Geotechnical Investigation and Hydrogeological Assessment

600 March Road, Kanata (Ottawa), Ontario

First Gulf

16 June 2023

→ The Power of Commitment

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1. Introduction

The technical services of GHD were retained by First Gulf (Client) to carry out a supplementary Geotechnical Investigation and Hydrogeological Assessment for supporting the redevelopment plan for the Nokia Property. The Nokia Property is located at 600 March Road, Kanata (Ottawa), Ontario, hereafter referred to as the Site. The Site was subjected to a zoning bylaw amendment and severance application to separate the southern portion of the site from the retained northern land currently occupied by the existing Nokia office building. The new Nokia campus will be developed at the south end of the Site.

The Site was originally investigated in 2022. As part of this initial investigation, ten boreholes were advanced, five monitoring wells were installed, and laboratory testing carried out to provide geotechnical comments and recommendations to support the Zoning By-law Amendment application for the initial concept plan. The results of this initial investigation are presented under Report No. 12566614-RPT-1, dated April 7, 2022. Relevant geotechnical information from the initial investigation have also been considered and incorporated within the current supplementary investigation to facilitate the transmission of available geotechnical information.

The purpose of the supplementary investigation was to consider project concept design changes and to develop a better understanding of the soil and bedrock stratigraphy at a deeper depth. This report provides geotechnical and hydrogeological recommendations and comments with respect to the most recent project concept/construction, including:

- Foundation design and geotechnical resistances and reaction values at limit states.
- Subgrade preparation for the building's slab-on-grade and external works.
- Recommendation on excavation and backfilling.
- Site seismic classification in accordance with the National Building Code of Canada (NBCC).
- Control of subsurface ground water during and after construction including drainage requirements.
- General construction recommendations.

As part of this investigation, seven boreholes were advanced, including installation of three monitoring wells, in situ hydraulic response testing, and laboratory testing to provide interpretation of factual information obtained. This report is accompanied by five appendices including the following:

- Appendix A | Geotechnical Borehole Logs from Current Investigation
- Appendix B | Borehole Reports from Previous Investigation
- Appendix C | Rock Core Photos
- Appendix D | Summary Table and Results of Geotechnical Laboratory Testing
- Appendix E | MASW Investigation - Seismic Site Classification Report
- Appendix F | Hydrogeological Assessment

Furthermore, this report has been prepared with 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.

This work was completed in accordance with our proposal reference number 12606873 dated March 20, 2023. This report is subject to a number of limiting conditions due to the inherent nature of geological, geotechnical, and hydrogeological profiles determined by investigative soundings. The applicable limitations of this investigation are explained following the technical section of this report. These limiting conditions are an integral part of this report, and the reader is strongly encouraged to inform themselves in order to facilitate their comprehension, interpretation, and use of this document.

2. Site and Project Description

It is understood that Nokia (Property Owner) is looking to improve its existing campus at the southeast corner of Terry Fox and March Road (600 March Road) which currently covers about 750,000 square feet of land. The Site was subjected to a zoning bylaw amendment and severance application to separate the southern portion of the site from the retained northern land currently occupied by the existing Nokia office building. It is understood that the new Nokia campus will be developed at the south end of the site on the existing parking lot area (the current project limit) and will consist of the following interconnected structures:

- A high-rise office and retail building with 12-storeys above grade and one underground level for basement and parking.
- A 6-storey building with one underground parking level.
- A 4-storey parking structure with one underground parking level.

The existing grade of the Site is relatively flat with minimal changes in elevation proposed. The Site is surrounded by the existing Nokia office building to the north, March Road to the west, Legged Drive to the east, and a commercial building to the south. The location of the Site is illustrated on the Site Location Plan attached as Figure 1 at the end of this report.

A retail street, running east to west, connecting March Road to Legget Drive will be developed adjacent to the Nokia campus at the north end. Retail units are proposed on the south side of the street with the high-rise office and 6-storey buildings over top.

In addition to the boreholes advanced for the current investigation, boreholes and monitoring wells were advanced within the project limits as part of the previous geotechnical and Phase II environmental site assessment investigations. The results of those investigations are contained in the following reports:

- Report prepared by GHD to Nokia, titled “Geotechnical Investigation and Hydrogeological Assessment, 600 March Road, Kanata, Ontario” and dated April 7, 2022 (report No. 12566614).
- Report prepared by GHD to Nokia, titled “Phase Two Environmental Site Assessment, 600 March Road, Kanata, Ontario” and dated July 19, 2022

Six boreholes (i.e., BH 01-22 to BH06-22, inclusive) as part of the previous geotechnical investigation and three additional monitoring wells (i.e., BH11-22 to BH13-22, inclusive) as part of previous Phase II ESA investigation were advanced within the current project limit on the southern portion of the Nokia campus. Based on the previous investigations, the subsurface conditions within the project limits consisted of a surface layer of asphalt, overlying fill material and discontinuous layer of native silty clay to clay, overlying sandstone with dolomite interbeds bedrock. Shallow bedrock at a depth of 0.4 metres below ground surface (mBGS) (elevation 79.2 metres [m]) was encountered at the northern site limit and gradually increased in depth to 3.6 mBGS (elevation 76.6 m) at the southern site boundary. The location of the relevant boreholes from the previous investigations are included on the attached Site Location Plan (Figure 1) and the borehole reports from the previous investigations are provided in Appendix B.

The Site is located in the physiographic region of the Ottawa Valley Clay Plains. Surficial geological mapping indicates that the site is underlain by the clay plain consisting of the glaciomarine clay and silt deposits commonly known as the Leda Clay, with lenses of sand. According to the Paleozoic Geology of Southern Ontario map, bedrock at this site consists of interbedded dolomite with sandstone of Beekmantown Group.

3. Field Investigation

The fieldwork program for this supplementary investigation was undertaken between April 17 and 27, 2022, and consisted of the advancement of seven additional boreholes, identified as BH1-23 to BH7-23, drilled to refusal/bedrock. The boreholes were advanced to depths ranging from 4.7 to 10.5 mBGS. Auger refusal was encountered in all boreholes at depths of 0.3 to 1.6 m below grade. Upon encountering auger refusal, all boreholes were extended an additional 3.3 m to 10.2 m into the bedrock using rotary diamond drilling techniques while retrieving HQ sized cores. The locations of these boreholes are illustrated on the Site Location Plan in Figure 1.

The borehole drilling operations were carried out with a rubber-track mounted drill rig, supplied, and operated by Aardvark Drilling Inc., under the supervision of GHD field staff. Boreholes were advanced into the overburden using hollow stem augers with Standard Penetration Tests (SPTs) at regular intervals using a 50-millimetre (mm) diameter split spoon sampler and a 63.5-kilogram (kg) hammer, free falling from a distance of 760 mm, to collect soil samples. The number of drops required to drive the sampler 0.3 m recorded on the borehole logs as "N" value.

Sampling procedures were conducted in accordance with American Society for Testing and Materials (ASTM) Standard D 1586.

Wire line techniques using HQ size cores (96 mm outside diameter and 63.5 mm inside diameter) were used to advance the boreholes into the bedrock. A GHD field personnel documented the percentage recovery, thickness and depths of beddings, rock quality designation (RQD), the amount of water loss/return, and presence of voids or cavities in the bedrock. The rock cores were placed in partitioned wooden core boxes to keep each core run separate with depths of recovery clearly marked. Pictures of recovered cores have been provided in Appendix B. The percentage core recovery and RQD values are provided on the borehole logs included in Appendix A.

Boreholes BH3-23, BH4-23, and BH6-23 were fitted with a monitoring well for groundwater level measurement and hydrogeological assessment. All three monitoring wells were sealed within the bedrock. Measurement for stabilized groundwater level and single well response tests (SWRTs) were completed on April 25, 2023, by GHD personnel.

All monitoring wells were instrumented with 3 m (10-foot) long, 50 mm (2-inch) inside diameter, No. 10 slot, Schedule 40 PVC screen set in the bedrock, and riser pipe. A fresh commercially available silica sand pack was placed in the annular space between the PVC screen/riser pipe and the borehole, from the bottom of the well screen to at least 0.30 m above the top of the well screen. Bentonite seal was placed above the sand pack to within 0.30 m of the ground surface. A protective casing with a concrete collar was placed around each of the monitoring wells upon completion. The monitoring well installation details are shown on the individual borehole logs included in Appendix A.

The elevations of the boreholes were surveyed using a survey grade GPS equipment referenced to the NAD 83 UTM Zone 18 and geodetic datum.

3.1 Laboratory Testing

Following the field work, all of the recovered geotechnical soil samples were transported to our laboratory where they were logged and visually examined. The geotechnical laboratory testing was conducted on representative soil and rock samples collected during the field work. The purpose of these laboratory tests was to determine the geotechnical engineering properties of the subsurface soil and rock for use in analysis. The laboratory tests undertaken are shown in Table 1.

Table 1 Laboratory Testing

Laboratory test	Quantity of tests undertaken
Water content testing	6
Atterberg limits tests	2
Sieve analysis	4
Hydrometer testing	2
Corrosivity testing	2*
UCS testing of rock core	7

Notes: UCS = Unconfined compressive strength
* Including two water samples

The geotechnical laboratory test results are presented in Appendix D. Results of the laboratory testing were used to confirm site soil logging and are discussed in the proceeding relevant subsurface condition section. One water sample from borehole BH4-23 and one water sample from monitoring well BH6-23 were submitted to Eurofins Environment Testing for corrosivity testing parameters including, chloride, sulphate, pH, sulphide, redox potential, and resistivity. The results of chemical testing are included in Appendix D.

4. Subsurface Conditions

The detailed subsoil conditions encountered at the locations of drilled boreholes are presented within the borehole reports located in Appendix A and Appendix B of this report. The following table presents an overview of the depth and elevation of each subsoil stratum encountered at the drilling locations:

Table 2 Summary of Subsurface Conditions

Borehole No.	Ground Surface Elevation (m)	Asphalt Thickness (mm)	Fill Thickness (m)	Silty Clay (m)		Glacial Till (m)		Bedrock (m)		End of Borehole	
				Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
BH1-23	79.8	76	0.4	0.5	79.3			1.5	78.3	4.9	74.9
BH2-23	79.9	51	0.7	0.8	79.1	1.4	78.5	1.6	78.3	9.3	70.6
BH3-23	80.0	38	0.2	-		0.2	79.8	1.1	78.9	9.3	70.7
BH4-23	79.8	51	0.7	0.8	79.0			1.4	78.4	10.5	69.3
BH5-23	80.1	25	0.3	-	-			0.3	79.8	4.7	75.4
BH6-23	80.8	25	0.5	-	-			0.5	80.3	9.4	71.4
BH7-23	80.9	25	0.5	-	-			0.5	80.4	4.8	76.1
BH01-22	80.2	-	0.6	0.6	79.6			-	-	3.6	76.6
BH02-22	79.7	100	0.5	0.6	79.1			2.4	77.3	8.6	71.1
BH03-22	80.7	100	0.5	0.6	80.1			1.4	79.3	3.0	77.7
BH04-22	79.8	100	0.5	0.6	79.2			-	-	1.7	78.1
BH05-22	81.1	100	0.5	0.6	80.5			-	-	0.9	80.2
BH06-22	79.6	100	0.3	-	-			0.4	79.2	3.6	76.0
BH11-22	80.21	-	0.6	0.6	79.6	4.0	75.6	4.1	75.5	7.9	72.3
BH12-22	79.6	-	0.6	0.6	79.0	2.4	76.6	4.4	75.2	7.9	71.7
BH13-22	82.0	-	0.7	-	-	0.7	81.3	1.4	80.6	6.4	75.6

In general, the soils encountered at the borehole locations consisted of a surface layer of asphalt, overlying a fill material and discontinuous layer of native silty clay to clay, overlying sandstone with dolomite interbeds bedrock. Shallow bedrock ranging in depths from 0.3 to 2.4 mBGS was encountered.

General descriptions of the subsurface conditions encountered during current investigation are summarized in the following sections. A graphical representation of each borehole for current investigation are provided on the Geotechnical Logs in Appendix A. The previous investigation borehole reports are provided in Appendix B. Notes on borehole logs are provided in Appendix A. Results from the laboratory testing and a summary table of pertinent laboratory results are presented in Appendix D.

4.1 Pavement Structure and Fill

An asphalt layer with a thickness ranging from 25 to100 mm was encountered at the ground surface at the location of all boreholes. Granular base/subbase (fill material) consisting of sand and gravel to gravelly sand was encountered below the asphalt and extends to depths ranging from 0.2 to 0.8 m.

The fill material was loose to dense and was generally in a moist condition. Water content testing on fill materials returned results ranging from 1 percent to 19 percent. Sieve Analysis tests on four samples of the fill indicated the material consisted of 21 to 57 percent gravel, 29 to 71 percent sand, and 3 to 8 percent fines.

4.2 Silty Clay to Clayey Silt

Silty clay to clayey silt deposits were encountered below the fill layer in boreholes BH1-23, BH2-23, and BH4-23, at depths ranging from 0.5 to 0.8 mBGS (Elevations 79.3 m to 79.0 m).

The SPT "N" values recorded within the silty clay deposit range from 5 blows to 9 blows per 0.3 m of penetration. The water content of two samples of the silty clay to clayey silt was measured at 29 percent and 32 percent. The silty clay has been weathered to form a very stiff to stiff brown crust.

Grain size and Atterberg limits tests were carried out on two samples of this deposit. The laboratory results are included in Appendix D. A review of the results shows that the samples have 70 to 93 percent fines passing the No. 200 sieve, liquid limits between 56 and 65 percent, plastic limits between 17 and 25 percent, and plasticity indices between 31 and 40 percent, classifying the soil a high plasticity clay. Based on the laboratory test results, the clay deposits can be classified as Organic or Fat Clays (CH) in accordance with ASTM D2487. The fat clays are susceptible to volume change with change in moisture content, i.e., would shrink on drying and swell upon wetting.

4.3 Glacial Till

A glacial till deposit was encountered below silty clay in BH2-23, and below fill in BH3-23 at depths of 0.2 m and 1.4 mBGS (Elevations 79.8 m and 78.5 m). The till materials generally comprised of silty sand to gravelly sand with varying proportions of gravel and clay and may contain cobbles and boulders. Grain size distribution test was carried out on one sample of the till deposit and the results are shown in Appendix D.

The SPT "N" values recorded within the till deposit ranged from five blows to more than 50 blows per 0.3 m of penetration, indicative of a loose to very dense state.

The water content measured on one sample of till material is 19 percent.

4.4 Bedrock

Bedrock was encountered at depths ranging from 0.3 to 4.4 mBGS (Elevations 80.6 to 75.2 m). A summary of the bedrock depths and elevation for each borehole is presented in Table 2.

Upon refusal on the presumed bedrock, bedrock was cored in all boreholes to depths ranging from 4.7 m to 10.5 m using HQ diamond coring methods in boreholes BH3-23, BH4-23 and BH6-23 and NQ diamond coring methods in the remaining boreholes to confirm the presence, type, and quality of bedrock.

Based on retrieved rock core and rock exposures, bedrock at the site consisted of slightly weathered to fresh, thinly to medium bedded, light grey to grey-black with yellow bands dolomitic sandstone of the Beekmantown Group per the published Paleozoic geology map.

RQD values measured on the bedrock core samples generally range from 62 to 100 percent, indicating fair to excellent quality rock, except for the bedrock at borehole BH4-23, where RQD values of 45 and 44 percent indicating poor quality rock is noted at depths of 2.1 to 3.2 mBGS and 5.0 to 6.7 mBGS, respectively.

Notes on RQD, solid core recovery (SCR) and total core recovery (TCR) are presented on the borehole logs in Appendix A. Bedrock core photographs are presented in Appendix B.

Unconfined compressive strength (UCS) testing of twelve samples of the sandstone bedrock returned UCS values ranging from 91.1 megapascal (MPa) to 154.6 MPa, resulting in an average value of 128.7 MPa. In accordance with the Canadian Foundation Engineering Manual – 2006 (CFEM), the bedrock is classified as strong to very strong. The results of UCS testing are presented in Appendix D and a summary of the UCS results is presented in Table 3 below.

Table 3 Results of Uniaxial Unconfined Compressive Strength Tests on Selected Bedrock

Borehole No.	Run No.	Sample Depth (m)	Compressive Strength (MPa)
BH2-23	2	3.4 – 3.5	150.0
BH3-23	3	4.3 – 4.5	148.4
BH4-23	4	4.7 – 4.8	145.9
BH4-23	5	6.4 – 6.5	154.6
BH6-23	4	5.3 – 5.5	136.1
BH6-23	5	7.6 – 7.4	127.2
BH7-23	3	3.8 – 3.9	138.3
BH02-22	5	6.5 - 7.5	122.5
BH03-22	2	2.0 - 3.0	91.1
BH06-22	2	1.9 - 3.6	94.2

4.5 Groundwater Conditions

Boreholes BH3-23, BH4-23, and BH6-23 were instrumented as monitoring wells during current investigation and in boreholes BH01-22, BH02-22, BH03-22, BH06-22 BH11-22, and BH12-22 during the previous investigation to allow for groundwater sampling, hydraulic response testing, and measurements of groundwater levels. Groundwater levels were measured in the old monitoring wells on May 26, 2022, and in both the new and old monitoring wells on April 27, 2023. The measured groundwater levels are provided in Table 4 below.

Table 4 Groundwater Elevations

Well ID	Ground Surface (mAMSL)	Screened Unit	May 26, 2022		April 27, 2023	
			Depth (mBGS)	Elevation (mAMSL)	Depth (mBGS)	Elevation (mAMSL)
BH01-22	80.18	Overburden	2.56	77.61	1.57	78.60
BH02-22	79.72	Bedrock	3.21	76.51	2.27	77.45
BH03-22	80.71	Bedrock	1.02	79.69	0.78	79.93
BH06-22	79.61	Bedrock	2.83	76.77	2.84	76.76
BH11-22	80.21	Bedrock	6.02	74.19	5.69	74.52
BH12-22	79.60	Bedrock	2.26	77.34	1.60	78.00
BH3-23	80.02	Bedrock	-	-	1.89	78.14
BH4-23	79.75	Bedrock	-	-	4.50	75.25
BH6-23	80.78	Bedrock	-	-	2.48	78.31

Notes:
mAMSL – metres above mean sea level

Bedrock groundwater levels were measured at depths of 0.78 mBGS (BH03-22) to 6.02 mBGS (BH11-22) corresponding to elevations ranging from 79.93 mAMSL (BH03-22) to 74.52 mAMSL (BH11-22). These groundwater levels are based only on wells where the static groundwater levels have stabilized following well development.

It should be noted that the groundwater table is subject to seasonal fluctuations and in response to precipitation and snowmelt events.

5. Discussion and Recommendations

According to the information provided by the client, the project will consist of the construction of multiple interconnected buildings including a high-rise office and retail building, a 6-story building, and a 4-story parking structure. The buildings are interconnected through one level of underground parking with the lower excavation depth approximately 4.5 m below future site grade.

Structural details were not available at the time this report was prepared; however, it is anticipated that the proposed building foundations will be founded within the underlying bedrock at depth of about 5.0 m below the future site grade (about elevation 75.0 m).

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 geotechnical and hydrogeological recommendations and comments are provided in the following subsections. The following recommendations are provided on the basis that the structures will be designed in accordance with Part 4 of the 2012 Ontario Building Code (OBC).

5.1 Site Preparation and Grading

Based on the conditions encountered in the boreholes, the Site is covered by an asphalt layer or surficial topsoil layer overlying earth fill material followed by a discontinuous layer of native silty clay to clayey silt and glacial till and ultimately overlying dolomitic sandstone bedrock.

The site topography is noted to be relatively flat, hence significant grade raises are not anticipated as part of the proposed development plan.

Initial site preparation within the proposed structure footprints would require removal of existing topsoil, fill, deleterious materials, and disturbed native in order to expose the underlying native soils or bedrock. Within the proposed pavement footprint, the existing fill below anticipated subgrade levels may remain in place as long as the material is proven to be competent, stable, and free of any organics and deleterious materials.

Prior to site grading activity, the exposed subgrade soils should be visually inspected, compacted, and proof rolled under examination by geotechnical personnel using large axially loaded equipment. Any soft, organic, or unacceptable areas should be removed as directed by the qualified geotechnical personnel and replaced with suitable engineered fill materials compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). Recommendations regarding placement of engineered fill are provided in Sections 5.8 of this report.

The granular fill material, free of topsoil/organic and rootlets, encountered at the site might be suitable for reuse as backfill to raise site grades, where required, or as trench backfill during installation of buried services, provided they are free of organic material, and are within the optimum moisture content. The surficial fill at this site should not be used as backfill against the foundation elements. Native soils with high proportions of silt and clays will be difficult to compact and are also susceptible to volume change with change in volume and therefore should not be used for backfilling under or around structure or for raising grades in the proposed pavement areas.

Reclaimed asphalt pavement (RAP) and/or reclaimed concrete material (RCM) may be used on this project as granular as stated in OPSS.MUNI 1010 "Material Specification for Aggregates – Base, Subbase, Select Subgrade and

Backfill Material" and as amended by City of Ottawa specification F-3142 "Reclaimed Asphalt Pavement (RAP) for Road Base".

5.2 Bulk Excavation

Considering one level of underground parking at all building locations, an excavation depth of up to 5.0 m is assumed for this project, as is presented on the provided Nokia Master Site Plan. The excavation will be carried out through topsoil or pavement structure fill layers followed by stiff to very stiff silty clay to clayey silt layer and silty sand to gravelly sand till, and ultimately the underlying bedrock. These excavations will extend below the groundwater beyond a depth of approximately 0.8 m to 6.0 m below site grade.

5.2.1 Overburden Excavation

All excavations should be completed and maintained in accordance with the Occupational Health and Safety Act (OHSA) requirements. The following recommendations for excavations should be considered to be a supplement to, not a replacement of, the 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 5 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 (H) to one vertical (V)
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 (O. Reg.) 213/91, s. 226 (5).

No unusual problems are anticipated in excavating the soil using conventional excavating equipment. 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. Furthermore, no vertical unbraced excavations should be performed in the soil.

Depending on the weather 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 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.

5.2.2 Bedrock Excavation

Within the bedrock, near-vertical excavations (10V:1H within sound bedrock) can be considered for this project. Bedrock at the site was noted to generally be good to excellent quality and strong to very strong.

Based on our experience with similar projects, the excavation of the upper portion of the fractured rock may potentially be 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 these works.

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.

5.2.3 Temporary Drainage

Surface water seepage is expected in the excavation. Based on the excavation depth of about 4.5 to 5 m, groundwater seepage is expected in the excavated areas. Groundwater levels depend on seasonal conditions and dewatering may need to be reassess especially where any variation in depth of excavations is proposed or where excavations are left open. Conventional construction dewatering techniques should be undertaken during construction, such as pumping from sumps and or ditches. Additional information on groundwater control during the construction is provided in Section 5.7 and in the Hydrogeologic Assessment memorandum, attached in Appendix F for reference.

5.3 Foundations

In general, the subsurface conditions in the area of the proposed developments consist of fill/topsoil overlying discontinuous deposit of silty clay to clayey silt and glacial till, over bedrock. The depth to bedrock is variable across the site, ranging from elevations 78.3 m to 80.4 m (i.e., 1.6 to 0.3 mbgs). Considering one level of underground parking at all building locations to depth of about 5.0 m below the ground, the foundations of the new buildings should consist of conventional spread and/or strip footings resting on sound bedrock, clean and free of weathering or loose fragments.

Footings placed on sound sandstone bedrock can be designed using a factored bearing capacity value at Ultimate Limit State (ULS) of 3.0 MPa. The factored ULS value includes the geotechnical resistance factor (Φ) of 0.5 for shallow foundations. Serviceability Limit State (SLS) resistance do not apply to footings founded on the bedrock, since the SLS resistance is greater than the factored bearing capacity at ULS.

The bedrock surface should be covered with a minimum 50 mm thick mat of high-slump 0.4 to 1 MPa unshrinkable concrete to provide a smooth working surface and to fill any low depressions and 'nook' and crannies'.

5.4 Frost Protection

All of the exterior building foundations (exterior pile caps, grade beams, footings, etc.) for heated structures should be placed at least 1.5 m beneath the final exterior grade in order to provide adequate frost protection.

Building foundations for unheated structures or isolated exterior foundations (retaining walls, signs, lamp posts, etc.) should be placed at least 1.8 m beneath the final exterior grade in order to provide adequate frost protection.

5.5 Seismic Site Classification

The 2020 Ontario Building Code (OBC) requires the assignment of a seismic site class for calculations of earthquake design forces and the structural design based on a 2 percent probability of exceedance in 50 years. According to the 2020 OBC, the seismic site class is a function of soil profile and is based on the average properties of the subsoil strata to a depth of 30 m below the ground surface. The 2012 OBC provides the following three methods to obtain the average properties for the top 30 m of the subsoil strata:

- Average shear wave velocity.
- Average Standard Penetration Test (SPT) values (uncorrected for overburden).
- Average undrained shear strength.

For this Site, the average shear wave velocity within the upper 30 m of the soil profile (Vs30) immediately below the founding level of the buildings were obtained using Multi-Channel Analysis of Surface Waves (MASW). Based on the calculations presented in MASW Investigation Memorandum presented in Appendix E, the average shear wave velocity (from 4.5 mBGS to 34.5 mBGS) along the two investigation lines is 1480 metres per second (m/s). In accordance with Table 4.1.8.4.A of the OBC 2020 and based on presented data in Table 2 attached to the MASW Memorandum, the measured average shear wave velocity indicates the Site can be classified as Class 'B' for the seismic load calculations.

The seismic hazards for the site as obtained from Natural Resources Canada (NRC) website are provided as Appendix E to this report.

5.6 Floor Slabs

A conventional slab-on-grade, structurally separated from the columns and foundation walls, can be used for the lowest basement level floor slab of the buildings on the site prepared as discussed in Sections 5.1. Based on the borehole data, the subgrade beneath a slab-on-grade within the investigated area is expected to comprise of native soil or sandstone bedrock.

Specifically, the native soil at the site is suitable to support the slab-on-grade provided unsuitable materials that may be present are removed and the exposed subgrade is proof-rolled, recompacted, and inspected by qualified geotechnical personnel. If grades are to be raised, then suitable engineered fill should be placed as discussed in Section 5.9. Prior to the placement of the floor slab or any fill materials used to raise grades, the subgrade should be inspected by geotechnical staff for obvious soft or loose areas. Areas found to be soft should be sub excavated and replaced with compacted fill as described herein.

A layer consisting of Granular 'A' at least 200 mm thick and combined with a drainage system as specified in Section 5.7.1 should be placed immediately below the floor slabs to support the slab-on-grade. 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.

The slabs should not be tied into the foundation walls. Construction and control joints in the concrete should be designed by a suitably qualified and experienced engineer.

5.7 Groundwater Control

Based on groundwater measurements (for wells sealed within the soil and bedrock), the groundwater level across the Site appears to vary between elevations 79.93 m and 74.52 m. Calculated horizontal hydraulic conductivity values in sandstone bedrock ranged from 2.1×10^{-6} centimetres per second (cm/sec) to 9.2×10^{-4} cm/sec with a geometric mean of 3.9×10^{-5} cm/sec

Based on the groundwater levels and design mass excavation, the excavation will be below the groundwater table and excavations for utility trenches may potentially also extend below the groundwater level and some form of proactive dewatering is expected to be required.

