FINAL REPORT

GEOTECHNICAL INVESTIGATION

Proposed renovations to Cisco campus - 2000 and 3000 Innovation Drive

Submitted to:

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Distribution List

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by CBRE Limited (herein as the Client) to conduct a geotechnical, environmental (Phase One ESA) and geophysical investigation in support of the proposed renovations to Cisco campus located at 2000 and 3000 Innovation Drive, Ottawa, Ontario. The work was carried out in general conformance with the Terms of Reference 306789-ARUP-STR-RPT-ALL provided, and WSP Proposal number 2025CA430115-Rev1, dated July 29, 2025. The approximate location of the site is shown on the Key Map on the attached Site Plan (Figure 1).

The purpose of the investigation was to assess subsurface soil and groundwater conditions at selected locations within the Site, by means of several boreholes, and associated laboratory testing. The subsurface conditions obtained from the previous and current investigation and available project details were used to prepare geotechnical recommendations for the associated design aspects of the project, including construction considerations which could influence design decisions.

An environmental assessment (Phase One ESA) and geophysical surveys were completed at the same time as the present geotechnical investigation. The results of the environmental assessment are provided in a separate report. The results of the geophysical investigation are provided in Appendix E and F.

This report should be read in conjunction with the attached "*Important Information and Limitations of This Report*" which follows the text but forms an integral part of this document. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2 DESCRIPTION OF PROJECT

The project site is located in Kanata North, Ontario, and consists of two existing two-storey buildings at 2000 and 3000 Innovation Drive. These buildings belong to the Cisco Ottawa Development Centre and were constructed in the year 2000. The project site is bordered to the west, east, and south by parking lots and Innovation Drive, and to the north by grassed areas, parking lots, and existing buildings. Both buildings are rectangular in shape and measure approximately 80 m in length, 59 m in width, and 9 m in height.

It is understood from the RFP that both buildings are constructed using reinforced concrete, including the roof structures, and feature slabs-on-grade without basements. The buildings are supported on shallow spread footings, arranged in a typical grid spacing of 6.6 m x 8.69 m. The lateral resisting system and the perimeter foundation walls rest on shallow continuous strip footings. The slabs-on-grade, perimeter foundation wall footings, and typical interior footings are founded at approximate elevations of 88.90 m, 87.35 m, and 88.22 m geodetic, respectively.

Based on the information provided, the Client is planning renovations or extension and the added mass will require reinforcing the second floor, roof, and shear wall structures. Underpinning of existing foundation elements may therefore be required. Moreover, parts of the existing 150 mm-thick slab-on-grade will likely be replaced with a structural bearing slab to handle loadings of up to 12 kPa.

The details of the proposed renovations, foundations, loadings, etc. have been provided to WSP, and are therefore not known at the time of this report.

3 DESKTOP REVIEW

Golder Associates (now a member of WSP Canada Inc., herein referred to as WSP) has previously carried out several investigations at this site and is familiar with the existing ground conditions. WSP has reviewed relevant previous investigation reports, including the following:

- Golder Report No. 991-2238 titled: “Geotechnical Investigation, Proposed Cisco Systems Development, Northtech Park, Kanata, Ontario”, dated January 2000;

- Golder Report No. 001-2075 titled: “Geotechnical Investigation, Proposed Cisco Systems, Building 2, Northtech Park, Kanata, Ontario”, dated June 2000;

- Golder Report No. 001-2129 titled: “Geotechnical Investigation, Proposed Cisco Systems, Building 3, Northtech Park, Kanata, Ontario”, dated August 2000;

- Golder Report No. 001-2129A titled: “Geotechnical Investigation, Proposed Cisco Systems, Buildings 4, 5 and Parking Garage, Northtech Park, Kanata, Ontario”, dated August 2002, and

- Golder Report No. 08-1121-0122 titled: “Geotechnical Investigation, Proposed Generator Building, 5050 Innovation Drive, Ottawa, Ontario”, dated January 2011.

WSP reviewed the existing information available for the site including the following documents provided by the Client:

- A set of As-Built Drawings titled "Building No.1 Northtech Campus. Innovation Drive, Kanata, Ontario", dated April 7, 2000.

- A set of As-Built Drawings titled "Building No.2 Northtech Campus. Innovation Drive, Kanata, Ontario", dated January 26, 2001.

3.1 Physiography

Published surficial geology mapping of the study area from Geological Survey of Canada (2019) was reviewed for the desktop assessment. The map sources indicates that the site lies within the physiographic unit of Great Lakes – St. Lawrence Lowlands[1].

3.2 Published Geological Information

Based on the surficial geology maps of Southern Ontario published by the Ontario Geological Survey (as well as previous investigations) the Site is expected to be underlain by fine-textured glaciomarine deposits (silt and clay, with minor sand and gravel).

Based on the bedrock geology map of Ontario published by OGS, the bedrock beneath the project site is expected to comprise dolostone or sandstone of the Beekmantown Group.

3.3 Subsurface Information from Golder Report No. 991-2238

A previous geotechnical investigation was completed by Golder Associates Ltd. in 2000 at the site located at 2000 Innovation Drive, Kanata, ON. The results of the investigation were presented in Golder Report No. 991-2238, entitled *“Geotechnical Investigation, Proposed Cisco Systems Development, Northtech Park, Kanata, Ontario”* and dated January 2000. Borehole record sheets from that report are included in Appendix I.

During that investigation, a total of nine boreholes designated as BH99-201, BH99-201A, BH99-202 to BH99-204, BH99-204A, BH99-205, and BH99-206 were drilled in an undeveloped lot. The boreholes were advanced to

[1] Geological Survey of Canada, 2019. The Atlas of Canada – Physiographic Regions. <**Physiographic Regions | Natural Resources Canada**>. Accessed October 14, 2025.

depths ranging from 5.9 m bgs to 14.4 m bgs. The borehole records indicate that the subsurface materials at the site comprised topsoil overlying a weathered crust, underlain by grey silty clay, glacial till, and bedrock. Refusal (presumed bedrock) was encountered only in borehole BH99-200 at a depth of 14.4 m below the existing (at the time) surface. Groundwater levels were measured in boreholes BH99-202 and BH99-205 at depths of 1.0 to 1.5 m below the existing ground surface.

The weathered crust was encountered at depths ranging from 0.1 m to 0.4 m, and extended to depths of 3.9 m to 4.9 m. The results of in-situ shear vane testing within this layer indicated undrained shear strengths greater than 96 kPa, indicating a stiff consistency.

Unweathered grey clay was encountered below the silty clay and extended to depths ranging from 5.9 m to 12.0 m. The results of in-situ shear vane testing indicated undrained shear strengths from 27 kPa to 38 kPa, indicating a firm consistency.

A layer of glacial till was encountered below the grey clay in borehole BH99-200 only. The layer consisted of sandy till with cobbles and was about 2.4 m in thickness.

3.4 Subsurface Information from Golder Report No. 001-2075

A previous geotechnical investigation was completed by Golder Associates Ltd. in 2000 at the site located at 3000 Innovation Drive, Kanata, ON. The results of the investigation were presented in Golder Report No. 001-2075, entitled *“Geotechnical Investigation, Proposed Cisco Systems Development, Building2, Northtech Park, Kanata, Ontario”* and dated June 2000. Borehole record sheets from that report are included in Appendix I.

During that investigation, a total of six boreholes designated as BH 00-1 to BH 00-6 were drilled in an undeveloped lot. The boreholes were advanced to depths ranging from 4.4 m to 7.6 m. The borehole records indicate that the subsurface materials at the site comprised topsoil overlying a weathered crust, underlain by grey silty clay, glacial till, and bedrock. Refusal (presumed bedrock) was encountered only in borehole BH 00-2, 00-3, and 00-6 at a depth ranging from 6.4 m to 7.2 m. The groundwater level was measured in borehole BH 00-1 at depth of 2.1 m below the existing ground surface.

The weathered crust was encountered at depths ranging from 0.1 m to 0.3 m and extended to depths of 3.3 m to 4.8 m. The results of in-situ shear vane testing within this layer indicated undrained shear strengths greater than from 95 kPa, indicating a stiff consistency.

Unweathered grey clay was encountered below the silty clay and extended to depths ranging from 4.4 m to 7.6 m. The results of in-situ shear vane testing indicated undrained shear strengths from 40 kPa to 55 kPa, indicating a firm to stiff consistency.

A layer of very loose to dense glacial till was encountered below the grey clay in borehole BH 00-1, BH 00-2 and BH 00-6.

4 GEOTECHNICAL INVESTIGATION PROCEDURE

4.1 Utility Locates

Prior to commencing the intrusive site investigation activities, WSP conducted a Site visit on September 7, 2025, in order to lay out and clear the proposed borehole locations of any underground utilities. WSP retained the services of USL-1 to identify the location of public and private subsurface utilities within the proposed investigation areas to reduce the risk of encountering buried utilities during daylighting and drilling works. All boreholes were cleared out underground utilities and a stakeout report was provided to WSP prior to mobilizing on site.

4.2 Hydro-Vac Excavation Investigation

Following WSP's review of the underground utility survey reports and given the significant number of buried services within the Site, hydrovac excavation was required at five locations (BH25-02, BH25-04, BH25-06, BH25-08, and BH25-09, see Figure 1), from ground surface to about 1.9 m depth, to confirm the absence of buried utilities at the proposed drilling locations. The hydrovac excavation was carried out on September 24, 2025 by Badger Daylighting Limited.

At the end of the hydrovac excavation, all holes were backfilled with imported engineered fill (sand and gravel), and the asphalt surface was reinstated with compacted cold patch.

4.3 Drilling Investigation

The drilling program for the current geotechnical investigation was carried out between September 22 and 30, 2025 and included advancing nine boreholes (BH25-01 to BH25-09). The approximate borehole locations are shown on the site plan attached as Figure 1.

The boreholes were advanced with a CME-75 truck-mounted drill rig supplied and operated by George Downing Estate Drilling of Grenville-sur-la-Rouge, Quebec.

Soil samples were obtained during drilling using a 35 mm inside diameter split-spoon sampler driven using a 63.5 kg hammer, dropped from a height of 760 mm, in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Soil samples were obtained at sampling intervals of about 0.76 m, where possible.

All boreholes were advanced through engineered fill and native soil to refusal on cobbles/boulders or bedrock at depths ranging from 2.1 m (~EL. 84.94 m) to 14.9 m (~ 73.35 m) below the existing ground surface. Bedrock was cored at borehole BH25-06 only and NQ-sized bedrock core samples were obtained using a rotary diamond drilling technique up to a depth of 12.1 m or approximately 74.88 m elevation.

Monitoring wells were installed in boreholes BH25-06 and BH25-07 to allow for measurement of the groundwater levels in the soil overburden and bedrock. The monitoring wells comprised 50 mm inside diameter (ID) rigid PVC pipe with a 3.0 m long slotted screen section. The screen sections were backfilled with silica sand and then sealed above with bentonite hole plug. WSP personnel measured the groundwater levels within the monitoring wells on October 8 and 24, 2025.

All fieldwork was supervised by WSP’s geotechnical staff who logged the boreholes, directed in-situ testing, and collected soil and rock samples retrieved in the boreholes. On completion of the drilling operations, the soil and core samples were transported to WSP’s Ottawa laboratory for further examination, and for selective laboratory testing. Chemical analyses were completed by Eurofins Environment Testing.

The borehole coordinates and existing ground surface elevations were measured using a Trimble R10 GPS survey unit. The geodetic elevation reference system used for the survey is the North American datum of 1983 (NAD83-CSRS). The borehole coordinates are based on the Universal Transverse Mercator (UTM Zone 18) coordinate system.

4.4 Laboratory Testing

The following laboratory tests were carried out on selected materials (soil, rock) from the boreholes; tests are conducted in general accordance with applicable ASTM standards.

- Natural water content (61 tests) - ASTM D2216
- Grain size distribution (7 tests) - ASTM D422
- Atterberg Limits (10 tests) - ASTM D4318
- Oedometer (1 test) – ASTM D2435
- Uniaxial Compressive Strength (2 tests) – ASTM D7012 Method C

In addition, chemical analyses of corrosivity parameters in four soil samples were performed. Analytes included soluble sulphate, chloride, Electrical Conductivity, Resistivity, and pH.

The geotechnical laboratory test reports are summarized in the borehole logs in Appendix A and also included in Appendix B and C, except consolidation results, which will be included in the final version of the report. Basic chemical analysis reports are included in Appendix D.

5 SUBSURFACE CONDITIONS

5.1 General

The Record of Borehole sheets in Appendix A describes the subsurface conditions at the boreholes' locations only. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and, therefore, represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface soil, bedrock, and groundwater conditions will vary between and beyond the boreholes' locations.

5.2 Summary of Subsurface Stratigraphy

Based on the results of the borehole investigation, the general subsurface stratigraphy at the project site consists of topsoil or asphalt, underlain by granular fill over weathered crust, overlying grey clay, thin layer of glacial till, over bedrock.

Further descriptions of the soil and bedrock layers encountered during current investigation are provided in the subsections below.

5.2.1 Asphaltic Concrete

Asphalt concrete surface material was encountered at borehole BH25-06 and BH25-08 only. The asphalt thickness was found to be 80 mm and 110 mm at borehole BH25-06 and BH25-08, respectively. The asphalt was underlain by granular fill. The asphalt thickness is summarized below in Table 1:

Table 1: Summary of Pavement Structure

Borehole ID.	Asphalt Thickness (mm)	Base/Subbase Materials
BH25-06	80	Granular
BH25-08	110	Gravel with sand

5.2.2 Topsoil

A layer of topsoil at the surface was observed at all boreholes except boreholes BH25-06 and BH25-08. The topsoil thickness at the borehole locations ranged from 100 mm to 460 mm.

5.2.3 Granular Fill

Fill consisting of a variety of soil types ranging from silty sand to gravel with sand, were encountered at ground surface in boreholes BH25-01, BH25-03, BH25-05, BH25-07 and BH25-09. Granular fill was also encountered beneath asphalt at Boreholes BH25-06 and BH25-08. The cohesionless fill at these borehole locations extended to depths ranging from about 0.4 to 1.4 m (~El. 86.7 to 86.1). SPT 'N' values in the cohesionless fill ranged from 11 to 16 blows per 0.3 m of penetration, indicating a compact state of packing.

The natural moisture content measured in selected samples of the fill ranged from 1% to 13%. Two samples of the fill were submitted for laboratory grain size distribution analysis, and samples were found to contain 3% to 20% gravel, 27% to 55% sand, and 24% to 69% fines (i.e., silt and clay). Results of grain size distribution analyses are provided on Figures C2 and C8 in Appendix C, and summarized as follows.

Table 2: Results of Grain Size Distribution Analysis for Fill Samples

Borehole ID	Sample No.	Sampling Depth (m)	Grain Size Distribution			
			% Gravel	% Sand	% Silt	% Clay
BH25-01	2	0.7 – 1.3	3.3	27.4	69.3	
BH25-03	2	0.7 – 1.3	20.1	55.5	24.4	

5.2.4 Lean to Fat Clay (Weathered Crust)

A layer of lean to fat clay with low plasticity clayey fines was encountered below the in all boreholes. This layer extended to depths ranging from 2.9 m to 4.6 m (~El. 84.1 to 82.6). The lean clay crust was grey-brown in colour. The SPT 'N' values recorded in this layer range from 19 to 2 blows per 0.3 m of penetration. Field shear strength within the weathered crust was not measured during the current investigation, as the strength of the weathered crust typically exceeds the limits of the test (96 kPa). Based on our experience in the area, the weathered crust typically has an drained shear strength in excess of 100 kPa (which has been assumed in the subsequent analyses).

The natural moisture content measured on selected samples of the weathered crust ranged from 32% to 63%. The results of Atterberg limits testing completed on 3 samples of this material indicated Liquid Limit ranging from 40% to 52%, Plastic Limit ranging from 21% to 22%, and a Plasticity Index ranging from 31% to 43%. Atterberg limits test results indicate weathered crust (CH) of high plasticity. Results are illustrated on Figures C3, C9, and C15 in Appendix C, and summarized as follows.

Table 3: Results of Atterberg Limits Testing on Lean to Fat Clay (Weathered Crust)

Borehole ID	Sample No.	Sampling Depth (m)	Moisture Content (%)	Atterberg Limits (%)			
				W_L	W_P	PI	LI
BH25-01	4	2.1 – 2.7	40.5	58	21	37	0.53
BH25-03	5	3.0 – 3.6	52.6	65	22	43	0.71
BH25-06	4	2.3 – 2.9	52.4	52	21	31	1.01

5.2.5 Fat Clay (Unweathered Clay)

A fat clay was encountered below the upper lean clay in all boreholes. It was generally grey in colour and of high plasticity. The layer extended to depths ranging from 5.8 m to 12.2 m (~El. 83.2 to 82.6 m). SPT 'N' values recorded in this layer ranged from weight of hammer to 2 blows per 0.3 m of penetration. Field shear vane testing performed in this fat clay deposit indicated undrained shear strength values ranging from 34 kPa to 95 kPa, indicating a firm to stiff consistency. Undrained shear strength values were typically observed to increase with depth

Remoulded undrained shear strength values ranged from 2 kPa to 13 kPa and the evaluation of the sensitivity of the fat clay (i.e., ratio of intact to remoulded undrained shear strength) yields values ranging from less than 8 to 30. According to the classification of typical sensitivity values (Canadian Foundation Engineering Manual, Fifth Edition), these values indicates that the cohesive soils encountered in the boreholes are classified as low to medium sensitive.

One consolidation test was carried out on relatively undisturbed Shelby tube samples collected in Borehole BH25-04 at a depth of about 6.2 mbgs. The results of the test will be included in the final report.

The natural moisture content measured on selected samples of the fat clay ranged from 43% to 66%. The results of Atterberg limits testing completed on 8 samples of this material indicated Liquid Limit ranging from 48% to 61%, Plastic Limit ranging from 20% to 23%, and a Plasticity Index ranging from 28% to 38%. Atterberg limits test results indicate fat clay (CH) of medium to high plasticity. Results are illustrated on Figures C4, C5, C10, C16, C17, C19, C20, and C24 in Appendix C, and summarized as follows.

Table 4: Results of Atterberg Limits Testing on Fat Clay (Unweathered Clay)

Borehole ID	Sample No.	Sampling Depth (m)	Moisture Content (%)	Atterberg Limits (%)			
				W_L	W_P	PI	LI
BH25-01	8	5.3 – 5.9	58.7	56	20	36	1.07
BH25-01	13	9.1 – 9.7	65.0	59	21	38	1.16
BH25-03	8	6.8 – 7.4	55.2	54	22	32	1.04
BH25-06	6	3.8 – 4.4	50.9	52	20	32	0.97
BH25-06	10	6.8 – 7.4	52.7	53	21	32	0.99
BH25-07	8	4.5 – 5.2	62.3	61	23	38	1.03
BH25-07	12	7.6 – 8.2	52.1	53	21	32	0.97
BH25-09	14	10.6 – 11.2	50.3	48	20	28	1.08

5.2.6 Glacial Till

A deposit of glacial till comprised of a mixture of sandy clayey silt and silty sand with gravel was encountered below the fat clay at depths ranging from 6.8 m (~El. 81.94 m) to 12.2 m (~El. 74.90 m). This layer is mostly wet and contains low plasticity fines. The sandy clayey silt layer extended to about 15.3 mbgs (~El. 71.73 m) in Borehole BH25-09. SPT 'N' values in this layer were 4 to 50 blows per 0.3 m of penetration, indicating a loose to very dense state of packing.

The natural moisture content measured on selected samples of glacial till ranged from 10% to 49% based on laboratory tests. The results of grain size distribution testing carried out on six samples of the glacial till are presented in Figure C6, C11, C12, C22, C25 and C26 in Appendix C.

Table 5: Results of Grain Size Distribution Test for the Glacial Till

Borehole ID	Sample No.	Sampling Depth (m)	Grain Size Distribution			
			% Gravel	% Sand	% Silt	% Clay
BH25-01	15	10.6 – 11.2	11.6	50.5	37.9	
BH25-03	11	10.6 – 11.2	16.6	42.3	41.1	
BH25-03	12	12.2 – 12.8	3.0	45.7	51.3	
BH25-08	10	9.1 – 9.7	14.4	44.8	40.8	
BH25-09	15	12.2 – 12.8	11.5	41.8	46.7	
BH25-09	16	13.7 – 14.3	15.0	50.6	34.4	

5.2.7 Refusal

Refusal was encountered at all boreholes except BH25-05, at depths ranging from 6.9 m to 15.3 m (~El. 81.81 m to El. 71.72 m). Refusal to augering could be an indication of the presence of boulders/cobbles, very dense soil or the bedrock surface.

Table 6: Summary of Auger Refusal

Borehole ID	Ground Surface Elevation (m)	Depth to Refusal (m)	Refusal Elevation (m)
BH25-01	89.1	11.6	77.5
BH-25-02	88.8	8.2	80.6
BH25-03	88.3	14.9	73.4
BH25-04	88.7	6.9	81.8
BH25-06	87.1	9.2	77.9
BH25-07	87.0	11.8	75.2
BH25-08	87.2	9.8	77.5
BH25-09	87.1	15.4	71.7

Borehole BH25-05 was terminated at about 2.1 mbgs (~El. 84.94 m) on top of a buried pipe.

5.2.8 Bedrock

Borehole BH25-06 was advanced to refusal at a depth of 9.2 m (~EL. 77.9 m). The borehole was then cored using rotary diamond drilling after auger refusal to confirm bedrock. The bedrock coring was extended to a depth of about 12.1 m (~El. 75.1 m) while retrieving N sized core.

Table 7 which follows, summarizes ground surface elevations and the depth and elevation of the bedrock.

Table 7: Summary of Depths/Elevations to Bedrock

Borehole ID	Ground Surface Elevation (m)	Depth to Top of Bedrock (m)	Elevation to Top of Bedrock (m)	Core Length (m)	Depth to Bottom of Borehole (m)	Elevation of Bottom of Borehole (m)
BH25-06	87.1	9.2	77.9	2.9	12.1	75.0

The bedrock encountered in the cored borehole (BH25-06) was described as fresh to slightly weathered, thickly to very thickly bedded, medium-coarse grained, non-porous, light greyish pink granite. Photographs of the recovered bedrock cores are presented on Figure B1 and B2 of Appendix B.

Total Core Recovery (TCR) was 100%. Solid Core Recovery (SCR) ranged between about 84 and 98%. RQD values ranged between about 80 and 83% indicating good rock quality. The results of UCS tests carried out on two core specimens of the bedrock were 85 MPa and 141 MPa. The results of the UCS test are provided in Figure B3 in Appendix B.

5.3 Groundwater Condition

The groundwater levels in the monitoring well in Borehole BH25-06 and BH25-07, taken on October 24, 2025, are summarized below in Table 8.

Table 8: Summary of Groundwater Levels in Monitoring Wells

Borehole ID	Screened Zone	Groundwater Depth measured on October 24, 2025 (mbgs)	Elevation (m)[1]
BH25-06	Clay	2.4	84.6
BH25-07	Clay	2.6	84.3

Note: (1) Elevation is geodetic, in metres (m), per NAD 83.

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels or shallow perched water are expected during wet periods of the year, such as spring and fall.

5.4 Basic Chemical Analyses

Four samples of soil from Boreholes BH25-01, BH25-04, BH25-05 and BH25-09 were submitted to Eurofins Environmental testing for basic chemical analysis related to potential sulphate attack on buried concrete elements, corrosion of buried ferrous elements. The results of this testing are provided in Appendix D and are summarized below in Table 9.

Table 9: Summary of Basic Chemical Analyses Results on Soil Samples

Borehole ID	Sample Number	Depth Intervals (m)	Chlorides (%)	Sulphates (%)	pH	Resistivity (Ohm-cm)	Electrical Conductivity (mS/cm)
BH25-01	3	1.5 – 2.1	0.152	0.01	7.87	730	1.37
BH25-04	3	3.0 – 3.6	0.043	<0.01	7.50	1190	0.84
BH25-05	3	1.5 – 2.1	0.046	<0.01	7.57	1176	0.85
BH25-09	5	2.3 – 2.9	0.049	0.01	7.66	971	1.03

5.5 Geophysical Surveys

Geophysical surveys, including soil including soil resistivity surveys and Multi-channel MASW (Multichannel Analysis of Surface Waves), were conducted by WSP personnel on September 5, 2025. The results of the survey are provided in Appendix E and F of this report.

5.6 Environmental Considerations

The following section presents the findings of the limited screening level environmental soil quality testing undertaken in conjunction with the geotechnical investigation.

5.6.1 Applicable Regulatory Criteria

Given that the Site is consists of a commercial office building and parking, soil quality for beneficial on-Site reuse was compared against the following site condition standard:

- MECP Table 3: Full Depth Generic Site Condition Standards for Industrial/Commercial/Community Property (I/C/C) Use, O. Reg. 153/04 (Table 3 Site Condition Standards (SCS))

Soil quality results were also compared against the following Excess Soil Quality Standards (ESQS), as provided under Ontario Regulation 406/19 – Excess Soil Regulation for consideration in the event of off-Site beneficial reuse. It is noted that the following ESQS standard were selected for comparison as a commonly applicable ESQS for local reuse sites. The actual ESQS applicable will be determined once a reuse site is identified, if any.

- ESQS Table 1: Full Depth Background Site Condition Standards for Residential/Parkland/Institutional/ Industrial/Commercial/Community Property (R/P/I/I/C/C) Use, O. Reg. 153/04 (Table 1 Site Condition Standards (SCS))
- ESQS Table 2.1: Full Depth Excess Soil Quality Standards in a Potable Ground Water Condition for Residential/Parkland/Institutional (R/P/I) Property Use (Table 2.1 ESQS)

5.6.2 Soil Quality Results

As part of the soil quality investigation, WSP collected, and submitted for analysis, three soil samples from two of the geotechnical boreholes located with the two Areas of Potential Environmental Concern (APEC) on the Site. These samples included BH25-01 SA1B (granular fill), BH25-01 SA2 (silty clay) and BH25-07 SA2 (silty clay). The samples were analysed for the following chemicals of concern associated with the APEC (transformers and diesel storage) along with metals and inorganics to satisfy the minimum testing requirements under Ontario Regulation 406/19.

- Petroleum hydrocarbons (PHCs F1-F4)
- Benzene, toluene, ethylbenzene and xylene (BTEX)
- Metals
- Inorganics

Sample results compared to their respective criteria is included in the soil quality table and laboratory reports in Appendix G and H.

<u>On-Site reuse (Ontario Regulation 153/04)</u>**:**

In comparison to Table 3 SCS, two exceedances were identified as follows,

- Vanadium: BH25-01 SA2
- Sodium adsorption ratio (SAR) and electrical conductivity (EC): BH25-01 SA2

It is considered that the vanadium is within an acceptable range to be considered naturally occurring and therefore meeting the Table 3 SCS. Additionally, where an exceedance is directly related to the application of salt for safety purposes (i.e. EC/SAR) is considered as meeting the Table 3 SCS. Therefore, soil excavated from the Site is suitable for reuse on the Site. Additionally, there was no evidence of impacts associated with the APECs in any of the samples.

<u>Off-Site reuse (Ontario Regulation 406/19):</u>

In comparison to the two comparative ESQS (Table 1 (background) and Table 2.1 (RPI), the following exceedances were identified

- SAR: BH25-01 SA1B and BH25-01 SA2
- EC: BH25-01 SA2
- Barium: BH25-01 SA2 and BH25-07 SA2
- Chromium and BH25-01 SA2
- Vanadium: BH25-01 SA2 and BH25-07 SA2

6 GEOTECHNICAL DISCUSSION

This section of the report provides geotechnical recommendations and comments for the design of the proposed building renovations and expansion based on our interpretation of the subsurface information and the project requirements.

The information in this portion of the report is provided for the geotechnical planning and design purposes by the design engineers. Where comments are made on construction, they are provided only to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, costs, sequences, schedules, equipment and other resource requirements, and safety.

The geotechnical recommendations herein are provided in general conformance with the requirements of the National Building Code of Canada 2020 (NBCC 2020) and excerpts of the Ontario Building Code (OBC 2024) where relevant.

The project comprises renovations and potential expansion of the existing building. Details of the proposed renovations or expansions are not known at this time. It is, however, understood that the proposed expansion may result in additional loading of the existing foundations including new vertical stair and escalator, and/or the requirement for new foundations both within the existing building footprint and around the exterior of the building(s).

It is understood that significant grade changes are not required, and that basements are not currently envisioned for the proposed works. Considerations for foundation design are discussed below.

6.1 Frost Protection

6.1.1 Frost Penetration Depth

The frost penetration depth at the project site is estimated to be 1.8 mbgs based on Ontario Provincial Standard Drawing (OPSD) 3090.101.

6.1.2 Frost cover Requirements

The upper existing fill and native clay layers at the project site are considered to be frost susceptible. All unheated and partially heated foundation elements (including exterior side slabs and footings) should be protected against frost heave by providing a minimum of 1.8 m soil cover or with the use of rigid insulation.

6.1.3 Rigid Insulation Requirements

If insulation is used in place of frost cover insulated footings should have a minimum depth of 0.76 m below the finished exterior grade, in accordance with Canadian Foundation Engineering Manual (CFEM 2023). A minimum of 75 mm of rigid insulation should be used to insulate the foundation wall extending from 0.3 m above the ground surface to the top of the footing pad and then extending horizontally to a minimum length of 1.2 m for footings supporting heated structures and 2.4 m for footings supporting unheated structures.

For footing depths deeper than 0.76 m, the horizontal extent of insulation may be reduced in linear interpolation so that insulation will not be required at depth of 1.8 m. For example, if the footing depth is 1.28 m (halfway between 0.76 m and 1.8 m), then the insulation should extend horizontally to a minimum length of 0.6 m and 1.2 m for heated and unheated structures, respectively. Any horizontally extended insulation should have a minimum soil cover of 0.3 m (or in accordance with the manufacturer’s recommendations).

6.1.4 Insulation for Slabs-On-Grade

Based on CFEM (2023), insulation of slab on grade should consist of a minimum of 100 mm thick rigid insulation placed underneath the slab to cover the entire slab footprint and extending horizontally at least 1.8 m beyond the edges of the slab.

The rigid insulation should be placed on a minimum of 200 mm thick, clean well graded granular engineered fill of max particle size 26 mm (such as OPSS Granular A). The rigid insulation extending outside the slab footprint should have a minimum soil cover of 300 mm (or in accordance with the manufacturer’s recommendations).

In addition, the rigid insulation should be designed to resist the compressive stress applied from the slab. The selected rigid insulation should also have the required compressive strength and stiffness to resist any loading from the slab.

6.1.5 Insulation for Underground Utilities

Proposed underground utilities that will be affected by freezing such as watermain, sanitary and sewers should also be provided with a minimum of 75 mm thick rigid insulation if they are placed above the estimated frost depth of 1.8 m below the finished grade. The rigid insulation should extend 1.8 m horizontally over the utility pipe or vertically on both sides of the pipe (though this vertical insulation is difficult to construct and backfill). The horizontal insulation over the pipe should have a minimum soil cover of 300 mm.

6.2 Seismic Design

6.2.1 Liquefaction Assessment

A liquefaction assessment was carried out at the project site following the approach in Idriss and Boulanger (2008). The liquefaction assessment involves comparing the cyclic shear stresses applied to the soil by the design earthquake, represented as the cyclic stress ratio (CSR), to the cyclic shear resistance provided by the soil, represented as the cyclic resistance ratio (CRR). Liquefaction is predicted to occur when the available cyclic shear resistance of the soil is less than the cyclic stress imposed by the earthquake.

An earthquake magnitude of 6.2 and PGA of 0.322g (for Site Class C) were considered in the liquefaction assessment. In addition, the highest groundwater level of 2.3 m (~El. 84.67 m) at the surrounding of the existing buildings footprint was considered as measured from BH25-06.

The results of the assessment suggest that the thin portion of the compact sandy soil (fill) may not be potentially liquefiable during a seismic event between Elevation 88.2 and 86.8 m in borehole BH25-03. Based on the thickness (less than 1 m) of this marginally liquefiable layer and the corresponding low SPT ‘N’ value, the risk of liquefaction during the design seismic event may reasonably be ignored.

6.2.2 Seismic Site Classification

Multichannel analysis of Surface Waves (MASW) test was carried out at the site to evaluate the average wave velocity of the upper 30 m (Vs of soil/bedrock at the site. The shear wave velocities measured at the site are presented in a technical memorandum (see results in Appendix E). The results indicate that the average shear wave velocity in the upper 30 m of the subsurface at the MASW location was about 386 m/s, and according to 2020 NBCC site classification for seismic site response that this site can be assigned a Site Class C.

6.3 Site Preparation and Grading

The subsurface stratigraphy generally consists of topsoil underlain by fill. The fill is underlain by low to medium plasticity weathered crust, which is underlain by medium to high plasticity native clay, overlying glacial till over bedrock.

All the topsoil, existing fills containing organics and rootlets, and other unsuitable materials should be removed from the site. The exposed subgrade should be protected from disturbance of construction traffic and graded to quickly drain away surficial runoff from the project site.

Public and private utility owners should be notified prior to the commencement of any construction activities. Existing underground utilities in the vicinity of the proposed excavation should be reviewed before commencing any excavation works to identify potential damage hazards due to the proposed excavation. Existing utilities that are excavated or exposed as part of the construction will need to be supported and rerouted during the construction

No site grade raise is anticipated for the proposed upgrades. If more than 0.5 m of site grade raise is required, it should be assessed for settlement of the existing adjacent structures and new addition structures.

6.4 Foundation Design Considerations

Based on encountered subsurface conditions and review of construction drawings of the existing buildings, the following types of foundations may be considered:

- Shallow foundation placed on weathered crust or native clay deposit
- Raft slab foundations and slab-on-grade
- Deep foundation (driven and drilled piles)

In general, the native clay soil was stiff to very soft in strength. The clay soil was found to be low to highly plastic, with groundwater levels at the project site ranging from 2.3 mbgs to 2.6mbgs. It is understood that the existing foundations are founded at elevations between 88.22 m and 87.35 m, within the weathered crust, which is typically very stiff to stiff in consistency. Therefore, shallow footings supported on the weathered crust deposit may provide higher bearing capacity. Raft slabs can also be considered as an alternative foundation system.

6.4.1 Geotechnical Design Parameters

Geotechnical conditions may vary between and beyond borehole locations. WSP reviewed available information to assess the geotechnical conditions and parameters that are considered suitable for carrying out analyses and developing engineering comments and recommendations for the proposed structures. The review incorporated available results of the geotechnical investigation, laboratory test results, and WSP's experience with similar soils and geological conditions.

Preliminary soil parameters for the design of the proposed structures are shown in Table 10. It should be noted that many soil parameters are not intrinsic characteristics of the soils themselves, but depend upon the loading conditions, imposed stresses, mechanisms under consideration, etc. The designer should review and adjust these parameters as appropriate based on the actual detailed design considerations.

Table 10: Summary of In-Situ Geotechnical Properties

Soil Type	Bulk Unit Weight Above Water Table (kN/m^2)	Bulk Unit Weight Below Water Table (kN/m^2)	Drained Conditions		Undrained Conditions(1)		Coefficient of Friction between Concrete and Soil (2)
			C' (kPa)	Φ (Deg)	S_u (kPa)	Φ (Deg)	
Existing Fill	19 - 21	9.2 – 11.2	0	30	-	32	-
(Lean to Fat Clay) Weathered Crust - Upper	18 – 18.5	8.2 - 8.7	5 – 8	25	>100	-	0.25 – 0.40
(Lean to Fat Clay) Weathered Crust - Lower	18 – 18.5	8.2 - 8.7	5 – 8	25	55 - 95	-	0.25 – 0.40
Fat Clay (Unweathered clay)	17 – 17.5	7.2 – 7.7	2 - 12	26	38 - 95	-	0.25 – 0.40
Glacial Till	20 - 22	10.2 – 12.2	0	33 - 35	-	33 - 35	0.35 – 0.45
Granular "A" (OPSS 1010)	21	12.2	-	36	-	36	0.40 – 0.50
Granular "B" Type II (OPSS 1010)	22	13.2	-	34	-	34	0.40 – 0.50

Notes:
(1) The undrained shear strengths have not been corrected for plasticity. These are estimated values (average constant values increasing with depth) based on field vane tests, from current and previous investigations
(2) These are friction angle values based on CFEM 2023 and WSP's experience on similar soils
(3) Engineered fill as specified as OPSS 1010 specifications

6.4.2 Shallow Spread and Strip Footings on Undisturbed Weathered Crust

As discussed above, the low to medium plastic native clay deposit was stiff to very soft in consistency and would provide low bearing capacity to support the shallow foundations. It is understood that the proposed footings will be founded at the same elevations as the existing footings, which are between 88.22 m and 87.35 m.

