



REPORT

FOUNDATION INVESTIGATION AND DESIGN REPORT

Additional Breakaway Signs

Gananoque South Commercial Vehicle Inspection Facility

Town of Gananoque, Leeds and Grenville County, Ontario

MTO Assignment No. 4017-E-0003, G.W.P. 4009-14-00

Submitted to:

Dillon Consulting Limited

130 Dufferin Avenue, Suite 1400

London, Ontario

N6A 5R2

Submitted by:

Golder Associates Ltd.

100 Scotia Court, Whitby, Ontario L1N 8Y6 Canada

+1 905 723 2727

1780055

May 8, 2020

GEOCRES No. 31C-289

Latitude: 44.355095

Longitude: --76.094446

Distribution List

- 1 PDF - Ministry of Transportation, Ontario - Eastern Region
- 1 PDF - Ministry of Transportation, Ontario (Foundations Section)
- 1 PDF - Dillon Consulting Limited
- 1 PDF - Golder Associates Ltd.

Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	1
3.0 INVESTIGATION PROCEDURES	1
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS	2
4.1 Regional Geology	2
4.2 Subsurface Conditions	3
4.2.1 Topsoil	3
4.2.2 Gravel (GW) (FILL)	3
4.2.3 Silty Clay (CL) to Silty Clay (CI) (FILL)	3
4.2.4 Sandy Silt (ML) to Sand (SP-SM) – Borehole OS-1	3
4.2.5 Clayey Silt-Silt (CL-ML) to Silty Clay (CI) – Boreholes OS-2 and OS-3	4
4.2.6 Silty Sand (SM) to Silt (ML) and Sand – Boreholes OS-2 and OS-3	4
4.2.7 Granite Bedrock – Borehole OS-2	4
4.2.8 Groundwater Conditions	5
4.2.9 Analytical Testing Results	5
5.0 CLOSURE	6

PART B - FOUNDATION DESIGN REPORT

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS	8
6.1 General	8
6.2 Breakaway Sign Foundations	8
6.3 Construction Considerations	9
6.3.1 Soil and Groundwater Control	9
6.3.2 Recommendations for Construction Materials Based on Analytical Testing	9
7.0 CLOSURE	10

REFERENCES

DRAWINGS

Drawing 1 Borehole Locations

LIST OF APPENDICES

Appendix A Borehole and Drillhole Records

Abbreviations and Terms Used on Records of Boreholes and Test Pits

Lists of Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes OS-1 to OS-3

Record of Drillhole OS-2

Appendix B Laboratory Test Results and Bedrock Core Photographs

Figure B1 Grain Size Distribution – Sand (SP-SM)

Figure B2 Grain Size Distribution – Clayey Silt-Silt (CL-ML) to Silty Clay (CI)

Figure B3 Plasticity Chart – Clayey Silt-Silt (CL-ML) to Silty Clay (CI)

Figure B4 Grain Size Distribution – Silty Sand (SM) to Silt (ML) and Sand

Figure B5 Bedrock Core Photographs

Figures B6-B7 Unconfined Compression Test (UC) of Intact Rock Core Specimens

Analytical Test Results – AGAT Laboratories

Appendix C Notice to Contractor

Control of Overburden Soils for Breakaway Sign Foundations

PART A

FOUNDATION INVESTIGATION REPORT
ADDITIONAL BREAKAWAY SIGNS
GANANOQUE SOUTH COMMERCIAL VEHICLE INSPECTION FACILITY
TOWN OF GANANOQUE, LEEDS AND GRENVILLE COUNTY, ONTARIO
MTO ASSIGNMENT NO. 4017-E-0003, G.W.P. 4009-14-00

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed additional breakaway signs associated with the proposed Gananoque South Commercial Vehicle Inspection Facility (CVIF) along Highway 401, in the Town of Gananoque, Leeds and Grenville County, Ontario.

This report addresses the results of the foundation investigation carried out for the proposed breakaway signs located on Highway 401 eastbound lanes west of the proposed CVIF site, as shown on the key plan on Drawing 1. The Terms of Reference for the foundation engineering services are outlined in MTO's Request for Proposal, dated April 2017, which forms part of the Consultant Agreement (Assignment No. 4017-E-0003) for this project. The scope of work for the foundation engineering services for the proposed undercrossing and are summarized in Golder's Proposal document (Project No. 1780055-CVIF GanS) dated September 25, 2019. This addendum to the assignment is rated as "low complexity".

2.0 SITE DESCRIPTION

The proposed CVIF is to replace the existing Gananoque South Truck Inspection Station (TIS) and includes a new facility building, triage canopy, inspection canopy and bays, garage building, static scale, and tri-chord overhead sign and breakaway sign supports. The proposed CVIF / existing TIS is located south of the eastbound Highway 401, approximately 7 km east of the Town of Gananoque, as shown on the Key Plan on Drawing 1. There is an existing abandoned off-ramp on the north side of the westbound Highway 401 at the proposed CVIF site, that leads to an associated abandoned TIS on the north side. At the site, Highway 401 is oriented in a southwest to northeast orientation; however, for the purposes of this report, Highway 401 is considered oriented in a west to east orientation.

Based on the latest design drawing provided by Dillon titled "Highway 401, Gananoque South CVIF, Sta. 10+000 to Sta. 11+190", the additional breakaway signs are located west of the existing TIS along the southern side of Highway 401 eastbound lanes at Stations 10+114, 10+450 and 11+114. The proposed signs are located near Cliffe Road overpass ranging in distance from approximately 310 m west of the bridge to around 790 m east of the bridge. Overall the sites consist of grassy areas near Highway 401. The ground surface elevation across the sites varies from site to site between Elev. 77.6 m and Elev. 89.5 m. The adjacent properties south of the existing TIS and north of the Highway 401 are generally flat and are actively used for agricultural purposes.

3.0 INVESTIGATION PROCEDURES

Field work for the investigation was carried out between November 18, 2019 and December 5, 2019. During this time a total of three sampled boreholes, designated as Boreholes OS-1, OS-2, and OS-3, were advanced at the approximate locations shown on Drawing 1. The boreholes were advanced to depths ranging from 5.0 m to 6.1 m below existing ground surface, including coring of bedrock for a core length of 1.9 m in Borehole OS-2.

The investigation was carried out using portable drilling equipment supplied and operated by Ohlmann Geotechnical Services Inc. of Almonte, Ontario. The boreholes were advanced using continuous sampling and wash boring techniques using NW casing.

Continuous soil samples were obtained from ground surface using a 50 mm outer diameter and 35 mm inside diameter split-spoon sampler driven by a full-weight manual hammer in accordance with SPT procedures (ASTM D1586). The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger

than this dimension would not be sampled or represented in the grain size distributions. Where possible, the groundwater conditions were noted during drilling and immediately following drilling operations. All boreholes were backfilled to ground surface in accordance with Ontario Regulation 903 (Wells, as amended).