Further discussion of the hydrogeologic assessment results is provided in the Hydrogeologic Assessment memorandum, attached in Appendix F. According to the Hydrogeological Assessment carried out, the dewatering rates of 34,720 Liter per day (L/day) and 104,160 L/day was estimated for the construction dewatering and long-term groundwater control structures, respectively.

According to O. Reg. 63/16 and O. Reg. 387/04, if the volume of water to be pumped from excavations for the purpose of construction dewatering is greater than 50,000 L/day a Permit to Take Water (PTTW) is required from the Ministry of the Environment, Conservation and Parks (MECP). According to O. Reg. 63.16, if short-term construction site dewatering is greater than 50,000 L/day but less than 400,000 L/day, registry with the Environmental Activity Sector Registry (EASR) is sufficient and PTTW is not required. Based on the preliminary groundwater inflow estimates provided above, water taking exceeding 400,000 L/day will not be required for this Site and PTTW will not be required for construction dewatering.

Assuming excavations for all three structures will be completed simultaneously, the estimated dewatering rates, including a 3× factor of safety for groundwater seepage, are above the threshold that require registry with the EASR but below the threshold requiring a PTTW.

Long-term, permanent, dewatering rates of 34,720 L/day are expected to control groundwater after construction. Therefore, the water taking associated with long-term dewatering would not require a PTTW.

It should be noted that the SWRTs used to estimate the hydraulic conductivity of the overburden and bedrock tests the immediate vicinity of the well. SWRTs do not provide an indication of the long-term availability of groundwater to recharge the well. Accordingly, it is possible that the instantaneous recharge to the bedrock wells is extremely fast, but the long-term effects of dewatering may result in progressively lower groundwater intrusion over time.

Below sections provide additional recommendations for permanent drainage, perimeter drainage and sub-floor drainage.

5.7.1 Permanent Drainage

5.7.1.1 Underfloor Drainage

Under floor drains are recommended for structures with underground levels. The drains should be connected to a frost-free outlet for year-round drainage. For preliminary purposes, the under-slab drainage system should consist of:

- 300 mm thick clear stone (20-5 mm) having a permeability of 1 cm/s or more, compacted with a heavy compactor. Moreover, a Texel geotextile membrane or equivalent should be placed between the crushed stone and sand deposit fill to avoid clogging of the clean crushed stone and reducing the thickness of the drainage layer.
- 100 mm (4") perforated drainpipes spaced at 4 to 6 m centre to centre, connected to sufficient capacity collectors depending on the area covered by the drainpipes.
- A sump pump of sufficient capacity with an additional half design-capacity pump for uninterrupted service in low discharge periods, with proper backup system.

It is recommended that the underside of the basement floor slab be protected with a waterproofing membrane to prevent water penetration into the basement level.

5.7.1.2 Perimeter Drainage

Where foundation walls are present, it is recommended that Composite Drainage Blanket (CDB) or geo-drain be used for the perimeter walls. There are several commercially available product liens available. The CDB should be connected by a collection piping system and drained to a frost-free outlet for year-round drainage.

As the underground portion of the structure is anticipated to be below the water table, it is also recommended that the exterior walls be protected with a waterproofing membrane applied to the wall in addition to the CDB.

5.7.1.3 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.

5.8 Corrosion Potential of Soils

Analytical testing on one soil sample and three water samples were undertaken to assess the corrosion potential of buried concrete and steel structural elements. The test results are provided in Appendix D and summarized in Table 9.

Table 6 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 (Mohm-cm)	Redox Potential (mV)
BH4-23	-	1176	354	7.71	<0.2	288
BH6-23	-	1310	730	7.72	<0.2	289
BH01-22, SS2	2.3 - 2.7	0.067	0.04	7.79	<0.2	210
BH02-22	-	820	220	7.54	<0.2	237

Based on the results obtained for the samples submitted, the soil and groundwater at the site are considered to be extremely 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 the soil sample and between 220 milligram per litre (mg/L) to 730 mg/L in the water samples. Based on the test results and Table 3 of the Canadian Standards Association (CSA) document A23.1-19/A23.2-19 '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 moderate. Therefore, moderate sulphate resistance (MS) cement should be used for the below grade concrete structures.

5.9 Building Backfill

Where it is required to have the placement and compaction of the granular materials and these will support the floor slabs, foundations, pavement, or any interior backfill then these materials must be treated as Engineered Fill.

5.9.1 Engineered Fill

The fill operations for Engineered Fill must satisfy the following criteria:

- Engineered Fill must be placed under the continuous supervision of the Geotechnical Engineer.
- Prior to placing any Engineered Fill, all unsuitable existing fill, topsoil, and deleterious materials must be removed. Following this the subgrade should be proof rolled with any weak/soft areas being over excavated and replaced with engineered fill.
- Prior to the placement of Engineered Fill, the source or borrow areas for the Engineered Fill must be evaluated for its suitability. Samples of proposed fill material must be provided to the Geotechnical Engineer and tested in the geotechnical laboratory for SPMDD and grain size, prior to approval of the material for use as Engineered Fill. The Engineered Fill must consist of environmentally suitable soils (as per industry standard procedures of federal or provincial guidelines/regulations), free of organics and other deleterious material (building debris such as wood, bricks, metal, and the like), compactable, and of suitable moisture content so that it is within -2 percent to +0.5 percent of the Optimum Moisture as determined by the Standard Proctor test. Imported granular soils meeting the requirements of Granular 'A', or 'B' Type II Ontario Provincial Standard Specifications (OPSS) 1010 criteria would be suitable.
- The Engineered Fill must be placed in maximum loose lift thicknesses appropriate to the compaction equipment utilized. Typical loose thicknesses range from 0.2 m to 0.3 m. Each lift of Engineered Fill must be compacted to 100 percent SPMDD using an appropriately sized roller, suitable for the fill material.
- Field density tests must be taken by the Geotechnical Engineer, on each lift of Engineered Fill. Any Engineered Fill, not meeting compaction specifications, shall be removed or re-compacted and retested.

5.9.2 Exterior Foundation Wall Backfill

Where applicable and/or if necessary, any backfill placed against the foundation walls should be free draining granular materials meeting the grading requirements of OPSS 1010 for Granular 'B' Type I specifications up to within 0.3 m of the ground surface. The upper 0.3 m should be a low permeable soil to reduce surface water infiltration. Foundation backfill should be placed and compacted as outlined below.

- Free-draining granular backfill should be used for the foundation wall.
- Backfill should not be placed in a frozen condition or placed on a frozen subgrade.
- Backfill should be placed and compacted in uniform lift thickness compatible with the selected construction equipment, but not thicker than 0.2 m. Backfill should be placed uniformly on both sides of the foundation walls to avoid build-up of unbalanced lateral pressures.
- At exterior flush door openings, the underside of sidewalks should be insulated, or the sidewalk should be placed on frost walls to prevent heaving. Granular backfill should be used and extended laterally beneath the entire area of the entrance slab. The entrance slab should slope away from the building.

- For backfill that would underlie paved areas, sidewalks, or exterior slabs-on-grade, each lift should be uniformly compacted to at least 98 percent of its SPMDD.
- For backfill on the building exterior that would underlie landscaped areas, each lift should be uniformly compacted to at least 95 percent of its SPMDD.
- In areas on the building exterior where an asphalt or concrete pavement will not be present adjacent to the foundation wall, the upper 0.3 m of the exterior foundation wall backfill should be a low permeable soil to reduce surface water infiltration.
- Exterior grades should be sloped away from the foundation wall, and roof drainage downspouts should be placed so that water flows away from the foundation wall.

5.10 Underground Services

5.10.1 Bedding and Cover

Underground service lines, if any, can be founded on either undisturbed native soils or on bedrock. The suitability of the foundation soils to provide adequate support for buried services must be verified and confirmed on site at the time of construction/installation by qualified geotechnical personnel experienced in such work.

The following are recommendations for service trench bedding and cover materials that may be associated with the development.

- Bedding for buried utilities should consist of 150 mm Granular 'A' and placed in accordance with City of Ottawa specifications.
- The cover material, from bedding level to at least 300 mm above the top of pip, should consist of Granular 'A' or Granular B Type I and the dimensions should comply with City of Ottawa standards.
- The bedding material and cover materials should be compacted as per City of Ottawa standards and to at least 95 percent of its SPMDD.
- Compaction equipment should be used in such a way that the utility pipes are not damaged during construction.

5.10.2 Service Trench Backfill

Backfill above the cover for buried utilities should be in accordance with the following recommendation:

- The backfill should be placed and compacted in uniform thickness compatible with the selected compaction equipment and not thicker than 200 mm. Each lift should be compacted to a minimum of 95 percent SPMDD.
- The upper 300mm of the backfill below pavement subgrade areas should be compacted to a minimum of 100 percent SPMDD.
- To reduce the potential for differential settlement and frost heave, the selected backfill materials should reasonably match the existing soil profile within the frost penetration zone (1.5 m below finished grade). Alternatively, if imported backfill, including granular materials, are used then the excavation sides should have frost tapers - essentially there should be a back slope of 10H:1V from the bedding grade to the finished grade.
- If the native excavated soils are used as backfill, this material should be protected from moisture increases during construction. The native excavated soils should be assessed and approved by the Geotechnical staff prior to placement.

5.11 Pavement Design Recommendations

Access driveways and parking areas are expected to be constructed over native stiff silty clay to clay, glacial till, bedrock, or engineered fill. In order to prepare the site for the pavement area, it is necessary that the area be stripped of any existing cover materials such as surficial topsoil, or any other deleterious materials deemed unsuitable by geotechnical personnel to expose a suitable subgrade. The exposed subgrade should be proof rolled in the presence of a Geotechnical Engineer. Any areas where "soft spots", rutting, local anomalies, or appreciable deflection are noted should be excavated and replaced with suitable fill. In problematic areas the use of geotextiles may be warranted for strength improvement. The fill placed to repair a subgrade should be compacted to at least 98 percent of its SPMDD.

The preliminary pavement sections described in the table below are recommended for areas subjected to parking lot and access road. GHD could review these preliminary pavement structures should Nokia provide GHD with project traffic design parameters. Pavement materials and workmanship should conform to the appropriate OPSS.

Table 7 Recommended Pavement Structure - 20 Year Design Life

Pavement Structure Elements	Compaction Requirement	Layer Thicknesses (mm)	
		Standard Duty (Car Parking Areas)	Heavy Duty (Access Roads)
Surface Course OPSS 1150 HL3 Hot Mix	OPSS 310, Table 10	50	40
Base Course OPSS 1150 HL8 HS Hot Mix Asphalt	OPSS 310, Table 10	-	50
Granular A Base (19 mm crusher run limestone)	100% SPMDD	150	150
Granular B Type I Subbase (Sand and Gravel)	100% SPMDD	250	500

In order to accommodate the recommended thicknesses, designers will need to review grades and determine where stripping or filling is necessary. Pavement materials and workmanship should conform to the appropriate OPSS.

To maintain the integrity of the pavement at the Site, filter-cloth wrapped 100 mm diameter PVC perforated subdrains should be installed at all catch basins (3 m stubs in the upgradient direction) and all along the perimeter of the parking lot. The invert of the subdrains should be at least 300 mm below the bottom of the subbase and should be sloped to drain to adjacent catch basins. The subdrains should be installed in a 300 mm by 300 mm trench lined by suitable geotextile and consist of a 100 mm diameter perforated pipe wrapped in a suitable geotextile and surrounded with a minimum thickness of 50 mm of free draining sand such as clear stone wrapped with a filter cloth or concrete sand.

Grading adjacent to pavement areas should be designed so that water is not allowed to pond adjacent to the outside edges of the pavement. Surface runoff should be directed to storm sewers or allowed to flow into ditches.

Annual or regular maintenance will be required to achieve maximum life expectancy. Generally, the asphalt pavement maintenance will involve crack sealing and repair of local distress.

It should be noted that the preliminary pavement sections described within this report represent end-use conditions only, which includes light vehicular traffic and occasional garbage or service trucks. It may be necessary that these sections be temporarily over-built during the construction phase to withstand larger construction loadings such as loaded dump trucks or concrete trucks. Pavement design for the new road dissecting the property into commercial and residential sections can be provided during the detail design when project traffic design parameters are available.

5.12 Construction Field Review

The recommendations provided in this report are based on an adequate level of construction monitoring being conducted during construction phase of the proposed building. GHD requests to be retained to review the drawings and specifications, once complete, to verify that the recommendations within this report have been adhered to, and to look for other geotechnical problems. Due to the nature of the proposed development, an adequate level of construction monitoring is considered to be as follows:

- Prior to construction of footings, the exposed foundation subgrade should be examined by a Geotechnical Engineer or a qualified Technologist acting under the supervision of a Geotechnical Engineer, to assess whether the subgrade conditions correspond to those encountered in the boreholes, and the recommendations provided in this report have been implemented.

- A qualified Technologist acting under the supervision of a Geotechnical Engineer should monitor placement of Engineered Fill underlying floor slabs.
- Backfilling operations should be conducted in the presence of a qualified Technologist on a part time basis, to ensure that proper material is employed, and specified compaction is achieved.
- Placement of concrete should be periodically tested to ensure that job specifications are being achieved.

6. Scope and Limitation

This report has been prepared by GHD for First Gulf and may only be used and relied on by First Gulf for the purpose agreed between GHD and First Gulf as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Nokia Inc. arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 6 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

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 exercised 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 or 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 are completed.

Figures

LEGEND

- PROPERTY BOUNDARY
- PROPERTY BUILDING OUTLINE
- ☒ SOIL SAMPLING LOCATION (GHD, 2022)
- ■ BOREHOLE LOCATION (GHD, 2022)
- ■ BOREHOLE LOCATION (GHD, 2023)
- ● MONITORING WELL (GHD, 2022)
- ● MONITORING WELL (GHD, 2023)

0 25 50 75m
1:2500
Coordinate System:
UTM with NAD83 datum,
Zone 18, Meter;

FIRST GULF
NOKIA PROPERTY REDEVELOPMENT
GEOTECHNICAL INVESTIGATION
600 MARCH ROAD, KANATA (OTTAWA), ON

SITE LOCATION PLAN

Project No. **12606873**
Date **June 2023**

FIGURE 1

Filename: \\ghdnet\ghd\CA\Ottawa\Projects\661\12606873\Digital_Design\ACAD\Figures\RPT001-Geotech\12606873-GHD-00-00-RPT-EN-D101_WA-001- Geotech, jm.dwg
Plot Date: 12 June 2023 11:55 AM

Appendices

Appendix A

Geotechnical Borehole Logs – Current Investigation

Notes on Borehole and Test Pit Reports

Soil description :

Each subsurface stratum is described using the following terminology. The relative density of granular soils is determined by the Standard Penetration Index ("N" value), while the consistency of clayey sols is measured by the value of undrained shear strength (Cu).

Classification (Unified system)

Clay	< 0.002 mm		
Silt	0.002 to 0.075 mm		
Sand	0.075 to 4.75 mm	fine	0.075 to 4.25 mm
		medium	0.425 to 2.0 mm
		coarse	2.0 to 4.75 mm
Gravel	4.75 to 75 mm	fine	4.75 to 19 mm
		coarse	19 to 75 mm
Cobbles	75 to 300 mm		
Boulders	>300 mm		

Terminology

"trace"	1-10%
"some"	10-20%
adjective (silty, sandy)	20-35%
"and"	35-50%

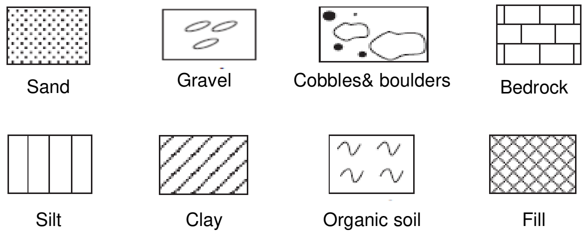
Relative density of granular soils	Standard penetration index "N" value
	(BLOWS/ft – 300 mm)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Consistency of cohesive soils	Undrained shear strength (Cu)	
	(P.S.F)	(kPa)
Very soft	<250	<12
Soft	250-500	12-25
Firm	500-1000	25-50
Stiff	1000-2000	50-100
Very stiff	2000-4000	100-200
Hard	>4000	>200

Rock quality designation

"RQD" (%) Value	Quality
<25	Very poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

STRATIGRAPHIC LEGEND



Samples:

Type and Number

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

SS: Split spoon
SSE, GSE, AGE: Environmental sampling
ST: Shelby tube
PS: Piston sample (Osterberg)
AG: Auger
RC: Rock core
GS: Grab sample

Recovery

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil

RQD

The "Rock Quality Designation" or "RQD" value, expressed as percentage, is the ratio of the total length of all core fragments of 4 inches (10 cm) or more to the total length of the run.

IN-SITU TESTS:

N: Standard penetration index
R: Refusal to penetration
N_c: Dynamic cone penetration index
Cu: Undrained shear strength
Pr: Pressure meter
k: Permeability
ABS: Absorption (Packer test)

LABORATORY TESTS:

I_p: Plasticity index
W_l: Liquid limit
Wp: Plastic limit
H: Hydrometer analysis
GSA: Grain size analysis
A: Atterberg limits
w: Water content
γ: Unit weight
C: Consolidation
CS: Swedish fall cone
CHEM: Chemical analysis
O.V.: Organic vapor

REFERENCE No.: 12606873

BOREHOLE No.: BH1-23

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash

CHECKED BY: John McAuley

DATE (START): 17 April 2023

DATE (FINISH): 17 April 2023

LEGEND

☒	SS	- SPLIT SPOON
▨	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
▮	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021881

EASTING: 428021

ELEVATION: 79.8

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p ├─┤ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	PIEZOMETER/ STANDPIPE INSTALLATION
			GROUND SURFACE									
0.1	79.7		ASPHALT (76 mm)									
			FILL: SAND and GRAVEL, trace silt, brown to grey, loose (Granular Subbase)	☒								
0.5	79.3		NATIVE: SILTY CLAY to CLAYEY SILT (Weathered Crust), some sand and gravel, brown, moist, stiff oxidized	☒	SS1	12-14-37-37		41.7	29	2-3-2-2	5	
				☒	SS2			83.3	--	1-3-5-5	8	
1.5	78.3		DOLOMITIC SANDSTONE, oxidization, grey, moderate to fresh Weathered (W3-W1), medium Strong (R3), thinly bedded									▼ 4/27/2023
					Run1			97	--	76	97	
					Run2			99	--	89	98	
4.9	74.9		**END OF BOREHOLE**									

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12606873\TECH\GINT LOGS\12606873 LOG-GEOTECH.GPJ Library File: 12606873 GHD_GEOTECH_V10.GLB Report: 12606873 SOIL LOG Date: 12/6/23

REFERENCE No.: 12606873

GHD

BOREHOLE No.: BH1-23

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 17 April 2023 DATE (FINISH): 17 April 2023

LEGEND

☒ SS - SPLIT SPOON
⧄ ST - SHELBY TUBE
◫ VA - VANE SHEAR
◧ AU - AUGER PROBE
⧅ GS - GRAB SAMPLE
▼ - WATER LEVEL

NORTHING: 5021881 EASTING: 428021 ELEVATION: 79.8

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	△ Undisturbed Vane Value (kPa) ☐ Remoulded Field Vane Value (kPa) △³ Number refer to Sensitivity ○ Water content (%) W_p ⊢⊣ W_l Atterberg limits (%) ● "N" Value (blows / 12 in.-30 cm)	PIEZOMETER/ STANDPIPE INSTALLATION
Feet	Metres			GROUND SURFACE			%	MPa	%	%	%	%	10 20 30 40 50 60 70 80 90	
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5			**NOTE:** - End of the borehole at 4.9 m bgs. - Water level at 1.5 m bgs (Elevation 78.3 m) on April 27, 2023. - bgs means below ground surface.										

REFERENCE No.: 12606873

BOREHOLE No.: BH2-23

ELEVATION: 79.9 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 20 April 2023 DATE (FINISH): 20 April 2023

LEGEND

☒	SS	- SPLIT SPOON
◿	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021836 EASTING: 427997 ELEVATION: 79.9

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	PIEZOMETER/ STANDPIPE INSTALLATION
0		GROUND SURFACE								
0.1	79.8	ASPHALT (51 mm)								
		FILL: SAND AND GRAVEL, trace silt, grey to brown, wet, loose	SS1			37.5	--	11-6-2-2	8	
0.8	79.1	NATIVE: SILTY CLAY (Weathered Crust), some sand and gravel, brown to grey, moist to wet, stiff, oxidized	SS2			70.8	--	2-3-4-5	7	
1.4	78.5	SILTY SAND, trace gravel, brown, wet, loose, oxidized	SS3			100.0	--	4-2- 50+/100mm	50	
1.6	78.3	DOLOMITIC SANDSTONE, some oxidization, non-porous, grey, slightly Weathered (W2), very Strong (R5), thinly bedded								
			Run1			93	--	87	93	▼ 4/27/2023
		some oxidization								
			Run2		150.0	100	--	96	100	
		grey with black banding, Strong								

REFERENCE No.: 12606873

BOREHOLE No.: BH2-23

ELEVATION: 79.9 m (GEODETIC)

BOREHOLE REPORT

Page 2 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash
CHECKED BY: John McAuley

DATE (START): 20 April 2023
DATE (FINISH): 20 April 2023

LEGEND

☒	SS	- SPLIT SPOON
⧄	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021836
EASTING: 427997
ELEVATION: 79.9

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p ⊢⊣ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE										
17														
						Run3			99	--	62	97		
18	5.5													
19														
	6.0													
20														
21														
	6.5													
22														
						Run4			100	--	100	100		
23	7.0													
24														
	7.5													
25														
				grey										
26	8.0													
27														
28	8.5					Run5			94	--	88	92		
29														
	9.0													
30														
	9.3	70.6		**END OF BOREHOLE** **NOTE:** - End of the borehole at 9.3 m bgs. - Groundwater at 1.3 m upon completion of drilling. - Water level at 2.2 m bgs (Elevation 77.7 m) on April 27, 2023. - bgs means below ground surface.										
31	9.5													
32														

REFERENCE No.: 12606873

BOREHOLE No.: BH3-23

ELEVATION: 80.0 m (GEODETIC)

BOREHOLE REPORT

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CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash

CHECKED BY: John McAuley

DATE (START): 17 April 2023

DATE (FINISH): 17 April 2023

LEGEND

☒	SS	- SPLIT SPOON
▨	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
◹	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021847

EASTING: 427929

ELEVATION: 80.0

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
			GROUND SURFACE									
0	0.0	80.0	ASPHALT (38 mm)									Sand and Concrete
	0.2	79.8	FILL: SAND and GRAVEL, trace silt, brown, moist, loose (Granular Subbase)									0.2 m
1–2	0.5		NATIVE: GRAVELLY SAND, trace silt and clay, brown, moist, loose	SS1			41.7	--	4-3-2-1	5	●	
3	1.0		loose to very dense	SS2	21-71-(8)		100.0	19	1-1-50/51mm	51/203 mm	○	
4	1.1	78.9	DOLOMITIC SANDSTONE, light grey, slightly weathered to fresh (W2-W1), very Strong (R5), thinly bedded, non-porous									Bentonite
5	1.5			Run1			100	--	71	96		
6	2.0		with oxidation at joints, light grey with orange partings									▼ 4/27/2023
8	2.5											2.4 m Sand
9				Run2			83	--	65	82		2.7 m
10–13	3.0–4.0											
14												Screen
15	4.5			Run3		148.4	100	--	87	98		
16												

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REFERENCE No.: 12606873

BOREHOLE No.: BH3-23
ELEVATION: 80.0 m (GEODETIC)

BOREHOLE REPORT

Page 2 of 2

CLIENT: First Gulf
PROJECT: Geotechnical Investigation-Nokia Campus
LOCATION: 600 March Road, Ottawa, Ontario
DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley
DATE (START): 17 April 2023 DATE (FINISH): 17 April 2023

LEGEND

- ☒ SS - SPLIT SPOON
- ⧄ ST - SHELBY TUBE
- ◫ VA - VANE SHEAR
- ◨ AU - AUGER PROBE
- ⧅ GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5021847 EASTING: 427929 ELEVATION: 80.0

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
△ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
17				grey to black										
18	5.5													
19														5.8 m
	6.0					Run4			100	--	68	98		
20														6.1 m
21	6.5													
22														
23	7.0													
24														
	7.5					Run5			100	--	77	95		
25														
26	8.0													
27														
28	8.5													
29						Run6			100	--	75	100		
	9.0													
30														
	9.3	70.7		**END OF BOREHOLE**										9.3 m
31	9.5													
32														

NOTE:
- End of the borehole at 9.3 m bgs.
- Water level at 1.9 m bgs (Elevation 78.1 m) on April 27, 2023.
- bgs means below ground surface.

