Preliminary Geotechnical and Hydrogeological Investigation

1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario

1209 St. Laurent Limited Partnership

13 May 2022

→ The Power of Commitment

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1. Introduction

The technical services of GHD were retained by 1209 St. Laurent Limited Partnership to complete a preliminary geotechnical and hydrogeological investigation as part of a due diligence for a proposed new residential development which will consist of two 30-storey towers (Tower A and B), a two-story structure connecting Tower A and B, and two to three levels of underground parking which will encompass almost the entire development footprint. The development is located at 1209 St. Laurent Boulevard and 1200 Lemieux Street in Ottawa, Ontario, hereafter referred to as the Site.

The purpose of this investigation was to evaluate the subsurface soil, bedrock and groundwater conditions at the location of the proposed development in order to provide preliminary recommendations for the foundation design, bearing capacities at limit states, seismic site classification, subgrade quality and preparation for floor slabs and exterior pavement areas, groundwater management as well as any other pertinent subsoil conditions which may affect the construction of the proposed towers. As part of this investigation, seven boreholes were advanced and in situ hydraulic response testing and laboratory testing were carried out to provide interpretation of factual information obtained.

In addition, this report is accompanied by a series of five appendices:

– Appendix A: Record of Boreholes – Current Investigation
– Appendix B: Record of Borehole Sheets – Previous Investigation
– Appendix C: Bedrock Core Photos
– Appendix D: Geotechnical and Chemical Laboratory Test Results
– Appendix E: Single Well Response Test Results

A Phase One and Phase Two Environmental Site Assessment (ESA) were carried out in conjunction with the geotechnical and hydrogeological investigation. The reader is referred to the Phase One ESA report and the Phase Two ESA report prepared by GHD for this project, which are provided under separate covers.

This work was completed in accordance with our proposal reference number 11230705 dated July 2, 2021. This report is subject to a number of limiting conditions due to the inherent nature of geological, geotechnical, and hydrogeological profiles determined by investigative fieldwork. The applicable limitations of this study are explained following the technical section of this report. These limitations are an integral part of this report and the reader is strongly encouraged to inform himself/herself in order to facilitate their comprehension, interpretation, and use of this document.

Furthermore, this report has been prepared with limited understanding of the design as described in Section 2 and will be carried out in accordance with all applicable codes and standards. Any changes to the project described herein will require that GHD be retained to assess the impact of the changes on the recommendations provided.

Site and Project Description

The Site currently consists of a vacant land located at 1209 St. Laurent Boulevard and a surface level parking lot at 1200 Lemieux Street. The vacant land is situated on the west side of the Site, and the parking lot on the east half of the Site.

The site is bounded to the north and east by Lemieux Street, to the west by St. Laurent Boulevard, and to the south by transit way.

The Site is surrounded by a commercial building, a hotel, and restaurants to the north and east and by a shopping mall to the west. The Site is irregular in shape and covers an area of about 3,100 square metres (m^2). The west portion of the Site is covered by over grown vegetation, mainly grass and a tree and the east portion of the Site is mainly paved with a treeline along the west perimeter. The majority of the Site footprint is evenly levelled (with site grade elevations at the borehole locations varying between 68.04 metres [m] and 69.33 m) but includes a relatively steep embankment slope along the south perimeter towards the transitway access ramp. The location of the Site is illustrated on the Site Location Plan attached as Figure 1 at the end of this report.

GHD understands that the proposed development will consist of construction of two 30-storey towers (Tower A and B), a two-story structure connecting Tower A and B, and two to three levels of underground parking which will encompass the entire footprint of the development area. Additional associated development comprises, above ground access roads, service connections and landscaped areas.

Five existing boreholes drilled as part of the Phase II ESA investigation (completed by Stantec) have been used to supplement the current investigation. The locations of the previous boreholes are shown on the attached Borehole Location Plan (Figure 2). The borehole logs from previous investigation are provided in Appendix B. The results of the previous investigations are contained in the following report:

– Report prepared by Stantec to City of Ottawa, titled "Phase II Environmental Site Assessment – 1209 St. Laurent Boulevard, Ottawa, Ontario", dated December 11, 2018 (project no. 122170233).

Borehole results from Stantec investigation to the west of the Site suggest the presence of up to 0.5 m of topsoil or sand and gravel fill overlying a layer of stratified silty sand to clayey silt to silt underlain by a stiff silty clay till extending to a maximum depth of 4.9 m below existing ground surface.

Furthermore, the surficial geological mapping produced by the Geologic Survey of Canada (GSC) indicates that the native overburden consists of till plain with depth to bedrock (drift thickness) of between 3 m to 5 m. The bedrock geology mapping indicates that the bedrock consists of shale of the Billings formation.

2. Methods of Investigation

2.1 Field Procedures

The field work consisted of drilling of seven boreholes, identified as Borehole numbers MW-1-21 to MW-7-21, inclusively. All boreholes were drilled to refusal/bedrock and further continued into bedrock using conventional HQ-diameter diamond drilling technique. Four boreholes (i.e., Boreholes MW-3-21 to MW-5-21 and MW-7-21) were advanced to 12 m below ground surface (mbgs). The other three boreholes (i.e., Boreholes MW-1-21, MW-2-21 and MW-6-21) were drilled to refusal depth and then cored for approximately 1.5 m into bedrock. The locations of the completed boreholes are shown in the Borehole Location Plan as Figure 2 at the end of this report.

All the boreholes were retrofitted with monitoring wells for groundwater level measurements and hydrogeological assessments, as well as to allow for collection of groundwater samples for environmental analysis assessments as required for Phase II ESA. Four monitoring wells (MW-3-21, MW-4-21, MW-5-21 and MW-7-21) were sealed within bedrock at various depths; and three monitoring wells (MW-1-21, MW-2-21, MW-6-21) were sealed within overburden soil.

Following a stabilization period, GHD conducted a return visit to record stabilized groundwater levels and collect representative groundwater samples from select monitoring wells for environmental purposes.

The borehole drilling fieldwork program was carried out between July 14th and July 16th, 2021, with a track mounted drill rig, under the full-time supervision of GHD field staff. Measurement for stabilized groundwater level was completed on July 29, 2021 by GHD personnel.

Boreholes were advanced into the overburden using hollow stem augers.

Sampling procedures within the overburden were performed in accordance with American Society for Testing and Materials (ASTM) Standard D-1586 which allowed soil samples to be secured at regular intervals with a 50-millimeter (mm) diameter standard split-spoon sampler (SS) with a 63.5 kilogram (kg) hammer and a free falling distance of 760 mm and provided the penetration resistance ("N-Value") of the soils. The penetration N values were used to estimate the relative density of the granular subsoils.

The undrained shear strength of the clayey soils encountered was measured in situ using a field vane equipment.

To confirm bedrock and rock quality (ASTM D2113) rock coring at seven boreholes was undertaken using HQ diamond coring equipment.

All boreholes drilled into overburden were backfilled with silica sand within the screen depths and then backfilled with bentonite to the surface. Auger cuttings were placed in drums and left on site for testing and future disposal.

Each borehole location was surveyed for horizontal and vertical control using Global Navigation Satellite Systems (GNSS) equipment (EOS Arrow Gold RTK GNSS receiver), with accuracy 1 centimetres (cm) accuracy."

The completed borehole logs are presented in Appendix A of this report. The monitoring well installation schematics are presented on the accompanying logs located in Appendix A.

2.2 Geotechnical Laboratory Testing

All of the recovered soil and core samples were transported to our laboratory, where they were logged and visually identified for presentation purposes in this report. A photo documentation of the rock core samples recovered within boreholes MW-1-21 to MW-7-21 was completed in our laboratory. The photographs are presented in Appendix C of this report.

Laboratory tests were conducted on representative soil and bedrock samples to determine their geotechnical properties. A summary of laboratory tests undertaken are shown in Table 1.

Table 1 Laboratory Testing

Laboratory test	Quantity of tests undertaken
Water content determination	15
Atterberg limits	4
Sieve analysis	3
Sieve and hydrometer analysis	2
Corrosivity	2[(1)]
UCS on bedrock	6
Note: *UCS - Unconfined compressive strength* *[(1)] - 1 soil and 1 water sample undertaken*	

One sample of the soil recovered from Borehole MW-7-21 and one water sample from monitoring well MW-5-21 were submitted to ALS Environmental Laboratory for basic chemical testing related to corrosion of buried concrete and steel.

The laboratory test results are presented in Appendix D of this report. Results of the laboratory testing were used to confirm site soil logging and are discussed in the proceeding relevant subsurface conditions in Section 4.

The borehole samples will be stored for a 6-month period, after which they will be discarded unless otherwise requested by the Client.

2.3 Hydrogeologic Investigation

As discussed above, all seven boreholes were completed as monitoring wells (MW-1-21 through MW-7-21). Monitoring wells were installed to facilitate the collection of groundwater samples for laboratory analyses, groundwater level measurements, and completion of single well response tests (SWRTs). Detailed stratigraphic logs for the monitoring wells are included in Appendix A.

Between July 16, 2021 and July 20, 2021, each well was developed by purging out between five to eight well volumes of groundwater in order to remove loose sediment that may have been disturbed during the drilling process. This was done to ensure water samples collected are representative of groundwater conditions and that hydraulic testing is representative of the surrounding aquifer.

On July 26, 2021, GHD field staff collected groundwater samples from all monitoring locations with the exception of MW-4-21 and MW-7-21. The groundwater samples were collected using inertial lift pumping techniques following purging three to five well volumes of water from the monitoring well to ensure representative groundwater was collected. In the event the well went dry during the purging process, a sample was collected once there was sufficient recharge. Samples submitted for dissolved metals were field filtered using a 0.45 microgram (µm) inline filter. The results of groundwater quality sampling are presented under separate cover in the Phase Two ESA report (GHD, August 2021).

GHD completed depth to water level measurements readings on July 26, 2021, and July 29, 2021 (prior to sampling and prior to the SWRTs).

SWRTs were completed, on July 29, 2021. SWRT were completed by inducing displacement of the water level in each of the monitoring wells and measuring the rate at which water levels returned to static (recovery of water within the well based on the induced change). A falling and rising head SWRT was completed in each of the monitoring wells. Falling and rising head tests were completed by adding and removing a solid PVC slug, of known volume, to the water column and monitoring the rate of recovery (decrease – falling head or increase – rising head) in the well. The change in water level during the tests was monitored at regular intervals both manually and electronically. Solinist™ water level tapes were used to collect manual measurements and Solinist™ Edge Water Level Data loggers were used to electronically record the change in water levels throughout the SWRTs.

Water level measurements were collected manually and continuously until water levels had recovered 90 percent or more.

3. Subsurface Conditions

In general, soils encountered at the borehole locations consisted of a surface layer of asphalt or topsoil, overlying a fill material, followed by a native sand to clayey silt, a glacial till deposits and ultimately a shale bedrock.

Table 2 presents an overview of the depth and elevation of the main subsoil strata encountered at the borehole locations and each of these units is briefly described in the following sections.

Table 2 Stratigraphic Summary in Metres (m)

Borehole No.	Ground Surface Elevation	Fill Thickness	Sand/Clayey Silt Thickness	Till Deposit		Bedrock		End of borehole	
				Depth	Elev.	Depth	Elev.	Depth	Elev.
MW-1-21	68.04	0.83	0.61	1.52	66.52	4.27	63.77	5.92	62.12
MW-2-21	68.76	0.63	1.53	2.29	66.47	4.57	64.19	6.8	61.96
MW-3-21	68.74	1.48	-	1.52	67.22	4.11	64.63	12.01	56.73
MW-4-21	68.10	2.19	-	2.29	65.81	7.44	60.66	12.07	56.03
MW-5-21	68.54	0.76	1.4	2.29	66.25	5.18	63.36	12.14	56.4
MW-6-21	69.11	1.47	-	1.52	67.59	4.95	64.16	6.91	62.20
MW-7-21	69.33	1.47	-	1.52	67.81	4.57	64.67	12.03	57.03

The detailed subsurface conditions encountered at the borehole locations are presented on the borehole logs attached in Appendix A. The laboratory results for the water content, grain size analysis and Atterberg Limit are summarised on the borehole logs in Appendix A, and the detailed laboratory test results are shown in Appendix D. The recovered rock core photographs are presented in Appendix C.

3.1 Surface Material

Boreholes MW-3-21, MW-6-21 and MW-7-21 were advanced through the existing pavement structure. In general, the pavement structure within the Site consisted of asphalt overlying granular base/subbase. The composition of the granular base/subbase varied from sand and gravel to silty or gravelly sand. The asphalt structure within these boreholes has a thickness of 40 to 50 millimetre (mm) and the thickness of granular base/subbase layer ranges between 1.1 to 1.5 m.

Topsoil was encountered in Boreholes MW-1-21, MW-2-21, MW-4-21 and MW-5-21 with thicknesses ranging between about 80 and 13 mm.

3.2 Fill

Fill material was encountered below the topsoil in Boreholes MW-1-21, MW-2-21, MW-4-21 and MW-5-21 to depths up to 2.29 m. The composition of fill material was variable and mainly consists of sand and gravel, gravelly sand, sandy gravel, silty sand and silty clay. Rootlets were also encountered within the fill material.

SPT 'N' values obtained within the fill range from 6 to 38 per 0.3 m of penetration. The moisture content of the tested samples ranges from 7 percent to 13 percent.

Sieve analysis performed on one sample of the fill material encountered in Borehole MW-1-21 resulted 13 precent gravel, 64 percent sand, and 23 percent fine soil matrix. The detailed laboratory test result is presented in Appendix D.

3.3 Sand

The fill material is underlain by a sand layer in Boreholes MW-1-21 and MW-2-21. The sand deposit extended to depths of 1.5 and 2.3 m within both of these boreholes. Laboratory tests on two samples of sand from Borehole MW-2-21 resulted in water content values of 2 percent and 4 percent.

SPT 'N' values obtained for the sand deposits is within the range of 12 and 23, indicating a compact relative density.

3.4 Clayey Silt

A clayey silt deposit underlain by fill was encountered in Borehole MW-5-21 within the depths of 0.9 m and 2.29 m below ground surface.

An in-situ vane shear test conducted in the clayey silt deposit resulted in a measured undrained shear strength value of 83 kilopascal (kPa), indicative of a stiff consistency.

Furthermore, SPT 'N' values obtained for the silty clay to clayey silt deposits vary between 8 and 24, indicating a stiff to very stiff consistency. The water content measured on one sample of clayey silt deposit was 19 percent.

The results for Atterberg Limits determination conducted on one sample of the clayey silt deposit is summarized in Table 3 and presented in Appendix D.

Table 3 Atterberg Limits Results on Representative Soil Sample of the Clayey Silt Deposit

Borehole N°.	Sample N°.	Depth(m)	Water content (%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)
MW-5-21	SS3	1.52 - 2.13	19	23	16	7

3.5 Glacial Till

Below the aforementioned layers, a glacial till deposit was encountered within all borehole at depths ranging between 1.52 m and 2.29 m below existing site grades, The glacial till deposit thickness varies from 2.28 to 3.70 m and overlies bedrock at all borehole locations.

The composition of till material was variable, consisting of clayey silt to silty clay to sandy silt to silty sand to sand and/or gravel with cobbles and boulders.

The SPT "N" values recorded within the granular till ranges from 13 to more than 50 blows per 0.3 m of penetration, indicating a compact to very dense state of packing. The water contents measured on samples of till deposits range from 8 percent to 17 percent.

Spoon refusal was encountered during multiple SPT tests. Spoon refusal may indicate the presence of boulders, cobbles abundant gravel or very dense layers. Accordingly, sieve analysis of till materials collected from split spoons will not be representative of all till materials present at the Site.

Three representative soil samples of the granular till and one sample of cohesive till deposit were subjected to laboratory testing for determinations of gradation properties. The results grain size distribution testing carried out on the samples of till deposits are summarised in Table 4, and the detailed results are presented in Appendix D of this report.

Table 4 Gradation Results for Samples of Glacial Till Deposits

Borehole N°.	Sample N°.	Depth (m)	Water content (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
MW-2-21	SS5	2.29 - 2.90	9.0	14	43	30	13
MW-3-21	SS4	2.29 - 2.90	-	18	43	39[1]	
MW-4-21	SS5	3.05 - 3.66	-	6	64	30[1]	
MW-7-21	SS5	3.05 - 3.66	15.0	7	33	47	13
Note: [1] - Fractions of silt and clay							

The results of Atterberg limit testing carried out on samples of cohesive till deposit are provided in Table 5 and the detailed results are provided in Appendix D.

Table 5 Atterberg Limits Results for Samples of Glacial Till Deposits

Borehole N°.	Sample N°.	Depth (m)	Water content (%)	Liquid limit (%)	Plastic limit (%)	Plasticity index (%)
MW-2-21	SS5	3.05 - 3.66	9.0	15.5	10.0	5.5
MW-6-21	SS3	1.52 - 2.13	17.0	22.0	13.0	9.0
MW-7-21	SS5	3.05 - 3.66	15.0	18.0	11.0	7..0

3.6 Bedrock

All boreholes were advanced into bedrock using HQ diamond coring method to confirm the presence, type, and quality of bedrock. Bedrock was encountered within Boreholes MW-1-21 to MW-7-21 at depths ranging from 4.11 m to 7.44 m (Elevations 64.8 m to 60.6 m). Boreholes were terminated within bedrock at depths ranging between 5.9 and 12.10 m below existing site grade. The depth and elevations of the confirmed bedrock surface at the borehole locations are summarized in Table 6.

Table 6 Bedrock Depth and Elevations

Borehole No.	Existing Ground Surface Elevation	Bedrock Surface	
		Depth (m)	Elevation (m)
MW-1-21	68.0	4.2	63.8
MW-2-21	68.8	4.6	64.2
MW-3-21	68.7	4.1	64.6
MW-4-21	68.1	7.4	60.7
MW-5-21	68.5	5.1	63.4
MW-6-21	69.1	5.0	64.1
MW-7-21	69.3	4.6	64.7

Based on retrieved rock core samples, the bedrock at the Site consists of the black shale of Billings formation with thinly bedded interlaminations of limestone.

Poor quality bedrock, with Rock Quality Designation (RQD) values below 60 percent was encountered near the bedrock surface to depths varying between 4.5 m and 7.5 m (Elevations 64.2 to 60.6 m) within all boreholes. Following this zone and at all borehole locations excluding Borehole MW-2-21, MW-3-21 and MW-5-21, RQD values generally ranged from 52 to 100 percent, indicating a fair to excellent quality bedrock. Locally, Bedrock at MW-3-21 and MW-5-21 was noted to be fair to excellent quality to depth of 10.5 m and 9.0 m, overlying poor quality (RQD of 45 and 48 percent) bedrock below the aforementioned depths. Fair to excellent quality bedrock was not confirmed at MW-2-21.

The results of unconfined compression strength (UCS) tests carried out on six representative bedrock samples are presented in Table 7. An average compressive strength value of 15.9 MPa were obtained for the rock samples, which is indicative of a weak rock (R2) according to Table 3.5 of the 2006 *Canadian Foundation Engineering Manual* (CFEM).

Table 7 Results of Uniaxial Unconfined Compressive Strength Tests on Selected Bedrock

Borehole No.	Run No.	Sample Depth (m)	Compressive Strength (MPa)
MW-1-21	1	5.0 - 5.4	16.6
MW-2-21	2	0.8 - 1.4	15.4
MW-3-21	4	1.5 - 2.1	13.5
MW-4-21	4	3.0 - 3.7	17.7
MW-5-21	4	6.2 - 6.7	16.7
MW-6-21	1	2.3 - 2.9	15.5

The location and depths of the bedrock discontinuities are detailed on the borehole logs located in Appendix A of this report. Photo documentations of the rock cores can be found in Appendix C of this report.

4. Groundwater Conditions

Groundwater levels were monitored in all seven monitoring wells installed across the Site on July 26, 2021, and July 29, 2021. The measured depth to groundwater and calculated groundwater elevations are summarized in Table 8 below. Groundwater conditions should be expected to vary in response to seasonal conditions and weather events.

Table 8 Groundwater Elevation Summary

Well ID	Ground Surface (mAMSL)	Media	July 26, 2021		July 29, 2021	
			Depth (mBGS)	Elevation (mAMSL)	Depth (mBGS)	Elevation (mAMSL)
MW-1-21	68.04	OB	2.0	66.0	2.0	66.0
MW-2-21	68.76	OB	2.8	65.9	2.8	66.0
MW-3-21	68.74	Bedrock	5.1	63.6	2.8	66.0
MW-4-21	68.10	Bedrock	2.6	65.5	2.3	65.8
MW-5-21	68.54	Bedrock	2.4	66.1	2.4	66.1
MW-6-21	69.11	OB	2.7	66.5	2.5	66.6
MW-7-21	69.33	Bedrock	4.6	64.7	3.4	65.9
Notes: mBGS - metres below ground surface; mBTOR – metres below top of riser; mAMSL – metres above mean sea level; OB - overburden						

As shown above, groundwater depths in the overburden ranged from 2.0 to 4.6 mBGS and elevations ranged from 65.90 to 66.04 mAMSL. Groundwater depths and elevations in the bedrock wells ranged from depths of 2.28 to

5.12 mBGS and 63.63 to 66.09 mAMSL. Based on the estimated groundwater elevations above, groundwater flow direction in the overburden is directed to the northwest. Groundwater elevations in bedrock varied between monitoring events and flow direction is uncertain.

SWRT data was used to estimate hydraulic conductivity values. AQTESOLV™ aquifer test analysis software was used to complete the analysis of the SWRTs. AQTESOLVtm solution output reports for each of the SWRTs are presented in Appendix E. AQTESOLV™ solution output reports for each of the SWRTs are presented in Appendix E. In order to analyze the SWRTs, the Dagan (1978), Bower-Rice (1976), and Hvorslev (1951) solution methods were used. The Hvorlsev (1951) solution is a mathematic solution describing the water pressure (water level) response in a confined aquifer due to the injection or withdrawal of water (or other displacement method) from a well. The Dagan (1978) solution provides a mathematical solution to describe water level responses in unconfined aquifers where the monitoring well is screened across the water table. The Bower-Rice (1976) solution provides mathematical solution for water level responses in unconfined aquifers where the monitoring well is screened entire below the water table. Each solution calculates the hydraulic conductivity based on time-displacement relationship measured during SWRTs.

A summary of the geometric mean estimated hydraulic conductivities resulting from the analyses are presented in Table 9, below. Appendix E includes a detailed summary of the monitoring well details and water levels used to complete the SWRT solutions as well as individual solution is provided in Table 10, attached. SWRT results and AQTESOLV™ outputs are summarized in Table 11, attached.

Table 9 ***Single Well Response Test Results Summary***

Monitoring Well	Screened Media	Solution Method	Geometric Mean Hydraulic Conductivity (cm/sec)*
MW1-21	Overburden (Till)	Dagan - unconfined	3.52E-04
MW2-21	Overburden (Till)	Dagan - unconfined	4.09E-04
MW3-21	Bedrock (Shale)	Hvorslev - confined	2.06E-05
MW4-21	Bedrock (Shale)	Hvorslev - confined	1.32E-04
MW5-21	Bedrock (Shale)	Hvorslev - confined	9.81E-05
MW6-21	Overburden (Till)	Bower-Rice - unconfined	9.81E-05
MW7-21	Bedrock (Shale)	Hvorslev - confined	9.93E-06
Overburden (Till) – Geometric mean			**2.42E-04**
Bedrock (Shale) – Geometric mean			**4.03E-05**
Combined – Geometric mean			**6.80E-05**

The hydraulic conductivities calculated based on the SWRTs are on the order of 10^{-4} cm/sec in the overburden (till) and between 10^{-4} to 10^{-5} cm/sec in bedrock.

The hydraulic conductivity estimated for the overburden materials are generally consistent with a poor, very fine sand, and silt aquifer. Horizontal hydraulic conductivity estimates for shale aquifers can range greatly depending on how weathered the rock is. Horizontal hydraulic conductivity values for shale can range from 10^{-11} to 10^{-5} cm/sec (Groundwater, Freeze and Cherry, 1979 and Heath, 1983). The estimated hydraulic conductivity from the SWRTs is consistent with the larger estimates for shale aquifers. This reflects the weathered nature of bedrock at the Site.

5. Discussion and Recommendations

According to the information provided by the client, the project will consist of the construction of two 30-storey towers connecting to each other with a two-story building with either two or three underground parking levels that will cover the entire Site footprint.

Structural details were not available at the time this report was prepared; however, it is anticipated that the proposed building foundations will rest within the underlying bedrock up to 10 m below site grade.

Based on the aforementioned information, the geotechnical and hydrogeological findings at the borehole locations and assuming they are representative of the subsurface conditions across the entire Site, the preliminary geotechnical and hydrogeological recommendations and comments are provided in the following subsections. The following recommendations are provided on the basis that the towers will be designed in accordance with Part 4 of the 2012 Ontario Building Code (OBC).

Note that these recommendations are provided as part of a due diligence process and are solely intended to guide the client during this phase of the development of this project. The recommendations presented herein should not be used for specific project design, nor should it be used for the City permitting process. We request that the recommendations presented herein be reviewed and re-evaluated as needed once the specific project details are known. Additional testing may be required in order to complete a detailed final geotechnical investigation report for permitting and design purposes.

5.1 Geotechnical/Hydrogeological Constraint and Recommendations

As discussed, bedrock was encountered at depth between 4.1 to 7.4 m. Bedrock excavation will be required for the construction of underground parking. Bedrock at this site is classified as weak rock of fair to excellent quality. Bedrock excavation can be done with no issue however adequate monitoring will be required during the rock excavation.

