



FINAL REPORT

Foundation Investigation Report

West Noise Barrier Wall Replacement

Highway 401/Bloor Street/Harmony Road Interchange Reconstruction

City of Oshawa, Ontario

MTO G.W.P 2146-20-00

Submitted to:

AECOM Canada Ltd.

30 Leek Crescent, 4th Floor

Richmond Hill, Ontario L4B 4N4

Submitted by:

WSP Golder

100 Scotia Court, Whitby, Ontario, L1N 8Y6, Canada

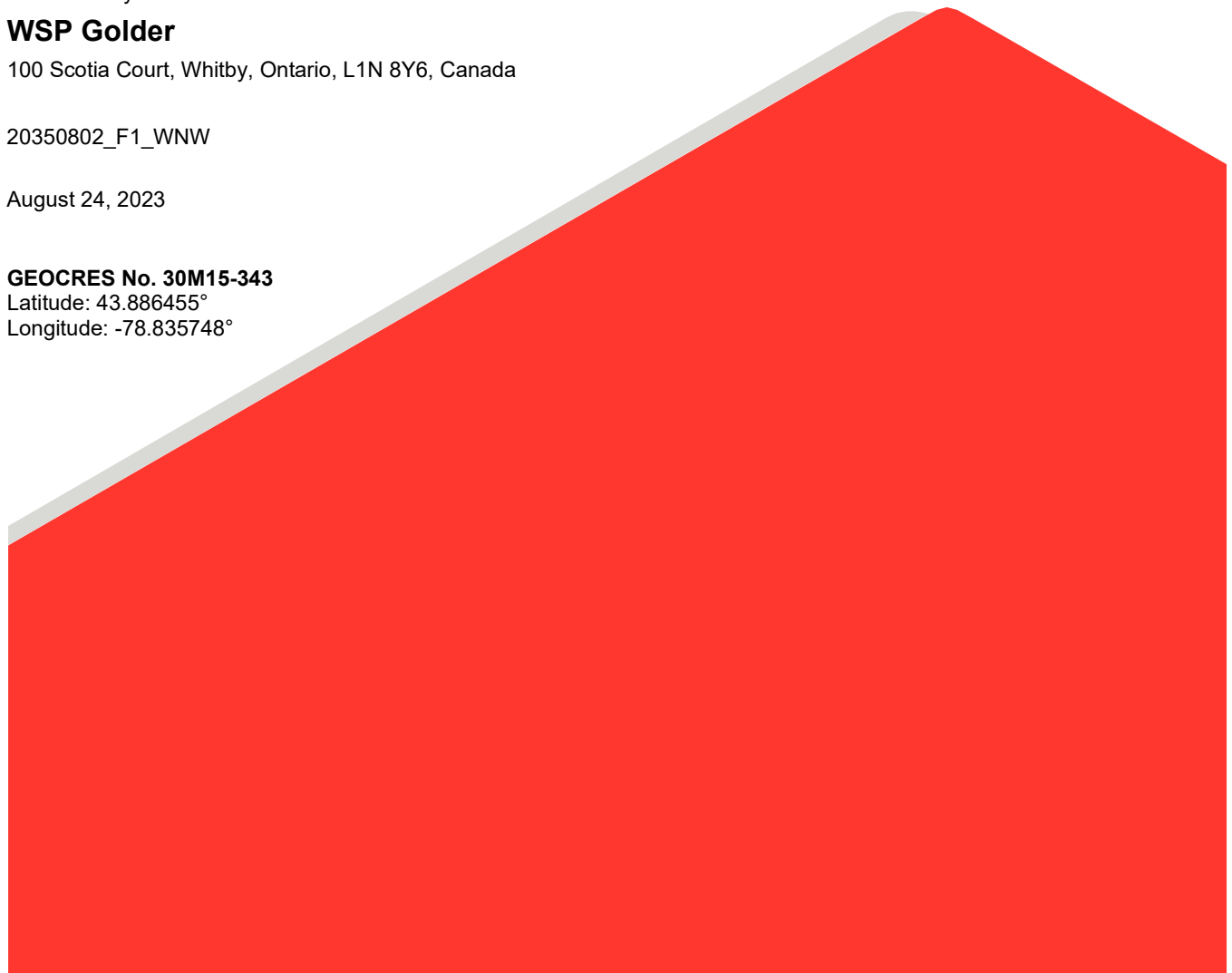
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1.0 INTRODUCTION

WSP Golder (formerly Golder Associates Ltd., now a member of WSP Canada Inc.) has been retained by AECOM on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for Highway 401 / Bloor Street / Harmony Road interchange reconstruction in the City of Oshawa, Ontario.

This report presents the results of the foundation investigation carried out for the proposed noise barrier walls to be constructed on the north and south sides of Highway 401 from about 225 m west of Wilson Road South to near the Harmony Creek Tributary about 350 m east of Wilson Road. This section of noise barrier walls is referred to as the west noise walls, as additional noise walls will be constructed east of this location under a separate contract.

The purpose of this investigation is to establish the subsurface soil conditions at the proposed noise barrier wall locations by borehole drilling and laboratory testing of selected soil samples. The results of foundation investigations for the east noise walls and other works associated with the interchange reconstruction are presented in separate reports.

This report was developed based on information from the current foundation investigation, supplemented with relevant information from Golder's previous foundation investigation carried out within the project limits. The results of the relevant previous foundation investigation are presented in the following report:

- **MTO GEOCREC 30M15-132:** "Noise Barrier Wall Replacement, Highway 401 from West of Wilson Road to Harmony Road, Oshawa, Ontario, Assignment No.: 2011-E-0018", Golder Report No. 11-1184-0109 (8), dated June 2013.

2.0 SITE DESCRIPTION

Existing noise barrier walls are currently located along the north and south side of Highway 401, and these will be replaced with new walls behind the existing alignment as part of the planned Highway 401 widening and future interchange improvements. The proposed western section of noise walls included in this contract extends from west of Wilson Road easterly to near the Harmony Creek tributary, as shown on Drawing 1 and as follows:

- **North Noise Barrier Wall:** This proposed noise barrier wall extends along the north side of Highway 401 from about 225 m west of Wilson Road South to the Harmony Creek Tributary about 350 m east of Wilson Road, between approximately Station 14+350 and 14+925 (about 575 m long).
- **South Noise Barrier Wall:** This proposed noise barrier wall extends along the south side of Highway 401 from about 225 m west of Wilson Road South to 325 m east of Wilson Road, between approximately Station 14+350 and 14+900 (about 450 m long).

The terrain along the proposed noise barrier wall alignments is rolling and generally declines eastward toward the Harmony Creek tributary. The ground surface along the north noise barrier wall ranges from about Elevation 98 m at the west limit to about Elevation 84 m at the east limit. The ground surface along the south noise barrier wall ranges from about Elevation 100 m at the west limit to about Elevation 87 m at the east limit.

The land along the proposed noise barrier wall alignments, behind the existing walls and within MTO's right-of-way, is vegetated with grasses, bushes and trees. In general, the area surrounding the proposed noise walls consists of residential properties.

3.0 INVESTIGATION PROCEDURES

3.1 2013 Subsurface Investigation (GEOCRES No. 30M15-135)

In 2013, Golder carried out a foundation investigation in support of the foundation design for the then-proposed noise walls (MTO GEOCRES 30M15-132, as referenced in Section 1.0 of this report). Three boreholes (designated as BH1, BH11, and BH12) were advanced in the vicinity of the proposed noise walls. The approximate borehole locations are shown on Drawing 1.

The boreholes were drilled using continuous flight solid-stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth using a 50 mm nominal outside diameter split-spoon sampler driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedure. The groundwater conditions were observed in the open boreholes during drilling. Index and classification testing (water content, Atterberg limits and grain size distributions) was completed on selected samples.

The ground surface elevations and coordinates of the previous boreholes were obtained from a Global Positioning System (GPS). The borehole locations (in MTM NAD 83 Zone 10 northing and easting coordinates and latitude and longitude), the ground surface elevations (referenced to Geodetic datum), and borehole depths are summarized below.

Borehole No.	Location (MTM NAD 83, Zone 10)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing, m (Latitude, °)	Easting, m (Longitude, °)		
BH1	4,860,782.2 (43.885111)	357,899.1 (-78.839179)	99.0	4.8
BH11	4,860,923.1 (43.886345)	358,370.6 (-78.833297)	89.1	5.0
BH12	4,860,923.2 (43.886342)	358,425.3 (-78.832616)	88.6	5.0

3.2 Current Subsurface Investigation

The field work for the current subsurface investigation was carried out between December 14, 2021 and February 15, 2022. A total of six boreholes (designated as Boreholes SNW-1 to SNW-4, WRO-4A/B/C, and WRO-8) were advanced in the vicinity of the proposed south noise barrier wall and ten boreholes (designated as Boreholes NNW-1 to NNW-8, WRO-1, and WRO-5) were advanced in the vicinity of the proposed north noise barrier wall.

The investigation was carried out using track-mounted Marl T5 and CME55 drill rigs supplied and operated by Drilltech of Newmarket, Ontario and Davis Drilling of Milton, Ontario, respectively. The boreholes were generally advanced through the overburden using 152 mm outside diameter solid-stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with American Society for Testing and Materials (ASTM) procedure D1586-18. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions. Where soft cohesive soils were encountered, field vane shear tests using standard 'N' size vanes were carried out to assess the undrained shear strengths of the cohesive soils. Rock coring was carried in Boreholes WRO-1, WRO-4C, WRO-5, and WRO-8 using HW-size casing and an HQ core barrel. Water was sourced off-site for coring operations.

The groundwater conditions were noted in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in seven boreholes (Boreholes SNW-1, SNW-4, NNW-1, NNW-5, NNW-8, WRO-4A,

and WRO-5) to allow for monitoring of the groundwater level. The remaining boreholes were backfilled with cement bentonite grout in accordance with Ontario Regulation 903 (as amended) and the ground surface was restored to near original condition as practicable.

The field work was observed by members of WSP Golder's engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to WSP Golder's Whitby laboratory where the samples underwent further visual examination. Geotechnical laboratory testing (water content, grain size distribution, and Atterberg limits) was carried out on selected soil samples, in accordance with MTO and / or ASTM Standards, as appropriate. In addition, six soil samples were submitted to Bureau Veritas Laboratories of Mississauga, Ontario for analysis of select parameters to assess for the potential corrosion to buried steel and deterioration of concrete.

The Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD), weathering and strength indices, and discontinuity characterises of the bedrock core samples from Boreholes WRO-1, WRO-4C, WRO-5, and WRO-8 were recorded in the field based on visual observation and measurement. The bedrock was sequentially photographed, packed, and transported to WSP Golder's Mississauga laboratory for further visual examination. Laboratory testing consisting of uniaxial compressive strength (UCS) testing was carried out on selected specimens of the bedrock core samples by Geomechanica Inc. of Mississauga, Ontario.

The borehole locations were surveyed by WSP Golder using a hand-held Trimble GPS unit with a horizontal and vertical accuracy of about 0.1 m, and compared to the existing terrain model provided by AECOM. The locations are positioned relative to MTM NAD 83 northing and easting (Zone 10 CSRS CBNv6-2010.0) coordinates and the ground surface elevations are referenced to a Geodetic datum (CGVD28 / HT2_0). The borehole locations, including geographic coordinates, ground surface elevations, and borehole depths are summarized below.

Location	Borehole ID	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
North Noise Barrier Wall (North of Highway 401)	NNW-1	4,860,842.8 (43.885658)	357,872.1 (-78.839508)	97.4	8.1
	NNW-2	4,860,854.4 (43.885759)	357,929.5 (-78.838793)	94.9	6.4
	NNW-3	4,860,881.6 (43.885998)	358,013.6 (-78.837744)	93.3	6.7
	NNW-4	4,860,933.7 (43.886455)	358,173.6 (-78.835748)	91.4	5.2
	NNW-5	4,860,958.3 (43.886670)	358,254.5 (-78.834738)	90.1	5.9
	NNW-6	4,860,978.1 (43.886842)	358,337.7 (-78.833700)	89.8	6.7
	NNW-7	4,860,997.2 (43.887009)	358,412.6 (-78.832767)	88.5	6.7
	NNW-8	4,861,013.7 (43.887153)	358,479.8 (-78.831929)	85.5	5.2
	WRO-1	4,860,901.5 (43.886172)	358,077.6 (-78.836946)	92.4	21.9
	WRO-5	4,860,911.2 (43.886258)	358,108.2 (-78.836565)	91.5	20.4

Location	Borehole ID	MTM NAD83 Northing (Latitude, °)	MTM NAD83 Easting (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
South Noise Barrier Wall (South of Highway 401)	SNW-1	4,860,798.8 (43.885257)	357,946.5 (-78.838587)	95.1	8.2
	SNW-2	4,860,824.3 (43.885481)	358,026.5 (-78.837589)	93.8	6.7
	SNW-3	4,860,875.1 (43.885925)	358,207.4 (-78.835332)	90.5	6.7
	SNW-4	4,860,901.5 (43.886157)	358,285.2 (-78.834363)	89.2	6.7
	WRO-4A	4,860,842.5 (43.885640)	358,098.3 (-78.836694)	92.2	9.6
	WRO-4B	4,860,842.3 (43.885638)	358,096.9 (-78.836711)	92.5	22.1
	WRO-4C	4,860.841.8 (43.885634)	358,096.2 (-78.836720)	92.5	22.1
	WRO-8	4,860,854.6 (43.885746)	358,132.0 (-78.836274)	92.1	22.3

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984) and *Urban Geology of Canadian Cities* (Brennard, 1998). The Iroquois Plain extends around the western shores of Lake Ontario. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in this area of the Iroquois Plain are typically comprised of glaciolacustrine clays, silts and sands to gravelly sands, which are underlain by an extensive till deposit that is mapped in this area as the Bowmanville Till. More recent alluvial deposits of gravel, sand, silt and/or clay are present in the creek valleys.

Bedrock underlying the City of Oshawa is Ordovician shales of the lower Whitby formation, alternately known as Collingwood shale, as indicated in *Aggregate Resources Inventory of the City of Oshawa, Regional Municipality of Durham, Southern Ontario* (Scott and Billings, 1981). The lower Whitby formation is described as a black fossiliferous and highly proliferous calcareous shale.

4.2 Subsurface Conditions

The subsurface soil and groundwater conditions as encountered in the boreholes advanced as part of the previous and current subsurface investigations are presented on the borehole records in Appendices A and B. In addition, *Method of Soil Classification, Abbreviations and Terms Used on Records of Boreholes and Test Pits* and *List of Symbols* sheets are provided in Appendices A and B to assist in the interpretation of the borehole records. The geotechnical laboratory test results and analytical laboratory test results from the current investigation are presented in Appendices C and D, respectively.

The results of the in-situ field tests (i.e., SPT “N”-values and undrained shear strengths) as presented on the borehole records and in this section of the Foundation Investigation Report are uncorrected. The boundaries between the strata on the borehole records have been inferred from drilling observations and non-continuous

sampling. Therefore, these boundaries represent transitions between soil types rather than exact planes of geological change. The interpreted stratigraphic profiles along the proposed noise walls as shown on Drawings 1 to 2 are simplifications of the subsurface conditions. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected.

In general, the subsurface conditions at the proposed north and south alignments of the west noise walls consist of fill which is underlain, at some locations, by an upper silty clay deposit, subsequently underlain by a till / till-like deposit that varies from cohesive to non-cohesive. The till / till-like deposit is generally underlain by a deposit of silty sand, which is further underlain by a lower silty clay deposit. Shale bedrock was encountered below the silty sand and silty clay deposits. A more detailed description of the soil deposits at the site is provided in the following sub-sections. Some soil descriptions from the previous investigations may have been modified/reclassified based on the geotechnical laboratory test results consistent with the current MTO standards for soil classification.

4.2.1 Topsoil

An approximately 50 mm to 250 mm thick layer of topsoil was encountered at ground surface in Boreholes BH1, BH11, BH12, NNW-1, NNW-4 to NNW-8, SNW-1, SNW-2, WRO-5, and WRO-8.

4.2.2 Fill

A 0.5 m to 3.6 m thick layer of cohesive / non-cohesive fill was encountered at ground surface or below the surficial topsoil layer in all boreholes, excluding Borehole NNW-1. The fill extends to depths below ground surface ranging from 0.7 m to 3.7 m (Elevations 96.9 m to 81.8 m, generally declining eastward toward the creek). The cohesive fill consists of clayey silt, trace to sandy to clay. The non-cohesive fill consists of sandy silt, trace to some gravel to silty sand, some gravel. Trace organics were noted within the fill in Boreholes BH1 and BH12, and rootlets were noted within the fill in Borehole SNW-2.

The SPT “N”-values measured within the cohesive fill range from 4 blows to 18 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency. Two in-situ shear vane tests within the cohesive fill in Boreholes SNW-1 and SNW-4 measured about 24 kPa and greater than 96 kPa, indicating a firm to stiff consistency. The SPT “N”-values measured within the non-cohesive fill range from 6 blows to 19 blows per 0.3 m of penetration, indicating a loose to compact state of compactness.

Grain size distribution testing was carried out on one sample of the cohesive fill and the results are presented on Figure C-1 in Appendix C. Atterberg limits testing was carried out on two samples of the cohesive fill and the results are presented on Figure C-2 in Appendix C. The Atterberg limits tests measured liquid limits ranging from about 35% to 56%, plastic limits ranging from about 17% to 24%, and plasticity indices ranging from about 18% to 32%, indicating the material ranges from low plasticity to high plasticity. The natural water content measured on samples of the cohesive fill ranges from about 13% to 55%.

Grain size distribution testing was carried out on one sample of the non-cohesive fill and the results are presented on Figure C-3 in Appendix C. The natural water content measured on samples of the non-cohesive fill ranges from about 6% to 19%.

4.2.3 Upper Silty Clay to Clayey Sand

A 1.5 m to 5.2 m thick upper deposit of silty clay to clayey sand was encountered underlying the fill in Boreholes NNW-2, NNW-3, NNW-5, NNW-6, SNW-2, SNW-3, SNW-4, WRO-4, WRO-5 and WRO-8 at depths below ground surface ranging from about 0.7 m to 1.5 m (Elevations 93.5 m to 87.8 m) and extending to depths below ground

surface ranging from about 2.2 m to 6.7 m (Elevations 90.8 m to 82.5 m). The elevation of the surface and base of this layer generally declines to the east, toward the creek tributary.

The SPT “N”-values measured within the upper silty clay to clayey sand deposit range from 3 blows to 26 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency. In-situ field vane tests within the upper silty clay deposit measured about 40 kPa to greater than 96 kPa, indicating a firm to stiff consistency.

Grain size distribution testing carried out on nine samples of the upper silty clay to clayey sand deposit and the results are shown on Figures C-4A and C-4B in Appendix C. Atterberg limits testing was carried out on eleven samples of the upper silty clay deposit and the results are presented on Figure C-5A and C-5B in Appendix C. The Atterberg limits testing measured liquid limits ranging from about 21% to 45%, plastic limits ranging from about 13% to 19%, and plasticity indices ranging from about 9% to 27%, indicating the material is of low to intermediate plasticity. The natural water content measured on samples of the upper silty clay to clayey sand deposit ranges from about 7% to 39%.

4.2.4 Upper Silty Sand Interlayer

A 0.7 m to 2.4 m thick upper silty sand interlayer was encountered underlying the upper silty clay in Borehole NNW-2, within the upper silty clay deposit in Boreholes NNW-5 and SNW-4, and within the till deposit in Borehole WRO-8 at depths below ground surface ranging from about 2.8 m to 6.3 m (Elevations 90.0 m to 85.5 m) and extending to depths below ground surface ranging from about 3.5 m to 8.7 m (Elevations 89.3 m to 83.4 m).

The SPT “N”-values measured within the upper silty sand interlayer range from 13 blows to 72 blows per 0.3 m of penetration, with one SPT “N”-value was measured 106 blows for 0.28 m of penetration, indicating a compact to very dense state of compactness.

Grain size distribution testing carried out on two samples of the upper silty sand interlayer and the results are shown on Figures C-6 in Appendix C. The natural water content measured on samples of the upper silty sand interlayer ranges from about 8% to 22%.

4.2.5 Till/Till-like Deposit

A 0.8 m to 7.8 m thick glacially derived cohesive and non-cohesive till / till-like deposit was encountered in all boreholes except Boreholes NNW-5 and SNW-4. The till / till-like deposit was encountered at depths below ground surface ranging from about 0.3 m to 14.8 m (Elevations 97.1 m to 77.3 m) and extending to depths below ground surface ranging from 4.8 m to 17.8 m (Elevations 74.3 m to 94.2 m).

The cohesive till / till-like deposit consists clayey silt, some sand, trace gravel to clayey sand, some gravel of clayey sand, some gravel and the non-cohesive till / till-like deposit consists of silty sand, trace gravel to sandy silty gravel. A 100 mm thick sand seam was encountered in Borehole WRO-5 at a depth below ground surface of 9.5 m (Elevation 82.0 m). Auger grinding / bouncing of the SPT spoon was observed within Boreholes NNW-1, SNW-1, WRO-5, WRO-8, and BH11, indicating the potential presence of cobbles/boulders within the deposit. Heaving / flowing sands were observed within Borehole WRO-4A at a depth below ground surface of 9.1 m (Elevation 83.4 m).

The deposit has been classified herein as a till / till-like deposit based on the results grain size distribution curves, observed auger grinding, and our understanding of the geology in the area.

The SPT “N”-values measured within the cohesive portion of the till / till-like deposit range from 5 blows per 0.3 m of penetration to 100 blows per 0.13 m of penetration, suggesting a firm to hard consistency. The SPT “N”-values

measured within the non-cohesive portion of the till / till-like deposit range from 4 blows per 0.3 m of penetration to 100 blows per 0.07 m of penetration, indicating a loose to very dense state of compactness.

