GEOTECHNICAL DESIGN MEMORANDUM

TO: Metropolitan Transportation Authority (MTA), Metro-North Railroad (MNR)
Structures Department

CC: Michael Moskowitz, P.E.

FROM: Robert D. Bunting, P.E.

RE: MTA MNR, Scarsdale and Hartsdale Train Station Elevator Pits
Scarsdale and Hartsdale, New York

DATE: 01.16.2020

Introduction

This memorandum summarizes the subsurface field exploration and provides geotechnical engineering recommendations for the design and construction of the proposed elevator pits to be constructed at the Metro-North Railroad's (MNR) Scarsdale and Hartsdale Train Stations. Elevations noted herein are in feet and referenced to the North American Vertical Datum of 1988 (NAVD88).

Existing Conditions

Hartsdale Train Station

The site at Hartsdale Train Station is relatively flat with paved parking areas, the Bronx River and wooded areas adjacent to the outbound platform and paved parking areas, wooded areas, a 1 story train station building and a multilevel parking garage adjacent to the inbound platform. An overhead pedestrian overpass bisects the platforms. Pedestrian stairways only are located at the pedestrian overpass.

The Hartsdale Station is underlain by metamorphic, Middle Proterozoic, biotite and/or hornblende-quartz-feldspar Yonkers Gneiss and Precambrian-Middle Proterozoic, Fordham Gneiss containing amphibolite, granulite and quartzite. The soil deposits overlying the bedrock consist of sandy glacial till. The geology at the station is described as presented in the Mineral Resources On-line Spatial Data website maintained by the U.S. Department of the Interior, U.S. Geological Survey (2015) and as presented in the Geotechnical Design Manual published by the New York State Department of Transportation (2013).

Scarsdale Train Station

The tracks at Scarsdale were constructed in a cut with a 14 to 20-foot high slope on the outboard platform side. One-story structures are along the top of the slope with a retaining wall near the Popham Road Bridge. The inbound side platform is generally flat with a parking lot, a 1 story structure for the train station and a 1 story commercial property between a

pedestrian overpass and the Popham Road Bridge. The overhead pedestrian overpass bisects the platforms. Pedestrian stairways only are located at the pedestrian overpass.

Bedrock is exposed along the slope adjacent to the outbound platform roughly 100 to 175 feet from the north end of the platform.

The Scarsdale Station is underlain by metamorphic, Precambrian-Middle Proterozoic, Fordham Gneiss containing amphibolite, granulite and quartzite and Early Cambrian-Lower Ordovician, Inwood Marble containing calc-schist, granulite and quartzite. The soil deposits overlying the bedrock consist of sandy glacial till.

Proposed Construction

The proposed construction will include additions of elevators to the pedestrian overpasses. Two elevators are required for the Hartsdale Train Station overpass and one elevator is required for the Scarsdale Train Station overpass. The elevator pits to support the elevators will be approximately 10.3 feet wide by 10.7 feet long by 6 feet deep. A cross section of the proposed elevator pits is shown in **Figure 1**.

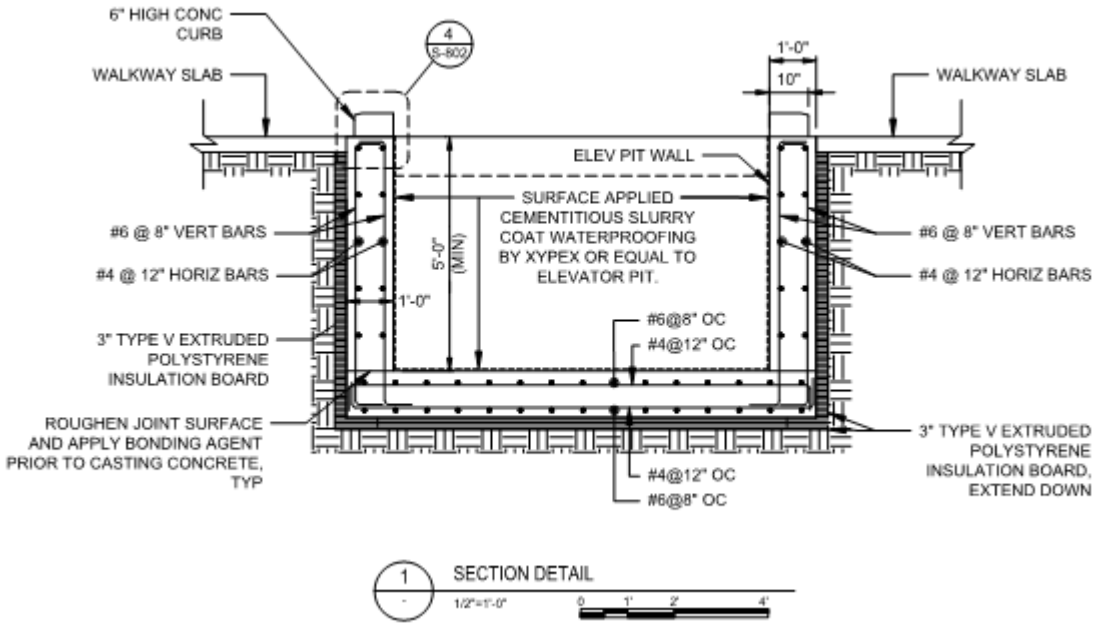


Figure 1: Elevator Pit Section

Subsurface Exploration Program

A subsurface exploration program was conducted with a boring performed adjacent to the proposed elevator pit at Scarsdale Train Station on June 21, 2019, and one boring performed within the proposed footprint of the southern elevator pit for the Hartsdale Train Station on December 13, 2019. Previous borings were drilled at the Hartsdale Train Station in February 2018. These borings were used to supplement the recent information. Boring Location Plans are included as Attachment A.

The soil borings were drilled using 4-inch inside diameter casing and mud rotary techniques. The upper 5-feet of each boring was hand augered to clear utilities. Split spoon sampling was then conducted continuously from 5 to 17 feet bgs and then at 5-foot intervals in accordance with ASTM D1586 (using a 2-inch outside diameter sampler, driven 24 inches by blows from a 140-pound automatic hammer falling freely for 30-inches). The number of blows required to drive the sampler each 6-inch increment was recorded, and the Standard Penetration Test (SPT) resistance (N-value) was determined as the sum of the blows over the middle 12 inches of penetration. An STV representative visually classified the soil samples recovered in the field in general accordance with the Burmister classification system. Representative soil samples from each split spoon were collected and stored in jars for subsequent review and laboratory testing.

The groundwater level at the soil boring locations were estimated by the observed water levels within the borehole at the completion of drilling. The soil borings were backfilled upon completion with soil cuttings.

Soil borings were located in the field by taping and line of sight from existing site features. The soil boring logs, prepared by STV, are included in Attachment B.

Subsurface Conditions

Soil and Bedrock

Table 1 summarizes the STV borings and provides the coordinates and elevations of the as-drilled locations.

The boring performed at Scarsdale Train Station (STV-SB-1) consisted of approximately 9-feet of medium dense to dense (SPT N-values of 17 and 40 blows per foot, bpf) coarse to fine sand with various amounts of gravel and silt. Underlying the sand approximately 1-foot of decomposed bedrock overlaid Grey Gneiss bedrock. The Gneiss bedrock was cored 5-feet and 100% of the rock was recovered with the Rock Quality Designation (RQD) reported as 86% which is considered good. The boring was terminated 15 feet below ground surface.

Table 1 – STV Boring Summary

Boring No.	Coordinates		Date Drilled	Ground Elevation (ft)	As Drilled Depth (ft)	Water Depth During Drilling (ft)	Depth To Top of Rock (ft)
	Northing	Easting					
STV-SB-1	786270	683002	6/21/19	143.5	15.0	Dry	10.0
STV-HB-1	794028	686607	12/13/19	164.4	51.8	13.0	N.E.
HB-2	793985	686444	2/13/18	165.0	45.1	7.2	N.E.
HB-3	794084	686633	2/15/18	166.0	51.5	-	N.E.
HB-4	794321	686694	2/14/18	167.0	23.0	-	18.0

Note N.E. = Not Encountered

The soil encountered at Hartsdale Train Station in Borings HB-2 through HB-4 was generally described as silty gravelly sand with the soil having SPT N-values ranging from 4 to 53 bpf with an average of 20 bpf. This soil is generally considered medium dense, however, Boring HB-3 encountered loose material in the upper 15 feet of the boring. Gneiss was cored at 18 feet below the ground surface in Boring HB-4.

The soil encountered at Hartsdale Train Station in Boring STV-HB-1 was generally described as loose, coarse to fine sand with varying amounts of silt and gravel in the upper 32 feet of the soil profile which is within the depth of the influence of the elevator shaft. SPT N-values ranged from 3 to 18 bpf with an average of 7 bpf in this upper layer. The boring was terminated at a depth of 51.8 feet below ground surface in medium dense sand.