The excavation faces through the overburden depth will need to be adequately shored or sloped. Upper levels of fractured bedrock should be planned to be sloped at 6V:1H. The underlying sound bedrock should be able to be cut at / near vertical as described in Section 6.3.2.

Note that the bedrock at this site consists of shale of Billings formation. The Billings formation shale may swell and delaminate as it exposes to air. We therefore recommend the rock surface would be protected with a thin layer of lean concrete immediately after cleaning of the rock surface.

There is an embankment slope for the transit way access ramp at the south side of the site. Temporary shoring will be required during the excavation to support the transitway embankment.

Depending on the design and available footprint area for the embankment slope reconstruction, a permanent retaining wall may be required at the south boundary of the site along the transit way access ramp.

The initial dewatering estimates show that the project will need to be registered in the Environmental Activity Sector Registry (EASR) for the construction phase. It is recommended that measurements of stable dewatering rates are recorded during construction activities in order to provide additional insight into the anticipated long-term dewatering requirements for the proposed underground parking structure. However, a Permit to Take Water (PTTW) will likely be required for long-term dewatering (i.e., groundwater control after construction). Water quality analytical results show several parameters exceeding the Provincial Water Quality Objectives (PWQOs) so dewatering cannot be discharged directly to the environment.

Once the design is finalized and better understanding of the excavation depth and load is provided, the following additional investigation and geotechnical laboratory analysis during the detailed design phase is recommended:

– Advance additional boreholes along and near the embankment slope for design of temporary shoring and retaining wall, if required.
– Advance boreholes to better define the vertical extent of bedrock elevation for deep foundation recommendations.

5.2 Site Preparation

General site preparation within the structure footprint, beneath roads/pavements will involve the removal of existing vegetation, topsoil, asphalt, fill and deleterious materials to expose native soils/bedrock.

Any exposed subgrade surface should be visually inspected and/or compacted and proof rolled under examination by geotechnical personnel. This would be part of a program to assess the competency and any identified local anomalies (over size materials) or soft spots which should be subsequently excavated, replaced with suitable fill, and compacted. Field verification should be carried out by qualified geotechnical personnel during construction.

The development will require excavations through the surficial fill, sand (where present), the glacial till deposit and ultimately the underlying bedrock. No unusual problems are anticipated with excavating the overburden using conventional hydraulic excavating equipment. Bedrock excavations will be required within the tower and underground structure footprints. Recommendations for excavation of overburden and bedrock are provided in Section 6.2.

It is also understood that an embankment slope exists at the south boundary of the site and may need to be removed during the excavation. A temporary shoring will be required to support the embankment during the excavation. It is recommended that additional boreholes be advanced along the embankment slope to further understand the composition of soil along the embankment and to provide slope stability recommendations for the eventual embankment reconstruction Depending on the development design, the embankment slope could potentially be substituted with a retaining wall to provide additional footprint area for the proposed construction.

It is noted that environmental requirements for removal of existing materials is provided under a separate cover and not addressed in this report.

5.3 Excavations

Depending on the number of basement levels, a mass excavation of 7 m to 10 m will be required for this project. These excavations will be carried out through a fill layer followed by a compact sand to clayey silt, and glacial till deposits which contains cobbles and boulders; and will penetrated the underlying bedrock. Beyond a depth of approximately 2 m below site grade, the excavation will be completed below the permanent water table.

All excavations should be completed and maintained in accordance with the Occupational Health and Safety Act (OHSA) requirements. The Occupational Health and Safety Act (OHSA) regulations require that if workmen must enter an excavation deeper than 1.2 m, the excavation must be suitably sloped and/or braced in accordance with the OHSA requirements. OHSA specifies maximum slope of the excavations for four broad soil types as summarized in the following table:

Table 10 Maximum Slope Inclinations based on Soil Types (OHSA)

Soil Type	Base of Slope	Maximum Slope Inclination
1	Within 1.2 m of bottom	One horizontal to one vertical
2	Within 1.2 m of bottom of trench	One horizontal to one vertical
3	From bottom of excavation	One horizontal to one vertical
4	From bottom of excavation	Three horizontal to one vertical

OHSA Section 226 defines the four soil types as follows:

Type 1 Soil:

1. Hard, very dense, and only able to be penetrated with difficulty by a small sharp object.
2. Has a low natural moisture content and a high degree of internal strength.
3. Has no signs of water seepage.
4. Can be excavated only by mechanical equipment.

Type 2 Soil:

1. Very stiff, dense and can be penetrated with moderate difficulty by a small sharp object.
2. Has a low to medium natural moisture content and a medium degree of internal strength.
3. Has a damp appearance after it is excavated.

Type 3 Soil:

1. Stiff to firm and compact to loose in consistency or is previously excavated soil.
2. Exhibits signs of surface cracking.

3. Exhibits signs of water seepage.
4. If it is dry may run easily into a well-defined conical pile.
5. Has a low degree of internal strength.

Type 4 Soil:

1. Soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength.
2. Runs easily or flows unless it is completely supported before excavating procedures.
3. Has almost no internal strength.
4. Wet or muddy.
5. Exerts substantial fluid pressure on its supporting system. Ontario Regulation 213/91, s. 226 (5).

The subsoils above the water table can be considered Type 3 soils. Subsoils below the water table should be considered as Type 4 soils unless groundwater levels are lowered in advance of excavation.

Unsupported side slopes should, however, be adjusted depending on the true subsoil conditions encountered during excavation work and flatter side slopes than those mentioned above may be required locally. Furthermore, no vertical unbraced excavations should be performed in the soil.

Depending on the climatic conditions and duration of the work, impermeable membranes may be required in order to prevent erosion and the development of local instabilities in the excavation slopes (soils).

During the excavation, excavated material, machinery or equipment should not be placed closer than one meter or to the equivalent excavation depth (whichever is larger) from the top of the excavation sidewalls and the safety guidelines provided by OHSA (Section 226) should be strictly adhered to for the open cut excavations.

5.3.1 Shoring

Due to the limited work area and according to the conceptual design drawing showing the underground parking footprints covering almost the entire Site footprint, the majority of the site, including southern limit of the site adjacent to the transit way, will require a temporary shoring system to allow for this mass excavation.

The type, design and construction of a temporary shoring system must be carried out by a competent contractor specialized in this field. As this is temporary work, the contractor is responsible for the design of shoring system.

The shoring system must be designed to take into account the nature of the subsoils, bedrock, and groundwater conditions, and must be sufficiently embedded in order to ensure the stability of the excavation bottom, walls, and safety of the workers.

As a guideline, the earth pressure coefficients and parameters quoted on Table 11 below are suggested for computation of earth pressures against temporary supports:

Table 11 Design Parameters/Temporary Supports

Geotechnical Parameter	Fill and Sand Deposit	Glacial Till
Moist Unit Weight (kN/m^3)	18.0	22.0
Submerged Unit Weight (kN/m^3)	8.2	12.2
Angle of Internal Friction, ϕ	28°	34°
Coeff. of Active Earth Pressure, K_a	0.36	0.29
Coeff. of Passive Earth Pressure, K_p	2.77	3.45
Coeff. of Earth Pressure at Rest, K_o	0.53	0.44

A rock-grout bond strength of 0.5 MPa is recommended for design of rock anchors.

The apparent pressure distribution along the retaining structure should be calculated using the applicable method presented in Figure 26.8 of Section 26.10.4 of the CFEM (2013). Surcharges created by the presence of neighbouring buildings and structures as well as the circulation of vehicles should also be considered during the design of the shoring system and permanent walls. The K_o coefficient should be used to calculate loading on permanent foundation walls.

The lateral earth pressures on temporary supports are dependent on the type of system or bracing used, as are the vertical and lateral movements associated with the excavation as well. These lateral earth pressures will also need to take into account the hydrostatic pressures created behind the supporting wall in the case of water-tight designs. We would be pleased to comment and elaborate on this upon any guidelines for the shoring system once the plans are finalized and the construction method is known.

No unsupported vertical slopes should be excavated in the soil.

5.3.2 Bedrock Excavation

Within bedrock, near-vertical excavations (10V:1H within sound bedrock and 6V:1H in fractured bedrock) can be considered for this project. Bedrock at the site was noted to generally be fair to good quality and weak. Based on our experience in this sector with similar projects, the excavation of the upper portion of the rock is possible with mechanical equipment (jackhammer and hydraulic shovel). Alternatively, the rock mass may be excavated through blasting techniques provided that adequate monitoring is performed by a qualified geotechnical engineer during the work.

To minimize overbreak of bedrock, line-drilling should be completed along the excavation perimeter. This will help maintain the integrity of the rock face throughout the depth of the excavation.

Rock excavation, including vibration control, during these works must be completed in accordance with municipal regulation. Additionally, these works must be monitored by a specialized firm (blasting patterns, protection of adjacent structures, etc.). It should be noted that blasting works can modify the permeability and bearing capacity of the bedrock. Excessive fracturing of bedrock, caused by poorly controlled blasting operations, should thus be avoided. Rigorous control of rock excavation work should therefore be a priority.

All rock excavation faces should be inspected by qualified geotechnical engineer, to detect any possible instabilities. Fractured rock areas must be removed or where possible, bolted with rock anchors and protected (if required) by a minimum 50 mm of shotcrete layer. All stabilization works must comply with applicable health and safety regulations and must be validated by a geotechnical engineer.

5.4 Foundations

In general, the subsurface condition encountered in the boreholes consist of topsoil and fill over silty sand, and glacial till extending to 4.1 m to 7.4 m underlain by shale bedrock. Considering the proposed construction of two to three underground parking levels the building foundations should rest on or within fair to good quality shale bedrock.

The foundation configurations and design will depend on the various loading conditions for the development. conventional shallow footings can be used to support the loads induced by the buildings assuming that the preliminary bearing capacities at limit states provided in the sections below are sufficient. Alternatively, deep foundations can be used to support the structures. Sections below will provide foundation options for conventional shallow foundations resting on the sound bedrock as well as deep foundation, in this particular case, drilled caissons within bedrock. Note that the recommendations provided below will need to be re-evaluated once the loading conditions and founding depths for the structural building elements are established. As such the values presented below are preliminary in nature and intended to guide the client during this initial due diligence portion of the project. The values presented below should not be used for design without the written permission from GHD.

5.4.1 Conventional Shallow Foundations

Footings placed on sound Shale bedrock can be designed using a preliminary Serviceability Limit State (SLS) bearing capacity value of 750 kPa. A corresponding preliminary bearing capacity value at limit states (ULS) of 2000 kPa can be used for structural elements resting on sound bedrock. A resistance factor of 0.5 should be applied to the ultimate bearing capacity value in order to obtain the factored ultimate bearing capacity value. Under such stress, anticipated settlements should be negligible.

We recommend that the bedrock surfaces at the footing level be inspected to ensure that they are horizontal, clean, and free of loose fragments and that the conditions encountered correspond to those anticipated. All loose and weathered rock zones which are easily removed with a mechanical shovel should be excavated in order to bear the foundations on sound bedrock.

Note that the exposed rock may swell and delaminate due to change in moisture conditions or as a result of frost which will ultimately require additional cleaning and prepping of the rock surface. We therefore recommend the rock surface would be protected with a thin layer of lean concrete immediately (no later than 24 hours) after cleaning/preparation of the rock surface.

5.4.2 Deep Foundations (Caissons)

Should the serviceability bearing capacities provided in Section 5.4.1 prove to be insufficient for the building, the new structure could potentially rest on deep foundations (caissons) embedded within bedrock.

The caisson design can be carried out according to the methods presented in Section 18.6 of the CFEM 2013, using the parameters of geotechnical resistance to limit states (SLS and ULS) presented in the table below for a preliminary evaluation. The preliminary ultimate and allowable resistance values presented below corresponds to a Ls/Bs ratio of 2.

Table 12 Geotechnical Parameters for Design of Rock-Socketed Drilled Shafts

Parameter	Symbol	Value for Shale
Rock unit weight (bulk)	γ	26.2 kN/m^3
Submerged rock unit weight	γ'	16.4 kN/m^3
Intact rock compressive strength	UCS	15 MPa(1)
Poisson ratio	ν	0.20
Concrete compressive strength at 28 days	f'_c	35 MPa
Concrete deformation modulus (for 35 MPa)	E_c	25.4 GPa
Minimum Rock Quality Designation index in socket (2)	RQD	≥ 60 %
Coefficient of discontinuity spacing	K_{sp}	0.1
Ultimate side-wall shear stress (rock-concrete) (3)	$q_{ult\ emb}$	1.73 MPa
Allowable side-wall shear stress (rock-concrete) (4)	$q_{adm\ emb}$	0.77 MPa
Ultimate base resistance (MPa), Ls/Bs=2.0	$q_{ult\ base}$	2.92 MPa
Allowable base resistance (MPa), Ls/Bs=2.0	$q_{adm\ base}$	0.97 MPa

Notes:
(1) Representative values obtained from the limitative borehole test results.
(2) Minimal value specified at socket level. RQD values obtained from the boreholes have been considered in the calculations.
(3) Average value to consider in a limit states analysis for a relatively rough socket.
(4) Lower bound value to consider in a working stress analysis for a relatively rough socket.

Based on the design parameters listed in the table above, the preliminary caisson design values are obtained for a Ls/Bs ratio of 2:

Serviceability Limit States (SLS):

End bearing capacity	0.97 MPa
Bond strength for the rock/concrete adhesion along the socket wall (using 35 MPa grout and the lowest of the two values)	0.77 MPa or 0.05f'c

Ultimate Limit States (ULS):

Ultimate bearing capacity	2.92 MPa
Ultimate bond strength for the rock/concrete adhesion along the socket wall using 35 MPa grout	1.73 MPa

The ultimate bearing and adhesion values presented should be factored using the following values:

Compression	0.4
Uplift	0.3

These preliminary design values were obtained based on uniaxial rock compression test results adjusted to consider the quality of the bedrock in certain boreholes while applying equation 9.1 of the CFEM 2013, modified based on Equation 18.42 of the CFEM 2013 to take into account a minimum socket length indicated in the paragraph below.

Unless designing caisson, which acts in end bearing only, the end bearing component of the caissons capacity should be calculated based on comments given in section 18.6.5 of the CFEM, 2013, but limited in any case to a maximum of 25 percent of the total axial capacity if the shaft resistance is taken into account in these calculations.

The preliminary design criteria given above assume that the walls of the sockets are of sound rock (RQD>60%), not damaged by the rock excavation process, and clean from any drilling mud (adequate cleaning of the socket bottom is also imperative). This preliminary design criteria also implies that the rock below the socket base is solid, massive, and contains no seams or open joints.

The fractured upper portion of the bedrock should not be considered for these design calculations.

In order to validate these assumptions, it is recommended that sockets be visually inspected by qualified geotechnical personnel. These verifications should be completed for a length greater or equal to twice the diameter of the caisson on a selected number of caissons. For isolated caissons of large diameters, each caisson's socket should be verified. The water level within the casings should be maintained above the groundwater level during the construction of the caissons.

The anticipated settlement of the structure, with a properly installed caisson foundation system, would be negligible.

5.5 Seismic Site Classification

In accordance with 2012 National Building Code of Canada, the building and its structural elements must be designed to resist a minimum earthquake force.

Based on the borehole overburden and bedrock results, and in absence of geophysical seismic survey in accordance with Table 4.1.8.4.A of the 2012 National Building Code of Canada, this Site can be classified as Site Class "C".

Knowing that the structures will have two to three levels of underground parking and will likely be founded on or within bedrock, a Site Class A or B may be able to be provided but will require to carry out a geophysical field testing. It is therefore recommended to carry out geophysical field testing such as Multi-Channel Analysis of Surface Waves (MASW) during the detailed design phase.

5.6 Frost Protection

It is anticipated that foundations for the structure shall comprise piles and / or shallow foundations on bedrock. Where adequate drainage is provided or the depth of cover over the foundation is greater than 1.8 m detrimental frost action effects will be negligible.

Where foundations do not comply with the above, all exterior footings associated with either heated or unheated / isolated structures must be provided with a minimum of 1.5 m or 1.8 m of soil cover respectively (or its equivalent in insulation).

Common examples of unheated and isolated structures include signs, entrance canopies and piers.

5.7 Slab-on-Grade

A normal slab-on-grade, structurally separated from the columns and foundation walls, can be used for the lowest basement level floor slab of the buildings.

Note that the exposed surface at the slab level will be composed of shale bedrock. The exposed shale bedrock may swell and delaminate due to change in moisture conditions or as a result of frost which will ultimately require additional cleaning and prepping of the rock surface. We therefore recommend that the exposed rock surface be protected with a thin layer of lean concrete.

A layer consisting of Granular 'A' at least 150 mm thick should be placed immediately below the floor slabs to support the slab-on-grade and overlying a clear crushed stone drainage layer (see Section 6.8 below). This layer should be compacted to 100 percent of its SPMDD and placed on approved subgrade surfaces.

If floor coverings are to be used on slab-on-grades then, a vapour barrier is recommended to be incorporated beneath the slab and should be specified by the architect. Floor toppings may also be impacted by curing and moisture conditions of the concrete. Floor finish manufacturer's specifications and requirements should be consulted, and procedures outlined in the specifications should be followed.

All slabs should be structurally separated from all columns and foundation walls. Construction and control joints in the concrete should be designed by a suitably qualified and experienced engineer.

5.8 Hydrogeologic Conditions

The results of the preliminary hydrogeologic investigation have been used to estimate the amount short and long-term de-watering required during and post-construction. Dewatering estimates have been used to determine requirements for registration on the Environmental Activity and Sector Registry (EASR) and/or Permit-To-Take-Water (PTTW). The following subsections discuss the dewatering estimates.

5.8.1 Dewatering Calculations

For the purposes of estimating dewatering volumes for the proposed underground parking structures the following assumptions are made:

– The underground parking structure will cover the entire area of the Site (i.e., 0.43 hectares [ha])
– An excavation of 10 mBGS will be required for construction. This includes 3 levels of underground parking with a height of 3 m on each level. An addition metre has been added to the total excavation depth to be conservative
– It is interpreted that a minimal contribution to groundwater seepage in the excavations will occur from the unsaturated fill materials.

The equation for construction dewatering rate of a shaft in an unconfined aquifer (i.e., the overburden) [Canadian Geotechnical Society/Southern Ontario Section - Toronto Group, International Association of Hydrogeologists/ Canadian National Chapter (CGS), 2013], presented below, is applied to estimate construction dewatering in the overburden.

$$Q=\frac{\pi K_h(H^2-h^2)}{\ln\left(\frac{R_0}{r_w}\right)} \qquad \text{Equation 6-1}$$

Where:

– Q | is pumping rate in units of cubic metres/day (m^3/day)
– Ln | is the natural logarithm
– K_h | is the hydraulic conductivity, as defined in Section 3.3, in metres per day
– H | is the height of groundwater pressure at the trench or shaft in meters above a relevant datum
– H | is the height of groundwater near the shaft in meters following dewatering activities and is referenced to a relevant datum
– R_0 | is the zero drawdown distance, or zone of influence (ZOI)
– r_w | the equivalent radius of the shaft and is estimated in Equation 6.2, below

$$r_w = \sqrt{\frac{ab}{\pi}} \qquad \text{Equation 6-2}$$

Where:

– a | is the length of the shaft

– b | is the width of the shaft

To estimate the radius to zero drawdown (R_0), representing the zone of influence (ZOI) near the trench and shafts GHD applied the empirical Sichardt relationship expressed as Equation 6-3, below.

$$R_0=3{,}000(H\text{-}h)\sqrt{K_h \times \frac{1\ \text{day}}{86{,}400\ \text{seconds}}} + r_w \qquad \text{Equation 6-3}$$

The height of the aquifer thickness, H, was measured based on static water levels measured in the monitoring wells and the maximum depth of the overburden.

The equation for construction dewatering rate of a shaft in a confined aquifer (i.e., the bedrock) [Canadian Geotechnical Society/Southern Ontario Section - Toronto Group, International Association of Hydrogeologists/ Canadian National Chapter (CGS), 2013], presented below, is applied to estimate construction dewatering.

$$Q=\frac{2\pi K_h B(H\text{-}h)}{\ln\left(\frac{R_0}{r_w}\right)} \qquad \text{Equation 6-4}$$

Where:

– B | is aquifer thickness
– r_w | the equivalent radius of the shaft and is estimated in Equation 6.2, above

5.8.1.1 Overburden Dewatering

Monitoring wells MW1-21, MW2-21, and MW6-21 represent overburden hydrogeologic conditions across the Site. The height of water that will need to be dewatered is equal to the saturated thickness of the overburden materials which is from the static water level to the depth of the overburden/bedrock interface.

A summary of the depths and corresponding elevations is provided in the table below:

Table 13 Overburden Dewatering Elevations and Depths

Well ID	Ground surface	Water Table Elevations (7/29/21)	Depth to Bedrock (Bedrock Surface)		Height of Water to be Dewatered
	(mAMSL)	(mAMSL)	(mAMSL)	(mBGS)	(m)
MW1-21	68.042	66.02	63.8	4.24	2.22
MW2-21	68.760	65.96	64.2	4.56	1.76
MW6-21	69.105	66.58	64.2	4.91	2.28

Notes:
(1) - Water table elevations from July 29, 2021, are slightly higher than July 26, 2021 and have been used above. Thus, providing a conservative measure

As shown above, the location requiring the greatest depth of dewatering is in the vicinity of MW6-21. Overburden in this area will require dewatering of slightly less than 2.3 m of saturated thickness. An additional 1 m below this depth should be included to provide a conservative approach. Thus, the thickness of saturated overburden requiring dewatering has been assumed to be 3.3 m. This approach provides a conservative (high) estimation of the volume of water expected to enter the overburden excavation.

The following inputs were used to estimate the dewatering for the overburden:

K_h = 2.4 × 10^{-4} cm/sec (2.4 × 10^{-6} m/sec) (Overburden geometric mean value)
H = 3.3 m (height of water table + 1 m)
h_w = 0 m dewatering height (relative to 1 m below base of excavation)
r_w = 36.7 m
a = 65 m and b = 65 m (Assumed excavation width is 0.43 ha [65 m x 65 m] which includes the entire Site)

The above equation assumes that construction will require the entire Site to be excavated simultaneously. Thus, the area of excavation has been set to the Site area, 0.43 ha.

Based on the conservative inputs above, the dewatering needed for the overburden is 20.4 m^3/day (20,400 Litre/day).

The estimated dewatering volumes only account for groundwater inflow into the excavation and do not account for any surface water accumulation from precipitation, snow melt, or any other overland flow source (runoff). The estimate also assumes that the depth to water measurements is representative. Static water levels may fluctuate throughout the year due to seasonal changes.

A safety factor of 3X is applied to the estimated steady state groundwater seepage rate to account for lowering groundwater levels quickly to the base of the excavations, as may be needed. Thus, a conservative dewatering rate of 61.2 m^3/day (61,200 L/day) is estimated.

5.8.1.2 Bedrock Dewatering

Following a similar approach, dewatering can be estimated for the bedrock excavation required to construct three levels of underground parking (to a depth of 10m).

Monitoring wells MW3-21, MW4-21, MW5-21, MW7-21 represent bedrock groundwater conditions across the Site. Dewatering in the overburden has been accounted for in the previous section, thus, the height of water that will need to be dewatered is equal to the height of groundwater pressure measured in the bedrock wells to the maximum depth of excavation (i.e., to 10 mBGS).

A summary of the depths and corresponding elevations is provided in the table below:

Table 14 Bedrock Dewatering Elevations and Depths

Well ID	Ground surface	Depth to Accommodate Parking Structure (to 10 mBGS)	Static Water Level Pressure (7/29/21)	Height of groundwater pressure in bedrock
	(mAMSL)	(mAMSL)	(mAMSL)	(m)
MW3-21	68.741	58.741	65.97	7.2
MW4-21	68.102	58.102	65.82	7.7
MW5-21	68.536	58.536	66.09	7.6
MW7-21	69.325	59.325	65.90	6.6

Notes:
(1) – height of groundwater pressure = static water level pressure – depth to accommodate parking structure
(2) - Water table elevations from July 29, 2021, are slightly higher than July 26, 2021 and have been used above. Thus, providing a conservative measure

As shown above, the location requiring the greatest depth of dewatering in the bedrock is in the vicinity of MW-4-21. In order to facilitate a three-story underground parking structure, the height of water that will need to be dewatered during excavation will be 7.7 m. As previously mentioned, the excavation depth of 10 m is inclusive of an additional one metre as a factor of safety. Thus, the height of groundwater pressure is a conservative estimate. This approach provides a conservative (high) estimation of the volume of water expected to enter the bedrock excavation.

The following inputs were used to estimate the dewatering for the bedrock:

$K_h = 4.0 \times 10^{-5}$ cm/sec (4.0×10^{-7} m/sec) (Bedrock Geometric mean)
H = 7.7 m height of bedrock excavation required
$h_w = 0$ m dewatering height (relative to 1 m below base of excavation)
$r_w = 26.5$ m
a = 65 m and b = 65 m (Assumed excavation width is 0.43 ha [65 m x 65 m] which includes the entire Site)

The above equation assumes that construction will require the entire Site to be excavated simultaneously. Thus, the area of excavation has been set to the Site area, 0.43 ha.

Based on the inputs above, the dewatering needed for the bedrock is 22.5 m^3/day (22,500 L/day).

Applying a safety factor of 3X to the estimated steady state groundwater seepage rate to account for lowering groundwater levels quickly to the base of the excavations, as may be needed. Thus, a conservative dewatering rate of 67.5 m^3/day (67,500 L/day).