Grain size distribution testing was carried out on eight samples of the cohesive till / till-like deposit and the results are presented on Figure C-7A and C-7B in Appendix C. Atterberg limits testing was carried out on seven samples of the cohesive till / till-like deposit and the results are presented on Figure C-8 in Appendix C. The Atterberg limits testing measured liquid limits ranging from 15% to 20%, plastic limits ranging from 10% to 13%, and plasticity indices ranging from 5% to 8%, indicating the cohesive till / till like material is of low plasticity. The natural water content measured on samples of the cohesive portion of the till / till-like deposit ranges from about 8% to 21%.

Grain size distribution testing was carried out on fifteen samples of the non-cohesive till / till-like deposit and the results are presented on Figure C-9A to C-9C in Appendix C. Atterberg limits testing carried out on seven samples of the non-cohesive till / till-like deposit indicated the non-cohesive portion of the deposit is non plastic. The natural water content measured on samples of the non-cohesive portion of the till / till-like deposit ranges from about 4% to 26%.

4.2.6 Lower Silty Sand

A 0.9 m to 6.1 m thick lower deposit of non-cohesive silty sand, trace to some gravel, was encountered beneath the till / till-like deposit in Boreholes WRO-1, WRO-4B, and WRO-5, and interlayered within the till / till-like deposit in Borehole WRO-8, at depths below ground surface ranging from 8.7 m to 17.8 m (Elevation 83.7 m to 74.3 m), extending to depths below ground surface ranging from 14.8 m to 18.7 m (Elevations 77.7 m to 73.4 m).

Trace organics were observed within the silty sand in Borehole WRO-8 and WRO-B5. Trace organics and shell fragments were observed within the silty sand deposit in Boreholes WRO-1 and WRO-4B between depths below ground surface of 10.2 m and 13.3 m (Elevations 82.2 m and 79.0 m), suggesting the silty sand deposit is from the former Lake Iroquois lakebed.

The SPT “N”-values measured within the lower silty sand deposit range from 8 blows to 57 blows per 0.3 m of penetration, with one SPT “N”-value of 100 blows per 0.14 m of penetration, indicating a loose to very dense state of compactness.

Grain size distribution testing was carried out on four samples of the silty sand and the results are presented on Figure C-10 in Appendix C. Organic content testing was carried out on three samples of the lower silty sand deposit and indicate an organic content of about 1%. The water content measured on samples of the lower silty sand deposit range from 12% to 21%.

4.2.7 Lower Silty Clay

A 1.5 m to 3.8 m thick lower deposit of silty clay, trace sand, trace gravel was encountered underlying the lower silty sand deposit in Boreholes WRO-1, WRO-4B, and WRO-5 at depths below ground surface ranging from 10.2 m to 14.8 m (Elevations 81.3 m to 76.7 m), extending to depths below ground surface ranging from 11.7 m to 18.6 m (Elevations 79.8 m to 73.9 m).

The SPT “N”-values measured within the lower silty clay deposit range from 13 blows to 43 blows per 0.3 m of penetration, indicating a stiff to hard consistency.

Grain size distribution testing was carried out on two samples of lower silty clay deposit are presented on Figure C-11 in Appendix C. Atterberg limits testing was carried out on two samples of the lower silty clay deposits

are presented on Figure C-12 in Appendix C. The Atterberg limits testing measured liquid limits ranging from about 38% to 40%, plastic limits ranging from about 16% to 18%, and plasticity indices of about 22%, indicating the material is of intermediate plasticity. The natural water content measured on samples of the lower silty clay deposit range from about 16% to 27%.

4.2.8 Residual Soil

A 0.6 m and 0.1 m thick deposit of residual soil was encountered underlying the lower silty clay deposit in Boreholes WRO-1 and WRO-5 at depths below ground surface of 18.0 m and 17.1 m (Elevations 74.4 m).

A single SPT “N” value measured within the residual soil deposit was greater than 30 blows per 0.03 m of penetration, suggesting a hard consistency.

The water content measured on one sample of the residual soil deposit was about 8%.

4.2.9 Bedrock

Bedrock was encountered and core samples were recovered in Boreholes WRO-1, WRO-4C, WRO-5 and WRO-8, and the bedrock surface was inferred from augering and/or split-spoon sampling in Borehole WRO-4B; all of these deeper boreholes were drilled in the vicinity of the Wilson Road overpass. The depths to bedrock below ground surface, and the corresponding bedrock surface elevation are summarized below. Photographs of the recovered core samples are presented on Figures B-1A to B-4B in Appendix B.

Borehole	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Comments
WRO-1	18.6	73.9	Bedrock Cored
WRO-4B	18.6	73.9	Split Spoon Sample
WRO-4C	18.7	73.8	Bedrock Cored
WRO-5	17.2	74.3	Bedrock Cored
WRO-8	18.7	73.4	Bedrock Cored

Based on a review of the bedrock core samples from the current investigation, the bedrock consists of shale of the Whitby Formation. In general, the bedrock samples are described as slightly weathered to fresh, thinly bedded, fine grained, faintly porous, very weak to strong, grey. The degree of weathering of the bedrock samples (i.e. fresh to moderately weathered – W1 to W3), and the strength classification of the intact rock mass based on field identification (i.e. weak to very strong – R2 to R4) are described in accordance with the International Society for Rock Mechanics (ISRM)¹ standard classification system.

The Rock Quality Designation (RQD) measured on the core samples ranges from about 0% to 100%, and is generally greater than 50%, indicating a rock mass of poor to excellent quality, and generally fair to excellent

¹ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.

quality, as per Table 3.10 of CFEM (2006)². The Total Core Recovery (TCR) and Solid Core Recovery (SCR) of samples recovered is between 0% and 100% and between 0% and 100%, respectively.

Uniaxial compressive strengths (UCS) obtained from UC tests (ASTM D7012) carried out on selected core samples of the shale bedrock are summarised in the table below and the details are presented on the Rock Laboratory Test Result report from Geomechanica in Appendix C.

Borehole No.	Sample Depth (m)	UCS (MPa)	Bulk Density (g/cm ³)
WRO-1	21.3 – 21.5	107.3	2.7
WRO-4C	21.4 – 21.5	47.5	2.6
WRO-4C	21.7 – 21.9	80.1	2.6
WRO-5	20.0 – 20.2	86.5	2.6
WRO-8	20.8 – 21.0	50.9	2.6
WRO-8	21.0 – 21.3	53.9	2.6

Based on the laboratory UCS results, in accordance with Table 3.5 in CFEM (2006)⁴, the shale bedrock is generally classified as medium strong (R3, 25 MPa < UCS < 50 MPa) to very strong (R5, 100 MPa < UCS < 250 MPa).

4.3 Groundwater Conditions

Details of the water levels observed in the boreholes upon completion of drilling are summarized on the borehole records in Appendix A and B. A 50 mm diameter PVC standpipe piezometer, equipped with stickup casing, was installed in seven boreholes as part of the current investigation to allow for monitoring the groundwater level at the site, as shown on the borehole records. The groundwater levels measured within the standpipe piezometers are summarized below; in general, the groundwater level declines from west to east, toward the creek valley. It should be noted that the groundwater level is subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

² Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual (CFEM), 4th Edition. The Canadian Geotechnical Society, BiTech Published Ltd., British Columbia.

Borehole	Screened Stratigraphy	Screened Depth (m) (Elevation) (m)	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date of Measurement
NNW-1	Silty sand till	3.1 – 6.1 (94.3 – 91.3)	97.4	Dry	Dry	04-Mar-2022
				7.3	91.0	20-May-2022
NNW-5	Silty sand / silty clay	3.7 – 5.2 (86.4 – 84.9)	90.1	2.8	87.3	04-Mar-2022
				2.9	87.2	20-May-2022
NNW-8	Silty clay fill / Silty sand (till-like)	3.7 – 5.2 (81.8 – 80.3)	85.5	0.1 ¹	85.4	04-Mar-2022
				0.8	84.7	20-May-2022
SNW-1	Silty clay till	4.6 – 7.6 (90.5 – 87.5)	95.1	0.7	94.3	04-Mar-2022
				1.1	93.9	20-May-2022
SNW-4	Silty sand / silty clay to clayey silt	2.3 – 5.3 (86.9 – 83.9)	89.2	4.1	85.1	11-Feb-2022
				3.0	86.2	04-Mar-2022
				2.8	86.4	20-May-2022
WRO-4A	Silty sand till	4.6 – 7.6 (87.9 – 84.9)	92.5	3.8	88.7	13-Jan-2022
				3.9	88.6	14-Feb-2022
				3.8	88.7	04-Mar-2022
				3.8	88.7	20-May-2022
WRO-5	Clayey sand till / silty clay	7.6 – 10.7 (83.9 – 80.8)	91.5	4.3	87.2	14-Feb-2022
				4.3	87.2	04-Mar-2022
				4.3	87.2	20-May-2022

Note 1. Groundwater frozen in piezometer during 04-Mar-2022 reading.

4.4 Analytical Testing

Six soil samples were collected and submitted for analyses of parameters used to assess corrosion potential and sulphate attack. A summary of the results of the analyses is presented below and the detailed test results and Certificates of Analysis are presented in Appendix D.

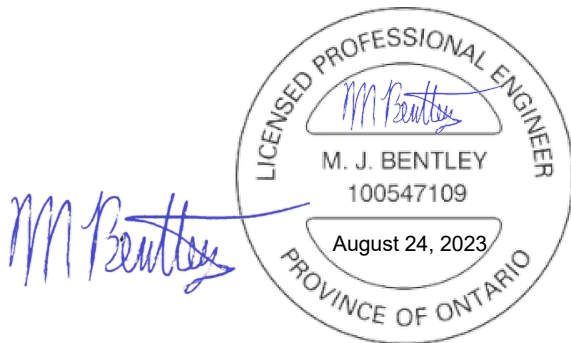
Borehole	Sample	Sample Depth (Elevation) (m)	Soil Type	Parameters				
				Chloride (µg/g)	Sulphate (µg/g)	pH	Conductivity (umho/cm)	Resistivity (ohm-cm)
NNW-2	4	2.3 - 2.9 (92.6 - 92.0)	Clayey Silt	390	<20	7.75	745	1,300
NNW-7	2	0.8 - 1.4 (87.7 - 87.1)	Clay	<20	<20	7.69	188	5,300
NNW-8	3	1.5 - 2.1 (84.0 - 83.4)	Silty Clay	110	<20	7.90	377	2,700
SNW-1	2	0.8 - 1.4 (94.3 - 93.7)	Clayey Silt	41	<20	7.73	309	3,200
SNW-2	3	1.5 - 2.1 (92.3 - 91.7)	Silty Clay	400	<20	7.94	848	1,200
SNW-4	2	0.8 - 1.4 (88.4 - 87.8)	Clayey Silt	360	<20	7.89	895	1,100

5.0 CLOSURE

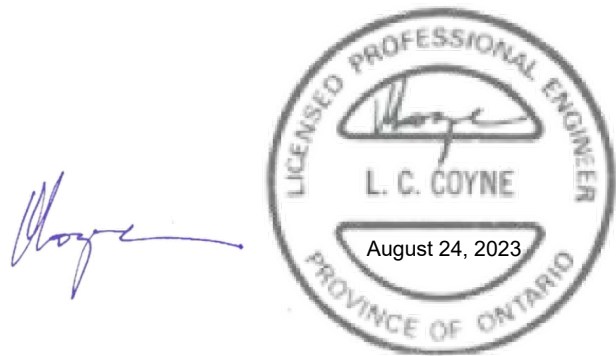
This Foundation Investigation Report was prepared by Jordan Schaaf, E.I.T., and was reviewed by Michael Bentley, P.Eng., geotechnical engineer and Anastasia Poliacik, P.Eng., senior geotechnical engineer with WSP Golder. Lisa Coyne, P.Eng., a Fellow and Designated MTO Foundations Contact with WSP Golder, conducted an independent technical and quality control review of this report.

Signature Page

WSP Golder



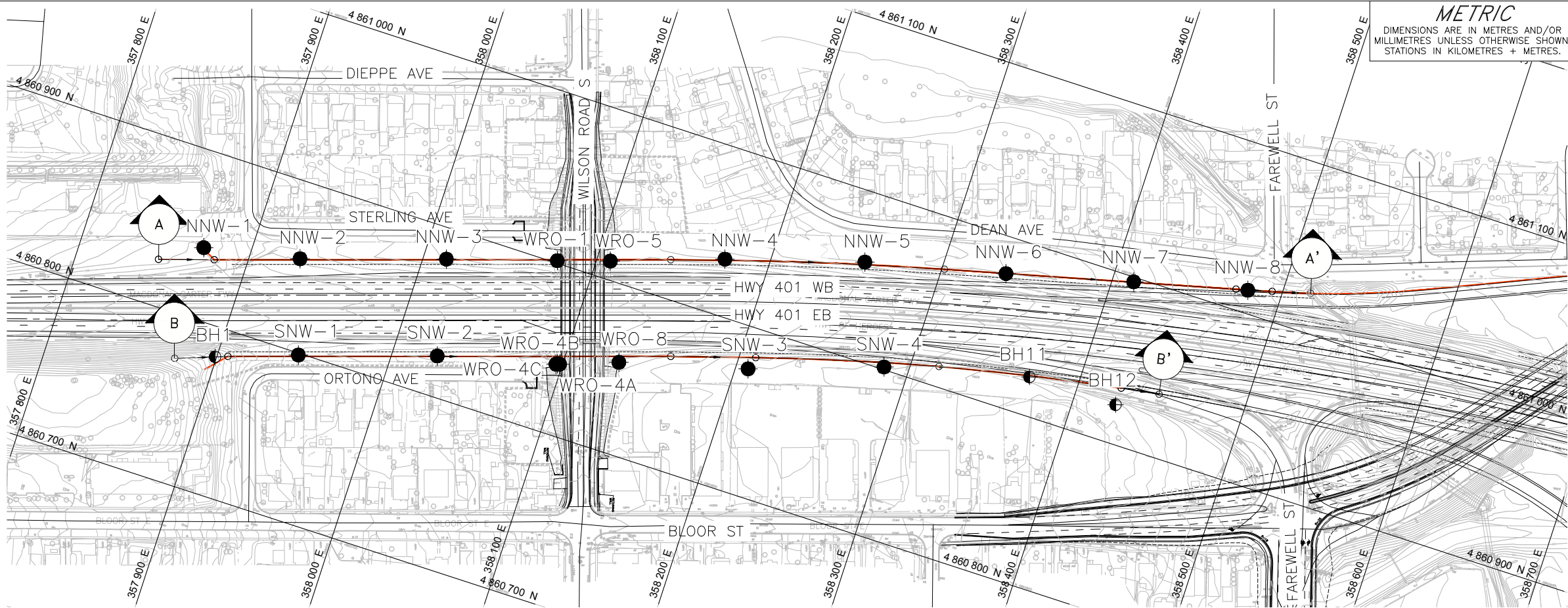
Michael Bentley, P.Eng.
Geotechnical Engineer



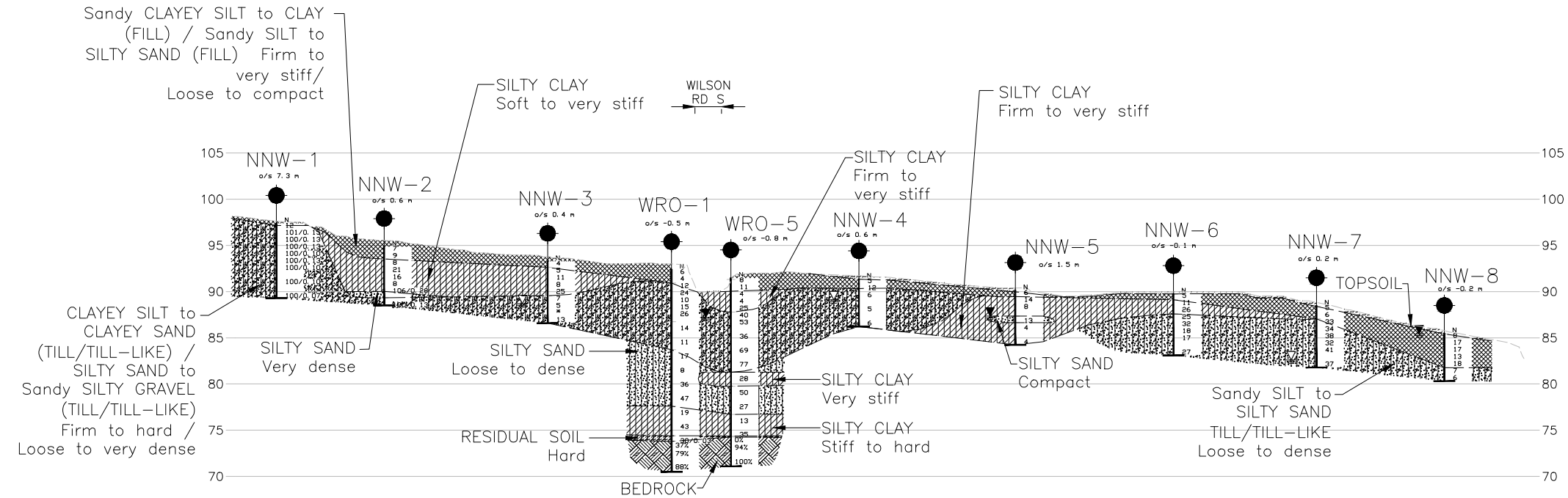
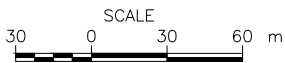
Lisa Coyne, P.Eng.
Fellow, MTO Designated Foundations Contact

JS/AMP/MB/LCC/ljv

[https://golderassociates.sharepoint.com/sites/132178/project files/6 deliverables/2. foundations/2. west noise wall \(contract a\)/3. final/fir/20350802 fir rev0 2023'08'24 wnw \(gwp 2146-20-00\).docx](https://golderassociates.sharepoint.com/sites/132178/project%20files/6%20deliverables/2.%20foundations/2.%20west%20noise%20wall%20(contract%20a)/3.%20final/fir/20350802%20fir%20rev0%202023'08'24%20wnw%20(gwp%202146-20-00).docx)



PLAN



REFERENCE

Base plans provided in digital format by Aecom, drawing file nos. 401_Bloor_Harmony_base.dwg, x-design.dwg, X-Utl_21-23954-401-HARMONY-SUE1-Model_20210715.dwg and 60653736_S1 Wilson Rd_General Arrangement.dwg, received October 1, 2021.
Utilities plan provided in digital format by Aecom, file nos. 401_Bloor_Harmony_Utility.dwg, X-Existing Storm-Model_ACAD13.dwg and X-HWY Existing Storm Sewer-Model_ACAD13.dwg, received November 17, 2021.