The recommended bearing resistances for the design of shallow footings supported on the undisturbed weathered crust deposit are provided in Table 11, based on foundation sizes.

Table 11: Recommended Bearing Resistances for Shallow Foundations

Footing Type	Assumed Founding Elevation (m)	Footing Size (m)[2]	Allowable Bearing Pressure at SLS (kPa) (2)	Factored Resistance ULS (kPa)(3)
Interior	88.22	4 x 4	165	300
		3.5 x 3.5	165	300
		3.0 x 3.0	165	300
		2.5 x 2.5	210	300
		2.0 x 2.0	250	300
		1.75 x 1.75	250	300
		4 x 2.5	165	330
		3.5 x 2.5	165	320
		3.0 x 5.4	165	280
		1.525 x 6.3	220	260
Perimeter Wall	87.35	3.5 x 3.5	175	300
		2.5 x 2.5	200	300
		2.0 x 2.0	200	300
		1.75 x 1.75	200	300
		1.525 x 6.3	200	260

Notes:

(1) Footings should be placed on competent, undisturbed weathered crust deposit; however, footings shall not be placed shallower than 1.8 m for bearing capacity requirement and to extend through the upper potential fill layer. Insulation should be provided if footings are placed below frost depth as specified in section 6.1.3

(2) A resistance factor of 0.5 was used to calculate the factored ultimate bearing resistance at ULS.

(3) The SLS bearing resistance was calculated for the corresponding estimated footing settlement of less than 25 mm.

The values above are based on limiting the stresses in the underlying clay soil as well as an anticipated post-construction settlement of 25 mm (total) and 20 mm (differential). It should be noted that where new foundations are constructed adjacent to existing foundations the existing foundations will have already settled. Any new settlement will therefore be entirely differential.

6.4.2.1 Horizontal (sliding) Resistance of Footings

For cast-in-place concrete footings, resistance to horizontal loads (sliding resistance) can be calculated by considering the sliding friction resistance between the concrete footing base and the bearing stratum. The recommended interfacial adhesion strength (C_a) and recommended interface friction coefficient (tan δ) between cast-in-place footing concrete and native clay soil bearing strata are provided below:

- Cast-in-place concrete footing to native clay soil: c_a = 75 kPa (undrained loading condition)
- Cast-in-place concrete footing to native clay soil: tan δ=0.45 (drained loading condition)

The calculated sliding resistances using the above interface adhesion strength will be the ultimate value. A geotechnical resistance factor of 0.8 should be used to calculate the factored ultimate sliding resistance.

[2] If new foundations are placed immediately adjacent to existing foundations, or existing foundations are widened then the relevant foundation width should be taken as the combined width (i.e., if a new 2 m wide foundation is placed adjacent to an existing 1.5 m wide foundation the foundation width should be considered to be 3.5 m). For areas where foundations are close (but not immediately adjacent to) existing foundations the potential for overlapping zones of stress will need to be assessed on a case-by-case basis.

6.4.3 Raft slab Foundation and Slab-On-Grade

6.4.3.1 Subgrade Preparation

All unsuitable materials such as topsoil, organics, existing fill, boulders, cobbles, and any wet, weak, or disturbed native clay soil should be stripped off from the proposed slab-on-grade and raft slab footprints. The exposed subgrades after excavation should be thoroughly cleaned of debris and loose materials. The excavated subgrade should also be visually inspected and approved by a qualified geotechnical consultant prior to placement of engineered fill or slab-on-grade or raft slab construction.

The exposed native clay stratum should be carefully reviewed to determine if compaction of the granular engineered fill will further disturb the native clay soil.

6.4.3.1 Granular Bedding

A minimum of 200 mm thick, clean well-graded crushed stone granular bedding (grain size distribution satisfying OPSS.MUNI 1010 Granular A with less than 5% of fine particles passing 75µm sieve) should be installed on the prepared subgrade for the purpose of levelling and draining. The granular bedding should be installed in a single lift and compacted to 100% of SPMDD at ±2% of OMC.

6.4.3.2 Vertical Modulus of Subgrade Reaction

Load bearing slab-on-grade or raft slab should be structurally designed. It is anticipated that a portion of the existing 150 mm slab-on-grade will be replaced with a structural bearing slab designed to support loads of up to 12 kPa. The recommended vertical modulus of subgrade reaction values for the design of slab-on-grade or raft slab are provided below for anticipated bearing strata:

- Native clay soil bearing stratum: 7/B (MPa/m)

Where B (in meters) is the shortest dimension of the loaded area on slab-on-grade or raft slab. The slab design should consider the variability of stiffness between native soil and engineered fill. The slab-on-grade or raft slab should be designed structurally to accommodate the transition in bearing stratum stiffness. Expansion joints should also be provided for the slab-on-grade as required by the design.

Subgrade preparation below the slab-on-grade will involve the removal of all topsoil, organic matter and unsuitable soils to expose a competent native subgrade approved by the geotechnical engineer.

6.4.3.3 Permanent Drainage

It is understood that the proposed upgrades will not include a below grade level (or basement) at the existing buildings.

As previously discussed, the design groundwater level of 2.3 mbgs (~El. 84.67 m) is recommended based on the water level measurement from the installed monitoring wells and considering the seasonal groundwater level fluctuations. Therefore, the proposed ground floor slab and/or raft slab and foundation walls are anticipated to be above the groundwater level and will not be subjected to hydrostatic pressures.

However, the prepared subgrade within and around the existing buildings footprint may consist of different soil materials including existing fill, native clay soil, granular engineered fill, and bedrock. Thus, the different subgrade soil conditions may block the free movement of water for draining and cause local ponding of water beneath the building’s footprint.

A perimeter weeping tile subdrain system should be provided around the buildings footprint to facilitate drainage of surface water infiltration and perched water away from the building foundations and ground slabs. The weeping tile subdrain system may consist of perforated pipes surrounded by free drain granular material (OPSS.MUNI 1004 19 mm Clear Stone or approved equivalent) and wrapped up with OPSS.MUNI 1860 Class II non-woven geotextile (Terrafix 360R or approved equivalent). The subdrains should be connected to the site drainage system or catch basins. Alternately, they can be drained into a sump and pump out. Inspection and maintenance of the subdrain system are recommended to ensure that the drainage system does not become blocked.

Due to the shallow groundwater table, the slab-on-grade or raft slab should be provided with impermeable damp-proof membranes, such as a minimum 150 µm thick polyethylene sheet vapor barrier.

The perimeter subdrain systems should be properly designed by the Civil Design Consultant of the project. The above recommendations are provided for general guidelines only.

6.4.4 Deep Foundations

Based on the subsurface conditions and laboratory test results, the lower portion of the clay is firm to stiff, sensitive and highly compressible when subjected to new loads. Based on these conditions, deep foundation system may be considered as an alternative option to shallow foundations at the project site.

Piles would typically be drilled or driven piles for exterior additions to the buildings. If piles are required for the interior they would typically be smaller diameter drilled shafts (as driving piles inside a structure is typically very difficult)

6.4.4.1 Drilled Shafts

6.4.4.1.1 Axial Capacity in Compression

Based on the uniaxial compressive strength of the bedrock at this site, and a minimum of 1.0 m long bedrock socket, the recommended skin friction and end bearing resistances are provided in Table 12 below. For piles drilled into bedrock, the resistance provided by the soil is typically very small (compared to the resistance of the rock socket) and can reasonably be ignored.

End-bearing resistance could be included in the total compressive resistance if adequate measures to clean the bases of the shaft are implemented during construction (though this is typically difficult for smaller diameters and end bearing should be neglected for drilled shafts less than approximately 450 mm unless there is a high level of certainty in the contractors ability to clean and inspect the base.

The cleaned base should be visually inspected by a qualified geotechnical engineer during construction. Should the inspection indicate that loosened material is present at the base, the base would need to be re-cleaned and re-inspected.

Table 12: Recommended Unfactored Ultimate Resistances for Drilled Shafts

Soil Type	Depth Below Existing Grade (m)	Unfactored Ultimate Skin Friction at ULS(1) (kPa)	Unfactored Ultimate End Bearing at ULS (1) (kPa)
Bedrock	>14.9	1,500	15,000

Notes:

(1) A resistance factor of 0.4 should be applied to calculate the factored ultimate unit resistance.

(2) The geotechnical resistance factor may be increased to 0.5 if a program of dynamic testing is carried out, or 0.6 if a static load test is carried out.

SLS does not apply to caissons end bearing on/in bedrock at this site, since the SLS resistance for 25 mm of settlement is greater than factored axial geotechnical resistance at ULS.

6.4.4.1.2 Downdrag (Negative Skin Friction)

When the caissons have been installed in or through the soil deposit that is subject to settlement, the resulting relative downward movement of the clay around the piles, as well as in any soil above the clay layers, induces downdrag forces on the piles through negative skin friction.

Downdrag increases the structural loads in the pile and thus should be accounted for when evaluating the structural ultimate limit state of the pile. As per Section 9.2.5 of CFEM (2023), the total drag load can be calculated by multiplying the unit ultimate skin friction values by shaft circumference or pile perimeter length and by the length of the pile embedded in settling soil.

The recommended unit ultimate (negative) skin friction that can be used in the design are provided below.

Table 13: Recommended Unfactored Unit Ultimate (negative) Skin Friction for Drilled Shafts

Soil Type	Depth Below Existing Grade (m)	Unfactored Unit Ultimate Skin Friction at ULS (kPa)
Fill / Native Silty sand	0 – 1.5	3
Unweathered Clay	1.5 – 3.7	40
Weathered Clay	3.7 – 10.4	30
Sandy Glacial Till	10.4 – 14.9	70

6.4.4.1.3 Lateral Capacity

For drilled shafts socketed into competent bedrock, a fixed condition at the shaft toe may be assumed, provided the socket length and rock properties are sufficient to ensure fixity. This condition (i.e., fixity at the rock socket) may be assumed to be met if the length of the rock socket is the greater of: at least two times the diameter of the drilled shaft, or 1 m.

For the proposed deep foundations, the SLS lateral geotechnical reaction of the soil in front of the piles under lateral loading may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction, k_h, is based on the equations given below, as described by Terzaghi (1955) and the Canadian Foundation Engineering Manual (CFEM 2023) and API (2003). The equations provided, and the associated resistances are based on vertical piles; a modification factor would need to be applied for inclined piles.

Where ground conditions are generally competent and the lateral loads on piles are relatively small such that the maximum lateral pile deflections will be relatively small, the resistance to lateral loading in front of a single pile can be estimated using subgrade reaction theory (as outlined below). However, it should be noted that the response of a pile to lateral loads is highly non-linear and methods that assume linear behaviour (such as subgrade reaction theory) are only appropriate where the maximum pile deflections are less than 1 percent of the pile diameter, where the loading is static (no cycling) and where the pile material is linear (CFEM, 2006). Where these conditions are not met, the non-linear lateral behaviour of the soil should be considered using P-y curves.

For cohesionless soils:

$$k_h = \frac{n_h z}{B}$$

Where: n_h is the constant of horizontal subgrade reaction (kPa/m) (Table below);

z is the depth (m); and,

B is the pile diameter or width (m).

For cohesive soils:

$$k_h = \frac{67 s_u}{B}$$

Where: s_u is the undrained shear strength of the soil (kPa); and,

B is the pile diameter/width (m).

Table 14 outlines the ranges for the values of n_h and s_u that may be used in the lateral analysis of the piles at this site. The ranges in values reflect the variability in the subsurface conditions, the soil properties, and the approximate nature of the linear-elastic subgrade reaction analysis.

Table 14: nh and su values for Lateral Load Resistance Calculations

Soil Type	Depth below ground surface (m)	Nh (kPa/m)	Average Su (kPa)
Sandy Fill (cohesionless)	0 – 1.4	2,200	-
Weathered Crust (cohesive)	1.4 – 3.7	-	85
Fat Clay (cohesive)	3.7 – 10.5	-	65
Glacial Till	10.5 - Bedrock	11,000	-

For piles arranged in closely spaced groups, the pile-soil-pile interaction causes the individual piles in a group to be less effective than a single pile. Theses "group effects" can be incorporated into the design by reducing the calculated coefficient of horizontal subgrade reaction values either in the direction of loading or perpendicular to the direction of loading using a method that modifies the single pile lateral resistance by some factor (i.e., a p-reduction factor).

6.4.4.1.4 Construction Consideration for Drilled Shafts

The construction feasibility of the drilled shafts depends on the means and methods of construction by the specialty contractor including the availability of equipment suitable to the site-specific conditions. Therefore, the selection of the caisson should be confirmed by the contractor prior to design.

Given the high groundwater level, temporary steel casing and dewatering (bailing water) will be required to reduce soil sloughing and seepage into the pile boring. The potential presence of cobbles and boulders within the existing soil deposit should also be considered in selecting the pile boring and casing equipment.

As previously discussed, the base of each caisson shall be thoroughly cleaned of any cuttings or other material and inspected and tested. The method of cleaning proposed by the selected piling contractor should be approved by a qualified geotechnical engineer prior to commencement of field works. The cleaned base should be visually inspected (with a camera if necessary, depending on the length and construction setup) by a qualified geotechnical engineer during construction. Should the inspection indicate that loosened material is present at the base, the base would need to be re-cleaned and re-inspected. If an inspection approach is not feasible then a shaft resistance design approach should be used for the rock socket as per Section 9.10.4 of CFEM (2023).

Piles should be spaced at center-to-center spacing of at least three times pile diameter (3D) to minimize pile group effect. A minimum shaft diameter of 400 mm is recommended for drilled shafts to minimize void formation during pouring of the concrete.

If caisson caps are to be included as part of the design at or below the existing ground surface, they should be constructed at a minimum depth of 1.8 m for frost protection purposes, per OPSD 3090.101.

The various soils at this site are sensitive soils and could “flow” into the auger hole during drilled shaft installation if left unsupported. Temporary liners will be required for construction. It should be assumed that these liners will need to be “set” into the underlying bedrock.

It is expected that the temporary liners/casings would be installed using rotation methods. If a vibratory hammer is used, vibration monitoring of the existing hotel building and utilities is recommended. Casing installation through the cobbles and boulders of the fill deposit is expected to require rotary drilling methods, and churn drilling or down-hole hammer techniques may also be required to advance the caisson to the required depth if and where boulders are encountered as well as to form the rock socket in the bedrock. Provisions should be given for the presence of hard cobbles and boulders in selecting suitable drilling equipment to advance pile boring through the obstructions.

Full-time monitoring of caisson installation by a qualified geotechnical inspector is recommended to confirm the proper installation of caisson and base cleaning.

6.4.4.2 Driven Steel Piles

6.4.4.2.1 Axial Capacity in Compression

Steel piles driven to refusal on granite bedrock may be considered as an alternative foundation option for the proposed building expansion. Consideration can be given to both H piles and concrete-filled pipe piles. The recommended skin friction and end bearing resistances are provided.

Table 15: Recommended Unfactored Unit Ultimate (negative) Skin Friction for Driven Steel Piles

Soil Type	Depth Below Existing Grade (m)	Unfactored Unit Ultimate Skin Friction at ULS(1) (kPa)	Unfactored Ultimate End Bearing at ULS (1) (kPa)
Fill / Native Silty sand	0 – 1.5	5	-
Unweathered Clay	1.5 – 3.7	40	-
Weathered Clay	3.7 – 10.4	30	-
Sandy Glacial Till	10.4 – 14.9	100	200
Bedrock	>14.9	-	12,000

Notes:
(1) A resistance factor of 0.4 should be applied to calculate the factored ultimate unit resistance.

SLS does not apply to piles end bearing on/in bedrock at this site, since the SLS resistance for 25 mm of settlement is greater than factored axial geotechnical resistance at ULS.

The factored geotechnical resistance of strong bedrock is often higher (sometimes significantly so) than the capacity of the steel section. The design loads should therefore also be limited to the structural capacity of the pile.

6.4.4.2.2 Downdrag (Negative Skin Friction)

As mentioned in Section 6.4.4.1.2, the total drag load can be calculated by multiplying the unit ultimate skin friction values by shaft circumference or pile perimeter length and by the length of the pile embedded in settling soil.

The recommended unit ultimate (negative) skin friction that can be used in the design are provided below.

Table 16: Recommended Unfactored Unit Ultimate (negative) Skin Friction for Driven Steel Piles

Soil Type	Depth Below Existing Grade (m)	Unfactored Unit Ultimate Skin Friction at ULS(1) (kPa)
Fill / Native Silty sand	0 – 1.5	5
Unweathered Clay	1.5 – 3.7	40
Weathered Clay	3.7 – 10.4	30
Sandy Glacial Till	10.4 – 14.9	100

Since the steel piles are expected to be driven to refusal on sound bedrock to achieve required resistance, the effect of drag loads on the settlement (or SLS geotechnical axial resistance) of the driven pile will be negligible.

6.4.4.2.3 Lateral Capacity

The lateral capacity of piles can be calculated as per Section 6.4.4.1.3.

As piles are driven to refusal without socketing, their lateral capacity is controlled by overburden soil resistance, and no fixity at the rock surface is assumed. If the foundations cannot generate sufficient lateral resistance, then rock anchors can be considered.

6.4.4.2.4 Construction Consideration for Driven Steel Piles

Driven piles must be installed in accordance with OPSS 903.

For the installation of steel piles, consideration must be given to the potential presence of cobbles and boulders within the fill and glacial till deposit. The use of driving shoe/ or flange plates is recommended to minimize damage while penetrating the fill and till deposit (which is expected to contain boulders and cobbles) and seating on to the granite bedrock. Pipe piles are considered to have a higher risk than H-piles for hanging up or being deflected away from their vertical or battered orientation, if cobbles and boulders are encountered during driving.

The installation of steel piles is typically associated with increased noise and ground vibrations, which may affect existing hotel structure, utilities, and nearby development. If the option of driven pile is selected, it is recommended that a vibration monitoring plan be implemented during construction. This plan should include baseline vibration measurements, continuous monitoring during pile driving, and the establishment of threshold limits to ensure potential impacts are identified and managed promptly. Appropriate mitigation measures should also be in place to address any exceedances and minimize disturbance to neighbouring properties. The vibration monitoring plan should be prepared by a specialist geotechnical engineer.

Provision should be made for restriking all piles at least once to confirm the design set and/or the permanence of the set and to check for upward displacement due to driving adjacent piles. Piles that do not meet the design set criteria on the first restrike should receive additional restriking until the design set is met. All restriking should be performed a minimum of 48 hours after the previous set.

Pile driving criteria depend not only on the details of the pile (size, length, load, etc.) but also on the equipment used for installation. Preliminary pile driving criteria should be established prior to construction using wave equation analysis (WEAP or similar) or other approved means and confirmed through a program of dynamic (PDA) testing carried out at an early stage in the piling program. Additional PDA testing should be used to confirm the pile capacities at regular intervals as the project progresses. As a preliminary guideline, the specification should require that at least 10% of the piles be included in the dynamic testing program. CASE method estimates of the capacities should be provided for all piles tested. These estimates should be provided by means of a field report on the day of testing; CAPWAP analyses should be carried out for at least one half of the piles tested, with the results provided no later than three days following testing. The final report should be stamped by an engineer licensed in the province of Ontario. The PDA testing program will justify an increase in the geotechnical resistance factor to 0.5.

The driving energies required to confirm the ultimate geotechnical resistance of the pile (typically the testing is intended to prove a load of twice the design load) will be significantly higher than the energy required to install the pile. This is especially true if very large pile capacities are assumed due to the high geotechnical resistance. Insufficient energy is a common problem in demonstrating the true ultimate capacity of piles during PDA testing, and larger pile driving hammers may be required for testing than are required for installation. It is also likely that the stresses induced in the piles during driving and testing will be limiting factor in pile testing, not the capacity of the bedrock to resist the loading (i.e., it is common to damage or break a pile during driving and/or testing long before the bedrock yields). The ability to test the piles during construction can become a constraint on the pile design if very high capacities are adopted.

The piling specifications should be reviewed by an experienced geotechnical engineer prior to tender, as should the contractor's submission (shop drawings, equipment, procedures, preliminary set criteria, etc.) prior to construction. Piling operations should be inspected on a full-time basis by geotechnical personnel to monitor the pile locations and plumbness, initial sets, penetrations on restrike, and to check the integrity of the piles following installation.

6.4.5 Rock Anchors

The use of rock anchors to resist uplift forces on the foundations could be considered where additional uplift resistance is required.

The design of the rock anchors should be generally carried out in accordance with the guidelines provided in the CFEM and FHWA-IF-99-015 (Section 5.9.2 and other sections). The design and construction of tiedown rock anchors should also follow the specifications in OPSS.MUNI 942.

Rock anchors are typically installed in a borehole that is drilled with air-percussion equipment or with rotary diamond drilling equipment with water circulation; those drilling methods can fairly penetrate through boulder/cobblery ground as well as bedrock. A cased hole would be drilled through the overburden with a socket drilled into the bedrock, the steel anchor inserted, and then the annular space around the bar filled with grout.

In designing grouted rock anchors, consideration should be given to four possible anchor failure modes:

i) Failure of the steel tendon or top anchorage;

ii) Failure of the grout/tendon bond;

iii) Failure of the rock/grout bond, and

iv) Failure within the rock mass, or rock cone pull-out.

Potential failure modes i) and ii) are structural and are best addressed by a structural engineer.

For potential failure mode iii), the factored bond stress at the grout/rock interface may be taken as 1,000 kPa (or 1/30 of the compressive strength of the grout) for ULS design purposes. This value should be used in calculating the resistance under ULS conditions. If the response of the anchor under SLS conditions needs to be evaluated, it may be taken as approximately the elastic elongation of the unbonded portion of the anchor under the design loading.

For potential failure mode iv), the resistance is calculated based on the weight of the potential mass of rock and soil which could be mobilized by the anchor. This is typically considered as the mass of rock included within a cone (or wedge for a line of closely spaced anchors) having an apex at the tip of the anchor and having an apex angle of 60 degrees. For each individual anchor, the ULS factored geotechnical resistance can be calculated based on the following equation:

$$Q_r = \varphi \frac{\pi}{3} \gamma' D^3 \tan^2\text{–}\theta$$

Where: Q_r = Factored uplift resistance of the anchor (kN);

φ = Geotechnical resistance factor (use 0.4);

γ' = Effective unit weight of rock (use 16.5 kN/m^3 below the groundwater level);

D = Anchor length in metres; and,

θ = one-half of the apex angle of the rock failure cone (use 30°).

Where the anchor load is applied at an angle to the vertical, the anchor capacity should be reduced as follows:

$$Q_r' = Q_r \cos(\alpha)$$

Where: Qr' = Factored uplift resistance of the anchor subject to inclined load (kN)

Qr = Factored uplift resistance of the anchor (kN)

α = Angle between the load direction and the vertical

For a group of anchors or for a line of closely spaced anchors, the resistance must consider the potential overlap between the rock masses mobilized by individual anchors. In the case of group effects for a series of rock anchors in a rectangle with width "a" and length "b" installed to a depth "D", the equation for the volume of the truncated trapezoid failure zone would be as follows:

$$V = \frac{4}{3} D^3 sin^2\varphi + aD^2 \sin\varphi + bD^2 \sin\varphi + abD$$

Where: V = Volume of the truncated trapezoid failure zone (m^3);

D = Depth of anchor group (m);

a = Width of anchor group (m);

b = Length of the anchor group (m); and,

φ = ½ of the apex angle of the rock failure cone, use 30°.

The ULS factored geotechnical resistance for the truncated trapezoid failure formed by the group of anchors can then be calculated based on the following equation:

$$Q_r = \varphi\gamma' V$$

Where: Qr = Factored uplift resistance of the anchor (KN);

φ = Geotechnical resistance factor, use 0.4;

γ' = Effective unit weight of rock and soil, use 10 kN/m^3 below the water table; and,

V = Volume of truncated trapezoid (m^3).

The method described above does not explicitly consider the tensile strength of the rock that must be overcome prior to mobilization of the weight of the rock mass. If required, the tensile strength of the rock mass can be assessed based on the unconfined compressive strength, recovery, and quality of bedrock core obtained. This assessment, however, requires a detailed understanding of the anchor lengths, geometry, loads, etc. and would need to be completed during detailed design.

It is recommended that proof load tests be carried out on the anchors to confirm their resistance. The proof load tests should be carried out in accordance with OPSS 942 *(Prestressed Soil and Rock Anchors).*

A geotechnical engineer should be present during the installation and testing of the anchors. Care must be taken during grouting to ensure that the grouting pressure is sufficient to bond the entire length of the grouted area with minimum voids.

Confirmation of sufficient embedment into the rock beneath the foundations should be carried out during construction to make sure that the anchors are being installed in rock of adequate quality. The anchor holes must be thoroughly flushed with water to remove all debris and rock flour. It is essential that rock flour be completely removed from the holes to be grouted to promote an adequate bond between the grout and the rock. Prestressing of the anchors prior to loading will minimize anchor movement due to service loads.

6.5 Earthworks

6.5.1 Temporary Excavation in Overburden

Existing deleterious fill material containing organics and debris should be removed from beneath and beyond the structure footprints as required by the Engineer. Should any additional buried organics become evident during excavation, WSP must be called to review the conditions and confirm subexcavation requirements, including lateral / slope support if required.

No unusual problems are anticipated with excavating in the soil using conventional hydraulic excavating equipment. In general, it is anticipated that open-cut methods will be feasible for excavations in soil. Where space is restricted, steel trench boxes, possibly in conjunction with steel plates and/or unsupported slopes at the surface, or a shoring system may be required to accommodate excavations

As a minimum requirement, all side slopes of temporary open-cut excavations should conform to the Occupational Health and Safety Act (OHSA) – Regulation for Construction Projects (O. Reg. 213/91). The existing fill soil and native soils would be classified as Type 4 soils, and excavations in these materials should be sloped no steeper than 3H:1V based on OSHA requirements. Excavations should be protected from exposure to precipitation and associated ground surface runoff and should be inspected regularly for signs of instability. If localized instability is noted during excavation, or if wet conditions are encountered, side slopes should be flattened to maintain safe working conditions. Stockpiling of excavated soils adjacent to the excavation must be avoided to prevent causing related instabilities in the excavation's sidewalls and/or base.

Site soils below the anticipated founding elevations are susceptible to strength loss or deformation when saturated and/or disturbed by construction traffic. The Contractor shall be responsible for the techniques and methods they utilize, including temporary shoring and erosion control, and subgrade preparation and protection. The Contractor and Designer should assess exposed subgrade soils and prevailing climatic conditions at the time of construction and decide whether an application of a lean concrete mud mat or other protection strategies are warranted.

6.5.2 Temporary Excavation Adjacent to Existing Buildings

Care should be taken in conducting temporary excavations adjacent to or within the vicinity of the existing buildings. The temporary excavation may undermine the stability of the existing foundations, grade beams, ground supported slabs, or other grade supported structures including sidewalks and pavements.

As a minimum requirement, excavations adjacent to existing foundations should not extend below the bottom of the existing building footings. Trench excavations adjacent to the existing structures should be carried out in stages of short stretch lengths. All the excavations should also be protected with steel braced walls or trench boxes for the stability of adjacent structures and workers safety. The braced protection system to support the temporary excavations should be properly designed by the contractor. The protection system must consider the loads imposed by existing foundations and safeguard against any detrimental ground movements.

All temporary excavations adjacent to the existing structures should be backfilled as soon as practical and not be left open for longer time. In addition, the open excavations and adjacent structures should be periodically inspected for any signs of instability or movement.

6.5.3 Temporary Excavation inside Existing Buildings

It is WSP's understanding that new foundations may be required inside existing buildings to support additional loads. Before any interior excavation work begins, all underground utilities must be accurately located. As-built drawings should be obtained from the client or building owner to avoid damaging hidden utilities, including electrical cables and pipes.

Excavations inside buildings may qualify as confined spaces, requiring ventilation and atmospheric testing. The excavation area must be continuously monitored using a calibrated 4-gas detector to ensure conditions remain safe. If hazards are detected, mechanical ventilation must be implemented (e.g., to remove gases or exhaust fumes from heavy equipment or address low oxygen levels). Where ventilation alone is insufficient, additional controls such as respiratory protection must be used to reduce exposure to acceptable levels.

Excavations must not extend below the bottom of existing building footings. Appropriate support systems (such as shoring, shielding, or engineered fill) should be installed to prevent cave-ins or wall collapse, particularly for trenches deeper than 1.2 meters. A safe distance from existing structural elements (e.g., piles, beams, walls) should be maintained to avoid compromising their integrity. Excavation should proceed in phases to minimize unsupported earth at any time. Heavy equipment that generates significant vibration should be avoided inside the building. All temporary excavations should be inspected daily and after any event that could affect stability.

As with excavations adjacent to the existing structures, excavations within the structure must be designed to provide adequate support for existing foundation elements and prevent any adverse ground movements.

6.5.4 Temporary Dewatering

Based on the shallow groundwater condition observed in the installed monitoring well in BH25-06 to BH25-07, a design groundwater level of 2.3 mbgs (~El. 84.67 m) is recommended considering the seasonal groundwater level fluctuations.

Excavations deeper than about 2.3 mbgs (~El. 84.67 m) may be under the groundwater, depending on the time of year that construction occurs. The rate of groundwater inflow into the excavations will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where precipitation collects in an open excavation following rainfall and must be rapidly pumped out.

According to O.Reg 63/16 and O.Reg 387/04, if the volume of water to be pumped from excavations for the purpose of construction dewatering is greater than 50,000 litres per day and less than 400,000 litres per day, the water taking will need to be registered as a prescribed activity in the Environmental Activity and Sector Registry (EASR) and requires the completion of a "Water Taking Plan". A Permit to Take Water (PTTW) is required from the Ministry of the Environment Conservation and Parks (MECP) if a volume of water greater than 400,000 litres per day is to be pumped out from an excavation.

Temporary dewatering systems are the Contractor’s responsibility, and the rate and volume required for dewatering is dependent on the construction methods and staging chosen by the contractor. A groundwater management plan should be submitted by the Contractor along with the study to determine the need of EASR registry and PTTW by MECP.

6.5.5 Engineered Fill

Structural engineered fill should be used for grade raise underneath load supporting structures such as footings and ground slabs. OPSS 1010 Granular A material (or approved alternate) may be considered as structural engineered fill. The granular structural engineered fill should be placed in maximum loose lifts of 200 mm and compacted to minimum 98% of SPMDD for the first lift, and minimum 100% of SPMDD for the remaining lifts, at ±2% of Optimum Moisture Content (OMC). Engineered fill should extend laterally beyond the edge of load supporting structures, such as footings and slabs, to a minimum distance equal to the fill thickness or 1 m, whichever is greater.

For utility trench backfill, Unshrinkable Fill (U-Fill) as per OPSS.MUNI 1359 may be used in lieu of engineered backfill.

General engineered fill should be used for grade raising outside of the load supporting structures, such as roads and foundation areas. The general engineered fill is not recommended to consist of the excavated existing fill soils containing organics and topsoil, nor native clayey soils. Existing soils consisting of substantial silt content should also be avoided to reduce frost heave issues. Well graded granular fill such as Granular A or B Type I & II as per OPSS 1010, or approved granular borrow, should be considered. The imported fill should be free from topsoil, organics, debris, boulders, cobbles, rootlets and other unsuitable materials. A qualified person shall confirm that that imported fill is acceptable for the site, according to Provincial regulations. The general engineered fill should be placed in maximum loose lifts of 200 mm and compacted to minimum 95% of Standard Proctor Maximum Dry Density (SPMDD) for the first lift and minimum 98% of SPMDD for the remaining lifts, at ±2% of Optimum Moisture Content (OMC).

The exposed subgrade should be inspected by WSP to confirm stiffness and that the bearing surfaces have been adequately prepared and cleaned prior to the placement of the engineered fill. The prepared subgrade should be protected from disturbance of construction traffic, excessive wetting or drying.

6.6 Reuse of Existing Soils

From a geotechnical perspective, the existing soils at the project site are not compactable and are classified as frost-susceptible; therefore, they are unlikely to be suitable for reuse as backfill material.

The reuse of any excavated existing soils for construction backfilling is also subjected to environmental assessment. Due to the presence of EC and SAR exceedances, soil would require reuse at a site capable of accepting elevated salt related impacts and which is subject to one of exemptions for salt impacts under Ontario Regulation 406/19. Barium, chromium, and vanadium are considered naturally occurring metals present in eastern Ontario clays and can be beneficially reused at reuse sites capable of accepting elevated natural metals. If these exceptions are applied, the soil is considered as meeting both comparative ESQS.

If at the time of construction, more than 2,000 m3 of soil is removed from the Site as excess, a Notice must be filled in the RRPA Excess Soil database along with the completion of all the applicable planning documents (i.e. Assessment of Past Uses/Phase One ESA, Soil Characterisation Report, Excess Soil Destination Assessment Report). This would include collection of additional samples at the required density based on the anticipated volume of excess soil from within the two APECs. Additional testing may be required by any potential reuse site, at their discretion.

6.7 Earth Retaining Structures

It is understood that the proposed upgrades will not consist of a basement or below grade level. The below recommendations for lateral earth pressures are provided for any potential earth retaining structures proposed at the project site.

6.7.1 Lateral Earth Pressures

Lateral earth pressures will need to be considered in the design of earth retaining structures or walls. The lateral earth pressures will depend on retained soil type, backfill type and compaction method, surcharge loads, wall movement, seismic effect, and drainage condition.

For retaining walls that are designed to allow sufficient lateral movement, active earth pressure may be used for design. For rigidly tied and unyielding structures, such as the retaining or foundation walls, the at-rest earth pressure should be used for design.

The recommended earth pressure coefficients are provided in Table 17 for static conditions and in Table 18 for seismic (static plus dynamic) conditions. The earth pressure coefficients were determined for the assumed conditions of no wall-to-soil friction, vertical back of the wall, and horizontal back slope of the ground surface behind the wall. The earth pressure coefficients for the retained soils along the active/passive failure planes should be used for lateral earth pressure calculations. The failure planes rise from horizontal at 45 + $\phi/2$ for the active pressure condition and 45 – $\phi/2$ for the passive pressure condition.

Table 17: Static Lateral Earth Pressure Coefficients

Material	Unit Weigth (kN/m^3)	Effective Friction Angle (deg)	Coefficients of Static Lateral Earth Structures		
			Active, K_a	At rest, K_o	Passive, K_p
Granular A or Granular B Type II	21 - 22	35	0.27	0.43	3.69
Existing Fill or Native Clay Soil	18.5	25	0.41	0.58	2.46

Table 18: Seismic (Static + Dynamic) Lateral Earth Pressure Coefficients

Material	Seismic Earth Pressure Coefficients (Site Class C, 2% probability in 50 years)		
	Active, K_{AE} (Yielding)	Active, K_{AE} (Non-Yielding)	Passive, K_{PE}
Granular A or Granular B Type II	0.37	0.50	3.37
Existing Fill or Native Clay Soil	0.53	0.71	2.19

The point of application of the active lateral seismic (static + dynamic) earth pressure should be calculated as follows:

- Static active lateral earth pressure acts at H/3 of the wall, measured from the base upwards; and
- Dynamic active lateral earth pressure acts at 0.6 H of the wall, also measured from the base upwards.

The location of the applied earth pressures described above has the effect of moving the point of application of the seismic pressure (which is the combined static and dynamic lateral earth pressures) closer to the mid-height of the wall. The above point of application is for lateral pressure due to the weight of retained soil (γh), and the calculated point of applications are presented in Table 19. For a uniform surcharge load at the top of backfill surface, the seismic pressure point of applications should be recalculated by considering a static pressure point of application of 0.5H for uniform surcharge load.

For higher walls, the point of application should be established from complex dynamic analysis methods.

Table 19: Load Application Height (h) from Base of Wall as a Ratio of Wall Height (H)

Material	h/H Ratio for seismic (Static + Dynamic) (Site Class C, 2% probability in 50 years)		
	Active, K_{AE} (Yielding)	Active, K_{AE} (Non-Yielding)	Passive, K_{PE}
Granular A or Granular B Type II	0.42	0.47	0.30
Existing Fill or Native Clay Soil	0.41	0.47	0.29

6.7.2 Backfill Behind Earth Retaining Structures

Granular fill materials that are non-frost susceptible and free-draining conforming to OPSS Granular A or Granular B (Type I or II) with a maximum particle size of 26.5 mm and less than 5% fines content (or other approved equivalent) should be used to reduce problems with frost adhesion and heaving. A Class II non-woven geotextile separator as per OPSS.MUNI 1860 should be placed between the existing soil and free-draining granular fill to filter fines from water.