5.8.1.3 Combined Construction Dewatering

Combining the dewatering estimates from the overburden and bedrock to facilitate a three-storey, 10 m deep, underground parking structure results in a dewatering rate of 128.7 m^3/day (128,700 L/day) (61.2 m^3/day in the overburden and 67.5 m^3/day in the bedrock).

This is inclusive of conservative saturated thicknesses in the overburden and bedrock as well as a 3X factor of safety to account for quickly lowering groundwater levels to the base of excavation.

This, conservative, construction dewatering rate is greater than 50,000 L/day and less than 400,000 L/day. As outlined in Ontario Regulation 63/16 this volume of daily dewatering will need to be registered with the MECP Environmental Activity and Sector Registry (EASR) prior to beginning construction excavation.

5.8.1.4 Long-term Dewatering

In order to ensure the underground parking structure is not flooded following construction, long-term groundwater control will be required. The assumptions incorporated into the construction dewatering calculations are likely overly conservative for a long-term dewatering scenario. In particular, the 3X factor of safety to account for higher dewatering rates during the initial stages of excavation is not necessary in the scenario of long-term dewatering. Accordingly, long-term dewatering rates are likely to be much lower than those observed during construction.

Given the above it is still prudent to include a factor of safety to account for variability in water recharge and the limitation of SWRTs in representing subsurface character over a larger area. Using a safety factor of 2X results in an anticipated long-term dewatering rate 85.8 m^3/day (85,800 L/day) (40.8 m^3/day in the overburden and 45 m^3/day in the bedrock). The long-term dewatering will require a PTTW.

It is recommended that measurements of stable dewatering rates are recorded during construction activities in order to provide additional insight into the anticipated long-term dewatering requirements for the proposed underground parking structure.

5.8.2 Preliminary Water Quality

A comparison of the environmental groundwater quality samples collected as part of the PhaseTwo ESA to the PWQOs shows many exceedances of dissolved metals and several PAH compounds. Based on these results groundwater quality during excavation is unlikely to meet the criteria for direct discharge to surface (i.e., will not meet the PWQOs). Water treatment, to the level that meets PWQOs, would likely be cost-prohibitive due to the potential volumes of dewatering and concentrations.

As an alternative, it may be more practical to dispose of the water under Hazardous Waste Information Network (HWIN) procedures or to the sanitary sewer. In order to discharge to the sanitary sewer, discharge water may need additional characterization. Water quality results will need to show compliance with local sewer-use bylaws. Some preliminary treatment may be required to ensure water quality meets the appropriate sewer use criteria. In addition, a discharge permit may need to be obtained from the municipality in order to discharge to the sanitary sewer.

5.8.3 Summary

Given the estimated daily dewatering required to facilitate the construction of the underground parking structure, it is recommended that the construction project be registered with the EASR prior to beginning the project. The EASR registry will need to be completed by a Qualified Person (QP). It should be noted that the dewatering estimates described above represent a conservative, high, total flow rates. Actual dewatering is likely to be lower. It should also be noted that the dewatering rates can be limited if the area of excavation can be limited. Including a factor of safety will result in a long-term dewatering rate that will required a PTTW. Similar to the EASR, obtaining a PTTW will need to be completed by a QP.

Analytical results show that groundwater quality is unlikely to meet PWQO and cannot be directly discharged to the environment. Consideration should be given to discharging to the local sanitary sewer. Additional analysis and primary treatment may be required to demonstrate water quality meets local sewer-use discharge by-laws.

5.9 Permanent Drainage

5.9.1 Building

For long-term protection, it is recommended that a perimeter French Drain and vertical drainage system combined with a free-draining under-slab drainage system be installed for this project.

The exact drainage details will depend on the project excavation depth and retaining structure design retained for this project. For example, a rigid secant or slurry wall retaining system would significantly reduce the drainage and pumping requirement when compared to a permeable soldier pile and wood lagging system.

The exterior vertical drains should be connected to the slab under drainage system by means of conduits that carry the water inflows from the exterior through the base of the foundation walls or footings into the drainage system conduits below the lowermost basement slab. In any case, the drainage system should be designed to prevent mixing with the native deposit fine grain particles.

Additionally, any drain system should be provided with sufficient clean-outs to permit maintenance when required, leading to a positive outlet. The backfill material around the basement walls, if applicable, should consist of a free-draining granular material.

It is important to note that one of the objectives of the exterior drainage system is to eliminate any possible hydrostatic pressure by removal of the groundwater inflow accumulated around and under the structure. However, water tightness and dampness are also important factors that must not be neglected.

Groundwater may seep through the concrete elements through joints, cracks and construction defects, as well as by capillary action and in the form of water vapor. The need or not to prevent water infiltrations and to control moisture (dampness) are serviceability condition criteria. Depending on these criteria, it is the responsibility of the designer to make sure that the necessary protection against moisture and water infiltration is provided (water stops at construction joints, vapor barriers, waterproofing membranes or coatings, etc.).

GHD will be pleased to comment on these requirements once the project details are established.

5.9.2 Elevator Pits

Elevator pits, if present, should have drainage weepers and waterproofing design measures. If drainage weepers are not practical then the pits will need to be designed to resist hydraulic buoyancy pressures.

If elevator pistons are used, then the designers of these shafts and installations will need to also consider buoyancy issues. Installation of these will also need to consider groundwater control and buoyancy during installation.

5.10 Corrosion Potential of Soils

Analytical testing on one soil sample and one water sample was undertaken to assess the corrosion potential to buried concrete and steel structural elements. The test results are provided in Appendix D and summarized in Table 15.

Table 15 Corrosivity Test Results

Sample ID/Type	Depth Intervals (m)	Chlorides (% for Soil) (mg/L for Water)	Sulphates (% for Soil) (mg/L for Water)	pH	Resistivity (Ohm-cm)	Redox Potential (mV)
MW-5-21/ Water	-	399	97	8.05	455	353

Sample ID/Type	Depth Intervals (m)	Chlorides (% for Soil) (mg/L for Water)	Sulphates (% for Soil) (mg/L for Water)	pH	Resistivity (Ohm-cm)	Redox Potential (mV)
MW-5-21/ SS4	2.3 - 3.0	0.02	0.007	7.81	3110	268

Based on the results obtained for the sample submitted, the soil and groundwater at the site are considered to be corrosive to cast iron pipe.

A review of the analytical test results shows the sulphate content in the tested sample is less than 0.1 percent in soil sample and less than 150 mg/L in water sample. Based upon the test results and Table 3 of the Canadian Standards Association (CSA) document A23.1-04/A23.2-04 'Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete', the degree of exposure of the subsurface concrete structures to sulphate attack is low. Therefore, normal General Use (GU) hydraulic cement can be used for the below grade concrete structures.

5.11 General Recommendations

5.11.1 Site Inspections

We recommend that the rock surface at the footing level be verified to ensure that it is clean, free of loose fragments and has a slope of no more than 15 percent. All loose and weathered rock zones, and rock which is easily removed with a mechanical shovel, should be excavated in order to bear the foundations on solid bedrock.

It is recommended that all piling operations be controlled under full-time supervision by qualified geotechnical personnel.

The effects of vibrations caused by the pile driving operations, upon adjacent structures or services should be monitored and pre-construction surveys of existing defects within nearby structures should be carried out where necessary.

Finally, all of the backfilling operations should also be supervised to ensure that proper materials are employed and that full compaction is achieved.

5.11.2 Winter Conditions

The subsoils encountered across the Site are frost-susceptible and freezing conditions could cause problems to the structure. As preventive measures, the following recommendations are presented:

- During winter construction, exposed surfaces to support foundations must be protected against freezing by means of loose straw and tarpaulins, heating, etc.
- Care must be exercised so that the sidewalks and/or asphalt pavements do not interfere with the opening of doors during the winter when the soils are subject to frost heave. This problem may be minimised by any one of several means, such as keeping the doors well above outside grade, installing structural slabs at the doors, and by using well graded backfill and positive drainage, etc.
- Because of the frost heave potential of the soils during winter, it is recommended that the trenches for exterior underground services be excavated with shallow transition slopes in order to minimise the abrupt change in density between the granular backfill, which is relatively non-frost susceptible, and the more frost-susceptible native soils.

6. Scope and Limitations

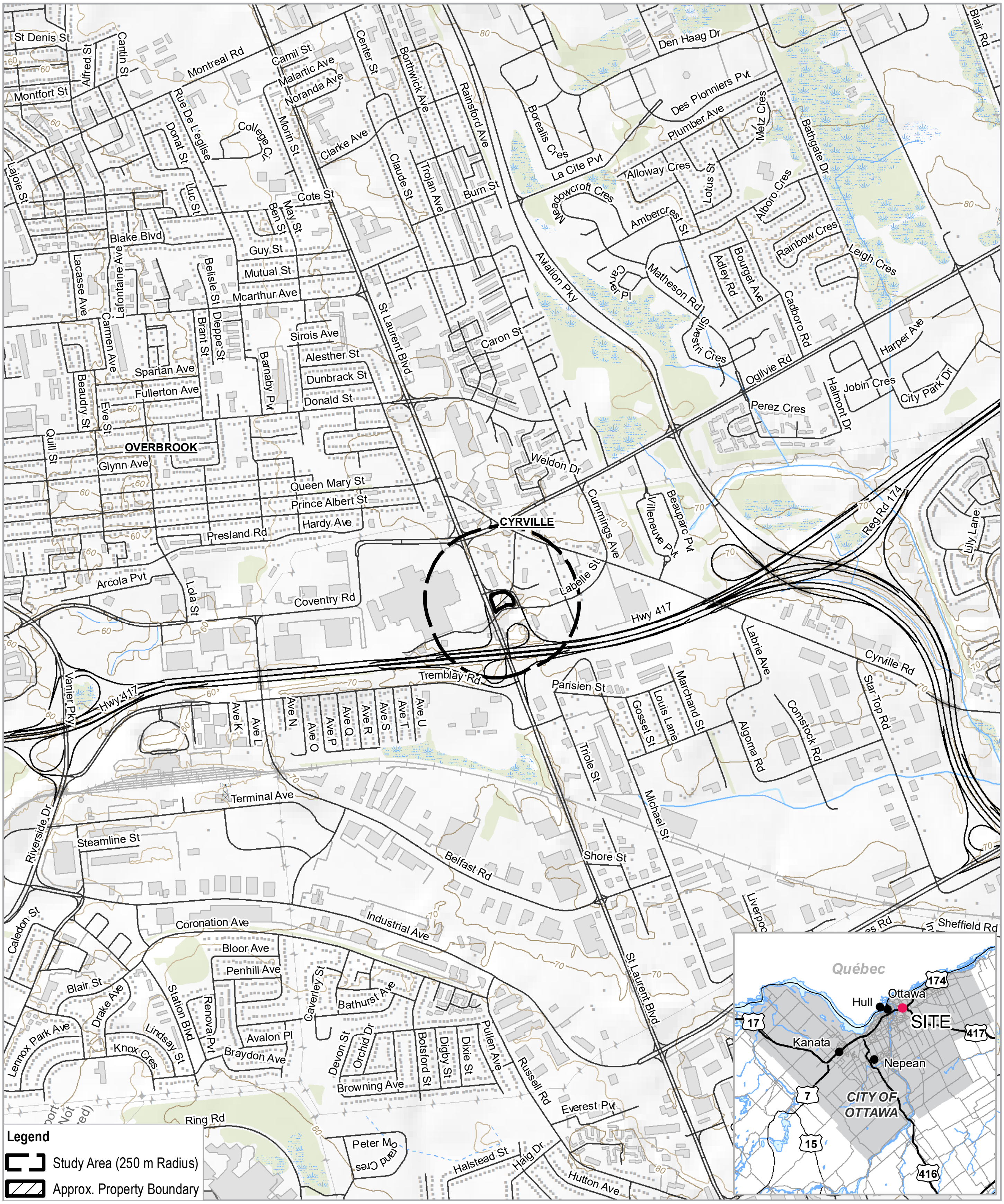
This report is intended solely for 1209 St. Laurent Limited Partnership, and is prohibited for use by others without GHD's prior written consent. This report is considered GHD's professional work product and shall remain the sole property of GHD. Any unauthorized reuse, redistribution of, or reliance on the report shall be at the Client and recipient's sole risk, without liability to GHD. The Client shall defend, indemnify, and hold GHD harmless from any liability arising from, or related to, the Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current Site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercises by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in this report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, GHD will not be liable for any misunderstanding of our recommendations of their application and adaptation into the final design. By issuing this report, GHD is the geotechnical engineer of record. It is recommended that GHD be retained during construction of all foundations and during earth-work operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the test locations only. The subsurface conditions confirmed at the test locations may vary at other locations. The subsurface conditions can also be significantly modified by the construction activities on Site (ex., excavation, dewatering and drainage, blasting, pile driving, etc.). These conditions can also be modified by exposure of soils or bedrock to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the Site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by GHD is completed.

Figures



Paper Size ANSI A

0 140 280 420 560

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 18N

N

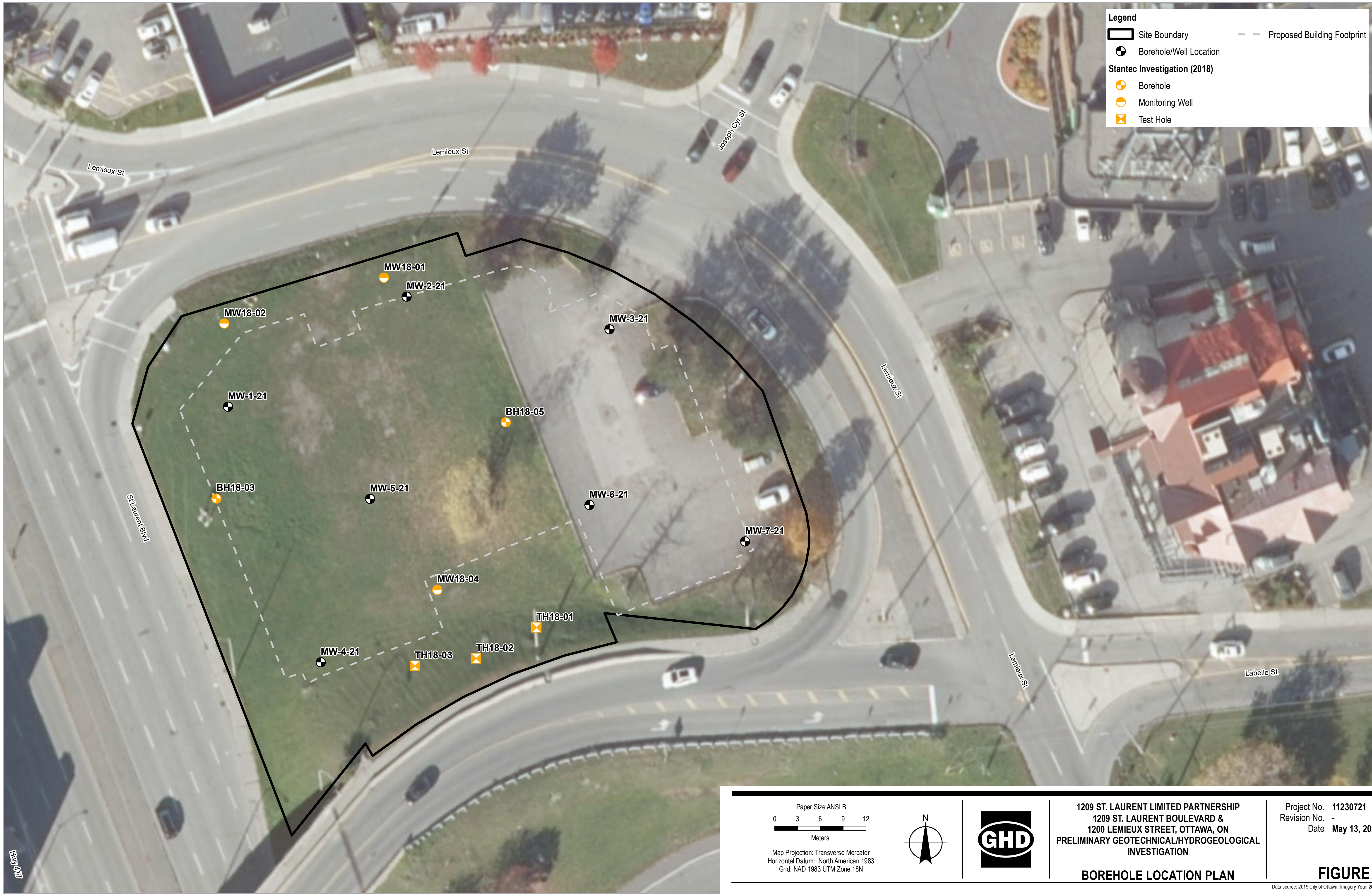
GHD

1209 ST. LAURENT LIMITED PARTNERSHIP
1209 ST. LAURENT BOULEVARD &
1200 LEMIEUX STREET, OTTAWA, ON
PRELIMINARY GEOTECHNICAL/HYDROGEOLOGICAL INVESTIGATION

Project No.	**11230721**
Revision No.	**-**
Date	**Aug 10, 2021**

SITE LOCATION PLAN

FIGURE 1



1209 ST. LAURENT LIMITED PARTNERSHIP
1209 ST. LAURENT BOULEVARD &
1200 LEMIEUX STREET, OTTAWA, ON
PRELIMINARY GEOTECHNICAL/HYDROGEOLOGICAL INVESTIGATION

BOREHOLE LOCATION PLAN

Project No. 11230721
Revision No. -
Date May 13, 2022

FIGURE 2

Data source: 2019 City of Ottawa, Imagery Year: 2019 .

Appendices

Appendix A

Record of Boreholes - Current Investigtion

BOREHOLE REPORT

Borehole No. MW-1-21

CLIENT: 1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT: PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION: 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY: J. SCOTT VERIFIED BY: S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450263.5
Y : 5030050.1
Z : 68.04

- WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.022

Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-14
Date (finish) : 2021-07-14

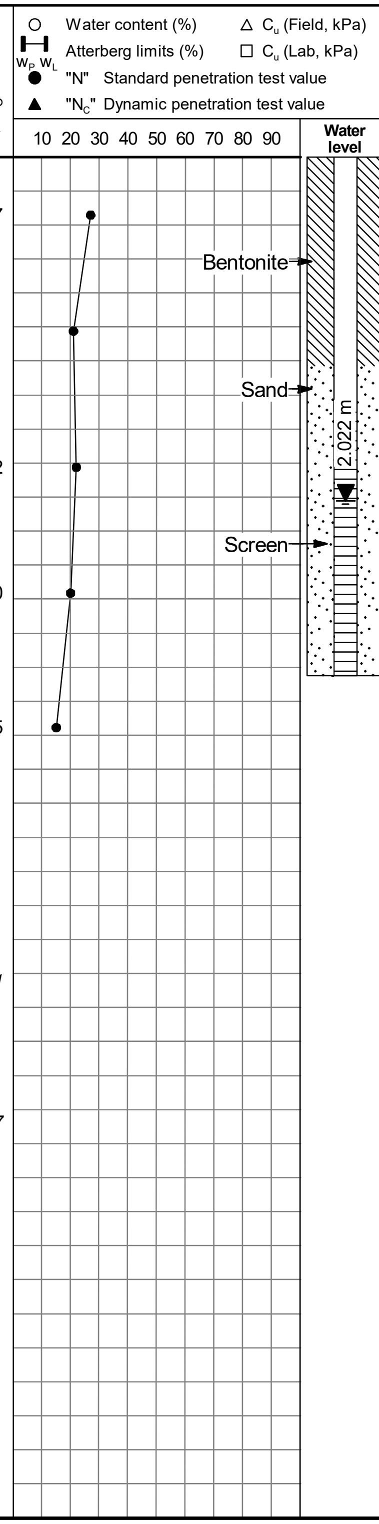
SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.04	Ground surface						
0.08	67.97	TOPSOIL	SS-1A			0.4		
0.18	67.86	FILL, Sandy GRAVEL, grey, moist, compact	SS-1B	75	GSA	0.5	2-13 14-21	27
		FILL, Silty SAND, some gravel, brown, moist, compact	SS-2A		CA	0.1		
0.91	67.13	SAND, trace silt, brown, moist, compact	SS-2B	54	CA	0	10-10 11-9	21
1.52	66.52	Clayey silty SAND (TILL), some gravel, dark brown, moist to wet, compact	SS-3	58		0.2	3-7-15-11	22
2.26	65.78	contains cobbles and boulders	SS-4	63		0.2	8-11-9-8	20
			SS-5	33		0.2	8-10-5-3	15
			SS-6	0			11 50/11cm	R
4.27	63.77	SHALE with limestone interbeds, slightly weathered to fresh, black with grey bands, fair quality; 4.75 m, vertical fracture	RC-1	94	UCS = 16.6 MPa			*51*
		5.44 m, becoming good quality	RC-2	100				*87*
5.92	62.12	End of borehole						



See the attached explicative note for the complete list of symbols and abbreviations

BOREHOLE REPORT

Borehole No. MW-2-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450287.0
Y : 5030064.5
Z : 68.76

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.802

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-14
Date (finish) :	2021-07-14

SAMPLE TYPE
- SS(E)- Split Spoon (Environment)
- RC(E)- Rock diamond core
- AU(E)- Auger
- TEE - Sampling Tube Environment
- ST - Shelby tube
- GS(E)- Grab sample

SAMPLE STATE
- Remoulded
- Intact
- Diamond drilling
- Lost

TEST SYMBOL
- GSA: grain size analysis
- CA: chemical analysis
- W_L: liquid limit
- W_P: plastic limit
- w : water content
- C_u: undrained shear strength
- S_T: sensitivity
- Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.76	Ground surface							
		TOPSOIL							
0.13	68.63	FILL, SAND and GRAVEL, trace silt, brown, moist, compact contains rootlets	Remoulded	SS-1	79		0.1	6-6-16-43	22
0.76	68.00	SAND, trace silt, brown, moist	Remoulded	SS-2	91	w CA	0	7-12 11-10	23
			Remoulded	SS-3	71	w	0	4-6-6-6	12
2.29	66.47	Silty SAND (TILL), some gravel and clay, moist to wet, dark grey, loose to compact	Remoulded	SS-4	54	CA	0	3-5-8-7	13
			Remoulded	SS-5	91	GSA W_L-W_P w	0	3-4-5-9	9
			Remoulded	SS-6	79		0	2-8-14-37	22
4.57	64.19	SHALE with limestone interbeds, highly weathered to fresh, black with grey bands, fair quality	Diamond drilling	RC-1	98				*51*
		5.44 m, clay seam 5.56 m, vertical fracture							
		6.20 m, vertical fracture	Diamond drilling	RC-2	100	UCS = 15.4 MPa			*44*
6.80	61.96	End of borehole							

Water level: Bentonite; Sand; Screen; 2.802 m

GHD

BOREHOLE REPORT

Borehole No. MW-3-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450313.6
Y : 5030060.2
Z : 68.74

- WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.77

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-16
Date (finish) :	2021-07-16

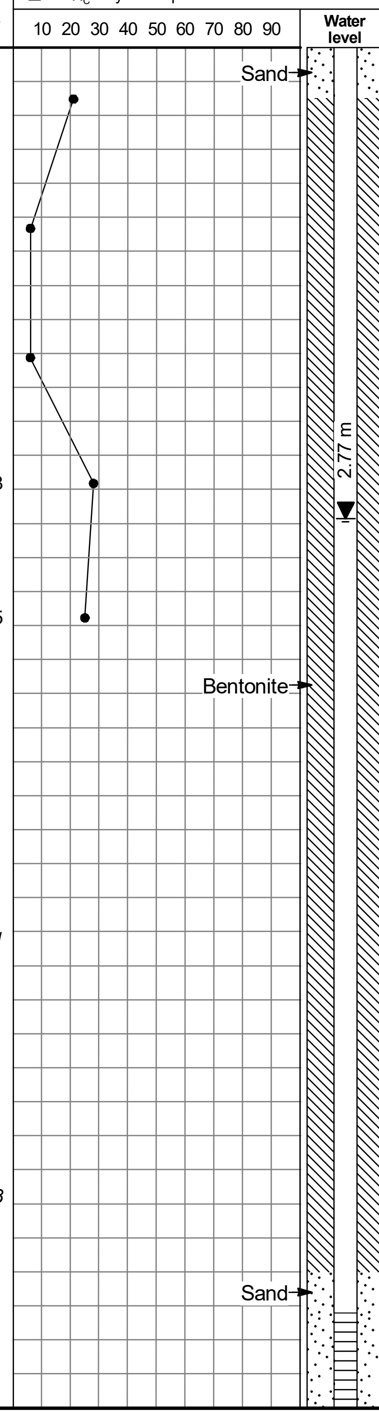
SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS
Water content (%) | C_u (Field, kPa)
Atterberg limits (%) W_P W_L | C_u (Lab, kPa)
"N" Standard penetration test value
"N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.74	Ground surface						
0.04	68.70	ASPHALT						
		FILL, SAND and GRAVEL, trace silt, grey, compact, moist	SS-1	41		7.7	15-15-6-9	21
0.86	67.88	FILL, Sandy SILT to silty SAND, grey, moist to wet, loose	SS-2A	75	CA	7.2	3-3-3-5	6
			SS-2B			6.3		
1.52	67.22	Clayey silt to silty CLAY (TILL), some gravel and sand, greenish-grey to brown, stiff	SS-3	38	GSA	0.5	1-3-3-6	6
2.29	66.45	Silty SAND (TILL), some gravel and clay, brown, compact to very dense Contains cobbles and boulders	SS-4	100		1.8	4-10 18-15	28
			SS-5	92		17.6	9-8-17-20	25
		Spoon refusal	SS-6	0			50	R
4.11	64.63	SHALE with limestone interbeds, highly weathered to fresh, dark grey thinly bedded, very poor quality 4.30 m, vertical fracture 4.50 m, becoming fair quality	RC-1	77				*0*
			RC-2	100				*71*
		6.00 m, becoming excellent to good quality	RC-3	100				*98*