PROFILE A-A'

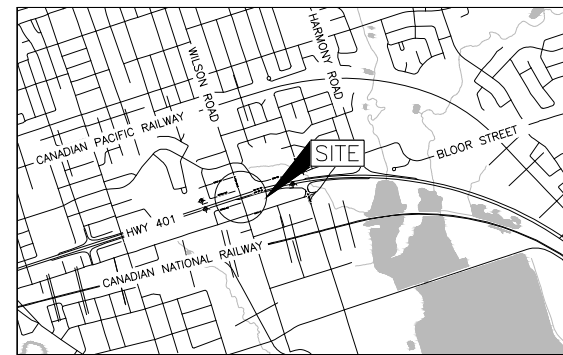


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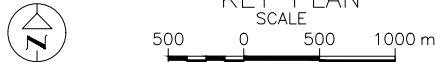
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

CONT No.
WP No.2146-20-00

HIGHWAY 401
NOISE BARRIER WALLS
BOREHOLE LOCATION PLAN AND
SOIL STRATA



KEY PLAN



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on MMM DD, YYYY
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3
NNW-1	97.4	4860842.8	357872.1
NNW-2	94.9	4860854.4	357929.5
NNW-3	93.3	4860881.6	358013.6
NNW-4	91.4	4860933.7	358173.6
NNW-5	90.1	4860958.3	358254.5
NNW-6	89.8	4860978.1	358337.7
NNW-7	88.5	4860997.2	358412.6
NNW-8	85.5	4861013.7	358479.8
SNW-1	95.1	4860798.8	357946.5
SNW-2	93.8	4860824.3	358026.5
SNW-3	90.5	4860875.1	358207.4
SNW-4	89.2	4860901.5	358285.2
WRO-1	92.4	4860901.5	358077.6
WRO-4A	92.5	4860842.5	358098.3
WRO-4B	92.5	4860842.3	358096.9
WRO-4C	92.5	4860841.8	358096.2
WRO-5	91.5	4860911.2	358108.2
WRO-8	92.1	4860854.6	358132.0

NO.	DATE	BY	REVISION
1	08/15/2023	DD/SA	1
Geocres No. 30M15-343			
HWY. 401	PROJECT NO. 20350802		DIST.
SUBM'D. AMP	CHKD. AMP	DATE: 08/15/2023	SITE:
DRAWN: DD/SA	CHKD. MJB	APPD. LCC	DWG. 1

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

CONT No.
WP No.2146-20-00

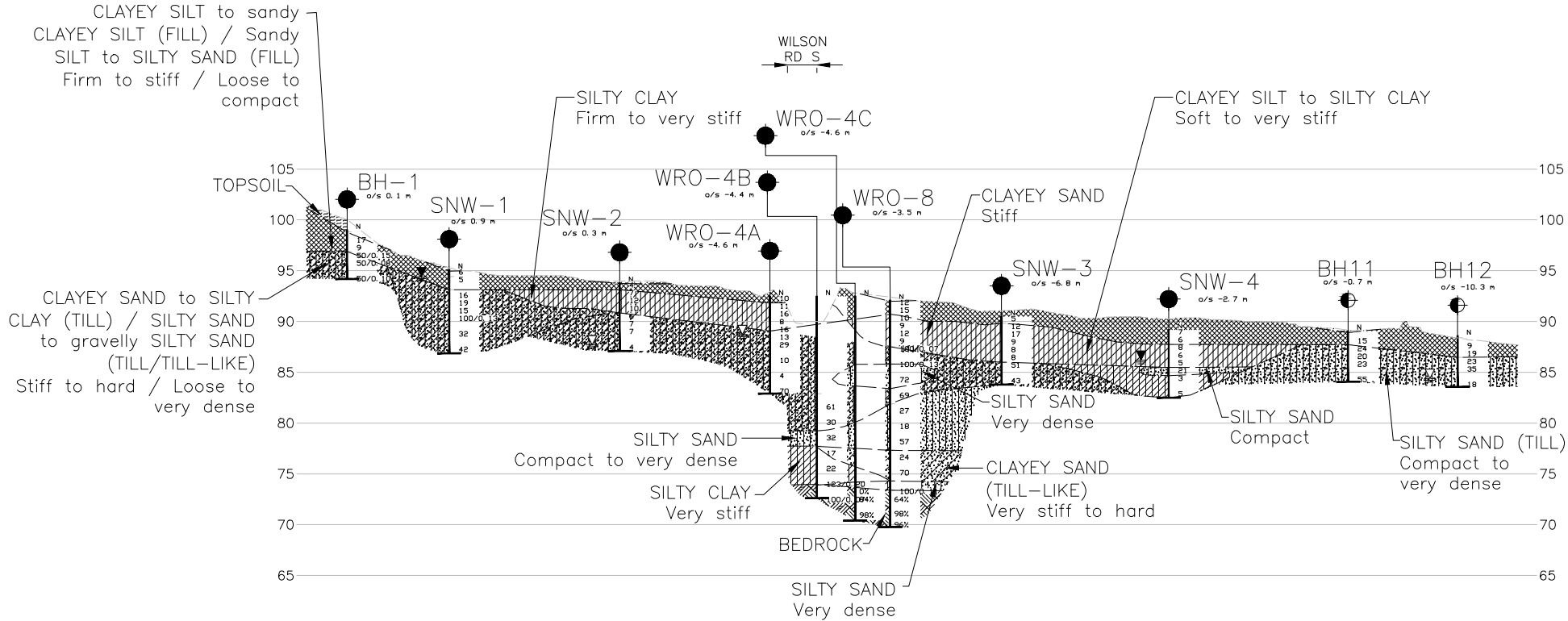
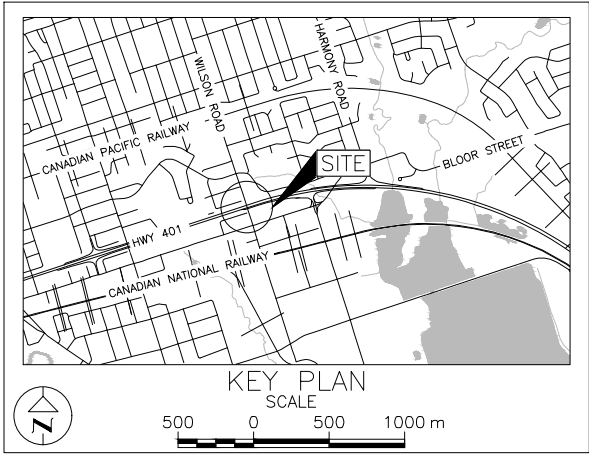
HIGHWAY 401
NOISE BARRIER WALLS

SOIL STRATA

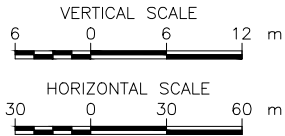




SHEET



PROFILE B-B'



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation 1
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on MMM DD, YYYY
- WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3
SNW-1	95.1	4860798.8	357946.5
SNW-2	93.8	4860824.3	358026.5
SNW-3	90.5	4860875.1	358207.4
SNW-4	89.2	4860901.5	358285.2
WRO-4A	92.5	4860842.5	358098.3
WRO-4B	92.5	4860842.3	358096.9
WRO-4C	92.5	4860841.8	358096.2
WRO-8	92.1	4860854.6	358132.0



REFERENCE

Base plans provided in digital format by Aecom, drawing file nos.
401_Bloor_Harmony_base.dwg, X-design.dwg,
X-Utl_21-23954-401-HARMONY-SUE1-Model_20210715.dwg and
60653736_S1 Wilson Rd_General Arrangement.dwg, received October 1,
2021.
Utilities plan provided in digital format by Aecom, file nos.
401_Bloor_Harmony_Uilities.dwg, X-Existing Storm-Model_ACAD13.dwg and
X-HWY Existing Storm Sewer-Model_ACAD13.dwg, received November 17,
2021.

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

NO.	DATE	BY	REVISION
Geocres No. 30M15-343			
HWY. 401	PROJECT NO. 20350802		DIST. .
SUBM'D. AMP	CHKD. AMP	DATE: 08/15/2023	SITE: .
DRAWN: DD/SA	CHKD. MJB	APPD. LCC	DWG. 2

APPENDIX A

**Borehole Records - 2013
Investigations (GEOCRES No.
30M15-132)**

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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
FoS	factor of safety

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
ν	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 $\gamma = \rho \cdot g$ (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
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified 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
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
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 or 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
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH1		SHEET 1 OF 1		METRIC										
LOCATION		N 4860782.2 ; E 357899.1		ORIGINATED BY		JL												
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY										
AV		DATE		April 30, 2013		CHECKED BY		TJG										
DATUM		Geodetic																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L	15 30 45				
99.0	0.0	GROUND SURFACE																
		TOPSOIL (200 mm)																
0.2		Silty sand to sandy silt, trace to some clay, trace gravel, trace organics (FILL) Loose to compact Brown Moist		1	SS	17		98										
				2	SS	9		97										
96.9	2.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Hard Grey Moist		3	SS	50/0.15		96										
				4	SS	50/0.08		95										
94.2	4.8	END OF BOREHOLE		5	SS	50/0.10												
		NOTE: 1. Open borehole dry upon completion of drilling.																

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH11		SHEET 1 OF 1		METRIC								
LOCATION		N 4860923.1 ; E 358370.6		ORIGINATED BY		JL										
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY								
AV		DATE		May 1, 2013		CHECKED BY		TJG								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)
89.1	GROUND SURFACE															
0.0	TOPSOIL (170 mm)															
0.2	Sandy silt, some gravel, trace clay (FILL) Compact Brown Moist		1	SS	15											
87.7																
1.4	Silty SAND, some gravel, trace to some clay (TILL) Compact to very dense Brown Moist		2	SS	24											
			3	SS	20											
			4	SS	23											
	Auger grinding indicating probable cobbles/boulders at a depth of 3.7 m															
84.1			5	SS	55											
5.0	END OF BOREHOLE															
	NOTE: 1. Open borehole dry upon completion of drilling.															

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH12		SHEET 1 OF 1		METRIC														
LOCATION		N 4860923.2 ; E 358425.3		ORIGINATED BY		JL																
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY														
AV		DATE		May 1, 2013		CHECKED BY		TJG														
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
88.6	0.0	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L 15 30 45			kN/m ³			GR SA SI CL		
0.2		TOPSOIL (180 mm)																				
		Sandy silt, trace gravel, trace organics (FILL) Loose to compact Dark brown to black Moist		1	SS	9		88														
				2	SS	19		87														
86.5	2.1	Silty SAND, trace to some gravel, trace to some clay (TILL) Compact to dense Brown becoming grey below a depth of 4.6 m Moist to wet		3	SS	23		86														
				4	SS	35		85														
				5	SS	18		84														
83.6	5.0	END OF BOREHOLE																				
		NOTE: 1. Water level in open borehole at a depth of 4.2 m below ground surface (Elev. 84.4 m) upon completion of drilling.																				

APPENDIX B

**Borehole Records - 2021-22
Investigations**

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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
FoS	factor of safety

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
ν	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 $\gamma = \rho \cdot g$ (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
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified 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
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
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 or 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
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

Fresh (W1): no visible sign of rock material weathering.

Slightly Weathered (W2): discoloration indicates weathering of rock mass material on discontinuity surfaces. **Less than 5%** of rock mass is altered or weathered.

Moderately Weathered (W3): less than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Highly Weathered (W4): more than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Completely Weathered (W5): 100% of the rock mass is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.

Residual Soil (W6): all rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

AXJ Axial Joint	KV Karstic Void
BD Bedding	K Slickensided
BC Broken Core	LC Lost Core
CC Continuous Core	MB Mechanical Break
CL Closed	PL Planar
CO Contact	PO Polished
CU Curved	RO Rough
CT Coated	SA Slightly Altered
FLT Fault	SH Shear
FOL Foliation	SM Smooth
FR Fracture	SR Slightly Rough
GO Gouge	SY Stylolite
IN Infilled	UN Undulating
IR Irregular	VN Vein
JN Joint	VR Very Rough

ISRM Intact Rock Material Strength Classification

Grade	Description	Approx. Range of Uniaxial Compressive Strength (MPa)
R0	Extremely weak rock	0.25 – 1.0
R1	Very weak rock	1.0 – 5.0
R2	Weak rock	5.0 – 25
R3	Medium strong rock	25 – 50
R4	Strong rock	50 -100
R5	Very strong rock	100 -250
R6	Extremely strong rock	>250

PROJECT		RECORD OF BOREHOLE		No NNW-1		SHEET 1 OF 1		METRIC					
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY					
DATE		DATE		COMPILED BY		CHECKED BY							
20350802		N 4860842.8; E 357872.1 MTM NAD 83 ZONE 10 (LAT. 43.885658; LONG. -78.839508)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		MJB					
CGVD28 / HT2 0 (Geodetic)		February 8, 2022		JNS		AMP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	GR SA SI CL
97.4	GROUND SURFACE												
0.0	TOPSOIL (250 mm)												
0.3	SILTY SAND (SM), trace to some gravel (TILL) Compact to very dense Brown to grey Dry		1	SS	12		97						
			2	SS	101/0.15								
			3	SS	100/0.15		96						2 30 46 22
	- Grey below a depth of 2.0 m (Elev. 95.4 m).		4	SS	100/0.15		95						
			5	SS	100/0.10		94						
	- Auger grinding between a depth of 4.0 m to 4.3 m (Elev. 93.4 m to 93.1 m)		6	SS	100/0.10		93						
	- Auger grinding between a depth of 4.9 m to 5.2 m (Elev. 92.5 m to 92.2 m)		7	SS	100/0.10		92						
	- Auger grinding between a depth of 6.1 m to 6.7 m (Elev. 91.3 m to 90.7 m)		8	SS	100/0.10		91						4 35 43 18
			9	SS	100/0.07		90						
89.3	END OF BOREHOLE												
8.1	NOTES: 1. Borehole caved to a depth of 6.9 m (Elev. 90.5 m) below ground surface upon completion of drilling. 2. Borehole dry inside open borehole upon completion of drilling borehole 3. Water measured in 50 mm dia. piezometer, with stickup casing, as follows: Date Depth (m) Elev. (m) 4-Mar-22 Dry Dry 20-Mar-22 6.4 91.0												

PROJECT		RECORD OF BOREHOLE		No NNW-2		SHEET 1 OF 1		METRIC					
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY					
DATUM		DATE		COMPILED BY		CHECKED BY							
20350802		N 4860854.4; E 357929.5 MTM NAD 83 ZONE 10 (LAT. 43.885759; LONG. -78.838793)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		KC					
CGVD28 / HT2 0 (Geodetic)		February 9, 2022		JNS		AMP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
94.9	GROUND SURFACE												
0.0	Sandy SILT (ML), trace gravel (FILL) Loose Brown Moist		1	SS	7		94						0 39 48 13
93.5			2	SS	9								
1.4	SILTY CLAY (CI), trace to some sand, trace gravel Stiff to very stiff Brown to grey Moist		3	SS	8		93						0 10 60 30
			4	SS	21		92						
			5	SS	16								
	- Grey below a depth of 3.7 m (Elev. 91.2 m).		6	SS	8		91						
90.0			7A	SS	106/0.28		90						
4.9	SILTY SAND (SM), trace gravel Very dense Grey Moist		7B										
89.3													
5.6	CLAYEY SILT (CL) and sand, trace gravel (TILL) Hard Grey Moist		8	SS	100/0.13		89						2 36 40 22
88.5													
6.4	END OF BOREHOLE												
NOTES: 1. Borehole open upon completion of drilling. 2. Water not encountered during drilling. 3. Water measured in open borehole at a depth of 6.4 m (Elev. 88.5 m) below ground surface upon completion of drilling borehole. 4. Undrained shear strength testing completed in second borehole adjacent to original borehole.													

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PROJECT		20350802		RECORD OF BOREHOLE		No NNW-3		SHEET 1 OF 1		METRIC				
G.W.P.		2146-20-00		LOCATION		N 4860881.6; E 358013.6 MTM NAD 83 ZONE 10 (LAT. 43.885998; LONG. -78.837744)		ORIGINATED BY		KC				
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY		JNS				
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		February 7, 2022		CHECKED BY		AMP				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
93.3	GROUND SURFACE													
0.0	CLAYEY SILT (CL), trace sand (FILL)		1	SS	4									
92.6	Firm													
0.7	Brown													
	Moist													
	SILTY CLAY (CI), trace sand		2	SS	5									
	Firm to very stiff													
	Brown													
	Moist													
			3	SS	11									
			4	SS	8									
			5	SS	25									
89.6														
3.7	CLAYEY SAND (SC), some gravel (TILL-Like)		6	SS	7									
	Firm to stiff													
	Grey													
	Moist													
	- No sample recovery from Sample 7													
			7	SS	5									
			8	SS	*									
			9	SS	13									
86.6														
6.7	END OF BOREHOLE													
NOTES: 1. Borehole open upon completion of drilling. 2. Water encountered at a depth of 3.1 m below ground surface (Elev. 90.2 m) during drilling. 3. Water measured in open borehole at a depth of 4.6 m (Elev. 88.7 m) below ground surface upon completion of drilling borehole. 4. *N value for sample 8 not recorded in field.														

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PROJECT		20350802		RECORD OF BOREHOLE No NNW-4		SHEET 1 OF 1		METRIC																
G.W.P.		2146-20-00		LOCATION		N 4860933.7; E 358173.6 MTM NAD 83 ZONE 10 (LAT. ; LONG.)		ORIGINATED BY																
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY																
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		December 17, 2021		CHECKED BY																
AMP																								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
91.4		GROUND SURFACE																						
89.7	0.7	TOPSOIL (70 mm)		1	SS	5																		
		CLAYEY SILT (CL), trace to some sand (FILL)		2A	SS	12																		
90.3	1.1	Firm to stiff Brown Moist		2B	SS	6																		
		SILTY SAND (SM), trace gravel (TILL-LIKE)		3	SS	6																		
		Loose to compact Brown to grey Moist																						
		- Grey below a depth of 3.1 m (Elev. 88.3 m).		4	SS	5																		
				5	SS	6																		
86.2	5.2	END OF BOREHOLE																						
		NOTES:																						
		1. Borehole open upon completion of drilling.																						
		2. Water encountered at a depth of 2.3 m (Elev. 89.1 m) below ground surface during drilling.																						

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PROJECT		RECORD OF BOREHOLE		No NNW-5		SHEET 1 OF 1		METRIC	
G.W.P. 2146-20-00		LOCATION		N 4860958.3; E 358254.5 MTM NAD 83 ZONE 10 (LAT. 43.886670; LONG. -78.834738)		ORIGINATED BY		NT	
DIST Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY		JNS	
DATUM CGVD28 / HT2 0 (Geodetic)		DATE		December 21, 2021		CHECKED BY		AMP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
90.1	GROUND SURFACE															
0.0	TOPSOIL (150 mm)		1A	SS	6											
0.2	SILTY SAND (SM), trace clay (FILL)		1B													
89.4	Loose Brown Moist		2	SS	14											
0.7	SILTY CLAY (CI), some sand, trace gravel		3	SS	8											
	Stiff Brown Moist															
87.3	SILTY SAND (SM)		4A	SS	13											
2.8	Compact Brown Wet		4B													
86.6	SILTY CLAY (CI), trace sand		5	SS	4											
3.5	Firm Grey Moist															
	- Grey below a depth of 3.5 m (Elev. 86.6 m).															
84.2	END OF BOREHOLE		6	SS	4											
5.9																

NOTES:

- Borehole caved to a depth of 2.7 m (Elev. 87.4 m) below ground surface upon completion of drilling.
- Water measured in open borehole at a depth of 2.7 m (Elev. 87.4 m) below ground surface upon completion of drilling.
- Water measured in 50 mm dia. piezometer with stickup casing as follows:

Date	Depth (m)	Elev. (m)
4-Mar-22	2.8	87.3
20-May-22	2.9	87.2

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PROJECT		RECORD OF BOREHOLE		No NNW-6		SHEET 1 OF 1		METRIC					
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY					
DATE		DATE		CHECKED BY									
20350802		N 4860978.1; E 358337.7 MTM NAD 83 ZONE 10 (LAT. 43.886842; LONG. -78.833700)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		JP					
2146-20-00		December 17, 2021		JNS		AMP							
CGVD28 / HT2 0 (Geodetic)													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
89.8	GROUND SURFACE												
89.7	TOPSOIL (50 mm)		1	SS	5								
89.1	CLAYEY SILT (CL) (FILL) Firm Brown Moist		2	SS	11		89						
87.6	SILTY CLAY (CI), trace sand, trace gravel Stiff to very stiff Brown Moist		3	SS	26		88						1 9 35 55
87.2	SILTY SAND (SM), some gravel to gravelly, trace to some clay (TILL) Compact to dense Brown to grey Moist		4	SS	25		87						30 36 26 8
			5	SS	32		86						
			6	SS	18		85						
			7	SS	17		84						
			8	SS	27								
83.1	- Grey below a depth of 4.6 m (Elev. 85.2 m)												
6.7	END OF BOREHOLE												
NOTE: 1. Borehole open and dry upon completion of drilling.													

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PROJECT		20350802		RECORD OF BOREHOLE		No NNW-7		SHEET 1 OF 1		METRIC			
G.W.P.		2146-20-00		LOCATION		N 4860997.2; E 358412.6 MTM NAD 83 ZONE 10 (LAT. 43.887009; LONG. -78.832767)		ORIGINATED BY		ZP			
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY		JNS			
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		December 17, 2021		CHECKED BY		AMP			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
88.5	GROUND SURFACE												
88.0	TOPSOIL (100 mm)		1	SS	5								
87.1	CLAY (CH) (FILL) Firm Brown Moist		2	SS	6								
87.1	Sandy SILT (ML), trace gravel (TILL) Dense Brown Moist - Wet sand lenses at 2.3 m depth		3	SS	33								
86.0			4	SS	34								
85.0			5	SS	38								
84.0			6	SS	32								
83.0			7	SS	41								
82.0			8	SS	37								
81.8	END OF BOREHOLE												
6.7	NOTES: 1. Borehole open upon completion of drilling. 2. Water measured in open borehole at a depth of 5.9 m (Elev. 82.6 m) below ground surface upon completion of drilling.												

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PROJECT		RECORD OF BOREHOLE		No NNW-8		SHEET 1 OF 1		METRIC														
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY														
DATUM		DATE		COMPILED BY		CHECKED BY																
20350802		N 4861013.7; E 358479.8 MTM NAD 83 ZONE 10 (LAT. 43.887153; LONG. -78.831929)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		ZP														
CGVD28 / HT2 0 (Geodetic)		December 17, 2021		JNS		AMP																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)													
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL									
85.5	GROUND SURFACE																					
85.4	TOPSOIL (70 mm)		1	SS	8		85															
	SILTY CLAY (CI), some sand (FILL) Stiff to very stiff Brown Moist		2	SS	17		84						0 12 38 50									
			3	SS	17		83															
			4	SS	13		82															
			5	SS	18		81															
81.8	SILTY SAND (SM), some gravel (TILL-LIKE) Loose Grey Moist		6	SS	7																	
80.3			7	SS	6							Non-plastic	15 51 22 12									
5.2	END OF BOREHOLE																					
NOTES: 1. Borehole open upon completion of drilling. 2. Water measured in open borehole at a depth of 4.6 m (Elev. 80.9 m) below ground surface upon completion of drilling borehole. 3. Water measured in 50 mm dia. piezometer with stickup casing as follows: <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev. (m)</th> </tr> </thead> <tbody> <tr> <td>4-Mar-22</td> <td>0.1</td> <td>85.4</td> </tr> <tr> <td>20-May-22</td> <td>0.8</td> <td>84.7</td> </tr> </tbody> </table> - Water frozen in piezometer during Mar 4/22 reading.														Date	Depth (m)	Elev. (m)	4-Mar-22	0.1	85.4	20-May-22	0.8	84.7
Date	Depth (m)	Elev. (m)																				
4-Mar-22	0.1	85.4																				
20-May-22	0.8	84.7																				

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PROJECT		RECORD OF BOREHOLE		No SNW-1		SHEET 1 OF 1		METRIC	
G.W.P. 2146-20-00		LOCATION		N 4860798.8; E 357946.5 MTM NAD 83 ZONE 10 (LAT. 43.885257; LONG. -78.838587)		ORIGINATED BY		ZP	
DIST Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY		JNS	
DATUM CGVD28 / HT2 0 (Geodetic)		DATE		December 15, 2021		CHECKED BY		AMP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
95.1	GROUND SURFACE															
0.0	TOPSOIL (130 mm)															
0.1	SILTY SAND (SM), some gravel (FILL)		1	SS	6											
94.4	Loose Brown Moist															
0.7	CLAYEY SILT (CL) (FILL)		2	SS	5											
	Firm Brown Moist															
93.1																
2.0	SILTY CLAY (CI), some sand to sandy, trace to some gravel (TILL)		3	SS	16											
	Stiff to hard Brown to grey Moist															
	- Grey below a depth of 3.0 m (Elev.92.1 m).		4	SS	19											
			5	SS	15											
			6	SS	100/0.1											
	-SPT spoon bounding at a depth of 4.9 m (Elev. 90.2 m)															
			7	SS	32											
			8	SS	42											
86.9	END OF BOREHOLE															
8.2	NOTES:															
	1. Borehole open upon completion of drilling.															
	2. Water encountered at a depth of 4.6 m (Elev. 90.5 m) below ground surface during drilling.															
	3. Water measured in piezometer as follows:															
	Date Depth (m) Elev. (m)															
	4-Mar-22 0.7 94.4															
	20-Mar-22 1.2 93.9															

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PROJECT		20350802		RECORD OF BOREHOLE No SNW-2		SHEET 1 OF 1		METRIC																					
G.W.P.		2146-20-00		LOCATION		N 4860824.3; E 358026.5 MTM NAD 83 ZONE 10 (LAT. 43.885481; LONG. -78.837589)		ORIGINATED BY																					
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 152 mm O.D. Solid Stem Augers		COMPILED BY																					
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		December 15, 2021		CHECKED BY																					
AMP																													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT			NATURAL MOISTURE CONTENT			LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																							
93.8		GROUND SURFACE																											
8.0		TOPSOIL (80 mm)		1	SS	4																							
93.1	0.7	CLAYEY SILT (CL), trace sand, containing rootlets (FILL) Firm Brown Moist		2	SS	7																							
		SILTY CLAY (CI), trace sand Firm to stiff Brown Moist		3	SS	12																							
				4	SS	10																							
90.8	3.0	SILTY SAND (SM), some gravel to gravelly, trace to some clay (TILL-LIKE) Loose Brown to grey Moist - Grey below a depth of 4.0 m (Elev. 89.8 m)		5	SS	6																							
				6A	SS	7																							
				6B	SS	7																							
				7	SS	7																							
				8	SS	4																							
87.1	6.7	END OF BOREHOLE																											
		NOTES: 1. Borehole open upon completion of drilling. 2. Water measured in open borehole at a depth of 6.1 m (Elev. 87.7 m) below ground surface upon completion of drilling borehole. 3. Undrained shear strength testing completed in second borehole adjacent to original borehole.																											

