Geotechnical Investigation and Hydrogeological Assessment

570 March Road, Kanata (Ottawa), Ontario

Nokia

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→ The Power of Commitment

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1. Introduction

The technical services of GHD were retained by Nokia (Client) to update a Geotechnical Investigation and Hydrogeological Assessment supporting the redevelopment of the Nokia Ottawa Campus located at 570 March Road following the latest design modifications. As such, this report updates and supersedes the geotechnical report and hydrogeological assessment No. 12606873 dated March 13, 2024. The latest development details are summarized in Section No. 2 of this report.

The Nokia Site was previously subjected to a zoning bylaw amendment and severance application to separate the southern portion of the site, the location of the proposed new campus, from the retained northern land currently occupied by the existing Nokia office building.

The entire Site, including both the northern and southern portions, 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 preliminary 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.

Concurrently to the preliminary geotechnical investigation, a Phase Two Environmental Site Assessment was completed for the entire site and included the advancement of seven additional boreholes. The results of this assessment are presented under Report No. 12566614-RPT-3, dated July 19th, 2022.

A supplementary geotechnical investigation was completed in 2023 on the Southern portion site to consider the original design concept as well as to develop a better understanding of the soil and bedrock stratigraphy within the proposed Nokia Ottawa Campus footprint. As part of this supplementary investigation, seven boreholes were advanced, including installation of three monitoring wells, in situ hydraulic response testing, and laboratory testing to provide project specific geotechnical and hydrogeological comments and recommendations to support the previous design concept. The results of this supplementary investigation are presented under Report No. 12606873, dated March 13th, 2024.

Relevant geotechnical and hydrogeological information from the previous investigations stated above have been considered and incorporated within this updated Geotechnical Investigation and Hydrogeological Assessment to facilitate the transmission of available geotechnical and hydrogeological information while considering the latest design concept. Additional in-situ testing was not completed as part of this latest updated Geotechnical Investigation and Hydrogeological Assessment.

This report summarizes the soil, bedrock and groundwater conditions encountered within the previous investigations and provides project specific geotechnical and hydrogeological comments and recommendations to support the design and construction of the most recent development concept, including:

- Foundation design and geotechnical resistances and reaction values at limit states.
- Site seismic classification in accordance with the 2015 and 2020 National Building Code of Canada (NBCC).
- Subgrade preparation for the building's slab-on-grade and external works, including exterior pavement.
- Excavation and backfilling recommendations.
- Control of subsurface groundwater, both during and after construction, including drainage requirements.
- General construction recommendations.

This report is accompanied by five appendices including the following:

- Appendix A | Borehole Reports from Previous Investigations
- Appendix B | Bedrock Core Photographs
- Appendix C | Summary Table and Results of Geotechnical Laboratory Testing
- Appendix D | MASW Survey – Seismic Site Classification Report

- Appendix E | Hydrogeological Assessment

Furthermore, this report has been prepared with understanding of the design as described in Sections 2 and 4.1 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 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. Project and Site Description

Nokia is planning to redevelop its existing campus located at the southeast corner of Terry Fox and March Road (570 March Road). The existing Site was subjected to a zoning bylaw amendment and severance application to separate the southern portion of the site from the retained northern portion of the site currently occupied by the existing Nokia office building. According to the latest development details summarized within the November 2024 Design Brief, shared by Novatech, the project civil engineer, the new Nokia Campus will be developed at the southern portion the site within the existing parking lot area bounded by the existing Nokia Campus to the North, a light industrial building to the South, Legget Drive to the East and March Road to the West and will consist of the following interconnected structures:

- An eight storey R&D engineering hub (including a small retail section) covering an approximate footprint 4,000 square metres (m^2) within an anticipated finished floor elevation (FFE) at 82.5 metres (m). The R&D engineering hub footprint will also contain a partial basement covering an approximate footprint of 3,300 m^2, placed at elevation 74.5 m.
- A five storey R&D lab building covering an approximate footprint 6,500 m^2 within an anticipated FFE at 82.0 m. A loading dock is planned at the southern limit of the R&D lab building.
- A three-storey parking structure covering an approximate footprint 9,500 m^2 within an anticipated FFE at 82.5 m.
- Access to the R&D lab building loading dock will be provided via an access road planned to the southern limit of the site, connecting both Legget Drive and March Road.
- Access to the R&D engineering hub and parking structure will be provided along March Road
- A new street (Liberty Street) is proposed along the northern limit of the new campus connecting both Legget Drive and March Road.

The existing site grade is relatively flat, sloping gently towards the South and East with elevations generally varying between 81.2 m and 79.4 m. Surrounding structures are generally near the same elevation as the site with the exception of March Road which is up to 1.2 m higher. Based on the proposed FFE provided, site grade raise up to 2.5 m is anticipated.

The location of the Site is illustrated on the Site Location Plan attached as Figure 1 at the end of this report.

Based on the previous investigations, the subsurface conditions within the proposed development footprint consist 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 0.3 metres below ground surface (mBGS) (elevation 80.6 m) was encountered at the northern site limit and gradually increased in depth to 4.7 mBGS (elevation 75.2 m) at the southern limit of the site. Specifically, within the proposed building footprints, bedrock was encountered at depths (elevations) varying between 0.3 m and 1.6 mBGS (78.3 m and 80.4 m).

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 A.

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. Subsurface Conditions

The detailed subsoil conditions encountered at the borehole locations are presented within the borehole reports located in Appendix A of this report. The following table presents a summary of the depth and elevation of each subsoil stratum encountered at the borehole locations.

Table 1 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	80.2	-	0.6**	0.6	79.6	4.6	75.6	4.7	75.5	7.9	72.3
BH12-22	79.6	-	0.6**	0.6	79.0	3.0	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

Notes: **Topsoil

In general, the soils encountered at the borehole locations consist of a surficial pavement structure, or localized topsoil or fill layers, overlying a discontinuous layer of native silty clay to clayey silt, a discontinuous glacial till layer, followed by a sandstone bedrock with dolomite interbeds. The shallow bedrock was encountered at depths ranging from 0.3 to 4.7 mBGS across the site.

General descriptions of the subsurface conditions encountered during the previously completed investigations are summarized in the following sections. The borehole reports are provided in Appendix A while the bedrock photographs are provided in Appendix B. Results from the laboratory testing and a summary table of pertinent laboratory results are presented in Appendix C.

3.1 Pavement Structure and Fill

An asphalt layer with a thickness ranging from 25 to 100 millimetres (mm) was encountered at the ground surface at the location of all boreholes with the exception of BH01-22 and BH11-22 to BH13-22. Granular base/subbase (fill material) consisting of sand and gravel to gravelly sand was encountered below the asphalt as well as at the surface of BH01-22 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 samples of the fill materials ranged from 1 percent to 19 percent by weight. 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.

Exceptionally at BH11-22 to BH13-22, the fill material consists of a 0.6 m to 0.7 m layer of topsoil.

3.2 Silty Clay to Clayey Silt

A silty clay to clayey silt layer was encountered below the fill layer in boreholes BH1-23, BH2-23, BH4-23, BH01-22 to BH05-22, BH11-22 and BH12-22 at depths ranging from 0.5 to 0.8 mBGS (Elevations 80.5 m to 79.0 m).

Throughout the majority of the site, the silty clay to clayey silt layer is less than 1.0 m thick, with the exception of the southern limit of the site where a thickness up to 4.0 m was observed. The silty clay to clayey silt deposit can be described as having a stiff to very stiff consistency.

Grain size and Atterberg limits tests were carried out on selected representative samples of this deposit. A review of the results shows that the samples have 29 to 54 percent by weight water content, 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 a Fat Clays (CH) in accordance with ASTM D2487.

3.3 Glacial Till

A thin glacial till layer was encountered below silty clay in BH2-23, BH11-22, and BH12-22 as well as below the fill in BH3-23 and BH13-22 and extended to depths varying between of 0.2 m and 4.6 mBGS (Elevations 81.3 m and 75.6 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 C.

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.

3.4 Bedrock

Bedrock was encountered at depths ranging from 0.3 to 4.7 mBGS (Elevations 80.6 to 75.2 m). A summary of the bedrock depths and elevation for each borehole is presented in Table 1.

Upon refusal on the presumed bedrock, the base of the borehole was cored in the majority of 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 – 2014 (CFEM), the bedrock is classified as strong to very strong. The results of UCS testing are presented in Appendix C and a summary of the UCS results is presented in Table 2 below.

Table 2 Uniaxial Unconfined Compressive Strength Tests on Selected Bedrock Core Samples

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

3.5 Groundwater Conditions

Boreholes BH3-23, BH4-23, BH6-23, BH01-22, BH02-22, BH03-22, BH06-22 BH11-22, and BH12-22 were instrumented as monitoring wells to allow for groundwater sampling, hydraulic response testing, and measurements of groundwater levels. Groundwater levels were measured on May 26, 2022, within the wells installed as part of the preliminary investigation, and on April 27, 2023 within the wells installed as part of the preliminary and supplemental investigations. The measured groundwater levels are provided in Table 3 below.

Table 3 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

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 static groundwater levels having 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.

4. Discussion and Recommendations

According to the latest development details summarized within the November 2024 Design Brief, shared by Novatech, the project civil engineer, the new Nokia Campus will be developed at the southern portion the site within the existing parking lot area bounded by the existing Nokia Campus to the North, a light industrial building to the South, Legget Drive to the East and March Road to the West and will consist of the following interconnected structures:

- An eight storey R&D engineering hub (including a smaller retail section) covering an approximate footprint 4,000 m^2 within an anticipated FFE at 82.5 m. The R&D hub footprint will also contain a partial basement covering an approximate footprint 3,300 m^2, placed at elevation 74.5 m.
- A five storey R&D lab building covering an approximate footprint 6,500 m^2 within an anticipated FFE at 82.0 m. A loading dock is planned at the southern limit of the R&D lab building.
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- Access to the R&D lab building loading dock will be provided via an access road planned to the southern limit of the site, connecting both Legget Drive and March Road.
- Access to the R&D engineering hub and parking structure will be provided along March Road.
- A new street (Liberty Street) is proposed along the northern limit of the new campus connecting both Legget Drive and March Road.

The existing site grade is relatively flat, sloping gently towards the South and East with elevations generally varying between 81.2 m and 79.4 m. Surrounding structures are generally near the same elevation as the site with the exception of March Road which is up to 1 m higher. Based on the proposed FFE provided, site grade raise up to 2.5 m is anticipated.

According to preliminary loading information provided by the project’s structural engineer, ARR, typical column loads for the R&D engineering hub, R&D lab building and parking structure will vary between 4500 kilonewton (kN) and 17000 kN. Although specific loading configurations for the slabs have yet to be established, ARR confirmed that combined slab live, and dead loads should not exceed 12.5 kilopascal (kPa).

The location of the Site is illustrated on the Site Location Plan attached as Figure 1 at the end of this report.

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.

4.1 Site Grading and Preparation

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

As mentioned above Section 4.1, the proposed site building finished floor elevations will result in site grade raises ranging between approximately 1.0 m to 2.5 m. Specifically, based on the proposed grading plan provided by Novatech site grade raise up to 2.5 m is anticipated within general vicinity of the proposed building footprints underlain by less than 1 m of native stiff to very stiff silty clay to clayey silt, followed by glacial till and bedrock at a shallow depths. A limited grade raise, generally less than 1 m, is anticipated closer to the southern limit of the site (closer to proposed access road) where a 4 m stiff silty clay layer is present, followed by glacial till and bedrock. Considering the anticipated subsoil conditions and building loading configurations (including slab live and dead loads less than 12.5 kPa and building foundations resting upon bedrock) the proposed grade raise values are acceptable and will not lead to undesirable settlements.

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 activities, 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 100 percent Standard Proctor Maximum Dry Density (SPMDD).

Recommendations regarding placement of engineered fill are provided in Sections 4.12.1 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 therefore should not be used for backfilling under or around structure or for raising grades in the proposed pavement areas.

4.2 Mass Excavation

Localized excavation depths of up to approximately 6 m is assumed for this project. 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 and may extend below the groundwater table particularly within the proposed basement footprint area.

4.2.1 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 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 4 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 (H) to one vertical (V)

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.

4.2.2 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, it is recommended that line-drilling 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 a 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 qualified geotechnical engineer.

4.2.3 Temporary Drainage

Surface water seepage is expected during the excavation. Based on the excavation depth of up to 6 m below grade, 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 4.5 and in the Hydrogeologic Assessment memorandum, attached in Appendix E for reference.

4.3 Foundations

In general, the subsurface conditions in the area of the proposed development consist of fill/topsoil overlying a discontinuous deposit of silty clay to clayey silt and glacial till, over bedrock. The depth to bedrock is variable across the proposed building area, ranging from elevations 78.3 m to 80.4 m (i.e., 1.6 to 0.3 mBGS) within the proposed building footprints.

Furthermore, according to preliminary loading information provided by the project’s structural engineer, ARR, typical column loads for the R&D engineering hub, R&D lab building and parking structure will be substantial and will vary between 4500 kN and 17000 kN. Consequently, the foundations of the new buildings should consist of conventional spread and/or strip footings founded on sound bedrock, clean and free of weathering or loose fragments.

4.3.1 Conventional Foundations on Bedrock

Prior to placing the footing or required mass concrete elements, we recommend that bedrock surfaces be prepared as indicated below:

- Proceed with the removal of all excavated rock fragments (either mechanically or by blasting) to sound bedrock.
- A survey at each cleaned and prepped footing location should be completed to ensure that topographical criteria is respected (footing elevation, rock surface slope, etc.). The rock surface slope should not exceed 15 percent at each footing or mass concrete location.
- Following the excavation, rock surface preparation and surveying activities, a visual inspection of the footing/mass concrete bedrock surface should be completed by a qualified geotechnical engineer in order to ensure that the conditions encountered on site correspond to those that were anticipated. This visual inspection should be completed for all footing surfaces.
- All small vertical joints (less than 5 centimeters [cm]) should be cleaned and sealed with a cement grout to a depth of at least five times the size of the joint opening.
- In the event that unfavorable geological conditions are encountered (shear zones, excessive fractured rock, large open joints, etc.) or if the sound rock surface slope exceeds 15 percent at the footing locations, corrective measures will need to be established on site, during the construction works by a qualified rock mechanics engineer in collaboration with the projects structural engineer.
- All water infiltrations within bedrock will need to be controlled not only during the bedrock prepping phase but also when pouring the concrete footings.

Footings placed on sound and massive sandstone bedrock can be designed using a factored bearing capacity value at Ultimate Limit State (ULS) of 3.0 Megapascal (MPa). The factored ULS value includes the geotechnical resistance factor (Φ) of 0.5 for shallow foundations. Serviceability Limit State (SLS) resistance for this bedrock will be higher than the factored ULS value. Therefore, we recommend using the factored ULS value provided above for the SLS resistance value if required.

Where required and if applicable, for the design of conventional footing placed on fractured bedrock, a SLS bearing capacity value of 750 kPa can be used for conventional foundation design. A factored bearing capacity value at ULS of 1.00 MPa can be used for foundations resting on fractured bedrock. Similar to above, the factored ULS value includes the geotechnical resistance factor (Φ) of 0.5 for shallow foundations.

Under such stress, anticipated settlements should be negligible.

4.3.2 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.

4.3.3 Seismic Site Classification

For this Site, the average shear wave velocity within the upper 30 m of the geological profile (V_{s30}) 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 D, the average shear wave velocity V_{S30} along the two investigation lines is 1427 metres per second (m/s) for founding level at a depth of 1.0 mBGS.

In accordance with Table 4.1.8.4.A of the NBCC 2015 and based on presented data in Table 1 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.

In accordance with Table 4.1.8.4.A of the NBCC 2020, a X_{1427} Site Designation can be used for this project.

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

4.3.4 Rock Anchors

It is understood that rock anchors may be required for this project. The design and analysis of any anchor system includes determination of anchor loads, spacing, depth and bonding of the anchor. The following types of failure must be considered in the design:

- Failure between rock and grout/anchor.
- Failure within the grout or the rod.
- Failure in the rock mass.
- Failure of the steel rod.

The following parameters are recommended for rock anchors design.

Table 5 Geotechnical Parameters for Rock Anchor Design

Rupture	Parameter	Symbol	Value
Steel bar	Steel shear strength	F_u, F_y	Material specifications
Steel/Grout	Ultimate Adhesion steel/grout (ULS) Grout compressive strength	S_b f'_c	5.2 MPa 30 MPa at 28 days

Rupture	Parameter	Symbol	Value
Rock/Grout	Ultimate Adhesion rock/grout (ULS)	S_r	3.0 MPa
	Grout Compressive strength	f'_c	30 MPa at 28 days
	Rock Compressive strength	C_o	90 MPa
Rock mass	Reverse cone apex angle	β	45 °
	Rock unit weight (bulk)	γ	26.0 kN/m^3
	Submerged rock unit weight	γ'	16.2 kN/m^3

When more than one anchor is used, interaction between anchors must be considered in design. A reduction factor must be applied as soon as spacing between anchors is less than twice the diameter of the reverse cone considered when calculating the length of the anchor.

For information purposes, the rock anchor designer can refer to the Canadian Foundation Engineering Manual (4th edition), the National Building Code in force (NBCC 2020) and Chapter 4 “Recommendations for Prestressed Rock and Soil Anchors” and other relevant sections of the latest version of the Post-Tensioning Manual published by the Post-Tensioning Institute (PTI) for the design, installation, testing and inspection of structural anchors installed in bedrock.

4.4 Floor Slabs

A conventional slab-on-grade, structurally separated from the columns and foundation walls, can be used for the lowest level floor slab of the buildings on the site prepared as discussed in Sections 4.1. Based on the borehole data, the subgrade beneath a slab-on-grade within the investigated area is expected to comprise or native overburden or sandstone bedrock (within the proposed basement footprint).

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 Sections 4.1 and 4.12.1. 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 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. In areas with a basement level, this base layer should be combined with a drainage system as specified in Section 4.5.1.

A vapour barrier is recommended to be incorporated beneath the floor slabs 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.

4.5 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/s) to 9.2×10^{-4} cm/s with a geometric mean of 3.9×10^{-5} cm/s.

Based on the groundwater levels and design mass excavation, the excavation within the proposed building footprint with a basement will be below the groundwater table and excavations for utility trenches and underground tanks 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 E. According to the Hydrogeological Assessment carried out, the dewatering rates of 83,700 Liter per day (L/day) and 20,340 L/day is 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 400,000 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 this groundwater taking rate, an EASR will be required. It should be noted that an EASR would be required for the Level-01 (Basement) excavation on its own.

As the staging of excavations for linear infrastructure cannot be known, the peak dewatering quantity for this portion of the construction project cannot be known. The actual dewatering amounts from the linear infrastructure features will be a function of the construction schedule and the amount of open trench excavation at any given time. Given this uncertainty, it may be prudent for the project to seek a PTTW to allow for takings greater than 400,000 L/day for the construction period.

Long-term, permanent, dewatering rates of 20,340 L/day are expected to control groundwater after construction. Therefore, the water taking associated with long-term dewatering would not require a PTTW. It is recommended that the long-term dewatering estimate is updated based on observed dewatering rates during construction, as the estimate provided relies on point source (monitoring well) data and cannot account for natural variability between the monitoring wells tested.

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.

4.5.1 Permanent Drainage

For long-term protection, it is recommended that a drainage system consisting of perimeter French Drain and vertical drainage membrane (such as a Composite Drainage Blanket [CDB] or geo-drain) combined with sub-slab drains be provided for the portion of the structures with a basement.

The drainage system must be provided with sufficient clean-outs to permit maintenance when required and lead to a frost-free positive outlet (sump pit) with sufficient capacity for year-round drainage. The drainage system should be designed to prevent mixing with the native fine grain particles to avoid potential clogging while the backfill material around the basement walls should consist of a free-draining granular material such as a Granular B type I or II.

For preliminary purposes, the under-slab drainage system should consist of:

- Minimum 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 clear crushed stone and any overburden fill and/or base layers to avoid clogging of the clean crushed stone and reducing the thickness of the drainage layer.
- 100 mm (4") perforated drainpipe 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 important to note that one of the objectives of the exterior drainage system is to eliminate any possible hydrostatic pressure by removal of the groundwater inflow accumulated around and under the structure. However, water tightness and dampness are also important factors that must not be neglected.

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

Regardless, and at a minimum, the underside of the basement slab on grade should be provided with a vapour barrier while the perimeter basement foundation walls should be provided with a waterproofing membrane.

Elevator pits, if present, should include a subdrain system and waterproofing. 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 and consider groundwater control during installation.

