results.

7. We modeled a caisson in each of the six platform zones to evaluate the variability of the fill density and thickness (Figure 3).

CONCLUSIONS

We have the following general conclusions:

1. The lateral caisson response is primarily controlled by the historical fill (thickness and density), even where the fill was thinnest (fill at the west test was about 35 feet thick and at the east test was about 18 feet thick based on borings).

2. The modeled caisson response is not sensitive to the assigned strength parameters in the clay (below the fill) because the mobilized soil reaction below the fill is relatively small. In addition, the mobilized reaction in the clay during the load tests was small and representative p-y curves could not be developed.

3. The depth and type of bedrock did not have a significant impact on the test results because the mobilized reaction below the fill is relatively small, even on the east load test where the fill was thinnest and rock shallowest.

4. The results of the three lateral load tests show relatively similar top load versus deflection responses (Figure 2).

5. Using published p-y models to fit the p-y curves developed from the load tests produced a reasonable approximation of the response of all three load tests (Figure 2).

6. The predicted responses of caissons across the six project zones show about a 10 to 15 percent difference in the load and deflection response in the general anticipated range of working loads (corresponding to less than ½ inch deflection); therefore, for simplicity in design we recommend using an average response for the entire WRY.

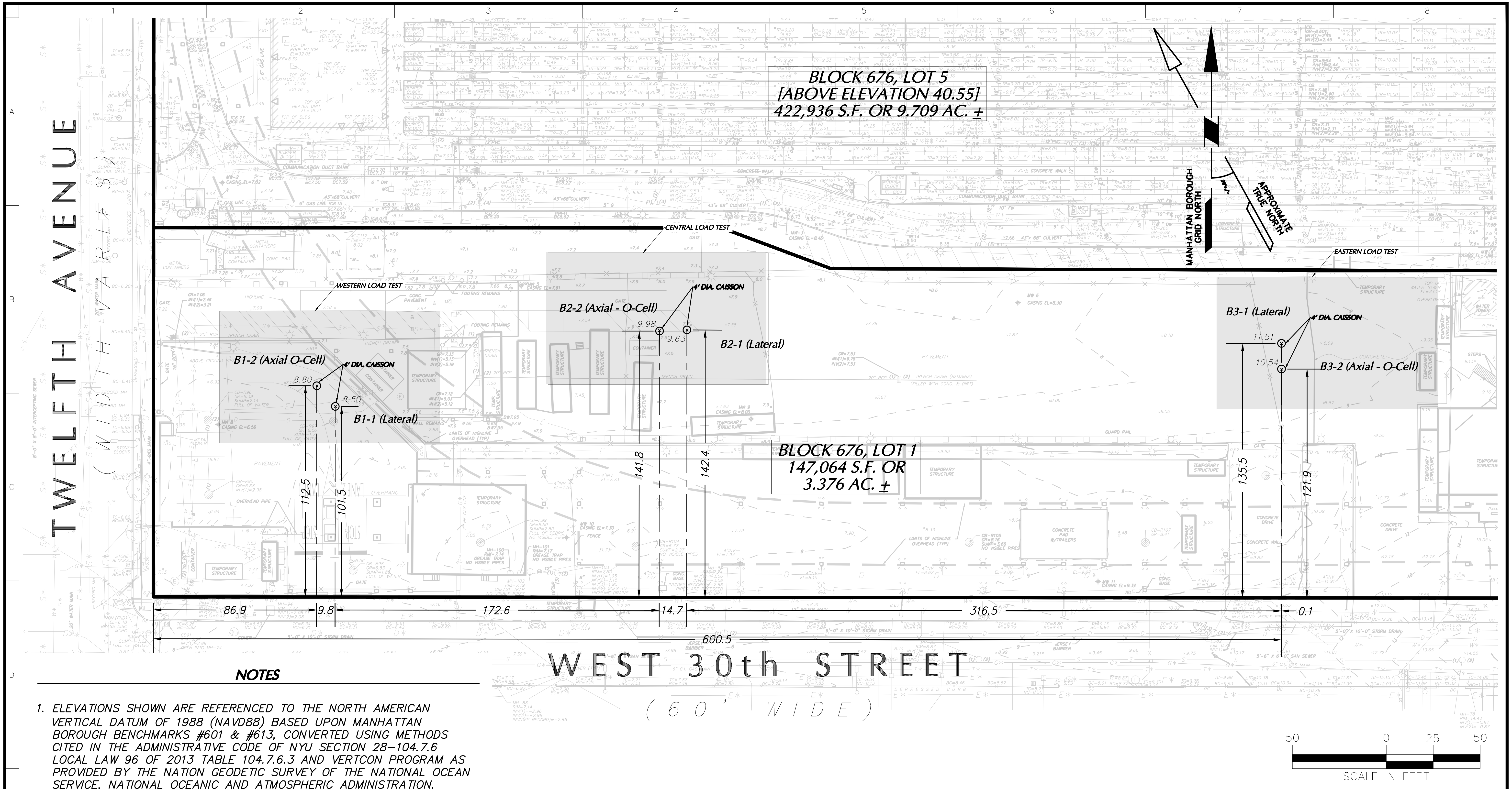
DESIGN PARAMETERS

The attached tables present our recommended p-y curves for the fill, clay and bedrock, and include curves for 24 to 96 inch diameter caissons.

- Historical Fill
  - For the fill layer we recommend using an average response from the six zones.

  - The attached tables include p-y curves as a function of depth of fill for each caisson diameter.
  - The typical depth of fill for each zone can be obtained from our previously issued geotechnical parameter summary for each zone.
  - Below the depth of fill for each project zone, the p-y curve for clay are used.
- Clay
  - P-y curves for the clay are presented as a function of undrained shear strength.
  - Undrained shear strength and thickness of the clay for each zone can be obtained from our previously issued geotechnical parameter summary for each zone.
- Bedrock
  - Bedrock was not significantly mobilized during the load tests to produce p-y curves; therefore the attached tables are a repeat of the previously recommended p-y curves.

If you have any questions or require any additional information, please contact us.



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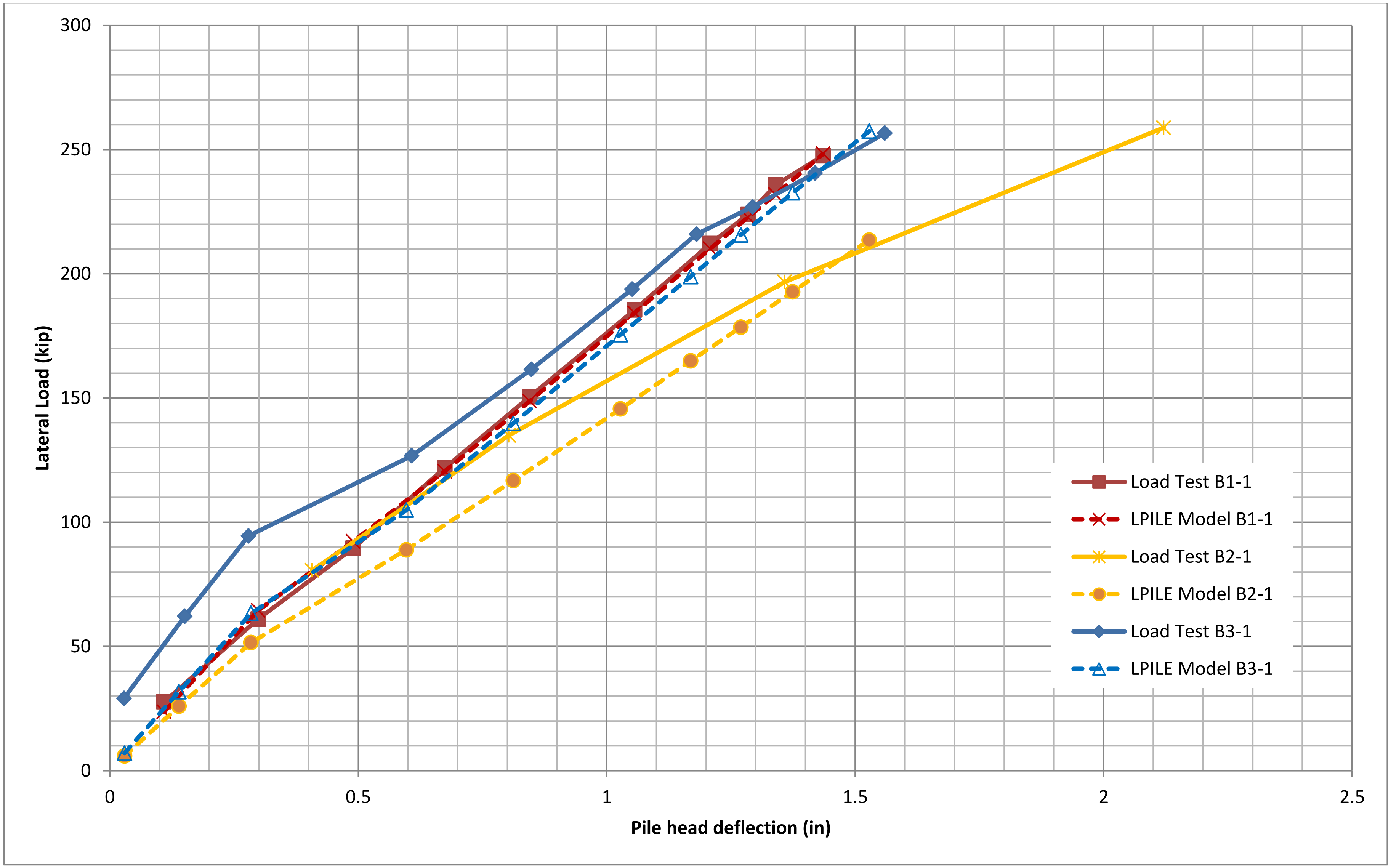
Project
HUDSON YARDS
WEST RAIL YARD
TERRAFIRMA
BLOCK No. 676, LOT No. 1
BOROUGH OF MANHATTAN
NEW YORK NEW YORK

Drawing Title
TEST CAISSON
LOCATION
PLAN

Project No.
170444101
Date
03/28/2018
Scale
1"=50'
Drawn By TO
Checked By PF
Submission Date
04/04/2018

Drawing No.
1
Sheet 1 of 1



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Project

Hudson Yards West
Rail Yard

NEW YORK NEW YORK

Drawing Title

Lateral Load – Lateral Deflection Plot (Load Tests vs LPILE Model)

Project No. 170444101

Date 2018/06/29

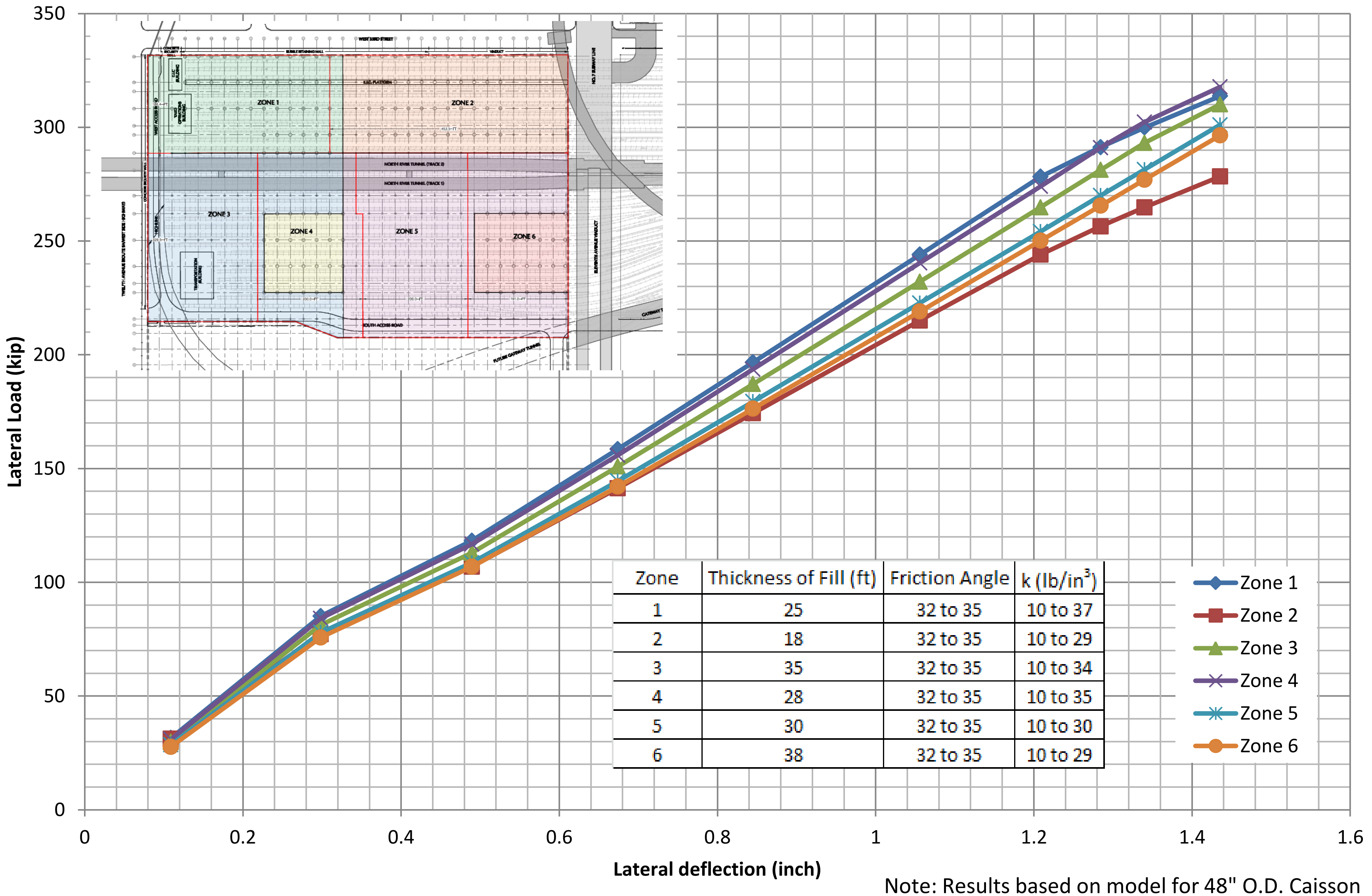
Scale No Scale

Drawn By MP/ZW

Submission Date 2018/06/29

Drawing No. 2

Sheet 2 of 3



Zone	Thickness of Fill (ft)	Friction Angle	k (lb/in^3)
1	25	32 to 35	10 to 37
2	18	32 to 35	10 to 29
3	35	32 to 35	10 to 34
4	28	32 to 35	10 to 35
5	30	32 to 35	10 to 30
6	38	32 to 35	10 to 29

Note: Results based on model for 48" O.D. Caisson

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Project

Hudson Yards West
Rail Yard

COUNTY STATE

Drawing Title

Lateral Load – Lateral
Deflection Plot
(All Zones)

Project No.
170444101

Date
2018/06/29

Scale
No Scale

Drawn By
MP/ZW

Submission Date
2018/06/29

Drawing No.
3

Sheet 3 of 3

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (24 inch Caisson)	0.5	y	0.00	0.11	0.22	0.33	0.44	0.56	0.67	0.78	0.89	1.00	1.11	1.22	1.33	1.45	1.56	1.87	2.18
		p	0	7	13	20	27	33	40	47	53	60	67	73	80	87	93	93	93
	1.5	y	0.00	0.13	0.25	0.38	0.51	0.64	0.76	0.89	1.02	1.15	1.27	1.40	1.53	1.65	1.78	2.14	2.49
		p	0	23	46	69	92	115	137	160	183	206	229	252	275	298	321	321	321
	2.5	y	0.00	0.13	0.27	0.40	0.53	0.67	0.80	0.94	1.07	1.20	1.34	1.47	1.60	1.74	1.87	2.24	2.62
		p	0	40	80	120	160	200	240	281	321	361	401	441	481	521	561	561	561
	3.5	y	0.00	0.13	0.27	0.40	0.54	0.67	0.80	0.94	1.07	1.20	1.34	1.47	1.61	1.74	1.87	2.25	2.62
		p	0	56	112	169	225	281	337	393	450	506	562	618	675	731	787	787	787
	4.5	y	0.00	0.13	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.17	1.30	1.43	1.56	1.69	1.82	2.19	2.55
		p	0	70	141	211	282	352	422	493	563	633	704	774	845	915	985	985	985
	5.5	y	0.00	0.44	0.48	0.51	0.55	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.83	0.86	0.90	1.08	1.26
		p	0	987	1019	1050	1081	1112	1143	1174	1205	1236	1267	1298	1329	1360	1391	1391	1391
	6.5	y	0.00	0.36	0.36	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.40	0.40	0.65	0.90	1.08	1.26
		p	0	948	952	957	961	965	969	974	978	982	986	990	995	1260	1525	1525	1525
	7.5	y	0.00	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	876	892	907	923	938	953	968	982	996	1010	1024	1038	1367	1697	1697	1697
	8.5	y	0.00	0.24	0.26	0.27	0.29	0.30	0.31	0.33	0.34	0.36	0.37	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	843	871	898	925	951	976	1001	1026	1050	1074	1097	1120	1519	1918	1918	1918
	9.5	y	0.00	0.25	0.26	0.27	0.29	0.30	0.32	0.33	0.34	0.36	0.37	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	954	986	1018	1048	1078	1107	1136	1165	1193	1220	1247	1274	1748	2221	2221	2221
	10.5	y	0.00	0.26	0.27	0.29	0.30	0.31	0.32	0.34	0.35	0.36	0.37	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	1124	1157	1188	1219	1250	1280	1310	1339	1368	1397	1425	1453	2005	2557	2557	2557
	11.5	y	0.00	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	1382	1409	1436	1462	1489	1515	1540	1566	1591	1616	1640	1665	2297	2930	2930	2930
	12.5	y	0.00	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.37	0.38	0.39	0.39	0.40	0.65	0.90	1.08	1.26
		p	0	1680	1700	1720	1739	1759	1778	1797	1816	1835	1854	1872	1891	2609	3328	3328	3328
	13.5	y	0.00	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.39	0.39	0.40	0.40	0.65	0.90	1.08	1.26
		p	0	2024	2034	2044	2053	2063	2073	2083	2092	2102	2112	2121	2131	2941	3751	3751	3751
	14.5	y	0.00	0.41	0.45	0.48	0.52	0.56	0.60	0.64	0.67	0.71	0.75	0.79	0.82	0.86	0.90	1.08	1.26
		p	0	2416	2553	2690	2827	2965	3102	3239	3376	3513	3650	3787	3925	4062	4199	4199	4199
	15.5	y	0.00	0.45	0.49	0.52	0.56	0.59	0.62	0.66	0.69	0.73	0.76	0.80	0.83	0.87	0.90	1.08	1.26
		p	0	2861	3005	3144	3283	3422	3561	3700	3838	3977	4116	4255	4394	4533	4672	4672	4672
	16.5	y	0.00	0.50	0.53	0.56	0.59	0.62	0.65	0.68	0.72	0.75	0.78	0.81	0.84	0.87	0.90	1.08	1.26
		p	0	3362	3520	3657	3795	3932	4070	4207	4345	4483	4620	4758	4895	5033	5170	5170	5170
	17.5	y	0.00	0.55	0.58	0.60	0.63	0.66	0.68	0.71	0.74	0.77	0.79	0.82	0.85	0.87	0.90	1.08	1.26
		p	0	3925	4104	4237	4369	4502	4634	4766	4899	5031	5164	5296	5429	5561	5694	5694	5694
	18.5	y	0.00	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88	0.96	1.04	1.12	1.35	1.57
		p	0	446	892	1338	1784	2229	2675	3121	3567	4013	4459	4905	5351	5797	6242	6242	6242
	19.5	y	0.00	0.08	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.83	0.92	1.00	1.08	1.17	1.40	1.63
		p	0	487	974	1461	1947	2434	2921	3408	3895	4382	4869	5355	5842	6329	6816	6816	6816

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Project	Drawing Title	Project No.	Table No.
Hudson Yards West Rail Yard	Fill p-y Table 24-inch Diameter	170444101	1
MANHATTAN NEW YORK		Date: 2018/07/02	
		Scale: No Scale	
		Drawn By / Checked By: ZW / MGP	
		Submission Date: 2018/07/02	Sheet 1 of 11

Zone	Depth		Curve Points															
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (24 inch Caisson)	20.5	y	0.00	0.09	0.17	0.26	0.34	0.43	0.52	0.60	0.69	0.78	0.86	0.95	1.03	1.12	1.21	1.45	1.69
		p	0	530	1059	1589	2119	2648	3178	3707	4237	4767	5296	5826	6356	6885	7415	7415	7415
	21.5	y	0.00	0.09	0.18	0.27	0.36	0.45	0.53	0.62	0.71	0.80	0.89	0.98	1.07	1.16	1.25	1.50	1.74
		p	0	574	1148	1723	2297	2871	3445	4019	4594	5168	5742	6316	6890	7464	8039	8039	8039
	22.5	y	0.00	0.09	0.18	0.28	0.37	0.46	0.55	0.64	0.74	0.83	0.92	1.01	1.10	1.20	1.29	1.54	1.80
		p	0	621	1241	1862	2482	3103	3723	4344	4964	5585	6205	6826	7446	8067	8688	8688	8688
	23.5	y	0.00	0.09	0.19	0.28	0.38	0.47	0.57	0.66	0.76	0.85	0.95	1.04	1.14	1.23	1.33	1.59	1.86
		p	0	669	1337	2006	2675	3343	4012	4681	5349	6018	6687	7356	8024	8693	9362	9362	9362
	24.5	y	0.00	0.10	0.20	0.29	0.39	0.49	0.59	0.68	0.78	0.88	0.98	1.08	1.17	1.27	1.37	1.64	1.92
		p	0	719	1437	2156	2874	3593	4312	5030	5749	6468	7186	7905	8623	9342	10061	10061	10061
	25.5	y	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.81	0.91	1.01	1.11	1.21	1.31	1.41	1.69	1.97
		p	0	770	1541	2311	3081	3852	4622	5392	6163	6933	7704	8474	9244	10015	10785	10785	10785
	26.5	y	0.00	0.10	0.21	0.31	0.41	0.52	0.62	0.73	0.83	0.93	1.04	1.14	1.24	1.35	1.45	1.74	2.03
		p	0	824	1648	2472	3295	4119	4943	5767	6591	7415	8239	9063	9886	10710	11534	11534	11534
	27.5	y	0.00	0.11	0.21	0.32	0.43	0.53	0.64	0.75	0.85	0.96	1.07	1.17	1.28	1.39	1.49	1.79	2.09
		p	0	879	1758	2638	3517	4396	5275	6154	7033	7913	8792	9671	10550	11429	12309	12309	12309
	28.5	y	0.00	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.20	1.31	1.42	1.53	1.84	2.15
		p	0	936	1873	2809	3745	4681	5618	6554	7490	8427	9363	10299	11236	12172	13108	13108	13108
	29.5	y	0.00	0.11	0.22	0.34	0.45	0.56	0.67	0.79	0.90	1.01	1.12	1.24	1.35	1.46	1.57	1.89	2.20
		p	0	995	1990	2986	3981	4976	5971	6966	7962	8957	9952	10947	11942	12937	13933	13933	13933
	30.5	y	0.00	0.12	0.23	0.35	0.46	0.58	0.69	0.81	0.92	1.04	1.15	1.27	1.38	1.50	1.62	1.94	2.26
		p	0	1056	2112	3168	4224	5279	6335	7391	8447	9503	10559	11615	12671	13726	14782	14782	14782
	31.5	y	0.00	0.12	0.24	0.36	0.47	0.59	0.71	0.83	0.95	1.07	1.18	1.30	1.42	1.54	1.66	1.99	2.32
		p	0	1118	2237	3355	4473	5592	6710	7829	8947	10065	11184	12302	13420	14539	15657	15657	15657
	32.5	y	0.00	0.12	0.24	0.36	0.49	0.61	0.73	0.85	0.97	1.09	1.21	1.33	1.46	1.58	1.70	2.04	2.38
		p	0	1183	2365	3548	4731	5913	7096	8279	9461	10644	11826	13009	14192	15374	16557	16557	16557
	33.5	y	0.00	0.12	0.25	0.37	0.50	0.62	0.75	0.87	0.99	1.12	1.24	1.37	1.49	1.62	1.74	2.09	2.44
		p	0	1249	2497	3746	4995	6244	7492	8741	9990	11238	12487	13736	14985	16233	17482	17482	17482
	34.5	y	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75	2.10	2.45
		p	0	1296	2591	3887	5183	6479	7774	9070	10366	11661	12957	14253	15549	16844	18140	18140	18140
	35.5	y	0.00	0.12	0.25	0.37	0.50	0.62	0.75	0.87	1.00	1.12	1.25	1.37	1.50	1.62	1.75	2.10	2.44
		p	0	1328	2656	3985	5313	6641	7969	9297	10625	11954	13282	14610	15938	17266	18594	18594	18594
	36.5	y	0.00	0.12	0.25	0.37	0.50	0.62	0.75	0.87	0.99	1.12	1.24	1.37	1.49	1.62	1.74	2.09	2.44
		p	0	1361	2721	4082	5443	6803	8164	9524	10885	12246	13606	14967	16328	17688	19049	19049	19049
	37.5	y	0.00	0.12	0.25	0.37	0.50	0.62	0.74	0.87	0.99	1.11	1.24	1.36	1.49	1.61	1.73	2.08	2.43
		p	0	1393	2786	4179	5572	6965	8359	9752	11145	12538	13931	15324	16717	18110	19503	19503	19503

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table
24-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
1

Sheet 1 of 11

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (36 inch Caisson)	0.5	y	0.00	0.16	0.32	0.48	0.64	0.81	0.97	1.13	1.29	1.45	1.61	1.77	1.93	2.10	2.26	2.71	3.16
		p	0	10	19	29	39	48	58	68	77	87	97	106	116	126	135	135	135
	1.5	y	0.00	0.18	0.36	0.54	0.72	0.91	1.09	1.27	1.45	1.63	1.81	1.99	2.17	2.35	2.53	3.04	3.55
		p	0	33	65	98	130	163	196	228	261	293	326	358	391	424	456	456	456
	2.5	y	0.00	0.19	0.39	0.58	0.77	0.97	1.16	1.35	1.55	1.74	1.93	2.13	2.32	2.51	2.71	3.25	3.79
		p	0	58	116	174	232	290	348	406	464	522	580	638	696	754	812	812	812
	3.5	y	0.00	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.35	3.91
		p	0	84	168	252	335	419	503	587	671	755	839	922	1006	1090	1174	1174	1174
	4.5	y	0.00	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.36	3.92
		p	0	108	216	324	432	540	649	757	865	973	1081	1189	1297	1405	1513	1513	1513
	5.5	y	0.00	0.75	0.80	0.84	0.89	0.93	0.98	1.03	1.07	1.12	1.17	1.21	1.26	1.30	1.35	1.62	1.89
		p	0	1681	1729	1767	1806	1845	1883	1922	1961	1999	2038	2077	2115	2154	2193	2193	2193
	6.5	y	0.00	0.64	0.70	0.75	0.81	0.86	0.92	0.97	1.02	1.08	1.13	1.19	1.24	1.30	1.35	1.62	1.89
		p	0	1709	1760	1810	1860	1910	1960	2011	2061	2111	2161	2211	2262	2312	2362	2362	2362
	7.5	y	0.00	0.55	0.55	0.56	0.56	0.57	0.57	0.58	0.58	0.59	0.59	0.60	0.60	0.98	1.35	1.62	1.89
		p	0	1684	1689	1693	1698	1703	1707	1712	1717	1721	1726	1730	1735	2108	2481	2481	2481
	8.5	y	0.00	0.48	0.49	0.50	0.51	0.52	0.53	0.54	0.56	0.57	0.58	0.59	0.60	0.98	1.35	1.62	1.89
		p	0	1654	1668	1682	1696	1710	1724	1737	1751	1764	1777	1790	1803	2226	2649	2649	2649
	9.5	y	0.00	0.41	0.43	0.45	0.47	0.48	0.50	0.52	0.53	0.55	0.57	0.58	0.60	0.98	1.35	1.62	1.89
		p	0	1606	1633	1659	1685	1710	1735	1759	1783	1806	1829	1851	1873	2360	2847	2847	2847
	10.5	y	0.00	0.36	0.38	0.41	0.43	0.45	0.47	0.49	0.51	0.54	0.56	0.58	0.60	0.98	1.35	1.62	1.89
		p	0	1554	1596	1637	1677	1716	1754	1791	1827	1862	1896	1930	1963	2533	3103	3103	3103
	11.5	y	0.00	0.30	0.33	0.35	0.38	0.41	0.44	0.46	0.49	0.52	0.55	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	1402	1468	1531	1592	1651	1708	1763	1817	1870	1921	1971	2020	2681	3342	3342	3342
	12.5	y	0.00	0.26	0.29	0.32	0.35	0.39	0.42	0.45	0.48	0.51	0.54	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	1341	1427	1510	1589	1665	1739	1811	1880	1947	2013	2077	2140	2897	3654	3654	3654
	13.5	y	0.00	0.27	0.30	0.33	0.36	0.39	0.42	0.45	0.48	0.51	0.54	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	1468	1563	1654	1741	1826	1908	1987	2065	2140	2213	2285	2355	3212	4070	4070	4070
	14.5	y	0.00	0.27	0.30	0.33	0.36	0.39	0.42	0.45	0.48	0.51	0.54	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	1593	1697	1797	1894	1987	2078	2166	2251	2335	2417	2496	2575	3539	4503	4503	4503
	15.5	y	0.00	0.28	0.31	0.34	0.37	0.40	0.43	0.46	0.48	0.51	0.54	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	1790	1898	2003	2105	2203	2299	2392	2482	2571	2658	2743	2826	3900	4974	4974	4974
	16.5	y	0.00	0.31	0.34	0.36	0.39	0.42	0.44	0.47	0.49	0.52	0.55	0.57	0.60	0.98	1.35	1.62	1.89
		p	0	2086	2192	2295	2396	2493	2588	2681	2772	2861	2948	3034	3118	4302	5487	5487	5487
	17.5	y	0.00	0.34	0.36	0.39	0.41	0.43	0.46	0.48	0.50	0.53	0.55	0.58	0.60	0.98	1.35	1.62	1.89
		p	0	2417	2519	2618	2715	2810	2903	2993	3082	3170	3256	3340	3423	4724	6025	6025	6025
	18.5	y	0.00	0.81	0.85	0.89	0.93	0.98	1.02	1.06	1.10	1.14	1.18	1.23	1.27	1.31	1.35	1.62	1.89
		p	0	4487	4692	4850	5008	5166	5324	5482	5640	5798	5956	6114	6272	6430	6588	6588	6588
	19.5	y	0.00	0.88	0.92	0.95	0.99	1.02	1.06	1.10	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.62	1.89
		p	0	5144	5356	5530	5680	5829	5979	6129	6278	6428	6578	6727	6877	7026	7176	7176	7176

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table
36-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
2

