Foundation Investigation and Design Report

Noise Barrier Walls, Highway 401 Westbound Core and Collector Lanes
Neilson Road to Warden Avenue, City of Toronto, Ontario
Ministry of Transportation, Ontario, G.W.P. No. 2162-11-00

Submitted to:

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PART A

FOUNDATION INVESTIGATION REPORT
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HIGHWAY 401 WESTBOUND CORE AND COLLECTOR LANES,
NEILSON ROAD TO WARDEN AVENUE, CITY OF TORONTO, ONTARIO
MTO G.W.P. 2162-11-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the rehabilitation and operational improvements of the Highway 401 westbound (WB) core and collector lanes, from Neilson Road to Warden Avenue in the City of Toronto, Ontario (GWP 2162-11-00).

This report addresses the foundation investigation carried out for the proposed noise barrier walls associated with the northward widening of Highway 401. This report was developed based on information from the 2018 (current) investigation, supplemented with information from a 1966 (previous) foundation investigation completed by others at the structure site, reported as follows:

- **MTO GEOCRES No. 30M14-74**: Report titled "Foundation Investigation Report for the Proposed Extension of Hwy. #401 and Midland Ave. Crossing, Metropolitan Toronto, District #6, W.J. 66-F-87 - W.P. 260-61", by DHO, Foundation Section, Materials and Testing Division, dated January 4, 1967;

The results of the 1966 investigation are also summarized in the following report:

- **MTO GEOCRES No. 30M14-340:** "Preliminary Foundation Investigation and Design Report, Retaining Walls, Highway 401 Rehabilitation from Warden Avenue to Brock Road, Toronto, Ontario, W.O. 07-20012," by Golder Associates Ltd., dated April, 2012.

The Terms of Reference and Scope of Work for the foundation engineering services are outlined in MTO's Request for Proposal, dated November 21, 2016, which forms part of the Consultant Agreement (No. 2016-E-0009) for this project. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated July 10, 2017.

2.0 SITE DESCRIPTION

Based on the General Arrangement drawings for the noise barrier walls provided by WSP on September 12, 2018, a description of each proposed Noise Barrier Wall is summarized below, and the locations of the proposed noise barrier walls are shown on Drawings 1 to 3.

Noise Barrier Wall Number	Approximate Stationing	Site Description
Highway 401/Warden Ave N-W ramp	N/A	An extension to the north of the existing noise barrier wall along the west side of the ramp was proposed at the time of the field work. Boreholes NB-01 and NB-02 were advanced along the alignment of the proposed wall extension, however this proposed wall has since been removed from this contract.
NBW 1 Warden Ave N-W Ramp	Hwy 401 Station 21+325 to Station 21+590	NBW 1 extends from the east side of the Hwy 401/Warden Ave. interchange, eastward along the north side of Hwy 401 for about 265 m, between the widened highway and the adjacent residential properties.

Noise Barrier Wall Number	Approximate Stationing	Site Description
NBW 2	Hwy 401 Station 23+775 to Station 24+210	NBW 2 extends from the east side of the Hwy 401/Midland Ave. interchange, eastward for about 435 m, along the north side of Hwy 401 between the north edge of the widened highway and the adjacent residential properties; and parallel to a proposed new retaining wall (addressed under separate cover).
NBW 3	Hwy 401 Station 24+735 to Station 25+075	NBW 3 extends from the east side of the Hwy 401/Brimley Road interchange, eastward for about 340 m along the north side of Hwy 401 between the widened highway and the adjacent residential properties and Snowhill Park. Boreholes NW-01A, NW-01B, NW-02 and NW-03 were advanced along a portion of this retaining wall adjacent to the Brimley Road S-W ramp, however following the completion of the field work the alignment of this wall was shortened and the portion of this wall along the S-W ramp was removed form this contract.

3.0 INVESTIGATION PROCEDURES

3.1 1966 Investigation

A total of 15 boreholes were advanced as part of a 1966 investigation (GEOCRES No. 30M14-74) along the existing retaining wall and noise barrier wall extending easterly from Midland Avenue. The previous investigation boreholes used in this report have been renumbered to show the MTO GEOCRES reference number followed by the original borehole designation. For example, the boreholes from MTO GEOCRES Report No. 30M14-74 have been renumbered as 74-X, where X is the original borehole number.

The locations of the boreholes are summarized below and shown on Drawing 2. These borehole locations have been developed based on plotting the station and offset as shown on the 1966 borehole records and drawings, adjusted based on the site features shown on the drawings and converted to MTM NAD83 (Zone 10) coordinates. The borehole records from the 1966 investigation, including the summary results of the groundwater conditions and results of the geotechnical laboratory testing are presented in Appendix A and a summary of the borehole locations, ground surface elevation referenced to Geodetic datum and drilled depths are presented below.

Borehole No.	MTM NAD 83 (Zone 10)		Borehole Elevation (m)	Borehole Depth (m)
	Northing (m)	Easing (m)		
74-1	4,848,650.4	322,931.3	166.1	36.6
74-2	4,848,645.5	322,914.7	165.6	11.1
74-14	4,848,659.2	322,962.8	167.5	9.6
74-15	4,848,667.7	322,991.8	169.9	6.6

Borehole No.	MTM NAD 83 (Zone 10)		Borehole Elevation (m)	Borehole Depth (m)
	Northing (m)	Easing (m)		
74-16	4,848,679.9	323,027.0	173.0	9.6
74-17	4,848,688.6	323,055.0	175.1	6.6
74-18	4,848,697.4	323,087.6	175.3	6.6
74-19	4,848,708.0	323,118.0	177.2	9.6
74-20	4,848,717.0	323,146.8	178.8	6.6
74-21	4,848,725.5	323,178.4	178.6	6.6
74-22	4,848,731.4	323,207.3	178.1	9.6
74-23	4,848,738.7	323,239.2	177.7	6.6
74-24	4,848,744.3	323,263.5	177.4	6.6
74-25	4,848,750.0	323,290.5	176.7	9.6
74-26	4,848,753.3	323,316.8	174.3	6.6

The Standard Penetration Test (SPT) “N”-values presented on the borehole records of the 1966 investigation were obtained using a manual hammer with a reported driving energy of 350 ft-lbs.

3.2 2018 Investigation

The foundation investigation was carried out by Golder between March 25 and July 3, and on October 30 and 31, 2018, during which time twenty-one boreholes (designated as Boreholes NB-01, NB-02, NW1-01 to NW1-04, MA-03, NBP1-01 to NBP1-03, RW-01, RW-02 and NW-01 (A and B) to NW-08) were advanced along the proposed retaining wall alignments at the locations shown on Drawings 1 to 3.

The borehole investigation was carried out using CME-55 and CME-75 truck and track-mounted drill rigs supplied and operated by Geo-Environmental Drilling Inc. of Acton, Ontario, except for Boreholes NW-01A and NW-01B which were advanced using portable drilling equipment (utilizing ‘NW’ size casing and wash-boring techniques) supplied and operated by Walker Drilling Inc. of Utopia, Ontario and OGS Drilling Inc. of Almonte, Ontario. The boreoles were advanced using 152 mm, 165 mm, 203 mm and 216 mm outer-diameter continuous flight hollow stem augers.

Soil samples were generally obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm outer-diameter split-spoon sampler driven by an automatic hammer, or cathead/safety hammer and continuous split-spoon sampling (for NW-01A and NW-01B), in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-11)[1].

[1] ASTM D1586-11 – Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.

Groundwater conditions in the open boreholes were observed during and immediately following the drilling operations. Standpipe piezometers were installed in Boreholes NB-02, MA-03 and RW-01 to permit monitoring of the groundwater level. The installed piezometers consist of a 50 mm diameter PVC pipe with a 1.5 m slotted screen sealed at a selected depth within the boreholes. The borehole annulus surrounding the piezometer screen was backfilled with sand and the remainder of the borehole was then backfilled with bentonite to near the ground surface. A flush-mount protective casing was then placed and grouted over the piezometer pipe at the pavement surface. The remainder of the boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (Wells, as amended) and those boreholes drilled from the asphalt pavement were topped with cold patch asphalt.

The field work was observed on a full-time basis by members of Golder's engineering and technical staff, who located the boreholes in the field, arranged for the clearance of underground services, observed and directed the drilling, sampling, and in-situ testing operations, logged the boreholes, and examined and cared for the soil samples. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's geotechnical laboratory in Mississauga where the samples underwent further visual examination and laboratory testing. Index and classification testing, consisting of natural moisture contents, Atterberg limits and grain size distributions, was conducted on selected soil samples in accordance with MTO and / or ASTM standards, as applicable. Thirteen soil samples were submitted to a specialist accredited analytical laboratory under chain of custody procedures for analysis of parameters used to assess the corrosivity and deterioration potential of the site soil to steel and concrete.

Borehole locations were laid out in the field by Golder personnel relative to existing road features and pre-selected coordinates using a hand-held global positioning system (GPS) unit with an accuracy of 1 m in the horizontal and vertical directions. The borehole locations were then measured relative to existing site features and the ground surface (or pavement) elevation at the borehole locations was established from the Digital Terrain Model for the project. The locations given on the borehole records and shown on Drawings 1 to 3 are positioned relative to MTM NAD 83 (Zone 10) CSRS CBNv6-2010.0 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, including both MTM NAD 83 and geographic coordinates, ground surface elevation, and drilled depth are summarized below.

Noise Barrier Wall No.	Borehole No.	MTM NAD83 (Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m) (Latitude °)	Easting (m) (Longitude °)		
Warden Ave. N-W Ramp	NB-01	4,848,068.2 (43.772417)	320,476.3 (-79.305277)	183.5	8.5
	NB-02	4,848,126.6 (43.773006)	320,462.0 (-79.305464)	184.0	9.1
NBW1	NW1-01	4,847,924.9 (43.771122)	320,671.1 (-79.302862)	181.0	8.2
	NW1-02	4,847,944.4 (43.771378)	320,723.9 (-79.302278)	181.8	7.9
	NW1-03	4,847,963.0 (43.771430)	320,793.1 (-79.301430)	183.0	8.2

Noise Barrier Wall No.	Borehole No.	MTM NAD83 (Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing (m) (Latitude °)	Easting (m) (Longitude °)		
	NW1-04	4,847,981.7 (43.771630)	320,849.0 (-79.300650)	183.5	8.2
NBW2	MA-03	4,848,662.6 (43.777710)	322,955.3 (-79.274464)	167.4	4.9
	RW-01	4,848,771.1 (43.778708)	323,333.3 (-79.269855)	175.0	7.9
	RW-02	4,848,707.5 (43.778110)	323,129.3 (-79.272300)	174.4	8.4
	NBP1-01	4,848,821.8 (43.779130)	323,493.7 (-79.267770)	174.6	7.9
	NBP1-02	4,848,807.7 (43.779004)	323,435.8 (-79.268489)	174.6	8.2
	NBP1-03	4,848,787.0 (43.778851)	323,379.0 (-79.269207)	174.8	8.2
NBW3	NW-01A	4,849,037.2 (43.781064)	323,693.3 (-79.265283)	173.8	2.4
	NW-01B	4,849,040.0 (43.781089)	323,694.9 (-79.265262)	173.1	3.5
	NW-02	4,848,998.1 (43.780710)	323,763.6 (-79.264410)	175.2	8.2
	NW-03	4,848,961.6 (43.780380)	323,816.8 (-79.263750)	172.6	8.2
	NW-04	4,848,918.5 (43.779990)	323,885.4 (-79.262900)	171.5	8.2
	NW-05	4,848,937.6 (43.780160)	323,957.8 (-79.262000)	171.3	8.2
	NW-06	4,848,957.8 (43.780340)	324,031.8 (-79.261080)	170.7	8.2
	NW-07	4,848,979.1 (43.780530)	324,104.2 (-79.260180)	170.0	8.2
	NW-08	4,849,002.6 (43.780740)	324,176.5 (-79.259280)	168.9	7.9

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the physiographic region known as the South Slope, according to *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)[2].

The South Slope region is comprised of calcareous clay till with lacustrine clay and silt reworked by glaciers, with numerous scattered drumlins and deep valley cuts caused by streams flowing towards Lake Ontario. The surface topography slopes gradually and uniformly southwards towards Lake Ontario. The overburden within the majority of the South Slope area is underlain by shale bedrock of the Queenston and Georgian Bay Formations which contain limestone interlayers.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during the current investigation, including piezometer installation details and water level readings in the piezometers, and the results of the geotechnical laboratory tests carried out on selected soil samples, are presented on the borehole records provided in Appendix B. The results of the in-situ field tests (i.e., SPT "N"-values) as presented on the borehole records and in Section 4.2 are uncorrected. Plots of the grain size distribution and Atterberg limits test results of the geotechnical laboratory testing from the current investigation are shown on Figures C-1 to C-17, inclusive, presented in Appendix C.

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations; however, the factual data presented in the borehole records governs any interpretation of the site conditions.

A detailed description of the subsurface conditions encountered in the boreholes drilled along the noise barrier wall alignments is provided in the following sections of this report.

4.2.1 Noise Barrier Wall – Warden Avenue N-W Ramp

Two boreholes (NB-01 and NB-02) were advanced along the alignment of this proposed section of noise barrier wall extending along a portion of the Warden Avenue N-W Ramp in the event that this section of wall is considered necessary at a later date. Therefore, the borehole information presented herein for this section of wall is for factual purposes only. The existing ground surface at Warden Ave. along the pavement of the on-ramp to Highway 401 WB Collector lanes immediately adjacent to along the previously proposed NBW ranges from about Elevation 184 m at the north limit to Elevation 183.5 m at the south limit. The borehole locations associated with this previously proposed NBW are shown on Drawing 1.

4.2.1.1 Asphalt/Fill

An approximately 50 mm thick layer of asphalt pavement was encountered immediately below ground surface in Boreholes NB-01 and NB-02, which were advanced from the Hwy 401/Warden Avenue N-W ramp.

[2] Chapman, L.J. and Putman, D.F., 1984, The Physiography of Southern Ontario, Ontario Geological Society, Special Volume 2, Third Edition. Accompanied by Map p. 2715, Scale 1:600,000.)

An approximately 1.9 m and 1.4 m thick layer of fill was encountered underlying the asphalt pavement in Boreholes NB-01 and NB-02, respectively. The fill is comprised of sand and gravel to silty sand to sand some silt and contains organics. An approximately 1.0 m thick layer of clayey silt fill was encountered within the granular fill in Borehole NB-01. The fill extends to Elevations of 181.5 m and 182.5 m in Boreholes NB-01 and NB-02, respectively.

The measured Standard Penetration Test (SPT) "N"-values within the granular fill ranges from 9 blows to 11 blows per 0.3 m of penetration, indicating a loose to compact level of compactness. One SPT "N"-value measured within the cohesive (clayey silt) fill is 6 blows per 0.3 m of penetration, suggesting a firm consistency.

4.2.1.2 Gravelly Sand to Sand and Gravel to Sand to Silty Sand

A non-cohesive deposit ranging in composition from Sand to gravelly sand to sand and gravel, was encountered underlying the fill in Boreholes NB-01 and NB-02 at depths of 2.0 m and 1.5 m below ground surface (Elevation 181.5 m and 182.6 m), respectively. Both of the boreholes were terminated within this deposit at depths of 8.5 m and 9.1 m below ground surface (Elevation 175.0 m and 174.9 m)

The SPT "N"-values measured within the non-cohesive deposit range between 31 blows and 210 blows per 0.3 m of penetration, and up to 50 blows for 0.08 m of penetration, indicating a dense to very dense level of compactness.

Grain size distribution tests were carried out on six samples of the gravelly sand to sand and gravel to sand to silty sand deposit and the results are shown on Figure C-1 in Appendix C.

The natural water content measured on selected samples of the non-cohesive deposit ranges between about 2 per cent and 13 per cent.

4.2.1.3 Groundwater Conditions

The soil samples obtained from the current investigation were generally in a moist condition. The groundwater level in the open boreholes was measured upon completion of drilling operations and in the piezometer installed in Borehole NB-02. These water level readings are shown on the borehole records and are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
NB-01	183.5	Dry	-	June 5, 2018	Open Borehole
NB-02	183.9	Dry	-	May 29, 2018	Piezometer (on completion)
		Dry	-	October 4, 2018	Piezometer

The water levels measured immediately after completion of drilling may not represent the stabilized groundwater level at the site. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.2.2 Noise Barrier Wall 1 – Station 21+325 to Station 21+590

Four boreholes (NW1-01 to NW1-04) were advanced along the alignment of this proposed section of Noise Barrier Wall 1 (NBW1). The existing ground surface at Highway 401 WB Collector lanes along the proposed NBW1 location ranges from about Elevation 181 m at the west limit to Elevation 184 m at the east limit. The borehole locations and ground surface elevations associated with NBW1 are shown on Drawing 1.

4.2.2.1 Topsoil/Asphalt/Fill

An approximately 50 mm and 100 mm thick layer of topsoil was encountered immediately below ground surface in Boreholes NW1-01 and NW1-02, respectively, which were advanced in the grass covered area north of the Highway 401 WB Collector lanes and south of the existing NBW. An approximately 229 mm and 203 mm thick layer of asphalt pavement was encountered immediately below ground surface in Boreholes NW1-03 and NW1-04, respectively, which were advanced from the shoulder of the Highway 401 WB Collector lanes.

An approximately 0.5 m thick deposit of gravelly sand fill, containing trace to some silt, was encountered underlying the asphalt pavement in Boreholes NW1-03 and NW1-04. An approximately 0.6 m and 1.4 m thick deposit of sandy clayey silt fill, containing trace to some gravel and rootlets, was encountered below the topsoil at a depth of about 0.1 m in Boreholes NW1-01 and NW1-02 and below the gravelly sand fill at a depth of about 0.7 m in Borehole NW1-04. The sandy clayey silt fill extends to depths ranging between 0.7 m and 1.8 m below ground surface, corresponding to Elevations 180.3 m and 181.7 m, respectively.

A 1.2 m to 2.4 m thick layer of silty sand to sand fill, containing trace to some gravel and trace clay, was encountered below the gravelly sand fill at a depth of 0.7 m in Borehole NW1-03 and below the sandy clayey silt fill in Boreholes NW1-01, NW1-02, and NW1-04 at depths ranging between 0.7 m and 1.8 m below ground surface, corresponding to Between Elevations 182.3 m and 181.7 m, respectively. The presence of cobbles was inferred from auger grinding in Borehole NW1-02 between depths of about 1.8 m and 2.1 m and between 2.7 m and 3.0 m below ground surface. The silty sand to sand fill extends to depths ranging between 3.0 m and 4.0 m below ground surface, to between Elevations 180.5 m and 178.0 m.

The SPT “N”-values measured within the layer of clayey silt fill range from 8 blows to 34 blows per 0.3 m of penetration, suggesting a firm to hard consistency. The SPT “N”-values measured within the non-cohesive fill range from 16 blows to 80 blows per 0.3 m of penetration, indicating a compact to very dense level of compactness.

Grain size distribution tests were carried out on four samples of the sand layer of the fill and the results are shown Figure C-2 in Appendix C.

The natural water content measured on one sample of the clayey silt fill is about 10 per cent, and the natural water content measured on selected samples of the silty sand to sand fill ranges between about 3 per cent and 8 per cent.

4.2.2.2 Gravelly Silty Sand

An approximately 0.7 m thick layer of gravelly silty sand was encountered below the fill deposit in Borehole NW1-01 at a depth of about 3.1 m below ground surface (Elevation of 178.0 m). The presence of cobbles was inferred from auger grinding within this deposit between depths of about 3.4 m and 3.7 m below ground surface, as noted on the borehole record.

One SPT “N”-value measured within the gravelly silty sand deposit is 62 blows per 0.3 m of penetration, indicating a very dense level of compactness.

One grain size distribution test was carried out on a sample of the gravelly silty sand and the result is shown on Figure C-3 in Appendix C.

The natural water content measured on a selected sample of the silty gravelly sand is about 7 per cent.

4.2.2.3 Silt and Sand to Sand

A non-cohesive soil deposit comprised of silt and sand to sand some silt, containing trace gravel and clay, was encountered in all boreholes at this site underlying the fill deposits, and underlying the gravelly silty sand deposit in Borehole NW1-01 at depths between 3.0 m and 4.0 m below ground surface, at between Elevations 180.5 m and 177.3 m. The presence of cobbles within this deposit was inferred from auger grinding in Borehole NW1-01 between depths of about 5.2 m and 5.5 m below ground surface, as noted on the borehole record. All of the boreholes were terminated within the silt and sand to sand deposit at depths ranging between 7.9 m and 8.2 m below ground surface, at between Elevations 175.2 m and 172.8 m.

The SPT “N”-values measured within the silt and sand to sand deposit range between 21 blows and 133 blows per 0.3 m of penetration, and up to 100 blows for 0.13 m of penetration, indicating a compact to very dense level of compactness.

Grain size distribution tests were carried out on five samples of the silt and sand to sand deposit and the results are shown on Figure C-4 in Appendix C.

The natural water content measured on selected samples of the silt and sand to sand deposit range between about 2 per cent and 8 per cent.

4.2.2.4 Groundwater Conditions

The soil samples obtained from Boreholes NW1-01 to NW1-04 were generally in a moist condition. The open boreholes were observed to be dry upon completion of drilling operations. The water levels measured immediately after completion of drilling may not represent the stabilized groundwater level at the site. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.2.3 Noise Barrier Wall 2 – Station 23+775 to Station 24+210

Six boreholes (Boreholes MA-03, RW-01, RW-02 and NBP1-01 to NBP1-03) were advanced along the alignment of this proposed NBW2 as part of the current (2018) foundation investigation, supplemented with fifteen boreholes (Boreholes 74-1, 74-2 and 74-14 to 74-26) advanced as part of the previous (1966) investigation. The ground surface along the alignment of the existing noise barrier wall immediately south of the proposed NBW2 alignment ranges between Elevation 172.6 m at the westerly end (near the Midland Avenue overpass) and Elevation 173.6 m at the easterly end. The Highway 401 roadway grade is between about Elevations 172.5 m and 175.5 m, rising from west to east along the alignment of NBW2. The borehole locations and ground surface elevations associated with NBW2 are shown on Drawing 2.

4.2.3.1 Asphalt

An approximately 76 mm to 203 mm thick layer of asphalt pavement was encountered immediately below ground surface in Boreholes RW-01, RW-02 and NBP1-01 to NBP1-03, which were advanced on the Highway 401 roadway; and an approximately 203 mm thick layer of concrete pavement was encountered immediately below the asphalt layer in Borehole NBP1-01.

4.2.3.2 Fill

An approximately 0.3 m to 0.5 m thick layer of gravelly sand fill was encountered underlying the asphalt pavement in Boreholes RW-01, RW-02 and NBP1-01 to NBP1-03, which were advanced on the Highway 401 roadway. The gravelly sand fill is underlain by an approximately 0.8 m and 1.4 m thick layer of sandy silt fill and silt and sand fill

in Boreholes RW-01 and NBP1-01, respectively; an approximately 3.5 m thick layer of clayey silt with sand fill in Borehole RW-02; and an approximately 0.8 m thick layer of sandy clayey silt fill in Boreholes NBP1-02 and NBP1-03. The fill extends to between Elevations 173.5 m and 170.3 m in Boreholes RW-01, RW-02 and NBP1-01 to NBP1-03. An approximately 0.8 m thick layer of silty sand fill was encountered immediately below ground surface in Borehole MA-03, advanced in the walkway north of Highway 401 east of Midland Avenue and extends to about Elevation 166.6 m in Borehole MA-03.

The measured Standard Penetration Test (SPT) "N"-values within the non-cohesive fill (sandy silt and silt and sand) range between 19 blows and 49 blows per 0.3 m of penetration, indicating a compact to dense level of compactness. The SPT "N"-values measured within the cohesive (sandy clayey silt) fill range between 10 blows and 36 blows per 0.3 m of penetration, suggesting a stiff to hard consistency.

A grain size distribution test was carried out on one sample of the cohesive fill layer encountered during the 2018 investigation, and the result is shown on Figure C-5 in Appendix C. Atterberg limits testing was carried out on two selected samples of the fill deposits encountered during the 2018 investigation and measured liquid limits of 13 per cent and 17 per cent, plastic limits of 10 per cent, and corresponding plasticity indices of 3 per cent and 7 per cent. The results, which are plotted on a plasticity chart on Figure C-6 in Appendix C, indicate that the cohesive fill layer consists of silt of slight plasticity to clayey silt of low plasticity. A grain size distribution test was carried out on one sample of the silt and sand portion of the non-cohesive fill layer encountered during the 2018 investigation, and the result is shown on Figure C-7 in Appendix C

The natural water content measured selected samples of the cohesive fill ranges between about 8 and 11 per cent. The natural water content measured on selected samples of the non-cohesive fill is between about 7 and 11 per cent.

4.2.3.3 Sand to Sand and Gravel

A sandy silt to sand to sand and gravel till-like deposit, comprised of various interlayers ranging in composition from sandy silt to silt and sand to silty sand to sand to sand and gravel was encountered in most boreholes, of both the 1966 and 2018 investigations, as described in more detail below.