4.6 Lateral Earth pressures

Structures subject to unbalanced earth pressures such as foundation walls, retaining walls and other similar structures should be designed to resist the lateral earth pressures. The following table below summarizes the recommended soil parameters to be used for lateral earth pressure calculations.

Table 6 Summary of Soil Parameters for Lateral Earth Pressure Calculations

Geotechnical Parameter	Granular A or Granular B Type II	Fill or Silty Clay/Clayey Silt	Dolomitic Sandstone
Bulk Unit Weight (kN/m^3)	21	17.0	See Table 5
Submerged Unit Weight (kN/m^3)	12.2	8.2	See Table 5
Saturated Unit Weight (kN/m^3)	22.0	18.0	--
Angle of Internal Friction, ϕ (°)	33	26	--
Friction Factor (1), tan δ (-)	0.40	0.20	0.50
Static Earth Pressure Coefficients			
Coeff. Of Active Earth Pressure, Ka	0.29	0.39	--
Coeff. Of Passive Earth Pressure, Kp	3.39	2.56	--
Coeff. Of Earth Pressure at Rest, Ko	0.46	0.56	--
Seismic Earth Coefficients Considering a Flexible Wall (Based on Mononobe-Okabe Method with kh = 0.5*PGA)(2)			
Coeff. Of Dynamic Active Earth Pressure, Kae	0.37	0.47	--
Coeff. Of Dynamic Passive Earth Pressure, Kpe	7.01	3.13	--
Seismic Earth Coefficients Considering a Rigid Wall (Based on Mononobe-Okabe Method with k_h = PGA)(2)			
Coeff. Of Dynamic Active Earth Pressure, Kae	0.55	0.69	--
Coeff. Of Dynamic Passive Earth Pressure, Kpe	5.71	2.51	--

Notes:

(1) Formed or pre-cast concrete

(2) A PGA value of 0.279 was obtained from the Government of Canada Hazard Alea calculator pertained to the NBCC 2020 (2 percent-in-50-year event). This value considers the X_{1427} Site Designation presented in Section 4.3.3 (PGA = PGA[X_{1427}]).

Surcharge and hydrostatic pressures should be considered as appropriate. The above-noted earth pressure coefficients apply to horizontal surfaces behind the walls/supports only.

It is noted that large deformation will be required prior to the full mobilization of passive earth pressure and mobilization of full active or passive resistance requires a measurable and significant wall movement or rotation. Therefore, unless the structural element can tolerate these deflections, the at-rest earth pressure should be used in design.

4.7 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 C and summarized in the table below.

Table 7 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 corrosive to cast iron pipe. As such, ductile iron pipes and fittings in contact with the subgrade or groundwater should be protected against potential corrosion.

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.

4.8 Underground Utilities

Underground utilities can be founded on either bedrock, undisturbed native soils or a prepared fill subgrade. The suitability of the foundation soils to provide adequate support for buried services must be verified and confirmed on the Site at the time of construction/installation by qualified geotechnical personnel experienced in such work.

The frost penetration depth for the region of Ottawa is considered as 1.8 m in accordance with Ontario Provincial Standard Drawing (OPSD) 3090.101. Accordingly, underground utilities should be located below the depth of frost penetration and in accordance with City of Ottawa specifications.

Note that the City of Ottawa specifies that watermains and sanitary and storm sewer require respective minimum soil cover above of 2.4, 2.5 m and 2.0 m.

Where the available cover is less than required, thermal rigid insulation should be incorporated as specified in the City of Ottawa specifications.

Bedding and backfill materials should be in accordance with the most recent Materials Specifications & Standard Detail Drawing from the City of Ottawa. Trench details should be completed as per the applicable cases such as those shown in Detail Drawings W17, S6 and S7.

The material should be placed in lifts no thicker than 300 mm and compacted to 95 percent of the materials SPMMD. Depending on the required detail, the bedding material should extend to at least the spring of the pipe.

A transition zone with a minimum 1.0 H/1.0 V slope is recommended for the service trenches within frost depth to minimize differential heaving between the backfill materials and the surrounding soil, assuming that the backfill material is of a similar nature to the surrounding soil.

If imported non-frost susceptible granular backfill is used to fill the trenches, a transition zone with a minimum 3.0 H/1.0 V slope should be excavated within the frost depth to insure proper future behaviour of the paved surfaces.

Due to the relatively low permeability of the native subsoil and depth of excavation, no major groundwater problems are foreseen at this time for such excavations. Infiltration into the excavations should be readily handled with ordinary sumps and pumps.

4.9 Storm Tanks

This draft report does not provide any geotechnical recommendations with respect to proposed storm tanks. Once design and serviceability requirements are provided, GHD can update this section of the report.

4.10 Exterior Slabs

In order to avoid the potential detrimental effects of freeze-thaw cycles on the good behaviour of exterior concrete slabs around the proposed building, we recommend that a non-frost susceptible base layer, such as a Granular ‘A’ as per Ontario Provincial Standard Specifications (OPSS Form 1010), be used under the exterior slabs down to a depth of 1.8 m below the top of the slabs.

This base layer should be placed in thin lifts not exceeding 300 mm and compacted to 100 percent of SPMDD.

The base layer should also be properly drained by means of a French drain in order to prevent water accumulation under the slabs.

Transition slopes of 3.0 H/1.0 V should be provided at the edges of an exterior slab between the non-frost susceptible aggregate base layer and the surrounding soils (silty clay/clayey silt deposit), over the entire frost depth of 1.8 m.

A possible alternative to the placement of non-frost susceptible base material to a depth of 1.8 m below exterior slabs grades could include the use of sufficient insulation material under the slabs to replace the equivalent amount granular base backfill omitted to frost depth. As a general rule of thumb, one inch (25 mm) of insulation is equivalent to 300 mm of non-frost susceptible material.

In any case, the slabs should incorporate a granular base layer consisting of at least 300 mm of OPSS Granular ‘A’ compacted to at least 100 percent of the material's SPMDD.

4.11 Pavement Design Recommendations

Access 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 qualified 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 100 percent of its SPMDD.

4.11.1 Design Parameters

The design for the proposed pavement structures were evaluated according to the traffic data provided by the traffic engineer, Stantec. The parameters considered for pavement design are as presented in the following Table 8.

Table 8 Design Parameters for Development, Including Liberty Street

Parameters	Data
Road Classification	Regional
Average Annual Daily Traffic (AADT)	3,300
Heavy Duty Vehicles (%)	2
Annual Traffic Growth Rate (%)	3
Service Life (years)	20
USCS Classification	CH
Normal freezing index in °C x days (Saint-Hubert Station)	1012

4.11.2 Pavement Structure

The based on the design values above, the following flexible pavement structures are recommended for standard duty parking areas, heavy duty access road areas and Liberty Street.

Table 9 Recommended Pavement Structure – 20 Year Design Life

Pavement Structure Elements	Compaction Requirement	Layer Thicknesses (mm)
		Standard Duty and Heavy Duty (Parking and Access Roads) and Liberty Street
Surface Course OPSS.MUNI 1150 HL1 Hot Mix PG70-34	OPSS.MUNI 310, Table 10	50
Base Course OPSS.MUNI 1150 HDBC (HL8 HS) Hot Mix PG70-34	OPSS.MUNI 310, Table 10	70
Granular A Base (19 mm crusher run limestone)	100 percent SPMDD	150
Granular B Type II Subbase (50 mm crusher run limestone)	100 percent SPMDD	650

Considering the limited light duty parking footprint, surrounded by access areas, we recommended using the heavy-duty parking structure design for the proposed light duty parking area.

The pavement design considers that construction will be carried out during dry periods of the year and that the subgrade is competent. If the subgrade becomes excessively wet or rutted during construction activities, additional subbase material may be required. The need for additional subbase material is best determined during construction.

It is noted that the pavement granular base and subbase layers can consist of crushed limestone, as specified above. The material gradation and durability requirements of the selected granular courses should meet OPSS 1010 specifications.

The installation of a geotextile membrane at the subgrade level is required to prevent contamination of the sub-base layers with fines particles where applicable.

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. The pavement surface and subgrade should be free of depressions and sloped, preferably at a minimum grade of 2 percent for the pavement surface and 3 percent for the subgrade, to provide effective drainage toward the edge of pavement and toward catch basins.

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.

4.12 General Construction Recommendations

4.12.1 Construction of Engineered Fill

The following procedure should be considered for the construction of Engineered Fill:

- Engineered Fill must be placed under the continuous supervision of a Geotechnical Engineer.
- Prior to placing any Engineered Fill, all unsuitable existing fill, topsoil, and deleterious materials must be removed.
- The area to receive the engineered fill should be inspected, compacted, and approved by the geotechnical engineer. Spongy, wet, or soft/loose spots should be sub-excavated to expose stable subgrade and replaced with competent approved soil, compatible with subgrade conditions, as directed by the geotechnical engineer.
- The source or borrow areas for the Engineered Fill must be evaluated for 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), and be well graded, granular, homogeneous and compactable, with a suitable moisture content that it is within +/-2 percent of the optimum moisture as determined by the Standard Proctor test for maximum compaction. Oversize particles (cobbles and boulders) larger than 150 mm should be discarded.
- Imported granular soils meeting Ontario Provincial Standard Specifications (OPSS) 1010 requirements for Granular 'A', or 'B' Type II are 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.
- Full-time geotechnical inspection and quality control (by means of frequent field density and laboratory testing) are necessary for the construction of a certifiable engineered fill pad. The compaction procedure and efficiency should be controlled by the geotechnical engineer.

The engineered fill should not be placed during winter months when freezing ambient temperatures occur persistently or intermittently

4.12.2 Sensitivity of the Subsoils

The native subsoils are saturated and susceptible to strength loss and deformation by construction traffic. Therefore, care must be taken to protect the exposed subgrade from excess moisture and from construction traffic.

4.12.3 Construction Review and Site Inspection

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 should be retained to review the drawings and specifications, once complete, to verify that the recommendations within this report have been adhered to.

It is recommended that all exposed subgrade and footing excavations be inspected and approved by qualified geological personnel to ensure that subsoil conditions correspond to those encountered in the boreholes, that the exposed subgrade is suitable to receive engineered fill, and that footing are placed within the correct bedrock strata, horizontal, clean and free of any loose rock fragments or weathered zones, and the recommendations provided in this report have been implemented.

All of the backfilling operations should also be supervised to ensure that proper material is employed, and that full compaction is achieved.

The effect of vibrations upon adjacent structures caused by construction works, including but not limited to bedrock excavation, should be monitored and pre-construction surveys of existing defects within nearby structures should be carried out where necessary.

4.12.4 Winter Conditions

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

- During winter construction, exposed surfaces to support foundations must be protected against freezing by means of loose straw and tarpaulins, heating, etc.
- Care must be exercised so that the sidewalks and/or asphalt pavements do not interfere with the opening of doors during the winter when the soils are subject to frost heave. This problem may be minimised by any one of several means, such as keeping the doors well above outside grade, installing structural slabs at the doors, and by using well graded backfill and positive drainage, etc.

  Because of the frost heave potential of the soils during winter, it is recommended that the trenches for exterior underground services be excavated with shallow transition slopes in order to minimise the abrupt change in density between the granular backfill, which is relatively non-frost susceptible, and the more frost-susceptible native soils.

5. 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.

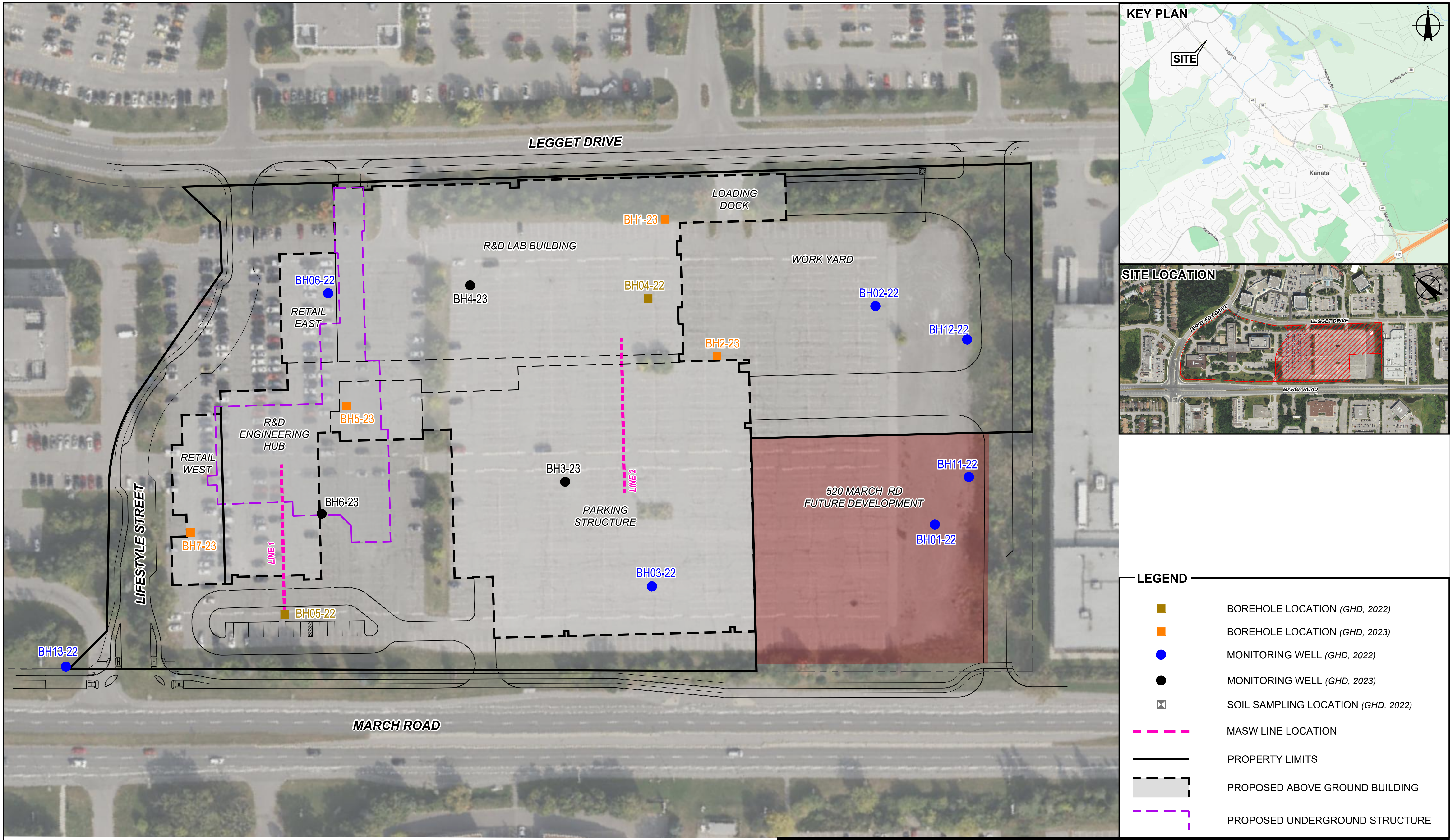
The recommendations made in this report are in accordance with our present understanding of the project, the current Site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent 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



0 12.5 25 37.5m

1:1250

Coordinate System:
UTM with NAD83 datum,
Zone 18, Meter;

Plan North

FIRST GULF
600 MARCH ROAD, KANATA (OTTAWA), ONTARIO
NOKIA PROPERTY REDEVELOPMENT

GEOTECHNICAL INVESTIGATION SITE LOCATION PLAN

Project No. **12646241**
Date **2/7/25**

FIGURE 1

Filename: \\ghdnet\ghd\CA\Ottawa\Projects\662\12646241\Digital_Design\ACAD\Figures\RPT001\12646241-GHD-00-00-RPT-GE-D101_MT-001.dwg
Plot Date: 07 février 2025 10:04

Appendices

Appendix A

Borehole Reports from Previous Investigations

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%

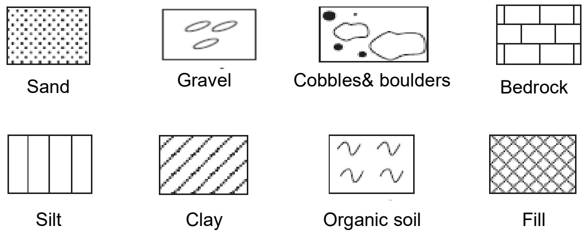
Relative density of granular soils	Standard penetration index "N" value
	(BLOWS/ft – 300 mm)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

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

GHD

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

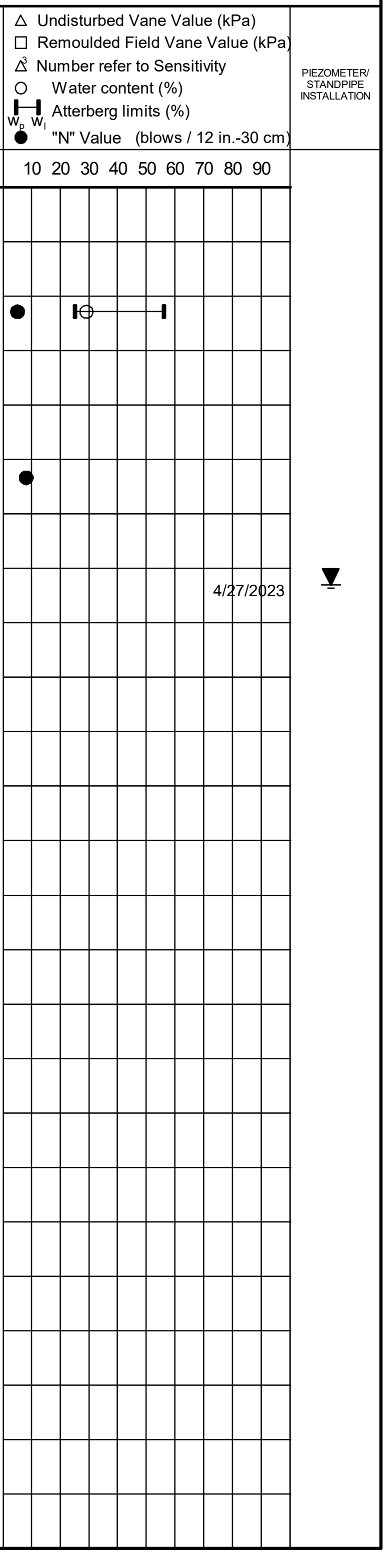
DATE (START): 17 April 2023 DATE (FINISH): 17 April 2023

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

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 (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							
			Run1			97	--	76	97
			Run2			99	--	89	98
4.9	74.9	**END OF BOREHOLE**							



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REFERENCE No.: 12606873

BOREHOLE No.: BH1-23

ELEVATION: 79.8 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: 5021881 EASTING: 428021 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) $\triangle^3$ 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				**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.										
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

GHD

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)
△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(%) %	"N" Value (10 20 30 40 50 60 70 80 90)	PIEZOMETER/ STANDPIPE INSTALLATION
		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									
										4/27/2023	▼
			Run1			93	--	87	93		
		some oxidization									
			Run2		150.0	100	--	96	100		
		grey with black banding, Strong									

Depth scale: Feet 0–16; Metres 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5

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REFERENCE No.: 12606873

GHD

BOREHOLE No.: **BH2-23**

ELEVATION: 79.9 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): 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	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														
						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														
						Run5			94	--	88	92		
28	8.5													
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

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

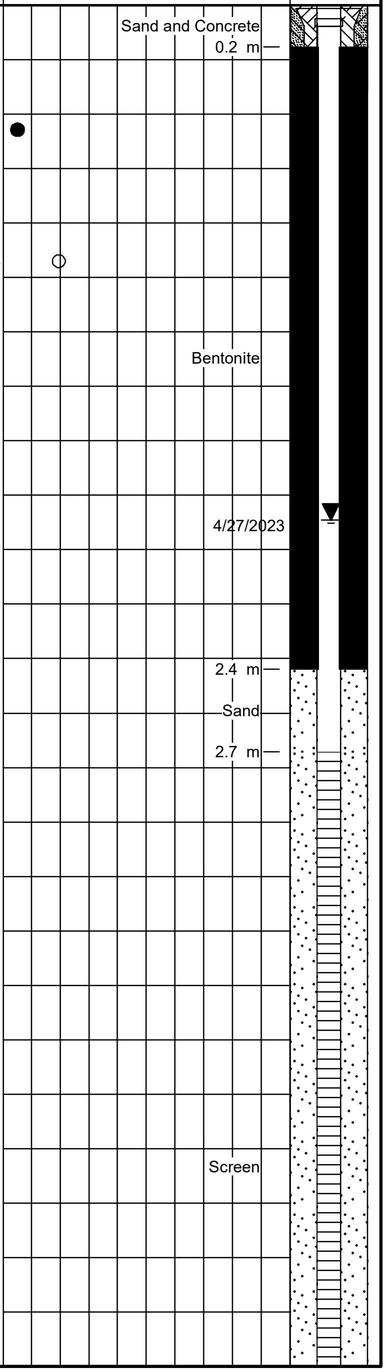
☒	SS	- SPLIT SPOON
◿	ST	- SHELBY TUBE
◫	VA	- VANE SHEAR
▐	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021847 EASTING: 427929 ELEVATION: 80.0

△ 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)

GROUND SURFACE

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(%) %
0.0	80.0	ASPHALT (38 mm)							
0.2	79.8	FILL: SAND and GRAVEL, trace silt, brown, moist, loose (Granular Subbase)							
		NATIVE: GRAVELLY SAND, trace silt and clay, brown, moist, loose	SS1			41.7	--	4-3-2-1	5
		loose to very dense	SS2	21-71-(8)		100.0	19	1-1-50/51mm	51/203 mm
1.1	78.9	DOLOMITIC SANDSTONE, light grey, slightly weathered to fresh (W2-W1), very Strong (R5), thinly bedded, non-porous	Run1			100	--	71	96
		with oxidation at joints, light grey with orange partings	Run2			83	--	65	82
			Run3		148.4	100	--	87	98



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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

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) $\overset{3}{\triangle}$ 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	
17				grey to black										
18	5.5													
19													5.8 m	
						Run4			100	--	68	98		
	6.0													
20													6.1 m	
21														
	6.5													
22														
23	7.0													
24														
						Run5			100	--	77	95		
	7.5													
25														
26														
	8.0													
27														
	8.5													
28														
						Run6			100	--	75	100		
29														
	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.