Laboratory Tests

Representative soil and bedrock samples were tested on samples taken from the Hartsdale Station in February 2018. Index testing consisting of water content (ASTM D2216) and particle size distribution (ASTM D422) were performed to verify visual descriptions and determine soil parameters. Point load tests (ASTM D5731) on bedrock samples were performed to determine rock compressive strength. Corrosivity testing consisting of resistivity (AASHTO T288), pH (AASHTO T289), chloride content (AASHTO T291) and sulfate content (AASHTO T290) were performed. Existing soils are considered non-corrosive to steel and concrete structures. Laboratory test results are presented in Appendix C.

Groundwater

Groundwater was not encountered in Boring STV-SB-1.

Groundwater was measured in Boring STV-HB-1 at the completion of drilling and HB-2 24-hours after the boring was completed. The groundwater elevation was recorded at El. 151.4 feet in Boring STV-HB-1 and El. 157.8 feet in Boring HB-2.

Variation in Subsurface Conditions

Interpretation of general subsurface conditions presented herein is based on soil and groundwater conditions observed at the exploration locations. However, subsurface conditions may vary between exploration locations. If conditions are found to be different than assumed, recommendations contained in this memorandum should be reevaluated by STV and confirmed in writing.

Water levels measured in the borings should not necessarily be considered to represent stabilized groundwater levels. Groundwater levels are expected to fluctuate with rainfall, season, and construction activities in the area. Therefore, actual conditions at the time of construction may be different from those observed at the time of exploration.

Foundation Recommendations

General

Geotechnical engineering evaluations and design recommendations have been made as they relate to the proposed elevator pits at the Scarsdale and Hartsdale Elevator Pits. In general, these evaluations have been based on the results of field testing programs conducted for the design, published correlations with soil properties, and the design standards of AREMA, AASHTO and FHWA. In addition, recommended design criteria are based on performance tolerances, such as allowable settlement and horizontal deflection as set forth by MNR.

Design Requirements

The foundations for the elevators must be designed for a 1 tsf applied load. A resistance factor of 0.45 was used to determine the factored bearing resistance at each elevator pit. Allowable vertical settlement needs to remain less than 1-inch. The design groundwater was assumed to be at the ground surface.

Elevator Pit Foundation Design

Based on the poorest subsurface conditions encountered at each site, it was determined that the factored bearing resistance at each pit would be above the 1 tsf (2 ksf) required for the design. A factored bearing resistance of 4 ksf was calculated for the Hartsdale elevator pits and 8 ksf for the Scarsdale elevator pit. In addition, the maximum vertical settlement calculated at any of the elevator test pits was approximately 1-inch of immediate settlement. It is anticipated that the majority of this settlement will occur during construction.

Construction Considerations

Excavation and Excavation Support

Anticipated excavation depths will be approximately 6-feet below grade. Based on the subsurface exploration data, it is anticipated that foundation excavations can typically be made using conventional earth moving equipment.

Existing structures are in the vicinity of the proposed structures. Excavations shall not extend into the zone of influence of any existing building, utilities of other structures. The zone of influence is defined as extending 2-feet beyond the bottom exterior edge of the existing foundation and then down and away at a one horizontal to 1 vertical (1H:1V) slope. Undermining of existing foundations must not occur. Where open excavations are feasible, the side slopes should be designed in accordance with OSHA regulations.

The selection of the type of excavation support system should be performed by the Contractor. The Contractor should be required to retain a registered Professional Engineer licensed in the State of New York to design the excavation support systems. Where applicable, the design of the excavation support systems should be performed in conjunction with the design of the dewatering systems. Excavation support systems that are installed within the zone of influence of structures should be left-in-place. Any sheeting or soldier piles left in place should be cut-off at least 5-feet below the adjacent finished grade.

Dewatering

Based on the available groundwater information, the excavations are not anticipated to extend below the existing groundwater level at any of the proposed structures. However, due to seasonal changes in groundwater, the Contractor should be required to design and implement a dewatering system that maintains a dry, undisturbed subgrade. It is anticipated that a sump and pump system may be utilized for this purpose. To avoid disturbance to the subgrade, water elevation should be maintained at least 2-feet below the subgrade level during the entire period of excavation.

If wet weather is encountered during construction, the Contractor shall take care to schedule excavations to limit the duration of open cuts, slope the bottoms of the excavations to facilitate drainage and provide berms to limit runoff into the excavations.

Excavated material to be reused as fill should be stockpiled in such a manner that promotes run off and limits saturation of the materials.

Preparation and Protection of Foundation Subgrades

Care should be taken to avoid excess traffic on the excavated subgrades prior to placement of structural fill or concrete foundations. Final excavation including any over excavation should be made using a smooth edged bucket where possible. Any unsuitable material present at the subgrade level should be removed and replaced with compacted structural fill. Soil subgrades should be proofrolled with at least four coverages of a vibratory compactor prior to placement of fill. the exposed subgrade should be protected against precipitation, and the subgrade should not be allowed to freeze.

Attachments

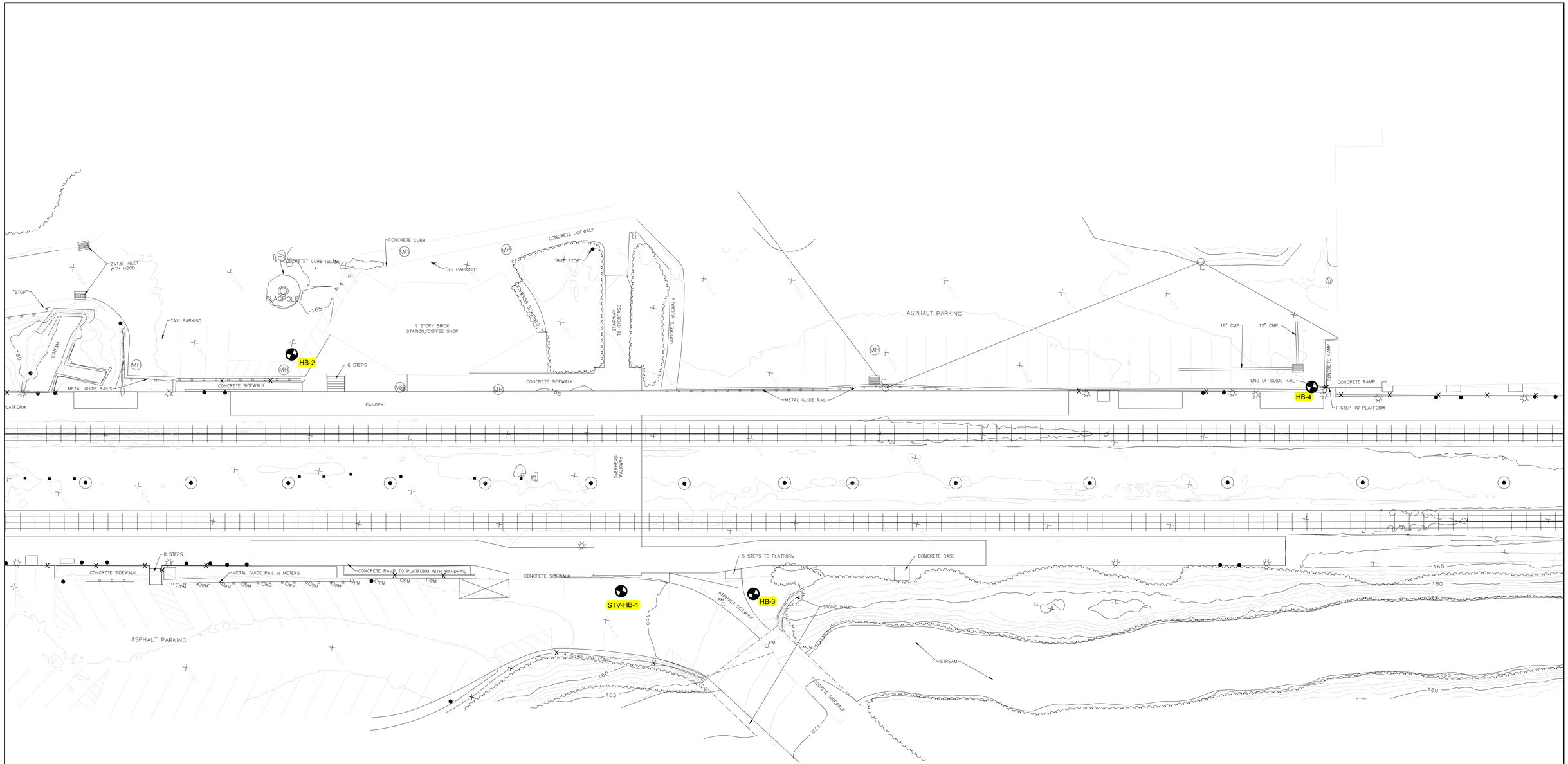
Attachment A – Boring Location Plans

Attachment B – Soil Boring Logs

Attachment C – Geotechnical Laboratory Test Results

ATTACHMENT A

BORING LOCATION PLANS



LEGEND

BORING LOCATION

A BORING LOCATION PLAN

1"=20' 20' 0 20'