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (36 inch Caisson)	20.5	y	0.00	0.95	0.98	1.01	1.05	1.08	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.62	1.89
		p	0	5867	6054	6242	6423	6560	6696	6833	6969	7106	7243	7379	7516	7653	7789	7789	7789
	21.5	y	0.00	1.03	1.06	1.08	1.11	1.13	1.15	1.18	1.20	1.23	1.25	1.28	1.30	1.33	1.35	1.62	1.89
		p	0	6662	6819	6977	7134	7291	7449	7599	7717	7836	7954	8072	8191	8309	8427	8427	8427
	22.5	y	0.00	1.12	1.13	1.15	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.30	1.31	1.33	1.35	1.62	1.89
		p	0	7532	7654	7775	7897	8018	8140	8262	8383	8505	8626	8748	8869	8991	9091	9091	9091
	23.5	y	0.00	1.20	1.21	1.23	1.24	1.25	1.26	1.27	1.28	1.29	1.30	1.32	1.33	1.34	1.35	1.62	1.89
		p	0	8482	8562	8642	8721	8801	8880	8960	9040	9119	9199	9279	9358	9438	9518	9779	9779
	24.5	y	0.00	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.32	1.33	1.33	1.34	1.34	1.35	1.35	1.62	1.89
		p	0	9516	9548	9579	9610	9641	9673	9704	9735	9766	9798	9829	9860	9891	9923	10493	10493
	25.5	y	0.00	0.10	0.21	0.31	0.42	0.52	0.63	0.73	0.84	0.94	1.05	1.15	1.26	1.36	1.47	1.76	2.06
		p	0	802	1604	2407	3209	4011	4813	5616	6418	7220	8022	8825	9627	10429	11231	11231	11231
	26.5	y	0.00	0.11	0.22	0.32	0.43	0.54	0.65	0.75	0.86	0.97	1.08	1.19	1.29	1.40	1.51	1.81	2.11
		p	0	857	1714	2570	3427	4284	5141	5998	6854	7711	8568	9425	10282	11138	11995	11995	11995
	27.5	y	0.00	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.89	1.00	1.11	1.22	1.33	1.44	1.55	1.86	2.17
		p	0	913	1826	2739	3653	4566	5479	6392	7305	8218	9131	10045	10958	11871	12784	12784	12784
	28.5	y	0.00	0.11	0.23	0.34	0.45	0.57	0.68	0.80	0.91	1.02	1.14	1.25	1.36	1.48	1.59	1.91	2.23
		p	0	971	1943	2914	3885	4856	5828	6799	7770	8742	9713	10684	11655	12627	13598	13598	13598
	29.5	y	0.00	0.12	0.23	0.35	0.47	0.58	0.70	0.82	0.93	1.05	1.17	1.28	1.40	1.51	1.63	1.96	2.28
		p	0	1031	2062	3094	4125	5156	6187	7218	8250	9281	10312	11343	12375	13406	14437	14437	14437
	30.5	y	0.00	0.12	0.24	0.36	0.48	0.60	0.72	0.84	0.96	1.08	1.19	1.31	1.43	1.55	1.67	2.01	2.34
		p	0	1093	2186	3279	4372	5465	6558	7651	8743	9836	10929	12022	13115	14208	15301	15301	15301
	31.5	y	0.00	0.12	0.24	0.37	0.49	0.61	0.73	0.86	0.98	1.10	1.22	1.35	1.47	1.59	1.71	2.06	2.40
		p	0	1156	2313	3469	4626	5782	6939	8095	9252	10408	11565	12721	13877	15034	16190	16190	16190
	32.5	y	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75	2.11	2.46
		p	0	1222	2444	3665	4887	6109	7331	8552	9774	10996	12218	13439	14661	15883	17105	17105	17105
	33.5	y	0.00	0.13	0.26	0.38	0.51	0.64	0.77	0.90	1.03	1.15	1.28	1.41	1.54	1.67	1.80	2.15	2.51
		p	0	1289	2578	3867	5155	6444	7733	9022	10311	11600	12889	14177	15466	16755	18044	18044	18044
	34.5	y	0.00	0.13	0.26	0.39	0.52	0.66	0.79	0.92	1.05	1.18	1.31	1.44	1.57	1.71	1.84	2.20	2.57
		p	0	1358	2716	4073	5431	6789	8147	9504	10862	12220	13578	14935	16293	17651	19009	19009	19009
	35.5	y	0.00	0.13	0.27	0.40	0.54	0.67	0.80	0.94	1.07	1.21	1.34	1.48	1.61	1.74	1.88	2.25	2.63
		p	0	1428	2857	4285	5714	7142	8571	9999	11427	12856	14284	15713	17141	18570	19998	19998	19998
	36.5	y	0.00	0.14	0.27	0.41	0.55	0.69	0.82	0.96	1.10	1.23	1.37	1.51	1.64	1.78	1.92	2.30	2.69
		p	0	1501	3002	4503	6004	7505	9005	10506	12007	13508	15009	16510	18011	19512	21013	21013	21013
	37.5	y	0.00	0.14	0.28	0.42	0.56	0.70	0.84	0.98	1.12	1.26	1.40	1.54	1.68	1.82	1.96	2.35	2.74
		p	0	1575	3150	4726	6301	7876	9451	11026	12601	14177	15752	17327	18902	20477	22053	22053	22053

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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2018/07/02
Scale
No Scale
Drawn By / Checked By
ZW / MGP
Submission Date
2018/07/02

Table No.
2

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (48 inch Caisson)	0.5	y	0.00	0.21	0.42	0.63	0.84	1.06	1.27	1.48	1.69	1.90	2.11	2.32	2.53	2.74	2.96	3.55	4.14
		p	0	13	25	38	51	63	76	89	101	114	127	139	152	165	177	177	177
	1.5	y	0.00	0.23	0.46	0.70	0.93	1.16	1.39	1.63	1.86	2.09	2.32	2.56	2.79	3.02	3.25	3.91	4.56
		p	0	42	84	126	167	209	251	293	335	377	418	460	502	544	586	586	586
	2.5	y	0.00	0.25	0.50	0.75	0.99	1.24	1.49	1.74	1.99	2.24	2.49	2.73	2.98	3.23	3.48	4.18	4.87
		p	0	75	149	224	298	373	447	522	597	671	746	820	895	970	1044	1044	1044
	3.5	y	0.00	0.26	0.52	0.78	1.04	1.30	1.56	1.81	2.07	2.33	2.59	2.85	3.11	3.37	3.63	4.36	5.08
		p	0	109	218	327	436	544	653	762	871	980	1089	1198	1307	1415	1524	1524	1524
	4.5	y	0.00	0.27	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.66	2.92	3.19	3.45	3.72	4.46	5.20
		p	0	143	287	430	574	717	860	1004	1147	1290	1434	1577	1721	1864	2007	2007	2007
	5.5	y	0.00	1.00	1.07	1.13	1.19	1.25	1.31	1.37	1.43	1.49	1.56	1.62	1.68	1.74	1.80	2.16	2.52
		p	0	2255	2317	2366	2415	2464	2513	2562	2611	2660	2709	2758	2808	2857	2906	2906	2906
	6.5	y	0.00	0.90	0.96	1.03	1.10	1.17	1.24	1.31	1.38	1.45	1.52	1.59	1.66	1.73	1.80	2.16	2.52
		p	0	2375	2440	2503	2565	2627	2690	2752	2814	2877	2939	3001	3064	3126	3189	3189	3189
	7.5	y	0.00	0.81	0.88	0.96	1.04	1.11	1.19	1.27	1.34	1.42	1.49	1.57	1.65	1.72	1.80	2.16	2.52
		p	0	2471	2546	2622	2698	2774	2849	2925	3001	3077	3152	3228	3304	3380	3455	3455	3455
	8.5	y	0.00	0.73	0.74	0.74	0.75	0.75	0.76	0.77	0.77	0.78	0.79	0.79	0.80	1.30	1.80	2.16	2.52
		p	0	2527	2535	2542	2550	2557	2564	2571	2578	2586	2593	2600	2607	3146	3686	3686	3686
	9.5	y	0.00	0.66	0.67	0.68	0.70	0.71	0.72	0.73	0.75	0.76	0.77	0.79	0.80	1.30	1.80	2.16	2.52
		p	0	2546	2563	2580	2597	2613	2629	2645	2661	2676	2692	2707	2722	3300	3877	3877	3877
	10.5	y	0.00	0.59	0.61	0.63	0.65	0.67	0.69	0.71	0.72	0.74	0.76	0.78	0.80	1.30	1.80	2.16	2.52
		p	0	2532	2561	2589	2616	2643	2670	2696	2721	2746	2771	2795	2819	3445	4071	4071	4071
	11.5	y	0.00	0.53	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73	0.75	0.78	0.80	1.30	1.80	2.16	2.52
		p	0	2481	2524	2566	2607	2647	2686	2725	2762	2798	2834	2869	2904	3593	4283	4283	4283
	12.5	y	0.00	0.48	0.51	0.53	0.56	0.59	0.62	0.65	0.68	0.71	0.74	0.77	0.80	1.30	1.80	2.16	2.52
		p	0	2428	2488	2547	2603	2658	2712	2764	2814	2863	2911	2958	3004	3774	4544	4544	4544
	13.5	y	0.00	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80	1.30	1.80	2.16	2.52
		p	0	2389	2469	2546	2620	2691	2761	2828	2893	2956	3018	3079	3137	4010	4883	4883	4883
	14.5	y	0.00	0.38	0.42	0.46	0.50	0.53	0.57	0.61	0.65	0.69	0.72	0.76	0.80	1.30	1.80	2.16	2.52
		p	0	2268	2375	2476	2573	2666	2756	2843	2928	3009	3089	3166	3242	4225	5208	5208	5208
	15.5	y	0.00	0.32	0.37	0.41	0.45	0.50	0.54	0.58	0.63	0.67	0.71	0.76	0.80	1.30	1.80	2.16	2.52
		p	0	2047	2188	2322	2449	2571	2688	2800	2909	3015	3117	3216	3313	4414	5516	5516	5516
	16.5	y	0.00	0.29	0.34	0.38	0.43	0.48	0.52	0.57	0.62	0.66	0.71	0.75	0.80	1.30	1.80	2.16	2.52
		p	0	1964	2134	2294	2446	2591	2730	2863	2992	3117	3238	3356	3471	4695	5919	5919	5919
	17.5	y	0.00	0.30	0.34	0.39	0.43	0.48	0.52	0.57	0.62	0.66	0.71	0.75	0.80	1.30	1.80	2.16	2.52
		p	0	2111	2294	2467	2631	2788	2939	3084	3225	3361	3493	3621	3747	5096	6446	6446	6446
	18.5	y	0.00	0.63	0.65	0.66	0.68	0.69	0.71	0.72	0.74	0.75	0.77	0.78	0.80	1.30	1.80	2.16	2.52
		p	0	3504	3554	3603	3652	3700	3748	3796	3843	3890	3936	3982	4028	5510	6992	6992	6992
	19.5	y	0.00	0.65	0.67	0.68	0.69	0.71	0.72	0.73	0.75	0.76	0.77	0.79	0.80	1.30	1.80	2.16	2.52
		p	0	3815	3862	3909	3955	4001	4047	4092	4137	4182	4226	4270	4314	5936	7557	7557	7557

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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

Project

**Hudson Yards West
Rail Yard**

MANHATTAN NEW YORK

Drawing Title

**Fill p-y Table
48-inch Diameter**

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
3

Sheet 3 of 11

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (48 inch Caisson)	20.5	y	0.00	0.69	0.70	0.71	0.72	0.73	0.74	0.75	0.76	0.77	0.78	0.79	0.80	1.30	1.80	2.16	2.52
		p	0	4233	4271	4308	4346	4383	4420	4457	4494	4530	4566	4602	4638	6401	8163	8163	8163
	21.5	y	0.00	0.74	0.75	0.75	0.76	0.76	0.77	0.77	0.78	0.78	0.79	0.79	0.80	1.30	1.80	2.16	2.52
		p	0	4784	4805	4825	4846	4867	4887	4908	4928	4948	4969	4989	5009	6913	8816	8816	8816
	22.5	y	0.00	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	1.30	1.80	2.16	2.52
		p	0	5385	5386	5387	5388	5389	5389	5390	5391	5392	5393	5393	5394	7444	9494	9494	9494
	23.5	y	0.00	0.86	0.93	1.00	1.07	1.15	1.22	1.29	1.36	1.44	1.51	1.58	1.65	1.73	1.80	2.16	2.52
		p	0	6040	6363	6683	7002	7322	7641	7961	8280	8599	8919	9238	9558	9877	10197	10197	10197
	24.5	y	0.00	0.92	0.99	1.05	1.12	1.19	1.26	1.33	1.39	1.46	1.53	1.60	1.66	1.73	1.80	2.16	2.52
		p	0	6751	7086	7406	7726	8046	8366	8686	9006	9326	9645	9965	10285	10605	10925	10925	10925
	25.5	y	0.00	0.98	1.05	1.11	1.17	1.23	1.30	1.36	1.42	1.49	1.55	1.61	1.67	1.74	1.80	2.16	2.52
		p	0	7521	7876	8193	8510	8826	9143	9460	9777	10094	10411	10727	11044	11361	11678	11678	11678
	26.5	y	0.00	1.05	1.11	1.17	1.22	1.28	1.34	1.40	1.45	1.51	1.57	1.63	1.68	1.74	1.80	2.16	2.52
		p	0	8353	8736	9046	9356	9666	9976	10286	10596	10906	11216	11526	11836	12146	12456	12456	12456
	27.5	y	0.00	1.12	1.17	1.23	1.28	1.33	1.38	1.43	1.49	1.54	1.59	1.64	1.70	1.75	1.80	2.16	2.52
		p	0	9250	9672	9971	10270	10569	10868	11167	11466	11765	12064	12363	12662	12960	13259	13259	13259
	28.5	y	0.00	1.19	1.24	1.29	1.33	1.38	1.43	1.47	1.52	1.57	1.61	1.66	1.71	1.75	1.80	2.16	2.52
		p	0	10215	10613	10972	11255	11539	11822	12105	12388	12672	12955	13238	13521	13805	14088	14088	14088
	29.5	y	0.00	1.27	1.31	1.35	1.39	1.43	1.47	1.52	1.56	1.60	1.64	1.68	1.72	1.76	1.80	2.16	2.52
		p	0	11250	11610	11970	12317	12579	12842	13104	13367	13629	13891	14154	14416	14679	14941	14941	14941
	30.5	y	0.00	1.35	1.39	1.42	1.45	1.49	1.52	1.56	1.59	1.63	1.66	1.70	1.73	1.77	1.80	2.16	2.52
		p	0	12360	12676	12992	13308	13624	13931	14167	14403	14640	14876	15112	15348	15584	15820	15820	15820
	31.5	y	0.00	1.43	1.46	1.49	1.52	1.55	1.57	1.60	1.63	1.66	1.69	1.72	1.74	1.77	1.80	2.16	2.52
		p	0	13546	13813	14079	14346	14612	14878	15145	15411	15678	15909	16113	16316	16520	16723	16723	16723
	32.5	y	0.00	1.52	1.54	1.56	1.58	1.61	1.63	1.65	1.67	1.69	1.71	1.74	1.76	1.78	1.80	2.16	2.52
		p	0	14813	15024	15234	15445	15655	15866	16076	16287	16497	16708	16918	17129	17339	17550	17652	17652
	33.5	y	0.00	1.61	1.62	1.64	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.76	1.77	1.79	1.80	2.16	2.52
		p	0	16164	16312	16460	16608	16756	16905	17053	17201	17349	17497	17645	17794	17942	18090	18606	18606
	34.5	y	0.00	1.70	1.71	1.72	1.72	1.73	1.74	1.75	1.75	1.76	1.77	1.78	1.78	1.79	1.80	2.16	2.52
		p	0	17601	17680	17759	17838	17918	17997	18076	18155	18234	18313	18393	18472	18551	18630	19585	19585
	35.5	y	0.00	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	2.16	2.52
		p	0	19128	19131	19135	19138	19141	19144	19148	19151	19154	19157	19160	19164	19167	19170	20589	20589
	36.5	y	0.00	0.14	0.28	0.42	0.56	0.71	0.85	0.99	1.13	1.27	1.41	1.55	1.69	1.83	1.97	2.37	2.76
		p	0	1544	3088	4632	6177	7721	9265	10809	12353	13897	15442	16986	18530	20074	21618	21618	21618
	37.5	y	0.00	0.14	0.29	0.43	0.58	0.72	0.86	1.01	1.15	1.30	1.44	1.58	1.73	1.87	2.02	2.42	2.82
		p	0	1619	3239	4858	6478	8097	9717	11336	12956	14575	16195	17814	19434	21053	22672	22672	22672

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Collectively known as Langan

Project

Hudson Yards West Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table 48-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
3

Sheet 3 of 11

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (72 inch Caisson)	0.5	y	0.00	0.31	0.62	0.93	1.24	1.55	1.86	2.17	2.48	2.80	3.11	3.42	3.73	4.04	4.35	5.22	6.09
		p	0	19	37	56	75	93	112	130	149	168	186	205	224	242	261	261	261
	1.5	y	0.00	0.33	0.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.34	3.67	4.00	4.34	4.67	5.60	6.54
		p	0	60	120	180	240	300	360	420	480	540	600	660	720	781	841	841	841
	2.5	y	0.00	0.35	0.71	1.06	1.41	1.77	2.12	2.47	2.83	3.18	3.53	3.89	4.24	4.59	4.95	5.94	6.93
		p	0	106	212	318	424	530	636	742	848	954	1060	1166	1272	1378	1484	1484	1484
	3.5	y	0.00	0.37	0.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.69	4.06	4.43	4.80	5.17	6.21	7.24
		p	0	155	310	466	621	776	931	1086	1242	1397	1552	1707	1862	2017	2173	2173	2173
	4.5	y	0.00	0.38	0.76	1.15	1.53	1.91	2.29	2.67	3.05	3.44	3.82	4.20	4.58	4.96	5.35	6.41	7.48
		p	0	206	412	619	825	1031	1237	1443	1649	1856	2062	2268	2474	2680	2887	2887	2887
	5.5	y	0.00	1.44	1.54	1.64	1.73	1.83	1.93	2.02	2.12	2.22	2.31	2.41	2.51	2.60	2.70	3.24	3.78
		p	0	3238	3322	3395	3467	3540	3613	3685	3758	3831	3903	3976	4048	4121	4194	4194	4194
	6.5	y	0.00	1.32	1.43	1.53	1.64	1.75	1.85	1.96	2.06	2.17	2.28	2.38	2.49	2.59	2.70	3.24	3.78
		p	0	3505	3598	3687	3777	3867	3956	4046	4136	4225	4315	4405	4494	4584	4673	4673	4673
	7.5	y	0.00	1.23	1.34	1.45	1.57	1.68	1.79	1.91	2.02	2.13	2.25	2.36	2.47	2.59	2.70	3.24	3.78
		p	0	3752	3859	3965	4071	4177	4284	4390	4496	4603	4709	4815	4921	5028	5134	5134	5134
	8.5	y	0.00	1.14	1.15	1.15	1.16	1.16	1.17	1.17	1.18	1.18	1.19	1.19	1.20	1.95	2.70	3.24	3.78
		p	0	3959	3965	3970	3976	3981	3987	3993	3998	4004	4009	4015	4020	4789	5559	5559	5559
	9.5	y	0.00	1.07	1.08	1.10	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.95	2.70	3.24	3.78
		p	0	4155	4169	4183	4197	4210	4224	4237	4251	4264	4277	4291	4304	5141	5978	5978	5978
	10.5	y	0.00	1.01	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	4344	4367	4389	4412	4434	4456	4477	4499	4520	4541	4562	4582	5491	6399	6399	6399
	11.5	y	0.00	0.95	0.98	1.00	1.02	1.04	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	4480	4514	4547	4579	4612	4643	4674	4705	4736	4766	4795	4824	5801	6778	6778	6778
	12.5	y	0.00	0.90	0.93	0.95	0.98	1.01	1.04	1.06	1.09	1.12	1.15	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	4592	4637	4682	4725	4768	4810	4852	4892	4932	4972	5010	5048	6089	7131	7131	7131
	13.5	y	0.00	0.85	0.88	0.91	0.95	0.98	1.01	1.04	1.07	1.10	1.14	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	4683	4741	4798	4853	4907	4960	5012	5063	5112	5161	5209	5256	6357	7458	7458	7458
	14.5	y	0.00	0.80	0.83	0.87	0.91	0.94	0.98	1.02	1.05	1.09	1.13	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	4714	4787	4858	4927	4994	5059	5123	5185	5246	5305	5363	5420	6575	7730	7730	7730
	15.5	y	0.00	0.75	0.79	0.83	0.87	0.91	0.95	0.99	1.04	1.08	1.12	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	4724	4814	4901	4985	5066	5146	5223	5298	5371	5442	5512	5580	6805	8030	8030	8030
	16.5	y	0.00	0.70	0.75	0.79	0.84	0.88	0.93	0.97	1.02	1.06	1.11	1.15	1.20	1.95	2.70	3.24	3.78
		p	0	4711	4821	4927	5029	5128	5223	5316	5406	5493	5578	5661	5742	7058	8375	8375	8375
	17.5	y	0.00	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.95	2.70	3.24	3.78
		p	0	4624	4758	4887	5011	5130	5245	5355	5463	5567	5668	5766	5861	7270	8679	8679	8679
	18.5	y	0.00	1.01	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	5622	5660	5698	5735	5772	5809	5845	5881	5916	5952	5987	6021	7545	9068	9068	9068
	19.5	y	0.00	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	5713	5764	5813	5863	5912	5960	6007	6055	6101	6147	6193	6239	7904	9569	9569	9569

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Langan CT, Inc.
Langan International LLC
Collectively known as Langan

Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table
72-inch Diameter

Project No. 170444101
Date 2018/07/02
Scale No Scale
Drawn By / Checked By ZW / MGP
Submission Date 2018/07/02

Table No. **4**

Sheet 4 of 11

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (72 inch Caisson)	20.5	y	0.00	0.93	0.96	0.98	1.01	1.03	1.05	1.08	1.10	1.13	1.15	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	5742	5809	5875	5940	6004	6067	6129	6191	6252	6312	6372	6431	8245	10060	10060	10060
	21.5	y	0.00	0.88	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	5696	5784	5871	5956	6040	6123	6204	6285	6364	6442	6519	6596	8567	10538	10538	10538
	22.5	y	0.00	0.82	0.86	0.89	0.93	0.96	0.99	1.03	1.06	1.10	1.13	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	5559	5676	5789	5901	6011	6119	6225	6329	6432	6533	6632	6730	8866	11003	11003	11003
	23.5	y	0.00	0.75	0.79	0.83	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	5313	5466	5615	5761	5904	6044	6181	6316	6448	6579	6706	6832	9141	11450	11450	11450
	24.5	y	0.00	0.72	0.77	0.81	0.85	0.90	0.94	0.98	1.03	1.07	1.11	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	5315	5492	5665	5833	5998	6160	6318	6473	6625	6775	6922	7067	9551	12035	12035	12035
	25.5	y	0.00	0.74	0.78	0.82	0.87	0.91	0.95	0.99	1.03	1.07	1.12	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	5671	5851	6027	6199	6367	6532	6694	6853	7010	7164	7315	7464	10125	12785	12785	12785
	26.5	y	0.00	0.76	0.80	0.84	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	6039	6221	6399	6574	6745	6914	7079	7242	7402	7559	7714	7867	10711	13555	13555	13555
	27.5	y	0.00	0.78	0.82	0.85	0.89	0.93	0.97	1.01	1.05	1.08	1.12	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	6417	6601	6782	6959	7133	7303	7472	7637	7800	7961	8120	8276	11310	14345	14345	14345
	28.5	y	0.00	0.80	0.83	0.87	0.91	0.94	0.98	1.02	1.05	1.09	1.13	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	6807	6992	7174	7353	7528	7702	7872	8040	8206	8369	8530	8689	11921	15153	15153	15153
	29.5	y	0.00	0.81	0.85	0.88	0.92	0.95	0.99	1.02	1.06	1.09	1.13	1.16	1.20	1.95	2.70	3.24	3.78
		p	0	7208	7393	7576	7756	7933	8108	8280	8450	8617	8783	8946	9108	12544	15980	15980	15980
	30.5	y	0.00	0.85	0.88	0.91	0.94	0.98	1.01	1.04	1.07	1.10	1.14	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	7749	7926	8101	8274	8444	8612	8777	8941	9103	9263	9421	9578	13218	16857	16857	16857
	31.5	y	0.00	0.89	0.92	0.95	0.98	1.01	1.03	1.06	1.09	1.12	1.14	1.17	1.20	1.95	2.70	3.24	3.78
		p	0	8456	8615	8771	8926	9079	9231	9380	9529	9676	9821	9965	10108	13949	17790	17790	17790
	32.5	y	0.00	0.94	0.97	0.99	1.01	1.04	1.06	1.08	1.11	1.13	1.15	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	9209	9346	9482	9616	9750	9882	10013	10143	10272	10399	10526	10652	14700	18747	18747	18747
	33.5	y	0.00	1.00	1.01	1.03	1.05	1.07	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.95	2.70	3.24	3.78
		p	0	10009	10122	10234	10346	10456	10566	10675	10784	10891	10998	11105	11210	15470	19730	19730	19730
	34.5	y	0.00	1.05	1.06	1.08	1.09	1.10	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.95	2.70	3.24	3.78
		p	0	10859	10945	11031	11116	11201	11285	11369	11453	11536	11619	11701	11783	16261	20738	20738	20738
	35.5	y	0.00	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.17	1.18	1.19	1.20	1.95	2.70	3.24	3.78
		p	0	11760	11816	11872	11928	11984	12039	12095	12150	12205	12260	12315	12370	17070	21771	21771	21771
	36.5	y	0.00	1.16	1.16	1.17	1.17	1.18	1.18	1.18	1.19	1.19	1.19	1.20	1.20	1.95	2.70	3.24	3.78
		p	0	12713	12737	12760	12784	12807	12831	12854	12878	12901	12924	12948	12971	17900	22829	22829	22829
	37.5	y	0.00	1.22	1.33	1.45	1.56	1.68	1.79	1.90	2.02	2.13	2.24	2.36	2.47	2.59	2.70	3.24	3.78
		p	0	13722	14506	15290	16074	16857	17641	18425	19209	19993	20777	21561	22344	23128	23912	23912	23912

[a]y = Lateral pile deflection in inches

[b]p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table 72-inch Diameter

Project No. 170444101

Date 2018/07/02

Scale No Scale

Drawn By / Checked By ZW / MGP

Submission Date 2018/07/02

Table No. 4

Sheet 4 of 11

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (96 inch Caisson)	0.5	y	0.00	0.41	0.82	1.23	1.64	2.05	2.46	2.87	3.28	3.69	4.10	4.51	4.92	5.33	5.74	6.89	8.04
		p	0	25	49	74	98	123	148	172	197	221	246	271	295	320	344	344	344
	1.5	y	0.00	0.43	0.87	1.30	1.73	2.17	2.60	3.04	3.47	3.90	4.34	4.77	5.20	5.64	6.07	7.29	8.50
		p	0	78	156	234	312	390	468	547	625	703	781	859	937	1015	1093	1093	1093
	2.5	y	0.00	0.46	0.91	1.37	1.82	2.28	2.73	3.19	3.64	4.10	4.55	5.01	5.46	5.92	6.37	7.65	8.92
		p	0	137	273	410	546	683	819	956	1092	1229	1365	1502	1638	1775	1912	1912	1912
	3.5	y	0.00	0.47	0.95	1.42	1.90	2.37	2.84	3.32	3.79	4.27	4.74	5.22	5.69	6.16	6.64	7.97	9.29
		p	0	199	398	597	797	996	1195	1394	1593	1792	1991	2191	2390	2589	2788	2788	2788
	4.5	y	0.00	0.49	0.98	1.47	1.96	2.45	2.94	3.43	3.92	4.41	4.90	5.39	5.88	6.37	6.86	8.24	9.61
		p	0	265	530	794	1059	1324	1589	1853	2118	2383	2648	2912	3177	3442	3707	3707	3707
	5.5	y	0.00	1.82	1.96	2.10	2.23	2.37	2.51	2.64	2.78	2.92	3.05	3.19	3.33	3.46	3.60	4.32	5.04
		p	0	4092	4196	4293	4390	4487	4584	4681	4778	4875	4972	5069	5166	5263	5360	5360	5360
	6.5	y	0.00	1.68	1.83	1.98	2.13	2.27	2.42	2.57	2.72	2.86	3.01	3.16	3.31	3.45	3.60	4.32	5.04
		p	0	4467	4586	4704	4822	4940	5058	5176	5294	5412	5530	5648	5766	5884	6002	6002	6002
	7.5	y	0.00	1.58	1.58	1.58	1.58	1.59	1.59	1.59	1.59	1.59	1.60	1.60	1.60	2.60	3.60	4.32	5.04
		p	0	4831	4833	4835	4837	4838	4840	4842	4844	4845	4847	4849	4850	5743	6635	6635	6635
	8.5	y	0.00	1.50	1.51	1.51	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.59	1.60	2.60	3.60	4.32	5.04
		p	0	5188	5198	5207	5217	5227	5236	5246	5255	5265	5274	5283	5293	6277	7260	7260	7260
	9.5	y	0.00	1.43	1.44	1.46	1.47	1.49	1.51	1.52	1.54	1.55	1.57	1.58	1.60	2.60	3.60	4.32	5.04
		p	0	5532	5550	5568	5586	5604	5621	5639	5656	5674	5691	5708	5725	6799	7873	7873	7873
	10.5	y	0.00	1.36	1.39	1.41	1.43	1.45	1.47	1.49	1.51	1.54	1.56	1.58	1.60	2.60	3.60	4.32	5.04
		p	0	5843	5871	5898	5926	5952	5979	6005	6031	6057	6083	6108	6133	7296	8459	8459	8459
	11.5	y	0.00	1.30	1.33	1.36	1.38	1.41	1.44	1.47	1.49	1.52	1.55	1.57	1.60	2.60	3.60	4.32	5.04
		p	0	6115	6153	6191	6229	6266	6302	6339	6374	6409	6444	6478	6512	7761	9010	9010	9010
	12.5	y	0.00	1.25	1.28	1.32	1.35	1.38	1.41	1.44	1.47	1.51	1.54	1.57	1.60	2.60	3.60	4.32	5.04
		p	0	6385	6435	6483	6531	6579	6625	6671	6716	6761	6805	6848	6890	8228	9566	9566	9566
	13.5	y	0.00	1.21	1.24	1.28	1.32	1.35	1.39	1.42	1.46	1.49	1.53	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	6659	6720	6780	6838	6896	6953	7008	7063	7117	7170	7222	7273	8705	10137	10137	10137
	14.5	y	0.00	1.16	1.20	1.24	1.28	1.32	1.36	1.40	1.44	1.48	1.52	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	6888	6962	7034	7105	7175	7243	7309	7375	7439	7502	7564	7625	9148	10671	10671	10671
	15.5	y	0.00	1.12	1.16	1.21	1.25	1.29	1.34	1.38	1.42	1.47	1.51	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	7066	7155	7242	7326	7409	7490	7569	7646	7722	7796	7869	7940	9552	11164	11164	11164
	16.5	y	0.00	1.07	1.12	1.17	1.22	1.27	1.31	1.36	1.41	1.46	1.50	1.55	1.60	2.60	3.60	4.32	5.04
		p	0	7230	7335	7436	7535	7631	7725	7817	7906	7993	8079	8163	8245	9942	11639	11639	11639
	17.5	y	0.00	1.03	1.09	1.14	1.19	1.24	1.29	1.34	1.39	1.45	1.50	1.55	1.60	2.60	3.60	4.32	5.04
		p	0	7387	7507	7624	7737	7847	7954	8058	8159	8258	8355	8449	8542	10320	12098	12098	12098
	18.5	y	0.00	1.58	1.58	1.58	1.58	1.59	1.59	1.59	1.59	1.59	1.60	1.60	1.60	2.60	3.60	4.32	5.04
		p	0	8758	8762	8766	8770	8773	8777	8781	8784	8788	8792	8796	8799	10654	12508	12508	12508
	19.5	y	0.00	1.51	1.52	1.53	1.54	1.54	1.55	1.56	1.57	1.58	1.58	1.59	1.60	2.60	3.60	4.32	5.04
		p	0	8839	8855	8871	8887	8903	8919	8935	8951	8966	8982	8998	9014	10939	12864	12864	12864