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REFERENCE No.: 12606873

BOREHOLE No.: BH4-23
ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 3

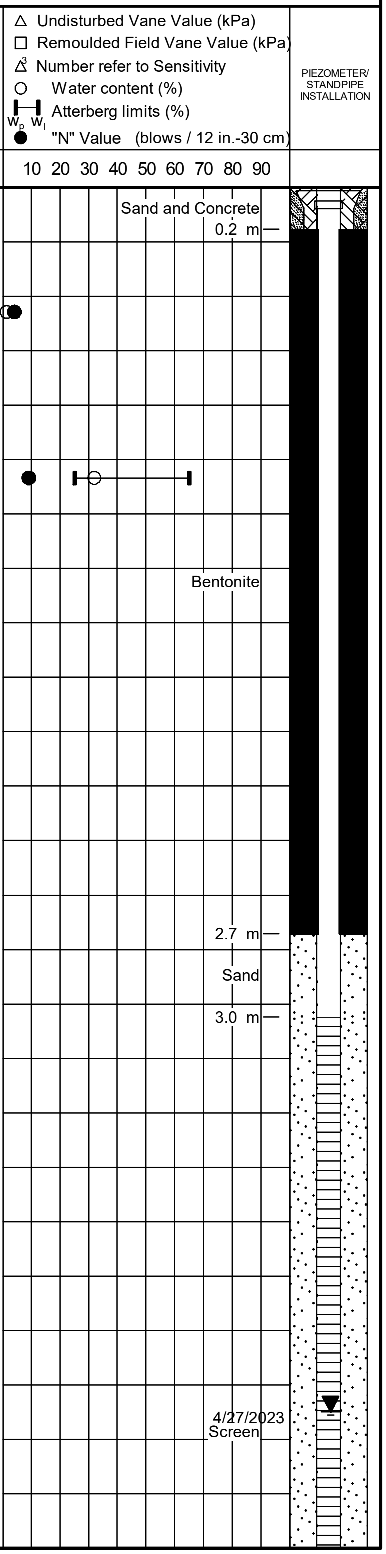
CLIENT: First Gulf
PROJECT: Geotechnical Investigation-Nokia Campus
LOCATION: 600 March Road, Ottawa, Ontario
DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley
DATE (START): 18 April 2023 DATE (FINISH): 18 April 2023

LEGEND

- ☒ SS - SPLIT SPOON
- ▨ ST - SHELBY TUBE
- ◫ VA - VANE SHEAR
- ◨ AU - AUGER PROBE
- ⧅ GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5021917 EASTING: 427959 ELEVATION: 79.8

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %
		GROUND SURFACE							
0.1	79.7	ASPHALT (51 mm)							
		FILL: SAND and GRAVEL, trace silt, grey to brown, moist, loose	SS1	57-40-(3)		25.0	1	6-2-2-5	4
0.8	79.0	NATIVE: SILTY CLAY to CLAYEY SILT, some sand, trace gravel, grey to brown, moist, very stiff, oxidized	SS2	9-21-39-31		75.0	32	3-4-5-7	9
		grey/brown to orange	SS3			100.0	--	50/102mm	50/102 mm
1.4	78.4	DOLOMITIC SANDSTONE, light grey with orange partings, Fresh (W1), very Strong (R5), thinly bedded, non-porous	Run1			100	--	80	100
		some oxidization	Run2			100	--	46	96
			Run3			100	--	82	96
		dark grey	Run4		145.9	96	--	78	91



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REFERENCE No.: 12606873

BOREHOLE No.: BH4-23

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 18 April 2023 DATE (FINISH): 18 April 2023

LEGEND

☒ SS - SPLIT SPOON
◿ ST - SHELBY TUBE
◫ VA - VANE SHEAR
◨ AU - AUGER PROBE
⧅ GS - GRAB SAMPLE
▼ - WATER LEVEL

NORTHING: 5021917 EASTING: 427959 ELEVATION: 79.8

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p ├─┤ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE										
17				grey to grey/black										
18	5.5													
19						Run5		154.6	91	--	44	97		
	6.0													
20														6.1 m
21														6.4 m
	6.5													
22														
23	7.0													
24						Run6			100	--	77	97		
	7.5													
25														
26	8.0													
27														
28	8.5													
29						Run7			100	--	83	93		
	9.0													
30														
31	9.5													
32														

REFERENCE No.: 12606873

GHD

BOREHOLE No.: BH4-23

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 18 April 2023 DATE (FINISH): 18 April 2023

LEGEND

☒	SS	- SPLIT SPOON
◪	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021917 EASTING: 427959 ELEVATION: 79.8

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
33						Run8			97	--	81	71		
34														
	10.5	69.3		**END OF BOREHOLE** **NOTE:** - End of the borehole at 10.5 m bgs. - Water level at 4.5 m bgs (Elevation 75.3 m) on April 27, 2023. - bgs means below ground surface.									10.5 m	
35														
36	11.0													
37														
	11.5													
38														
39														
	12.0													
40														
41	12.5													
42														
	13.0													
43														
44														
	13.5													
45														
46	14.0													
47														
	14.5													
48														
49														

REFERENCE No.: 12606873

BOREHOLE No.: BH5-23

ELEVATION: 80.1 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 20 April 2023 DATE (FINISH): 20 April 2023

LEGEND

☒	SS	- SPLIT SPOON
⧄	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021922 EASTING: 427899 ELEVATION: 80.1

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	PIEZOMETER/ STANDPIPE INSTALLATION
			GROUND SURFACE								
0	0.0	80.1	ASPHALT (25 mm)								
			FILL: SAND and GRAVEL, trace silt, brown/grey, wet, very dense	SS1	50-46-(4)		100.0	7	50/152mm	50/152 mm	
1	0.3	79.8	DOLOMITIC SANDSTONE, moderately weathered to fresh (W3-W1), grey to grey/black, Strong (R4), thinly bedded								
3	1.0			Run1			100	--	59	94	
8	2.5			Run2			100	--	88	97	
13	4.0			Run3			100	--	79	98	
14	4.5										▼ 4/27/2023
15	4.7	75.4	**END OF BOREHOLE**								
16			**NOTE:**								

REFERENCE No.: 12606873

BOREHOLE REPORT

Page 2 of 2

BOREHOLE No.: BH5-23

ELEVATION: 80.1 m (GEODETIC)

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 20 April 2023 DATE (FINISH): 20 April 2023

LEGEND

- ☒ SS - SPLIT SPOON
- ◪ ST - SHELBY TUBE
- ◫ VA - VANE SHEAR
- ◧ AU - AUGER PROBE
- ⧅ GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5021922 EASTING: 427899 ELEVATION: 80.1

- △ Undisturbed Vane Value (kPa)
- ☐ Remoulded Field Vane Value (kPa)
- $\overset{3}{\triangle}$ Number refer to Sensitivity
- ○ Water content (%)
- W_p ├─┤ W_l Atterberg limits (%)
- ● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
17				- End of the borehole at 4.7 m bgs. - Water level at 4.4 m bgs (Elevation 75.8 m) on April 27, 2023. - bgs means below ground surface.										
18	5.5													
19														
	6.0													
20														
21														
	6.5													
22														
23	7.0													
24														
	7.5													
25														
26	8.0													
27														
28	8.5													
29														
	9.0													
30														
31	9.5													
32														

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REFERENCE No.: 12606873

BOREHOLE No.: BH6-23

ELEVATION: 80.8 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 19 April 2023 DATE (FINISH): 19 April 2023

LEGEND

- ☒ SS - SPLIT SPOON
- ◸ ST - SHELBY TUBE
- ◫ VA - VANE SHEAR
- ◨ AU - AUGER PROBE
- ◹ GS - GRAB SAMPLE
- ▼ - WATER LEVEL

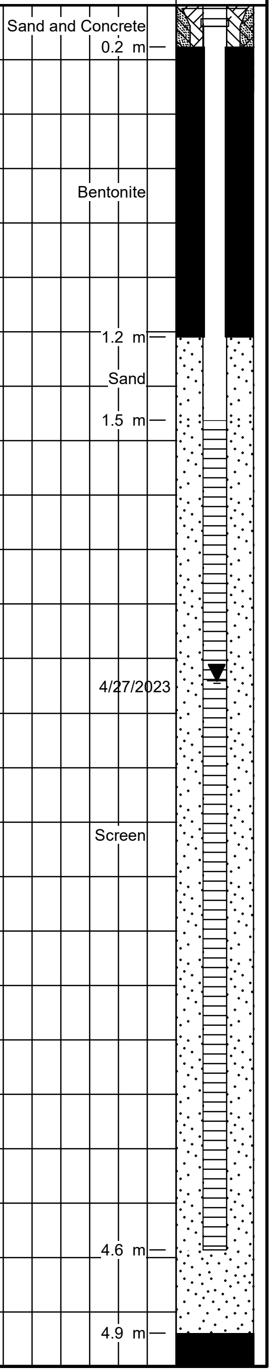
NORTHING: 5021904 EASTING: 427865 ELEVATION: 80.8

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p ├┤ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)
10 20 30 40 50 60 70 80 90

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %
		GROUND SURFACE							
0.0	80.8	ASPHALT (25 mm)							
0.2	80.6	FILL: SAND and GRAVEL, trace silt, grey, moist, very dense	SS1			100.0	--	9-15-50/0mm	65/152 mm
0.5	80.3	GRAVELLY SAND, trace silt, some oxidation, moist, orange brown, very dense DOLOMITIC SANDSTONE, non-porous, grey, slightly Weathered (W2), Strong (R4), thinly bedded							
			Run1			100	--	65	96
		some oxidization, Fresh (W1)							
			Run2			100	--	100	100
		grey with black bands							
			Run3			100	--	73	100
		grey, very strong							

Depth scale: Feet 0–16; Metres 0.0, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

PIEZOMETER/ STANDPIPE INSTALLATION



REFERENCE No.: 12606873

GHD

BOREHOLE No.: **BH6-23**
ELEVATION: 80.8 m (GEODETIC)

BOREHOLE REPORT

CLIENT: First Gulf
PROJECT: Geotechnical Investigation-Nokia Campus
LOCATION: 600 March Road, Ottawa, Ontario
DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley
DATE (START): 19 April 2023 DATE (FINISH): 19 April 2023

LEGEND
☒ SS - SPLIT SPOON
▨ ST - SHELBY TUBE
◫ VA - VANE SHEAR
◧ AU - AUGER PROBE
▨ GS - GRAB SAMPLE
▼ - WATER LEVEL

NORTHING: 5021904 EASTING: 427865 ELEVATION: 80.8

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
△ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
17														
18	5.5					Run4		136.1	87	--	72	84		
19														
20	6.0													
21	6.5													
22														
23	7.0													
24						Run5		127.2	100	--	73	95		
25	7.5													
26	8.0													
27														
28	8.5													
29						Run6			99	--	80	99		
30	9.0													
31	9.4	71.4		**END OF BOREHOLE**									9.4 m	
	9.5													
32														

NOTE:
- End of the borehole at 9.4 m bgs.
- Water level at 2.5 m bgs (Elevation 78.3 m) on April 27, 2023.
- bgs means below ground surface

REFERENCE No.: 12606873

BOREHOLE No.: BH7-23

ELEVATION: 80.9 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 20 April 2023 DATE (FINISH): 20 April 2023

LEGEND

☒ SS - SPLIT SPOON
◪ ST - SHELBY TUBE
◫ VA - VANE SHEAR
◧ AU - AUGER PROBE
◩ GS - GRAB SAMPLE
▼ - WATER LEVEL

NORTHING: 5021934 EASTING: 427830 ELEVATION: 80.9

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	△ Undisturbed Vane Value (kPa) ☐ Remoulded Field Vane Value (kPa) △³ Number refer to Sensitivity ○ Water content (%) W_p ⊢⊣ W_l Atterberg limits (%) ● "N" Value (blows / 12 in.-30 cm) 10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
0	0.0	80.9		ASPHALT (25 mm)										
1				FILL: SAND and GRAVEL, trace silt, grey, wet, very dense (Granular base) brown (Granular subbase)	☒	SS1	45-52-(3)		78.6	8	5-13-50/51mm	63/203 mm	○	
2	0.5	80.4		DOLOMITIC SANDSTONE, grey, non-porous, moderatly Weathered (W3), very Strong (R5), thinly bedded										
4	1.0					Run1			95	--	40	83		
7	2.0			Fresh (W1)										
8	2.5												4/27/2023	▼
9						Run2			100	--	100	93		
13	4.0					Run3		138.3	100	--	60	80		
16	4.8	76.1		**END OF BOREHOLE**										

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12606873\TECH\GINT LOGS\12606873 LOG-GEOTECH.GPJ Library File: 12606873 GHD_GEOTECH_V10.GLB Report: 12606873 SOIL LOG Date: 12/6/23

REFERENCE No.: 12606873

BOREHOLE No.: BH7-23

ELEVATION: 80.9 m (GEODETIC)

BOREHOLE REPORT

Page 2 of 2

CLIENT: First Gulf

PROJECT: Geotechnical Investigation-Nokia Campus

LOCATION: 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: John McAuley

DATE (START): 20 April 2023 DATE (FINISH): 20 April 2023

LEGEND

☒	SS	- SPLIT SPOON
◿	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
◹	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021934 EASTING: 427830 ELEVATION: 80.9

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p ├─┤ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE			%	MPa	%	%	%	%		
17				**NOTE:** - End of the borehole at 4.8 m bgs. - Water level at 2.4 m bgs (Elevation 78.5 m) on April 27, 2023. - bgs means below ground surface.										
18	5.5													
19														
	6.0													
20														
21														
	6.5													
22														
23	7.0													
24														
	7.5													
25														
26														
	8.0													
27														
28	8.5													
29														
	9.0													
30														
31														
	9.5													
32														

Appendix B

Borehole Reports from Previous Investigation

REFERENCE No.: 12566614

BOREHOLE No.: BH01-22

ELEVATION: 80.2 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 28 January 2022 DATE (FINISH): 28 January 2022

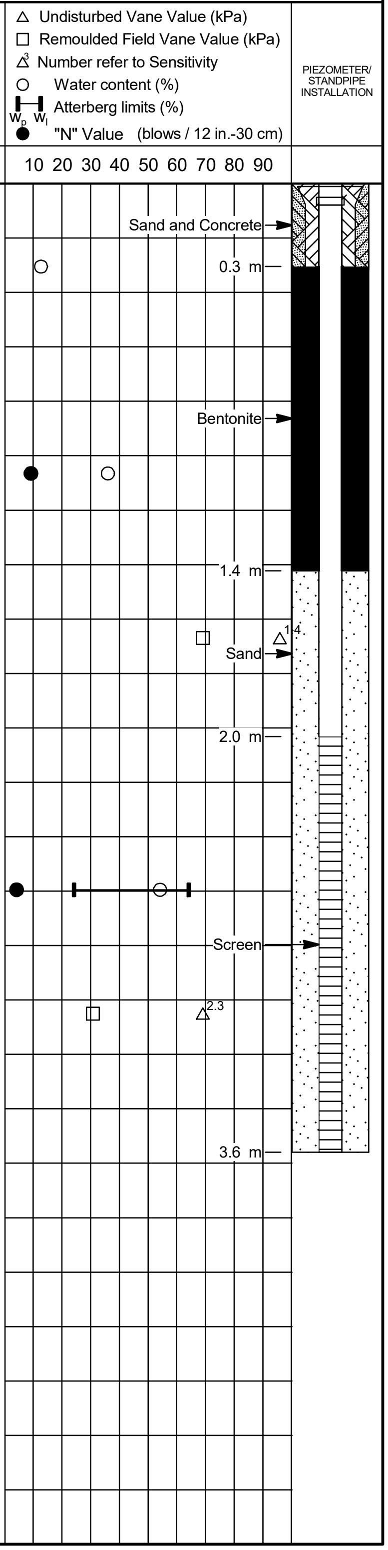
LEGEND

- ☒ SS - SPLIT SPOON
- ▨ ST - SHELBY TUBE
- VA - VANE SHEAR
- AU - AUGER PROBE
- GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5021740.104 EASTING: 428002.481 ELEVATION: 80.2

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
0		GROUND SURFACE							
		FILL - Gravelly silty SAND, some clay, greyish brown, moist, dense	GS1	29-37-22-12		--	13	--	--
0.6	79.6	CLAY, greyish brown, moist, very stiff to stiff	SS1			100.0	36	2-4-5-5	9
		grey, moist to wet, stiff				--	--	--	--
			SS2			100.0	54	2-2-2-2	4
						--	--	--	--
3.6	76.6	END OF BOREHOLE (Auger Refusal)							

NOTE:
1. Borehole dry upon completion of drilling.
2. Borehole dry on February 3, 2022.



REFERENCE No.: 12566614

GHD

BOREHOLE No.: BH02-22

ELEVATION: 79.7 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 2

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

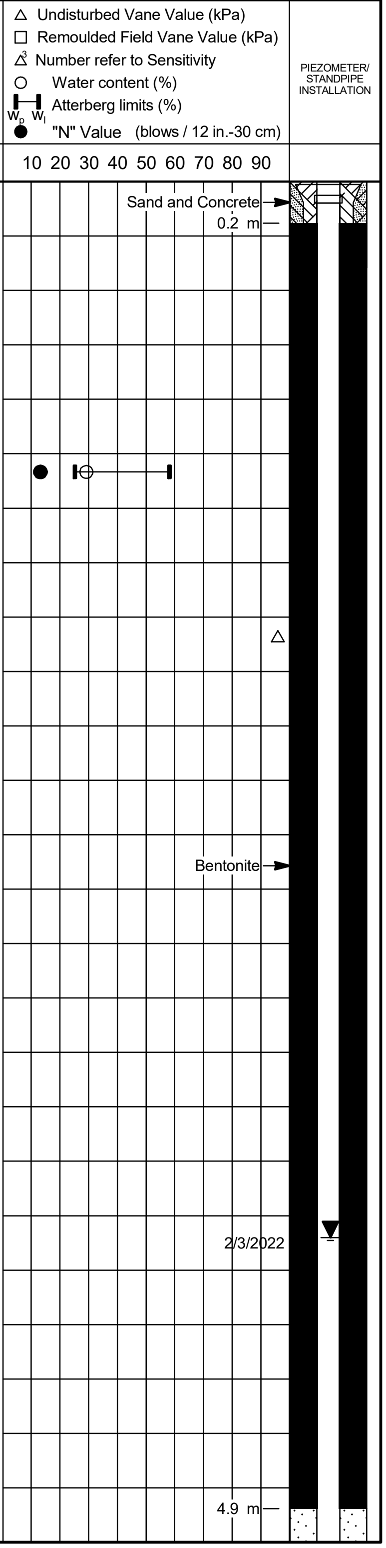
DATE (START): 31 January 2022 DATE (FINISH): 1 February 2022

LEGEND

☒	SS	- SPLIT SPOON
▨	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
▮	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021805.708 EASTING: 428046.309 ELEVATION: 79.7

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
		GROUND SURFACE							
0		ASPHALT							
0.1	79.6	FILL - GRAVEL, some sand and silt, grey, moist, dense	GS1			--	--	--	--
0.6	79.1	CLAY, some silt, trace sand and gravel, greyish brown, moist, stiff	SS1	2-5-48-45		83.3	29	9-6-7-7	13
						--	--	--	--
			SS2			0.0	--	50/102mm	50/102 mm
2.4	77.3	DOLOMITIC SANDSTONE, grey, slightly weathered, excellent to fair qullity	Run1			100	--	91	100
		joint, perpendicular to core axis	Run2			100	--	68	89
		joint, perpendicular to core axis	Run3			95	--	84	92



File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12566614\TECH\GINT LOGS\12566614 LOG.GPJ Library File: 12566614 GHD_GEOTECH_V10.GLB Report: 12566614 SOIL LOG Date: 24/3/22

REFERENCE No.: 12566614

BOREHOLE No.: BH02-22

ELEVATION: 79.7 m (GEODETIC)

BOREHOLE REPORT

Page 2 of 2

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 31 January 2022 DATE (FINISH): 1 February 2022

LEGEND

☒	SS	- SPLIT SPOON
▨	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

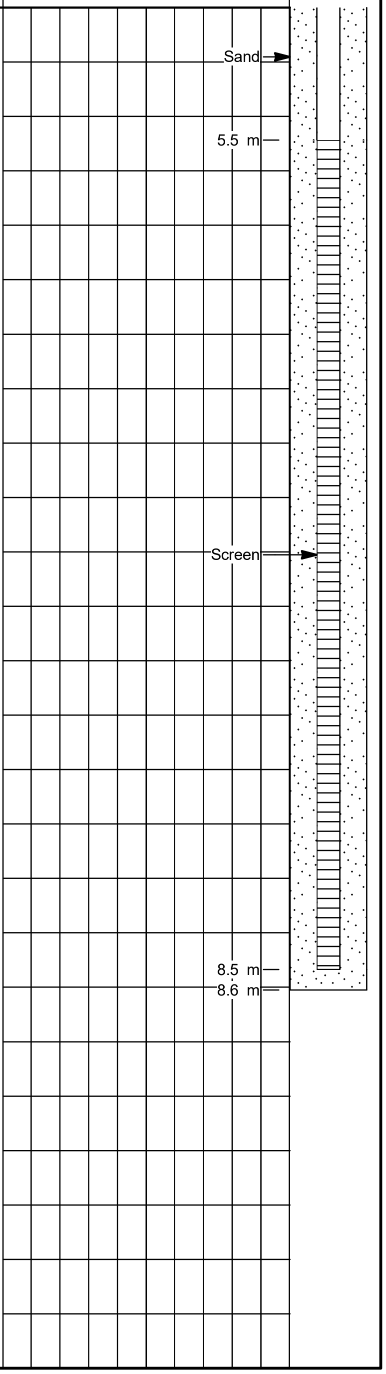
NORTHING: 5021805.708 EASTING: 428046.309 ELEVATION: 79.7

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
Feet	Metres			GROUND SURFACE			%	MPa	%	%	%	%
17												
18	5.5					Run4			100	--	73	94
19												
20	6.0			joint, approximately 30 degrees to core axis								
21	6.5											
22												
23	7.0											
24	7.5					Run5		122.5	100	--	63	98
25												
26	8.0											
27						Run6			83	--	76	83
28	8.5											
	8.6	71.1		END OF BOREHOLE NOTE: 1. Water level at a depth of 3.88 m (Elev. 75.84 m) below ground surface on February 3, 2022.								
29	9.0											
30												
31	9.5											
32												

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

PIEZOMETER/ STANDPIPE INSTALLATION



File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12566614\TECH\GINT LOGS\12566614 LOG.GPJ Library File: 12566614 GHD_GEOTECH_V10.GLB Report: 12566614 SOIL LOG Date: 24/3/22

REFERENCE No.: 12566614

BOREHOLE No.: BH03-22
ELEVATION: 80.7 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia
PROJECT: Geotechnical Investigation-Nokia Campus Rezoning
LOCATION: 570 and 600 March Road, Ottawa, Ontario
DESCRIBED BY: Dathon Ash
CHECKED BY: Sahar Soleimani
DATE (START): 28 January 2022
DATE (FINISH): 31 January 2022

LEGEND

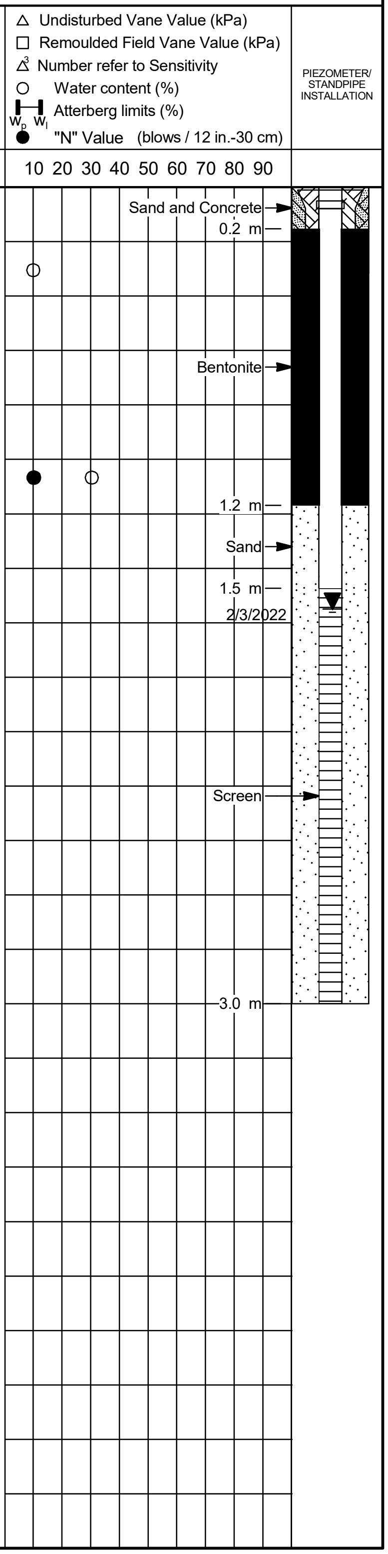
- ☒ SS - SPLIT SPOON
- ▨ ST - SHELBY TUBE
- VA - VANE SHEAR
- AU - AUGER PROBE
- GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5021800.342
EASTING: 427921.429
ELEVATION: 80.7

- △ Undisturbed Vane Value (kPa)
- ☐ Remoulded Field Vane Value (kPa)
- △³ Number refer to Sensitivity
- ○ Water content (%)
- W_p W_l Atterberg limits (%)
- ● "N" Value (blows / 12 in.-30 cm)

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%) (%)	Moisture Content (%)	Blows per 15cm/ RQD(%) (%)	'N' Value SCR(%) (%)
0		GROUND SURFACE							
0.1	80.6	ASHPHALT							
		FILL - Sandy GRAVEL, some silt, trace clay, greyish brown, moist, dense	GS1	45-29-18-8		--	10	--	--
0.6	80.1	Silty CLAY, some sand, trace gravel, greyish brown, moist, stiff	SS1	1-28-(71)		95.8	30	4-5-5-5	10
1.4	79.3	DOLOMITIC SANDSTONE, light grey with yellow bands, slightly weathered, excellent quality	Run1			100	--	100	100
			Run2		91.1	100	--	100	100
3.0	77.7	END OF BOREHOLE							

NOTE:
1. Water level at a depth of 1.55 m (Elev. 79.15 m) below ground surface on February 3, 2022.



REFERENCE No.: 12566614

BOREHOLE No.: BH04-22

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 28 January 2022 DATE (FINISH): 28 January 2022

LEGEND

☒	SS	- SPLIT SPOON
◩	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
◪	GS	- GRAB SAMPLE
▼		- WATER LEVEL

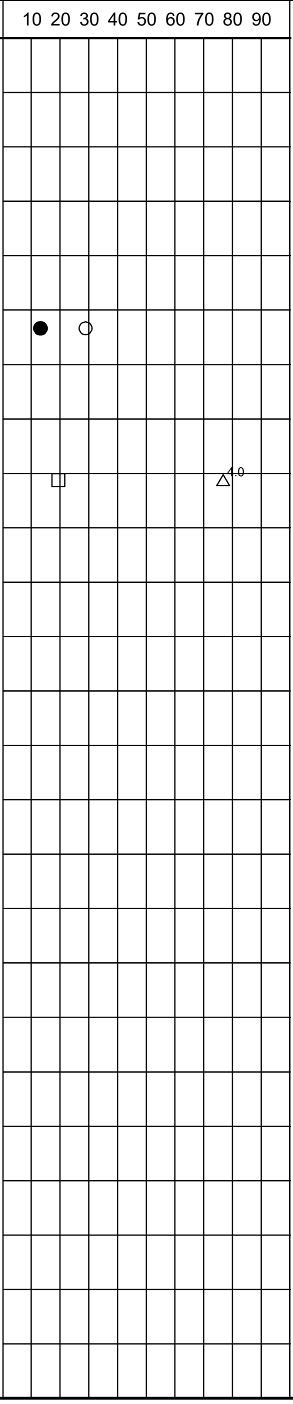
NORTHING: 5021867.201 EASTING: 427996.294 ELEVATION: 79.8

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
		GROUND SURFACE							
0.1	79.7	ASPHALT							
		FILL - Gravelly SAND, some silt and clay, grey, moist, dense	GS1	23-58-(19)		--	--	--	--
0.6	79.2	Silty CLAY, some sand, greyish brown, moist, stiff	SS1	0-10-44-46		77.0	29	5-6-7-7	13
						--	--	--	--
1.7	78.1	END OF BOREHOLE (Auger Refusal)							

Feet: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Metres: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)



PIEZOMETER/ STANDPIPE INSTALLATION

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12566614\TECH\GINT LOGS\12566614 LOG.GPJ **Library File:** 12566614 GHD_GEOTECH_V10.GLB **Report:** 12566614 SOIL LOG **Date:** 24/3/22

REFERENCE No.: 12566614

BOREHOLE No.: BH05-22

ELEVATION: 81.1 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

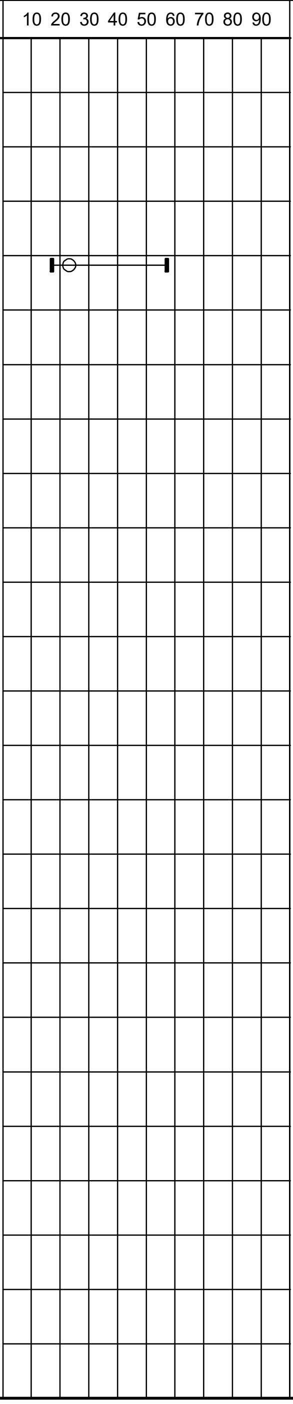
DATE (START): 1 February 2022 DATE (FINISH): 1 February 2022

LEGEND

☒	SS	- SPLIT SPOON
◿	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021890.495 EASTING: 427830.004 ELEVATION: 81.1

Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	△ Undisturbed Vane Value (kPa) ☐ Remoulded Field Vane Value (kPa) △ Number refer to Sensitivity ○ Water content (%) W_p ├┤ W_l Atterberg limits (%) ● "N" Value (blows / 12 in.-30 cm) 10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
0			GROUND SURFACE										
0.1	81.0	■	ASPHALT										
		⊠	FILL - Sandy SILT, some gravel, greyish brown, moist, dense	⧅	GS1			--	--	--	--		
0.6	80.5	▨	CLAY, some silt and sand, trace gravel, greyish brown, moist, firm to stiff	☒	SS1	1-15-50-34		100.0	23	13-50/76mm	50/76 mm		
0.9	80.2		END OF BOREHOLE (Auger Refusal)										



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REFERENCE No.: 12566614

BOREHOLE No.: BH06-22

ELEVATION: 79.6 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash

CHECKED BY: Sahar Soleimani

DATE (START): 2 February 2022

DATE (FINISH): 2 February 2022

LEGEND

☒	SS	- SPLIT SPOON
◩	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
◪	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021952.611

EASTING: 427924.443

ELEVATION: 79.6

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
$\overset{3}{\triangle}$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

Depth Metres	Elevation (m) BGS	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %
		GROUND SURFACE								
0.1	79.5	ASPHALT								
0.4	79.2	FILL - Sandy SILT, some gravel, brown, moist, dense		GS1			--	--	--	--
		DOLOMITIC SANDSTONE, light grey with yellow bands, fresh, good quality		Run1			97	--	87	97
3.6	76.0			Run2		94.2	90	--	75	90

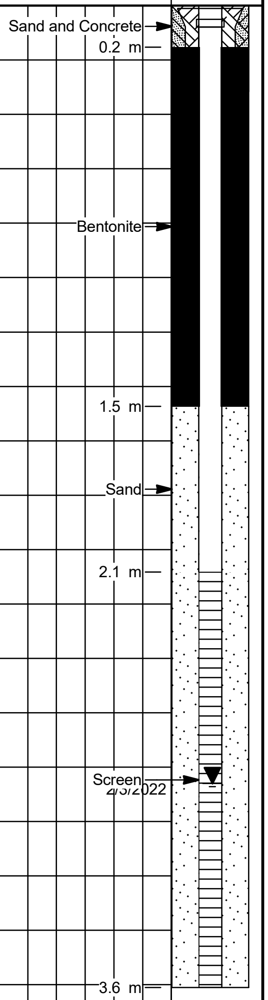
Feet: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Metres: 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

END OF BOREHOLE

NOTE:
1. Water level at a depth of 2.86 m (Elev. 79.15 m) below ground surface on February 3, 2022.