See the attached explicative note for the complete list of symbols and abbreviations

BOREHOLE REPORT

Borehole No. MW-3-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	GEODETIC COORDINATES (MTM, NAD-83) (m)	- WATER LEVEL
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450313.6	Date : 2021-07-29
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	Y : 5030060.2	Depth (m) : 2.77
DESCRIBED BY:	J. SCOTT VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	Z : 68.74	Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-16
Date (finish) :	2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
☒ Remoulded
▨ Intact
◫ Diamond drilling
■ Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS
○ Water content (%)
△ C_u (Field, kPa)
W_P W_L Atterberg limits (%)
□ C_u (Lab, kPa)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD	Water level
8.00	60.74		Ground surface								
				■	RC-4	100	UCS = 13.5 MPa			88	
				■	RC-5	100				98	Screen
				■	RC-6	77				45	
12.01	56.73		End of borehole								

Depth scale: 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0
Tests results scale: 10 20 30 40 50 60 70 80 90

See the attached explicative note for the complete list of symbols and abbreviations

BOREHOLE REPORT

Borehole No. MW-4-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450275.7
Y : 5030016.5
Z : 68.10

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.278

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-15
Date (finish) :	2021-07-15

SAMPLE TYPE
- SS(E)- Split Spoon (Environment)
- RC(E)- Rock diamond core
- AU(E)- Auger
- TEE - Sampling Tube Environment
- ST - Shelby tube
- GS(E)- Grab sample

SAMPLE STATE
- Remoulded
- Intact
- Diamond drilling
- Lost

TEST SYMBOL
- GSA: grain size analysis
- CA: chemical analysis
- W_L: liquid limit
- W_P: plastic limit
- w : water content
- C_u: undrained shear strength
- S_T: sensitivity
- Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); W_P W_L Atterberg limits (%); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value; △ C_u (Field, kPa); □ C_u (Lab, kPa)

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.10	Ground surface						
		TOPSOIL						
0.10	68.00	FILL, Gravelly SAND, some silt, brown, dry, compact	SS-1	58	CA	0	1-4-9-24	13
			SS-2	0			10-8-7-18	15
1.52	66.58	FILL, Silty CLAY, some sand, trace gravel, brown, moist, stiff	SS-3	92	w	0.1	12-12 13-24	25
2.29	65.81	Clayey silty SAND (TILL), some gravel, dark brown, moist, compact	SS-4	79		0.1	7-7-6-8	13
3.20	64.90	Silty SAND (TILL), trace gravel and clay, grey, wet, dense	SS-5	75	GSA	0.1	11-13 23-30	36
			SS-6	42	w	0.1	18-50/13cm	R
			SS-7	0			50/13cm	R
5.99	62.11	Highly weathered, fractured SHALE						
7.44	60.66	SHALE with limestone interbeds, weathered to fresh, dark grey to black bands, fair quality 7.77 m, clay seam	RC-1	100				0

Water level: 2.278 m; Bentonite; Sand

Graph scale: 10 20 30 40 50 60 70 80 90

Depth scale: 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0

BOREHOLE REPORT

Borehole No. MW-4-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	GEODETIC COORDINATES (MTM, NAD-83) (m)	- WATER LEVEL
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450275.7	Date : 2021-07-29
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	Y : 5030016.5	Depth (m) : 2.278
DESCRIBED BY:	J. SCOTT VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	Z : 68.10	Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-15
Date (finish) :	2021-07-15

SAMPLE TYPE
- SS(E)- Split Spoon (Environment)
- RC(E)- Rock diamond core
- AU(E)- Auger
- TEE - Sampling Tube Environment
- ST - Shelby tube
- GS(E)- Grab sample

SAMPLE STATE
- Remoulded
- Intact
- Diamond drilling
- Lost

TEST SYMBOL
- GSA: grain size analysis
- CA: chemical analysis
- W_L: liquid limit
- W_P: plastic limit
- w : water content
- C_u: undrained shear strength
- S_T: sensitivity
- Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD	10 20 30 40 50 60 70 80 90	Water level
8.00	60.10		Ground surface									
					RC-2	100				78		
					RC-3	100				64		Screen
			10.49 m, becoming good to excellent quality									
					RC-4	100	UCS = 17.7 MPa			90		
12.07	56.03		End of borehole									

Depth scale: 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

BOREHOLE REPORT

Borehole No. MW-5-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450282.2
Y : 5030037.9
Z : 68.54

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.444

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-15
Date (finish) :	2021-07-15

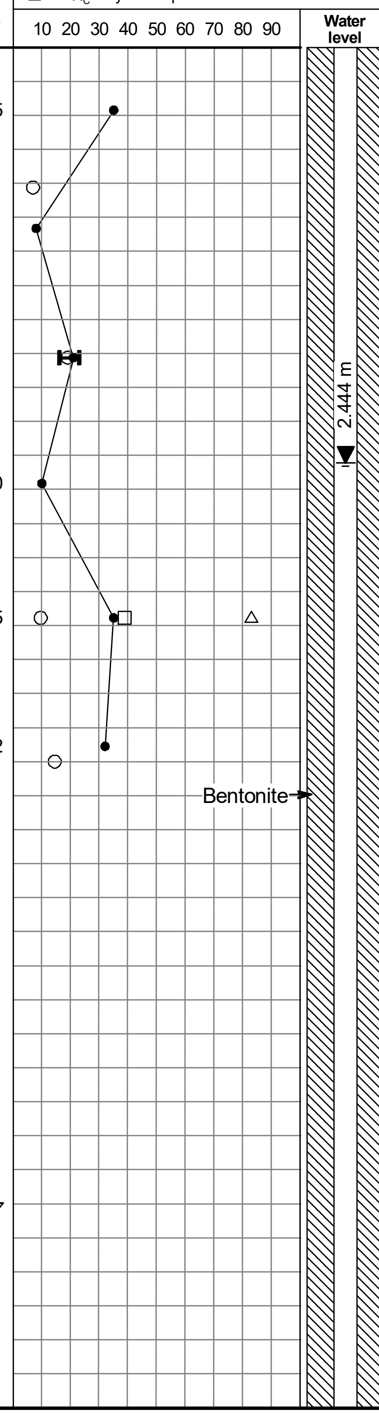
SAMPLE TYPE
SS(E) - Split Spoon (Environment)
RC(E) - Rock diamond core
AU(E) - Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E) - Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	68.54	Ground surface						
		TOPSOIL						
0.13	68.41	FILL, SAND and GRAVEL, trace silt, grey, moist	SS-1A	96		0	5-21	35
0.41	68.13	FILL, Silty SAND, trace gravel, brown, moist	SS-1B		CA	0	14-11	
			SS-2A		w	0		
0.89	67.65	Clayey SILT, trace sand and gavel, dark grey, moist, firm	SS-2B	75	CA	0	4-3-5-4	8
		1.52 m, becoming very stiff and wet	SS-3	79	W_L-W_P w	0	3-9-12-7	21
2.29	66.25	Silty CLAY (TILL), some sand and gravel, brown to grey, moist, stiff to very stiff. Contains cobbles and boulders	SS-4	96		0	5-5-5-6	10
			SS-5	100	w	0	4-13 22-6	35
			SS-6A			0		
3.99	64.55	Silty SAND (TILL), some gravel, dark grey, wet, dense. Contains cobbles and boulders	SS-6B	92	w	0	7-10 22-15	32
			SS-7	54		0	--	
5.18	63.36	SHALE with limestone interbeds, weathered to fresh, dark grey thinly bedded, very poor quality	RC-1	74				*0*
		6.07 m, clay seam						
		6.80 m, vertical fracture	RC-2	100				*47*

TESTS RESULTS
○ Water content (%) △ C_u (Field, kPa)
W_P W_L Atterberg limits (%) □ C_u (Lab, kPa)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value



BOREHOLE REPORT

Borehole No. MW-5-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450282.2
Y : 5030037.9
Z : 68.54

- WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.444

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-15
Date (finish) :	2021-07-15

SAMPLE TYPE
- SS(E)- Split Spoon (Environment)
- RC(E)- Rock diamond core
- AU(E)- Auger
- TEE - Sampling Tube Environment
- ST - Shelby tube
- GS(E)- Grab sample

SAMPLE STATE
- ☒ Remoulded
- ▨ Intact
- ◫ Diamond drilling
- ■ Lost

TEST SYMBOL
- GSA: grain size analysis
- CA: chemical analysis
- W_L: liquid limit
- W_P: plastic limit
- w : water content
- C_u: undrained shear strength
- S_T: sensitivity
- Dup: duplicate sample

TESTS RESULTS
- ○ Water content (%)
- W_P W_L Atterberg limits (%)
- ● "N" Standard penetration test value
- ▲ "N_C" Dynamic penetration test value
- △ C_u (Field, kPa)
- □ C_u (Lab, kPa)

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
8.00	60.54	Ground surface						
			RC-3	100				75
			RC-4	100	UCS = 16.7 MPa			48
		9.85 m, clay seam						
			RC-5	100				76
12.14	56.40	End of borehole						

Depth scale: 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

Tests results scale: 10 20 30 40 50 60 70 80 90

Water level: Sand, Screen

See the attached explicative note for the complete list of symbols and abbreviations

BOREHOLE REPORT

Borehole No. MW-6-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450311.0
Y : 5030037.1
Z : 69.11

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 2.523

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-16
Date (finish) :	2021-07-16

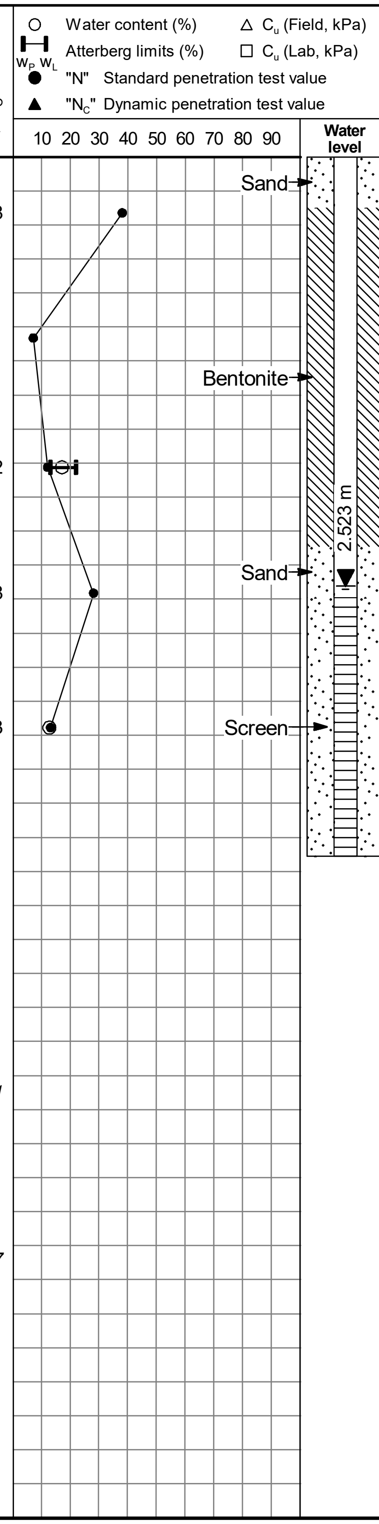
SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

STRATIGRAPHY / SAMPLE / TESTS RESULTS

Depth (m)	Elevation (m)	Description	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
0.00	69.11	Ground surface						
0.05	69.06	ASPHALT						
		FILL, SAND and GRAVEL, grey, dry, dense	SS-1	20		3	4-16 22-29	38
			SS-2	29	CA	10.3	2-3-4-4	7
1.52	67.59	Silty CLAY (TILL), trace gravel, brown, moist, stiff	SS-3	71	W_L-W_P w	3.4	4-4-8-10	12
1.83	67.28	SAND and GRAVEL (TILL), grey, moist to wet, compact						
			SS-4	92	CA	8.7	33-21-7-6	28
3.05	66.06	Clayey silty SAND (TILL), grey, moist to wet, compact	SS-5	83	w	4.8	5-5-8-3	13
3.81	65.30	SAND and GRAVEL (TILL), grey, wet, dense to very dense	SS-6	33		5.9	21 50/13cm	R
4.95	64.16	SHALE with limestone interbeds, thinly bedded, highly weathered to fresh, black with grey bands, fair quality	RC-1	100	UCS = 15.5 MPa			*51*
		6.17 m, becoming excellent quality	RC-2	97				*97*
6.91	62.20	End of borehole						



BOREHOLE REPORT

Borehole No. MW-7-21

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO
DESCRIBED BY:	J. SCOTT
VERIFIED BY:	S. SOLEIMANI/ A. FIORILLI

GEODETIC COORDINATES (MTM, NAD-83) (m)
X : 450331.5
Y : 5030032.3
Z : 69.33

▼ - WATER LEVEL
Date : 2021-07-29
Depth (m) : 3.421

Location plan :

Borehole type :	Auger 200mm
Core bit size :	
Hammer type :	
Energy ratio :	
Date (start) :	2021-07-16
Date (finish) :	2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend:
○ Water content (%)
△ C_u (Field, kPa)
W_P W_L Atterberg limits (%)
□ C_u (Lab, kPa)
● "N" Standard penetration test value
▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Description
0.00	69.33	Ground surface
0.05	69.28	ASPHALT
		FILL, Gravelly SAND, trace silt, grey, dry, compact
1.52	67.81	Clayey silty SAND (TILL), trace gravel, brown, moist, firm
2.29	67.04	Sandy SILT (TILL), some clay, trace gravel, grey, wet, stiff
4.06	65.27	SAND and GRAVEL (TILL), some clay, grey, wet, saturated
4.57	64.76	SHALE with limestone interbeds, thinly bedded, moderately weathered to fresh, black with grey bands, poor quality
		6.10 m, becoming fair quality

Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD
SS-1	33		3	3-10 11-10	21
SS-2	0			4-2-2-6	4
SS-3	95		0.9	2-2-3-5	5
SS-4	92	CA	2.7	5-6-9-8	15
SS-5	50	GSA W_L-W_P w	1.3	3-2-1-8	3
SS-6	0			8-8 50/10cm	R
RC-1	100				42
RC-2	100				70

Water level: Sand; Bentonite; 3.421 m

BOREHOLE REPORT

Borehole No. **MW-7-21**

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	GEODETIC COORDINATES (MTM, NAD-83) (m)	- WATER LEVEL
PROJECT:	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION	X : 450331.5	Date : 2021-07-29
LOCATION:	1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	Y : 5030032.3	Depth (m) : 3.421
DESCRIBED BY:	J. SCOTT — VERIFIED BY: S. SOLEIMANI/ A. FIORILLI	Z : 69.33	Location plan :

Borehole type : Auger 200mm
Core bit size :
Hammer type :
Energy ratio :
Date (start) : 2021-07-16
Date (finish) : 2021-07-16

SAMPLE TYPE
SS(E)- Split Spoon (Environment)
RC(E)- Rock diamond core
AU(E)- Auger
TEE - Sampling Tube Environment
ST - Shelby tube
GS(E)- Grab sample

SAMPLE STATE
Remoulded
Intact
Diamond drilling
Lost

TEST SYMBOL
GSA: grain size analysis
CA: chemical analysis
W_L: liquid limit
W_P: plastic limit
w : water content
C_u: undrained shear strength
S_T: sensitivity
Dup: duplicate sample

TESTS RESULTS legend: ○ Water content (%); △ C_u (Field, kPa); W_P W_L Atterberg limits (%); □ C_u (Lab, kPa); ● "N" Standard penetration test value; ▲ "N_C" Dynamic penetration test value

Depth (m)	Elevation (m)	Symbol	Description	State	Type and Number	Recovery %	Other tests	PID (ppm)	6 in / 15 cm Blow counts (sampler size)	N, N_C or RQD	Water level
8.00	61.33		Ground surface								
				Diamond drilling	RC-3	100				71	Sand
				Diamond drilling	RC-4	100				52	Screen
			10.5 m, becoming excellent quality	Diamond drilling	RC-5	100				95	
12.03	57.30		End of borehole								

Depth scale: 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

Tests results scale: 10 20 30 40 50 60 70 80 90

Appendix B

Record of Boreholes - Previous Investigations

Monitoring Well: MW18-01

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.56 m RTD
Number:	122170233	**Top of casing elevation:**	100.47 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030067
Contractor:	Strata Drilling Group	**Northing:**	450284

SUBSURFACE PROFILE

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
Ground Surface	100.56
SAND and GRAVEL (FILL)	100.56 / 0.00 – 100.03
SAND brown, medium grained, loose, dry	100.03 / 0.53 – 98.43
CLAY (TILL) dark brown, wet - damp	98.43 / 2.13 – 96.14
Refusal End of Borehole	96.14 / 4.42

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb	ppm TOV
1	DP	12"		<5	1.0
		n/a			
2		28"		<5	1.0
3	DP	17"		<5	<0.02
		n/a			
4		17"	PHC F1-F4, PAH, VOC	<5	1.0
5	DP	26"	Metals		
		n/a			
6		26"			

INSTALLATION DETAILS

- Flushmount protective cover with concrete seal
- 50 mm ID PVC pipe backfilled with bentonite
- Groundwater Level: 3.22 m BGS 20-Sep-18
- 50 mm ID slotted PVC pipe backfilled with silica sand

Screen Interval: 2.29 - 4.42 m BGS
Sand Pack Interval: 2.13 - 4.42 m BGS
Well Seal Interval: 0.23 - 2.13 m BGS

Notes:
m BGS - metres below ground surface
DP - direct push sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Monitoring Well: MW18-02

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	99.70 m RTD
Number:	122170233	**Top of casing elevation:**	99.56 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030061
Contractor:	Strata Drilling Group	**Northing:**	450263

SUBSURFACE PROFILE | SAMPLE DETAILS | INSTALLATION DETAILS

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb / ppm TOV	Installation Description
Ground Surface	99.70						
TOPSOIL with gravel	0.00 / 99.39						Flushmount protective cover with concrete seal
SILT brown, dry	0.30 / 99.16	1	DP	21"		<5 / 1.0	
CLAY (TILL) brown to dark brown, dry	0.53			n/a			
		2		21"	Metals	<5 / <0.02	50 mm ID PVC pipe backfilled with bentonite
							Groundwater Level: 1.81 m BGS 20-Sep-18
	97.56	3	DP	24"	PAH	<5 / 1.0	
SILTY CLAY light brown, dry	2.13			n/a			
	96.95	4		24"		<5 / 1.0	
CLAY (TILL) dark brown, wet	2.74						50 mm ID slotted PVC pipe backfilled with silica sand
		5	DP	n/a 30"	PHC F1-F4, VOC	<5 / 1.0	
	95.89						
Refusal End of Borehole	3.81						

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

%LEL Comb: 20 40 60 80; ppm: 200 400 600 800 (○ TOV, ● Comb)

Screen Interval: 2.29 - 3.81 m BGS
Sand Pack Interval: 1.98 - 3.81 m BGS
Well Seal Interval: 0.23 - 1.98 m BGS

Notes:
m BGS - metres below ground surface
DP - direct push sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

Borehole: BH18-03

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	99.61 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	5030038
Contractor:	Strata Drilling Group	**Northing:**	450262

SUBSURFACE PROFILE

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
Ground Surface	99.61
TOPSOIL with gravel	0.00
SAND brown, medium grained, loose, with clay lenses	99.31 0.30
CLAY (TILL) dark brown - 125 mm seam of sand - wet - with gravel	98.85 0.76
Refusal End of Borehole	95.50 4.11

SAMPLE DETAILS

Sample Number	Sample Type	Lab Analyses	%LEL Comb / ppm (Comb ● / TOV ○)
1	DP	pH	15 / 1.0
2	DP		10 / 1.0
3	DP	VOC	125 / 7.0
4	DP	PHC F1-F4	15 / 2.0
5	DP	Metals	20 / <0.02

INSTALLATION DETAILS

Diagram / Description: Backfilled with bentonite

Notes:
m BGS - metres below ground surface
DP - direct push sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

Monitoring Well: MW18-04

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.46 m RTD
Number:	122170233	**Top of casing elevation:**	100.35 m RTD
Field investigator:	C. Jolicoeur	**Easting:**	5030026
Contractor:	Strata Drilling Group	**Northing:**	450291

SUBSURFACE PROFILE / SAMPLE DETAILS / INSTALLATION DETAILS

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	Comb (ppm)	TOV (ppm)
Ground Surface	100.46						
SAND and GRAVEL (FILL)	0.00						
SAND brown, medium grained, dry	100.23 0.23	1	DP	20"		<5	<0.02
CLAY (TILL) dark brown	99.69 0.76	2	DP	20"	Metals	<5	<0.02
		3	DP	22"		85	<0.02
		4	DP	22"	PHC F1-F4, VOC	40	<0.02
		5	DP	n/a		110	<0.02
- wet		6	DP	n/a	PAH	145	<0.02
		7	DP	n/a 12"		145	<0.02
Refusal End of Borehole	95.58 4.88						

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

%LEL Comb▲ 20 40 60 80; ppm ○TOV ●Comb 200 400 600 800

Installation Details – Description:
- Flushmount protective cover with concrete seal
- 50 mm ID PVC pipe backfilled with bentonite
- Groundwater Level: 2.01 m BGS 20-Sep-18
- 50 mm ID slotted PVC pipe backfilled with silica sand

Screen Interval: 3.35 - 4.88 m BGS
Sand Pack Interval: 3.05 - 4.88 m BGS
Well Seal Interval: 0.23 - 3.05 m BGS

Notes:
m BGS - metres below ground surface
DP - direct push sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

STANTEC BOREHOLE AND WELL V2 122170233_BHLOGS.GPJ STANTEC - DATA TEMPLATE.GDT 11/2/18 MIFORD

Borehole: BH18-05

Project:	Phase II ESA	**Drilling method:**	Geoprobe 7822DT (Direct Push)
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	100.49 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	5030048
Contractor:	Strata Drilling Group	**Northing:**	450300

SUBSURFACE PROFILE

Stratigraphic Description	Elevation (m RTD) / Depth (m BGS)
Ground Surface	100.49
TOPSOIL with sand	0.00
CLAYEY SILT	100.03 / 0.46
SILT brown, dry	99.80 / 0.69
- moist	
CLAY (TILL) dark brown, dry	98.20 / 2.29
- wet	
- damp	
End of Borehole	95.92 / 4.57

SAMPLE DETAILS

Sample Number	Sample Type	Recovery	Lab Analyses	Comb (ppm)	TOV (ppm)
1	DP	13"		<5	<0.02
2	DP	13"		<5	<0.02
	DP	n/a			
3	DP	24"		55	<0.02
	DP	n/a			
4	DP	24"	Metals	25	<0.02
5	DP	30"	PHC F1-F4, VOC	185	<0.02
	DP	n/a			
6	DP	30"	PAH	5	<0.02

%LEL Comb▲ 20 40 60 80; ppm ○TOV ●Comb 200 400 600 800

INSTALLATION DETAILS

Diagram / Description: Backfilled with bentonite

Depth (ft): 2, 4, 6, 8, 10, 12, 14, 16; (m): 1, 2, 3, 4, 5

Notes:
m BGS - metres below ground surface
DP - direct push sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Drawn By/Checked By: M. Ford

Test Hole: TH18-1

Project:	Phase II ESA	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	101.74 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

SUBSURFACE PROFILE				SAMPLE DETAILS					INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80 / ppm ○TOV ● Comb 200 400 600 800	Diagram	Description
		Ground Surface	101.74							
		TOPSOIL	0.00							
			101.28							
		SAND (FILL) medium grained	0.46	1	HA	n/a	Metals, PHC F1-F4, PAH, VOC			Slough
			100.83							
		End of Borehole	0.91							

Depth scale (ft): 2, 4, 6, 8, 10, 12, 14, 16; (m): 1, 2, 3, 4, 5

Notes:
m BGS - metres below ground surface
HA - hand auger sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

Test Hole: TH18-2

Project:	Phase II ESA	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	101.96 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

SUBSURFACE PROFILE				SAMPLE DETAILS					INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80; ppm ○TOV ● Comb 200 400 600 800	Diagram	Description
		Ground Surface	101.96							
		TOPSOIL	0.00							
			101.50	1	HA	n/a	Metals, PHC F1 - F4, PAH, VOC			Slough
		SAND (FILL) medium grained	0.46							
			101.05							
		End of Borehole	0.91							

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

Notes:
m BGS - metres below ground surface
HA - hand auger sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

Test Hole: TH18-3

Project:	Phase II ESA	**Drilling method:**	Hand Auger
Client:	City of Ottawa	**Date started/completed:**	13-Sep-2018
Location:	1209 St. Laurent Boulevard, Ottawa, Ontario	**Ground surface elevation:**	102.07 m RTD
Number:	122170233	**Top of casing elevation:**	n/a
Field investigator:	C. Jolicoeur	**Easting:**	n/a
Contractor:	Stantec Consulting Ltd.	**Northing:**	n/a