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table
96-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
5

Zone	Depth		Curve Points																
	ft		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FILL (96 inch Caisson)	20.5	y	0.00	1.45	1.46	1.48	1.49	1.51	1.52	1.53	1.55	1.56	1.57	1.59	1.60	2.60	3.60	4.32	5.04
		p	0	8926	8955	8984	9012	9041	9069	9097	9125	9153	9180	9208	9235	11252	13270	13270	13270
	21.5	y	0.00	1.40	1.42	1.44	1.45	1.47	1.49	1.51	1.53	1.55	1.56	1.58	1.60	2.60	3.60	4.32	5.04
		p	0	9025	9068	9109	9151	9192	9233	9274	9314	9354	9394	9433	9472	11609	13745	13745	13745
	22.5	y	0.00	1.34	1.37	1.39	1.41	1.44	1.46	1.48	1.51	1.53	1.55	1.58	1.60	2.60	3.60	4.32	5.04
		p	0	9056	9114	9173	9230	9287	9344	9400	9455	9510	9564	9618	9671	11927	14183	14183	14183
	23.5	y	0.00	1.28	1.31	1.34	1.37	1.39	1.42	1.45	1.48	1.51	1.54	1.57	1.60	2.60	3.60	4.32	5.04
		p	0	9009	9088	9166	9244	9320	9395	9469	9543	9615	9687	9758	9828	12205	14581	14581	14581
	24.5	y	0.00	1.23	1.26	1.30	1.33	1.36	1.40	1.43	1.47	1.50	1.53	1.57	1.60	2.60	3.60	4.32	5.04
		p	0	9038	9136	9233	9329	9423	9516	9608	9698	9787	9875	9961	10047	12572	15098	15098	15098
	25.5	y	0.00	1.20	1.23	1.27	1.31	1.34	1.38	1.42	1.45	1.49	1.53	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	9168	9284	9398	9510	9620	9728	9835	9940	10044	10146	10247	10347	13053	15759	15759	15759
	26.5	y	0.00	1.16	1.20	1.24	1.28	1.32	1.36	1.40	1.44	1.48	1.52	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	9243	9379	9513	9645	9774	9901	10026	10149	10271	10390	10508	10623	13518	16412	16412	16412
	27.5	y	0.00	1.12	1.17	1.21	1.25	1.30	1.34	1.38	1.43	1.47	1.51	1.56	1.60	2.60	3.60	4.32	5.04
		p	0	9254	9415	9573	9728	9880	10030	10177	10321	10463	10603	10740	10875	13966	17056	17056	17056
	28.5	y	0.00	1.07	1.12	1.17	1.22	1.27	1.31	1.36	1.41	1.46	1.50	1.55	1.60	2.60	3.60	4.32	5.04
		p	0	9191	9382	9570	9753	9933	10109	10281	10451	10618	10781	10942	11101	14395	17688	17688	17688
	29.5	y	0.00	1.02	1.07	1.13	1.18	1.23	1.28	1.34	1.39	1.44	1.49	1.55	1.60	2.60	3.60	4.32	5.04
		p	0	9043	9271	9494	9711	9923	10131	10335	10535	10730	10923	11112	11298	14802	18307	18307	18307
	30.5	y	0.00	0.96	1.02	1.08	1.14	1.19	1.25	1.31	1.37	1.43	1.48	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	8798	9070	9335	9593	9845	10091	10331	10567	10797	11024	11246	11464	15188	18911	18911	18911
	31.5	y	0.00	0.89	0.96	1.02	1.09	1.15	1.21	1.28	1.34	1.41	1.47	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	8441	8767	9082	9389	9688	9980	10264	10542	10814	11080	11341	11598	15548	19499	19499	19499
	32.5	y	0.00	0.86	0.93	1.00	1.07	1.13	1.20	1.27	1.33	1.40	1.47	1.53	1.60	2.60	3.60	4.32	5.04
		p	0	8428	8788	9137	9476	9806	10127	10440	10746	11046	11339	11626	11908	16087	20265	20265	20265
	33.5	y	0.00	0.88	0.95	1.01	1.08	1.14	1.21	1.27	1.34	1.40	1.47	1.53	1.60	2.60	3.60	4.32	5.04
		p	0	8863	9229	9585	9931	10268	10597	10918	11232	11539	11841	12136	12427	16833	21239	21239	21239
	34.5	y	0.00	0.90	0.96	1.03	1.09	1.15	1.22	1.28	1.35	1.41	1.47	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	9308	9680	10042	10395	10739	11075	11404	11725	12040	12349	12653	12951	17592	22233	22233	22233
	35.5	y	0.00	0.92	0.98	1.04	1.10	1.17	1.23	1.29	1.35	1.41	1.48	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	9763	10141	10509	10868	11218	11561	11897	12226	12548	12865	13176	13482	18364	23246	23246	23246
	36.5	y	0.00	0.93	0.99	1.06	1.12	1.18	1.24	1.30	1.36	1.42	1.48	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	10228	10611	10984	11349	11706	12055	12397	12733	13062	13386	13704	14017	19148	24279	24279	24279
	37.5	y	0.00	0.95	1.01	1.07	1.13	1.19	1.25	1.31	1.36	1.42	1.48	1.54	1.60	2.60	3.60	4.32	5.04
		p	0	10702	11090	11469	11839	12201	12557	12905	13247	13583	13914	14239	14559	19945	25330	25330	25330

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Langan CT, Inc.
Langan International LLC
Collectively known as Langan

Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Fill p-y Table
96-inch Diameter

Project No. 170444101

Date 2018/07/02

Scale No Scale

Drawn By / Checked By ZW / MGP

Submission Date 2018/07/02

Table No. 5

Sheet 5 of 11

Zone	Su		Curve Points																
	psf		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CLAY (24 inch Caisson)	650	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	66	133	199	265	331	398	464	530	596	663	729	795	861	928	994	994
	675	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	69	138	206	275	344	413	481	550	619	688	756	825	894	963	1031	1031
	700	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	71	143	214	285	356	428	499	570	641	713	784	855	926	998	1069	1069
	725	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	74	148	221	295	369	443	516	590	664	738	811	885	959	1033	1106	1106
	750	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	76	153	229	305	381	458	534	610	686	763	839	915	991	1068	1144	1144
	775	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	79	158	236	315	394	473	551	630	709	788	866	945	1024	1103	1181	1181
	800	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	81	163	244	325	406	488	569	650	731	813	894	975	1056	1138	1219	1219
	825	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	84	168	251	335	419	503	586	670	754	838	921	1005	1089	1173	1256	1256
	850	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	86	173	259	345	431	518	604	690	776	863	949	1035	1121	1208	1294	1294
	875	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	89	178	266	355	444	533	621	710	799	888	976	1065	1154	1243	1331	1331
	900	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	91	183	274	365	456	548	639	730	821	913	1004	1095	1186	1278	1369	1369
	925	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	94	188	281	375	469	563	656	750	844	938	1031	1125	1219	1313	1406	1406
	950	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	96	193	289	385	481	578	674	770	866	963	1059	1155	1251	1348	1444	1444
	975	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	99	198	296	395	494	593	691	790	889	988	1086	1185	1284	1383	1481	1481
	1000	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	101	203	304	405	506	608	709	810	911	1013	1114	1215	1316	1418	1519	1519
	1025	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	104	208	311	415	519	623	726	830	934	1038	1141	1245	1349	1453	1556	1556
	1050	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	106	213	319	425	531	638	744	850	956	1063	1169	1275	1381	1488	1594	1594
	1075	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	109	218	326	435	544	653	761	870	979	1088	1196	1305	1414	1523	1631	1631
	1100	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	111	223	334	445	556	668	779	890	1001	1113	1224	1335	1446	1558	1669	1669
	1125	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	114	228	341	455	569	683	796	910	1024	1138	1251	1365	1479	1593	1706	1706
	1150	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	116	233	349	465	581	698	814	930	1046	1163	1279	1395	1511	1628	1744	1744
	1175	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	119	238	356	475	594	713	831	950	1069	1188	1306	1425	1544	1663	1781	1781
	1200	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	121	243	364	485	606	728	849	970	1091	1213	1334	1455	1576	1698	1819	1819
	1225	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	124	248	371	495	619	743	866	990	1114	1238	1361	1485	1609	1733	1856	1856
	1250	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	126	253	379	505	631	758	884	1010	1136	1263	1389	1515	1641	1768	1894	1894
	1275	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	129	258	386	515	644	773	901	1030	1159	1288	1416	1545	1674	1803	1931	1931
	1300	y	0.0000	0.0007	0.0057	0.0192	0.0455	0.0889	0.1536	0.2439	0.3641	0.5184	0.7111	0.9465	1.2288	1.5623	1.9513	2.4000	2.5500
		p	0	131	263	394	525	656	788	919	1050	1181	1313	1444	1575	1706	1838	1969	1969

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West Rail Yard

MANHATTAN NEW YORK

Drawing Title

Clay p-y Table 24-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
6

Sheet 6 of 11

Zone	Su		Curve Points																
	psf		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CLAY (36 inch Caisson)	650	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	99	199	298	398	497	596	696	795	894	994	1093	1193	1292	1391	1491	1491
	675	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	103	206	309	413	516	619	722	825	928	1031	1134	1238	1341	1444	1547	1547
	700	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	107	214	321	428	534	641	748	855	962	1069	1176	1283	1389	1496	1603	1603
	725	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	111	221	332	443	553	664	774	885	996	1106	1217	1328	1438	1549	1659	1659
	750	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	114	229	343	458	572	686	801	915	1029	1144	1258	1373	1487	1601	1716	1716
	775	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	118	236	354	473	591	709	827	945	1063	1181	1299	1418	1536	1654	1772	1772
	800	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	122	244	366	488	609	731	853	975	1097	1219	1341	1463	1584	1706	1828	1828
	825	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	126	251	377	503	628	754	879	1005	1131	1256	1382	1508	1633	1759	1884	1884
	850	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	129	259	388	518	647	776	906	1035	1164	1294	1423	1553	1682	1811	1941	1941
	875	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	133	266	399	533	666	799	932	1065	1198	1331	1464	1598	1731	1864	1997	1997
	900	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	137	274	411	548	684	821	958	1095	1232	1369	1506	1643	1779	1916	2053	2053
	925	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	141	281	422	563	703	844	984	1125	1266	1406	1547	1688	1828	1969	2109	2109
	950	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	144	289	433	578	722	866	1011	1155	1299	1444	1588	1733	1877	2021	2166	2166
	975	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	148	296	444	593	741	889	1037	1185	1333	1481	1629	1778	1926	2074	2222	2222
	1000	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	152	304	456	608	759	911	1063	1215	1367	1519	1671	1823	1974	2126	2278	2278
	1025	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	156	311	467	623	778	934	1089	1245	1401	1556	1712	1868	2023	2179	2334	2334
	1050	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	159	319	478	638	797	956	1116	1275	1434	1594	1753	1913	2072	2231	2391	2391
	1075	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	163	326	489	653	816	979	1142	1305	1468	1631	1794	1958	2121	2284	2447	2447
	1100	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	167	334	501	668	834	1001	1168	1335	1502	1669	1836	2003	2169	2336	2503	2503
	1125	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	171	341	512	683	853	1024	1194	1365	1536	1706	1877	2048	2218	2389	2559	2559
	1150	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	174	349	523	698	872	1046	1221	1395	1569	1744	1918	2093	2267	2441	2616	2616
	1175	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	178	356	534	713	891	1069	1247	1425	1603	1781	1959	2138	2316	2494	2672	2672
	1200	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	182	364	546	728	909	1091	1273	1455	1637	1819	2001	2183	2364	2546	2728	2728
	1225	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	186	371	557	743	928	1114	1299	1485	1671	1856	2042	2228	2413	2599	2784	2784
	1250	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	189	379	568	758	947	1136	1326	1515	1704	1894	2083	2273	2462	2651	2841	2841
	1275	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	193	386	579	773	966	1159	1352	1545	1738	1931	2124	2318	2511	2704	2897	2897
	1300	y	0.0000	0.0011	0.0085	0.0288	0.0683	0.1333	0.2304	0.3659	0.5461	0.7776	1.0667	1.4197	1.8432	2.3435	2.9269	3.6000	3.8250
		p	0	197	394	591	788	984	1181	1378	1575	1772	1969	2166	2363	2559	2756	2953	2953

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Langan CT, Inc.
Langan International LLC
Collectively known as Langan

Project

Hudson Yards West Rail Yard

MANHATTAN NEW YORK

Drawing Title

Clay p-y Table 36-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
7

Sheet 7 of 11

Zone	Su		Curve Points																
	psf		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CLAY (48 inch Caisson)	650	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	133	265	398	530	663	795	928	1060	1193	1325	1458	1590	1723	1855	1988	1988
	675	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	138	275	413	550	688	825	963	1100	1238	1375	1513	1650	1788	1925	2063	2063
	700	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	143	285	428	570	713	855	998	1140	1283	1425	1568	1710	1853	1995	2138	2138
	725	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	148	295	443	590	738	885	1033	1180	1328	1475	1623	1770	1918	2065	2213	2213
	750	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	153	305	458	610	763	915	1068	1220	1373	1525	1678	1830	1983	2135	2288	2288
	775	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	158	315	473	630	788	945	1103	1260	1418	1575	1733	1890	2048	2205	2363	2363
	800	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	163	325	488	650	813	975	1138	1300	1463	1625	1788	1950	2113	2275	2438	2438
	825	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	168	335	503	670	838	1005	1173	1340	1508	1675	1843	2010	2178	2345	2513	2513
	850	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	173	345	518	690	863	1035	1208	1380	1553	1725	1898	2070	2243	2415	2588	2588
	875	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	178	355	533	710	888	1065	1243	1420	1598	1775	1953	2130	2308	2485	2663	2663
	900	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	183	365	548	730	913	1095	1278	1460	1643	1825	2008	2190	2373	2555	2738	2738
	925	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	188	375	563	750	938	1125	1313	1500	1688	1875	2063	2250	2438	2625	2813	2813
	950	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	193	385	578	770	963	1155	1348	1540	1733	1925	2118	2310	2503	2695	2888	2888
	975	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	198	395	593	790	988	1185	1383	1580	1778	1975	2173	2370	2568	2765	2963	2963
	1000	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	203	405	608	810	1013	1215	1418	1620	1823	2025	2228	2430	2633	2835	3038	3038
	1025	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	208	415	623	830	1038	1245	1453	1660	1868	2075	2283	2490	2698	2905	3113	3113
	1050	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	213	425	638	850	1063	1275	1488	1700	1913	2125	2338	2550	2763	2975	3188	3188
	1075	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	218	435	653	870	1088	1305	1523	1740	1958	2175	2393	2610	2828	3045	3263	3263
	1100	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	223	445	668	890	1113	1335	1558	1780	2003	2225	2448	2670	2893	3115	3338	3338
	1125	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	228	455	683	910	1138	1365	1593	1820	2048	2275	2503	2730	2958	3185	3413	3413
	1150	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	233	465	698	930	1163	1395	1628	1860	2093	2325	2558	2790	3023	3255	3488	3488
	1175	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	238	475	713	950	1188	1425	1663	1900	2138	2375	2613	2850	3088	3325	3563	3563
	1200	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	243	485	728	970	1213	1455	1698	1940	2183	2425	2668	2910	3153	3395	3638	3638
	1225	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	248	495	743	990	1238	1485	1733	1980	2228	2475	2723	2970	3218	3465	3713	3713
	1250	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	253	505	758	1010	1263	1515	1768	2020	2273	2525	2778	3030	3283	3535	3788	3788
	1275	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	258	515	773	1030	1288	1545	1803	2060	2318	2575	2833	3090	3348	3605	3863	3863
	1300	y	0.0000	0.0014	0.0114	0.0384	0.0910	0.1778	0.3072	0.4878	0.7282	1.0368	1.4222	1.8930	2.4576	3.1246	3.9026	4.8000	5.1000
		p	0	263	525	788	1050	1313	1575	1838	2100	2363	2625	2888	3150	3413	3675	3938	3938

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

.

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Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Clay p-y Table
48-inch Diameter

Project No. 170444101

Date 2018/07/02

Scale No Scale

Drawn By / Checked By ZW / MGP

Submission Date 2018/07/02

Table No. 8

Zone	Su		Curve Points																
	psf		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CLAY (72 inch Caisson)	650	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	190	379	569	759	948	1138	1327	1517	1707	1896	2086	2276	2465	2655	2845	2845
	675	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	198	397	595	794	992	1190	1389	1587	1786	1984	2182	2381	2579	2778	2976	2976
	700	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	207	415	622	829	1036	1244	1451	1658	1866	2073	2280	2488	2695	2902	3109	3109
	725	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	216	433	649	865	1082	1298	1514	1731	1947	2163	2380	2596	2812	3029	3245	3245
	750	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	226	451	677	902	1128	1353	1579	1804	2030	2255	2481	2706	2932	3157	3383	3383
	775	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	235	470	705	939	1174	1409	1644	1879	2114	2348	2583	2818	3053	3288	3523	3523
	800	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	244	488	731	975	1219	1463	1706	1950	2194	2438	2681	2925	3169	3413	3656	3656
	825	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	251	503	754	1005	1256	1508	1759	2010	2261	2513	2764	3015	3266	3518	3769	3769
	850	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	259	518	776	1035	1294	1553	1811	2070	2329	2588	2846	3105	3364	3623	3881	3881
	875	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	266	533	799	1065	1331	1598	1864	2130	2396	2663	2929	3195	3461	3728	3994	3994
	900	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	274	548	821	1095	1369	1643	1916	2190	2464	2738	3011	3285	3559	3833	4106	4106
	925	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	281	563	844	1125	1406	1688	1969	2250	2531	2813	3094	3375	3656	3938	4219	4219
	950	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	289	578	866	1155	1444	1733	2021	2310	2599	2888	3176	3465	3754	4043	4331	4331
	975	y	0.0000	0.0043	0.0341	0.1152	0.2731	0.5333	0.9216	1.4635	2.1845	3.1104	4.2667	5.6789	7.3728	9.3739	11.7077	14.4000	15.3000
		p	0	296	593	889	1185	1481	1778	2074	2370	2666	2963	3259	3555	3851	4148	4444	4444
	1000	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	304	608	911	1215	1519	1823	2126	2430	2734	3038	3341	3645	3949	4253	4556	4556
	1025	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	311	623	934	1245	1556	1868	2179	2490	2801	3113	3424	3735	4046	4358	4669	4669
	1050	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	319	638	956	1275	1594	1913	2231	2550	2869	3188	3506	3825	4144	4463	4781	4781
	1075	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	326	653	979	1305	1631	1958	2284	2610	2936	3263	3589	3915	4241	4568	4894	4894
	1100	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	334	668	1001	1335	1669	2003	2336	2670	3004	3338	3671	4005	4339	4673	5006	5006
	1125	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	341	683	1024	1365	1706	2048	2389	2730	3071	3413	3754	4095	4436	4778	5119	5119
	1150	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	349	698	1046	1395	1744	2093	2441	2790	3139	3488	3836	4185	4534	4883	5231	5231
	1175	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	356	713	1069	1425	1781	2138	2494	2850	3206	3563	3919	4275	4631	4988	5344	5344
	1200	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	364	728	1091	1455	1819	2183	2546	2910	3274	3638	4001	4365	4729	5093	5456	5456
	1225	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	371	743	1114	1485	1856	2228	2599	2970	3341	3713	4084	4455	4826	5198	5569	5569
	1250	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	379	758	1136	1515	1894	2273	2651	3030	3409	3788	4166	4545	4924	5303	5681	5681
	1275	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	386	773	1159	1545	1931	2318	2704	3090	3476	3863	4249	4635	5021	5408	5794	5794
	1300	y	0.0000	0.0021	0.0171	0.0576	0.1365	0.2667	0.4608	0.7317	1.0923	1.5552	2.1333	2.8395	3.6864	4.6869	5.8539	7.2000	7.6500
		p	0	394	788	1181	1575	1969	2363	2756	3150	3544	3938	4331	4725	5119	5513	5906	5906

[a] y = Lateral pile deflection in inches

[b] p = Lateral pile resistance in pounds per inch

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Langan CT, Inc.
Langan International LLC
Collectively known as Langan

Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Clay p-y Table
72-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.
9

Zone	Su		Curve Points																
	psf		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
CLAY (96 inch Caisson)	650	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	229	459	688	917	1147	1376	1605	1834	2064	2293	2522	2752	2981	3210	3440	3440
	675	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	239	479	718	958	1197	1437	1676	1916	2155	2395	2634	2874	3113	3352	3592	3592
	700	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	250	500	749	999	1249	1499	1748	1998	2248	2498	2747	2997	3247	3497	3746	3746
	725	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	260	520	781	1041	1301	1561	1821	2082	2342	2602	2862	3122	3383	3643	3903	3903
	750	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	271	542	812	1083	1354	1625	1895	2166	2437	2708	2978	3249	3520	3791	4062	4062
	775	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	281	563	844	1126	1407	1689	1970	2252	2533	2815	3096	3378	3659	3941	4222	4222
	800	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	292	585	877	1169	1462	1754	2046	2339	2631	2923	3216	3508	3800	4093	4385	4385
	825	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	303	607	910	1213	1517	1820	2123	2427	2730	3033	3337	3640	3943	4247	4550	4550
	850	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	314	629	943	1258	1572	1887	2201	2516	2830	3145	3459	3774	4088	4402	4717	4717
	875	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	326	651	977	1303	1629	1954	2280	2606	2932	3257	3583	3909	4234	4560	4886	4886
	900	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	337	674	1011	1349	1686	2023	2360	2697	3034	3371	3709	4046	4383	4720	5057	5057
	925	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	349	697	1046	1395	1743	2092	2441	2789	3138	3487	3836	4184	4533	4882	5230	5230
	950	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	360	721	1081	1441	1802	2162	2523	2883	3243	3604	3964	4324	4685	5045	5406	5406
	975	y	0.0000	0.0057	0.0455	0.1536	0.3641	0.7111	1.2288	1.9513	2.9127	4.1472	5.6889	7.5719	9.8304	12.4985	15.6103	19.2000	20.4000
		p	0	372	744	1117	1489	1861	2233	2605	2978	3350	3722	4094	4466	4839	5211	5583	5583
	1000	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	384	768	1152	1537	1921	2305	2689	3073	3457	3842	4226	4610	4994	5378	5762	5762
	1025	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	396	793	1189	1585	1981	2378	2774	3170	3566	3963	4359	4755	5151	5548	5944	5944
	1050	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	409	817	1226	1634	2043	2451	2860	3268	3677	4085	4494	4902	5311	5719	6128	6128
	1075	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	421	842	1263	1684	2104	2525	2946	3367	3788	4209	4630	5051	5471	5892	6313	6313
	1100	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	433	867	1300	1734	2167	2600	3034	3467	3901	4334	4767	5201	5634	6068	6501	6501
	1125	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	446	892	1338	1784	2230	2676	3122	3568	4015	4461	4907	5353	5799	6245	6691	6691
	1150	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	459	918	1377	1835	2294	2753	3212	3671	4130	4589	5047	5506	5965	6424	6883	6883
	1175	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	472	944	1415	1887	2359	2831	3303	3774	4246	4718	5190	5662	6133	6605	7077	7077
	1200	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	485	970	1455	1939	2424	2909	3394	3879	4364	4849	5334	5818	6303	6788	7273	7273
	1225	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	495	990	1485	1980	2475	2970	3465	3960	4455	4950	5445	5940	6435	6930	7425	7425
	1250	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	505	1010	1515	2020	2525	3030	3535	4040	4545	5050	5555	6060	6565	7070	7575	7575
	1275	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	515	1030	1545	2060	2575	3090	3605	4120	4635	5150	5665	6180	6695	7210	7725	7725
	1300	y	0.0000	0.0028	0.0228	0.0768	0.1820	0.3556	0.6144	0.9756	1.4564	2.0736	2.8444	3.7860	4.9152	6.2492	7.8052	9.6000	10.2000
		p	0	525	1050	1575	2100	2625	3150	3675	4200	4725	5250	5775	6300	6825	7350	7875	7875

[a]y = Lateral pile deflection in inches

[b]p = Lateral pile resistance in pounds per inch

.

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Langan CT, Inc.
Langan International LLC
Collectively known as Langan

Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Clay p-y Table
96-inch Diameter

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

Table No.

10

Sheet 10 of 11

Size	UCS		Curve Points																
	psi		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
24 inch	4200	y	0.0000	0.0080	0.0107	0.0133	0.0160	0.0187	0.0213	0.0240	0.0267	0.0293	0.0320	0.0347	0.0373	0.0400	0.0427	0.0453	0.0480
		p	0	33600	34160	34720	35280	35840	36400	36960	37520	38080	38640	39200	39760	40320	40880	41440	42000
	7000	y	0.0000	0.0080	0.0107	0.0133	0.0160	0.0187	0.0213	0.0240	0.0267	0.0293	0.0320	0.0347	0.0373	0.0400	0.0427	0.0453	0.0480
		p	0	56000	56933	57867	58800	59733	60667	61600	62533	63467	64400	65333	66267	67200	68133	69067	70000
36 inch	4200	y	0.0000	0.0120	0.0160	0.0200	0.0240	0.0280	0.0320	0.0360	0.0400	0.0440	0.0480	0.0520	0.0560	0.0600	0.0640	0.0680	0.0720
		p	0	50400	51240	52080	52920	53760	54600	55440	56280	57120	57960	58800	59640	60480	61320	62160	63000
	7000	y	0.0000	0.0120	0.0160	0.0200	0.0240	0.0280	0.0320	0.0360	0.0400	0.0440	0.0480	0.0520	0.0560	0.0600	0.0640	0.0680	0.0720
		p	0	84000	85400	86800	88200	89600	91000	92400	93800	95200	96600	98000	99400	100800	102200	103600	105000
48 inch	4200	y	0.0000	0.0168	0.0224	0.0280	0.0336	0.0392	0.0448	0.0504	0.0560	0.0616	0.0672	0.0728	0.0784	0.0840	0.0896	0.0952	0.1008
		p	0	70560	71736	72912	74088	75264	76440	77616	78792	79968	81144	82320	83496	84672	85848	87024	88200
	7000	y	0.0000	0.0168	0.0224	0.0280	0.0336	0.0392	0.0448	0.0504	0.0560	0.0616	0.0672	0.0728	0.0784	0.0840	0.0896	0.0952	0.1008
		p	0	117600	119560	121520	123480	125440	127400	129360	131320	133280	135240	137200	139160	141120	143080	145040	147000
72 inch	4200	y	0.0000	0.0264	0.0352	0.0440	0.0528	0.0616	0.0704	0.0792	0.0880	0.0968	0.1056	0.1144	0.1232	0.1320	0.1408	0.1496	0.1584
		p	0	110880	112728	114576	116424	118272	120120	121968	123816	125664	127512	129360	131208	133056	134904	136752	138600
	7000	y	0.0000	0.0264	0.0352	0.0440	0.0528	0.0616	0.0704	0.0792	0.0880	0.0968	0.1056	0.1144	0.1232	0.1320	0.1408	0.1496	0.1584
		p	0	184800	187880	190960	194040	197120	200200	203280	206360	209440	212520	215600	218680	221760	224840	227920	231000
96 inch	4200	y	0.0000	0.0360	0.0480	0.0600	0.0720	0.0840	0.0960	0.1080	0.1200	0.1320	0.1440	0.1560	0.1680	0.1800	0.1920	0.2040	0.2160
		p	0	151200	153720	156240	158760	161280	163800	166320	168840	171360	173880	176400	178920	181440	183960	186480	189000
	7000	y	0.0000	0.0360	0.0480	0.0600	0.0720	0.0840	0.0960	0.1080	0.1200	0.1320	0.1440	0.1560	0.1680	0.1800	0.1920	0.2040	0.2160
		p	0	252000	256200	260400	264600	268800	273000	277200	281400	285600	289800	294000	298200	302400	306600	310800	315000

[a]y = Lateral pile deflection in inches

[b]p = Lateral pile resistance in pounds per inch

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Project

Hudson Yards West
Rail Yard

MANHATTAN NEW YORK

Drawing Title

Bedrock p-y Table
20 to 90 inch
Diameter Socket

Project No.
170444101

Date
2018/07/02

Scale
No Scale

Drawn By / Checked By
ZW / MGP

Submission Date
2018/07/02

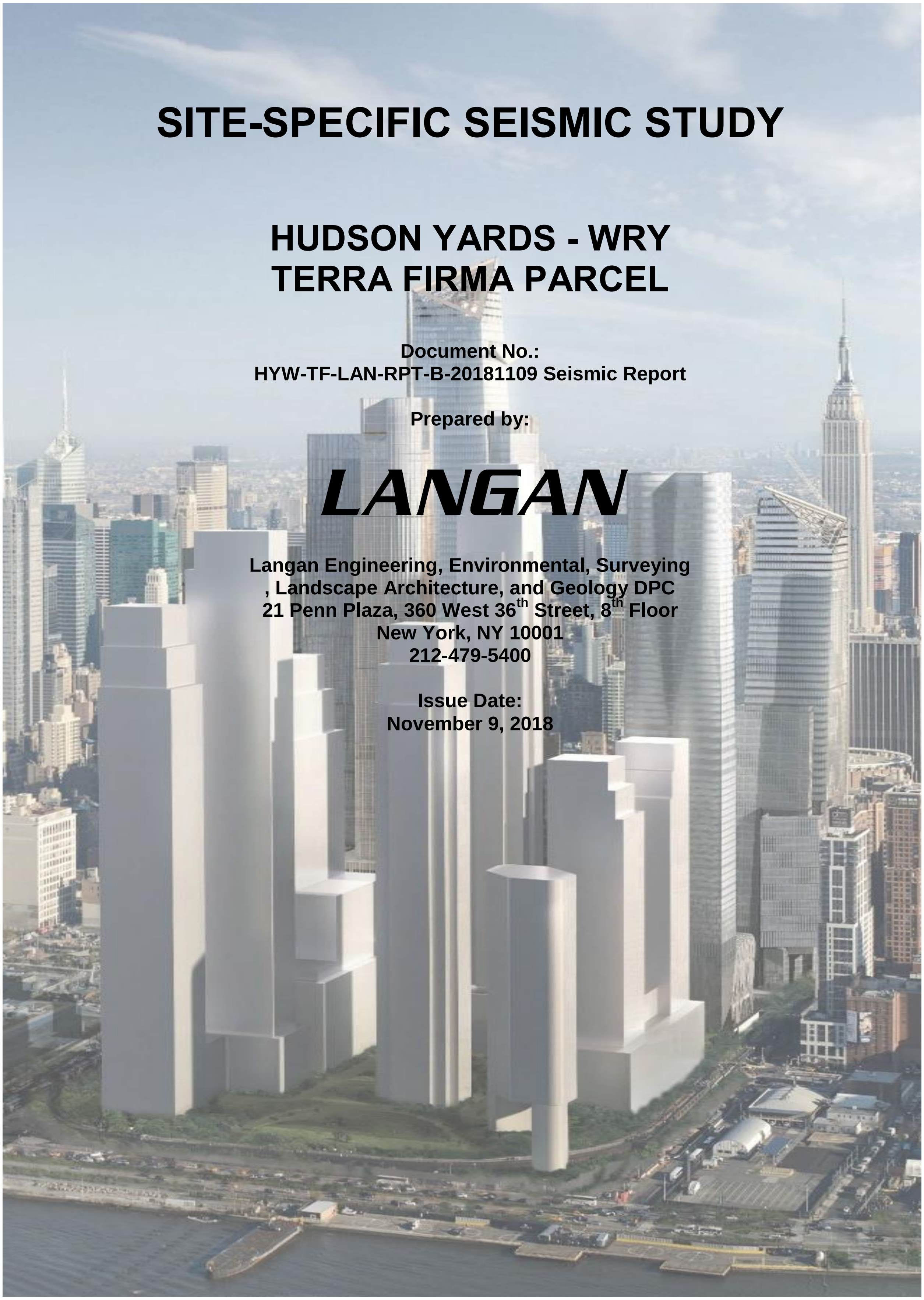
Table No.
11

Sheet 11 of 11

APPENDIX G

Site-Specific Seismic Study

RELATED OXFORD
HUDSON YARDS



SITE-SPECIFIC SEISMIC STUDY

HUDSON YARDS - WRY
TERRA FIRMA PARCEL

Document No.:
HYW-TF-LAN-RPT-B-20181109 Seismic Report

Prepared by:

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212-479-5400

Issue Date:
November 9, 2018

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 Executive Summary

Langan Engineering, Environmental, Surveying, Landscape Architecture, and Geology D.P.C. performed site-specific seismic studies for the proposed buildings within the terra firma site of the West Rail Yard of Hudson Yards. Two towers (Towers 5 and 6) were independently evaluated in this study. One low-rise structure (Building C), located between the two towers, was also evaluated using the site-specific studies for the towers.