PIEZOMETER/ STANDPIPE INSTALLATION



REFERENCE No.: 12566614

BOREHOLE No.: BH07-22

ELEVATION: 82.5 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash

CHECKED BY: Sahar Soleimani

DATE (START): 31 January 2022

DATE (FINISH): 31 January 2022

LEGEND

- ☒ SS - SPLIT SPOON
- ◩ ST - SHELBY TUBE
- ◫ VA - VANE SHEAR
- ▮ AU - AUGER PROBE
- ⧅ GS - GRAB SAMPLE
- ▼ - WATER LEVEL

NORTHING: 5022030.466

EASTING: 427695.319

ELEVATION: 82.5

- △ Undisturbed Vane Value (kPa)
- □ Remoulded Field Vane Value (kPa)
- $\overset{3}{\triangle}$ Number refer to Sensitivity
- ○ Water content (%)
- W_p W_l Atterberg limits (%)
- ● "N" Value (blows / 12 in.-30 cm)

Depth Metres	Elevation (m) BGS	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
0		GROUND SURFACE										
		TOPSOIL - Clayey SILT, contains rootlets and organic matter, dark brown, moist		GS1			--	--	--	--		
0.6	81.9	Silty CLAY to Clayey SILT, some sand and gravel, dark brown, moist, soft, organics matter		SS1			41.7	--	3-5-50/0	>50		
1.0	81.5	DOLOMITIC SANDSTONE, slightly weathered, light grey to grey with yellow bands, fair to good quality		Run1			100	--	66	100		
				Run2			96	--	89	96		
				Run3		111.8	100	--	88	88		
4.1	78.4	END OF BOREHOLE										

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REFERENCE No.: 12566614

BOREHOLE No.: BH08-22

ELEVATION: 79.8 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 2 February 2022 DATE (FINISH): 2 February 2022

LEGEND

☒	SS	- SPLIT SPOON
⧄	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◧	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5022071.843 EASTING: 427843.613 ELEVATION: 79.8

Depth		Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay	Unconfined Compressive Strength	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)	△ Undisturbed Vane Value (kPa) ☐ Remoulded Field Vane Value (kPa) $\overset{3}{\triangle}$ Number refer to Sensitivity ○ Water content (%) W_p W_l Atterberg limits (%) ● "N" Value (blows / 12 in.-30 cm)	PIEZOMETER/ STANDPIPE INSTALLATION
Feet	Metres			GROUND SURFACE			%	MPa	%	%	%	%	10 20 30 40 50 60 70 80 90	
0	0.1	79.7	■	ASPHALT										
1			▨	FILL - Sandy SILT, trace gravel, greyish brown, moist, dense	⧅	GS1			--	--	--	--		
2	0.5 0.6	79.2		END OF BOREHOLE (Auger Refusal)										
3	1.0													
4														
5	1.5													
6														
7	2.0													
8	2.5													
9														
10	3.0													
11														
12	3.5													
13	4.0													
14														
15	4.5													
16														

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REFERENCE No.: 12566614

GHD

BOREHOLE No.: BH09-22

ELEVATION: 82.1 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 31 January 2022 DATE (FINISH): 31 January 2022

LEGEND

☒	SS	- SPLIT SPOON
◩	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
◨	AU	- AUGER PROBE
⧄	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5022131.544 EASTING: 427632.69 ELEVATION: 82.1

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
$\triangle^3$ Number refer to Sensitivity
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL	State	Type and Number	Gravel Sand Silt Clay %	Unconfined Compressive Strength MPa	Recovery/ TCR(%) %	Moisture Content %	Blows per 15cm/ RQD(%) %	'N' Value SCR(%) %	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
				GROUND SURFACE										
0				TOPSOIL- SILT, trace sand and gravel, contains rootlets and organic matter, dark brown, moist										
1					⧄	GS1			--	--	--	--		
	0.5													
2														
					☒	SS1			25.0	--	2-50/0mm	>50		
3	0.9	81.2		END OF BOREHOLE (Auger Refusal)										
	1.0													
4														
5	1.5													
6														
	2.0													
7														
8	2.5													
9														
10	3.0													
11														
	3.5													
12														
13	4.0													
14														
	4.5													
15														
16														

REFERENCE No.: 12566614

BOREHOLE No.: BH10-22

ELEVATION: 80.4 m (GEODETIC)

BOREHOLE REPORT

Page 1 of 1

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

DATE (START): 2 February 2022 DATE (FINISH): 2 February 2022

LEGEND

☒	SS	- SPLIT SPOON
⧄	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
▐	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

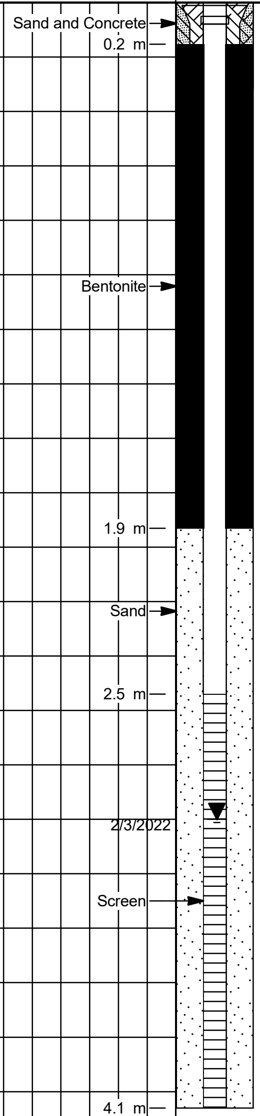
NORTHING: 5022166.631 EASTING: 427726.321 ELEVATION: 80.4

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△³ Number refer to Sensitivity
○ Water content (%)
W_p ├─┤ W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

Depth (Metres)	Elevation (m) BGS	DESCRIPTION OF SOIL	Type and Number	Gravel Sand Silt Clay (%)	Unconfined Compressive Strength (MPa)	Recovery/ TCR(%)	Moisture Content (%)	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
		GROUND SURFACE							
0.1	80.3	ASPHALT							
		FILL - Sandy SILT, some gravel, brown, moist, dense	GS1			--	--	--	--
			SS1			0.0	--	50/152mm	50/152 mm
0.9	79.5	DOLOMITIC SANDSTONE, slightly weathered, excellent to fair quality							
		joint, perpendicular to core axis	Run1		113.3	100	--	81	100
			Run2			100	--	95	100
			Run3			50	--	36	50
4.1	76.3	END OF BOREHOLE							

NOTE:
1. Water level at a depth of 3.00 m (Elev. 77.43 m) below ground surface on February 3, 2022.

PIEZOMETER/ STANDPIPE INSTALLATION



Appendix C

Rock Core Photographs

BH1-23 (Dry)

Box 1 of 1

Run No.	Run Start/End (m)
1	1.47 - 3.28
2	3.28 - 4.88

Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH1-23 (Wet)

Box 1 of 1

Run No.	Run Start/End (m)
1	1.47 - 3.28
2	3.28 - 4.88

Client :	First Gulf
Project :	Geotechnical Investigation
Reference N°. :	12606873
Location:	600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH2-23 (Dry)

Box 1 of 2

Run No.	Run Start/End (m)
1	1.63 - 3.18
2	3.18 - 4.60
3	4.60 - 6.15

Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH2-23 (Wet)

Box 1 of 2

Run No.	Run Start/End (m)
1	1.63 - 3.18
2	3.18 - 4.60
3	4.60 - 6.15

Client : First Gulf

Project : Geotechnical Investigation

Reference No. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH2-23 (Dry)

Box 2 of 2

Run No.	Run Start/End (m)
4	6.15 - 7.67
5	7.67 - 9.30

Client : First Gulf

Project : Geotechnical Investigation

Reference N^{o.} : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH2-23 (Wet)

Box 2 of 2

Run No.	Run Start/End (m)
4	6.15 - 7.67
5	7.67 - 9.30

Client : First Gulf

Project : Geotechnical Investigation

Reference Nº. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH3-23 (Dry)

Box 1 of 3

Run No.	Run Start/End (m)
1	1.12 - 1.83
2	1.83 - 3.63
3	3.63 - 4.29 (Continued in box 2)

Client : First Gulf

Project : Geotechnical Investigation

Reference Nº. : 12606873

Location: 600 March Road, Kanata, Ontario

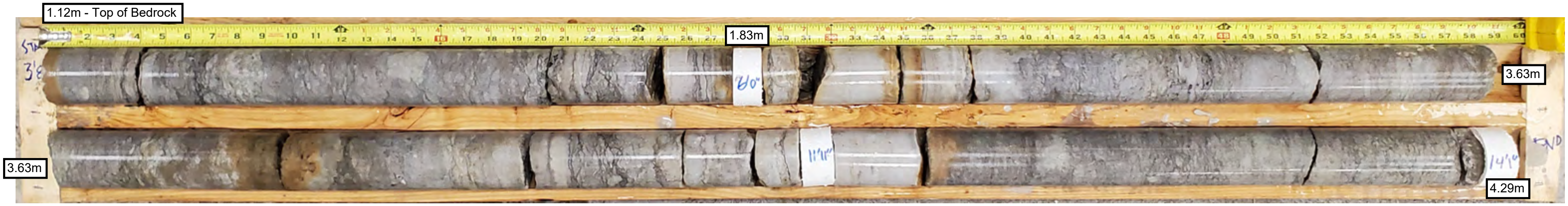
Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH3-23 (Wet)

Box 1 of 3

Run No.	Run Start/End (m)
1	1.12 - 1.83
2	1.83 - 3.63
3	3.63 - 4.29 (Continued in box 2)



Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH3-23 (Dry)

Box 2 of 3

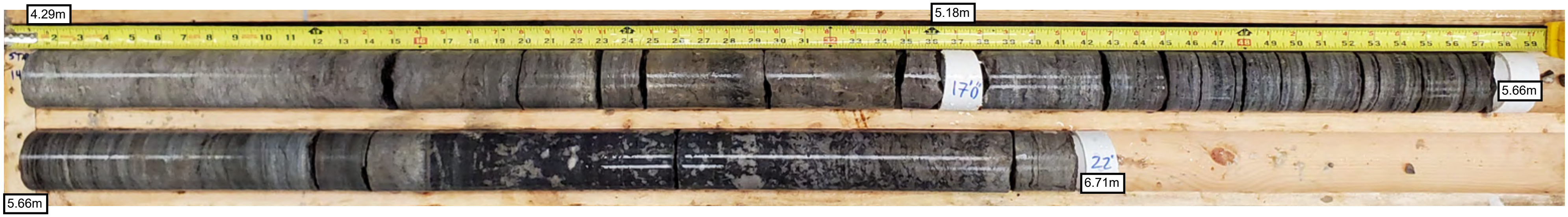
Run No.	Run Start/End (m)
3	4.29 - 5.18 (Continued from Box 1)
4	5.18 - 6.71

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N^{o.} :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

BH3-23 (Wet)

Box 2 of 3

Run No.	Run Start/End (m)
3	4.29 - 5.18 (Continued from Box 1)
4	5.18 - 6.71



Client : First Gulf

Project : Geotechnical Investigation

Reference N^o.^ : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH3-23 (Dry)

Box 3 of 3

Run No.	Run Start/End (m)
5	6.71 - 8.23
6	8.23 - 9.35

Client : First Gulf

Project : Geotechnical Investigation

Reference N^{o.} : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH3-23 (Wet)

Box 3 of 3

Run No.	Run Start/End (m)
5	6.71 - 8.23
6	8.23 - 9.35

Client : First Gulf

Project : Geotechnical Investigation

Reference Nº. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH4-23 (Dry)

Box 1 of 3

Run No.	Run Start/End (m)
1	1.45 - 2.08
2	2.08 - 3.20
3	3.20 - 4.45

Client :	First Gulf
Project :	Geotechnical Investigation
Reference N°. :	12606873
Location:	600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH4-23 (Wet)

Box 1 of 3

Run No.	Run Start/End (m)
1	1.45 - 2.08
2	2.08 - 3.20
3	3.20 - 4.45

Client : First Gulf

Project : Geotechnical Investigation

Reference Nº. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH4-23 (Dry)

Box 2 of 3

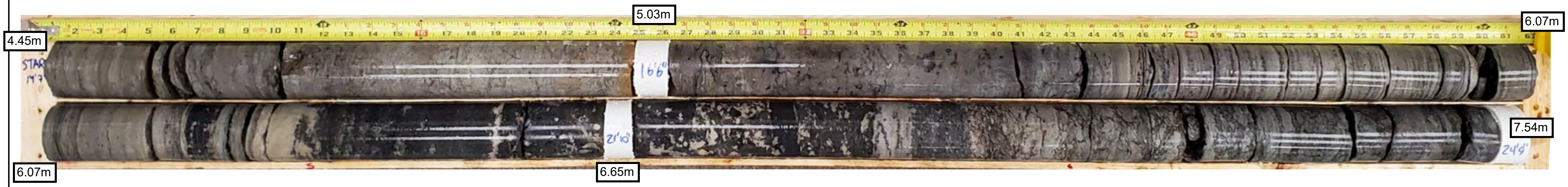
Run No.	Run Start/End (m)
4	4.45 - 5.03
5	5.03 - 6.65
6	6.65 - 7.54 (Continued in Box 3)

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N^{o.} :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

BH4-23 (Wet)

Box 2 of 3

Run No.	Run Start/End (m)
4	4.45 - 5.03
5	5.03 - 6.65
6	6.65 - 7.54 (Continued in Box 3)



Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

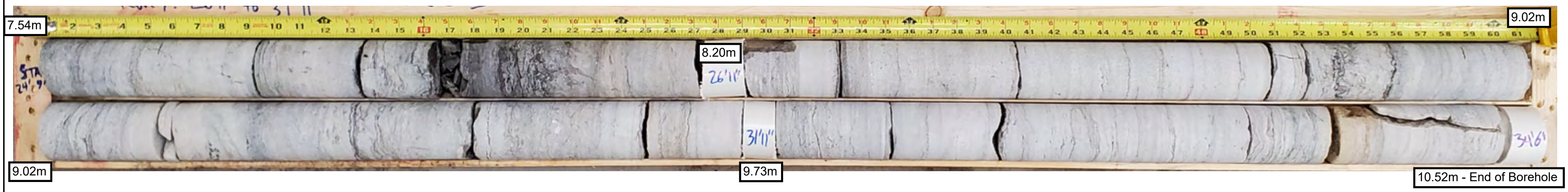
Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH4-23 (Dry)

Box 3 of 3

Run No.	Run Start/End (m)
6	7.54 - 8.20 (Continued from Box 2)
7	8.20 - 9.73
8	9.73 - 10.52



Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

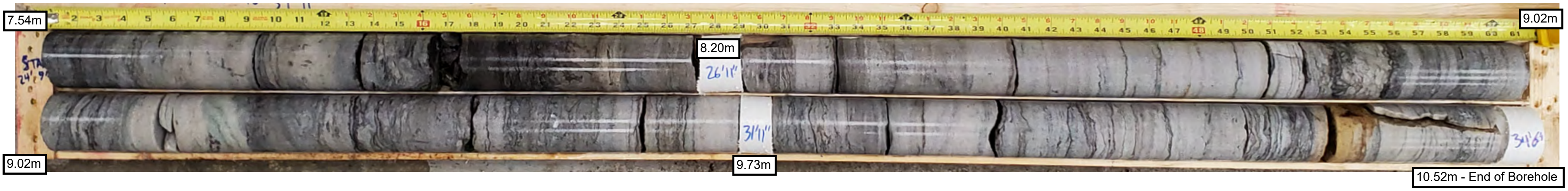
Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH4-23 (Wet)

Box 3 of 3

Run No.	**Run Start/End (m)**
6	7.54 - 8.20 (Continued from Box 2)
7	8.20 - 9.73
8	9.73 - 10.52



Client :	First Gulf
Project :	Geotechnical Investigation
Reference Nº. :	12606873
Location:	600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH5-23 (Dry)

Box 1 of 1

Run No.	Run Start/End (m)
1	0.28 - 1.63
2	1.63 - 3.10
3	3.10 - 4.70

0.28m - Top of Bedrock

1.63m

1.63m

3.10m

3.10m

4.70m - End of Borehole

Client : First Gulf

Project : Geotechnical Investigation

Reference No. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH5-23 (Wet)

Box 1 of 1

Run No.	Run Start/End (m)
1	0.28 - 1.63
2	1.63 - 3.10
3	3.10 - 4.70

Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

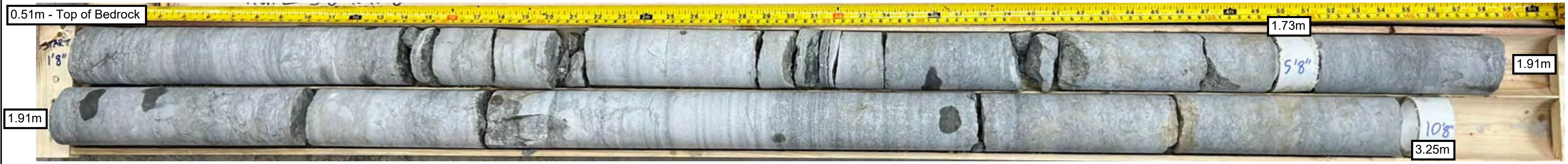
Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH6-23 (Dry)

Box 1 of 3

Run No.	Run Start/End (m)
1	0.51 - 1.73
2	1.73 - 3.25



Client : First Gulf

Project : Geotechnical Investigation

Reference N

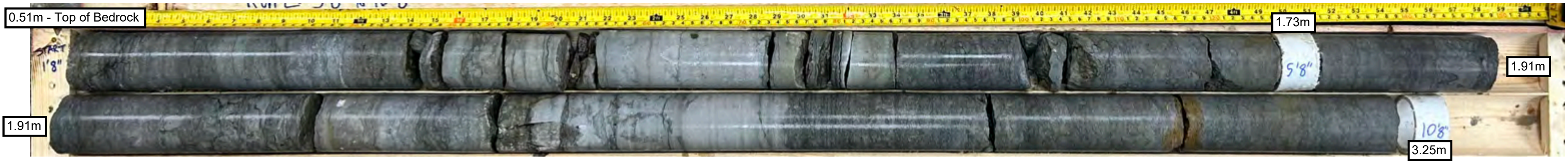
Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH6-23 (Wet)

Box 1 of 3

Run No.	Run Start/End (m)
1	0.51 - 1.73
2	1.73 - 3.25



Client :	First Gulf
Project :	Geotechnical Investigation
Reference Nº. :	12606873
Location:	600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH6-23 (Dry)

Box 2 of 3

Run No.	Run Start/End (m)
3	3.25 - 4.78
4	4.78 - 6.50

Client : First Gulf

Project : Geotechnical Investigation

Reference Nº. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH6-23 (Wet)

Box 2 of 3

Run No.	**Run Start/End (m)**
3	3.25 - 4.78
4	4.78 - 6.50

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N°. :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

BH6-23 (Dry)
Box 3 of 3

Run No.	Run Start/End (m)
5	6.50 - 8.03
6	8.03 - 9.40

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N^{o.} :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

BH6-23 (Wet)

Box 3 of 3

Run No.	Run Start/End (m)
5	6.50 - 8.03
6	8.03 - 9.40

Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH7-23 (Dry)

Box 1 of 1

Run No.	Run Start/End (m)
1	0.51 - 1.98
2	1.98 - 3.40
3	3.40 - 4.83

Client :	First Gulf
Project :	Geotechnical Investigation
Reference Nº. :	12606873
Location:	600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

BH7-23 (Wet)

Box 1 of 1

Run No.	Run Start/End (m)
1	0.51 - 1.98
2	1.98 - 3.40
3	3.40 - 4.83

Client : First Gulf

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

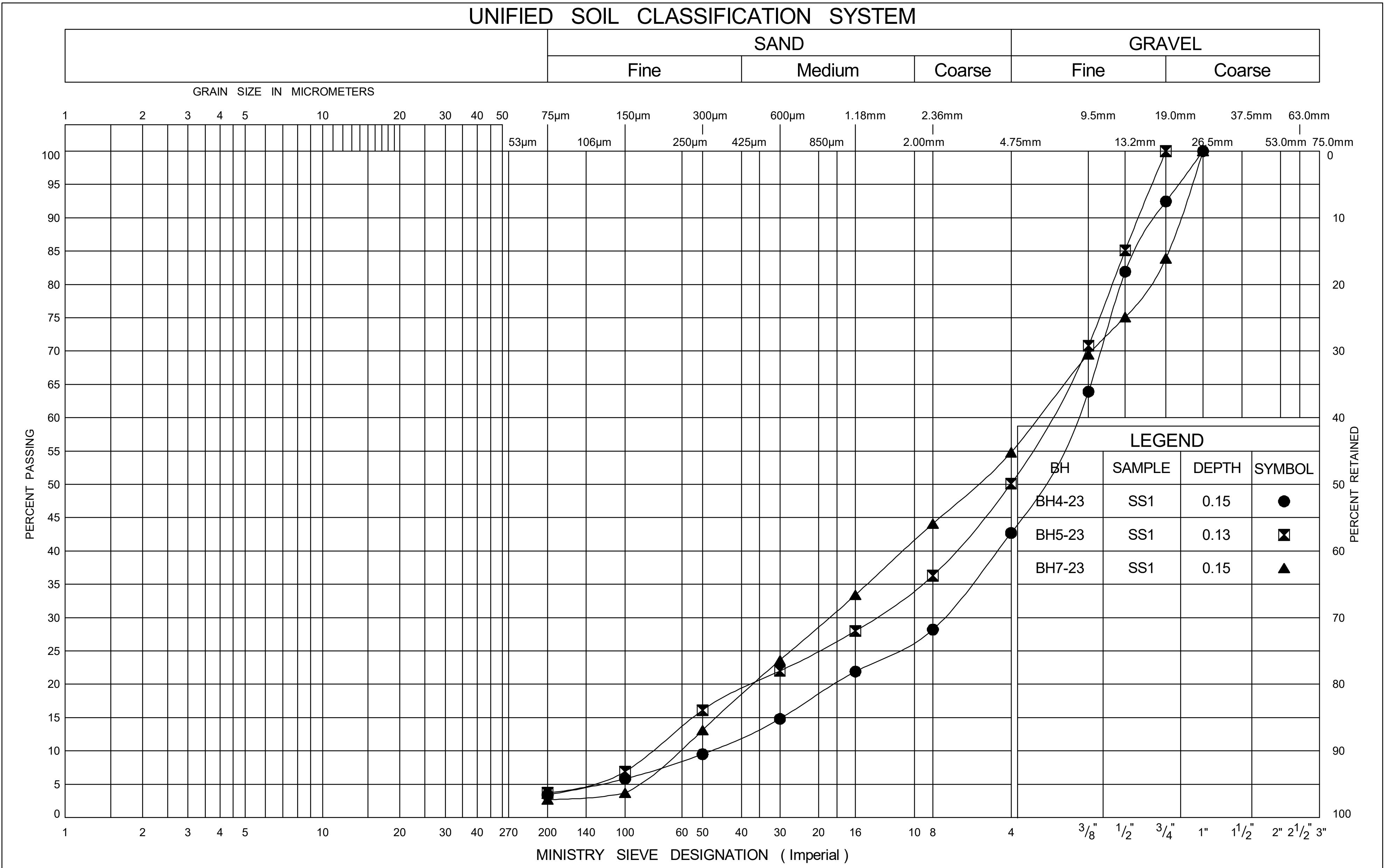
Revised by : Sahar Soleimani, P.Eng.