REFERENCE No.: 12606873

GHD

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

- △ 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(%)	"N" Value / Water content / Atterberg limits	PIEZOMETER/ STANDPIPE INSTALLATION
		GROUND SURFACE									
0.1	79.7	ASPHALT (51 mm)									Sand and Concrete 0.2 m
		FILL: SAND and GRAVEL, trace silt, grey to brown, moist, loose	SS1	57-40-(3)		25.0	1	6-2-2-5	4	● N = 4; ○ 1	
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	● N = 9; ├○─┤	
1.4	78.4	grey/brown to orange	SS3			100.0	--	50/102mm	50/102 mm		Bentonite
		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		2.7 m Sand 3.0 m
			Run3			100	--	82	96		
4.5		dark grey									▼ 4/27/2023 Screen
			Run4		145.9	96	--	78	91		

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

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

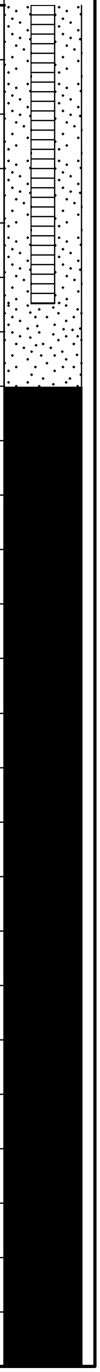
LEGEND

☒	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)
$\overset{3}{\triangle}$ 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										
				grey to grey/black										
17														
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

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)
$\triangle^3$ 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										
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

GHD

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)
△ 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 (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(%) (%)	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						Run1			100	--	59	94	
8						Run2			100	--	88	97	
13						Run3			100	--	79	98	
15													▼ 4/27/2023
	4.7	75.4		**END OF BOREHOLE**									
16				**NOTE:**									

Feet: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Metres: 0.0 0.3 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 4.7

REFERENCE No.: 12606873

GHD	**BOREHOLE No.:** BH5-23 **ELEVATION:** 80.1 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: 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 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				- 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														

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.: 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

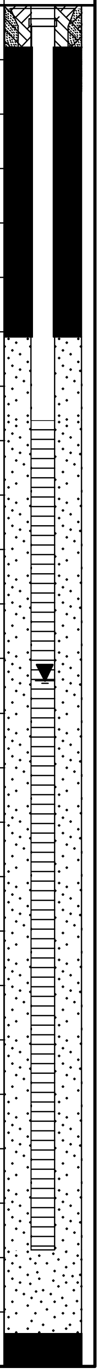
NORTHING: 5021904   EASTING: 427865   ELEVATION: 80.8

△ Undisturbed Vane Value (kPa)
☐ Remoulded Field Vane Value (kPa)
△ 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							

Feet: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Metres: 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5

PIEZOMETER/ STANDPIPE INSTALLATION



REFERENCE No.: 12606873

BOREHOLE No.: **BH6-23**

ELEVATION: 80.8 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): 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 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														
18	5.5													
						Run4		136.1	87	--	72	84		
19														
	6.0													
20														
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		
	9.0													
30														
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

GHD

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

Plot legend:
- △ 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	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	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	○	
	0.5	80.4	DOLOMITIC SANDSTONE, grey, non-porous, moderatly Weathered (W3), very Strong (R5), thinly bedded										
2													
3													
	1.0												
4					Run1			95	--	40	83		
	1.5												
5													
6													
	2.0		Fresh (W1)										
7													
8												4/27/2023	▼
	2.5												
9					Run2			100	--	100	93		
	3.0												
10													
11													
	3.5												
12													
13													
	4.0												
					Run3		138.3	100	--	60	80		
14													
	4.5												
15													
	4.8	76.1	**END OF BOREHOLE**										
16													

REFERENCE No.: 12606873

GHD

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)
$\overset{3}{\triangle}$ 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				**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														

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

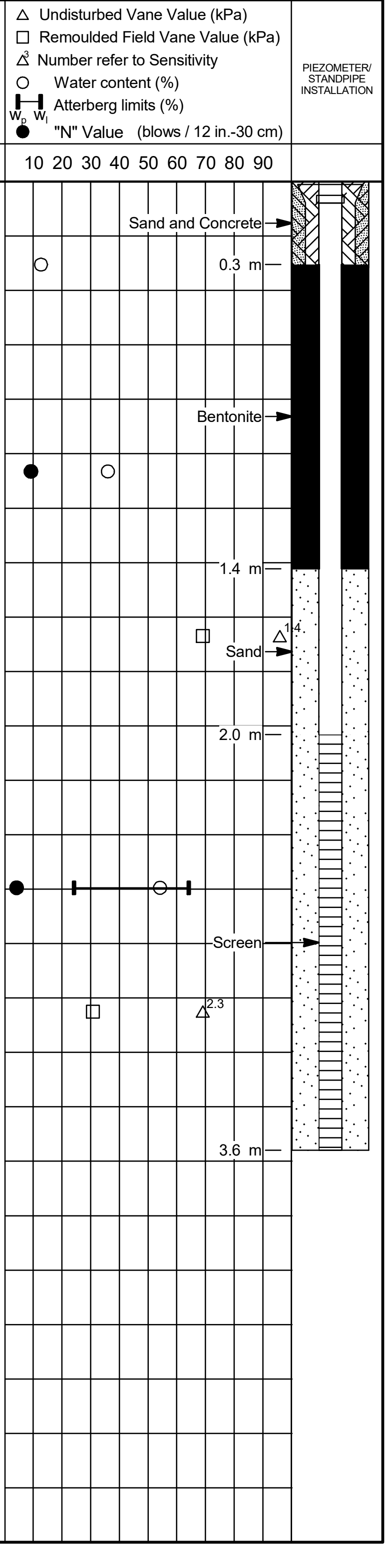
LEGEND

- ☒ 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

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

△ 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(%)	10 20 30 40 50 60 70 80 90	PIEZOMETER/ STANDPIPE INSTALLATION
		GROUND SURFACE									
0.1	79.6	ASPHALT									Sand and Concrete 0.2 m
		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									Bentonite
			Run1			100	--	91	100		
		joint, perpendicular to core axis	Run2			100	--	68	89		
											▼ 2/3/2022
		joint, perpendicular to core axis	Run3			95	--	84	92		
											4.9 m

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

REFERENCE No.: 12566614

BOREHOLE No.: BH02-22

ELEVATION: 79.7 m (GEODETIC)

BOREHOLE REPORT

CLIENT: Nokia

PROJECT: Geotechnical Investigation-Nokia Campus Rezoning

LOCATION: 570 and 600 March Road, Ottawa, Ontario

DESCRIBED BY: Dathon Ash CHECKED BY: Sahar Soleimani

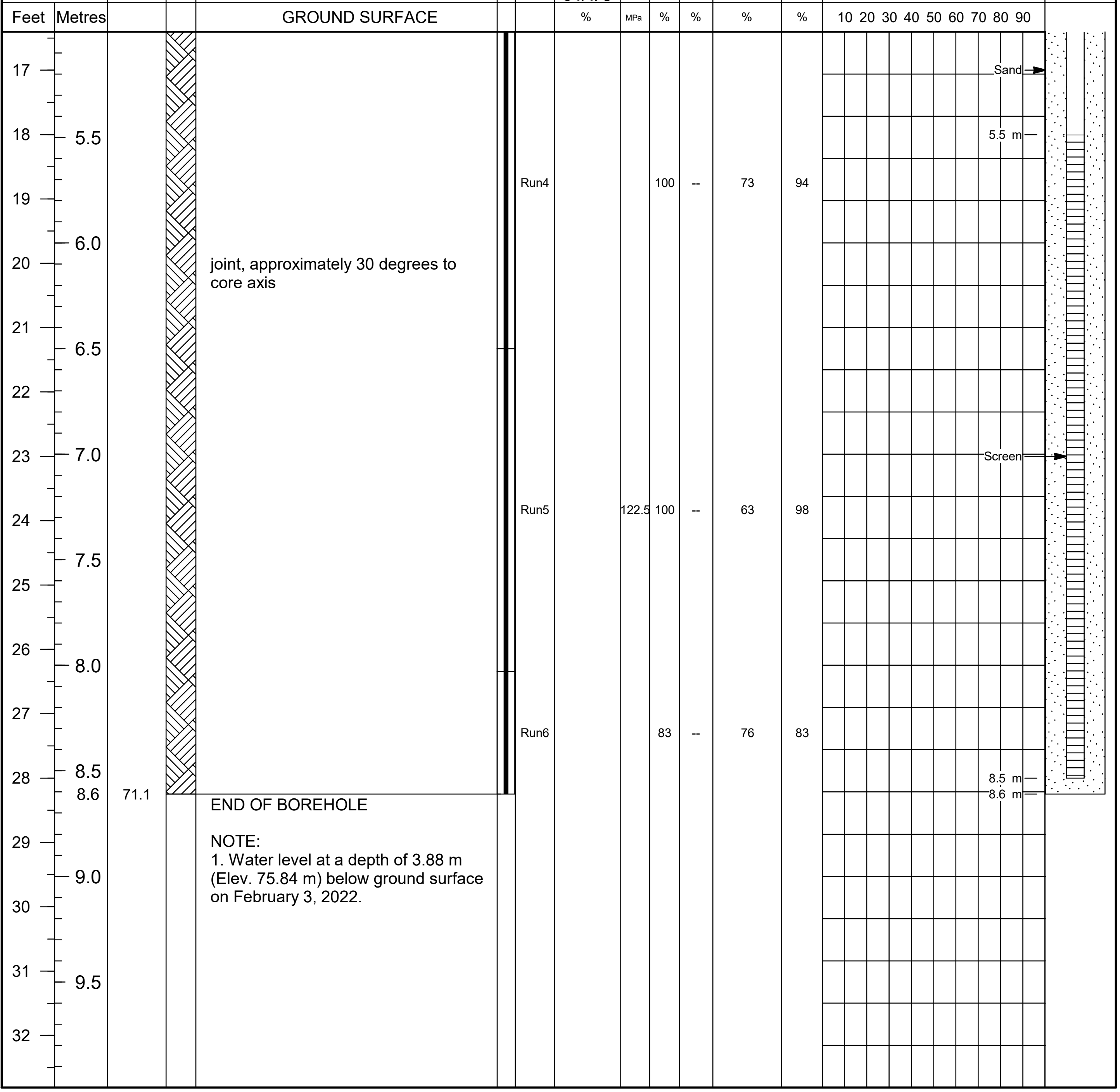
DATE (START): 31 January 2022 DATE (FINISH): 1 February 2022

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

- △ 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	Recovery/ TCR(%)	Moisture Content	Blows per 15cm/ RQD(%)	'N' Value SCR(%)
			GROUND SURFACE		%	MPa	%	%	%	%
				Run4			100	--	73	94
			joint, approximately 30 degrees to core axis							
				Run5		122.5	100	--	63	98
				Run6			83	--	76	83
	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.

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

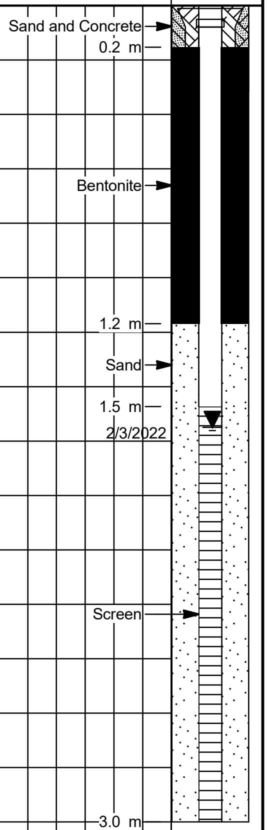
NORTHING: 5021800.342 EASTING: 427921.429 ELEVATION: 80.7

Plot legend: △ 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); scale 10 20 30 40 50 60 70 80 90

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(%)
0			GROUND SURFACE							
	0.1	80.6	ASHPHALT							
1			FILL - Sandy GRAVEL, some silt, trace clay, greyish brown, moist, dense	GS1	45-29-18-8		--	10	--	--
2	0.5 0.6	80.1	Silty CLAY, some sand, trace gravel, greyish brown, moist, stiff							
3	1.0			SS1	1-28-(71)		95.8	30	4-5-5-5	10
4	1.4	79.3	DOLOMITIC SANDSTONE, light grey with yellow bands, slightly weathered, excellent quality							
5	1.5									
6				Run1			100	--	100	100
7	2.0									
8	2.5			Run2		91.1	100	--	100	100
9										
10	3.0	77.7	END OF BOREHOLE							
11	3.5									
12										
13	4.0									
14										
15	4.5									
16										

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

PIEZOMETER/ STANDPIPE INSTALLATION



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

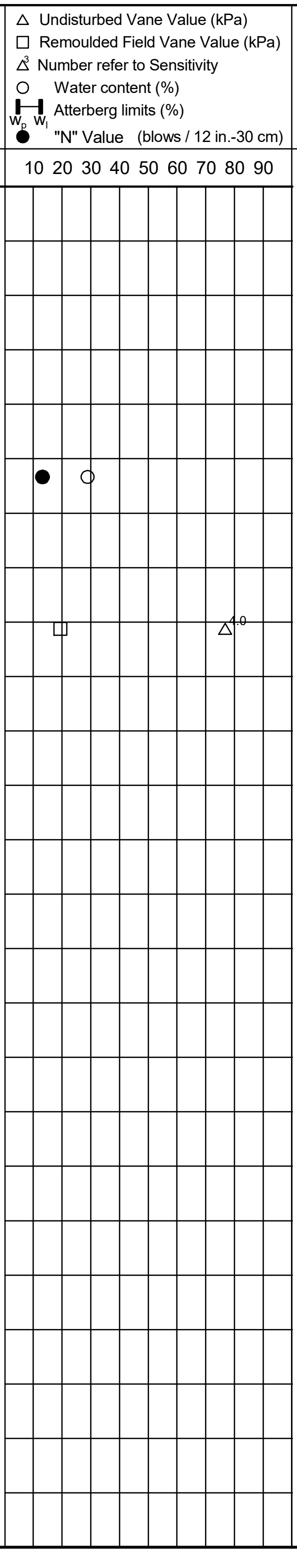
LEGEND

☒	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 (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(%) (%)
0				GROUND SURFACE								
	0.1	79.7		ASPHALT								
1				FILL - Gravelly SAND, some silt and clay, grey, moist, dense	GS	GS1	23-58-(19)		--	--	--	--
2	0.6	79.2		Silty CLAY, some sand, greyish brown, moist, stiff								
3	1.0				SS	SS1	0-10-44-46		77.0	29	5-6-7-7	13
5	1.5				VA				--	--	--	--
6	1.7	78.1		END OF BOREHOLE (Auger Refusal)								

Depth scale: Feet 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Metres 0.1, 0.5, 0.6, 1.0, 1.5, 1.7, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5



PIEZOMETER/ STANDPIPE INSTALLATION

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

△ 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
0				GROUND SURFACE										
	0.1	81.0	■	ASPHALT										
1			⊠	FILL - Sandy SILT, some gravel, greyish brown, moist, dense	⧅	GS1			--	--	--	--		
2	0.5 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	├○──┤	
3	0.9 1.0	80.2		END OF BOREHOLE (Auger Refusal)										
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														

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

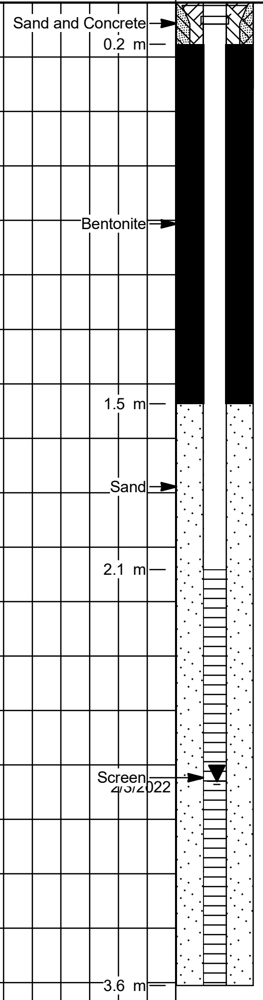
☒	SS	- SPLIT SPOON
◪	ST	- SHELBY TUBE
▯	VA	- VANE SHEAR
▮	AU	- AUGER PROBE
⧅	GS	- GRAB SAMPLE
▼		- WATER LEVEL

NORTHING: 5021952.611 EASTING: 427924.443 ELEVATION: 79.6

△ Undisturbed Vane Value (kPa)
□ Remoulded Field Vane Value (kPa)
△ 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	79.5	ASPHALT							
		FILL - Sandy SILT, some gravel, brown, moist, dense	GS1			--	--	--	--
0.4	79.2	DOLOMITIC SANDSTONE, light grey with yellow bands, fresh, good quality	Run1			97	--	87	97
			Run2		94.2	90	--	75	90
3.6	76.0	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.

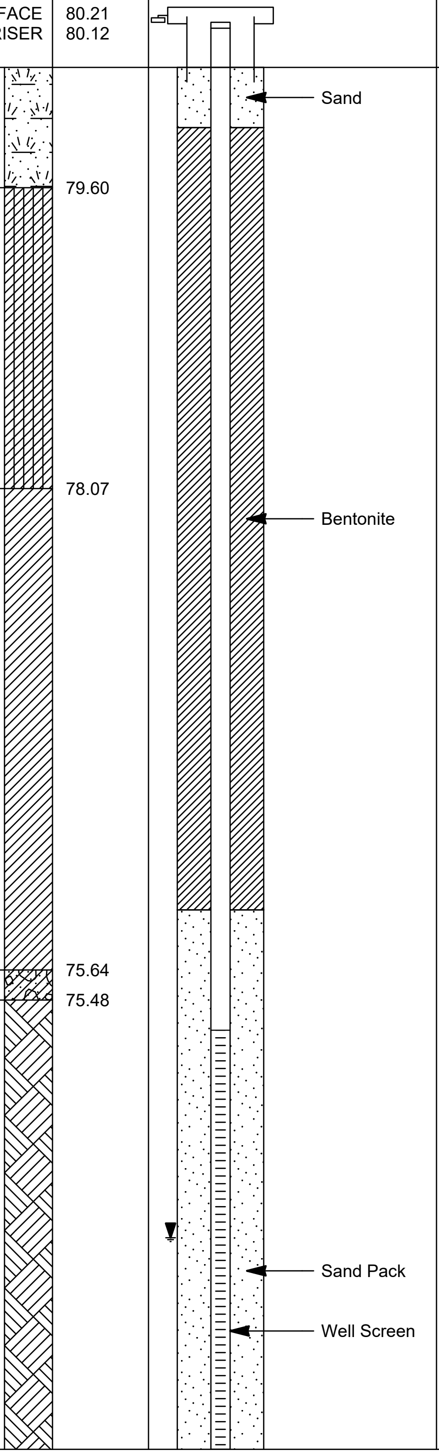


STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME:
PROJECT NUMBER: 12566614
CLIENT: Nokia Canada Inc.
LOCATION: 600 March Road, Ottawa, Ontario

HOLE DESIGNATION: BH11-22
DATE COMPLETED: 11 May 2022
DRILLING METHOD: Auger/Air hammer
FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' Value
	GROUND SURFACE TOP OF RISER	80.21 80.12					
	TOPSOIL, silt with gravel, well graded, brown, trace organics						
0.5	SILTY CLAY, well graded, dark brown, moist	79.60					
1.0							
1.5							
2.0	CLAY, well graded, dense, grey-brown, moist	78.07					
2.5							
3.0	- trace gravel from 3.05 to 3.66m BGS						
3.5	- sand from 3.81 to 4.57m BGS						
4.0							
4.5	TILL, gravel, trace clay, grey, very moist	75.64					
	BEDROCK	75.48					
5.0							
5.5							
6.0							
6.5							



NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
STATIC WATER LEVEL ▼ May 26, 2022

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME:

PROJECT NUMBER: 12566614

CLIENT: Nokia Canada Inc.