The entire terra firma site was preliminarily classified as Site Class F because of liquefaction susceptibility identified using the 2014 New York City Building Code (NYCBC) and 2015 New York State Building Code (NYSBC) general procedures. Site Class F requires site-specific seismic analyses to assess the seismic response of the ground and to determine seismic design parameters.

This study is specific to the referenced site and reflects the state-of-practice in the fields of seismology and geotechnical earthquake engineering. This study was performed in accordance with the provisions of 2014 NYCBC, 2015 NYSBC and ASCE 7-10. The following summarizes the approach and key conclusions from the study:

1. Seismic hazard analysis and selection of bedrock acceleration time series:

   a. We performed a probabilistic seismic hazard analysis to develop the target bedrock acceleration response spectrum.

   b. We selected 11 representative “seed” ground motion acceleration time series and modified them by matching their acceleration spectra to the target spectrum to develop 11 input bedrock motions for the site-specific ground response analyses.

2. Site-specific ground-response analyses:

   a. The site was divided into two zones corresponding to the proposed Tower 5 and Tower 6 locations. For each tower, we performed individual site-specific total-stress and effective-stress ground response analyses (soil amplification analysis) using the developed input bedrock motions (acceleration time series). We applied the motions at the base of one dimensional soil columns and estimated ground response spectra.

   b. We developed a site-specific design response spectrum for each tower using the respective estimated ground response spectra.

3. Liquefaction analyses:

   a. For each tower, we evaluated the potential for liquefaction of the granular soils below the groundwater table for the risk-targeted maximum considered earthquake (MCE_R) level event (about 10 percent higher PGA than the geometric mean – MCE_{GM} level).

   b. We estimated the potential free-field ground surface seismic settlements during the MCE_R event.

   c. We estimated excess pore water pressure ratios in the soils during the MCE_R level event.

4. Conclusions and recommendations:

   a. The recommended short- and long-period design spectral accelerations and Seismic Design Categories are provided in Appendices A (Tower 5) and B (Tower 6). Note the response spectra for both towers are limited to a Code dictated lower-bound. We recommend LIRR Building C be designed using the same lower-bound response spectra as the towers.

b. We estimated excess pore water pressure ratios as high as about 90 percent for Tower 5 and 60 percent for Tower 6 during the MCE_R-level event, corresponding to partial liquefaction (partial soil strength loss). The excess pore water pressure ratios we estimated using empirical methods were as high as 40 percent and 50 percent, respectively. Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We recommend using the higher predicted pore water pressures from the Tower 5 analysis for the design of LIRR Building C.

c. We estimated up to about 0.5 inch of seismic-event-induced settlement for free-field conditions after the MCE_R-level event. Utilities under the sidewalks and site connections should be designed to account for differential settlements up to about 0.5 inch between sidewalk and pile- or rock-supported structures.

2 Introduction

This report presents the results of our site-specific seismic study for the proposed development within the terra firma site of the West Rail Yard of Hudson Yards. Our study was performed to assess the seismic response of the ground at the project site, as required by the 2014 NYCBC and 2015 NYSBC for sites susceptible to liquefaction (i.e. Site Class F), and to determine appropriate seismic parameters for use in design of the proposed structures.

The analyses and recommendations presented herein are in accordance with the NYCBC, NYSBC and ASCE 7-10. All elevations contained herein reference the North American Vertical Datum of 1988 (NAVD88) and are approximate.

3 Project Overview

3.1 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 “terra firma” (Block 676, Lot 1) and “platform” (Block 676, Lot 5) parcels. This report focuses solely on the terra firma site. The terra firma site measures about 147,000 square feet and is bound by the LIRR South Access Road and platform parcel on the north, West 30th Street 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 terra firma site is occupied by several LIRR support facilities at the east end of the site, a laydown area for ongoing construction within Hudson Yards near the center of the site, and a Vehicle Processing Center (VPC) near the west end of the site. An LIRR access road borders the north side of the site. The High Line Park elevated rail line traverses along the south and west sides of the site. The structure parallels West 30th Street then arcs north, near the west end of the site. Numerous structures are adjacent to the site, including an active rail yard to the north and the Eleventh Avenue viaduct and Segment 2 of the Amtrak Gateway tunnel to the east.

Additional details pertaining to the site are included in our Geotechnical Report, dated 9 November 2018.

3.2 Proposed Development

The planned development includes construction of three structures:

- **Tower 5 –** Tower 5 will be on the west side of terra firma and will consist of a high-rise residential building spanning over the Highline. The tower will be supported by a core northeast of the Highline and two mega columns southwest of the Highline. A cellar is limited to the core area northeast of the Highline. Maintenance space will occupy the ground and platform levels, and a residential lobby will occupy the plaza level. The full tower footprint will span over the Highline above the plaza level.

  Tower 5 will be designed in accordance with the 2014 New York City Building Code (NYCBC). The design team has not been selected.

- **Tower 6 –** Tower 6 will be on the east side of the site between the Highline and LIRR South Access Road and will consist of a high-rise building with residential, retail, and school spaces. The building will have a single cellar level for use as parking and utility space. Retail space, a school, maintenance facilities, and parking will occupy the ground level and extend under the Highline to provide frontage along West 30th Street. A portion of the school and additional parking will occupy the platform level. Portions of the school, retail space, and a residential lobby will occupy the plaza level. The tower will contain residential units.

  Tower 6 will be constructed over, and will be partially supported by the Amtrak Gateway tunnel Segment 3 (to be constructed).

  Tower 6 will be designed in accordance with the NYCBC. The design team has not been selected.

- **LIRR Building C –** A two-story LIRR support building (“Building C”) will be constructed below the platform and between towers 5 and 6. Building C will have a single cellar level.

  The LIRR building will be designed in accordance with the 2015 New York State Building Code (NYSBC) with applicable Uniform Code supplements through 2017.

3.3 Local Faults and Seismicity

New York City is on the Manhattan Prong, in the passive continental margin of the stable central and eastern United States, far from tectonic plate boundaries (approximately 1,400 miles from the nearest tectonic plate boundary). Seismicity in this region is overall low, with the exception of a few zones such as the New Madrid (Missouri) and Charleston, South Carolina seismic zones. The Manhattan Prong is relatively active compared to most of this region; the largest earthquake in the area was a magnitude mbLg 5.25 event offshore of New York City in 1884.

Many faults have been identified in the Manhattan Prong and the surrounding regions, but the locations of active faults is not clear (Sykes et al. 2008). There are difficulties in characterizing the activity of faults in the region because of the small sizes of ruptures, the absence of surface rupture, and the distribution of seismicity on many smaller faults, each with very low displacement rates.

A fault known as Cameron’s Line is about 2.5 miles east of the site. Cameron’s Line is described as an Ordovician (Taconic) suture zone. Geologists postulate that the fault was healed by Paleozoic metamorphism and is no longer a zone of brittle faulting or a source of earthquakes. Assumed brittle faults of the Manhattan Prong include the 125th Street fault, which extends across Manhattan to Queens; the Dyckman Street fault; and the Dobbs Ferry fault. Experts recognize that research is needed to improve the mapping and dating of these various faults to improve seismic-hazard studies.

3.4 Subsurface Data

Subsurface data was derived from numerous investigations undertaken within and adjacent to the WRY. This information includes borings and cone penetration testing (CPT) data, as well as laboratory testing of soil 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 2.

The geotechnical parameters used in this study were primarily derived from 16 geotechnical borings, five seismic CPTs, and laboratory testing performed as part of the design of the proposed New York Sports and Convention Center (NYSCC) in 2004, and three additional borings drilled for the test caissons in 2017. This data was supplemented with historical data within and adjacent to the site prepared by others.

3.5 Generalized Subsurface Conditions

The subsurface conditions were interpreted separately for each tower using available boring, CPT and lab data in the vicinity of each building.

The general subsurface conditions consist of uncontrolled fill underlain by consecutive layers of clay and silt, sand, glacial till, and bedrock. Bedrock was encountered from about el -22 feet to -131 ft; the depth to rock generally increases from east to west.

Groundwater was measured in monitoring wells installed in the vicinity of the site from as high as about el 3.9 ft to as low as el -1.5 ft, but groundwater is generally expected to vary from about el 0 to 2 ft. Groundwater levels are tidally influenced along the west side of the site given the relatively close proximity to the present Hudson River shoreline. In addition, groundwater levels are likely to fluctuate with seasonal changes and precipitation events. Zones of perched water may be present at some locations due to the inconsistent nature of the fill and native soils.

The shear wave velocity of the bedrock was estimated to be around 9,000 feet per second based on the cross-hole seismic tests and borehole suspension logging performed within the same rock formation at nearby sites.

The soil and rock parameters used in the site specific seismic analyses are summarized for each tower in Appendices A and B.

Additional details are presented in our Geotechnical Report, dated 9 November 2018.

4 Seismic Evaluation

4.1 Introduction

We performed a site-specific seismic study for each tower to develop a design acceleration response spectrum, as required by the NYCBC and NYSBC for sites susceptible to liquefaction. Site specific analyses are more rigorous than the general procedures outlined in the NYCBC and NYSBC. The general procedures typically do not accurately represent the amplitude and frequency content specific to an individual site. As such, design acceleration response spectrum values derived using the general procedures may be either overly conservative or, in some cases, unconservative.

Our evaluation included:

1. Performing a probabilistic seismic-hazard analysis;
2. Selecting and modifying appropriate bedrock acceleration time series;
3. Estimating dynamic soil and bedrock properties for each zone;
4. Determining the Site Class per the Building Code for each zone;
5. Performing total-stress and effective-stress ground response analyses for each zone;

6. Performing analyses to evaluate the liquefaction potential and estimate excess pore water pressures in the granular soils situated below the groundwater table for each zone;

7. Recommending an appropriate design acceleration response spectrum for each zone; and,

8. Determining the Seismic Design Category (SDC) for each zone.

We developed a design acceleration-response spectrum specific to each tower using state of practice methods and reflecting in situ soil and bedrock conditions. Our evaluation was performed in accordance with provisions of 2014 NYCBC, 2015 NYSBC, and ASCE 7-10. The study included one-dimensional wave-propagation analyses to estimate the response at the site ground surface during a design seismic event.

The total-stress one-dimensional analyses were performed using the commercial computer program Shake2000 (Geomotions, 2015). The effective-stress one-dimensional analyses were performed using the commercial computer program D-MOD2000 (Geomotions, 2015).

4.2 Probabilistic Seismic Hazard Analysis

We performed a probabilistic seismic-hazard analysis (PSHA) to systematically account for uncertainties in the location, recurrence interval, and magnitude of future earthquakes. The results of a PSHA define a uniform hazard for a site in terms of a probability that a particular level of shaking will be exceeded during the given life of the structure.

As part of the development of the risk-targeted maximum considered earthquake (MCE_R) spectrum at bedrock level, we performed a PSHA to develop a site-specific response spectrum for a 2 percent probability of exceedance in 50 years (i.e. a return period of 2,475-year earthquake). The bedrock spectrum was developed using the computer code EZ-FRISK 8.00 (Fugro Consultants Inc. 2016). The approach used in EZ-FRISK is based on the probabilistic seismic-hazard model developed by Cornell (1968) and McGuire (1976).

4.3 Source Modeling and Characterization

We used the Petersen et al. (2014) seismic source model with the same logic tree used for the production of the USGS 2014 maps. We understand that Fugro Consultants Inc. obtained this database directly from the USGS.

4.4 Empirical Ground Motion Prediction Equations (GMPEs)

The estimate of uniform hazard spectral accelerations at bedrock level is based on empirical GMPEs, which use the bedrock shear-wave velocity in the upper 30 meters (Vs_{30}) as input. We assigned average bedrock Vs_{30} of 9,000 feet per second. We used the same weighting and the same empirical GMPEs that were used in Petersen et al. (2014).

4.5 Epistemic Uncertainty and Aleatory Variability

The term "epistemic uncertainty" is used to describe the uncertainty because of incomplete knowledge and data about the physics of the earthquake process. For example, there is uncertainty as to which attenuation relationship is more applicable for the site at hand. Similarly, the term "aleatory variability" is used to describe the randomness in the ground motion predicted by each attenuation equation. The epistemic uncertainty is taken into account by using a suite of attenuation relations with different weights. All the different weight combinations are incorporated in the final hazard estimations by using a logic-tree approach (McGuire 2004). The aleatory variability is taken into account by explicitly considering the randomness (standard deviation) in the predicted ground motions.

4.6 Probabilistic Seismic Hazard Analysis Results

The computed uniform hazard spectrum for 2 percent probability of exceedance in 50 years was based on the geometric mean component of the attenuation equations, and was then adjusted for the maximum direction component by multiplying with period-dependent amplification factors according to Sahi and Baker (2013), and was further adjusted by using the ASCE 7-10 risk coefficients for the site to determine the risk-targeted maximum considered earthquake (MCE_R) ground motion response accelerations. At each spectral response period, the uniform hazard bedrock response spectrum was multiplied by the risk coefficient C_R in accordance with Section 21.2.1 of ASCE 7-10. We used the USGS risk-targeted ground motion calculator, along with the site-specific hazard curves for periods of 0.2 and 1 second to estimate the C_{RS} and C_{R1} respectively. For periods less than or equal to 0.2 second, C_R=C_{Rs}=0.93; for periods greater than or equal to 1 second, C_R=C_{R1}=0.94; and for periods between 0.2 seconds and 1 second, C_R was linearly interpolated between C_{Rs} and C_{R1}. The bedrock MCE_R spectrum is shown in Figure 3. Digitized MCE_R values are listed in Table 1.

Table 1 – Bedrock Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectrum SA(g) for 5 Percent Damping

Structural Period T (sec)	Site-Specific SA(g) P.E. 2% in 50 years
0.01	0.146
0.10	0.255
0.20	0.192
0.30	0.136
0.40	0.103
0.50	0.081
0.75	0.052
1.0	0.039
2.0	0.020
3.0	0.013
4.0	0.010
5.0	0.008
6.0	0.006
7.0	0.004
8.0	0.003

4.7 Seismic Hazard Deaggregation Results

Seismic hazard deaggregation was performed to estimate the contribution of the various magnitudes events at various distances to the total seismic hazard. The results are useful in identifying pairs of earthquake magnitude and source-to-site distances that contribute the most to the estimated seismic hazard, performing deterministic analyses, and developing different scenarios to be used in selecting acceleration time series.

For the peak ground acceleration, which is of interest for the soil liquefaction-potential analyses, the majority of the hazard for the maximum considered earthquake comes from small to moderate magnitude earthquakes from the CEUS Gridded seismic zone. The corresponding modal (most likely) moment magnitude and distance were estimated to be magnitude of 5.05 and a distance of 11 kilometers. The mean moment magnitude and distance were estimated to be 5.45 and 22 kilometers respectively.

4.8 Bedrock Acceleration Time Series

We selected 11 bedrock acceleration time series for use in our analyses following the guidelines of ASCE 7-10. All time series were recorded during earthquakes with magnitudes between 5.3 and 6.2, consistent with typical NYC design magnitudes. All time series were modified to match the target bedrock MCE_R spectrum presented in Figure 3 using a time-domain spectral-matching routine. The seed time series we used are listed in Table 2.

Table 2 – Acceleration Time Series Used for Matching to the Target MCER Rock Spectrum

No.	Earthquake & Year	NGA Sequence No.	Magnitude	Station Name	Closest Distance to Rupture (km)	Component
1, 2	Morgan Hill, 1984	455	6.19	Gilroy Array No.1	15	1230, 1320
3, 4	Whittier Narrows, 1987	624	5.99	Huntington Beach	45	270, 360
5	CA/Baja Border Area, 2002	2003	5.31	Calexico Fire Station	40	90
6, 7	Chi-Chi, Taiwan, 1999	2949	6.20	CHY033	13	E, N
8, 9	Chi-Chi, Taiwan, 1999	2985	6.20	CHY094	91	N, W
10, 11	Mineral, Virginia, 2011	8529	5.74	NP2555	124	N, E

Information obtained from the NGA-West and the NGA-East Flatfile (http://ngawest2.berkeley.edu/)

4.9 Dynamic Soil and Bedrock Parameters

Dynamic soil and bedrock parameters are required for use in ground-response analyses. These parameters are:

- Small-strain shear modulus (G_{max});
- Shear modulus degradation curve with increased shear strains (i.e., G-γ curve); and
- Soil damping curve with increased shear strains (i.e., β-γ curve).

The small-strain shear modulus was estimated from in situ measurements of shear-wave velocity. The modulus degradation and damping curves were selected from published data for specific representative soil types; the following curves were used in our analyses:

- Fill – Seed and Idriss "sand average" curve (1970)
- Organic Clay– Vucetic and Dobry (1991), PI = 40
- Silt and Clay– Vucetic and Dobry (1991), PI = 30
- Sand– EPRI Sand(1993)
- Bedrock – EPRI Rock (1993)

4.10 Minimum Permissible Level of Design Response Spectrum

The site class and associated code-specified acceleration-response spectrum are required to determine the minimum permissible levels of the design response spectrum derived from a site-specific study. The minimum permissible level of the design spectrum is based on the Site Class determined according to the building code without considering soil liquefaction. Site Class E was used for the terra firma site.

4.11 Ground Response Analyses Results

Total-Stress ground-response analyses were performed using the selected bedrock acceleration time series and dynamic soil and bedrock properties described above. All bedrock acceleration time series were applied as rock-outcrop motions in accordance with ASCE 7-10.

For each zone, one-dimensional analyses were performed to assess the sensitivity of the ground surface acceleration-response spectra to variable depth to rock and stiffness of the soil column. The sensitivity of the depth to rock was assessed by varying the soil column thickness; we selected two representative soil columns for each zone, corresponding to the lower(C1) and higher (C2) depth to rock for each zone. The sensitivity of the soil stiffness was assessed by varying the best-estimate shear-wave velocities for all layers by 20 percent above and below the estimated average, yielding six different soil columns in total.

The 11 modified bedrock acceleration time series were applied at the base of each of soil column, resulting in a suite of 66 acceleration-response spectra. This relatively high number of spectra allows the mean response spectrum to provide a reasonable estimate of the average ground response during the design earthquake event, capturing the variable earthquake motions and variable soil conditions for each zone.

Per section 1613.5.4 of the 2014 NYCBC, section 1613.3.4 of the 2015 NYSBC and section 21.3 of ASCE 7-10, these 66 calculated MCE_R spectra were multiplied by a factor of two-thirds to model the “Design Earthquake (DE).”

The mean total-stress spectrum for each soil column is presented in Appendices A to F for Zones 1 to 6, respectively.

4.12 Soil Liquefaction Potential Analyses

The NYCBC requires an evaluation of the liquefaction potential of noncohesive soils below the groundwater table and to a depth of 50 feet below the ground surface. The potential for soil liquefaction was evaluated using the procedure outlined by Idriss and Boulanger (2008). This evaluation develops an empirical relationship between the earthquake demand, represented by the Cyclic Stress Ratio (CSR), and the soil’s resistance to dynamic loading, represented by the Cyclic Resistance Ratio (CRR). The CSR is correlated to the Peak Ground Acceleration (PGA) of the design earthquake event and the in situ soil stresses. The CRR is correlated to SPT N-values, or cone penetration testing (CPT) resistance obtained from field tests at the site. The field N-values are converted to $N_{1,60,N}$ by applying correction factors for soil overburden pressure, hammer energy efficiency and atmospheric pressure. Field CPT tip resistances are converted to $q_{t1,N}$ by applying correction factors for soil overburden pressure, percent fines and atmospheric pressure.

Liquefaction analyses results are also presented in Appendices A and B. Both zones have points with factors of safety of 1.0 or below, indicating susceptibility to liquefaction.

To further assess the effect of liquefaction, we performed effective-stress non-linear soil amplification analyses with D-MOD2000 for each tower. This approach models the generation of excess pore water pressure (EPWP) and allows a more accurate evaluation of liquefaction potential during the MCE_R event, and of the ground surface acceleration response spectrum. The EPWP ratio is defined as the ratio of pore water pressures developed in the soil at a certain depth, to the soil’s effective stress at that depth. A ratio of 1.0 (or 100 percent) implies that the pore water pressure is equal to the effective stress at a specific depth; when this occurs, the soil has reached complete liquefaction. EPWP ratios less than 1.0 (less than 100 percent) correspond to partial liquefaction. For each zone:

- We modeled two soil columns for each tower (east and west) to consider the influence of different depth to rock.
- We used time series CHY094N for each soil column as the bedrock input motion, to obtain the most conservative estimates of excess pore water pressures. CHY094N is the time series that give the highest acceleration response spectra and EPWP.
- We performed total-stress analyses with SHAKE2000 and D-MOD2000 and calibrated the D-MOD2000 damping parameters so that the ground surface acceleration spectra estimated by the two computer codes reasonably match. Then we performed effective stress analyses with D-MOD2000 using the previously estimated damping parameters.
- We used published relationships that are available in the D-MOD2000 library to model the pore water generation, the soil degradation, the redistribution of the pore water pressures, and the pore water pressure dissipation during the MCER-level event.

The EPWP were also estimated using

- the SHAKE2000-estimated PGA,
- the SPT and CPT data for each tower,
- the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and
- the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983).

Estimated EPWP are presented in Appendices A (Tower 5) and B (Tower 6).

The recommended EPWP ratios to be considered for foundation design at each tower are presented in Appendices A and B. Note that the D-MOD2000 analyses yielded maximum EPWP ratios up to about 90 percent for the upper fill layer for Tower 5 and EPWP ratios up to about 60 percent for the upper fill layer for Tower 6. The associated ground-surface seismic volumetric settlements are estimated to be less than 0.5 inches for both Tower 5 and Tower 6.

5 Results

The results of our analyses are summarized in Appendices A (Tower 5) and B (Tower 6).

Both towers have the same code dictated lower-bound design response spectra. We recommend that LIRR building C (located between the two towers—with similar subsurface conditions) be designed with the same response spectra as the towers, and the higher pore pressure ratios predicted in the Tower 5 analysis.

6 Limitations

The conclusions and recommendations provided in this report are based on current state of practice. Research is ongoing to develop empirical ground-motion attenuation relations, as well as reviewing information related to the seismicity in the project region. Future research may prove counter to the assumed conditions. In addition, the subsurface conditions were inferred from a limited number of historic borings. The recommendations provided are dependent upon one another and no recommendation should be followed independent of the others.

Any proposed changes in structures or their locations should be brought to Langan’s attention as soon as possible so that we can determine whether such changes affect our recommendations. The information is assumed to represent conditions reported only at the locations indicated and at the time of investigation. If different conditions are encountered during construction, they should immediately be brought to Langan’s attention for evaluation, as they may affect our recommendations.

This report has been prepared to assist the Owner, architect and structural engineer in the design process and is only applicable to the design of the specific project identified. The information in this report cannot be utilized or depended on by engineers or contractors who are involved in evaluations or designs of facilities (including underpinning, grouting, stabilization, etc.) on adjacent properties which are beyond the limits of that which is the specific subject of this report.

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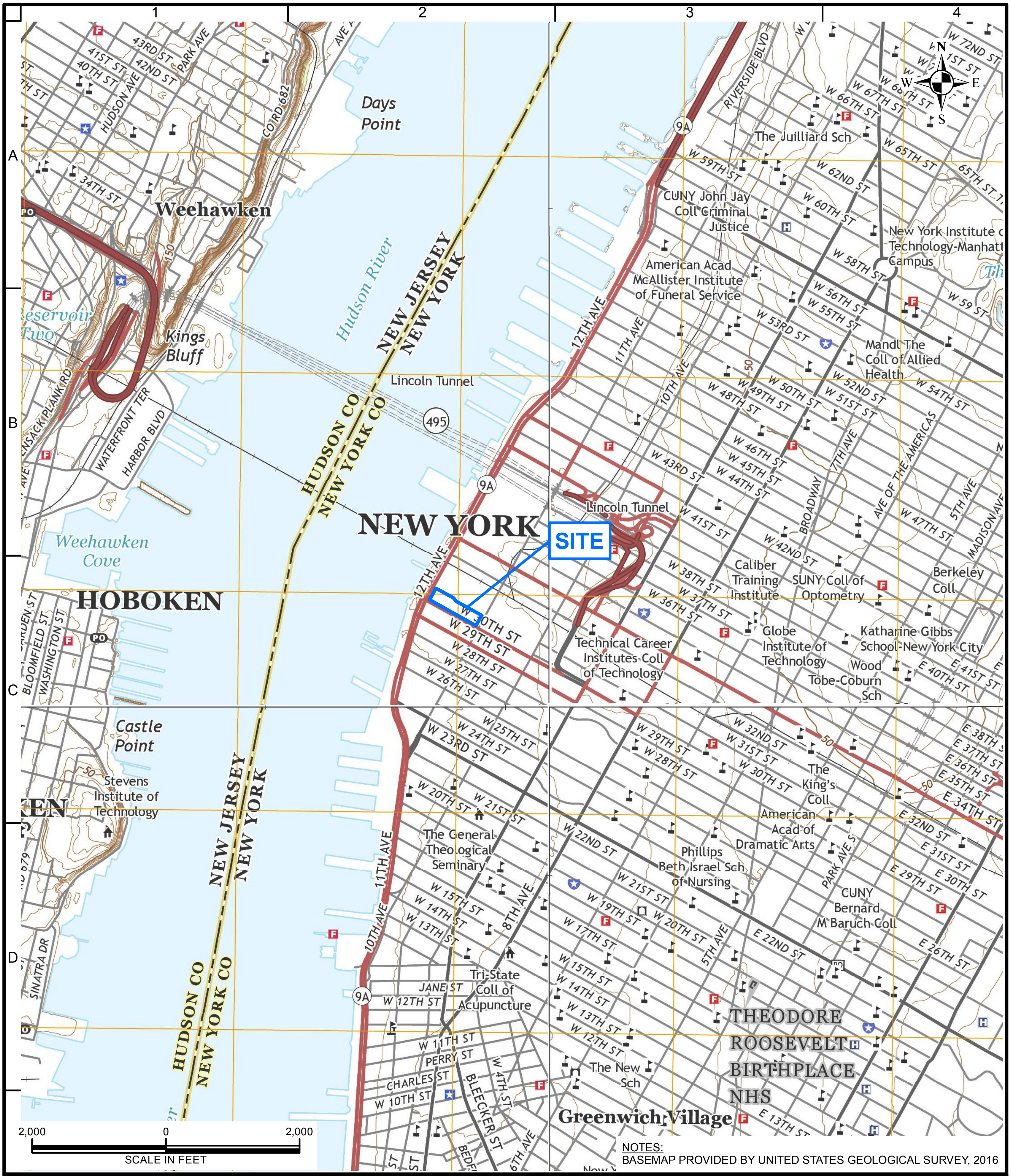
End of Report

FIGURES



NOTES:
BASEMAP PROVIDED BY UNITED STATES GEOLOGICAL SURVEY, 2016

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Langan International LLC

Collectively known as Langan

Project

WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

SITE LOCATION MAP

Project No.
170444101

Date
7/3/2018

Scale
1"=2000'