To avoid ground settlements around the earth retaining structures, which could affect site grading and drainage, all of the backfill materials should be placed in maximum loose lifts of 200 mm and compacted to at least 95% of SPMDD at ±2% of OMC. Care must be taken during the compaction operation not to overstress the retaining structures. Heavy construction equipment should be maintained at a distance of at least 1 m away from the retaining structures while the backfill soils are being placed, and the backfill should be uniformly raised around the retaining structures. Hand operated vibratory compaction equipment should be used to compact the backfill soils within a 1 m wide zone adjacent to the earth retaining structures.

6.7.3 Drainage Behind Earth Retaining Structures

Drainage behind earth retaining structures should be provided by means of perforated pipe subdrains at the bottom of retaining structures. The perforated pipes should be surrounded by free drain granular material (OPSS.MUNI 1004 19 mm Clear Stone or approved equivalent) and wrapped up with OPSS.MUNI 1860 Class II non-woven geotextile. The pipes should be directed by gravity drainage to nearby storm sewer or sump pit.

The top of free-draining granular backfill behind the earth retaining structures should be sealed with either an impermeable geomembrane or a 300 mm clay layer.

The retaining structures should also be provided with impermeable damp-proof membranes.

The drainage system should be designed by a qualified Civil Design Consultant of the project to effectively mitigate the buildup of hydrostatic pressure behind the retaining structures. The subdrain pipes should be inspected and maintained to ensure that they do not become blocked.

6.7.4 Corrosion and Cement Type

Four soil samples were submitted to a Eurofins Environment Testing for corrosivity analyses related to the potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The samples were analysed for chloride, sulphate and sulphide concentrations, pH, conductivity/resistivity, and redox potential. The results of these testing are provided in Appendix D and are summarized in Table 9.

Based on ASTM STP1013 (Chaker and Palmer, 1989), a soil with a resistivity of less than 2,000 Ohm-centimetre is considered very corrosive, a soil with a resistivity between 2,000 and 5,000 Ohm-centimetre is considered corrosive, and a soil with a resistivity between 5,000 and 10,000 Ohm-centimetre is considered moderately corrosive.

The pH, resistivity and chloride concentration give an indication of the degree of corrosiveness of the sub-surface environment. Generally, the test results indicate a high to mild potential for corrosion of exposed ferrous metal respectively for the project site, which should be considered in the design of substructures. The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The sulphate results were compared with Table 3 of Canadian Standards Association (CSA A23.1-24) and indicated a low degree of sulphate attack potential on concrete structures at this site. Accordingly, Type GU Portland cement or equivalent can be considered for buried concrete substructures in contact with native soils. All imported soils should be tested for soluble sulphate contents the properties of concrete in contact with soil or groundwater shall meet all the requirements of

CSA A23.1:24.

Tables 1 to 4 of CSA-A23.1-24 should be referenced for additional requirements and further information regarding concrete in contact with sulphates.

6.7.5 Radon Potential

The proposed work includes building reinforcement and possible additions to house electronic equipment. Radon mitigation would not be possible with respect to modifications to the existing structure without addressing the entire building. It is also inferred that the new additions are not intended to be occupied full time (i.e. server rooms). Testing for radon gas in the existing structures was not included within the current scope.

7 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from construction traffic, and frost.

All subgrade areas should be inspected by a qualified geotechnical consultant prior to backfilling to confirm that the correct/expected strata exist and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill should be inspected to ensure that the materials used conform to the specifications from both grading and compaction requirements.

WSP should review the final drawings and specifications for this project prior to tendering to confirm that the recommendations in this report have been adequately interpreted.

8 CLOSURE

We trust that this geotechnical report provided sufficient information to support the design and construction of the proposed development. WSP expects to be contacted if one of the assumptions made about the sign is changed. We remain available for any questions or concerns about the report.

Signature Page

WSP Canada Inc.

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: WSP Canada Inc. (WSP) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to WSP by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. WSP cannot be responsible for use of this report, or portions thereof, unless WSP is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without WSP's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, WSP may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to WSP. The report, all plans, data, drawings and other documents as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of WSP. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of WSP's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, communications between WSP and the Client, and to any other reports prepared by WSP for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. WSP can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, WSP does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that WSP interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: WSP will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of WSP's report. WSP should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of WSP's report.

During construction, WSP should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of WSP's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in WSP's report. Adequate field review, observation and testing during construction are necessary for WSP to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, WSP's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that WSP be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that WSP be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. WSP takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

FIGURE

KEY MAP

SCALE: 1:250,000

LEGEND

- BOREHOLE LOCATION (WSP, SEP 2025)
- TEST HOLE LOCATION (PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT NO'S 961-2237, 762234, 760265A)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT NO. 991-2238)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT NO. 001-2129)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT NO. 981-2030)
- BOREHOLE LOCATION (PREVIOUS INVESTIGATION BY GOLDER ASSOCIATES LTD., REPORT NO. 001-2075)
- MASW SURVEY (WSP, SEPT 2025)
- VES SURVEY (WSP, SEPT 2025)

0 15 30 60

1:1,500 METRES

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE - ONTARIO
2. BASE MAP: MICROSOFT, VANTOR, SOURCES: ESRI, TOMTOM, GARMIN, FAO, NOAA, USGS, © OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
3. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N

CLIENT

CBRE LIMITED

PROJECT

GEOTECHNICAL INVESTIGATION FOR PROPOSED RENOVATIONS TO CISCO CAMPUS
2000 AND 3000 INNOVATION DRIVE, KANATA, ONTARIO

TITLE

SITE PLAN

CONSULTANT

wsp

YYYY-MM-DD	2025-10-29
DESIGNED	----
PREPARED	GU
REVIEWED	AKP
APPROVED	CH

PROJECT NO.	CONTROL	REV.	FIGURE
CA0058422.0115	0001	A	1

APPENDIX A

Record of Borehole Logs (Current Investigation)

METHOD OF SOIL CLASSIFICATION

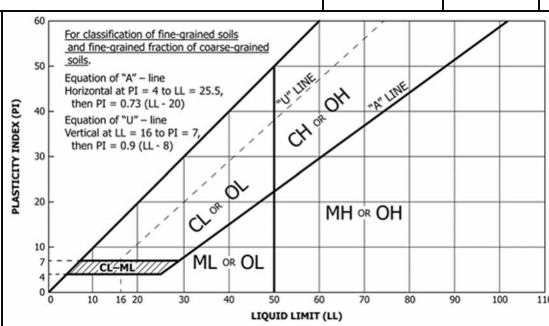
The WSP Canada Soil Classification[1] System is based on the Unified Soil Classification System (USCS) (after ASTM D2487)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content [6,9]	USCS Group Symbol[3,5,7]	Primary Group Name[2]
INORGANIC (Organic Content <30% by mass)	**COARSE-GRAINED SOILS** (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Clean Gravels with <5% fines [3] (by mass)	Well Graded	≥4 (and)	≥1 to ≤3	≤30%	GW	Well-graded GRAVEL [4,6]
				Poorly Graded	<4 (and/or)	<1 or >3		GP	Poorly graded GRAVEL [4,6]
			Gravels with >12% fines [3] (by mass)	Below A Line	n/a			GM	SILTY GRAVEL [4,6]
				Above A Line	n/a			GC	CLAYEY GRAVEL [4,5,6]
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Clean Sands with <5% fines [7] (by mass)	Well Graded	≥6 (and)	≥1 to ≤3		SW	Well-graded SAND [6,8]
				Poorly Graded	<6 (and/or)	<1 or >3		SP	Poorly graded SAND [6,8]
			Sands with >12% fines [7] (by mass)	Below A Line	n/a			SM	SILTY SAND [6,8]
				Above A Line	n/a			SC	CLAYEY SAND [5,6,8]

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content [B,H]	USCS Group Symbol [A]	Primary Group Name [A]
				Dilatancy	Dry Strength	Shine Test	Thread Diameter (mm)	Toughness (of 3 mm thread)			
INORGANIC (Organic Content <30% by mass)	**FINE-GRAINED SOILS** (≥50% by mass is smaller than 0.075 mm)	SILTS (Nonplastic or PI and LL plot **below A-Line** on Plasticity Chart below) [C]	Liquid Limit <50 [D]	Rapid	None to Low	Dull to None	3 to >6	Low/can't roll 3 mm	<15%	ML	SILT [H]
				None to Slow	Low to Medium	Dull to Slight	3 to 6	Low	15% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50 [D]	None to V.Slow	Low to Medium	Slight	3 to 6	Low to Medium	<15%	MH	ELASTIC SILT[H]
				None	Medium to High	Dull to Slight	1 to 3	Low to Medium	15% to <30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot **above A-Line** on Plasticity Chart below) [A]	Liquid Limit <50 [D]	None to Medium Slow	Medium to High	Slight to Shiny	1 to 3	Medium	<15%	CL	LEAN CLAY [A,E,F,G,H]
				None to V.Slow	Medium to High	Slight to Shiny	1 to 3	Medium	15% to <30%	OL	ORGANIC CLAY [E,F,G]
			Liquid Limit ≥50 [D]	None	High to V.High	Shiny	<1	High	<15%	CH	FAT CLAY [E,F,G,H]
				None	High	Shiny	<1 to 1	High	15% to <30%	OH	ORGANIC CLAY [E,F,G]
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures	Relatively lightweight, possibly spongy. Some water may squeeze from sample. Some shrinkage may occur on air drying. Sand fraction may be visible. Low to high dilatancy. Thread weak near plastic limit. Low to medium dry strength.						30% to <75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat	Lightweight, spongy. Much water squeezes from sample. Shrinks considerably on air drying (i.e., very high water content). Plant structure identiable to altered.						75% to 100%		PEAT

Coarse-Grained Soil Note(s):

1. Based on the material passing the 75 mm sieve.
2. If field sample contains or drilling observations indicate cobbles or boulders or both, add, "with cobbles" or "with cobbles and boulders". Include notes on the depth(s) encountered, and sizes if possible.
3. Gravels with 5% to 12% fines require dual symbols:
   (GW-GM) Well-graded GRAVEL with silt,
   (GW-GC) Well-graded GRAVEL with clay,
   (GP-GM) Poorly graded GRAVEL with silt,
   (GP-GC) Poorly graded GRAVEL with clay.
4. If soil contains ≥15% sand, add "with sand" to Group Name.
5. If fines classify as CL-ML, use dual symbol (GC-GM) or (SC-SM) for Group Symbol.
6. If the soil has an organic content (OC) 15%≤OC<30% the prefix "Organic" should be added before the Group Name. If the soil has an organic content 3%≤OC<15% add "with organic fines" to Group Name. If the soil contains >0% to ≤3% organics, the descriptor "trace organics" may be added to the Group Name.
7. Sands with 5% to 12% fines require dual symbols:
   (SW-SM) Well-graded SAND with silt,
   (SW-SC) Well-graded SAND with clay,
   (SP-SM) Poorly graded SAND with silt,
   (SP-SC) Poorly graded SAND with clay.
8. If soil contains ≥15% gravel, add "with gravel" to Group Name.



Fine-Grained Soil Note(s):

- **A.** If Atterberg limits plot above the A-line but in the 'hatched' area on the plasticity chart, soil is a (CL-ML) SILTY CLAY.
- **B.** If the soil contains >0% to ≤3% organics, the descriptor "trace organics" may be added to the Group Name.
- **C.** If fine-grained materials are nonplastic (i.e., a plastic limit (PL) cannot be measured), soil is a (ML) SILT.
- **D.** If soil has a liquid limit (LL) >30% to <50%, the term 'medium plasticity' may be included in the description, but the Group Name/Symbol is not changed.
- **E.** If soil contains 15% to <30% +No.200, add "with sand" or "with gravel".
- **F.** If soil contains ≥30% +No.200 mainly sand, add "Sandy" to Group Name.
- **G.** If soil contains ≥30% +No.200 mainly gravel, add "Gravelly" to Group Name.
- **H.** If the soil has an organic content (OC) 3%≤OC<15% add "with organic fines" to Group Name.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

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

GRADATIONAL COMPONENT TERMS

% (by mass)	Term
< 5	Use "trace"
≥ 5 to ≤ 12	Use "few"
> 12 to <30	Use "little"
≥ 30 to <50	Use "some"
≥ 50	Use "mostly"

PENETRATION RESISTANCE

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

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

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

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

ROCK

RDQ (Rock Quality Designation)

Quality Designation	RQD (%)
Very poor quality	< 25
Poor quality	25 – 50
Fair quality	50 – 75
Good quality	75 – 90
Excellent quality	> 90

USUAL SAMPLES

AS	Auger sample
DD	Diamond Drilling
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split-spoon sampler (50 mm OD); larger sizes use MC
TP	Thin-walled, piston – note size (Shelby tube)
TT	Seamless open ended, driven, pushed tube sampler, or geoprobe macro-core – note size (transparent tubing)

OTHER SAMPLES

BS	Block sample
DS	Denison type sample
EX-F	Floor sample
EX-P	Wall sample
MC	Modified California Samples – note sample diameter and hammer weight
MS	Modified Shelby (for frozen soil)
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
WS	Wash sample

STATE

Disturbed Lost Undisturbed Cored

CALIBER

Calibre (SS)	Interior diameter (mm)	Caliber (core barrel)	Interior diameter (mm)
P	75.9	PQ	85.0
H	63.2	HQ	63.5
N	50.5	NQ	47.6
B	37.8	BQ	36.4

WELL INSTALLATION

GROUNDWATER LEVEL AND DATE OF SURVEY

LEVEL OF LIQUID IN NON-AQUEOUS PHASE AND DATE OF SURVEY

MAT.	Material for well construction
DIA.	Well diameter
OP.	Opening of the slotted screen
PVC	Polyvinyl chlorid
SCH	Schedule (width of the PVC wall)
SS	Stainless steel

OBSERVATIONS[1]

Odours		Visual	
L	Low	D	Disseminated
M	Medium	S	Saturated
P	Strong	-	-

1 The odours reported were perceived incidentally during fieldwork. No sample has been deliberately smelled.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

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

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

Field Moisture Condition

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

COHESIVE SOILS

Consistency

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

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

Water Content

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

Plasticity

Term	Liquid Limit (LL)
Low	< 30%
Medium	30 – 50%
High	> 50%

Sensitivity (CFEM, 2023)

Term	Sensitivity, S_t
Low	< 8
Medium	8 – 30
High	> 30

SOIL TESTS

GSA	grain size analysis
w_N	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
PI	plastic index
LI	liquidity index
C	consolidation (oedometer) test
σ'_P	consolidation pressure
C_c	compression index
C_{cr}	recompression index
e_0	initial void ratio
k	hydraulic conductivity
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
c_u	Undrained shear strength on undisturbed soil using a fall cone penetrometer
c_r	Undrained shear strength on remolded soil using a fall cone penetrometer
s_u	Undrained shear strength on undisturbed soil - field
s_r	Undrained shear strength on remoulded soil - field
R	Refusal
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
γ	unit weight

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

ROCK TESTS

UCS (σ_c)	uniaxial compressive strength
γ	Unit weight
ν	Poisson's ratio
E	Linear deformation modulus
E_D	Dilatometer modulus
E_M	Pressuremeter modulus

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_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
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	nonplastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes

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

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

RECORD OF BOREHOLE: BH25-01

PROJECT: CA0058422.0115
LOCATION: N 5021358.62; E 427287.19
BORING DATE: September 22, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

BORING METHOD: Power Auger — 200 mm O.D; 108 mm I.D Hollow Stem Auger

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.3m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. +, Q - ●, rem V. ⊕, U - ○; 20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl; 10, 20, 30, 40) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Soil Profile

ELEV. / DEPTH (m)	DESCRIPTION
89.06	GROUND SURFACE
0.00	TOPSOIL - (SM) SILTY SAND; dark brown, few rootlets, trace wood fragments; non-cohesive, moist, compact
88.86 / 0.20	Fill - (GP) mostly GRAVEL with sand, trace silt; grey; non-cohesive, moist, compact
88.37 / 0.69	(CL/CH) LEAN CLAY to FAT CLAY, weathered crust; grey-brown; cohesive, w<PL to W~PL, firm to stiff
85.25 / 3.81	(CH) FAT CLAY; grey; cohesive, w>PL, medium plasticity clayey, stiff
83.26 / 5.80	(CH) FAT CLAY; grey; cohesive, W>PL, stiff to firm

Samples

NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT / LIMITS (printed values)	ADDITIONAL LAB. TESTING	GRAIN SIZE (GR SA SI CL)
1A	SS				
1B	SS	11			
2	SS	8			3 27 (70)
3	SS	5		CHEM	
4	SS	6	58		
5	SS	3	52.7		
6	SS	WH	59.3		
7	SS	WH			
8	SS	WH	56; 58.7		
9	SS	WH	59.4		
10	SS	WH	57.2		
11	SS	WH	60.8		
12	SS	WH	57.8		
13	SS	WH	59; 65		
14	SS	WH			

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50
LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-01

PROJECT: CA0058422.0115
LOCATION: N 5021358.62; E 427287.19
SPT/DCPT HAMMER: MASS, 140kg DROP, mm

BORING DATE: September 22, 2025
DRILL RIG: CME 55 LC/Track

DATUM:
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE / SHEAR STRENGTH Cu, kPa	HYDRAULIC CONDUCTIVITY / WATER CONTENT PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		--- *CONTINUED FROM PREVIOUS PAGE* ---									
10	Power Auger	(CH) FAT CLAY; grey; cohesive, W>PL, stiff to firm		78.70 / 10.36	14	SS	WH		W ≈ 44		
11		(SM) SILTY SAND, some gravel, mostly silt, some clay, some sand; grey (GLACIAL TILL); non-cohesive, wet, very loose to very dense			15A / 15B	SS	2	rem V. ≈ 2; nat V. ≈ 40	W ≈ 11		12 51 (37)
				77.48 / 11.58	16	SS	>50				
		END OF BOREHOLE Auger refusal on inferred possible bedrock or boulder									

DEPTH SCALE 1 : 50

LOGGED: IUK
CHECKED: AKP

GTA-BHS 005 S:\CLIENTS\CBRE_LIMITED\OTTAWA_ON\02_DATA\GINT\OTTAWA_ON.GPJ GAL-MIS.GDT 12/11/25

RECORD OF BOREHOLE: BH25-02

PROJECT: CA0058422.0115
LOCATION: N 5021292.60; E 427261.73
SPT/DCPT HAMMER: MASS, 140kg DROP, mm

BORING DATE: September 29, 2025
DRILL RIG: CME 55 LC/Track

DATUM:
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa (rem V. ⊕ / nat V. +)
0		GROUND SURFACE	88.78				
	Hydrovac	TOPSOIL	0.00				
		(CL/CH) LEAN CLAY to FAT CLAY, weathered crust, medium plasticity clayey fines; grey, brown; cohesive, w~PL, stiff to soft	88.48 / 0.30				
2	Power Auger, 200 mm O.D; 108 mm I.D Hollow Stem Auger			1	SS	10	
				2	SS	5	
3		- soft at 3.05 m		3	SS	2	
		(CH) FAT CLAY, medium to high plasticity fines; grey, cohesive, w~PL to w>PL, stiff to firm	85.05 / 3.73	4	SS	WH	
4							⊕ +
							⊕ +
5				5	SS	WH	
				6	SS	WH	⊕ +
6							⊕ +
				7	SS	WH	
7				8	SS	WH	+
							⊕ +
				9	SS	WH	
8		(ML) SANDY SILT, little clay; grey (GLACIAL TILL); non-cohesive, wet, very dense	80.60 / 8.23	10	SS	>50	
		END OF BOREHOLE Spoon and Auger refusal on inferred possible bedrock or boulder					

DEPTH SCALE
1 : 50

wsp

LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-03

PROJECT: CA0058422.0115
LOCATION: N 5021355.75; E 427351.40
SPT/DCPT HAMMER: MASS, 140kg DROP, mm

BORING DATE: September 23, 2025
DRILL RIG: CME 55 LC/Track

DATUM:
HAMMER TYPE: AUTOMATIC

Boring method: Power Auger, 200 mm O.D; 108 mm I.D Hollow Stem Auger

DEPTH (m)	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH / WATER CONTENT (%)
	GROUND SURFACE	88.28				
0	TOPSOIL. few rootlets and wood fragments, trace gravel; dark brown; non-cohesive, dry, compacted	0.00	1A			
	FILL - (SM) SILTY SAND with gravel, rootlets; dark brown mottled, orange; non-cohesive, dry, compact	0.10	1B	SS	14	
1			2	SS	15	
	(CL/CH) LEAN CLAY to FAT CLAY; grey mottled, brown (WEATHERED CRUST); cohesive, w<PL to w~PL, stiff to soft	86.83 / 1.45	3	SS	10	
2	- firm from 2.29 m		4	SS	5	
3	- soft from 3.05		5	SS	3	Wp–Wl: 52.6, 65
	(CH) FAT CLAY, medium to highly plasticity fines; grey; cohesive, w>PL, firm to stiff	84.55 / 3.73				
4			6	SS	WH	55.7
5						
6			7	SS	1	60.3
7			8	SS	WH	Wp–Wl: 55.2, 54
8			9	SS	WH	56.7
9			10	SS	WH	56.4
10						

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 50

LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-03

PROJECT: CA0058422.0115
LOCATION: N 5021355.75; E 427351.40
BORING DATE: September 23, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

BORING METHOD: Power Auger — 200 mm O.D; 108 mm I.D Hollow Stem Auger

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
10	(CH) FAT CLAY, medium to highly plasticity fines; grey; cohesive, w>PL, firm to stiff	77.76 / 10.52				
11	(SM) SILTY SAND with gravel, mostly silt, some clay, some sand, few gravel; grey; non-cohesive, wet, very loose to loose		11	SS	2	17 42 (41)
12	- few gravel from 12.19 m		12	SS	4	3 46 (51)
14		73.95 / 14.33	13	SS	8	
	Dynamic Cone Penetration Test (DCPT)	73.35 / 14.93				
15	END OF BOREHOLE END OF DCPT Auger and DCPT refusal on inferred bedrock or boulder					

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp —○W— Wl; 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE 1 : 50

LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-04

PROJECT: CA0058422.0115
LOCATION: N 5021287.07; E 427356.14
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
BORING DATE: September 30, 2025
DRILL RIG: CME 55 LC/Track
SHEET 1 OF 1
DATUM:
HAMMER TYPE: AUTOMATIC

Soil Profile

Boring Method	Description	Elev. (m)	Depth (m)
	GROUND SURFACE	88.72	
Hydro-Vac	TOPSOIL		0.00
Hydro-Vac	CLAY, contains cobbles; cohesive, stiff	88.26	0.46
Power Auger, 210 mm O.D. Hollow Stem Auger	(CL/CH) LEAN CLAY to FAT CLAY, clayey fines, low to medium plasticity; grey brown (WEATHERED CRUST); cohesive, w<PL to w~PL, firm	86.51	2.21
Power Auger, 210 mm O.D. Hollow Stem Auger	(CH) FAT CLAY; grey; cohesive, w~PL to w>PL, firm to stiff	84.99	3.73
Power Auger, 210 mm O.D. Hollow Stem Auger	(SM) SILTY SAND, sand and gravel, mostly silt, some clay, some sand, little gravel; grey (GLACIAL TILL); cohesive, w>PL, very soft	81.94	6.78
	END OF BOREHOLE Spoon on auger refusal on inferred bedrock or boulder	81.54	7.18

Samples

Number	Type	Blows/0.3m	Additional Lab. Testing	Notes
1	SS	7		
2	SS	7		
3	SS	4	CHEM	
4	SS	2		Water content 55.3
5	SS	WH		Shear strength (nat V. and rem V.) plotted
6	SS	WH		
7	TP	WH		
8	SS	>50		

Dynamic Penetration Resistance, Blows/0.3m: 20, 40, 60, 80
Shear Strength Cu, kPa: nat V. + Q - ● ; rem V. ⊕ U - ○ ; 20, 40, 60, 80
Hydraulic Conductivity, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}
Water Content Percent: Wp — W — Wl ; 10, 20, 30, 40
Piezometer or Standpipe Installation; Grain Size Distribution (%): GR SA SI CL

Depth Scale (metres): 0–10

DEPTH SCALE 1 : 50

LOGGED: IUK
CHECKED: AKP

wsp

RECORD OF BOREHOLE: BH25-05

PROJECT: CA0058422.0115
LOCATION: N 5021388.89; E 427376.14
BORING DATE: September 23, 2025
SHEET 1 OF 1
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
		GROUND SURFACE		87.07				
0	Power Auger; 200 mm O.D; 108 mm I.D Hollow Stem Auger	TOPSOIL - (PT) SILTY PEAT; dark brown, little rootlets; dry, compact		0.00	1A			
		FILL - (SM) SILTY SAND with gravel; dark brown with mottled redish orange, grey; non-cohesive, dry, compact		0.11	1B	SS	16	
1		(CL/CH) LEAN CLAY, low to medium plasticity clayey fines; grey mottled brown (WEATHERED CRUST); cohesive, w<PL, very stiff to firm		86.46 0.61	2A			
		- pockets of sand			2B	SS	19	
2					3	SS	5	CHEM
		END OF BOREHOLE NOTE: 1. Stopped borehole above buried grey pipe.		84.94 2.13				

Chart columns (no data plotted): DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. +, Q - ●, rem V. ⊕, U - ○; 20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl; 10, 20, 30, 40); PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE
1 : 50

wsp

LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-06

PROJECT: CA0058422.0115
LOCATION: N 5021310.61; E 427408.85
SPT/DCPT HAMMER: MASS, 140kg DROP, mm

BORING DATE: September 24, 2025
DRILL RIG: CME 55 LC Track

DATUM:
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT PERCENT	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE	86.97						
	Hydro-Vac	ASPHALT	0.00						Sand
		FILL - (GW) well graded GRAVEL with sand; grey; non-cohesive (PAVEMENT STRUCTURE)	0.08	1	GS				Bentonite
		(CL/CH) LEAN CLAY to FAT CLAY, weathered crust; grey mottled brown; cohesive, w~PL, firm to soft	86.42 / 0.55						
1				2	GS				Sand
2	Power Auger, 210 mm O.D. Hollow Stem Auger			3	SS	6			
				4	SS	4		52; 52.4	October 24, 2025 (water level)
3				5	SS	2		63.1	Screen
		(CH) FAT CLAY; grey; cohesive, w>PL, stiff	83.24 / 3.73						
4				6	SS	WH		52; 50.9	
5				7	SS	WH		61.1	Sand
									Hole Plug
6				8	SS	WH		54.1	
				9	SS	WH		59.3	
7				10	SS	WH		53; 52.7	
8									
9		(SM) SILTY SAND with gravel, mostly sand, some silt, little gravel, little clay; grey (GLACIAL TILL); non-cohesive, wet, very dense	77.83 / 9.19	11	SS	50/ 0.05			
		END OF BOREHOLE Refer to Record of Drillhole BH25-06							RQD = 84%
10									

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

RECORD OF BOREHOLE: BH25-06

PROJECT: CA0058422.0115
LOCATION: N 5021310.61; E 427408.85
SHEET 2 OF 2
BORING DATE: September 24, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: CME 55 LC Track
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp —○W— Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		--- CONTINUED FROM PREVIOUS PAGE ---									
10		NOTE: 1. Groundwater level measured on October 24, 2025 at 2.37 mbgs.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

PROJECT: CA0058422.0115

RECORD OF DRILLHOLE: BH25-06

SHEET 1 OF 1

LOCATION: N 5021310.61 ;E 427408.85

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: September 24, 2025

DRILL RIG: CME 55 LC Track

DRILLING CONTRACTOR: Downing Drilling

DATUM:

NOTE: For abbreviations, symbols and descriptions refer to **LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY**

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION	FEATURES
	GROUND SURFACE	77.78			
	SANDSTONE, fresh, thickly to very thickly bedded; light greyish pink; medium to coarse grained, non-porous, very strong	9.19	1	BD,PL,SM JN,PL,SM JN,PL,SM,SO JN,UN,RO JN,PL,RO	Broken Core
10	UCS=141 MPa	76.41		JN,UN,RO	Broken Core
11	SANDSTONE, slightly weathered, thickly to very thickly bedded; light greyish pink; medium to coarse grained, non-porous, very strong	10.56	2	JN,UN,RO JN,PL,SM,SO JN,PL,SM,PC	
12	UCS=85 MPa	74.88			
	END OF DRILLHOLE	12.09			
13					
14					
15					
16					
17					
18					
19					

Column headings: DRILLING RECORD; SYMBOLIC LOG; FLUSH RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER; DIP w.r.t. CORE AXIS; Jr; Ja; Jcon; WEATHERING INDEX (W1–W6); Diametral Point Load Index (MPa); PIEZOMETER

PROJECT: CA0058422.0115

RECORD OF BOREHOLE: BH25-07

LOCATION: N 5021422.34; E 427420.81

BORING DATE: September 26, 2025

DATUM:

SPT/DCPT HAMMER: MASS, 140kg DROP, mm

DRILL RIG: Hydrovac/Day/CME 55 LC/Track

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa (nat V. + / rem V. ⊕)	WATER CONTENT PERCENT (W)	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	86.94						
0	Hydro-Vac	TOPSOIL - (ML) SANDY SILT, (PT) SILTY PEAT; dark brown; some rootlets	0.00	1	GS				Bentonite
		FILL - (GP) poorly graded GRAVEL with SAND; grey, contains cobbles; non-cohesive	0.15	2	GS				
1		(CL/CH) LEAN CLAY to FAT CLAY, mostly low plasticity clayey fines; grey mottled brown (WEATHERE CRUST); cohesive, w<PL to w>PL, stiff to soft	86.10 / 0.84	3	GS				
2				4	SS	9			Sand
	Power Auger, 210 mm O.D. Hollow Stem Auger	- firm from 2.21		5	SS	5			▽ October 24, 2025; Screen
3		- soft from 2.97, w>PL		6	SS	4			
		(CH) FAT CLAY, mostly high plasticity, clayey fines; grey; cohesive, w>PL, firm to stiff	83.29 / 3.65						
4				7	SS	2		50.2	
5				8	SS	WH		61 / 62.3	
									Bentonite
6				9	SS	WH		59.2	Backfill
				10	SS	WH		51.5	
7				11	SS	WH		61.9	
8				12	SS	WH		53 / 52.1	
9				13	SS	WH		56	
10									

CONTINUED NEXT PAGE

Additional column headings: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT Wp ⊢ W ⊣ Wl (10, 20, 30, 40); ADDITIONAL LAB. TESTING; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL; Q - ● U - ○

DEPTH SCALE 1 : 50

wsp

LOGGED: IUK

CHECKED: AKP

RECORD OF BOREHOLE: BH25-07

PROJECT: CA0058422.0115
LOCATION: N 5021422.34; E 427420.81
SPT/DCPT HAMMER: MASS, 140kg DROP, mm

BORING DATE: September 26, 2025
DRILL RIG: Hydrovac/Day/CME 55 LC/Track

DATUM:
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES – NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger; 210 mm O.D. Hollow Stem Auger	(CH) FAT CLAY, mostly high plasticity, clayey fines; grey; cohesive, w>PL, firm to stiff									Backfill
11		- little sand			14	SS	WH	nat V. ≈ 49 kPa; rem V. ≈ 2 kPa, nat V. ≈ 62 kPa	W ≈ 44		
		(SM) SILTY CLAYEY SAND, mostly fines to medium, little low plasticity, fines, little gravel; grey (GLACIAL TILL); non-cohesive, wet, very dense		75.15 / 11.81	15	SS	50				
12		END OF BOREHOLE NOTE: 1. Groundwater level measured on October 24, 2025 at 2.64 mbgs.									
13–20											

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

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RECORD OF BOREHOLE: BH25-08

PROJECT: CA0058422.0115
LOCATION: N 5021335.13; E 427450.54
SHEET 1 OF 2
BORING DATE: September 29, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: Hydrovac/Day/CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa (nat V. + / rem V. ⊕)	WATER CONTENT PERCENT	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		GROUND SURFACE	87.22						
0	Hydro-Vac	ASPHALT	0.00						
		FILL - GRANULAR; grey; non-cohesive	0.11						
1		(CL/CH) LEAN CLAY; grey, weathered crust; cohesive, w<PL to w~PL, stiff to soft	86.46 / 0.76						
2	Power Auger, 200 mm O.D; 108 mm I.D Hollow Stem Auger			1	SS	9			
				2	SS	4			
3		w~PL, soft, trace white shell		3	SS	3			
4				4	SS	2			
		(CH) FAT CLAY; grey; cohesive, w>PL, stiff	82.65 / 4.57						
5				5	SS	WH	⊕ / +		
							⊕ / +		
6				6	SS	WH			
				7	SS	WH	⊕ / +		
							⊕ / +		
7				8	SS	WH			
8				9	SS	WH	⊕ / +		
							⊕ / +		
9		(SM) SILTY SAND, mostly silt, some clay, little sand, little gravel; grey (GLACIAL TILL); cohesive, w>PL, soft	78.08 / 9.14	10	SS	4		○	14 45 (41)
10									

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

PROJECT: CA0058422.0115

LOCATION: N 5021335.13; E 427450.54

RECORD OF BOREHOLE: BH25-08

BORING DATE: September 29, 2025

DATUM:

SPT/DCPT HAMMER: MASS, 140kg DROP, mm

DRILL RIG: Hydrovac/Day/CME 55 LC/Track

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
		--- CONTINUED FROM PREVIOUS PAGE ---									
10	Power Auger	(SM) SILTY SAND, mostly silt, some clay, little sand, little gravel; grey (GLACIAL TILL); cohesive, w>PL, soft		76.68 10.54							
		END OF BOREHOLE Auger refusal on inferred bedrock or boulder									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

LOGGED: IUK

CHECKED: AKP

RECORD OF BOREHOLE: BH25-09

PROJECT: CA0058422.0115
LOCATION: N 5021372.50; E 427476.12
BORING DATE: September 26, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: Hydrovac/Day/CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

Column headings: DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)) | SAMPLES (NUMBER, TYPE, BLOWS/0.3m) | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. +, Q - ●, rem V. ⊕, U - ○) (20, 40, 60, 80) | HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp ⊢—○W—⊣ Wl) (10, 20, 30, 40) | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION; GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Soil Profile

Boring Method	Description	Elev. / Depth (m)
	GROUND SURFACE	87.10 / 0.00
Hydro-Vac	TOPSOIL - (PT) SANDY SILT to SILTY SAND, silty peat, few gravel; dark brown, some think rootlets;	86.90 / 0.20
Hydro-Vac	FILL - (GP) poorly graded GRAVEL with sand, contains cobbles, little thick rootlets; grey; non-cohesive	86.69 / 0.41
Hydro-Vac	(CL-ML) CLAYEY SILT with sand, mostly low plasticity clayey fines, little fine sand; grey-brown, contains rootlets; cohesive, w<PL, very stiff	85.22 / 1.88
Power Auger, 210 mm O.D. Hollow Stem Auger	(CL/CH) LEAN CLAY, mostly low plasticity clayey fines; grey-brown, weathered crust; cohesive, w<PL to w~PL, stiff to firm	84.13 / 2.97
Power Auger, 210 mm O.D. Hollow Stem Auger	(CH/CL) FAT CLAY to LEAN CLAY; grey; cohesive, w~PL to w>PL, stiff to firm	

Samples

Number	Type	Blows/0.3m	Water Content (%)	Additional Lab. Testing
1	GS	-		
2	GS	-		
3	GS	-		
4	SS	8		
5	SS	4		CHEM
6	SS	1	51.6	
7	SS	2	53.7	
8	SS	WH	59.3	
9	SS	WH	62.7	
10	SS	WH	56	
11	SS	WH	66	
12	SS	WH	51.7	
13	SS	WH	54.1	

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

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RECORD OF BOREHOLE: BH25-09

PROJECT: CA0058422.0115
LOCATION: N 5021372.50; E 427476.12
BORING DATE: September 26, 2025
DATUM:
SPT/DCPT HAMMER: MASS, 140kg DROP, mm
DRILL RIG: Hydrovac/Day/CME 55 LC/Track
HAMMER TYPE: AUTOMATIC

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ ; 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}
WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl ; 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION
GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