Appendix D

Summary Table and Results of Geotechnical Laboratory Testing

Table D1 Summary of Geotechnical Laboratory Test Results

Borehole	Sample No.	Depth (m)	Material	WC (%)	LL (%)	PL (%)	PI (%)	Grain Size Distribution (%)				UCS (MPa)
								Gravel	Sand	Silt	Clay	
BH1-23	SS-1	0.5 – 0.8	Silty Clay	29	56	25	31	12	14	37	37	-
BH2-23	R3	4.4 – 4.5	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	150
BH3-23	SS-2	0.8 – 1.1	Gravelly Sand	19	-	-	-	21	71	8		-
BH3-23	R3	4.3 – 4.5	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	148
BH4-23	SS-1	0.2 – 0.8	Gravel and Sand	1	-	-	-	57	40	3		-
BH4-23	SS-2	0.8 – 1.4	Silty Clay	32	65	25	40	9	21	39	31	-
BH4-23	R4	4.7 – 4.8	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	146
BH4-23	R5	6.4 – 6.5	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	155
BH5-23	SS-1	0.1 – 0.3	Gravel and Sand	7	-	-	-	50	46	4		-
BH6-23	R4	5.3 – 5.5	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	136
BH6-23	R5	7.6 – 7.7	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	127
BH7-23	SS-1	0.1 – 0.5	Sand and Gravel	8	-	-	-	45	52	3		-
BH7-23	R3	3.8 – 3.9	Dolomitic Sandstone Bedrock	-	-	-	-	-	-	-	-	138
BH01-22	GS1	0 – 0.6	Gravelly silty sand	13	-	-	-	29	37	22	12	-
BH01-22	SS1	0.8 – 1.4	Clay	36	-	-	-	-	-	-	-	-
BH01-22	SS2	2.3 – 2.9	Clay	54	64	24	40	-	-	-	-	-
BH02-22	SS1	0.8 – 1.4	Clay	29	58	25	33	2	5	48	45	-
BH02-22	R5	7.3 – 8.3	Sandstone bedrock	-	-	-	-	-	-	-	-	123
BH03-22	GS1	0.1 – 0.6	Sandy gravel	10	-	-	-	45	29	18	8	-
BH03-22	SS1	0.8 – 1.4	Silty clay	30	-	-	-	1	28	71	-	
BH03-22	R2	2.4 – 3.4	Sandstone bedrock	-	-	-	-	-	-	-	-	91
BH04-22	GS1	0.1 – 0.6	Gravelly sand	-	-	-	-	23	58	19	-	
BH04-22	SS1	0.8 – 1.4	Silty clay	29	-	-	-	0	10	44	46	-
BH05-22	SS1	0.8 – 1.4	Clay	23	57	17	40	1	15	50	34	-
BH06-22	R2	2.0 – 3.0	Sandstone bedrock	-	-	-	-	-	-	-	-	94
BH07-22	R3	4.0 – 5.0	Sandstone bedrock	-	-	-	-	-	-	-	-	112
BH10-22	R1	0.9 – 1.9	Sandstone bedrock	-	-	-	-	-	-	-	-	113



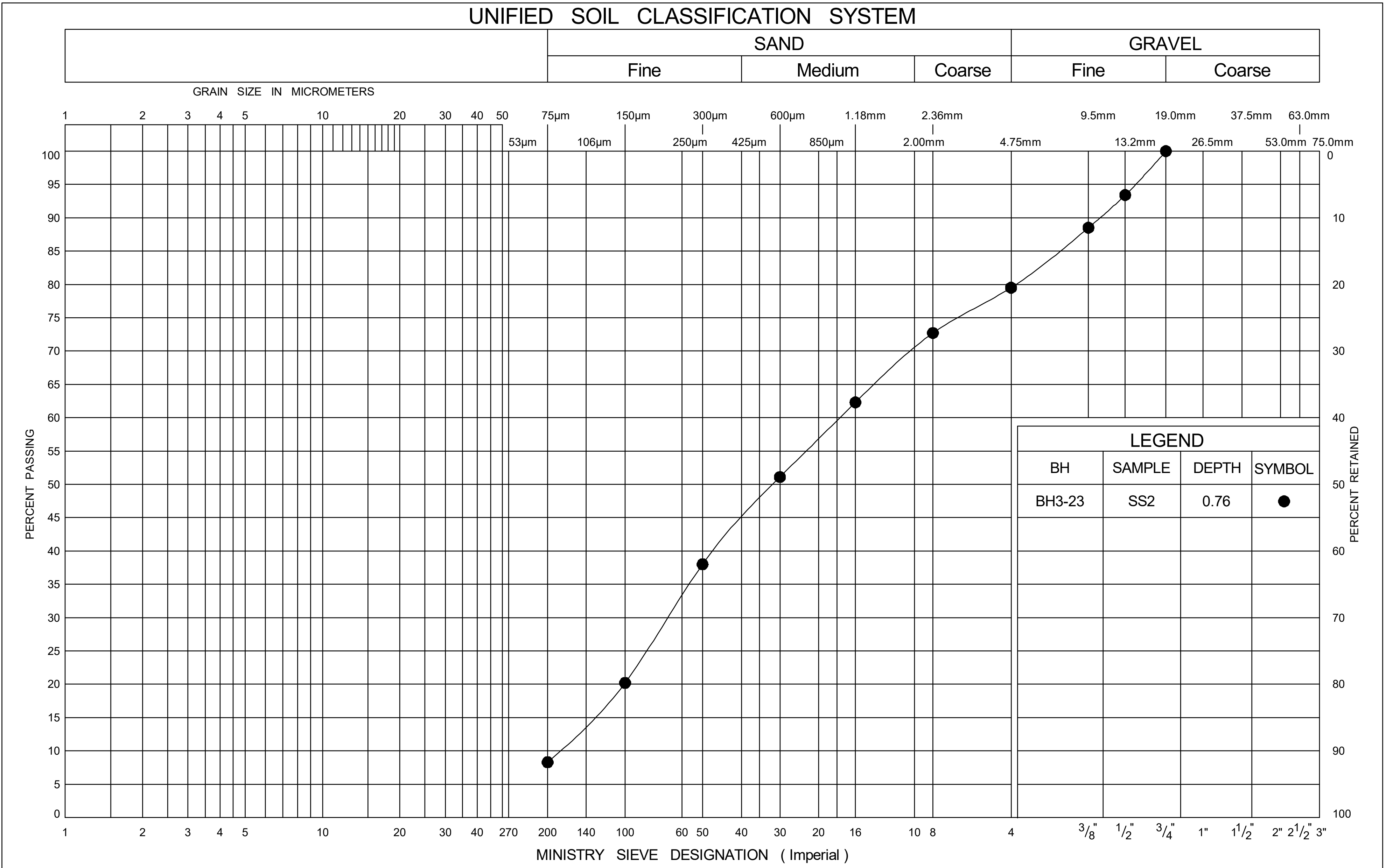
BH	SAMPLE	DEPTH	SYMBOL
BH4-23	SS1	0.15	●
BH5-23	SS1	0.13	☒
BH7-23	SS1	0.15	▲

GHD

GRAIN SIZE DISTRIBUTION

FILL - Sand and Gravel

Project No.:	12606873
Project Name:	Geotechnical Investigation-Nokia Campus
Figure No.:	1
Date: June 12, 2023	Prepared by: A.W Checked by: S.S



LEGEND

BH	SAMPLE	DEPTH	SYMBOL
BH3-23	SS2	0.76	●

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

Project No.: 12606873

Project Name: Geotechnical Investigation-Nokia Campus

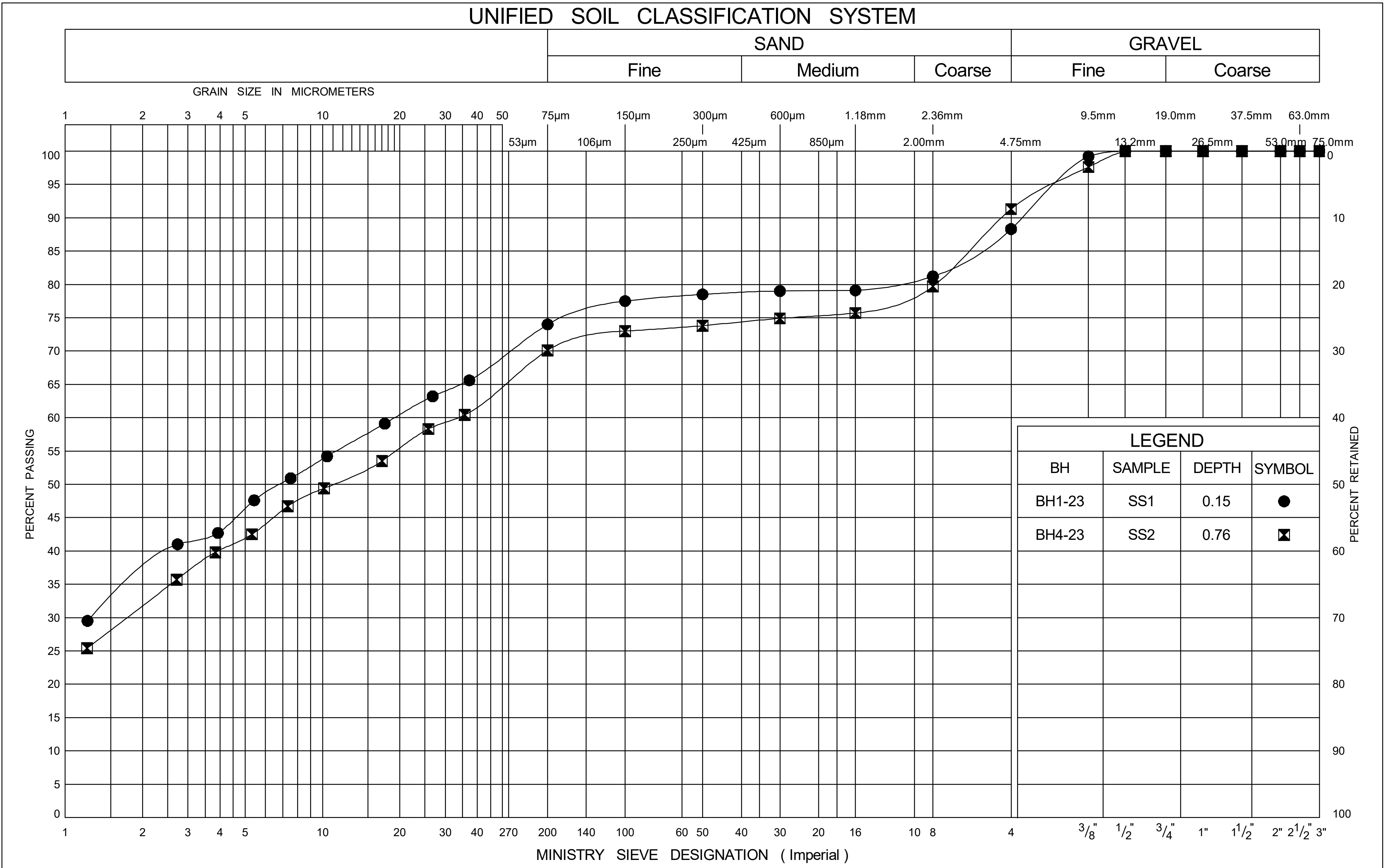
Figure No.: 2

Date: June 12, 2023

Prepared by: A.W
Checked by: S.S

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12606873\TECH\GINT LOGS\12606873 LOG-GEOTECH.GPJ **Library File:** 12606873 GHD_GEOTECH_V10.GLB **Report:** 12606873_GRAIN SIZE DISTRIBUTIO

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12606873\TECH\GINT LOGS\12606873 LOG-GEOTECH.GPJ **Library File:** 12606873 GHD_GEOTECH_V10.GLB **Report:** 12606873_GRAIN SIZE DISTRIBUTIO



LEGEND

BH	SAMPLE	DEPTH	SYMBOL
BH1-23	SS1	0.15	●
BH4-23	SS2	0.76	☒

GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAYEY SILT

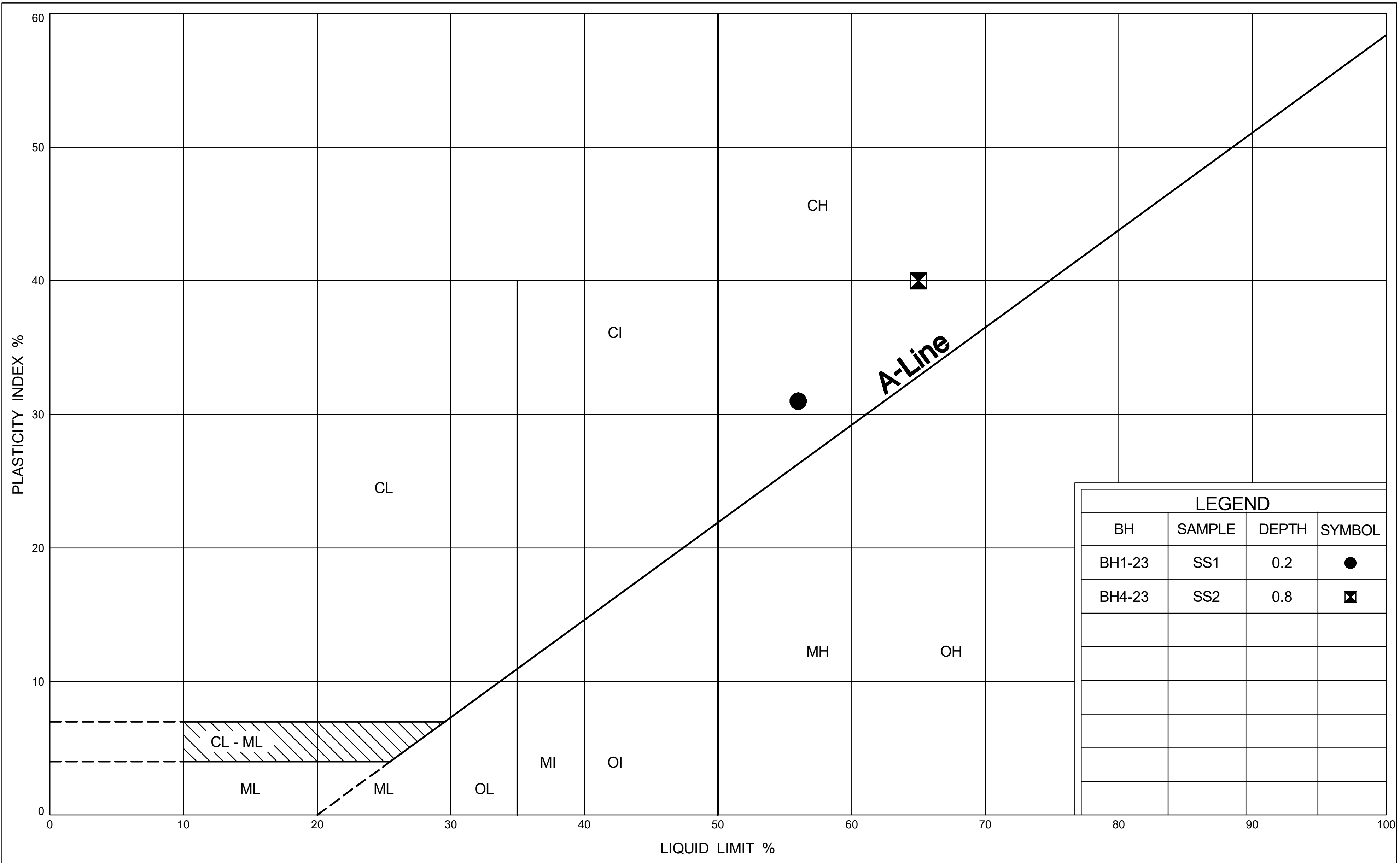
Project No.: 12606873

Project Name: Geotechnical Investigation-Nokia Campus

Figure No.: 3

Date: June 12, 2023

Prepared by: A.W
Checked by: S.S



LEGEND

BH	SAMPLE	DEPTH	SYMBOL
BH1-23	SS1	0.2	●
BH4-23	SS2	0.8	⧗

PLASTICITY CHART

SILTY CLAY to CLAYEY SILT

Project No.: 12606873
Project Name: Geotechnical Investigation-Nokia Campus
Figure No.: 4
Date: June 12, 2023
Prepared by: A.W
Checked by: S.S

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

Client : Nokia

Project : 600 March Road, Kanata, Ontario

Project N° : 12606873

Sample N° : BH 2-23 r.2

Depth : 3,43 - 3,53 m

Sampling Date : 4/20/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N° _1__________**

Technical Data

				Average	
Diameter :	47.46	47.48	47.48	**47.47**	(mm)
Length :	96.88	96.64	96.72	**96.75**	(mm)
Straightness (0.5mm maximum) (S1) :	0.0	0.1	0.1	**0.1**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.00	0.00	0.00	**0.00**	(°)

Mass : 453.5 (g) Volume: 171248 (mm^3)

Density : 2648 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.84 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 178 (seconds)

Maximum Applied Load : 265.43 (kN)

Compressive Strength : 150.0 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

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

Client : Nokia

Project : 600 March Road, Kanata, Ontario

Project N° : 12606873

Sample N° : BH 3-23 r.3

Depth : 4,34 - 4,46 m

Sampling Date : 4/17/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N°_1__________**

Technical Data

				Average	
Diameter :	59.98	60.04	60.06	**60.03**	(mm)
Length :	123.26	124.22	124.70	**124.06**	(mm)
Straightness (0.5mm maximum) (S1) :	0.0	0.0	0.0	**0.0**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.00	0.00	0.00	**0.00**	(°)

Mass : 924.4 (g) Volume: 351083 (mm^3)

Density : 2633 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.77 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 192 (seconds)

Maximum Applied Load : 419.88 (kN)

Compressive Strength : 148.4 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

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

Client : Nokia
Project : 600 March Road, Kanata, Ontario

Project N° : 12606873
Sample N° : BH 4-23 r4
Depth : 4,72 - 4,84 m
Sampling Date : 4/18/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N° _1_________**

Technical Data

				Average	
Diameter :	60.54	60.44	60.52	**60.50**	(mm)
Length :	121.78	122.00	122.26	**122.01**	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.2	**0.1**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.10	0.10	0.05	**0.08**	(°)

Mass : 922.4 (g) Volume: 350758 (mm^3)

Density : 2630 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.86 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 169 (seconds)

Maximum Applied Load : 419.32 (kN)

Compressive Strength : 145.9 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

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

Client : Nokia
Project : 600 March Road, Kanata, Ontario

Project N° : 12606873
Sample N° : BH 4-23 r.5
Depth : 6,35 - 6,47 m
Sampling Date : 4/18/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N° _1_________**

Technical Data

				Average	
Diameter :	60.48	60.52	60.50	**60.50**	(mm)
Length :	121.08	121.04	121.06	**121.06**	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.1	0.0	**0.1**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.00	0.00	0.00	**0.00**	(°)

Mass : 918.8 (g) Volume: 348018 (mm^3)

Density : 2640 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.82 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 188 (seconds)

Maximum Applied Load : 444.37 (kN)

Compressive Strength : 154.6 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

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

Client : Nokia

Project : 600 March Road, Kanata, Ontario

Project N° : 12606873

Sample N° : BH 6-23 r.4

Depth : 5,33 - 5,45 m

Sampling Date : 4/19/2023

Testing Apparatus Used :

Loading device N°_9130____

Caliper N° _1__________

Technical Data

				Average	
Diameter :	60.42	60.46	60.40	**60.43**	(mm)
Length :	121.84	122.02	121.80	**121.89**	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.2	0.1	**0.1**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.00	0.00	0.00	**0.00**	(°)

Mass : 891.5 (g) Volume: 349545 (mm^3)

Density : 2550 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.84 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 162 (seconds)

Maximum Applied Load : 390.3 (kN)

Compressive Strength : 136.1 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde

Date : 5/4/2023

Verified by :

Date :

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

Client : Nokia

Project : 600 March Road, Kanata, Ontario

Project N° : 12606873

Sample N° : BH 6-23 r.5

Depth : 7,62 - 7,74 m

Sampling Date : 4/19/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N° _1__________**

Technical Data

				Average	
Diameter :	60.40	60.38	60.42	**60.40**	(mm)
Length :	124.46	124.34	124.20	**124.33**	(mm)
Straightness (0.5mm maximum) (S1) :	0.2	0.1	0.2	**0.2**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.10	0.10	0.15	**0.12**	(°)

Mass : 932.3 (g) Volume: 356247 (mm^3)

Density : 2617 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.82 (MPa/sec)

Type of Fracture : Shearing Along Single Plain

Test Duration (2-15 Minutes) : 155 (seconds)

Maximum Applied Load : 364.5 (kN)

Compressive Strength : 127.2 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

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

Client : Nokia

Project : 600 March Road, Kanata, Ontario

Project N° : 12606873

Sample N° : BH 7-23 r.3

Depth : 3,84 - 3,94 m

Sampling Date : 4/20/2023

Testing Apparatus Used : **Loading device N°_9130____** **Caliper N° _1__________**

Technical Data

				Average	
Diameter :	47.46	47.56	47.56	**47.53**	(mm)
Length :	98.14	97.98	98.20	**98.11**	(mm)
Straightness (0.5mm maximum) (S1) :	0.1	0.0	0.1	**0.1**	(mm)
Flatness (25µm maximum) (FP2) :	Ok	Ok	Ok	**Ok**	(µm)
Parallelism (0.25 ° maximum) (FP2) :	0.00	0.00	0.00	**0.00**	(°)

Mass : 473.2 (g) Volume: 174046 (mm^3)

Density : 2719 (kg/m^3)

Moisture Conditions : Dry

Loading Rate (0.5 to 1.0 MPa / sec) : 0.81 (MPa/sec)

Type of Fracture : Axial Splitting

Test Duration (2-15 Minutes) : 171 (seconds)

Maximum Applied Load : 245.36 (kN)

Compressive Strength : 138.3 (MPa)

View of Specimen

Before Test :

After Test :

Remarks :

Analysed by : J. Lalonde **Date :** 5/4/2023

Verified by : **Date :**

Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Sahar Soleimani
PO#: 735-006602
Invoice to: GHD Limited (Ottawa)

Report Number: 1996342
Date Submitted: 2023-04-28
Date Reported: 2023-05-05
Project: 12606873
COC #: 222189

Dear Sahar Soleimani:

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

Report Comments:

R Zafari Raheleh Zafari 2023.05.05 16:07:10 -04'00'

APPROVAL: ______________________
Raheleh Zafari, Environmental Chemist

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

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

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

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Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Sahar Soleimani
PO#: 735-006602
Invoice to: GHD Limited (Ottawa)

Report Number: 1996342
Date Submitted: 2023-04-28
Date Reported: 2023-05-05
Project: 12606873
COC #: 222189

				Lab I.D.	1684337	1684338
				Sample Matrix	GW	GW
				Sample Type		
				Sampling Date	2023-04-27	2023-04-27
				Sample I.D.	BH4-23-COR	BH6-23-COR
Group	**Analyte**	**MRL**	**Units**	**Guideline**		
Anions	Cl	1	mg/L		1176	1310
	SO4	50	mg/L		354	730
General Chemistry	Conductivity	5	uS/cm		4380	5180
	pH	1.00			7.71	7.72
	Resistivity	0.2	Mohm-cm		<0.2	<0.2
	S2-	0.02	mg/L			<0.02
		0.05	mg/L		<0.05	
Redox Potential	REDOX Potential		mV		288	289

Guideline = *** = Guideline Exceedence**

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

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

Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Sahar Soleimani
PO#: 735-006602
Invoice to: GHD Limited (Ottawa)

Report Number: 1996342
Date Submitted: 2023-04-28
Date Reported: 2023-05-05
Project: 12606873
COC #: 222189

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 441113 **Analysis/Extraction Date** 2023-05-03 **Analyst** AsA **Method** SM2320,2510,4500H/F			
Conductivity	<5 uS/cm	95	90-110
pH		100	90-110
Run No 441148 **Analysis/Extraction Date** 2023-05-04 **Analyst** AaN **Method** SM 4110			
Chloride	<1 mg/L	100	90-110
SO4	<50 mg/L	100	90-110
Run No 441185 **Analysis/Extraction Date** 2023-05-04 **Analyst** AaN **Method** C SM4500-S2-D			
S2-	<0.01 mg/L	93	80-120
Run No 441231 **Analysis/Extraction Date** 2023-05-05 **Analyst** AsA **Method** Resistivity - water			
Resistivity			
Run No 441237 **Analysis/Extraction Date** 2023-05-05 **Analyst** NF **Method** C SM2580B			
REDOX Potential	137 mV	100	97-103

Guideline = *** = Guideline Exceedence**

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

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Certificate of Analysis

Client:	GHD Limited (Ottawa) 400-179 Colonnade Rd. Ottawa, ON K2E 7J4		Report Number:	1996342
			Date Submitted:	2023-04-28
			Date Reported:	2023-05-05
			Project:	12606873
			COC #:	222189
Attention:	Mr. Sahar Soleimani			
PO#:	735-006602			
Invoice to:	GHD Limited (Ottawa)			

Sample Comment Summary

Sample ID: 1684337 BH4-23-COR For this report: S2- & SO4 MRL elevated due to matrix interference (dilution was done).

Guideline = *** = Guideline Exceedence**

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

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

Certificate of Analysis

Client:	GHD Limited (Ottawa) 400-179 Colonnade Rd. Ottawa, ON K2E 7J4		Report Number:	1971489
			Date Submitted:	2022-02-09
			Date Reported:	2022-02-17
			Project:	12566614 - Nokia
			COC #:	886034
Attention:	Mr. Kenneth Omenogor			
PO#:	735-002201			
Invoice to:	GHD Limited (Ottawa)			

Dear Kenneth Omenogor:

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

Report Comments:

APPROVAL: A. Thomas

Addrine Thomas
2022.02.17
14:49:49 -05'00'

Addrine Thomas, Inorganics Supervisor

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

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: http://www.cala.ca/scopes/2602.pdf.

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Certificate of Analysis

Client:	GHD Limited (Ottawa) 400-179 Colonnade Rd. Ottawa, ON K2E 7J4
Attention:	Mr. Kenneth Omenogor
PO#:	735-002201
Invoice to:	GHD Limited (Ottawa)

Report Number:	1971489
Date Submitted:	2022-02-09
Date Reported:	2022-02-17
Project:	12566614 - Nokia
COC #:	886034

				Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1609628 Soil 2022-01-28 BH 01-22 SS2 (7.5ft - 9.5ft)
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Anions	SO4	0.01	%		0.04
Cl in Concrete	Cl	0.002	%		0.067
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.86
	pH	2.00			7.79
	Resistivity	1	ohm-cm		1180
Redox Potential	REDOX Potential		mV		210
Subcontract	Moisture-Humidite	0.25	%		33.2
	S2-	0.2	ug/g		<0.20

Guideline = *** = Guideline Exceedence**

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

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

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Certificate of Analysis

Client:	GHD Limited (Ottawa) 400-179 Colonnade Rd. Ottawa, ON K2E 7J4
Attention:	Mr. Kenneth Omenogor
PO#:	735-002201
Invoice to:	GHD Limited (Ottawa)

Report Number:	1971489
Date Submitted:	2022-02-09
Date Reported:	2022-02-17
Project:	12566614 - Nokia
COC #:	886034

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 416967 **Analysis/Extraction Date** 2022-02-10 **Analyst** MW **Method** C SM2580B			
REDOX Potential	191 mV	100	
Run No 416987 **Analysis/Extraction Date** 2022-02-11 **Analyst** AA **Method** C CSA A23.2-4B			
Chloride	<0.002 %		80-120
Run No 417077 **Analysis/Extraction Date** 2022-02-14 **Analyst** MW **Method** Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	97	90-110
pH	8.68	101	90-110
Resistivity			
SO4	<0.01 %	98	70-130
Run No 417237 **Analysis/Extraction Date** 2022-02-16 **Analyst** AET **Method** SUBCONTRACT-A			
Moisture-Humidite	<0.25 %	100	
S2-	<0.20 ug/g	86	

Guideline = *** = Guideline Exceedence**

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

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

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Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Kenneth Omenogor
PO#: 735-002201
Invoice to: GHD Limited (Ottawa)

Report Number: 1971490
Date Submitted: 2022-02-09
Date Reported: 2022-02-17
Project: 12566614 - Nokia
COC #: 886034

Dear Kenneth Omenogor:

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

Report Comments:

APPROVAL: A. Thom
Addrine Thomas
2022.02.17
07:29:51 -05'00'

Addrine Thomas, Inorganics Supervisor

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Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Kenneth Omenogor
PO#: 735-002201
Invoice to: GHD Limited (Ottawa)

Report Number: 1971490
Date Submitted: 2022-02-09
Date Reported: 2022-02-17
Project: 12566614 - Nokia
COC #: 886034

				Lab I.D.	1609629
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2022-02-09
				Sample I.D.	BH 02-22
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Anions	Cl	1	mg/L		820
	SO4	1	mg/L		220
General Chemistry	Conductivity	5	uS/cm		3360
	pH	1.00			7.54
	Resistivity	0.2	Mohm-cm		298
	S2-	2	mg/L		<2
Redox Potential	REDOX Potential		mV		237

Guideline = *** = Guideline Exceedence**

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

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

Certificate of Analysis

Client: GHD Limited (Ottawa)
400-179 Colonnade Rd.
Ottawa, ON
K2E 7J4
Attention: Mr. Kenneth Omenogor
PO#: 735-002201
Invoice to: GHD Limited (Ottawa)

Report Number: 1971490
Date Submitted: 2022-02-09
Date Reported: 2022-02-17
Project: 12566614 - Nokia
COC #: 886034

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 416967 **Analysis/Extraction Date** 2022-02-10 **Analyst** MW **Method** C SM2580B			
REDOX Potential	191 mV	100	
Run No 416968 **Analysis/Extraction Date** 2022-02-10 **Analyst** AsA **Method** SM2320,2510,4500H/F			
Conductivity	<5 uS/cm	99	90-110
pH		99	90-110
Run No 416971 **Analysis/Extraction Date** 2022-02-11 **Analyst** AaN **Method** SM 4110			
Chloride	<20 mg/L		90-110
SO4	<20 mg/L	100	90-110
Run No 417051 **Analysis/Extraction Date** 2022-02-14 **Analyst** AsA **Method** C SM4500-S2-D			
S2-	<0.01 mg/L	86	80-120
Run No 417218 **Analysis/Extraction Date** 2022-02-17 **Analyst** AET **Method** Resistivity - water			
Resistivity			

Guideline = *** = Guideline Exceedence**

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

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

Sample Comment Summary

Sample ID: 1609629 BH 02-22 Cl, S2- & SO4 MRL elevated due to matrix interference (dilution was done).