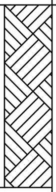
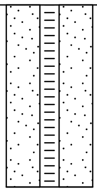
LOCATION: 600 March Road, Ottawa, Ontario

HOLE DESIGNATION: BH11-22

DATE COMPLETED: 11 May 2022

DRILLING METHOD: Auger/Air hammer

FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE				
				NUMBER	INTERVAL	REC (%)	'N' Value	
7.5								
8.0	END OF BOREHOLE @ 7.92m BGS	72.28	WELL DETAILS Screened interval: 75.33 to 72.28mAMSL 4.88 to 7.92m BGS Length: 3.05m Diameter: 51mm Slot Size: #10 Material: PVC Sand Pack: 75.94 to 72.28mAMSL 4.27 to 7.92m BGS Material: Silica					
8.5								
9.0								
9.5								
10.0								
10.5								
11.0								
11.5								
12.0								
12.5								
13.0								
13.5								

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

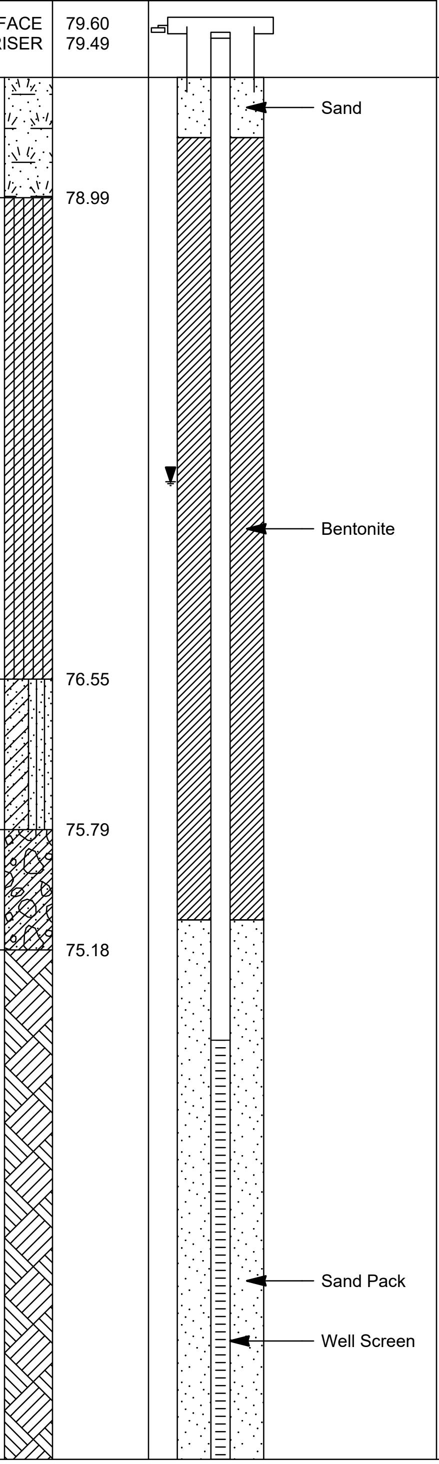
STATIC WATER LEVEL ▼ May 26, 2022

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME:
PROJECT NUMBER: 12566614
CLIENT: Nokia Canada Inc.
LOCATION: 600 March Road, Ottawa, Ontario

HOLE DESIGNATION: BH12-22
DATE COMPLETED: 12 May 2022
DRILLING METHOD: Auger/Air hammer
FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' Value
	GROUND SURFACE	79.60					
	TOP OF RISER	79.49					
	TOPSOIL, silt, trace sand, trace gravel, loose, dark brown, organics						
	SILTY CLAY, trace sand, well graded, dense, grey-brown, organics	78.99					
	CLAYEY SAND, trace till and gravel, brown, moist	76.55					
	TILL, trace silty clay, dense, grey, moist	75.79					
	BEDROCK	75.18					

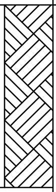
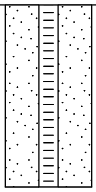


NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE
STATIC WATER LEVEL ▼ May 26, 2022

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME:
PROJECT NUMBER: 12566614
CLIENT: Nokia Canada Inc.
LOCATION: 600 March Road, Ottawa, Ontario

HOLE DESIGNATION: BH12-22
DATE COMPLETED: 12 May 2022
DRILLING METHOD: Auger/Air hammer
FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE				
				NUMBER	INTERVAL	REC (%)	'N' Value	
7.5								
8.0	END OF BOREHOLE @ 7.92m BGS	71.67	WELL DETAILS Screened interval: 74.72 to 71.67mAMSL 4.88 to 7.92m BGS Length: 3.05m Diameter: 51mm Slot Size: #10 Material: PVC Sand Pack: 75.33 to 71.67mAMSL 4.27 to 7.92m BGS Material: Silica					
8.5								
9.0								
9.5								
10.0								
10.5								
11.0								
11.5								
12.0								
12.5								
13.0								
13.5								

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

STATIC WATER LEVEL ▼ May 26, 2022

STRATIGRAPHIC AND INSTRUMENTATION LOG (OVERBURDEN)

PROJECT NAME:

PROJECT NUMBER: 12566614

CLIENT: Nokia Canada Inc.

LOCATION: 600 March Road, Ottawa, Ontario

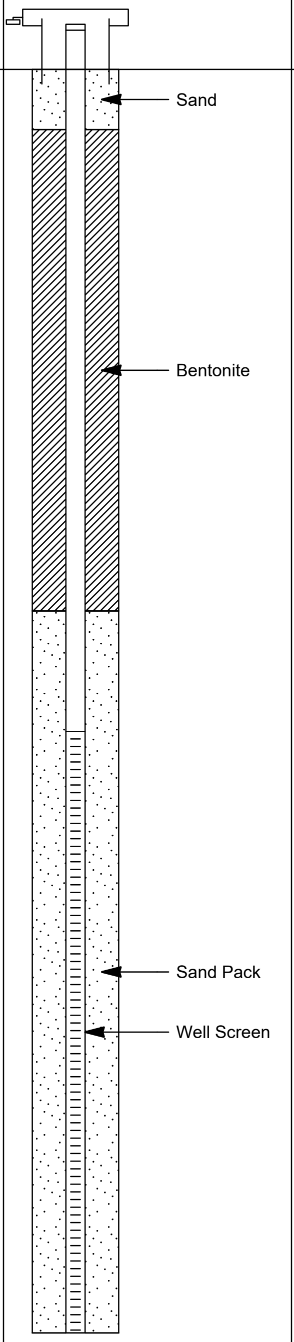
HOLE DESIGNATION: BH13-22

DATE COMPLETED: 11 May 2022

DRILLING METHOD: Auger/Air hammer

FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE INTERVAL	SAMPLE REC (%)	SAMPLE 'N' Value
	GROUND SURFACE TOP OF RISER	81.95 81.83					
0.5	TOPSOIL, silty sand, poorly graded, trace gravel, brown, organics						
1.0	SANDY SILT, poorly graded, trace till and topsoil, dark brown, trace organics	81.34					
1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0	BEDROCK	80.58					
6.5	END OF BOREHOLE @ 6.40m BGS Note: Borehole dry upon completion of drilling	75.55	WELL DETAILS Screened interval: 78.60 to 75.55mAMSL 3.35 to 6.40m BGS				



NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

File: \\GHDNET\GHD\CA\OTTAWA\PROJECTS\661\12566614\TECH\GINT LOGS\12566614-ENVIRO.GPJ Library File: GHD_ENVIRO_V04.GLB Report: OVERBURDEN LOG Date: 30/6/22

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME:
PROJECT NUMBER: 12566614
CLIENT: Nokia Canada Inc.
LOCATION: 600 March Road, Ottawa, Ontario

HOLE DESIGNATION: BH13-22
DATE COMPLETED: 11 May 2022
DRILLING METHOD: Auger/Air hammer
FIELD PERSONNEL: N. Gupta

DEPTH m BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEV. mAMSL	MONITOR INSTALLATION	SAMPLE				
				NUMBER	INTERVAL	REC (%)	'N' Value	
7.5			Length: 3.05m Diameter: 51mm Slot Size: #10 Material: PVC Sand Pack: 79.21 to 75.55mAMSL 2.74 to 6.40m BGS Material: Silica					
8.0								
8.5								
9.0								
9.5								
10.0								
10.5								
11.0								
11.5								
12.0								
12.5								
13.0								
13.5								

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

Appendix B

Bedrock 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 Nº. :	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 No. : 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 N°. : 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		**Prepared by :**	John McAuley
Project :	Geotechnical Investigation			
Reference Nº. :	12606873		**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario			

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

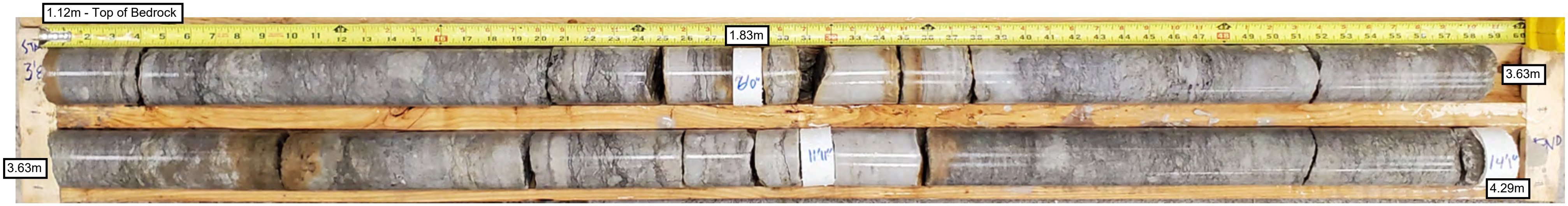
Run No.	Run Start/End (m)
1	1.12 - 1.83
2	1.83 - 3.63
3	3.63 - 4.29 (Continued in box 2)

Client :	First Gulf
Project :	Geotechnical Investigation
Reference N^{o.} :	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

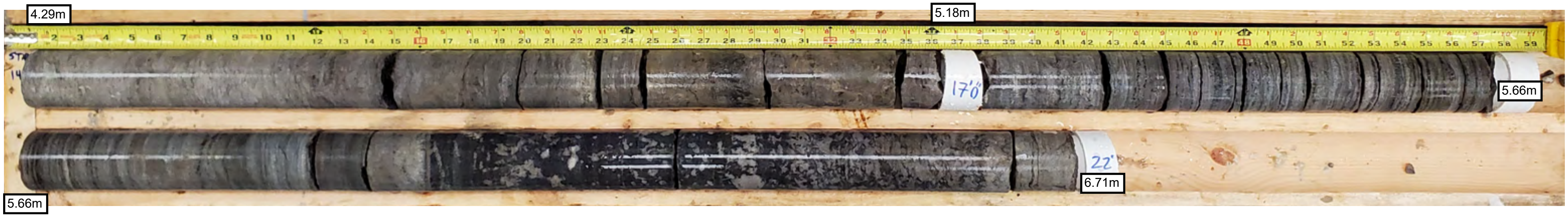
Run No.	**Run Start/End (m)**
3	**4.29 - 5.18 (Continued from Box 1)**
4	**5.18 - 6.71**

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference Nº. :	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°. : 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	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N°· :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

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^{o.} : 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

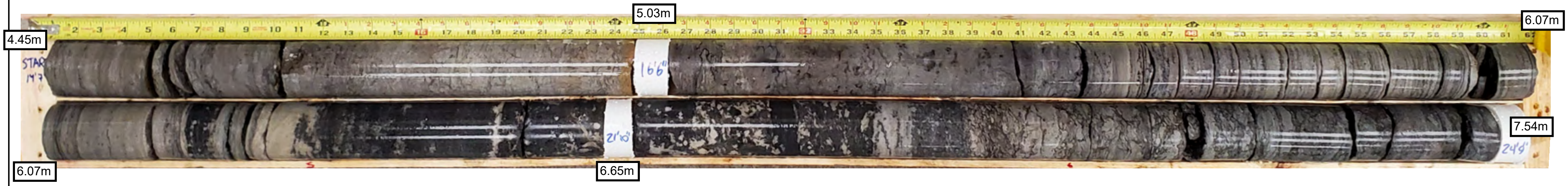
Run No.	Run Start/End (m)
4	4.45 - 5.03
5	5.03 - 6.65
6	6.65 - 7.54 (Continued in Box 3)

Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N°. :	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

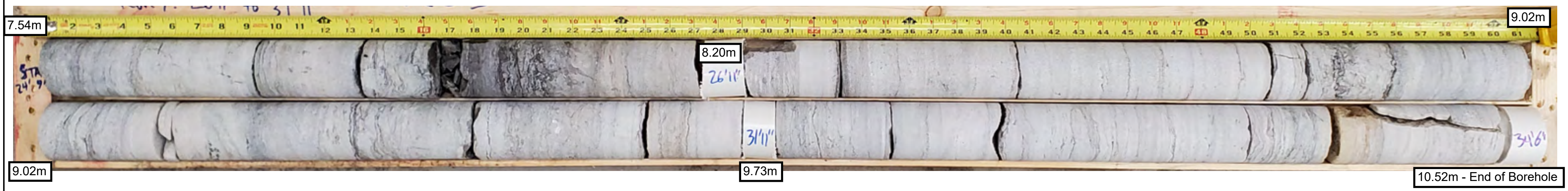
Prepared by : John McAuley

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

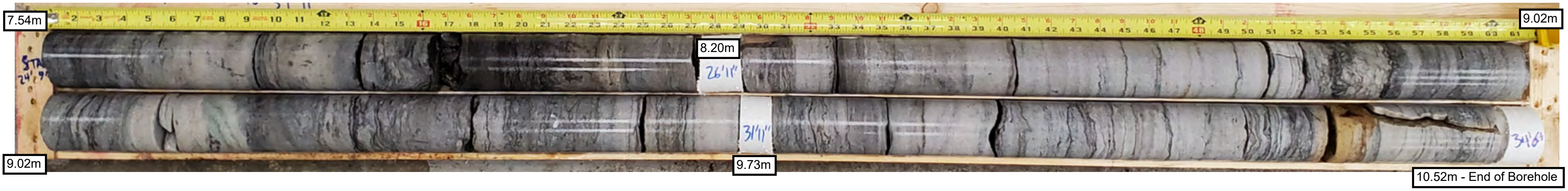
Prepared by : John McAuley

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

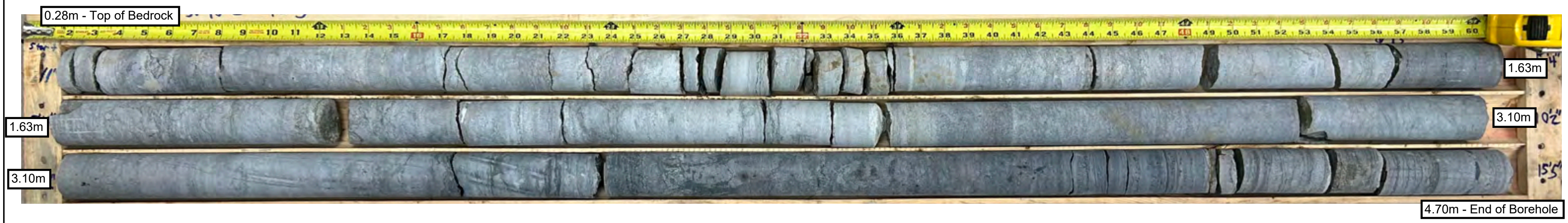


Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference N^{o.} :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

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



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^{o.} : 12606873

Location: 600 March Road, Kanata, Ontario

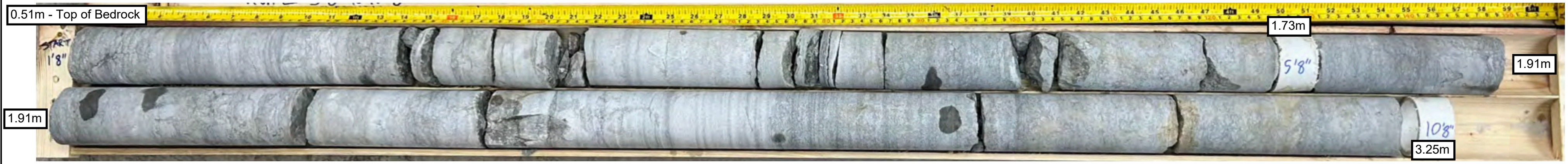
Prepared by : John McAuley

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

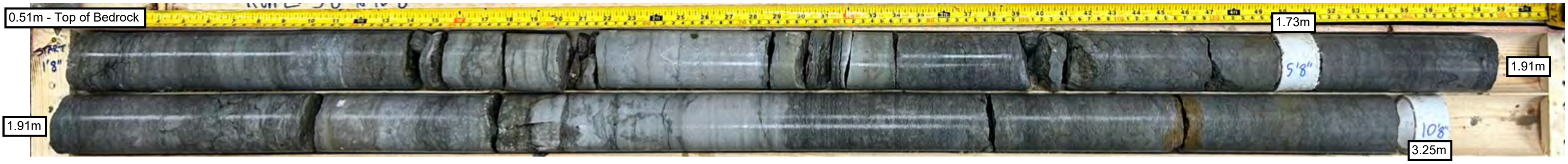


Client :	First Gulf	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference Nº. :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

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	**Prepared by :**	John McAuley
Project :	Geotechnical Investigation		
Reference Nº. :	12606873	**Revised by :**	Sahar Soleimani, P.Eng.
Location:	600 March Road, Kanata, Ontario		

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

Project : Geotechnical Investigation

Reference N°. : 12606873

Location: 600 March Road, Kanata, Ontario

Prepared by : John McAuley

Revised by : Sahar Soleimani, P.Eng.

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.