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PROJECT		RECORD OF BOREHOLE		No SNW-3		SHEET 1 OF 1		METRIC					
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY					
DATUM		DATE		COMPILED BY		CHECKED BY							
20350802		N 4860875.1; E 358207.4 MTM NAD 83 ZONE 10 (LAT. 43.885925; LONG. -78.835332)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		KC					
CGVD28 / HT2 0 (Geodetic)		February 10, 2022		JNS		AMP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
90.5	GROUND SURFACE												
0.0	CLAYEY SILT (CL), trace sand (FILL) Firm Brown Wet		1	SS	5		90					54.5	
89.8													
0.7	SILTY CLAY (CI), trace sand Stiff to very stiff Brown to grey Moist		2	SS	12		89					42	
			3	SS	17								
			4	SS	9		88						
			5	SS	8		87					45	0 3 43 54
	- Grey below a depth of 3.7 m (Elev. 90.2 m).		6	SS	8								
86.0							86						
4.5	Gravelly SILTY SAND (SM) (TILL) Dense to very dense Grey Moist		7	SS	51		85						
			8	SS	43		84						19 40 28 13
83.8													
6.7	END OF BOREHOLE												
NOTES: 1. Borehole open upon completion of drilling. 2. Borehole dry inside open borehole upon completion of drilling borehole. 3. Borehole shifted 6 m south of original staked located due to on site accessibility conditions.													

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PROJECT		RECORD OF BOREHOLE		No SNW-4		SHEET 1 OF 1		METRIC					
G.W.P.		LOCATION		DIST		BOREHOLE TYPE		ORIGINATED BY					
DATE		DATE		COMPILED BY		CHECKED BY							
20350802		N 4860901.5; E 358285.2 MTM NAD 83 ZONE 10 (LAT. 43.886157; LONG. -78.834363)		Central HWY 401		Power Auger; 152 mm O.D. Solid Stem Augers		KC					
CGVD28 / HT2 0 (Geodetic)		February 11, 2022		JNS		AMP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	GR SA SI CL
89.2	GROUND SURFACE												
0.0	CLAYEY SILT (CL), trace sand to sandy (FILL) Firm Brown Moist		1	SS	7		89						
			2	SS	6		88	>96 ₊					
87.8	SILTY CLAY (CI), trace sand Firm to stiff Brown Moist		3	SS	8		87						0 2 62 36
1.5			4	SS	6		86	>96 ₊					
			5	SS	5		85	>96 ₊					
85.5	SILTY SAND (SM) Compact Brown Wet		6	SS	21		84						0 81 16 3
3.7			7	SS	3		83	>96 ₊					
84.7	CLAYEY SILT (CL), trace sand Soft to firm Grey Moist - Grey below a depth of 4.5 m (Elev. 84.7 m).		8	SS	5								0 4 58 38
4.5													
82.5	END OF BOREHOLE												
6.7	NOTES: 1. Borehole caved to a depth of 5.3 m (Elev. 83.9 m) below ground surface upon completion of drilling. 2. Water encountered at a depth of 3.8 m below ground surface (Elev. 85.4 m) during drilling. 3. Water measured in open borehole at a depth of 4.6 m (Elev. 84.6 m) below ground surface upon completion of drilling borehole. 4. Undrained shear strength testing completed in second borehole 1 m west to original borehole. 3. Water measured in piezometer as follows: Date Depth (m) Elev. (m) 11-Feb-22 4.1 85.1 4-Mar-22 3.0 86.2 20-May-22 2.8 86.4												



PROJECT		20350802		RECORD OF BOREHOLE No WRO-1		SHEET 1 OF 2		METRIC									
G.W.P.		2146-20-00		LOCATION		N 4860901.5; E 358077.6 MTM NAD 83 ZONE 10 (LAT. 43.886172; LONG. -78.836946)		ORIGINATED BY		JL/JS							
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY		MJB							
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		January 13, 2022		CHECKED BY		AMP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
92.4	GROUND SURFACE																
0.0	Sandy CLAYEY SILT (CL) (FILL) Firm Dark brown to brown Moist		1	SS	6												
			2	SS	4												
91.0																	
1.5	SILTY SAND (SM), some gravel to gravelly (TILL-LIKE) Compact Brown to grey Moist to wet		3	SS	12												
			4	SS	24												
	- Grey below a depth of 3.0 m (Elev. 89.4 m)		5	SS	10												
			6	SS	15												
	- Wet below a depth of 4.6 m (Elev. 87.8 m)		7	SS	26												
86.8																	
5.6	Sandy SILTY GRAVEL (GM) (TILL-LIKE) Compact Grey Moist		8	SS	14												
			9	SS	11												
83.7																	
8.7	SILTY SAND (SM) Loose to dense Grey Wet		10	SS	17												
			11	SS	8												
	-Trace organics and shell fragments between a depth of 10.2 m and 13.3 m (Elev. 82.2 and 79.0 m)		12	SS	36												
			13	SS	47												
77.6																	
14.8																	

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE



PROJECT		20350802		RECORD OF BOREHOLE No WRO-1		SHEET 2 OF 2		METRIC								
G.W.P.		2146-20-00		LOCATION		N 4860901.5; E 358077.6 MTM NAD 83 ZONE 10 (LAT. 43.886172; LONG. -78.836946)		ORIGINATED BY		JL/JS						
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY		MJB						
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		January 13, 2022		CHECKED BY		AMP						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	SILTY CLAY (CI), trace sand Very stiff to hard Grey Moist		14	SS	19											
			15	SS	43											
74.4																
18.0	RESIDUAL SOIL															
	Hard															
	Brown															
73.8	Moist		16	SS	30/0.03											
18.6	SHALE (BEDROCK)		2	RC	REC 100%											
	Coring carried out between a depth of 18.5 m and 21.9 m (Elev. 73.9 m to 70.5 m). Refer to Record of Drillhole WRO-1.		3	RC	REC 100%											
			4	RC	REC 93%											
70.5																
21.9	END OF BOREHOLE															

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE




DEPTH SCALE

1 : 50



LOGGED: JS

CHECKED: ACK

PROJECT <u>20350802</u>		RECORD OF BOREHOLE No WRO-4B		SHEET 1 OF 2		METRIC							
G.W.P. <u>2146-20-00</u>		LOCATION <u>N 4860842.3; E 358096.9 MTM NAD 83 ZONE 10 (LAT. 43.885638; LONG. -78.836711)</u>		ORIGINATED BY <u>JL</u>									
DIST <u>Central</u> HWY <u>401</u>		BOREHOLE TYPE <u>Power Auger; Mud Rotary</u>		COMPILED BY <u>MJB</u>									
DATUM <u>CGVD28 / HT2 0</u> (Geodetic)		DATE <u>January 12, 2022</u>		CHECKED BY <u>AMP</u>									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
92.5 0.0	GROUND SURFACE Borehole straight drilled to a depth of 9.6 m (Elev. 82.9 m).						20 40 60 80 100	20 40 60 80 100	10 20 30				
82.9 9.6	CLAYEY SAND (SC), trace gravel (TILL) Hard Grey Moist		11	SS	61								
79.2 13.3	SILTY SAND (SM), trace organics and shell fragments Dense Grey Wet		12	SS	30								
77.7 14.8			13	SS	32								

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

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PROJECT		20350802		RECORD OF BOREHOLE No WRO-4B				SHEET 2 OF 2		METRIC				
G.W.P.		2146-20-00		LOCATION				N 4860842.3; E 358096.9 MTM NAD 83 ZONE 10 (LAT. 43.885638; LONG. -78.836711)		ORIGINATED BY JL				
DIST		Central HWY 401		BOREHOLE TYPE				Power Auger, Mud Rotary		COMPILED BY MJB				
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE				January 12, 2022		CHECKED BY AMP				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
								20 40 60 80 100						
73.9	SILTY CLAY (CI), trace sand, trace gravel Very stiff Grey Moist		14	SS	17		77						40	1 9 38 52
							76							
			15	SS	22		75							
18.6	Inferred SHALE (BEDROCK)		16	SS	23/0.20		74							
							73							
72.6	END OF BOREHOLE		17	SS	100/0.07									
19.9	NOTES: 1. Refer to Borehole WRO-4A for stratigraphy above a depth of 9.6 m (Elev. 82.9 m). Refer to Borehole WRO-4C for rock coring information. 2. Borehole caved to a depth of 12.2 m (Elev. 80.3 m) upon completion of drilling. 3. Water measured inside borehole at a depth of 4.0 m (Elev. 88.5 m) upon completion of drilling.													



PROJECT		20350802		RECORD OF BOREHOLE		No WRO-4C		SHEET 1 OF 2		METRIC													
G.W.P.		2146-20-00		LOCATION		N 4860841.8; E 358096.2 MTM NAD 83 ZONE 10 (LAT. 43.885634; LONG. -78.836720)		ORIGINATED BY		ZP													
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY		MJB													
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		February 10, 2022		CHECKED BY		AMP													
SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40	60	80	100	10
92.5 0.0	GROUND SURFACE Borehole straight drilled to a depth of 18.3 m (Elev. 74.2 m).						92																
							91																
							90																
							89																
							88																
							87																
							86																
							85																
							84																
							83																
							82																
							81																
							80																
							79																
							78																

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PROJECT		RECORD OF BOREHOLE				No WRO-4C		SHEET 2 OF 2		METRIC						
G.W.P. 2146-20-00		LOCATION N 4860841.8; E 358096.2 MTM NAD 83 ZONE 10 (LAT. 43.885634; LONG. -78.836720)				ORIGINATED BY ZP										
DIST Central HWY 401		BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers				COMPILED BY MJB										
DATUM CGVD28 / HT2 0 (Geodetic)		DATE February 10, 2022				CHECKED BY AMP										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
74.2	Borehole straight drilled to a depth of 18.3 m (Elev. 74.2 m).															
73.8	SILTY SAND (SM)		1	SS	28/0.29											
18.7	Grey Moist SHALE (BEDROCK)		1	RC	REC 100%											RQD = 0%
	Coring carried out between a depth of 18.9 m and 22.1 m (Elev. 73.9 m to 70.4 m). Refer to Record of Drillhole WRO-4C.		2	RC	REC 100%											RQD = 84%
			3	RC	REC 98%											RQD = 98%
70.4	END OF BOREHOLE															
22.1																

PROJECT: 20350802

RECORD OF DRILLHOLE: WRO-4C

SHEET 1 OF 1

LOCATION: N 4860841.8 ;E 358096.2

DRILLING DATE: February 10, 2022

DATUM: CGVD28 / HT2_0
(Geodetic)

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME-55

DRILLING CONTRACTOR: Davis Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										FEATURES	ROFT ZONES	NOTES WATER LEVELS INSTRUMENTATION						
						RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA				ROCK STRENGTH INDEX			WEATH- ERING INDEX							
						TOTAL CORE %	SOLID CORE %			B Angle	DIP w/LL CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	R4	R3	R2	R1	W1	W2	W3	W4	W5	W6
19		Continued from Borehole WRO-4C		73.57 18.93	1							BD,PL,SM	1	1										
		Slightly weathered to fresh, thinly bedded, grey, fine grained, faintly porous, medium strong SHALE (Whitby Formation)			2							BD,IR,SM JN,PL,SM BD,ST,SM BD,CU,SM	2	1										
20												BD,IR,SM BD,PL,SM JN,IR,RO	2	1										
					3							BD,PL,RO	1.5	1										
21												BD,PL,RO	1.5	1										
												BD,PL,RO	1.5	1										
22		END OF DRILLHOLE		70.41 22.09																				
23																								
24																								
25																								
26																								
27																								

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50

WSP GOLDER

LOGGED: JS

CHECKED: ACK

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PROJECT 20350802			RECORD OF BOREHOLE No WRO-5			SHEET 1 OF 2			METRIC											
G.W.P. 2146-20-00			LOCATION N 4860911.2; E 358108.2 MTM NAD 83 ZONE 10 (LAT. 43.886258; LONG. -78.836565)			ORIGINATED BY JS														
DIST Central HWY 401			BOREHOLE TYPE Power Auger; 190 mm O.D. Hollow Stem Augers			COMPILED BY MJB														
DATUM CGVD28 / HT2 0 (Geodetic)			DATE February 11, 2022			CHECKED BY AMP														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
91.5	GROUND SURFACE						20 40 60 80 100					20 40 60 80 100			10 20 30					
0.0	TOPSOIL (200 mm)						○ UNCONFINED + FIELD VANE					○ QUICK TRIAXIAL × REMOULDED								
0.2	SILTY CLAY (CI), trace sand (FILL) Firm to very stiff Brown Moist		1	SS	8	91														
			2	SS	11															
90.0						90														
1.5	SILTY CLAY (CI), trace sand to sandy, trace gravel to gravelly Firm to very stiff Brown Moist		3	SS	4															
			4	SS	4	89														
	- Gravelly, sandy below a depth of 3.0 m (Elev. 88.5 m)		5	SS	25	88														
87.8																				
3.7	CLAYEY SAND (SC), some gravel (TILL) Hard Grey Moist		6	SS	40	87														
			7	SS	53															
	- Auger grinding between a depth of 5.2 m to 5.5 m (Elev. 86.3 m to 86.0 m).					86														
			8	SS	36	85														
			9	SS	69	84														
			10	SS	77	82														
81.3	-100 mm sand seam at a depth of 9.5 m (Elev. 82.0 m)					81														
10.2	SILTY CLAY (CI) Very stiff Grey Moist		11	SS	28	80														
79.8																				
11.7	SILTY SAND (SM) Compact to dense Grey Moist		12	SS	50	79														
			13	SS	27	78														
76.7	- Trace organics between 13.3 m and 14.8 m (Elev. 78.2 m to 76.7 m).					77														
14.8																				

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

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PROJECT		20350802		RECORD OF BOREHOLE No WRO-5		SHEET 2 OF 2		METRIC									
G.W.P.		2146-20-00		LOCATION		N 4860911.2; E 358108.2 MTM NAD 83 ZONE 10 (LAT. 43.886258; LONG. -78.836565)		ORIGINATED BY JS									
DIST		Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY MJB									
DATUM		CGVD28 / HT2 0 (Geodetic)		DATE		February 11, 2022		CHECKED BY AMP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
	SILTY CLAY (CI) Stiff to hard Grey Moist		14	SS	13												
74.4			15A 15B 15C	SS	35 REC												
17.3	RESIDUAL SOIL Hard Grey Moist SHALES (BEDROCK)		15C	RC	100%												RQD = 0%
	Coring carried out between depth of 17.3 m to 20.4 m (Elev. 74.2 m to 71.1 m). Refer to Record of Drillhole WRO-5.		2	RC	REC 95%												RQD = 94%
			3	RC	REC 100%												RQD = 100%
71.1	END OF BOREHOLE																
20.4	NOTE: 1. Water measured in 50 mm dia. PVC piezometer as follows: Date Depth (m) Elev. (m) 14-Feb-22 4.3 87.2 04-Mar-22 4.3 87.2 20-May-22 4.3 87.2																

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50

LOGGED: JS

CHECKED: ACK



PROJECT		RECORD OF BOREHOLE		No WRO-8		SHEET 1 OF 2		METRIC					
G.W.P. 2146-20-00		LOCATION		N 4860854.6; E 358132.0 MTM NAD 83 ZONE 10 (LAT. 43.885746; LONG. -78.836274)		ORIGINATED BY		JS					
DIST Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY		MJB					
DATUM CGVD28 / HT2 0 (Geodetic)		DATE		February 15, 2022		CHECKED BY		AMP					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
92.1	GROUND SURFACE												
8.9	TOPSOIL (100 mm)		1	SS	12		92						
0.1	CLAYEY SAND (SC), some gravel (FILL) Stiff Brown Moist		2	SS	15		91						
90.6													
1.5	CLAYEY SAND (SC), some gravel Stiff Grey Moist		3	SS	10		90						
			4	SS	9		89						
			5	SS	12		88						
			6	SS	9		87						
87.5	-SPT spoon bouncing at 4.6 m depth (Elev. 87.5 m)		7	SS	100/0.07		86						
4.6	SILTY SAND (SM), some gravel (TILL) Very dense Grey Moist		8A	SS	100/0.13		85						
	- Auger grinding between a depth of 4.6 m and 5.5 m (Elev. 87.5 m to 86.6 m)		8B	SS			84						
85.8	- Auger grinding between a depth of 6.3 m and 7.3 m (Elev. 85.8 m to 84.8 m)		9	SS	72		83						
6.3	SILTY SAND (SM) Very dense Grey Wet		10	SS	69		82						
							81						
83.4	SILTY SAND (SM), some gravel (TILL) Very dense Grey Moist		11	SS	27		80						
							79						
81.9	SILTY SAND (SM) Compact to very dense Grey Moist to wet		12	SS	18		78						
10.2													
	-Trace organics between a depth of 11.7 m and 13.3 m (Elev. 80.4 m to 78.8 m)		13	SS	57								
77.3													
14.8													

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE



PROJECT		RECORD OF BOREHOLE		No WRO-8		SHEET 2 OF 2		METRIC															
G.W.P. 2146-20-00		LOCATION		N 4860854.6; E 358132.0 MTM NAD 83 ZONE 10 (LAT. 43.885746; LONG. -78.836274)		ORIGINATED BY		JS															
DIST Central HWY 401		BOREHOLE TYPE		Power Auger; 190 mm O.D. Hollow Stem Augers		COMPILED BY		MJB															
DATUM CGVD28 / HT2 0 (Geodetic)		DATE		February 15, 2022		CHECKED BY		AMP															
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL					
							20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL
	--- CONTINUED FROM PREVIOUS PAGE ---																						
74.3	CLAYEY SAND (SC), trace gravel (TILL-LIKE) Very stiff to hard Grey Moist to wet		14	SS	24	77																	
						76																	
			15	SS	70	75																	
73.4	SILTY SAND (SM), some gravel Very dense Grey Moist					74																	
73.4			16	SS	100	73																	
18.7	SHALES (BEDROCK)					72																	
	Coring carried out between depth of 18.7 m to 22.3 m (Elev. 73.4 m to 69.8 m). Refer to Record of Drillhole WRO-8.		2	RC	REC 80%	71																	
			3	RC	REC 100%	70																	
69.8			4	RC	REC 96%																		
22.3	END OF BOREHOLE																						

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

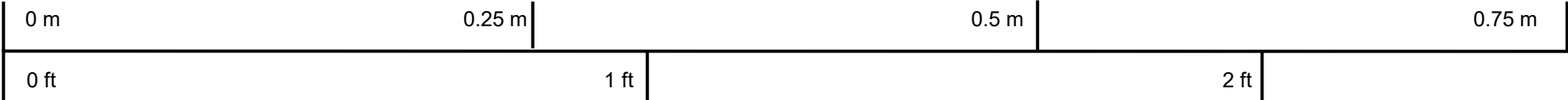
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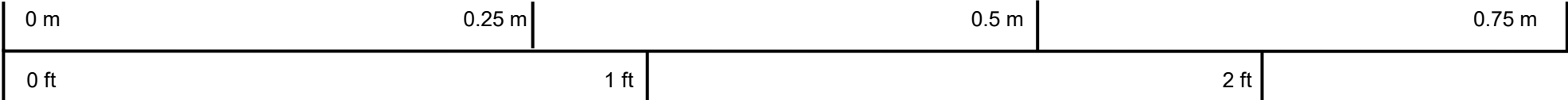
CHECKED: ACK