A silt and sand till-like deposit was encountered underlying the fill layer in Borehole MA-03 at a depth of 0.8 m, corresponding to Elevation 166.6 m. The borehole terminated within this deposit, penetrating it for a thickness of 4.1 m. A 0.5 m thick sand deposit was encountered underlying the clayey silt with sand deposit (described below in Section 4.2.3.4) in Borehole RW-02 at a depth of 7.8 m, corresponding to Elevation 166.6 m. A silt and sand to silty sand to sand deposit was encountered underlying the clayey silt to silt with sand deposit (described in Section 4.2.3.4) in Boreholes NBP1-03 and NBP1-02 at a depth of 7.2 m and 3.7 m, respectively (corresponding to Elevation 167.6 m and 170.9 m); and the boreholes were terminated within this deposit, penetrating it for thicknesses of 1.0 m and 4.5 m. Interlayered deposits of silty sand, silty and sand, and sand and gravel were encountered in Borehole NBP1-01 below the silt and sand fill deposit at a depth of 2.2 m, corresponding to Elevation 172.4 m; and the borehole was terminated within this deposit at Elevation 166.7 m after penetrating it for a thickness of 5.7 m. A silty sand to sandy silt deposit containing clayey silt interlayers was encountered immediately below the original ground surface in Boreholes 74-1, 74-2, 74-14 to 74-17, and 74-19 to 74-26 from the 1966 investigation. All boreholes from the 1966 investigation, except Borehole 74-1, terminated within this deposit, penetrating it for a thickness between 6.5 m and 11.2 m. The thickness of the deposit in Borehole 74-1 is 22.6 m, with the bottom of the deposit encountered at Elevation 143.5 m.

The SPT “N”-values measured within the various layers of the sandy silt to sand to sand and gravel till-like deposit range vary from 25 blows to 166 blows per 0.3 m of penetration, and up to 100 blows for 0.04 m of penetration, with the “N”-values generally increasing with depth, indicating a compact to very dense level of compactness. One “N”-value of 6 blows per 0.3 m of penetration was measured within the sand layer underlying the clayey silt with sand deposit in Borehole RW-02 indicating a loose level of compactness in this layer.

Grain size distribution tests were carried out on seven samples of the silt and sand to sand to sand and gravel till-like deposit encountered during the 2018 investigation, and the results are shown on Figure C-8 in Appendix C. Grain size distribution tests were carried out on eight selected samples of the silty sand to sandy silt deposit recovered during the 1966 investigation and the results are presented on the borehole records included in Appendix A. Atterberg limits testing was carried out on five selected samples of the silt and sand till-like deposit encountered during the 2018 investigation, one sample was determined to be non-plastic while for four samples the Atterberg Limits test measured liquid limits ranging between 13 per cent and 14 per cent, plastic limits ranging between 11 per cent and 13 per cent, and plasticity indices ranging between 1 per cent and 2 per cent. The results, which are plotted on a plasticity chart on Figure C-9 in Appendix C, indicate that the deposit contains silt of slight plasticity.

Atterberg limits testing was carried out on selected samples of the clayey silt interlayers from the 1966 investigation and measured plastic limits ranging from about 10 per cent to 18 per cent, liquid limits ranging from about 15 per cent to 29 per cent, and plasticity indices ranging from about 3 per cent to 11 per cent. These test results confirm that the interlayers consist of clayey silt of low plasticity. Two Atterberg limit tests carried out on selected samples of the silty sand to sandy silt deposit were non-plastic, and overall indicate that the deposit is predominantly non-cohesive.

The natural water content measured selected samples of the sandy silt to silty sand to sand to sand and gravel range between about 3 per cent and 23 per cent. The high/variable water contents are inferred to be attributed to the presence of clayey silt layers within the predominantly non-cohesive deposit.

4.2.3.4 Sandy Clayey Silt to Clayey Silt to Silt

A sandy clayey silt to clayey silt-to-silt with sand till-like deposit was encountered underlying the fill in Boreholes RW-01, RW-02 and NBP1-01 to NBP1-03 at depths ranging from 1.5 m to 4.1 m below ground surface, corresponding to between Elevations 173.5 m and 170.3 m. Borehole RW-01 was terminated within this deposit, penetrating it for a thickness of 6.4 m. The deposit is between 2.2 m thick and 5.7 m thick in the boreholes where it was fully penetrated. A lower 0.1 m thick till-like layer of sandy clayey silt was encountered underlying the sand till-like deposit in Borehole RW-02 at a depth of 8.3 m, corresponding Elevation 166.1 m. The borehole terminated within this layer on refusal to further split spoon advancement. A sandy silt deposit with occasional layers of clayey silt and a silt to clayey silt deposit was encountered immediately beneath ground surface in Boreholes 74-2 and 74-18 of the 1966 investigation; and the borehole was terminated within this deposit, penetrating it for a thickness of 11.1 m and 6.6 m (Elevations 154.4 m and 168.7 m), respectively.

The SPT “N”-values measured within the cohesive till-like deposit / layers encountered during the 1966 and 2018 investigations range from 20 blows to 185 blows per 0.3 m of penetration, with “N”-values up to 100 blows for 0.08 m of penetration, and generally increasing with depth, suggesting a very stiff to hard consistency.

Grain size distribution tests were carried out on five samples of the till-like cohesive deposit encountered during the 2018 investigation, and the results are shown on Figure C-10 in Appendix C. Atterberg limits testing was carried out on five selected samples of the till-like cohesive deposit encountered during the 2018 investigation and measured liquid limits ranging between 14 per cent and 17 per cent, plastic limits ranging between 9 per cent and

12 per cent, and plasticity indices ranging between 4 per cent and 7 per cent. The results, which are plotted on a plasticity chart on Figure C-11 in Appendix C, indicate that the deposit consists of clayey silt of low plasticity. Atterberg limits test was carried out on two selected samples of the cohesive deposit encountered during the 1966 investigation and measured liquid limits of about 18 per cent and 19 per cent, plastic limits of about 11 per cent and 12 per cent, and plasticity indices of about 7 per cent and one sample of the sandy silt with layers of clayey silt measured a liquid limit of 29 per cent, a plastic limit of 19 per cent and a plasticity index of 10 per cent, indicating that the material of the overall deposit is classified as a clayey silt of low plasticity. The natural water content measured selected samples of the cohesive deposit range between about 4 per cent and 10 per cent.

4.2.3.5 Lower Clayey Silt

A clayey silt deposit was encountered below the silty sand to sandy silt till-like deposit in Borehole 74-1 from the 1966 investigation at a depth of 22.6 m below the original ground surface, corresponding to Elevation 143.5 m. The borehole terminated within this deposit, penetrating it for a thickness of 14.0 m.

The measured SPT “N” values within the clayey silt deposit range from 91 to 106 blows per 0.3 m of penetration, suggesting a hard consistency.

Atterberg limits testing was carried out on one sample of the clayey silt deposit and measured a plastic limit of about 17 per cent, a liquid limit of about 25 per cent, and a corresponding plasticity index of about 8 per cent, confirming that the deposit consists of a clayey silt of low plasticity. The natural water content measured on three samples of the clayey silt is about 18 per cent.

4.2.3.6 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations during the 2018 and 1966 investigations, and in the piezometers installed in Boreholes MA-03 and RW-01, as summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
MA-03	167.4	Dry	-	May 31, 2018	Piezometer (on completion)
		3.7	163.7	July 30, 2018	Piezometer
RW-01	175.0	Dry	-	Mar. 28, 2018	Piezometer (on completion)
		4.5	170.5	July 30, 2018	Piezometer
RW-02	174.4	6.3	168.1	Apr. 9, 2018	Open Borehole
NBP1-01 to NBP1-03	174.6 - 174.8	Dry	-	Mar. 25 to April 9, 2018	Open Boreholes
74-1	166.1	1.8	164.3	Oct. 5, 1966	Open Borehole
74-2	165.6	2.5	163.1	Oct. 6, 1966	Open Borehole
74-22	178.1	6.7	171.4	Nov. 9, 1966	Open Borehole

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
74-23	177.7	4.7	173.0	Nov. 9, 1966	Open Borehole
74-24	177.4	4.5	172.9	Nov. 14, 1966	Open Borehole
74-25	176.7	4.6	172.1	Nov. 14, 1966	Open Borehole

As these water levels were measured immediately after completion of drilling, they may not represent the stabilized groundwater level at the site, nor the current level in the case of the 1966 data. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.2.4 Noise Barrier Wall 3 – Station 24+735 to Station 25+075

Nine boreholes (NW-01A, NW-01B and NW-02 to NW-08) were advanced along the alignment of this proposed section of NBW3 as part of the current (2018) foundation investigation at the locations shown on Drawing 3. The existing ground surface along the proposed NBW3 alignment ranges from about Elevation 169 m at the east limit along the Highway 401 WB Collector lanes to Elevation 175 m at the Hwy 401/Brimley Rd S-W Ramp. Boreholes NW-01A, NW-01B, NW-02 and NW-03 were advanced along the Brimley Road S-W Ramp as the proposed noise wall at the time of the investigation in the event that the wall was to extend along the length of the ramp.

4.2.4.1 Topsoil/Asphalt/Fill

An approximately 100 mm and 300 mm thick layer of topsoil was encountered immediately below ground surface in Boreholes NW-01A and NW-01B, which were advanced in the grass covered area east of the east curb line of Brimley Rd and north of the Brimley Road S-W ramp. An approximately 229 mm thick layer of asphalt pavement was encountered immediately below ground surface in Boreholes NW-02 and NW-03, which were advanced from the Brimley Road S-W ramp. An approximately 152 mm to 229 mm thick layer of asphalt pavement was encountered immediately below ground surface in Boreholes NW-04 to NW-08, which were advanced along the right shoulder of the Highway 401 WB Collector lanes.

A non-cohesive fill deposit comprised of sandy silt to silty sand to sand to sand and gravel was encountered below the topsoil in Boreholes NW-01A and NW-01B and extends to a depth of 2.2 m (Elevation 171.6 m) in Borehole NW-01A. Borehole NW-01B was terminated within the fill deposit at a depth of 3.5 m below ground surface (Elevation 169.6 m).

An approximately 0.2 m to 2.1 m thick deposit of non-cohesive fill, consisting of sand to gravelly sand to sand and gravel, was encountered below the asphalt pavement in Boreholes NW-02 to NW-08. The granular fill extends to depths ranging between 0.5 m and 2.2 m below ground surface, to between Elevations 174.5 m and 169.3 m.

A deposit of cohesive fill consisting of clayey silt some sand to clayey silt with sand, containing trace organics, was encountered below the granular fill at depths ranging between 0.5 m and 0.7 m below ground surface in Boreholes NW-02, NW-03 and NW-05 to NW-08. The cohesive fill is between approximately 1.7 m and 3.2 m thick and extends to depths ranging between 2.2 m and 3.7 m below ground surface, to between Elevation 171.9 m and 167.0 m.

An approximately 0.3 m thick layer of sandy silt fill was encountered below the cohesive fill in Borehole NW-02 at a depth of 3.3 m (Elevation 171.9 m).

The SPT "N"-values measured within the non-cohesive fill range from 11 blows to 200 blows per 0.3 m of penetration to 50 blows for 0.15 m of penetration, indicating a compact to very dense level of compactness. The SPT "N"-values measured within the cohesive fill range from 4 blows to 22 blows per 0.3 m of penetration, with one N-value of 31 blows per 0.3 m of penetration at the interface with the underlying sandy silt till, suggesting a soft to very stiff consistency.

A grain size distribution test was carried out on a selected sample of the cohesive fill and the result is shown on Figure C-12 in Appendix C. An Atterberg limits test was also carried out on a selected sample of the cohesive fill and measured a liquid limit of about 18 per cent, a plastic limit of about 13 per cent, and a plasticity index of about 5 per cent. The result, which is plotted on a plasticity chart on Figure C-13 in Appendix C, indicates that the cohesive fill is comprised of clayey silt of low plasticity.

The natural water content measured on selected samples of the non-cohesive fill range between about 5 per cent and 12 per cent. The natural water content measured on selected samples of the cohesive fill range between about 8 per cent and 14 per cent.

4.2.4.2 Silt and Sand to Sand

A deposit of silt and sand to sand was encountered underlying the fill in Boreholes NW-02, NW-03, NW-04, NW-06 and NW-07, and underlying the clayey silt with sand deposit (described in Section 4.2.4.3) in Borehole NW-05 at depths ranging from 2.2 m to 6.1 m below ground surface (Elevation 171.5 m to 165.2 m). The thickness of this deposit ranges from 0.9 m to 3.9 m, extending to between Elevation 168.0 m and 166.4 m. Borehole NW-05 was terminated within this deposit at a depth of 8.2 m below ground surface, corresponding to Elevation 163.1 m.

The SPT "N"-values measured within this deposit range from 11 blows to 90 blows per 0.3 m of penetration, indicating a compact to very dense level of compactness.

Grain size distribution tests were carried out on seven samples of this deposit and the results are shown on Figure C-14 in Appendix C. Atterberg limits testing was carried out on five samples of this deposit and measured liquid limits ranging between about 13 per cent and 16 per cent, plastic limits ranging between about 10 per cent and 12 per cent, and plasticity indices ranging between about 2 per cent and 4 per cent. The results, which are plotted on a plasticity chart on Figure C-15 in Appendix C, indicate that the deposit can be classified as a silt of slight plasticity.

The natural water content measured on selected samples of this deposit range between about 6 per cent and 15 per cent.

4.2.4.3 Clayey Silt

A deposit of sandy clayey silt to clayey silt with sand was encountered underlying the fill deposit in Boreholes NW-01A, NW-05, and NW-08 and underlying the silt and sand deposit in Borehole NW-02, NW-03, NW-04, NW-06 and NW-07. The presence of cobbles was inferred from auger grinding in Borehole NW-05 between depths of about 3.0 m and 3.7 m below ground surface, as noted on the borehole record. The surface of the deposit was encountered at depths ranging from 2.2 m to 7.2 m (Elevation 171.6 m to 164.4 m), and the thickness of this deposit is 3.1 m in Borehole NW-05 where it was fully penetrated. The remaining boreholes were terminated within this deposit at depths ranging between 2.4 m and 8.2 m below ground surface (Elevation 171.4 m to 161.0 m), penetrating into the deposit between 0.2 m and 5.7 m.

The SPT “N”-values measured within this deposit range from 17 blows to 91 blows per 0.3 m of penetration with “N”-values up to 80 blows for 0.10 m of penetration, suggesting a very stiff to hard consistency.

Grain size distribution tests were carried out on eight samples of this deposit and the results are shown on the borehole records as well as on Figure C-16A and C-16B in Appendix C. Atterberg limits testing was carried out on eight samples of this deposit and measured liquid limits ranging between about 16 per cent and 19 per cent, plastic limits ranging between about 10 per cent and 12 per cent, and plasticity indices ranging between about 5 per cent and 9 per cent. The results, which are plotted on a plasticity chart on Figure C-17 in Appendix C, indicate that the deposit can be classified as a clayey silt of low plasticity.

The natural water content measured on selected samples of this deposit range between about 7 per cent and 12 per cent.

4.2.4.4 Groundwater Conditions

The groundwater levels in the open boreholes were measured upon completion of drilling operations, as noted on the borehole records and summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)	Date	Comments
NW-01A	173.8	Dry	-	July 3, 2018	Open Borehole
NW-01B	173.1	Dry	-	Oct. 31, 2018	Open Borehole
NW-02	175.2	Dry	-	Apr. 6, 2018	Open Borehole
NW-03	172.6	Dry	-	Apr. 6, 2018	Open Borehole
NW-04	171.5	7.7	163.8	Apr. 11, 2018	Inside Casing
NW-05	171.3	8.0	163.3	Apr. 11, 2018	Inside Casing
NW-06	170.7	Dry	-	Apr. 10, 2018	Open Borehole
NW-07	170.0	Dry	-	Apr. 10, 2018	Open Borehole
NW-08	168.9	5.9	163.0	Apr. 10, 2018	Open Borehole

The water levels were measured immediately after completion of drilling may not represent the stabilized groundwater level at the site. The groundwater level will be subject to seasonal fluctuations and should be expected to be higher during the spring season or during and following periods of heavy precipitation.

4.3 Analytical Testing Results

Thirteen soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix D and the test results are summarized below:

Borehole No. / Sample No.	pH	Resistivity (ohm-cm)	Electrical Conductivity (umho/cm)	Chlorides (ug/g)	Soluble Sulphates (ug/g)
NB-02 / 4	8.24	870	1,150	670	62
NBP1-01 / 9	8.13	1,200	835	460	<20*
NBP1-03 / 6**	8.0	1,600	627	320	<20*
NW1-01 / 4	8.24	4,200	238	78	<20*
NW1-02 / 3	8.13	2,300	429	170	<20*
NW1-04 / 6	8.26	2,000	508	230	<20*
NW-03 / 7**	8.08	1,600	643	340	23
NW-04 / 4	8.16	1,000	979	510	<20*
NW-05 / 7B	8.11	620	1,620	820	24
NW-07 / 5A	8.1	610	1,630	810	<20*
NW-08 / 7	8.13	1,300	778	350	77
RW-01 / 3	8.07	1,300	743	370	<20*
RW-02 / 9	8.28	6,300	160	<20*	68

* Reportable Detection Limit

** Numbered as NBP1-3 SA#6 and NW-03S SA#7, respectively, in the analytical test report

5.0 CLOSURE

This Foundation Investigation Report was prepared Mr. Jeremy Lebow, B.A.Sc., E.I.T. and reviewed by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant of Golder, conducted an independent technical and quality control review of the report.

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PART B

FOUNDATION DESIGN REPORT
NOISE BARRIER WALLS
HIGHWAY 401 WESTBOUND CORE AND COLLECTOR LANES,
NEILSON ROAD TO WARDEN AVENUE, CITY OF TORONTO, ONTARIO
MTO G.W.P. 2162-11-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the proposed noise barrier walls associated with the northward widening of Highway 401 as part of the rehabilitation and operational improvements of the Highway 401 westbound core and collector lanes, from Neilson Road to Warden Avenue in the City of Toronto, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the 2018 subsurface investigation at this site, supplemented with boreholes from a previous (1966) investigation. The discussion and recommendations presented are intended to provide the designer with sufficient information to assess the feasible foundation alternatives and carry out the design of the proposed noise barrier walls. The foundation design report, discussions and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and their designers, and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on the aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling, and the like.

6.2 Noise Barrier Wall Foundation Design

The proposed alignments of Noise Barrier Walls 1 to 3 are presented on Drawings 1 to 3. It is assumed that the noise barrier walls will be supported using conventional augered caissons, with a diameter of between 0.6 m and 0.9 m. Geotechnical design parameters for design of the caisson foundations for the proposed Noise Barrier Walls 1 to 3 are provided in Table 1 following the text of this report, based on the subsurface conditions encountered in the borehole investigations in the vicinity of the proposed noise barrier walls. The stratigraphy presented in Table 1 has been simplified for the purposes of the noise barrier wall foundation design. The parameters presented in Table 1 are based on field and laboratory test data as well as accepted correlations (in NAVFAC (1986), Bowles (1984) and Kulhawy and Mayne (1990) and the analysis was tempered by engineering judgement based on experience in similar soils.

Where both an undrained shear strength, s_u, and an effective friction angle, ϕ', have been given for a specific stratum, the caisson design should be checked for both the drained and the undrained condition, and the larger of the two calculated caisson depths shall govern.

The passive resistance within the upper 1.2 m below ground surface should be neglected to account for frost action within the depth of frost penetration zone as interpreted for OPSD 3090.101 (Foundation Frost Penetration Depths for Southern Ontario). In addition, for foundation design, full passive resistance will be mobilized only where the ground surface in front of and behind the caissons is level (i.e. the width of soil in front and behind the caissons is equal to or greater than eight caisson diameters). If there is a lesser width of a zone of soil for development of passive resistance (i.e. if there is sloping ground adjacent to the noise barrier wall), the magnitude of the passive resistance may be determined by interpolating between zero passive resistance at ground surface and full passive resistance at the depth where the slope face is at a distance greater than eight caisson diameters away the face of the caisson.

6.3 Corrosion Assessment and Protection

Soil corrosivity may affect the concrete foundations and reinforced steel and other concrete or steel elements buried in the soil. The long-term performance and durability of the foundations are directly related to their respective corrosion resistance. Generally, the corrosivity potential to a structure depends on the soil resistivity / electrical conductivity, hydrogen ion concentration, and salt (chloride and sulphate) concentrations. The analytical results for the samples submitted for testing are summarized in Section 4.3 and the analytical laboratory test reports are included in Appendix D.

6.3.1 Potential for Sulphate Attack

The analytical test results were compared to CSA Standard, CAN/CSA-A23.1-14 Table 3 *("Additional requirements for concrete subjected to sulphate attack")* for potential sulphate attack on concrete. The sulphate concentrations measured in the tested samples (ranging from less than 0.002% to 0.008%) are below the exposure class of S-3 (Moderate) and are considered Negligible according to Table 7-2 in Gravity Pipe Design Guidelines (2014). Therefore, based on the thirteen samples of soil tested, when the designer is selecting the exposure class for the structure, the effects of sulphates may not need to be considered.

6.3.2 Potential for Corrosion

The test results indicate a pH between about 8.0 and 8.3 and a resistivity between about 610 ohm-cm and 6,300 ohm-cm. According to the Gravity Pipe Design Guidelines (MTO, 2014), the pH is not considered detrimental to concrete durability. However, the resistivity indicates that the soil corrosiveness is generally “moderate” (2,000 ohm-cm < R < 4,500 ohm-cm) to “severe” (2,000 ohm-cm > R), as per Table 3.2 of the Gravity Pipe Design Guidelines (MTO, 2014), and some level of corrosion protection should be applied to the foundation element / materials. Further, given that the foundations are located adjacent to the roadway shoulder and will be exposed to de-icing salt, consideration should be given to selection of a “C” type exposure class as defined by CSA A23.1 Table 1.

It is ultimately up to the structural designer to determine the appropriate exposure class and to ensure that all aspects of CSA A23.1 Section 4.1.1 “Durability Requirements” are followed.

6.4 Construction Considerations

Caisson construction is anticipated to require augering/excavation through the existing fill and into the native gravelly sand to silt and sand deposit, and the sandy clayey silt to clayey silt with sand deposits and the till-like deposits at the noise barrier wall locations. The existing fills and native deposits contain granular layers (potentially saturated) which may be susceptible to disturbance during caisson excavation and construction. The use of a temporary liner to advance the auger holes for caissons at the noise barrier walls is recommended, in order to reduce disturbance and ground loss during drilling and concrete placement. Further, cobbles and boulders are inferred to be present within some of the glacially derived soil deposits at these sites and appropriate equipment and methods will need to be employed to penetrate through such obstructions, if encountered. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of these conditions since they may affect the installation of the noise barrier wall foundations. A sample NSSP is provided in Appendix E.

The noise barrier walls should be constructed in accordance with OPSS 760 and MTO’s Special Provision (SP) 760F01, a copy of which is provided in Appendix E.

7.0 CLOSURE

This Foundation Investigation Report was prepared Mr. Jeremy Lebow, B.A.Sc., E.I.T. and reviewed by Mr. Matthew Kelly, P.Eng., a geotechnical engineer with Golder. Mr. Jorge M.A. Costa, P.Eng., an MTO Foundations Designated Contact and Senior Consultant of Golder, conducted an independent technical and quality control review of the report.

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ASTM International:

ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Ontario Provisional Standard Drawing:

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

Ontario Special Provisions

SP 799F01 Construction Specification for the Construction of Noise Barrier

Ontario Water Resources Act:

Ontario Regulation 903 Wells (as amended)

Ontario Occupational Health and Safety Act:

Ontario Regulation 213/91 Construction Projects (as amended)

Ministry of Transportation, Ontario

Gravity Pipe Design Guideline, Culverts and Storm Sewers (2014). Drainage and Hydrology Design and Contract Standards Office, Ministry of Transportation, Ontario.