Drawn By
TKS

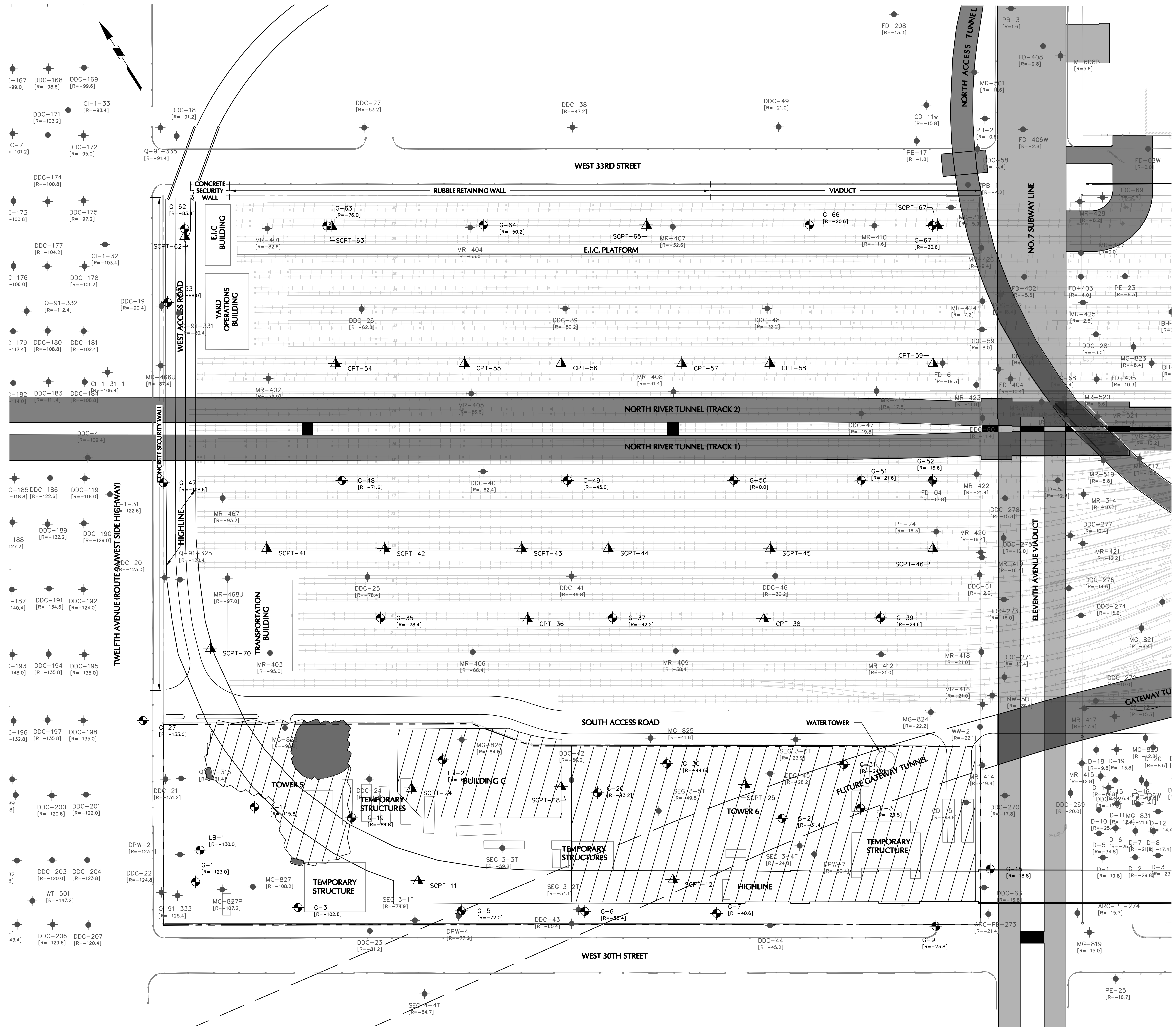
Submission Date
7/3/2018

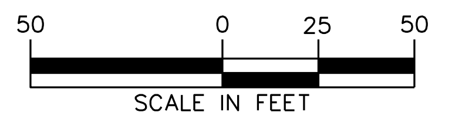
Drawing

1

Sheet 1 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 1 - Site_Location_Map_Update.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 1.676 FEET BELOW THE BOROUGH OF MANHATTAN DATUM (BPMD).
4. DATUM CONVERSIONS
   BPMD = NAVD88 – 1.676'
   NGVD29 = NAVD88 + 1.076'
   NYCT = NAVD88 + 98.423'
   PENN = NAVD88 + 298.351'
5. BORING, CPT AND TEST PIT LOCATIONS SHOULD BE CONSIDERED APPROXIMATE.
6. 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.
7. 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.
8. 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

⊕ LB-# ELEV (NAVD88)	LANGAN BORINGS 2017 APPROXIMATE ELEVATION (TOP OF ROCK)
⊕ 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 WEST RAIL YARD TERRA FIRMA SITE

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Project

WEST RAIL YARD
TERRA FIRMA

HUDSON YARDS

MANHATTAN **NEW YORK**

Drawing Title

BORING AND CPT LOCATION PLAN

Project No.
170444101

Date
7/2/18

Scale
1" = 50'

Drawn By
KM

Checked By
MP

Submission Date
-

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2

Sheet 2 of 3

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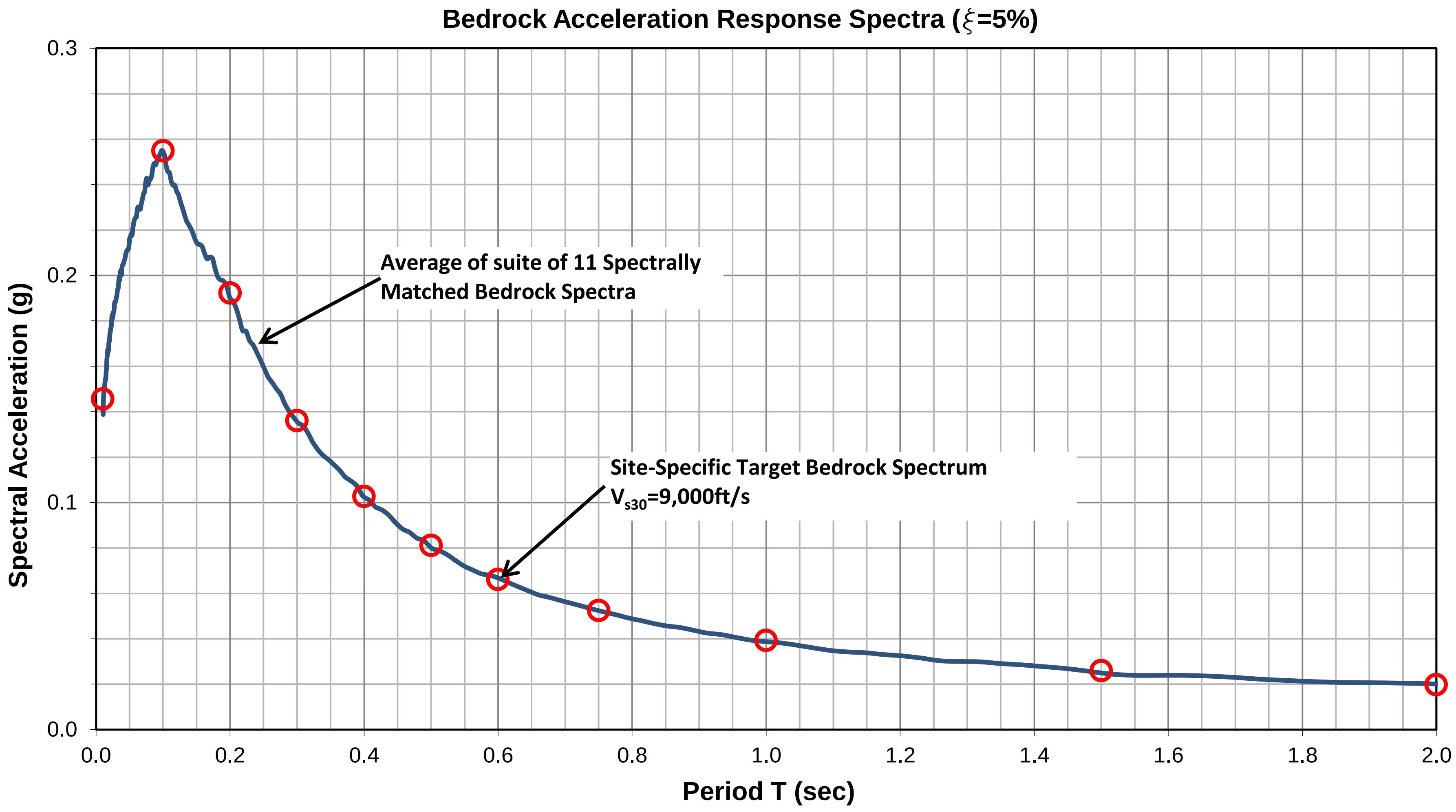

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Drawing Title

BEDROCK MCE$_R$
SPECTRA

Project No. 170444103
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Submission Date 7/3/2018
Drawing No. 3
Sheet 3 of 3

APPENDIX A

Tower 5 Site-Specific Seismic Study

We performed a site-specific seismic analysis for Tower 5 of the terra firma site. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Tower 5 consist of fill, underlain by consecutive layers of organic clay, silty clay/clayey silt, sand and finally bedrock. The depth to bedrock varies from 72 to 140 feet, increasing east to west. We selected two soil columns (east and west) to represent differing soil conditions and the variation in depth to bedrock of the zone. The depth to rock of the two soil columns are based on the average depth to rock of the borings in the east and west side of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table A-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table A-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

East Column - Representative of the east side of the zone Based on G-5, G-19, LB-2, SCPT-11, SCPT-24			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	30	290 to 678	440
Organic Silty Clay	27	406 to 510	460
Silty Clay/Clayey Silt	21	570 to 832	625
Sand	3	1,000 to 1,490	1,250
Bedrock	N/A	9,000	9,000

West Column - Representative of west side of the zone Based on G-1, G-3, G-17, LB-1, SCPT-11, SCPT-24			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	30	290 to 678	440
Organic Silty Clay	27	406 to 510	460
Silty Clay/Clayey Silt	53	550 to 730	625
Sand	3	1,000 to 1,490	1,250
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\bar{V}_s$) between about 485 and 495 feet per second (fps). The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure A-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Idriss and Boulanger (2008) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude (5.45), but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.33g for Site Class E;
- A magnitude scaling factor (MSF) of 1.6, per the Idriss and Boulanger (2008).

The initial Idriss and Boulanger (2008) liquefaction analysis indicated potential liquefaction at depths between about 8 and 35 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as 90 percent at depths between 25 to 30 feet, corresponding to partial liquefaction (partial soil strength loss).

The EPWP were also estimated using the SHAKE2000-estimated PGA of 0.112g, the SPT and CPT data from G-1, G-3, G-17, G-19, CPT-11 and CPT-24, the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983). The estimated EPWP are shown on Figure A-2. The DMOD-estimated EPWP are typically higher than the empirically-estimated EPWP.

Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We gave more weight to the DMOD-2000 results. The excess pore water pressure ratios estimated from DMOD2000 analyses and empirical method mentioned above are presented in Figure A-2 and listed in Table A-2.

Table A-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
0 to 10	<10%	0%
10 to 20	0% to 50%	30%
20 to 30	40% to 90%	65%
Below 30	<20%	0%

We estimated up to 0.5 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table A-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure A-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table A-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure A-4. The short-period and 1-second-period design accelerations obtained from the recommended design spectrum are as follows:

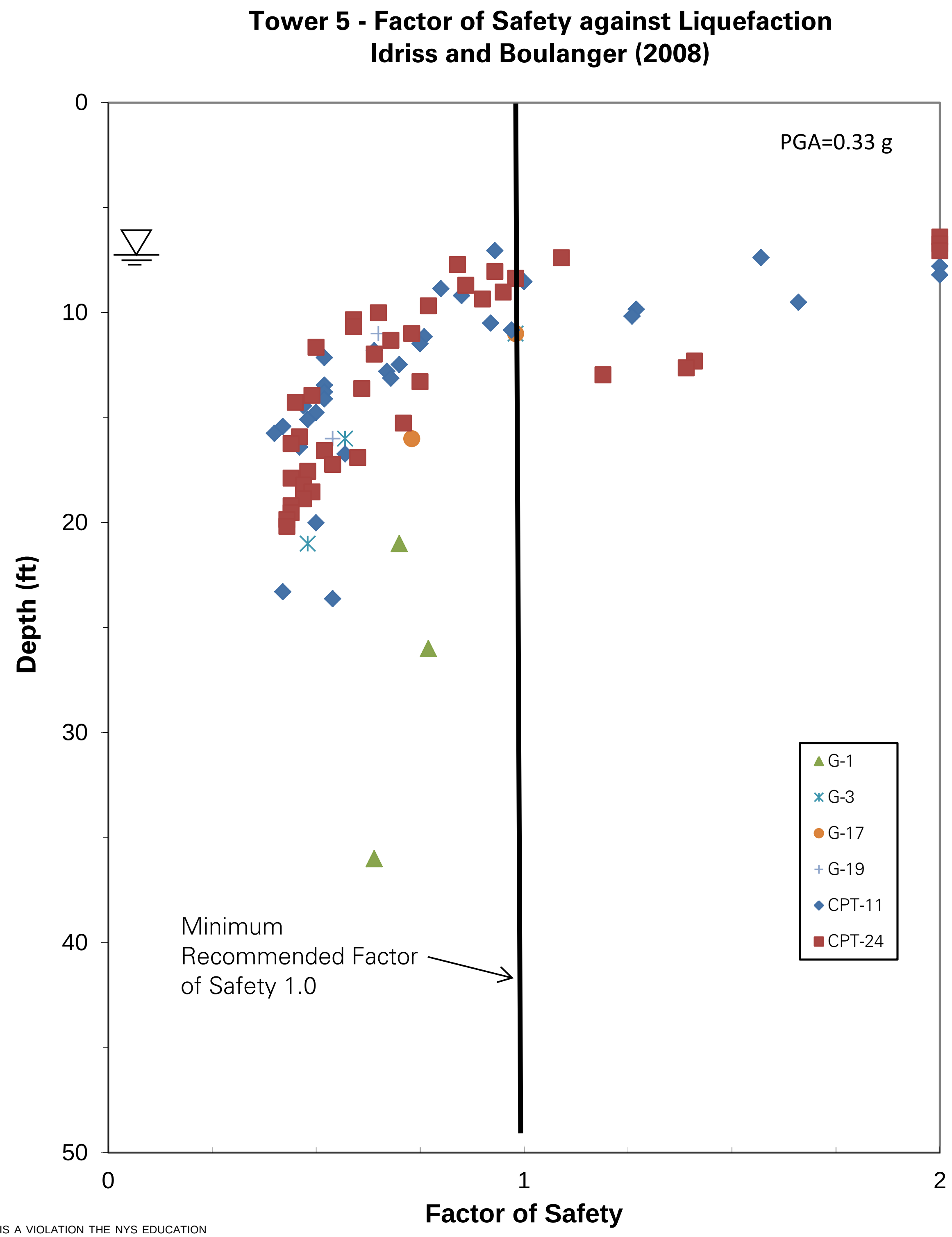
- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table A-4.

Table A-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.112g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C



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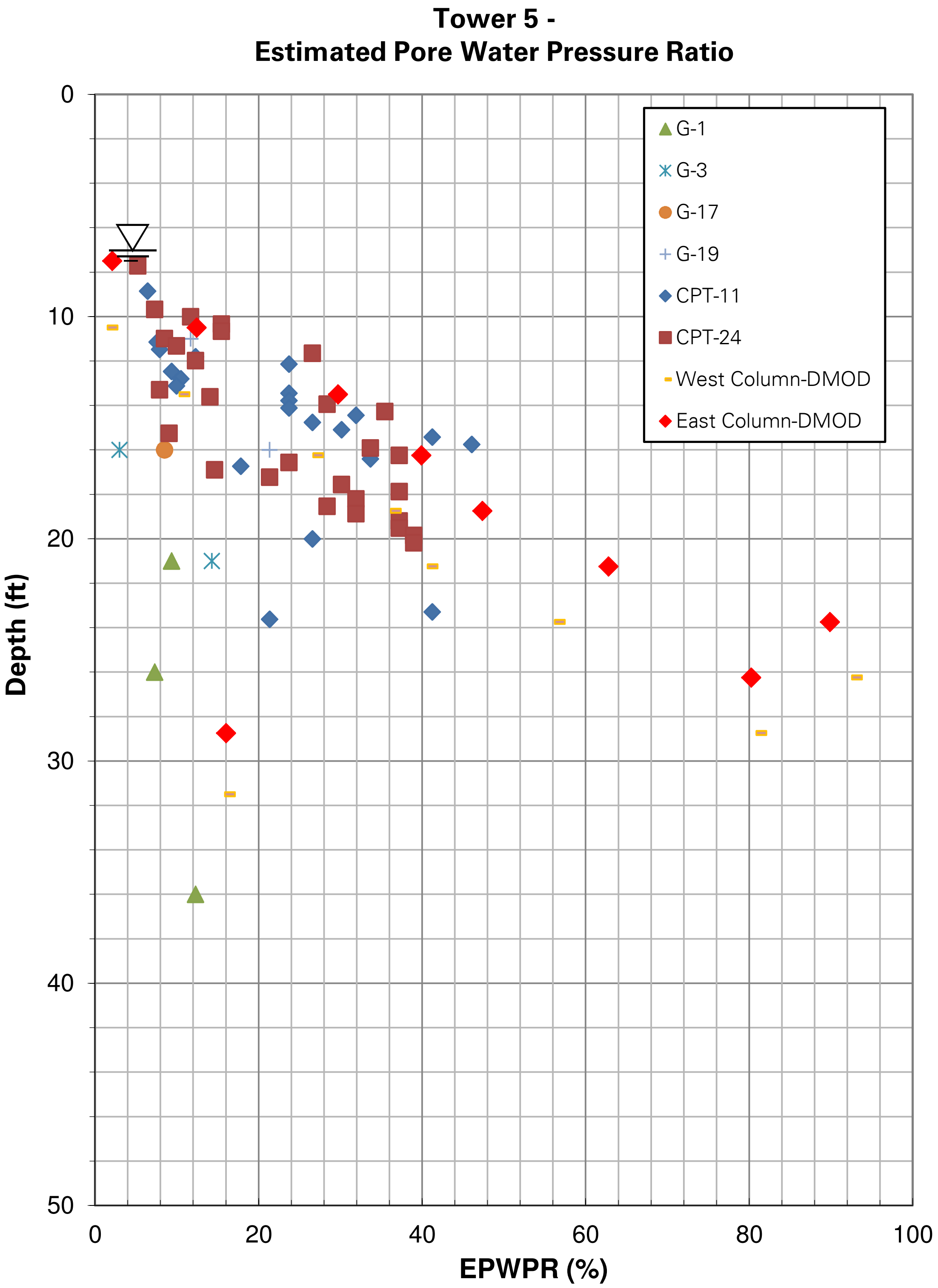
WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
TOWER 5
LIQUEFACTION
ASSESSMENT
(IDRISS AND
BOULANGER, 2008)

Project No.	170444103
Date	7/3/2018
Scale	NTS
Drawn By	LY
Submission Date	7/3/2018
Drawing No.	A-1
	Sheet 1 of 4



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HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

TOWER 5
ESTIMATED PORE
WATER PRESSURE
RATIO FROM DMOD
AND EMPIRICAL
METHOD

Project No.
170444103

Date
7/3/2018

Scale
NTS

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LY

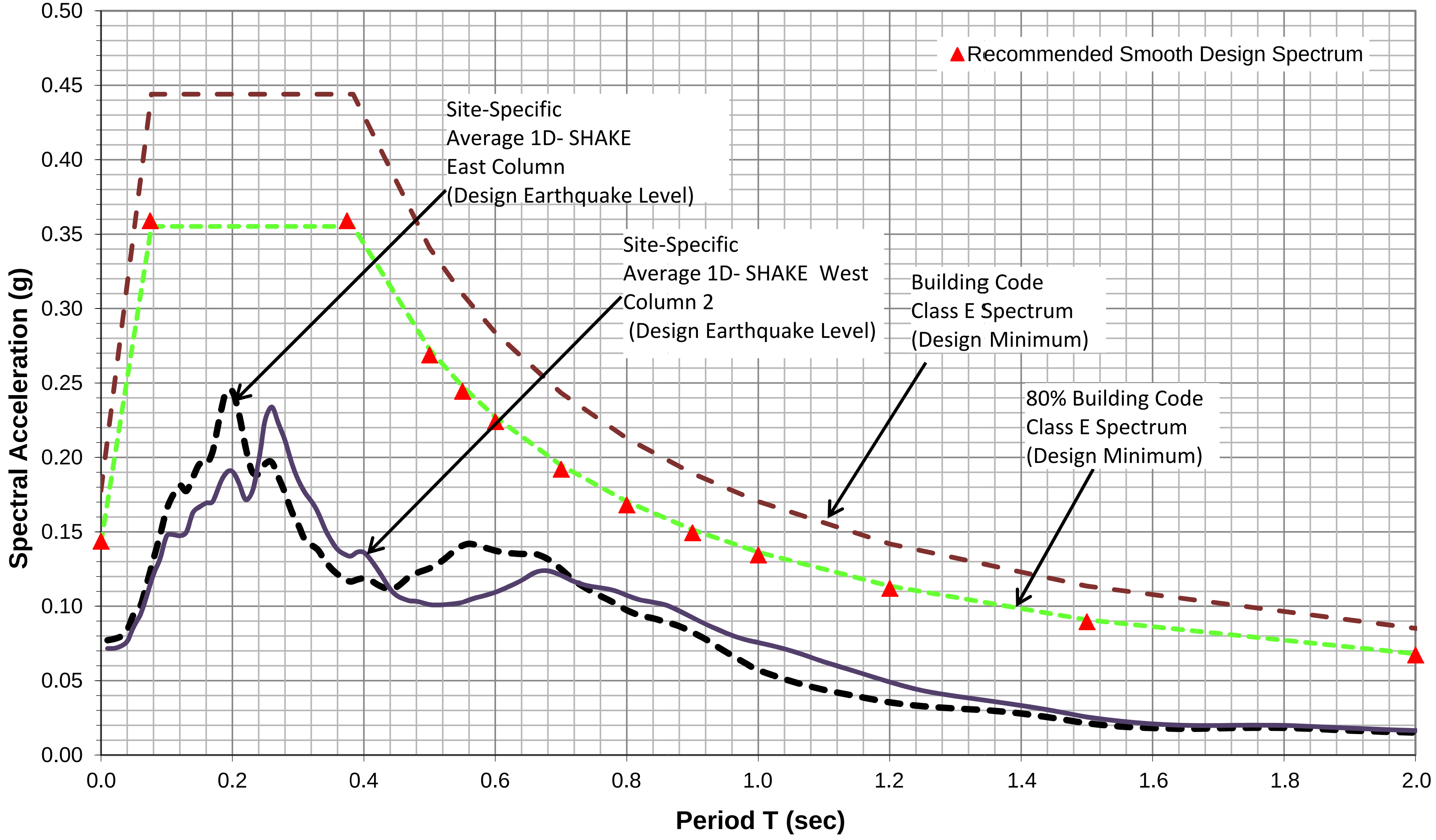
Submission Date
7/3/2018

Drawing No.

A-2

Sheet 2 of 4

Ground Surface Design Acceleration Response Spectra (ξ=5%)



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TOWER 5
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

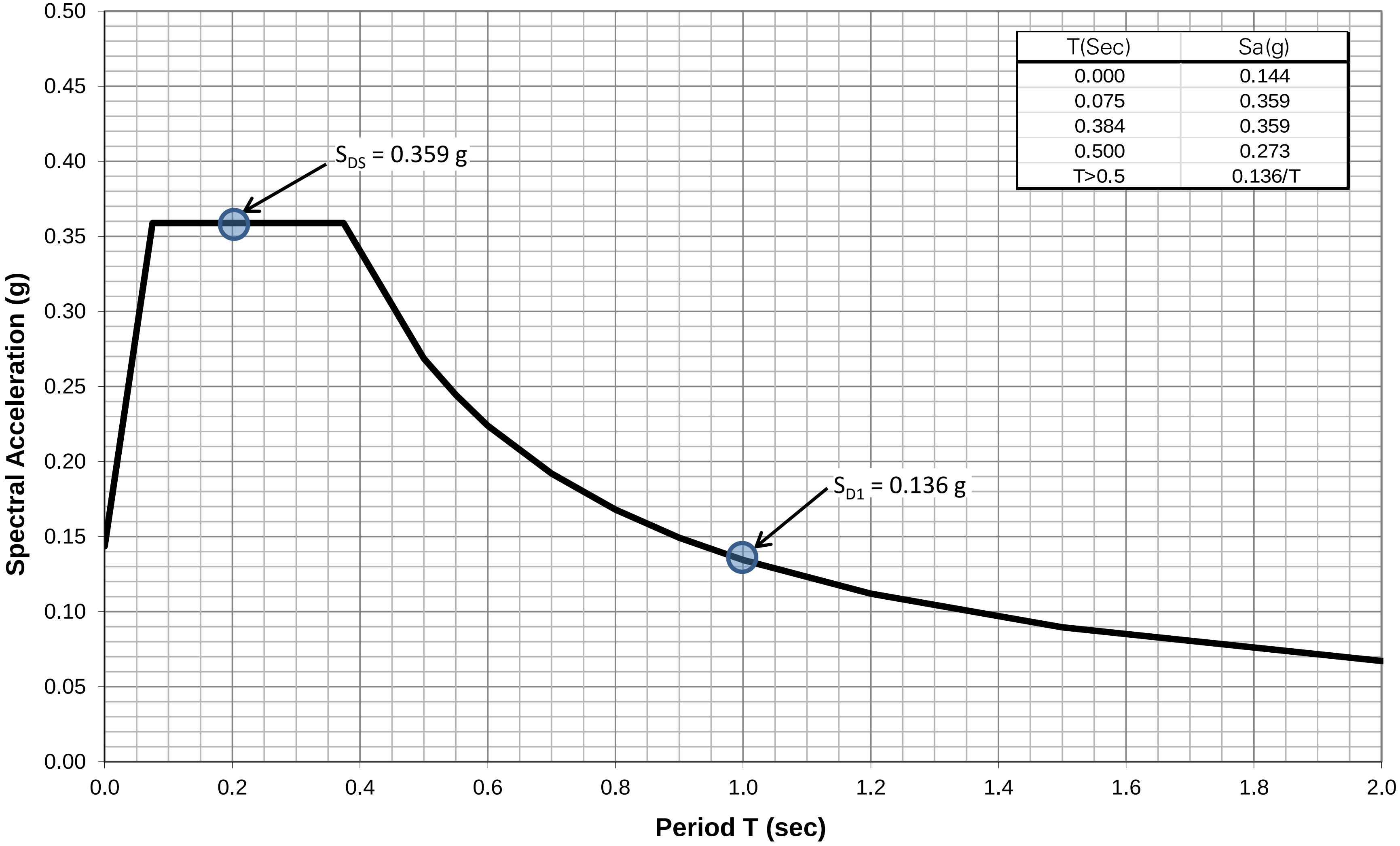
Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.

A-3

Sheet 3 of 4

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



T(Sec)	Sa(g)
0.000	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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Drawing Title
TOWER 5
RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.
A-4

Sheet 4 of 4

APPENDIX B

Tower 6 Site-Specific Seismic Study

We performed a site-specific seismic analysis for Tower 6 of the terra firma site. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Tower 6 consist of fill, underlain by consecutive layers of silty clay/clayey silt, sand and finally bedrock. The depth to bedrock varies from 32 to 70 feet, increasing east to west. We selected two soil columns (east and west) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table B-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table B-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

East Column - Representative of the east side of the zone Based on G-9, G-15, G-21, G-31, LB-3, SCPT-25			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	20	325 to 875	475
Silty Clay/Clayey Silt	15	350 to 450	425
Sand	5	675 to 1,150	900
Bedrock	N/A	9,000	9,000

West - Representative of west side of the zone Based on G-6, G-7, G-20, G-30, SCPT-12, SCPT-68			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	29	407 to 670	550
Silty Clay/Clayey Silt	22	370 to 570	445
Sand	10	650 to 1,490	1,050
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 490 and 540 feet per second (fps). The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure B-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Idriss and Boulanger (2008) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.33g for site class E;
- A magnitude scaling factor (MSF) of 1.6, per Idriss and Boulanger (2008).

The initial Idriss and Boulanger (2008) liquefaction analysis indicated potential liquefaction at depths between about 6 and 40 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as about 60 percent at depths around 15 to 20 feet, corresponding to partial liquefaction (partial soil strength loss).

The EPWP were also estimated using the SHAKE2000-estimated PGA of 0.129g, the SPT and CPT data from G-9, G-15, G-21, G-31, LB-3, G-6, G-7, G-20, G-30, SCPT-25, SCPT-12, SCPT-68, the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983). The estimated EPWP are shown on Figure B-2.

Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We gave more weight to the DMOD-2000 results. The excess pore water pressure ratios estimated from DMOD2000 analyses and empirical method mentioned above are presented in Figure B-2 and listed in Table B-2.

Table B-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
6 to 10	<20%	0%
10 to 30	10% to 60%	40%
Below 30	< 20%	0%

We estimated up to about 0.5 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table B-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure B-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table B-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure B-4. The short-period and 1-second-period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

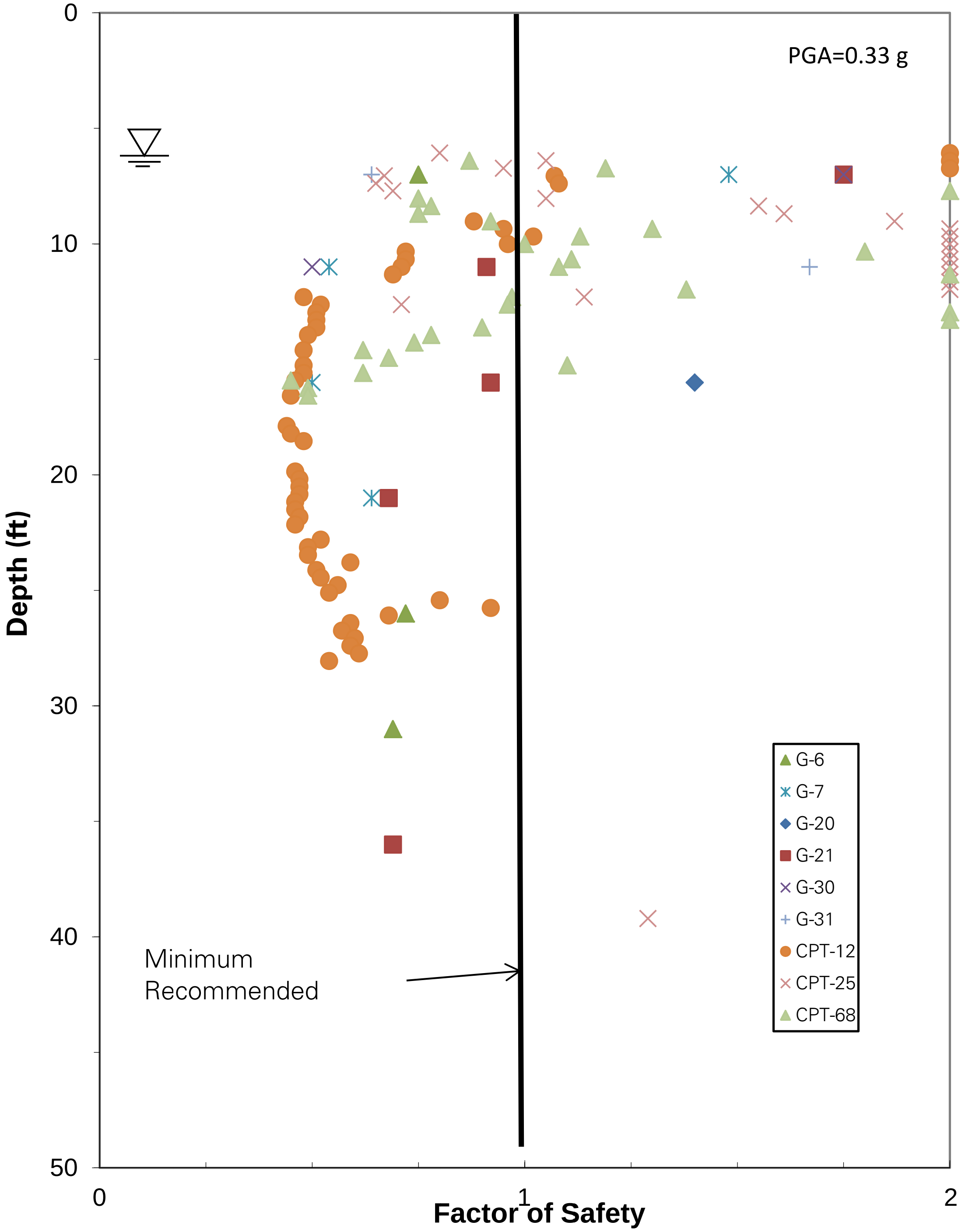
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table B-4.