Borehole WRO-1
Box 1 of 2



Scale

PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00					
TITLE Core Photographs Borehole WRO-1 (18.47 m – 21.25 m)					
wsp GOLDER			PROJECT No. 20350802		FILE No. 1203508027
			DRAFT	LJV	MAR 2022
			CADD	--	
			CHECK	AMP	MAR 2022
			REVIEW		
			SCALE	AS SHOWN	VER. 1.
			FIGURE B-1A		




Scale

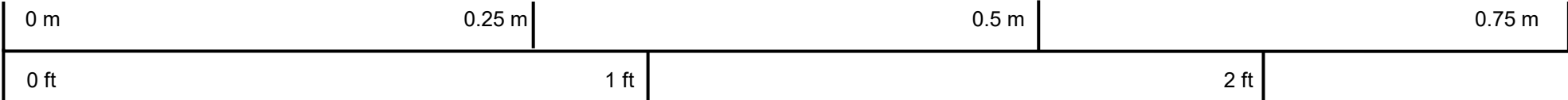
PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00						
TITLE Core Photographs Borehole WRO-1 (21.25 m – 21.89 m)						
wsp GOLDER			PROJECT No. 20350802		FILE No. 1203508027	
			DRAFT	LJV	MAR 2022	SCALE AS SHOWN VER. 1.
			CADD	--		FIGURE B-1B
			CHECK	AMP	MAR 2022	
			REVIEW			


Borehole WRO-4C
Box 1 of 2



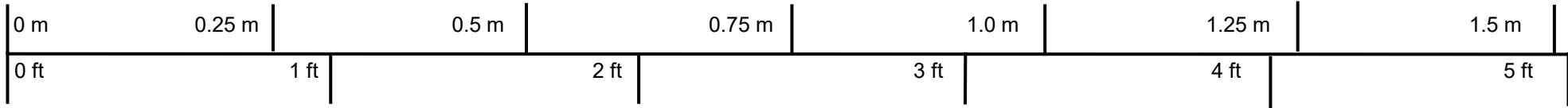
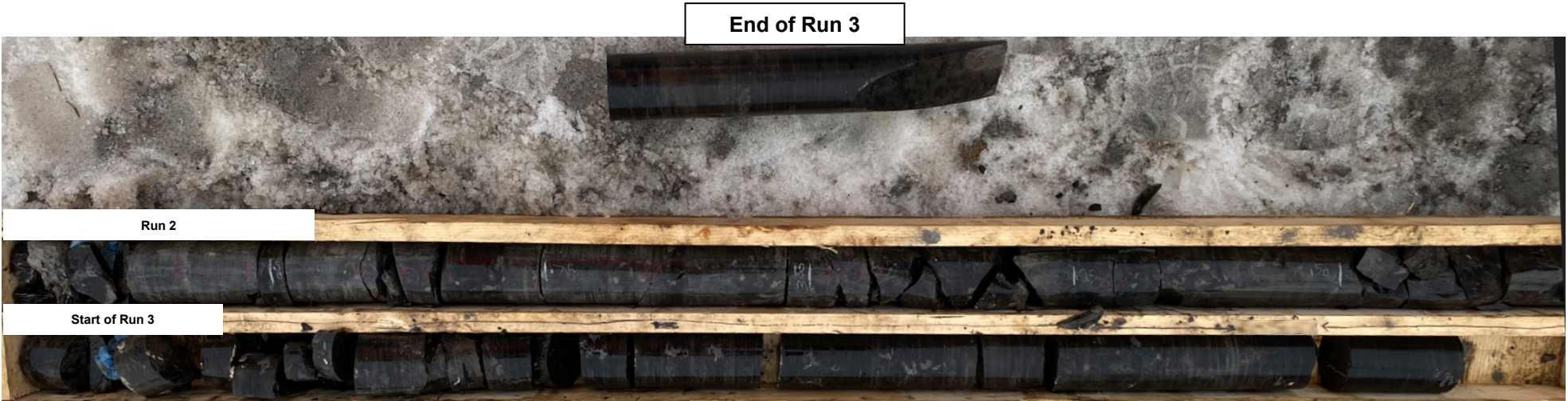
0 m	0.25 m	0.5 m	0.75 m
0 ft	1 ft	2 ft	

PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00						
TITLE Core Photographs Borehole WRO-4 (18.93 m – 21.05 m)						
			PROJECT No. 20350802		FILE No. 1203508027	
			DRAFT	LJV	MAR 2022	SCALE AS SHOWN
			CADD	--		VER. 1.
			CHECK	AMP	MAR 2022	FIGURE B-2A
			REVIEW			



PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00						
TITLE Core Photographs Borehole WRO-4 (21.05 m – 22.09 m)						
			PROJECT No. 20350802		FILE No. 1203508027	
			DRAFT	LJV	MAR 2022	SCALE AS SHOWN
			CADD	--		VER. 1.
			CHECK	AMP	MAR 2022	FIGURE B-2B
			REVIEW			

Borehole WRO-5



PROJECT					
Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00					
TITLE					
Core Photographs Borehole WRO-5 (18.57 to 21.89 m)					
			PROJECT No. 20350802		FILE No. 1203508027
			DRAFT	LJV	MAR 2022
			CADD	--	
			CHECK	AMP	MAR 2022
			REVIEW		
			SCALE AS SHOWN VER. 1.		
			FIGURE B-3		

Borehole WRO-8
Box 1 of 2



0 m	0.25 m	0.5 m	0.75 m
0 ft	1 ft	2 ft	

PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00					
TITLE Core Photographs Borehole WRO-8 (18.71 m to 21.28 m)					
			PROJECT No. 20350802		FILE No. 1203508027
			DRAFT	LJV	MAR 2022
			CADD	--	
			CHECK	AMP	MAR 2022
			REVIEW		
			SCALE	AS SHOWN	VER. 1.
FIGURE B-4A					



0 m	0.25 m	0.5 m	0.75 m
0 ft	1 ft	2 ft	

PROJECT Highway 401/Bloor Street/Harmony Rd Interchange Reconstruction City of Oshawa, Durham Region MTO 2019-E-0077, GWP 2146-20-00					
TITLE Core Photographs Borehole WRO-8 (21.84 m to 22.33 m)					
wsp GOLDER			PROJECT No. 20350802		FILE No. 1203508027
			DRAFT	LJV	MAR 2022
			CADD	--	
			CHECK	AMP	MAR 2022
			REVIEW		
			SCALE	AS SHOWN	VER. 1.
FIGURE B-4B					

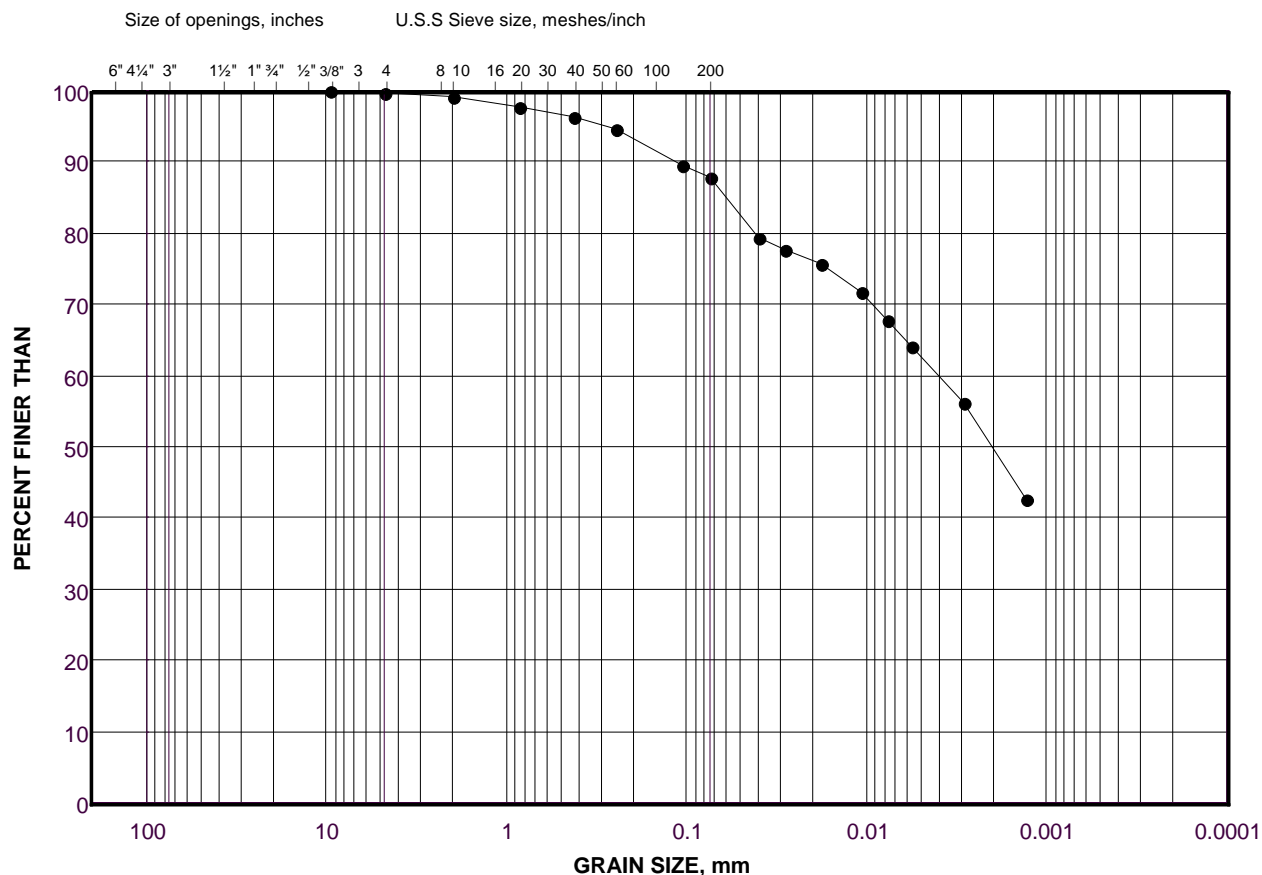
APPENDIX C

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to SILTY CLAY (CI) (FILL)

FIGURE C-1



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	NNW-8	2	84.4

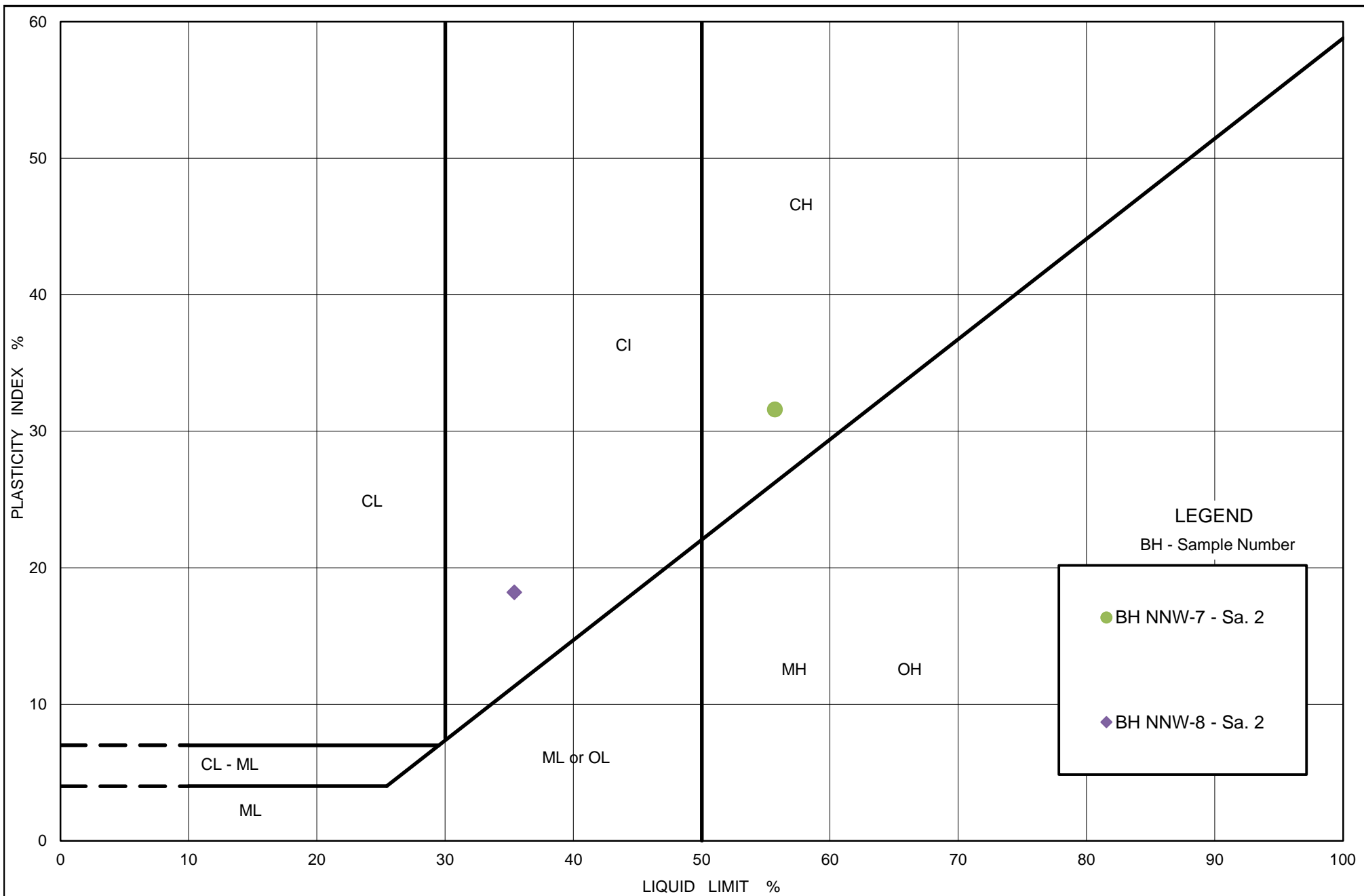
Project Number: 20350802-WNW-F1

Checked By: _AMP_____

Golder Associates

Date: 14-Mar-23

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



PLASTICITY CHART

SILTY CLAY (CI) TO CLAY (CH) (FILL)

Figure No.: C-2

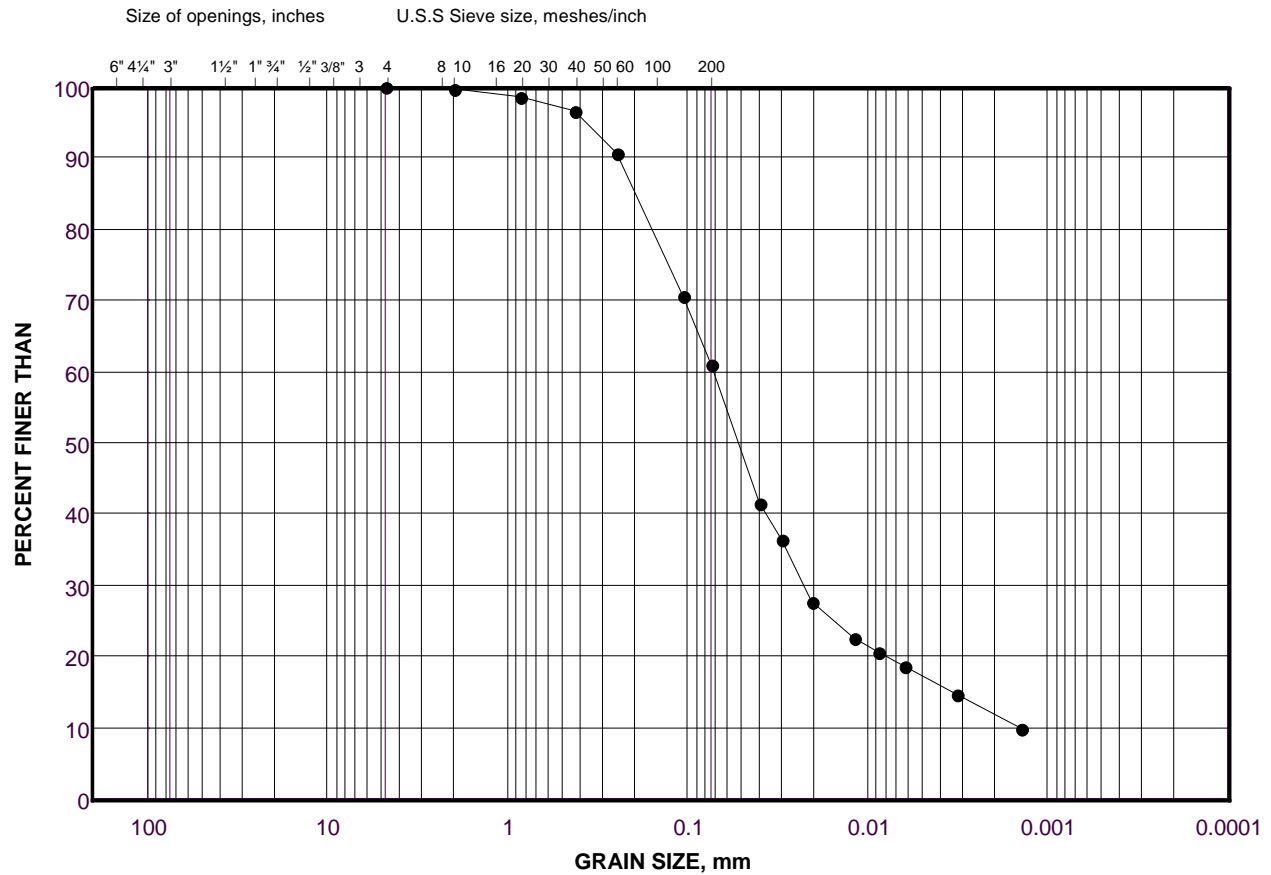
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

Sandy SILT (ML) (FILL)

FIGURE C-3



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	NNW-2	2	93.8

Project Number: 20350802-WNW-F1

Checked By: AMP

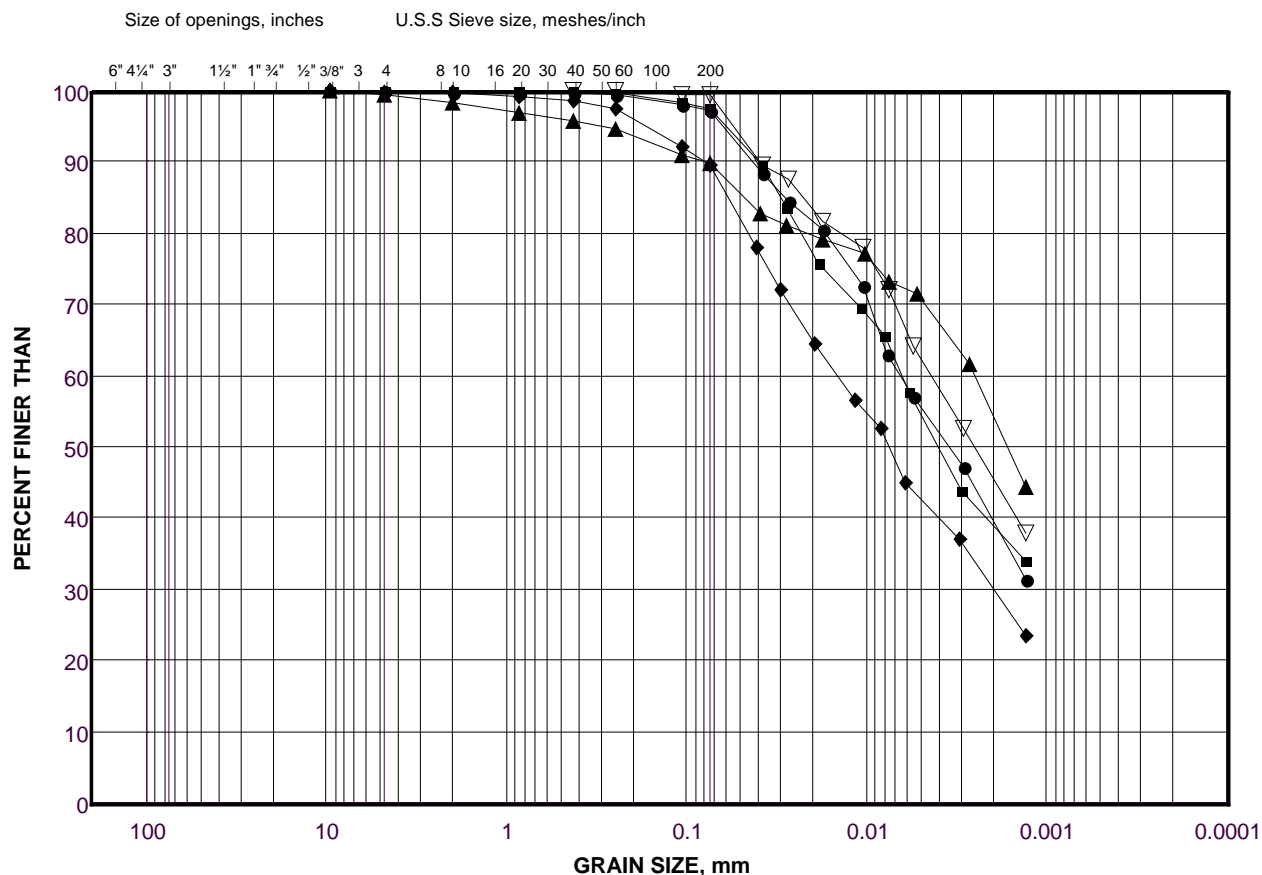
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

CLAYEY SAND (SC) TO CLAYEY SILT (CL) TO SILTY CLAY (CI)

FIGURE C-4A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-3	2	92.2
■	SNW-2	2	92.8
◆	NNW-2	3	93.1
▲	NNW-6	3	88.0
▽	NNW-5	5	90.8