The field work was observed on a full-time basis by members of Golder's engineering staff, who located the boreholes in the field, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes and examined the soil and rock samples. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Whitby laboratory where the samples underwent further visual examination and geotechnical laboratory testing. Classification testing (water content, grain size distribution and Atterberg limits) was carried out on selected soil samples, to MTO LS and/or ASTM Standards, as appropriate. In addition, three soil samples were submitted to AGAT Laboratories (AGAT) of Mississauga, Ontario for analytical testing to assess corrosion potential against concrete and buried steel and to assess environmental quality parameters for soil disposal purposes.

The Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD), weathering and strength indices, discontinuity characteristics such as type, shape and surface roughness and classification data of the retrieved bedrock core samples were recorded in the field based on visual observation. The bedrock was sequentially photographed, packed and transported to Golder's Mississauga laboratory for further visual examination. Laboratory testing consisting of Unconfined Compression (UC) testing (including measurement of core density), was carried out on selected specimens of the bedrock core samples.

The as-drilled borehole locations and elevations were surveyed by Tulloch Engineering in MTM NAD 83 Zone 9 northing and easting coordinates and Geodetic datum. The as-drilled borehole coordinates were converted from MTM NAD 83 Zone 9 coordinates to corresponding latitudes and longitudes. The borehole coordinates together with latitude and longitude conversions, ground surface elevations and drilled depths are summarized below.

Borehole No.	Location (MTM NAD 83)		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
OS-1	4,912,650.1 (44.353162)	336,752.1 (-76.099203)	77.6	5.0
OS-2	4,912,866.7 (44.355095)	337,130.3 (-76.094446)	82.8	5.3 ¹
OS-3	4,913,191.1 (44.357989)	337,710.0 (-76.087154)	89.5	6.1

Note 1 – Includes 1.9 m of bedrock coring

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The project area is located within the Leeds Knobs and Flats physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putman, 1984).

The Leeds Knobs and Flats is in an area consisting of Precambrian rock knobs and channels which were filled with clay flats by the waters of glacial Lake Iroquois during the Pleistocene Age. Surficial deposits of clay or sand

and gravel and/or glacial till generally overlie the bedrock. The bedrock generally consists of strong to very strong granitic gneiss as part of the Central Metasedimentary Belt of the Grenville Province.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during the current investigation, together with the results of the laboratory tests and in situ testing carried out, are presented on the borehole and drillhole records, and laboratory test sheets in Appendices A and B.

The stratigraphic boundaries shown on the borehole records are inferred based on the continuous sampling, observations of drilling progress and the results of SPT testing. These boundaries may represent transitions between soil types rather than exact planes of geological change. Furthermore, subsurface conditions will vary between and beyond the borehole locations.

Reference should be made to the closest borehole for the anticipated subsurface conditions at each of the proposed sign locations. Discussion regarding the general subsurface conditions encountered at the breakaway sign sites is provided in the following sub-sections.

4.2.1 Topsoil

A layer of topsoil ranging in thickness from 50 mm to 130 mm was encountered at ground surface in all three boreholes advanced at the sign sites.

4.2.2 Gravel (GW) (FILL)

A layer of non-cohesive gravel fill was encountered beneath the topsoil in Borehole OS-3. The thickness of the non-cohesive fill layer was 0.1 m, extending to a depth of 0.2 m below ground (Elevation 89.3 m).

The single SPT “N”-value measured within the gravel fill layer is 23 blows per 0.3 m of penetration, indicating a compact state of compactness.

4.2.3 Silty Clay (CL) to Silty Clay (CI) (FILL)

A layer of cohesive silty clay fill was encountered beneath the topsoil in Borehole OS-2 and beneath the gravel fill in Borehole OS-3. The thickness of the cohesive fill layer is about 0.6 m and 1.0 m, extending to depths of 0.6 m and 1.2 m below ground surface (Elevations 88.3 m and 82.2 m). The silty clay fill contained rootlets and organic inclusions in Borehole OS-3.

The SPT “N”-values measured within the cohesive fill layer range from 5 to 23 blows per 0.3 m of penetration, suggesting a firm to very stiff consistency.

4.2.4 Sandy Silt (ML) to Sand (SP-SM) – Borehole OS-1

A 0.5 m thick non-cohesive sandy silt deposit was encountered underlying the topsoil in Borehole OS-1. The deposit extended to a depth of 0.6 m below ground surface (Elevation 77.0 m). It is underlain by a non-cohesive wet sand deposit with a thickness of 4.4 m that extended to the borehole’s termination depth of 5.0 m (Elevation 72.6 m).

The single SPT “N”-value measured within the sandy silt deposit is 5 blows per 0.3 m of penetration, indicating a loose state of compactness. The SPT “N”-values measured within the sand deposit range from 8 to 42 blows per 0.3 m of penetration, indicating a loose to dense state of compactness.

The results of grain size distribution tests carried out on one sample from the sand deposit is shown on Figure B1 in Appendix B. The natural water content measured on one sample of the sand deposit is about 21 per cent.

4.2.5 Clayey Silt-Silt (CL-ML) to Silty Clay (CI) – Boreholes OS-2 and OS-3

A cohesive deposit ranging in composition from clayey silt-silt to clayey silt to silty clay was encountered underlying the cohesive fill in Boreholes OS-2 and OS-3. The thickness of the deposit is about 1.2 m and 3.1 m, extending to depths of 1.8 m and 4.3 m below ground surface (Elevations 85.2 m and 81.0 m).

The SPT “N”-values measured within the clayey silt-silt to silty clay deposit range from 6 to 33 blows per 0.3 m of penetration, suggesting a firm to hard consistency.

The results of grain size distribution tests carried out on three samples from the clayey silt-silt to silty clay deposit are shown on Figure B2 in Appendix B. The results of Atterberg limits testing on the deposit measured liquid limits ranging from about 22 to 35 per cent, plastic limits ranging from about 15 to 20 per cent, and plasticity indices ranging from about 6 to 15 per cent. These results, which are plotted on a plasticity chart on Figure B3 in Appendix C, indicate the tested samples of the deposit range from a clayey silt-silt of low plasticity, to a clayey silt of low plasticity, to a silty clay of medium plasticity. The natural water contents measured on samples of the clayey silt-silt to silty clay deposit range from about 22 to 27 per cent.