SUBSURFACE PROFILE				SAMPLE DETAILS					INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m RTD) Depth (m BGS)	Sample Number	Sample Type	Recovery	Lab Analyses	%LEL Comb▲ 20 40 60 80 / ppm ○TOV ● Comb 200 400 600 800	Diagram	Description
		Ground Surface	102.07							
		TOPSOIL	101.61 0.00							
		SAND (FILL) medium grained	101.15 0.46	1	HA	n/a	Metals, PHC F1-F4. PAH, VOC			Slough
		End of Borehole	0.91							

Depth scale: (ft) 2, 4, 6, 8, 10, 12, 14, 16; (m) 1, 2, 3, 4, 5

Notes:
m BGS - metres below ground surface
HA - hand auger sample
ppm - parts per million by volume
n/a - not available
RTD - relative to datum
PHC F1-F4 - petroleum hydrocarbon fractions 1 to 4
VOC - volatile organic compounds
PAH - polycyclic aromatic hydrocarbons

Stantec

Drawn By/Checked By: M. Ford

Appendix C

Bedrock Core Photos

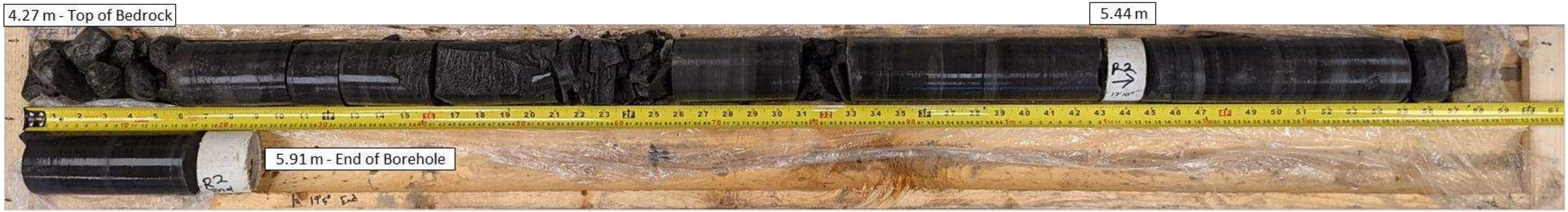
MW-1-21 (Dry)
Box 1 of 1

Run No.	Run Start/End (m)
1	4.27 - 5.44
2	5.44 - 5.91

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-1-21 (Wet)
Box 1 of 1

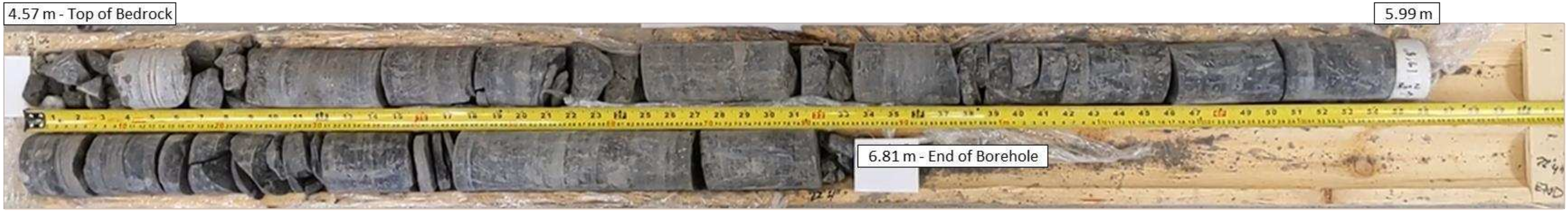
Run No.	Run Start/End (m)
1	4.27 - 5.44
2	5.44 - 5.91



Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-2-21 (Dry)
Box 1 of 1

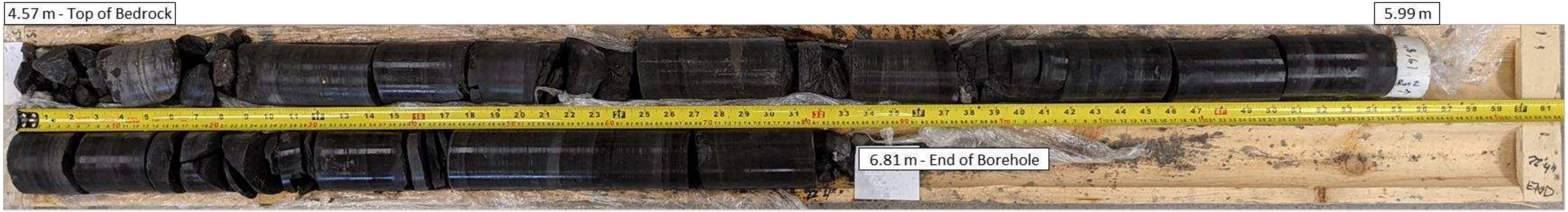
Run No.	Run Start/End (m)
1	4.57 - 5.99
2	5.99 - 6.81



Client :	1209 St. Laurent Limited Partnership
Project :	Preliminary Geotechnical and Hydrogeological Investigation
Reference Nº. :	11230721
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

MW-2-21 (Wet)
Box 1 of 1

Run No.	Run Start/End (m)
1	4.57 - 5.99
2	5.99 - 6.81



Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-3-21 (Dry)
Box 1 of 3

Run No.	Run Start/End (m)
1	4.11 - 4.50
2	4.50 - 5.99
3	5.99 - 6.91

4.11 m - Top of Bedrock
4.50 m

5.99 m
6.91 m

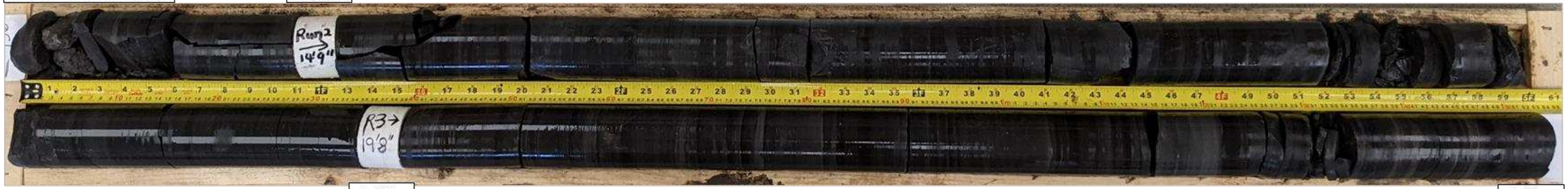
Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-3-21 (Wet)
Box 1 of 3

Run No.	Run Start/End (m)
1	4.11 - 4.50
2	4.50 - 5.99
3	5.99 - 6.91

4.11 m - Top of Bedrock

4.50 m



5.99 m

6.91 m

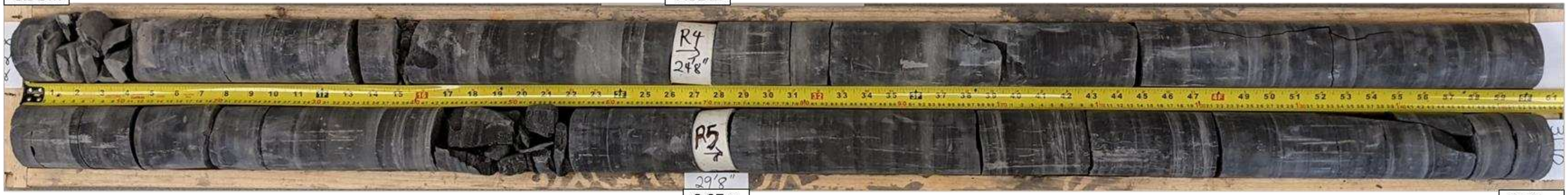
Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference No. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-3-21 (Dry)
Box 2 of 3

Run No.	Run Start/End (m)
3	6.91 - 7.52
4	7.52 - 8.97
5	8.97 - 9.70

6.91 m

7.52 m



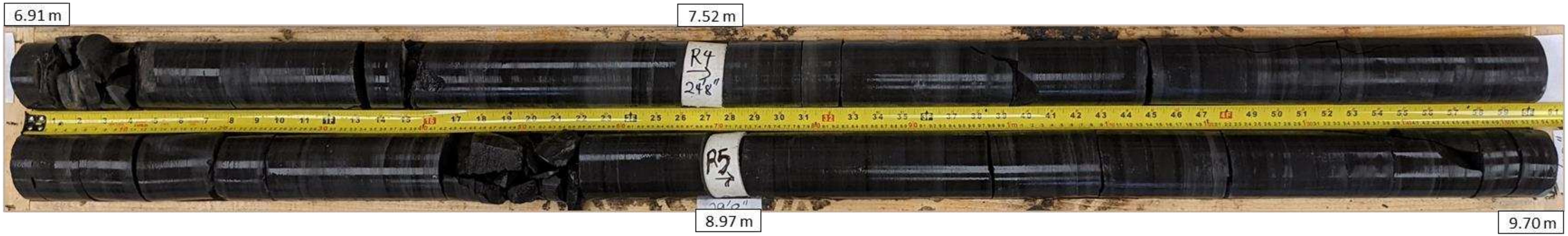
8.97 m

9.70 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference N^{o.} :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-3-21 (Wet)
Box 2 of 3

Run No.	Run Start/End (m)
3	6.91 - 7.52
4	7.52 - 8.97
5	8.97 - 9.70



Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

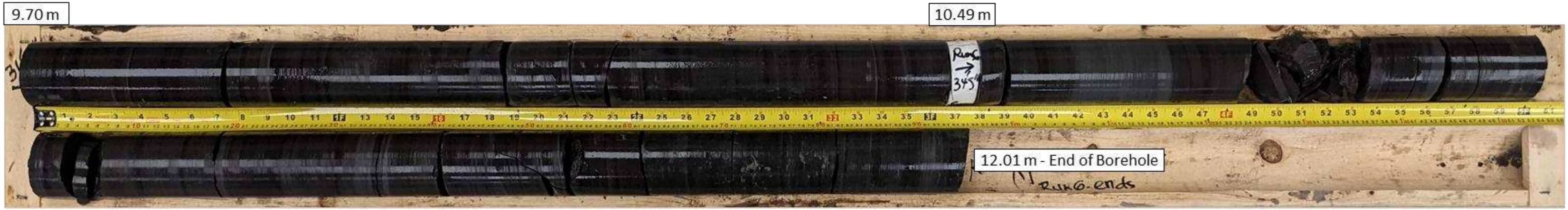
MW-3-21 (Dry)
Box 3 of 3

Run No.	Run Start/End (m)
5	9.70 - 10.49
6	10.49 - 12.01

Client :	1209 St. Laurent Limited Partnership
Project :	Preliminary Geotechnical and Hydrogeological Investigation
Reference Nº. :	11230721
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

MW-3-21 (Wet)
Box 3 of 3

Run No.	Run Start/End (m)
5	9.70 - 10.49
6	10.49 - 12.01



Client :	1209 St. Laurent Limited Partnership
Project :	Preliminary Geotechnical and Hydrogeological Investigation
Reference N°. :	11230721
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

MW-4-21 (Dry)
Box 1 of 2

Run No.	Run Start/End (m)
1	7.44 - 7.52
2	7.52 - 9.04
3	9.04 - 10.36

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-4-21 (Wet)
Box 1 of 2

Run No.	Run Start/End (m)
1	7.44 - 7.52
2	7.52 - 9.04
3	9.04 - 10.36

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference N°. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-4-21 (Dry)
Box 2 of 2

Run No.	Run Start/End (m)
3	10.36 - 10.80
4	10.08 - 12.07

Client :	1209 St. Laurent Limited Partnership
Project :	Preliminary Geotechnical and Hydrogeological Investigation
Reference No. :	11230721
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

MW-4-21 (Wet)
Box 2 of 2

Run No.	Run Start/End (m)
3	10.36 - 10.80
4	10.08 - 12.07

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-5-21 (Dry)
Box 1 of 3

Run No.	Run Start/End (m)
1	5.18 - 6.07
2	6.07 - 7.59
3	7.59 - 8.26

Client :	1209 St. Laurent Limited Partnership
Project :	Preliminary Geotechnical and Hydrogeological Investigation
Reference Nº. :	11230721
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

MW-5-21 (Wet)
Box 1 of 3

Run No.	Run Start/End (m)
1	5.18 - 6.07
2	6.07 - 7.59
3	7.59 - 8.26

5.18 m - Top of Bedrock

6.07 m

7.59 m

8.26 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

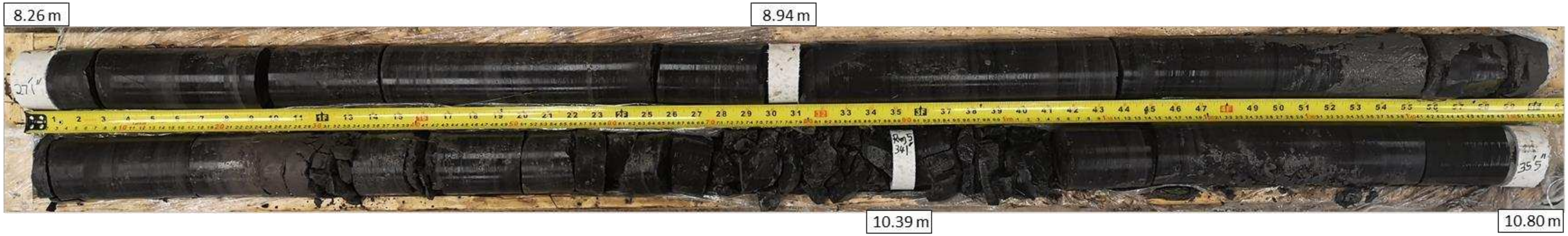
MW-5-21 (Dry)
Box 2 of 3

Run No.	Run Start/End (m)
3	8.26 - 8.94
4	8.94 - 10.39
5	10.39 - 10.80

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-5-21 (Wet)
Box 2 of 3

Run No.	Run Start/End (m)
3	8.26 - 8.94
4	8.94 - 10.39
5	10.39 - 10.80

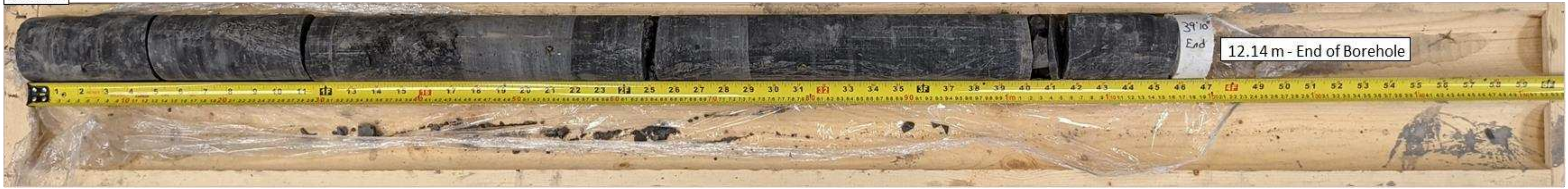


Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-5-21 (Dry)
Box 3 of 3

Run No.	Run Start/End (m)
5	10.80 - 12.14

10.80 m



Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference No. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-5-21 (Wet)
Box 3 of 3

Run No.	Run Start/End (m)
5	10.80 - 12.14

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-6-21 (Dry)
Box 1 of 1

Run No.	Run Start/End (m)
1	4.95 - 6.05
2	6.05 - 6.91

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference N°. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-6-21 (Wet)
Box 1 of 1

Run No.	Run Start/End (m)
1	4.95 - 6.05
2	6.05 - 6.91

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Dry)
Box 1 of 3

Run No.	Run Start/End (m)
1	4.57 - 6.10
2	6.10 - 7.47

4.57 m - Top of Bedrock

6.10 m

7.47 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Wet)
Box 1 of 3

Run No.	Run Start/End (m)
1	4.57 - 6.10
2	6.10 - 7.47

4.57 m - Top of Bedrock

6.10 m

7.47 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Dry)
Box 2 of 3

Run No.	Run Start/End (m)
3	7.47 - 8.99
4	8.99 - 10.21

7.47 m

8.99 m

10.21 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Wet)
Box 2 of 3

Run No.	Run Start/End (m)
3	7.47 - 8.99
4	8.99 - 10.21

7.47 m

8.99 m

10.21 m

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Dry)
Box 3 of 3

Run No.	Run Start/End (m)
4	10.21 - 10.51
5	10.51 - 12.04

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

MW-7-21 (Wet)
Box 3 of 3

Run No.	Run Start/End (m)
4	10.21 - 10.51
5	10.51 - 12.04

Client :	1209 St. Laurent Limited Partnership	**Prepared by :**	Kenneth O. Omenogor
Project :	Preliminary Geotechnical and Hydrogeological Investigation		
Reference Nº. :	11230721	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	1209 Saint Laurent Boulevard, Ottawa, Ontario | 1200 Lemieux Street, Ottawa, Ontario		

Appendix D

Geotechnical and Chemical Laboratory Test Results

Table D.1 Summary of Laboratory Test Results

Borehole ID	Sample No.	Depth (m)	Sample Composition	WC (%)	LL (%)	PL (%)	PI (%)	Grain Size Distribution				UCS (MPa)
								Gravel (%)	Sand (%)	Silt (%)	Clay (%)	
MW-1-21	SS1B	0.2 - 0,6	FILL, silty SAND, some gravel					13	64	23		
MW-1-21	Run 1	5.0 - 5.4	SHALE									16.6
MW-2-21	SS2	0.8 - 1.4	SAND, trace silt	2.3								
MW-2-21	SS3	1.5 - 2.1	SAND, trace silt	4.1								
MW-2-21	SS5	3.0 - 3.7	Silty SAND, some gravel and clay (TILL)	9	15.5	10	6	14	43	30	13	
MW-2-21	Run 2	6.2 - 6.7	SHALE									15.4
MW-3-21	SS4	2.3 - 2.9	Silty SAND, some gravel and clay (TIL)					18	43	39		
MW-3-21	Run 4	8.3 - 8.6	SHALE									13.5
MW-4-21	SS3	1.5 - 2.1	FILL, silty CLAY, some sand, trace gravel	13.4								
MW-4-21	SS5	3.2 - 3.7	Silty SAND, trace gravel and clay					6	64	30		
MW-4-21	SS6	4.0 - 4.6	Silty SAND, some gravel and clay (TIL)	8.2								
MW-4-21	Run 4	10.7 - 11	SHALE									17.7
MW-5-21	SS2A	0.8 - 0.9	FILL, silty SAND, trace gravel	6.9								
MW-5-21	SS3	1.5 - 2.1	Clayey SILT	19	23	16	7					
MW-5-21	SS5	3.0 - 3.7	Silty CLAY, some sand and gravel (TILL)	9.6								
MW-5-21	SS6B	4.0 - 4.4	Silty SAND, some gravel	14.5								
MW-5-21	Run 4	9 - 9.5	SHALE									16.7
MW-6-21	SS3	1.5 - 2.1	Silty CLAY, trace gravel (TILL)	17	22	13	9					
MW-6-21	SS5	3.0 - 3.7	Clayey silty SAND (TILL)	12.6								
MW-6-21	Run 1	5.7 -6.1	SHALE									15.5
MW-7-21	SS5	3.0 - 3.7	Sandy Silt, some clay, trace gravel (TILL)	15	18	11	7	7	33	47	13	

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client : 1209 St. Laurent Limited Partnership
Project N° : 11230721
Project : 1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On
Sample N° : MW-1-21
Depth : 14-17'
Sampling Date : July 14, 2021

Testing Apparatus Used : **Loading device N° 1** **Caliper N° 1**

Technical Data

				Average	
Diameter :	62.9	63.2	63.1	63.1	(mm)
Length :	121.6	121.3	121.4	121.4	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.1	0.1	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 995.2 (g) Volume: 379339 (mm^3)

Density : 2624 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

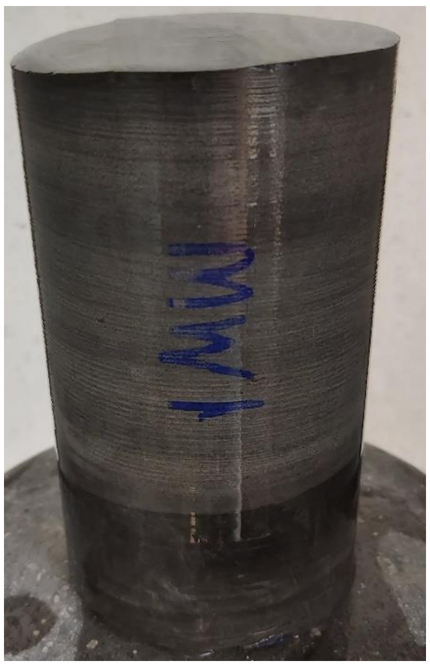
Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 51.98 ☑ kN ☐ lbs

Compressive Strength : 16.6 (MPa)

View of Specimen

Before Test :



After Test :

Remarks :

Analysed by : Z. Mathurin **Date :** August 4, 2021

Verified by : E. Bennett **Date :** August 4, 2021

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client : 1209 St. Laurent Limited Partnership
Project N° : 11230721

Project : 1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On
Sample N° : MW-2-21

Depth : 19-22'

Sampling Date : July 14, 2021

Testing Apparatus Used : **Loading device N° 1** **Caliper N° 1**

Technical Data

				Average	
Diameter :	63	63.2	63.1	63.1	(mm)
Length :	121.1	120.8	120.4	120.8	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.2	0.1	0.1	(mm)
Flatness (25μm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 986.6 (g) Volume: 377655 (mm^3)

Density : 2612 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 48.13 ☑ kN ☐ lbs

Compressive Strength : 15.4 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : Z. Mathurin **Date :** August 4, 2021

Verified by : E. Bennett **Date :** August 4, 2021

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client :	1209 St. Laurent Limited Partnership	**Project N° :**	11230721
Project :	1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On	**Sample N° :**	MW-3-21
		Depth :	24.8”-29’.5”
		Sampling Date :	July 14, 2021

Testing Apparatus Used : **Loading device N° 1** **Caliper N° 1**

Technical Data

				Average	
Diameter :	63.2	63.2	63.1	63.2	(mm)
Length :	104.6	104.8	104.3	104.6	(mm)

Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.1	0.1	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 867.1 (g) Volume: 327687 (mm^3)

Density : 2646 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 42.43 ☑ kN ☐ lbs

Compressive Strength : 13.5 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by :	Z. Mathurin	**Date :**	August 4, 2021
Verified by :	E. Bennett	**Date :**	August 4, 2021

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client :	1209 St. Laurent Limited Partnership	**Project N° :**	11230721
Project :	1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On	**Sample N° :**	MW-4-21
		Depth :	34'5"-39'7"
		Sampling Date :	July 14, 2021

Testing Apparatus Used : **Loading device N° 1** **Caliper N° 1**

Technical Data

				Average	
Diameter :	63.2	63.4	63.3	63.3	(mm)
Length :	105.8	105.9	106	105.9	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.1	0.1	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 873.1 (g) Volume: 333268 (mm^3)

Density : 2620 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

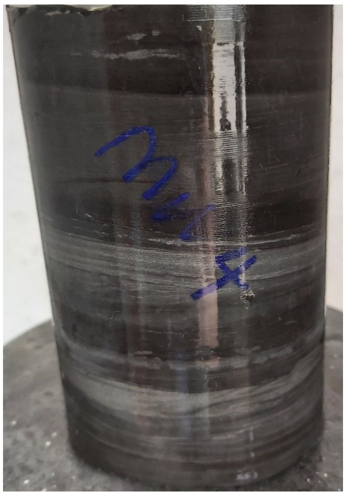
Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 55.77 ☑ kN ☐ lbs

Compressive Strength : 17.7 (MPa)

View of Specimen

Before Test :



After Test :

Remarks :

Analysed by :	Z. Mathurin	**Date :**	August 4, 2021
Verified by :	E. Bennett	**Date :**	August 4, 2021

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client : 1209 St. Laurent Limited Partnership
Project : 1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On

Project N° : 11230721
Sample N° : MW-5-21
Depth : 29'4"-31'1"
Sampling Date : July 14, 2021

Testing Apparatus Used : **Loading device N°** 1 **Caliper N°** 1

Technical Data

				Average	
Diameter :	63.2	63.1	63.1	63.1	(mm)
Length :	120.6	120.1	120.5	120.4	(mm)
Straightness (0.5mm maximum) (S1) :	0.2	0.1	0.2	0.2	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 990.9 (g) Volume: 376907 (mm^3)

Density : 2629 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 52.3 ☑ kN ☐ lbs

Compressive Strength : 16.7 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : Z. Mathurin **Date :** August 4, 2021

Verified by : E. Bennett **Date :** August 4, 2021

Unconfined Compressive Strength of Intact Rock Core Specimen
ASTM D 7012, ASTM D 4543

Client : 1209 St. Laurent Limited Partnership

Project : 1209 St. Laurent Blvd and 1200 Lemieux Street, Ottawa, On

Project N^{o} : 11230721

Sample N^{o} : MW-6-21

Depth : 16'3” to 19'10""

Sampling Date : July 14, 2021

Testing Apparatus Used : **Loading device N^{o}** 1 **Caliper N^{o}** 1

Technical Data

				Average	
Diameter :	63	63.2	63.1	63.1	(mm)
Length :	87.6	87.4	87.2	87.4	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.1	0.1	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	Ok	
Parallelism (0.25 ° maximum) (FP2) :	0.15	0.15	0.15	0.15	(°)

Mass : 709.6 (g) Volume: 273313 (mm^{3})

Density : 2596 (kg/m^{3})

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.75 (MPa/sec)

Type of Fracture : 3

Test Duration (2-15 Minutes) : 5 (minutes)

Maximum Applied Load : 48.43 ☑ kN ☐ lbs

Compressive Strength : 15.5 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