Project Number: 20350802-WNW-F1

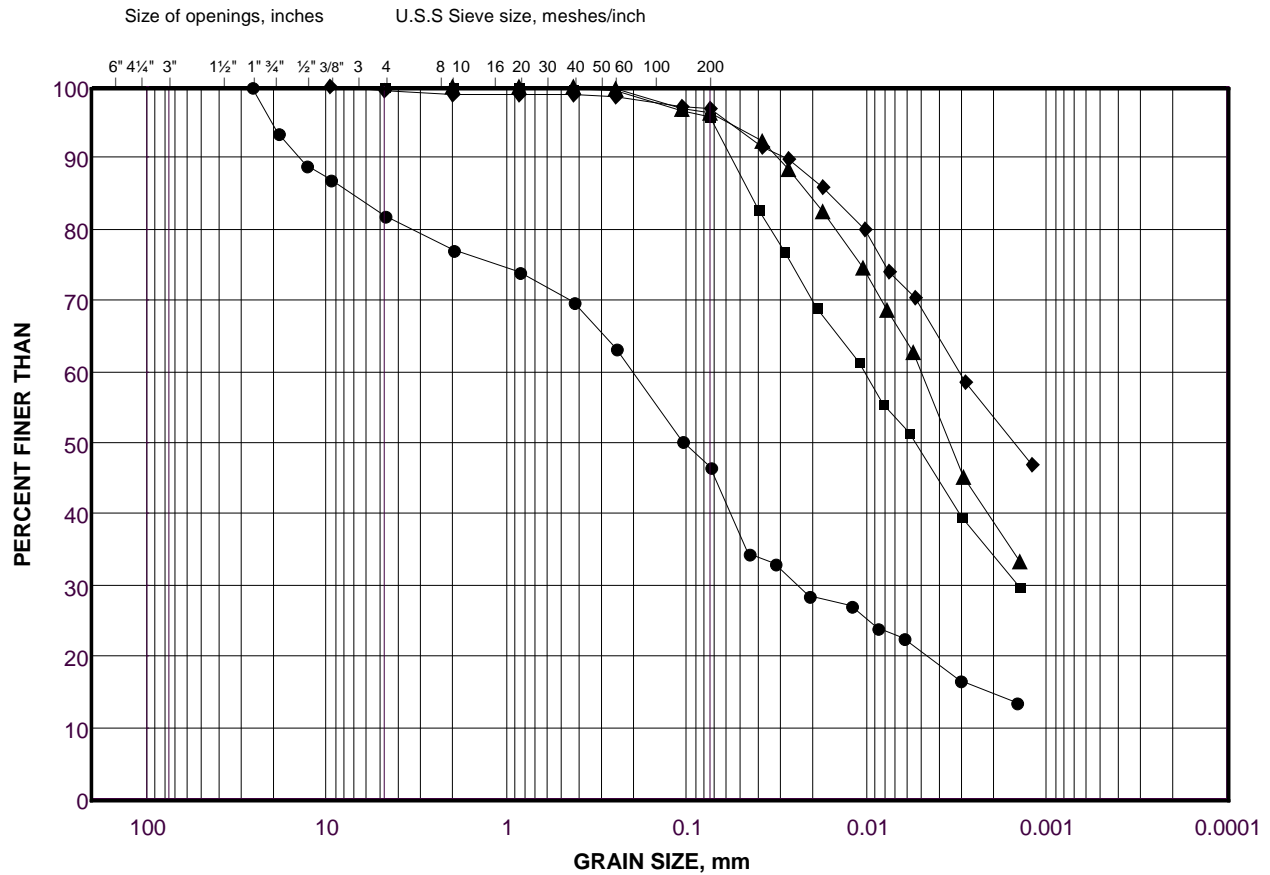
Checked By: AMP

Golder Associates

Date: 14-Mar-23

GRAIN SIZE DISTRIBUTION CLAYEY SAND (SC) TO CLAYEY SILT (CL) TO SILTY CLAY (CI)

FIGURE C-4B



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-8	3	89.7
■	WRO-5	3	90.3
◆	SNW-3	5	90.5
▲	SNW-4	7	84.3

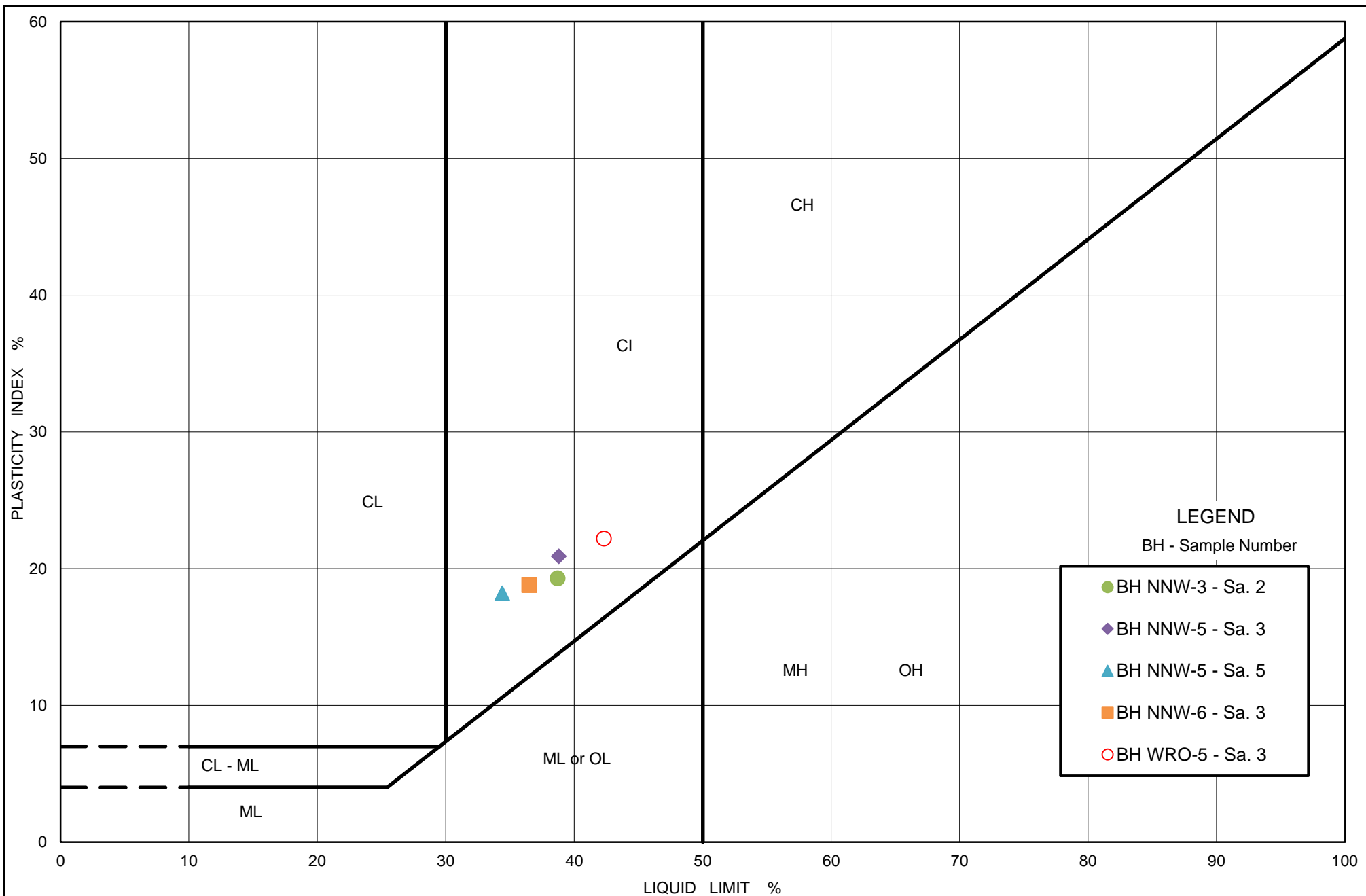
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 14-Mar-23

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



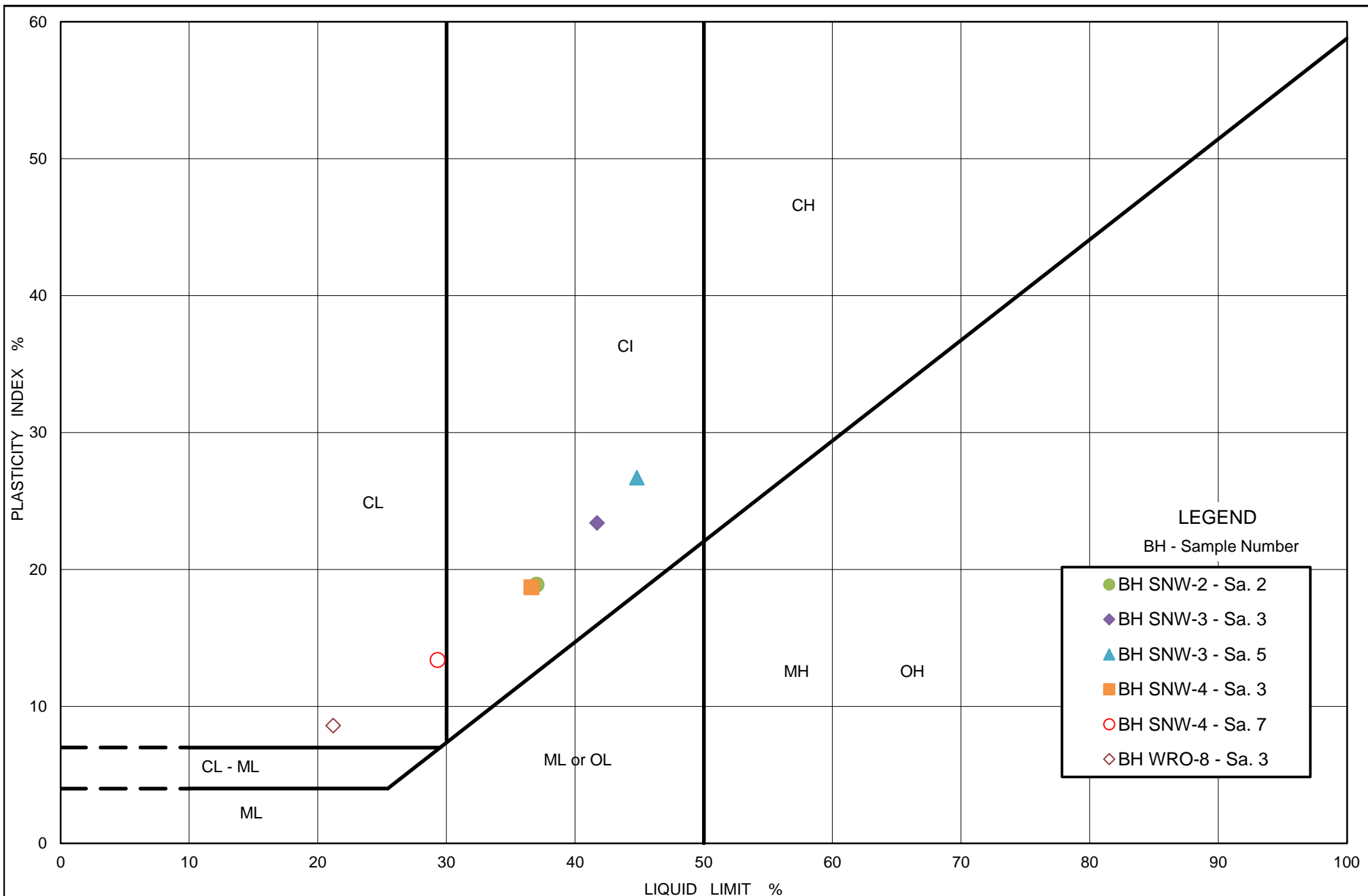
PLASTICITY CHART
CLAYEY SAND (SC) to CLAYEY SILT (CL)
TO SILTY CLAY (CI)

Figure No.: C-5A

Project No.: 20350802-WNW-F1

Checked By: AMP

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



PLASTICITY CHART
CLAEY SAND (SC) to CLAYEY SILT (CL)
TO SILTY CLAY (CI)

Figure No.: C-5B

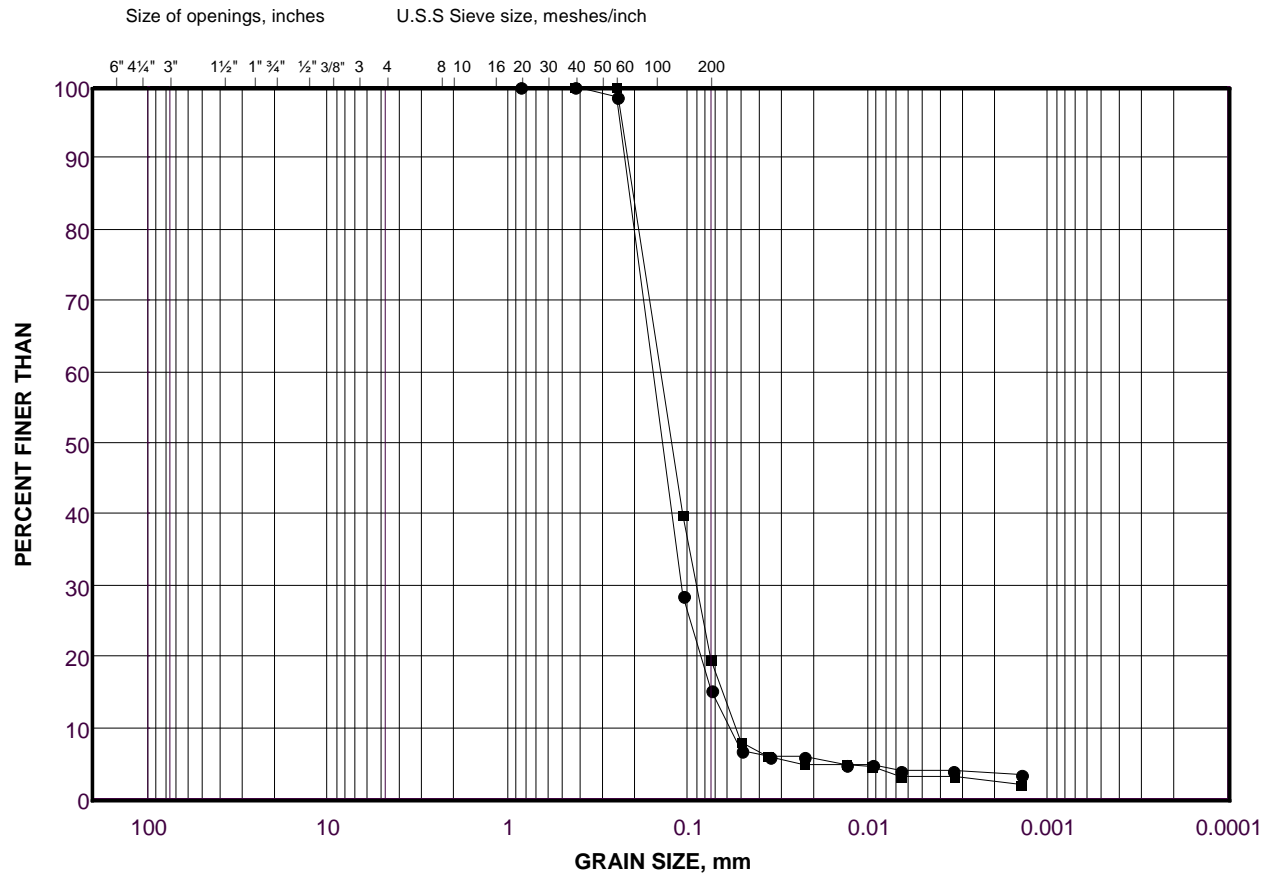
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE C-6



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-5	4A	91.7
■	SNW-4	6	85.1

Project Number: 20350802-WNW-FI

Checked By: AMP

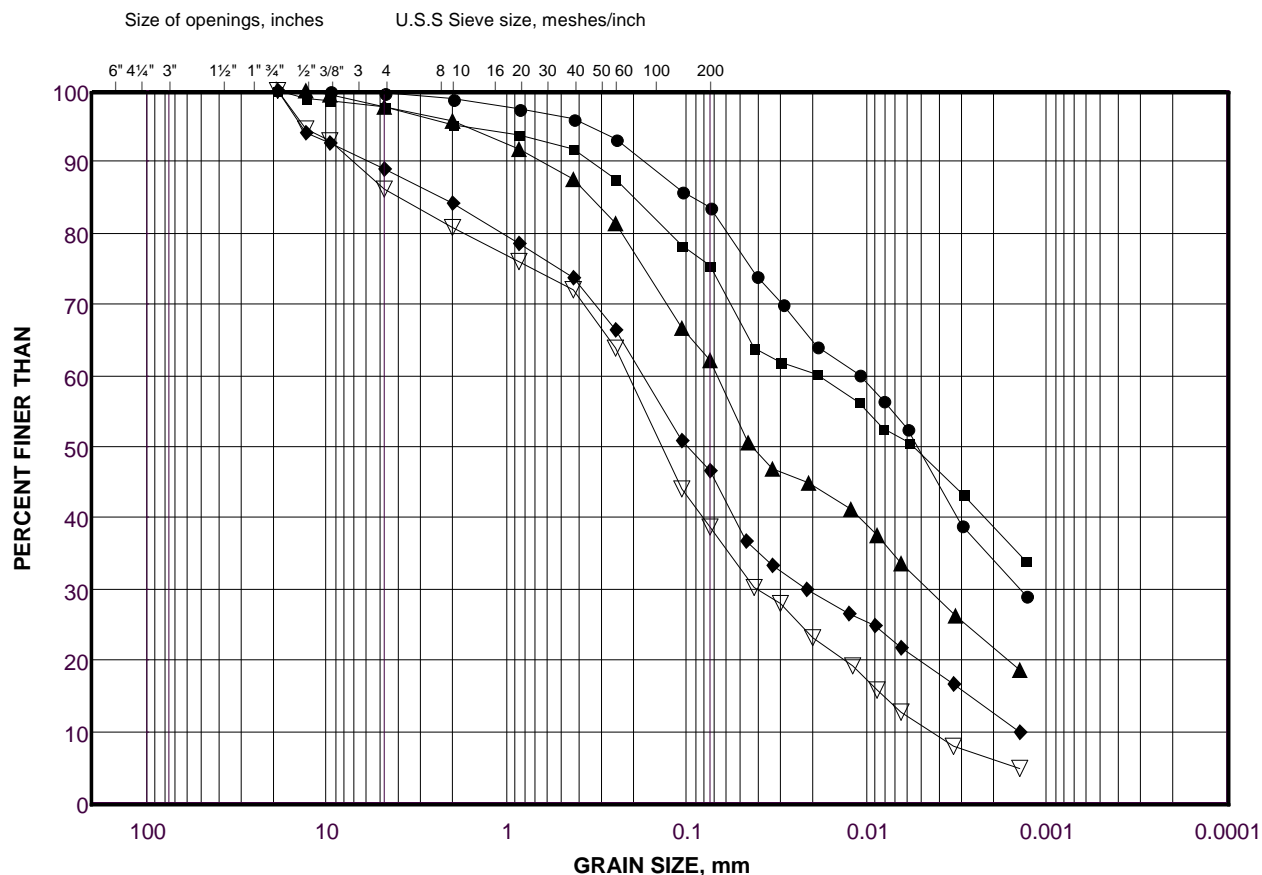
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

FIGURE C-7A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	SNW-1	3	95.1
■	SNW-1	7	95.1
◆	NNW-3	8	93.3
▲	NNW-2	8	94.9
▽	NNW-3	9	93.3

Project Number: 20350802-WNW-F1

Checked By: _AMP_____

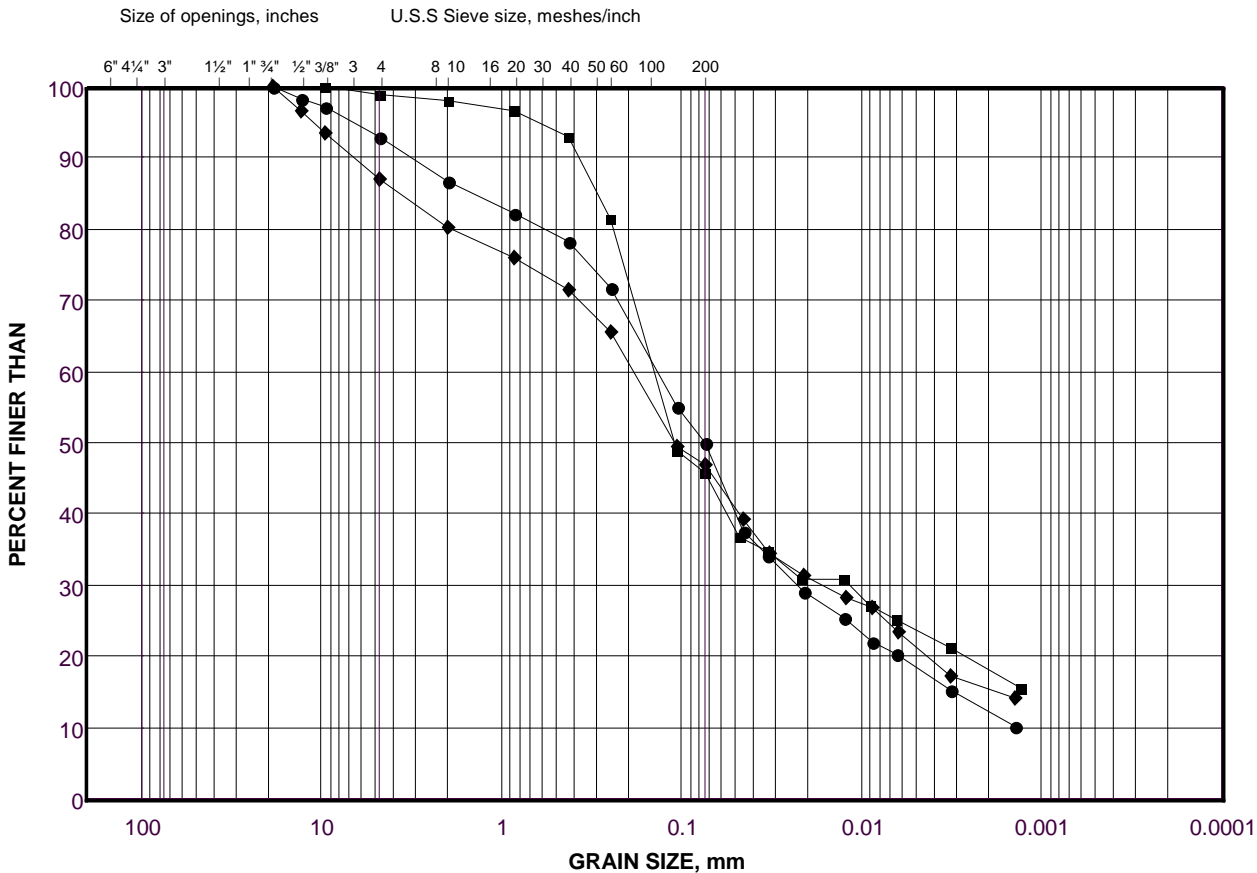
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