4.2.6 Silty Sand (SM) to Silt (ML) and Sand – Boreholes OS-2 and OS-3

A non-cohesive deposit ranging from silty sand to silt and sand was encountered underlying the clayey silt-silt to silty clay deposit in Boreholes OS-2 and OS-3. The surface of the deposit was encountered at depths of 3.4 m and 4.3 m (Elevations 85.2 m and 81.0 m). The thickness of the deposit is 1.6 m where fully penetrated in Borehole OS-2 and 1.8 m in Borehole OS-3; however, Borehole OS-3 was terminated within the silty sand deposit.

The SPT “N”-values measured within the silty sand to silt and sand deposit range from 7 to greater than 50 blows for 0.3 m of penetration indicating a loose to very dense state of compactness.

The results of a grain size distribution test carried out on two samples from the silty sand to silt and sand deposit are shown on Figure B4 in Appendix B. The natural water content measured on samples of the silty sand to silt and sand deposit are about 23 and 24 per cent.

4.2.7 Granite Bedrock – Borehole OS-2

Bedrock was encountered below the silt and sand deposit in Borehole OS-2 and confirmed by coring. The results of the drilling and bedrock coring including depth to the bedrock surface, corresponding elevations and the cored length are summarized below.

Borehole No.	Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)	Cored Length (m)
OS-2	82.8	3.4	79.4	1.9

Based on visual assessment of the bedrock core samples, the bedrock generally consists of slightly weathered, slightly foliated, pink to grey, coarse grained, faintly porous, medium strong granite. Details of the bedrock coring

and core descriptions are presented on the Record of Drillhole sheet in Appendix A. Photographs of the recovered rock core samples are presented on Figure B5 in Appendix B.

The degree of weathering of the bedrock samples (i.e. slightly weathered – W2), and the strength classification of the intact rock mass based on field identification (i.e. strong – R4) are described in accordance with the *International Society for Rock Mechanics* (ISRM) standard classification system.

The Rock Quality Designation (RQD) measured on the core samples obtained from the investigation ranges from about 81 per cent to 96 per cent, indicating a rock mass of good to excellent quality, as per Table 3.10 of the *Canadian Foundation Engineering Manual* (CFEM, 2006). The Total Core Recovery (TCR) was 100 per cent on both runs and the Solid Core Recovery (SCR) of samples ranges from 81 per cent to 96 per cent.

An Unconfined Compression (UC) test (in general accordance with ASTM D7012) was carried out on one selected core sample of the granite bedrock. The uniaxial compressive strength (UCS) of the intact sample is summarized below and the details are presented on Figures B6 and B7 in Appendix B. Based on the UCS test result and in accordance with Table 3.5 in CFEM (2006), the granite bedrock is classified as strong (R4, 50 MPa < UCS < 100 MPa).

Borehole No.	Run No.	Sample Depth Interval (m)	Sample Elevation Interval (m)	Uniaxial Compressive Strength (UCS) (MPa)
OS-2	1	3.7 – 3.9	79.1 – 78.9	69.3

4.2.8 Groundwater Conditions

The overburden samples obtained from the boreholes during the current investigation were generally moist to wet. The groundwater conditions observed in the boreholes immediately following the overburden continuous sampling operations are summarized below; these measurements may not represent the stabilized groundwater level at the sites.

Borehole No.	Ground Surface Elevation (m)	Groundwater Depth (m)	Groundwater Elevation (m)	Date of Measurement
OS-1	77.6	0.2	77.4	December 5, 2019
OS-2	82.8	1.8 ¹	81.0	November 19, 2019
OS-3	89.5	1.8	87.7	November 18, 2019

Note 1: Groundwater depth/elevation inferred based on soil moisture transition from moist to wet.

It should be noted that the groundwater levels in the area are subject to seasonal fluctuations and precipitation events and should be expected to be higher during wet periods of the year.

4.2.9 Analytical Testing Results

Analytical testing was carried out on selected soil samples recovered from the boreholes. The soil samples were submitted to AGAT Laboratories of Mississauga, Ontario for testing a suite of parameters associated with potential corrosion to steel and deterioration of concrete. The analytical laboratory test results are summarized below, and the detailed analytical laboratory test report is included in Appendix B.

Borehole No.	Sample No.	Depth (m) (Elev. m)	Parameters				
			Resistivity (ohm-cm)	Electrical Conductivity (mS/cm)	Soluble Sulphate (SO ₄) Content (µg/g)	Chloride (Cl) Content (µg/g)	pH
OS-1	3	1.5 (76.1)	6900	0.145	6	35	7.98
OS-2	3	1.5 (81.3)	2420	0.414	9	16	8.08
OS-3	3	1.5 (88.0)	2020	0.495	15	36	8.17

5.0 CLOSURE

This Foundation Investigation Report was prepared by Mr. Yusuf Soliman, B.A.Sc., E.I.T., a geotechnical engineering intern with Golder and Ms. Mo'oud Nasr, P.Eng., a geotechnical engineer with Golder. Ms. Lisa Coyne, P.Eng., a Principal and MTO Foundations Designated Contact for Golder, conducted an independent technical and quality control review of the report.

Signature Page

Golder Associates Ltd.



Yusuf Soliman, E.I.T.
Geotechnical Engineering Intern



Mo'oud Nasr, P.Eng.
Geotechnical Engineer



Lisa C. Coyne, P.Eng.
Principal, MTO Foundations Designated Contact

YS/MN/LCC/ljv

Golder and the G logo are trademarks of Golder Associates Corporation

[https://golderassociates.sharepoint.com/sites/12573g/wo cvif dd gananoque south/4 foundations/5 reporting/3. cvif - additional breakaway signs/final/1780055-rpt 2020/05/08 rev0 fidr gan. s. cvif breakaway signs - final.docx](https://golderassociates.sharepoint.com/sites/12573g/wo%20cvif%20dd%20gananoque%20south/4%20foundations/5%20reporting/3.%20cvif%20-%20additional%20breakaway%20signs/final/1780055-rpt%202020%2005%2008%20rev0%20fidr%20gan.%20s.%20cvif%20breakaway%20signs%20-%20final.docx)

PART B

FOUNDATION DESIGN REPORT
ADDITIONAL BREAKAWAY SIGNS
GANANOQUE SOUTH COMMERCIAL VEHICLE INSPECTION FACILITY
TOWN OF GANANOQUE, LEEDS AND GRENVILLE COUNTY, ONTARIO
MTO ASSIGNMENT NO. 4017-E-0003, G.W.P. 4009-14-00

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation engineering recommendations for the proposed additional breakaway signs, associated with the proposed Gananoque South Commercial Vehicle Inspection Facility (CVIF), in the Town of Gananoque, Leeds and Grenville County, Ontario. These recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface investigation at the proposed sign sites along Highway 401, approximately 7 km west of Gananoque, Ontario.