BORING METHOD: Power Auger — 210 mm O.D. Hollow Stem Auger

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
10	(CH/CL) FAT CLAY to LEAN CLAY; grey; cohesive, w~PL to w>PL, stiff to firm	
11	- Lean clay	
12.20	(SM) SILTY SAND with gravel, mostly sand, some silt, little gravel, little clay; grey (GLACIAL TILL); non-cohesive, wet, compact to very dense	74.90 / 12.20
15.37	END OF BOREHOLE Spoon refusal on inferred bedrock or boulder	71.73 / 15.37

SAMPLE NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT	GR	SA	SI	CL
14	SS	WH	50.3				
15	SS	5		12	42		(47)
16	SS	21		15	51		(34)
17A / 17B	SS	50					

DEPTH SCALE
1 : 50

LOGGED: IUK
CHECKED: AKP

APPENDIX B

Rock Core Photographs and Uniaxial Compressive Strengths (UCS)

Top of Roc

BH-25-06 (DRY)
Core Box 1 to 2 of 2
From 9.19 m (ELEV. 77.78 m) to 12.09 m (ELEV. 74.88 m)

Elevation 74.88 m
End of Drillhole

wsp	**Geotechnical Investigation** **RENOVATIONS TO CISCO CAMPUS**	Project No. CA0058422.0115	**Figure B1**
	Ottawa (Ontario)	Drawn : AKP Date : 2025-10-21 Checked : AKP Revised : CH	

Top of Roc

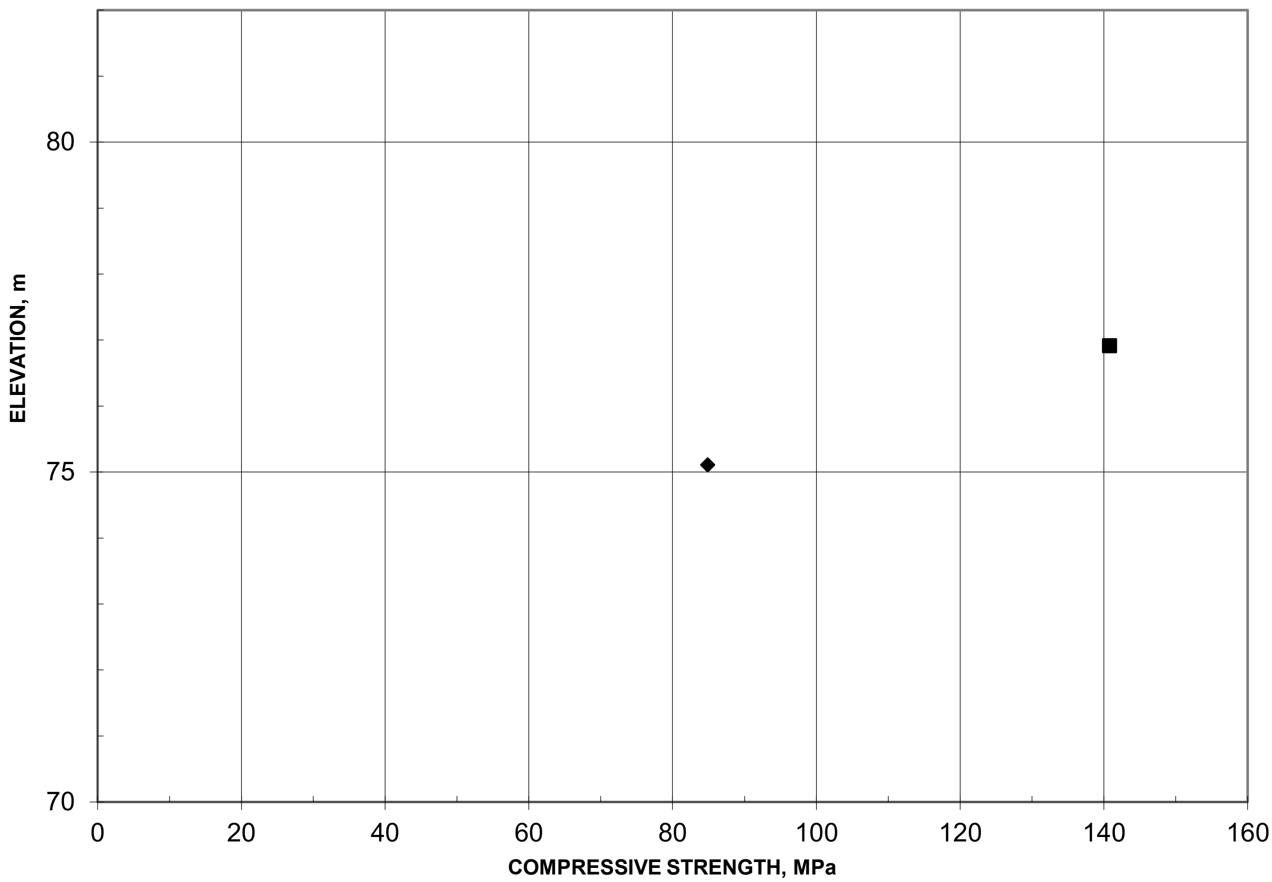
BH-25-06 (WET)
Core Box 1 to 2 of 2
From 9.19 m (ELEV. 77.78 m) to 12.09 m (ELEV. 74.88 m)

Elevation 74.88 m
End of Drillhole

wsp	**Geotechnical Investigation** **RENOVATIONS TO CISCO CAMPUS**	Project No. CA0058422.0115	**Figure B2**
	Ottawa (Ontario)	Drawn : AKP Date : 2025-10-21 Checked : AKP Revised : CH	

ASTM D7012 - Method C
UNCONFINED UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE
SUMMARY OF LABORATORY TEST RESULTS

FIGURE B3



	Borehole	Depth (m)	L/D	Bulk Density (kg/m^3)	Lithology	UCS (MPa)	Failure Type
■	25-06 RC1	10.1	2.3	2628	Granite	141	1
◆	25-06 RC2	11.9	2.3	2628	Granite	85	1

Notes:

Failure Types
1. Well formed cones on both ends
2. Well formed cones on one end, vertical cracks through cap
3. Columnar vertical craking through both ends
4. Diagonal fracture with no cracking through ends
5. Side fractures at top or bottom
6. Side fractures at both sides of top or bottom

Remarks
- Cores tested in vertical direction.
- Cores tested in air-dry condition.
- Time to failure > 2 and < 15 minutes.

Project: CA0058422.0115

Created by:	MI
Checked by:	CW

APPENDIX C

Geotechnical Laboratory Test Results

FIGURE C1

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

11/05/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01165-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-01	2	0.70	1.30	SS		34.2	BLC25-01674	Melanie Ireland	
25-01	4	2.10	2.70	SS		40.5	BLC25-01675		
25-01	5	3.00	3.60	SS		52.7	BLC25-01676		
25-01	6	3.80	4.40	SS		59.3	BLC25-01677		
25-01	7	4.50	5.20	SS		49.0	BLC25-01678		
25-01	8	5.30	5.90	SS		58.7	BLC25-01679		
25-01	9	6.10	6.70	SS		59.4	BLC25-01680		
25-01	10	6.80	7.50	SS		57.2	BLC25-01681		
25-01	11	7.60	8.20	SS		60.8	BLC25-01682		
25-01	12	8.40	8.90	SS		57.8	BLC25-01683		
25-01	13	9.10	9.70	SS		65.0	BLC25-01684		
25-01	14	9.90	10.50	SS		44.5	BLC25-01685		
25-01	15	10.60	11.20	SS		11.1	BLC25-01686		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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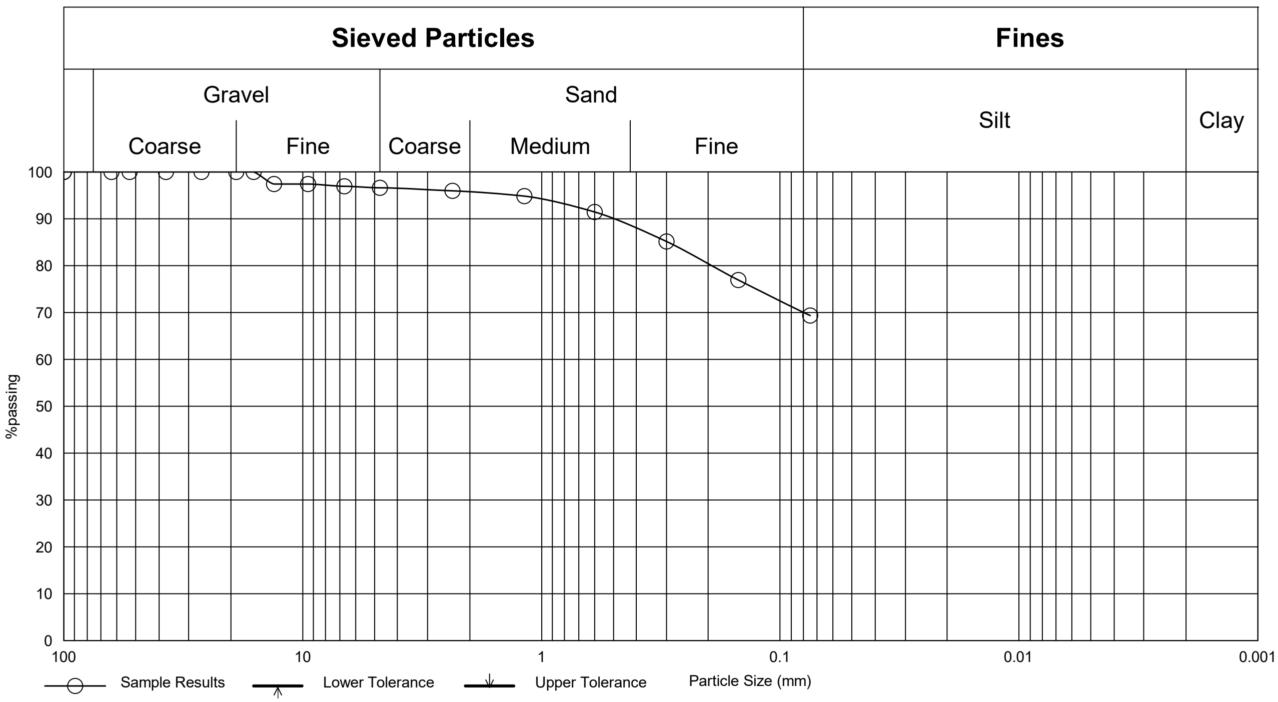
FIGURE C2
11/05/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-602 (Rev. 39)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-01
Source:		Borehole Type:	SS
Report Number:	BLC01165-25	Borehole Depth (m):	0.7 - 11.2
Sample Number:	2	WSP Lab Number:	BLC25-01674
Soil Description:	Silty, clayey sand	Specimen Depth (m):	0.7 - 1.3
Soil Classification:	SC-SM	Date of Test:	10/27/2025
Specification:		Tested By:	Zito, Sebastian

Grain Size Distribution	Gravel	Sand	Silt / Clay
	3.3	27.4	69.3



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
63.0			
53.0			
37.5			
26.5			
19.0			
16.0	100.0		
13.2	97.5		
9.5	97.5		
6.7	97.0		
4.75	96.7		
2.36	95.9		
1.18	94.8		
0.600	91.5		
0.300	85.1		
0.150	76.9	0.005mm	
0.075	69.3	0.002mm	
		D60	
		D30	NA
		D10	NA
		Cu	NA
		Cc	NA

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C3

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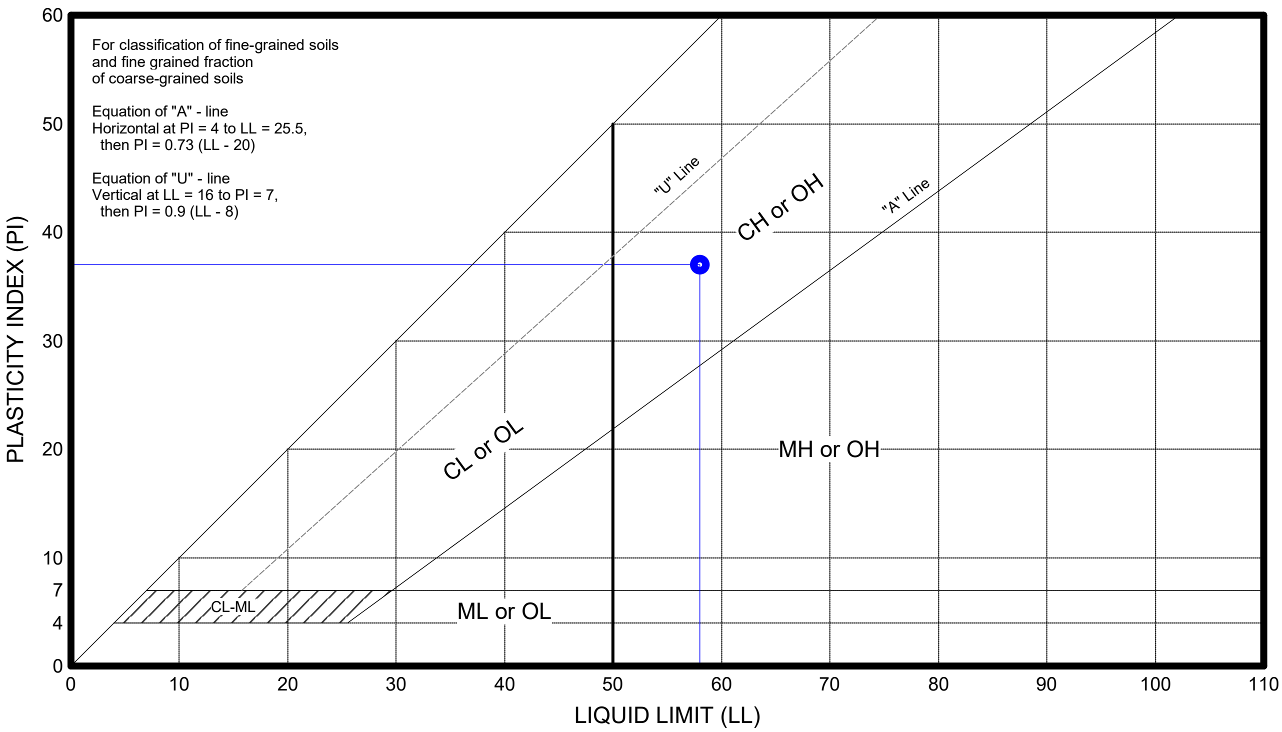
11/05/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-01
Source:		Borehole Type:	SS
Report Number:	BLC01165-25	Borehole Depth (m):	0.7 - 11.2
Sample Number:	4	WSP Lab Number:	BLC25-01675
Soil Description:	Fat clay	Specimen Depth (m):	2.1 - 2.7
Soil Classification:	CH	Date of Test:	10/31/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-01	4	2.10	2.70		40.5	58	21	37	0.53

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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WSP Canada Inc.
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613-592-9600

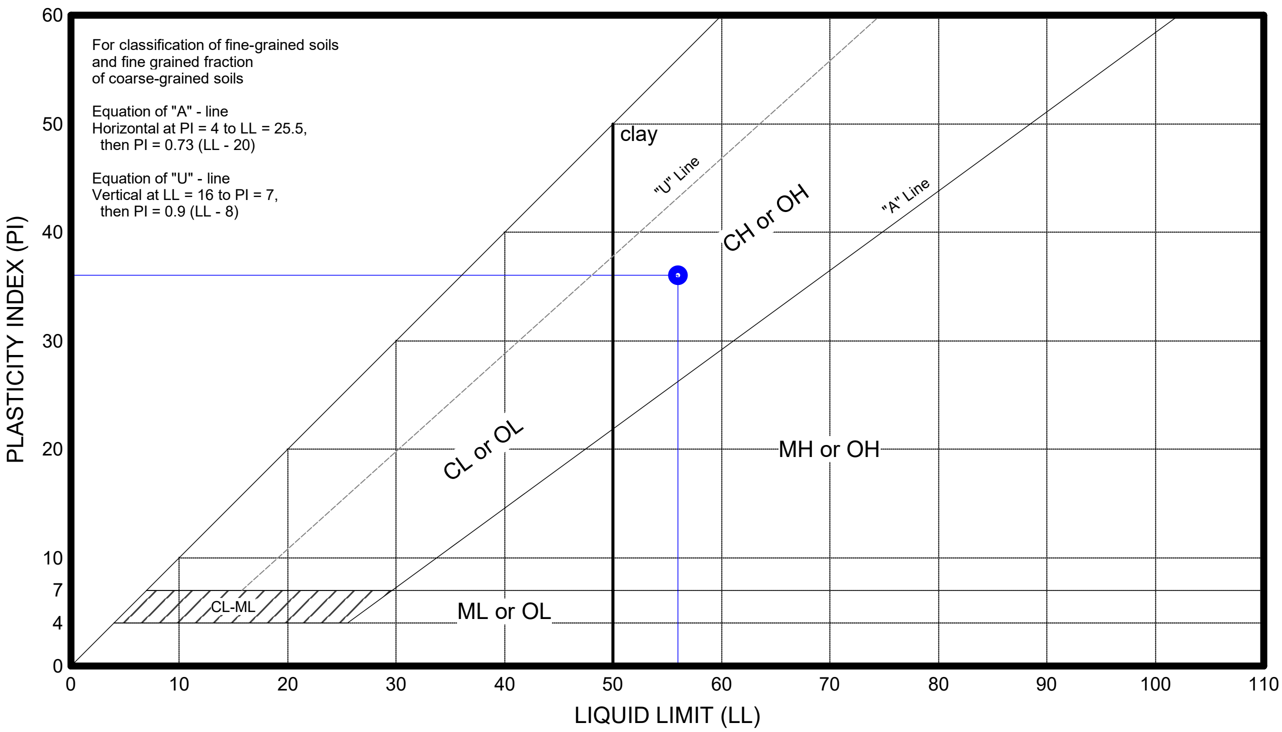
FIGURE C4

11/05/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-01
Source:		Borehole Type:	SS
Report Number:	BLC01165-25	Borehole Depth (m):	0.7 - 11.2
Sample Number:	8	WSP Lab Number:	BLC25-01679
Soil Description:	Fat clay	Specimen Depth (m):	5.3 - 5.9
Soil Classification:	CH	Date of Test:	10/27/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-01	8	5.30	5.90		58.7	56	20	36	1.07

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed
Lab Testing Comments / Deviations:
General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C5

WSP Canada Inc.
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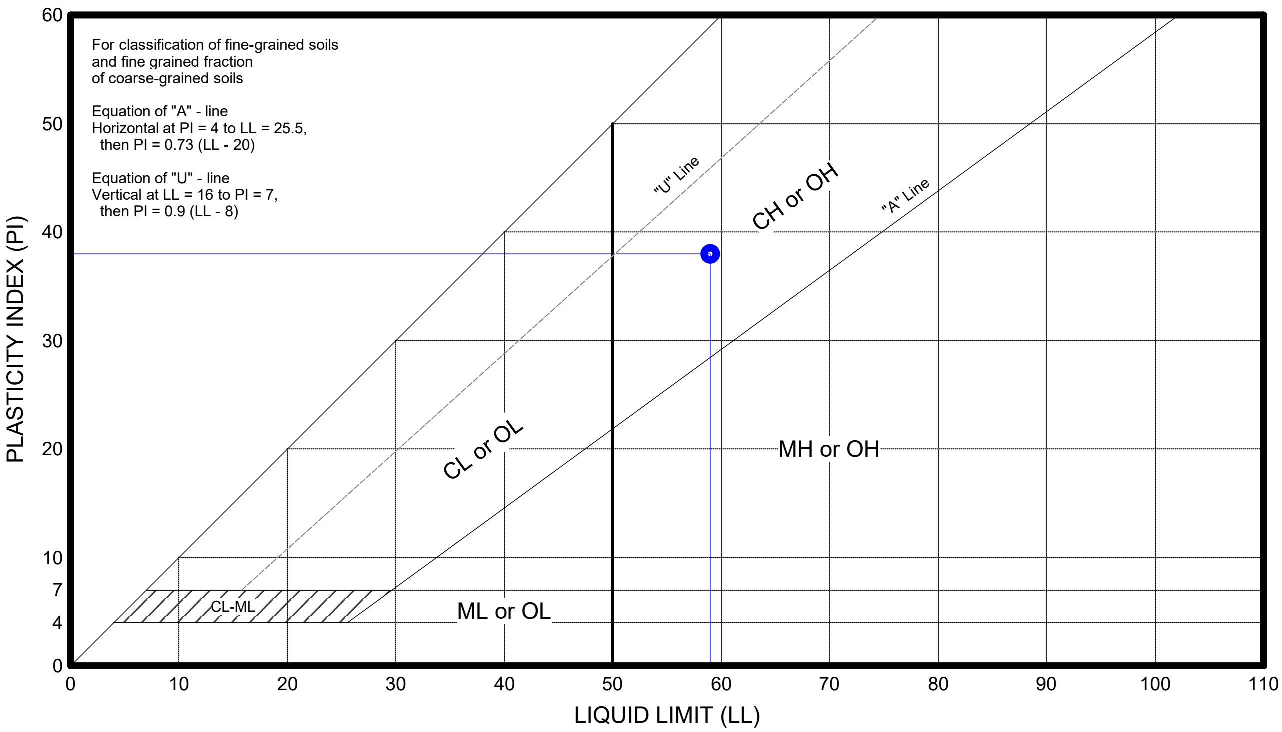
Bells Corners, K2H 5B7
613-592-9600

11/05/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-01
Source:		Borehole Type:	SS
Report Number:	BLC01165-25	Borehole Depth (m):	0.7 - 11.2
Sample Number:	13	WSP Lab Number:	BLC25-01684
Soil Description:	Fat clay	Specimen Depth (m):	9.1 - 9.7
Soil Classification:	CH	Date of Test:	10/29/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-01	13	9.10	9.70		65.0	59	21	38	1.16

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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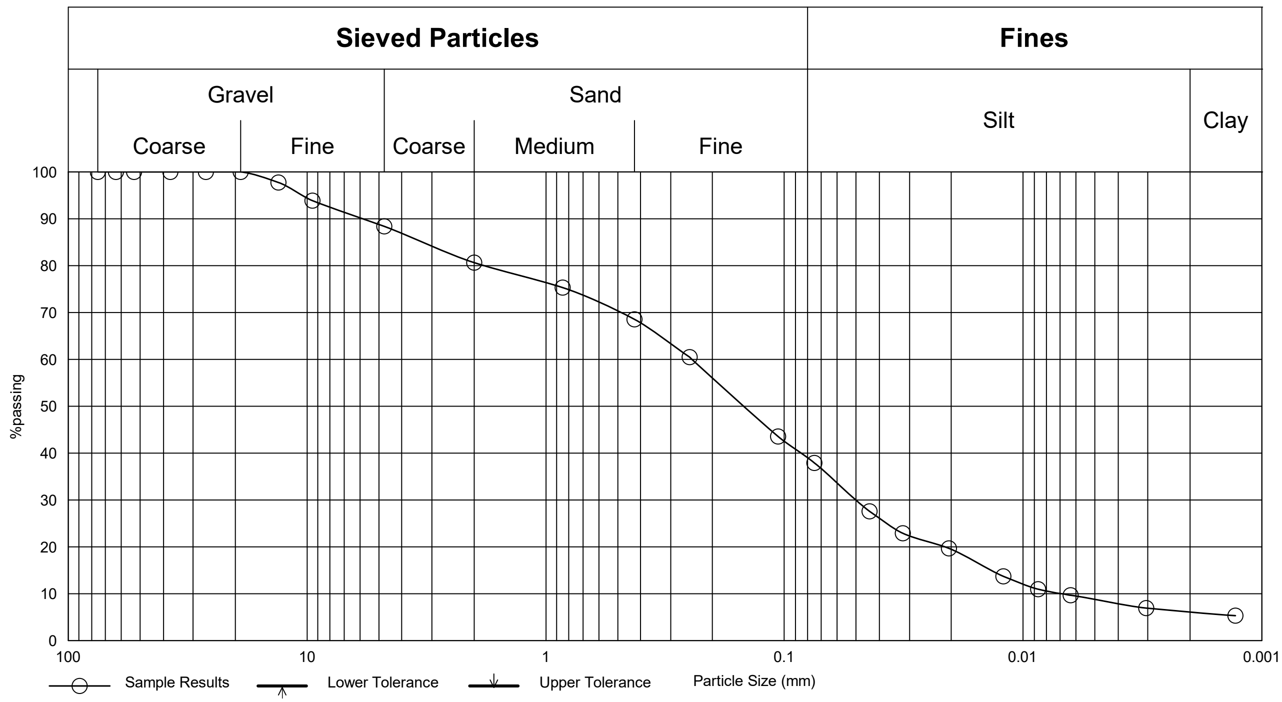
FIGURE C6
11/05/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051088	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-01
Source:		Borehole Type:	SS
Report Number:	BLC01165-25	Borehole Depth (m):	0.7 - 11.2
Sample Number:	15	WSP Lab Number:	BLC25-01686
Soil Description:	Silty sand	Specimen Depth (m):	10.6 - 11.2
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Zito, Sebastian

Grain Size Distribution	Gravel	Sand	Silt / Clay
	11.6	50.5	37.9



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0439	27.6
		0.0319	22.9
		0.0205	19.6
		0.0121	13.7
		0.0087	11.0
		0.0063	9.7
75.0		0.0031	7.0
63.0		0.0013	5.3
53.0			
37.5			
26.5			
19.0	100.0		
13.2	97.8		
9.5	93.9		
4.75	88.4	0.005mm	8.7
2.00	80.7	0.002mm	6.0
0.850	75.3	D60	0.244
0.425	68.6	D30	0.050
0.250	60.4	D10	0.007
0.106	43.5	Cu	35.282
0.075	37.9	Cc	1.48

Notes:

Disclaimer:

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Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C7

WSP Canada Inc.
1931 Robertson Road
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613-592-9600

11/05/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01167-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-03	1B	0.10	0.60	SS		13.4	BLC25-01687	Melanie Ireland	
25-03	2	0.70	1.30	SS		10.3	BLC25-01688		
25-03	3	1.50	2.10	SS		32.8	BLC25-01689		
25-03	4	2.30	2.90	SS		43.2	BLC25-01690		
25-03	5	3.00	3.60	SS		52.6	BLC25-01691		
25-03	6	3.80	4.40	SS		55.7	BLC25-01692		
25-03	7	5.30	5.90	SS		60.3	BLC25-01693		
25-03	8	6.80	7.40	SS		55.2	BLC25-01694		
25-03	9	7.60	8.20	SS		56.7	BLC25-01695		
25-03	10	9.10	9.70	SS		56.4	BLC25-01696		
25-03	11	10.60	11.20	SS		10.2	BLC25-01697		
25-03	12	12.20	12.80	SS		18.4	BLC25-01698		
25-03	13	13.70	14.30	SS		11.8	BLC25-01699		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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613-592-9600

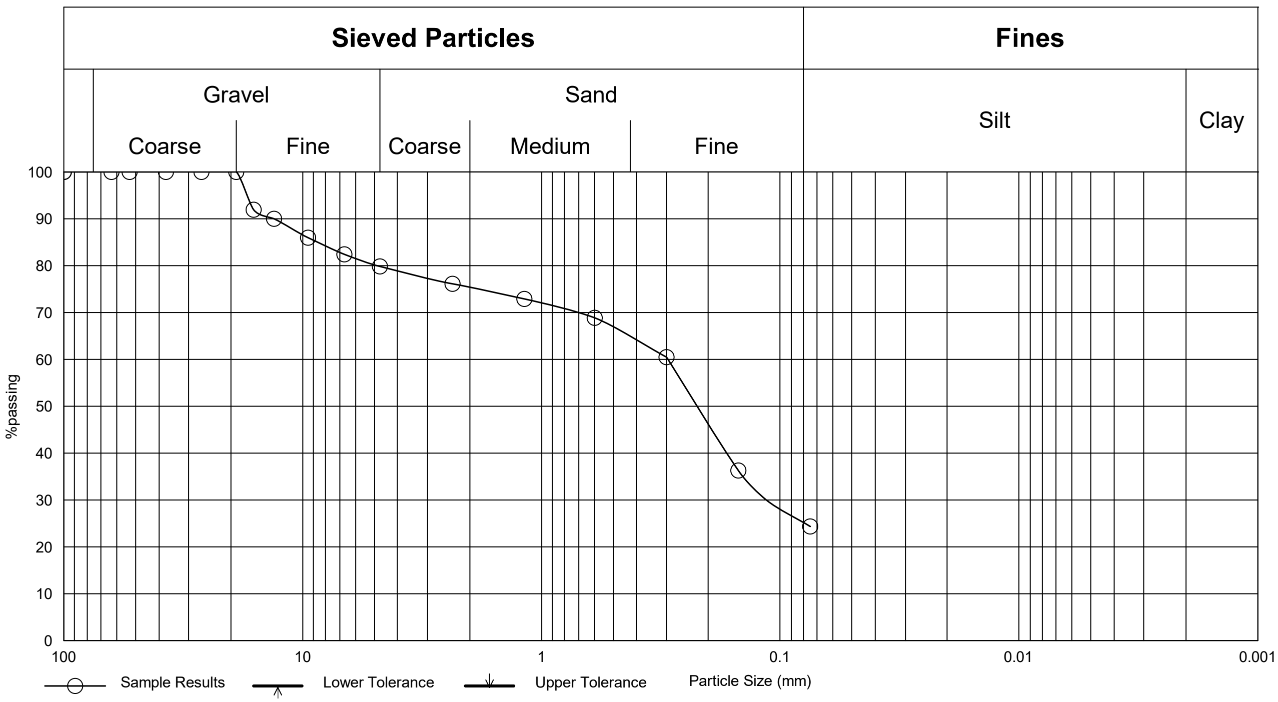
FIGURE C8
11/05/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-602 (Rev. 39)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-03
Source:		Borehole Type:	SS
Report Number:	BLC01167-25	Borehole Depth (m):	0.1 - 14.3
Sample Number:	2	WSP Lab Number:	BLC25-01688
Soil Description:	Silty sand with gravel	Specimen Depth (m):	0.7 - 1.3
Soil Classification:	SM	Date of Test:	10/27/2025
Specification:		Tested By:	Zito, Sebastian

Grain Size Distribution	Gravel	Sand	Silt / Clay
	20.1	55.5	24.4



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
63.0			
53.0			
37.5			
26.5			
19.0	100.0		
16.0	91.9		
13.2	90.1		
9.5	86.0		
6.7	82.4		
4.75	79.9		
2.36	76.1		
1.18	72.8		
0.600	68.9		
0.300	60.5		
0.150	36.2	0.005mm	
0.075	24.4	0.002mm	
		D60	0.295
		D30	0.114
		D10	NA
		Cu	NA
		Cc	NA

Notes:

Disclaimer:

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Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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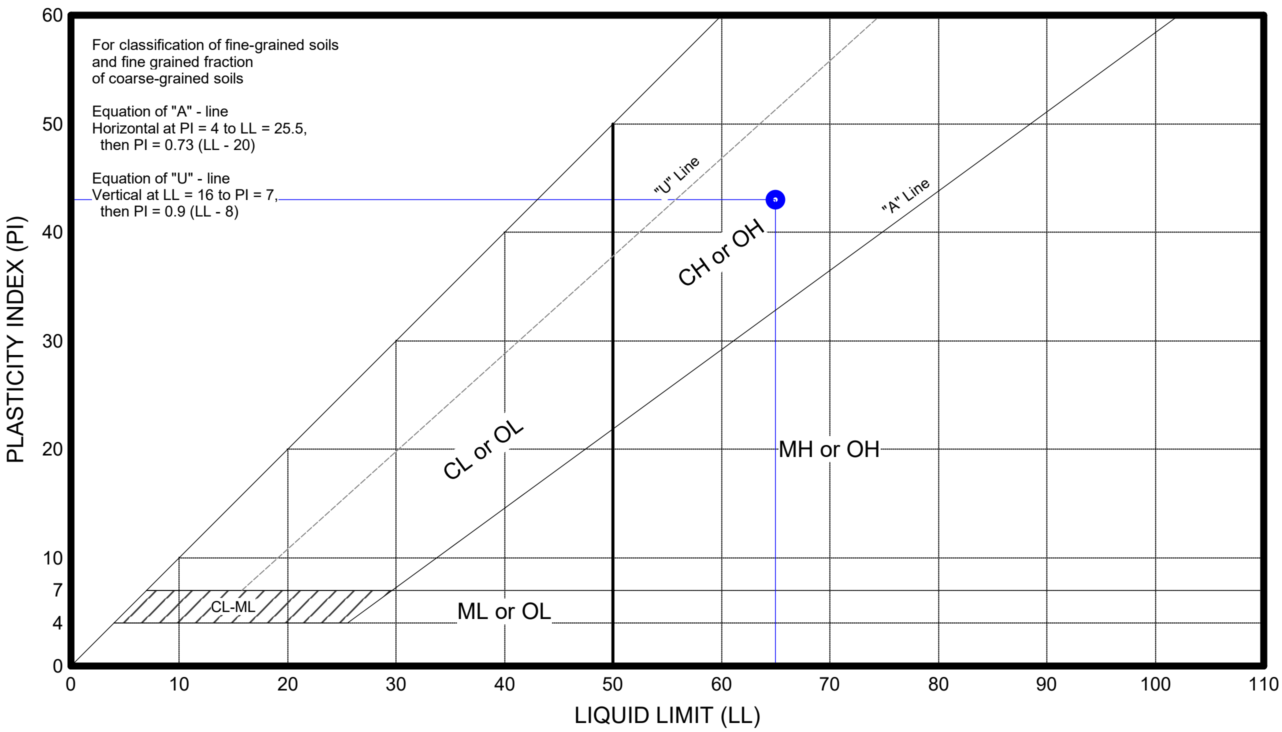
FIGURE C9

11/05/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-03
Source:		Borehole Type:	SS
Report Number:	BLC01167-25	Borehole Depth (m):	0.1 - 14.3
Sample Number:	5	WSP Lab Number:	BLC25-01691
Soil Description:	Fat clay	Specimen Depth (m):	3 - 3.6
Soil Classification:	CH	Date of Test:	10/29/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-03	5	3.00	3.60		52.6	65	22	43	0.71

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C10

WSP Canada Inc.
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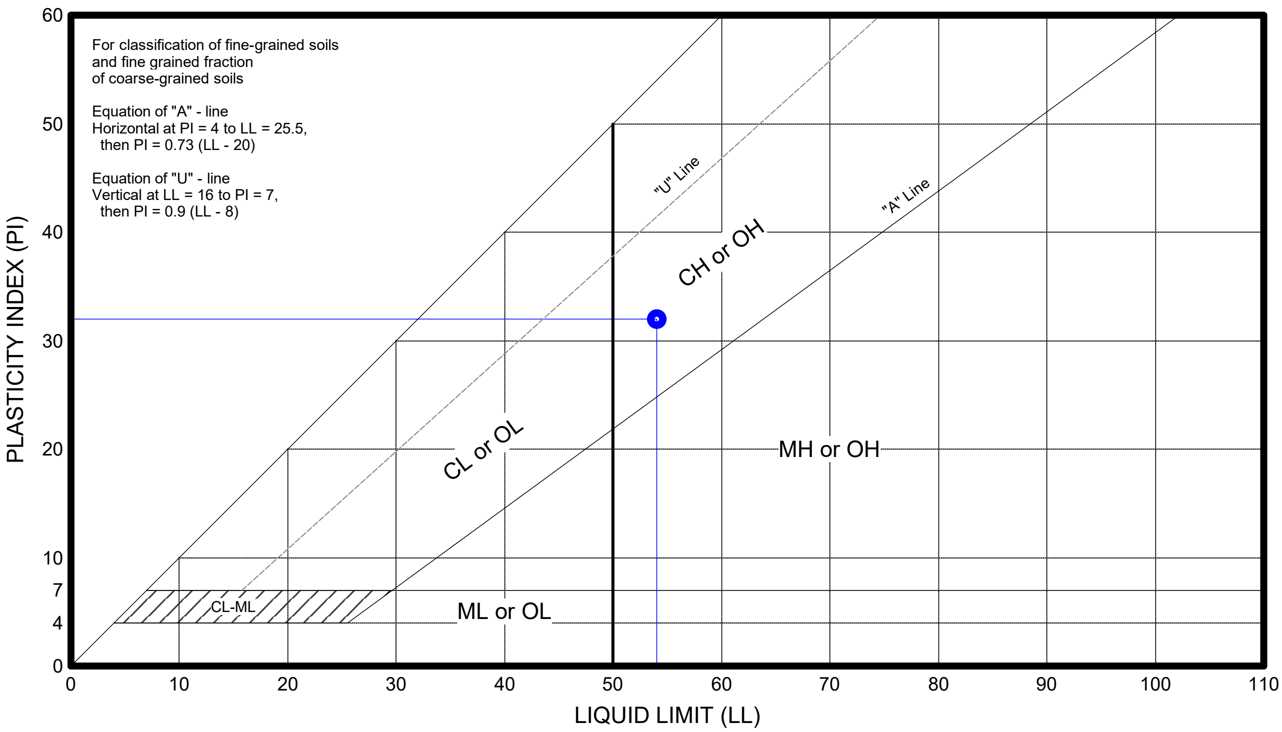
613-592-9600