100% FINAL SUBMISSION

DESIGNED						CONFORMED					
DRAWN											
CHECKED											
APPROVED											
		NO.	DATE		DRWN	CHKD	APPVD	NO.	DATE	DRWN	CHKD	APPVD
		REVISION						REVISION				

STV 100 Years
225 PARK AVENUE SOUTH,
NEW YORK, NY 10003

MTA Metro-North Railroad
420 Lexington Avenue
New York, NY 10017

TITLE
HARTSDALE AND SCARSDALE STATION IMPROVEMENTS

BORING LOCATION PLAN

HARTSDALE STATION

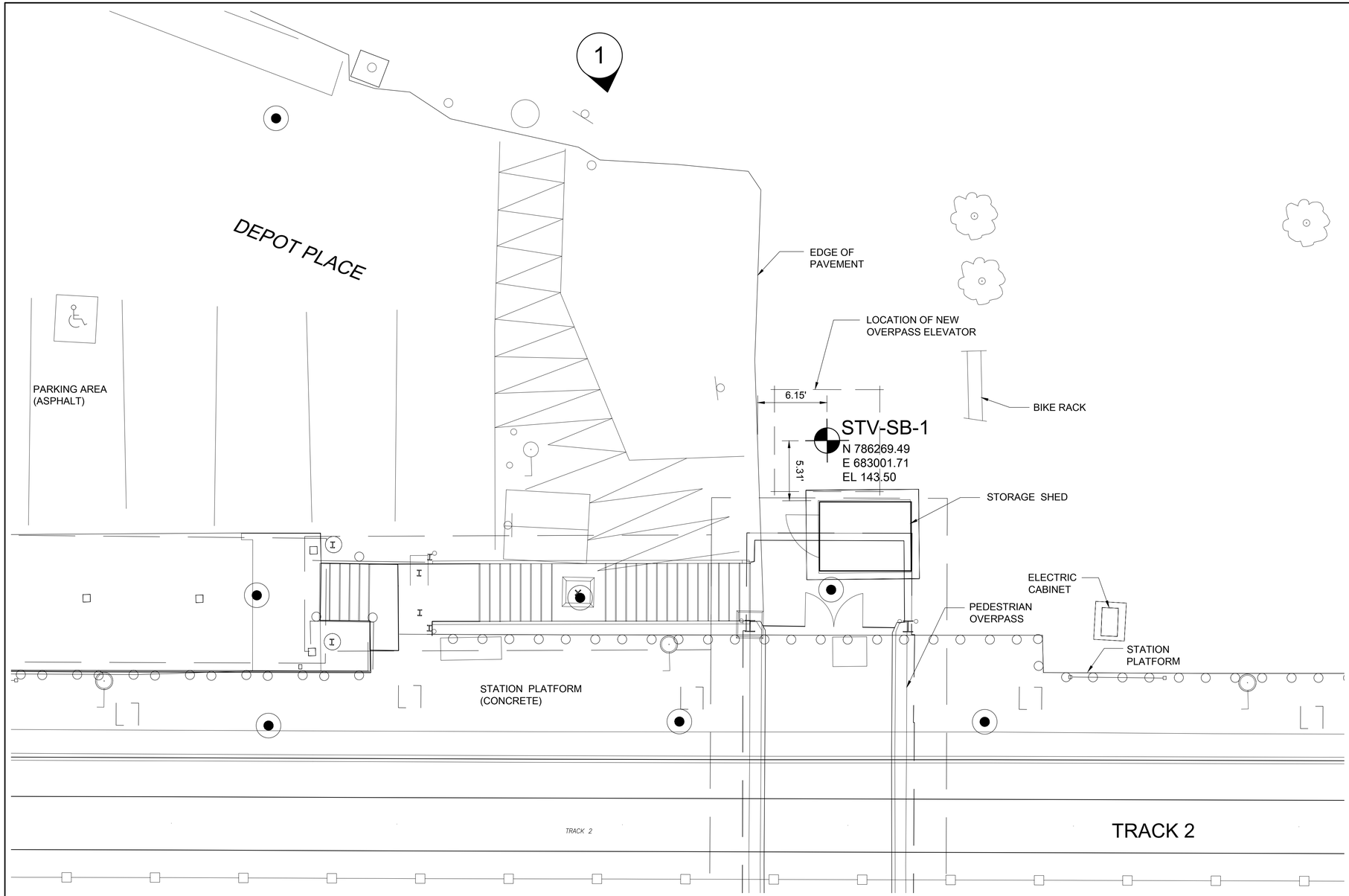
CONTRACT NO. 1000106733

SCALE

DATE 08/23/2019

DRAWING NO. HTD-GE-000

SHEET OF 95



BORING LOCATION PLAN

SCALE: 1"= 5'

PHOTO LOCATION

SCALE: NTS

100% FINAL SUBMISSION

DESIGNED	RB
DRAWN	SR
CHECKED	JS
APPROVED	MM

NO.	DATE		DRWN	CHKD	APPVD

REVISION

NO.	DATE	CONFORMED	DRWN	CHKD	APPVD

REVISION

STV 100 Years
225 PARK AVENUE SOUTH,
NEW YORK, NY 10003

MTA Metro-North Railroad
420 Lexington Avenue
New York, NY 10017

TITLE
HARTSDALE AND SCARSDALE STATION IMPROVEMENTS

BORING LOCATION PLAN

SCARSDALE STATION

CONTRACT NO.
1000106733

SCALE

DATE
08/23/2019

DRAWING NO.
SCD-GE-000

SHEET 1 OF ***

ATTACHMENT B

TEST BORING LOGS

BORING LOG

BORING NUMBER:STV-HB-1

SHEET NUMBER: 1 of 3

CONTRACT NUMBER: 1000106733

PROJECT: **Scarsdale and Hartsdale Station Improvements**
LOCATION (City/State): **Hartsdale, NY**
CLIENT: **Metro-North Railroad**
CONTRACTOR: **Aquifer Drilling & Testing Inc.**

LOCATION: Hartsdale Station

COORD.: N: 794028.30 E: 686606.89
SURFACE ELEV.: 164.4 Feet
DATUM: NAVD88

DRILLER: **Dom Pepe**
INSPECTOR: **Max Korngold**

DRILLING METHOD: **Mud Rotary**
Rig Type: **CME-75**

START DATE: 12/13/19 TIME: 8:45 AM
FINISH DATE: 12/13/19 TIME: 2:00 PM

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol		S ■	U ▯	D ▨	G ☒	C ▤
I.D.	4"	1.5"				
O.D.	4.5"	2"				
Length	60"	24"				
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)			
Hammer Fall	30"	30"	Hammer Type		Automatic	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
12/13/19	10:30 am	13		

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
						0.0 - 5.0	H	A	N	D		0-3": Asphalt 3"-6": Black C GRAVEL 6"-5': Brown cf SAND, trace (+) cf Gravel, tr (-) Silt.
5			S	1		5.0 - 7.0	2	2	1	2	15	Brown mf SAND, some (-) Silt & Clay, trace (-) f Gravel.
			S	2		7.0 - 9.0	1	2	2	3	17	Brown mf SAND, some (-) Silt & Clay, trace (-) f Gravel.
			S	3		9.0 - 11.0	3	3	9	16	11	Brown cf SAND, little (-) Silt & Clay.
10			S	4		11.0 - 13.0	16	13	5	2	8	Top 6": Brown cf SAND, some (-) mf Gravel, trace (-) Silt. Bottom 2": Decomposed Rock.
			S	5		13.0 - 15.0	1	2	2	2	9	Gray cf SAND, some (+) Silt & Clay. (Wet)
15			S	6		15.0 - 17.0	4	2	3	4	11	Top 10": Gray cf SAND, some (+) Silt & Clay. (Wet) Bottom 1": Red cf SAND, trace (-) Silt. (Wet)

RED LINE BORING LOG HARTSDALE.GPJ LIB_LIBRARY.GLB 12/19/19

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER:STV-HB-1
SHEET NUMBER: 2 of 3
CONTRACT NUMBER: 1000106733

PROJECT: **Scarsdale and Hartsdale Station Improvements**
LOCATION: **Hartsdale Station**
Client: **Metro-North Railroad**

CONTRACTOR: **Aquifer Drilling & Testing Inc.**
DRILLER: **Dom Pepe**
INSPECTOR: **Max Korngold**

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			S	7		20.0 - 22.0	3	3	4	5	10.5	Brown cf SAND, trace (-) f Gravel, trace (-) f Silt. (Wet)
25			S	8		25.0 - 27.0	3	2	3	3	2	Brown cf SAND, some (+) mf Gravel, trace (-) Silt. (Wet)
30			S	9		30.0 - 32.0	4	4	2	5	6	Gray mf SAND, some (-) Silt & Clay, trace (-) f Gravel. (Wet)
35			S	10		35.0 - 37.0	9	11	8	5	3	Gray cf SAND, little (-) mf Gravel, trace (-) Silt. Fragments of decomposed rock. (Wet)
40			S	11		40.0 - 42.0	7	5	5	6	0	No recovery. 2" diameter piece of gravel caught in spoon.
												Rig Chatter @ 43'.