BH 2-22 (Dry)

Box 1 of 3

Run No.	Run Start/End (m)
1	2.39 - 3.10
2	3.10 - 3.45
3	3.45 - 4.93

Client :	Colliers
Project :	Geotechnical Investigation
Reference N°. :	12566614
Location:	600 March Road, Kanata, Ontario

Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

CHD

BH 2-22 (Wet)
Box 1 of 3

Run No.	Run Start/End (m)
1	2.39 - 3.10
2	3.10 - 3.45
3	3.45 - 4.93

2.39 m - Top of Bedrock

3.10 m

3.45 m

3.45 m

4.93 m

Client :	Colliers
Project :	Geotechnical Investigation
Reference N°. :	12566614
Location:	600 March Road, Kanata, Ontario

Prepared by : Kenneth O. Omenogor

Revised by : Sahar Soleimani, **P.Eng.**

BH 2-22 (Dry)
Box 2 of 3

Run No.	Run Start/End (m)
4	4.93 - 6.50
5	6.50 - 7.49

Client :	Colliers	**Prepared by :**	Kenneth O. Omenogor
Project :	Geotechnical Investigation		
Reference N°. :	12566614	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	600 March Road, Kanata, Ontario		

BH 2-22 (Wet)
Box 2 of 3

Run No.	Run Start/End (m)
4	4.93 - 6.50
5	6.50 - 7.49

Client :	Colliers
Project :	Geotechnical Investigation
Reference No. :	12566614
Location:	600 March Road, Kanata, Ontario
Prepared by :	Kenneth O. Omenogor
Revised by :	Sahar Soleimani, **P.Eng.**

BH 2-22 (Dry)
Box 3 of 3

Run No.	Run Start/End (m)
5	7.49 - 8.03
6	8.03 - 8.61

Client :	Colliers
Project :	Geotechnical Investigation
Reference N°. :	12566614
Location:	600 March Road, Kanata, Ontario

Prepared by : Kenneth O. Omenogor

Revised by : Sahar Soleimani, **P.Eng.**

BH 2-22 (Wet)
Box 3 of 3

Run No.	Run Start/End (m)
5	7.49 - 8.03
6	8.03 - 8.61

Client :	Colliers	**Prepared by :**	Kenneth O. Omenogor
Project :	Geotechnical Investigation		
Reference N°. :	12566614	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	600 March Road, Kanata, Ontario		

BH 3-22 (Dry)
Box 1 of 1

Run No.	Run Start/End (m)
1	1.37 - 2.03
2	2.03 - 3.00

1.37 m - Top of Bedrock

2.03 m

2.03 m

3.00 m - End of Borehole

Client :	Colliers	**Prepared by :**	Kenneth O. Omenogor
Project :	Geotechnical Investigation		
Reference No. :	12566614	**Revised by :**	Sahar Soleimani, **P.Eng.**
Location:	600 March Road, Kanata, Ontario		

BH 3-22 (Wet)

Box 1 of 1

Run No.	Run Start/End (m)
1	1.37 - 2.03
2	2.03 - 3.00

Client :	Colliers
Project :	Geotechnical Investigation
Reference N°. :	12566614
Location:	600 March Road, Kanata, Ontario

Prepared by : Kenneth O. Omenogor

Revised by : Sahar Soleimani, **P.Eng.**

BH 6-22 (Dry)
Box 1 of 1

Run No.	Run Start/End (m)
1	0.41 - 1.88
2	1.88 - 3.61

0.41 m - Top of Bedrock

1.88 m

1.88 m

3.61 m - End of Borehole

Client : Colliers

Project : Geotechnical Investigation

Reference N°. : 12566614

Location: 600 March Road, Kanata, Ontario

Prepared by : Kenneth O. Omenogor

Revised by : Sahar Soleimani, **P.Eng.**

BH 6-22 (Wet)
Box 1 of 1

Run No.	Run Start/End (m)
1	0.41 - 1.88
2	1.88 - 3.61

Client :	Colliers
Project :	Geotechnical Investigation
Reference N°. :	12566614
Location:	600 March Road, Kanata, Ontario

Prepared by : Kenneth O. Omenogor

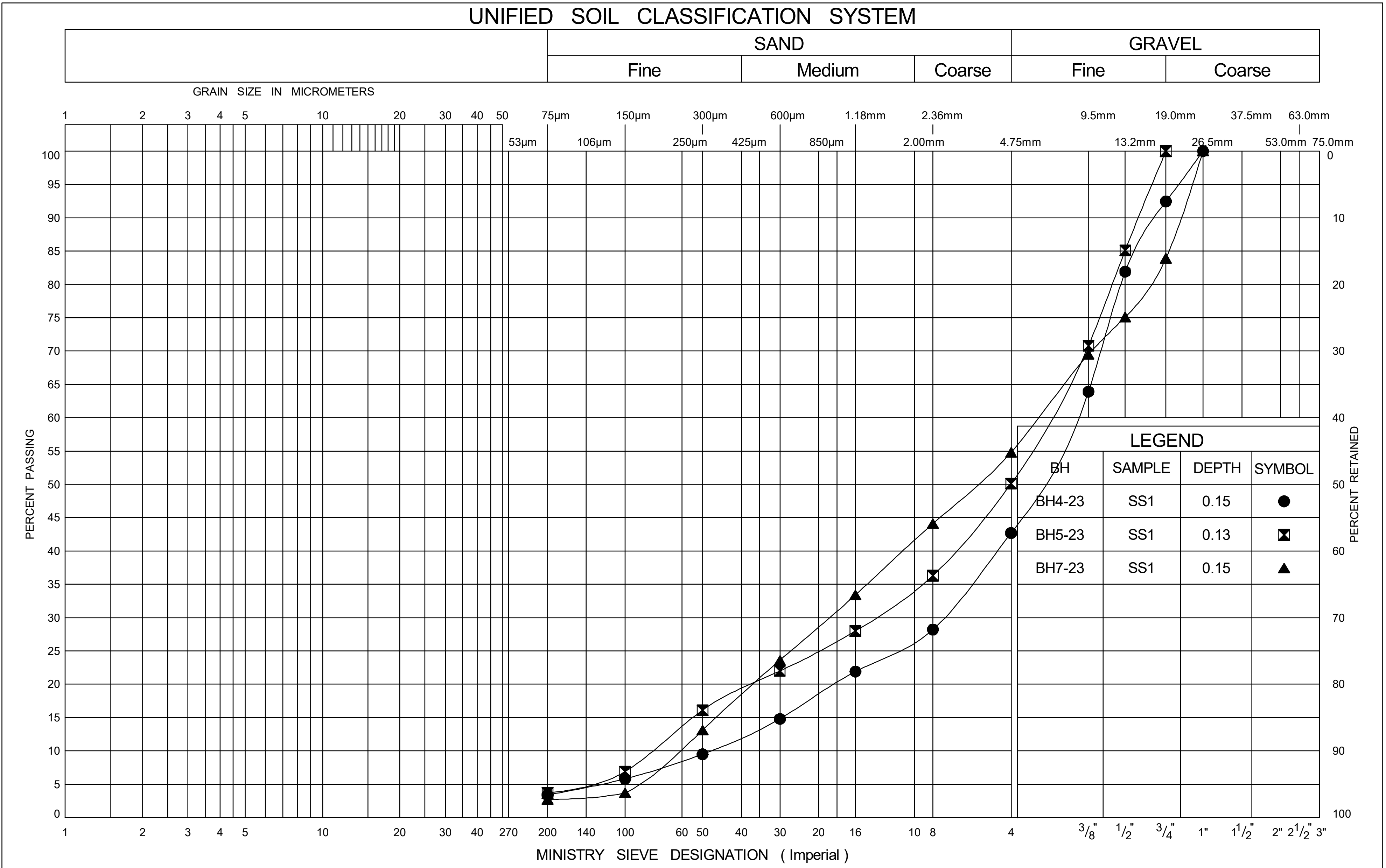
Revised by : Sahar Soleimani, **P.Eng.**

Appendix C

Summary Table and Results of Geotechnical Laboratory Testing

Table C1 *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	▲

GRAIN SIZE DISTRIBUTION

FILL - Sand and Gravel

Project No.: 12606873

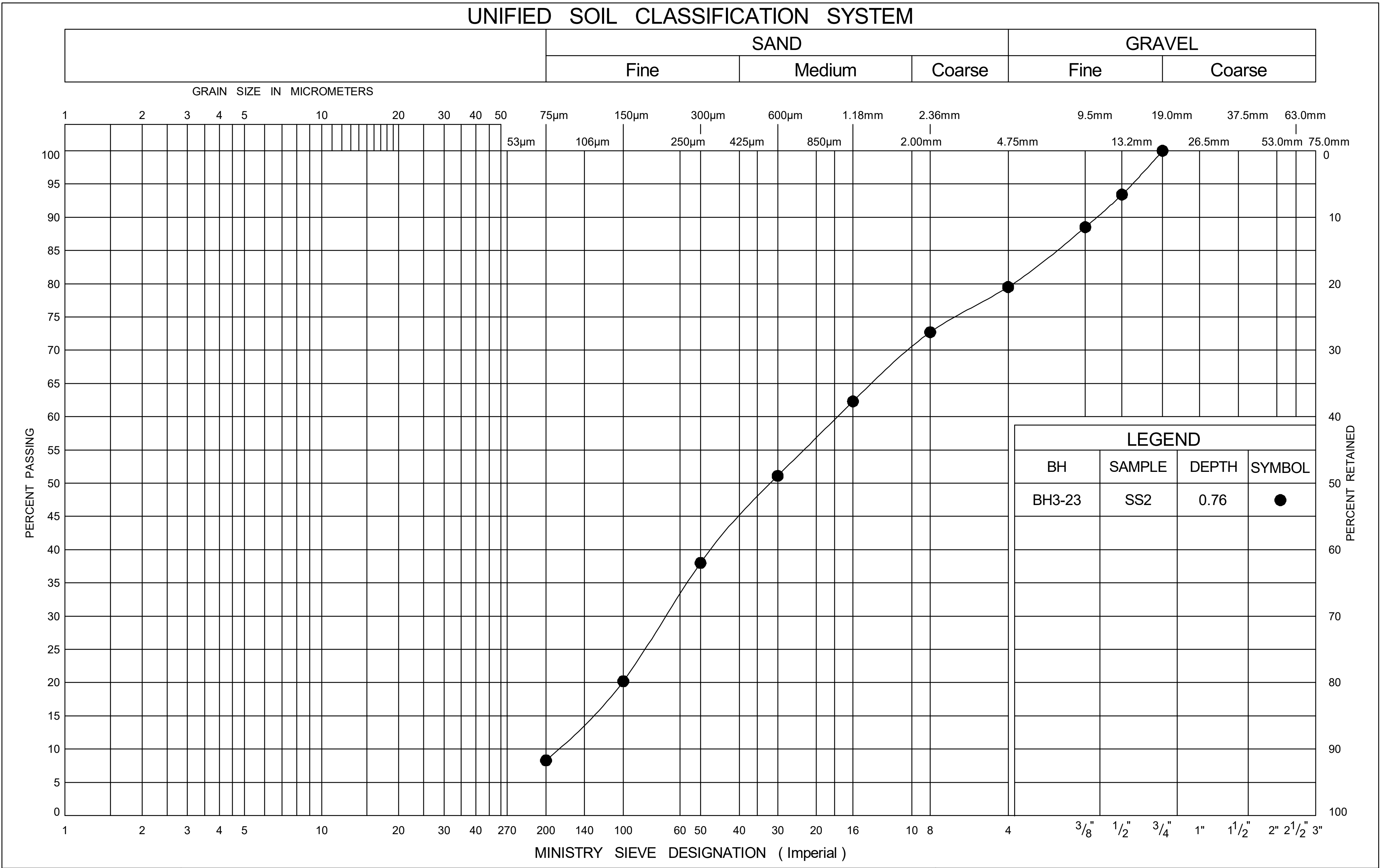
Project Name: Geotechnical Investigation-Nokia Campus

Figure No.: 1

Date: June 12, 2023

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

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



GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

Project No.: 12606873

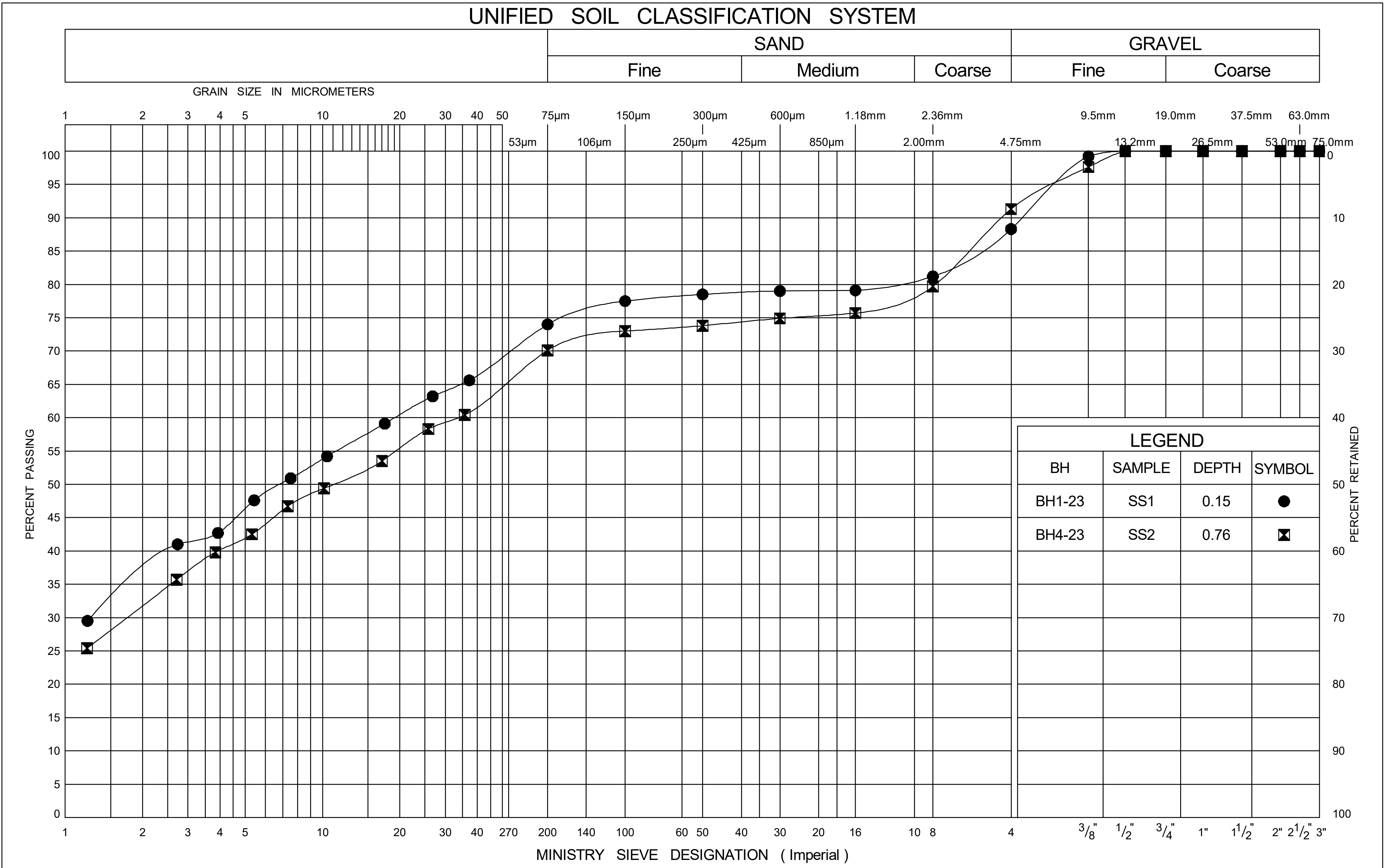
Project Name: Geotechnical Investigation-Nokia Campus

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



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

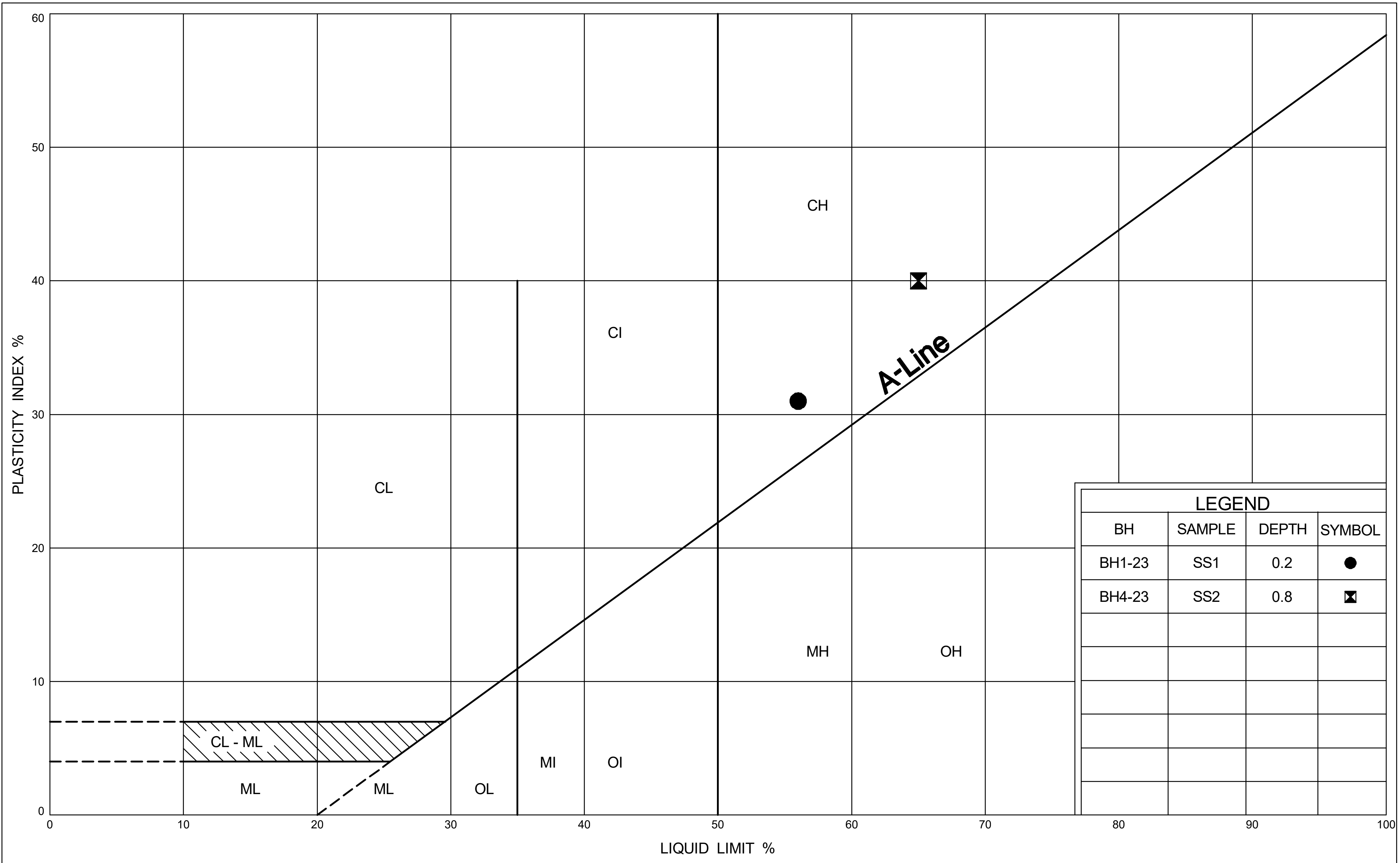
Figure No.: 3

Date: June 12, 2023

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

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_PLASTICITY CHART **Date**



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 N° : 12606873
Project : 600 March Road, Kanata, Ontario
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 N° : 12606873
Project : 600 March Road, Kanata, Ontario
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 :**

eurofins | Environment Testing

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/.

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

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

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

Certificate of Analysis

eurofins | Environment Testing

Client: 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	Report Number:	1996342
Attention:	Mr. Sahar Soleimani	Date Submitted:	2023-04-28
PO#:	735-006602	Date Reported:	2023-05-05
Invoice to:	GHD Limited (Ottawa)	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

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			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
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

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.

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

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

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

Certificate of Analysis

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**

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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
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.

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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. Thomas

Addrine Thomas
2022.02.17
07:29:51 -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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Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

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**

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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

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

Certificate of Analysis

Client:	GHD Limited (Ottawa) 400-179 Colonnade Rd. Ottawa, ON K2E 7J4		Report Number:	1971490
			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)			

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 D

MASW Survey – Seismic Site Classification Report

Technical Memorandum

February 7, 2025

To	Margaret Wolodarski, Nokia	**Contact No.**	
Copy to		**Email**	Margaret.wolodarski@nokia.com
From	Brice Zanne/Ali Ghassemi	**Project No.**	12646241
Project Name	Nokia		
Subject	MASW Investigation – 570 March Road, Ottawa, Ontario		

1. Introduction

GHD was retained by Nokia (Client) to update a Multichannel Analysis of Surface Waves (MASW) survey as part of the updated geotechnical and hydrological investigation for the Nokia Ottawa Campus redevelopment project located at 570 March Road in Kanata (Ottawa), Ontario (Site). This memorandum supersedes the memorandum dated March 6 and appended to the geotechnical report and hydrogeological assessment Report No. 12606873 dated March 13, 2024.

It is our understanding that the proposed developments will consist of an eight storey engineering hub and retail building with a partial one underground level, one, three storey parking structure and a five storey R&D lab building. It is expected that the proposed buildings will be surrounded by pavement structures. Further details regarding the development plans are summarized in Sections 2 and 4.1 of the geotechnical report and hydrogeological assessment Report No. 12646241.

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 **Appendix A** of GHD's geotechnical report and hydrogeological assessment Report No. 12646241, 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 metres (m) to 0.8 m below ground surface (mBGS) (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 mBGS (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 mBGS (BH4-23 shown in **Figure 1**). The described relative density/consistency terms and soil classification in this section are based on the recorded SPT "N" values and soil descriptions provided on the GHD 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.

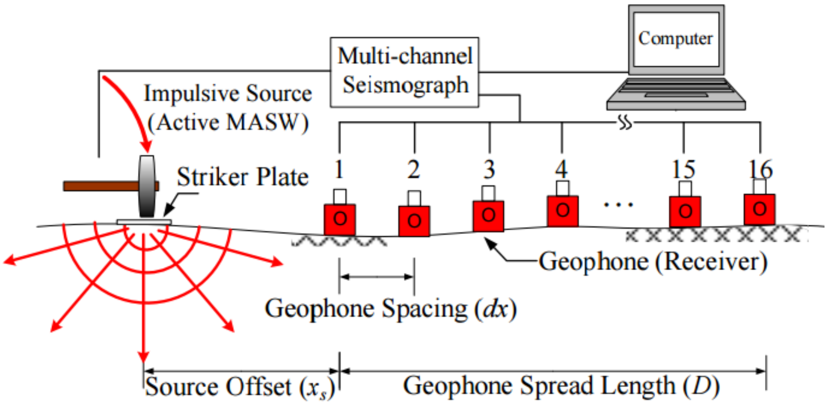

Figure 2.1 Schematic Layout of MASW Test Setup (Sahadewa et al., 2012[2])

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), 24 - 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 millimetres (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-kilogram (kg) sledgehammer hitting the ground surface at three different offset distances (distance

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[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).

between the source and first geophone) along each survey line. The following table summarizes the geometry for each investigation line.