11/05/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-03
Source:		Borehole Type:	SS
Report Number:	BLC01167-25	Borehole Depth (m):	0.1 - 14.3
Sample Number:	8	WSP Lab Number:	BLC25-01694
Soil Description:	Fat clay	Specimen Depth (m):	6.8 - 7.4
Soil Classification:	CH	Date of Test:	10/29/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-03	8	6.80	7.40		55.2	54	22	32	1.04

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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613-592-9600

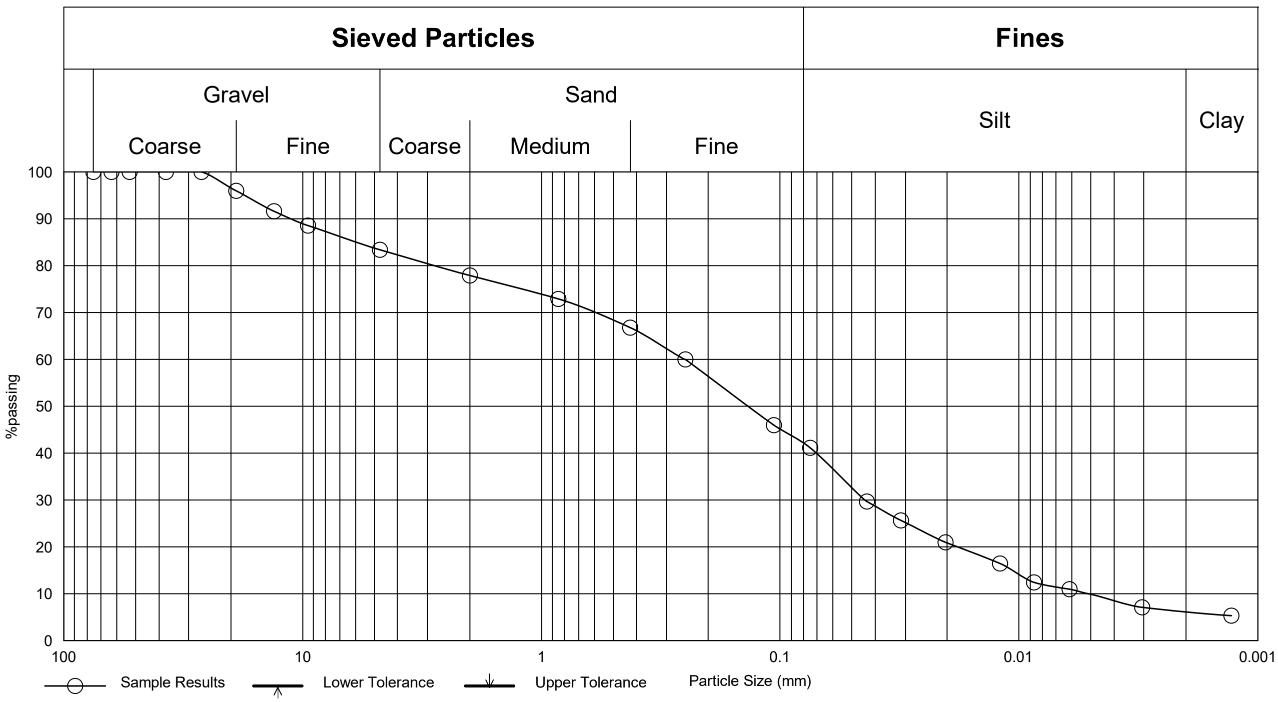
FIGURE C11
11/05/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-03
Source:		Borehole Type:	SS
Report Number:	BLC01167-25	Borehole Depth (m):	0.1 - 14.3
Sample Number:	11	WSP Lab Number:	BLC25-01697
Soil Description:	Silty sand with gravel	Specimen Depth (m):	10.6 - 11.2
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Zito, Sebastian

Grain Size Distribution	Gravel	Sand	Silt / Clay
	16.6	42.3	41.1



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0434	29.7
		0.0313	25.7
		0.0203	21.0
		0.0120	16.4
		0.0086	12.4
		0.0061	11.0
75.0		0.0031	7.1
63.0		0.0013	5.3
53.0			
37.5			
26.5	100.0		
19.0	95.9		
13.2	91.6		
9.5	88.5		
4.75	83.4	0.005mm	9.8
2.00	77.8	0.002mm	6.0
0.850	72.9	D60	0.251
0.425	66.8	D30	0.044
0.250	59.9	D10	0.005
0.106	46.0	Cu	48.957
0.075	41.1	Cc	1.52

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:			

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Bells Corners, K2H 5B7
613-592-9600

FIGURE C12

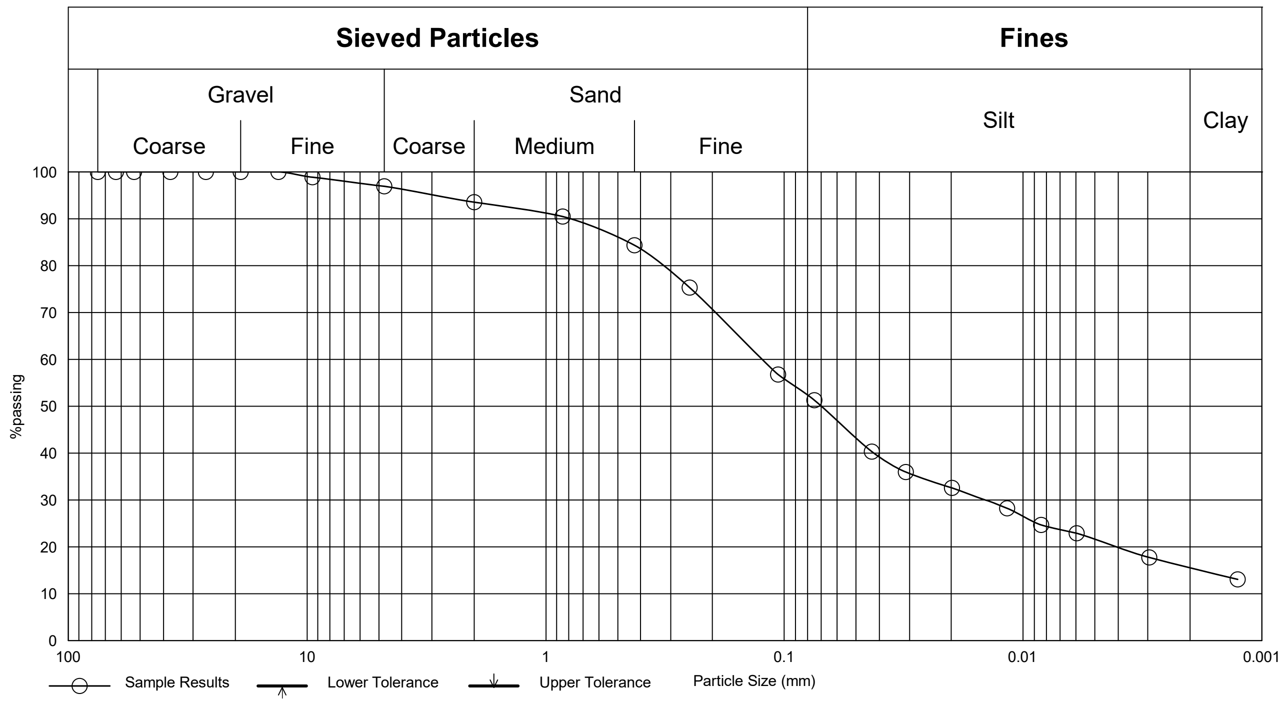
11/05/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051098	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-03
Source:		Borehole Type:	SS
Report Number:	BLC01167-25	Borehole Depth (m):	0.1 - 14.3
Sample Number:	12	WSP Lab Number:	BLC25-01698
Soil Description:	Silty sand	Specimen Depth (m):	12.2 - 12.8
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Zito, Sebastian

Grain Size Distribution	Gravel	Sand	Silt / Clay
	3.0	45.7	51.3



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0432	40.3
		0.0311	36.0
		0.0199	32.5
		0.0117	28.2
		0.0084	24.7
		0.0060	23.0
75.0		0.0030	17.7
63.0		0.0013	13.0
53.0			
37.5			
26.5			
19.0			
13.2	100.0		
9.5	98.8		
4.75	97.0	0.005mm	21.7
2.00	93.6	0.002mm	15.2
0.850	90.4	D60	0.124
0.425	84.4	D30	0.014
0.250	75.3	D10	NA
0.106	56.7	Cu	NA
0.075	51.3	Cc	NA

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

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Signature:	Chelsea Ward		

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FIGURE C13

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

11/06/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051099	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01170-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-04	4	3.80	4.40	SS		55.3	BLC25-01700	Melanie Ireland	
25-04	5	5.30	5.90	SS		47.7	BLC25-01701		
25-04	6	6.80	7.40	SS		49.9	BLC25-01702		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C14

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613-592-9600

11/06/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051100	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01171-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-06	4	2.30	2.90	SS		52.4	BLC25-01703	Melanie Ireland	
25-06	5	3.00	3.60	SS		63.1	BLC25-01704		
25-06	6	3.80	4.40	SS		50.9	BLC25-01705		
25-06	7	4.50	5.20	SS		61.1	BLC25-01706		
25-06	8	5.30	5.90	SS		54.1	BLC25-01707		
25-06	9	6.10	6.70	SS		59.3	BLC25-01708		
25-06	10	6.80	7.40	SS		52.7	BLC25-01709		
25-06	11	7.60	8.20	SS		49.2	BLC25-01710		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C15

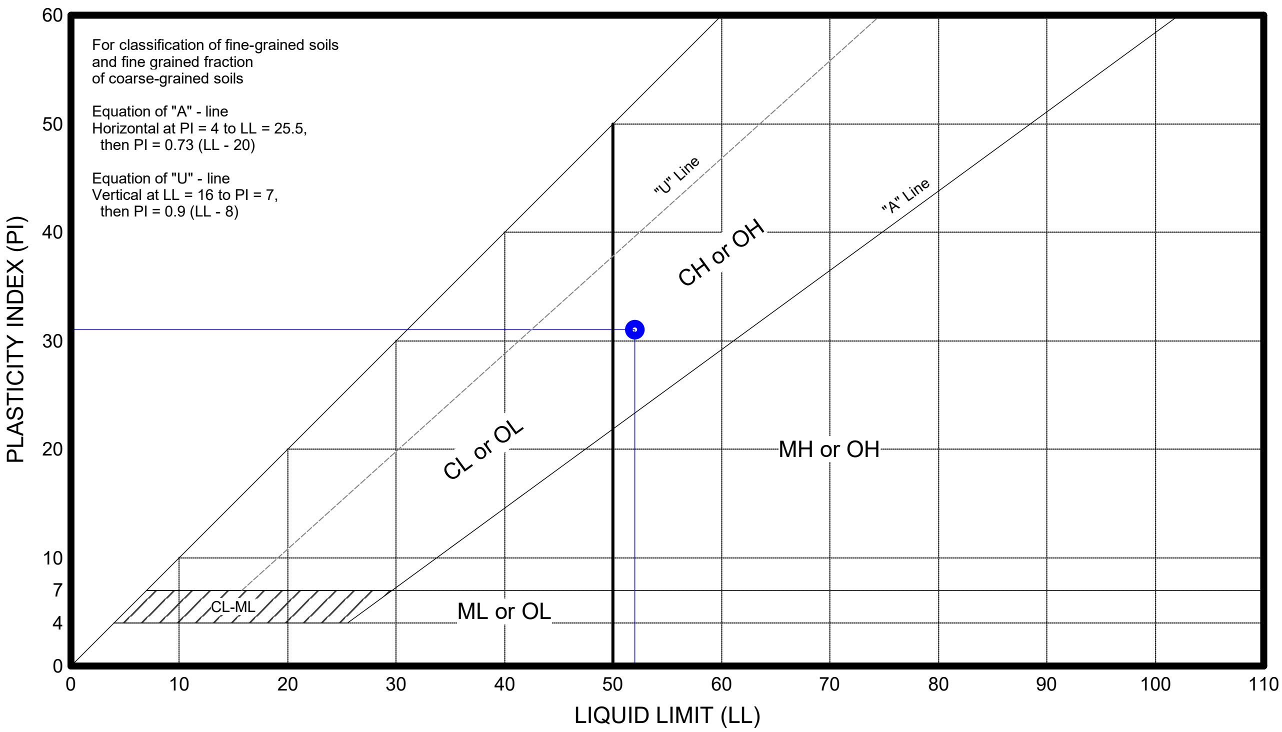
11/06/2025

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051100	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-06
Source:		Borehole Type:	SS
Report Number:	BLC01171-25	Borehole Depth (m):	2.3 - 8.2
Sample Number:	4	WSP Lab Number:	BLC25-01703
Soil Description:	Fat clay	Specimen Depth (m):	2.3 - 2.9
Soil Classification:	CH	Date of Test:	10/31/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-06	4	2.30	2.90		52.4	52	21	31	1.01

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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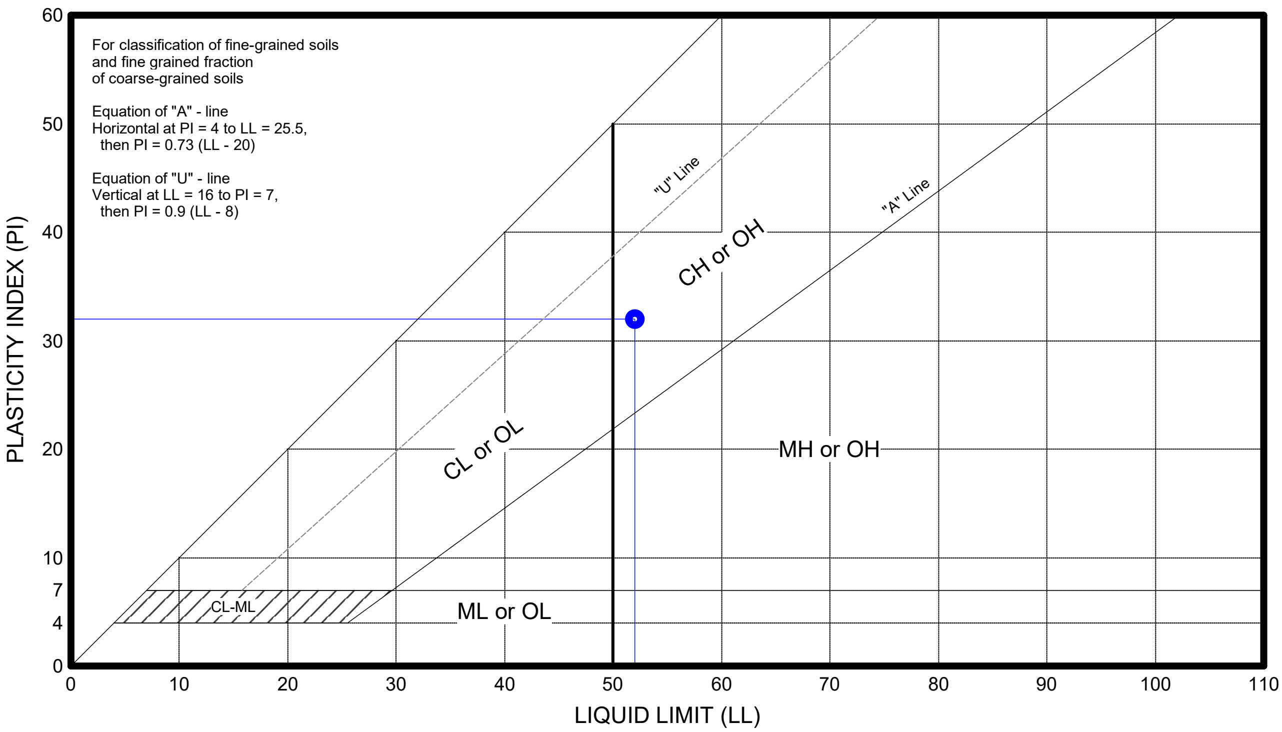
WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

FIGURE C16
11/06/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051100	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-06
Source:		Borehole Type:	SS
Report Number:	BLC01171-25	Borehole Depth (m):	2.3 - 8.2
Sample Number:	6	WSP Lab Number:	BLC25-01705
Soil Description:	Fat clay	Specimen Depth (m):	3.8 - 4.4
Soil Classification:	CH	Date of Test:	10/29/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-06	6	3.80	4.40		50.9	52	20	32	0.97

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

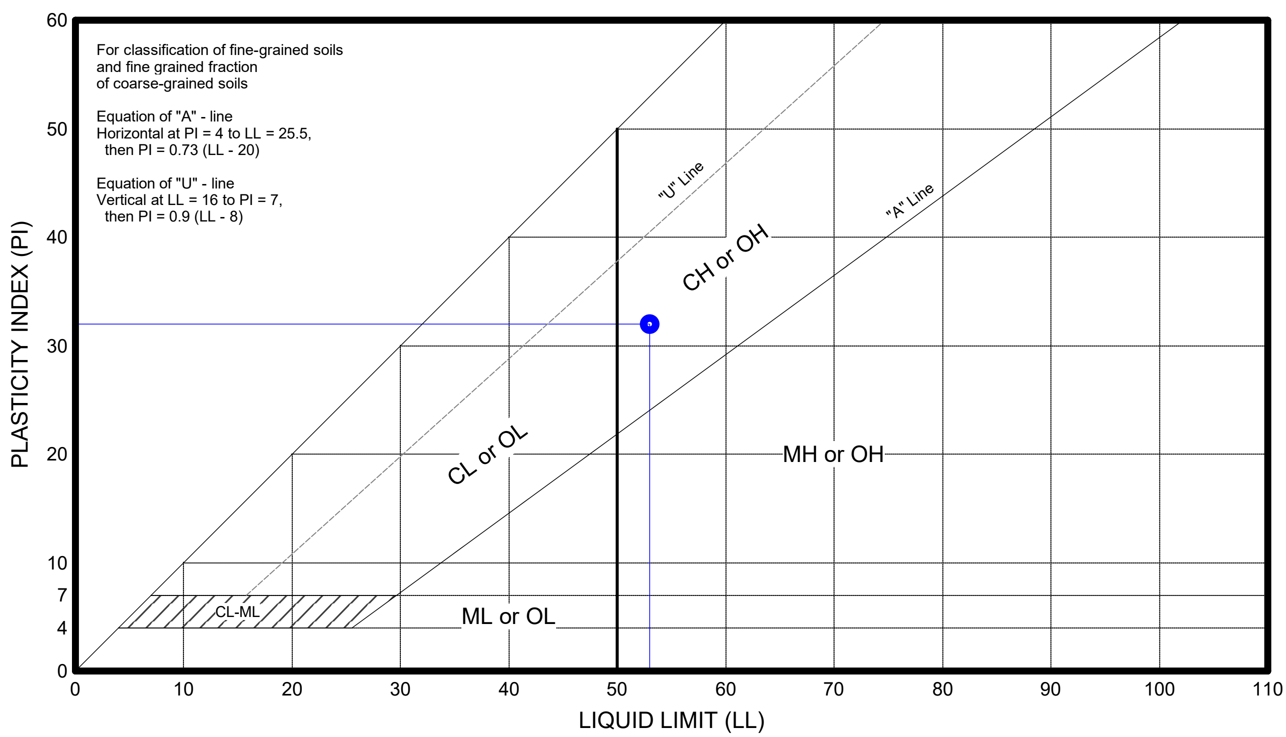
WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

FIGURE C17
11/06/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051100	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-06
Source:		Borehole Type:	SS
Report Number:	BLC01171-25	Borehole Depth (m):	2.3 - 8.2
Sample Number:	10	WSP Lab Number:	BLC25-01709
Soil Description:	Fat clay	Specimen Depth (m):	6.8 - 7.4
Soil Classification:	CH	Date of Test:	11/03/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-06	10	6.80	7.40		52.7	53	21	32	0.99

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C18

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

11/06/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051102	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01172-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-07	4	1.80	2.10	SS		37.3	BLC25-01711	Melanie Ireland	
25-07	5	2.30	2.90	SS		46.3	BLC25-01712		
25-07	6	3.00	3.60	SS		47.4	BLC25-01713		
25-07	7	3.80	4.40	SS		50.2	BLC25-01714		
25-07	8	4.50	5.20	SS		62.3	BLC25-01715		
25-07	9	5.30	5.90	SS		59.2	BLC25-01716		
25-07	10	6.10	6.70	SS		51.5	BLC25-01717		
25-07	11	6.80	7.40	SS		61.9	BLC25-01718		
25-07	12	7.60	8.20	SS		52.1	BLC25-01719		
25-07	13	9.10	9.70	SS		56.0	BLC25-01720		
25-07	14	10.60	11.20	SS		43.8	BLC25-01721		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C19

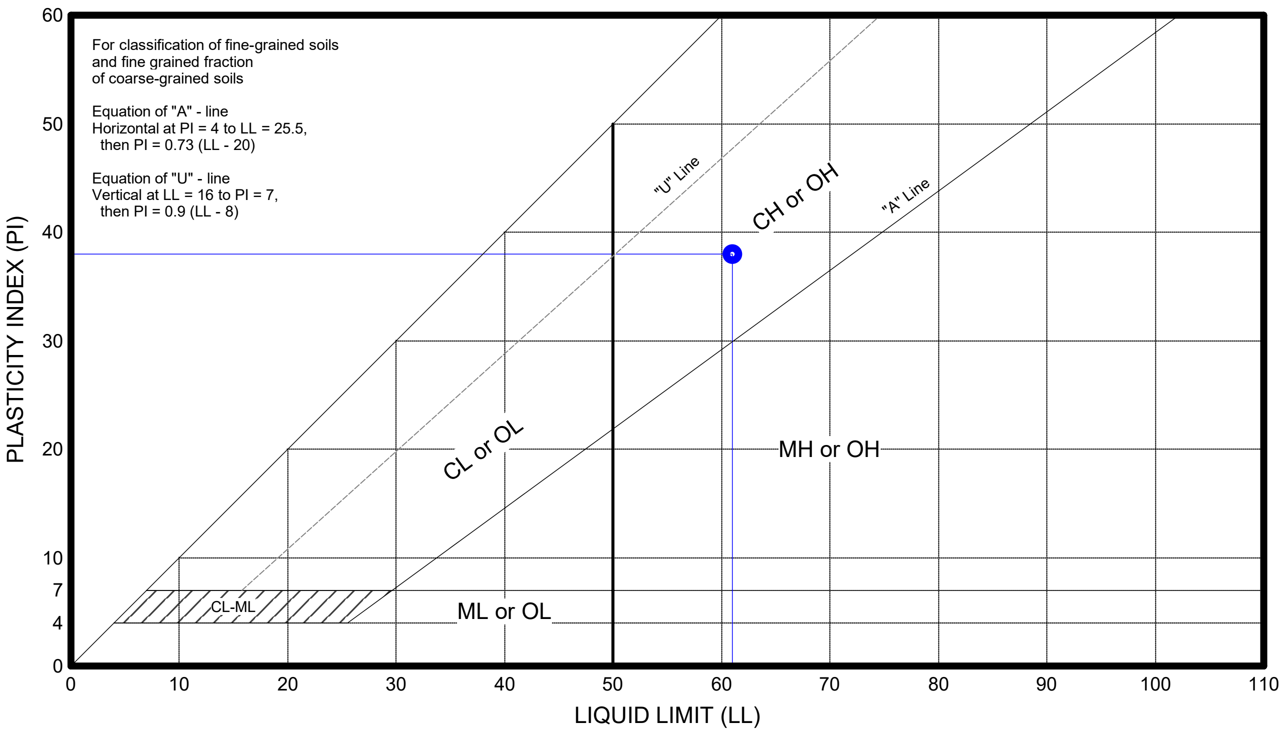
11/06/2025

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051102	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-07
Source:		Borehole Type:	SS
Report Number:	BLC01172-25	Borehole Depth (m):	1.8 - 11.2
Sample Number:	8	WSP Lab Number:	BLC25-01715
Soil Description:	Fat clay	Specimen Depth (m):	4.5 - 5.2
Soil Classification:	CH	Date of Test:	11/03/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-07	8	4.50	5.20		62.3	61	23	38	1.03

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

FIGURE C20

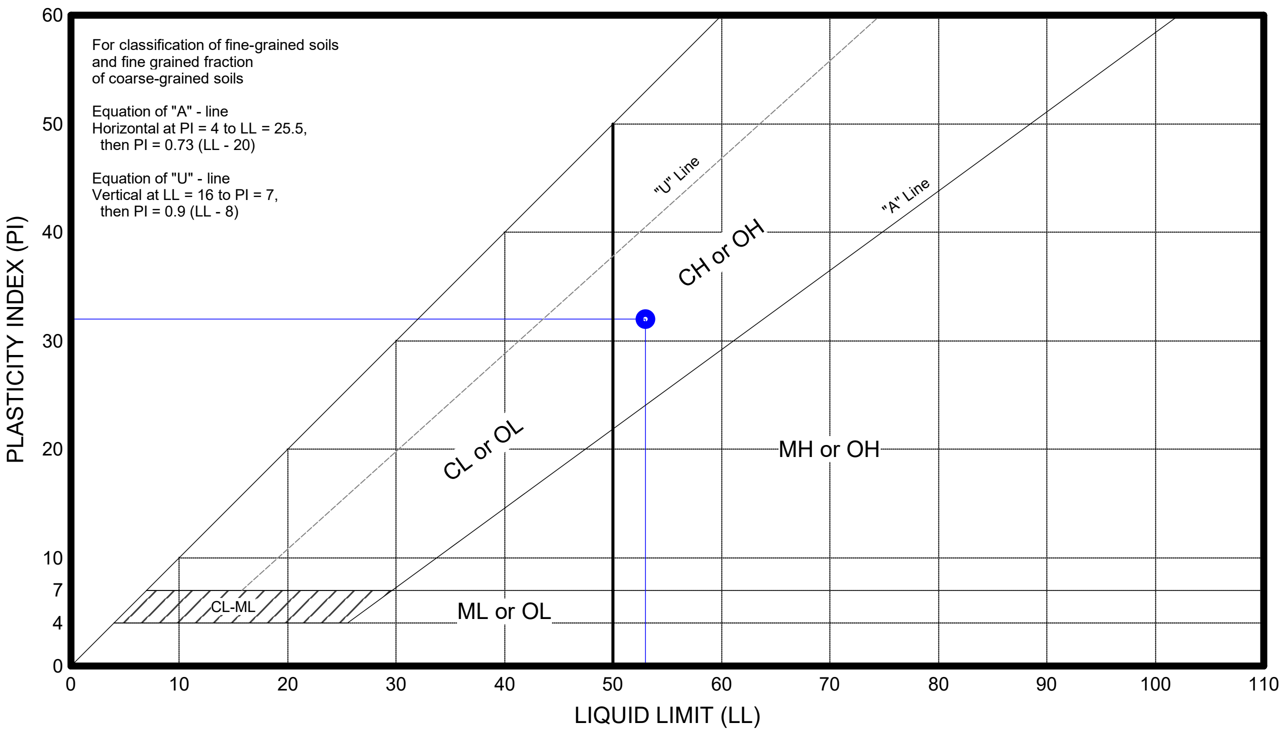
11/06/2025

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051102	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-07
Source:		Borehole Type:	SS
Report Number:	BLC01172-25	Borehole Depth (m):	1.8 - 11.2
Sample Number:	12	WSP Lab Number:	BLC25-01719
Soil Description:	Fat clay	Specimen Depth (m):	7.6 - 8.2
Soil Classification:	CH	Date of Test:	11/04/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-07	12	7.60	8.20		52.1	53	21	32	0.97

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

11/06/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051103	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01173-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-08	10	9.10	9.70	SS		13.0	BLC25-01722	Melanie Ireland	

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

FIGURE C22

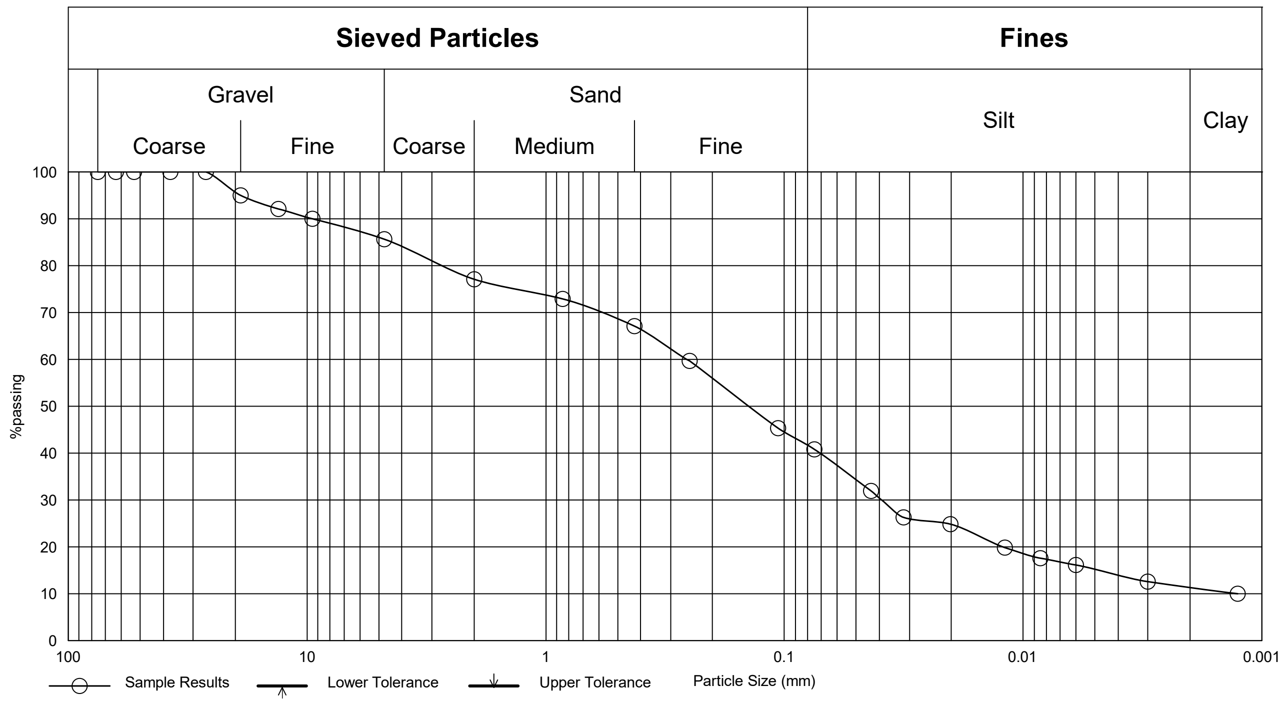
11/06/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051103	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-08
Source:		Borehole Type:	SS
Report Number:	BLC01173-25	Borehole Depth (m):	9.1 - 9.7
Sample Number:	10	WSP Lab Number:	BLC25-01722
Soil Description:	Silty sand	Specimen Depth (m):	9.1 - 9.7
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Ireland, Melanie

Grain Size Distribution	Gravel	Sand	Silt / Clay
	14.4	44.8	40.8



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0434	32.0
		0.0316	26.2
		0.0201	24.8
		0.0119	19.8
		0.0085	17.6
		0.0060	16.2
75.0		0.0030	12.5
63.0		0.0013	10.1
53.0			
37.5			
26.5	100.0		
19.0	95.0		
13.2	92.0		
9.5	89.9		
4.75	85.6	0.005mm	15.2
2.00	77.1	0.002mm	11.2
0.850	72.9	D60	0.256
0.425	67.0	D30	0.039
0.250	59.6	D10	NA
0.106	45.4	Cu	NA
0.075	40.8	Cc	NA

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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FIGURE C23

WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

11/06/2025

Water (Moisture) Content of Soils

Testing Standard: MTO LS-701 (Rev. 33)

Testing Program #:	051106	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Report Number:	BLC01174-25

Sample Location	Sample				Soil Description	Water Content (%)	WSP Lab Number	Tested By	Remarks
	Sample Number	Top (m)	Base (m)	Type					
25-09	4	1.50	2.10	SS		1.3	BLC25-01723	Melanie Ireland	
25-09	6	3.00	3.60	SS		51.6	BLC25-01724		
25-09	7	3.80	4.40	SS		53.7	BLC25-01725		
25-09	8	4.50	5.20	SS		59.3	BLC25-01726		
25-09	9	5.30	5.90	SS		62.7	BLC25-01727		
25-09	10	6.10	6.70	SS		56.0	BLC25-01728		
25-09	11	6.80	7.40	SS		66.0	BLC25-01729		
25-09	12	7.60	8.20	SS		51.7	BLC25-01730		
25-09	13	9.10	9.70	SS		54.1	BLC25-01731		
25-09	14	10.60	11.20	SS		50.3	BLC25-01732		
25-09	16	13.70	14.30	SS		10.5	BLC25-01734		

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

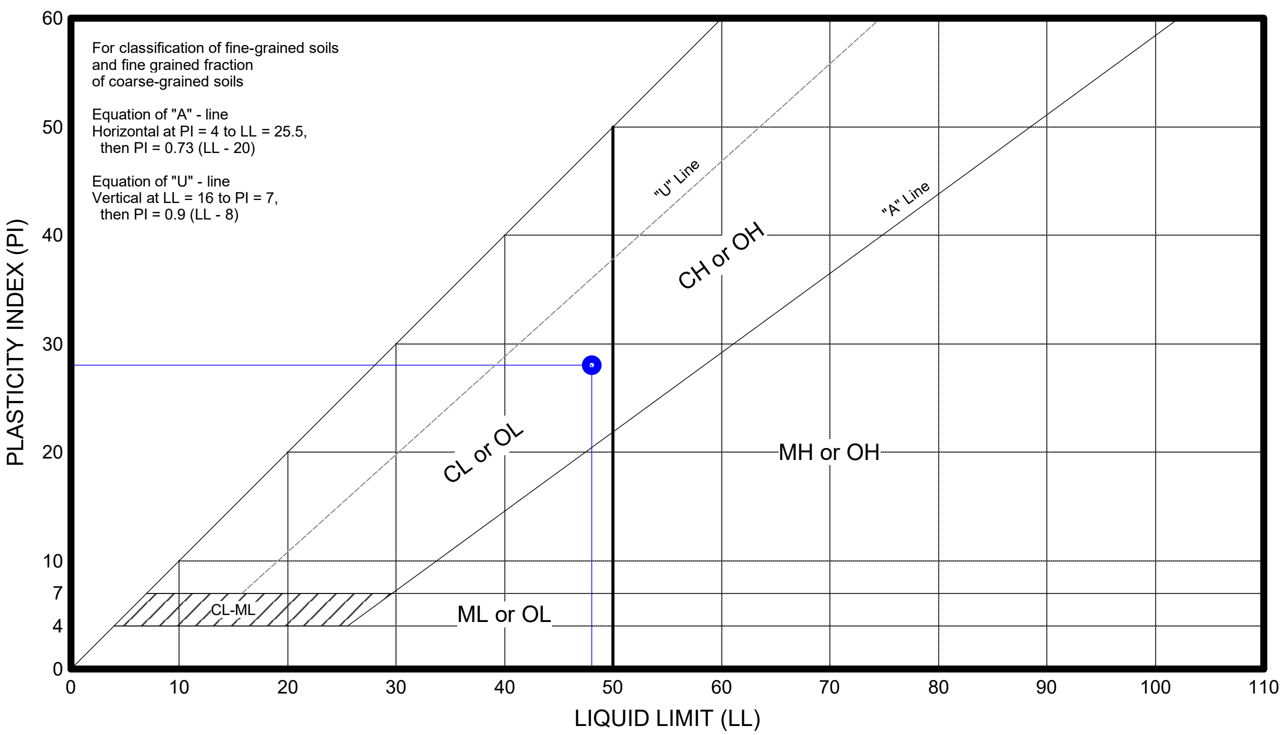
FIGURE C24

11/06/2025

Liquid Limit, Plastic Limit and Plasticity Index

Testing Standard: MTO LS-703/704 (Rev. 36)