RED LINE BORING LOG HARTSDALE.GPJ LIB_LIBRARY.GLB 12/19/19

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER:STV-HB-1
SHEET NUMBER: 3 of 3
CONTRACT NUMBER: 1000106733

PROJECT: **Scarsdale and Hartsdale Station Improvements**
LOCATION: **Hartsdale Station**
Client: **Metro-North Railroad**

CONTRACTOR: **Aquifer Drilling & Testing Inc.**
DRILLER: **Dom Pepe**
INSPECTOR: **Max Korngold**

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			S	12		45.0 - 47.0	22	13	6	7	3.5	Brown cf SAND, some (+) cf Gravel, trace (-) Silt. Fragments of decomposed rock. (Wet)
50			S	13		50.0 - 51.8	21	14	25	50/4"	8.5	Brown cf SAND, some (-) mf Gravel, trace (-) Silt. (Wet)
												End of boring at 51.8 ft.
55												
60												
65												

RED LINE BORING LOG HARTSDALE.GPJ LIB_LIBRARY.GLB 12/19/19

Rev01
Notes:

STV 100 Years

SOFT DIG

BORING NUMBER: **HB-2**
SHEET NUMBER: **1** of **1**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Hand Auger**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 793,985** **E: 686,444**
SURFACE ELEV.: **165.0 feet**
DATUM:
START DATE: **2/12/18** TIME: **9:45 am**
FINISH DATE: **2/12/18** TIME: **10:15 am**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol		S ■	U	D	G ☒	C
I.D.						
O.D.						
Length						
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			G	1		0.0 - 5.0						Top 6": COBBLES, CM Gravel. Bottom 54": Dark brown CM GRAVEL, some CM Sand, trace Silt, moist. (FILL)
5												(Start Boring at 5ft, see Boring Log)
10												
15												

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/27/18

Rev01
Notes:

BORING LOG

BORING NUMBER: **HB-2**
SHEET NUMBER: **1** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Mud Rotary**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 793,985** **E: 686,444**
SURFACE ELEV.: **165.0 feet**
DATUM:
START DATE: **2/12/18** TIME: **10:20 am**
FINISH DATE: **2/13/18** TIME: **12:45 pm**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol	Steel	S ■	U ▯	D ▨	G ☒	C ▤
I.D.	4"	1.375"				1.772"
O.D.	4.375"	2"				2.980"
Length	40"	24"				60"
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
2/13/18	2:45 pm	6.5	-	47.0
2/14/18	8:00 am	6.5	-	47.0
2/15/18	10:30 am	6.8	-	47.0
2/15/18	1:50 pm	7.2	-	47.0

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1		0.0 - 5.0											Previously hand cleared to 5' below ground surface. See Soft Dig Log for HB-2.
5				1		5.0 - 7.0	10	14	9	7	7						Dark brown CM SAND, and MF Gravel, trace Silt, moist. (SP)
				2		7.0 - 9.0	5	4	10	9	10						Dark brown CM SAND, some MF Gravel, little Silt, moist. (SP)
				3		9.0 - 11.0	3	3	4	8	7						Dark brown CM SAND, and MF Gravel, little Silt, moist. (SP)
10				4		11.0 - 13.0	6	6	8	10	7						Dark gray CM SAND, some M Gravel, trace Silt, moist. (SP)
				5		13.0 - 15.0	12	10	13	14	17						Dark gray CM SAND, little M Gravel, little Silt, moist. (SP)
15				6		15.0 - 17.0	12	13	11	13	21						Light brown CM SAND, some M Gravel, trace Silt, moist. (SP)

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER: **HB-2**
SHEET NUMBER: **2** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION: **Hartsdale Train Station**
CLIENT: **Metro North Railroad**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	
				7		20.0 - 22.0	15	14	15	21	7	Brown M GRAVEL, and MF Sand, little Silt, moist. (GP)
25				8		25.0 - 27.0	10	10	14	24	11	Black/Dark gray CM SAND, some F Gravel, trace Silt, moist. (SP)
30				9		30.0 - 32.0	15	12	8	8	13	Dark gray CM SAND, and CM Gravel, trace (-) Silt, moist. (SP)
35				10		35.0 - 37.0	12	11	10	10	7	Gray CM GRAVEL, little(-) MF Sand, moist. (GP)
40				11		40.0 - 42.0	20	24	22	20	13	Rig chattered at 37' to 39'. Gray CM GRAVEL and CM Sand. (Decomposed Rock)

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER: **HB-2**
SHEET NUMBER: **3** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION: **Hartsdale Train Station**
CLIENT: **Metro North Railroad**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			S	12		45.0 - 45.1	100/1	-	-	-	0	No Recovery.
												End of Borehole at 45.1 ft.
50												
55												
60												
65												

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

STV 100 Years

SOFT DIG

BORING NUMBER: **HB-3**
SHEET NUMBER: **1** of **1**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Hand Auger**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 794,084** **E: 686,633**
SURFACE ELEV.: **166.0 feet**
DATUM:
START DATE: **2/14/18** TIME: **1:20 pm**
FINISH DATE: **2/14/18** TIME: **2:30 pm**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol		S ■	U ▯	D ▨	G ☒	C ▤
I.D.						
O.D.						
Length						
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1		0.0 - 5.0											Brown CM SAND, and CM Gravel, trace roots, moist, COBBLES. (FILL)
5																	(Start Boring at 5ft, see Boring Log)
10																	
15																	

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/27/18

Rev01
Notes:

BORING LOG

BORING NUMBER: **HB-3**
SHEET NUMBER: **1** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Mud Rotary**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 794,084** **E: 686,633**
SURFACE ELEV.: **166.0 feet**
DATUM:
START DATE: **2/15/18** TIME: **8:00 am**
FINISH DATE: **2/15/18** TIME: **1:10 pm**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol	Steel	S ■	U ▯	D ▨	G ☒	C ▤
I.D.	4"	1.375"				1.772"
O.D.	4.375"	2"				2.980"
Length	25"	24"				60"
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
2/15/18	11:30 am	4.5	-	52.0

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1		0.0 - 5.0											Previously hand cleared to 5' below ground surface. See Soft Dig Log for HB-3.
5			S	1		5.0 - 7.0	3	3	2	2	4						Brown CM SAND, little MF Gravel, wet. (SP)
			S	2		7.0 - 9.0	3	3	2	2	7						Brown CM SAND, little MF Gravel, trace Silt, wet. (SP)
			S	3		9.0 - 11.0	2	2	2	2	0						No Recovery.
10			S	4		11.0 - 13.0	12	12	11	5	15						Brown CM SAND, some M Gravel, little Clayey Silt, wet. (SP)
			S	5		13.0 - 15.0	3	3	5	5	7						Gray Silty CLAY, and MF Sand, wet. (CL)
15			S	6		15.0 - 17.0	6	6	5	5	4						Brown CM SAND, and MF Gravel, little Silt, wet. (SP)

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER: **HB-3**
SHEET NUMBER: **2** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION: **Hartsdale Train Station**
CLIENT: **Metro North Railroad**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			S	7		20.0 - 22.0	2	5	5	4	4						Brown CM SAND, and Silt, some CM Gravel, wet. (SM)
25			S	8		25.0 - 27.0	5	5	6	9	15						Top 4": Gray CM GRAVEL, wet. (GP) Bottom 11": Brown CM SAND, and CM Gravel, trace (-) Silt, wet. (SP)
30			S	9		30.0 - 32.0	4	6	6	4	0						No Recovery.
35			S	10		35.0 - 37.0	3	4	4	5	13						Top 4": Gray MF GRAVEL, wet. (GP) Bottom 9": Brown/Gray CF SAND, trace Silt, wet. (SM)
40			S	11		40.0 - 42.0	5	5	5	7	16						Gray CM SAND, and CM Gravel, wet. (SP)