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 4 seconds with one sample per 0.25 millisecond (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** (attached to this report) 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 metre per second (m/s) below approximate depths of 17 m.

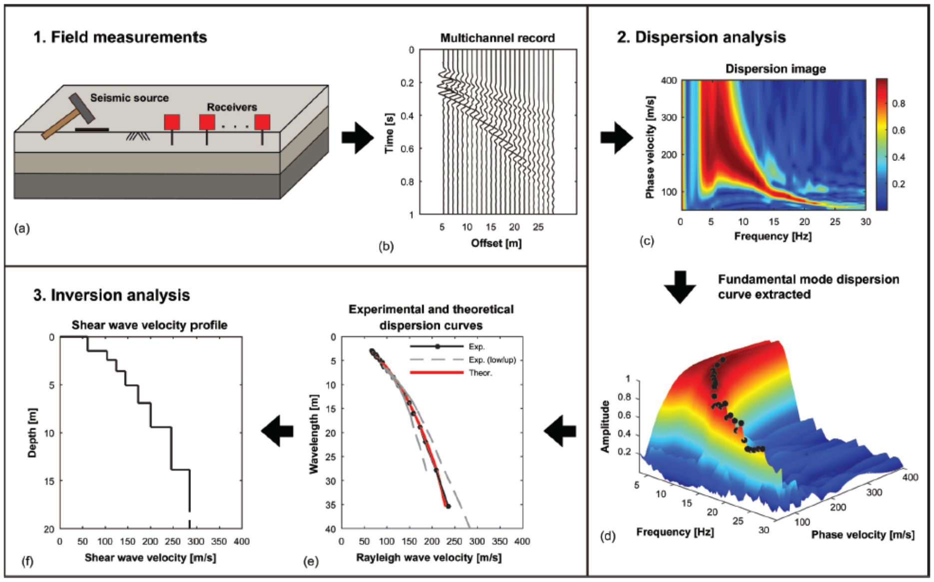


Figure 4.1 Overview of MASW method (Olafsdottir et al., 2018[3])

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 1.0 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 1.0 mBGS) 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 1.0 m BGS to 31.0 mBGS) along the two investigation lines is **1427 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 mBGS (BH4-23 as shown on **Figure 1**) and bedrock was encountered at approximately between 1.1 m to 1.6 mBGS in boreholes advanced by GHD.

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 X_{1427}** 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 1** to this correspondence. However, it should be noted that previous versions of NBCC are also available (https://earthquakescanada.nrcan.gc.ca/hazard-alea/interpolat/index-en.php) and it

---

[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.

is the responsibility of the designer to determine which version of the NBCC and seismic hazard tool is applicable.

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.

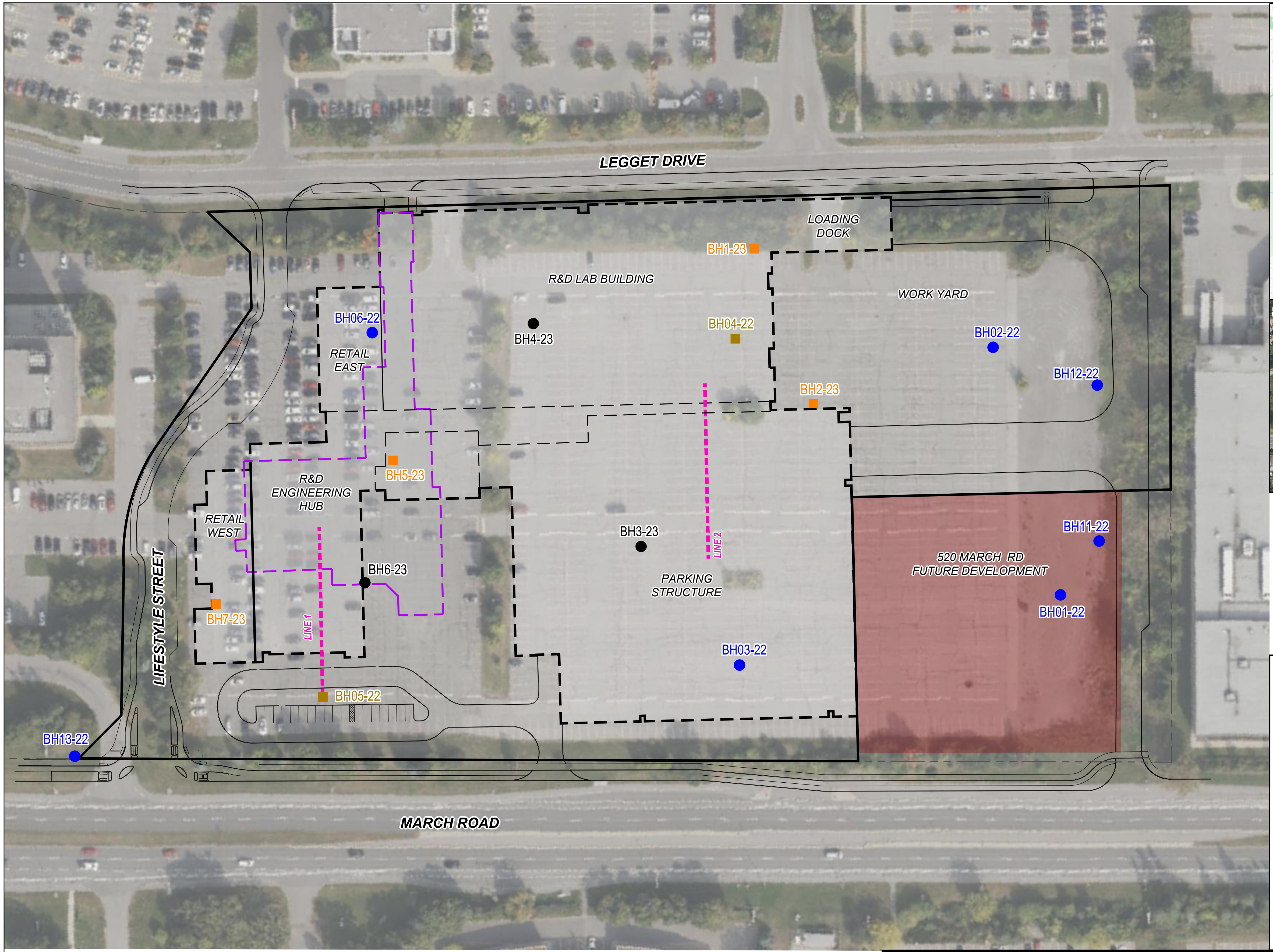
Regards,

Brice Zahne, M.Eng., EIT

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

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.

Figures



LEGEND

■	BOREHOLE LOCATION *(GHD, 2022)*
■	BOREHOLE LOCATION *(GHD, 2023)*
●	MONITORING WELL *(GHD, 2022)*
●	MONITORING WELL *(GHD, 2023)*
☒	SOIL SAMPLING LOCATION *(GHD, 2022)*
- - -	MASW LINE LOCATION
—	PROPERTY LIMITS
▨	PROPOSED ABOVE GROUND BUILDING
- - -	PROPOSED UNDERGROUND STRUCTURE

0 12.5 25 37.5m

1:1250

Coordinate System:
UTM with NAD83 datum,
Zone 18, Meter;

Plan North

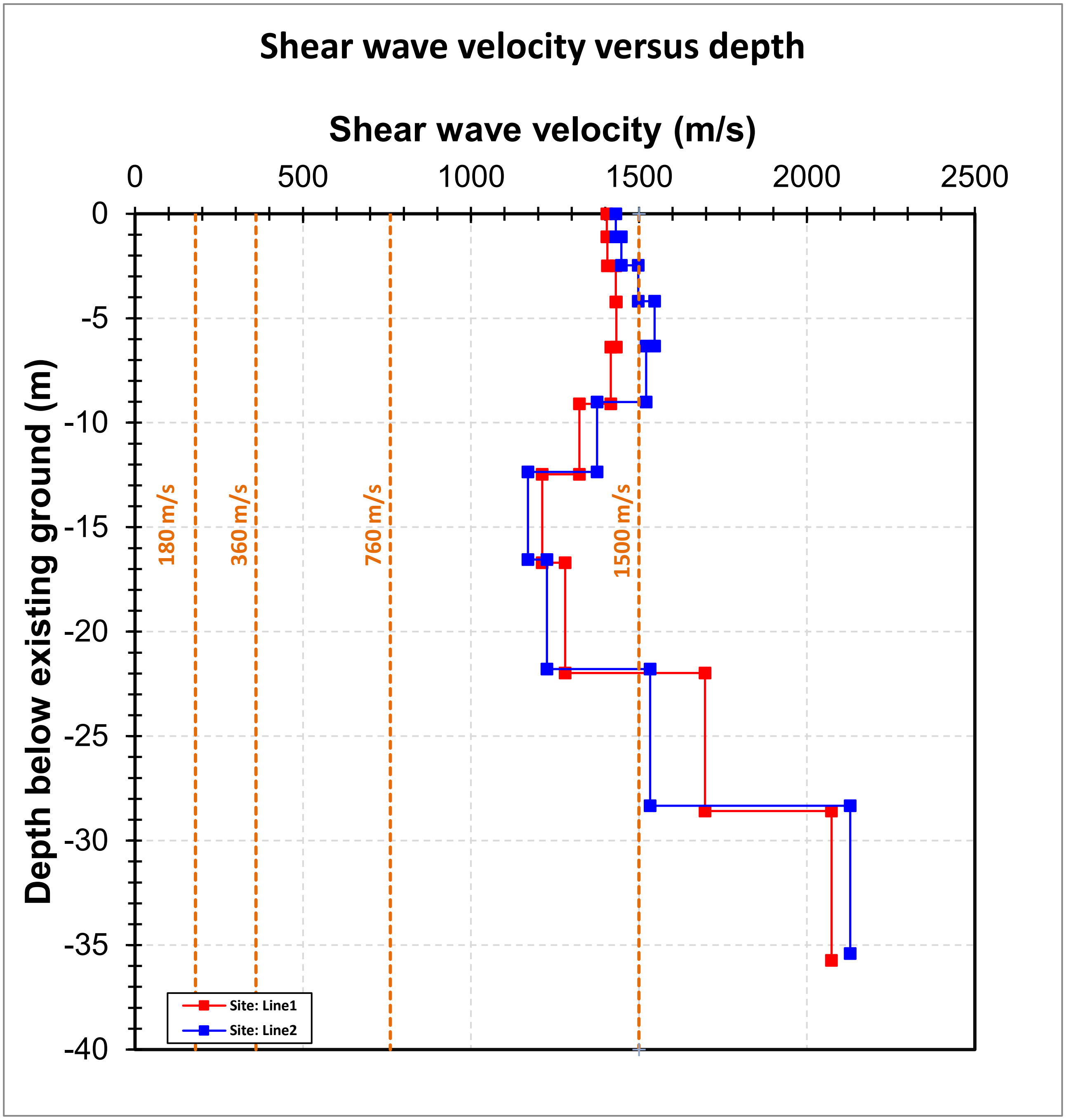
FIRST GULF
600 MARCH ROAD, KANATA (OTTAWA), ONTARIO
NOKIA PROPERTY REDEVELOPMENT

GEOTECHNICAL INVESTIGATION
SITE LOCATION PLAN

Project No. **12646241**
Date **2/7/25**

FIGURE 1

Filename: \\ghdnet\ghd\CA\Ottawa\Projects\662\12646241\Digital_Design\ACAD\Figures\RPT001\12646241-GHD-00-00-RPT-GE-D101_MT-001.dwg
Plot Date: 07 février 2025 10:04



Nokia
Geotechnical Investigation
570 March Rd, Kanata, ON K2K 2T6

PROJECT NO.
12646241
DATE
7-Feb-25

SHEAR WAVE VELOCITY VS DEPTH

FIGURE NO. 2

Tables

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

This sheet is password protected and only the data in ORANGE cells can be changed. F This sheet is password protected and only the data in ORANGE cells can be changed. Password is MASW.

Table 1-A: Average Shear Wave Velocity (VS_{30})
(Assumed foundation at 1.0 m below ground surface)

Line 1

Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	1.0	2.5	1.5	1406	0.0011
2	2.5	4.2	1.7	1431	0.0012
3	4.2	6.4	2.2	1433	0.0015
4	6.4	9.1	2.7	1417	0.0019
5	9.1	12.5	3.4	1323	0.0026
6	12.5	16.7	4.2	1212	0.0035
7	16.7	22.0	5.3	1280	0.0041
8	22.0	28.6	6.6	1697	0.0039
9	28.6	31.0	2.4	2073	0.0012
Total			30.0		0.0209
Average Shear Wave Velocity Along the Line (m/s)					***1434***

Table 1-B: Average Shear Wave Velocity (VS_{30})
(Assumed foundation at 1.0 m below ground surface)

Line 2

Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	1.0	2.5	1.5	1447	0.0010
2	2.5	4.2	1.7	1498	0.0011
3	4.2	6.3	2.1	1547	0.0014
4	6.3	9.0	2.7	1522	0.0018
5	9.0	12.4	3.4	1375	0.0024
6	12.4	16.5	4.2	1170	0.0036
7	16.5	21.8	5.2	1226	0.0043
8	21.8	28.3	6.5	1533	0.0043
9	28.3	31.0	2.7	2129	0.0013
Total			30.0		0.0211
Average Shear Wave Velocity Along the Line (m/s)					***1421***

Average VS_{30} = 1427 m/s

Recommended Minimal Site Designation (NBCC 2020) : **X_{1427}** 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.*				

Attachment 1

NBC Seismic Hazard and Site Classification for Seismic Site Response

Government of Canada Gouvernement du Canada

Canada.ca > Natural Resources Canada > Earthquakes Canada

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_{1427}
Latitude (°)	45.346
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

$S_a(0.2, X_{1427})$	$S_a(0.5, X_{1427})$	$S_a(1.0, X_{1427})$	$S_a(2.0, X_{1427})$	$S_a(5.0, X_{1427})$	$S_a(10.0, X_{1427})$	$PGA(X_{1427})$	$PGV(X_{1427})$
0.37	0.192	0.0989	0.0462	0.0127	0.00476	0.279	0.142

The log-log interpolated 2%/50 year $S_a(4.0, X_{1427})$ value is : **0.0174**

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

Download CSV

← Go back to the seismic hazard calculator form

Date modified: 2021-04-06

Appendix E

Hydrogeological Assessment

Memorandum

7 February 2025

To	Margaret Wolodarski, Nokia		
Copy to			
From	Allan Molenhuis, Ben Kempel	**Tel**	+1 519 884-0510
Subject	Hydrogeologic Assessment Update	**Project no.**	12646241

1. Introduction

GHD Limited (GHD) was retained by Nokia (Client) to update a Geotechnical Investigation and Hydrogeological Assessment supporting the redevelopment of the Nokia Ottawa Campus located at 570 March Road (Property or Site) following the latest design modifications. As such, this memorandum updates and supersedes the previous hydrogeological assessment memorandum dated March 13, 2024. The latest development details are summarized in this section with more detail provided in the body of the geotechnical report. Figure 1, within the body of the geotechnical 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. The space is currently occupied by a parking lot area which will be redeveloped with the following interconnected structures:

- An eight storey R&D engineering hub (including a small retail section) covering an approximate footprint of 4,000 square metres (m^2) within an anticipated finished floor elevation (FFE) at 82.5 metres (m).
- The R&D engineering hub footprint will also contain a partial basement (Level-01) covering an approximate footprint of 3,300 m^2, placed at elevation 74.5 m.
- A five storey R&D lab building covering an approximate footprint 6,500 m^2 within an anticipated FFE at 82.0 m. A loading dock is planned at the southern limit of the R&D lab building.
- A three-storey parking structure covering an approximate footprint 9,500 m^2 within an anticipated FFE at 82.5 m.
- Access to the R&D lab building loading dock will be provided via an access road planned to the southern limit of the site, connecting both Legget Drive and March Road.
- Access to the R&D engineering hub and parking structure will be provided along March Road.
- A new street (Liberty Street) is proposed along the northern limit of the new campus connecting both Legget Drive and March Road.

The redevelopment also presents six underground tanks and linear infrastructures for utilities (e.g., storm sewer, sanitary sewer). It is anticipated that the excavations associated with the six underground tanks, linear infrastructures and the partial basement (Level-01) will be the relevant construction features requiring dewatering efforts.

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 updated preliminary dewatering estimates during and post-construction.

To this end, this memo is inclusive of the available hydrogeologic data collected in the area of the proposed Site improvements (i.e., the Site as illustrated in Figure 1 in the body of the report). This area is referred to as the Study Area.

The hydrogeologic field investigation 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 m northeast of the Site, an area of surficial fluvial deposits is found. Quaternary geology mapping 600 and 700 m to the southwest and west of the Site, shows Precambrian and Paleozoic bedrock.

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 as an appendix in the geotechnical report as well as GHD's Phase Two Environmental Site Assessment report (GHD, July 2022).

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

Ground Cover | A surficial layer of asphalt with a thickness ranging from 25 millimetres (mm) to 100 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 at depths ranging 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 4.6 m. This unit extends to depths of 0.4 to 4.7 mBGS. This unit was observed to be generally moist to wet.

Bedrock | Bedrock was encountered at depths ranging from 0.3 to 4.7 mBGS (Elevations 75.2 to 80.6 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 is consistent with regional bedrock mapping and description of the Beekmantown Group.

The dolomitic sandstone unit was encountered to the maximum depth of investigation at 10.5 mBGS at BH4-23.

3. Methodology

3.1 Groundwater Level Monitoring

As part of the 2023 geotechnical and hydrogeologic investigation, a total of seven borehole were advanced 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 project north 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 1-1**, attached.

As shown in **Table 1-1**, water levels in BH01-22 (overburden) ranged from 1.20 to 2.56 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 periods.

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 1 summarizes the results of the hydraulic conductivity testing.

Table 1 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

Borehole ID	Hydraulic Conductivity (cm/sec)	Solution Method
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.

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 2-1**, 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 partial basement (Level-01) and six underground stormwater tanks. A review of the Nokia Ottawa Campus 570 March Road Design Brief, 2024, shows that the Level-01 (Basement) structure extends to an elevation of 74.0 meters above mean sea level (mAMSL). For the purposes of estimating dewatering, GHD has assumed this will be the bottom of the excavation required to support the construction of the Level-01 (Basement). Excavations to support installation of the underground stormwater tanks will vary from elevations of 77.7 to 80.2 mAMSL and the linear infrastructure will require excavations to elevations of 77.5 mAMSL.

The locations, dimensions and design base elevations of the six underground stormwater tanks were taken from the Civil Drawing set, included as Attachment 1. It is recommended that dewatering calculations are updated if the design is modified prior to construction.

As shown in the Nokia Ottawa Campus 570 March Road Design Brief, 2024, the grade of the Study Area will be raised on average 2.5 m to an elevation of 82.5 mAMSL. To be conservative, the 90th percentile of the

---

[1] Groundwater – Freeze and Cherry, 1979.

measured groundwater elevations within the bedrock has been applied to each area to be dewatered (79.26 mAMSL).

GHD prepared the water taking evaluation considering the dewatering requirements outlined in **Table 2**, below.

Table 2 Summary of Relevant Construction Dewatering Depths

Excavation (1)	Excavation Dimensions (m)	Ground surface (mAMSL)(4)	Water Table (mAMSL)	Bottom Excavation (mAMSL)	Dewatering Required (m) (2)
Linear Infrastructure	3.5 × various	82.5	79.26	77.5	2.8
Level-01 (Basement)(3)	110 x 30 3,300 m^2	82.5	79.26	74.0	6.3
Underground Tank 1	11.5 x 4 46 m^2	82.5	79.26	80.2	-
Underground Tank 2	23 x 5 115 m^2	82.5	79.26	79.6	-
Underground Tank 3	11 x 9 99 m^2	82.5	79.26	78.2	2.1
Underground Tank 4	52 x 10.5 546 m^2	82.5	79.26	78.2	2.1
Underground Tank 5	34 x 9 306 m^2	82.5	79.26	77.7	2.6
Underground Tank 6	12 x 3 36 m^2	82.5	79.26	78.2	2.1

Notes:

mAMSL – metres above mean sea level
mBGS – metres below ground surface
1 – Structures described by Nokia Master Site Plan, 2022 and Nokia Ottawa Campus 570 March Road Design Brief, 2024.