Testing Program #:	051106	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location	25-09
Source:		Borehole Type:	SS
Report Number:	BLC01174-25	Borehole Depth (m):	1.5 - 16
Sample Number:	14	WSP Lab Number:	BLC25-01732
Soil Description:	Lean Clay	Specimen Depth (m):	10.6 - 11.2
Soil Classification:	CL	Date of Test:	10/27/2025
		Tested By:	Melanie Ireland



Sample Location	Sample Number	Top Depth (m)	Base Depth (m)	Percent Passing 425um Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
25-09	14	10.60	11.20		50.3	48	20	28	1.08

NP = Non-Plastic
ND = Not Determined

Test Preparation
Dry Preparation Tested After >425um Removed

Lab Testing Comments / Deviations:

General Comments:

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

FIGURE C25

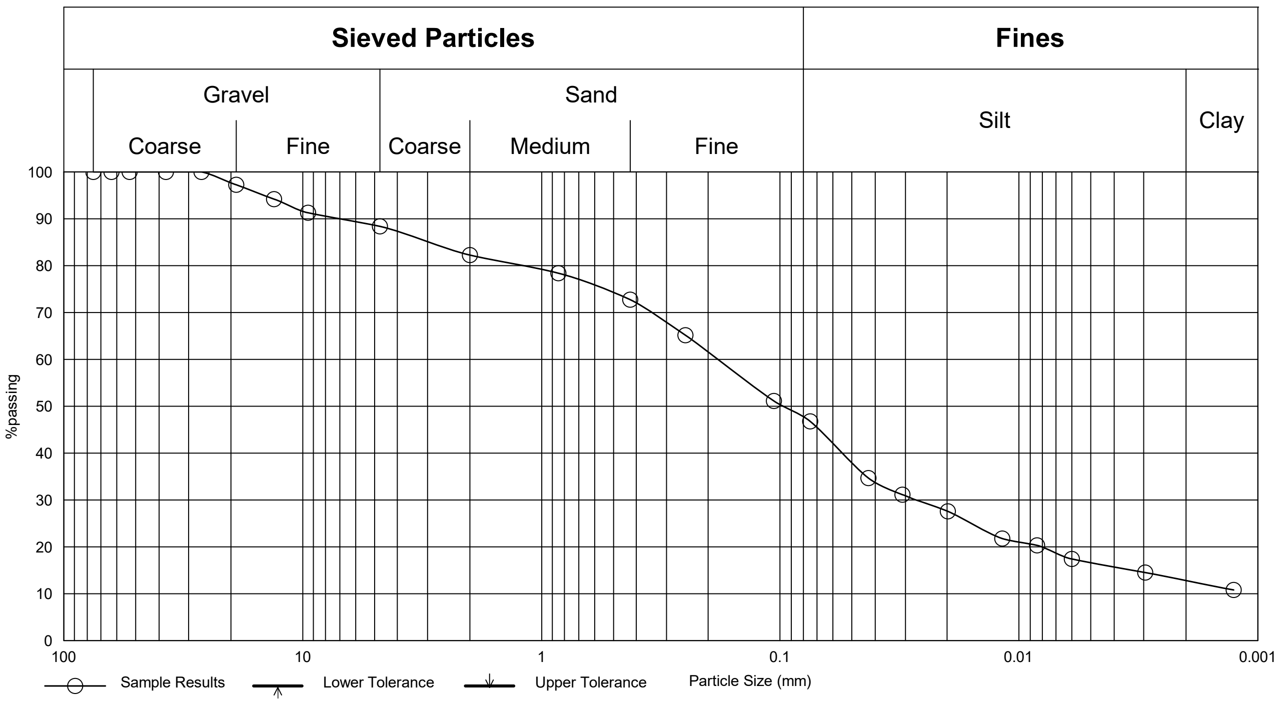
11/06/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051106	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-09
Source:		Borehole Type:	SS
Report Number:	BLC01174-25	Borehole Depth (m):	1.5 - 16
Sample Number:	15	WSP Lab Number:	BLC25-01733
Soil Description:	Silty sand	Specimen Depth (m):	12.2 - 12.8
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Ireland, Melanie

Grain Size Distribution	Gravel	Sand	Silt / Clay
	11.5	41.8	46.7



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0428	34.7
		0.0308	31.1
		0.0198	27.5
		0.0118	21.8
		0.0084	20.4
		0.0060	17.4
75.0		0.0030	14.5
63.0		0.0013	10.8
53.0			
37.5			
26.5	100.0		
19.0	97.2		
13.2	94.2		
9.5	91.4		
4.75	88.5	0.005mm	16.6
2.00	82.3	0.002mm	12.6
0.850	78.3	D60	0.182
0.425	72.7	D30	0.027
0.250	65.2	D10	NA
0.106	51.1	Cu	NA
0.075	46.7	Cc	NA

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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WSP Canada Inc.
1931 Robertson Road
Bells Corners, K2H 5B7
613-592-9600

FIGURE C26

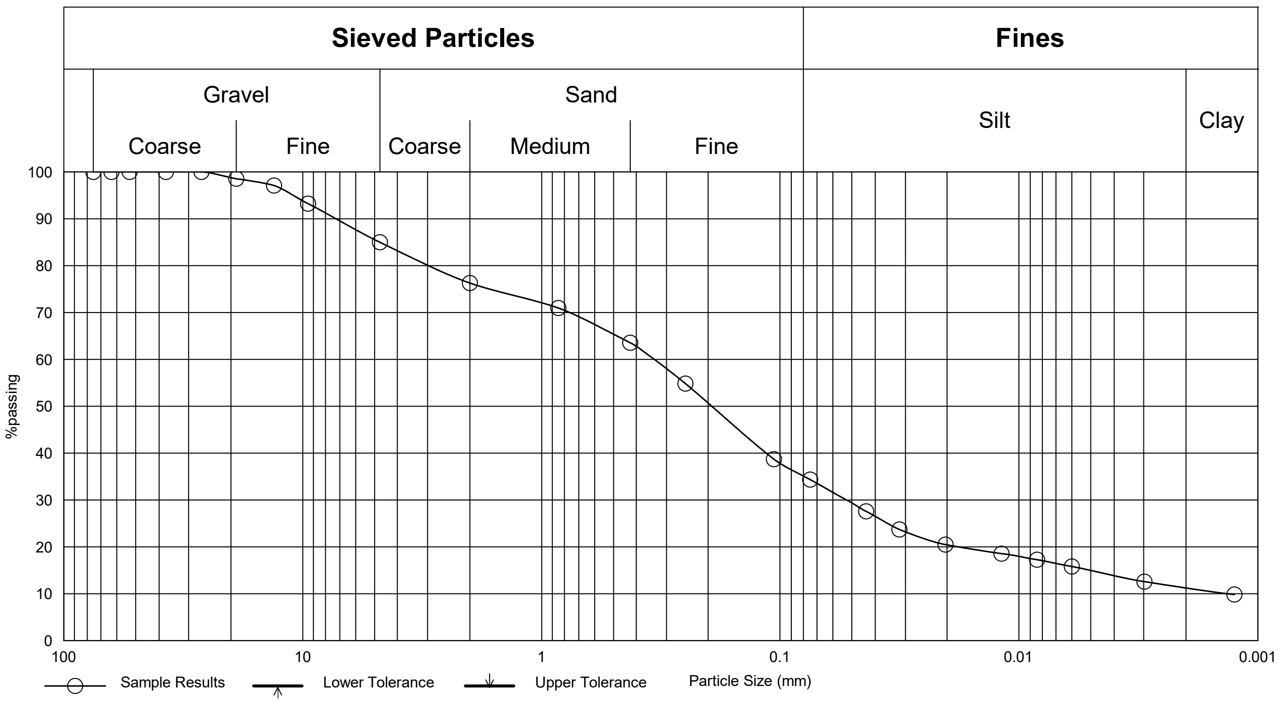
11/06/2025

Particle Size Distribution of Soils

Testing Standard: MTO LS-702 (Rev. 37)

Testing Program #:	051106	Project Number:	CA0058422.0115
Client:	Robert Construction Services Corp	Project Location:	
Project Name:	CA-CBRE/Cisco Ottawa Campus/Innovation Dr.	Sample Location:	25-09
Source:		Borehole Type:	SS
Report Number:	BLC01174-25	Borehole Depth (m):	1.5 - 16
Sample Number:	16	WSP Lab Number:	BLC25-01734
Soil Description:	Silty sand	Specimen Depth (m):	13.7 - 14.3
Soil Classification:	SM	Date of Test:	10/30/2025
Specification:		Tested By:	Ireland, Melanie

Grain Size Distribution	Gravel	Sand	Silt / Clay
	15.0	50.6	34.4



Sieve		Hydrometer Sedimentation	
Sieve Size (mm)	% Passing	Particle Size mm	% Passing
		0.0438	27.6
		0.0316	23.7
		0.0203	20.4
		0.0119	18.5
		0.0084	17.2
		0.0060	15.9
75.0		0.0030	12.6
63.0		0.0013	9.8
53.0			
37.5			
26.5	100.0		
19.0	98.5		
13.2	97.1		
9.5	93.2		
4.75	85.0	0.005mm	15.0
2.00	76.3	0.002mm	11.2
0.850	70.9	D60	0.337
0.425	63.5	D30	0.053
0.250	54.9	D10	0.001
0.106	38.7	Cu	250.326
0.075	34.4	Cc	6.16

Notes:

Disclaimer:

Notice: The test data given herein pertain to the sample provided and may not be applicable to other samples or to material from earlier or subsequent production. Reporting of these results constitutes a testing service only. Engineering interpretation and advice may be provided upon written request.

Reviewed By:	Chelsea Ward	Title:	Laboratory Technician
Signature:	Chelsea Ward		

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APPENDIX D

Basic Chemical Analyses

Certificate of Analysis

Client:	WSP Canada Inc. (Ottawa) 1931 Robertson Road Ottawa, Ontario K2H 5B7	Report Number:	3020614
Attention:	Mr. Arthur Kuitchoua Petke	Date Submitted:	2025-10-22
PO#:		Date Reported:	2025-10-29
Invoice to:	WSP Canada Inc.	Project:	CA0058422.0115, Task 1000
		COC #:	923131

Dear Arthur Kuitchoua Petke:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:

APPROVAL: ______________________________

Emma-Dawn Ferguson, Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: https://directory.cala.ca/.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

eurofins | Environment Testing

Client:	WSP Canada Inc. (Ottawa) 1931 Robertson Road Ottawa, Ontario K2H 5B7		Report Number:	3020614
Attention:	Mr. Arthur Kuitchoua Petke		Date Submitted:	2025-10-22
PO#:			Date Reported:	2025-10-29
Invoice to:	WSP Canada Inc.		Project:	CA0058422.0115, Task 1000
			COC #:	923131

Group	Analyte	MRL	Units	Guideline	1785815 Soil	1785816 Soil	1785817 Soil	1785818 Soil
				Lab I.D.	1785815	1785816	1785817	1785818
				Sample Matrix	Soil	Soil	Soil	Soil
				Sample Type				
				Sampling Date	2025-09-25	2025-09-23	2025-09-22	2025-09-03
				Sample I.D.	BH25-09 SA5/2.3-2.9m	BH25-05 SA3/1.5-2.1m	BH25-01 SA3/1.5-2.1m	BH25-04 SA3/3.0-3.6m
Anions	Cl	0.002	%		0.049	0.046	0.152	0.043
	SO4	0.01	%		0.01	<0.01	0.01	<0.01
General Chemistry	Electrical Conductivity	0.05	mS/cm		1.03	0.85	1.37	0.84
	pH	2.00			7.66	7.57	7.87	7.50
	Resistivity	1	ohm-cm		971	1176	730	1190

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range eurofins | Environment Testing

Certificate of Analysis

Client:	WSP Canada Inc. (Ottawa) 1931 Robertson Road Ottawa, Ontario K2H 5B7
Attention:	Mr. Arthur Kuitchoua Petke
PO#:	
Invoice to:	WSP Canada Inc.

Report Number:	3020614
Date Submitted:	2025-10-22
Date Reported:	2025-10-29
Project:	CA0058422.0115, Task 1000
COC #:	923131

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 483669 **Analysis/Extraction Date** 2025-10-28 **Analyst** NaR **Method** Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	100	90-110
pH	7.48	99	90-110
Resistivity			
Run No 483675 **Analysis/Extraction Date** 2025-10-29 **Analyst** AsA **Method** C CSA A23.2-4B			
Chloride	<0.002 %	104	75-125
Run No 483700 **Analysis/Extraction Date** 2025-10-29 **Analyst** IP **Method** AG SOIL			
SO4	<0.01 %	102	70-130

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX E

Geophysical Memorandum (MASW)

TECHNICAL MEMORANDUM

DATE September 27, 2025 **Project No.** CA0058422.0115

TO Arup Canada Inc

FROM Alex Bilson Darko, Jon Crawford **EMAIL** alex.bilson.dark@wsp.com; jonathan.crawford@wsp.com

2D MASW AND VES SURVEY RESULTS – CISCO OTTAWA DEVELOPMENT CENTRE

This technical memorandum presents the results of the 2D MASW and Vertical Electric Sounding survey carried out by WSP on September 5, 2025, at the Cisco Ottawa Development Centre in Ottawa, Ontario. The objective of the geophysical survey was to conduct an MASW to evaluate shear wave velocities of the subsurface and a soil resistivity test using the 4-electrode Wenner method. The alignment of the surveys are shown in Figure 1.

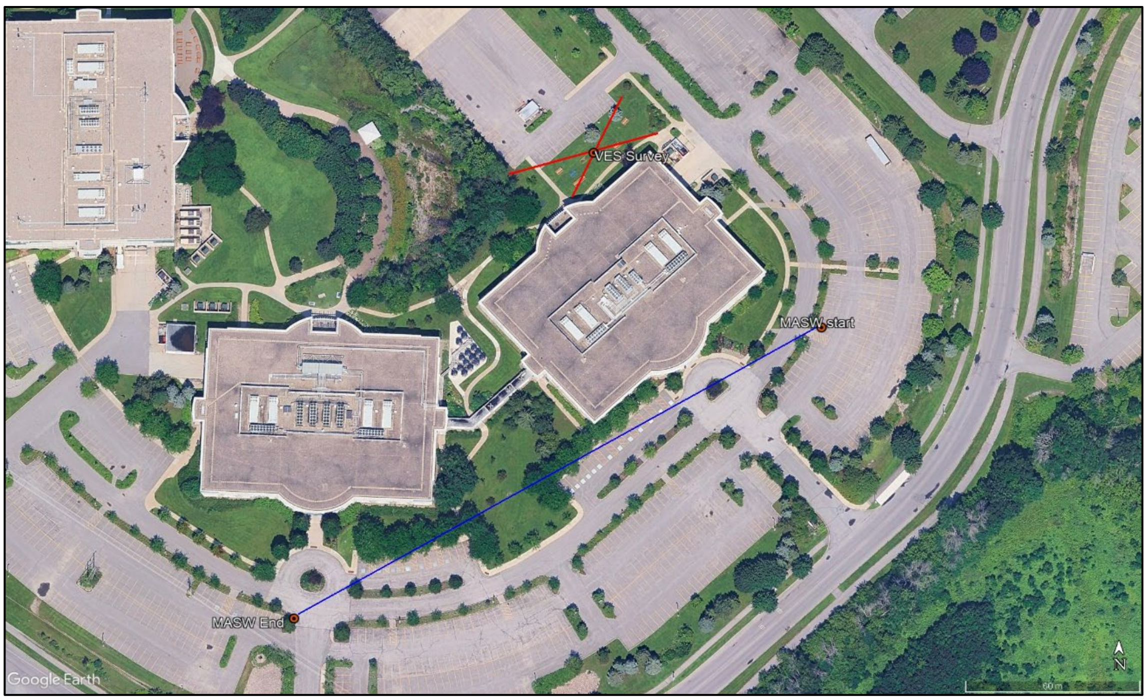


Figure 1: MASW (blue) and VES (red) Survey lines

Methodology

Vertical Electrical Sounding (VES)

The 4-electrode Wenner method, also known as vertical electric resistivity sounding (VES), is described by ASTM G57-06 and ANSI/IEEE Standard 81-1983 standards. Four evenly spaced steel electrodes are inserted into the soil in a straight line and a DC or AC test current is applied to the outer two electrodes. The associated potential difference V is measured between the inner pair of potential electrodes. The effective resistance R of subsurface material, measured in units of Ohms, follows from Ohms' law, $R=V/I$. Finally, to account for the influence of a specific electrode configuration and spacing between the four electrodes, an appropriate geometrical correction factor γ is applied to obtain the corresponding intrinsic parameter, apparent resistivity $\rho = \gamma R$, with units of ohm-metres (ohm-m). True resistivity of the ground with respect to depth is then modelled by applying an inversion process to the measured apparent resistivity data (Zohdy, 1989).

To test for vertical changes in the resistivity of the subsurface, the Wenner array is kept centered at a specific location, while the a-spacing between the current electrodes (C1 and C2) and potential electrodes (P1 and P2) is increased stepwise in order to achieve greater depth penetration (see Figure 1 below). Effective investigation depth increases with increasing electrode separation to yield a vertical electrical sounding of the subsurface. This approach highlights any significant vertical stratification in electrical properties of the ground. Additionally, the array is laid out and expanded in two orthogonal spreads about a common midpoint to investigate the possibility of planar anisotropy in the ground.

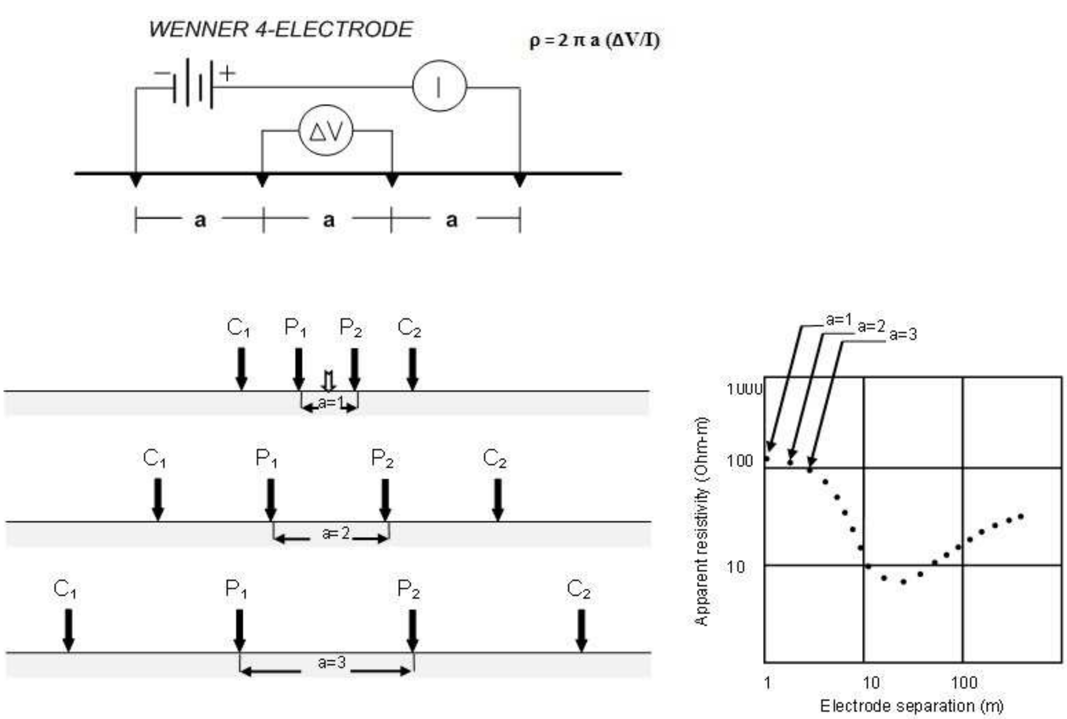


Figure 2: Typical Wenner Array Configuration

The data were acquired with the following standards as guidelines.

- Zohdy, A.A.A., 1989, A New Method for Automated Interpretation of Schlumberger and Wenner Sounding Curves, *GEOPHYSICS*, 54, 2, 245-253.
- ASTM Standard G 57, 2006, “Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method,” ASTM International, West Conshohocken, PA.
- ANSI/IEEE Standard 81, 1983, “Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System,” The Institute of Electrical and Electronics Engineers, Inc., New York, NY, USA.

Multichannel Analysis of Surface Waves (MASW)

The MASW method measures variations in surface-wave velocity with increasing distance and wavelength and can be used to infer the rock/soil types, stratigraphy and soil conditions.

A typical MASW survey requires a seismic source, to generate surface-waves, and a minimum of two geophone receivers, to measure the ground response at some distance from the source. Surface-waves are a special type of seismic wave whose propagation is confined to the near surface medium.

The depth of penetration of a surface-wave into a medium is directly proportional to its wavelength. In a non-homogeneous medium surface-waves are dispersive, i.e., each wavelength has a characteristic velocity owing to the subsurface heterogeneities within the depth interval that wavelength of surface-wave propagates through. The relationship between surface-wave velocity and wavelength is used to obtain the shear-wave velocity and attenuation profile of the medium with increasing depth.

The seismic source used can be either active or passive, depending on the application and location of the survey. Examples of active sources include explosives, weight-drops, sledgehammer and vibrating pads. Examples of passive sources are road traffic, micro-tremors and water-wave action (in near-shore environments).

The geophone receivers measure the wave-train associated with the surface-wave travelling from a seismic source at different distances from the source.

The participation of surface-waves with different wavelengths can be determined from the wave-train by transforming the wave-train results into the frequency domain. The surface-wave velocity profile with respect to wavelength (called the ‘dispersion curve’) is determined by the delay in wave propagation measured between the geophone receivers. The dispersion curve is then matched to a theoretical dispersion curve using an iterative forward-modelling procedure. The result is a shear-wave velocity profile of the tested medium with depth.

Field Work

VES

The work area was in the construction area at 9608 Carter Road which was a dirt covered area. The location of the survey lines are shown in Figure 2. The length and orientation were controlled by the work area available for this survey. A total of two VES lines were collected. The VES data were acquired using a Syscal R1+ soil resistivity meter (Iris Instruments) using the 4-electrode Wenner survey. Electrode ‘*a*’-spacings of 0.2, 0.3, 0.5, 1, 1.5, 2, 3, 4, 6, 8,10,12,14,16, and 18 m were employed. The data were stacked using a minimum of 5 readings to increase the signal to noise ratio.

MASW

The MASW data were acquired using a Geometrics Geode 24 channel seismograph and 24 low frequency (4.5 Hz) geophones with a geophone spacing of 3 metres for a total spread length 69 m. As acquisition progressed the spread was shifted along the alignment until then end of the planned line. At this site it was determined that a source offset of 3 metres and a grouping of 12 geophones provided good quality data for interpretation. An 8-kilogram (kg) sledgehammer striking a metal plate was used as the seismic source. The source was activated every 6m along the MASW alignments. Data was recorded with a 0.5 ms sampling rate.

Results

VES

Tables 1 and 2 show the measurements taken on site and Figure 3 presents the graphical results of the VES data for both lines. Line 2 shows slightly higher apparent resistivity along the line. Tables 3 and 4 provide information of site conditions and survey set up.

Table 1: Measured Data of VES Line 1

Electrode '*a*'-Spacing (m)	Voltage (mV)	Current (mAmps)	Apparent Resistivity (ohm-m)
0.2	3238.75	144.49	28.17
0.3	3244.67	175.9	34.77
0.5	3363.56	335.93	31.46
1	3487.47	606.35	36.14
1.5	3341.20	885.75	35.55
2	2581.25	903.24	35.91
3	1679.60	877.84	36.07
4	1350.35	904.24	37.53
6	1026.68	917.43	42.19
8	794.48	889.60	44.89
10	634.27	855.82	46.57
12	613.18	968.35	47.74
14	449.07	811.56	48.68

Table 2: Measured Data of VES Line 2

Electrode '*a*'-Spacing (m)	Voltage (mV)	Current (mAmps)	Apparent Resistivity (ohm-m)
0.2	3303.44	210.68	19.7
0.3	3336.99	260.32	24.16
0.5	3369.67	386.82	27.37
1	3361.66	740.85	28.51
1.5	1995.38	723.06	26.01

Electrode ‘*a*’-Spacing (m)	Voltage (mV)	Current (mAmps)	Apparent Resistivity (ohm-m)
2	1476.67	797.74	23.26
3	1072.75	822.33	24.59
4	888.71	797.81	28
6	697.27	841.29	31.25
8	583.73	947.81	30.96
10	457.66	917.83	31.33
12	359.02	839.14	32.26
14	332.98	917.27	31.93
16	296.58	951.65	31.33
20	198.41	805.71	30.95
22	168.66	766.81	30.4

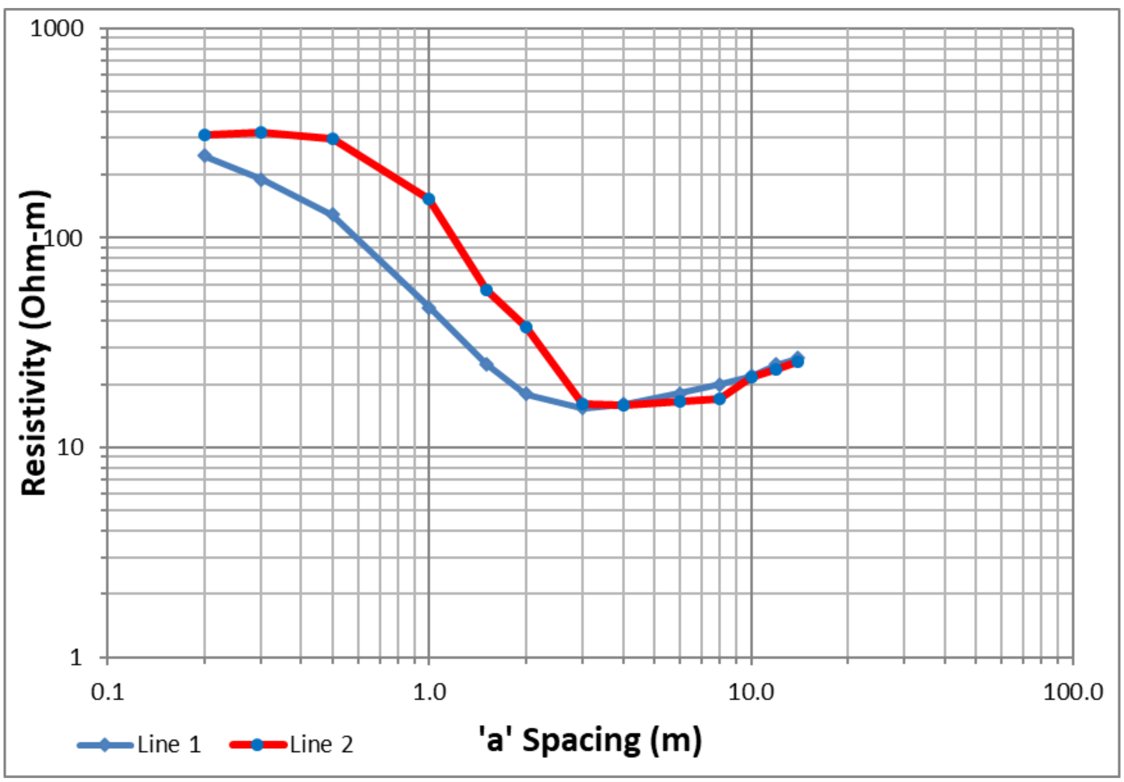


Figure 3: Graphical Presentation of Measured VES Data for both Lines.

Table 3: Line 1 Site Information

Date:	September 5, 2025	**Sounding Size:**	18m a spacing
Start Time:	12pm	**Equipment:**	Iris Syscal R1+
Location:	Cisco Ottawa Campus	**Weather:**	sunny
Sounding Orientation:	NW-SE	**Temp.:**	21 degrees
Line:	Line 1	**Datum:**	NAD83
Electrode Array:	Wenner	**Zone:**	18N
Comment:	50 cm long electrodes used	**Mid point:**	Easting: 427407.23m
Surface Soil Type:	Grass area		Northing: 5021418.29m
Surface Soil Condition:	Moist from rain previous night		

Table 4: Line 2 Site Information

Date:	September 5, 2025	**Sounding Size:**	14m a spacing
Start Time:	1pm	**Equipment:**	Iris Syscal R1+
Location:	Cisco Ottawa Campus	**Weather:**	sunny
Sounding Orientation:	SW-NE	**Temp.:**	21 degrees
Line:	Line 2	**Datum:**	NAD83
Electrode Array:	Wenner	**Zone:**	18N
Comment:	50 cm long electrodes used	**Mid point:**	Easting: 427407.23m
Surface Soil Type:	Grass area		Northing: 5021418.29m
Surface Soil Condition:	Moist from rain previous night		

MASW

The MASW data was processed using the Geometrics SeisImager S/W software package. The first step was to analyse the MASW data to determine the most suitable source offset and grouping of geophones to use for data processing. At this site it was determined that a source offset of 3 metres and a grouping of 12 geophones provided good quality data for interpretation. The source was activated every 6m along the MASW alignments. For each geophone grouping of 12 geophones, the data was analyzed to generate a dispersion curve (Figure 4) and then, using inverse modelling, to create a 1D shear wave velocity profile with depth. The midpoint of the geophone grouping was used to assign a location along the survey line. The 1D profiles were then imported into Surfer Mapping System and gridded using the Kriging method to create a 2D profile along the alignment. The 2D profile with interpreted bedrock is seen in the attached Figure 4.

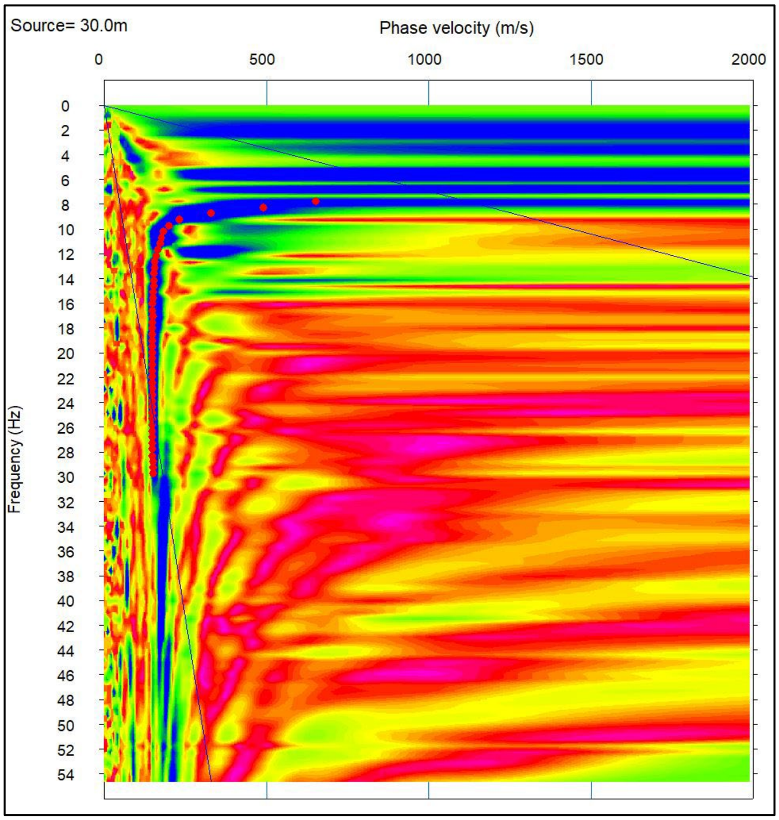


Figure 4: Example MASW Dispersion Curve Showing Picks (red dots).

Table 5: Representative Shear-Wave Velocity Profile along the MASW Line

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
0	1.1	1.1	123	0.008943
1.1	2.3	1.2	118	0.010169
2.3	3.7	1.4	150	0.009333
3.7	5.3	1.6	222	0.007207
5.3	7.0	1.7	327	0.005199
7.0	8.9	1.9	427	0.004450
8.9	11.0	2.1	435	0.004828
11.0	13.2	2.2	550	0.004000
13.2	15.6	2.4	619	0.003877

Model Layer (mbgs)		Layer Thickness (m)	Shear Wave Velocity (m/s)	Shear Wave Travel Time Through Layer (s)
Top	Bottom			
15.6	18.1	2.5	609	0.004269
18.1	20.9	2.8	600	0.004500
20.9	23.7	2.8	756	0.003704
23.7	26.8	3.1	875	0.003543
26.8	30.0	3.2	875	0.003657
			Vs Average to 30 mbgs (m/s)	**386**

To calculate the average shear-wave velocity as required by Seismic Site Classification, the results were modelled to 30 metres below ground surface (mbgs). The location chosen for the seismic site class was in the profile in the middle of the 2D MASW line at 90m.

The time-averaged shear-wave velocity (Vs30) for the MASW Line was found to be 386 m/s, as seen in **Table 5**. Based on the National Building Code of Canada (2020), this Vs30 values corresponds to seismic site class C.

The seismic site class provided is based solely on the average shear wave velocity derived from this study. There are site specific conditions that may be present, such as liquefiable soils, clay layers with certain properties that have thicknesses of greater than 3 m, etc. that could change this seismic site classification. For more information on these potential conditions the reader should review section 4.1.8.4 of the National Building Code of Canada (2020).

Limitations of Use

The geophysical interpretation presented in this report is based on the use of geophysical surveying techniques. As with any geophysical method, interpretation presented in this report should be confirmed by intrusive methods (boreholes, test pits, etc.).

Assumptions made in the geophysical interpretation have been stated, where applicable, throughout the report.

This geophysical survey was carried out in a manner consistent with the level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the time limits and financial and physical constraints applicable to the services provided. This report provides a professional opinion and therefore no warranty is either expressed, implied, or made as to the conclusions, advice, and recommendations offered.

Any use of the information within this report made by a third party, or any reliance on, or decisions to be made based on it, are the sole responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this letter.

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

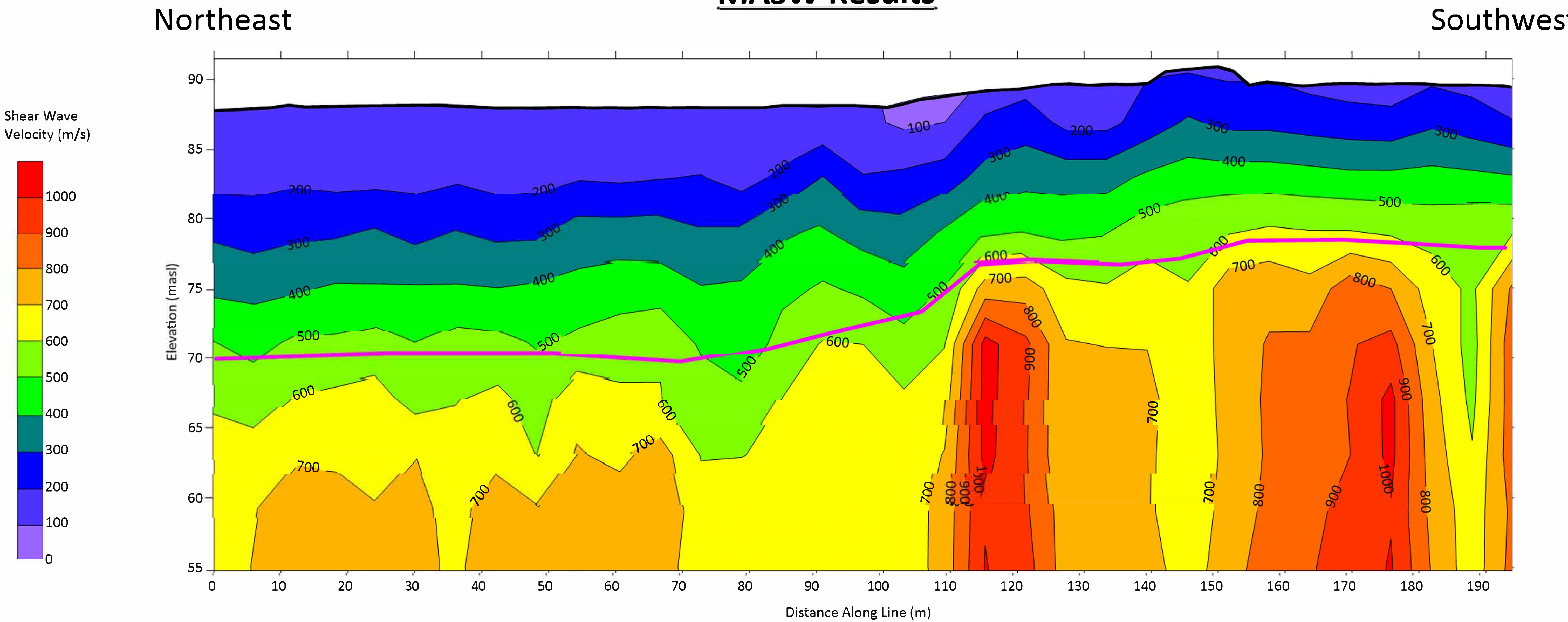
WSP Canada Inc.