FIGURE C-7B

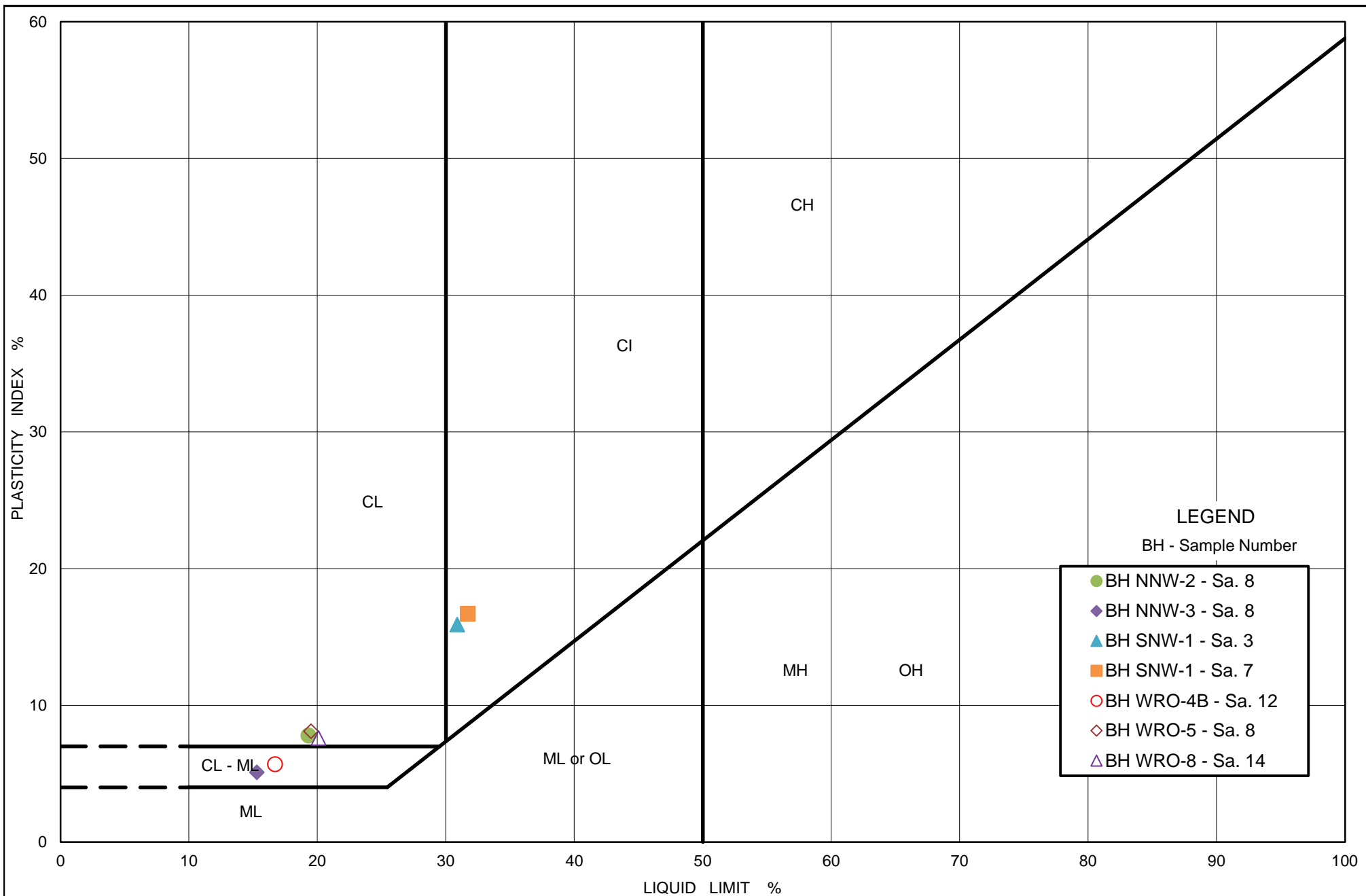


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4B	12	92.5
■	WRO-8	14	92.1
◆	WRO-5	8	91.5

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



PLASTICITY CHART

CLAYEY SILT (CL) to CLAYEY SAND (SC) (TILL)

Figure No.: C-8

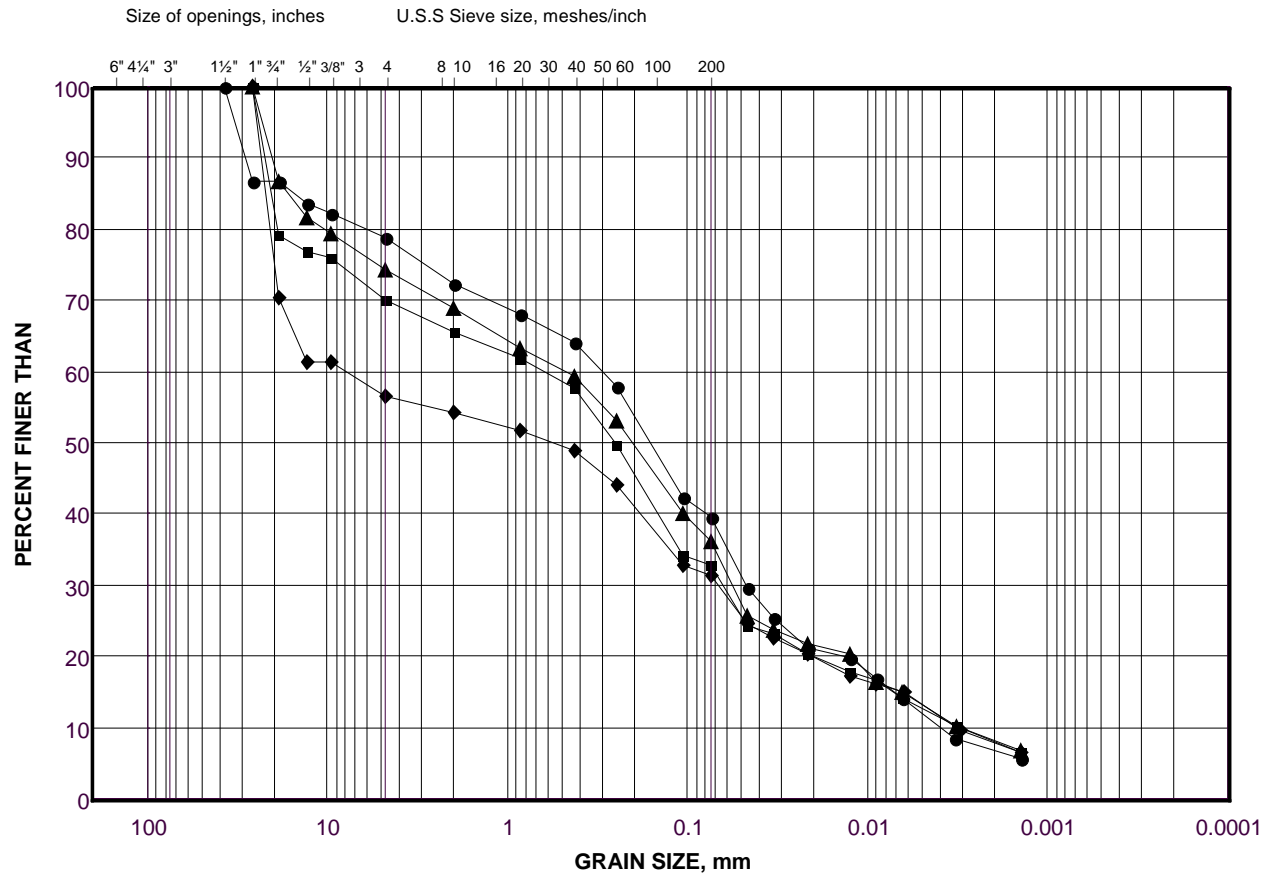
Project No.: 20350802-WNW-F1

Checked By: AMP

GRAIN SIZE DISTRIBUTION

Gravelly SILTY SAND (SM) (TILL)

FIGURE C-9A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-1	5	92.4
■	NNW-6	4	89.8
◆	WRO-1	8	92.4
▲	SNW-2	8	93.8

Project Number: 20350802-WNW-F1

Checked By: AMP

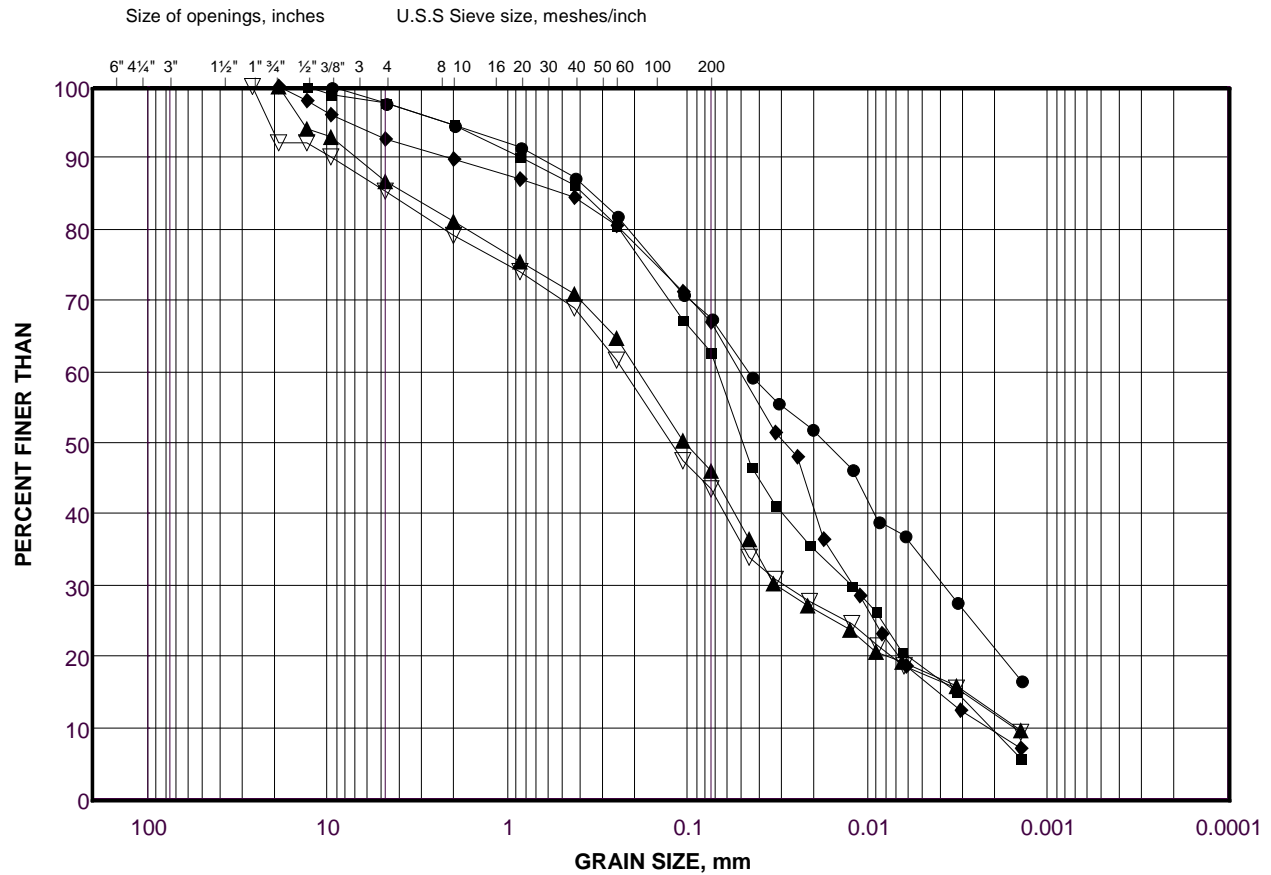
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) (TILL)

FIGURE C-9B



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NNW-1	3	97.4
■	NNW-7	4	88.5
◆	NNW-7	6	88.5
▲	SNW-2	6A	93.8
▽	NNW-8	7	85.5

Project Number: 20350802-WNW-F1

Checked By: AMP

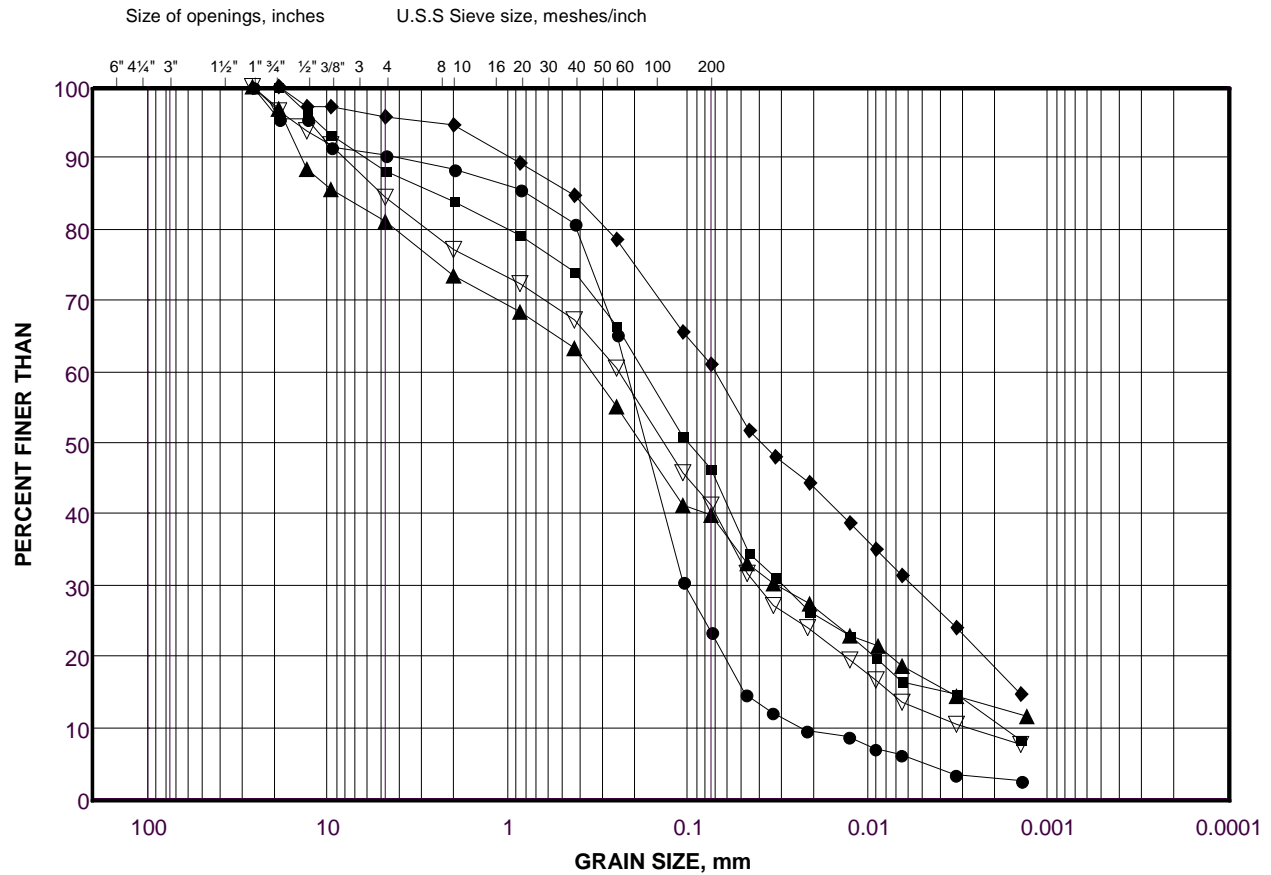
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM) (TILL)

FIGURE C-9C



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4	6	92.5
■	NNW-6	6	89.8
◆	NNW-1	8	97.4
▲	SNW-3	8	93.9
▽	WRO-4	9	92.5

Project Number: 20350802-WNW-F1

Checked By: AMP

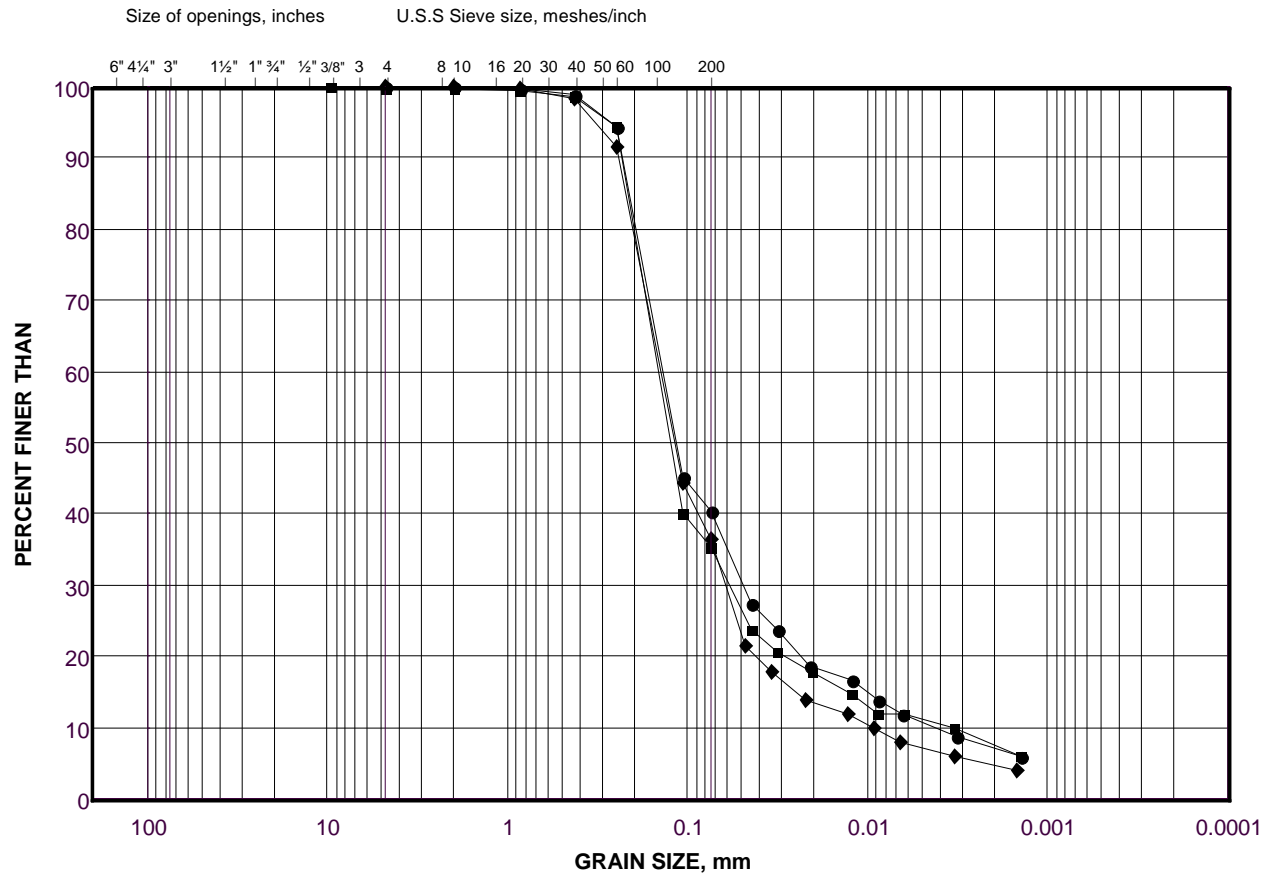
Golder Associates

Date: 20-May-22

GRAIN SIZE DISTRIBUTION

SILTY SAND (SM)

FIGURE C-10



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-5	12	79.0
■	WRO-1	12	79.9
◆	WRO-8	13	78.1