TABLE 1 – GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALLS

Noise Barrier Wall No.	Noise Barrier Wall Location[1]	Average Final Ground Surface Elevation Along Wall [approx. max – min] (m)	Relevant Boreholes	Stratum	Depth[2,4] (m)	Elevation[2] (m)	Design Parameters [3, 5, 6]					Design Groundwater Elevation (m)
							s_u (kPa)	Φ' (Degrees)	γ (kN/m^3)	γ' (kN/m^3)	K_p	
NBW1	STA 21+325 to STA 21+590	182 [181 to 184]	NW1-01 NW1-02 NW1-03 NW1-04	*FILL (Firm to hard Sandy Clayey Silt)	0.0 – 1.0	182 – 181	50	30	20	10	3.00	Below 173
				*FILL (Compact to Very Dense Sand)	1.0 – 4.0	181 – 178.5	-	32	19	9	3.25	
				Very Dense Gravelly Silty Sand / Compact to Very Dense Silt and Sand to Sand	3.5 – 8.2	178.5 – 172.8	-	32	20	10	3.25	
NBW2	STA 23+775 to STA 24+210	175 [176 to 173]	NBP1-03 RW-01 RW-02 74-16 to 74-26	*FILL (Compact to Dense Sandy Silt to Silt and Sand)	0.0 – 1.5	175.0 – 173.5	-	32	19	9	3.25	171
				*FILL (Stiff to Hard Sandy Clayey Silt)	1.5 – 2.2	173.5 – 172.8	50	30	20	10	3.00	
				Compact to Very Dense Silt to Sandy Silt to Silty Sand	2.2 – 4.0	172.8 – 171.0	-	32	20	10	3.25	
				Hard Sandy Clayey Silt to Clayey Silt with Sand (Till-like)	4.0 – 8.0	171.0 – 163.0	200	34	19	9	3.54	
NBW3	STA 24+735 to STA 25+075	171 [172 to 169]	NW-04 NW-05 NW-06 NW-07 NW-08	*FILL (Soft to Very Stiff Clayey Silt to Sandy Clayey Silt)	0.0 – 2.2	171.0 – 168.8	50	30	20	10	3.00	164
				Stiff to Hard Clayey Silt with Sand	2.2 – 3.7	168.8 – 167.3	100	32	20	10	3.25	
				Compact to Dense Silt and Sand	3.7 – 6.1	167.3 – 164.9	-	32	20	10	3.25	
				Very Stiff to Hard Clayey Silt with Sand	6.1 – 8.2	164.9 – 162.8	150	32	20	10	3.25	

Reviewed By:MWK

NOTES:

*Deposit thickness for design to be considered ½ of the fill thickness presented

1. Approximate stationing provided along adjacent Highway. Refer to Drawings 1 to 3 for wall locations.
2. Depths are given at closest borehole location(s) relative to current (2018) estimated ground surface according to topographic information provided by WSP; the ground surface elevation at the borehole location(s) should be compared to the ground surface elevation at the actual noise barrier wall location, and the depths to various soil stratum adjusted accordingly.
3. Design parameters:
   s_u = undrained shear strength (kPa);
   φ' = effective friction angle (degrees);
   γ = bulk unit weight (kN/m^3);
   γ' = effective unit weight below the groundwater level (kN/m^3); and
   K_p = passive earth pressure coefficient (assuming level ground).
4. The resistance in the upper 1.2 m below ground surface should be neglected to account for frost action.
5. The passive earth pressure coefficients provided assume a vertical foundation element, zero interface friction between the soil and the foundation element, and a horizontal backslope.
6. The total passive resistance below frost depth may be calculated based on the values of K_p provided, reduced by an appropriate factor considering the allowable wall movement (i.e., large strain required for mobilization of the full passive resistance), in accordance with Figure C6.16 of the CHBDC (2014).

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

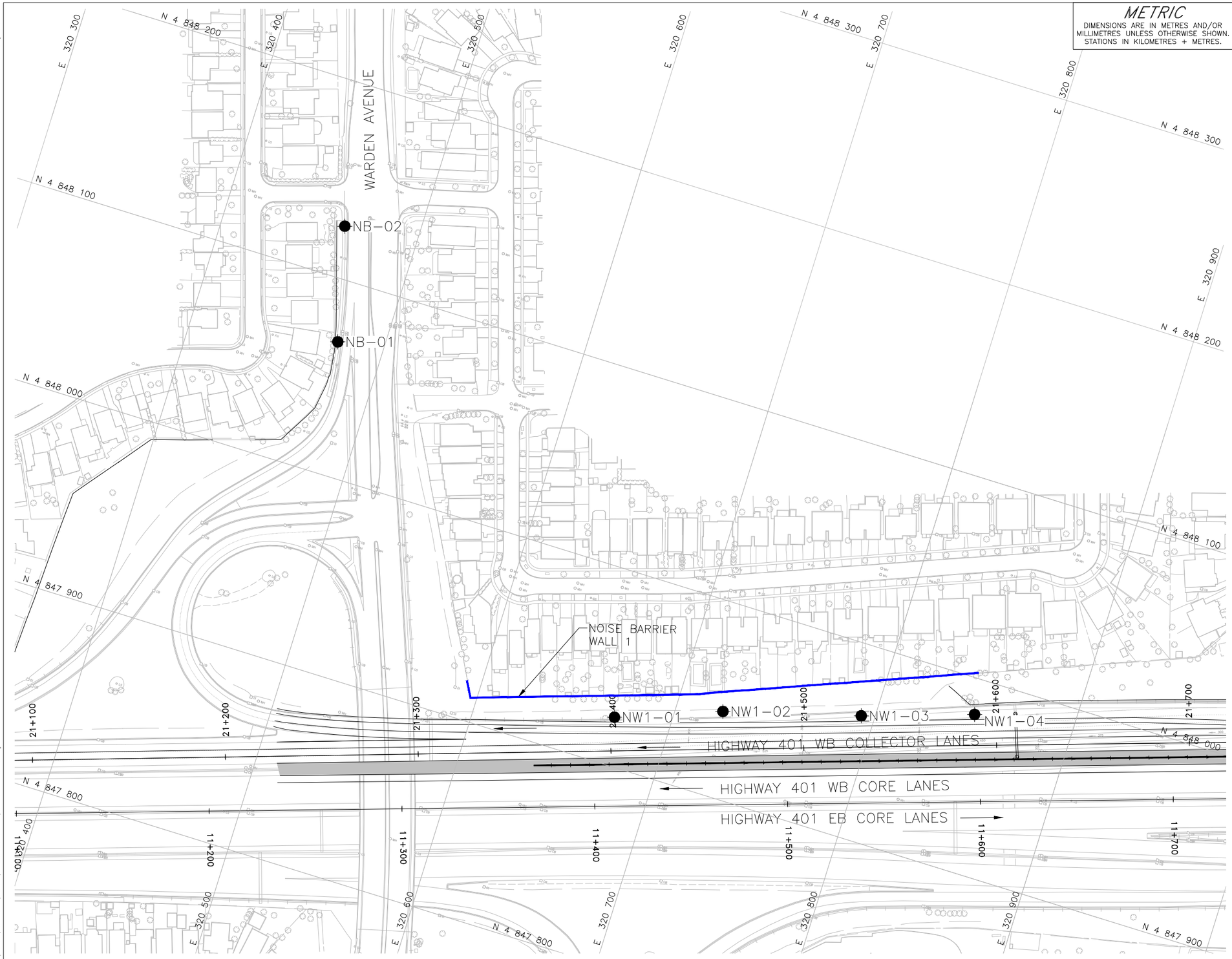
CONT No.
GWP No. 2162-11-00

NOISE BARRIER WALL 1
HIGHWAY 401 WESTBOUND CORE AND COLLECTORS

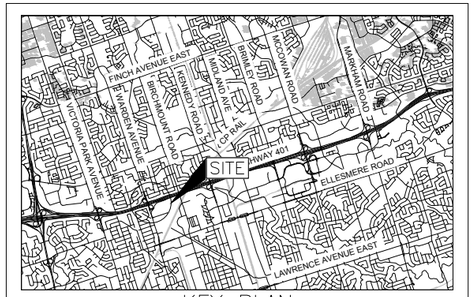
BOREHOLE LOCATIONS

SHEET

GOLDER



PLAN
SCALE
20 0 20 40 m



KEY PLAN
SCALE
1.5 0 1.5 3 km

LEGEND

● Borehole – 2018 Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
NB-01	183.5	4848068.2	320476.3
NB-02	184.0	4848126.6	320462.0
NW1-01	181.0	4847924.9	320671.0
NW1-02	181.8	4847944.4	320723.9
NW1-03	183.0	4847963.6	320793.1
NW1-04	183.5	4847981.7	320849.0

NOTES

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The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plan provided in digital format by WSP, drawings files no. H17M-01449-00_XA01.dwg, No.H17M-01449-00_XB01.dwg and H17M-01449-00_XY01.dwg, received October 26, 2017.
Design Layout provided in digital format by WSP, drawing file no. H17M-01449-00_XN01.dwg, received November 28, 2017.
Noise Barrier walls plan provided in digital format by WSP, drawings files New Noise Barrier Locations Sept 12, 2018.dwg, received September 12, 2018.
Existing ground provided in digital format by WSP, drawing file no. Contours Sept. 12, 2018.dwg, received September 12, 2018.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M14-500

HWY. 401		PROJECT NO. 1669995	DIST. .
SUBM'D. NK	CHKD. MWK	DATE: 03/08/2019	SITE: .
DRAWN: DD	CHKD. MWK	APPD. JMAC	DWG. 1

LICENSED PROFESSIONAL ENGINEER M.W.KELLY Mar. 08, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER U.M.A.COSTA Mar. 08, 2019 PROVINCE OF ONTARIO

PLOT DATE: March 8, 2019
FILENAME: S:\Clients\MTO\Hwy_401\VB_PROJ\1669995_WBL\45_PROD\0011_Noise_Barrier_Walls\1669995-0011-BG-0001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2162-11-00

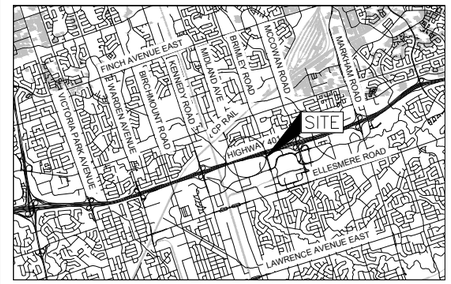
NOISE BARRIER WALL 2
HIGHWAY 401 WESTBOUND CORE AND COLLECTORS

BOREHOLE LOCATIONS

SHEET

GOLDER

PLAN
SCALE
20 0 20 40 m



KEY PLAN
SCALE
1.5 0 1.5 3 km

LEGEND

● Borehole – 2018 Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
74-1	166.1	4848650.4	322931.3
74-2	165.6	4848645.5	322914.7
74-14	167.5	4848659.2	322962.8
74-15	169.9	4848667.7	322991.8
74-16	173.0	4848680.0	323027.0
74-17	175.1	4848688.6	323055.0
74-18	175.3	4848697.4	323087.6
74-19	177.2	4848708.0	323118.0
74-20	178.8	4848717.0	323146.8
74-21	178.6	4848725.5	323178.4
74-22	178.1	4848731.4	323207.4
74-23	177.7	4848738.7	323239.2
74-24	177.4	4848744.3	323263.5
74-25	176.7	4848750.0	323290.5
74-26	174.3	4848753.3	323316.8
MA-03	167.4	4848662.6	322955.2
NBP1-01	174.6	4848821.8	323493.7
NBP1-02	174.6	4848807.7	323435.8
NBP1-03	174.8	4848787.0	323379.0
RW-01	175.0	4848771.1	323333.3
RW-02	174.4	4848707.5	323129.3

REFERENCE

Base plan provided in digital format by WSP, drawings files no. H17M-01449-00_XA01.dwg, No.H17M-01449-00_XB01.dwg and H17M-01449-00_XY01.dwg, received October 26, 2017.
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Existing ground provided in digital format by WSP, drawing file no. Contours Sept. 12, 2018.dwg, received September 12, 2018.

NOTES

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LICENSED PROFESSIONAL ENGINEER M.W.KELLY Mar. 08, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA Mar. 08, 2019 PROVINCE OF ONTARIO

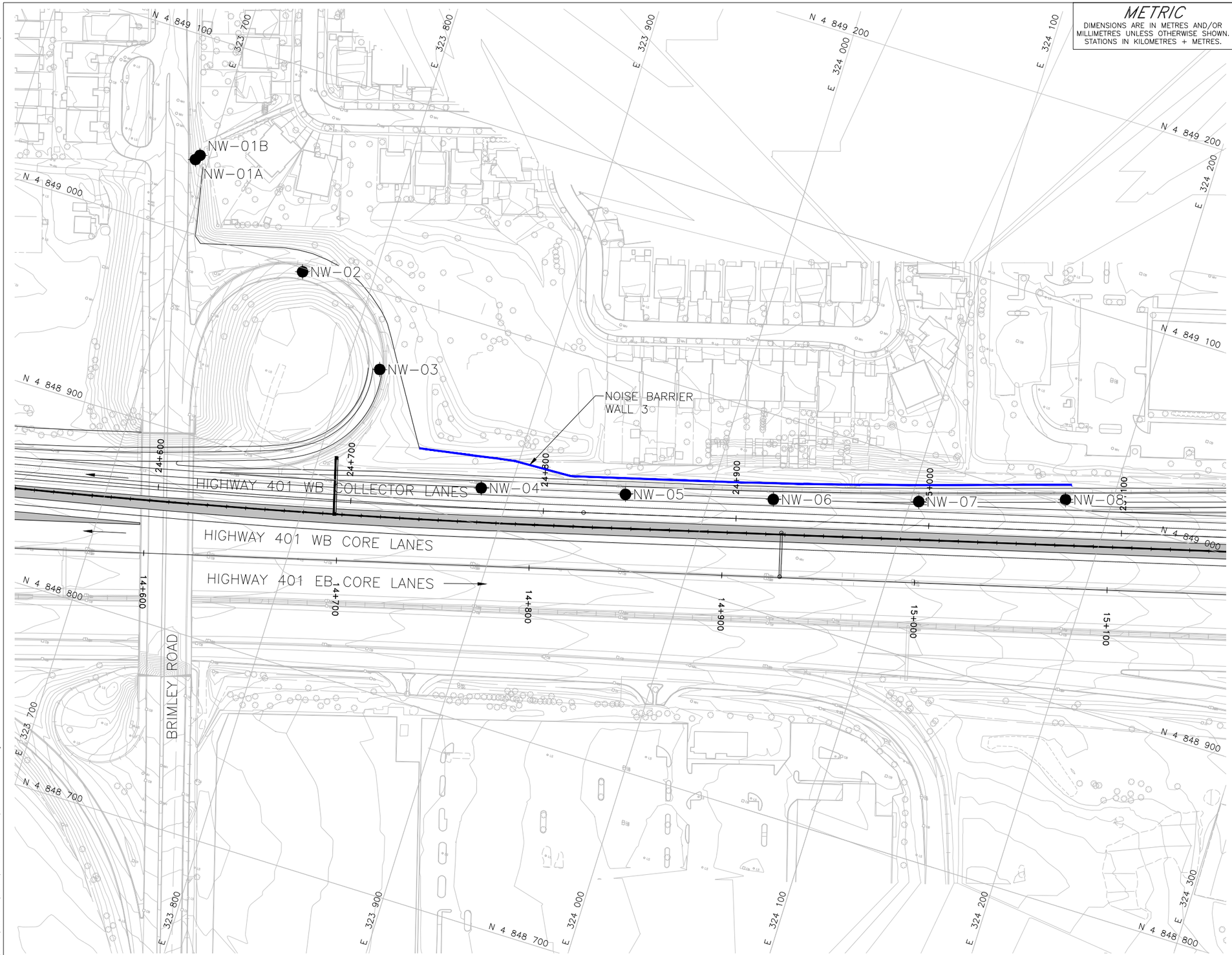
NO.	DATE	BY	REVISION

Geocres No. 30M14-500

HWY. 401		PROJECT NO. 1669995	DIST.
SUBM'D. NK	CHKD. MWK	DATE: 03/08/2019	SITE:
DRAWN: DD	CHKD. MWK	APPD. JMAC	DWG. 2

PLOT DATE: March 8, 2019
FILENAME: S:\Clients\MTO\Hwy_401\99_PROJ\1669995_WBL\40_PROD\011_Noise_Barrier_Walls\1669995-0011-BC-0002.dwg

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
20 0 20 40 m

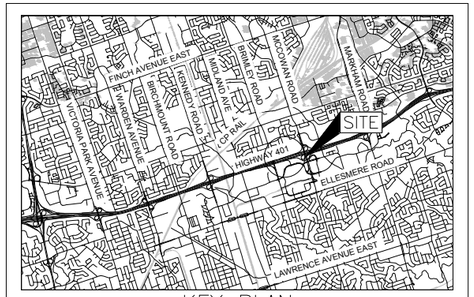
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2162-11-00

NOISE BARRIER WALL 3
HIGHWAY 401 WESTBOUND CORE AND COLLECTORS
BOREHOLE LOCATIONS

SHEET

GOLDER



KEY PLAN
SCALE
1.5 0 1.5 3 km

LEGEND

Borehole – 2018 Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 10)

No.	ELEVATION	NORTHING	EASTING
NW-01A	173.8	4849037.2	323693.3
NW-01B	173.1	4849040.0	323694.9
NW-02	175.2	4848998.1	323763.6
NW-03	172.6	4848961.6	323816.8
NW-04	171.5	4848918.5	323885.4
NW-05	171.3	4848937.6	323957.8
NW-06	170.7	4848957.8	324031.8
NW-07	170.0	4848979.1	324104.2
NW-08	168.9	4849002.6	324176.5

NOTES

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LICENSED PROFESSIONAL ENGINEER M.W.KELLY Mar. 08, 2019 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA Mar. 08, 2019 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 30M14-500

HWY. 401	PROJECT NO. 1669995		DIST. .
SUBM'D. NK	CHKD. MWK	DATE: 2019-03-08	SITE: .
DRAWN: DD	CHKD. MWK	APPD. JMAC	DWG. 3

PLOT DATE: March 8, 2019
FILENAME: S:\Clients\MTO\Hwy_401\99_PROJ\1669995_RBS_MD_PROD\001_Noise_Barrier_Walls\1669995-0011-BD-0003.dwg

APPENDIX A

Borehole Records from 1966 Investigation

FORM 08-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-1

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 371 +10; 134' Lt. of ℄ ORIGINATED BY A.K.B.
W.P. 260-61 BORING DATE Sept. 29-Oct. 5, 1966 COMPILED BY A.K.B.
DATUM Geodetic BOREHOLE TYPE Washboring, BX & NX Casing CHECKED BY AKR

Elev (m)	ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
166.1	544.9	GROUND LEVEL									
	0.0	Grey and Brown Sand to Silty Sand Traces of Gravel & clay. Compact to very dense.		1	SS	29	540				W.L. El. 538.9' 164.3m
				2	SS	31					
				3	SS	38					
				4	SS	51					
				5	SS	100/6"	530				
				6	SS	100/5"					
				7	SS	100/5"					
				8	SS	100/6"	520				
				9	SS	100/3"					
				10	SS	100/4"	510				Sa. 91% Si.&Cl. 9%
				11	SS	88					
							500				
				12	SS	100/5"					
							490				
				13	SS	100/1.5"					
							480				
42.5	470.9			14	SS	100					
22.6	74.0	Grey Clayey Silt Hard		15	SS	106	470				
				16	SS	91	460				
							450				
				17	SS	96	440				
							430				
29.5	424.9										
16.6	120.0	End of Borehole					420				

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-2

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 370 + 52: 134' Lt. of ℄ ORIGINATED BY A.K.B.
W.P. 260-61 BORING DATE Oct. 6, 1966 COMPILED BY A.K.B.
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

(W)	ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
165.6	543.2	GROUND LEVEL					
	0.0						540
		Brown & Grey		1	SS	28	
		Sandy		2	SS	32	
				3	SS	25	
		Silt with occasional layer of clayey silt		4	SS	72	530
				5	SS	100/6"	
				6	SS	100/6"	
		Very Dense		7	SS	100/5"	520
				8	SS	100/6"	
				9	SS	100/5"	510
154.4	506.7			10	SS	100/5"	
11.1	36.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY P.C.F.

REMARKS

▼ W.L. El. 535.2' 163.1m

Gr. 5%
Sa. 50%
Si. 42%
Cl. 3%

Gr. 1%
Sa. 30%
Si. 59%
Cl. 10%

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-14

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 14

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 372 + 15, 132' Lt. of ℄ ORIGINATED BY A.K.B.
W.P. 260-61 BORING DATE November 4, 1966 COMPILED BY A.K.B.
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(W)	ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
167.5	549.5	GROUND LEVEL					
	0.0	Brown & Grey Sandy Silt with traces of Clay. Very Dense.		1	SS	78	
				2	SS	113	
				3	SS	100/5"	540
				4	SS	100/4"	
							530
				5	SS	100/4"	
157.9	518.0						520
9.6	31.5	End of Borehole		6	SS	100/2"	

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY P.C.F.

REMARKS

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-15

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 373 + 13; 130' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 7, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY

(m) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	REMARKS
169.9 557.5	GROUND LEVEL						
0.0	Brown & Grey Sandy silt with traces of clay		1	SS	59		
			2	SS	126	550	
			3	SS	100/5"		
			4	SS	100/5"		
	Very Dense		5	SS	100/6"	540	Gr. 2% Sa. 39% Si. 50% Cl. 9%
163.4 536.0			6	SS	100/6"		
6.6 21.5	End of Borehole						

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30
N.P.

BULK DENSITY P.C.F.

FORM 08-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-16

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 374 + 33; 137' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 7, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(W)	ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
173.0	567.6	GROUND LEVEL									
	0.0	Brown to Grey Silty sand to sandy silt with traces of clay. Very dense.		1	SS	105					
				2	SS	136	560				
				3	SS	130					
				4	SS	100/5"					Gr. 3% Sa. 52% Si. & Cl. 45%
				5	SS	100/6"	550				
				6	SS	100/4"					Gr. 5% Sa. 40% Si. 41% Cl. 14%
163.4	536.1						540				
9.6	31.5	End of Borehole		7	SS	100/5"					

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-17

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 17

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 375 + 28; 137' Lt. of ℄ ORIGINATED BY A.K.B.
W.P. 260-61 BORING DATE November 8, 1966 COMPILED BY A.K.B.
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
(m) ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
175.1 574.6	GROUND LEVEL									
0.0	Brown Sandy Silt with traces of Clay. Very dense.		1	SS	95	570		o		
			2	SS	100/6"			o		
			3	SS	100/5"			o		
			4	SS	100/5"	560		o		
			5	SS	100/5"			o		
168.6 553.1			6	SS	166			o		
6.6 21.5										

FORM 08-MT-126
66-4846

OFFICE REPORT ON SOIL EXPLORATION

BH 74-18

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 18

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 376 + 37; 136' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 9, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY MK

(M) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
175.3 575.1	GROUND LEVEL					
0.0	Brown & Grey Silt to Clayey Silt Very dense or hard		1	SS	100/6"	570
			2	SS	158	
			3	SS	185	
			4	SS	155	560
			5	SS	160	
168.7 553.6			6	SS	100/4"	
6.6 21.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % — 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

FORM DB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-19

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 19

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 377 + 43.5'; 142' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 7, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(W)	ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % (10 20 30)	BULK DENSITY γ P.C.F.	REMARKS
177.2	581.5	GROUND LEVEL									
	0.0						580				
		Brown & Grey		1	SS	104					
				2	SS	141			N.P.		
		Sandy Silt to Silt.		3	SS	100/5"	570				
				4	SS	100/6"					
		Very Dense		5	SS	100/6"					
				6	SS	100/4"	560				
167.6	550.0			7	SS	100/3"					
9.6	31.5	End of Borehole									

FORM 08-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-20

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 20

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 378 + 42; 146.5' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 8, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
(M) 178.8 586.6	GROUND LEVEL									
0.0	Brown to Grey Sandy Silt to clayey silt. Very dense.		1	SS	54	580		o		
			2	SS	77			o		
			3	SS	100/5"			o		
			4	SS	100/5"			o		
			5	SS	100/5"	570		o		
172.2 565.1			6	SS	100/4"			o		
6.6 21.5	End of Borehole									

FORM DB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-21

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 21

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 379 + 46; 147' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 8, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(m) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
178.6 585.8	GROUND LEVEL									
0.0	Brown & Grey Sandy silt to silt with traces of clay. Dense to very dense		1	SS	46	580				
			2	SS	31					
			3	SS	100/5"					
			4	SS	126					
			5	SS	70	570				
172.0 564.3			6	SS	100/5"					
6.6 571.5	End of Borehole									

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH-74-22

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 22

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 380 ± 42; 141' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 9, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(M) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
178.1 584.4	GROUND LEVEL									
	Brown & Grey		1	SS	94	580				
			2	SS	55					Sa. 35% Si. 64% Cl. 1%
	Sandy Silt to Clayey Silt		3	SS	136					
			4	SS	121	570				
	Very Dense & Hard		5	SS	64					
			6	SS	102					W.L. El. 562.4 171.4m
						560				
168.5 9.6 552.9 31.5			7	SS	100/6"					
	End of Borehole									

FORM 08-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-23

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 23

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 381 + 49; 141.5' Lt. OF ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 9, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(m) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
177.7 583.1	GROUND LEVEL									
0.0	Brown & Grey Sandy silt to clayey silt.		1	SS	70	580				
			2	SS	155					
			3	SS	105					
	Very dense & hard		4	SS	113	570				
			5	SS	52					W.L. El. 567.6 173.0m
171.2 561.6			6	SS	100/5"					
6.6 21.5	End of Borehole									

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-24

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 24

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 382 + 29.5; 141' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 14, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(m) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
177.4 582.1	GROUND LEVEL					
0.0	Brown & Grey Sandy silt with traces of clay Very dense.		1	SS	26	580
			2	SS	62	
			3	SS	74	
			4	SS	156	570
			5	SS	100/6"	
170.9 560.6			6	SS	100/5"	
6.6 21.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY P.C.F.