The discussion and recommendations contained in this report are intended to provide the designers with sufficient information to complete the detail design of the proposed breakaway sign foundations. This Foundation Investigation and Design Report, including the interpretation and recommendations, is intended for the use of the MTO and Dillon, and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. The contractor undertaking the work must make their own interpretation based on the factual data in Part A (Foundation Investigation) of this report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project, and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as it may affect equipment selection, construction methods, and scheduling.

6.2 Breakaway Sign Foundations

The proposed breakaway sign support structures are located along the southern side of Highway 401 eastbound lanes at approximately Stations 10+014 (Borehole OS-1), 10+450 (Borehole OS-2) and 11+114 (Borehole OS-3). It is understood that the sign supports will be supported by steel columns in concrete-filled holes.

The standard foundation design for steel column sign supports is outlined in Division 5 of MTO's *Sign Support Manual* (2015) and the footing details are shown in Section 5.4.3 of the manual. In the standard foundation design, the footing extends a certain depth below ground surface without reduction for soil frost penetration depth.

The standard foundation design presented in MTO's *Sign Support Manual* (2015) has been developed based on a minimum passive earth pressure of 68 kPa at Serviceability Limits State (SLS). Based on a review of the subsurface conditions encountered in the boreholes advanced at the location of the proposed breakaway signs, the founding conditions meet or exceed the minimum passive earth pressure used in the development of the standard footing design, at a minimum footing depth of 1.7 m below ground surface. The final footing depth below ground surface depends on the size and quantity of steel columns supporting the sign as well as the sign area. This should be selected by the structural engineer based on the table below, while maintaining the minimum footing depth of 1.7 m below ground surface.

No. Columns	Sign Area (m ²)	Footing Depth (m)		
		W200x42	W200x46	W200x59
2	0 – 6.0	1.6	1.6	---
	6.1 – 12.0	2.0	2.2	2.5
	12.1 – 18.0	2.1	2.5	2.8
3	9.0 – 13.0	1.7	1.9	2.0
	13.1 – 18.0	1.9	2.0	2.2
	18.1 – 24.0	1.9	2.1	2.4

6.3 Construction Considerations

6.3.1 Soil and Groundwater Control

Depending on the required foundation depth for the proposed sign board size (i.e., up to 2.8 m depth), water-bearing cohesionless soils may be encountered and should be expected to run or flow into the foundation hole during or after augering of the hole. Therefore, appropriate equipment and procedures will be required to minimize ground loss during augering and concrete placement, such as by using temporary or permanent caisson liners, and/or using drilling mud. It is recommended that a Notice to Contractor be included in the Contract Documents to warn the Contractor of this condition; such an NTC is provided in Appendix C.

6.3.2 Recommendations for Construction Materials Based on Analytical Testing

The results of analytical testing completed on three samples, one sample of the native sand, one of the native clayey silt and one of the native silty clay, are summarized in Section 4.2.9 and presented in Appendix B. The potential for sulphate attack and corrosion are discussed in the following paragraphs. However, it is ultimately up to the designer to determine the appropriate construction materials, including the exposure class and ensuring that all aspects of the *Canadian Standards Association (CSA, 2014) A23.1-24* Section 4.1.1 “Durability Requirements” are followed when designing concrete elements.

The potential for sulphate attack on concrete was determined by comparing analytical test results to CSA A23.1-14 Table 3 “Additional Requirements for Concrete Subjected to Sulphate Attack”. The water-soluble sulphate concentration measured in the native sand and native clayey silt to silty clay were all below 0.1 per cent, which is below the exposure class of S-3 (Moderate). Therefore, based on the test results when the designer is selecting the exposure class for the structure in contact with the native sand and native clayey silt to silty clay the effects of the sulphates may not need to be considered. Additionally, given the location of the structure along Highway 401, it may be exposed to de-icing salts and selection of the exposure class should consider this.

The native sand and native clayey silt to silty clay have a pH ranging between 8.0 and 8.2. According to the MTO *Gravity Pipe Guidelines*, the pH is not considered detrimental to structure durability as it is less than a pH of 8.5 but greater than a pH of 5.5.

The resistivity of the native sand is 6,900 ohm-cm, which indicates that the soil corrosiveness is very low (10,000 ohm-cm < R < 6,000 ohm-cm), as per Table 3.2 “Soil Corrosiveness and Resistivity” of the MTO *Gravity Pipe Guidelines*. The resistivity of the native clayey silt to silty clay ranges between 2,020 ohm-cm and 2,420

ohm-cm, which indicates that the soil corrosiveness is moderate ($4,500 \text{ ohm-cm} < R < 2,000 \text{ ohm-cm}$), as per Table 3.2 “*Soil Corrosiveness and Resistivity*” of the MTO *Gravity Pipe Guidelines*.

7.0 CLOSURE

This Foundation Design Report was prepared by Ms. Mo'oud Nasr, P.Eng., a geotechnical engineer with Golder. Ms. Lisa C. Coyne, P.Eng., a Principal and MTO Foundations Designated Contact for Golder, conducted an independent technical and quality control review of the report.

Signature Page

GOLDER ASSOCIATES LTD.



Mo'oud Nasr, P.Eng.
Geotechnical Engineer



Lisa C. Coyne, P.Eng.
Principal, MTO Foundations Designated Contact

YS/MN/LCC/ljv

Golder and the G logo are trademarks of Golder Associates Corporation

[https://golderassociates.sharepoint.com/sites/12573g/wo cvif dd gananoque south/4 foundations/5 reporting/3. cvif - additional breakaway signs/final/1780055-rpt 2020'05'08 rev0 fidr gan. s. cvif breakaway signs - final.docx](https://golderassociates.sharepoint.com/sites/12573g/wo%20cvif%20dd%20gananoque%20south/4%20foundations/5%20reporting/3.%20cvif%20-%20additional%20breakaway%20signs/final/1780055-rpt%2020200508%20rev0%20fidr%20gan.%20s.%20cvif%20breakaway%20signs%20-%20final.docx)

REFERENCES

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

Canadian Standards Association (CSA). 2014. "Concrete materials and methods of concrete construction / Test methods and standard practices for concrete" (CSA A23.1-14/A23.2-14).

Chapman, L.J. and Putnam, D.F. 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

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

Ontario Ministry of Transportation, 2014. *MTO Gravity Pipe Design Guidelines: Circular Culverts and Storm Sewers*, Ontario Ministry of Transportation. Design and Contacts Standards Office, Drainage and Hydrology, St Catharines, Ontario

Ontario Ministry of Transportation, 2015. *Sign Support Manual*. Provincial Highways Management Division, Highway Standards Branch, Bridge Office. April 2015.