Table B-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.129 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Building 6
Factor of Safety against



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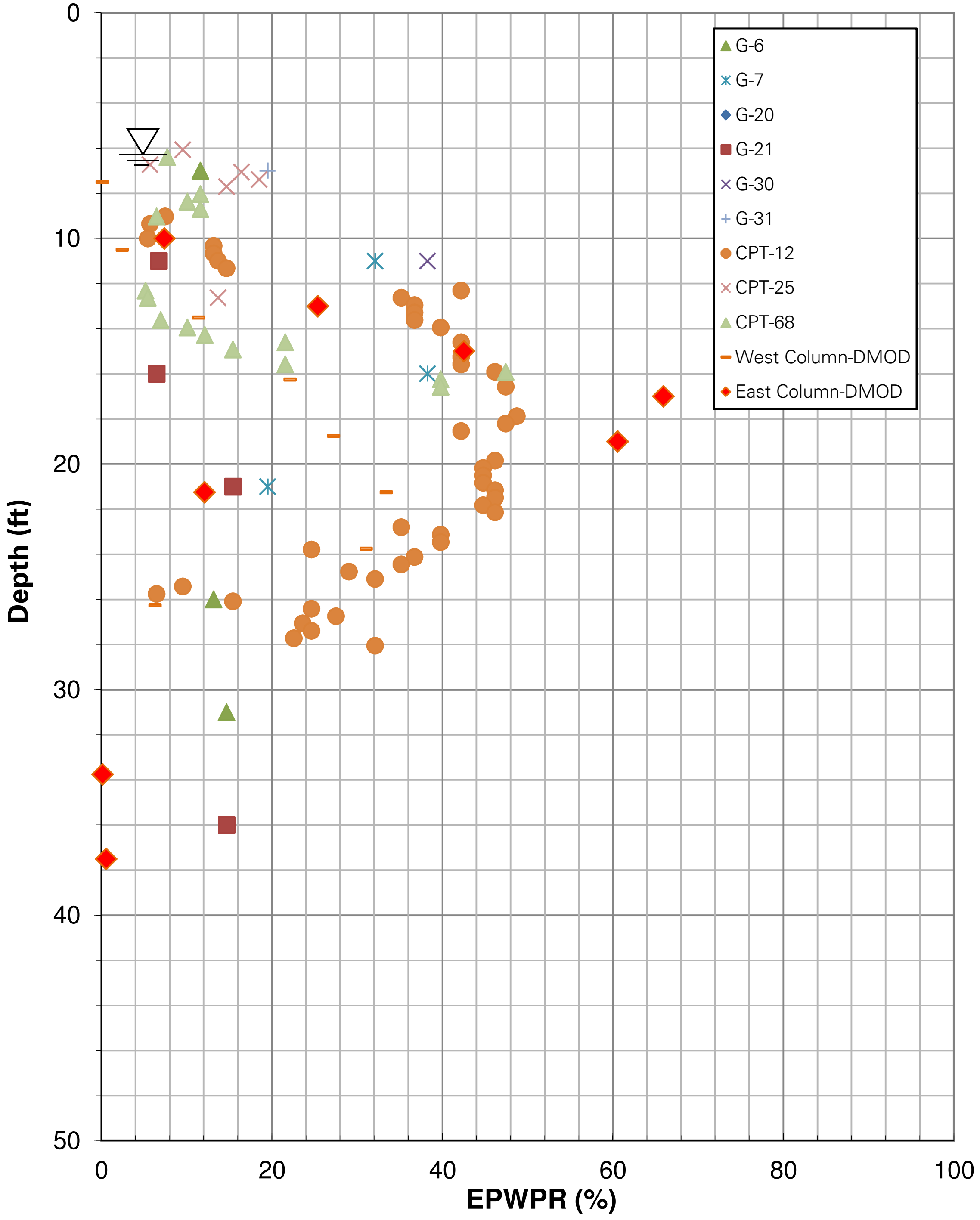
Drawing Title
TOWER 6
LIQUEFACTION
ASSESSMENT
(IDRISS AND
BOULANGER, 2008)

Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.
B-1
Sheet 1 of 4

Tower 6
Estimated Pore Water Pressure



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Drawing Title
TOWER 6
ESTIMATED PORE
WATER PRESSURE
RATIO FROM DMOD
AND EMPIRICAL
METHOD

Project No.
170444103
Date
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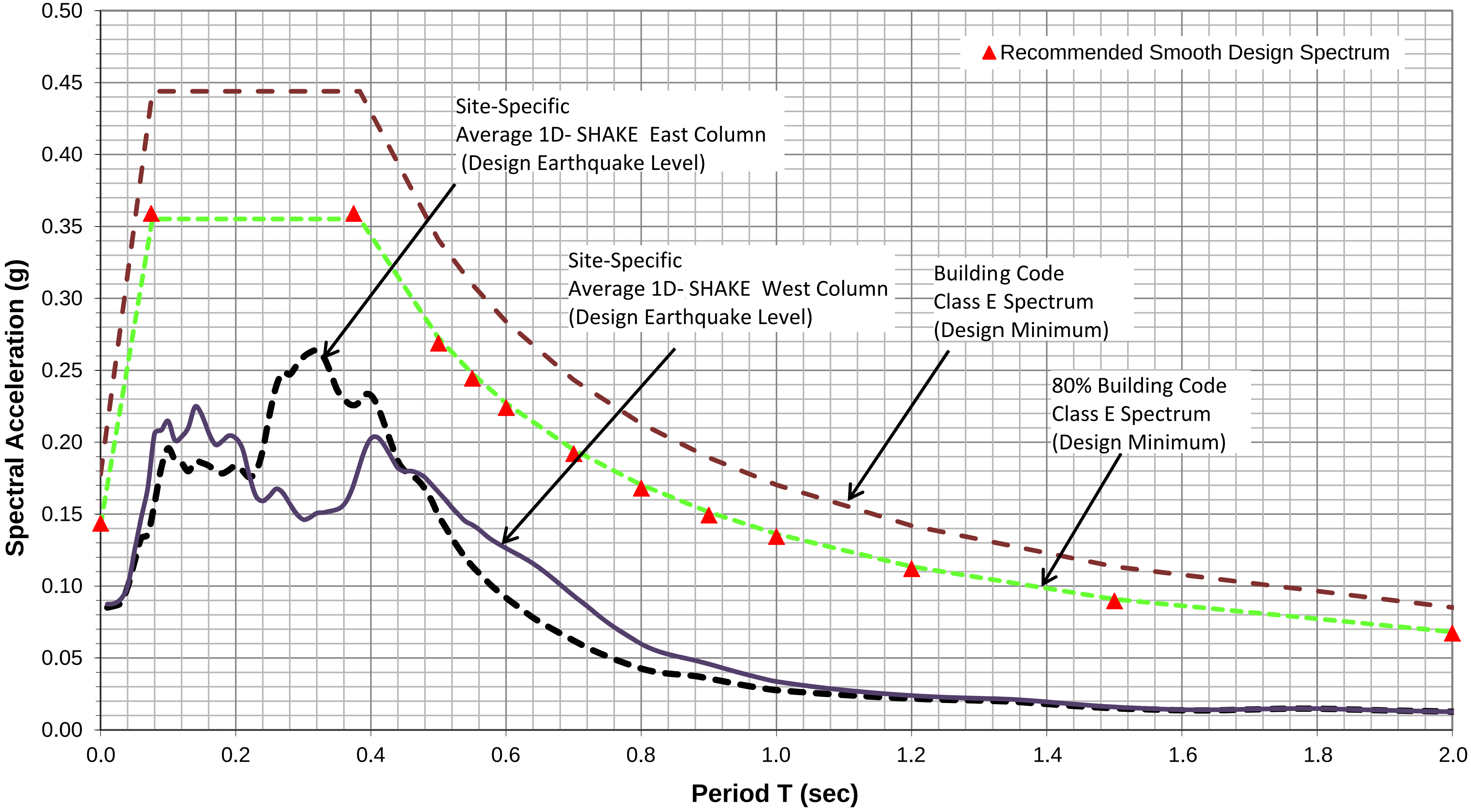
Scale
NTS
Drawn By
LY
Submission Date
7/3/2018

Drawing No.
B-2
Sheet 2 of 4

Ground Surface Design Acceleration Response Spectra (ξ=5%)



Site-Specific
Average 1D- SHAKE East Column
(Design Earthquake Level)

Site-Specific
Average 1D- SHAKE West Column
(Design Earthquake Level)

Building Code
Class E Spectrum
(Design Minimum)

80% Building Code
Class E Spectrum
(Design Minimum)

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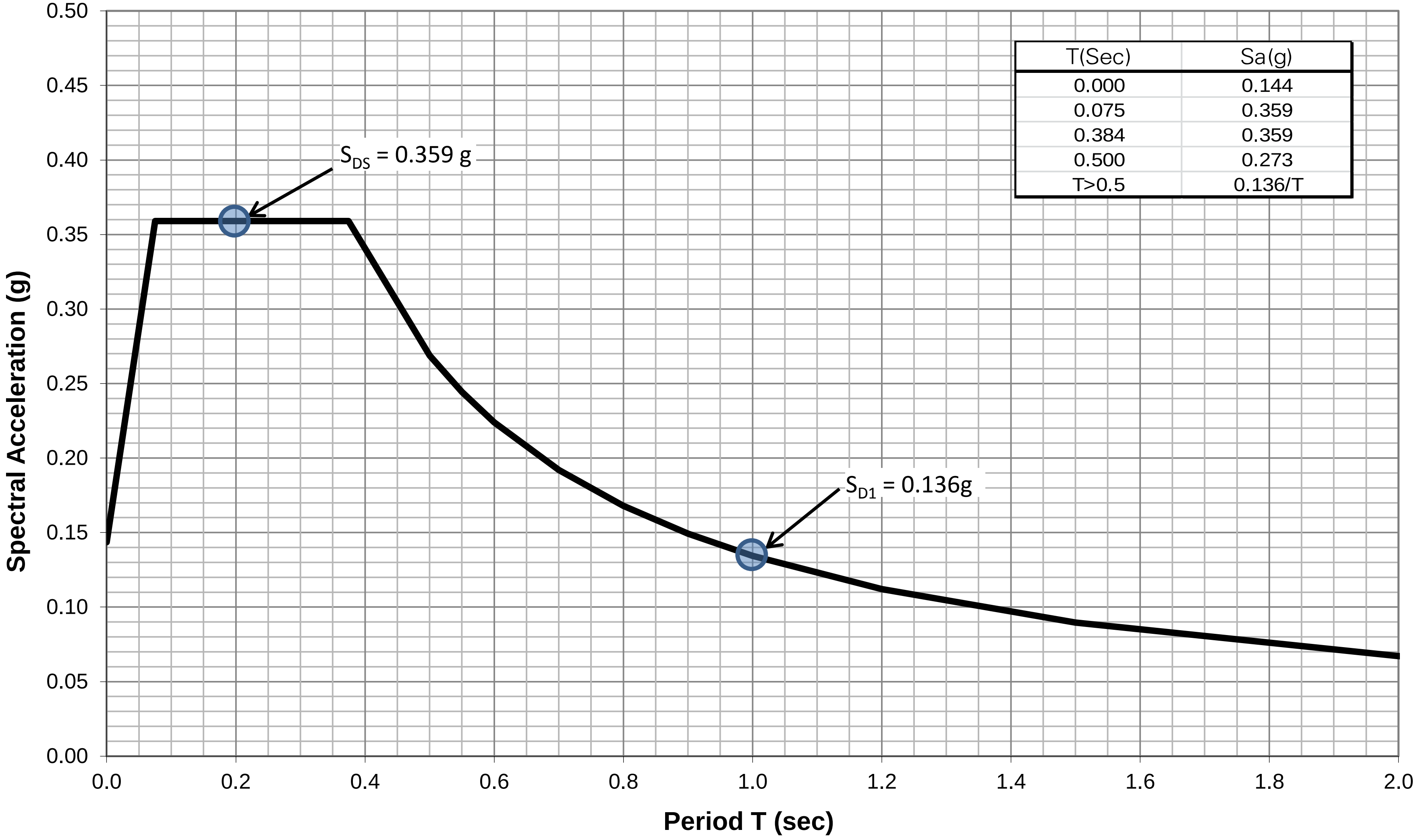
Drawing Title
TOWER 6
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.
B-3

Sheet 3 of 4

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



T(Sec)	Sa(g)
0.000	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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WEST RAIL YARD
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Drawing Title
TOWER 6
RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No. 170444103
Date 7/3/2018
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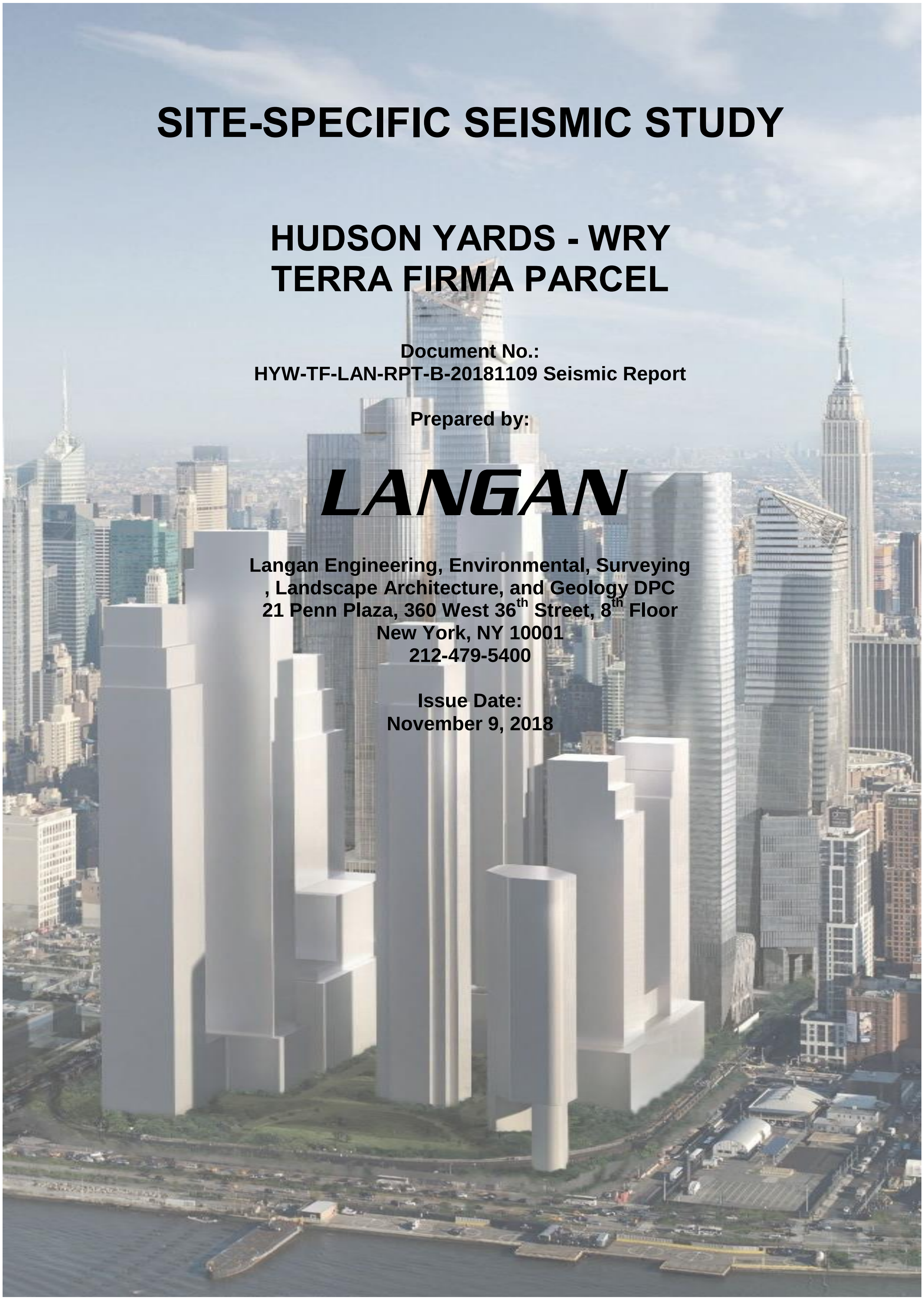
B-4

Sheet 4 of 4

Appendix J3 Site-Specific Seismic Study

RELATED OXFORD
HUDSON YARDS



SITE-SPECIFIC SEISMIC STUDY

HUDSON YARDS - WRY
TERRA FIRMA PARCEL

Document No.:
HYW-TF-LAN-RPT-B-20181109 Seismic Report

Prepared by:

LANGAN

Langan Engineering, Environmental, Surveying
, Landscape Architecture, and Geology DPC
21 Penn Plaza, 360 West 36th Street, 8th Floor
New York, NY 10001
212-479-5400

Issue Date:
November 9, 2018

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 Executive Summary

Langan Engineering, Environmental, Surveying, Landscape Architecture, and Geology D.P.C. performed site-specific seismic studies for the proposed buildings within the terra firma site of the West Rail Yard of Hudson Yards. Two towers (Towers 5 and 6) were independently evaluated in this study. One low-rise structure (Building C), located between the two towers, was also evaluated using the site-specific studies for the towers.

The entire terra firma site was preliminarily classified as Site Class F because of liquefaction susceptibility identified using the 2014 New York City Building Code (NYCBC) and 2015 New York State Building Code (NYSBC) general procedures. Site Class F requires site-specific seismic analyses to assess the seismic response of the ground and to determine seismic design parameters.

This study is specific to the referenced site and reflects the state-of-practice in the fields of seismology and geotechnical earthquake engineering. This study was performed in accordance with the provisions of 2014 NYCBC, 2015 NYSBC and ASCE 7-10. The following summarizes the approach and key conclusions from the study:

1. Seismic hazard analysis and selection of bedrock acceleration time series:

   a. We performed a probabilistic seismic hazard analysis to develop the target bedrock acceleration response spectrum.

   b. We selected 11 representative “seed” ground motion acceleration time series and modified them by matching their acceleration spectra to the target spectrum to develop 11 input bedrock motions for the site-specific ground response analyses.

2. Site-specific ground-response analyses:

   a. The site was divided into two zones corresponding to the proposed Tower 5 and Tower 6 locations. For each tower, we performed individual site-specific total-stress and effective-stress ground response analyses (soil amplification analysis) using the developed input bedrock motions (acceleration time series). We applied the motions at the base of one dimensional soil columns and estimated ground response spectra.

   b. We developed a site-specific design response spectrum for each tower using the respective estimated ground response spectra.

3. Liquefaction analyses:

   a. For each tower, we evaluated the potential for liquefaction of the granular soils below the groundwater table for the risk-targeted maximum considered earthquake (MCE_R) level event (about 10 percent higher PGA than the geometric mean – MCE_{GM} level).

   b. We estimated the potential free-field ground surface seismic settlements during the MCE_R event.

   c. We estimated excess pore water pressure ratios in the soils during the MCE_R level event.

4. Conclusions and recommendations:

   a. The recommended short- and long-period design spectral accelerations and Seismic Design Categories are provided in Appendices A (Tower 5) and B (Tower 6). Note the response spectra for both towers are limited to a Code dictated lower-bound. We recommend LIRR Building C be designed using the same lower-bound response spectra as the towers.

b. We estimated excess pore water pressure ratios as high as about 90 percent for Tower 5 and 60 percent for Tower 6 during the MCE_R-level event, corresponding to partial liquefaction (partial soil strength loss). The excess pore water pressure ratios we estimated using empirical methods were as high as 40 percent and 50 percent, respectively. Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We recommend using the higher predicted pore water pressures from the Tower 5 analysis for the design of LIRR Building C.

c. We estimated up to about 0.5 inch of seismic-event-induced settlement for free-field conditions after the MCE_R-level event. Utilities under the sidewalks and site connections should be designed to account for differential settlements up to about 0.5 inch between sidewalk and pile- or rock-supported structures.

2 Introduction

This report presents the results of our site-specific seismic study for the proposed development within the terra firma site of the West Rail Yard of Hudson Yards. Our study was performed to assess the seismic response of the ground at the project site, as required by the 2014 NYCBC and 2015 NYSBC for sites susceptible to liquefaction (i.e. Site Class F), and to determine appropriate seismic parameters for use in design of the proposed structures.

The analyses and recommendations presented herein are in accordance with the NYCBC, NYSBC and ASCE 7-10. All elevations contained herein reference the North American Vertical Datum of 1988 (NAVD88) and are approximate.

3 Project Overview

3.1 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 “terra firma” (Block 676, Lot 1) and “platform” (Block 676, Lot 5) parcels. This report focuses solely on the terra firma site. The terra firma site measures about 147,000 square feet and is bound by the LIRR South Access Road and platform parcel on the north, West 30th Street 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 terra firma site is occupied by several LIRR support facilities at the east end of the site, a laydown area for ongoing construction within Hudson Yards near the center of the site, and a Vehicle Processing Center (VPC) near the west end of the site. An LIRR access road borders the north side of the site. The High Line Park elevated rail line traverses along the south and west sides of the site. The structure parallels West 30th Street then arcs north, near the west end of the site. Numerous structures are adjacent to the site, including an active rail yard to the north and the Eleventh Avenue viaduct and Segment 2 of the Amtrak Gateway tunnel to the east.

Additional details pertaining to the site are included in our Geotechnical Report, dated 9 November 2018.

3.2 Proposed Development

The planned development includes construction of three structures:

- **Tower 5 –** Tower 5 will be on the west side of terra firma and will consist of a high-rise residential building spanning over the Highline. The tower will be supported by a core northeast of the Highline and two mega columns southwest of the Highline. A cellar is limited to the core area northeast of the Highline. Maintenance space will occupy the ground and platform levels, and a residential lobby will occupy the plaza level. The full tower footprint will span over the Highline above the plaza level.

  Tower 5 will be designed in accordance with the 2014 New York City Building Code (NYCBC). The design team has not been selected.

- **Tower 6 –** Tower 6 will be on the east side of the site between the Highline and LIRR South Access Road and will consist of a high-rise building with residential, retail, and school spaces. The building will have a single cellar level for use as parking and utility space. Retail space, a school, maintenance facilities, and parking will occupy the ground level and extend under the Highline to provide frontage along West 30th Street. A portion of the school and additional parking will occupy the platform level. Portions of the school, retail space, and a residential lobby will occupy the plaza level. The tower will contain residential units.

  Tower 6 will be constructed over, and will be partially supported by the Amtrak Gateway tunnel Segment 3 (to be constructed).

  Tower 6 will be designed in accordance with the NYCBC. The design team has not been selected.

- **LIRR Building C –** A two-story LIRR support building (“Building C”) will be constructed below the platform and between towers 5 and 6. Building C will have a single cellar level.

  The LIRR building will be designed in accordance with the 2015 New York State Building Code (NYSBC) with applicable Uniform Code supplements through 2017.

3.3 Local Faults and Seismicity

New York City is on the Manhattan Prong, in the passive continental margin of the stable central and eastern United States, far from tectonic plate boundaries (approximately 1,400 miles from the nearest tectonic plate boundary). Seismicity in this region is overall low, with the exception of a few zones such as the New Madrid (Missouri) and Charleston, South Carolina seismic zones. The Manhattan Prong is relatively active compared to most of this region; the largest earthquake in the area was a magnitude mbLg 5.25 event offshore of New York City in 1884.

Many faults have been identified in the Manhattan Prong and the surrounding regions, but the locations of active faults is not clear (Sykes et al. 2008). There are difficulties in characterizing the activity of faults in the region because of the small sizes of ruptures, the absence of surface rupture, and the distribution of seismicity on many smaller faults, each with very low displacement rates.

A fault known as Cameron’s Line is about 2.5 miles east of the site. Cameron’s Line is described as an Ordovician (Taconic) suture zone. Geologists postulate that the fault was healed by Paleozoic metamorphism and is no longer a zone of brittle faulting or a source of earthquakes. Assumed brittle faults of the Manhattan Prong include the 125th Street fault, which extends across Manhattan to Queens; the Dyckman Street fault; and the Dobbs Ferry fault. Experts recognize that research is needed to improve the mapping and dating of these various faults to improve seismic-hazard studies.

3.4 Subsurface Data

Subsurface data was derived from numerous investigations undertaken within and adjacent to the WRY. This information includes borings and cone penetration testing (CPT) data, as well as laboratory testing of soil 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 2.

The geotechnical parameters used in this study were primarily derived from 16 geotechnical borings, five seismic CPTs, and laboratory testing performed as part of the design of the proposed New York Sports and Convention Center (NYSCC) in 2004, and three additional borings drilled for the test caissons in 2017. This data was supplemented with historical data within and adjacent to the site prepared by others.

3.5 Generalized Subsurface Conditions

The subsurface conditions were interpreted separately for each tower using available boring, CPT and lab data in the vicinity of each building.

The general subsurface conditions consist of uncontrolled fill underlain by consecutive layers of clay and silt, sand, glacial till, and bedrock. Bedrock was encountered from about el -22 feet to -131 ft; the depth to rock generally increases from east to west.

Groundwater was measured in monitoring wells installed in the vicinity of the site from as high as about el 3.9 ft to as low as el -1.5 ft, but groundwater is generally expected to vary from about el 0 to 2 ft. Groundwater levels are tidally influenced along the west side of the site given the relatively close proximity to the present Hudson River shoreline. In addition, groundwater levels are likely to fluctuate with seasonal changes and precipitation events. Zones of perched water may be present at some locations due to the inconsistent nature of the fill and native soils.

The shear wave velocity of the bedrock was estimated to be around 9,000 feet per second based on the cross-hole seismic tests and borehole suspension logging performed within the same rock formation at nearby sites.

The soil and rock parameters used in the site specific seismic analyses are summarized for each tower in Appendices A and B.

Additional details are presented in our Geotechnical Report, dated 9 November 2018.

4 Seismic Evaluation

4.1 Introduction

We performed a site-specific seismic study for each tower to develop a design acceleration response spectrum, as required by the NYCBC and NYSBC for sites susceptible to liquefaction. Site specific analyses are more rigorous than the general procedures outlined in the NYCBC and NYSBC. The general procedures typically do not accurately represent the amplitude and frequency content specific to an individual site. As such, design acceleration response spectrum values derived using the general procedures may be either overly conservative or, in some cases, unconservative.

Our evaluation included:

1. Performing a probabilistic seismic-hazard analysis;
2. Selecting and modifying appropriate bedrock acceleration time series;
3. Estimating dynamic soil and bedrock properties for each zone;
4. Determining the Site Class per the Building Code for each zone;
5. Performing total-stress and effective-stress ground response analyses for each zone;

6. Performing analyses to evaluate the liquefaction potential and estimate excess pore water pressures in the granular soils situated below the groundwater table for each zone;

7. Recommending an appropriate design acceleration response spectrum for each zone; and,

8. Determining the Seismic Design Category (SDC) for each zone.

We developed a design acceleration-response spectrum specific to each tower using state of practice methods and reflecting in situ soil and bedrock conditions. Our evaluation was performed in accordance with provisions of 2014 NYCBC, 2015 NYSBC, and ASCE 7-10. The study included one-dimensional wave-propagation analyses to estimate the response at the site ground surface during a design seismic event.

The total-stress one-dimensional analyses were performed using the commercial computer program Shake2000 (Geomotions, 2015). The effective-stress one-dimensional analyses were performed using the commercial computer program D-MOD2000 (Geomotions, 2015).

4.2 Probabilistic Seismic Hazard Analysis

We performed a probabilistic seismic-hazard analysis (PSHA) to systematically account for uncertainties in the location, recurrence interval, and magnitude of future earthquakes. The results of a PSHA define a uniform hazard for a site in terms of a probability that a particular level of shaking will be exceeded during the given life of the structure.

As part of the development of the risk-targeted maximum considered earthquake (MCE_R) spectrum at bedrock level, we performed a PSHA to develop a site-specific response spectrum for a 2 percent probability of exceedance in 50 years (i.e. a return period of 2,475-year earthquake). The bedrock spectrum was developed using the computer code EZ-FRISK 8.00 (Fugro Consultants Inc. 2016). The approach used in EZ-FRISK is based on the probabilistic seismic-hazard model developed by Cornell (1968) and McGuire (1976).

4.3 Source Modeling and Characterization

We used the Petersen et al. (2014) seismic source model with the same logic tree used for the production of the USGS 2014 maps. We understand that Fugro Consultants Inc. obtained this database directly from the USGS.

4.4 Empirical Ground Motion Prediction Equations (GMPEs)

The estimate of uniform hazard spectral accelerations at bedrock level is based on empirical GMPEs, which use the bedrock shear-wave velocity in the upper 30 meters (Vs_{30}) as input. We assigned average bedrock Vs_{30} of 9,000 feet per second. We used the same weighting and the same empirical GMPEs that were used in Petersen et al. (2014).

4.5 Epistemic Uncertainty and Aleatory Variability

The term "epistemic uncertainty" is used to describe the uncertainty because of incomplete knowledge and data about the physics of the earthquake process. For example, there is uncertainty as to which attenuation relationship is more applicable for the site at hand. Similarly, the term "aleatory variability" is used to describe the randomness in the ground motion predicted by each attenuation equation. The epistemic uncertainty is taken into account by using a suite of attenuation relations with different weights. All the different weight combinations are incorporated in the final hazard estimations by using a logic-tree approach (McGuire 2004). The aleatory variability is taken into account by explicitly considering the randomness (standard deviation) in the predicted ground motions.

4.6 Probabilistic Seismic Hazard Analysis Results

The computed uniform hazard spectrum for 2 percent probability of exceedance in 50 years was based on the geometric mean component of the attenuation equations, and was then adjusted for the maximum direction component by multiplying with period-dependent amplification factors according to Sahi and Baker (2013), and was further adjusted by using the ASCE 7-10 risk coefficients for the site to determine the risk-targeted maximum considered earthquake (MCE_R) ground motion response accelerations. At each spectral response period, the uniform hazard bedrock response spectrum was multiplied by the risk coefficient C_R in accordance with Section 21.2.1 of ASCE 7-10. We used the USGS risk-targeted ground motion calculator, along with the site-specific hazard curves for periods of 0.2 and 1 second to estimate the C_{RS} and C_{R1} respectively. For periods less than or equal to 0.2 second, C_R=C_{Rs}=0.93; for periods greater than or equal to 1 second, C_R=C_{R1}=0.94; and for periods between 0.2 seconds and 1 second, C_R was linearly interpolated between C_{Rs} and C_{R1}. The bedrock MCE_R spectrum is shown in Figure 3. Digitized MCE_R values are listed in Table 1.

Table 1 – Bedrock Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectrum SA(g) for 5 Percent Damping

Structural Period T (sec)	Site-Specific SA(g) P.E. 2% in 50 years
0.01	0.146
0.10	0.255
0.20	0.192
0.30	0.136
0.40	0.103
0.50	0.081
0.75	0.052
1.0	0.039
2.0	0.020
3.0	0.013
4.0	0.010
5.0	0.008
6.0	0.006
7.0	0.004
8.0	0.003

4.7 Seismic Hazard Deaggregation Results

Seismic hazard deaggregation was performed to estimate the contribution of the various magnitudes events at various distances to the total seismic hazard. The results are useful in identifying pairs of earthquake magnitude and source-to-site distances that contribute the most to the estimated seismic hazard, performing deterministic analyses, and developing different scenarios to be used in selecting acceleration time series.