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

BORING LOG
(continued)

BORING NUMBER: **HB-3**
SHEET NUMBER: **3** of **3**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION: **Hartsdale Train Station**
CLIENT: **Metro North Railroad**

CONTRACTOR: **Jersey Boring & Drilling**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**

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	6/12	12/18	18/24	REC. (in.)	FIELD CLASSIFICATION AND REMARKS
							CORING					
							RUN (in.)	REC. (in.)	REC. %	L>4" (in.)	RQD %	
			S	12		45.0 - 47.0	8	10	38	20	13	Top 3": Gray MF GRAVEL, moist. (GP) Bottom 10": Brown CF SAND, little Silt, moist. (SM)
50			S	13		50.0 - 51.5	33	100/6	38	100/6	19	Brown/Gray CM GRAVEL, and CM Sand, moist. (GP)
												End of Borehole at 51.5 ft.
55												
60												
65												

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

STV 100 Years

SOFT DIG

BORING NUMBER: **HB-4**
SHEET NUMBER: **1** of **1**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Hand Auger**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 794,321** **E: 686,694**
SURFACE ELEV.: **167.0 feet**
DATUM:
START DATE: **2/13/18** TIME: **1:00 pm**
FINISH DATE: **2/13/18** TIME: **1:15 pm**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol		S ■	U ▯	D ▨	G ☒	C ▤
I.D.						
O.D.						
Length						
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1		0.0 - 5.0											Light brown CM SAND, little (-) F Gravel. (FILL)
5																	(Start Boring at 5ft, see Boring Log)
10																	
15																	

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/27/18

Rev01
Notes:

BORING LOG

STV 100 Years

BORING NUMBER: **HB-4**
SHEET NUMBER: **1** of **1**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Mud Rotary**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 794,321** **E: 686,694**
SURFACE ELEV.: **167.0 feet**
DATUM:
START DATE: **2/13/18** TIME: **1:20 pm**
FINISH DATE: **2/14/18** TIME: **10:45 am**

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol	Steel	S ■	U ▯	D ▨	G ▩	C ▤
I.D.	4"	1.375"				1.772"
O.D.	4.375"	2"				2.980"
Length	15"	24"				60"
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)		A / 1.875" (2.65")	
Hammer Fall	30"	30"	Hammer Type		Automatic Hammer	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
2/14/18	8:40 am	-	10.0	11.0
2/15/18	1:15 pm	9.4	15.0	23.0
2/15/18	2:00 pm	10.2	-	23.0

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
			G	1		0.0 - 5.0											Previously hand cleared to 5' below ground surface. See Soft Dig Log for HB-4.
5			S	1		5.0 - 7.0	4	7	15	21	21						Brown CM SAND, and C Gravel moist. (SP)
			S	2		7.0 - 9.0	13	17	35	24	16						Light brown / gray CM SAND, and CM Gravel, moist. (SP)
			S	3		9.0 - 11.0	17	17	36	50	20						Dark brown / gray CM SAND, some CM Gravel, moist. (Decomposed Rock)
10			S	4		11.0 - 11.0	100/3	-	-	-	2						MF GRAVEL.
			S	5		13.0 - 13.1	100/6	100/4	-	-	8						MF GRAVEL.
15			S	6		18.0 -18.0	100/0	-	-	-	0						No Recovery.
																	Start Coring at 18 ft, see Coring Log.

RED LINE BORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01
Notes:

Boring No. **HB-4** Sheet **1** of **1**

CORING LOG

BORING NUMBER: **HB-4**
SHEET NUMBER: **1** of **1**
CONTRACT NUMBER:

PROJECT: **MNR-26 Stations Repairs**
LOCATION (City/State): **Hartsdale / NY**
CLIENT: **Metro North Railroad**
CONTRACTOR: **Jersey Boring & Drilling Company Inc.**
DRILLER: **Roberto Santiago**
INSPECTOR: **Canan Ozudogru**
DRILLING METHOD: **Diamond Tip**
RIG TYPE: **Truck Rig**

LOCATION: **Hartsdale Train Station**
COORD.: **N: 794,321** **E: 686,694**
SURFACE ELEV.: **167.0 feet**
DATUM:
START DATE: **2/14/18** TIME: **11:00 am**
FINISH DATE: **2/14/18** TIME: **1:00 pm**

CORE BARREL DATA:

TYPE: Double Barrel, Split Inner Tube with Wireline.
CORE SIZE: NQ2
O.D.: 2.980"
I.D.: 1.772"
CASING SIZE I.D. (O.D.): 4" (4.375")

NOTES:

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 (Color, Lithology, Grain Size, Fracturing, Weathering, Strength, Structure)	WEATHERING	STRENGTH	DISCONTINUITY DATA ANGLE (deg)	Jr	Ja	DEPTH (feet)
20	6	R-1 18.0 - 23.0	60	100	17.5	GNEISS, gray, soft, highly weathered, medium spaced joints.	II/III	R2	10	1.0	4	18.31
	6								12	1.0	2	18.82
									10	1.0	2	19
	6								12	1.0	3	19.2
									5	1.0	3	19.75
									5	1.0	4	19.9
	8								10	1.0	2	20.7
									5	1.0	2	21.12
									18	1.0	2	21.5
	8								15_{MB}	-	-	21.8
									5_{MB}	-	-	22.4
									5	1.0	4	22.7
25						End of Coring at 23ft.			5	1.0	4	22.9
30												

RED LINE CORING LOG MNR_DATABASE.GPJ MNR_LIBRARY.GLB 2/28/18

Rev01

BORING LOG

BORING NUMBER:STV-SB-1
SHEET NUMBER: 1 of 1
CONTRACT NUMBER: 1000106733

PROJECT: Scarsdale and Hartsdale Station Improvements
LOCATION (City/State): Scarsdale, NY
CLIENT: Metro-North Railroad
CONTRACTOR: Aquifer Drilling & Testing Inc.

DRILLER: Mike Beveridge
INSPECTOR: Max Korngold

DRILLING METHOD:Mud Rotary
RIG TYPE:CME-55-LCT

LOCATION: Scarsdale Station

COORD.: N: 786269.5 E: 683001.7
SURFACE ELEV.: 143.5 ft.
DATUM: NAVD 88

START DATE: 6/21/19 TIME: 12:50 pm
FINISH DATE: 6/21/19 TIME: 5:30 pm

	Casing	Split Spoon	Shelby Tube	Dennison	Grab	Core Barrel
Type/Symbol	Steel	S	U	D	G	C
I.D.		2 in.				2 3/8 in.
O.D.		1 3/8 in.				2 in.
Length	5 ft.	2 ft.				5 ft.
Hammer Wt.	140 lbs	140 lbs	Drill Rod Size/ I.D.(O.D.)			
Hammer Fall	30"	30"	Hammer Type		Automatic	

GROUNDWATER DATA

Date	Time	Water Depth (ft)	Casing Depth (ft)	Hole Depth (ft)
6/21/19	4:00 pm	Dry	10	10

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	6/12	12/18	18/24	REC. (in.)	CORING RUN (in.)	CORING REC. (in.)	CORING REC. %	CORING L>4" (in.)	CORING RQD %	FIELD CLASSIFICATION AND REMARKS
						0.0 - 5.0	H	A	N	D							Grey-Brown cf SAND, trace (+) cf Gravel, trace (-) silt, plant roots near surface. 3.3ft: Tan cf SAND, trace (+) cf Gravel, trace (-) silt.
5			S	1		5.0 - 7.0	3	5	12	15	10						Grey cf SAND, trace f Gravel, trace (-) silt.
			S	2		7.0 - 9.0	16	18	22	26	9.5						cf GRAVEL, some (+) cf Sand, fragments of bedrock. Decomposed rock encountered at 9 ft.
			S	3		9.0 - 9.3	100/4"				4						DECOMPOSED ROCK
10		6.75	C	1		9.3 - 10.0 10.0 - 15.0	60	60	100	52	86						Could not advance split spoon through decomposed rock. Advance auger until refusal at 10 ft. GNEISS, white-grey, medium, slightly weathered, RQD = 86%.
		6.50															
		4.90															
		6.00															
		6.30															
15																	End of Boring at 15 ft.