REMARKS

▽W.L. = El. 567.1
Sa. 46% 172.9m
Si. 54%

FORM DB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-25

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 25

FOUNDATION SECTION

JOB 66-E-87 LOCATION Sta. 383 + 19; 140' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 14, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Continuous Flight Auger Hole CHECKED BY

(M) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
176.7 / 579.6	GROUND LEVEL					
0.0	Brown		1	SS	36	
	Sandy silt with occ. layers of clayey silt		2	SS	49	
			3	SS	97	570
			4	SS	100/3"	
	Dense to very dense and hard		5	SS	118	
						560
			6	SS	121	
167.1 / 548.1						550
9.6 / 31.5	End of Borehole		7	SS	100/5"	

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_p
WATER CONTENT — w
w_p w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

▼W.L.
W1.564.6
172.1m

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

BH 74-26

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 26

FOUNDATION SECTION

JOB 66-F-87 LOCATION Sta. 384 + 08; 131'' Lt. of ℄ ORIGINATED BY AKB
W.P. 260-61 BORING DATE November 10, 1966 COMPILED BY AKB
DATUM Geodetic BOREHOLE TYPE Washboring, BX Casing CHECKED BY

(m) ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
174.3 / 571.9	GROUND LEVEL					
0.0	Brown & Grey Sandy silt to clayey silt Very Dense & Hard		1	SS	55	570
			2	SS	109	
			3	SS	100/6"	560
			4	SS	100/5"	
			5	SS	100/6"	
167.8 / 550.4			6	SS	100/5"	
6.6 / 21.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

APPENDIX B

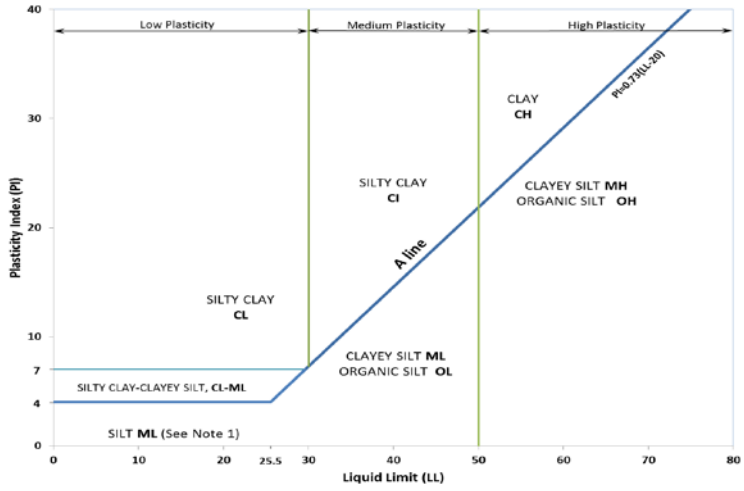
Borehole Records from 2018 Investigation

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

GOLDER

RECORD OF BOREHOLE No MA-03

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2219-14-00

LOCATION N 4848662.6; E 322955.2 MTM NAD 83 ZONE 10 (LAT. 43.777710; LONG. -79.274464)

ORIGINATED BY DS

DIST Central HWY 401

BOREHOLE TYPE CME 55 Truck-Mounted Drill Rig, 178 mm O.D. Hollow Stem Augers

COMPILED BY SE

DATUM Geodetic

DATE May 31, 2018

CHECKED BY NK/LCC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
167.4	GROUND SURFACE					
0.0	Silty sand, trace gravel (FILL) Brown Moist					
166.6						
0.8	SILT and SAND, trace to some clay, trace gravel Dense to very dense Brown to grey below 3.0 m Moist	1	SS	31		
		2	SS	33		5 45 41 9
		3	SS	56		
		4	SS	58/0.28		
		5	SS	50/0.13		
162.5		6	SS	50/0.13		NP 10 45 39 6
4.9	END OF BOREHOLE					

NOTES:

1. Piezometer dry on completion of installation.

2. Water level measured in piezometer as follow:

Date	Depth (m)	Elev. (m)
Jul 30/18	3.7	163.7

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

ELEVATION SCALE: 167, 166, 165, 164, 163

GROUND WATER CONDITIONS

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NB-01

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848068.2; E 320476.3 MTM NAD 83 ZONE 10 (LAT. 43.772417; LONG. -79.305277)

ORIGINATED BY MA

DIST Central HWY 401

BOREHOLE TYPE CME 55 Truck-Mounted Drill Rig, 152 mm O.D. Hollow Stem Augers

COMPILED BY SE

DATUM Geodetic

DATE June 5, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.5	GROUND SURFACE						183				
0.0 / 0.1	ASPHALT (50 mm)										
182.9	Sand and gravel, some silt (FILL) Brown										
0.6	Clayey silt, some sand (FILL) Firm Brown Moist		1	SS	6						
181.9			2A 2B	SS	11		182				
181.5	Sand, some silt, trace gravel (FILL) Compact Brown Moist										
2.0	Gravelly SAND, some silt, trace clay Compact to very dense Brown Moist		3	SS	31		181		○		
			4	SS	49						
			5	SS	62		180		○		28 53 16 3
			6	SS	52		179				
177.7							178				
5.8	SAND, trace to some silt, trace gravel, trace clay Very dense Brown Moist		7	SS	67				○		4 87 6 3
			8	SS	101		177				
175.0			9	SS	210		176		○		
8.5	END OF BOREHOLE						175				

NOTE:

1. Open borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NB-02

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848126.6; E 320462.0 MTM NAD 83 ZONE 10 (LAT. 43.773006; LONG. -79.305464)

ORIGINATED BY DS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 203 mm O.D. Hollow Stem Augers

COMPILED BY SE

DATUM Geodetic

DATE May 29, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.0	GROUND SURFACE										
0.0 / 0.1	ASPHALT (50 mm)										
	Silty sand, trace gravel to gravelly, trace organics (FILL) Loose Brown Moist		1	SS	10						
			2	SS	9		183				
182.6											
1.5	SAND, trace to some silt, trace to some gravel Dense Brown Moist		3	SS	32				○		0 79 20 1
			4	SS	44		182				
			5	SS	44		181				
			6	SS	43		180				
			7	SS	35		179		○		10 77 11 2
178.4											
5.6	SAND and GRAVEL, trace to some silt, trace clay Very dense Brown Moist		8	SS	88		178		○		34 55 9 2
			9	SS	50/0.08		177		○		
	- Split-spoon sampler refusal at approximately 7.9 m and 8.9 m depths						176				
			10	SS	96/0.23				○		30 60 9 1
174.9							175				
9.1	END OF BOREHOLE										

NOTES:

1. Piezometer dry on completion of installation.

2. Water level measured in piezometer as follows:

Date	Depth (m)	Elev. (m)
Oct 04/18	Dry	-

$+^3, \times^3$: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NBP1-01

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848821.8; E 323493.7 MTM NAD 83 ZONE 10 (LAT. 43.779130; LONG. -79.267770)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 55 Truck-Mounted Drill Rig, 216 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 9, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
174.6	GROUND SURFACE										
0.0	ASPHALT (76 mm)										
	CONCRETE (203 mm)		1	AS	-						
174.0	Gravelly sand, trace to some silt (FILL) Brown Moist						174				
0.6			2	SS	20				○		
	Silt and sand, some gravel, trace to some clay (FILL) Compact to dense Brown Moist		3	SS	49		173		○ H		10 42 38 10
172.4											
2.2	Silty SAND, some gravel, trace to some clay Very dense Brown Moist		4	SS	56		172				
171.9											
2.7	SILT and SAND, trace to some clay, trace gravel Very dense Brown Moist		5	SS	91		171				
170.9											
170.5	- Split spoon refusal at 3.5 m; gravel fragments in tip of sampler		6A 6B	SS	85				○		41 43 13 3
4.1	SAND and GRAVEL, trace silt, trace clay Very dense Brown Moist		7	SS	50/ 0.15		170				
	SILT and SAND, trace to some clay, trace gravel Very dense Brown Moist						169				
	- Split spoon refusal at 4.2 m; gravel fragments in tip of sampler		8	SS	89				H○		2 43 45 10
	- Split spoon refusal at 6.5 m; gravel fragments in tip of sampler						168				
166.7			9	SS	50/ 0.15		167				
7.9	- Split spoon refusal at 7.9 m; gravel fragments in tip of sampler										
	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 4.7 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NBP1-02

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848807.7; E 323435.8 MTM NAD 83 ZONE 10 (LAT. 43.779004; LONG. -79.268489)

ORIGINATED BY MB

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE March 25, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
174.6	GROUND SURFACE										
0.0	ASPHALT (178 mm)										
0.2	Gravelly sand, trace silt, trace asphalt fragments (FILL)		1	AS	-						
173.9	Brown						174				
0.7	Moist										
	Sandy clayey silt, trace gravel (FILL)		2	SS	16				○		
173.1	Very stiff										
1.5	Brown										
	Moist						173				
	CLAYEY SILT with SAND, trace to some gravel		3	SS	42						
	Hard										
	Brown										
	Moist		4	SS	42		172		○ ⊢⊣		8 34 43 15
			5	SS	64						
170.9											
3.7	Silty SAND, trace gravel						171				
	Very dense		6	SS	55						
	Brown containing oxidation stains										
170.1	Moist										
4.5	SAND, some silt, trace gravel, trace clay		7	SS	48		170		○		4 75 17 4
	Dense										
	Brown										
169.0	Moist										
5.6	SILT and SAND, trace to some clay, trace gravel						169				
	Very dense										
	Brown										
	Moist		8	SS	110				○ H		4 54 33 9
							168				
			9	SS	62		167				
166.4											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 7.0 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NBP1-03 SHEET 1 OF 1 METRIC

PROJECT 1669995
G.W.P. 2162-11-00
DIST Central HWY 401
DATUM Geodetic

LOCATION N 4848787.0; E 323379.0 MTM NAD 83 ZONE 10 (LAT. 43.778851; LONG. -79.269207)
BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers
DATE March 25, 2018

ORIGINATED BY MB
COMPILED BY KAW
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
174.8	GROUND SURFACE										
0.0	ASPHALT (178 mm)										
0.2	Gravelly sand, trace asphalt fragments (FILL)		1	AS	-						
174.1	Brown						174				
0.7	Moist										
	Sandy clayey silt (FILL) Stiff Brown Moist		2	SS	10						
173.3							173				
1.5	CLAYEY SILT with SAND to SILT and SAND, trace clay, trace gravel Hard Brown Moist		3	SS	31						
			4	SS	33		172				
			5	SS	36						1 33 52 14
			6	SS	45		171				
			7	SS	62		170				
							169				
			8	SS	82						
167.6							168				
7.2	SILT and SAND, trace to some clay, trace gravel Very Dense Brown Moist		9	SS	78		167				1 43 48 8
166.6											
8.2	END OF BOREHOLE										

NOTES:

1. Open borehole dry upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No NW-01A

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00 LOCATION N 4849037.2; E 323693.3 MTM NAD 83 ZONE 10 (LAT. 43.781064; LONG. -79.265283) ORIGINATED BY GG

DIST Central HWY 401 BOREHOLE TYPE NW Casing and Mud Rotary COMPILED BY

DATUM Geodetic DATE July 3, 2018 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.8	GROUND SURFACE										
0.0	TOPSOIL										
173.4	Sand, some gravel, some silt (FILL) Compact Brown Moist		1A 1B	SS	200						
0.6	Sand and gravel (FILL) Brown Moist		2	SS	35		173				
	Sand, some silt to silty sand, trace gravel (FILL) Dense Brown Moist		3	SS	36		172				
171.6			4	SS	80/0.10						
2.4	Sandy CLAYEY SILT, trace gravel Brown Moist Hard										
	END OF BOREHOLE - Refusal to Split Spoon										

NOTES:

1. Open borehole dry on completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NW-01B

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00 LOCATION N 4849040.0; E 323694.9 MTM NAD 83 ZONE 10 (LAT. 43.781089; LONG. -79.265262) ORIGINATED BY JB

DIST Central HWY 401 BOREHOLE TYPE NW Casing and Mud Rotary COMPILED BY

DATUM Geodetic DATE October 30 and 31, 2018 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.1	GROUND SURFACE										
0.0	TOPSOIL, some roots, trace sand, trace gravel Black to brown Dry		1A 1B	SS	11		173				
0.2	Sandy silt to silty sand, trace to some clay, trace to some gravel (FILL) Compact to very dense Grey-brown Dry		2	SS	24						
			3	SS	33		172				
			4	SS	100/0.15						
							171				
			5	SS	276						
			6	SS	108		170				
169.6											
3.5	END OF BOREHOLE - Refusal to Split Spoon NOTES: 1. Open borehole dry on completion of drilling.										

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NW-02

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848998.1; E 323763.6 MTM NAD 83 ZONE 10 (LAT. 43.780710; LONG. -79.264410)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 6, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.2	GROUND SURFACE						175				
0.0	ASPHALT (229 mm)										
0.2	Sand, trace to some silt, trace gravel (FILL)		1	AS	-						
174.5	Brown										
0.7	Moist										
	Clayey silt, some sand to sandy, trace gravel, trace organics (FILL) Stiff to very stiff Dark grey to grey Moist		2	SS	22		174	○	○		
			3	SS	13						
			4	SS	13		173		○		
171.9			5A 5B	SS	31		172				
171.5	Sandy silt, trace gravel (FILL) Compact Brown Moist										
3.7	SILT and SAND, trace to some clay, trace to some gravel Compact to dense Brown Moist		6	SS	11		171				
			7	SS	50			○ H			7 47 37 9
			8	SS	47		170				
168.0							169				
7.2	CLAYEY SILT with SAND, trace to some gravel Very stiff Grey Moist		9	SS	23		168		○ H		7 32 44 17
167.0							167				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 5.1 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NW-03

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848961.6; E 323816.8 MTM NAD 83 ZONE 10 (LAT. 43.780380; LONG. -79.263750)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 6, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.6	GROUND SURFACE										
0.0	ASPHALT (229 mm)										
0.2 / 171.9	Gravelly sand, trace to some silt (FILL) Brown Moist		1	AS	-						
0.7	Clayey silt, some sand to sandy, trace gravel (FILL) Firm to very stiff Brown Moist		2	SS	8		172		○		
			3	SS	22		171				
169.5			4	SS	17		170				
3.1	SILT and SAND, trace to some clay, trace gravel Dense Brown Moist		5	SS	36		169		○ H		3 51 38 8
	- Split spoon sampler refusal at a depth of approximately 4.0 m (Split Spoon Bouncing)		6	SS	13/0.15						
			7	SS	40		168				
166.4							167				
6.2	CLAYEY SILT with SAND, trace gravel Very stiff to hard Brown Moist		8	SS	19		166		⊢●⊣		3 33 46 18
			9	SS	57		165		○		
164.4											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.3 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NW-04

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848918.5; E 323885.4 MTM NAD 83 ZONE 10 (LAT. 43.779990; LONG. -79.262900)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 11, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.5	GROUND SURFACE										
0.0	ASPHALT (152 mm)										
171.0	Gravelly sand, trace to some silt (FILL)		1	AS	-		171				
0.5	Brown Moist										
	Sand, some gravel, some silt (FILL) Loose to compact Brown Moist		2	SS	13						
169.3			3	SS	6		170		○		
2.2	SILT and SAND, trace to some clay, trace to some gravel Compact to dense Brown Moist - Containing oxidation stains between depths of approximately 3.0 m and 5.6 m		4	SS	21		169				
			5	SS	36				○ H		9 44 37 10
			6	SS	33		168		○		
			7	SS	36		167		○		
165.4							166				
6.1	CLAYEY SILT with SAND, trace to some gravel Hard Brown to grey Moist		8	SS	48				○ H		6 36 44 14
	- Grey below 7.6 m		9	SS	41	▽	165				
163.3							164				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 5.8 m upon removal of augers.

2. Water level measured through casing to be approximately 7.7 m below ground surface (Elev. 163.8 m). Open borehole dry upon removal of casing.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No NW-05

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848937.6; E 323957.8 MTM NAD 83 ZONE 10 (LAT. 43.780160; LONG. -79.262000)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 11, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
171.3	GROUND SURFACE										
0.0	ASPHALT (229 m)										
170.8	Sand and gravel, trace to some silt (FILL)		1	AS	-		171				
0.5	Brown Moist										
	Clayey silt, some sand to sandy, trace gravel (FILL) Firm to very stiff Brown to grey Moist - Trace organics between depths of approximately 1.4 m and 2.2 m		2	SS	8						
			3A 3B	SS	9		170				
168.3			4	SS	18		169				
3.0	CLAYEY SILT with SAND, trace gravel Very stiff to hard Brown Moist - Auger grinding on inferred gravel/cobble between depths of approximately 3.0 m and 3.7 m		5	SS	25		168				
			6	SS	18		167				4 32 44 20
			7A 7B	SS	17		166				
165.2											
6.1	SILT and SAND, trace to some clay, trace gravel Very dense Brown Moist		8	SS	51		165				1 36 51 12
							164				
163.1			9	SS	74	▽					0 45 46 9
8.2	END OF BOREHOLE NOTES: 1. Borehole caved to a depth of approximately 5.9 m upon removal of augers. 2. Water level measured through casing to be approximately 8.0 m below ground surface (Elev. 163.3 m). Open borehole dry upon removal of casing.										

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NW-06

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848957.8; E 324031.8 MTM NAD 83 ZONE 10 (LAT. 43.780340; LONG. -79.261080)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 10, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.7	GROUND SURFACE										
0.0	ASPHALT (152 mm)										
170.2	Gravelly sand, trace to some silt (FILL)		1	AS	-						
0.5	Brown Moist										
	Clayey silt with sand, trace to some gravel (FILL) Stiff Brown to grey Moist		2	SS	11		170				
			3	SS	11		169		○		
			4	SS	12		168		○—|			12 40 37 11
			5	SS	11				○		
167.0							167				
3.7	SILT and SAND, trace clay Dense Brown		6A 6B	SS	32				○		0 69 30 1
166.4	Moist to wet										
4.3	CLAYEY SILT with SAND, trace to some gravel Hard Brown Dry to moist - Split spoon refusal on inferred gravel/cobble at a depth of approximately 5.1 m (bottom of Sample 7)		7	SS	63		166				
			8	SS	41		165		○—|			6 42 39 13
							164				
			9	SS	62		163				
162.5											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.9 m upon removal of augers.

2. Open borehole moist to wet at bottom upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NW-07

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4848979.1; E 324104.2 MTM NAD 83 ZONE 10 (LAT. 43.780530; LONG. -79.260180)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 10, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.0	GROUND SURFACE										
0.0	ASPHALT (229 mm)										
169.5	Gravelly sand, trace to some silt (FILL)		1	AS	-						
0.5	Brown Moist										
	Sandy clayey silt, trace gravel (FILL) Soft to firm Brown to grey Moist to wet		2A 2B	SS	7		169				
			3A 3B	SS	4		168				
167.8											
2.2	SAND, some silt, trace gravel Compact Brown Moist		4	SS	17		167				
167.0											
3.0	SILT and SAND, trace to some clay, trace gravel Compact to very dense Brown Moist - Containing oxidation stains between depths of approximately 3.0 m and 3.7 m - Black silt and sand layer between depths of approximately 3.4 m and 3.6 m		5A 5B	SS	37						
			6	SS	25		166				2 40 51 7
			7	SS	90		165				
	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 5.0 m (bottom of Sample 7)										
164.4											
5.6	Sandy CLAYEY SILT, trace gravel Hard Grey Moist		8	SS	60		164				
							163				
	- Some sand below a depth of approximately 7.6 m		9	SS	58		162				1 25 47 27
161.8											
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.0 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NW-08

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4849002.6; E 324176.5 MTM NAD 83 ZONE 10 (LAT. 43.780740; LONG. -79.259280)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 10, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
168.9	GROUND SURFACE										
0.0	ASPHALT (229 mm)										
	Gravelly sand, trace to some silt (FILL) Brown Moist		1	AS	-						
0.5	Clayey silt, some sand, trace gravel (FILL) Stiff to very stiff Grey mottled brown to brown Moist		2	SS	15		168		○		
			3A	SS	15		167				
166.7			3B								
2.2	CLAYEY SILT with SAND, trace to some gravel Hard Brown Dry to Moist		4	SS	31		166		○ ⊢		5 37 48 10
			5	SS	64				○		
			6	SS	91		165		○ ⊢		3 30 50 17
	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 4.2 m		7	SS	50/ 0.15						
	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 4.9 m					▽	164				
							163				
	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 6.3 m		8	SS	50/ 0.15		162				
161.0			9	SS	50/ 0.15						
7.9	- Split spoon refusal on inferred gravel/cobble at a depth of approximately 7.9 m										
	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.0 m upon removal of augers.

2. Water observed at a depth of approximately 5.9 m upon removal of augers.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No NW1-01

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4847924.9; E 320671.1 MTM NAD 83 ZONE 10 (LAT. 43.771122; LONG. -79.302862)

ORIGINATED BY MB

DIST Central HWY 401

BOREHOLE TYPE CME 55 Track-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE March 26, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.0	GROUND SURFACE										
0.0 / 0.1	TOPSOIL (50 mm)										
180.3	Sandy clayey silt, trace gravel, trace rootlets (FILL) Stiff Brown Moist		1	SS	10						
0.7	Sand, trace to some silt, trace clay, trace gravel (FILL) Compact Brown Moist		2	SS	16		180		○		
			3	SS	18		179		○		0 89 10 1
			4	SS	25						
178.0							178				
3.1	Gravelly silty SAND Very dense Brown Moist		5	SS	62				○		27 51 22 0
177.3											
3.7	- Augers grinding on inferred gravel/cobble between depths of approximately 3.4 m and 3.7 m		6	SS	99		177		○		2 48 49 1
	SILT and SAND, trace gravel, trace clay Very dense Brown Moist		7	SS	115				○		
	- Augers grinding on inferred gravel/cobble between depths of approximately 5.2 m and 5.5 m						176				
							175				
			8	SS	103				○		4 57 35 4
							174				
172.8			9	SS	116		173				
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.4 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

GTA-MTO 001 S:\CLIENTS\MTO\HWY_401\02_DATA\GINT\HWY_401.GPJ GAL-GTA.GDT 19-2-27

GOLDER

RECORD OF BOREHOLE No NW1-02

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2162-11-00

LOCATION N 4847944.4; E 320723.9 MTM NAD 83 ZONE 10 (LAT. 43.771378; LONG. -79.302278)

ORIGINATED BY MB

DIST Central HWY 401

BOREHOLE TYPE CME 55 Track-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE March 26, 2018

CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.8	GROUND SURFACE										
0.0	TOPSOIL (100 mm)										
0.1	Sandy clayey silt, trace gravel, trace rootlets (FILL) Firm to hard Brown containing oxidation stains Moist		1	SS	8		181				
			2	SS	34				○		
180.3											
1.5	Sand, some gravel, trace to some silt, trace clay (FILL) Compact to very dense Brown Moist - Augers grinding on inferred gravel/cobble between depths of approximately 1.8 m and 2.1 m		3	SS	25		180				
			4	SS	80		179		○		
	- Augers grinding on inferred gravel/cobble between depths of approximately 2.7 m and 3.0 m		5	SS	46				○		19 73 7 1
178.1							178				
3.7	SILT and SAND, trace clay, trace gravel Very dense Brown Moist		6	SS	133						
			7	SS	95		177		○		2 61 34 3
							176				
	- Split-spoon sampler refusal at approximately 6.2 m and 7.9 m		8	SS	100/ 0.13						
							175				
173.9			9	SS	100/ 0.13		174				
7.9	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 5.8 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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GOLDER

PROJECT 1669995

RECORD OF BOREHOLE No NW1-03

SHEET 1 OF 1

METRIC

G.W.P. 2162-11-00 LOCATION N 4847963.6; E 320793.1 MTM NAD 83 ZONE 10 (LAT. 43.771430; LONG. -79.301430) ORIGINATED BY JS

DIST Central HWY 401 BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers COMPILED BY KAW

DATUM Geodetic DATE April 5, 2018 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.0	GROUND SURFACE										
0.0	ASPHALT (203 mm)										
0.2 / 182.3	Gravelly sand, trace to some silt (FILL) Dark brown Moist		1	AS	-						
0.7	Sand, some silt to silty, trace clay (FILL) Compact to very dense Brown Moist		2	SS	27		182				
			3	SS	31		181		○		
			4	SS	32				○		0 79 20 1
179.0			5	SS	54		180				
4.0	SAND, trace to some silt, trace clay Dense to very dense Brown Moist		6	SS	35		179				
			7	SS	63		178		○		
			8	SS	48		177		○		0 92 7 1
174.8	- Trace gravel fragments below a depth of approximately 7.6 m		9	SS	64		176				
8.2	END OF BOREHOLE						175				