For the peak ground acceleration, which is of interest for the soil liquefaction-potential analyses, the majority of the hazard for the maximum considered earthquake comes from small to moderate magnitude earthquakes from the CEUS Gridded seismic zone. The corresponding modal (most likely) moment magnitude and distance were estimated to be magnitude of 5.05 and a distance of 11 kilometers. The mean moment magnitude and distance were estimated to be 5.45 and 22 kilometers respectively.

4.8 Bedrock Acceleration Time Series

We selected 11 bedrock acceleration time series for use in our analyses following the guidelines of ASCE 7-10. All time series were recorded during earthquakes with magnitudes between 5.3 and 6.2, consistent with typical NYC design magnitudes. All time series were modified to match the target bedrock MCE_R spectrum presented in Figure 3 using a time-domain spectral-matching routine. The seed time series we used are listed in Table 2.

Table 2 – Acceleration Time Series Used for Matching to the Target MCER Rock Spectrum

No.	Earthquake & Year	NGA Sequence No.	Magnitude	Station Name	Closest Distance to Rupture (km)	Component
1, 2	Morgan Hill, 1984	455	6.19	Gilroy Array No.1	15	1230, 1320
3, 4	Whittier Narrows, 1987	624	5.99	Huntington Beach	45	270, 360
5	CA/Baja Border Area, 2002	2003	5.31	Calexico Fire Station	40	90
6, 7	Chi-Chi, Taiwan, 1999	2949	6.20	CHY033	13	E, N
8, 9	Chi-Chi, Taiwan, 1999	2985	6.20	CHY094	91	N, W
10, 11	Mineral, Virginia, 2011	8529	5.74	NP2555	124	N, E

Information obtained from the NGA-West and the NGA-East Flatfile (http://ngawest2.berkeley.edu/)

4.9 Dynamic Soil and Bedrock Parameters

Dynamic soil and bedrock parameters are required for use in ground-response analyses. These parameters are:

- Small-strain shear modulus (G_{max});
- Shear modulus degradation curve with increased shear strains (i.e., G-γ curve); and
- Soil damping curve with increased shear strains (i.e., β-γ curve).

The small-strain shear modulus was estimated from in situ measurements of shear-wave velocity. The modulus degradation and damping curves were selected from published data for specific representative soil types; the following curves were used in our analyses:

- Fill – Seed and Idriss "sand average" curve (1970)
- Organic Clay– Vucetic and Dobry (1991), PI = 40
- Silt and Clay– Vucetic and Dobry (1991), PI = 30
- Sand– EPRI Sand(1993)
- Bedrock – EPRI Rock (1993)

4.10 Minimum Permissible Level of Design Response Spectrum

The site class and associated code-specified acceleration-response spectrum are required to determine the minimum permissible levels of the design response spectrum derived from a site-specific study. The minimum permissible level of the design spectrum is based on the Site Class determined according to the building code without considering soil liquefaction. Site Class E was used for the terra firma site.

4.11 Ground Response Analyses Results

Total-Stress ground-response analyses were performed using the selected bedrock acceleration time series and dynamic soil and bedrock properties described above. All bedrock acceleration time series were applied as rock-outcrop motions in accordance with ASCE 7-10.

For each zone, one-dimensional analyses were performed to assess the sensitivity of the ground surface acceleration-response spectra to variable depth to rock and stiffness of the soil column. The sensitivity of the depth to rock was assessed by varying the soil column thickness; we selected two representative soil columns for each zone, corresponding to the lower(C1) and higher (C2) depth to rock for each zone. The sensitivity of the soil stiffness was assessed by varying the best-estimate shear-wave velocities for all layers by 20 percent above and below the estimated average, yielding six different soil columns in total.

The 11 modified bedrock acceleration time series were applied at the base of each of soil column, resulting in a suite of 66 acceleration-response spectra. This relatively high number of spectra allows the mean response spectrum to provide a reasonable estimate of the average ground response during the design earthquake event, capturing the variable earthquake motions and variable soil conditions for each zone.

Per section 1613.5.4 of the 2014 NYCBC, section 1613.3.4 of the 2015 NYSBC and section 21.3 of ASCE 7-10, these 66 calculated MCE_R spectra were multiplied by a factor of two-thirds to model the "Design Earthquake (DE)."

The mean total-stress spectrum for each soil column is presented in Appendices A to F for Zones 1 to 6, respectively.

4.12 Soil Liquefaction Potential Analyses

The NYCBC requires an evaluation of the liquefaction potential of noncohesive soils below the groundwater table and to a depth of 50 feet below the ground surface. The potential for soil liquefaction was evaluated using the procedure outlined by Idriss and Boulanger (2008). This evaluation develops an empirical relationship between the earthquake demand, represented by the Cyclic Stress Ratio (CSR), and the soil's resistance to dynamic loading, represented by the Cyclic Resistance Ratio (CRR). The CSR is correlated to the Peak Ground Acceleration (PGA) of the design earthquake event and the in situ soil stresses. The CRR is correlated to SPT N-values, or cone penetration testing (CPT) resistance obtained from field tests at the site. The field N-values are converted to $N_{1,60,N}$ by applying correction factors for soil overburden pressure, hammer energy efficiency and atmospheric pressure. Field CPT tip resistances are converted to $q_{t1,N}$ by applying correction factors for soil overburden pressure, percent fines and atmospheric pressure.

Liquefaction analyses results are also presented in Appendices A and B. Both zones have points with factors of safety of 1.0 or below, indicating susceptibility to liquefaction.

To further assess the effect of liquefaction, we performed effective-stress non-linear soil amplification analyses with D-MOD2000 for each tower. This approach models the generation of excess pore water pressure (EPWP) and allows a more accurate evaluation of liquefaction potential during the MCE_R event, and of the ground surface acceleration response spectrum. The EPWP ratio is defined as the ratio of pore water pressures developed in the soil at a certain depth, to the soil's effective stress at that depth. A ratio of 1.0 (or 100 percent) implies that the pore water pressure is equal to the effective stress at a specific depth; when this occurs, the soil has reached complete liquefaction. EPWP ratios less than 1.0 (less than 100 percent) correspond to partial liquefaction. For each zone:

- We modeled two soil columns for each tower (east and west) to consider the influence of different depth to rock.
- We used time series CHY094N for each soil column as the bedrock input motion, to obtain the most conservative estimates of excess pore water pressures. CHY094N is the time series that give the highest acceleration response spectra and EPWP.
- We performed total-stress analyses with SHAKE2000 and D-MOD2000 and calibrated the D-MOD2000 damping parameters so that the ground surface acceleration spectra estimated by the two computer codes reasonably match. Then we performed effective stress analyses with D-MOD2000 using the previously estimated damping parameters.
- We used published relationships that are available in the D-MOD2000 library to model the pore water generation, the soil degradation, the redistribution of the pore water pressures, and the pore water pressure dissipation during the MCER-level event.

The EPWP were also estimated using

- the SHAKE2000-estimated PGA,
- the SPT and CPT data for each tower,
- the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and
- the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983).

Estimated EPWP are presented in Appendices A (Tower 5) and B (Tower 6).

The recommended EPWP ratios to be considered for foundation design at each tower are presented in Appendices A and B. Note that the D-MOD2000 analyses yielded maximum EPWP ratios up to about 90 percent for the upper fill layer for Tower 5 and EPWP ratios up to about 60 percent for the upper fill layer for Tower 6. The associated ground-surface seismic volumetric settlements are estimated to be less than 0.5 inches for both Tower 5 and Tower 6.

5 Results

The results of our analyses are summarized in Appendices A (Tower 5) and B (Tower 6).

Both towers have the same code dictated lower-bound design response spectra. We recommend that LIRR building C (located between the two towers—with similar subsurface conditions) be designed with the same response spectra as the towers, and the higher pore pressure ratios predicted in the Tower 5 analysis.

6 Limitations

The conclusions and recommendations provided in this report are based on current state of practice. Research is ongoing to develop empirical ground-motion attenuation relations, as well as reviewing information related to the seismicity in the project region. Future research may prove counter to the assumed conditions. In addition, the subsurface conditions were inferred from a limited number of historic borings. The recommendations provided are dependent upon one another and no recommendation should be followed independent of the others.

Any proposed changes in structures or their locations should be brought to Langan's attention as soon as possible so that we can determine whether such changes affect our recommendations. The information is assumed to represent conditions reported only at the locations indicated and at the time of investigation. If different conditions are encountered during construction, they should immediately be brought to Langan's attention for evaluation, as they may affect our recommendations.

This report has been prepared to assist the Owner, architect and structural engineer in the design process and is only applicable to the design of the specific project identified. The information in this report cannot be utilized or depended on by engineers or contractors who are involved in evaluations or designs of facilities (including underpinning, grouting, stabilization, etc.) on adjacent properties which are beyond the limits of that which is the specific subject of this report.

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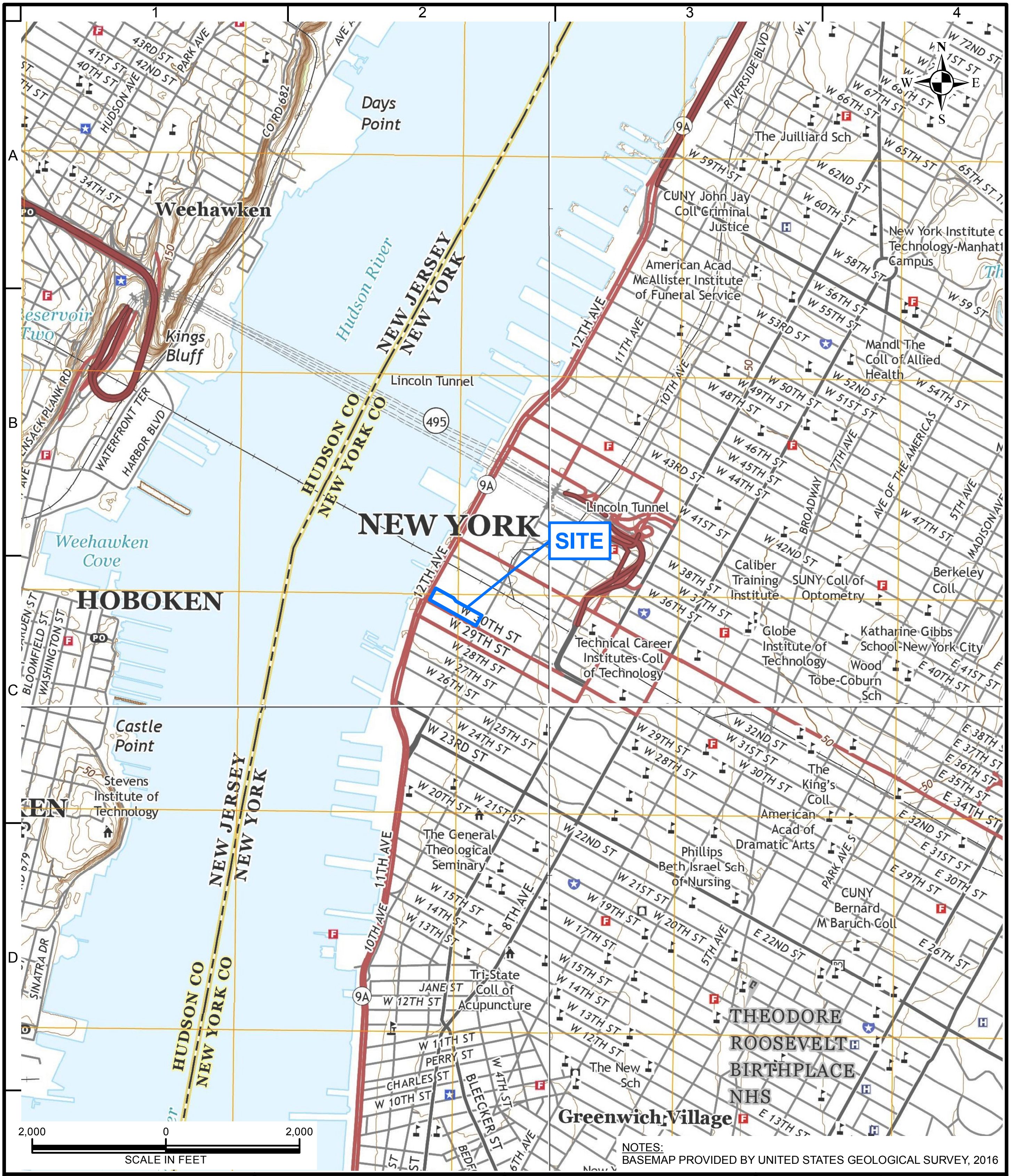
End of Report

FIGURES



NOTES:
BASEMAP PROVIDED BY UNITED STATES GEOLOGICAL SURVEY, 2016

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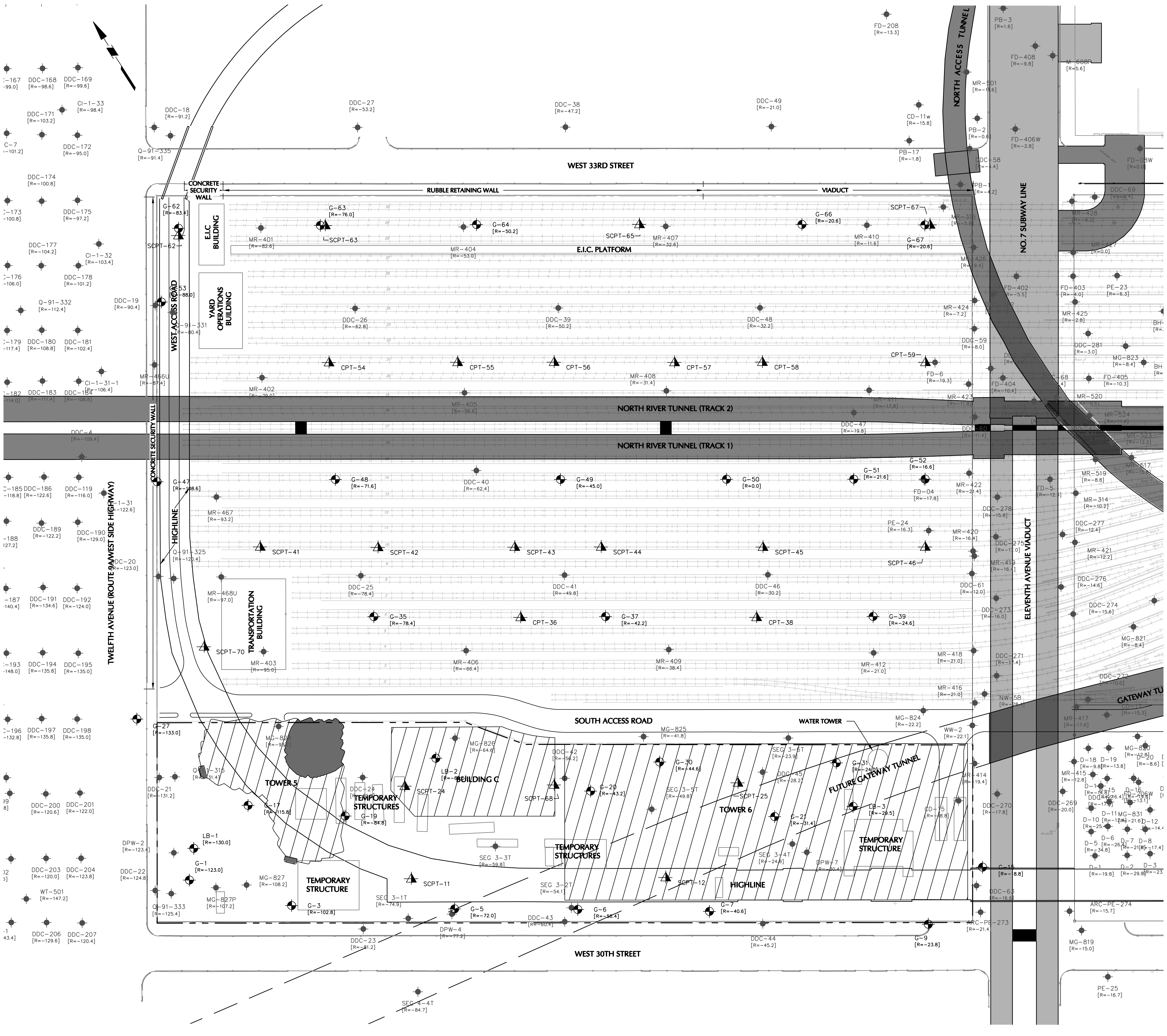
Langan International LLC
Collectively known as Langan

Project	WEST RAIL YARD TERRA FIRMA HUDSON YARDS MANHATTAN NEW YORK
Drawing Title	SITE LOCATION MAP
Project No.	170444101
Date	7/3/2018
Scale	1"=2000'
Drawn By	TKS
Submission Date	7/3/2018
Drawing	1

Sheet 1 of 18

Path: \\langan.com\data\NY\data1\170444101\ArcGIS\ArcMap_Documents\Updated ArcMap Documents 170444101\Figure 1 - Site_Location_Map_Update.mxd



50 0 25 50
SCALE IN FEET

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 1.676 FEET BELOW THE BOROUGH OF MANHATTAN DATUM (BPMD).

4. DATUM CONVERSIONS
   BPMD = NAVD88 – 1.676'
   NGVD29 = NAVD88 + 1.076'
   NYCT = NAVD88 + 98.423'
   PENN = NAVD88 + 298.351'

5. BORING, CPT AND TEST PIT LOCATIONS SHOULD BE CONSIDERED APPROXIMATE.

6. 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.

7. 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.

8. 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

⊕ LB-# ELEV (NAVD88)	LANGAN BORINGS 2017 APPROXIMATE ELEVATION (TOP OF ROCK)
⊕ 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 WEST RAIL YARD TERRA FIRMA SITE

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Project

WEST RAIL YARD
TERRA FIRMA

HUDSON YARDS

MANHATTAN **NEW YORK**

Drawing Title

BORING AND CPT LOCATION PLAN

Project No. **170444101**	Drawing No. 2
Date **7/2/18**	
Scale **1" = 50'**	
Drawn By **KM** / Checked By **MP**	
Submission Date -	Sheet 2 of 3

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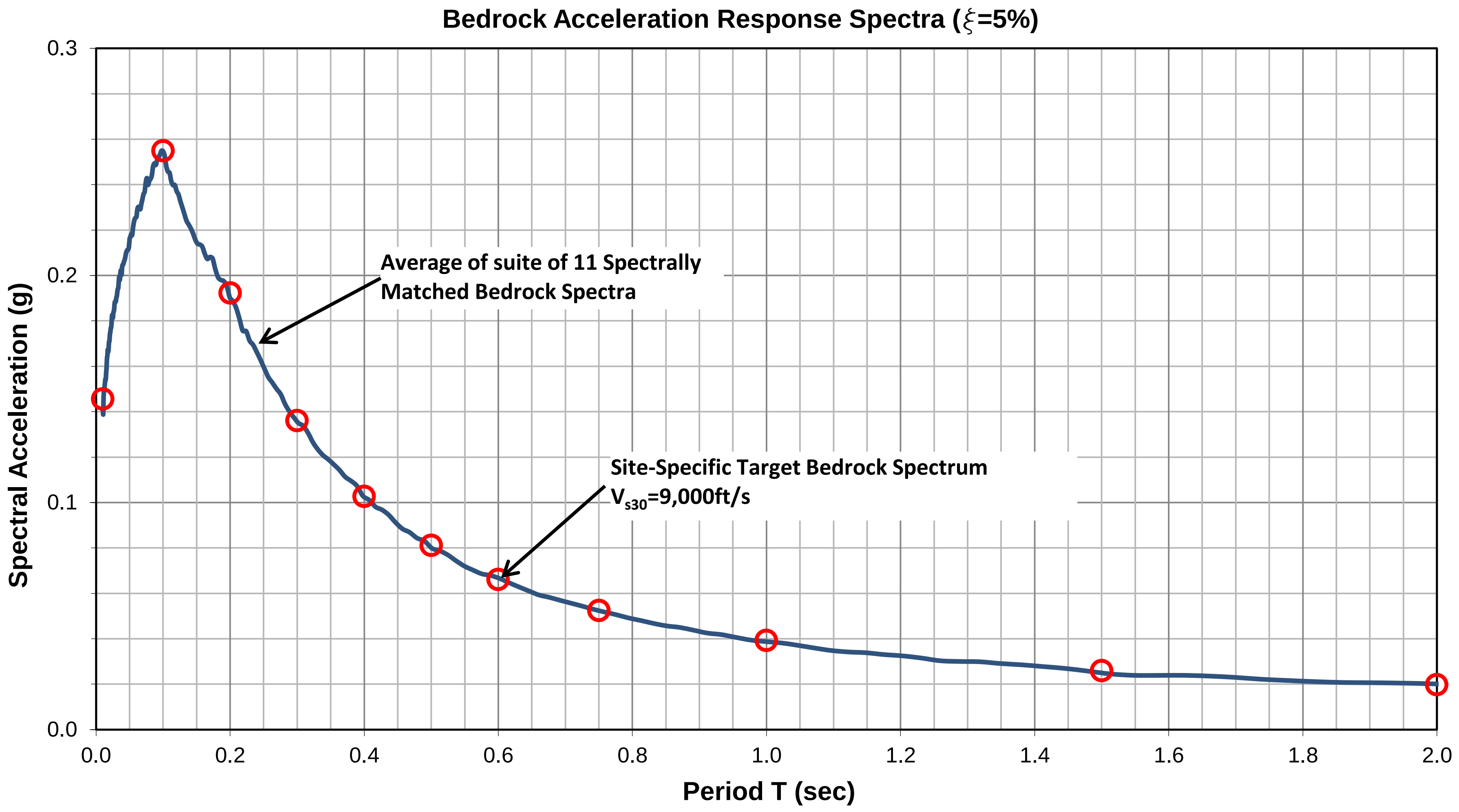
SUBMISSION DATE: ####
PROJECT NO. 170444101

Filename: \\langan.com\data\NY\data1\170444101\Cadd Data - 170444101\SheetFiles\Seismic\170444103-TF Boring and CPT Plan.dwg Date: 10/9/2018 Time: 11:21 User: kacker Style Table: Langan.stb Layout: ANSID-SL



Average of suite of 11 Spectrally Matched Bedrock Spectra

Site-Specific Target Bedrock Spectrum
V_{s30}=9,000ft/s

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TERRA FIRMA
HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

BEDROCK MCE$_R$
SPECTRA

Project No.
170444103

Date
7/3/2018

Scale
NTS

Drawn By
LY

Submission Date
7/3/2018

Drawing No.
3

Sheet 3 of 3

APPENDIX A

Tower 5 Site-Specific Seismic Study

We performed a site-specific seismic analysis for Tower 5 of the terra firma site. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Tower 5 consist of fill, underlain by consecutive layers of organic clay, silty clay/clayey silt, sand and finally bedrock. The depth to bedrock varies from 72 to 140 feet, increasing east to west. We selected two soil columns (east and west) to represent differing soil conditions and the variation in depth to bedrock of the zone. The depth to rock of the two soil columns are based on the average depth to rock of the borings in the east and west side of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table A-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table A-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

East Column - Representative of the east side of the zone Based on G-5, G-19, LB-2, SCPT-11, SCPT-24			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	30	290 to 678	440
Organic Silty Clay	27	406 to 510	460
Silty Clay/Clayey Silt	21	570 to 832	625
Sand	3	1,000 to 1,490	1,250
Bedrock	N/A	9,000	9,000

West Column - Representative of west side of the zone Based on G-1, G-3, G-17, LB-1, SCPT-11, SCPT-24			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	30	290 to 678	440
Organic Silty Clay	27	406 to 510	460
Silty Clay/Clayey Silt	53	550 to 730	625
Sand	3	1,000 to 1,490	1,250
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 485 and 495 feet per second (fps). The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure A-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Idriss and Boulanger (2008) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude (5.45), but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.33g for Site Class E;
- A magnitude scaling factor (MSF) of 1.6, per the Idriss and Boulanger (2008).

The initial Idriss and Boulanger (2008) liquefaction analysis indicated potential liquefaction at depths between about 8 and 35 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as 90 percent at depths between 25 to 30 feet, corresponding to partial liquefaction (partial soil strength loss).

The EPWP were also estimated using the SHAKE2000-estimated PGA of 0.112g, the SPT and CPT data from G-1, G-3, G-17, G-19, CPT-11 and CPT-24, the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983). The estimated EPWP are shown on Figure A-2. The DMOD-estimated EPWP are typically higher than the empirically-estimated EPWP.

Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We gave more weight to the DMOD-2000 results. The excess pore water pressure ratios estimated from DMOD2000 analyses and empirical method mentioned above are presented in Figure A-2 and listed in Table A-2.

Table A-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
0 to 10	<10%	0%
10 to 20	0% to 50%	30%
20 to 30	40% to 90%	65%
Below 30	<20%	0%

We estimated up to 0.5 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table A-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure A-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table A-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure A-4. The short-period and 1-second-period design accelerations obtained from the recommended design spectrum are as follows:

- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

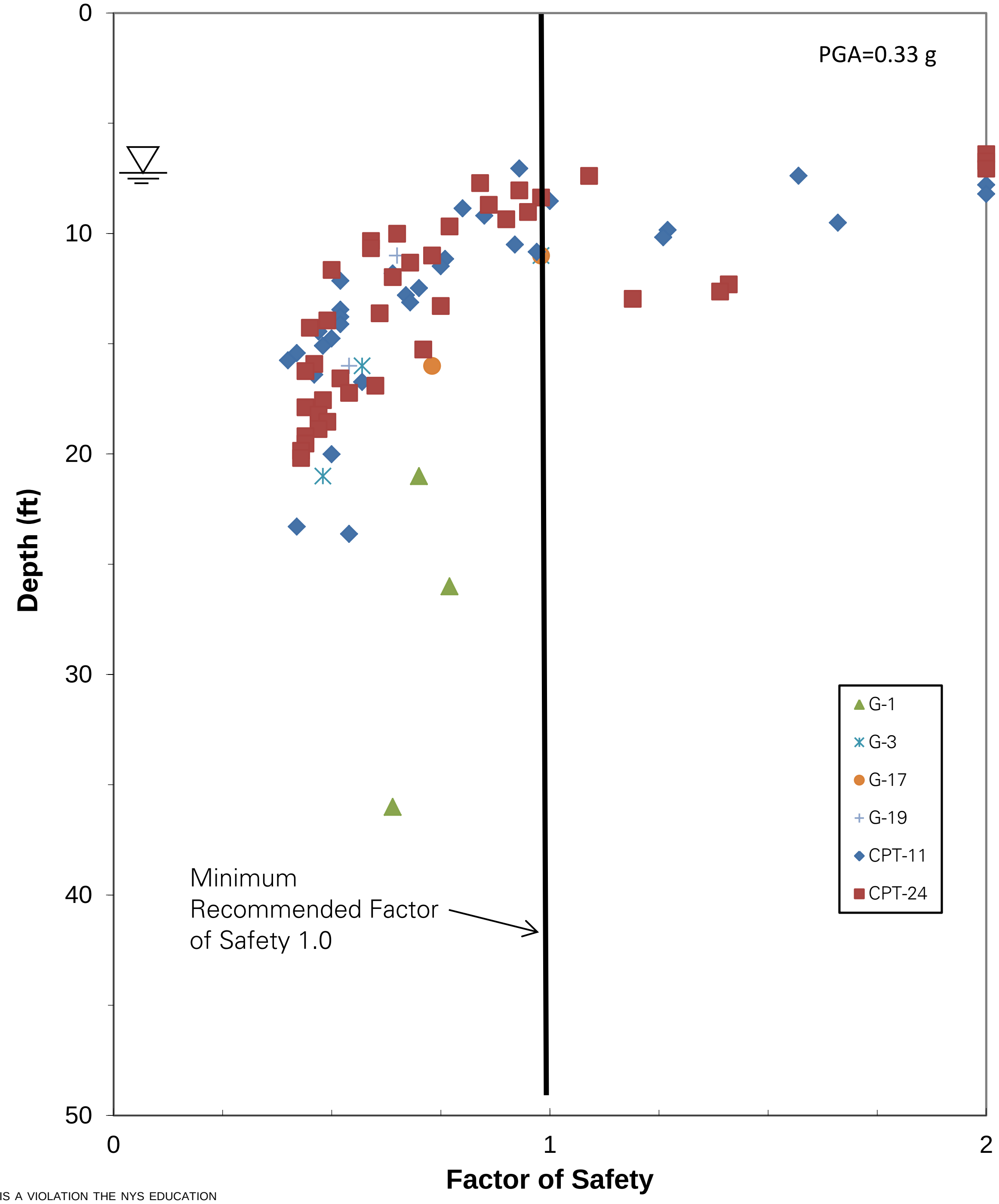
5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table A-4.