Alex Bilson Darko, MSc
Geophysicist

Jon Crawford, MSc, PGeo
Geophysicist, Senior Principal

JC/ABD/jc

MASW Results



Legend

- Ground Surface
- Interpreted Bedrock

NOTES

1. This figure is to be analyzed in conjunction with the accompanying report
2. Survey data collected September, 2025
3. Scale as shown

CLIENT	Arup Canada Inc.
PROJECT	Geophysical Investigation - Cisco Ottawa Development Centre
CONSULTANT	wsp
YYYY-MM-DD	2025-09-23
PREPARED	JC
DESIGN	JC
REVIEW	ABD
APPROVED	ABD
TITLE	MASW Survey Results
PROJECT No.	CA0058422.0115
PHASE	
Rev.	0
FIGURE	3

APPENDIX F

Geophysical Memorandum (Soil Resistivity and Grounding)

TECHNICAL MEMORANDUM

DATE October 09, 2025

Project No. CA0058422.0115

TO Arup Canada Inc

FROM Alex Bilson Darko, Jon Crawford

EMAIL alex.bilson.dark@wsp.com; jonathan.crawford@wsp.com

VES SURVEY RESULTS – CISCO OTTAWA DEVELOPMENT CENTRE

This technical memorandum presents the results of the Vertical Electric Sounding survey carried out by WSP on September 5, 2025, at the Cisco Ottawa Development Centre in Ottawa, Ontario. The objective of the geophysical survey was to conduct a soil resistivity test using the 4-electrode Wenner method. The alignment of the surveys are shown in Figure 1.

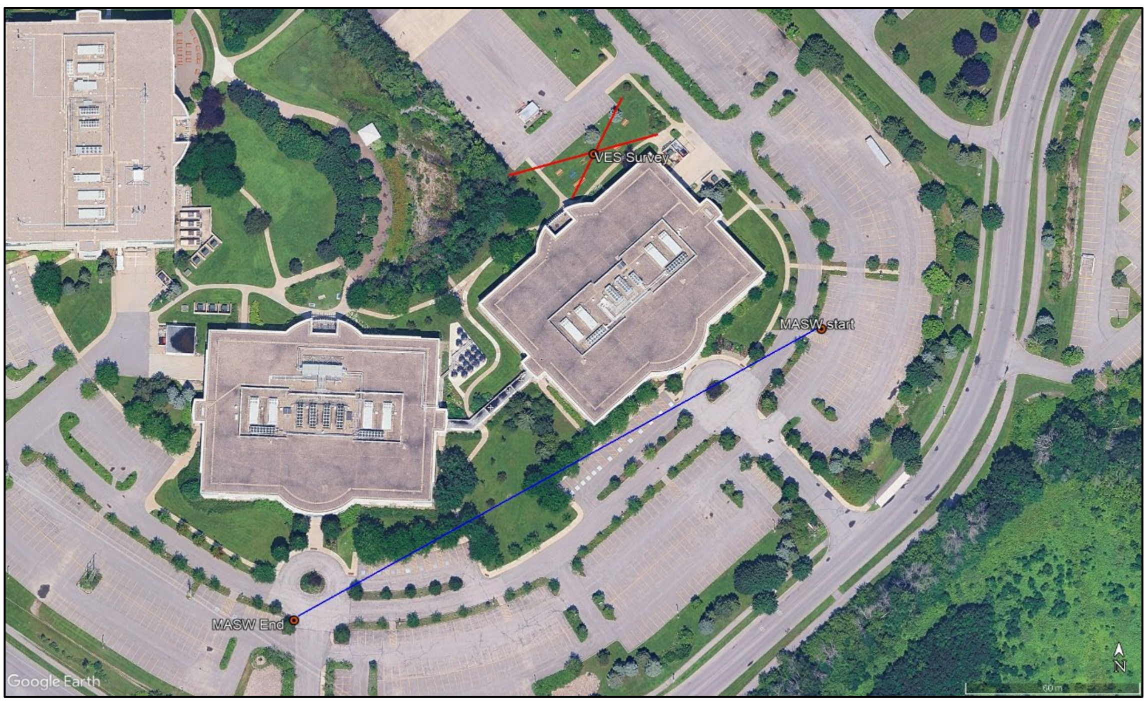


Figure 1: VES (red) Survey lines.

Methodology

The 4-electrode Wenner method, also known as vertical electric resistivity sounding (VES), is described by ASTM G57-06 and ANSI/IEEE Standard 81-1983 standards. Four evenly spaced steel electrodes are inserted into the soil in a straight line and a DC or AC test current is applied to the outer two electrodes. The associated potential difference V is measured between the inner pair of potential electrodes. The effective resistance R of subsurface material, measured in units of Ohms, follows from Ohms' law, $R=V/I$. Finally, to account for the influence of a specific electrode configuration and spacing between the four electrodes, an appropriate geometrical correction factor γ is applied to obtain the corresponding intrinsic parameter, apparent resistivity $\rho = \gamma R$, with units of ohm-metres (ohm-m). True resistivity of the ground with respect to depth is then modelled by applying an inversion process to the measured apparent resistivity data (Zohdy, 1989).

To test for vertical changes in the resistivity of the subsurface, the Wenner array is kept centered at a specific location, while the a-spacing between the current electrodes (C1 and C2) and potential electrodes (P1 and P2) is increased stepwise in order to achieve greater depth penetration (see Figure 2 below). Effective investigation depth increases with increasing electrode separation to yield a vertical electrical sounding of the subsurface. This approach highlights any significant vertical stratification in electrical properties of the ground. Additionally, the array is laid out and expanded in two orthogonal spreads about a common midpoint to investigate the possibility of planar anisotropy in the ground.

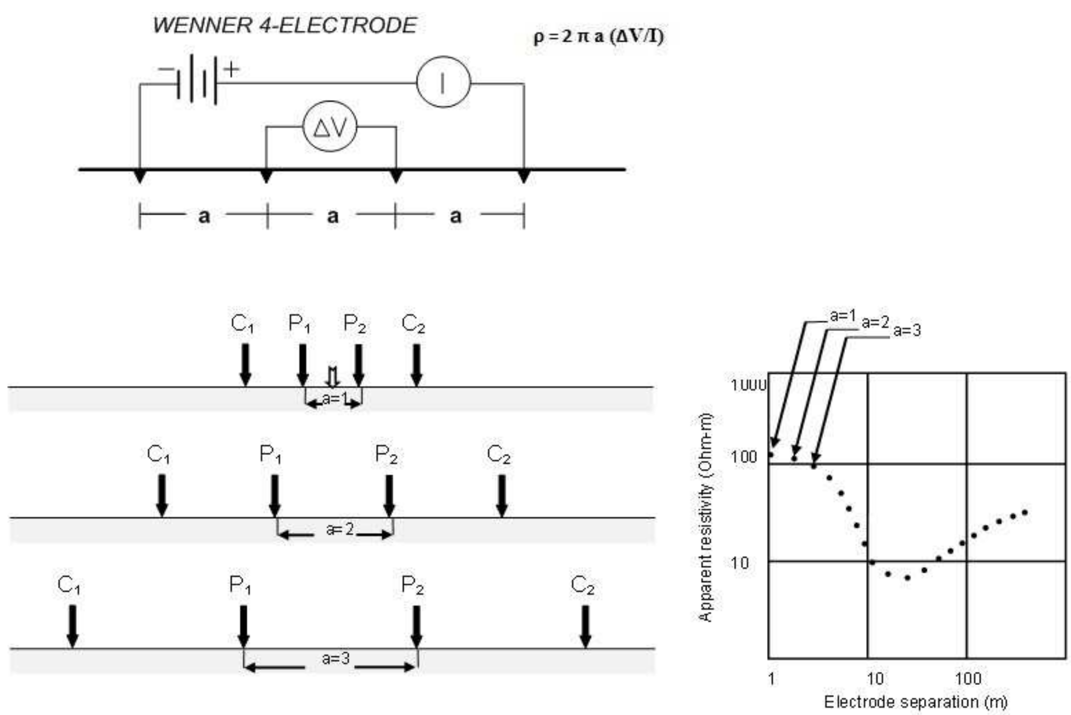


Figure 2: Typical Wenner Array Configuration

The data were acquired with the following standards as guidelines.

- Zohdy, A.A.A., 1989, A New Method for Automated Interpretation of Schlumberger and Wenner Sounding Curves, *GEOPHYSICS*, 54, 2, 245-253.
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Field Work

The work area was in the construction area at 9608 Carter Road which was a dirt covered area. The location of the survey lines are shown in Figure 1. The length and orientation were controlled by the work area available for this survey. A total of two VES lines were collected. The VES data were acquired using a Syscal R1+ soil resistivity meter (Iris Instruments) using the 4-electrode Wenner survey. Electrode ‘*a*’-spacings of 0.2, 0.3, 0.5, 1, 1.5, 2, 3, 4, 6, 8,10,12,14,16, and 18 m were employed. The data were stacked using a minimum of 5 readings to increase the signal to noise ratio.

Results

Tables 1 and 2 show the measurements taken on site and Figure 3 presents the graphical results of the VES data for both lines. Line 2 shows slightly higher apparent resistivity along the line. Tables 3 and 4 provide information of site conditions and survey set up.

Table 1: Measured Data of VES Line 1

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0.3	3244.67	175.9	34.77
0.5	3363.56	335.93	31.46
1	3487.47	606.35	36.14
1.5	3341.20	885.75	35.55
2	2581.25	903.24	35.91
3	1679.60	877.84	36.07
4	1350.35	904.24	37.53
6	1026.68	917.43	42.19
8	794.48	889.60	44.89
10	634.27	855.82	46.57
12	613.18	968.35	47.74
14	449.07	811.56	48.68

Table 2: Measured Data of VES Line 2

Electrode '*a*'-Spacing (m)	Voltage (mV)	Current (mAmps)	Apparent Resistivity (ohm-m)
0.2	3303.44	210.68	19.7
0.3	3336.99	260.32	24.16
0.5	3369.67	386.82	27.37
1	3361.66	740.85	28.51
1.5	1995.38	723.06	26.01
2	1476.67	797.74	23.26
3	1072.75	822.33	24.59
4	888.71	797.81	28
6	697.27	841.29	31.25
8	583.73	947.81	30.96
10	457.66	917.83	31.33
12	359.02	839.14	32.26
14	332.98	917.27	31.93
16	296.58	951.65	31.33
20	198.41	805.71	30.95
22	168.66	766.81	30.4

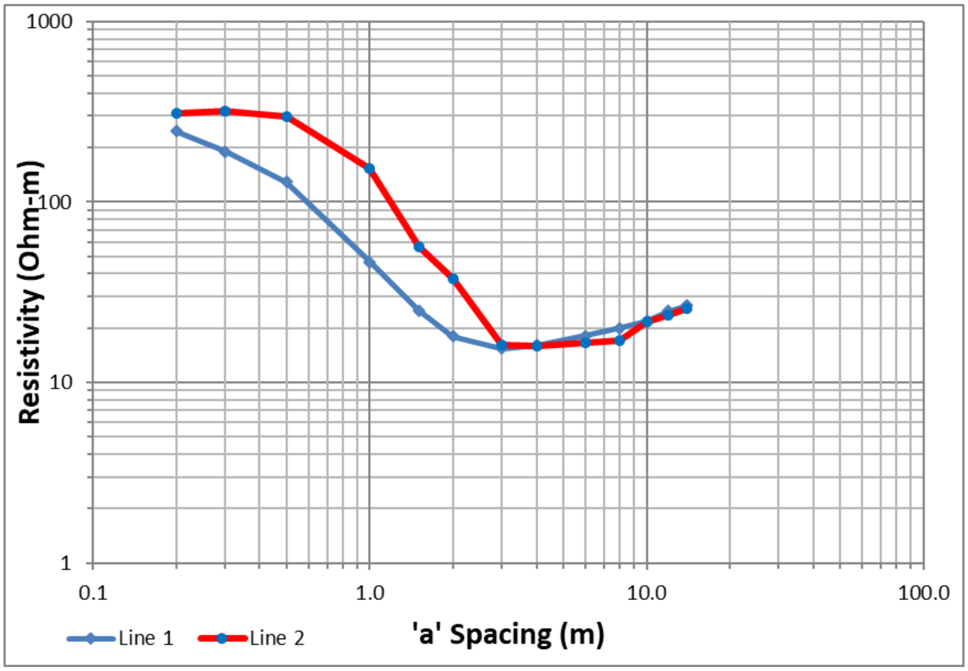


Figure 3: Graphical Presentation of Measured VES Data for both Lines.

Table 3: Line 1 Site Information

Date:	September 5, 2025	**Sounding Size:**	18m a spacing
Start Time:	12pm	**Equipment:**	Iris Syscal R1+
Location:	Cisco Ottawa Campus	**Weather:**	sunny
Sounding Orientation:	NW-SE	**Temp.:**	21 degrees
Line:	Line 1	**Datum:**	NAD83
Electrode Array:	Wenner	**Zone:**	18N
Comment:	50 cm long electrodes used	**Mid point:**	Easting: 427407.23m
Surface Soil Type:	Grass area		Northing: 5021418.29m
Surface Soil Condition:	Moist from rain previous night		

Table 4: Line 2 Site Information

Date:	September 5, 2025	**Sounding Size:**	14m a spacing
Start Time:	1pm	**Equipment:**	Iris Syscal R1+
Location:	Cisco Ottawa Campus	**Weather:**	sunny
Sounding Orientation:	SW-NE	**Temp.:**	21 degrees
Line:	Line 2	**Datum:**	NAD83
Electrode Array:	Wenner	**Zone:**	18N
Comment:	50 cm long electrodes used	**Mid point:**	Easting: 427407.23m
Surface Soil Type:	Grass area		Northing: 5021418.29m
Surface Soil Condition:	Moist from rain previous night		

The soil resistivity data collected on site and presented in Tables 1 & 2 have been used in the RESAP software to create the summer soil resistivity models shown below:

RESAP (Job ID: CISCO_OTT_Line1)
Metric/Logarithmic X and Y

22-septembre-2025 16:27:06

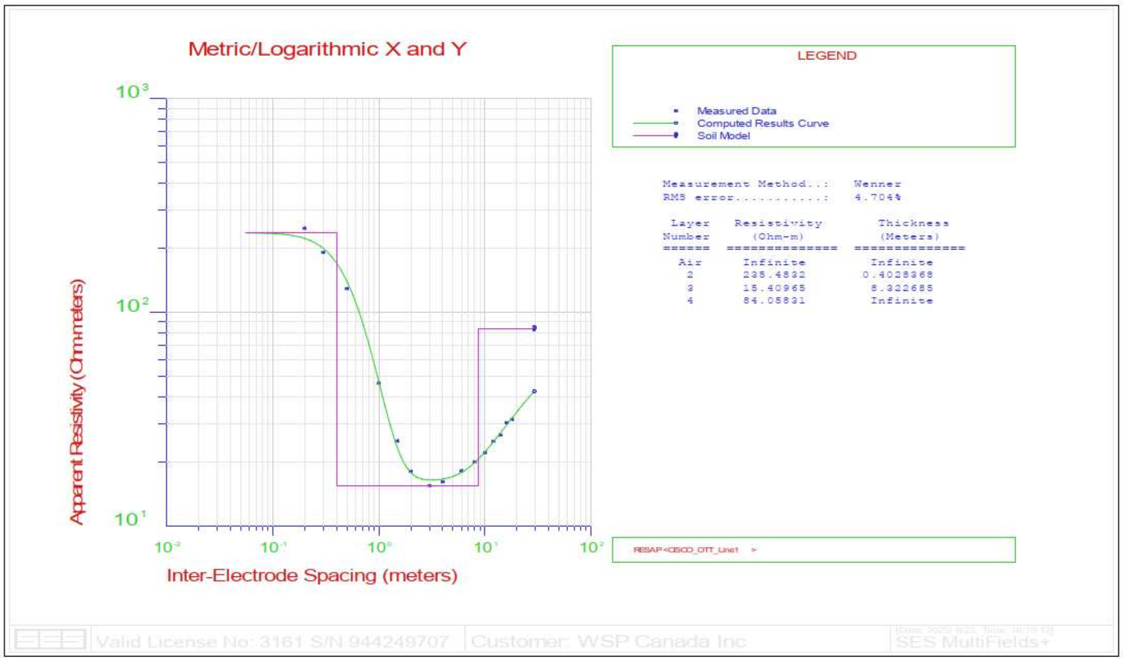


Figure 4: Soil Electrical Resistivity Model Based On Measured Data of VES Line 1

RESAP (Job ID: CISCO_OTT_Line2)

Metric/Logarithmic X and Y

22-septembre-2025 16:27:58

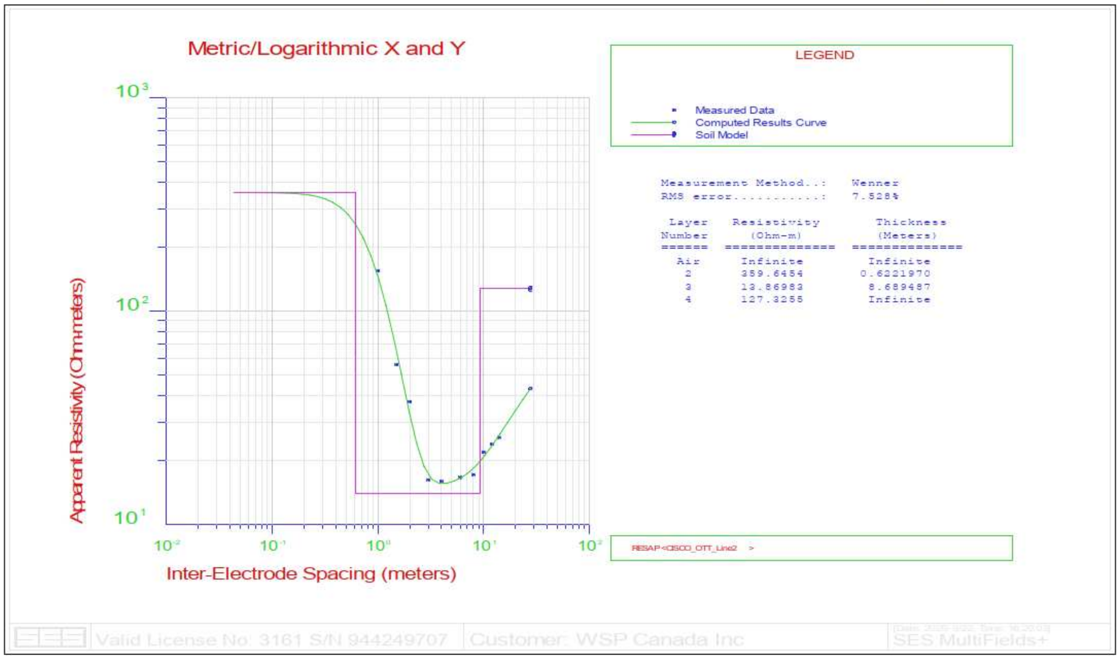


Figure 5: Soil Electrical Resistivity Model Based On Measured Data of VES Line 2

RESAP (Job ID: CISCO_OTT_Lineboth)
Metric/Logarithmic X and Y

22-septembre-2025 16:28:26

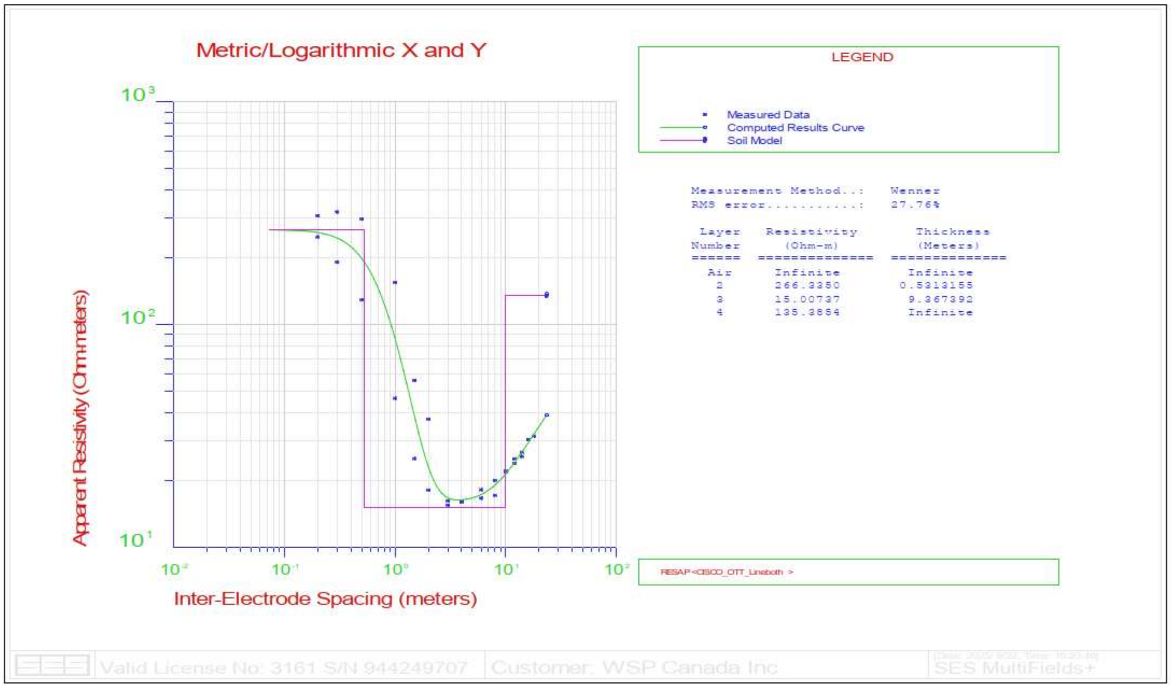


Figure 6: Soil Electrical Resistivity Model Based On Combined Measured Data of VES Line 1 and Line 2

The winter and spring soil resistivity models, shown below, were also generated using RESAP considering a frost penetration depth of 1.8 mbgs:

Winter Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	1829,97	0,402837	7,77115
2	105,865	1,39716	6,87005
3	15,4096	6,92553	1
4 (Bottom)	84,0583	Infinite	1

Figure 7: Winter Soil Electrical Resistivity Model for VES Line 1

Spring Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	241,458	0,15	1,02537
2	406,492	0,252837	1,72621
3	105,865	1,39716	6,87005
4	15,4096	6,92553	1
5 (Bottom)	84,0583	Infinite	1

Figure 8: Spring Soil Electrical Resistivity Model for VES Line 1

Winter Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	2350,75	0,622197	6,53632
2	70,552	1,1778	5,08674
3	13,8698	7,51169	1
4 (Bottom)	127,326	Infinite	1

Figure 9: Winter Soil Electrical Resistivity Model for VES Line 2

Spring Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	368,771	0,15	1,02537
2	827,912	0,472197	2,30203
3	70,552	1,1778	5,08674
4	13,8698	7,51169	1
5 (Bottom)	127,326	Infinite	1

Figure 10: Spring Soil Electrical Resistivity Model for VES Line 2

Winter Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	1844,75	0,531316	6,92642
2	87,2883	1,26868	5,81635
3	15,0074	8,09871	1
4 (Bottom)	135,385	Infinite	1

Figure 11: Winter Soil Electrical Resistivity Model for VES Line 1 And Line 2 Combined

Spring Soil Model

Layer Number	Resistivity (Ω·m)	Thickness (m)	Factor
1 (Top)	273,093	0,15	1,02537
2	556,007	0,381316	2,08762
3	87,2883	1,26868	5,81635
4	15,0074	8,09871	1
5 (Bottom)	135,385	Infinite	1

Figure 12: Spring Soil Electrical Resistivity Model for VES Line 1 And Line 2 Combined

WSP recommends using the soil models presented for both VES Line 1 and Line 2 combined in the grounding design of the project.

Limitations of Use

The geophysical interpretation presented in this report is based on the use of geophysical surveying techniques. As with any geophysical method, interpretation presented in this report should be confirmed by intrusive methods (boreholes, test pits, etc.).

Assumptions made in the geophysical interpretation have been stated, where applicable, throughout the report.

This geophysical survey was carried out in a manner consistent with the level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the time limits and financial and physical constraints applicable to the services provided. This report provides a professional opinion and therefore no warranty is either expressed, implied, or made as to the conclusions, advice, and recommendations offered.

Any use of the information within this report made by a third party, or any reliance on, or decisions to be made based on it, are the sole responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this letter.

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

WSP Canada Inc.

Alex Bilson Darko, MSc
Geophysicist

Jon Crawford, MSc, PGeo
Geophysicist, Senior Principal

JC/ABD/jc

Robin Richard, P.Eng.

Electrical Engineer

Guillaume Marcon, P.Eng.

Electrical Engineer

APPENDIX G

Soils Quality Results

Parameter		Comparative Criteria			Sample ID			
		406:19: Table 1-Background (Res/Park/Comm'ty)	406/19: Table 2.1- Res/Park/Inst	153/04: Table 3 - Indust/Comm/Comm'ty	BH25-01 SA1B	BH25-01 SA2	BH25-01 SA2 Lab-Dup	BH25-07 SA2
	Units				2025-09-22	2025-09-22	2025-09-22	2025-09-22
Inorganics								
Sodium Adsorption Ratio	N/A	2.4	5.0	12.0	4.3	***34***	-	0.85
Conductivity	mS/cm	0.57	0.70	1.40	0.2	***2.7***	-	0.29
Available (CaCl2) pH	pH	-	-	5-11	8.04	7.68	-	7.59
WAD Cyanide (Free)	ug/g	0.051	0.051	0.051	<0.01	<0.01	-	<0.01
Chromium (VI)	ug/g	0.66	8.00	8.00	<0.18	<0.18	-	<0.18
Metals								
Hot Water Ext. Boron (B)	ug/g	-			0.18	0.18		0.19
Acid Extractable Antimony (Sb)	ug/g	1.3	7.5	40	<0.20	<0.20	<0.20	<0.20
Acid Extractable Arsenic (As)	ug/g	18	18	18	1.2	<1.0	<1.0	1.7
Acid Extractable Barium (Ba)	ug/g	220	390	670	49	330	330	290
Acid Extractable Beryllium (Be)	ug/g	2.5	4	8	0.22	0.84	0.84	0.63
Acid Extractable Boron (B)	ug/g	36	1.5	2	8.5	5.6	5.1	<5.0
Acid Extractable Cadmium (Cd)	ug/g	1.2	1.2	1.9	<0.10	0.1	0.12	0.17
Acid Extractable Chromium (Cr)	ug/g	70	160	160	8.1	85	83	36
Acid Extractable Cobalt (Co)	ug/g	21	22	80	3.9	18	18	10
Acid Extractable Copper (Cu)	ug/g	92	140	230	11	30	29	18
Acid Extractable Lead (Pb)	ug/g	120	120	120	7.5	6.6	6.6	8.8
Acid Extractable Molybdenum (Mo)	ug/g	2	6.9	3.9	<0.50	<0.50	<0.50	<0.50
Acid Extractable Nickel (Ni)	ug/g	82	100	40	8.8	47	47	21
Acid Extractable Selenium (Se)	ug/g	1.5	2.4	270	<0.50	<0.50	<0.50	<0.50
Acid Extractable Silver (Ag)	ug/g	0.5	20	5.5	<0.20	<0.20	<0.20	<0.20
Acid Extractable Thallium (Tl)	ug/g	1	1	40	0.12	0.4	0.37	0.24
Acid Extractable Uranium (U)	ug/g	2.5	23	3.3	0.28	0.68	0.69	0.75
Acid Extractable Vanadium (V)	ug/g	86	86	86	7.3	***97***	***95***	48
Acid Extractable Zinc (Zn)	ug/g	290	340	340	8.3	120	120	69
Acid Extractable Mercury (Hg)	ug/g	0.27	0.27	3.9	<0.050	<0.050	<0.050	<0.050
PHCs (F1-F4)/BTEX								
Benzene	ug/g	0.02	0.02	0.32	<0.020	<0.020	-	<0.020
Toluene	ug/g	0.2	0.2	68	<0.020	<0.020	-	<0.020
Ethylbenzene	ug/g	0.05	0.05	9.5	<0.020	<0.020	-	<0.020
o-Xylene	ug/g	-	-	-	<0.020	<0.020	-	<0.020
p+m-Xylene	ug/g	-	-	-	<0.040	<0.040	-	<0.040
Total Xylenes	ug/g	0.05	0.091	26	<0.040	<0.040	-	<0.040
F1 (C6-C10)	ug/g	25	25	55	<10	<10	-	<10
F1 (C6-C10) - BTEX	ug/g	25	-	55	<10	<10	-	<10
F2 (C10-C16 Hydrocarbons)	ug/g	10	10	230	<7.0	<7.0	-	<7.0
F3 (C16-C34 Hydrocarbons)	ug/g	240	240	1700	<50	<50	-	<50
F4 (C34-C50 Hydrocarbons)	ug/g	120	2800	3300	<50	<50	-	<50
Reached Baseline at C50	ug/g	-	-	-	Yes	Yes	-	Yes

NOTES:

No Fill	No Exceedance
Shaded	Exceeds 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Commu Property Use
Bold/Italic	Exceeds 406/19 Excess Soil Standards, Table 2.1 Residential, Parkland, Institutional land use, coarse grained soil
Underlined	Exceeds 153/04 On-Site Soil Standards, Table 3, Full Depth Generic soil condition standards, Industrial, Commercial, Community, coarse grained soil

APPENDIX H

Environmental Laboratory Reports

Your Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Your C.O.C. #: N/A

Attention: Keith Holmes

WSP Canada Inc.
1931 Robertson Rd
Ottawa, ON
CANADA K2H 5B7

Report Date: 2025/10/10
Report #: R8629492
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C5C4402
Received: 2025/10/03, 13:35

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Hot Water Extractable Boron (1)	3	2025/10/08	2025/10/08	CAM SOP-00408	R153 Ana. Prot. 2011
Free (WAD) Cyanide (1)	3	2025/10/08	2025/10/08	CAM SOP-00457	OMOE E3015 m
Conductivity (1)	3	2025/10/08	2025/10/08	CAM SOP-00414	OMOE E3530 v1 m
Hexavalent Chromium in Soil by IC (1, 2)	3	2025/10/08	2025/10/08	CAM SOP-00436	EPA 3060A/7199 m
Petroleum Hydro. CCME F1 & BTEX in Soil (1, 3)	2	N/A	2025/10/06	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydro. CCME F1 & BTEX in Soil (1, 3)	1	N/A	2025/10/07	CAM SOP-00315	CCME PHC-CWS m
Petroleum Hydrocarbons F2-F4 in Soil (1, 4)	3	2025/10/06	2025/10/07	CAM SOP-00316	CCME CWS m
Acid Extractable Metals by ICPMS (1)	3	2025/10/08	2025/10/08	CAM SOP-00447	EPA 6020B m
Moisture (1)	3	N/A	2025/10/06	CAM SOP-00445	Carter 2nd ed 70.2 m
pH CaCl2 EXTRACT (1)	3	2025/10/08	2025/10/08	CAM SOP-00413	EPA 9045 D m
Sodium Adsorption Ratio (SAR) (1)	3	N/A	2025/10/09	CAM SOP-00102	EPA 6010C

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, EPA, APHA or the Quebec Ministry of Environment.