RED LINE BORING LOG SCARSDALE.GPJ LIB_LIBRARY_QA(CORRECTED N VALUES).GLB 6/24/19

Rev01
Notes:

ATTACHMENT C

GEOTECHNICAL LABORATORY TEST RESULTS

STV #18.005
MNR Hartsdale and Scarsdale Stations
LABORATORY SOIL TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS			REMARKS
			WATER CONTENT (%)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	
HB-2	S-3	9-11	17.5	GP-GM	6.8	See corrosion summary
HB-2	S-9	30-32	11.5	SP-SM	8.4	
HB-3	G-1	0-5	16.0	SP-SM	10.0	See corrosion summary
HB-3	S-2	7-9	16.4	SM	21.5	
HB-3	S-5	13-15	33.7	CL	64.8	
HB-4	S-1	5-7	5.2	SP-SM	9.1	See corrosion summary
HB-4	S-3	9-11	7.6	SM	12.8	

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

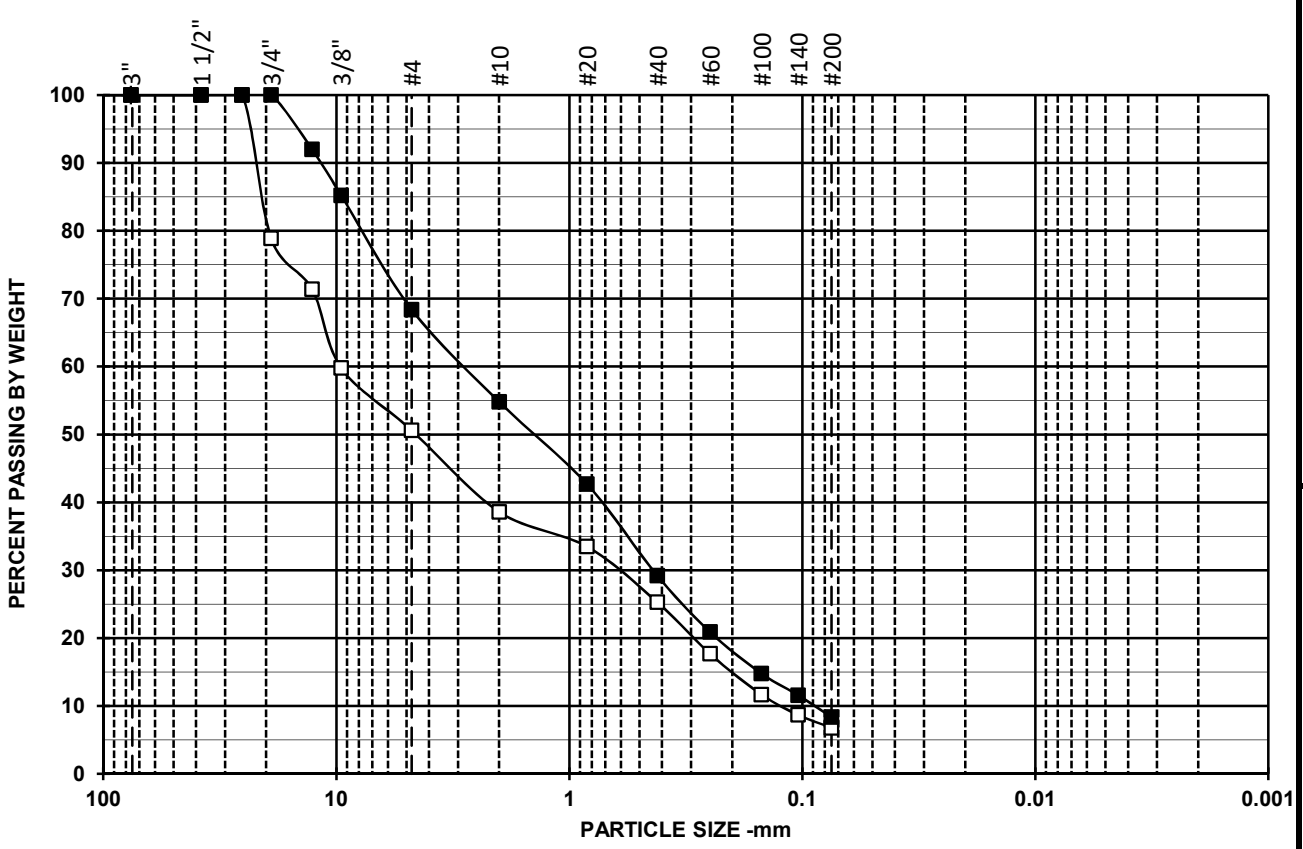
STV #18.005
MNR Hartsdale and Scarsdale Stations
Summary of Corrosion Testing

SAMPLE ID			RESISTIVITY TESTS		CHEMICAL TESTS				REMARKS
Boring No.	Sample No.	Depth (ft)	Test Date	Minimum Resistivity AASHTO T288 (kΩ - cm)	pH AASHTO T289 pH (pH units)	pH AASHTO T289 Temperature (°C)	Leachable Chloride (1) AASHTO T291 (ppm)	Leachable Sulfate(1) AASHTO T290 (ppm)	
HB-2	S-3	9-11	2/27/18	1.3	7.1	20.8	206	133	
HB-3	G-1	0-5	2/27/18	2.4	7.1	20.8	103	56	
HB-4	S-1	5-7	2/27/18	6.9	7.3	20.8	15	<5	

TerraSense, LLC
45H Commerce Way
Totowa, NJ 07512
(973) 812-1818

Prepared by: RT
Reviewed by: GET
Date: 3/20/2018

Project No. 8123-18002
File: Corrosion2.xlsx



Symbol	□	■	○
Boring	HB-2	HB-2	
Sample	S-3	S-9	
Depth	9-11	30-32	
% +3"	0.0	0.0	
% Gravel	49.4	31.6	
% SAND	43.8	60.0	
%C SAND	12.0	13.6	
%M SAND	13.3	25.6	
%F SAND	18.5	20.8	
% FINES	6.8	8.4	
D_{100} (mm)	25.400	19.050	
D_{60} (mm)	9.572	2.783	
D_{30} (mm)	0.625	0.437	
D_{10} (mm)	0.122	0.088	
Cc	0.300	0.800	
Cu	78.5	31.5	

Sieve Size/ID #	Percent Finer Data		
6"	100.0	100.0	
4"	100.0	100.0	
3"	100.0	100.0	
1 1/2"	100.0	100.0	
1"	100.0	100.0	
3/4"	78.9	100.0	
1/2"	71.4	92.0	
3/8"	59.8	85.2	
#4	50.6	68.4	
#10	38.6	54.8	
#20	33.5	42.7	
#40	25.3	29.2	
#60	17.7	20.9	
#100	11.7	14.8	
#140	8.7	11.6	
#200	6.8	8.4	
5μ m			
2μ m			
1μ m			

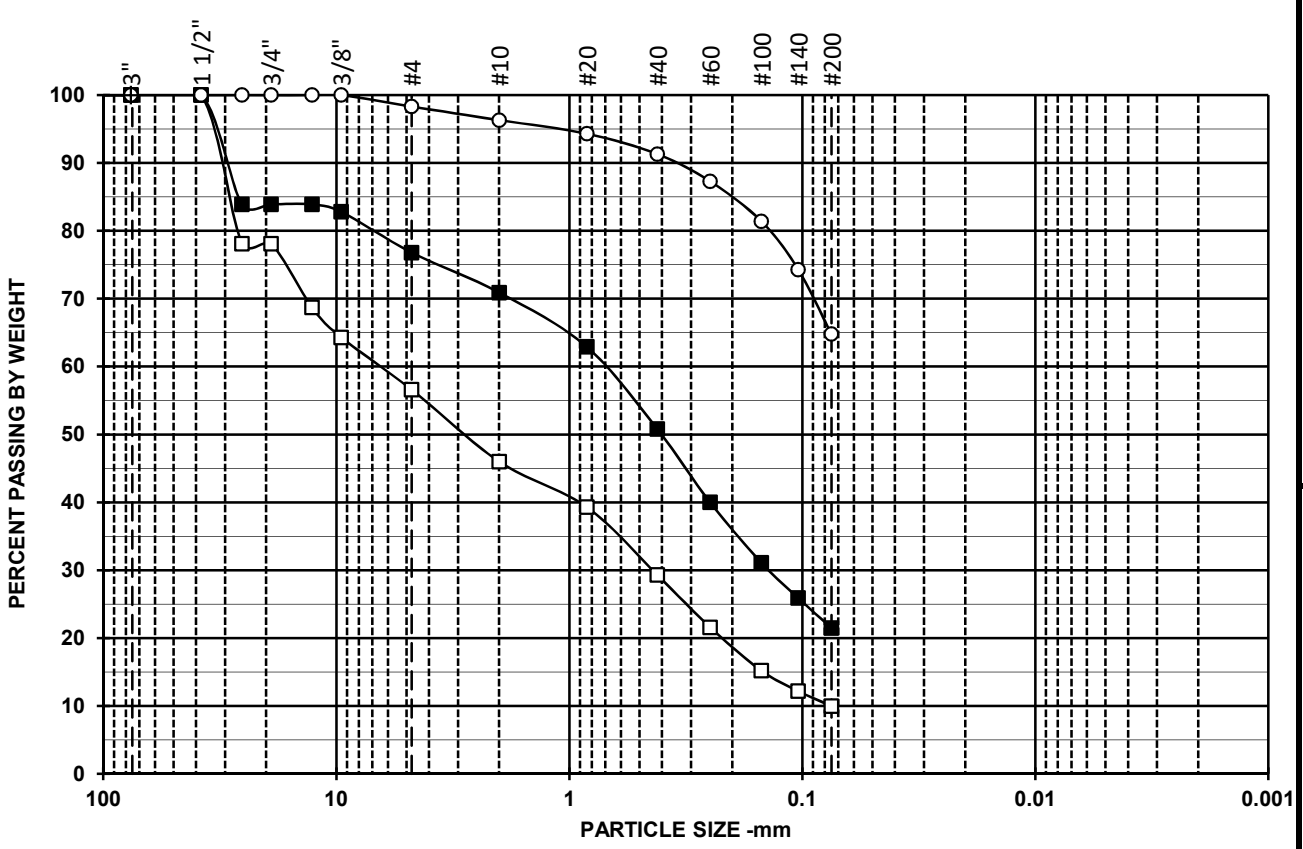
SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□	17.5				GP-GM		Gray, Poorly graded gravel with silt and sand petroleum product present	02/28/18
■	11.5				SP-SM		Dark grayish brown , Poorly graded sand with silt and gravel	02/26/18
○								