Guideline = *** = Guideline Exceedence**

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

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

Appendix E

MASW Investigation – Seismic Site Classification Report

Technical Memorandum

May 23, 2023

To	Peter Nikolakakos, First Gulf	**Contact No.**	
Copy to		**Email**	**pnikolakakos@firstgulf.com**
From	Brice Zanne / Ali Ghassemi	**Project No.**	12606873
Project Name	MASW		
Subject	MASW Investigation – 600 March Road, Ottawa, Ontario		

1. Introduction

GHD was retained by First Gulf. (Client) to conduct a Multichannel Analysis of Surface Waves (MASW) testing as part of the additional geotechnical and hydrological investigation for the proposed redevelopment plans at the Nokia Property located at 600 March Road (southeast corner of Terry Fox and March Road) in Kanata (Ottawa), Ontario (Site).

It is our understanding that the proposed developments will consist of a high-rise office and retail building with twelve storeys and one underground levels for basement and parking, a six-storey lab building with one underground parking level, and four-storey parking structure with one underground parking level. It is expected that the proposed buildings will be surrounded by pavement structures. Further details regarding the development plans at this property have not been provided to GHD at the time of writing this report.

Multichannel Analysis of Surface Waves (MASW) is a geophysical testing method that uses surface wave (Rayleigh wave) propagation to determine the subsurface profile. The purpose of the MASW survey was to assist with the seismic site class determination by measuring the average shear wave velocity approximately within the upper 30 m of the soil/rock profile below the founding elevation of the proposed structure at the Site. The shear wave velocity measurements were carried out along two MASW survey lines assumed to be representative of the Site. The location of investigation lines is shown in the attached **Figure 1**.

Based on the geotechnical investigation borehole logs provided in **sf20sf20x A** of GHD (2023) geotechnical investigation report, the reported soil profile in the advanced boreholes near the proposed development and the MASW lines consists of asphalt followed by a very loose to very dense cohesionless fill layer of sand and gravel in all boreholes. In Borehole BH6-23, the sand and gravel layer was followed by a very dense gravelly sand fill layer. The fill layer extends to depths varying approximately between 0.2 m to 0.8 m below ground surface (Elevation 79.8 m and 79.0 m). Underneath the fill, a silty clay deposit with a generally stiff to hard consistency was encountered in all boreholes except for BH3-23 in which the native soil consisted only of a loose to very dense gravelly sand deposit. In Borehole BH2-23, the silty clay deposit was further underlain by a very dense deposit of silty sand. The native soil extends to depths varying approximately between 1.1 m to 1.6 m below ground surface (Elevation 78.9 m and 78.3 m). Following the native strata, bedrock consisting of dolomitic sandstone was encountered and extended to the termination depth of investigation in all boreholes. The Rock Quality Designation (RQD) ranges from approximately 40 per cent to 100 per cent. The deepest investigative borehole was advanced to about 10.5 m below ground surface (BH4-23 shown in **Figure 1**). The described relative density/consistency terms and soil classification in this

This Technical Memorandum is provided as an interim output under our agreement with First Gulf. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

section are based on the recorded SPT “N” values and soil descriptions provided on the GHD (2023) geotechnical borehole logs.

2. MASW Procedure

To carry out the MASW test, 24 transducers (geophones) are deployed along a line at certain distances from a seismic source. The length of the geophone array determines the deepest investigation depth that can be obtained from the measurements. The source should produce enough seismic energy over the desired test frequency range to allow for detection of Rayleigh waves above background noise (Park et al., 1999[1]). A common seismic source is either a sledgehammer or a drop weight hitting a metallic or rubber base plate set at ground surface. The existing traffic noise or the noise generated by heavy machinery travelling close to the survey line can also be utilized as a source for investigating deep soil layers. For this site, only active seismic source is used. **Figure 2.1** shows a typical MASW setup.

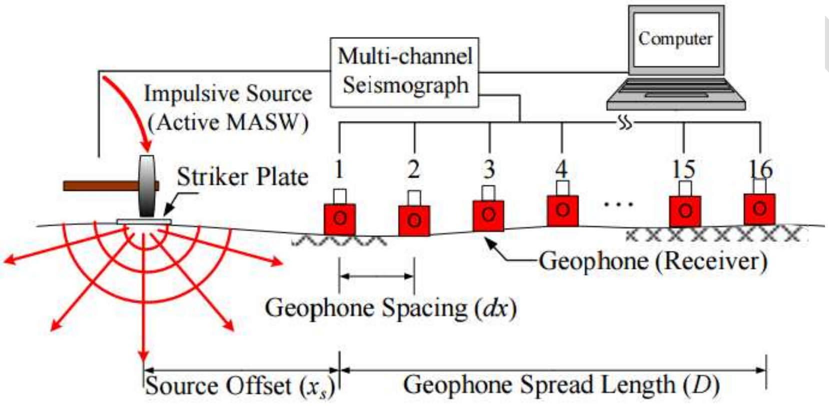

Figure 2.1: Schematic Layout of MASW Test Setup (Sahadewa et al., 2012[2])

3. Fieldwork

The fieldwork for this MASW investigation program was carried out on April 21st , 2022, by GHD professionals. The field data was collected using a 24-channel seismograph (Geometrics Geode 24 console #3389), twenty-four 4.5 Hz geophones, and one 24 take-out cable with 5 m spacing. A Panasonic Toughbook© laptop was used in the field to record and collect the seismic data utilizing Geometrics single geode OS controller version 9.14.0.0.

The survey was carried out along two survey lines in the footprint of the proposed development as shown on **Figure 1** attached to this report. For all survey lines, the geophones were installed 75 mm into the ground by manually pushing them into position.

A multi geometry approach was utilized for data collection along all lines. The active data sets were collected using a 4.5 kg sledgehammer hitting the ground surface at three different offset distances (distance between the source and first geophone) along each survey line. The following table summarizes the geometry for each investigation line.

---

[1] Park, C. B., Miller, R. D., & Xia, J. (1999). Multichannel analysis of surface waves. Geophysics, 64(3), 800-808.
[2] Sahadewa, A., Zekkos, D., & Woods, R. D. (2012). Observations from the implementation of a combined active and passive surface wave based methodology. In GeoCongress 2012: State of the Art and Practice in Geotechnical Engineering (pp. 2786-2795).

Table 1 MASW Lines Geometry

Line No.	Designation	Geophone Spacing (m)	Array Length (m)	Offset Distances (m)
Line 1	Long	2.0	46.0	30.0, 20.0, 10.0
Line 1	Short	1.0	23.0	15.0, 10.0, 5.0
Line 2	Long	2.0	46.0	30.0, 20.0, 10.0
Line 2	Short	1.0	23.0	15.0, 10.0, 5.0

Three sets of data files (active) were collected for each array location/set up. For the active survey measurements, the ground vibrations were recorded for four seconds with one sample per 0.25 ms.

4. Data Interpretation

MASW method utilizes the frequency-dependent properties of Rayleigh surface waves in order to develop the profile of shear wave velocity with depth. This method includes three stages as shown in **Figure 4.1**. In this project, generation of dispersion curves, inversion of the obtained dispersion curves and development of the 1D shear wave velocity profiles were carried out using SurfSeis© version 6.0. The dispersion curves were calculated at the middle stations along each line. At each investigation line, the dispersion images obtained from active data at different offsets were stacked to obtain a combined dispersion curve. The data inversion was carried out using a 10-layer soil velocity numerical model to obtain 1D shear wave velocity profiles at the location of each mid station. The calculated 1D velocity profile along the investigation lines is shown on the attached Shear Wave Velocity Profile. **Figure 2** shows the obtained results at the location of the proposed development. As it can be seen in this figure, values of shear wave velocity for Line 1 and Line 2 are relatively consistent in depth. The data obtained from the advanced boreholes also confirms a consistent subsurface soil profile in the vicinity of the MASW lines. The stratigraphy borehole logs are provided in **Appendix A** of the GHD (2023) geotechnical investigation report. For all investigation lines, the shear wave velocity increases with depth indicating values higher than 1200 m/s below approximate depths of 17 m.

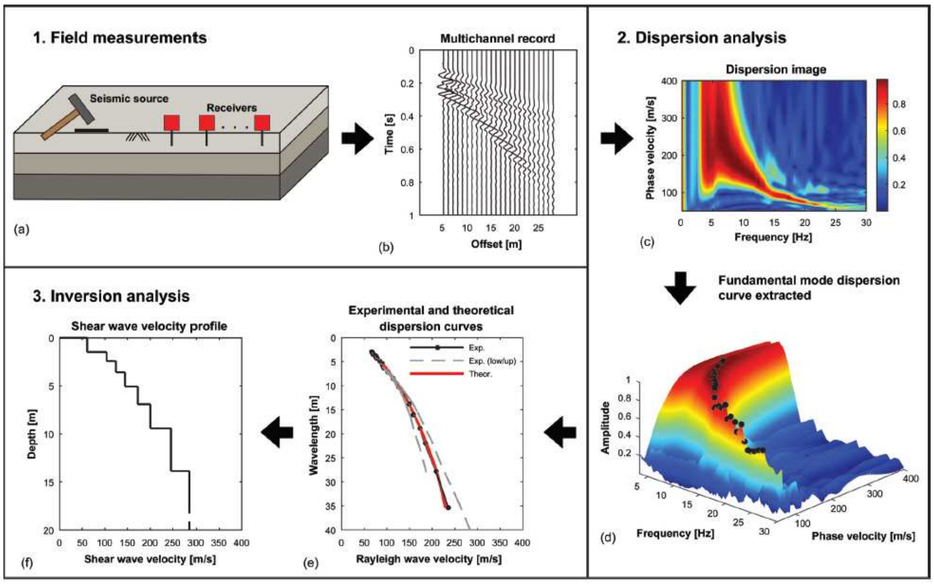

Figure 4.1: Overview of MASW method (Olafsdottir et al., 2018[3])

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[3] Olafsdottir, E. A., Erlingsson, S., & Bessason, B. (2018). Tool for analysis of multichannel analysis of surface waves (MASW) field data and evaluation of shear wave velocity profiles of soils. Canadian Geotechnical Journal, 55(2), 217-233.

In accordance with the requirements of Ontario Building Code (OBC 2012) and National Building Code of Canada (NBC 2020), the variation of the measured shear wave velocity versus depth up to 30 m below the proposed founding level of the buildings (assumed to be 4.5 m below existing ground surface for this project) was obtained along each line and is shown in **Table 1-A** and **Table 1-B** attached to this report. The average shear wave velocity within the upper 30 m of the soil/rock profile (Vs_{30}) immediately below the founding level of the building (assumed to be at 4.5 m below ground surface) were obtained utilizing the averaging scheme introduced in Sentence 4.1.8.4 (2) of NBC (2020) User's Guide.

Based on the calculations presented in **Table 1** attached to this report, the average shear wave velocity (from 4.5 m below ground surface to 34.5 m below ground surface) along the two investigation lines is **1480 m/s**. Therefore, in accordance with Table 4.1.8.4.A of the OBC 2012 (**Table 2** attached to this report) and based on the measured average shear wave velocity, the Site can be classified as **Class 'B'** for the seismic load calculations.

Based on available geotechnical information from the advanced boreholes in the Site, the deepest investigative borehole was advanced to approximately 10.5 m below ground surface (BH4-23 as shown on **Figure 1**) and bedrock was encountered at approximately between 1.1 m to 1.6 m below ground surface in boreholes advanced by GHD (2023).

In addition, based on the average shear wave velocity provided in **Table 1** and in accordance with Table 4.1.8.4.A and Section 4.1.8.4.(2) of the NBC 2020, site designation is determined using the average shear wave velocity Vs30, calculated from in situ measurements of shear wave velocity. For ground profile which contains no more than 3.0 m of softer materials between rock and underside of footing or mat foundation, the site designation shall be Xv, where V is the value of Vs30. As a result, a **Site Designation of** $\mathbf{X_{1480}}$ can be assigned for seismic load calculations.

The seismic site classification provided in this report is based solely on the shear wave velocity values derived from the MASW method and that it can be superseded by other geotechnical information as per requirement from NBC (2020).

The seismic hazards for the site as obtained from the 2020 National Building Code of Canada Seismic Hazard Tool are provided as **Attachment A** to this correspondence.

5. Closure

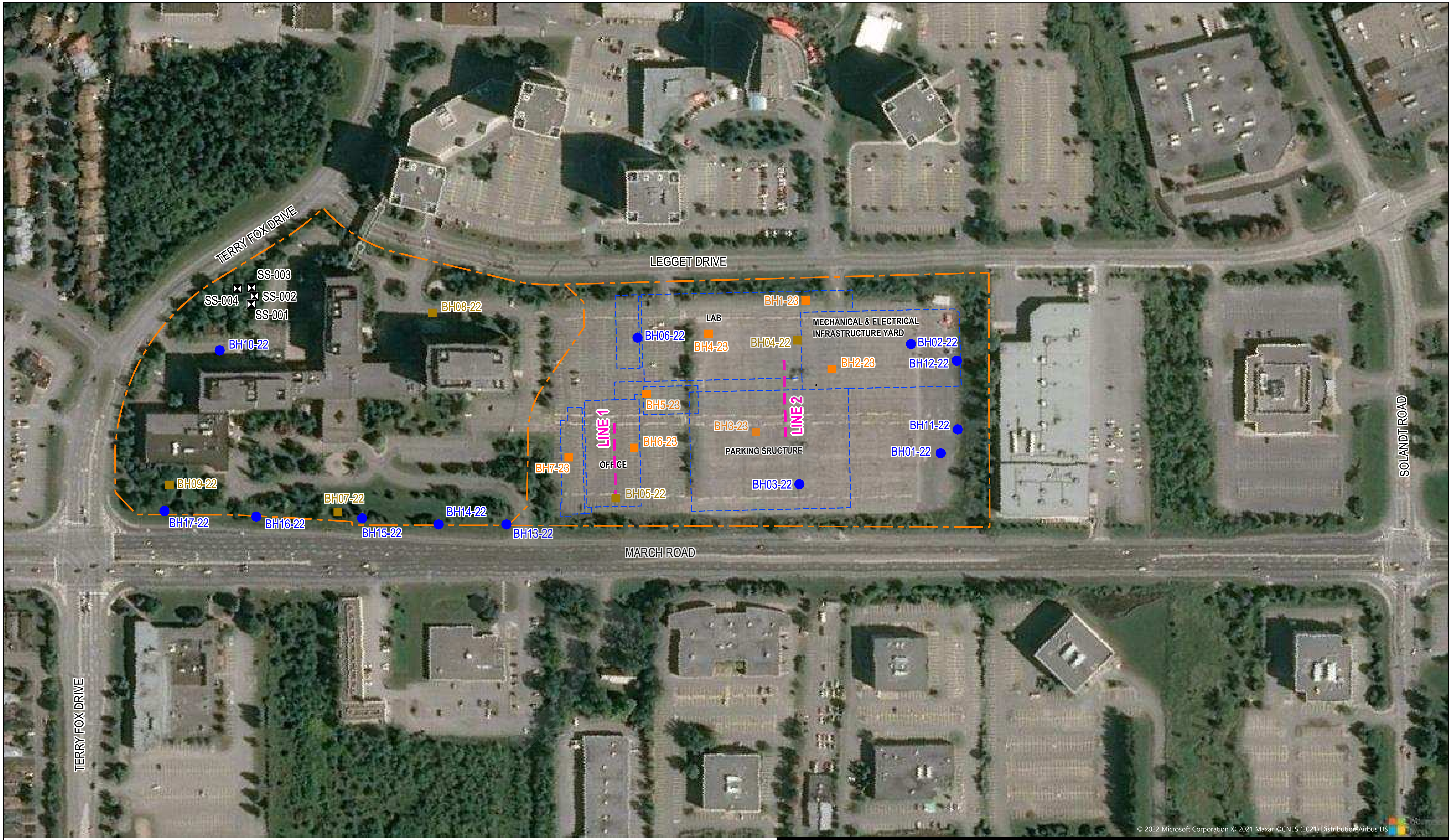
It is important to emphasize that the results and conclusions of the MASW analysis are based on the available geotechnical information and the survey conducted along the two investigation lines. Should any conditions at the Site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

Regards,

Brice Zanne, M.Eng., EIT

Ali Ghassemi, Ph.D., P.Eng.

Figures



LEGEND

— · —	PROPERTY BOUNDARY	●	MONITORING WELL (GHD, 2022)
——	PROPOSED BUILDING OUTLINE	☒	SOIL SAMPLING LOCATION (GHD, 2022)
– – –	MASW LINE LOCATION	■	BOREHOLE LOCATION (GHD, 2022)
		■	BOREHOLE LOCATION (GHD, 2023)

0 25 50 75m
1:2500
Coordinate System:
UTM with NAD83 datum,
Zone 18, Meter;

GHD

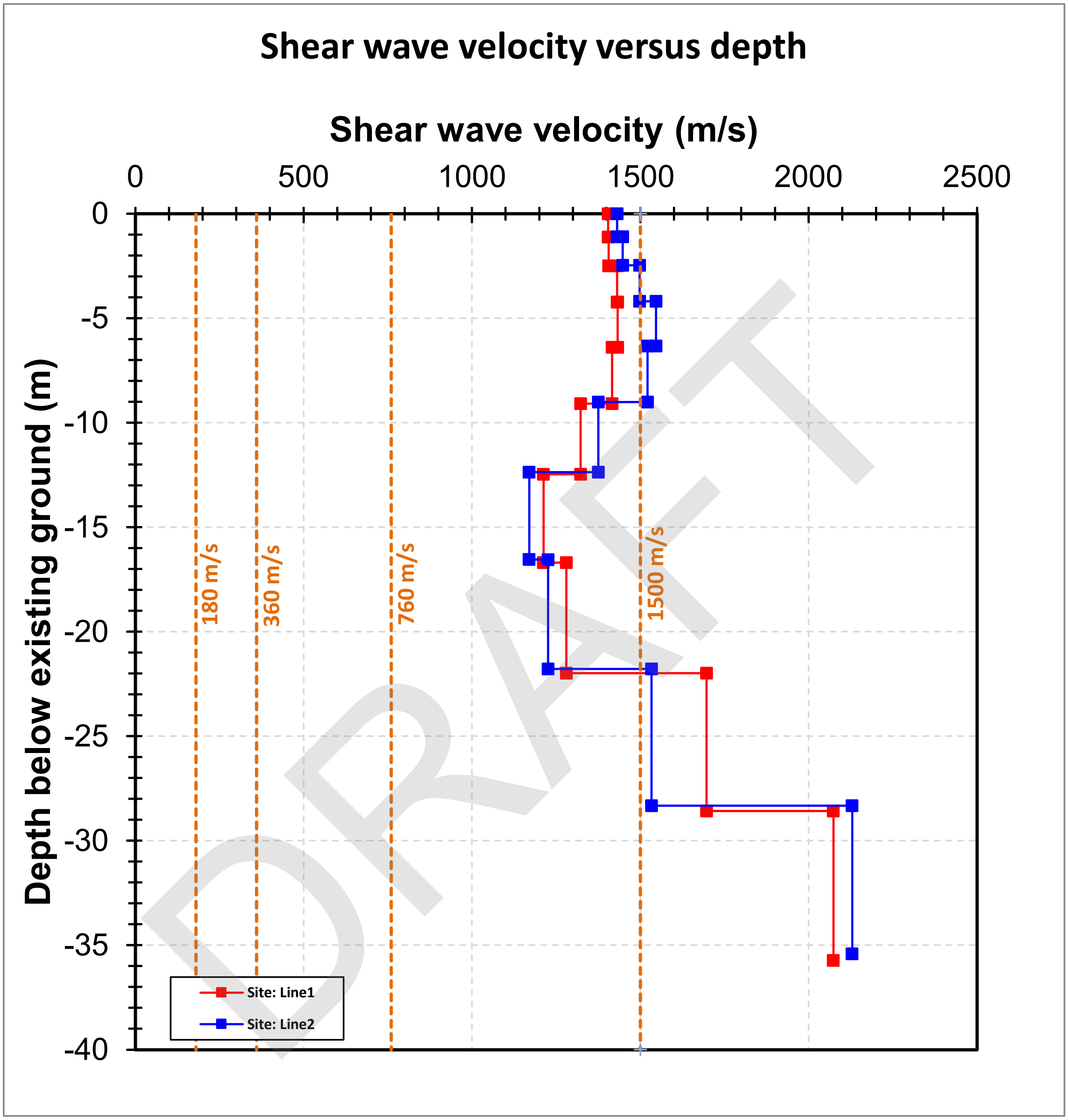
NOKIA CAMPUS REZONING
570 and 600 MARCH ROAD
KANATA
(OTTAWA)

BOREHOLE LOCATION PLAN / MASW LINES

Project No. 12606873
Date May 2023

FIGURE 1

Filename: N:\CA\Ottawa\Projects\661\12606873\Digital_Design\ACAD\Figures\RPT-MASW\12606873-GHD-00-00-RPT-EN-D101_WA-MASW.dwg
Plot Date: 15 May 2023 10:29 AM



First Gulf
Geotechnical Inveisitigation
600 March Rd, Kanata, ON K2K 2T6

PROJECT NO.
12606873
DATE
10-May-23

SHEAR WAVE VELOCITY VS DEPTH

FIGURE NO. 2

Tables

Table 1
Summary of Shear Wave Velocity Measurements
Seismic Site Class Determination
Geotechnical Investigation
First Gulf
600 March Rd, Kanata, ON K2K 2T6

.

Table 1-A: Average Shear Wave Velocity (VS_{30})
(Assumed foundation at 4.5 m below ground surface)

Line 1

Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	4.5	6.4	1.9	1433	0.0013
2	6.4	9.1	2.7	1417	0.0019
3	9.1	12.5	3.4	1323	0.0026
4	12.5	16.7	4.2	1212	0.0035
5	16.7	22.0	5.3	1280	0.0041
6	22.0	28.6	6.6	1697	0.0039
7	28.6	34.5	5.9	2073	0.0029
Total			30.0		0.0201
Average Shear Wave Velocity Along the Line (m/s)					***1490***

Table 1-B: Average Shear Wave Velocity (VS_{30})
(Assumed foundation at 4.5 m below ground surface)

Line 2

Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	4.5	6.3	1.8	1547	0.0012
2	6.3	9.0	2.7	1522	0.0018
3	9.0	12.4	3.4	1375	0.0024
4	12.4	16.5	4.2	1170	0.0036
5	16.5	21.8	5.2	1226	0.0043
6	21.8	28.3	6.5	1533	0.0043
7	28.3	34.5	6.2	2129	0.0029
Total			30.0		0.0204
Average Shear Wave Velocity Along the Line (m/s)					***1471***

Average VS_{30} = 1480 m/s

Recommended Minimal Site Designation (NBCC 2020) : X_{1480} Subjected to Code requirements

Notes:

1 - The Seismic Site designation is recommended in accordance to Table 4.1.8.4.A of the National Building code of Canada 2020 (NBCC 2020), section 4.1.8.4 (2) and based on the measured average shear wave velocity measured along the investigate Line 1.

2 - VS30 is the average shear wave velocity in top 30 m below the proposed founding elevation calculated from in situ measurements.

3 - Ground profile which contains no more than 3 m of softer materials between rock and underside of footing or mat foundation, the site designation shall be Xv, where V is the value of VS30.

Recommended Minimal Site Class (OBC 2012) : B Subjected to Code requirements

Notes:

1 - The Seismic Site class is recommended in accordance to Table 4.1.8.4.A of the Ontario Building Code (OBC 2012, O.Reg 332/12) and based on the measured average shear wave velocity measured along the investigated lines.

2 - VS30 is the average shear wave velocity in top 30 m below the proposed founding elevation calculated from in situ measurements.

3 - Site Classes A and B are only applicable if footings are founded on bedrock or there is no more than 3.0 m of soil between founding elevation and bedrock.

4 -The recommended site class is only applicable if site conditions for Site Class E and F are not applicable.

4.1- All below conditons must be satisfied for Site Class E:
- Vs30 <180 m/s
- Any profile with more than 3 m of soil with following characteristics:
  - plasticity index: PI>20
  - moisture content w ≥40%, and
  - undrained shear strength: Su < 25 kPa

4.2- Site Class F conditons:
- liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils, and other soils susceptible to failure or collapse under seismic loading,
- peat and/or highly organic clays greater than 3 m in thickness,
- highly plastic clays (PI > 75) more than 8 m thick, and
- soft to medium stiff clays more than 30 m thick

Table 2

Site Classification for Seismic Site Response Forming Part of Sentences 4.1.8.4. (1) to (3)

	Ground Profile Name	Average Properties in Top 30 m		
		Average Shear Wave Velocity, $\bar{V}_s$ (m/s)	Average Standard Penetration Resistance, $\bar{N}_{60}$	Soil Undrained Shear Strength, s_u
A	Hard rock	$\bar{V}_s > 1500$	N/A	N/A
B	Rock	$760 < \bar{V}_s \leq 1500$	N/A	N/A
C	Very dense soil and soft rock	$360 < \bar{V}_s < 760$	$\bar{N}_{60} > 50$	$s_u > 100$ kPa
D	Stiff soil	$180 < \bar{V}_s < 360$	$15 \leq \bar{N}_{60} \leq 50$	50 kPa $< s_u \leq$ 100 kPa
E	Soft soil	$\bar{V}_s < 180$	$\bar{N}_{60} \leq 15$	$s_u < 50$ kPa
		Any profile with more than 3m of soil with the following characteristics: plasticity index: PI > 20 moisture content w ≥ 40%, and undrained shear strength: $s_u < 25$ kPa		
F	Other soils	Site-specific evaluation required		

Reference: *2012 Ontario Building Code Compendium, Division B – Part 4, Section 4.1.8.4.*

Attachments

Attachment A

NBC Seismic Hazard and Site Classification for Seismic Site Response

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_V	X_{1480}
Latitude (°)	45.347
Longitude (°)	-75.92

Please select one of the tabs below.