2 – Dewatering required is assumed to be 1 m below the bottom of the excavation.

3 – The Level 01 Basement dimensions have been assumed to be an equivalent rectangle representing the full basement footprint.

4 – Ground surface elevation post-proposed re-grading.

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

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

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 (included in Table 2, above as per note [2]).

– The 90th percentile measured groundwater elevation 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, such as during initial dewatering).

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 litres per day (L/day) (1,000 L/day = 1 m^3/day)

ln = is the natural logarithm

K = is the hydraulic conductivity, in m per day

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

h = is the height of groundwater near the trench in m 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 in m

b = is the width of the excavation in m

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.

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

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.

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

---

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

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 m per day

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

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

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

r_w^s = is the equivalent radius of the excavation in m 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.

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

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 in m

b = the width of the shaft excavation in m

4.3 Dewatering Rates for Trench Shaped Excavations

Table 3, below, provides estimated dewatering rates for various lengths of excavation for linear infrastructure (e.g. storm sewer, sanitary sewer), Level-01 (Basement) and the six underground stormwater storage tanks 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 3 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_w^t)	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	2.8	0	6.5	3.5	3.2	3.9×10^{-05}	3.4×10^{-02}	8.4	1,040
Linear Structure	2.8	0	10	3.5	4.3	3.9×10^{-05}	3.4×10^{-02}	9.5	1,300

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	2.8	0	15	3.5	5.9	3.9×10^{-05}	3.4×10^{-02}	11.1	1,630
Linear Structure	2.8	0	20	3.5	7.5	3.9×10^{-05}	3.4×10^{-02}	12.7	1,950
Level-01 (Basement)	6.3	0	110	30	44.6	3.9×10^{-05}	3.4×10^{-02}	56.3	20,340
Underground Tank 1	-	-	-	-	-	-	-	-	-
Underground Tank 2	-	-	-	-	-	-	-	-	-
Underground Tank 4	2.1	0	52	10.5	19.9	3.9×10^{-05}	3.4×10^{-02}	23.8	2,911
Underground Tank 5	2.6	0	34	9	13.7	3.9×10^{-05}	3.4×10^{-02}	18.6	2,768
Underground Tank 6	2.1	0	12	3	4.8	3.9×10^{-05}	3.4×10^{-02}	8.7	990

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 0.0 m.

4.4 Dewatering Rates for Shaft Shaped Excavations

Table 4, 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 4 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
Underground Tank 3	2.1	0	11	9	5.6	3.9×10^{-05}	3.4×10^{-02}	9.5	880

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 0.0 m.

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.

$$Q = P \times A$$ 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 5 below summarizes the dewatering contribution from precipitation falling directly into the excavations.

Table 5 *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
Level-01 (Basement)	110	30	48	158,400
Underground Tank 1	11.5	4	48	2,208
Underground Tank 2	23	5	48	5,520
Underground Tank 3	11	9	48	4,752
Underground Tank 4	52	10.5	48	26,208
Underground Tank 5	34	9	48	14,688
Underground Tank 6	12	3	48	1,728

4.6 Water Taking Summary

4.6.1 Construction Dewatering

Table 6, 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 3X is applied to the estimated steady-state groundwater seepage rate to account for lowering groundwater levels quickly to the base of the excavations, as may be needed, for possible lateral extension of the excavation width to accommodate sloping requirements.

Table 6 *Dewatering Summary*

Excavation	Typical Groundwater Dewatering (L/day)	X3 Groundwater Dewatering (L/day)	EASR/PTTW[(1)]	Contribution from Precipitation (L/day)	Potential Maximum Dewatering Rate[(2)] (L/day)
Linear Infrastructure (6.5 m)	1,040	3,120	-	1,092	4,212
Linear Infrastructure (20 m)	1,950	5,850	-	3,360	9,210
Level-01 (Basement)	20,340	61,020	EASR	158,400	219,420
Underground Tank 1	-	-		2,208	2,208
Underground Tank 2	-	-	-	5,520	5,520

Excavation	Typical Groundwater Dewatering (L/day)	X3 Groundwater Dewatering (L/day)	EASR/PTTW[1]	Contribution from Precipitation (L/day)	Potential Maximum Dewatering Rate[2] (L/day)
Underground Tank 3	880	2,640	-	4,752	7,392
Underground Tank 4	2,920	8,760	-	26,208	34,968
Underground Tank 5	2,770	8,310	-	14,688	22,998
Underground Tank 6	909	2,970	-	1,728	4,698

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 L/day, and a Permit to Take Water (PTTW) is required for groundwater takings greater than 400,000 L/day.

Assuming that excavations for each structure will be completed at the same time (Level-01 (Basement) and all six underground tanks), a combined dewatering rate of 27,819 L/day is estimated for typical groundwater dewatering. Including a 3X factor of safety results in a dewatering rate of 83,700 L/day.

Based on this groundwater taking rate, an EASR will be required. It should be noted that an EASR would be required for the Level-01 (Basement) excavation on its own.

A Water Taking and Discharge Plan will be required to support the EASR application. The plan should describe the proposed methodology for dewatering the excavations and how discharge will be handled. The Water Taking and Discharge Plan should also include a monitoring program to be undertaken during dewatering.

As the staging of excavations for linear infrastructure cannot be known, the peak dewatering quantity for this portion of the construction project cannot be known. The actual dewatering amounts from the linear infrastructure features will be a function of the construction schedule and the amount of open trench excavation at any given time. Given this uncertainty, it may be prudent for the project to seek a PTTW to allow for takings greater than 400,000 L/day for the construction period.

As shown above, dewatering requirements in the event of a 2-year storm event will increase significantly from precipitation falling directly into the excavation(s).

It should be noted that the dewatering precipitation assumes a 2-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 L/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 a theoretical maximum of approximately 45 m from the proposed Level-01 (Basement) construction excavation. The radius of influence from excavations from other features are smaller than this radius and are summarized above in **Tables 3 and 4**.

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 3X 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 20,340 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, as the estimate provided relies on point source (monitoring well) data and cannot account for natural variability between the monitoring wells tested.

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 associated with dewatering and discharging to the environment are low[3][4].

Based on the water quality at the Site, summarized in **Table 2-1**, 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.

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 updated Site construction details. Data collected during the hydrogeologic studies have been extrapolated to estimate dewatering rates over representative areas.

Assuming excavations for all seven structures will be completed simultaneously (excluding trenches for linear infrastructure), the estimated dewatering rates, including a 3X factor of safety for groundwater seepage, are above the threshold that require registry with the EASR but below the threshold requiring a PTTW. Depending on the construction schedule, a PTTW may be necessary to account for additional simultaneous dewatering occurring from linear infrastructure trenching.

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

In the event of a significant precipitation event, dewatering rates will increase to account for precipitation falling directly into the excavations.

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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.

Best management practices should be employed while discharging 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. If discharge to the natural environment is the preferred alternative, a treatment system suitable to treat the discharge water quality to the PWQOs should be designed and verified prior to construction activities. 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

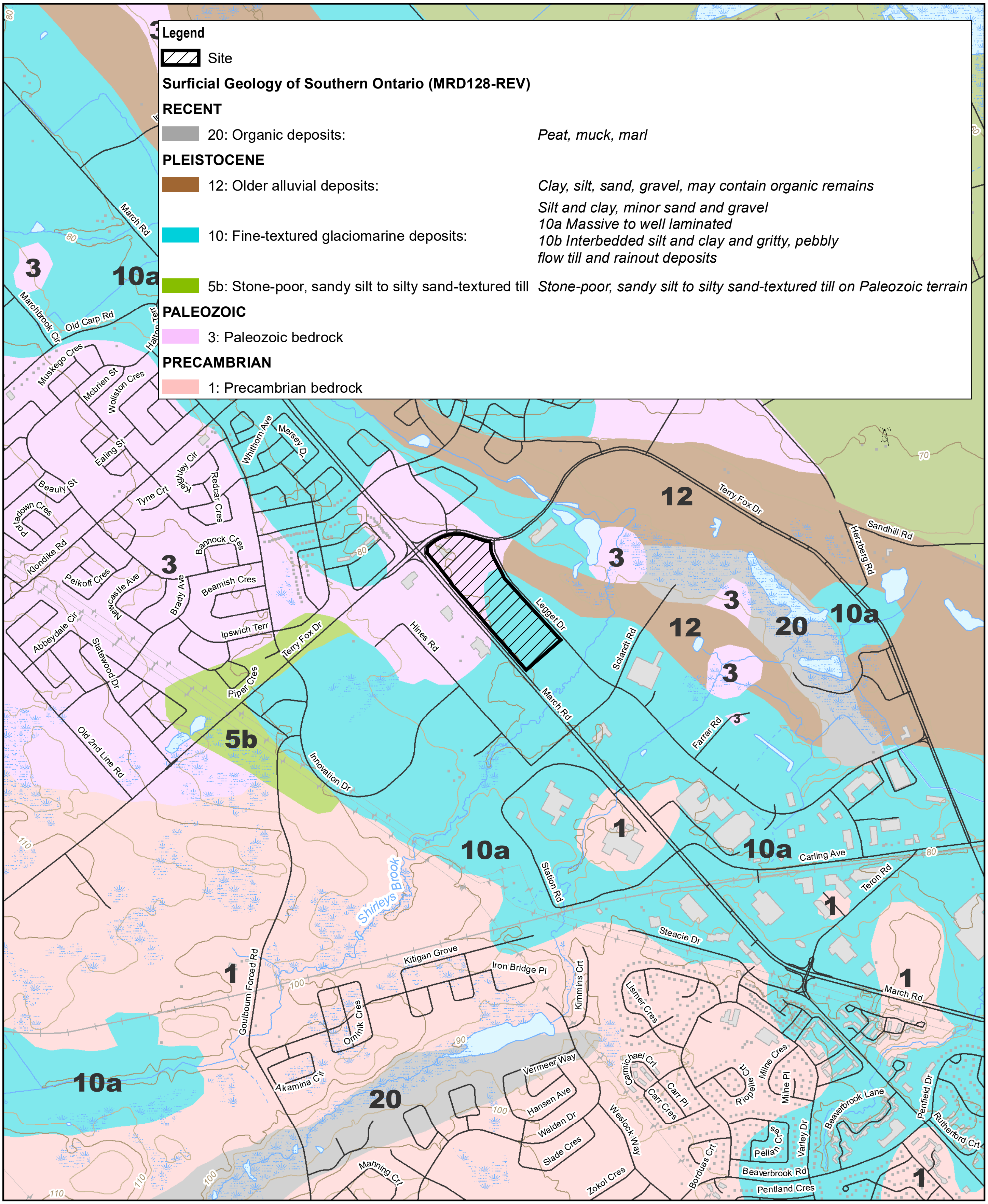
Allan Molenhuis

Allan Molenhuis, P. Geo.
Project Hydrogeologist

Ben Kempel, P. Geo.
Senior Hydrogeologist

Encl.

Figures



Paper Size ANSI A

0 200 400 600

Metres

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

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GHD

NOKIA
570 MARCH RD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

Project No.	12646241
Revision No.	-
Date	Feb 5, 2025

SURFICIAL GEOLOGY

FIGURE 1

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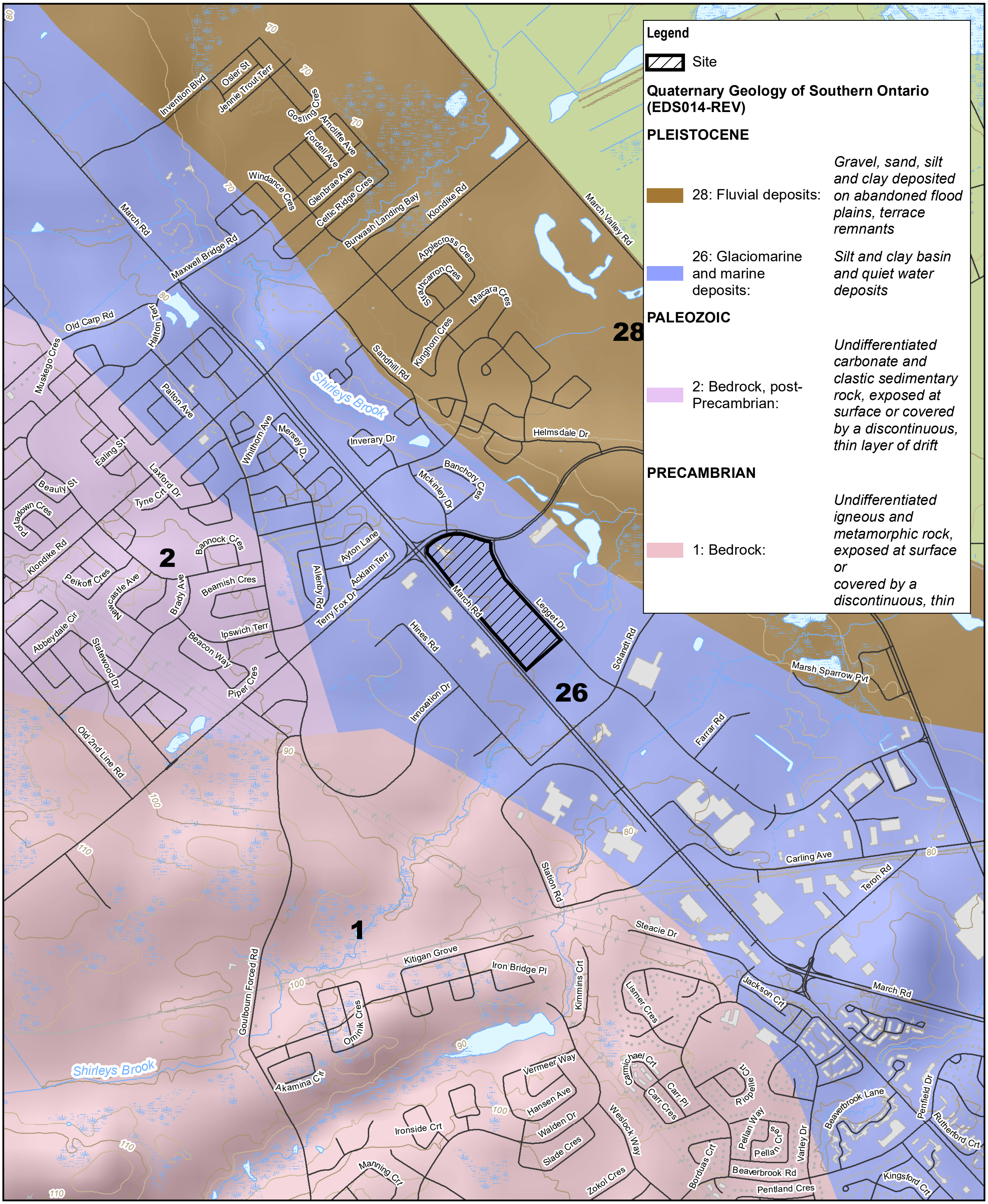
Data source: MNDM, EDS, MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © King's Printer 2025.MRD128-REV.
Ontario Geological Survey 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 128 – Revised.



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Metres

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

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NOKIA
570 MARCH RD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

Project No. 12646241
Revision No. -
Date Feb 5, 2025

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 2025.
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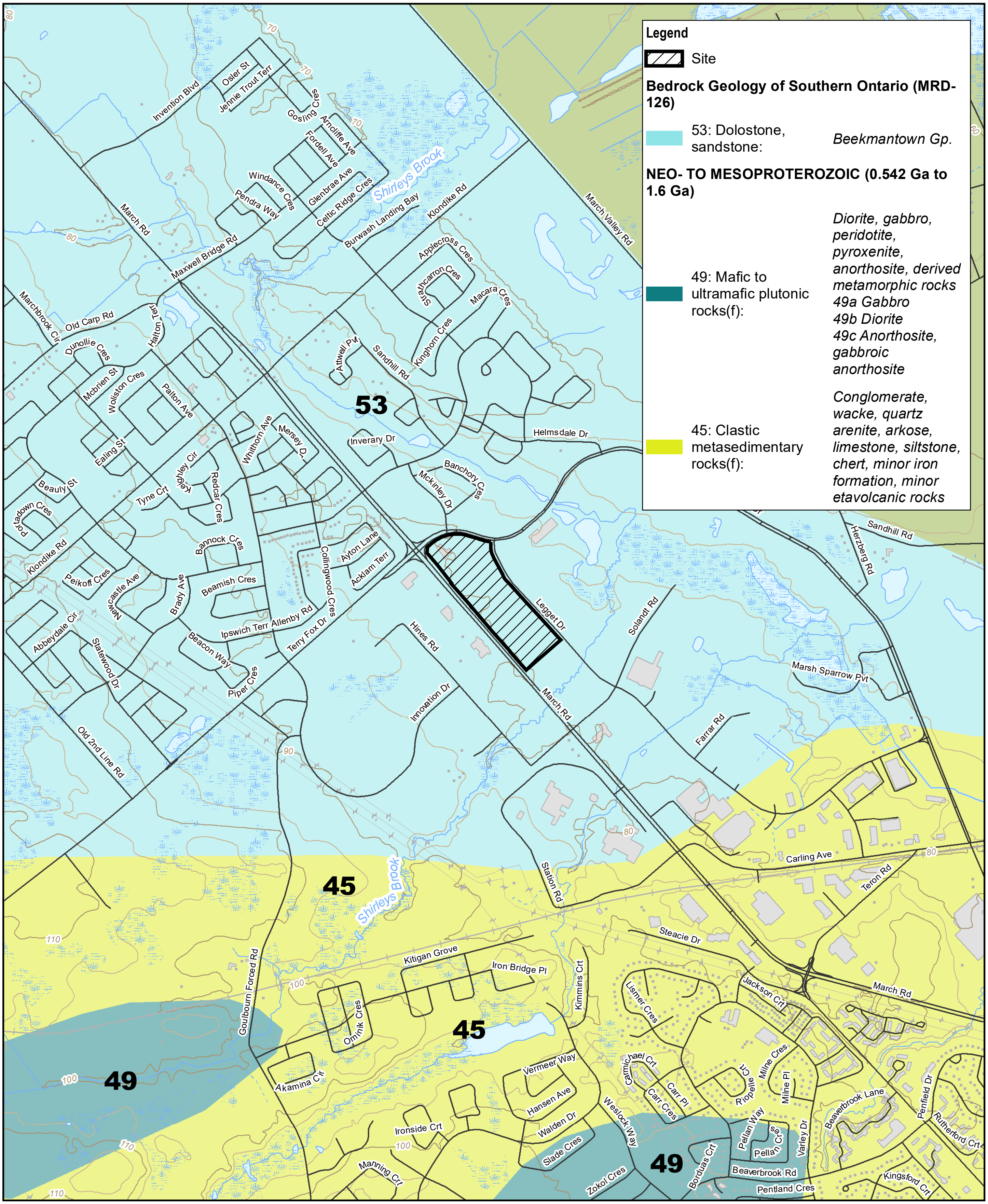

Paper Size ANSI A

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Metres

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

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NOKIA
570 MARCH RD
KANATA, ONTARIO
HYDROGEOLOGIC ASSESSMENT

Project No.	12646241
Revision No.	-
Date	Feb 5, 2025

BEDROCK GEOLOGY

FIGURE 3

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Print date: 05 Feb 2025 - 10:25

Data source: MNDM, EDS, MNRF NRVIS, 2018. Produced by GHD under licence from Ontario Ministry of Natural Resources and Forestry, © King's Printer 2025.© Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.