NOTES:

1. Borehole caved to a depth of approximately 6.4 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No NW1-04

SHEET 1 OF 1 **METRIC**

PROJECT 1669995
G.W.P. 2162-11-00
DIST Central HWY 401
DATUM Geodetic

LOCATION N 4847981.7; E 320849.0 MTM NAD 83 ZONE 10 (LAT. 43.771630; LONG. -79.300650)
BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers
DATE April 5, 2018

ORIGINATED BY JS
COMPILED BY KAW
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.5	GROUND SURFACE										
0.0	ASPHALT (229 mm)										
0.2 / 182.8	Gravelly sand, trace to some silt (FILL) Black Moist		1	AS	-		183				
0.7 / 181.7	Sandy clayey silt, trace to some gravel (FILL) Very stiff Brown to dark brown Moist		2	SS	18						
			3A 3B	SS	20		182				
1.8 / 180.5	Sand, some silt, trace clay (FILL) Compact Brown Moist		4	SS	25		181		○		0 85 14 1
3.0	SAND, some silt, trace gravel Compact to dense Brown Moist		5	SS	21		180		○		
			6	SS	33						
			7	SS	26		179		○		1 90 9 0
							178				
			8	SS	37		177		○		
							176				
175.3	- Trace gravel fragments below a depth of approximately 7.6 m		9	SS	34						
8.2	END OF BOREHOLE										

NOTES:

1. Borehole caved to a depth of approximately 6.2 m upon removal of augers.

2. Open borehole dry upon completion of drilling.

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GOLDER

RECORD OF BOREHOLE No RW-01

SHEET 1 OF 1 **METRIC**

PROJECT 1669995
G.W.P. 2219-14-00
DIST Central HWY 401
DATUM Geodetic

LOCATION N 4848771.1; E 323333.3 MTM NAD 83 ZONE 10 (LAT. 43.778678; LONG. -79.269764)
BOREHOLE TYPE CME 55 Track-Mounted Drill Rig, 216 mm O.D. Hollow Stem Augers
DATE March 28, 2018

ORIGINATED BY MB
COMPILED BY KAW
CHECKED BY NK/LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.0	GROUND SURFACE										
0.0	ASPHALT (152 mm)										
0.2	Gravelly sand, trace silt, trace clay (FILL)		1	AS	-						
174.3	Brown						174				
0.7	Moist										
	Sandy silt, some gravel, some clay (FILL)		2	SS	19				○		
173.5	Compact						173				
1.5	Brown containing oxidation stains										
	Moist		3	SS	32						
	Sandy CLAYEY SILT to CLAYEY SILT with SAND, trace gravel										
	Hard										
	Brown to grey below 5.6 m		4	SS	46		172		○⊢		2 35 50 13
	Moist										
	- Contains oxidation stains between depths of approximately 2.4 m and 3.7 m		5	SS	41				○		
			6	SS	75		171		○		
			7	SS	60		170				
			8	SS	100/ 0.13		169		○⊢		8 28 47 17
							168				
167.1			9	SS	100/ 0.08						
7.9	END OF BOREHOLE										

NOTES:

1. Piezometer dry upon completion of installation.

2. Water levels measured in standpipe piezometer:

Date	Depth (m)	Elev (m)
Jul 30/18	4.5	170.5

$+^3, \times^3$: Numbers refer to Sensitivity

$\bigcirc^{3\%}$ STRAIN AT FAILURE

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GOLDER

RECORD OF BOREHOLE No RW-02

SHEET 1 OF 1

METRIC

PROJECT 1669995

G.W.P. 2219-14-00

LOCATION N 4848707.5; E 323129.3 MTM NAD 83 ZONE 10 (LAT. 43.778110; LONG. -79.272300)

ORIGINATED BY JS

DIST Central HWY 401

BOREHOLE TYPE CME 75 Truck-Mounted Drill Rig, 165 mm O.D. Hollow Stem Augers

COMPILED BY KAW

DATUM Geodetic

DATE April 9, 2018

CHECKED BY NK/LCC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
174.4	GROUND SURFACE										
0.0	ASPHALT (203 mm)										
173.8	Gravelly sand, trace to some silt (FILL) Brown Moist		1	AS	-		174				
0.6	Clayey silt with sand, trace gravel (FILL) Very stiff to hard Grey Moist		2	SS	20						
			3	SS	36		173		○		
			4	SS	18		172		○		
			5	SS	32		171		○		4 37 43 16
170.3			6	SS	14				○		
4.1	CLAYEY SILT with SAND, trace to some gravel Stiff to hard Grey Moist to wet		7	SS	20		170				
							169				
			8	SS	36	▽	168		○		5 39 41 15
166.6			9A				167				
7.8	SAND, trace to some silt, trace to some clay Loose Grey Wet		9B	SS	6						
166.1			10A	SS	14/0.07						
8.4	Sandy CLAYEY SILT, trace gravel Very stiff Grey Moist		10B								
	END OF BOREHOLE - Refusal to Split Spoon										

NOTES:

1. Water level measured in open borehole at a depth of approximately 6.3 m (Elev. 168.1 m) below ground surface upon completion of drilling.

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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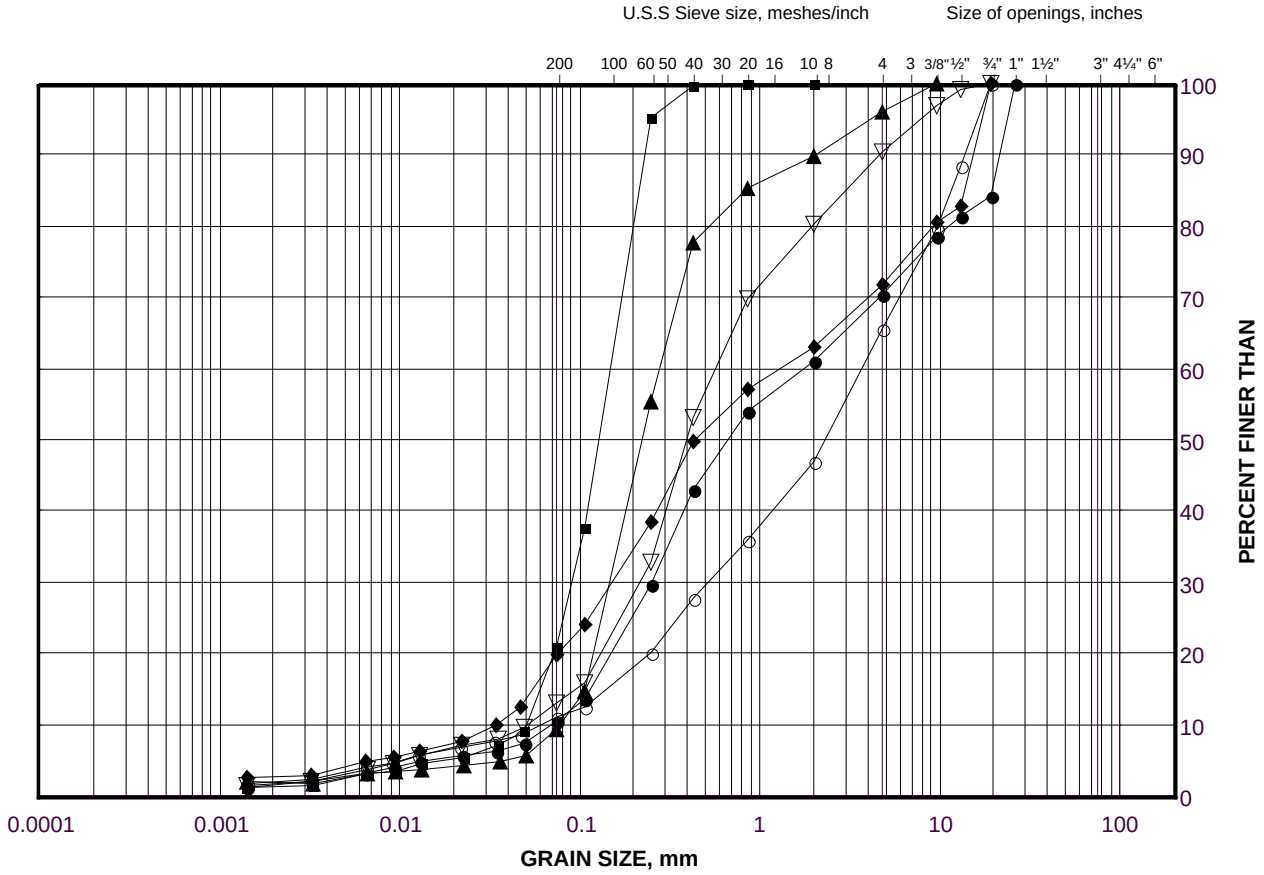
APPENDIX C

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sand to Gravelly Sand to Sand and Gravel

FIGURE C-1



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NB-02	10	175.2
■	NB-02	3	182.2
◆	NB-01	5	179.5
▲	NB-01	7	177.2
▽	NB-02	7	179.1
❍	NB-02	8	177.6

Project Number: 1669995

Checked By: MWK

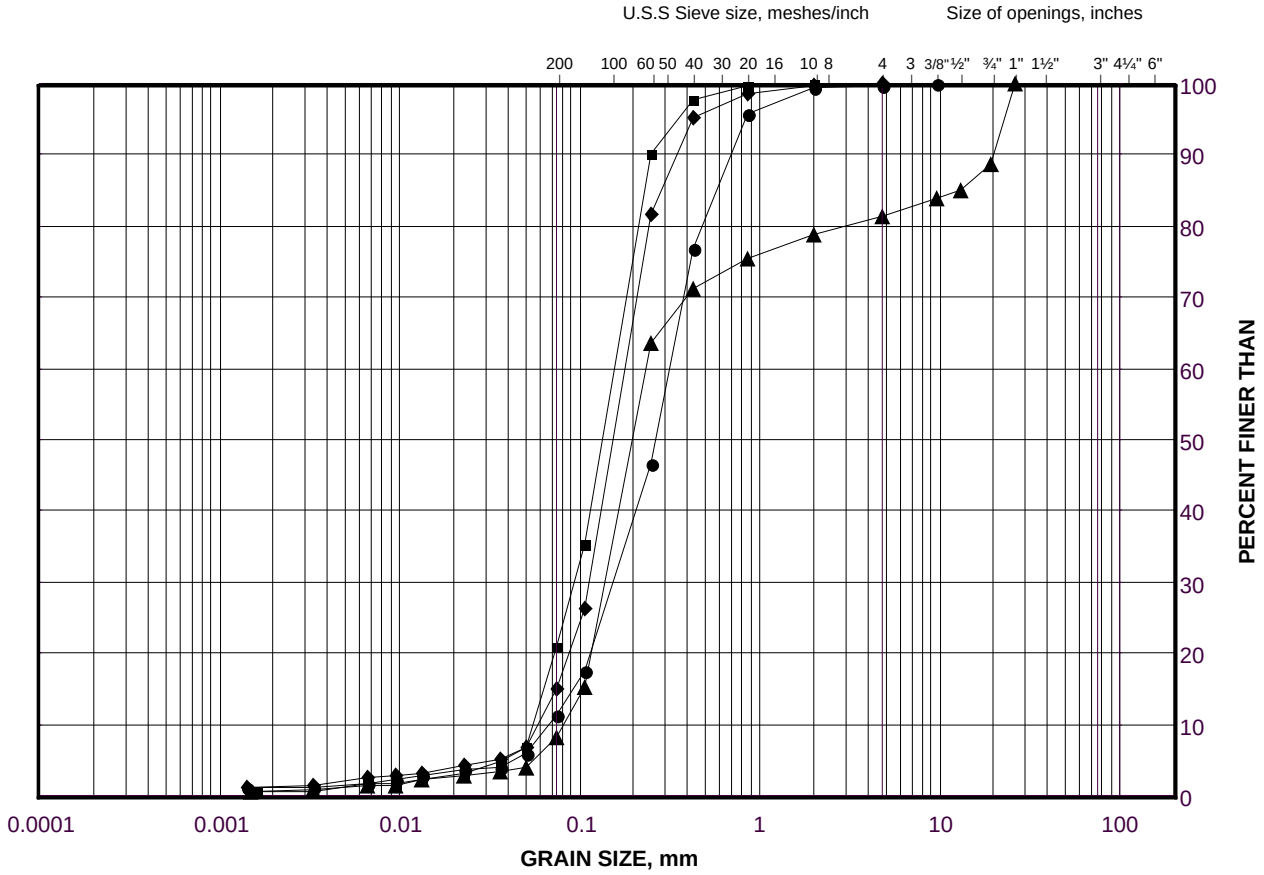
Golder Associates

Date: 26-Feb-19

GRAIN SIZE DISTRIBUTION

Sand (Fill)

FIGURE C-2



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW1-01	3	179.2
■	NW1-03	4	180.4
◆	NW1-04	4	180.9
▲	NW1-02	5	178.4

Project Number: 1669995

Checked By: MWK

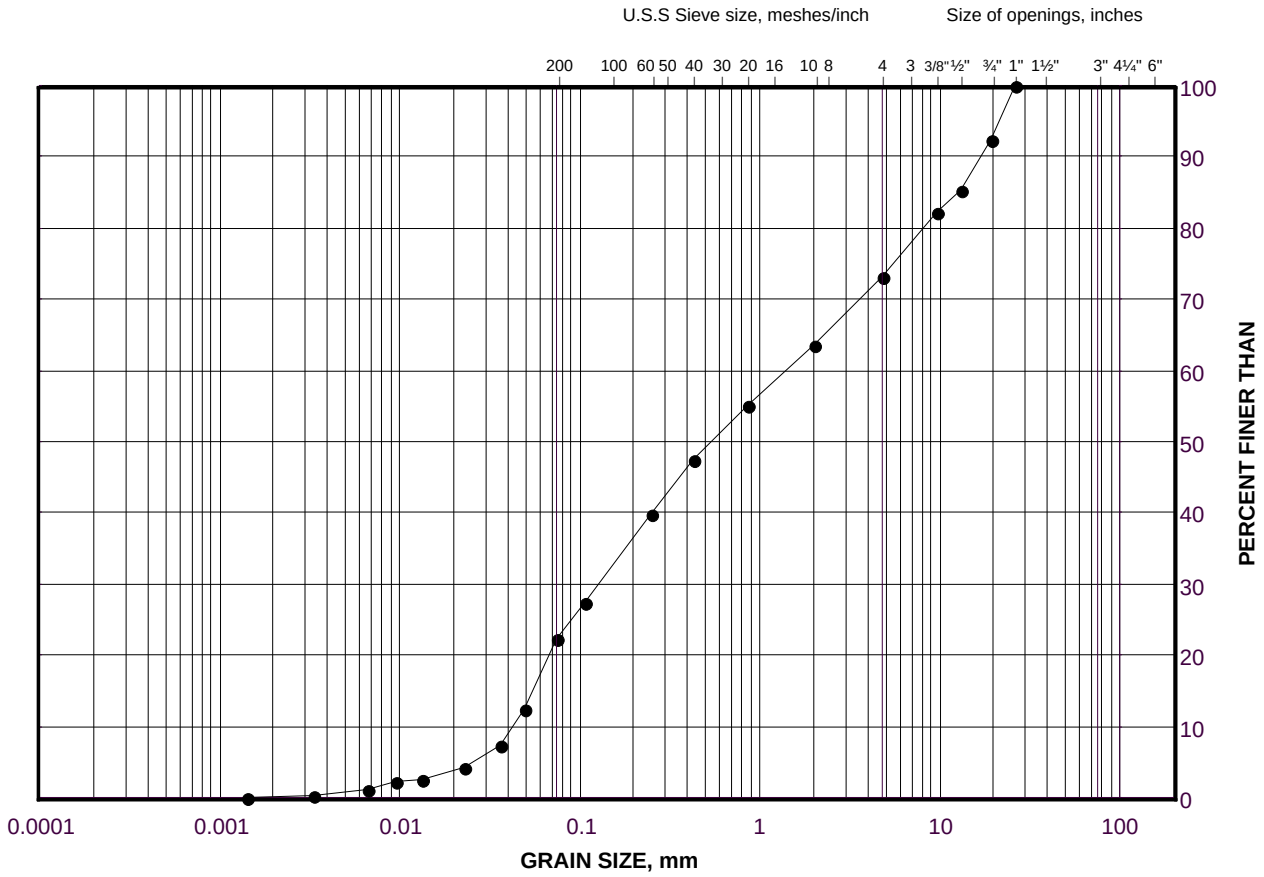
Golder Associates

Date: 04-Feb-19

GRAIN SIZE DISTRIBUTION

Gravelly Silty Sand

FIGURE C-3



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW1-01	5	177.6

Project Number: 1669995

Checked By: MWK

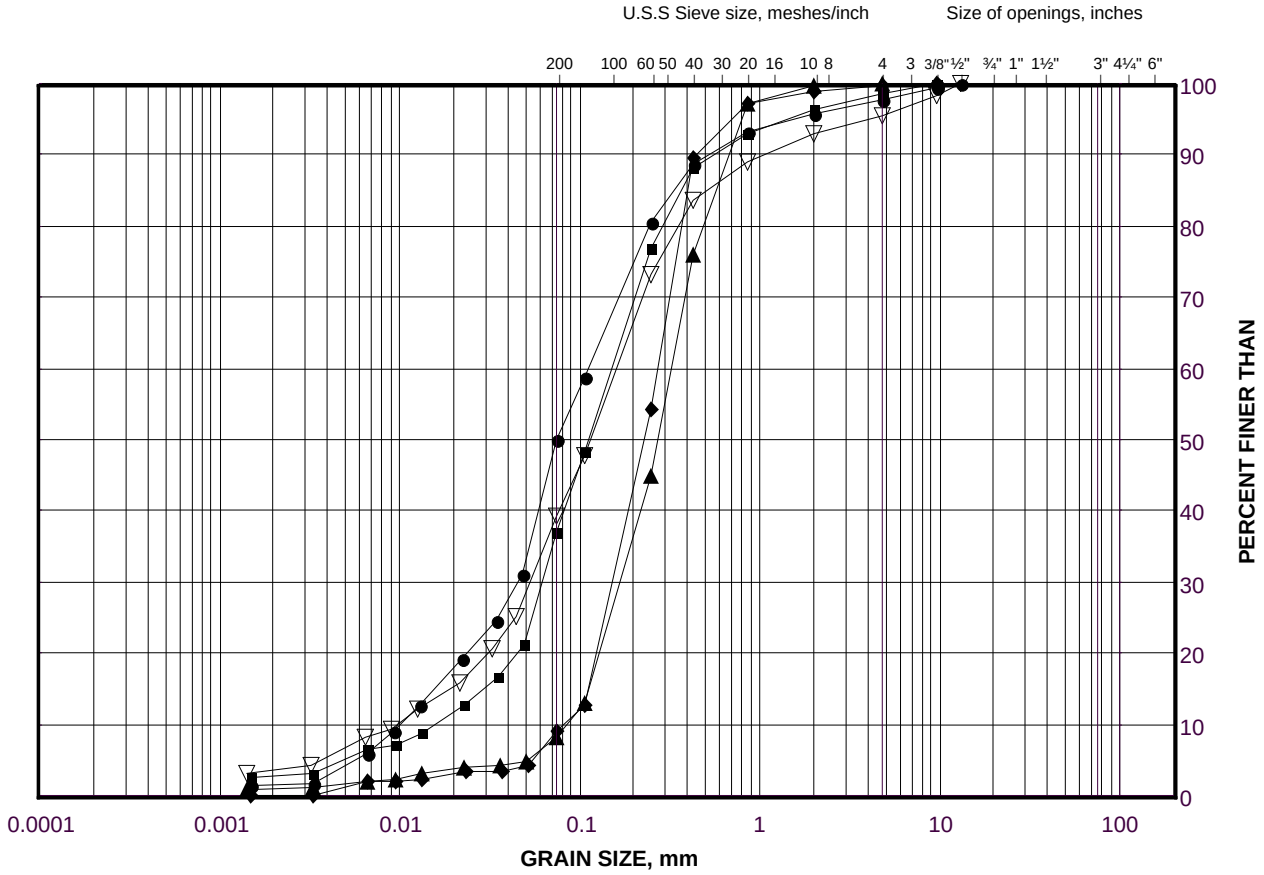
Golder Associates

Date: 04-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand

FIGURE C-4



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW1-01	6	176.9
■	NW1-02	7	176.9
◆	NW1-04	7	178.6
▲	NW1-03	8	176.6
▽	NW1-01	8	174.6

Project Number: 1669995

Checked By: MWK

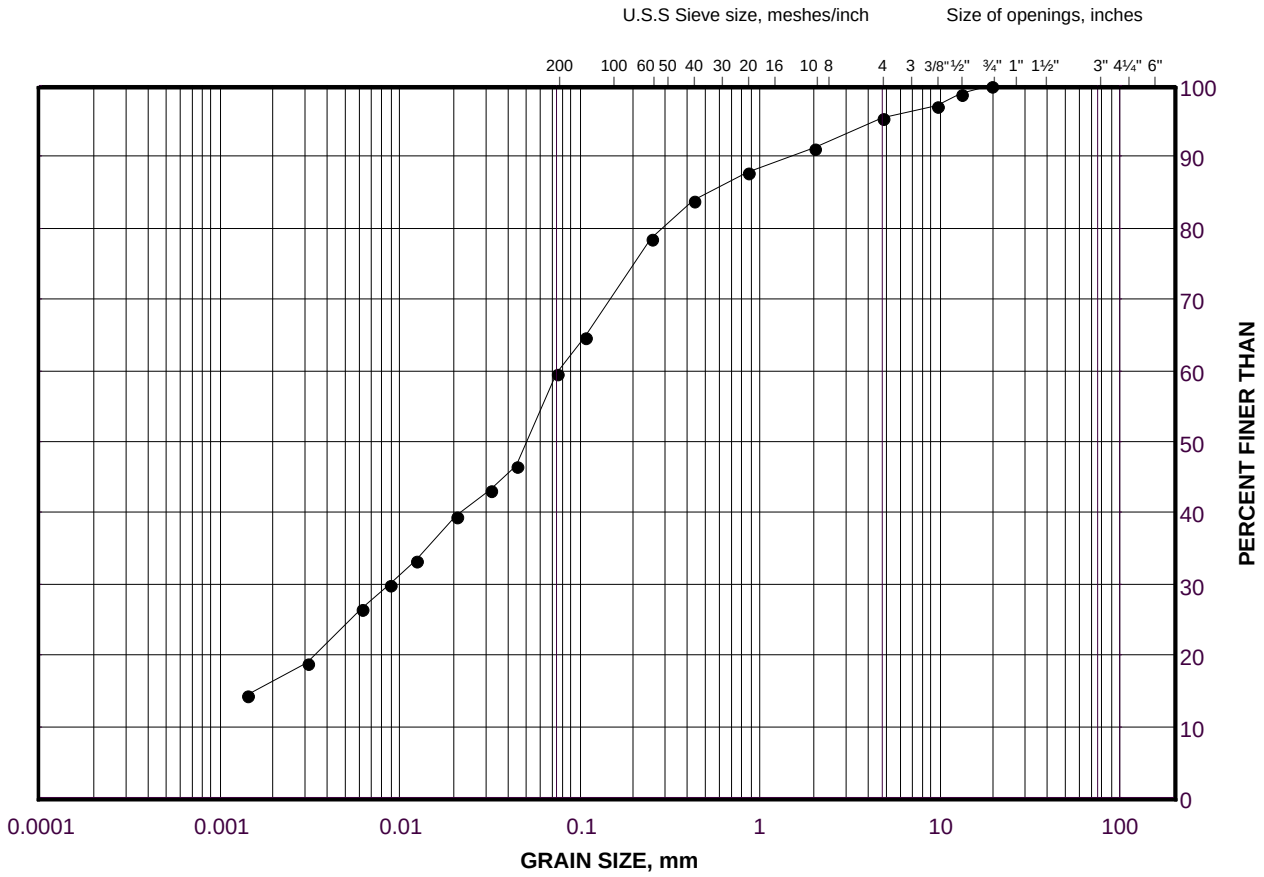
Golder Associates

Date: 04-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Fill)