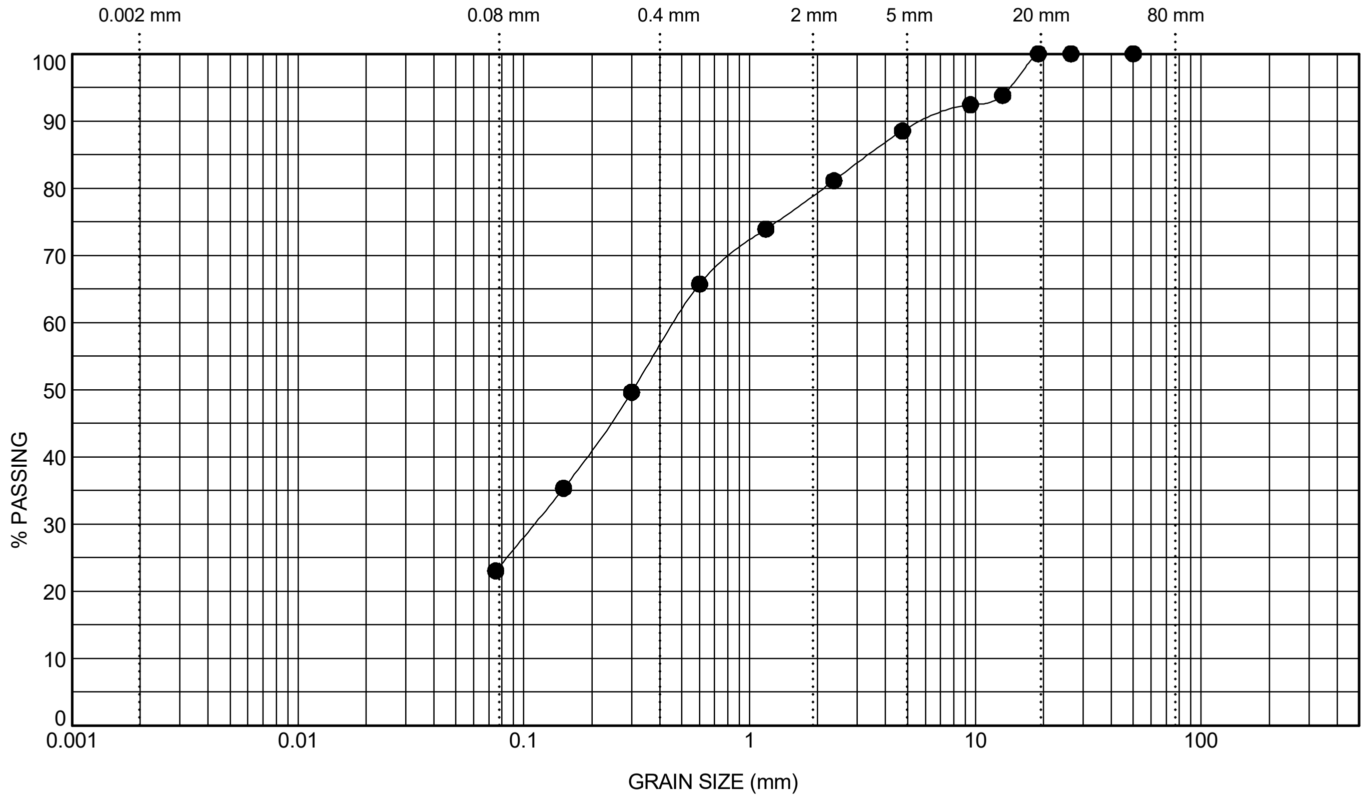
Analysed by : Z. Mathurin **Date :** August 4, 2021

Verified by : E. Bennett **Date :** August 4, 2021

GRAIN SIZE ANALYSIS REPORT

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	**REFERENCE No. :**	11230721-A1
PROJECT :	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION 1209 ST.	**BORING No. :**	MW-1-21
LOCATION :	LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	**SAMPLE No. :**	SS-1B
		DEPTH :	0.18 m **DATE :** 8/4/2021

UNIFIED SOIL CLASSIFICATION (BASED ON THE STANDARD LC 21-040)



CLAY	SILT	SAND			GRAVEL		COBBLES AND BOULDERS
		fine	medium	coarse	fine	coarse	

Description	**w (%)**	**W_L (%)**	**I_P (%)**	**Classification (1)**
Silty SAND, some gravel				

(1)

% Gravel	% Sand	% Silt and % Clay	c_U	c_C	D85	D60	D50	D30	D15	D10
11	65	23								

Remarks :

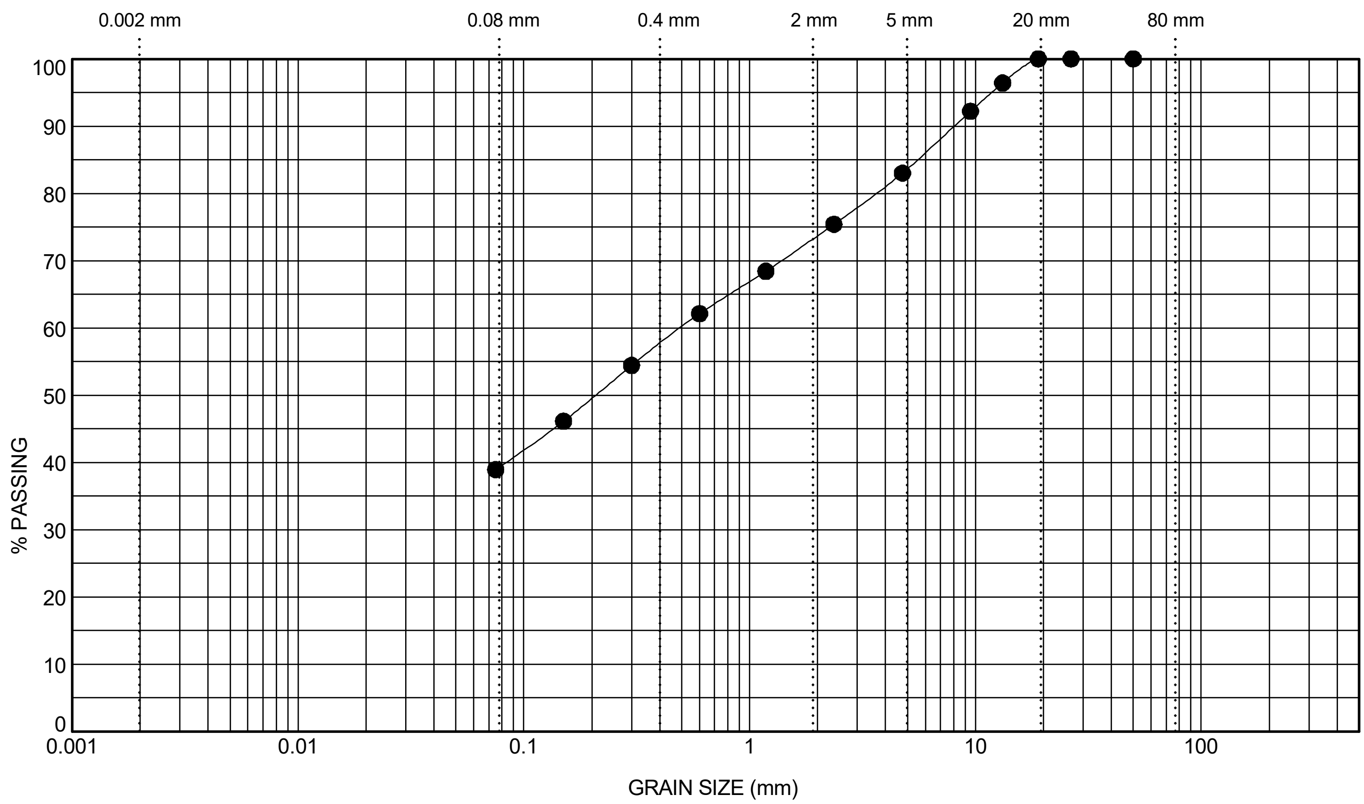
Prepared by : Z. Mathurin

Verified by : E. Bennett

GRAIN SIZE ANALYSIS REPORT

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	**REFERENCE No. :**	11230721-A1
PROJECT :	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION 1209 ST.	**BORING No. :**	MW-3-21
LOCATION :	LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	**SAMPLE No. :**	SS-4
		DEPTH :	2.26 m
		DATE :	8/4/2021

UNIFIED SOIL CLASSIFICATION (BASED ON THE STANDARD LC 21-040)



CLAY	SILT	SAND			GRAVEL		COBBLES AND BOULDERS
		fine	medium	coarse	fine	coarse	

Description	w (%)	W_L (%)	I_P (%)	Classification (1)
Silty SAND, some gravel and clay (TIL)				

(1)

% Gravel	% Sand	% Silt and % Clay	c_U	c_C	D85	D60	D50	D30	D15	D10
16	44	39								

Remarks :

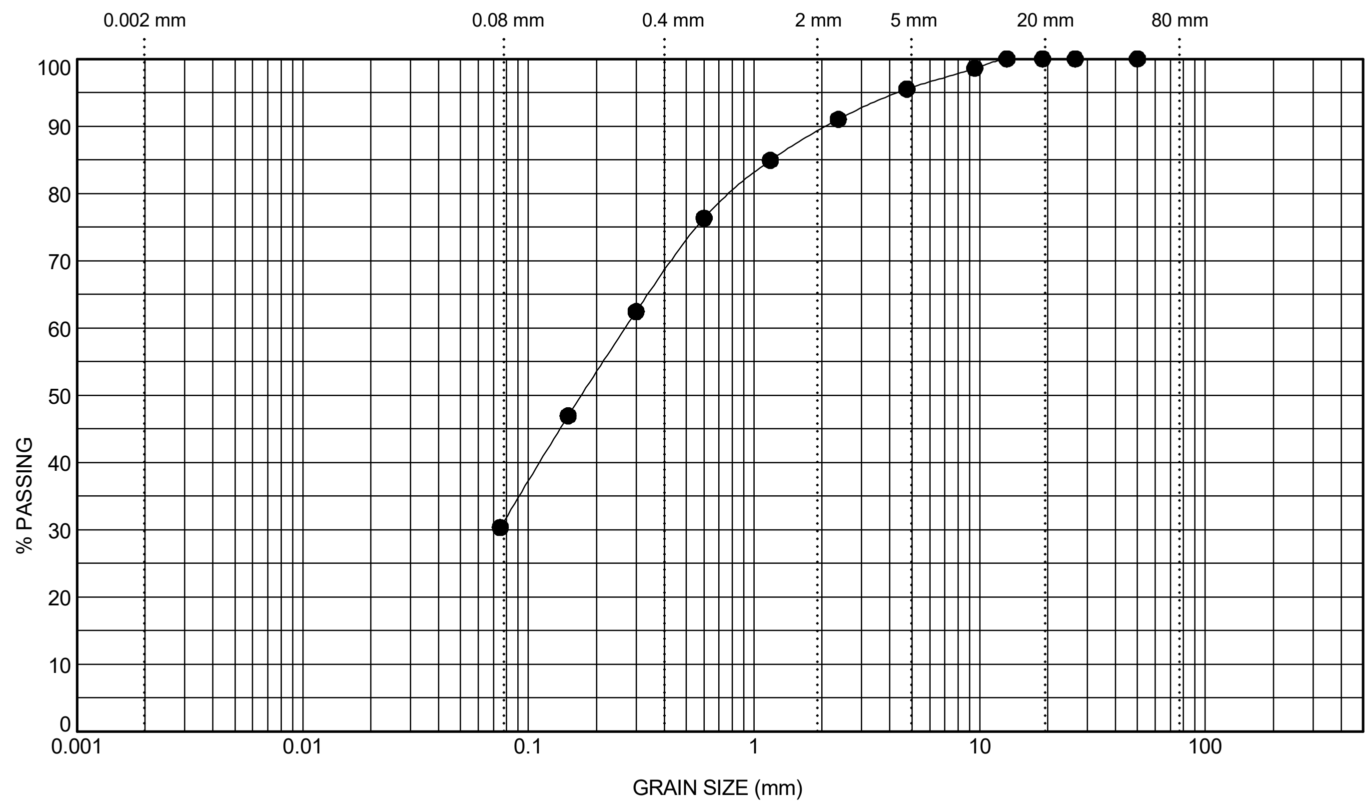
Prepared by : Z. Mathurin

Verified by : E. Bennett

GRAIN SIZE ANALYSIS REPORT

		REFERENCE No. :	11230721-A1
CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	**BORING No. :**	MW-4-21
PROJECT :	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION 1209 ST.	**SAMPLE No. :**	SS-5
LOCATION :	LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	**DEPTH :**	3.2 m **DATE :** 8/4/2021

UNIFIED SOIL CLASSIFICATION (BASED ON THE STANDARD LC 21-040)



CLAY	SILT	SAND			GRAVEL		COBBLES AND BOULDERS
		fine	medium	coarse	fine	coarse	

Description	**w (%)**	**W_L (%)**	**I_P (%)**	**Classification (1)**
Silty SAND, trace gravel and clay				

(1)

% Gravel	% Sand	% Silt and % Clay	c_U	c_C	D85	D60	D50	D30	D15	D10
4	64	30								

Remarks :

Prepared by : Z. Mathurin

Verified by : E. Bennett

CLASSIFICATION OF FINE GRAINED SOILS

REFERENCE No. : 11230721-A1

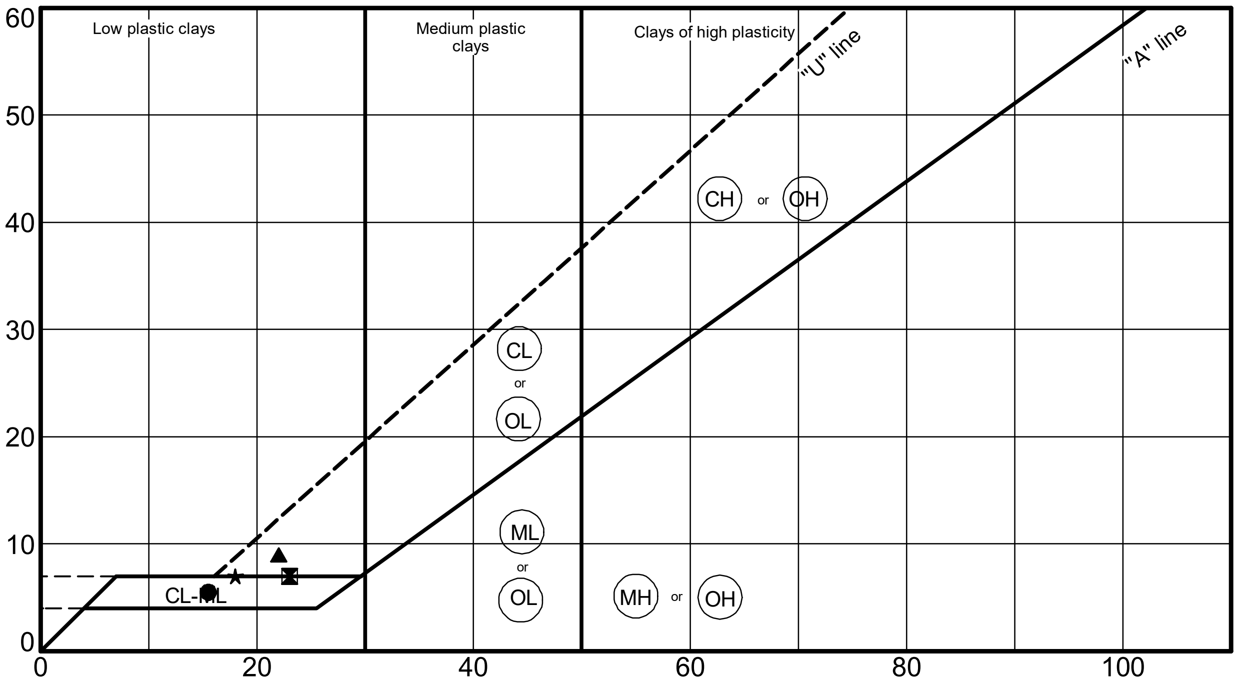
CLIENT : 1209 ST. LAURENT LIMITED PARTNERSHIP

LOCATION : 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO

PROJECT : PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION

DATE : 8/4/2021

Plasticity Chart (ASTM D2487)



	Bore No.	Sample	Depth	w	W_L	W_{L-S}	W_P	I_P	I_L	C_u	C_{ur}	S_T	Classification
●	MW-2-21	SS-5	3.05	9	16		10	6					
⧗	MW-5-21	SS-3	1.52	19	23		16	7					
▲	MW-6-21	SS-3	1.52	17	22		13	9					
★	MW-7-21	SS-5	3.05	15	18		11	7					

Legend

CL Inorganic clay of low plasticity
OL Organic silt
CH Inorganic clay of high plasticity
ML Inorganic silt
OH Organic clay and organic silt
MH Inorganic silt and very fine sand

w : Water content (%)
w_{L-S} : Oven dried liquid limit (%)
w_L : Liquid limit (%)
w_P : Plastic limit (%)
I_P : Plasticity index (%)

I_L : Liquidity index (%)
C_u : Intact undrained shear strength (kPa)
C_{ur} : Remoulded undrained shear strength (kPa)
S_T : Sensitivity

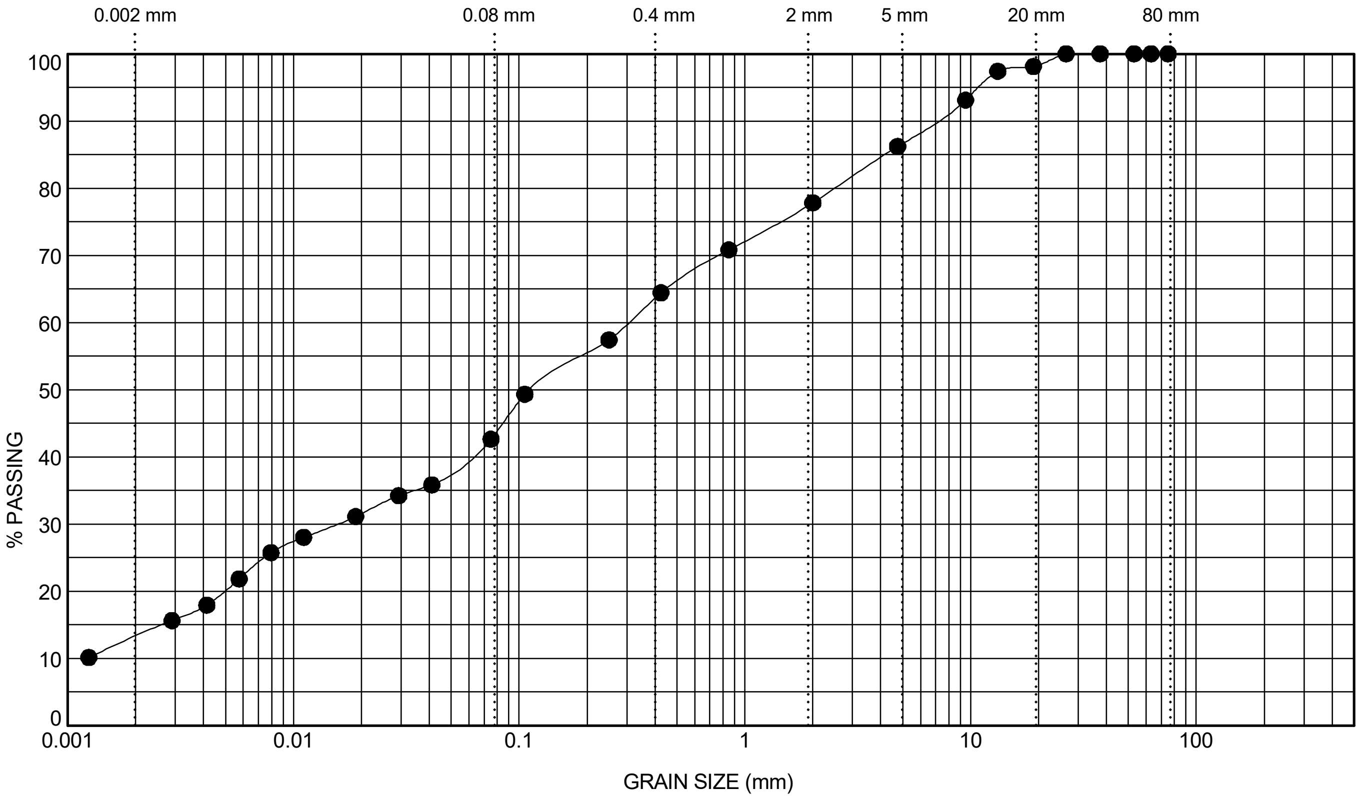
Prepared by : Z. Mathurin

Verified by : E. Bennett

GRAIN SIZE ANALYSIS REPORT
(WITH SEDIMENTATION)

CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	**REFERENCE No. :**	11230721-A1
PROJECT :	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION 1209 ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	**BORING No. :**	MW-2-21
LOCATION :		**SAMPLE No. :**	SS-5
		DEPTH :	3.05 m
		DATE :	8/4/2021

UNIFIED SOIL CLASSIFICATION (BASED ON THE STANDARD LC 21-040)



CLAY	SILT	SAND			GRAVEL		COBBLES AND BOULDERS
		fine	medium	coarse	fine	coarse	

Description	w (%)	W_L (%)	I_P (%)	Classification (1)
Silty SAND, some gravel and clay (TILL)	9	16	6	

(1)

% Gravel	% Sand	% Silt	% Clay	c_U	c_C	D85	D60	D50	D30	D15	D10
13	43	30	13								

Remarks :

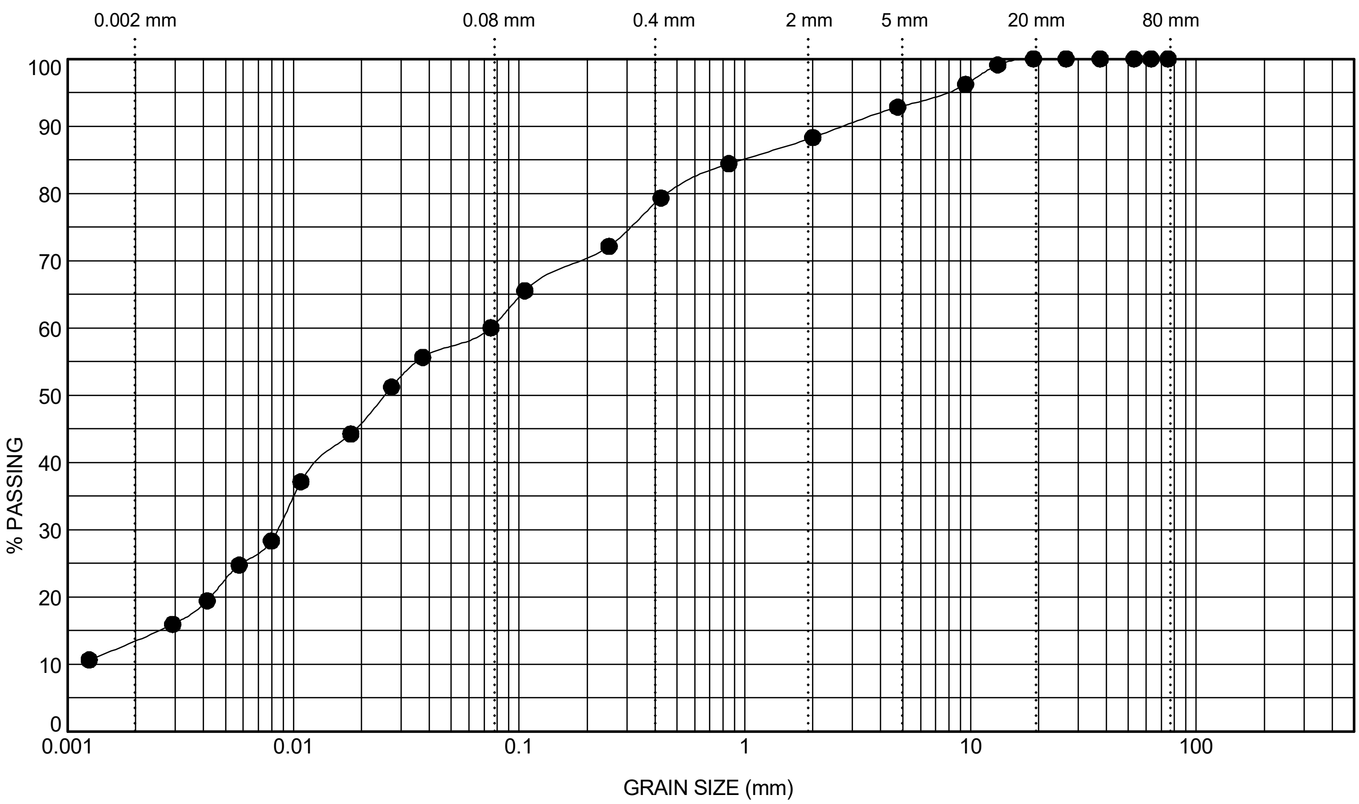
Prepared by : Z. Mathurin

Verified by : E. Bennett

GRAIN SIZE ANALYSIS REPORT
(WITH SEDIMENTATION)

		REFERENCE No. :	11230721-A1
CLIENT:	1209 ST. LAURENT LIMITED PARTNERSHIP	**BORING No. :**	MW-7-21
PROJECT :	PRELIMINARY GEOTECHNICAL AND HYDROGEOLOGICAL INVESTIGATION 1209	**SAMPLE No. :**	SS-5
LOCATION :	ST. LAURENT BOULEVARD AND 1200 LEMIEUX STREET, OTTAWA, ONTARIO	**DEPTH :**	3.05 m **DATE :** 8/4/2021

UNIFIED SOIL CLASSIFICATION (BASED ON THE STANDARD LC 21-040)



CLAY	SILT	SAND			GRAVEL		COBBLES AND BOULDERS
		fine	medium	coarse	fine	coarse	

Description	w (%)	W_L (%)	I_P (%)	Classification (1)
Sandy Silt, some clay, trace gravel (TILL)	15	18	7	

(1)

% Gravel	% Sand	% Silt	% Clay	c_U	c_C	D85	D60	D50	D30	D15	D10
7	33	47	13								

Remarks :

Prepared by : Z. Mathurin

Verified by : E. Bennett

GHD Limited (Waterloo)
ATTN: Pascal Renella
455 Phillip St
Waterloo ON N2L3X2

Date Received: 19-JUL-21
Report Date: 05-AUG-21 08:21 (MT)
Version: FINAL REV. 2

Client Phone: 519-884-0510

Certificate of Analysis

Lab Work Order #: L2615912

Project P.O. #: 73524385
Job Reference: 11230721-02
C of C Numbers:
Legal Site Desc:

Comments:

5-AUG-2021 Corrosivity - S-11230721-1600721-DA-MW7-21-SS-4

Rick Hawthorne
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2615912-3 S-11230721-1600721-DA-MW7-21-SS-4 Sampled By: DA on 16-JUL-21 @ 13:00 Matrix: SOIL							
Physical Tests							
Conductivity	0.322		0.0040	mS/cm		26-JUL-21	R5529333
% Moisture	14.8		0.25	%	22-JUL-21	23-JUL-21	R5527462
pH	7.81		0.10	pH units		23-JUL-21	R5528236
Redox Potential	268		-1000	mV		27-JUL-21	R5530245
Resistivity	3110		1.0	ohm*cm		26-JUL-21	
Leachable Anions & Nutrients							
Chloride	204		5.0	ug/g	23-JUL-21	23-JUL-21	R5529131
Anions and Nutrients							
Sulphate	66		20	ug/g	23-JUL-21	23-JUL-21	R5529131
Inorganic Parameters							
Acid Volatile Sulphides	0.25		0.20	mg/kg	23-JUL-21	23-JUL-21	R5528163

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

BTX-511-HS-WT	Soil	BTEX-O.Reg 153/04 (July 2011)	SW846 8260

BTX is determined by extracting a soil or sediment sample as received with methanol, then analyzing by headspace-GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0

5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Soil	Conductivity (EC)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

F1-F4-511-CALC-WT	Soil	F1-F4 Hydrocarbon Calculated Parameters	CCME CWS-PHC, Pub #1310, Dec 2001-S

Analytical methods used for analysis of CCME Petroleum Hydrocarbons have been validated and comply with the Reference Method for the CWS PHC.