NBC 2020 Additional Values Plots API

Background Information

The 5%-damped spectral acceleration ($S_a(T,X)$, where T is the period, in s, and X is the site designation) and peak ground acceleration (PGA(X)) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak ground velocity (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

S_a(0.2, X_{1480})	**S_a(0.5, X_{1480})**	**S_a(1.0, X_{1480})**	**S_a(2.0, X_{1480})**	**S_a(5.0, X_{1480})**	**S_a(10.0, X_{1480})**	**PGA(X_{1480})**	**PGV(X_{1480})**
0.367	0.19	0.098	0.0459	0.0127	0.00475	0.28	0.14

The log-log interpolated 2%/50 year S_a(4.0, X_{1480}) value is : **0.0174**

▼ Tables for 5% and 10% in 50 year values

NBC 2020 - 5%/50 years (0.001 per annum) probability

S_a(0.2, X_{1480})	**S_a(0.5, X_{1480})**	**S_a(1.0, X_{1480})**	**S_a(2.0, X_{1480})**	**S_a(5.0, X_{1480})**	**S_a(10.0, X_{1480})**	**PGA(X_{1480})**	**PGV(X_{1480})**
0.207	0.108	0.0548	0.025	0.00659	0.00249	0.153	0.076

The log-log interpolated 5%/50 year S_a(4.0, X_{1480}) value is : **0.0091**

NBC 2020 - 10%/50 years (0.0021 per annum) probability

S_a(0.2, X_{1480})	**S_a(0.5, X_{1480})**	**S_a(1.0, X_{1480})**	**S_a(2.0, X_{1480})**	**S_a(5.0, X_{1480})**	**S_a(10.0, X_{1480})**	**PGA(X_{1480})**	**PGV(X_{1480})**

$S_a(0.2, X_{1480})$	$S_a(0.5, X_{1480})$	$S_a(1.0, X_{1480})$	$S_a(2.0, X_{1480})$	$S_a(5.0, X_{1480})$	$S_a(10.0, X_{1480})$	$PGA(X_{1480})$	$PGV(X_{1480})$
0.129	0.0682	0.0338	0.015	0.00375	0.00143	0.0928	0.0455

The log-log interpolated 10%/50 year $S_a(4.0, X_{1480})$ value is : **0.0053**

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06

Appendix F

Hydrogeological Assessment

Memorandum

15 June 2023

To	Sahar Soleimani, GHD		
Copy to			
From	Allan Molenhuis, Ben Kempel	**Tel**	519-884-0510
Subject	Hydrogeologic Assessment	**Project no.**	12606873-MEM-1

1. Introduction

GHD Limited (GHD) has prepared this memorandum to present the findings of the hydrogeologic assessment that was completed in conjunction with the geotechnical investigation at the 600 March Road Nokia Property in Kanata (Ottawa), Ontario (Property or Site). Figure 1, within the body of this report, illustrates the Site layout and locations investigated as described throughout this memo.

GHD understands that the Site is being considered for improvements to the existing campus at the southeast corner of Terry Fox Drive and March Road. Site improvements will consist of several new buildings to the southeast of the existing campus (Study Area). The space is currently occupied by a parking lot area which will be redeveloped with the following interconnected structures:

- A high-rise office and retail building with twelve storeys and one underground level for basement and parking,
- A six-storey lab building with one underground parking level, and
- A four-storey parking structure with one underground parking level.

The objective of the hydrogeologic assessment is to characterize the hydrogeologic conditions at the Site in the area of the proposed upgrades and to provide preliminary dewatering estimates during and post-construction.

To this end, this memo is inclusive of all available hydrogeologic data collected in the area of the proposed Site improvements (i.e., the southeastern half of the Site as illustrated in Figure 1 in the body of the report). The work undertaken included completing boreholes as monitoring wells (both in overburden and shallow bedrock), collecting groundwater level measurements, completing single well response testing (SWRTs), and collecting groundwater quality samples.

Estimated dewatering rates have been used to provide recommendations regarding the need for a Permit to Take Water (PTTW) or registration on the Environmental Activity Service Registry (EASR) as well as comments on the potential water quality issues that may be encountered during dewatering.

2. Background

The Site is located in the physiographic region of the Ottawa Valley Clay Plains and is approximately 3.5 kilometres (km) southwest of the Ottawa River. The region is characterized by zones of exposed bedrock, glaciomarine silt and clay deposits, and fluvial deposits associated with the Ottawa River. Surficial geological mapping, illustrated on **Figure 1**, shows that the Site is underlain by glaciomarine deposits in the area of proposed improvements (i.e., southeast) and by Paleozoic bedrock beneath the existing campus buildings. Thus, overburden thickness in the region is expected to be thin.

Quaternary geology mapping, illustrated on **Figure 2**, indicates that the Site is immediately underlain by glaciomarine deposits of silt and clay. Approximately 250 metres (m) northwest of the Site, an area of surficial fluvial deposits is found. 600 m to the southeast, exposed bedrock is reported.

According to the Paleozoic Geology of Southern Ontario map, illustrated on **Figure 3**, bedrock at the Site consists of interbedded dolomitic sandstone of the March Formation within the Beekmantown Group.

As described in the body of this report, a number of borehole locations were advanced at the Site to investigate the characteristics of the Site's overburden and bedrock geology. A compilation of stratigraphic and instrumentation logs is included in the body of this report as well as GHD's Phase Two Environmental Site Assessment report (GHD, July 2022).

From a hydrogeologic perspective, the subsurface at the Site consists of the following:

Ground Cover – A surficial layer of asphalt with a thickness ranging from 25 millimetres (mm) to100 mm with a granular base/subbase of sandy silt, sandy gravel to gravelly sand was encountered extending to 0.2 to 0.8 metres below ground surface (mBGS). This unit was observed to be generally dry.

Silty Clay to Clayey Silt – A layer of fine grained, cohesive, silty clay to clayey silt deposits were encountered below the ground cover. This unit extends from 0.5 to 0.8 mBGS. This unit is anticipated to have very low groundwater yield.

Glacial Till – A glacial till deposit consisting of silty sand to gravelly sand was encountered below silty clay at depths ranging from 0.2 m and 4.0 m. This unit extends to depths of 1.1 to 4.4 mBGS. This unit was observed to be generally moist to wet.

Bedrock – Bedrock (including presumed) was encountered at depths ranging from 0.3 to 3.6 mBGS (Elevations 76.6 to 81.5 m). Based on retrieved rock core and rock exposures, bedrock at the Site consists of dolomitic sandstone that is described as slightly weathered to fresh, thinly to medium bedded, light grey to grey black with yellow bands. This bedrock unit was encountered to the maximum depth of investigation at 10.5 mBGS.

3. Methodology

3.1 Groundwater Level Monitoring

As part of this geotechnical and hydrogeologic investigation, a total of seven borehole were advance in the Study Area, three of those boreholes were completed as monitoring wells (BH3-23, BH4-23, and BH6-23). Previous investigations within the Study Area, completed by GHD, included the advancement of eight boreholes, six of which were completed as monitoring wells (BH01-22, BH02-22, BH03-22, BH06-22, BH11-22, BH12-22). Additional boreholes/monitoring wells were also completed on the northwestern half of the property during 2022.

Each monitoring well was developed to ensure a good hydraulic connection within its target water-bearing zone. Development assists in removing residual drilling fluids and fines disturbed by the drilling process by purging multiple well volumes.

GHD field staff completed depth to groundwater level measurements on a number of occasions including: pre and post well development, prior to completing single-well response testing, and prior to collecting groundwater samples. Groundwater levels measured in the Study Area are summarized in **Table 1**, attached.

As shown in **Table 1**, water levels in BH01-22 (overburden) ranged from 1.20 to 2.45 mBGS. Water levels in the bedrock wells within the Study Area ranged from depths of 0.6 to 6.02 mBGS with an average depth of 2.68 mBGS.

It should be noted that the groundwater table will fluctuate in response to precipitation and snowmelt or dry events.

3.2 Single Well Response Testing

GHD field staff completed SWRTs on February 9, 2022, at bedrock wells BH02-22 and BH10-22, and on April 25, 2023, at bedrock wells BH3-23, BH4-23, and BH6-23. SWRTs consisted of recovery testing. Recovery testing was completed by removing a known volume of water from the test well and observing water level recovery back to a static condition. GHD field staff monitored recovery manually using an electronic water level tape as well as continuously using electronic data loggers.

It is noted that monitoring well BH10-22 is located in the northwestern half of the Site. However, the SWRT data collected at this location is relevant as the bedrock unit is consistent between the two halves of the Property. Thus, the results have been included below.

The results from the recovery tests were analysed using the Bower-Rice (1976) and Dagan (1979) solution for unconfined aquifers. Analysis was completed using the software package AQTESOLV^{TM}. These solutions were used to determine the horizontal hydraulic conductivity of the geologic deposits within the immediate vicinity of the screened interval of the monitoring well.

Table 2 summarizes the results of the hydraulic conductivity testing.

Table 2 Single Well Response Test Results Summary

Borehole ID	Hydraulic Conductivity (cm/sec)	Solution Method
BH02-22	3.9×10^{-5}	Bouwer-Rice
BH10-22	2.1×10^{-6}	Dagan
BH3-23	1.2×10^{-4}	Bouwer-Rice
BH4-23	9.2×10^{-4}	Dagan
BH6-23	1.1×10^{-5}	Dagan
Notes: cm/sec – centimetre per seconds		

Calculated horizontal hydraulic conductivity values ranged from 2.1×10^{-6} cm/sec to 9.2×10^{-4} cm/sec with a geometric mean of 3.9×10^{-5} cm/sec. Published hydraulic conductivity values for sandstone range from 1×10^{-8} to 1×10^{-4} cm/sec[1]. The calculated hydraulic conductivity values are within the expected range.

It is noted that hydraulic testing was not completed on the overburden; however, given the stratigraphic description and length of time before measurable water was observed to be present within an on-Site overburden monitoring well following installation (i.e., approximately 4 months), the hydraulic conductivity of the glaciolacustrine clay is estimated to be on the order of 1×10^{-8} cm/sec. Published hydraulic conductivity values for marine clay, which would be similar to glaciolacustrine clay, range from 1×10^{-10} to 1×10^{-7} cm/sec. This very low hydraulic conductivity is likely to result in negligible groundwater seepage contribution to any excavation or long-term dewatering and has been discounted in the dewatering estimates discussed below.

The SWRT results are appended to the body of this report.

---

[1] Groundwater – Freeze and Cherry, 1979

3.3 Groundwater Sampling

GHD collected groundwater quality samples from BH01-22, BH02-22, BH03-22, BH06-22, BH11-22, BH12-22, BH3-23, BH4-23, and BH6-23. Sampled were collected on April 27, 2023, and submitted for laboratory analysis of general chemistry, dissolved metals, hydrocarbons, volatile organic compounds, and polycyclic aromatic hydrocarbons. The water quality results from the April 27, 2023, sampling event are summarized in **Table 3**, attached. The results are compared against the Ministry of the Environment, Conservation, and Parks (MECP) Table 7: Full Depth Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition as well as the Provincial Water Quality Objectives (PWQOs), and the City of Ottawa's Sewer-Use By-Law standards.

Groundwater quality at the Site in regard to dewatering is discussed below.

4. Water Taking Evaluation

Proposed Site upgrades include a high-rise office and retail building, lab building, and a four-storey parking structure with one level of underground parking to be completed beneath each structure. A review of the Nokia Master Plan, 2022 shows that the underground parking structure extends to a depth of 4.5 mBGS (15 ftBGS).

GHD prepared the water taking evaluation considering the dewatering requirements outlined in **Table 4**, below.

Table 4 Summary of Relevant Construction Dewatering Depths

Excavation (1)	Excavation Dimensions (m)	Ground surface (mAMSL)	Water Table (mAMSL/mBGS)	Bottom Excavation (mAMSL/mBGS)	Dewatering Required (m) (2)
Linear Infrastructure	3.5 × various	80.0	79.26 / 0.84	77.5 / 2.5	2.7
Office & Retail	75 x 50 3,750 m^2	80.0	79.26 / 0.84	75.5 / 4.5	4.7
Lab	90 x 60 5,400 m^2	80.0	79.26 / 0.84	75.5 / 4.5	4.7
Parking Structure	90 x 65 5,850 m^2	80.0	79.26 / 0.84	75.5 / 4.5	4.7

Notes:

mAMSL – metres above mean sea level
mBGS – metres below ground surface
1 – Structures described by Nokia Master Site Plan, 2022

2 – Dewatering required is 1 m below the bottom of the excavation

For excavation that will intersect the natural water table this equals:

Excavation Bottom (mBGS) + 1 m – depth to water (mBGS)

As the Site is relatively flat, dewatering estimates have been completed using an average ground surface elevation. To be conservative, the 90th percentile of the measured water levels within the bedrock has been applied to each area to be dewatered.

Proposed construction excavation water takings would consist of groundwater seepage, direct precipitation into the excavation, as well as potential surface water run-off. For the purposes of estimating dewatering for the proposed Site construction works, GHD takes a conservative approach. The following assumptions have been made to that end:

- As an additional factor of safety, dewatering estimates include the measured height of water plus an additional 1 m.
- The 90th percentile measured water level within the bedrock has been applied to each area to be dewatered. Using a percentile provides a conservative estimate while removing un-realistic water level data.
- A 2-year 24-hour storm event has been used to estimate potential contribution from large precipitation events.
- A final, 3x factor of safety has been applied to account for variation in excavation size and transient dewatering (where periods of short-term rapid drawdown are required).

4.1 Dewatering – Trenches

The equation for construction water-taking rate of an unconfined aquifer trench provided by the Canadian Geotechnical Society (CGS)[2], Equation 4-1, is applied to estimate construction water-taking for linear structures such as linear footings or subsurface utility lines (where the ratio of excavation length to width is greater than 1.5).

$$Q=\frac{\pi K(H^2-h^2)}{\ln\left(\frac{R_0}{r_w^t}\right)}+2\left[\frac{xK\left(H^2-h^2\right)}{2R_0}\right] \qquad \text{Equation 4-1}$$

Where:

Q = is pumping rate in units of L/day (1,000 x m³/day)

ln = is the natural logarithm

K = is the hydraulic conductivity, in metres per day

H = is the height of groundwater pressure at the trench in meters above a relevant datum

h = is the height of groundwater near the trench in meters following dewatering activities and is referenced to a relevant datum

R_0 = is the zero-drawdown distance, or zone of influence (ZOI)

x = the length of the trench

r_w^t = is the equivalent radius of the trench and is estimated in Equation 4-2, below

$$r_w^t=\frac{a+b}{\pi} \qquad \text{Equation 4-2}$$

Where:

a = is the length of the excavation

b = is the width of the excavation

To estimate the radius to zero drawdown (R_0), representing the zone of influence (ZOI) near the excavation, GHD applied the empirical Sichardt relationship expressed as Equation 4-3, below.

$$R_0=3{,}000(H\text{-}h)\sqrt{K_h \times \frac{1\text{ day}}{86{,}400\text{ seconds}}}+r_w \qquad \text{Equation 4-3}$$

---

[2] Canadian Geotechnical Society/Southern Ontario Section Toronto Group, International Association of Hydrogeologists/ Canadian National Chapter (CGS), 2013

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

4.2 Dewatering – Shafts

To estimate dewatering rates for the shaft shaped structures (shallow structure foundations), GHD has used the CGC equation for the construction dewatering rate of an unconfined aquifer shaft.

The equation for construction water-taking rate of an unconfined aquifer shaft (where the ratio of excavation length to width is less than 1.5) is provided in Equation 4-4, below.

$$Q=\frac{\pi K(H^2-h^2)}{\ln\left(\frac{R_0}{r_w^s}\right)} \qquad \text{Equation 4-4}$$

Where:

Q = is pumping rate in units of L/day (1,000 x m^3/day)

ln = is the natural logarithm

K = is the hydraulic conductivity, in metres per day

H = is the height of groundwater pressure at the excavation in meters above a relevant datum

h = is the height of groundwater near the excavation in meters following dewatering activities and is referenced to a relevant datum

R_0 = is the zero-drawdown distance, or zone of influence (ZOI). Equation 4-5 below

r_w^s = is the equivalent radius of the excavation and is estimated in Equation 4-6, below

Assuming the excavation is not hydraulically connected to the cooling water discharge channel, the empirical Sichardt relationship expressed as Equation 4-5 can be used to estimate the zero-drawdown distance, below.

$$R_0=3{,}000(H\text{-}h)\sqrt{K_h \times \frac{1\text{ day}}{86{,}400\text{ seconds}}}+r_w \qquad \text{Equation 4-5}$$

r_w^s is the equivalent radius of the shaft and is estimated in Equation 4-6, below

$$r_w^s=\sqrt{\frac{ab}{\pi}} \qquad \text{Equation 4-6}$$

Where

a = is the length of the shaft excavation

b = the width of the shaft excavation

4.3 Dewatering Rates for Linear Infrastructure

Table 5, below, provides estimated dewatering rates for various lengths of linear excavation through the low-permeable soils and intro the shallow bedrock. Dewatering rates are completed using assumed trench widths and depths.

Equations 4-1 through 4-3, for dewatering a trench, were populated with the following inputs for trench structures to arrive at an estimated daily dewatering rate (Q):

Table 5 ***Dewatering Inputs and Estimates – Trenches***

Structure	Height of groundwater (H) (1)	Height of groundwater after dewatering (h) (2)	Trench Length (x and a)	Trench Width (b)	Equivalent radius (r^t_w)	Hydraulic Conductivity (K)		Zone of Influence (R_0)	Dewatering Rate (Q)
	(m)	(m)	(m)	(m)	(m)	(cm/sec)	(m/day)	(m)	L/day
Linear Structure	2.7	0	6.5	3.5	3.2	3.9×10^{-05}	3.4×10^{-02}	8.2	990
Linear Structure	2.7	0	10	3.5	4.3	3.9×10^{-05}	3.4×10^{-02}	9.3	1,230
Linear Structure	2.7	0	15	3.5	5.9	3.9×10^{-05}	3.4×10^{-02}	10.9	1,560
Linear Structure	2.7	0	20	3.5	7.5	3.9×10^{-05}	3.4×10^{-02}	12.5	1,850

Notes:

1 – Dewatering required is 1 m below the bottom of the excavation;

2 – Height of groundwater after dewatering has been set to a reference elevation of 0.0m

4.4 Dewatering Rates for Underground Parking Lots

Table 6, below, provides a summary of the inputs to Equations 4-4 and 4-6 and the estimated dewatering rate for the shaft shaped structures.

Table 6 ***Dewatering Inputs and Estimates – Shafts***

Excavation Area	Height of groundwater (H) (1)	Height of groundwater after dewatering (h) (2)	Shaft Length (a) (3)	Shaft Width (b) (3)	Equivalent radius (r^s_w)	Hydraulic Conductivity (K)		Zone of Influence (R_0)	Dewatering Rate (Q)
	(m)	(m)	(m)	(m)	(m)	(cm/sec)	(m/day)	(m)	L/day
Office & Retail	4.7	0	75	50	34.5	3.9×10^{-05}	3.4×10^{-02}	43.3	10,210
Lab	4.7	0	90	60	41.5	3.9×10^{-05}	3.4×10^{-02}	50.2	12,030
Parking Structure	4.7	0	90	65	43.2	3.9×10^{-05}	3.4×10^{-02}	51.9	12,480

Notes:

1 – Dewatering required is 1 m below the bottom of the excavation;

2 – Height of groundwater after dewatering has been set to a reference elevation of 0.0m

4.5 Precipitation Contribution

Obtaining an EASR or PTTW for construction dewatering is based on groundwater seepage rates and should not include contribution from precipitation falling directly into the excavation. However, significant rainfall events can contribute significant volumes of water which will need to be managed.

Using the climate data from the Ottawa Macdonald-Cartier Airport weather station (Station ID: 6106000) and assuming a 2-year rainfall event occurs over a 24-hour period, a maximum of 48 mm of rain may fall onto the Site. If this occurs, precipitation will fall directly into the open excavations and will need to be dewatered. The contribution to dewatering requirements from a precipitation event can be estimated using Equation 4-7 below.

$$Q = P \times A \qquad \text{Equation 4-7}$$

Where:

Q = is pumping rate in units of m³/day (L/day = 1,000× m³/day)

P = precipitation falling over a 24-hr period during a 2-year storm event in m (where m = 1/1000 mm)

A = area of the excavation in m

Table 7 below summarizes the dewatering contribution from precipitation falling directly into the excavations.

Table 7 Precipitation Contribution

Excavation	Excavation Dimensions (m)		Precipitation over a 24-hr period (mm)	Volume (L/day)
	Length	Width		
Linear Infrastructure	6.5	3.5	48	1,092
Linear Infrastructure	20	3.5	48	3,360
Office & Retail	75	50	48	180,000
Lab	90	60	48	259,200
Parking Structure	90	65	48	280,800

4.6 Water Taking Summary

4.6.1 Construction Dewatering

Table 8, below, provides a summary of the anticipated construction dewatering rates (contribution from groundwater seepage into the excavation and the contribution from precipitation). The estimated dewatering volumes account for groundwater inflow to the excavation as well as precipitation falling directly into the excavation. The estimated dewatering does not account for any surface water entering the excavation from other overland flow sources.

A safety factor of 3× 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, for possible lateral extension of the excavation width to accommodate sloping requirements.

Table 8 Dewatering Summary

Excavation	Typical Groundwater Dewatering (Litres/day)	X3 Groundwater Dewatering (Litres/day)	EASR/PTTW(1)	Contribution from Precipitation (L/day)	Potential Maximum Dewatering Rate(2) (Litres/day)
Linear Infrastructure (6.5 m)	990	2,970	-	1,092	4,062
Linear Infrastructure (20 m)	1,850	5,550	-	3,360	8,910
Office & Retail	10,210	30,630	-	180,000	210,630
Lab	12,030	36,090	-	259,200	295,290
Parking Structure	12,480	37,440	-	280,800	318,240
Notes: (1) – the threshold for an EASR or PTTW is based on groundwater seepage only (2) – maximum dewatering rates includes 3X the contribution from groundwater seepage added to the potential contribution from precipitation					

Registration of construction water takings on the Ontario Environmental Activity and Sector Registry (EASR) is required for construction groundwater takings between 50,000 to 400,000 litres/day, and a Permit to Take Water (PTTW) is required for groundwater takings greater than 400,000 litres/day.

Assuming that excavations for each structure will be completed at the same time (Office & Retail, Lab, and Parking Structure), a combined dewatering rate of 34,720 litres/day is estimated for typical groundwater dewatering. Including a 3× factor of safety results in a dewatering rate of 104,160 Litres/day.

Based on this groundwater taking rate, an EASR will be required.

As shown above, dewatering requirements in the event of a two-year storm event will increase significantly from precipitation falling directly into the excavation(s).

It should be noted that the dewatering precipitation assumes a two-year storm which is not going to occur on a daily basis. Dewatering a significant precipitation event could be completed over several days to limit the daily dewatering amounts to less than 50,000 litres/day. Engineering approaches may also be employed to minimize the amount of open excavation which will, in turn, limit the amount of precipitation falling into the excavations.

Proposed construction excavation water takings would consist of groundwater seepage, direct precipitation into the excavation, as well as potential surface water run-off. Surface water run-off into the excavations should be eliminated with the use of Site grading to create positive drainage away from the construction excavations.

The dewatering zone of influence is estimated to extend to 42 to 50 m from the proposed construction excavations. Groundwater seepage is anticipated to occur entirely within the bedrock. Thus, potential settlement should not be an issue.

4.6.2 Long-Term Dewatering

The long-term steady state groundwater control dewatering rates can be estimated using a similar approach to the construction dewatering. Similar hydraulic conductivity values, saturated thickness, dewatering areas, and dewatering equations are used; however, the 3× factor of safety to account for rapid drawdown is not appropriate nor is the contribution from precipitation falling into the excavation.

Thus, the long-term dewatering rates are estimated to be approximately 35,000 L/day. This rate is below the threshold requiring a PTTW. It is recommended that the long-term dewatering estimate is updated based on observed dewatering rates during construction.

5. Water Quality and Impact Assessment

The Site is within the Mississippi Valley Source Water Protection Area which is designated a highly vulnerable aquifer; however, the Site does not fall within any wellhead protection areas (WHPA). The area is not noted to be a significant groundwater recharge area. The area is not near a surface water intake protection zone. There are no evaluated wetlands (i.e., significant wetlands) in the vicinity of the Site. Thus, risks associate with dewatering and discharging to the environment are low[3][4].

Based on the water quality at the Site, summarized in **Table 3**, attached, water quality is unlikely to meet the PWQOs in terms of metals parameters. Concentrations of dissolved copper and uranium were reported at concentrations above their respective PWQOs. Thus, water pumped from the excavations should not be directly discharged to the environment.

It should be noted that the PWQO are intended to be compared to total metals concentrations rather than dissolved. Typically, total concentrations are greater than dissolved; it is likely that additional PWQO exceedances will be reported in waters pumped from the excavation.

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[3] Source Protection Information Atlas, Ministry of the Environment, Conservation, and Parks: accessed May 24, 2023

[4] Wetlands database, Ministry of the Natural Resources and Forestry; accessed May 24, 2023

PWQO exceedances of metals are typical when comparing groundwater quality. It is recommended that best management practices for dewatering and discharging to the environment be employed. The use of settlement or bag filters or other suitable treatment technology will need to be employed if consideration is given to directly discharging excavation water to surface. It is recommended that a Discharge Plan that incorporates suitable water treatment technology to ensure safe discharge is developed for the construction dewatering program.

All concentrations met the City of Ottawa's Storm Sewer Discharge By-Law Standards. As an alternative to treatment and discharging directly to surface, it may be suitable to discharge excavation water to the City of Ottawa's storm sewer. This approach would need to be approved and permitted by the City of Ottawa.

6. Closing

The above hydrogeological and dewatering assessment was prepared based on the focused hydrogeological subsurface investigations completed at the Site. Dewatering estimates are based on the information obtained for the specific locations investigated and the preliminary Site construction details. Data collected during the hydrogeologic studies have been extrapolated to estimate dewatering rates over representative areas.

Assuming excavations for all three structures will be completed simultaneously, the estimated dewatering rates, including a 3× factor of safety for groundwater seepage, are above the threshold that require registry with the EASR but below the threshold requiring a PTTW.

It is recommended that an EASR be obtained before to beginning construction.

In the event of a significant precipitation event, dewatering rates will increase to account for precipitation falling directly into the excavations. In order to dewater the proposed excavations during a significant storm-event an EASR may be required. Alternately, construction dewatering following a significant precipitation event could be completed over a number of days following the event to reduce the daily dewatering rates to levels below 50,000 litres/day.