FIGURE C-5



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	RW-02	5	171.0

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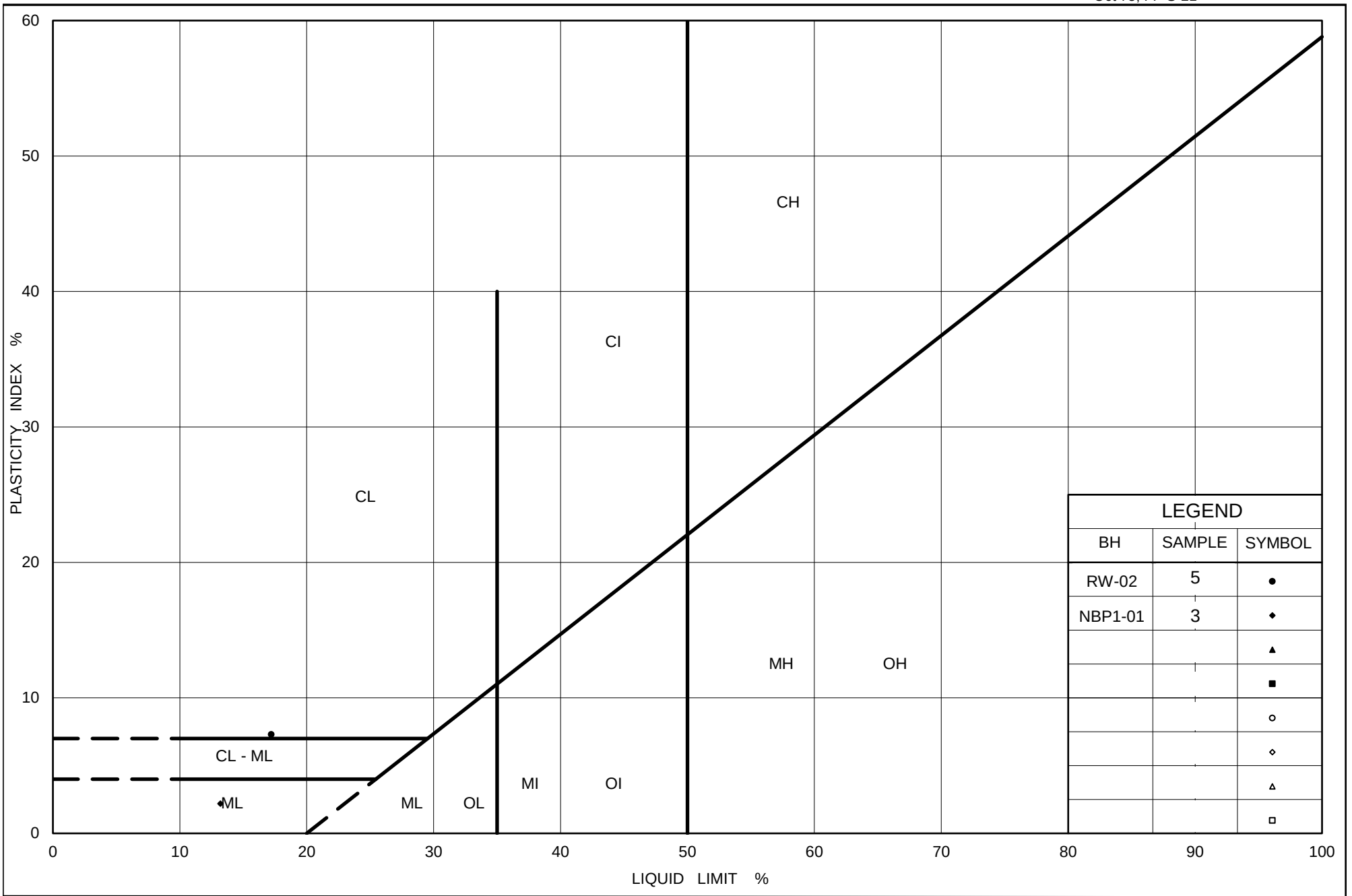
Date: 26-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt with Sand (Fill)/ Silt and Sand (Fill)

Figure No. C-6

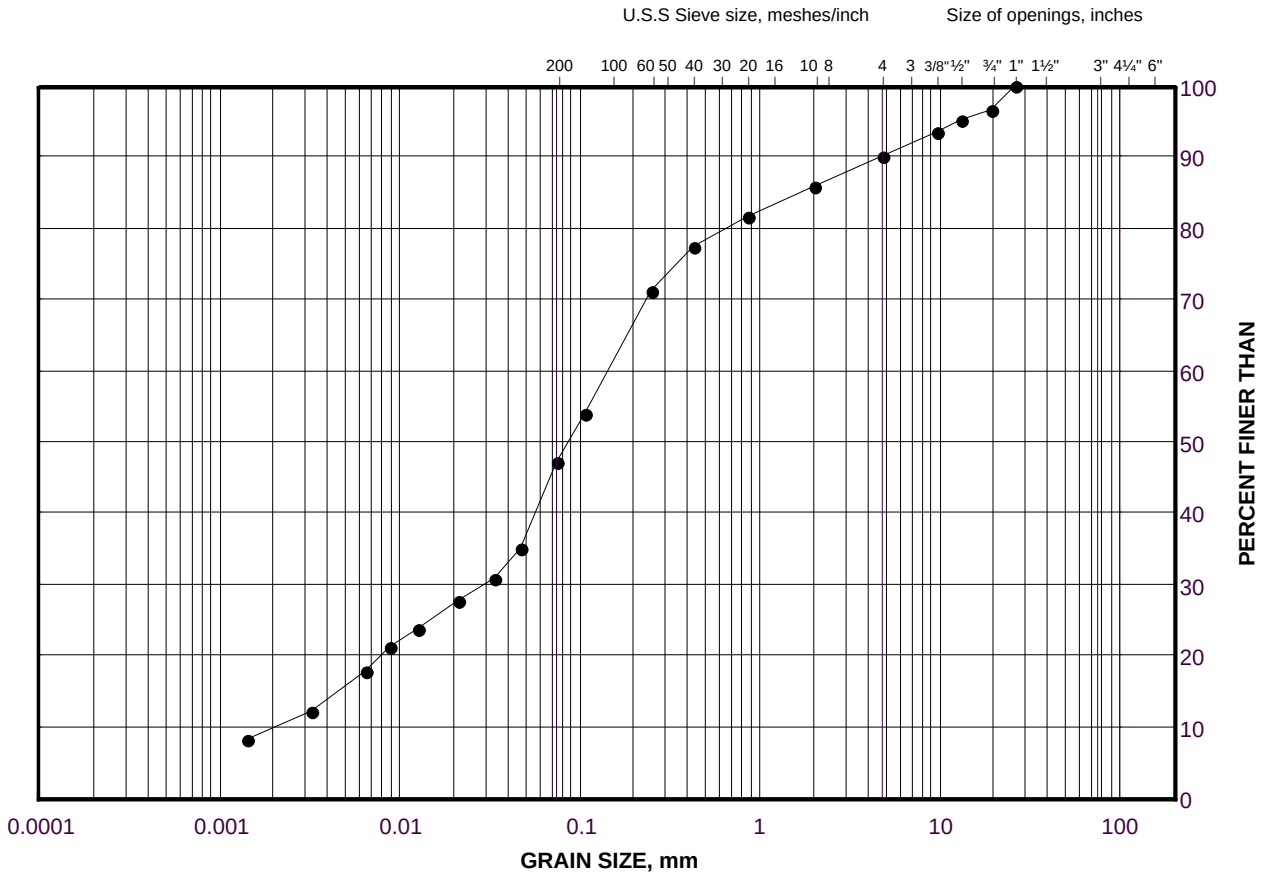
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Silt and Sand (Fill)

FIGURE C-7



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NBP1-01	3	172.8

Project Number: 1669995

Checked By: MWK

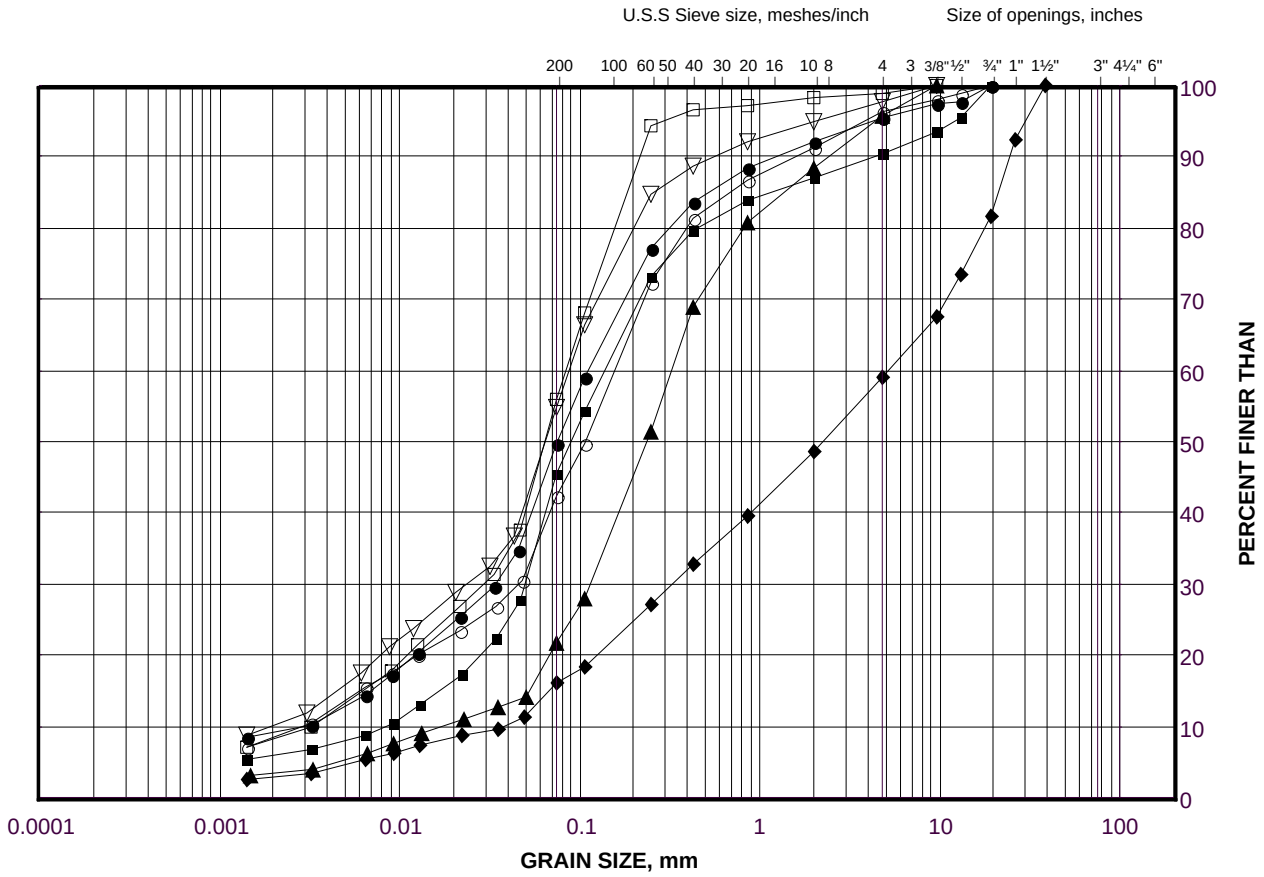
Golder Associates

Date: 04-Feb-19

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand and Gravel

FIGURE C-8



LEGEND

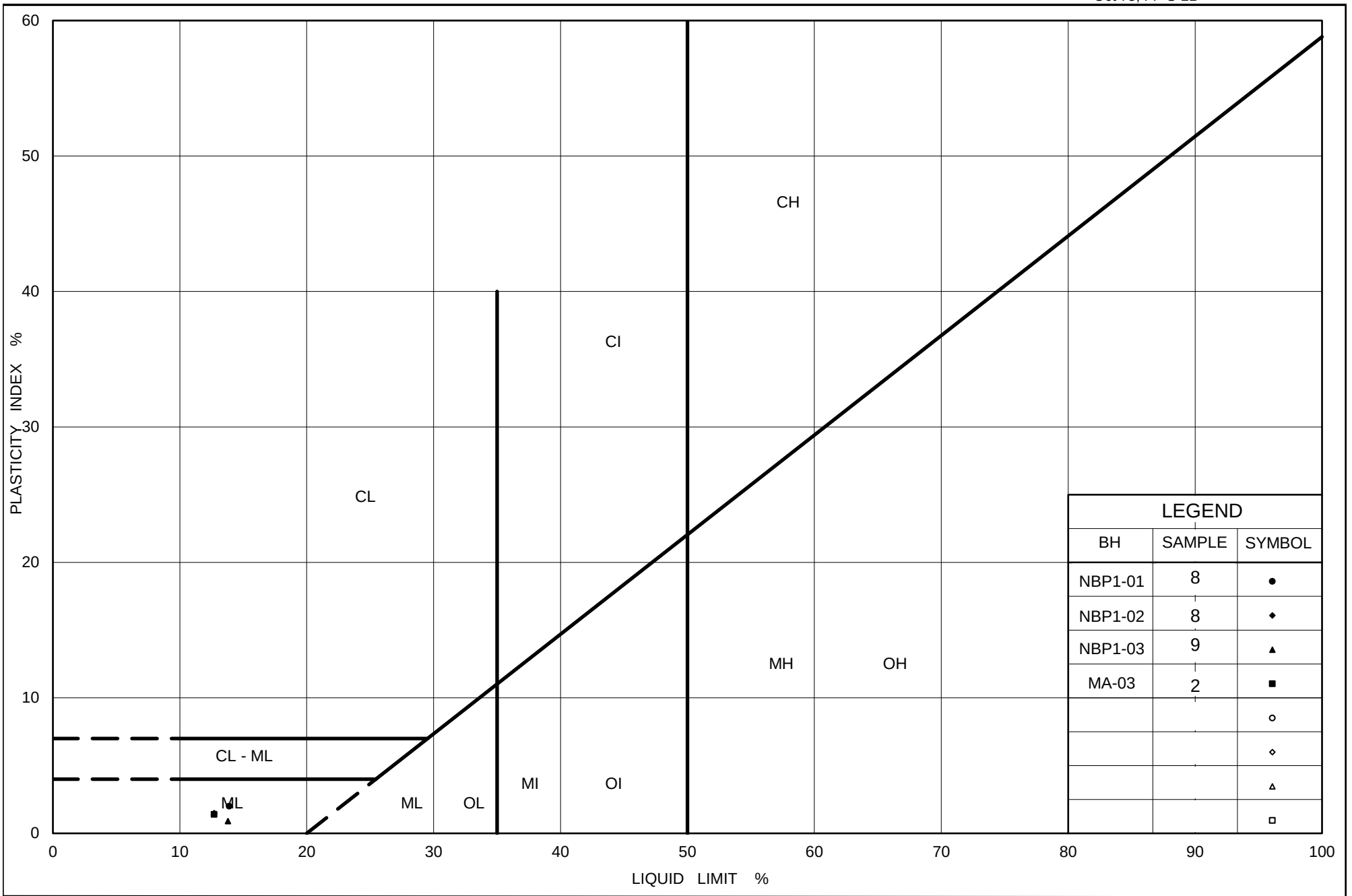
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	MA-03	2	165.6
■	MA-03	6	162.5
◆	NBP1-01	6A	170.6
▲	NBP1-02	7	169.7
▽	NBP1-01	8	168.2
❍	NBP1-02	8	168.2
□	NBP1-03	9	166.9

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 04-Feb-19



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PLASTICITY CHART
Silt and Sand

Figure No. C-9

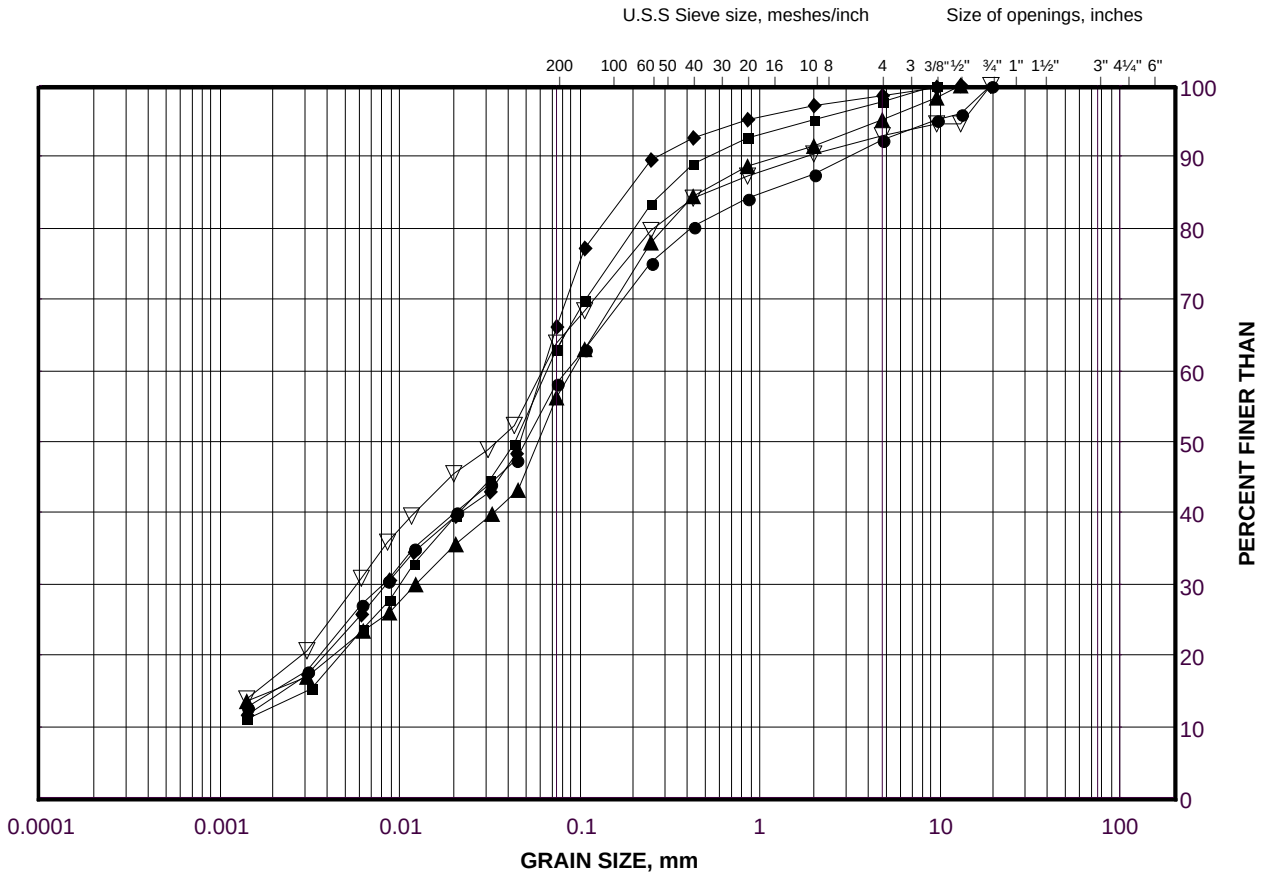
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Silt and Sand to Clayey Silt with Sand to Sandy Clayey Silt

FIGURE C-10



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NBP1-02	4	172.0
■	RW-01	4	172.4
◆	NBP1-03	5	171.4
▲	RW-02	8	168.0
▽	RW-01	8	168.8

Project Number: 1669995

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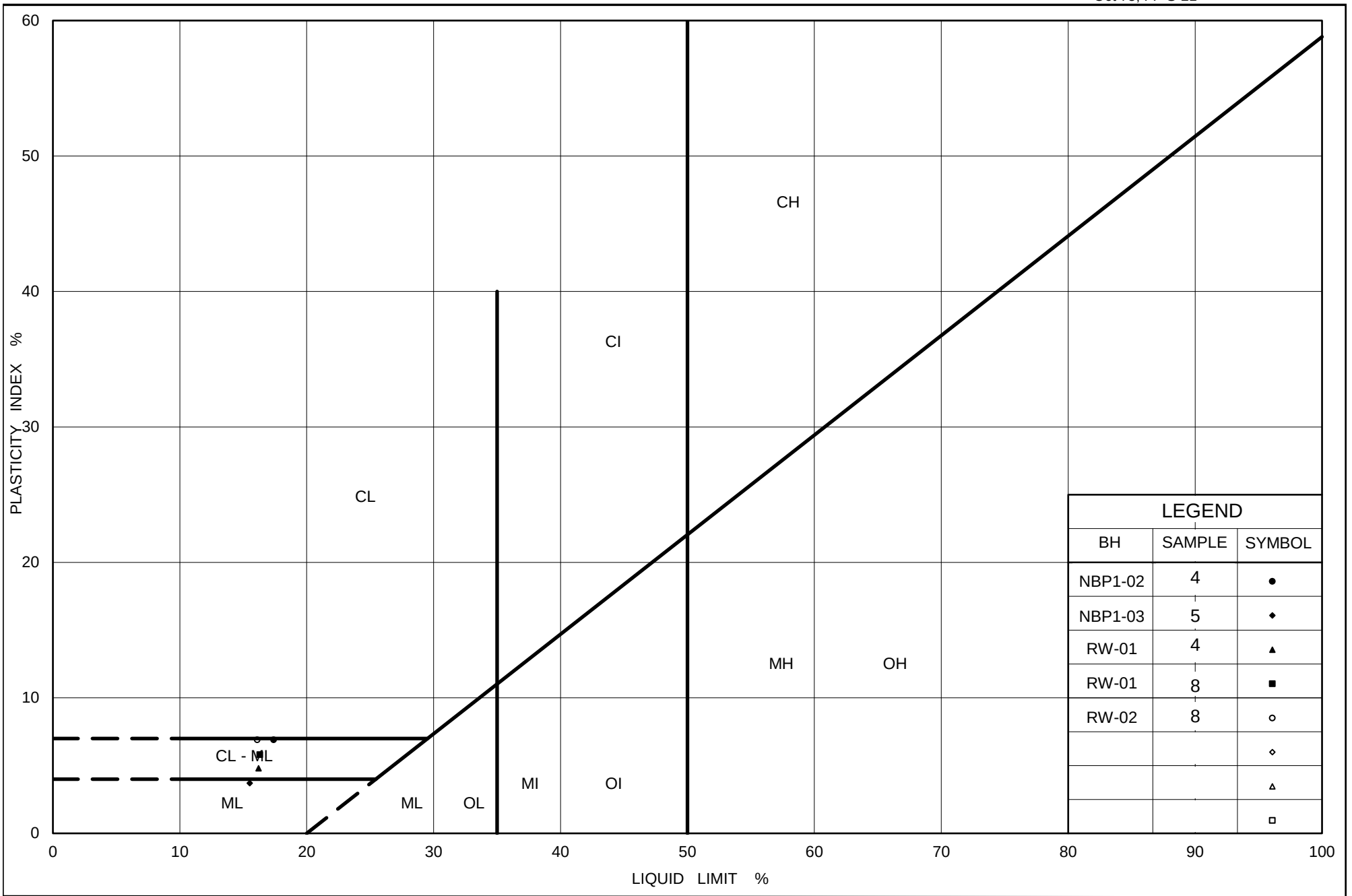
Date: 26-Feb-19



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PLASTICITY CHART

Sandy Clayey Silt to Clayey Silt with Sand to Silt and Sand

Figure No. C-11

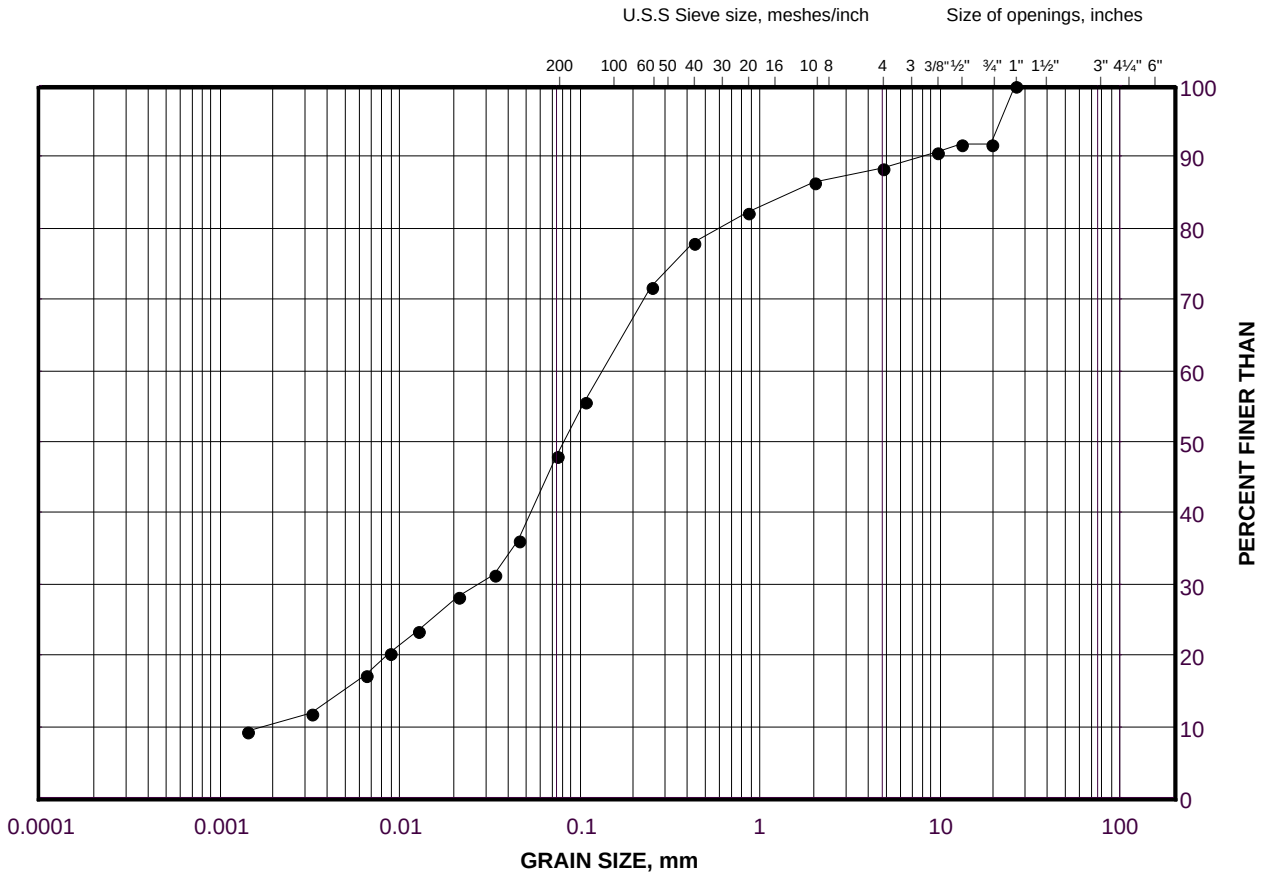
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Fill)