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.
(1) This test was performed by Bureau Veritas Mississauga, 6740 Campobello Rd , Mississauga, ON, L5N 2L8

Your Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Your C.O.C. #: N/A

Attention: Keith Holmes

WSP Canada Inc.
1931 Robertson Rd
Ottawa, ON
CANADA K2H 5B7

Report Date: 2025/10/10
Report #: R8629492
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C5C4402

Received: 2025/10/03, 13:35

(2) Soils are reported on a dry weight basis unless otherwise specified.
(3) No lab extraction date is given for F1BTEX & VOC samples that are field preserved with methanol. Extraction date is the date sampled unless otherwise stated.
(4) All CCME PHC results met required criteria unless otherwise stated in the report. The CWS PHC methods employed by Bureau Veritas conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following “Alberta Environment’s Interpretation of the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Validation of Performance-Based Alternative Methods September 2003”. Documentation is available upon request. Modifications from Reference Method for the Canada-wide Standard for Petroleum Hydrocarbons in Soil-Tier 1 Method: F2/F3/F4 data reported using validated cold solvent extraction instead of Soxhlet extraction.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Katherine Szozda, Project Manager
Email: Katherine.Szozda@bureauveritas.com
Phone# (613)274-0573 Ext:7063633
==
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 Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

Bureau Veritas 100 – 36 Antares Dr. Nepean, ON, K2E 7W5 Phone: 613-274-0573 Website: www.bvna.com

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

O.REG 406 EXCESS SOIL BULK INORGANICS (SOIL)

Bureau Veritas ID			AVVZ64		AVVZ65			AVVZ65		
Sampling Date			2025/09/22 12:00		2025/09/22 12:00			2025/09/22 12:00		
COC Number			N/A		N/A			N/A		
	UNITS	**Criteria**	**BH25-01 SA1B**	**QC Batch**	**BH25-01 SA2**	**RDL**	**QC Batch**	**BH25-01 SA2 Lab-Dup**	**RDL**	**QC Batch**
Calculated Parameters										
Sodium Adsorption Ratio	N/A	2.4	**4.3**	A025862	**34**		A025862			
Inorganics										
Conductivity	mS/cm	0.57	0.20	A027998	**2.7**	0.002	A027998			
Available (CaCl2) pH	pH	-	8.04	A027957	7.68		A027957			
WAD Cyanide (Free)	ug/g	0.051	<0.01	A027641	<0.01	0.01	A027641			
Chromium (VI)	ug/g	0.66	<0.18	A027698	<0.18	0.18	A027698			
Metals										
Hot Water Ext. Boron (B)	ug/g	-	0.18	A028073	0.18	0.050	A028073			
Acid Extractable Antimony (Sb)	ug/g	1.3	<0.20	A028053	<0.20	0.20	A027974	<0.20	0.20	A027974
Acid Extractable Arsenic (As)	ug/g	18	1.2	A028053	<1.0	1.0	A027974	<1.0	1.0	A027974
Acid Extractable Barium (Ba)	ug/g	220	49	A028053	**330**	0.50	A027974	**330**	0.50	A027974
Acid Extractable Beryllium (Be)	ug/g	2.5	0.22	A028053	0.84	0.20	A027974	0.84	0.20	A027974
Acid Extractable Boron (B)	ug/g	36	8.5	A028053	5.6	5.0	A027974	5.1	5.0	A027974
Acid Extractable Cadmium (Cd)	ug/g	1.2	<0.10	A028053	0.10	0.10	A027974	0.12	0.10	A027974
Acid Extractable Chromium (Cr)	ug/g	70	8.1	A028053	**85**	1.0	A027974	**83**	1.0	A027974
Acid Extractable Cobalt (Co)	ug/g	21	3.9	A028053	18	0.10	A027974	18	0.10	A027974
Acid Extractable Copper (Cu)	ug/g	92	11	A028053	30	0.50	A027974	29	0.50	A027974
Acid Extractable Lead (Pb)	ug/g	120	7.5	A028053	6.6	1.0	A027974	6.6	1.0	A027974
Acid Extractable Molybdenum (Mo)	ug/g	2	<0.50	A028053	<0.50	0.50	A027974	<0.50	0.50	A027974
Acid Extractable Nickel (Ni)	ug/g	82	8.8	A028053	47	0.50	A027974	47	0.50	A027974
Acid Extractable Selenium (Se)	ug/g	1.5	<0.50	A028053	<0.50	0.50	A027974	<0.50	0.50	A027974
Acid Extractable Silver (Ag)	ug/g	0.5	<0.20	A028053	<0.20	0.20	A027974	<0.20	0.20	A027974
Acid Extractable Thallium (Tl)	ug/g	1	0.12	A028053	0.40	0.050	A027974	0.37	0.050	A027974
Acid Extractable Uranium (U)	ug/g	2.5	0.28	A028053	0.68	0.050	A027974	0.69	0.050	A027974
Acid Extractable Vanadium (V)	ug/g	86	7.3	A028053	**97**	5.0	A027974	**95**	5.0	A027974
Acid Extractable Zinc (Zn)	ug/g	290	8.3	A028053	120	5.0	A027974	120	5.0	A027974

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
Criteria: Ont. Reg. 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

Bureau Veritas 100 – 36 Antares Dr. Nepean, ON, K2E 7W5 Phone: 613-274-0573 Website: www.bvna.com

O.REG 406 EXCESS SOIL BULK INORGANICS (SOIL)

Bureau Veritas ID			AVVZ64		AVVZ65			AVVZ65		
Sampling Date			2025/09/22 12:00		2025/09/22 12:00			2025/09/22 12:00		
COC Number			N/A		N/A			N/A		
	UNITS	**Criteria**	**BH25-01 SA1B**	**QC Batch**	**BH25-01 SA2**	**RDL**	**QC Batch**	**BH25-01 SA2 Lab-Dup**	**RDL**	**QC Batch**
Acid Extractable Mercury (Hg)	ug/g	0.27	<0.050	A028053	<0.050	0.050	A027974	<0.050	0.050	A027974

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
Criteria: Ont. Reg. 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

O.REG 406 EXCESS SOIL BULK INORGANICS (SOIL)

Bureau Veritas ID			AVVZ66		
Sampling Date			2025/09/22 12:00		
COC Number			N/A		
	UNITS	**Criteria**	**BH25-07 SA2**	**RDL**	**QC Batch**
Calculated Parameters					
Sodium Adsorption Ratio	N/A	2.4	0.85		A025862
Inorganics					
Conductivity	mS/cm	0.57	0.29	0.002	A027998
Available (CaCl2) pH	pH	-	7.59		A027957
WAD Cyanide (Free)	ug/g	0.051	<0.01	0.01	A027641
Chromium (VI)	ug/g	0.66	<0.18	0.18	A027693
Metals					
Hot Water Ext. Boron (B)	ug/g	-	0.19	0.050	A028183
Acid Extractable Antimony (Sb)	ug/g	1.3	<0.20	0.20	A028053
Acid Extractable Arsenic (As)	ug/g	18	1.7	1.0	A028053
Acid Extractable Barium (Ba)	ug/g	220	**290**	0.50	A028053
Acid Extractable Beryllium (Be)	ug/g	2.5	0.63	0.20	A028053
Acid Extractable Boron (B)	ug/g	36	<5.0	5.0	A028053
Acid Extractable Cadmium (Cd)	ug/g	1.2	0.17	0.10	A028053
Acid Extractable Chromium (Cr)	ug/g	70	36	1.0	A028053
Acid Extractable Cobalt (Co)	ug/g	21	10	0.10	A028053
Acid Extractable Copper (Cu)	ug/g	92	18	0.50	A028053
Acid Extractable Lead (Pb)	ug/g	120	8.8	1.0	A028053
Acid Extractable Molybdenum (Mo)	ug/g	2	<0.50	0.50	A028053
Acid Extractable Nickel (Ni)	ug/g	82	21	0.50	A028053
Acid Extractable Selenium (Se)	ug/g	1.5	<0.50	0.50	A028053
Acid Extractable Silver (Ag)	ug/g	0.5	<0.20	0.20	A028053
Acid Extractable Thallium (Tl)	ug/g	1	0.24	0.050	A028053
Acid Extractable Uranium (U)	ug/g	2.5	0.75	0.050	A028053
Acid Extractable Vanadium (V)	ug/g	86	48	5.0	A028053

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Ont. Reg. 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

O.REG 406 EXCESS SOIL BULK INORGANICS (SOIL)

Bureau Veritas ID			AVVZ66		
Sampling Date			2025/09/22 12:00		
COC Number			N/A		
	UNITS	**Criteria**	**BH25-07 SA2**	**RDL**	**QC Batch**
Acid Extractable Zinc (Zn)	ug/g	290	69	5.0	A028053
Acid Extractable Mercury (Hg)	ug/g	0.27	<0.050	0.050	A028053

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Ont. Reg. 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

O.REG 406 EXCESS SOIL BULK BTEX/F1-F4 (SOIL)

Bureau Veritas ID			AVVZ64	AVVZ65	AVVZ66		
Sampling Date			2025/09/22 12:00	2025/09/22 12:00	2025/09/22 12:00		
COC Number			N/A	N/A	N/A		
	UNITS	**Criteria**	**BH25-01 SA1B**	**BH25-01 SA2**	**BH25-07 SA2**	**RDL**	**QC Batch**
BTEX & F1 Hydrocarbons							
Benzene	ug/g	0.02	<0.020	<0.020	<0.020	0.020	A026268
Toluene	ug/g	0.2	<0.020	<0.020	<0.020	0.020	A026268
Ethylbenzene	ug/g	0.05	<0.020	<0.020	<0.020	0.020	A026268
o-Xylene	ug/g	-	<0.020	<0.020	<0.020	0.020	A026268
p+m-Xylene	ug/g	-	<0.040	<0.040	<0.040	0.040	A026268
Total Xylenes	ug/g	0.05	<0.040	<0.040	<0.040	0.040	A026268
F1 (C6-C10)	ug/g	25	<10	<10	<10	10	A026268
F1 (C6-C10) - BTEX	ug/g	25	<10	<10	<10	10	A026268
F2-F4 Hydrocarbons							
F2 (C10-C16 Hydrocarbons)	ug/g	10	<7.0	<7.0	<7.0	7.0	A026610
F3 (C16-C34 Hydrocarbons)	ug/g	240	<50	<50	<50	50	A026610
F4 (C34-C50 Hydrocarbons)	ug/g	120	<50	<50	<50	50	A026610
Reached Baseline at C50	ug/g	-	Yes	Yes	Yes		A026610
Surrogate Recovery (%)							
1,4-Difluorobenzene	%	-	104	105	100		A026268
4-Bromofluorobenzene	%	-	96	95	96		A026268
D10-o-Xylene	%	-	93	110	99		A026268
D4-1,2-Dichloroethane	%	-	101	103	106		A026268
o-Terphenyl	%	-	98	99	98		A026610

No Fill	No Exceedance
Grey	Exceeds 1 criteria policy/level
Black	Exceeds both criteria/levels

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Criteria: Ont. Reg. 406/19 Excess Soil Quality Standards, Table 1, Full Depth Background Site Condition Standards, Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		AVVZ64	AVVZ65	AVVZ65	AVVZ66		
Sampling Date		2025/09/22 12:00	2025/09/22 12:00	2025/09/22 12:00	2025/09/22 12:00		
COC Number		N/A	N/A	N/A	N/A		
	UNITS	**BH25-01 SA1B**	**BH25-01 SA2**	**BH25-01 SA2 Lab-Dup**	**BH25-07 SA2**	**RDL**	**QC Batch**
Inorganics							
Moisture	%	3.8	26	26	19	1.0	A026300

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

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

TEST SUMMARY

Bureau Veritas ID: AVVZ64
Sample ID: BH25-01 SA1B
Matrix: Soil

Collected: 2025/09/22
Shipped:
Received: 2025/10/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hot Water Extractable Boron	ICP	A028073	2025/10/08	2025/10/08	Medhat Nasr
Free (WAD) Cyanide	TECH	A027641	2025/10/08	2025/10/08	Prgya Panchal
Conductivity	AT	A027998	2025/10/08	2025/10/08	Gurparteek KAUR
Hexavalent Chromium in Soil by IC	IC/SPEC	A027698	2025/10/08	2025/10/08	Sousan Besharatlou
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	A026268	N/A	2025/10/06	Georgeta Rusu
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	A026610	2025/10/06	2025/10/07	Mohammed Abdul Nafay Shoeb
Acid Extractable Metals by ICPMS	ICP/MS	A028053	2025/10/08	2025/10/08	Daniel Teclu
Moisture	BAL	A026300	N/A	2025/10/06	Nisargsinh Takhatsinh Parihar
pH CaCl2 EXTRACT	AT	A027957	2025/10/08	2025/10/08	Sreena Thekkoot
Sodium Adsorption Ratio (SAR)	CALC/MET	A025862	N/A	2025/10/09	Automated Statchk

Bureau Veritas ID: AVVZ65
Sample ID: BH25-01 SA2
Matrix: Soil

Collected: 2025/09/22
Shipped:
Received: 2025/10/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hot Water Extractable Boron	ICP	A028073	2025/10/08	2025/10/08	Medhat Nasr
Free (WAD) Cyanide	TECH	A027641	2025/10/08	2025/10/08	Prgya Panchal
Conductivity	AT	A027998	2025/10/08	2025/10/08	Gurparteek KAUR
Hexavalent Chromium in Soil by IC	IC/SPEC	A027698	2025/10/08	2025/10/08	Sousan Besharatlou
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	A026268	N/A	2025/10/06	Georgeta Rusu
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	A026610	2025/10/06	2025/10/07	Mohammed Abdul Nafay Shoeb
Acid Extractable Metals by ICPMS	ICP/MS	A027974	2025/10/08	2025/10/08	Daniel Teclu
Moisture	BAL	A026300	N/A	2025/10/06	Nisargsinh Takhatsinh Parihar
pH CaCl2 EXTRACT	AT	A027957	2025/10/08	2025/10/08	Sreena Thekkoot
Sodium Adsorption Ratio (SAR)	CALC/MET	A025862	N/A	2025/10/09	Automated Statchk

Bureau Veritas ID: AVVZ65 Dup
Sample ID: BH25-01 SA2
Matrix: Soil

Collected: 2025/09/22
Shipped:
Received: 2025/10/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Acid Extractable Metals by ICPMS	ICP/MS	A027974	2025/10/08	2025/10/08	Daniel Teclu
Moisture	BAL	A026300	N/A	2025/10/06	Nisargsinh Takhatsinh Parihar

Bureau Veritas ID: AVVZ66
Sample ID: BH25-07 SA2
Matrix: Soil

Collected: 2025/09/22
Shipped:
Received: 2025/10/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Hot Water Extractable Boron	ICP	A028183	2025/10/08	2025/10/08	Medhat Nasr
Free (WAD) Cyanide	TECH	A027641	2025/10/08	2025/10/08	Prgya Panchal
Conductivity	AT	A027998	2025/10/08	2025/10/08	Gurparteek KAUR
Hexavalent Chromium in Soil by IC	IC/SPEC	A027693	2025/10/08	2025/10/08	Sousan Besharatlou
Petroleum Hydro. CCME F1 & BTEX in Soil	HSGC/MSFD	A026268	N/A	2025/10/07	Georgeta Rusu

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

TEST SUMMARY

Bureau Veritas ID: AVVZ66
Sample ID: BH25-07 SA2
Matrix: Soil

Collected: 2025/09/22
Shipped:
Received: 2025/10/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Petroleum Hydrocarbons F2-F4 in Soil	GC/FID	A026610	2025/10/06	2025/10/07	Mohammed Abdul Nafay Shoeb
Acid Extractable Metals by ICPMS	ICP/MS	A028053	2025/10/08	2025/10/08	Daniel Teclu
Moisture	BAL	A026300	N/A	2025/10/06	Nisargsinh Takhatsinh Parihar
pH CaCl2 EXTRACT	AT	A027957	2025/10/08	2025/10/08	Sreena Thekkoot
Sodium Adsorption Ratio (SAR)	CALC/MET	A025862	N/A	2025/10/09	Automated Statchk

Bureau Veritas 100 – 36 Antares Dr. Nepean, ON, K2E 7W5 Phone: 613-274-0573 Website: www.bvna.com

GENERAL COMMENTS

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

Package 1	14.3°C

Sample AVVZ64 [BH25-01 SA1B] : F1/BTEX Analysis: Soil weight exceeds the protocol specification of approximately 5g in the field preserved vial. Additional methanol was added to the vial to ensure extraction efficiency.

Results relate only to the items tested.

Bureau Veritas Job #: C5C4402
Report Date: 2025/10/10

QUALITY ASSURANCE REPORT

WSP Canada Inc.
Client Project #: CA0058422.0115 (3000)
Site Location: CISCO KANATA
Sampler Initials: IK

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
A026268	1,4-Difluorobenzene	2025/10/06	98	60 - 140	100	60 - 140	105	%		
A026268	4-Bromofluorobenzene	2025/10/06	99	60 - 140	98	60 - 140	95	%		
A026268	D10-o-Xylene	2025/10/06	80	60 - 140	92	60 - 140	88	%		
A026268	D4-1,2-Dichloroethane	2025/10/06	102	60 - 140	98	60 - 140	105	%		
A026610	o-Terphenyl	2025/10/06	85	60 - 140	93	60 - 140	99	%		
A026268	Benzene	2025/10/06	78	50 - 140	86	50 - 140	<0.020	ug/g	NC	50
A026268	Ethylbenzene	2025/10/06	86	50 - 140	98	50 - 140	<0.020	ug/g	NC	50
A026268	F1 (C6-C10) - BTEX	2025/10/06					<10	ug/g	NC	30
A026268	F1 (C6-C10)	2025/10/06	91	60 - 140	94	80 - 120	<10	ug/g	NC	30
A026268	o-Xylene	2025/10/06	85	50 - 140	96	50 - 140	<0.020	ug/g	NC	50
A026268	p+m-Xylene	2025/10/06	82	50 - 140	93	50 - 140	<0.040	ug/g	NC	50
A026268	Toluene	2025/10/06	75	50 - 140	84	50 - 140	<0.020	ug/g	NC	50
A026268	Total Xylenes	2025/10/06					<0.040	ug/g	NC	50
A026300	Moisture	2025/10/06							2.7	20
A026610	F2 (C10-C16 Hydrocarbons)	2025/10/07	87	60 - 140	93	80 - 120	<7.0	ug/g	34 (1)	30
A026610	F3 (C16-C34 Hydrocarbons)	2025/10/07	88	60 - 140	89	80 - 120	<50	ug/g	NC	30
A026610	F4 (C34-C50 Hydrocarbons)	2025/10/07	87	60 - 140	82	80 - 120	<50	ug/g	22	30
A027641	WAD Cyanide (Free)	2025/10/08	101	75 - 125	107	80 - 120	<0.01	ug/g	NC	35
A027693	Chromium (VI)	2025/10/08	86	70 - 130	89	80 - 120	<0.18	ug/g	NC	35
A027698	Chromium (VI)	2025/10/08	74	70 - 130	87	80 - 120	<0.18	ug/g	NC	35
A027957	Available (CaCl2) pH	2025/10/08			100	97 - 103			0.53	N/A
A027974	Acid Extractable Antimony (Sb)	2025/10/08	71 (2)	75 - 125	99	80 - 120	<0.20	ug/g	NC	30
A027974	Acid Extractable Arsenic (As)	2025/10/08	99	75 - 125	100	80 - 120	<1.0	ug/g	NC	30
A027974	Acid Extractable Barium (Ba)	2025/10/08	NC	75 - 125	97	80 - 120	<0.50	ug/g	1.8	30
A027974	Acid Extractable Beryllium (Be)	2025/10/08	102	75 - 125	96	80 - 120	<0.20	ug/g	0.25	30
A027974	Acid Extractable Boron (B)	2025/10/08	96	75 - 125	97	80 - 120	<5.0	ug/g	9.5	30
A027974	Acid Extractable Cadmium (Cd)	2025/10/08	102	75 - 125	97	80 - 120	<0.10	ug/g	14	30
A027974	Acid Extractable Chromium (Cr)	2025/10/08	NC	75 - 125	97	80 - 120	<1.0	ug/g	2.7	30
A027974	Acid Extractable Cobalt (Co)	2025/10/08	100	75 - 125	99	80 - 120	<0.10	ug/g	0.58	30
A027974	Acid Extractable Copper (Cu)	2025/10/08	NC	75 - 125	101	80 - 120	<0.50	ug/g	1.5	30
A027974	Acid Extractable Lead (Pb)	2025/10/08	99	75 - 125	97	80 - 120	<1.0	ug/g	0.97	30
A027974	Acid Extractable Mercury (Hg)	2025/10/08	104	75 - 125	99	80 - 120	<0.050	ug/g	NC	30

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
A027974	Acid Extractable Molybdenum (Mo)	2025/10/08	98	75 - 125	96	80 - 120	<0.50	ug/g	NC	30
A027974	Acid Extractable Nickel (Ni)	2025/10/08	NC	75 - 125	103	80 - 120	<0.50	ug/g	0.036	30
A027974	Acid Extractable Selenium (Se)	2025/10/08	101	75 - 125	102	80 - 120	<0.50	ug/g	NC	30
A027974	Acid Extractable Silver (Ag)	2025/10/08	102	75 - 125	98	80 - 120	<0.20	ug/g	NC	30
A027974	Acid Extractable Thallium (Tl)	2025/10/08	101	75 - 125	99	80 - 120	<0.050	ug/g	5.8	30
A027974	Acid Extractable Uranium (U)	2025/10/08	106	75 - 125	99	80 - 120	<0.050	ug/g	1.9	30
A027974	Acid Extractable Vanadium (V)	2025/10/08	NC	75 - 125	100	80 - 120	<5.0	ug/g	1.8	30
A027974	Acid Extractable Zinc (Zn)	2025/10/08	NC	75 - 125	100	80 - 120	<5.0	ug/g	0.17	30
A027998	Conductivity	2025/10/08			105	90 - 110	<0.002	mS/cm	0.097	10
A028053	Acid Extractable Antimony (Sb)	2025/10/08	96	75 - 125	100	80 - 120	<0.20	ug/g	NC	30
A028053	Acid Extractable Arsenic (As)	2025/10/08	100	75 - 125	95	80 - 120	<1.0	ug/g	12	30
A028053	Acid Extractable Barium (Ba)	2025/10/08	NC	75 - 125	101	80 - 120	<0.50	ug/g	1.4	30
A028053	Acid Extractable Beryllium (Be)	2025/10/08	103	75 - 125	94	80 - 120	<0.20	ug/g	3.2	30
A028053	Acid Extractable Boron (B)	2025/10/08	97	75 - 125	87	80 - 120	<5.0	ug/g	NC	30
A028053	Acid Extractable Cadmium (Cd)	2025/10/08	104	75 - 125	94	80 - 120	<0.10	ug/g	3.2	30
A028053	Acid Extractable Chromium (Cr)	2025/10/08	NC	75 - 125	92	80 - 120	<1.0	ug/g	1.1	30
A028053	Acid Extractable Cobalt (Co)	2025/10/08	96	75 - 125	93	80 - 120	<0.10	ug/g	1.2	30
A028053	Acid Extractable Copper (Cu)	2025/10/08	106	75 - 125	97	80 - 120	<0.50	ug/g	1.3	30
A028053	Acid Extractable Lead (Pb)	2025/10/08	101	75 - 125	91	80 - 120	<1.0	ug/g	1.7	30
A028053	Acid Extractable Mercury (Hg)	2025/10/08	94	75 - 125	84	80 - 120	<0.050	ug/g	NC	30
A028053	Acid Extractable Molybdenum (Mo)	2025/10/08	99	75 - 125	91	80 - 120	<0.50	ug/g	2.1	30
A028053	Acid Extractable Nickel (Ni)	2025/10/08	NC	75 - 125	93	80 - 120	<0.50	ug/g	0.61	30
A028053	Acid Extractable Selenium (Se)	2025/10/08	99	75 - 125	93	80 - 120	<0.50	ug/g	NC	30
A028053	Acid Extractable Silver (Ag)	2025/10/08	103	75 - 125	94	80 - 120	<0.20	ug/g	NC	30
A028053	Acid Extractable Thallium (Tl)	2025/10/08	104	75 - 125	94	80 - 120	<0.050	ug/g	3.1	30
A028053	Acid Extractable Uranium (U)	2025/10/08	106	75 - 125	93	80 - 120	<0.050	ug/g	3.7	30
A028053	Acid Extractable Vanadium (V)	2025/10/08	NC	75 - 125	93	80 - 120	<5.0	ug/g	2.3	30
A028053	Acid Extractable Zinc (Zn)	2025/10/08	NC	75 - 125	95	80 - 120	<5.0	ug/g	1.8	30
A028073	Hot Water Ext. Boron (B)	2025/10/08	107	75 - 125	102	75 - 125	<0.050	ug/g	6.3	40

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
A028183	Hot Water Ext. Boron (B)	2025/10/08	110	75 - 125	103	75 - 125	<0.050	ug/g	13	40

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.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

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) Duplicate results exceeded RPD acceptance criteria for flagged analytes. Sample extract was reanalyzed with the same results. This is likely due to sample heterogeneity.

(2) Matrix Spike exceeds acceptance limits, probable matrix interference

VALIDATION SIGNATURE PAGE

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

Louise Harding, 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 Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

Exceedance Summary Table – Reg 406 T1 Res (S)

Result Exceedances

Sample ID	Bureau Veritas ID	Parameter	Criteria	Result	DL	UNITS
BH25-01 SA1B	AVVZ64-01	Sodium Adsorption Ratio	2.4	4.3		N/A
BH25-01 SA2	AVVZ65-01-Lab Dup	Acid Extractable Barium (Ba)	220	330	0.50	ug/g
BH25-01 SA2	AVVZ65-01	Acid Extractable Barium (Ba)	220	330	0.50	ug/g
BH25-01 SA2	AVVZ65-01-Lab Dup	Acid Extractable Chromium (Cr)	70	83	1.0	ug/g
BH25-01 SA2	AVVZ65-01	Acid Extractable Chromium (Cr)	70	85	1.0	ug/g
BH25-01 SA2	AVVZ65-01	Conductivity	0.57	2.7	0.002	mS/cm
BH25-01 SA2	AVVZ65-01	Sodium Adsorption Ratio	2.4	34		N/A
BH25-01 SA2	AVVZ65-01-Lab Dup	Acid Extractable Vanadium (V)	86	95	5.0	ug/g
BH25-01 SA2	AVVZ65-01	Acid Extractable Vanadium (V)	86	97	5.0	ug/g
BH25-07 SA2	AVVZ66-01	Acid Extractable Barium (Ba)	220	290	0.50	ug/g

The exceedance summary table is for information purposes only and should not be considered a comprehensive listing or statement of conformance to applicable regulatory guidelines.

APPENDIX I

Records of Borehole Logs (Previous investigation)

PROJECT: 001-2075

RECORD OF BOREHOLE: 00-1

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: May 16, 2000

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200mm Diam (Hollow Stem)	Ground Surface	88.76				
		Brown clayey TOPSOIL	88.64				Bentonite Seal
		Very stiff to stiff brown to grey SILTY CLAY (Weathered Crust)	0.12				
2				1	50 DO	6	
3.5				2	50 DO	2	Native Backfill
4.3		Firm to stiff grey SILTY CLAY	84.46 / 4.30				
6.5							Standpipe
6.85		Very loose grey GLACIAL TILL	81.91 / 6.85				
7.2				3	50 DO	2	Caved Material
7.46		END OF BOREHOLE	81.30 / 7.46				W.L in Standpipe at Elev.86.68m May 16, 2000

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20, 40, 60, 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● ; rem V. ⊕ U - O : 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT: Wp, W, Wl: 20, 40, 60, 80

ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: S.F.

CHECKED: G

RECORD OF BOREHOLE: 00-2

PROJECT: 001-2075

LOCATION: See Site Plan

BORING DATE: May 16, 2000

SAMPLER HAMMER, 64kg; DROP, 760mm

SHEET 1 OF 1

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, 200mm Diam (Hollow Stem)	Ground Surface	88.33					
		Black clayey TOPSOIL	0.00					
		Very stiff to stiff brown to grey SILTY CLAY (Weathered Crust)	88.05 / 0.28					
1								∇
2				1	50 DO	4		
3–4				2	50 DO	2	rem V. ~18, nat V. ~80; rem V. ~18, nat V. ~63	
		Very loose grey GLACIAL TILL	83.91 / 4.42					
5				3	50 DO	2		
				4	50 DO	3		
6				5	50 DO	4		
7		END OF BOREHOLE SAMPLER REFUSAL	81.12 / 7.21					
8								W.L in Open Hole at Elev.87.26m on completion of drilling

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - O; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp —O W— Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: S.F.

CHECKED: [signature]

PROJECT: 001-2075

RECORD OF BOREHOLE: 00-3

LOCATION: See Site Plan

BORING DATE: May 16, 2000

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger, 200mm Diam (Hollow Stem)	Ground Surface	87.95				
		Black clayey TOPSOIL	0.00				Bentonite Seal
		Very stiff to stiff brown to grey SILTY CLAY (Weathered Crust)	87.67 / 0.28				
2				1	50 DO	8	
3							Native Backfill
		Firm to stiff grey SILTY CLAY	84.60 / 3.35	2	50 DO	2	
6							Standpipe
		END OF BOREHOLE AUGER REFUSAL	81.47 / 6.48				
7							W.L in Standpipe at Ground Surface on completion of drilling

Column headings: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ● ; rem V. ⊕ U - ○) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT Wp —O W— Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING; STRATA PLOT.

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: S.F.

CHECKED:

RECORD OF BOREHOLE: 00-4

PROJECT: 001-2075

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: May 16, 2000

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, 200mm Diam (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Ground Surface	87.90				
	Black clayey TOPSOIL	87.72 / 0.18				
	Very stiff to stiff brown to grey brown SILTY CLAY (Weathered Crust)					
2			1	50 DO	6	
3			2	50 DO	2	
4	Firm to stiff grey SILTY CLAY	83.64 / 4.26				∇
7.5	END OF BOREHOLE	80.43 / 7.47				W.L in Open Hole at Elev.83.63m on completion of drilling

Column headings: DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●; rem V. ⊕ U - O) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT Wp —O W— Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING; STRATA PLOT.

Shear strength readings are plotted at depths of about 4.0 m to 7.5 m (nat V. about 40–80 kPa; rem V. about 10–15 kPa).

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: S.F.

CHECKED: [initials]

BOREHOLE 001-2075.GPJ HYDROGEO.GDT 5 26 00

PROJECT: 001-2075

RECORD OF BOREHOLE: 00-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: May 17, 2000

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200mm Diam (Hollow Stem)

DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
Ground Surface	88.15			
Clayey TOPSOIL	0.00			
Very stiff to stiff brown to grey brown SILTY CLAY, trace fine sand (Weathered Crust)	87.90 / 0.25			
		1	50 DO	5
		2	50 DO	2
Firm to stiff grey SILTY CLAY	83.89 / 4.26			
END OF BOREHOLE	80.53 / 7.62			

Piezometer or standpipe installation: W.L in Open Hole at Elev.83.58m on completion of drilling

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)); SAMPLES (NUMBER, TYPE, BLOWS/0.3m); DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - O) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp — W — Wl) (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE 1 : 50

Golder Associates

LOGGED: D.W.M.

CHECKED:

RECORD OF BOREHOLE: 00-6

PROJECT: 001-2075

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: May 17, 2000

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		88.31				
	Power Auger 200mm Diam (Hollow Stem)	Clayey TOPSOIL		0.00				
		Very stiff to stiff brown to grey brown SILTY CLAY, trace fine sand (Weathered Crust)		88.06 0.25				
2					1	50 DO	4	
3					2	50 DO	1	
5		Firm grey SILTY CLAY		83.44 4.87				
7		Dense grey GLACIAL TILL		81.46 6.85	3	50 DO	67	
		END OF BOREHOLE AUGER REFUSAL		81.05 7.26				
8								W.L in Open Hole at Elev. 87.40m on completion of drilling

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20, 40, 60, 80

SHEAR STRENGTH Cu, kPa — nat V. + Q - ● rem V. ⊕ U - O: 20, 40, 60, 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}

WATER CONTENT PERCENT Wp —O^W— Wl: 20, 40, 60, 80

ADDITIONAL LAB. TESTING

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.W.M.

CHECKED: [signature]

RECORD OF BOREHOLE: 99-200

PROJECT: 991-2238
LOCATION: See Site plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: December 1, 1999

SHEET 1 OF 1
DATUM: Local
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Boring method: Power Auger, 200mm Diam (Hollow Stem)

Description	Elev. (m)	Depth (m)	Sample Number	Type	Blows/0.3m
Ground Surface	86.80				
TOPSOIL	86.56	0.24			
Very stiff to stiff grey brown SILTY CLAY (Weathered Crust)			1	50 DO	3
Firm to stiff grey SILTY CLAY	82.84	3.96			
Probably grey Silty Clay	79.79	7.01			
Probably layered Clay and silt, trace gravel	75.67	11.13			
Probably Sandy Silt Till, occasional cobble	74.76	12.04			
End of Borehole Auger Refusal	72.35	14.45			

Column headings: DEPTH SCALE METRES; BORING METHOD; SOIL PROFILE (DESCRIPTION, STRATA PLOT, ELEV. DEPTH (m)); SAMPLES (NUMBER, TYPE, BLOWS/0.3m); DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - O) (20, 40, 60, 80); HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT (Wp —O W— Wl) (20, 40, 60, 80); ADDITIONAL LAB. TESTING; PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: D.J.S.
CHECKED: ------------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-201

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 4, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface	86.70				
	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL	0.12				
		Very stiff to stiff brown to grey brown SILTY CLAY, trace fine sand (Weathered Crust)					
1				1	50 DO	6	∇
2				2	50 DO	4	
3				3	50 DO	2	
4		Firm to stiff grey SILTY CLAY	82.70 / 4.00				
5				4	50 DO	PM	
6.7		End of Borehole	80.00 / 6.70				W.L in Open Hole at Elev.85.79m Jan. 4, 2000

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—O W—⊣ Wl (20 40 60 80)

ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ----------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-201A

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 6, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp —O W— Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200mm Diam (Hollow Stem)	Ground Surface		86.70							
		Dark brown silty clay TOPSOIL		86.46							
		Very stiff to stiff brown to grey brown SILTY CLAY (Weathered Crust)		0.24							
4		Firm grey SILTY CLAY		82.74 / 3.96							
6		End of Borehole		80.77 / 5.93							

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ----------

RECORD OF BOREHOLE: 99-202

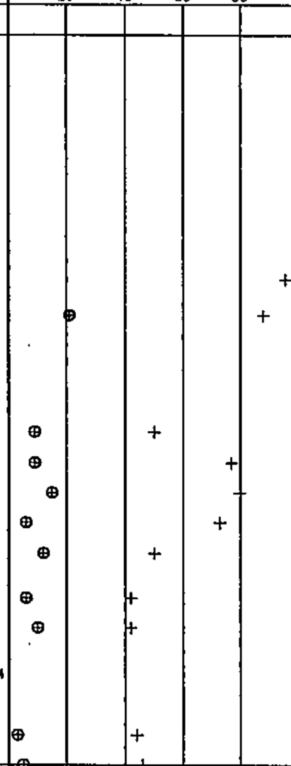
PROJECT: 991-2238
LOCATION: See Site plan
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: January 5, 2000

SHEET 1 OF 1
DATUM: Local
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger; 200mm Diam (Hollow Stem)	Ground Surface	86.60				
		TOPSOIL	0.14				Bentonite Seal
		Very stiff to stiff brown to grey brown SILTY CLAY, occasional Fe staining (Weathered Crust)					
1				1	50 DO	8	
2				2	50 DO	5	Native Backfill
3				3	50 DO	2	
4		Stiff to firm grey SILTY CLAY	82.64 / 3.96				
5							Bentonite Seal
6				4	50 DO	PM	Standpipe
7							Granular Filter
		End of Borehole	79.29 / 7.31				
8							W.L in Standpipe at Elev.85.61m Jan. 6, 2000
9							
10							
11							
12							
13							
14							
15							

Other column headings: STRATA PLOT; DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20, 40, 60, 80); SHEAR STRENGTH Cu, kPa (20, 40, 60, 80) nat V. + Q - ● rem V. ⊕ U - ○; HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); WATER CONTENT PERCENT Wp —○W— Wl (20, 40, 60, 80); ADDITIONAL LAB. TESTING



DEPTH SCALE
1 : 75

Golder Associates

LOGGED: D.W.M.
CHECKED: -----------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-203

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 5, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES – NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - O)	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT PERCENT Wp —O W— Wl	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		86.76							
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL		86.59							
		Very stiff to stiff brown to grey brown SILTY CLAY, occasional Fe staining (Weathered Crust)		0.17							
2					1	50 DO	6				∇
3					2	50 DO	3				
		Firm to stiff grey SILTY CLAY, occasional thin silty sand seams		83.06 3.70							
6					3	50 DO	2				
		End of Borehole		79.44 7.32							W.L in Open Hole at Elev.84.84m Jan. 5, 2000

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ----------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-204

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 4, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface	87.25				
	Power Auger, 200mm Diam (Hollow Stem)	TOPSOIL	0.10				
		Very stiff to stiff brown to grey brown SILTY CLAY, trace fine sand, occasional Fe streaks (Weathered Crust)					
1				1	50 DO	6	
2				2	50 DO	6	
3				3	50 DO	1	∇
4.57		Firm grey SILTY CLAY, occasional thin silty sand seams	82.68 / 4.57				
5				4	50 DO	PM	
6				5	50 DO	PM	
7.31		End of Borehole	79.94 / 7.31				W.L in Open Hole at Elev.84.50m on completion of drilling Jan. 4, 2000

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ----------

RECORD OF BOREHOLE: 99-204A

PROJECT: 991-2238

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 6, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—O^W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		87.25							
0	Power Auger 200mm Diam (Hollow Stem)	TOPSOIL		0.10							
		Very stiff to stiff brown to grey brown SILTY CLAY, trace fine sand, occasional Fe streaks (Weathered Crust)									
4		Firm grey SILTY CLAY		82.98 4.27							
6		End of Borehole		81.32 5.93							

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ------------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-205

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 4, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200mm Diam (Hollow Stem)	Ground Surface		87.22				
		TOPSOIL		0.11				Bentonite Seal
		Very stiff to stiff brown to grey brown SILTY CLAY (Weathered Crust)						
1					1	50 DO	5	
2					2	50 DO	4	
3					3	50 DO	2	Native Backfill
4		Firm to stiff grey SILTY CLAY		83.22 4.00				
5								Bentonite Seal
6								Standpipe
					4	50 DO	PM	Granular Filter
7		End of Borehole		79.88 7.34				
8								W.L in Standpipe at Elev.85.79m Jan. 4, 2000

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - O; 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—O W—⊣ Wl; 20 40 60 80

ADDITIONAL LAB. TESTING

Depth scale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: D.W.M.
CHECKED: ----------

PROJECT: 991-2238

RECORD OF BOREHOLE: 99-206

SHEET 1 OF 1

LOCATION: See Site plan

BORING DATE: January 5, 2000

DATUM: Local

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp —O W— Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200mm Diam (Hollow Stem)	Ground Surface		86.72							
		TOPSOIL		0.12							
		Very stiff to stiff brown to grey brown SILTY CLAY (Weathered Crust)									
3.7		Firm to stiff grey SILTY CLAY		83.02 3.70							
5.9		End of Borehole		80.79 5.93							

DEPTH SCALE 1 : 75

Golder Associates

LOGGED: D.W.M.

CHECKED: ----------

RECORD OF BOREHOLE 98-3

PROJECT: 981-2030
LOCATION: See Plan
SAMPLER HAMMER, 63.6kg; DROP, 760mm

BORING DATE: Apr. 27, 1998

SHEET 1 OF 1
DATUM: Geodetic
PENETRATION TEST HAMMER, 63.6kg; DROP, 760mm

BORING METHOD: Power Auger 200mm Diam (Hollow Stem)

Depth (m)	Description	Elev. / Depth (m)	Sample Number	Type	Blows/0.3m	Piezometer or Standpipe Installation
0	Ground Surface	86.63				
	Dark brown silty TOPSOIL	0.00				Bentonite Seal
	Mixed TOPSOIL and SILTY CLAY	86.23 / 0.40 / 0.55				Native Backfill
	Very stiff to stiff grey brown SILTY CLAY (Weathered Crust)		1	50 DO	7	
			2	50 DO	4	Standpipe
						Caved Material
		81.69 / 4.94	3	50 DO	1	
	Firm to stiff grey SILTY CLAY					
7	End of Hole	79.62 / 7.01				

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa: nat.V - + ; rem.V - ⊕ ; Q - ● ; U - O (scale 20, 40, 60, 80); values >96 at approx. 3.9 m and 4.2 m

WATER CONTENT, PERCENT: Wp —O W— Wl (scale 20, 40, 60, 80)

ADDITIONAL LAB. TESTING

W.L in Standpipe at Elev.85.99m May 1, 1998

DATA INPUT: C:98-3-030.drf/S.L

DEPTH SCALE 1 to 75

Golder Associates

LOGGED: D.J.S
CHECKED: [initials]

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