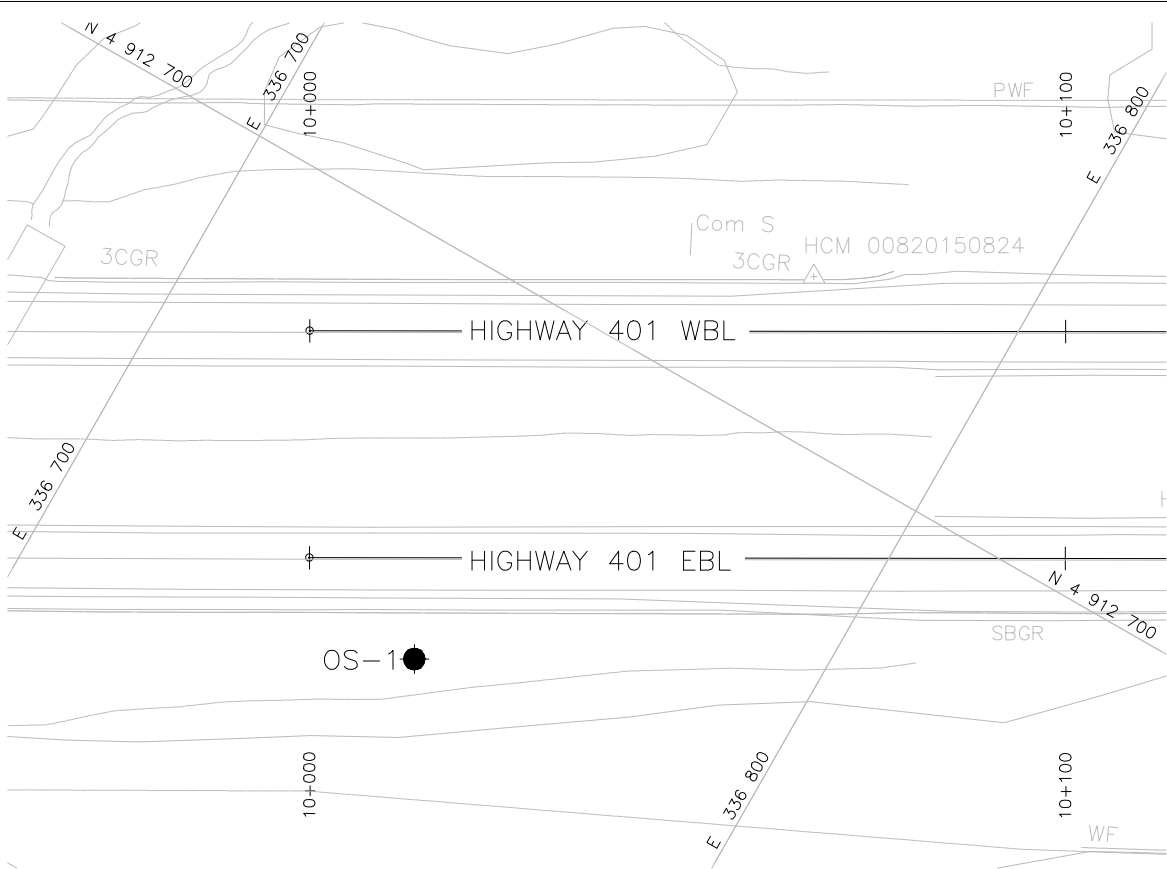
ASTM International:

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

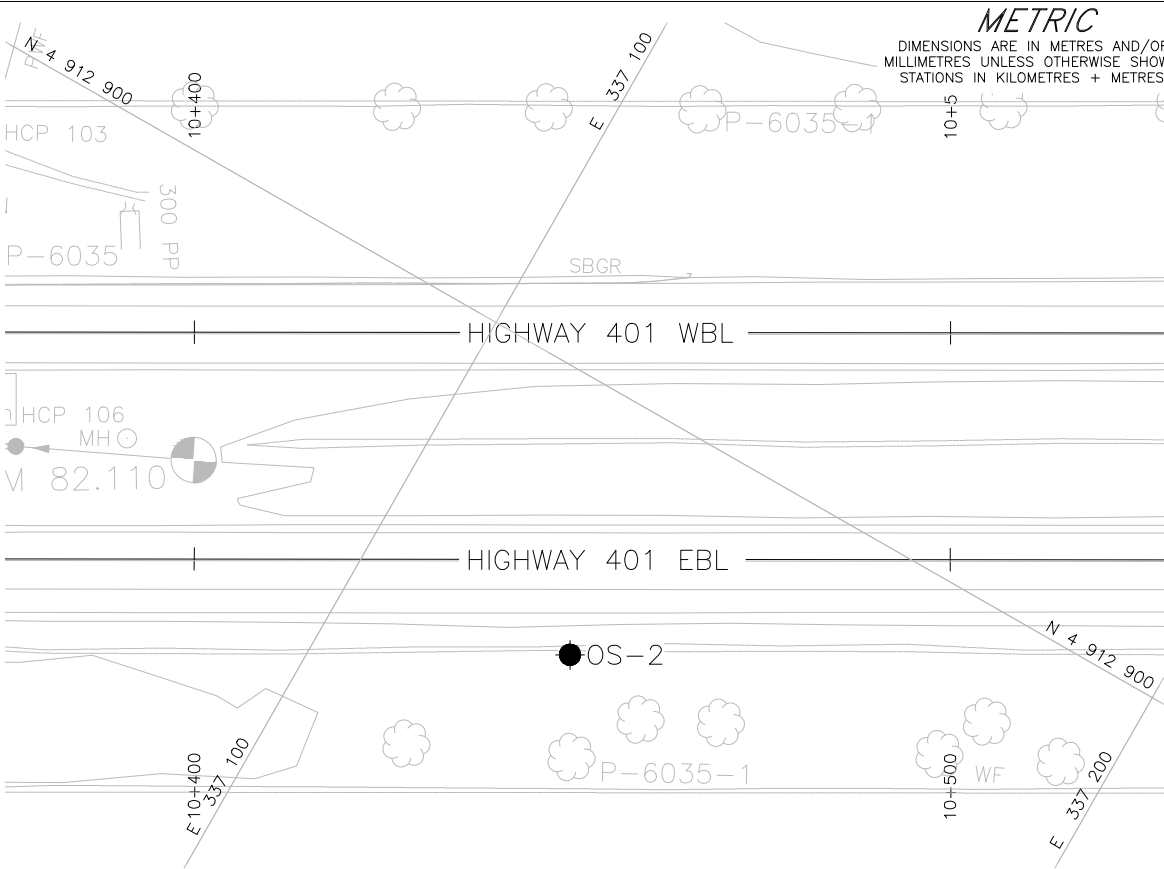
ASTM D7012 Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

Ontario Water Resources Act:

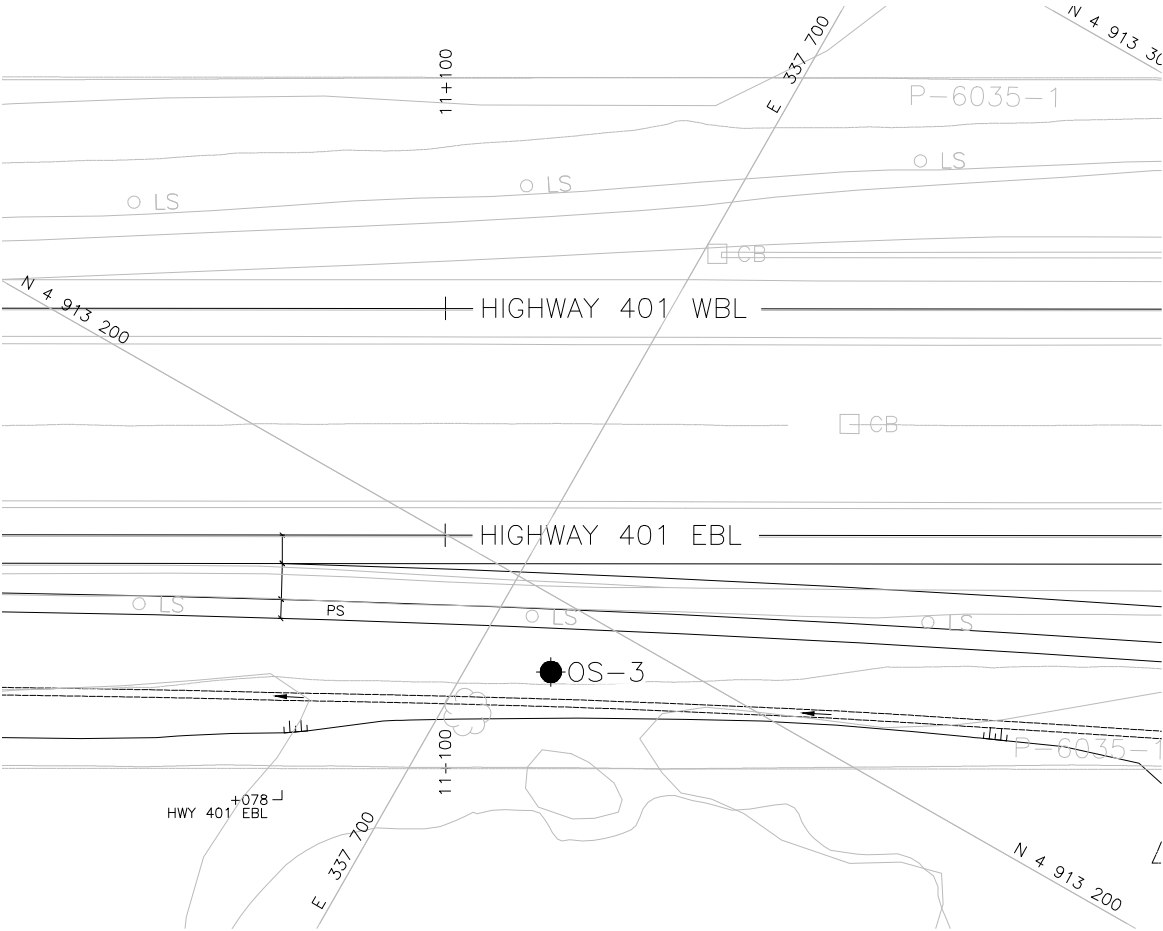
Ontario Regulation 903 Wells (as amended)



PLAN - SIGN AT STA 10+014



PLAN - SIGN AT STA 10+450



PLAN - SIGN AT STA 11+114



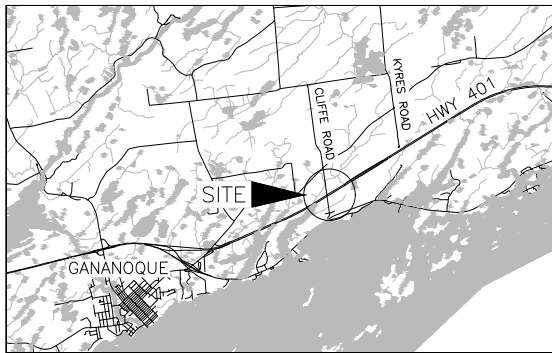
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.4009-14-00

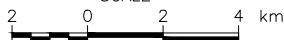


ADDITIONAL BREAKAWAY SIGNS
GANANOQUE SOUTH CVIF
BOREHOLE LOCATIONS

SHEET



KEY PLAN
SCALE



LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES (MTM NAD 83 ZONE 9)

No.	ELEVATION	NORTHING	EASTING
OS-1	77.6	4912650.1	336752.1
OS-2	82.8	4912866.7	337130.3
OS-3	89.5	4913191.1	337710.0

NOTES

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

REFERENCE

Base plans provided in digital format by Dillon, drawing file nos. 4009-Base.dwg and Alignments.dwg, received May 10, 2019, 4009-New Construction.dwg, received September 16, 2019 and ACAD-22-401-18-1.dwg, received January 6, 2020.



NO.	DATE	BY	REVISION
Geocres No. 31C-289			
HWY. 401	PROJECT NO. 1780055		DIST. .
SUBM'D. AP	CHKD. AP	DATE: 05/08/2020	SITE: .
DRAWN: DD	CHKD. MN	APPD. LCC	DWG. 1

APPENDIX A

Borehole and Drillhole Records

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

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

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (<i>i.e.</i> , SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (<i>i.e.</i> , some sand)
≤ 10	trace (<i>i.e.</i> , trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (*q_t*), porewater pressure (*u*) and sleeve friction (*f_s*) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
Y	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	➤ 50

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

4. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

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

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)

σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
U	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
E	void ratio
N	porosity
S	degree of saturation

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

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1
2

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

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT		1780055/ 3002		RECORD OF BOREHOLE No OS-1				SHEET 1 OF 1		METRIC							
G.W.P.		4009-14-00		LOCATION		N 4912650.1; E 336752.1 MTM NAD 83 ZONE 9 (LAT. 44.353120; LONG. -76.099203)		ORIGINATED BY		KM							
DIST		HWY 401		BOREHOLE TYPE		Portable Continuous Split Spoon/Wash Boring		COMPILED BY		YS							
DATUM		Geodetic		DATE		November 19 and December 5, 2019		CHECKED BY		MN/LCC							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
77.6	GROUND SURFACE																
0.0	TOPSOIL (130 mm)																
0.1	Sandy SILT (ML), containing organic inclusions and rootlets		1	SS	5												
77.0	Loose Brown Frozen		2	SS	8												
0.6	SAND (SP-SM), trace to some silt, trace to some gravel		3	SS	13												
	Loose to dense Brown Wet		4	SS	19												
			5	SS	8												
			6	SS	19												
			7	SS	42												
			8	SS	28												
72.6	- About 1.2 m of sand heave measured at 5.0 m depth																
5.0	END OF BOREHOLE																
NOTES:																	
1. Heaving sand conditions encountered at a depth of about 2.4 m below ground surface (Elev. 75.2 m). Switched from continuous spoon sampling to wash boring at 2.4 m depth.																	
2. Borehole caved to a depth of about 1.8 m below ground surface (Elev. 75.8 m) upon completion of drilling.																	
3. Water level measured at a depth of 0.2 m below ground surface (Elev. 77.4 m) upon completion of drilling.																	