FIGURE C-12



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW-06	4	168.1

Project Number: 1669995

Checked By: MWK

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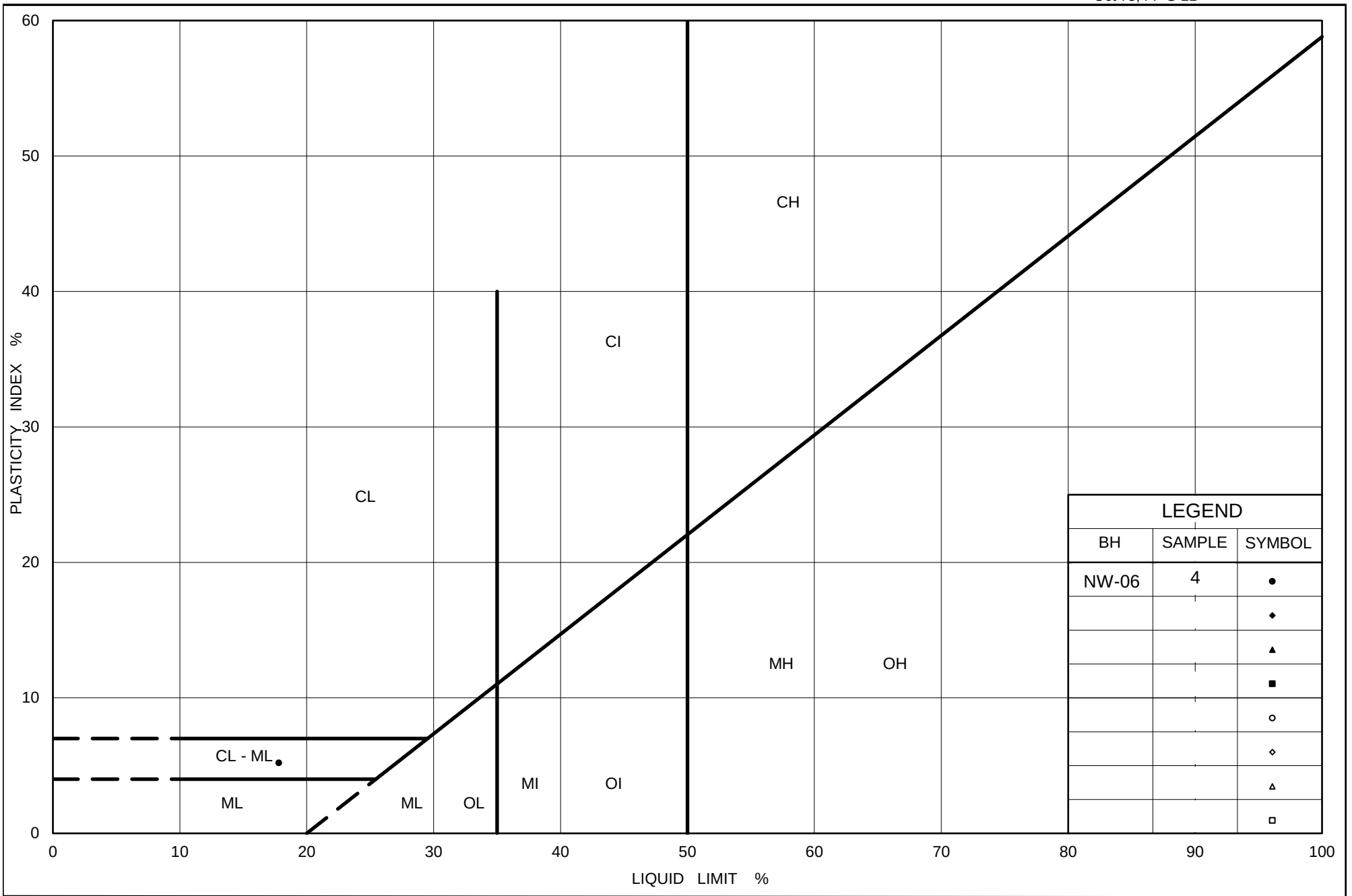
Date: 04-Feb-19



Ministry of Transportation

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PLASTICITY CHART
Clayey Silt with Sand (Fill)

Figure No. C-13

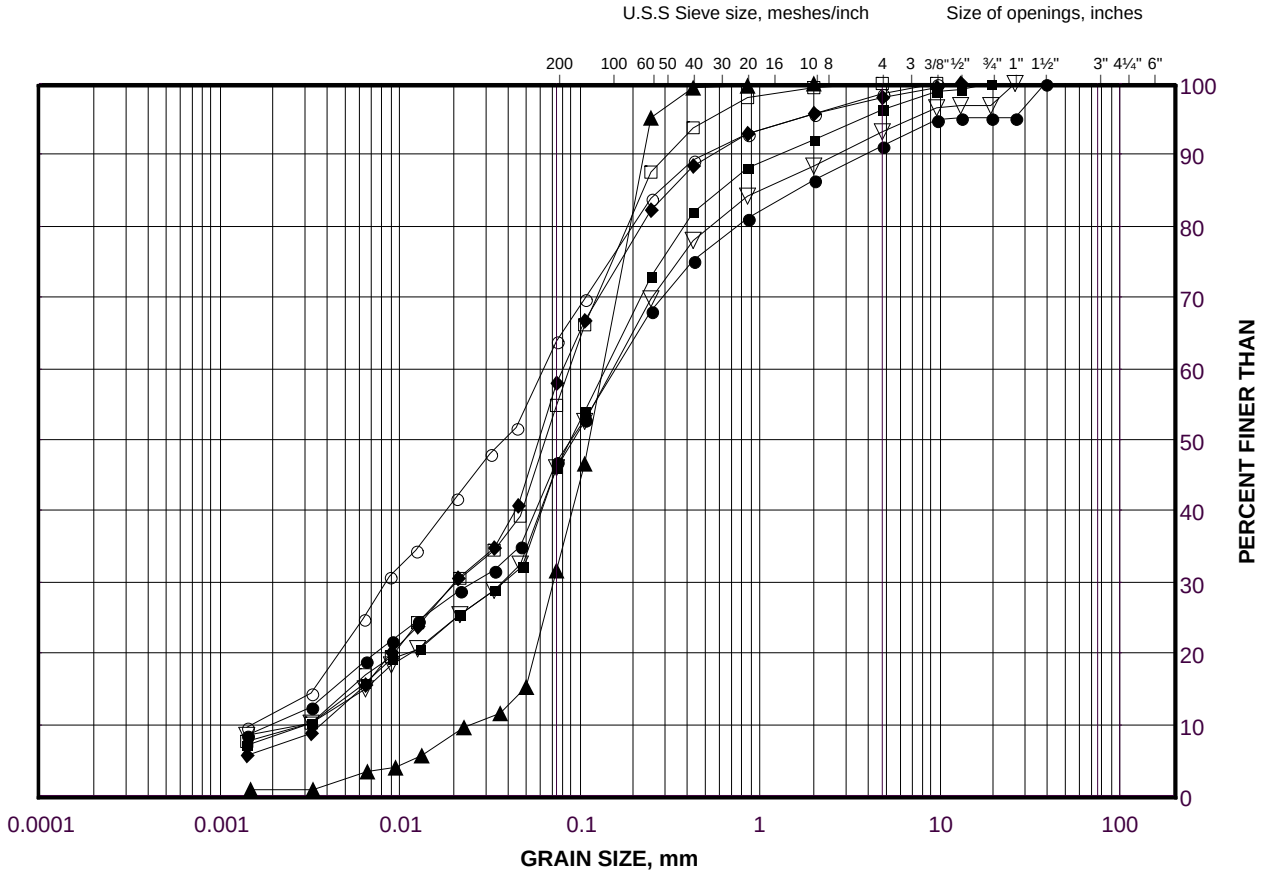
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Silt and Sand

FIGURE C-14



LEGEND

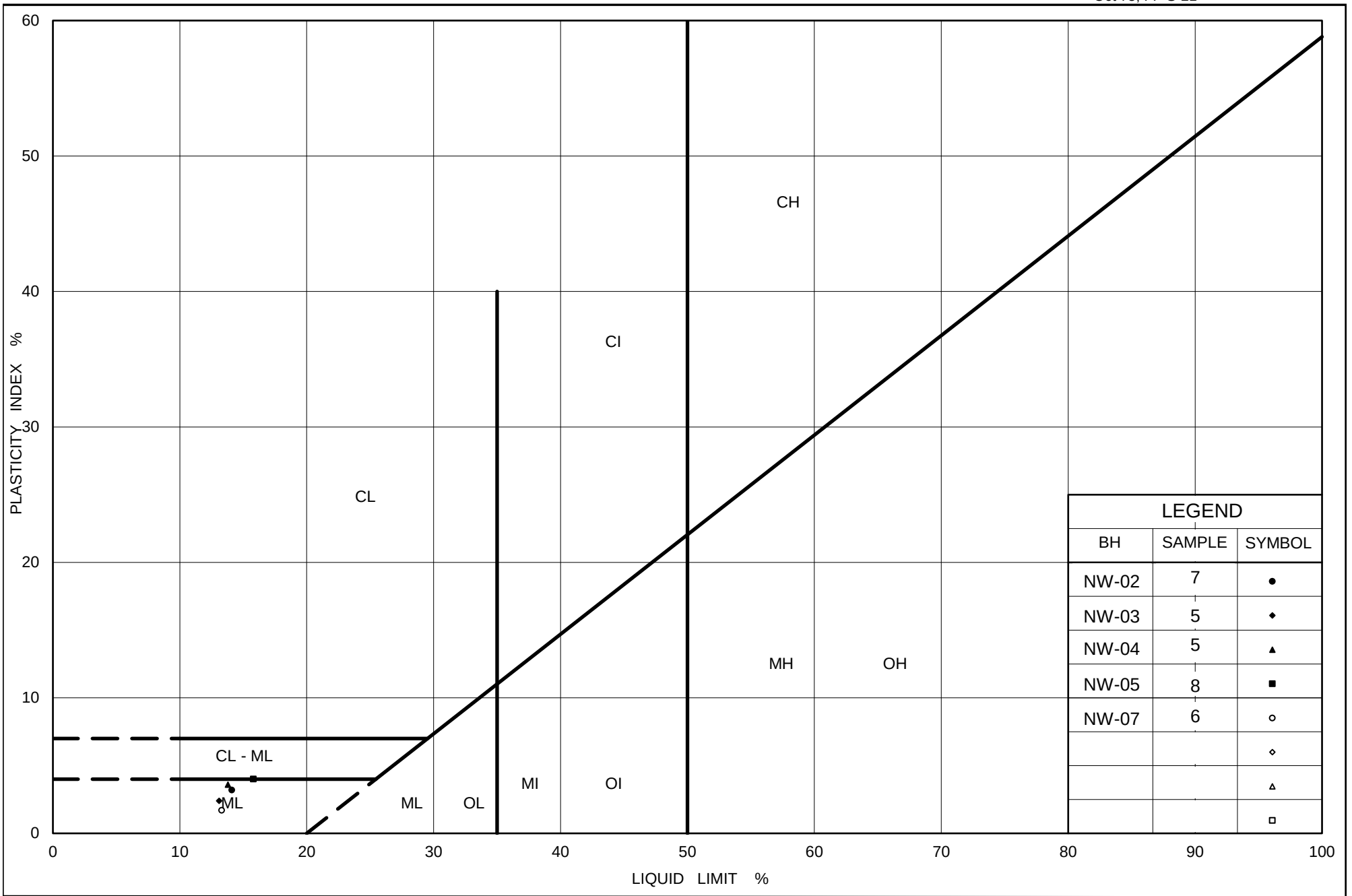
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW-04	5	168.1
■	NW-03	5	169.2
◆	NW-07	6	165.9
▲	NW-06	6A	166.6
▽	NW-02	7	170.3
❍	NW-05	8	164.9
□	NW-05	9	163.4

Project Number: 1669995

Checked By: MWK

Golder Associates

Date: 04-Feb-19



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PLASTICITY CHART
Silt and Sand

Figure No. C-15

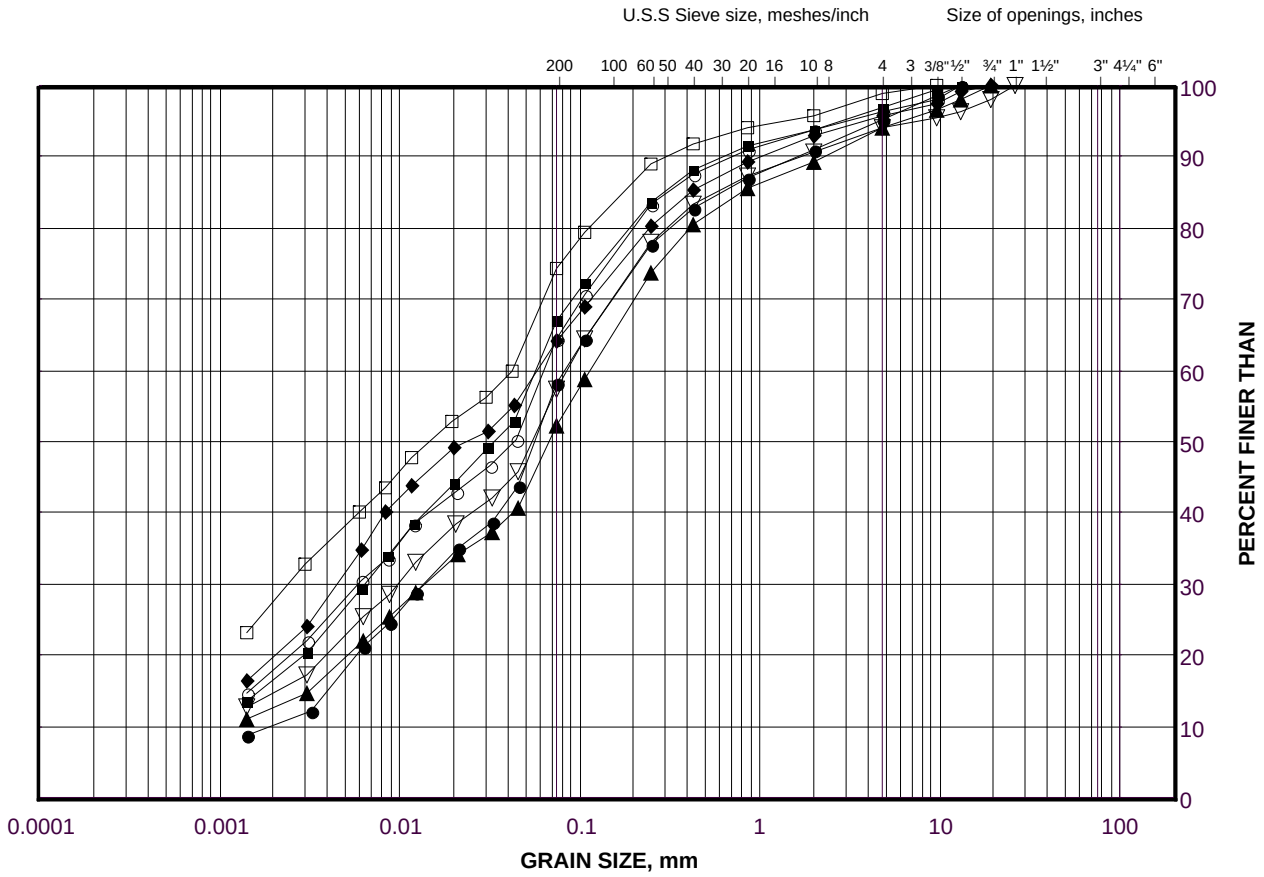
Project No. 1669995

Checked By: MWK

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Clayey Silt with Sand

FIGURE C-16A



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW-08	4	166.3
■	NW-08	6	164.9
◆	NW-05	6	167.2
▲	NW-06	8	164.3
▽	NW-04	8	165.1
❍	NW-03	8	166.2
□	NW-07	9	162.1

Project Number: 1669995

Checked By: MWK

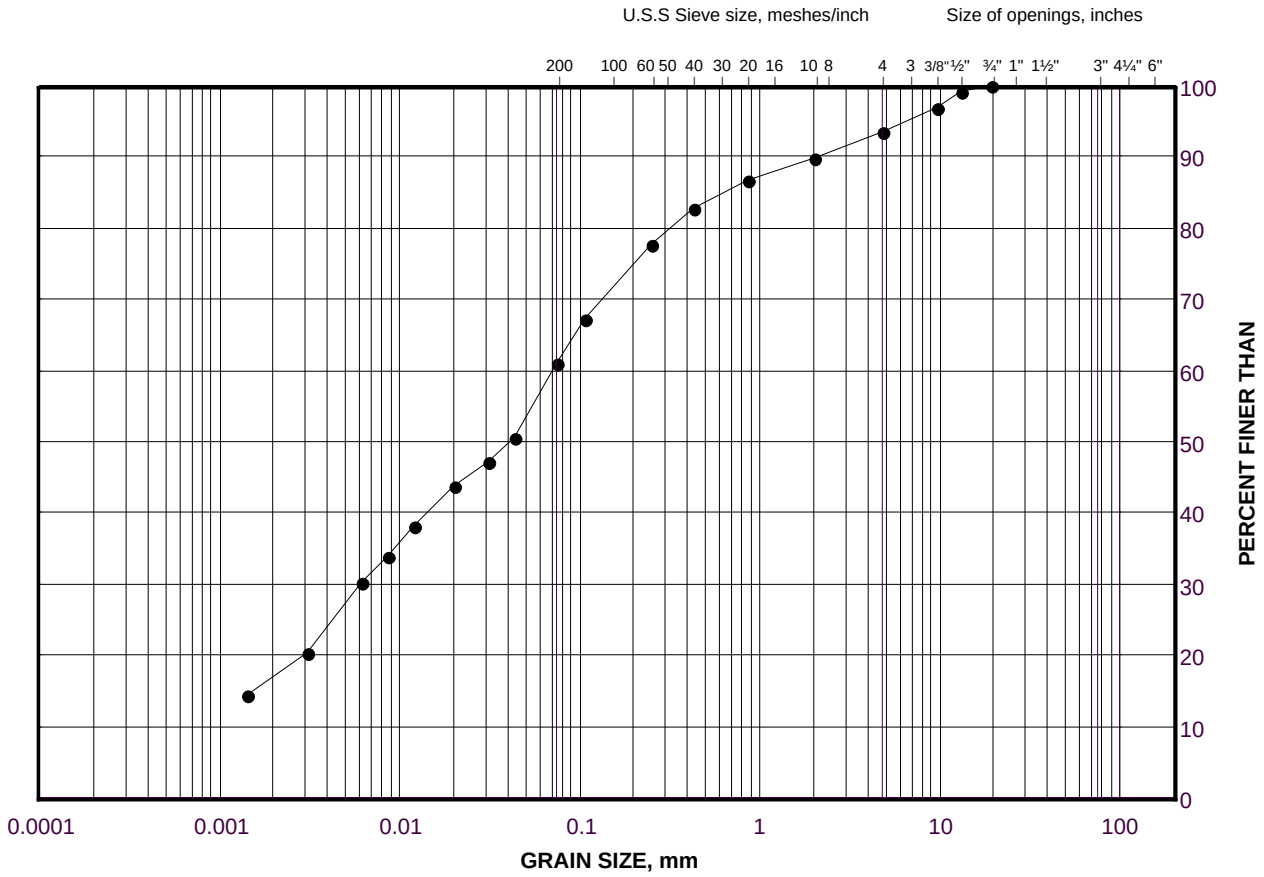
Golder Associates

Date: 04-Feb-19

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand

FIGURE C-16B



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	NW-02	9	167.3

Project Number: 1669995

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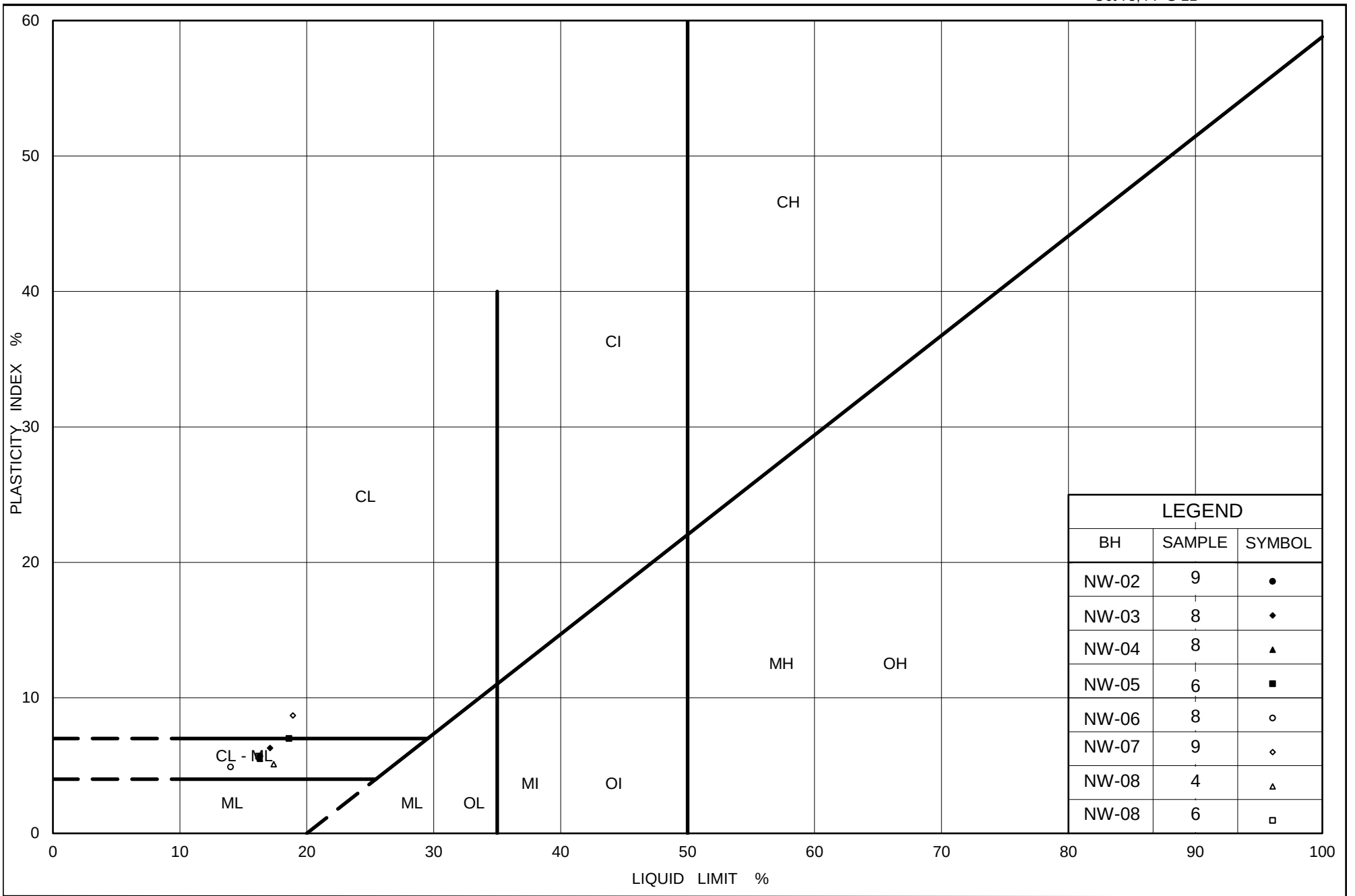
Golder Associates