Table A-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.112g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C

Tower 5 - Factor of Safety against Liquefaction
Idriss and Boulanger (2008)



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WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS
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Drawing Title
TOWER 5
LIQUEFACTION
ASSESSMENT
(IDRISS AND
BOULANGER, 2008)

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LY
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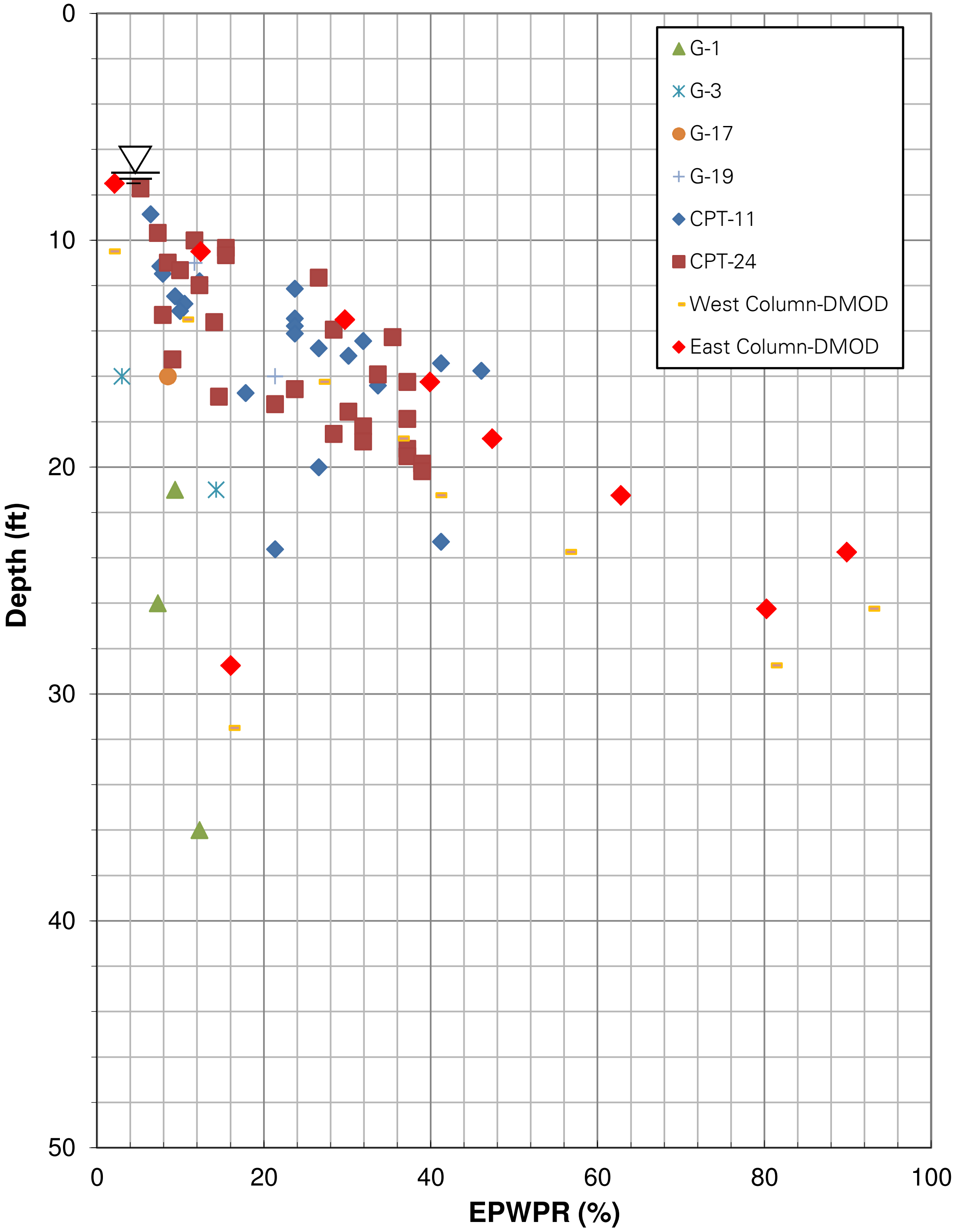
A-1
Sheet 1 of 4

Tower 5 -
Estimated Pore Water Pressure Ratio



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METHOD

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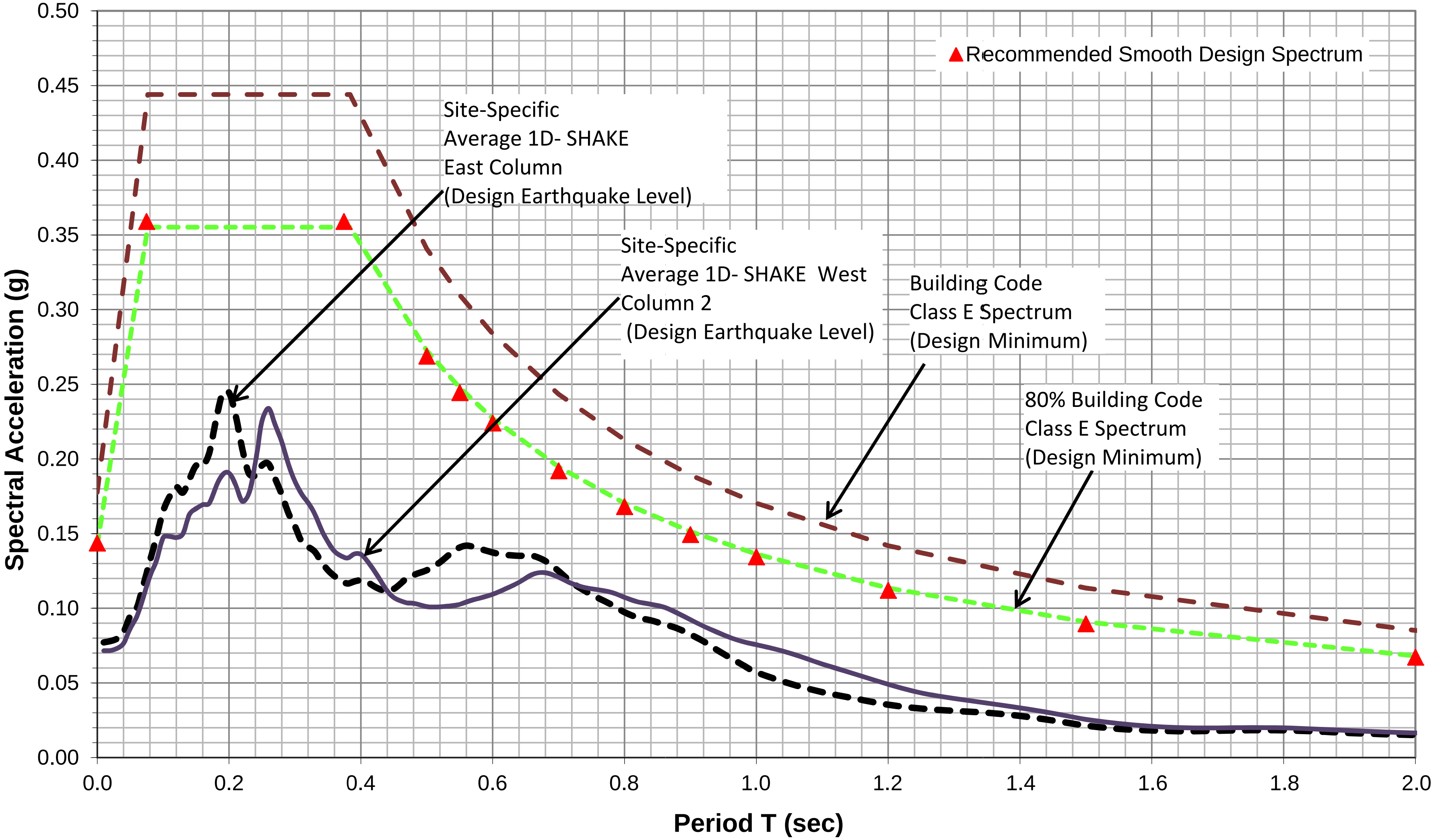
Sheet 2 of 4

Ground Surface Design Acceleration Response Spectra (ξ=5%)



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TOWER 5
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

Project No. 170444103	Drawing No.
Date 7/3/2018	A-3
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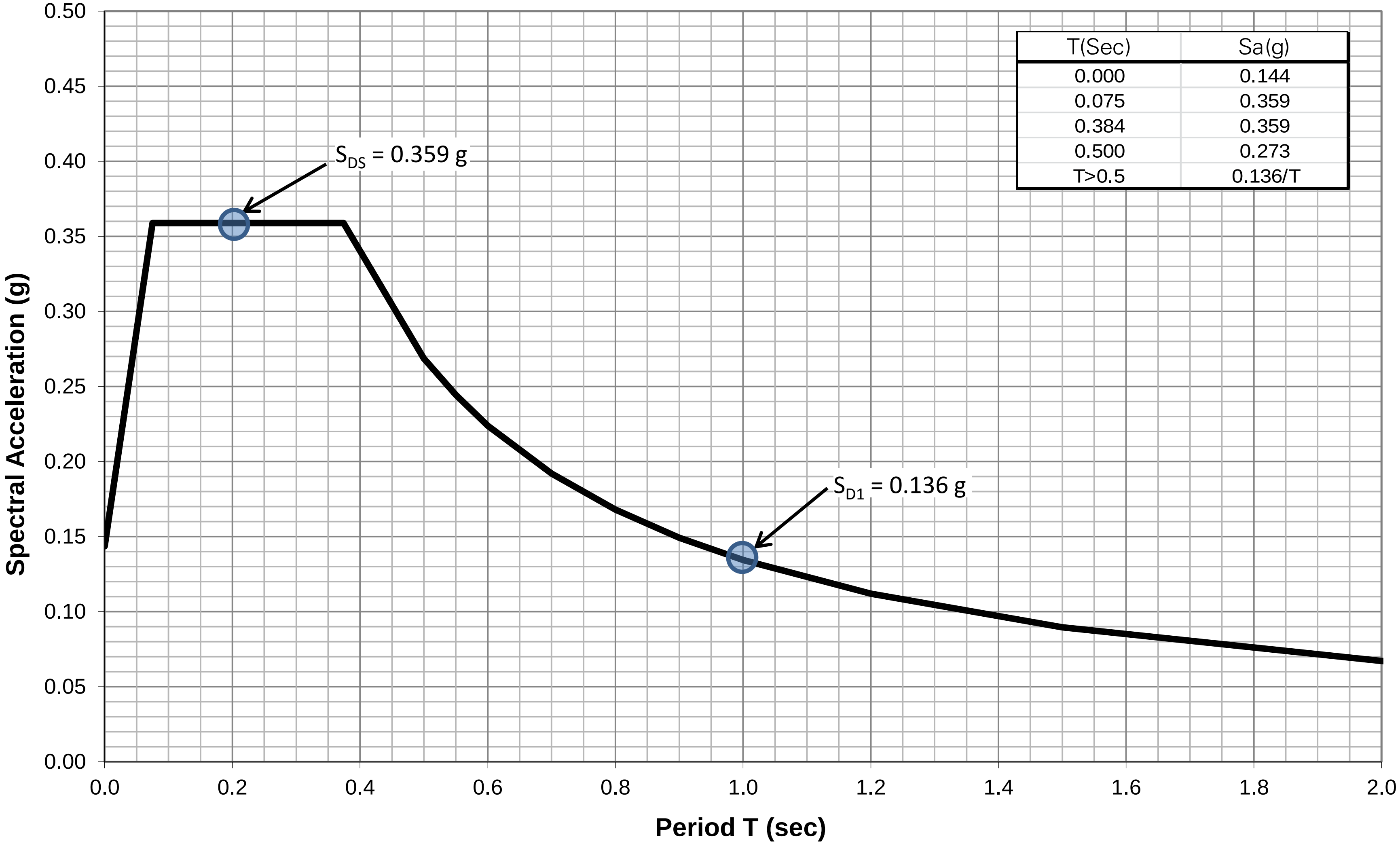
Drawn By LY	
Submission Date 7/3/2018	Sheet 3 of 4

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



T(Sec)	Sa(g)
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0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

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SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.
A-4

Sheet 4 of 4

APPENDIX B

Tower 6 Site-Specific Seismic Study

We performed a site-specific seismic analysis for Tower 6 of the terra firma site. The key assumptions and results are summarized below.

1 Subsurface Conditions

The subsurface conditions at Tower 6 consist of fill, underlain by consecutive layers of silty clay/clayey silt, sand and finally bedrock. The depth to bedrock varies from 32 to 70 feet, increasing east to west. We selected two soil columns (east and west) to represent differing soil conditions and the variation in depth to bedrock of the zone. The soil layer thicknesses and shear wave velocities used for each column are listed in Table B-1.

The shear wave velocity of the rock is estimated to be about 9,000 feet per second (fps), based on cross-hole seismic testing and borehole suspension logging from nearby sites in the same rock formation.

Table B-1 – Summary of Assumed Soil Layer Thickness and Shear Wave Velocities

East Column - Representative of the east side of the zone Based on G-9, G-15, G-21, G-31, LB-3, SCPT-25			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	20	325 to 875	475
Silty Clay/Clayey Silt	15	350 to 450	425
Sand	5	675 to 1,150	900
Bedrock	N/A	9,000	9,000

West - Representative of west side of the zone Based on G-6, G-7, G-20, G-30, SCPT-12, SCPT-68			
Layer	**Average layer thickness (feet)**	**Range of measured/assumed shear wave velocities (fps)**	**Shear wave velocity used in model (fps)**
Fill	29	407 to 670	550
Silty Clay/Clayey Silt	22	370 to 570	445
Sand	10	650 to 1,490	1,050
Bedrock	N/A	9,000	9,000

2 Site Class

We calculated weighted-average shear-wave velocities ($\overline{V}_s$) between about 490 and 540 feet per second (fps). The site was preliminarily classified as Site Class E, as per 1613.5.2 of 2014 NYCBC, without consideration of soil liquefaction. The site was re-classified as Site Class F because of its potential for liquefaction using simplified methods, as described below.

3 Soil Liquefaction

Figure B-1 shows a plot of the factor of safety with depth using standard penetration test (SPT) and cone penetration test (CPT) results according to the Idriss and Boulanger (2008) procedures with the following parameters:

- An earthquake magnitude of 5.75 earthquake event, which is more conservative than the estimated mean deaggregation magnitude, but consistent with older studies (2008 USGS Seismic Hazard Maps and the 2016 NYCDOT Report);
- A PGA of 0.33g for site class E;
- A magnitude scaling factor (MSF) of 1.6, per Idriss and Boulanger (2008).

The initial Idriss and Boulanger (2008) liquefaction analysis indicated potential liquefaction at depths between about 6 and 40 feet. We then performed DMOD2000 effective-stress nonlinear analyses and estimated maximum excess pore water pressure ratios as high as about 60 percent at depths around 15 to 20 feet, corresponding to partial liquefaction (partial soil strength loss).

The EPWP were also estimated using the SHAKE2000-estimated PGA of 0.129g, the SPT and CPT data from G-9, G-15, G-21, G-31, LB-3, G-6, G-7, G-20, G-30, SCPT-25, SCPT-12, SCPT-68, the corresponding factors of safety (FoS) against liquefaction following the method of Idriss and Boulanger (2008), and the FoS versus EPWPR curves from Tokimatsu & Yoshimi (1983). The estimated EPWP are shown on Figure B-2.

Partial liquefaction should be considered in the analysis of lateral pile capacity, using the estimated excess pore water pressure ratios to reduce the soil strength. We gave more weight to the DMOD-2000 results. The excess pore water pressure ratios estimated from DMOD2000 analyses and empirical method mentioned above are presented in Figure B-2 and listed in Table B-2.

Table B-2 – Summary of Estimated Excess Pore Water Pressure Ratios

Depth (ft)	EPWP ratios	Recommended Design EPWPR
6 to 10	<20%	0%
10 to 30	10% to 60%	40%
Below 30	< 20%	0%

We estimated up to about 0.5 inches of seismic-induced settlement for free-field conditions after the MCE_R-level event.

4 Design Acceleration Response Spectrum

The design spectrum recommendations based on the SHAKE2000 total-stress analyses are listed in Table B-3. The plot of the SHAKE2000 design spectra, and 80 percent of the Site Class E design spectrum (minimum allowed per ASCE 7-10) are presented in Figure B-3. The red triangles show our recommended design acceleration-response spectrum, which follows the 80% Site Class E line.

Table B-3 – Recommended Design Smooth Site-Specific spectrum, SA(g) for 5 percent damping

Period T (seconds)	Recommended Design Acceleration (g)
0.00	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

The recommended design spectrum satisfies the 2014 NYCBC, 2015 NYSBC and ASCE 7-10 requirements. A plot of the recommended design response spectrum containing a table with the spectral ordinates is presented on Figure B-4. The short-period and 1-second-period design accelerations obtained from the recommended design spectrum are as follows:

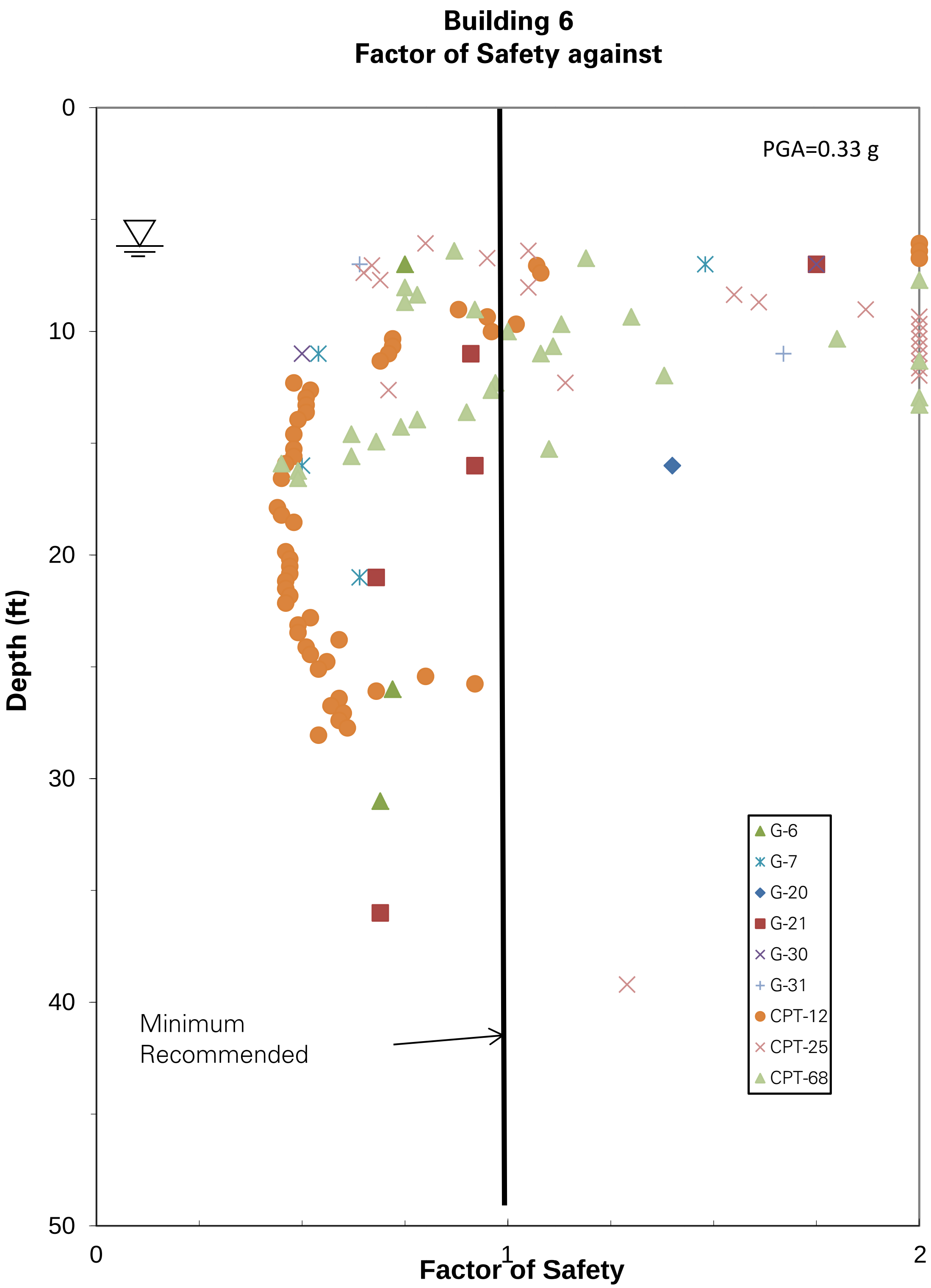
- SDS = 0.359 g at a period of 0.2 seconds
- SD1 = 0.136 g at a period of 1.0 second

5 Seismic Design Category

For Risk Category I, II and III, the recommended design spectral accelerations obtained from our site-specific analysis result in a Seismic Design Category C, regardless of the structure's fundamental period of vibration. The results of the site-specific seismic study are listed in Table B-4.

Table B-4 – Recommended Seismic Design Parameters – Site-Specific Seismic Study

Design 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
Site-Specific MCE_R-level PGA	0.129 g
Risk Category	I, II and III
Seismic Design Category, *SDC*	C



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Drawing Title

TOWER 6
LIQUEFACTION
ASSESSMENT
(IDRISS AND
BOULANGER, 2008)

Project No.	170444103
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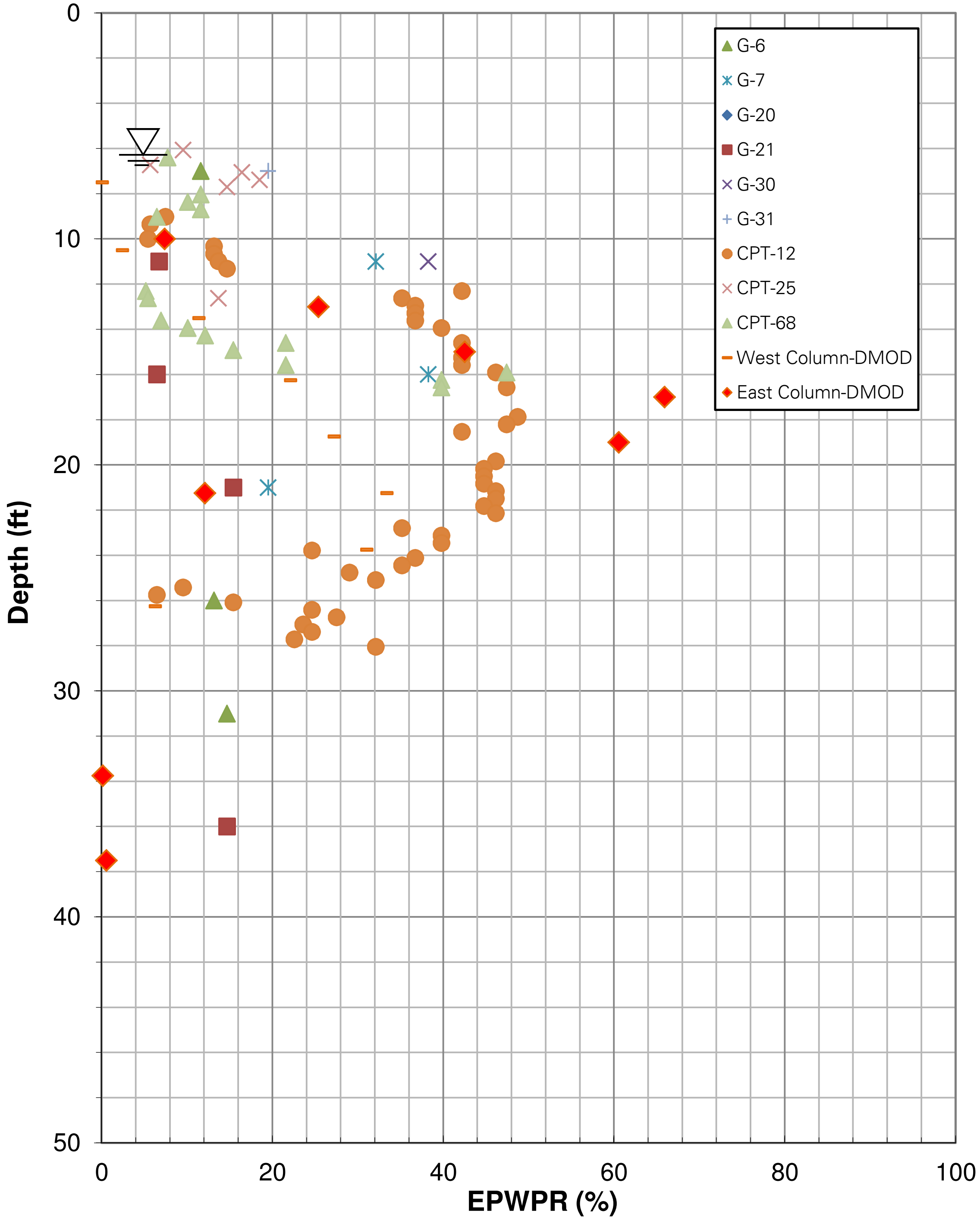
Scale	NTS
Drawn By	LY
Submission Date	7/3/2018

Drawing No.

B-1

Tower 6
Estimated Pore Water Pressure



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Drawing Title

TOWER 6
ESTIMATED PORE
WATER PRESSURE
RATIO FROM DMOD
AND EMPIRICAL
METHOD

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7/3/2018

Scale
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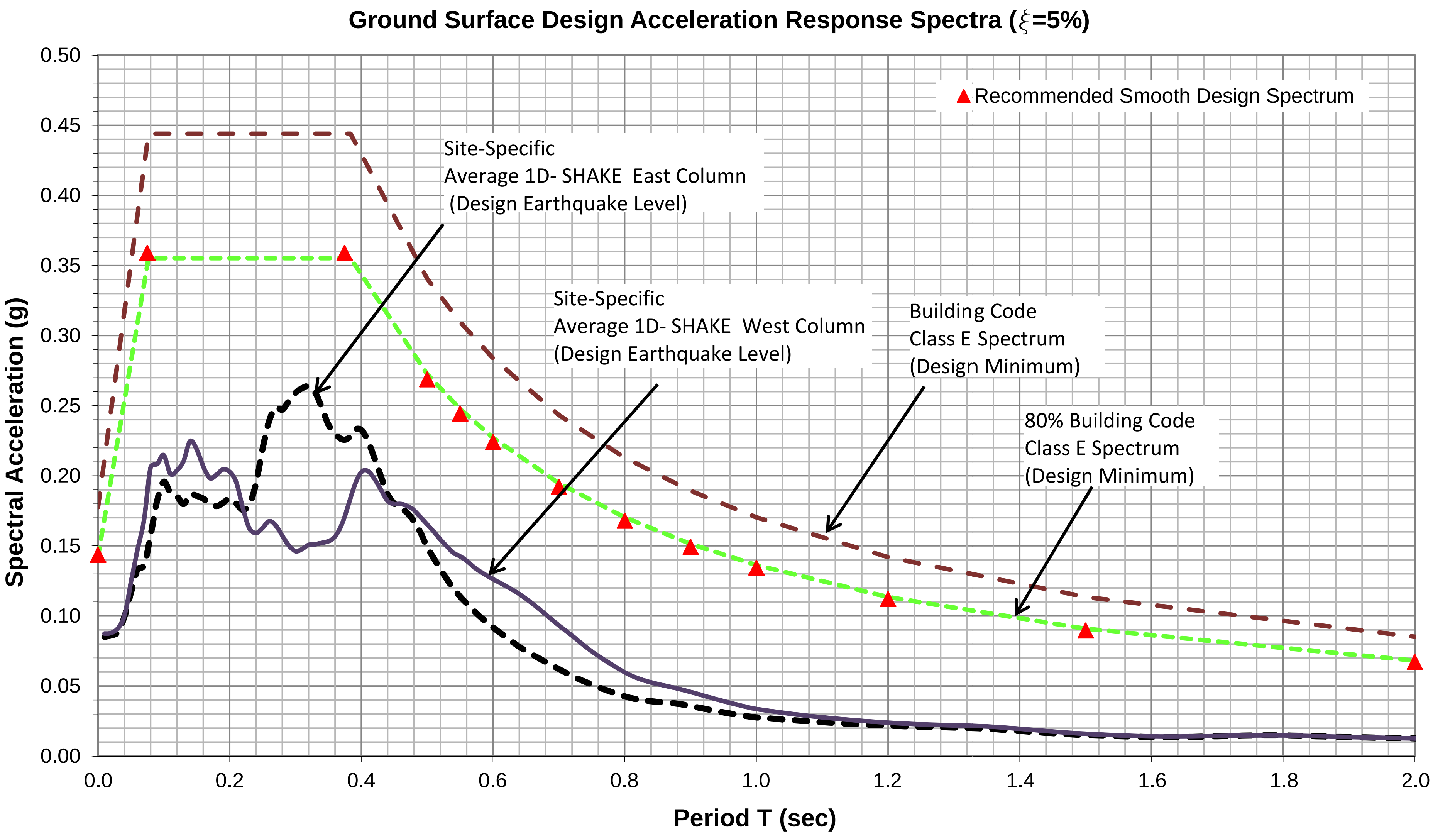
Sheet 2 of 4



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TERRA FIRMA
HUDSON YARDS
MANHATTAN NEW YORK

Drawing Title
TOWER 6
SITE-SPECIFIC DESIGN
RESPONSE SPECTRA

Project No.
170444103
Date
7/3/2018
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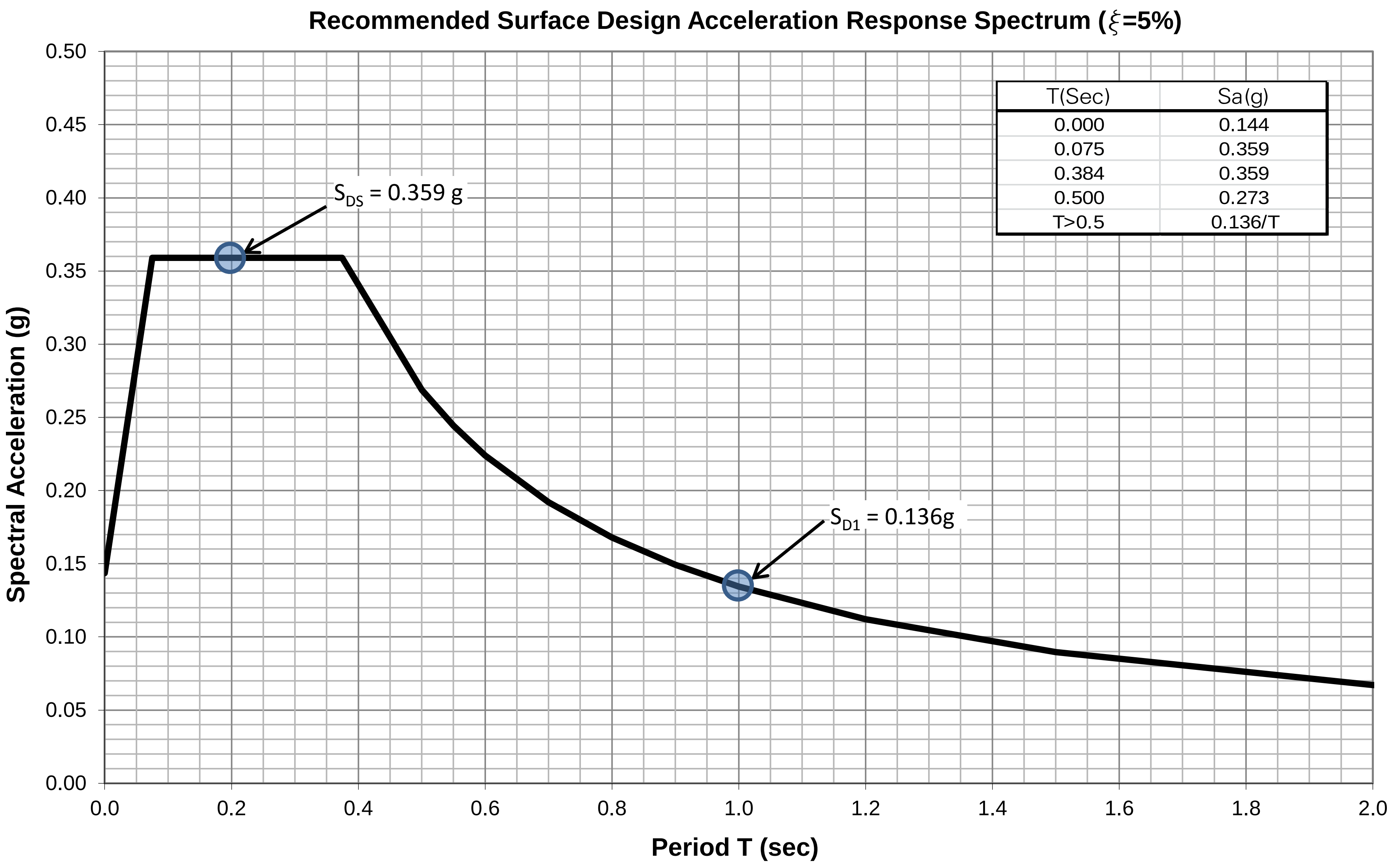
Submission Date
7/3/2018

Drawing No.
B-3
Sheet 3 of 4



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

T(Sec)	Sa(g)
0.000	0.144
0.075	0.359
0.384	0.359
0.500	0.273
T>0.5	0.136/T

WARNING: IT IS A VIOLATION THE NYS EDUCATION LAW ARTICLE 145 FOR ANY PERSON, UNLESS HE IS ACTING UNER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS ITEM IN ANY WAY.

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Langan International LLC
Collectively known as Langan

Project

WEST RAIL YARD
TERRA FIRMA
HUDSON YARDS

MANHATTAN NEW YORK

Drawing Title

TOWER 6
RECOMMENDED
SITE-SPECIFIC DESIGN
RESPONSE SPECTRUM

Project No. 170444103
Date 7/3/2018
Scale NTS
Drawn By LY
Submission Date 7/3/2018

Drawing No.
B-4

Sheet 4 of 4