Hydrocarbon results are expressed on a dry weight basis.

In cases where results for both F4 and F4G are reported, the greater of the two results must be used in any application of the CWS PHC guidelines and the gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
In samples where BTEX and F1 were analyzed , F1-BTEX represents a value where the sum of Benzene, Toluene, Ethylbenzene and total Xylenes has been subtracted from F1.

In samples where PAHs, F2 and F3 were analyzed, F2-Naphth represents the result where Naphthalene has been subtracted from F2. F3-PAH represents a result where the sum of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene has been subtracted from F3.

Unless otherwise qualified, the following quality control criteria have been met for the F1 hydrocarbon range:

Reference Information

PAH-511-WT	Soil	PAH-O.Reg 153/04 (July 2011)	SW846 3510/8270

A representative sub-sample of soil is fortified with deuterium-labelled surrogates and a mechanical shaking techniqueis used to extract the sample with a mixture of methanol and toluene. The extracts are concentrated and analyzed by GC/MS. Results for benzo(b) fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PH-WT	Soil	pH	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	APHA 2510 B

"Soil Resistivity (calculated)" is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

SO4-WT	Soil	Sulphate	EPA 300.0

5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.

SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J

This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H_2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.

VOC-1,3-DCP-CALC-WT	Soil	Regulation 153 VOCs	SW8260B/SW8270C

VOC-511-HS-WT	Soil	VOC-O.Reg 153/04 (July 2011)	SW846 8260 (511)

Soil and sediment samples are extracted in methanol and analyzed by headspace-GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

XYLENES-SUM-CALC-WT	Soil	Sum of Xylene Isomer Concentrations	CALCULATION

Total xylenes represents the sum of o-xylene and m&p-xylene.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

GHD Limited (Waterloo)
ATTN: Pascal Renella
455 Phillip St
Waterloo ON N2L3X2

Date Received: 26-JUL-21
Report Date: 05-AUG-21 08:15 (MT)
Version: FINAL REV. 2

Client Phone: 519-884-0510

Certificate of Analysis

Lab Work Order #: L2619458

Project P.O. #: 73524385
Job Reference: 11230721-02
C of C Numbers:
Legal Site Desc:

Comments:

5-AUG-2021 Corrosivity GW-11230721-260721-DA-MW5-21-001

Rick Hawthorne

Rick Hawthorne
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2619458-1 GW-11230721-260721-DA-MW5-21-001							
Sampled By: D. ASH on 26-JUL-21 @ 10:30							
Matrix: WATER							
Physical Tests							
Conductivity	2200		1.0	umhos/cm		28-JUL-21	R5531406
pH	8.05		0.10	pH units		28-JUL-21	R5531406
Redox Potential	353	PEHR	-1000	mV		04-AUG-21	R5543278
Resistivity	455		1.0	ohm*cm		29-JUL-21	
Anions and Nutrients							
Chloride (Cl)	399	DLDS	2.5	mg/L		29-JUL-21	R5534661
Sulfate (SO4)	97.0	DLDS	1.5	mg/L		29-JUL-21	R5534661
Sulphide as S	<0.18		0.18	mg/L		02-AUG-21	R5538861

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
PEHR	Parameter Exceeded Recommended Holding Time On Receipt: Proceed With Analysis As Requested.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BTX-511-HS-WT	Water	BTEX by Headspace	SW846 8260 (511)

BTX is determined by analyzing by headspace-GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

CL-IC-N-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

CN-WAD-R511-WT	Water	Cyanide (WAD)-O.Reg 153/04	APHA 4500CN I-Weak acid Dist Colorimet

Weak acid dissociable cyanide (WAD) is determined by undergoing a distillation procedure. Cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

CR-CR6-IC-R511-WT	Water	Hex Chrom-O.Reg 153/04 (July 2011)	EPA 7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution. Chromium (III) is calculated as the difference between the total chromium and the chromium (VI) results.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

EC-R511-WT	Water	Conductivity-O.Reg 153/04 (July 2011)	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

EC-SCREEN-WT	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

EC-WT	Water	Conductivity	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

F1-F4-511-CALC-WT	Water	F1-F4 Hydrocarbon Calculated Parameters	CCME CWS-PHC, Pub #1310, Dec 2001-L

Analytical methods used for analysis of CCME Petroleum Hydrocarbons have been validated and comply with the Reference Method for the CWS PHC.

In cases where results for both F4 and F4G are reported, the greater of the two results must be used in any application of the CWS PHC guidelines and the gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
In samples where BTEX and F1 were analyzed , F1-BTEX represents a value where the sum of Benzene, Toluene, Ethylbenzene and total Xylenes has been subtracted from F1.

Reference Information

In samples where PAHs, F2 and F3 were analyzed, F2-Naphth represents the result where Naphthalene has been subtracted from F2. F3-PAH represents a result where the sum of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene has been subtracted from F3.

Unless otherwise qualified, the following quality control criteria have been met for the F1 hydrocarbon range:
1. All extraction and analysis holding times were met.
2. Instrument performance showing response factors for C6 and C10 within 30% of the response factor for toluene.
3. Linearity of gasoline response within 15% throughout the calibration range.

Unless otherwise qualified, the following quality control criteria have been met for the F2-F4 hydrocarbon ranges:
1. All extraction and analysis holding times were met.
2. Instrument performance showing C10, C16 and C34 response factors within 10% of their average.
3. Instrument performance showing the C50 response factor within 30% of the average of the C10, C16 and C34 response factors.
4. Linearity of diesel or motor oil response within 15% throughout the calibration range.

F1-HS-511-WT	Water	F1-O.Reg 153/04 (July 2011)	E3398/CCME TIER 1-HS

Fraction F1 is determined by analyzing by headspace-GC/FID.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

F2-F4-511-WT	Water	F2-F4-O.Reg 153/04 (July 2011)	EPA 3511/CCME Tier 1

Petroleum Hydrocarbons (F2-F4 fractions) are extracted from water using a hexane micro-extraction technique. Instrumental analysis is by GC-FID, as per the Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil Tier 1 Method, CCME, 2001.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

HG-D-UG/L-CVAA-WT	Water	Diss. Mercury in Water by CVAAS (ug/L)	EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MET-D-UG/L-MS-WT	Water	Diss. Metals in Water by ICPMS (ug/L)	EPA 200.8

The metal constituents of a non-acidified sample that pass through a membrane filter prior to ICP/MS analysis.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

METHYLNAPS-CALC-WT	Water	PAH-Calculated Parameters	SW846 8270

PAH-511-WT	Water	PAH-O. Reg 153/04 (July 2011)	SW846 3510/8270

Aqueous samples, fortified with surrogates, are extracted using liquid/liquid extraction technique. The sample extracts are concentrated and then analyzed using GC/MS. Results for benzo(b) fluoranthene may include contributions from benzo(j)fluoranthene, if also present in the sample.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011). Holdtime for samples under this regulation is 28 days

REDOX-POTENTIAL-WT	Water	Redox Potential	APHA 2580

This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.

It is recommended that this analysis be conducted in the field.

Reference Information

RESISTIVITY-CALC-WT	Water	Resistivity Calculation	APHA 2510 B

Resistivity are calculated based on the conductivity using APHA 2510B where Conductivity is the inverse of Resistivity.

S2-T-COL-VA	Water	Total Sulphide by Colorimetric	APHA 4500 -S E-Auto-Colorimetry

Sulfide is determined using the gas dialysis automated methlyene blue colourimetric method. Results expressed "as H2S", if reported, represent the maximum possible H2S concentration based on the total sulfide concentration in the sample.

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

VOC-1,3-DCP-CALC-WT	Water	Regulation 153 VOCs	SW8260B/SW8270C
VOC-511-HS-WT	Water	VOC by GCMS HS O.Reg 153/04 (July 2011)	SW846 8260

Liquid samples are analyzed by headspace GC/MSD.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

XYLENES-SUM-CALC-WT	Water	Sum of Xylene Isomer Concentrations	CALCULATION

Total xylenes represents the sum of o-xylene and m&p-xylene.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Appendix E

Single Well Response Test Results

Table E1

Well Completion Details and Water Levels
Preliminary Geotechnical and Hydrogeological Investigation
1209 St. Laurent Boulevard and 1200 Lemieux Street
Ottawa, Ontario

Well	Completion Date	Ground Elevation (mAMSL)	Top of Riser/ Reference Elevation (mAMSL)	Stickup (m)	Media	Overburden/Bedrock Interface (mBGS)	Overburden/Bedrock Interface (mAMSL)	Bottom of Borehole (mBGS)	Bottom of Borehole (mAMSL)	Screened Interval (mBGS) from	Screened Interval (mBGS) to	Screened Interval (mAMSL) from	Screened Interval (mAMSL) to	Static Water Level 26-Jul-21 (mBTOR)	Static Water Level 26-Jul-21 (mBGS)	Static Water Level 26-Jul-21 (mAMSL)	Static Water Level 29-Jul-21 (mBTOR)	Static Water Level 29-Jul-21 (mBGS)	Static Water Level 29-Jul-21 (mAMSL)
MW-1-21	14-Jul-21	68.042	68.980	0.938	Overburden	4.3	63.8	5.9	62.1	1.5	3.0	65.0	68.0	2.94	2.01	66.04	2.96	2.02	66.02
MW-2-21	14-Jul-21	68.760	69.778	1.018	Overburden	4.6	64.2	6.8	62.0	2.9	4.4	64.3	68.8	3.84	2.82	65.94	3.82	2.80	65.96
MW-3-21	16-Jul-21	68.741	68.729	-0.012	Bedrock	4.1	64.6	12.0	56.7	7.4	10.5	58.3	68.7	5.10	5.12	63.63	2.76	2.77	65.97
MW-4-21	15-Jul-21	68.102	69.074	0.972	Bedrock	6.0	62.1	12.1	56.0	8.0	11.0	57.1	68.1	3.56	2.59	65.51	3.25	2.28	65.82
MW-5-21	15-Jul-21	68.536	69.452	0.916	Bedrock	5.2	63.4	12.1	56.4	9.1	12.1	56.4	68.5	3.34	2.42	66.12	3.36	2.44	66.09
MW-6-21	16-Jul-21	69.105	69.052	-0.053	Overburden	5.0	64.2	6.9	62.2	2.6	4.1	65.0	69.1	2.61	2.66	66.45	2.47	2.52	66.58
MW-7-21	16-Jul-21	69.325	69.244	-0.081	Bedrock	4.6	64.8	12.0	57.3	8.5	11.6	57.7	69.3	4.50	4.58	64.74	3.34	3.42	65.90

Notes:

mAMSL - metres above mean sea level
mBGS - metres below ground surface
mBTOR - metres below top of riser

Table E2

Single Well Response Test Results Summary
Preliminary Geotechnical and Hydrogeological Investigation
1209 St. Laurent Boulevard and 1200 Lemieux Street
Ottawa, Ontario

		Start time of SWRT				Estimated Hydraulic Conductivity (cm/s)		
Well ID	Date of SWRT	Falling Head 1	Rising Head 1	Solution	Stratigraphy	Falling Head 1	Rising Head 1	Geomean
MW-1-21	29-Jul-21	12:53	14:40	Dagan - unconfined	Native Till - clayey silty sand, some gravel, cobbles, boulders	inv.	3.52E-04	3.52E-04
MW-2-21	28-Jul-21	13:25	15:05	Dagan - unconfined	Native Till - clayey silty sand, some gravel	inv.	4.09E-04	4.09E-04
MW-3-21	29-Jul-21	12:29	14:17	Hvorslev - confined	Shale, with limetone interbeds; excellent to good quality	1.91E-05	2.22E-05	2.06E-05
MW-4-21	29-Jul-21	11:32	14:27	Hvorslev - confined	Shale, with limetone interbeds; excellent to good quality	6.84E-05	2.55E-04	1.32E-04
MW-5-21	29-Jul-21	10:50	13:37	Hvorslev - confined	Shale, with limetone interbeds; weathered to fresh	1.19E-04	8.10E-05	9.81E-05
MW-6-21	29-Jul-21	8:41	9:53	Bower-Rice - unconfined	Native Till - sand and gravel	1.19E-04	8.10E-05	9.81E-05
MW-7-21	29-Jul-21	8:16	12:09	Hvorslev - confined	Shale, with limetone interbeds; excellent quality	1.43E-05	6.91E-06	9.93E-06
						Overburden (Till) - Geomean		**2.42E-04**
						Bedrock (Shale) - Geomean		**4.03E-05**
						Combined - Geomean		**6.80E-05**

Notes and Assumptions

Dagan (1978)

Hvorslev (1951)

Bower-Rice (1976)

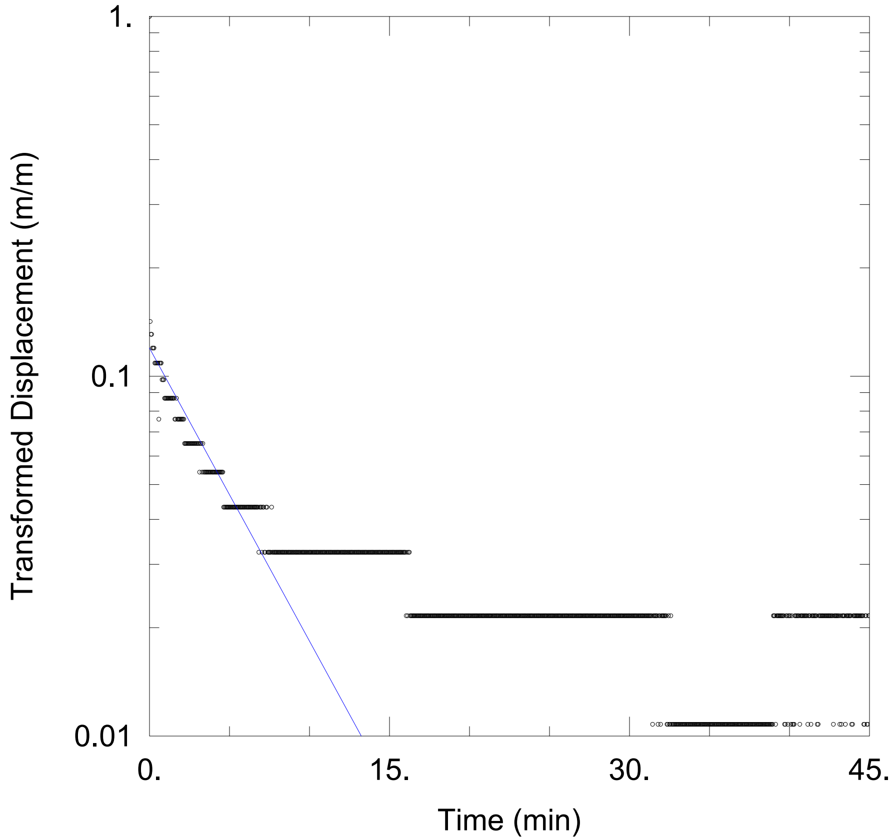
Static level is within the screen at MW1-21 and MW2-21; Falling head tests are invalid

The rising head test at MW1-21 did not stress the well. Results are consistent with other till wells and have been used in the geomean

The rising head test at MW5-21 is not consistent with the remaining bedrock SWRT and has be discounted

To overcome ambiguity in straight-line solutions, a normalized head range of 0.15-0.25 for Hvorslev solutions and 0.20-0.30 for Bouwer-Rice solutions has been used

This follows the approach provided by Butler, 1998.



MW-1-21 - RISING HEAD TEST

Data Set: \...\MW-1-21 - RH1.aqt
Date: 08/04/21 Time: 18:09:22

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-1-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan

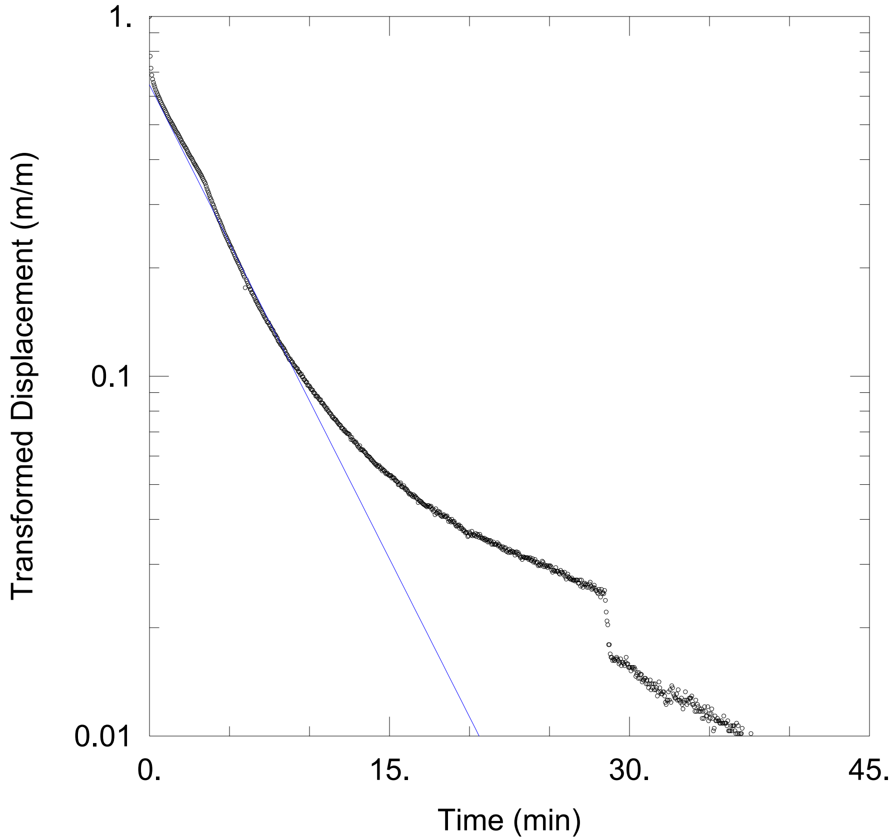
K = 0.0003516 cm/sec
y0 = 0.03298 m

AQUIFER DATA

Saturated Thickness: 1.7 m
Anisotropy Ratio (Kz/Kr): 0.5

WELL DATA (MW-1-21)

Initial Displacement: 0.255 m
Total Well Penetration Depth: 1.7 m
Casing Radius: 0.025 m
Static Water Column Height: 1.7 m
Screen Length: 1.5 m
Well Radius: 0.05 m
Gravel Pack Porosity: 0.3



MW-2-21 - RISING HEAD TEST

Data Set: \...\MW-2-21 - RH1.aqt
Date: 08/04/21 Time: 18:10:22

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-2-21
Test Date: July 28, 2021

SOLUTION

Aquifer Model: Unconfined
Solution Method: Dagan

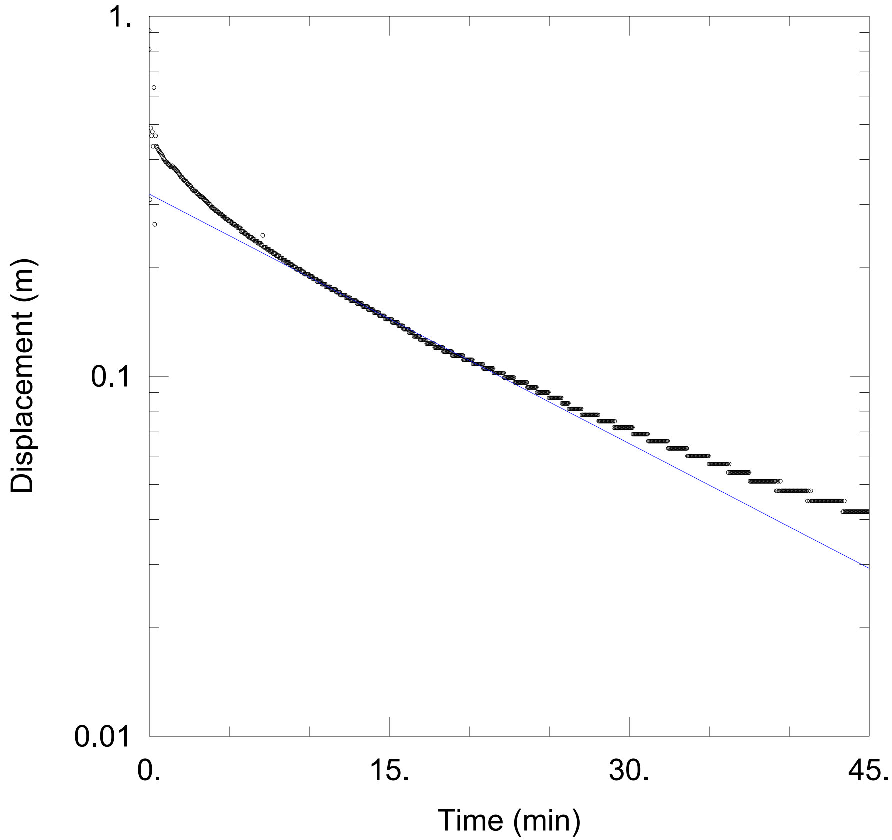
K = 0.0004094 cm/sec
y0 = 0.3326 m

AQUIFER DATA

Saturated Thickness: 1.45 m
Anisotropy Ratio (Kz/Kr): 0.5

WELL DATA (MW-2-21)

Initial Displacement: 0.4849 m
Total Well Penetration Depth: 1.45 m
Casing Radius: 0.025 m
Static Water Column Height: 1.45 m
Screen Length: 1.45 m
Well Radius: 0.05 m
Gravel Pack Porosity: 0.3



MW-3-21 - FALLING HEAD TEST

Data Set: \...\MW-3-21 - FH1.aqt
Date: 08/11/21 Time: 09:00:39

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-3-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