Tables

Table 1-1

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 2-1

Summary of Groundwater Analysis
Hydrogeologic Assessment
570 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 2-1

Summary of Groundwater Analysis
Hydrogeologic Assessment
570 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 2-1

Summary of Groundwater Analysis
Hydrogeologic Assessment
570 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

Attachment 1

LEGEND

SAN MH 1	PROPOSED SANITARY MANHOLE AND SEWER		PROPOSED TRENCH DRAIN
CBMH 250	PROPOSED CATCHBASIN MANHOLE		PROPOSED BUILDING ENTRANCE
STMMH 100	PROPOSED STORM MANHOLE AND SEWER		*EXISTING CONCRETE CURB*
CB 200	PROPOSED CATCHBASIN	*SANMH*	*EXISTING SANITARY MANHOLE*
LD 1	PROPOSED LANDSCAPE DRAIN	*CBMH*	*EXISTING CATCHBASIN MANHOLE*
	THERMAL INSULATION FOR SHALLOW SEWERS	*STMMH*	*EXISTING STORM MANHOLE*
		CB	*EXISTING CATCHBASIN*
HYD	PROPOSED HYDRANT AND VALVE	*HYD* *WV*	*EXISTING HYDRANT & VALVE*
V&VB	PROPOSED VALVE BOX		
VC	PROPOSED VALVE CHAMBER		*EXISTING TREES / VEGETATION*
RED	PROPOSED REDUCER	*EX UP*	*EXISTING UTILITY POLE C/W GUY WIRES*
	PROPOSED SIAMESE CONNECTION		*EXISTING FENCE*
	PROPOSED BARRIER CURB (PER SC1.1)		*EXISTING LIGHT STANDARD*
DC	PROPOSED DEPRESSED CURB (PER SC1.1)	X	REMOVALS
CC	PROPOSED CURB CUT		
ICD	PROPOSED INLET CONTROL DEVICE		
FFE	PROPOSED FINISHED FLOOR ELEVATION		
USF	PROPOSED UNDERSIDE OF FOOTING ELEVATION		

GENERAL NOTES:

1. COORDINATE AND SCHEDULE ALL WORK WITH OTHER TRADES AND CONTRACTORS.
2. DETERMINE THE EXACT LOCATION, SIZE, MATERIAL AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO COMMENCING CONSTRUCTION. PROTECT AND ASSUME RESPONSIBILITY FOR ALL EXISTING UTILITIES WHETHER OR NOT SHOWN ON THIS DRAWING.
3. OBTAIN ALL NECESSARY PERMITS AND APPROVALS FROM THE CITY OF OTTAWA BEFORE COMMENCING CONSTRUCTION.
4. BEFORE COMMENCING CONSTRUCTION OBTAIN AND PROVIDE PROOF OF COMPREHENSIVE, ALL RISK AND OPERATIONAL LIABILITY INSURANCE FOR $5,000,000.00. INSURANCE POLICY TO NAME OWNERS, ENGINEERS AND ARCHITECTS AS CO-INSURED.
5. RESTORE ALL DISTURBED AREAS ON-SITE AND OFF-SITE, INCLUDING TRENCHES AND SURFACES ON PUBLIC ROAD ALLOWANCES TO EXISTING CONDITIONS OR BETTER TO THE SATISFACTION OF THE CITY OF OTTAWA AND ENGINEER.
6. REMOVE FROM SITE ALL EXCESS EXCAVATED MATERIAL, ORGANIC MATERIAL AND DEBRIS UNLESS OTHERWISE INSTRUCTED BY ENGINEER. EXCAVATE AND REMOVE FROM SITE ANY CONTAMINATED MATERIAL. ALL CONTAMINATED MATERIAL SHALL BE DISPOSED OF AT A LICENSED LANDFILL FACILITY.
7. ALL ELEVATIONS ARE GEODETIC.
8. REFER TO GEOTECHNICAL REPORT (No. PG12606873-RPT-1, DATED MARCH 6, 2024) AND RELIANCE LETTER (DATED SEPTEMBER 5, 2024), PREPARED BY GHD, FOR SUBSURFACE CONDITIONS, CONSTRUCTION RECOMMENDATIONS, AND GEOTECHNICAL INSPECTION REQUIREMENTS. THE GEOTECHNICAL CONSULTANT IS TO REVIEW ON-SITE CONDITIONS AFTER EXCAVATION PRIOR TO PLACEMENT OF THE GRANULAR MATERIAL.
9. REFER TO ARCHITECT'S AND LANDSCAPE ARCHITECT'S DRAWINGS FOR BUILDING AND HARD SURFACE AREAS AND DIMENSIONS.
10. REFER TO DEVELOPMENT SERVICING STUDY AND STORMWATER MANAGEMENT REPORT (R-2023-082) PREPARED BY NOVATECH ENGINEERING CONSULTANTS LTD.
11. SAW CUT AND KEY GRIND ASPHALT AT ALL ROAD CUTS AND ASPHALT TIE IN POINTS AS PER CITY OF OTTAWA STANDARDS (R10).
12. PROVIDE LINE/PARKING PAINTING.

WATERMAIN NOTES:

1. SUPPLY AND CONSTRUCT ALL WATERMAINS AND APPURTENANCES IN ACCORDANCE WITH THE CITY OF OTTAWA STANDARDS AND SPECIFICATIONS - ALL CURRENT VERSIONS AND 'AS AMENDED'. EXCAVATION, INSTALLATION, BACKFILL AND RESTORATION OF ALL WATERMAINS BY THE CONTRACTOR. CONNECTIONS AND SHUT-OFFS AT THE MAIN AND CHLORINATION OF THE WATER SYSTEM SHALL BE PERFORMED BY THE CONTRACTOR IN THE PRESENCE CITY OF OTTAWA FORCES.
2. SPECIFICATIONS:

ITEM	SPEC. No.	REFERENCE
VALVE CHAMBER	W3	CITY OF OTTAWA
WATERMAIN TRENCHING	W17	CITY OF OTTAWA
HYDRANT INSTALLATION	W19	CITY OF OTTAWA
THERMAL INSULATION IN SHALLOW TRENCHES	W22	CITY OF OTTAWA
INSULATION ADJACENT TO OPEN STRUCTURES	W23	CITY OF OTTAWA
VALVE BOX ASSEMBLY	W24	CITY OF OTTAWA
WATERMAIN	PVC DR 18	
WATERMAIN CROSSING BELOW SEWER	W25	CITY OF OTTAWA
WATERMAIN CROSSING ABOVE SEWER	W25.2	CITY OF OTTAWA

3. WATERMAIN SHALL BE MINIMUM 2.4m DEPTH BELOW GRADE, UNLESS OTHERWISE INDICATED.
4. PROVIDE MINIMUM 0.5m CLEARANCE BETWEEN OUTSIDE OF PIPES AT ALL CROSSINGS, UNLESS OTHERWISE INDICATED.
5. WATER SERVICE IS TO BE CONSTRUCTED TO WITHIN 1.0m OF FOUNDATION WALL AND CAPPED.

BENCHMARK NOTES:

1. ELEVATIONS SHOWN ARE GEODETIC AND ARE REFERRED TO THE CGVD28 GEODETIC DATUM.
2. IT IS THE RESPONSIBILITY OF THE USER OF THIS INFORMATION TO VERIFY THAT THE JOB BENCHMARK HAS NOT BEEN ALTERED OR DISTURBED AND THAT IT'S RELATIVE ELEVATION AND DESCRIPTION AGREES WITH THE INFORMATION SHOWN ON THIS DRAWING.
3. BENCHMARKS WERE PROVIDED ON THE TOPOGRAPHIC PLAN OF SURVEY OF BLOCK 6 AND PART OF BLOCK 1 REGISTERED PLAN 4M-642 AND PART OF LOTS 8 AND 9 CONCESSION 4, GEOGRAPHIC TOWNSHIP OF MARCH, CITY OF OTTAWA, SURVEYED BY ANNIS, O'SULLIVAN AND VOLEBEKK LTD, SIGNED AND DATED FEBRUARY 20, 2022.

SEWER NOTES:

1. SUPPLY AND CONSTRUCT ALL SEWERS AND APPURTENANCES IN ACCORDANCE WITH THE MOST CURRENT CITY OF OTTAWA STANDARDS AND SPECIFICATIONS - ALL CURRENT VERSIONS AND 'AS AMENDED'.
2. SPECIFICATIONS:

ITEM	SPEC. No.	REFERENCE
CATCHBASIN (600x600mm)	705.010	OPSD
STORM / SANITARY MANHOLE (1200mmØ)	701.010	OPSD
CB, FRAME & COVER	S19.1	CITY OF OTTAWA
SANITARY MH FRAME & COVER	S24	CITY OF OTTAWA
STORM / CBMH MANHOLE FRAME AND COVER	S24.1	CITY OF OTTAWA
WATERTIGHT MH FRAME AND COVER	401.030	OPSD
LANDSCAPE DRAIN (ELBOW, COVER & PIPE)	S29 / S31	CITY OF OTTAWA
SEWER TRENCH	S6	CITY OF OTTAWA
SHALLOW SEWER	S35	CITY OF OTTAWA
STORM SEWER	PVC DR 35	
SANITARY SEWER	PVC DR 35	
CATCHBASIN LEAD	PVC DR 35	

3. ALL STORM AND SANITARY SERVICE LATERALS SHALL BE EQUIPPED WITH BACKFLOW PREVENTION DEVICES AS PER THE CITY OF OTTAWA STANDARD DETAILS S14 AND S14.1 OR S14.2.
4. INSULATE ALL PIPES (SAN/STM) THAT HAVE LESS THAN 1.8m COVER WITH HI-40 INSULATION PER CITY OF OTTAWA STANDARD DETAIL S35. PROVIDE 150mm CLEARANCE BETWEEN PIPE AND INSULATION.
5. SERVICES ARE TO BE CONSTRUCTED TO 1.0m FROM FACE OF BUILDING AT A MINIMUM SLOPE OF 1.0%.
6. PIPE BEDDING, COVER AND BACKFILL ARE TO BE COMPACTED TO AT LEAST 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSITY. THE USE OF CLEAR CRUSHED STONE AS A BEDDING LAYER SHALL NOT BE PERMITTED.
7. FLEXIBLE CONNECTIONS ARE REQUIRED FOR CONNECTING PIPES TO MANHOLES (FOR EXAMPLE KOR-N-SEAL, PSX: POSITIVE SEAL AND DURASEAL). THE CONCRETE CRADLE FOR THE PIPE CAN BE ELIMINATED.
8. THE OWNER SHALL REQUIRE THAT THE SITE SERVICING CONTRACTOR PERFORM FIELD TESTS FOR QUALITY CONTROL OF ALL SANITARY SEWERS. LEAKAGE TESTING SHALL BE COMPLETED IN ACCORDANCE WITH OPSS 410.07.16, 410.07.16.04 AND 407.07.24. DYE TESTING IS TO BE COMPLETED ON ALL SANITARY SERVICES TO CONFIRM PROPER CONNECTION TO THE SANITARY SEWER MAIN. THE FIELD TESTS SHALL BE PERFORMED IN THE PRESENCE OF A CERTIFIED PROFESSIONAL ENGINEER WHO SHALL SUBMIT A CERTIFIED COPY OF THE TEST RESULTS.
9. ALL STORM MANHOLES AND CATCHBASIN MANHOLES ARE TO HAVE 300mm SUMPS UNLESS OTHERWISE INDICATED. ALL CATCHBASINS ARE TO HAVE 600mm SUMPS.
10. ALL CATCHBASINS, MANHOLES AND/OR CATCHBASIN MANHOLES THAT ARE TO HAVE ICD'S INSTALLED WITHIN THEM ARE TO HAVE 600mm SUMPS.
11. ALL WEEPING TILE CONNECTIONS TO BE MADE TO THE PROPOSED STORM SEWER SYSTEM DOWNSTREAM OF ANY INLET CONTROL DEVICES.
12. CONTRACTOR TO TELEVISE (CCTV) ALL PROPOSED SEWERS, 200mmØ OR GREATER PRIOR TO BASE COURSE ASPHALT. UPON COMPLETION OF CONTRACT, THE CONTRACTOR IS RESPONSIBLE TO FLUSH AND CLEAN ALL SEWERS & APPURTENANCES.
13. CONTRACTOR TO PROVIDE THE CONSULTANT WITH A GENERAL PLAN OF SERVICES INDICATING ALL SERVICING AS-BUILT INFORMATION SHOWN ON THIS PLAN. AS-BUILT INFORMATION MUST INCLUDE: PIPE MATERIAL, SIZES, LENGTHS, SLOPES, INVERT AND T/G ELEVATIONS, STRUCTURE LOCATIONS, VALVE AND HYDRANT LOCATIONS, T/WM ELEVATIONS AND ANY ALIGNMENT CHANGES, ETC.

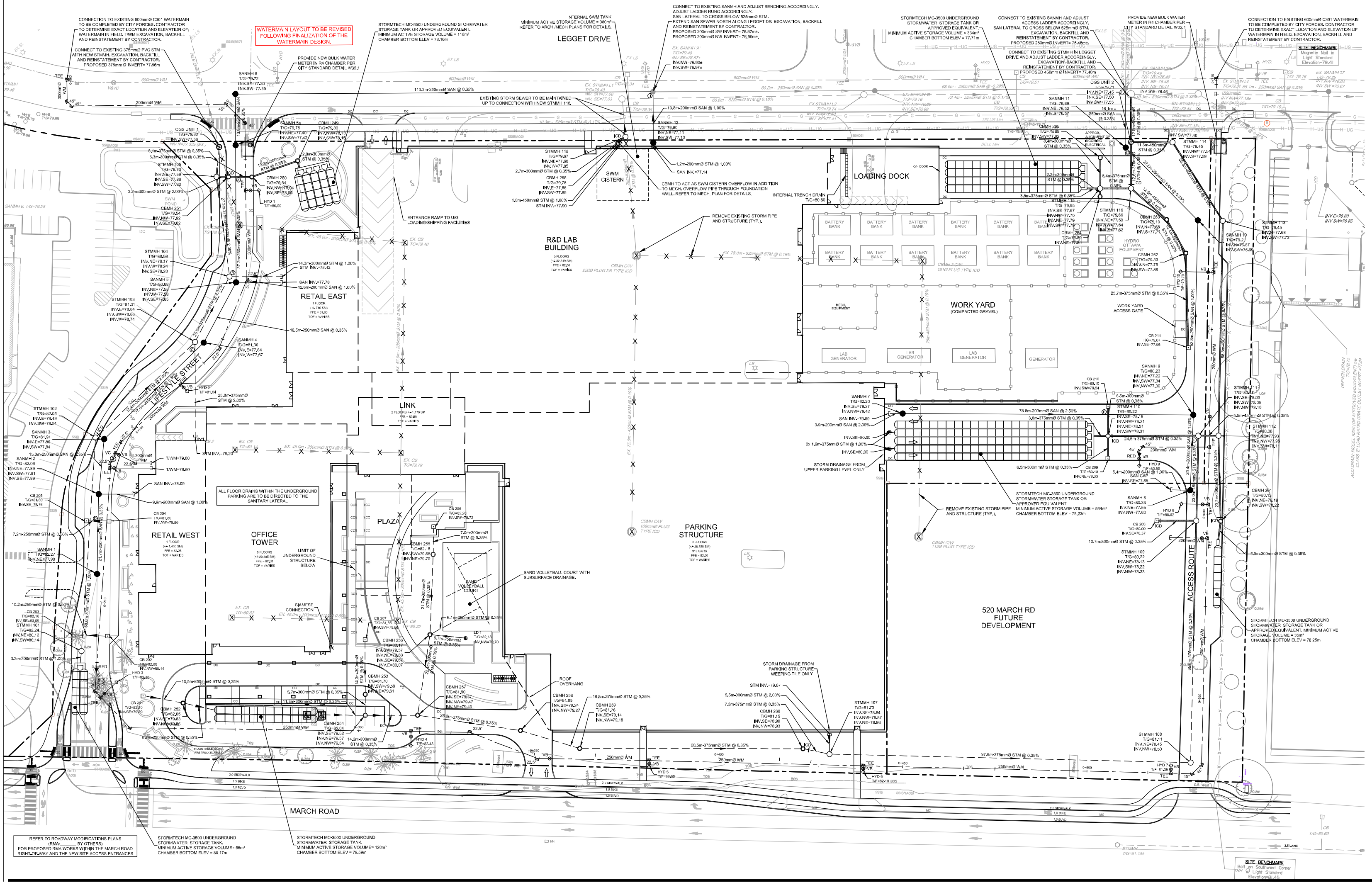
PROPOSED WATERMAIN TABLE

Station	F/G ELEVATION	TOP OF WATERMAIN	DESCRIPTION
0+000.00	79.46	77.99	300mmØ WM TEE CONNECTION TO EX. 600mmØ WM
0+006.04	79.62	78.44	45° VERTICAL BEND
0+007.17	79.72	78.52	45° VERTICAL BEND
0+050.00	79.78	78.57	45° VERTICAL BEND
0+056.45	79.63	77.31	45° VERTICAL BEND
0+060.70	80.53	78.96	BULK WATER METER IN R4 CHAMBER AT PROPERTY LINE
0+072.01	81.05	78.80	150mm HYDRANT TEE
0+100.78	81.17	79.17	22.5° VERTICAL BEND
0+115.96	81.89	79.55	150mm HYDRANT TEE
0+120.29	81.96	79.59	22.5° VERTICAL BEND
0+155.37	81.98	79.59	22.5° VERTICAL BEND
0+157.40	82.07	79.63	200mm WATER SERVICE TEE
0+158.58	82.17	79.82	VALVE AND VALVE CHAMBER
0+159.75	82.31	79.91	22.5° VERTICAL BEND
0+160.28	82.33	79.88	200mm WATER SERVICE TEE
0+219.46	82.40	79.96	300mm x 250mm REDUCER
0+225.37	82.11	79.71	45° VERTICAL BEND

Station	F/G ELEVATION	TOP OF WATERMAIN	DESCRIPTION
0+230.04	82.11	79.71	150mm HYDRANT TEE
0+235.53	82.19	79.78	45° VERTICAL BEND
0+309.65	81.93	79.66	150mm HYDRANT TEE
0+326.60	81.93	79.53	45° VERTICAL BEND
0+332.36	81.72	79.32	45° VERTICAL BEND
0+355.68	81.84	79.44	VALVE AND VALVE BOX
0+375.77	81.86	79.46	150mm HYDRANT TEE
0+422.92	81.13	78.73	11.25° VERTICAL BEND
0+428.05	81.19	78.79	11.25° VERTICAL BEND
0+434.56	81.06	78.66	150mm HYDRANT TEE
0+521.12	80.31	77.91	150mm HYDRANT TEE
0+525.68	80.23	77.83	45° VERTICAL BEND
0+528.97	80.14	77.74	45° VERTICAL BEND
0+588.06	80.04	77.64	200mm WATER SERVICE TEE
0+603.40	79.91	76.51	150mm HYDRANT TEE
0+621.40	79.85	76.45	150mm HYDRANT TEE
0+626.40	79.75	76.35	VALVE & VALVE BOX
0+658.40	79.55	76.15	150mm HYDRANT TEE
0+702.40	79.45	76.05	BULK WATER METER IN R4 CHAMBER AT PROPERTY LINE
0+718.40	79.41	76.01	250mmØ WM TEE CONNECTION TO EX. 600mmØ WM

CRITICAL SEWER PIPE CROSSING TABLE

CROSSING	LOWER PIPE	HIGHER PIPE	CLEARANCE	SURFACE ELEVATION
Ⓐ	250mmØ SAN T/P=77.71	300mmØ STM INV=78.02	± 0.25m	79.58 m
Ⓑ	250mmØ SAN T/P=77.81	300mmØ STM INV=78.29	± 0.48m	80.55 m
Ⓒ	250mmØ SAN T/P=77.94	375mmØ STM INV=78.70	± 0.76m	81.30 m
Ⓓ	250mmØ SAN T/P=78.01	300mmØ STM INV=79.78	± 1.77m	81.94 m
Ⓔ	200mmØ SAN T/P=78.07	300mmØ STM INV=78.53	± 0.46m	80.13 m
Ⓕ	200mmØ SAN T/P=77.61	375mmØ STM INV=78.10	± 0.49m	80.19 m
Ⓖ	250mmØ SAN T/P=76.83	375mmØ STM INV=77.48	± 0.65m	79.65 m
Ⓗ	250mmØ SAN T/P=76.72	525mmØ STM INV=77.30	± 0.58m	79.50 m
Ⓘ	200mmØ SAN T/P=77.20	525mmØ STM INV=77.47	± 0.27m	79.44 m



NOKIA Ottawa Campus
570 March Rd, KanataOttawa ON K2K 2T6

BLOCK 6 AND
PART OF BLOCK 1
REGISTERED PLAN 4M-642
AND
PART OF LOTS 8 AND 9
CONCESSION 4

Gensler
5005 Greenville Ave
Dallas TX 75206
Tel 214.273.1500

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Stantec Angelo.renon@stantec.com

△ Date	Description
SEP 12/24	ISSUED FOR SITE PLAN CONTROL APPROVAL
NOV 15/24	REVISED PER CITY COMMENTS

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
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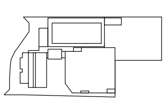
Key Plan



Seal / Signature

NOT FOR CONSTRUCTION

Project Name
Nokia Ottawa Campus

Project Number
027.7946.000

Description
GENERAL PLAN OF SERVICES

Scale

C100

City Project no: PC2023-0229

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→ The Power of Commitment