Best management practices should be employed while discharge to the natural environment. Based on the water quality results at the Site, pre-treatment such as settlement and/or filtration should be used to reduce metals prior to discharging to surface. Discharge to the City of Ottawa's Storm Sewer may be a suitable alternative.

The long-term, steady state groundwater control dewatering rates are estimated to be below the threshold requiring a PTTW. However, this estimate should be updated based on observed dewatering during construction.

This report has been prepared by and under the supervision of qualified persons registered as Professional Geoscientists with the Association of Professional Geoscientists of Ontario (PGO). This report presents the hydrogeological investigation results.

Should you have any questions regarding the above, please do not hesitate to contact our office.

Regards

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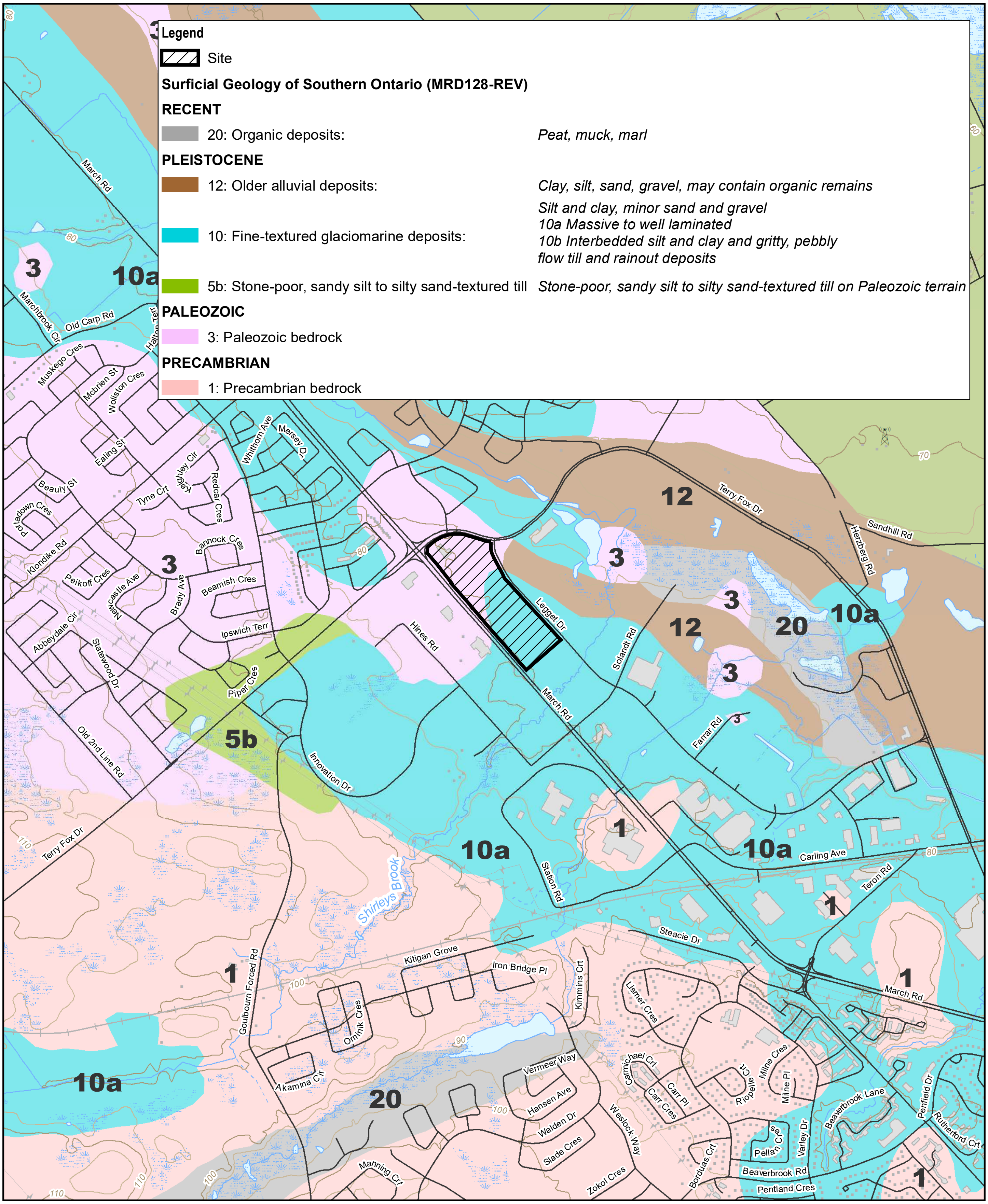
Senior Hydrogeologist

Encl. Figure 1 – Surficial Geology Map
Figure 2 – Quaternary Geology Map
Figure 3 – Bedrock Geology Map
Table 1 – Groundwater Monitoring Results Summary
Table 3 – Water Quality Summary

Figures



Paper Size ANSI A

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Metres

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

GHD

FIRST GULF
600 MARCH ROAD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

SURFICIAL GEOLOGY

Project No. **12606873**
Revision No. **-**
Date **May 24, 2023**

FIGURE 1

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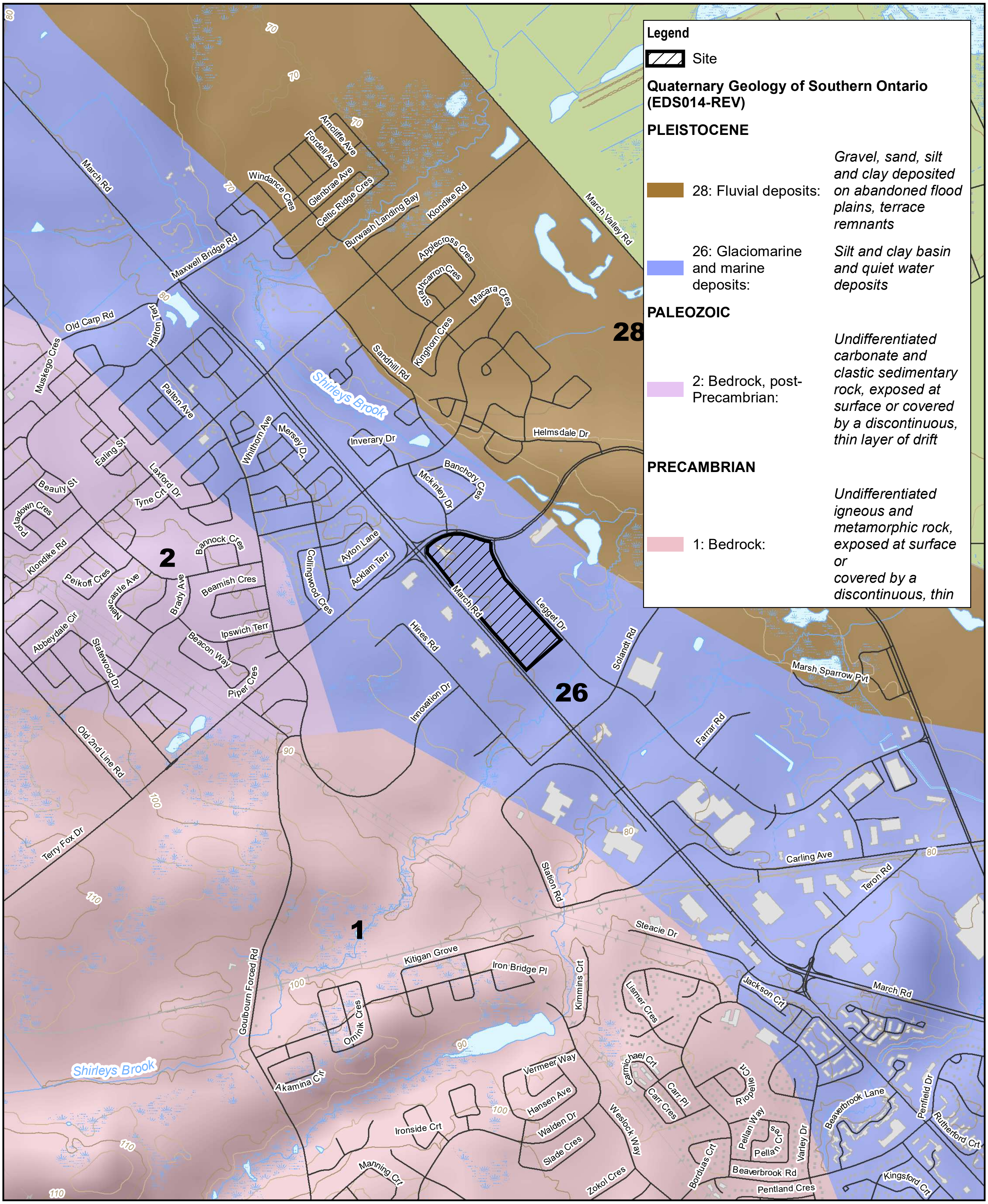
Data source: MNDM, EDS, MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © King's Printer 2023.MRD128-REV. Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised.



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

FIRST GULF
600 MARCH ROAD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

Project No. 12606873
Revision No. -
Date May 24, 2023

QUATERNARY GEOLOGY

FIGURE 2

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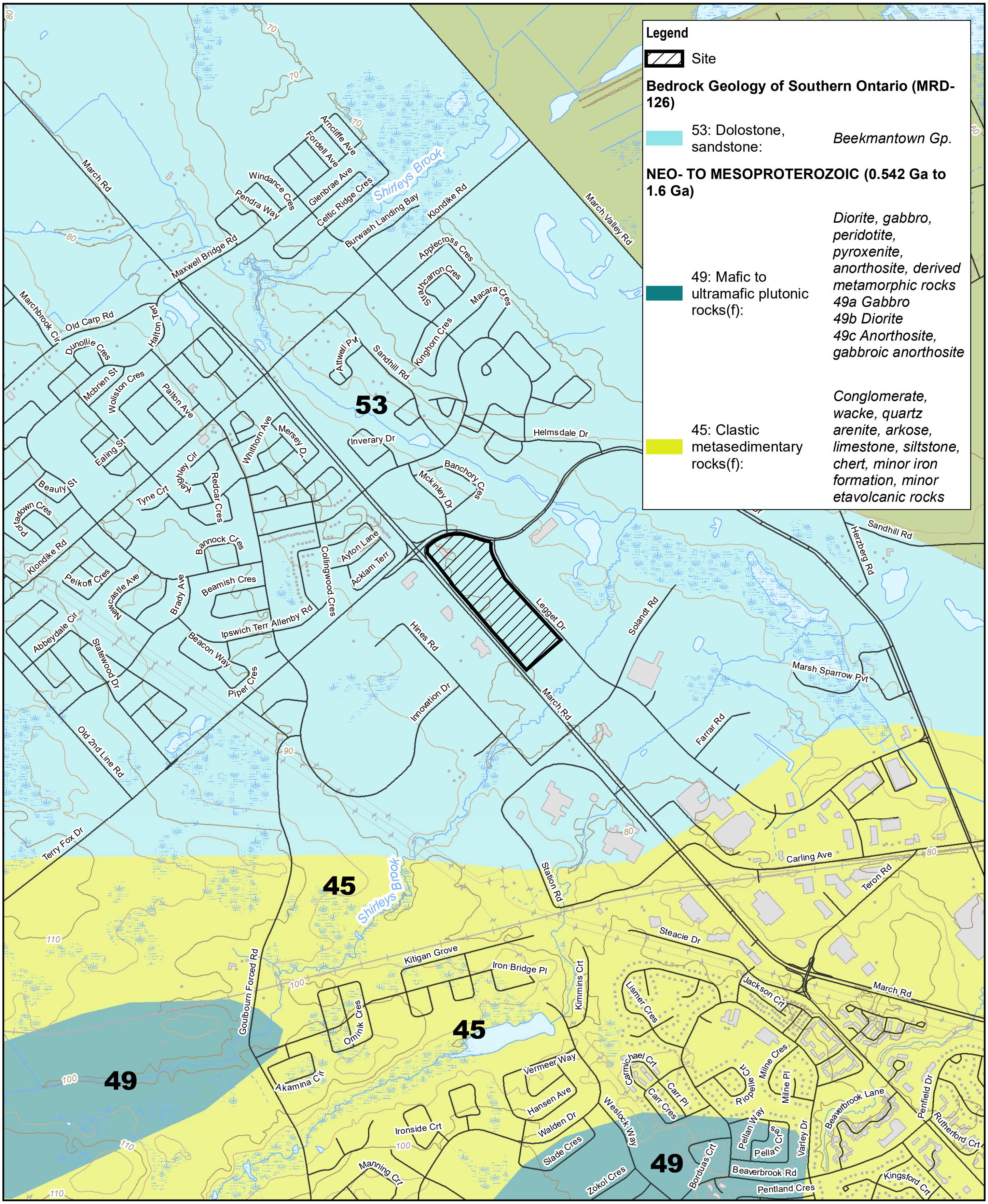
Data source: MNDM, EDS, MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © King's Printer 2023.
© Ontario Geological Survey, 1997. Quaternary geology, seamless coverage of the province of Ontario: Ontario Geological Survey, Data Set 14



Legend

▨ Site

Bedrock Geology of Southern Ontario (MRD-126)

🟦	53: Dolostone, sandstone:	*Beekmantown Gp.*

NEO- TO MESOPROTEROZOIC (0.542 Ga to 1.6 Ga)

🟦	49: Mafic to ultramafic plutonic rocks(f):	*Diorite, gabbro, peridotite, pyroxenite, anorthosite, derived metamorphic rocks* *49a Gabbro* *49b Diorite* *49c Anorthosite, gabbroic anorthosite*
🟨	45: Clastic metasedimentary rocks(f):	*Conglomerate, wacke, quartz arenite, arkose, limestone, siltstone, chert, minor iron formation, minor etavolcanic rocks*

Paper Size ANSI A

0 250 500 750 1,000

Metres

N

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

GHD

FIRST GULF
600 MARCH ROAD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

Project No. 12606873
Revision No. -
Date May 24, 2023

BEDROCK GEOLOGY

FIGURE 3

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Tables

Table 1

Groundwater Elevation Summary
Hydrogeologic Assessment
Nokia Campus
600 March Road, Kanata, Ontario

Well No.	Ground Elevation (mAMSL)	Top of Riser Elevation (mAMSL)	Stickup (m)	Screened Media	Screen Interval (mBGS)	Groundwater Elevation February 3, 2022			Groundwater Elevation February 9, 2022			Groundwater Elevation May 26, 2022			Groundwater Elevation April 21, 2023			Groundwater Elevation April 27, 2023		
						(mBTOR)	(mBGS)	(mAMSL)	(mBTOR)	(mBGS)	(mAMSL)	(mBTOR)	(mBGS)	(mAMSL)	(mBTOR)	(mBGS)	(mAMSL)	(mBTOR)	(mBGS)	(mAMSL)
BH01 22	80.18	80.06	-0.11	Overburden	2.0 - 3.6	Dry	Dry		Dry	Dry		2.45	2.56	77.61	1.09	1.20	78.98	1.46	1.57	78.60
BH02 22	79.72	79.65	-0.07	Bedrock	5.5 - 8.5	3.81	3.88	75.84	3.81	3.88	75.84	3.14	3.21	76.51	1.92	1.99	77.73	2.20	2.27	77.45
BH03 22	80.71	80.61	-0.10	Bedrock	1.5 - 3.0	1.45	1.55	79.15	Dry	Dry		0.92	1.02	79.69	0.50	0.60	80.11	0.68	0.78	79.93
BH06 22	79.61	79.51	-0.09	Bedrock	2.1 - 3.6	2.77	2.86	76.74	3.24	3.33	76.28	2.74	2.83	76.77	2.64	2.73	76.88	2.75	2.84	76.76
BH10 22	80.43	80.39	-0.04	Bedrock	2.5 - 4.1	2.96	3.00	77.43	3.15	3.19	77.24	2.53	2.57	77.86	-	-	-	-	-	-
BH11-22	80.21	80.12	-0.09	Bedrock	4.9 - 7.9	-	-	-	-	-	-	5.93	6.02	74.19	1.13	1.22	78.99	5.60	5.69	74.52
BH12-22	79.60	79.39	-0.21	Bedrock	4.9 - 7.9	-	-	-	-	-	-	2.05	2.26	77.34	0.90	1.11	78.49	1.39	1.60	78.00
BH3-23	80.02	79.92	-0.11	Bedrock	2.7 - 5.8	-	-	-	-	-	-	-	-	-	1.60	1.71	78.32	1.78	1.89	78.14
BH4-23	79.75	79.64	-0.11	Bedrock	3.0 - 6.1	-	-	-	-	-	-	-	-	-	4.32	4.44	75.32	4.39	4.50	75.25
BH6-23	80.78	80.74	-0.05	Bedrock	1.5 - 4.6	-	-	-	-	-	-	-	-	-	2.30	2.35	78.44	2.43	2.48	78.31

Notes:

mAMSL	metres Above Mean Sea Level.
mBTOR	metres Below Top of Riser.
mBGS	metres Below Ground Surface.

Table 5

Summary of Groundwater Analysis
Hydrogeologic Assessment
600 March Road, Ottawa, Ontario

Sample Location:						**BH01-22**	**BH02-22**	**BH03-22**	**BH06-22**	**BH11-22**	**BH12-22**	**BH3-23**	**BH3-23**	**BH4-23**	**BH6-23**
Sample ID (GW-12606873-270423-DA-###):						**-BH01-22**	**-BH02-22**	**-BH03-22**	**-BH06-22**	**-BH11-22**	**-BH12-22**	**-BH3-23**	**-DUP**	**-BH4-23**	**-BH6-23**
Sample Date:						**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**
Sample Type:						**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Duplicate**	**Original**	**Original**
Stratigraphy						**Overburden**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**
Parameters	**Units**	**MECP Table 7 All Property Types**	**City of Ottawa Storm Sewer Discharge**	**City of Ottawa Sanitary and Combined Sewer Discharge**	**MECP PWQO**										
Physical Tests															
Conductivity	mS/cm	--	-	-	-	2.53	3.26	3.12	6.4	3.54	3.81	1.88	1.86	4.92	5.95
pH	-	--	6->9	5.5 - 11	6.5 -> 8.5	7.88	7.57	7.93	8.04	7.71	7.71	8.16	8.14	7.81	7.74
Anions and Nutrients															
Chloride	ug/L	1800000	-	-	-	564000	695000	555000	1730000	895000	970000	187000	185000	1240000	1390000
Cyanides															
Cyanide	ug/L	52	20	2000	5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dissolved Metals															
Antimony	ug/L	16000	-	5000	20	0.13	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Arsenic	ug/L	1500	20	1000	5	0.2	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	4.53	<1.00
Barium	ug/L	23000	-	-	-	200	185	74.8	65.3	246	226	52.2	43.6	59.1	66.7
Beryllium	ug/L	53	-	-	1100	<0.020	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200	<0.200
Boron	ug/L	36000	-	25000	200	24	<100	<100	<100	<100	<100	<100	<100	<100	<100
Cadmium	ug/L	2.1	8	20	0.1	0.022	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500	<0.0500
Chromium	ug/L	640	80	5000	-	<0.50	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Cobalt	ug/L	52	-	5000	0.9	<0.10	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
Copper	ug/L	69	40	3000	1	0.95	<2.00	**2.31**	**7.16**	<2.00	**2.06**	**16**	**14.1**	<2.00	**8.14**
Lead	ug/L	20	120	5000	1	<0.050	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
Mercury	ug/L	0.1	0.4	1	0.2	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Molybdenum	ug/L	7300	-	5000	40	1.17	0.717	1.19	7.24	10.8	1.09	3.01	3.03	5.33	6.9
Nickel	ug/L	390	80	3000	25	<0.50	<5.00	<5.00	<5.00	6.16	<5.00	11	10	<5.00	<5.00
Selenium	ug/L	50	20	5000	100	0.447	<0.500	0.652	<0.500	<0.500	<0.500	0.797	0.846	<0.500	<0.500
Silver	ug/L	1.2	120	5000	0.1	<0.010	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Sodium	ug/L	1800000	-	-	-	237000	342000	214000	967000	356000	390000	255000	227000	702000	854000
Thallium	ug/L	400	-	-	0.3	0.019	<0.100	<0.100	<0.100	<0.100	0.141	<0.100	<0.100	<0.100	<0.100
Uranium	ug/L	330	-	-	5	2.67	1.69	3.21	4.42	**6.32**	4.36	3.8	3.66	**45.2**	**7.48**
Vanadium	ug/L	200	-	5000	6	<0.50	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00
Zinc	ug/L	890	40	3000	20	3	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
Hexavalent Chromium	ug/L	110				<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Hydrocarbons															
F1 (C6-C10)	ug/L	420	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1-BTEX	ug/L	420	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F2 (C10-C16)	ug/L	150	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F2-naphthalene	ug/L	--	-	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34)	ug/L	500	-	-	-	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250
F3-PAH	ug/L	--	-	-	-	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250
F4 (C34-C50)	ug/L	500	-	-	-	<250	<250	<250	<250	<250	<250	<250	<250	<250	<250
Total Hydrocarbons (C6-C50)	ug/L	--	-	-	-	<370	<370	<370	<370	<370	<370	<370	<370	<370	<370

Table 5

Summary of Groundwater Analysis
Hydrogeologic Assessment
600 March Road, Ottawa, Ontario

Sample Location:						**BH01-22**	**BH02-22**	**BH03-22**	**BH06-22**	**BH11-22**	**BH12-22**	**BH3-23**	**BH3-23**	**BH4-23**	**BH6-23**
Sample ID (GW-12606873-270423-DA-###):						**-BH01-22**	**-BH02-22**	**-BH03-22**	**-BH06-22**	**-BH11-22**	**-BH12-22**	**-BH3-23**	**-DUP**	**-BH4-23**	**-BH6-23**
Sample Date:						**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**
Sample Type:						**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Duplicate**	**Original**	**Original**
Stratigraphy						**Overburden**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**
Parameters	**Units**	**MECP Table 7 All Property Types**	**City of Ottawa Storm Sewer Discharge**	**City of Ottawa Sanitary and Combined Sewer Discharge**	**MECP PWQO**										
Volatile Organic Compounds															
Acetone	ug/L	100000	-	-	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Benzene	ug/L	0.5	2	10	100	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromodichloromethane	ug/L	67000	-	350	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromoform	ug/L	5	-	630	60	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bromomethane	ug/L	0.89	-	110	0.9	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Carbon Tetrachloride	ug/L	0.2	-	57	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chlorobenzene	ug/L	140	-	57	15	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Chloroform	ug/L	2	2	80	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.47
Dibromochloromethane	ug/L	65000	-	57	40	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,2-Dibromoethane	ug/L	0.2	-	28	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
1,2-Dichlorobenzene	ug/L	150	5.6	88	2.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,3-Dichlorobenzene	ug/L	7600	-	36	2.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,4-Dichlorobenzene	ug/L	0.5	6.8	17	4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichlorodifluoromethane	ug/L	3500	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1-Dichloroethane	ug/L	11	-	200	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,2-Dichloroethane	ug/L	0.5	-	210	100	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1-Dichloroethylene	ug/L	0.5	-	40	40	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,2-Dichloroethylene	ug/L	1.6	5.6	200	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
trans-1,2-Dichloroethylene	ug/L	1.6	-	200	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Dichloromethane	ug/L	--	-	-	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
1,2-Dichloropropane	ug/L	0.58	-	850	0.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
cis+trans-1,3-Dichloropropylene	ug/L	0.5	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
cis-1,3-Dichloropropene	ug/L	--	-	70	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
trans-1,3-Dichloropropene	ug/L	--	-	70	7	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Ethylbenzene	ug/L	54	2	57	8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Hexane (n)	ug/L	5	-	-	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methyl Ethyl Ketone [MEK]	ug/L	21000	-	-	400	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Methyl Isobutyl Ketone [MIBK]	ug/L	5200	-	-	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Methyl-Tert-Butyl Ether [MTBE]	ug/L	15	-	-	200	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Styrene	ug/L	43	-	40	4	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1,2-Tetrachloroethane	ug/L	1.1	-	-	20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2,2-Tetrachloroethane	ug/L	0.5	17	40	70	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Tetrachloroethylene	ug/L	0.5	4.4	50	50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	ug/L	320	2	80	0.8	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,1-Trichloroethane	ug/L	23	-	54	10	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
1,1,2-Trichloroethane	ug/L	0.5	-	800	800	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichloroethylene	ug/L	0.5	7.6	54	20	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Trichlorofluoromethane	ug/L	2000	-	20	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Vinyl Chloride	ug/L	0.5	-	400	600	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
m+p-Xylenes	ug/L	--	-	-	2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
o-Xylene	ug/L	--	-	-	40	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Xylenes (Total)	ug/L	72	4.4	320	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 5

Summary of Groundwater Analysis
Hydrogeologic Assessment
600 March Road, Ottawa, Ontario

Sample Location:						**BH01-22**	**BH02-22**	**BH03-22**	**BH06-22**	**BH11-22**	**BH12-22**	**BH3-23**	**BH3-23**	**BH4-23**	**BH6-23**
Sample ID (GW-12606873-270423-DA-###):						**-BH01-22**	**-BH02-22**	**-BH03-22**	**-BH06-22**	**-BH11-22**	**-BH12-22**	**-BH3-23**	**-DUP**	**-BH4-23**	**-BH6-23**
Sample Date:						**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**	**27-Apr-2023**
Sample Type:						**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Original**	**Duplicate**	**Original**	**Original**
Stratigraphy						**Overburden**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**	**Bedrock**
Parameters	**Units**	**MECP Table 7 All Property Types**	**City of Ottawa Storm Sewer Discharge**	**City of Ottawa Sanitary and Combined Sewer Discharge**	**MECP PWQO**										
Polycyclic Aromatic Hydrocarbons															
Acenaphthene	ug/L	17				<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	ug/L	1				<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	ug/L	1	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)anthracene	ug/L	1.8	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	ug/L	0.81	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(b+j)fluoranthene	ug/L	0.75	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(ghi)perylene	ug/L	0.2	-	-	0.00002	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	ug/L	0.4	-	-	0.0002	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	ug/L	0.7	-	-	0.0001	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dibenz(a,h)anthracene	ug/L	0.4	-	-	0.002	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Fluoranthene	ug/L	44	-	-	0.0008	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluorene	ug/L	290	-	59	0.2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-cd)pyrene	ug/L	0.2	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
1+2-Methylnaphthalene	ug/L	1500	-	-	-	<0.015	0.019	<0.015	0.015	<0.015	<0.015	<0.015	<0.015	0.017	<0.015
1-Methylnaphthalene	ug/L	1500	-	32	2	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2-Methylnaphthalene	ug/L	1500	-	22	2	<0.010	0.019	<0.010	0.015	0.013	0.012	<0.010	<0.010	0.017	0.013
Naphthalene	ug/L	7	6.4	59	7	<0.050	0.06	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Phenanthrene	ug/L	380	-	-	0.03	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Pyrene	ug/L	5.7	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Notes:

µg/L - microgram per litre
<0.0068 - Not detected at the associated detection limit
Bold/Border - Detected concentration exceeds the associated PWQO Standard
$^{(1)}$ MECP Table 7: Full Depth Generic Site Condition Standards for Shallow Soils in a Non-Potable Ground Water Condition.
$^{(2)}$ MECP - Provincial Water Quality Objectives for surface water

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