GTA-MTO 001 S:\CLIENTS\MTG\GANANOCQUE_CV\F02_DATA\GINT\GANANOCQUE_CV\F.GPJ GAL-GTA.GDT 5/8/20

PROJECT <u>1780055/3002</u>		RECORD OF BOREHOLE No OS-2		SHEET 1 OF 1		METRIC	
G.W.P. <u>4009-14-00</u>		LOCATION <u>N 4912866.7; E 337130.3 MTM NAD 83 ZONE 9 (LAT. 44.355095; LONG. -76.094446)</u>		ORIGINATED BY <u>KM</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>Portable Continuous Split Spoon/NQ Coring</u>		COMPILED BY <u>YS</u>			
DATUM <u>Geodetic</u>		DATE <u>November 18 and 19, 2019</u>		CHECKED BY <u>MN/LCC</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L			
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)				
82.8	GROUND SURFACE																	
82.2	TOPSOIL (50 mm)		1	SS	5													
82.2	CLAYEY SILT (CL), some sand, trace gravel (FILL)																	
82.2	Firm		2	SS	13													
82.2	Brown mottled																	
82.2	Frozen																	
82.2	CLAYEY SILT (CL), some sand																	
82.2	Stiff to very stiff																	
82.2	Brown		3	SS	28													
82.2	Moist to wet																	
81.0	SILT (ML) and sand, trace clay																	
81.0	Compact to very dense		4	SS	20													
81.0	Brown																	
81.0	Wet		5	SS	16													
81.0																		
81.0			6	SS	>50													
81.0																		
79.4	GRANITE (BEDROCK)																	
79.4	Bedrock cored from a depth of 3.4 m to 5.3 m.		1	RC	REC 100%													
79.4	For bedrock coring details, refer to Record of Drillhole OS-2.																	
79.4			2	RC	REC 100%													
79.4																		
77.5	END OF BOREHOLE																	
5.3																		

PROJECT: 1780055/3002

RECORD OF DRILLHOLE: OS-2

SHEET 1 OF 1

LOCATION: N 4912866.7 ; E 337130.3

DRILLING DATE: November 18, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Portable/Tripod

DRILLING CONTRACTOR: OGS Inc

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	JN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate										BD - Bedding FO - Foliation CO- Contact OR- Orthogonal CL - Cleavage										PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular										PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break										BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										FEATURES	R0/R1 ZONES	NOTES PIEZOMETER OR STANDPIPE INSTALLATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
				DEPTH (m)			RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle 0 90 180 270	DIP w.r.t CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	Jr	Ja	ROCK STRENGTH INDEX				WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							TOTAL CORE % 00 20 40 60 80 100	SOLID CORE % 00 20 40 60 80 100								R4	R3	R2	R1	W1	W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
		Continued from Borehole OS-2		79.40																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

FEATURES LEGEND



BROKEN CORE



CLAY SEAM



LIMESTONE



LOST CORE

DEPTH SCALE

1 : 50



GOLDER

LOGGED: KM

CHECKED:

GTA-RCK 054 S:\CLIENTS\MTG\GANANOQUE CVIF02 DATA\GINT\GANANOQUE CVIF GPJ GAL-MISS GDT 5/8/20

PROJECT		1780055/ 3002		RECORD OF BOREHOLE No OS-3		SHEET 1 OF 1		METRIC						
G.W.P.		4009-14-00		LOCATION		N 4913191.1; E 337710.0 MTM NAD 83 ZONE 9 (LAT. 44.357989; LONG. -76.087154)		ORIGINATED BY						
DIST		HWY 401		BOREHOLE TYPE		Portable Continuous Split Spoon		COMPILED BY						
DATUM		Geodetic		DATE		November 18, 2019		CHECKED BY						
								MN/LCC						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
89.5	GROUND SURFACE													
0.0	TOPSOIL (100 mm)													
0.2	GRAVEL (GW) (FILL) Compact Grey Moist		1	SS	23									
88.3	SILTY CLAY (CI), some sand to sandy, containing rootlets and organics inclusions (FILL) Firm to very stiff Brown mottled Moist		2	SS	6									
1.2	SILTY CLAY (CI), containing sandy silt seams Very stiff to hard Grey/brown Moist to wet		3	SS	33									
			4	SS	28									
86.5	CLAYEY SILT-SILT (CL-ML), trace gravel, trace sand Firm to stiff Grey Wet		5	SS	22									
3.1			6	SS	12									
			7	SS	6									
85.2	SILTY SAND (SM), trace clay Loose to compact Grey Wet		8	SS	7									
4.3			9	SS	7									
			10	SS	12									
83.4	END OF BOREHOLE													
6.1	NOTE: 1. Water level measured at a depth of 1.8 m below ground surface (Elev. 87.7 m) upon completion of drilling.													