Date: 26-Feb-19



Ministry of Transportation

Ontario

PLASTICITY CHART
Sandy Clayey Silt to Clayey Silt with Sand

Figure No. C-17

Project No. 1669995

Checked By: MWK

APPENDIX D

Analytical Chemical Test Results

Maxxam
A Bureau Veritas Group Company

Your Project #: 1669995
Site Location: 401W

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Your C.O.C. #: 668025-02-01, 668025-03-01, 668025-04-01, 668025-05-01

Report Date: 2018/06/08
Report #: R5226716
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8D5245
Received: 2018/06/05, 16:46

Sample Matrix: Soil
Samples Received: 31

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	31	N/A	2018/06/08	CAM SOP-00463	EPA 325.2 m
Conductivity	20	N/A	2018/06/07	CAM SOP-00414	OMOE E3530 v1 m
Conductivity	11	N/A	2018/06/08	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	20	2018/06/07	2018/06/07	CAM SOP-00413	EPA 9045 D m
pH CaCl2 EXTRACT	11	2018/06/08	2018/06/08	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	20	2018/06/06	2018/06/07	CAM SOP-00414	SM 23 2510 m
Resistivity of Soil	11	2018/06/06	2018/06/08	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	31	N/A	2018/06/08	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Your Project #: 1669995
Site Location: 401W

Attention: Nikol Kochmanova

Golder Associates Ltd
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Your C.O.C. #: 668025-02-01, 668025-03-01, 668025-04-01, 668025-05-01

Report Date: 2018/06/08
Report #: R5226716
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B8D5245
Received: 2018/06/05, 16:46

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ema Gitej, Senior Project Manager
Email: EGitej@maxxam.ca
Phone# (905)817-5829

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL599	GWL600	GWL601		GWL601		
Sampling Date		2018/02/14	2018/04/09	2018/02/28		2018/02/28		
COC Number		668025-02-01	668025-02-01	668025-02-01		668025-02-01		
	UNITS	BR-03 SA#14	RW-02 SA#9	MR-01 SA#10	QC Batch	MR-01 SA#10 Lab-Dup	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	680	6300	1400	5567331			
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	730	<20	390	5569372	420	20	5569372
Conductivity	umho/cm	1480	160	718	5568916	708	2	5568916
Available (CaCl2) pH	pH	8.02	8.28	8.08	5568601			
Soluble (20:1) Sulphate (SO4)	ug/g	270	68	50	5569377	51	20	5569377

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		GWL602		GWL603		GWL604		GWL605		
Sampling Date		2018/04/11		2018/04/12		2018/03/19		2018/03/21		
COC Number		668025-02-01		668025-02-01		668025-02-01		668025-02-01		
	UNITS	OH-7 SA#5	QC Batch	OH-4 SA#4	RDL	MRU-01 SA#4	RDL	BRU-01 SA#6	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	710	5567331	1300		330		990		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	680	5569369	220	20	1700	60	620	20	5569369
Conductivity	umho/cm	1410	5570740	764	2	3050	2	1010	2	5570740
Available (CaCl2) pH	pH	7.99	5568601	8.01		8.07		8.07		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	280	5569370	370	20	<20	20	<20	20	5569370

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL606			GWL606			GWL607	GWL608		
Sampling Date		2018/03/14			2018/03/14			2018/03/22	2018/04/05		
COC Number		668025-02-01			668025-02-01			668025-02-01	668025-02-01		
	UNITS	CN-02 SA#23B	RDL	QC Batch	CN-02 SA#23B Lab-Dup	RDL	QC Batch	KR-01 SA#9	NW1-04 SA#6	RDL	QC Batch
Calculated Parameters											
Resistivity	ohm-cm	3200		5567331				940	2000		5567331
Inorganics											
Soluble (20:1) Chloride (Cl)	ug/g	<20	20	5569369				580	230	20	5569372
Conductivity	umho/cm	312	2	5570740	314	2	5570740	1070	508	2	5568916
Available (CaCl2) pH	pH	8.12		5568601				8.01	8.26		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	200	20	5569370				<20	<20	20	5569377

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		GWL609	GWL610	GWL611	GWL612	GWL613	GWL614		
Sampling Date		2018/02/25	2018/04/11	2018/02/26	2018/04/11	2018/04/06	2018/04/10		
COC Number		668025-03-01	668025-03-01	668025-03-01	668025-03-01	668025-03-01	668025-03-01		
	UNITS	KR-03S SA#10	NW-05 SA#7B	MA-01 SA#11	NW-04 SA#4	NW-03S SA#7	NW-08 SA#7	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	2300	620	1300	1000	1600	1300		5567331
Inorganics									
Soluble (20:1) Chloride (Cl)	ug/g	210	820	280	510	340	350	20	5569372
Conductivity	umho/cm	437	1620	797	979	643	778	2	5568916
Available (CaCl2) pH	pH	8.21	8.11	8.09	8.16	8.08	8.13		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	<20	24	310	<20	23	77	20	5569377

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL615		GWL616		GWL617		GWL618		
Sampling Date		2018/04/10		2018/03/25		2018/03/28		2018/03/26		
COC Number		668025-03-01		668025-03-01		668025-03-01		668025-03-01		
	UNITS	NW-07 SA#5A	QC Batch	NBP1-3 SA#6	QC Batch	RW-01 SA#3	QC Batch	NW1-02 SA#3	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	610	5567331	1600	5567331	1300	5567331	2300		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	810	5569372	320	5569369	370	5569372	170	20	5569372
Conductivity	umho/cm	1630	5568916	627	5568916	743	5568916	429	2	5570740
Available (CaCl2) pH	pH	8.10	5568601	8.00	5568601	8.07	5568601	8.13		5568601
Soluble (20:1) Sulphate (SO4)	ug/g	<20	5569377	<20	5569370	<20	5569377	<20	20	5569377

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		GWL618		GWL619		GWL620		GWL621		
Sampling Date		2018/03/26		2018/03/26		2018/04/09		2018/03/06		
COC Number		668025-03-01		668025-04-01		668025-04-01		668025-04-01		
	UNITS	NW1-02 SA#3 Lab-Dup	QC Batch	NW1-01 SA#4	QC Batch	NBP1-01 SA#9	QC Batch	CN-01 SA#20A	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm			4200	5567331	1200	5567331	2900		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g			78	5569372	460	5569369	120	20	5569372
Conductivity	umho/cm			238	5568916	835	5570740	343	2	5568916
Available (CaCl2) pH	pH	8.09	5568601	8.24	5568601	8.13	5569005	8.34		5568601
Soluble (20:1) Sulphate (SO4)	ug/g			<20	5569377	<20	5569370	92	20	5569377

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL622		GWL623		GWL624		
Sampling Date		2018/02/25		2018/04/12		2018/04/13		
COC Number		668025-04-01		668025-04-01		668025-04-01		
	UNITS	CP-01 SA#12	QC Batch	OH-5 SA#7	QC Batch	OH-9 SA#5	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	1500	5567331	1000	5567331	1400		5567331
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	340	5569369	490	5569372	330	20	5569369
Conductivity	umho/cm	649	5570740	974	5568916	733	2	5570740
Available (CaCl2) pH	pH	8.10	5569005	8.14	5568601	8.16		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	<20	5569370	29	5569377	<20	20	5569370

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		GWL624			GWL625			GWL626		
Sampling Date		2018/04/13			2018/05/29			2018/04/12		
COC Number		668025-04-01			668025-04-01			668025-04-01		
	UNITS	OH-9 SA#5 Lab-Dup	RDL	QC Batch	NB-02 SA#4	RDL	QC Batch	OH-01 SA#7	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm				870		5567331	300		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	330	20	5569369	670	20	5569372	1700	60	5569369
Conductivity	umho/cm				1150	2	5568916	3300	2	5570740
Available (CaCl2) pH	pH				8.24		5569005	7.47		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	5569370	62	20	5569377	250	20	5569370

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		GWL627			GWL628			GWL629		
Sampling Date		2018/05/09			2018/05/07			2018/05/30		
COC Number		668025-04-01			668025-04-01			668025-05-01		
	UNITS	KR-02 SA#3	RDL	QC Batch	MR-02 SA#7	RDL	QC Batch	BR-01 SA#4	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	470		5567331	760		5567331	400		5567331
Inorganics										
Soluble (20:1) Chloride (Cl)	ug/g	1100	40	5569369	670	20	5569372	1300	60	5569369
Conductivity	umho/cm	2140	2	5568916	1310	2	5568916	2490	2	5570740
Available (CaCl2) pH	pH	8.24		5569005	8.08		5569005	8.04		5569005
Soluble (20:1) Sulphate (SO4)	ug/g	26	20	5569370	70	20	5569377	130	20	5569370

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL599
Sample ID: BR-03 SA#14
Matrix: Soil

Collected: 2018/02/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL600
Sample ID: RW-02 SA#9
Matrix: Soil

Collected: 2018/04/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL601
Sample ID: MR-01 SA#10
Matrix: Soil

Collected: 2018/02/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL601 Dup
Sample ID: MR-01 SA#10
Matrix: Soil

Collected: 2018/02/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL602
Sample ID: OH-7 SA#5
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL602 **Collected:** 2018/04/11
Sample ID: OH-7 SA#5 **Shipped:**
Matrix: Soil **Received:** 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL603 **Collected:** 2018/04/12
Sample ID: OH-4 SA#4 **Shipped:**
Matrix: Soil **Received:** 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL604 **Collected:** 2018/03/19
Sample ID: MRU-01 SA#4 **Shipped:**
Matrix: Soil **Received:** 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL605 **Collected:** 2018/03/21
Sample ID: BRU-01 SA#6 **Shipped:**
Matrix: Soil **Received:** 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL606 **Collected:** 2018/03/14
Sample ID: CN-02 SA#23B **Shipped:**
Matrix: Soil **Received:** 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL606
Sample ID: CN-02 SA#23B
Matrix: Soil

Collected: 2018/03/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL606 Dup
Sample ID: CN-02 SA#23B
Matrix: Soil

Collected: 2018/03/14
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar

Maxxam ID: GWL607
Sample ID: KR-01 SA#9
Matrix: Soil

Collected: 2018/03/22
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL608
Sample ID: NW1-04 SA#6
Matrix: Soil

Collected: 2018/04/05
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL609
Sample ID: KR-03S SA#10
Matrix: Soil

Collected: 2018/02/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

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Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL610
Sample ID: NW-05 SA#7B
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL611
Sample ID: MA-01 SA#11
Matrix: Soil

Collected: 2018/02/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL612
Sample ID: NW-04 SA#4
Matrix: Soil

Collected: 2018/04/11
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL613
Sample ID: NW-03S SA#7
Matrix: Soil

Collected: 2018/04/06
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL614
Sample ID: NW-08 SA#7
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

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Client Project #: 1669995
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TEST SUMMARY

Maxxam ID: GWL614
Sample ID: NW-08 SA#7
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL615
Sample ID: NW-07 SA#5A
Matrix: Soil

Collected: 2018/04/10
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL616
Sample ID: NBP1-3 SA#6
Matrix: Soil

Collected: 2018/03/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL617
Sample ID: RW-01 SA#3
Matrix: Soil

Collected: 2018/03/28
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL618
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL618
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL618 Dup
Sample ID: NW1-02 SA#3
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas

Maxxam ID: GWL619
Sample ID: NW1-01 SA#4
Matrix: Soil

Collected: 2018/03/26
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL620
Sample ID: NBP1-01 SA#9
Matrix: Soil

Collected: 2018/04/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL621
Sample ID: CN-01 SA#20A
Matrix: Soil

Collected: 2018/03/06
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

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Site Location: 401W
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TEST SUMMARY

Maxxam ID: GWL622
Sample ID: CP-01 SA#12
Matrix: Soil

Collected: 2018/02/25
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL623
Sample ID: OH-5 SA#7
Matrix: Soil

Collected: 2018/04/12
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5568601	2018/06/07	2018/06/07	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL624
Sample ID: OH-9 SA#5
Matrix: Soil

Collected: 2018/04/13
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL624 Dup
Sample ID: OH-9 SA#5
Matrix: Soil

Collected: 2018/04/13
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL625
Sample ID: NB-02 SA#4
Matrix: Soil

Collected: 2018/05/29
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

TEST SUMMARY

Maxxam ID: GWL625
Sample ID: NB-02 SA#4
Matrix: Soil

Collected: 2018/05/29
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL626
Sample ID: OH-01 SA#7
Matrix: Soil

Collected: 2018/04/12
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL627
Sample ID: KR-02 SA#3
Matrix: Soil

Collected: 2018/05/09
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL628
Sample ID: MR-02 SA#7
Matrix: Soil

Collected: 2018/05/07
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569372	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5568916	N/A	2018/06/07	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/07	2018/06/07	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569377	N/A	2018/06/08	Alina Dobreanu

Maxxam ID: GWL629
Sample ID: BR-01 SA#4
Matrix: Soil

Collected: 2018/05/30
Shipped:
Received: 2018/06/05

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5569369	N/A	2018/06/08	Deonarine Ramnarine
Conductivity	AT	5570740	N/A	2018/06/08	Tahir Anwar
pH CaCl2 EXTRACT	AT	5569005	2018/06/08	2018/06/08	Gnana Thomas
Resistivity of Soil		5567331	2018/06/08	2018/06/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	5569370	N/A	2018/06/08	Alina Dobreanu

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	20.0°C

Most samples have been received and analyzed past the recommended hold time of 30 days as per client request.

Results relate only to the items tested.

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5568601	Available (CaCl2) pH	2018/06/07			100	97 - 103			0.50	N/A
5568916	Conductivity	2018/06/07			98	90 - 110	<2	umho/cm	1.4	10
5569005	Available (CaCl2) pH	2018/06/08			101	97 - 103			0.13	N/A
5569369	Soluble (20:1) Chloride (Cl)	2018/06/08	NC	70 - 130	108	70 - 130	<20	ug/g	0.23	35
5569370	Soluble (20:1) Sulphate (SO4)	2018/06/08	114	70 - 130	107	70 - 130	<20	ug/g	NC	35
5569372	Soluble (20:1) Chloride (Cl)	2018/06/08	NC	70 - 130	107	70 - 130	<20	ug/g	7.2	35
5569377	Soluble (20:1) Sulphate (SO4)	2018/06/08	NC	70 - 130	102	70 - 130	<20	ug/g	2.5	35
5570740	Conductivity	2018/06/08			98	90 - 110	<2	umho/cm	0.64	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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Maxxam Job #: B8D5245
Report Date: 2018/06/08

Golder Associates Ltd
Client Project #: 1669995
Site Location: 401W
Sampler Initials: AM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Cristina Carriere

Cristina Carriere, Scientific Service Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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CHAIN OF CUSTODY RECORD

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Page 2 of 4

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Nikol Kochmanova	P.O. #:			668025
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1669995	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	(905) 567-6100 Ext: 1459 Fax:	Project Name:	401 W	C#668025-02-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Nikol_Kochmanova@golder.com	Site #:			
				Sampled By:			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other	

Include Criteria on Certificate of Analysis (Y/N)? ___

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests..
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Corrosivity pkg (Cl, SO4, pH, Resistivity/EC - no Sulphide and Redox Potential)	# of Bottles	Comments
1		BR-03 SA#14	Feb 14/18	AM	SOIL		X		
2		RW-02 SA# 9	April 9/18	AM	SOIL		X		
3		MR-01 SA# 10	Feb 28/18	AM	SOIL		X		
4		OH-7 SA#5	Apr 11/18	AM	SOIL		X		
5		OH-4 SA#4	Apr 12/18	AM	SOIL		X		
6		MEW-01 SA#4	Mar 19/18	AM	SOIL		X		
7		BRW-01 SA #6	Mar 21/18	AM	SOIL		X		
8		CN-02 SA#23b	Mar 14/18	AM	SOIL		X		
9		KR-01 SA# 9	Mar 22/18	AM	SOIL		X		
10		NW1-04 SA#6	Apr 5/18	AM	SOIL		X		

05-Jun-18 16:46
Ema Gitej
B8D5245
GK1 ENV-1309

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only			
Alex MacMillan	18/06/05	16:45	[illegible]	18/06/05	16:46		Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes / No
								20/20/20	Present / Intact	

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SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

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CHAIN OF CUSTODY RECORD

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Page 1 of 5

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Nikol Kochmanova	P.O. #:			668025
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1669995	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	(905) 567-6100 Ext: 1459 Fax:	Project Name:	401 W	C#668025-03-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Nikol_Kochmanova@golder.com	Site #:			
				Sampled By:			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___	

Include Criteria on Certificate of Analysis (Y/N)? ___

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT:
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Corrosivity pkg (Cl, SO4, pH, Resistivity/EC - no Sulphide and Redox Potential)	# of Bottles	Comments
1		KR_03 SA#10	Feb 25,18	AM	SOIL		X		
2		NW-05 SA#7B	Apr 11/18	AM	SOIL		X		
3		MA_01 SA#11	Feb 26/18	AM	SOIL		X		
4		NW-04 SA#4	Apr 11/18	AM	SOIL		X		
5		NW-03 SA#7	Apr 6/18	AM	SOIL		X		
6		NW-02 SA#7	Apr 10/18	AM	SOIL		X		
7		NW-07 SA#5A	Apr 10/18	AM	SOIL		X		
8		NBP1-3 SA#6	Mar 25/18	AM	SOIL		X		
9		RW-01 SA#3	Mar 28/18	AM	SOIL		X		
10		NWL02 SA#3	Mar 26/18	AM	SOIL		X		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only				
Sep page 1			See page one				Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
									Present		
									Intact		

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CHAIN OF CUSTODY RECORD

Page 4 of 8

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Nikol Kochmanova	P.O. #:			668025
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1669995	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	(905) 567-6100 Ext: 1459 Fax:	Project Name:	4 of W	C#668025-04-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Nikol_Kochmanova@golder.com	Site #:			
				Sampled By:			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011): ☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___

Other Regulations: ☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

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Job Specific Rush TAT (if applies to entire submission) *
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Corrosivity pkg. (Cl, SO4, pH, Resistivity/EC - no Sulphide and Redox Potential)	# of Bottles	Comments
1		NW1-01 SA#4	Mar 26/18	AM	SOIL		X		
2		NBP1-1 SA#9	Apr 9/18	AM	SOIL		X		
3		CN-01 SA#20A	Mar 6/18	AM	SOIL		X		
4		CP-01 SA#12	Feb 25/18	AM	SOIL		X		
5		OH-5 SA#7	Apr 12/18	AM	SOIL		X		
6		OH-1 SA#5	Apr 13/18	AM	SOIL		X		
7		NB-02 SA#4	May 29/18	AM	SOIL		X		
8		OH-1 SA#7	Apr 12/18	AM	SOIL		X		
9		KR-02 SA#3	May 9/18	AM	SOIL		X		
10		MR-02 SA#7	May 7/18	AM	SOIL		X		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted	Laboratory Use Only: Time Sensitive	Temperature (°C) on Recei	Custody Seal Present	Yes	No
See Page 1			See page one						Intact		

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CHAIN OF CUSTODY RECORD

Page 5 of 5

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#1326 Golder Associates Ltd	Company Name:		Quotation #:	B80683	Maxxam Job #:	Bottle Order #:
Attention:	Accounts Payable	Attention:	Nikol Kochmanova	P.O. #:			668025
Address:	6925 Century Ave Suite 100 Mississauga ON L5N 7K2	Address:		Project:	1669995	COC #:	Project Manager:
Tel:	(905) 567-4444 Fax: (905) 567-6561	Tel:	(905) 567-6100 Ext: 1459 Fax:	Project Name:		C#668025-05-01	Ema Gitej
Email:	AP_CustomerService@golder.com	Email:	Nikol_Kochmanova@golder.com	Site #:			
				Sampled By:			

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Other ___	

Include Criteria on Certificate of Analysis (Y/N)? ___

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	ANALYSIS REQUESTED (PLEASE BE SPECIFIC): Corrosivity pkg (Cl, SO4, pH, Resistivity/EC - no Sulphide and Redox Potential)	# of Bottles	Comments
1		BR_01 SA#4	May 30/18	AM	SOIL		X		
2									
3									
4									
5									
6									
7									
8									
9									
10									

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

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(will be applied if Rush TAT is not specified):
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Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

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See page 1			See page one						Intact		

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* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

White: Maxxa Yellow: Client

Maxxam Analytics International Corporation o/a Maxxam Analytics

APPENDIX E

Non-Standard Special Provisions

BOULDERS/OBSTRUCTIONS DURING EXCAVATION FOR NOISE BARRIER WALL FOUNDATIONS – Item No.

Special Provision

The site soils at the site are glacially-derived and should be expected to contain cobbles and boulders. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during excavation/drilling for noise barrier wall foundations.

Basis of Payment

Payment at the contract price for the above tender item shall include full compensation for all labour and materials to complete the work.

END OF SECTION

CONTROL OF OVERBURDEN SOILS DURING NOISE BARRIER WALL FOUNDATION INSTALLATION - Item No.

Special Provision

Excavations for the Noise Barrier Wall foundations will be advanced through granular fill materials (where present), various interlayers of granular native material through/into clayey silt which may contain lenses or layers of potentially saturated cohesionless soils. The granular soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment will be required to minimize ground loss during drilling, caisson installation and concrete placement.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION

***"height"* NOISE BARRIER SYSTEM - Item No.**
***"height"* NOISE BARRIER SYSTEM INCLUDING PRECAST NOISE/TRAFFIC BARRIER - Item No.**
***"height"* NOISE BARRIER SYSTEM ON STRUCTURES - Item No.**
NOISE BARRIER ACCESS - Item No.

Special Provision No. 760F01 March 2018

Amendment to OPSS 760, November 2014

760.03 DEFINITIONS

Section 760.03 of OPSS 760 is amended by the deletion of the definitions for **Certificate of Conformance** and **Quality Verification Engineer**.

760.04 DESIGN AND SUBMISSION REQUIREMENTS

760.04.01 Design Requirements

760.04.01.01 Footings

760.04.01.01.01 General

Clause 760.04.01.01.01 of OPSS 760 is amended by the addition of the following paragraph:

The soil design parameters for the design of footings shall be as specified in Table A: [* Designer Fill-In for Table A, See Notes to Designer].

Table A
Soil Design Parameters

Location	Soil Design Parameter

Subsection 760.04.01 of OPSS 760 is amended by the addition of the following clauses:

760.04.01.02 Wind Load

The wind load applied for the design of structure shall be: [** Designer Fill-In, See Notes to Designer].

760.04.01.03 Acoustics

The minimum acoustical characteristic of the noise barrier system shall be such that the noise barrier is: [*** Designer Fill-In, See Notes to Designer].

760.04.01.04 Aesthetics

The colour and texture for the noise barrier system shall be within the following parameters:

Number of colours adjacent to highway: [**** Designer Fill-in – See Notes to Designer]

in the proportion of _____ _____ _____ _____

Number of textures _____

in the proportion of _____ _____ _____ _____

Number of colours adjacent to residential property: [**** Designer Fill-In, See Notes to Designer].

in the proportion of _____ _____ _____ _____

Number of textures _____

in the proportion of _____ _____ _____ _____

Final colour selections shall be determined by the Contract Administrator at the point of manufacture from samples prepared by the manufacturer.

If only one colour and texture are specified, the noise barrier shall be constructed using the colour and texture specified by the Contract Administrator following the award of the Contract. Final colour selection shall be determined at the point of manufacture from samples prepared by the manufacturer.

760.07 CONSTRUCTION

760.07.13 Quality Control

760.07.13.01 Interim Inspection of Footings and Posts

Clause 760.07.13.01 of OPSS 760 is deleted in its entirety and replaced with the following:

760.07.13.01 Inspection before Installation of Noise Barrier Panels

A Request to Proceed shall be submitted to the Contract Administrator after the construction of the noise barrier footings and posts and prior to the installation of the noise barrier panels

The installation of the noise barrier panels shall not proceed until a Notice to Proceed has been received from the Contract Administrator.

760.07.13.02 Certificate of Conformance

Clause 760.07.13.02 of OPSS 760 is deleted in its entirety and replaced by the following:

760.07.13.02 Inspection after Installation of Noise Barrier System

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of the installation of the noise barrier system.

NOTES TO DESIGNER:

* Insert station to station limits and soil design parameters in Table A as per the example below:

Example

Location	Soil Design Parameter
East Bound Lane 17+320 to 17+790 (shoulder)	Ø = 28º
West Bound Lanes 17+100 to 17+600 (ROW) 17+600 to 17+720 (ROW) 17+700 to 18+050 (shoulder)	Ø = 28º Cu = 12 Kpa Ø = 28º

** Insert the reference wind load along with its respective area or city (e.g., 415 Pa for Hamilton area).

*** Insert one of the following acoustical characteristics:

- Either sound absorptive or reflective
- Sound absorptive on the highway side
- Sound absorptive on the residential side
- Sound absorptive on both sides.

If more than one acoustical characteristic applies to this Contract, each section shall be designed accordingly with clearly defined limits.

**** Insert the number of colours planned for this contract, the proportions in which each are required, the number of textures if applicable and their proportions of the total noise barrier area in the locations specified.

WARRANT: Always with these tender items.

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