STV #18.005

TerraSense, LLC #8123-18002

MNR Hartsdale and Scarsdale Stations

PARTICLE SIZE DISTRIBUTION



Symbol	□	■	○
Boring	HB-3	HB-3	HB-3
Sample	G-1	S-2	S-5
Depth	0-5	7-9	13-15
% +3"	0.0	0.0	0.0
% Gravel	43.4	23.2	1.7
% SAND	46.6	55.3	33.5
%C SAND	10.6	5.9	2.0
%M SAND	16.7	20.1	5.0
%F SAND	19.3	29.3	26.5
% FINES	10.0	21.5	64.8
D_{100} (mm)	38.100	38.100	9.530
D_{60} (mm)	6.458	0.712	
D_{30} (mm)	0.440	0.139	
D_{10} (mm)	0.075		
Cc	0.400		
Cu	86.1		

Sieve Size/ID #	Percent Finer Data		
6"	100.0	100.0	100.0
4"	100.0	100.0	100.0
3"	100.0	100.0	100.0
1 1/2"	100.0	100.0	100.0
1"	78.1	83.9	100.0
3/4"	78.1	83.9	100.0
1/2"	68.7	83.9	100.0
3/8"	64.3	82.8	100.0
#4	56.6	76.8	98.3
#10	46.0	70.9	96.3
#20	39.3	62.9	94.3
#40	29.3	50.8	91.3
#60	21.6	40.0	87.3
#100	15.2	31.1	81.4
#140	12.2	25.9	74.3
#200	10.0	21.5	64.8
5μ m			
2μ m			
1μ m			

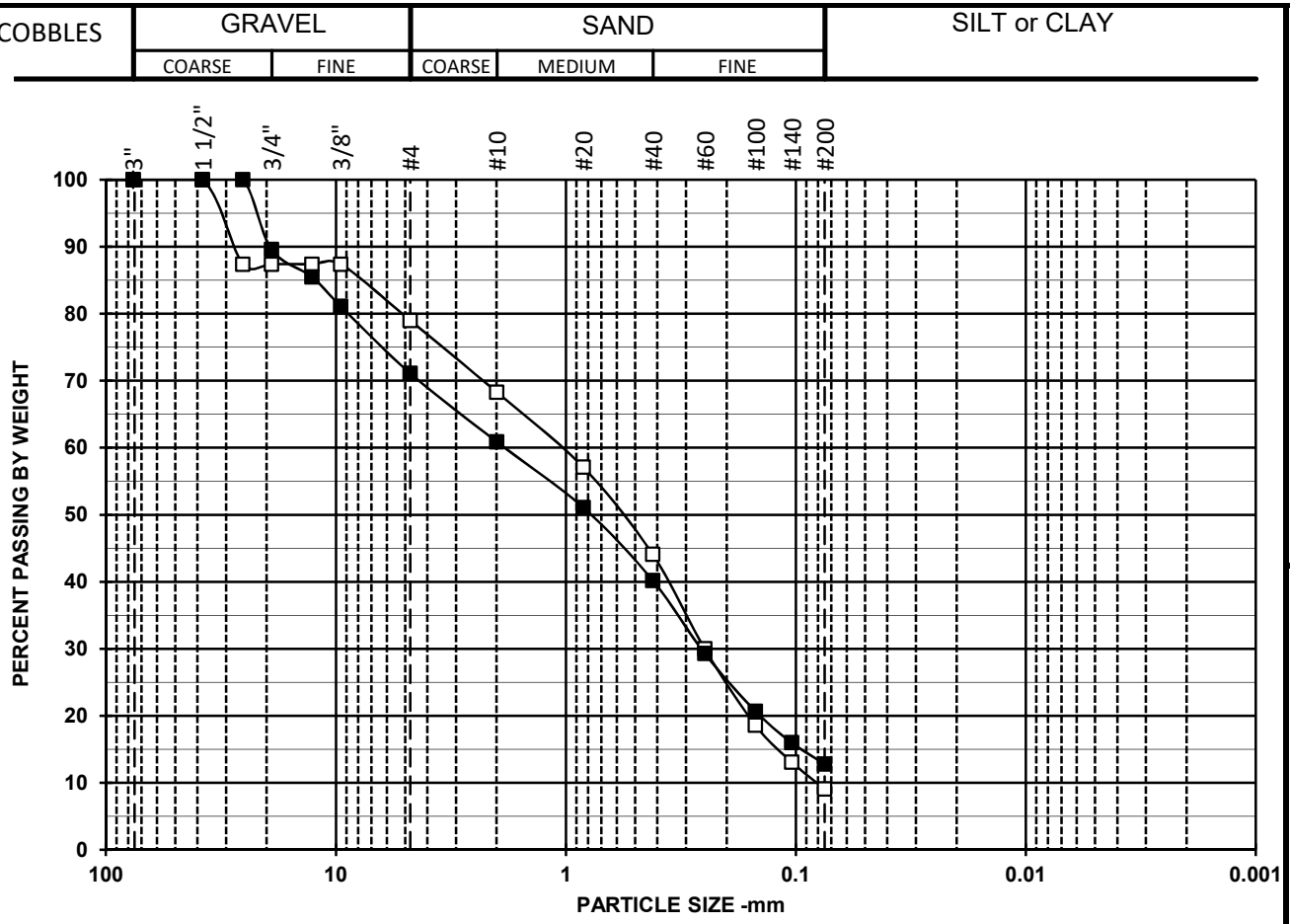
SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□	16.0				SP-SM		Gray, Poorly graded sand with silt and gravel	02/28/18
■	16.4				SM		Brown , Silty sand with gravel	02/26/18
○	33.7				CL		Very dark gray, Sandy lean clay	02/26/18

STV #18.005

TerraSense, LLC #8123-18002

MNR Hartsdale and Scarsdale Stations

PARTICLE SIZE DISTRIBUTION



Symbol	□	■	○
Boring	HB-4	HB-4	
Sample	S-1	S-3	
Depth	5-7	9-11	
% +3"	0.0	0.0	
% Gravel	21.0	28.9	
% SAND	69.9	58.3	
%C SAND	10.7	10.2	
%M SAND	24.2	20.7	
%F SAND	35.0	27.4	
% FINES	9.1	12.8	
D_{100} (mm)	38.100	25.400	
D_{60} (mm)	1.052	1.846	
D_{30} (mm)	0.249	0.257	
D_{10} (mm)	0.081		
Cc	0.700		
Cu	13.0		

Sieve Size/ID #	Percent Finer Data		
6"	100.0	100.0	
4"	100.0	100.0	
3"	100.0	100.0	
1 1/2"	100.0	100.0	
1"	87.4	100.0	
3/4"	87.4	89.6	
1/2"	87.4	85.5	
3/8"	87.4	81.1	
#4	79.0	71.1	
#10	68.3	60.9	
#20	57.1	51.1	
#40	44.1	40.2	
#60	30.0	29.3	
#100	18.6	20.7	
#140	13.1	16.0	
#200	9.1	12.8	
5μ m			
2μ m			
1μ m			

SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□	5.2				SP-SM		Brown, Poorly graded sand with silt and gravel	02/26/18
■	7.6				SM		Dark brown , Silty sand with gravel	02/26/18
○								

STV #18.005

TerraSense, LLC #8123-18002

MNR Hartsdale and Scarsdale Stations

PARTICLE SIZE DISTRIBUTION

STV
MNR Hartsdale and Scarsdale Stations
SUMMARY OF ROCK TESTING

SAMPLE IDENTIFICATION				STATE PROPERTIES			ENGINEERING PROPERTY TESTS				REMARKS
Boring	Run		Depth	WATER CONTENT (1) (%)	TOTAL UNIT WGT. (pcf)	DRY UNIT WGT. (pcf)	TEST TYPE (2)	ORIENTATION (3)	POINT LOAD TEST (ASTM D5731) STRENGTH INDEX Is(50) (MPa)	POINT LOAD TEST (ASTM D5731) ESTIMATED (4) COMPRESSIVE STRENGTH (psi)	
HB-4	R-1	T-1	19.0-19.1	0.27			PL	Diametral	1.1	3772	
HB-4	R-1	T-1	19.0-19.1				PL	Axial	9.2	28995	
HB-4	R-1	T-2	19.7-19.8	0.19			PL	Diametral	5.4	18409	
HB-4	R-1	T-2	19.7-19.8				PL	Axial	7.3	22766	
HB-4	R-1	T-3	20.2-20.3	0.20			PL	Diametral	4.1	14172	
HB-4	R-1	T-3	20.2-20.3				PL	Axial	7.3	22191	
HB-4	R-1	T-4	22.05-22.15	0.21			PL	Diametral	3.9	13230	
HB-4	R-1	T-4	22.05-22.15				PL	Axial	7.6	22453	
HB-4	R-1	T-5	22.6-22.7	0.20			PL	Diametral	3.8	12758	
HB-4	R-1	T-5	22.6-22.7				PL	Axial	6.8	20569	

Notes: (1) Water contents determined after trimming and shearing.
(2) Test Type Abbreviations: PL: Point Load
(3) Diametral orientation across core along bedding plane, axial perpendicular to bedding plane.
(4) Compressive Strength determined using generalized "K" factor in ASTM D5731

Depth:		
Load Orientation:	Diametral	Axial
Length to nearest free end, L (mm)	27.9	25.2
Specimen Width, W (mm)	52.4	52.4
D (mm)	52.4	28.0
D' (mm)	52.4	28.0
D_e (mm)	52.4	43.2
Failure Load, P (lb)	686	4144
Point Load (N)	**3051**	**18433**
Point Load (Mpa)	**1.14**	**9.25**
Index, Is50 (psi)	**160**	**1340**
Unconfined Compressive Strength (psi)	**3772**	**28995**
Specimen /Failure Sketch		
Tare No.	P-62	
Wet + Tare (gm)	493.9	
Dry + Tare (gm)	493.39	
Tare (gm)	307.49	
Water Content%	**0.27**	
Comments		

Test by: RAT Test Date: 2/21/2018 Reviewed by: GET

MNR Hartsdale and Scarsdale Stations		**POINT LOAD STRENGTH INDEX OF ROCK ASTM D5731**
STV	18.005	**Boring: HB-4 Run: R-1**
TerraSense, LLC	8123-18002	**Sample: T-1 Depth: 19.0-19.1**

Depth:		
Load Orientation:	Diametral	Axial
Length to nearest free end, L (mm)	27.7	26.4
Specimen Width, W (mm)	52.5	52.5
D (mm)	52.5	27.0
D' (mm)	52.5	27.0
D_e (mm)	52.5	42.5
Failure Load, P (lb)	3244	3179
Point Load (N)	**14430**	**14141**
Point Load (Mpa)	**5.35**	**7.28**
Index, Is50 (psi)	**780**	**1060**
Unconfined Compressive Strength (psi)	**18409**	**22766**
Specimen /Failure Sketch		
Tare No.	P-63	
Wet + Tare (gm)	478.18	
Dry + Tare (gm)	477.85	
Tare (gm)	307.82	
Water Content%	**0.19**	
Comments		

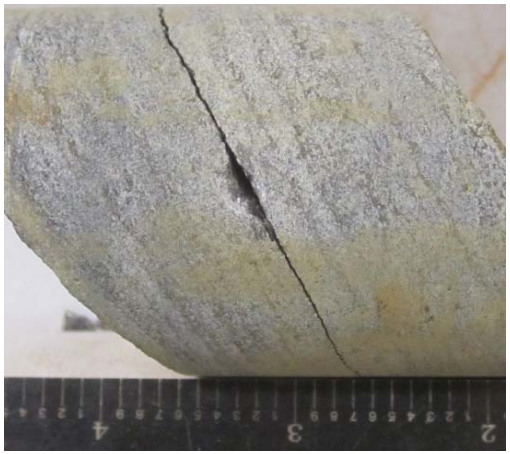
Test by: RAT Test Date: 2/21/2018 Reviewed by: GET

MNR Hartsdale and Scarsdale Stations		**POINT LOAD STRENGTH INDEX OF ROCK ASTM D5731**
STV	18.005	**Boring: HB-4 Run: R-1**
TerraSense, LLC	8123-18002	**Sample: T-2 Depth: 19.7-19.8**

Depth:		
Load Orientation:	Diametral	Axial
Length to nearest free end, L (mm)	25.6	25.1
Specimen Width, W (mm)	52.6	52.6
D (mm)	52.6	25.0
D' (mm)	52.6	25.0
D_e (mm)	52.6	40.9
Failure Load, P (lb)	2508	2990
Point Load (N)	**11156**	**13300**
Point Load (Mpa)	**4.13**	**7.26**
Index, Is50 (psi)	**600**	**1050**
Unconfined Compressive Strength (psi)	**14172**	**22191**
Specimen /Failure Sketch		
Tare No.	W-1	
Wet + Tare (gm)	423.95	
Dry + Tare (gm)	423.63	
Tare (gm)	266.54	
Water Content%	**0.20**	
Comments		

Test by: RAT Test Date: 2/21/2018 Reviewed by: GET

MNR Hartsdale and Scarsdale Stations		**POINT LOAD STRENGTH INDEX OF ROCK ASTM D5731**
STV	18.005	**Boring: HB-4 Run: R-1**
TerraSense, LLC	8123-18002	**Sample: T-3 Depth: 20.2-20.3**

Depth:		
Load Orientation:	Diametral	Axial
Length to nearest free end, L (mm)	24.3	25.1
Specimen Width, W (mm)	52.6	52.6
D (mm)	52.6	21.0
D' (mm)	52.6	21.0
D_e (mm)	52.6	37.5
Failure Load, P (lb)	2348	2719
Point Load (N)	**10444**	**12095**
Point Load (Mpa)	**3.86**	**7.55**
Index, Is50 (psi)	**560**	**1100**
Unconfined Compressive Strength (psi)	**13230**	**22453**
Specimen /Failure Sketch		
Tare No.	P-86	
Wet + Tare (gm)	421.04	
Dry + Tare (gm)	420.76	
Tare (gm)	288.84	
Water Content%	**0.21**	
Comments		

Test by: RAT Test Date: 2/21/2018 Reviewed by: GET

MNR Hartsdale and Scarsdale Stations		**POINT LOAD STRENGTH INDEX OF ROCK ASTM D5731**
STV	18.005	**Boring: HB-4 Run: R-1**
TerraSense, LLC	8123-18002	**Sample: T-4 Depth: 22.05-22.15**

Depth:		
Load Orientation:	Diametral	Axial
Length to nearest free end, L (mm)	28.7	26.8
Specimen Width, W (mm)	52.6	52.6
D (mm)	52.6	23.0
D' (mm)	52.6	23.0
D_e (mm)	52.6	39.3
Failure Load, P (lb)	2282	2645
Point Load (N)	**10151**	**11766**
Point Load (Mpa)	**3.75**	**6.85**
Index, Is50 (psi)	**540**	**990**
Unconfined Compressive Strength (psi)	**12758**	**20569**
Specimen /Failure Sketch		
Tare No.	P-94	
Wet + Tare (gm)	322.78	
Dry + Tare (gm)	322.39	
Tare (gm)	131.14	
Water Content%	**0.20**	
Comments		

Test by: RAT Test Date: 2/21/2018 Reviewed by: GET

MNR Hartsdale and Scarsdale Stations		**POINT LOAD STRENGTH INDEX OF ROCK ASTM D5731**
STV	18.005	**Boring: HB-4 Run: R-1**
TerraSense, LLC	8123-18002	**Sample: T-5 Depth: 22.6-22.7**