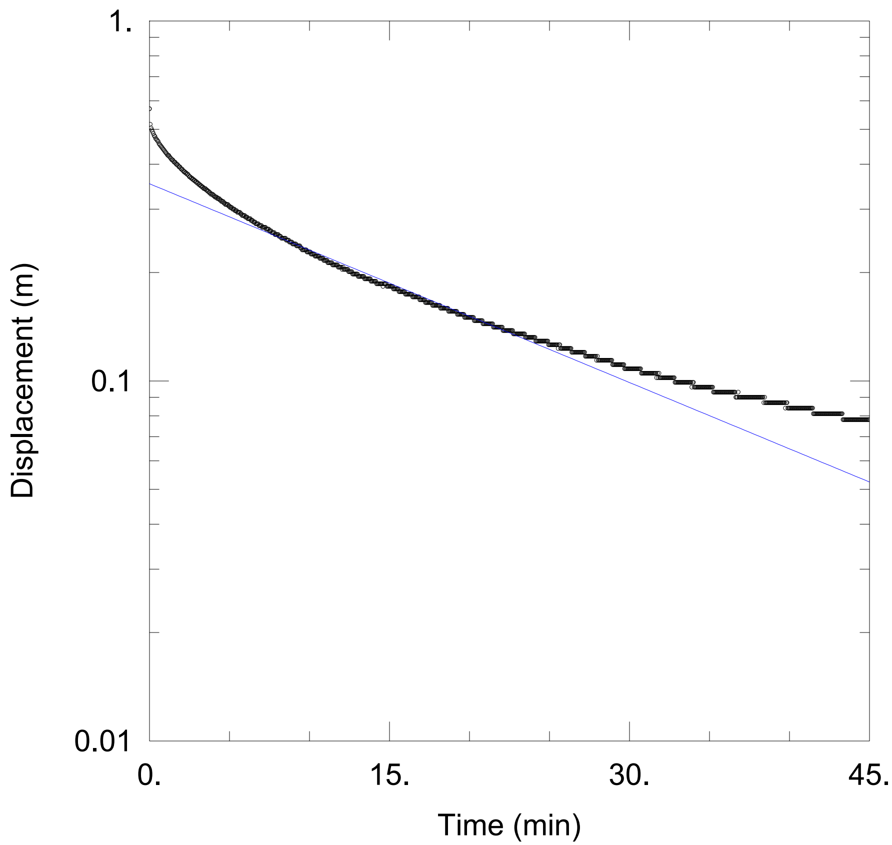
K = 5.522E-5 cm/sec
y0 = 0.3205 m

AQUIFER DATA

Saturated Thickness: 6.4 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-3-21)

Initial Displacement: 0.8081 m
Total Well Penetration Depth: 8.31 m
Casing Radius: 0.025 m
Static Water Column Height: 8.31 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-3-21 - RISING HEAD TEST

Data Set: \...\MW-3-21 - RH1.aqt
Date: 08/11/21 Time: 08:59:03

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-3-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

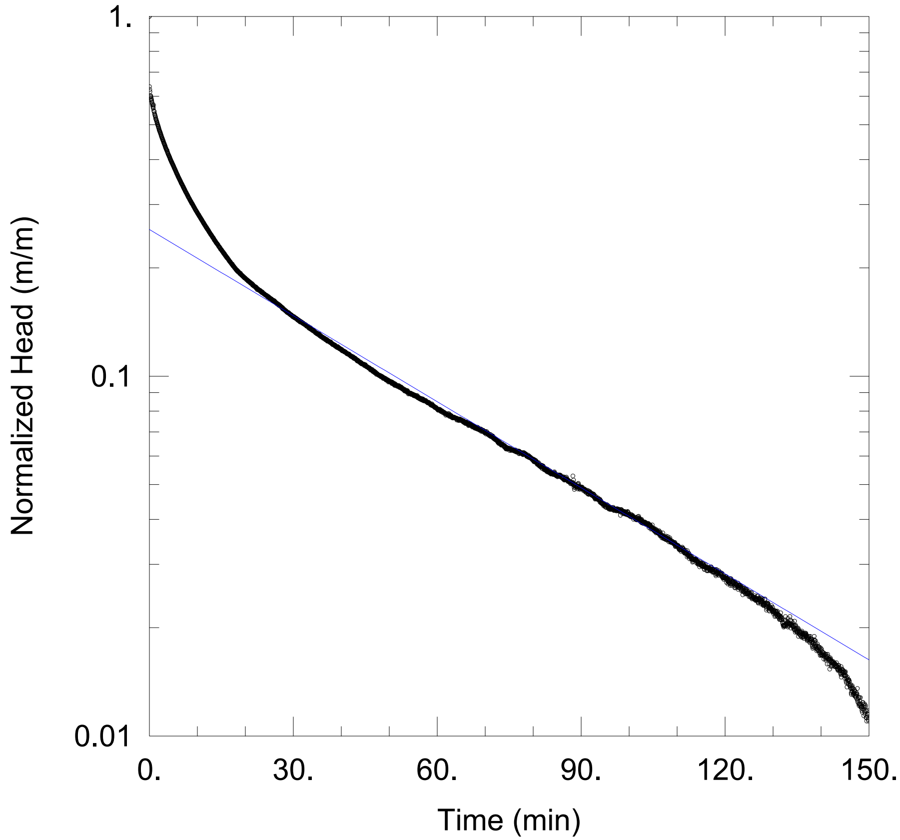
K = 4.4E-5 cm/sec
y0 = 0.353 m

AQUIFER DATA

Saturated Thickness: 6.4 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-3-21)

Initial Displacement: 0.57 m
Total Well Penetration Depth: 8.31 m
Casing Radius: 0.025 m
Static Water Column Height: 8.31 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-4-21 - FALLING HEAD TEST

Data Set: \...\MW-4-21 - FH1.aqt
Date: 08/11/21 Time: 09:02:35

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-4-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

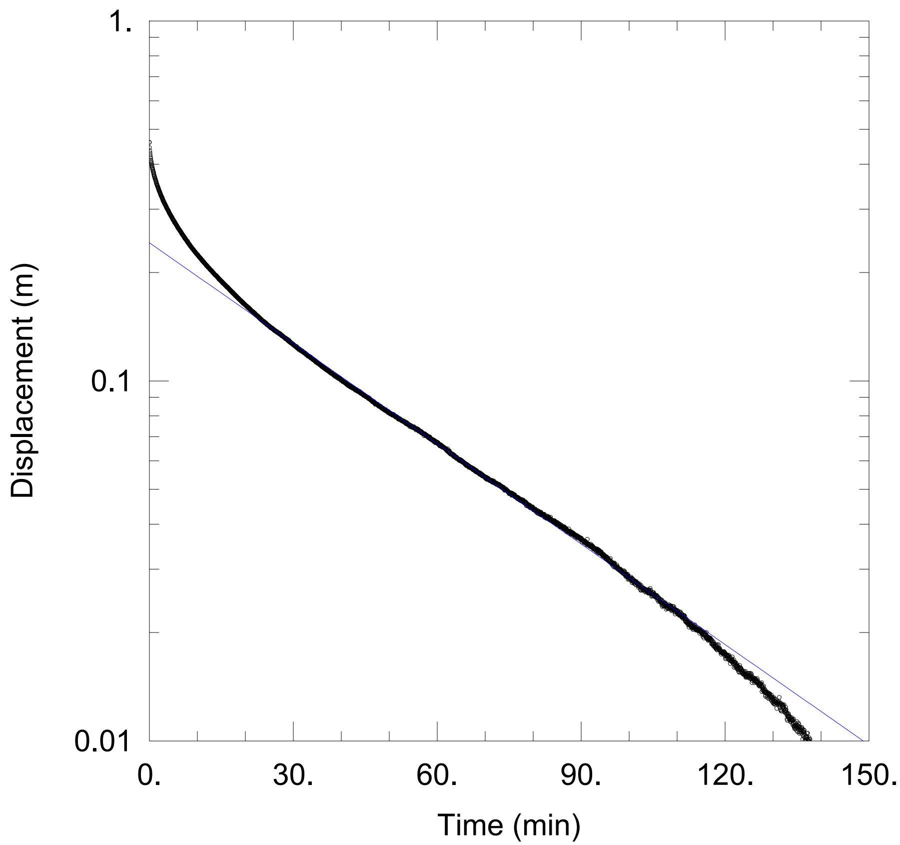
K = 1.906E-5 cm/sec
y0 = 0.2 m

AQUIFER DATA

Saturated Thickness: 5. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-4-21)

Initial Displacement: 0.7825 m
Total Well Penetration Depth: 8.6 m
Casing Radius: 0.025 m
Static Water Column Height: 8.6 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-4-21 - RISING HEAD TEST

Data Set: \...\MW-4-21 - RH1.aqt
Date: 08/11/21 Time: 09:03:17

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-4-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

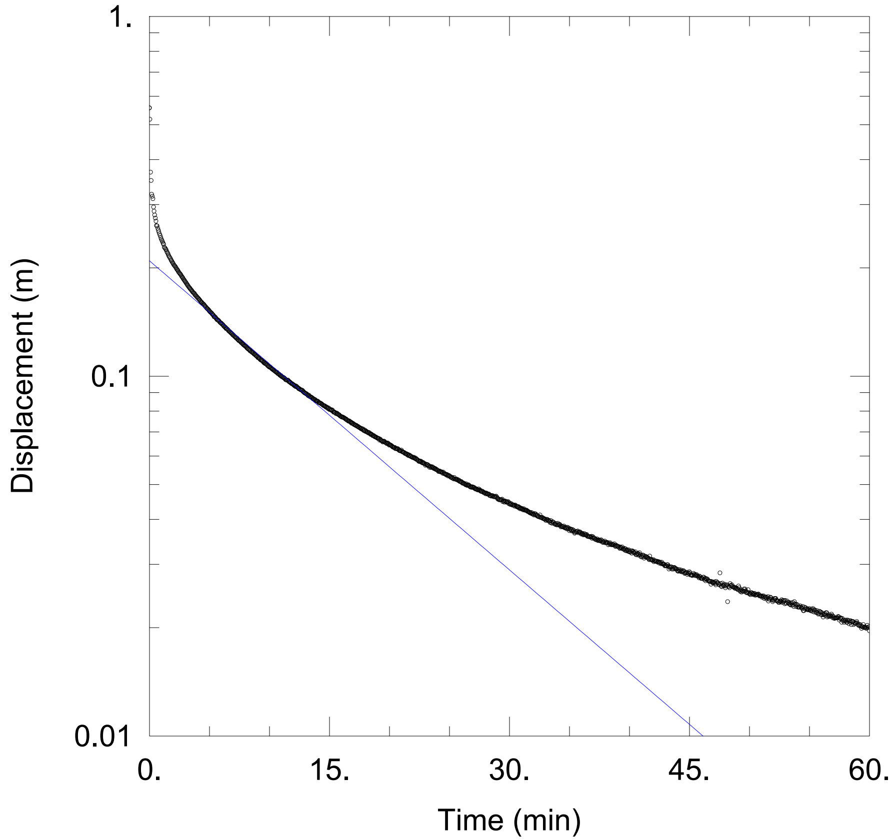
K = 2.223E-5 cm/sec
y0 = 0.2419 m

AQUIFER DATA

Saturated Thickness: 5. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-4-21)

Initial Displacement: 0.4595 m
Total Well Penetration Depth: 8.6 m
Casing Radius: 0.025 m
Static Water Column Height: 8.6 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-5-21 - FALLING HEAD TEST

Data Set: \...\MW-5-21 - FH1.aqt
Date: 08/11/21 Time: 09:05:10

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-5-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

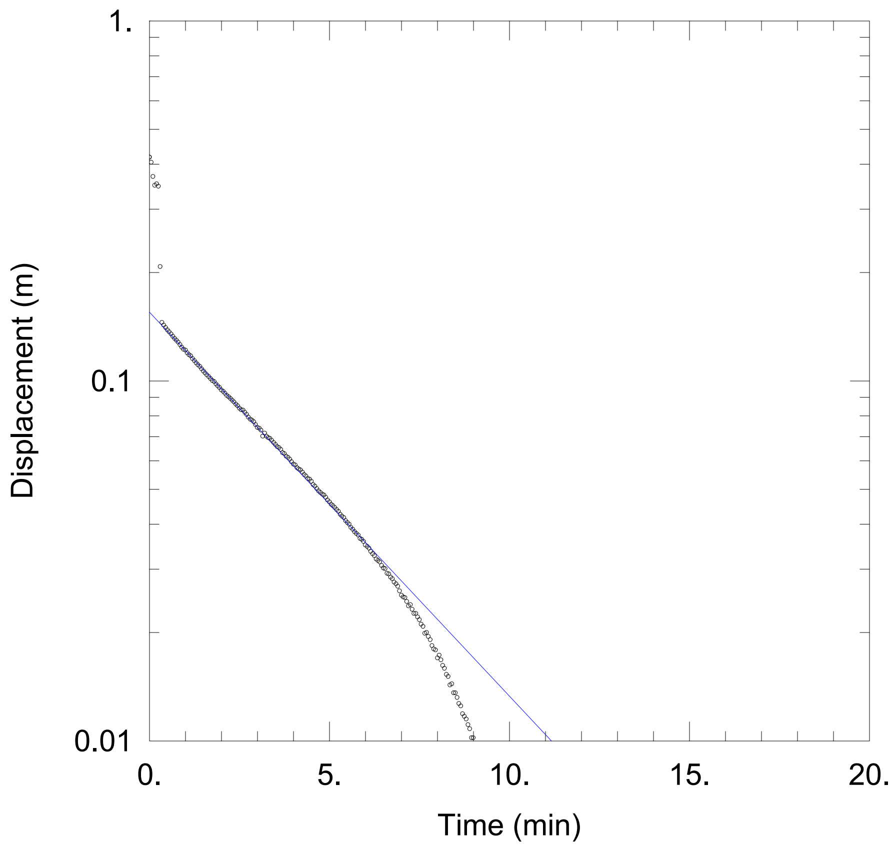
K = 6.842E-5 cm/sec
y0 = 0.2093 m

AQUIFER DATA

Saturated Thickness: 6.9 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-5-21)

Initial Displacement: 0.5568 m
Total Well Penetration Depth: 9.62 m
Casing Radius: 0.025 m
Static Water Column Height: 9.62 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-5-21 - RISING HEAD TEST

Data Set: \...\MW-5-21 - RH1.aqt
Date: 08/11/21 Time: 09:04:29

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-5-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

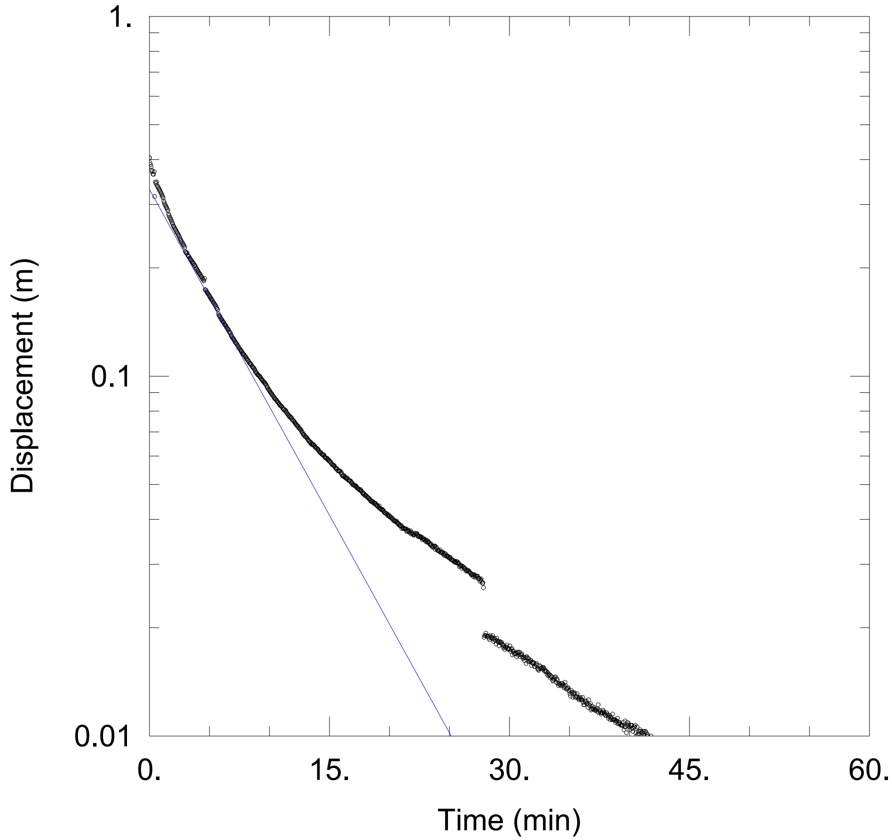
K = 0.0002549 cm/sec
y0 = 0.1552 m

AQUIFER DATA

Saturated Thickness: 6.9 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-5-21)

Initial Displacement: 0.4184 m
Total Well Penetration Depth: 9.62 m
Casing Radius: 0.025 m
Static Water Column Height: 9.62 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-6-21 - FALLING HEAD TEST

Data Set: \...\MW-6-21 - FH1.aqt
Date: 08/04/21 Time: 18:20:12

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-6-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

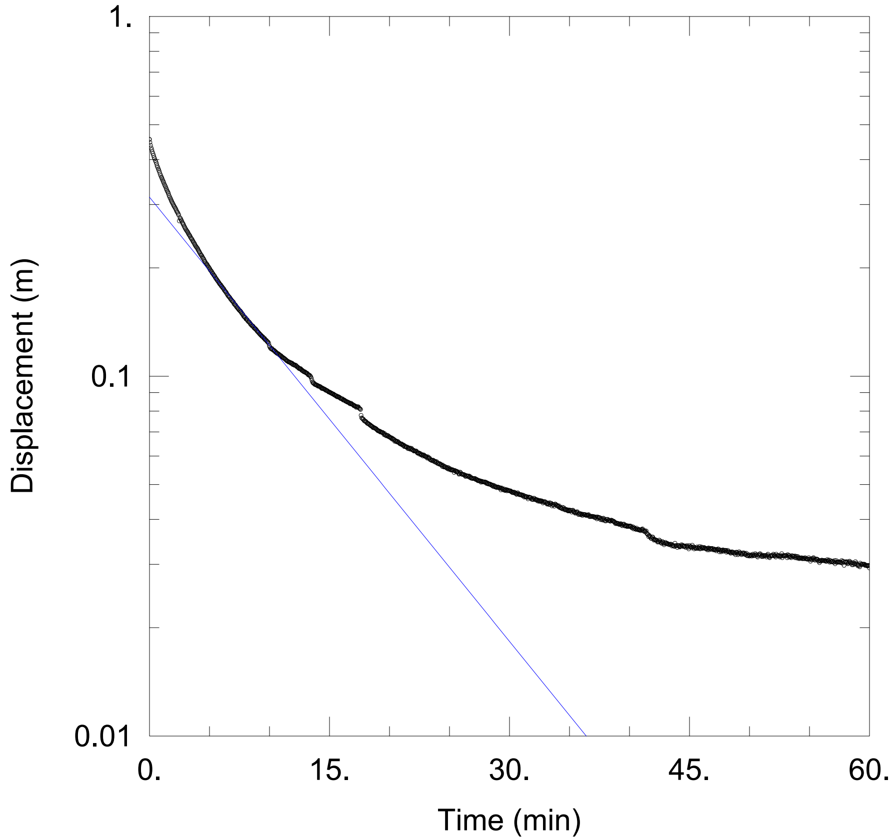
K = 0.0001188 cm/sec
y0 = 0.3304 m

AQUIFER DATA

Saturated Thickness: 2.06 m
Anisotropy Ratio (Kz/Kr): 0.5

WELL DATA (MW-6-21)

Initial Displacement: 0.4043 m
Total Well Penetration Depth: 2.06 m
Casing Radius: 0.025 m
Static Water Column Height: 2.06 m
Screen Length: 1.5 m
Well Radius: 0.1 m



MW-6-21 - RISING HEAD TEST

Data Set: \...\MW-6-21 - RH1.aqt
Date: 08/04/21 Time: 18:21:02

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-6-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

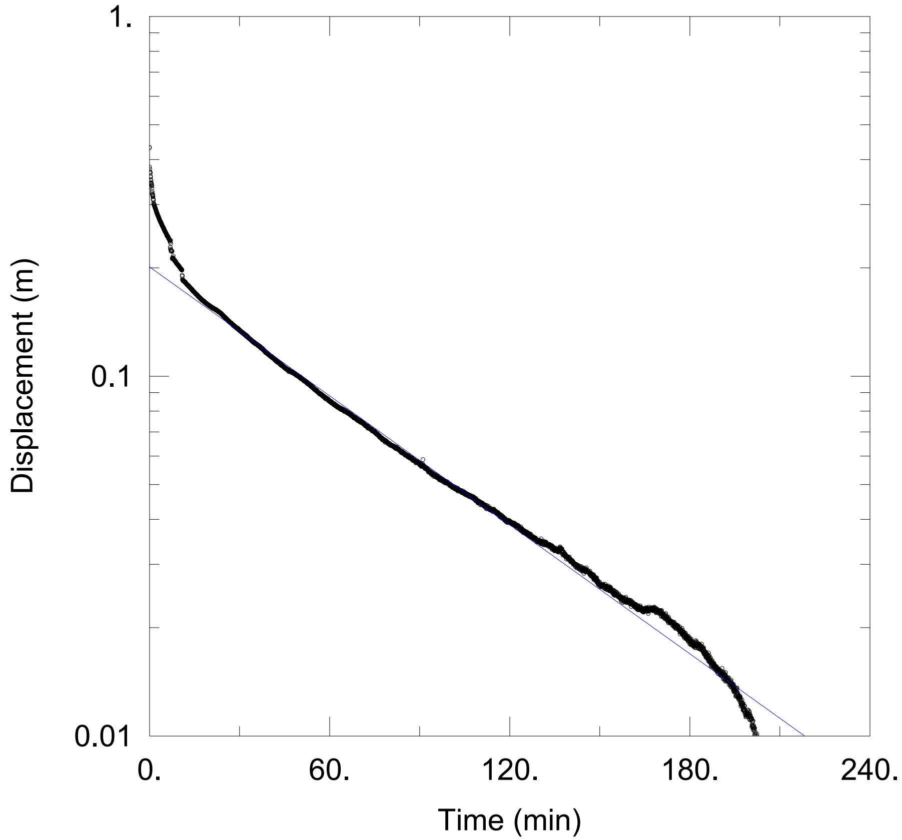
K = 8.095E-5 cm/sec
y0 = 0.3144 m

AQUIFER DATA

Saturated Thickness: 2.06 m
Anisotropy Ratio (Kz/Kr): 0.5

WELL DATA (MW-6-21)

Initial Displacement: 0.4551 m
Total Well Penetration Depth: 2.06 m
Casing Radius: 0.025 m
Static Water Column Height: 2.06 m
Screen Length: 1.5 m
Well Radius: 0.1 m



MW-7-21 - FALLING HEAD TEST

Data Set: \...\MW-7-21 - FH1.aqt
Date: 08/11/21 Time: 09:07:49

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-7-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

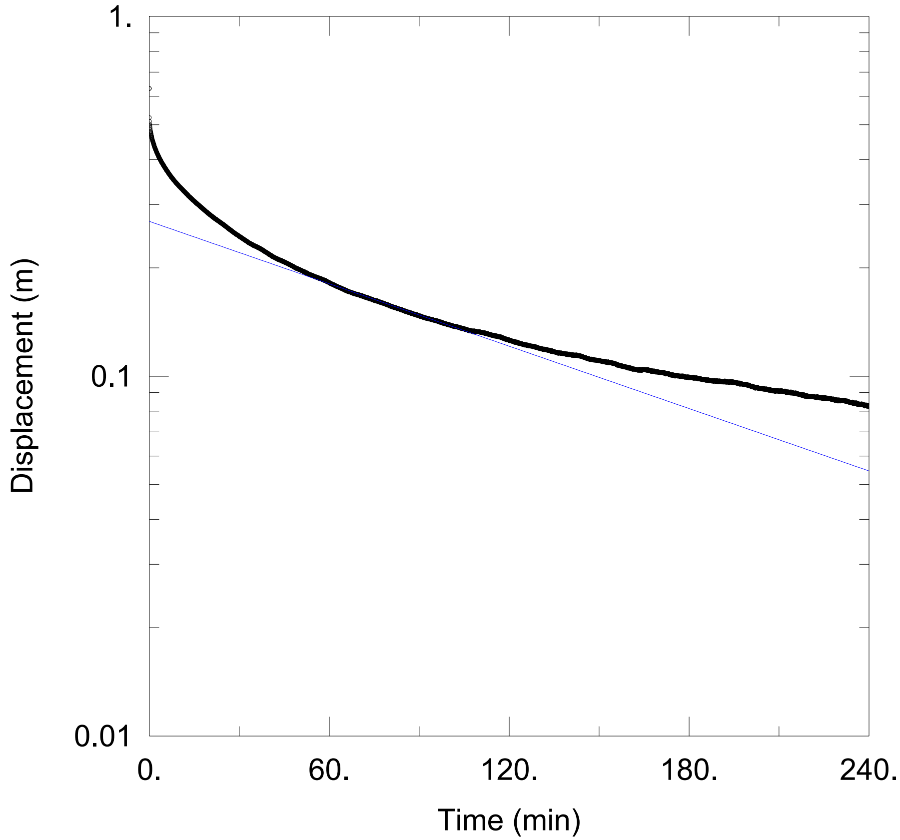
K = 1.428E-5 cm/sec
y0 = 0.2013 m

AQUIFER DATA

Saturated Thickness: 7.06 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-7-21)

Initial Displacement: 0.4319 m
Total Well Penetration Depth: 7.06 m
Casing Radius: 0.025 m
Static Water Column Height: 7.06 m
Screen Length: 3. m
Well Radius: 0.048 m



MW-7-21 - RISING HEAD TEST

Data Set: \...\MW-7-21 - RH1.aqt
Date: 08/11/21 Time: 09:07:11

PROJECT INFORMATION

Company: GHD Ltd.
Client: 1209 St. Laurent Limited Partnership
Project: 11230721
Location: Ottawa, Ontario
Test Well: MW-7-21
Test Date: July 29, 2021

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 6.907E-6 cm/sec
y0 = 0.2693 m

AQUIFER DATA

Saturated Thickness: 7.06 m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (MW-7-21)

Initial Displacement: 0.6303 m
Total Well Penetration Depth: 7.06 m
Casing Radius: 0.025 m
Static Water Column Height: 7.06 m
Screen Length: 3. m
Well Radius: 0.048 m