Project Number: 20350802-WNW-F1

Checked By: AMP

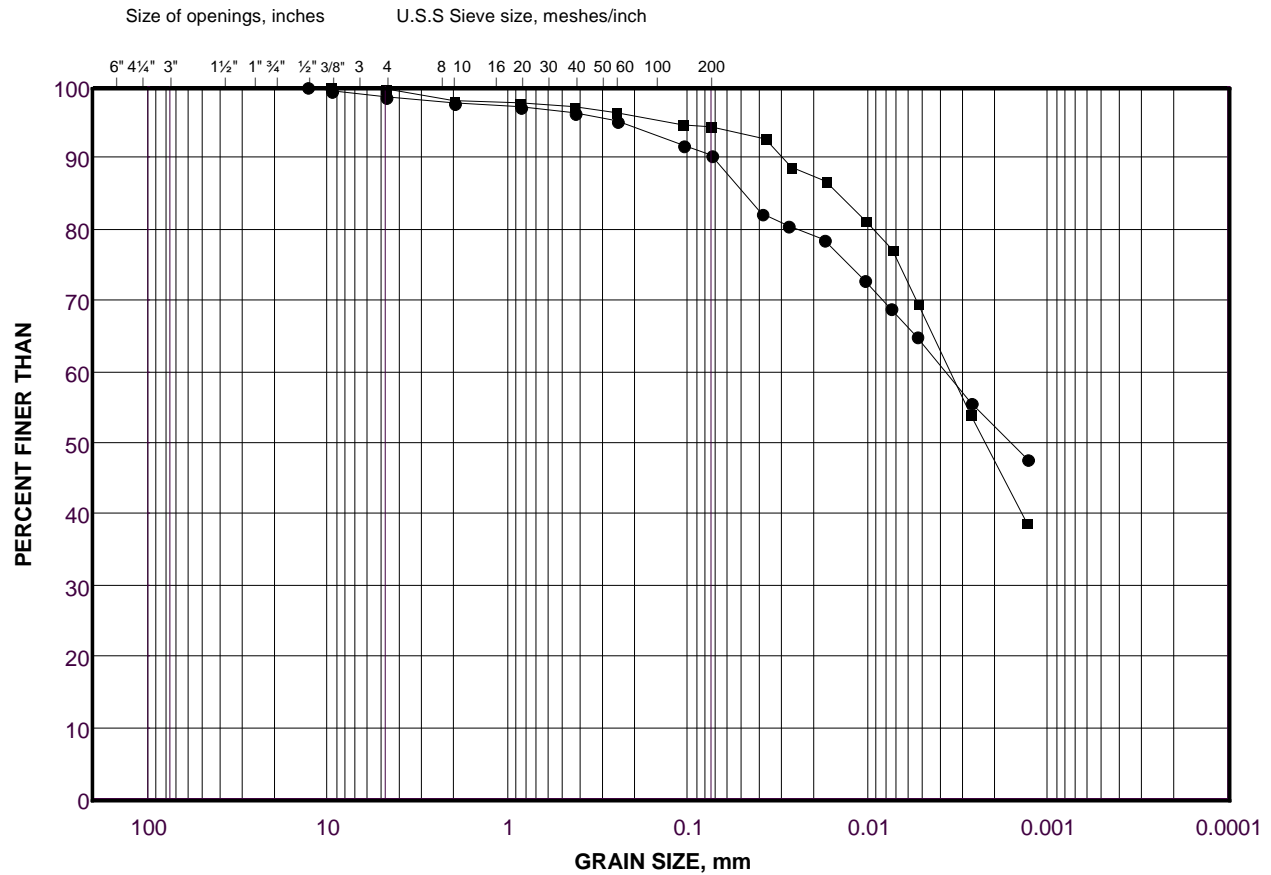
Golder Associates

Date: 17-May-22

GRAIN SIZE DISTRIBUTION

SILTY CLAY (CI)

FIGURE C-11



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WRO-4B	14	76.9
■	WRO-1	15	75.3

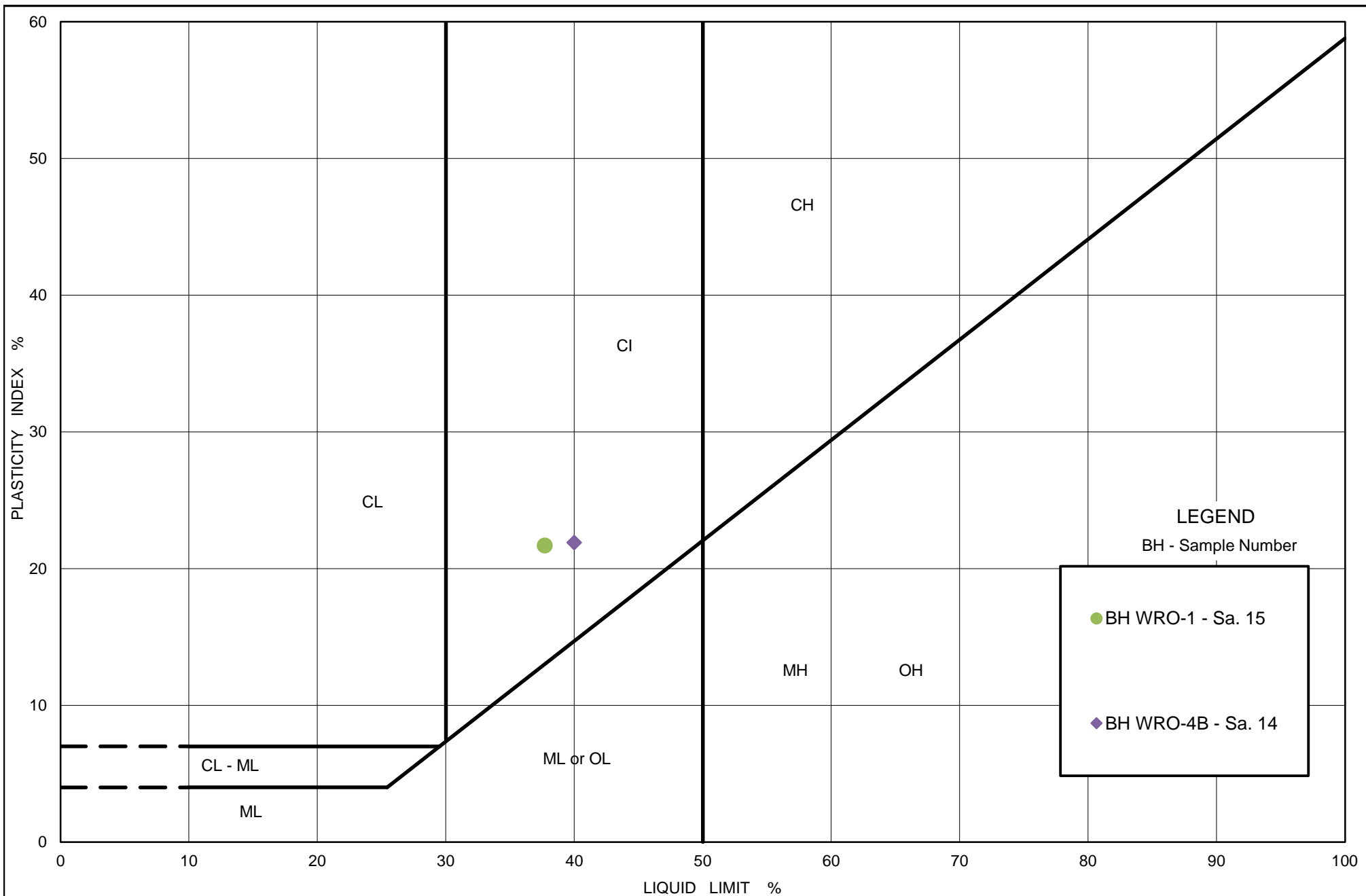
Project Number: 20350802-WNW-F1

Checked By: AMP

Golder Associates

Date: 17-May-22

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318)



PLASTICITY CHART

SILTY CLAY (CI)

Figure No.: C-12

Project No.: 20350802-WNW-F1

Checked By: AMP

April 20, 2022

Ms. Anastasia Poliacik
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Re: UCS testing
(Golder Project 20350802)

Dear Ms. Poliacik:

On February 9th and March 8th, 2022 one (1) and five (5) HQ-sized core samples were received by Geomechanica Inc. via drop off by Golder personnel, respectively. These samples were identified as being from Golder Project No. 20350802. From these samples, six (6) UCS specimens were prepared and tested.

Details regarding the steps of specimen preparation and testing along with the results and photographs of the test specimen before and after testing are presented in the accompanying laboratory report and summary spreadsheet(s).

Sincerely,



Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.
Tel: (647) 478-9767
Email: bryan.tatone@geomechanica.com

Rock Laboratory Testing Results

A report submitted to:

Anastasia Poliacik
Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario
Canada L5N 7K2

Prepared by:

Bryan Tatone, PhD, PEng
Omid Mahabadi, PhD, PEng
Geomechanica Inc.
#900-390 Bay St.
Toronto ON
M5H 2Y2 Canada
Tel: +1-647-478-9767
lab@geomechanica.com

April 20, 2022

Project number: 20350802

Abstract

This document summarizes the results of rock laboratory testing, including 6 Uniaxial Compressive Strength (UCS) tests. The UCS values along with photographs of specimens before and after testing are presented herein.

In this document:

1 Uniaxial Compressive Strength Tests	1
Appendices	3

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing. The testing was performed in Geomechanica's rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial displacement rate of approximately 0.150 mm/min (Figure 1). The specimen preparation and testing procedure included the following:

1. Unwrapping the core sample, inspecting it for damage, and re-wrapping it in electrical tape to preserve the moisture content and avoid potential damage during specimen preparation.
2. Diamond cutting the core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial load, and removing the electrical tape.
5. Axially loading the specimens to rupture while continuously recording axial force and axial deformation to determine the peak strength (UCS).



Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness

criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C.

1.2 Results

The results of UCS testing are summarized in Table 1. Additional specimen and testing details are available in the summary spreadsheet that accompanies this report.

Table 1: Summary of UCS test results.

Sample	Depth (m)	Bulk density ρ (g/cm ³)	UCS (MPa)	Lithology	Failure description
WRO-1, SA1	21.25 - 21.54	2.669	107.3	Brown shale	3
WRO-4, SA1	21.36 - 21.51	2.596	47.5	Brown shale	1
WRO-4, SA2	21.69 - 21.88	2.593	80.1	Brown shale	1
WRO-5, SA1	19.97 - 20.16	2.614	86.5	Brown shale	1
WRO-8, SA1	20.77 - 21.02	2.573	50.9	Brown shale	1, 2
WRO-8, SA2	21.02 - 21.28	2.567	53.9	Brown shale	3

¹ Inclined shear fracture and axial splitting failure

² Failure partly along pre-existing structure

³ Axial splitting failure

1.3 Specimen photographs



Photographs of the specimens before and after testing are presented in the Appendix of this report.

Appendices



Specimen sheets

- WRO-1, SA1
- WRO-4, SA1
- WRO-4, SA2
- WRO-5, SA1
- WRO-8, SA1
- WRO-8, SA2



Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802
Sample	WRO-1, SA1	Depth	21.25 - 21.54
<div>Specimen parameters</div>		Prior to testing	After testing
Diameter (mm) ^a	62.81		
Length (mm) ^a	128.67		
Bulk density ρ (g/cm ³)	2.669		
UCS (MPa)	107.3		
Lithology	Brown shale		
Failure description ^b	1		
<div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div> <div>^b Failure description: ¹ Axial splitting failure;</div>			
Remarks: Loading rate: 0.15 mm/min.			
Performed by	BSAT/HS	Date	2022-02-15

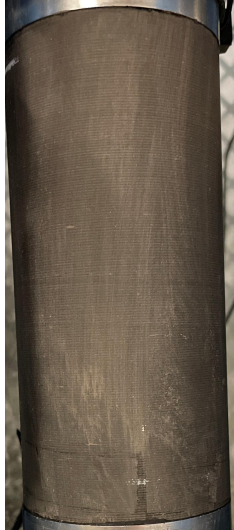

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802
Sample	WRO-4, SA1	Depth	21.36 - 21.51
<div>Specimen parameters</div> <div><div>Diameter (mm)^a</div><div>Length (mm)^a</div><div>Bulk density ρ (g/cm³)</div><div>UCS (MPa)</div><div>Lithology</div><div>Failure description^b</div><div></div></div>		<div>Prior to testing</div> <div></div>	<div>After testing</div> <div></div>
<div><div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div><div>^b Failure description: ¹ Inclined shear fracture and axial splitting failure;</div></div>			
Remarks: Loading rate: 0.15 mm/min.			
Performed by	HS/HS	Date	2022-03-15



Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802
Sample	WRO-4, SA2	Depth	21.69 - 21.88
<div>Specimen parameters</div> <div><div>Diameter (mm)^a</div><div>Length (mm)^a</div><div>Bulk density ρ (g/cm³)</div><div>UCS (MPa)</div><div>Lithology</div><div>Failure description^b</div></div>		<div>Prior to testing</div> <div></div>	<div>After testing</div> <div></div>
<div><div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div><div>^b Failure description: ¹ Inclined shear fracture and axial splitting failure;</div></div>			
Remarks: Loading rate: 0.15 mm/min.			
Performed by	HS/HS	Date	2022-03-15

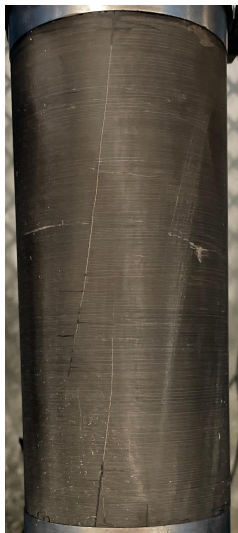

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802
Sample	WRO-5, SA1	Depth	19.97 - 20.16
<div>Specimen parameters</div>		Prior to testing	After testing
Diameter (mm) ^a	62.85		
Length (mm) ^a	131.27		
Bulk density ρ (g/cm ³)	2.614		
UCS (MPa)	86.5		
Lithology	Brown shale		
Failure description ^b	1		
<div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div> <div>^b Failure description: ¹ Inclined shear fracture and axial splitting failure;</div>			
Remarks: Loading rate: 0.15 mm/min.			
Performed by	HS/HS	Date	2022-03-15

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802												
Sample	WRO-8, SA1	Depth	20.77 - 21.02												
<div>Specimen parameters</div> <table><tr><td>Diameter (mm) ^a</td><td>62.75</td></tr><tr><td>Length (mm) ^a</td><td>130.46</td></tr><tr><td>Bulk density ρ (g/cm³)</td><td>2.573</td></tr><tr><td>UCS (MPa)</td><td>50.9</td></tr><tr><td>Lithology</td><td>Brown shale</td></tr><tr><td>Failure description ^b</td><td>1, 2</td></tr></table>		Diameter (mm) ^a	62.75	Length (mm) ^a	130.46	Bulk density ρ (g/cm ³)	2.573	UCS (MPa)	50.9	Lithology	Brown shale	Failure description ^b	1, 2	<div>Prior to testing</div> 	<div>After testing</div> 
Diameter (mm) ^a	62.75														
Length (mm) ^a	130.46														
Bulk density ρ (g/cm ³)	2.573														
UCS (MPa)	50.9														
Lithology	Brown shale														
Failure description ^b	1, 2														
<div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div> <div>^b Failure description: ¹ Inclined shear fracture and axial splitting failure; ² Failure partly along pre-existing structure;</div>															
Remarks: Loading rate: 0.15 mm/min. Specimen contained healed discontinuity.															
Performed by	HS/HS	Date	2022-03-15												

Uniaxial Compression Test

Client	Golder Associates Ltd.	Project	20350802
Sample	WRO-8, SA2	Depth	21.02 - 21.28
<div>Specimen parameters</div>		Prior to testing	After testing
Diameter (mm) ^a	62.71		
Length (mm) ^a	131.21		
Bulk density ρ (g/cm ³)	2.567		
UCS (MPa)	53.9		
Lithology	Brown shale		
Failure description ^b	3		
<div><div>^a Additional specimen measurement/details provided in accompanying summary spreadsheet.</div><div>^b Failure description: ³ Axial splitting failure;</div></div>			
Remarks: Loading rate: 0.15 mm/min. Specimen experienced pre-peak localized failure.			
Performed by	HS/HS	Date	2022-03-15

APPENDIX D

Analytical Laboratory Test Results



Your Project #: 20350802-ENW
Your C.O.C. #: 847598-39-01

Attention: Anastasia Poliacik

Golder Associates Ltd
100 Scotia Crt
Whitby, ON
CANADA L1N 8Y6

Report Date: 2022/03/11
Report #: R7038519
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C246239

Received: 2022/02/22, 15:15

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	6	2022/02/28	2022/02/28	CAM SOP-00463	SM 23 4500-Cl E m
Conductivity	6	2022/02/25	2022/02/25	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl2 EXTRACT	6	2022/02/24	2022/02/24	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	6	2022/02/23	2022/02/25	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	6	2022/02/28	2022/02/28	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas 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. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas 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 Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

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. When sampling is not conducted by Bureau Veritas, results relate to the supplied 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.



Your Project #: 20350802-ENW
Your C.O.C. #: 847598-39-01

Attention: Anastasia Poliacik

Golder Associates Ltd
100 Scotia Crt
Whitby, ON
CANADA L1N 8Y6

Report Date: 2022/03/11
Report #: R7038519
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C246239

Received: 2022/02/22, 15:15

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ankita Bhalla, Project Manager

Email: Ankita.Bhalla@bureauveritas.com

Phone# (905) 817-5700

=====

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.



BUREAU
VERITAS

Bureau Veritas Job #: C246239

Report Date: 2022/03/11

Golder Associates Ltd

Client Project #: 20350802-ENW

Sampler Initials: JS

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		RXI334	RXI335	RXI336	RXI337	RXI338	RXI339		
Sampling Date		2022/02/09 12:00	2022/02/17 12:00	2022/02/17 12:00	2022/02/15 12:00	2022/02/15 12:00	2022/02/11 12:00		
COC Number		847598-39-01	847598-39-01	847598-39-01	847598-39-01	847598-39-01	847598-39-01		
	UNITS	NNW2-SA4	NNW7-SA2	NNW8-SA3	SNW1-SS2	SNW2-SA3	SNW4-SA2	RDL	QC Batch

Calculated Parameters									
Resistivity	ohm-cm	1300	5300	2700	3200	1200	1100		7846790
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	390	<20	110	41	400	360	20	7855222
Conductivity	umho/cm	745	188	377	309	848	895	2	7852335
Available (CaCl2) pH	pH	7.75	7.69	7.90	7.73	7.94	7.89		7849981
Soluble (20:1) Sulphate (SO4)	ug/g	<20	<20	<20	<20	<20	<20	20	7855228
RDL = Reportable Detection Limit									
QC Batch = Quality Control Batch									



BUREAU
VERITAS

Bureau Veritas Job #: C246239

Report Date: 2022/03/11

Golder Associates Ltd

Client Project #: 20350802-ENW

Sampler Initials: JS

TEST SUMMARY

Bureau Veritas ID: RXI334
Sample ID: NNW2-SA4
Matrix: Soil

Collected: 2022/02/09
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslina Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI335
Sample ID: NNW7-SA2
Matrix: Soil

Collected: 2022/02/17
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslina Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI336
Sample ID: NNW8-SA3
Matrix: Soil

Collected: 2022/02/17
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslina Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI337
Sample ID: SNW1-SS2
Matrix: Soil

Collected: 2022/02/15
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslina Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI338
Sample ID: SNW2-SA3
Matrix: Soil

Collected: 2022/02/15
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran



BUREAU
VERITAS

Bureau Veritas Job #: C246239

Report Date: 2022/03/11

Golder Associates Ltd

Client Project #: 20350802-ENW

Sampler Initials: JS

TEST SUMMARY

Bureau Veritas ID: RXI338
Sample ID: SNW2-SA3
Matrix: Soil

Collected: 2022/02/15
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan

Bureau Veritas ID: RXI339
Sample ID: SNW4-SA2
Matrix: Soil

Collected: 2022/02/11
Shipped:
Received: 2022/02/22

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7855222	2022/02/28	2022/02/28	Alina Dobreanu
Conductivity	AT	7852335	2022/02/25	2022/02/25	Kien Tran
pH CaCl2 EXTRACT	AT	7849981	2022/02/24	2022/02/24	Taslima Aktar
Resistivity of Soil		7846790	2022/02/25	2022/02/25	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7855228	2022/02/28	2022/02/28	Avneet Kour Sudan



BUREAU
VERITAS

Bureau Veritas Job #: C246239

Report Date: 2022/03/11

Golder Associates Ltd

Client Project #: 20350802-ENW

Sampler Initials: JS

GENERAL COMMENTS

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

Package 1	1.3°C
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Revised Report [2022/03/11]: Sample IDs amended as per COC.

Results relate only to the items tested.



QUALITY ASSURANCE REPORT

QA/QC Batch	Init	QC Type	Parameter	Date Analyzed	Value	Recovery	UNITS	QC Limits
7849981	TAK	Spiked Blank	Available (CaCl ₂) pH	2022/02/24		100	%	97 - 103
7849981	TAK	RPD	Available (CaCl ₂) pH	2022/02/24	0.059		%	N/A
7852335	KIT	Spiked Blank	Conductivity	2022/02/25		101	%	90 - 110
7852335	KIT	Method Blank	Conductivity	2022/02/25	<2		umho/cm	
7852335	KIT	RPD	Conductivity	2022/02/25	0.85		%	10
7855222	ADB	Matrix Spike	Soluble (20:1) Chloride (Cl ⁻)	2022/02/28		NC	%	70 - 130
7855222	ADB	Spiked Blank	Soluble (20:1) Chloride (Cl ⁻)	2022/02/28		102	%	70 - 130
7855222	ADB	Method Blank	Soluble (20:1) Chloride (Cl ⁻)	2022/02/28	<20		ug/g	
7855222	ADB	RPD	Soluble (20:1) Chloride (Cl ⁻)	2022/02/28	3.5		%	35
7855228	AKD	Matrix Spike	Soluble (20:1) Sulphate (SO ₄)	2022/02/28		148 (1)	%	70 - 130
7855228	AKD	Spiked Blank	Soluble (20:1) Sulphate (SO ₄)	2022/02/28		112	%	70 - 130
7855228	AKD	Method Blank	Soluble (20:1) Sulphate (SO ₄)	2022/02/28	<20		ug/g	
7855228	AKD	RPD	Soluble (20:1) Sulphate (SO ₄)	2022/02/28	NC		%	35

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).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.



BUREAU
VERITAS

Bureau Veritas Job #: C246239

Report Date: 2022/03/11

Golder Associates Ltd

Client Project #: 20350802-ENW

Sampler Initials: JS

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



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