GTA-MTO 001 S:\CLIENTS\MTG\ANANCOQUE_CV\F02_DATA\GINT\ANANCOQUE_CV\F.GPJ GAL-GTA.GDT 5/8/20

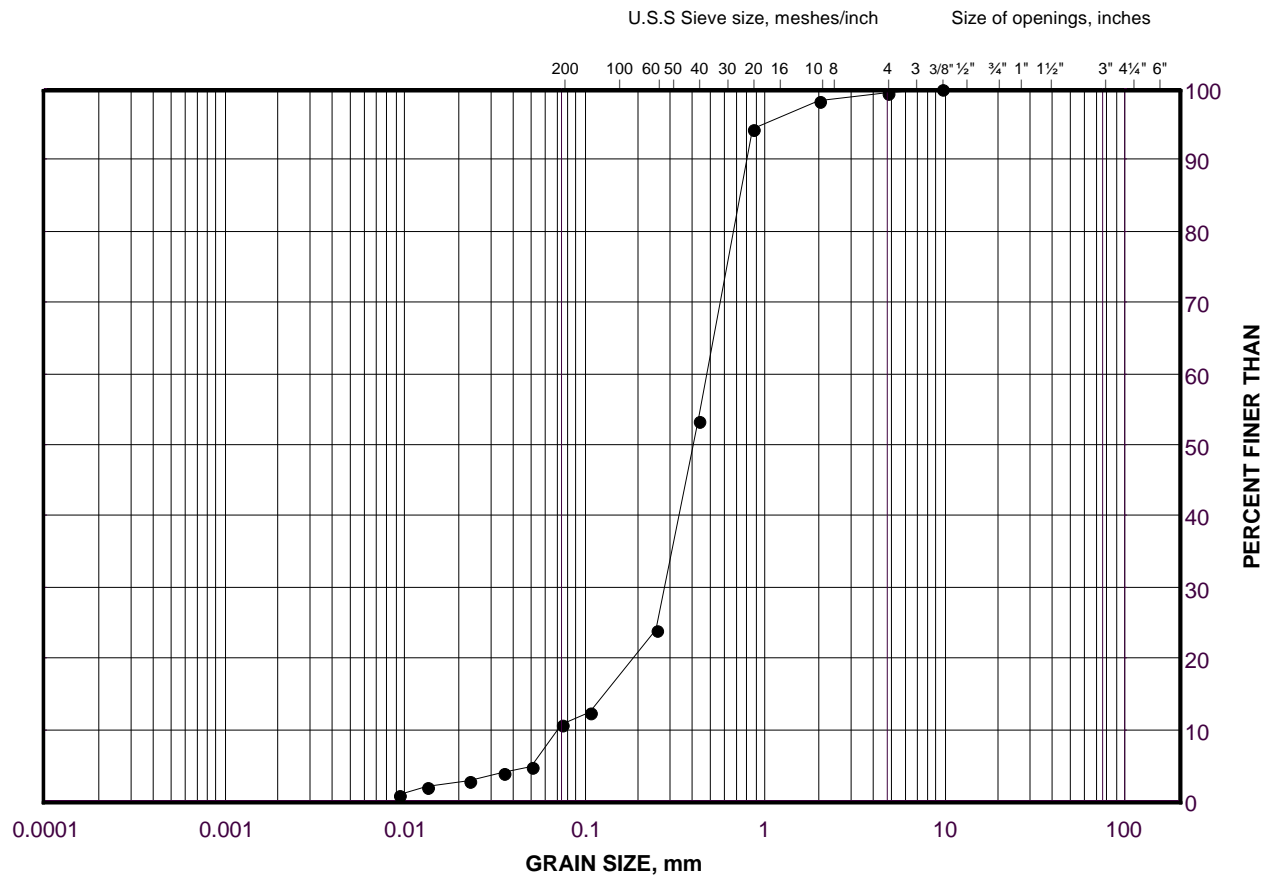
APPENDIX B

Laboratory Test Results and Bedrock Core Photographs

GRAIN SIZE DISTRIBUTION

Sand (SP-SM)

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	OS-1	2	76.7

Project Number: 1780055

Checked By: MN

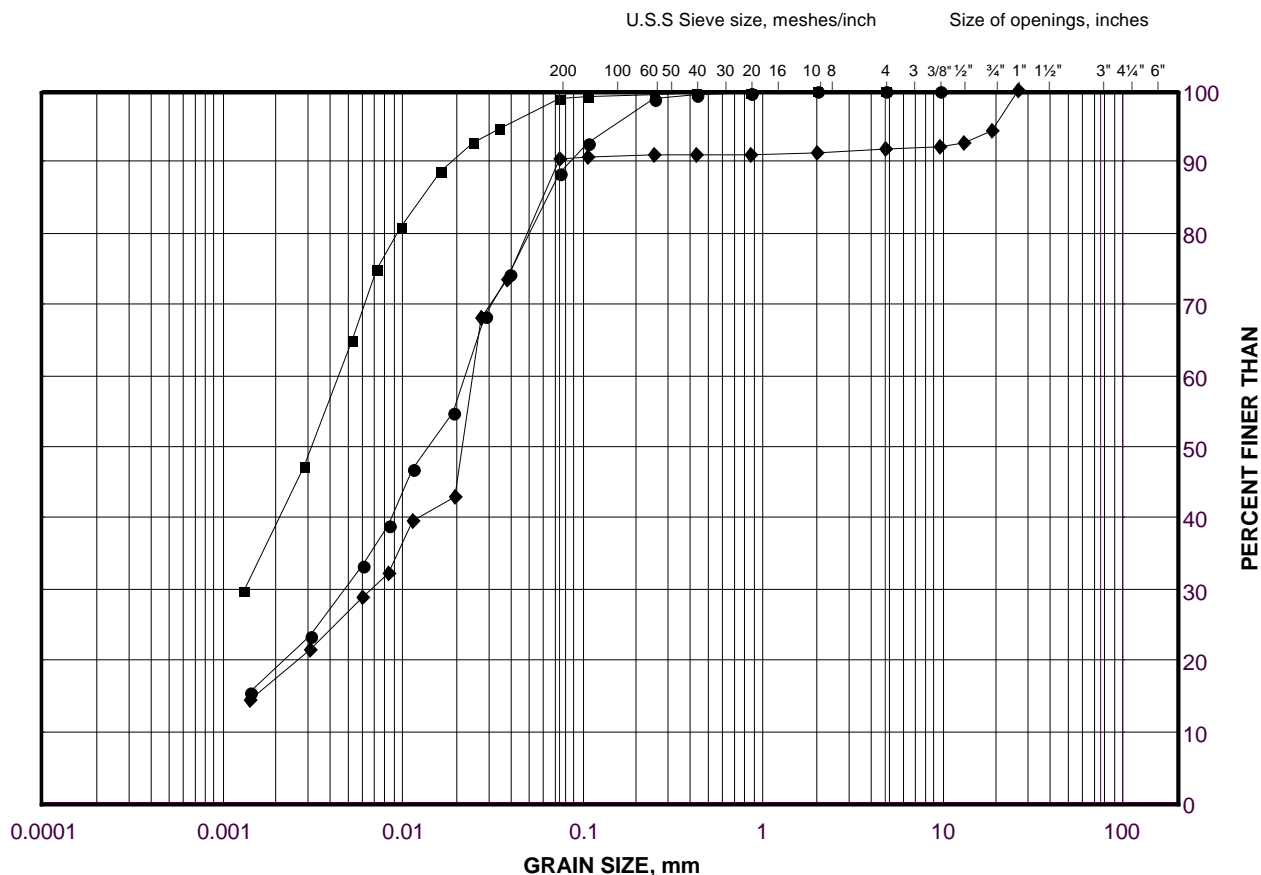
Golder Associates

Date: 17-Dec-19

GRAIN SIZE DISTRIBUTION

Clayey Silt-Silt (CL-ML) to Silty Clay (CI)

FIGURE B2



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

LEGEND

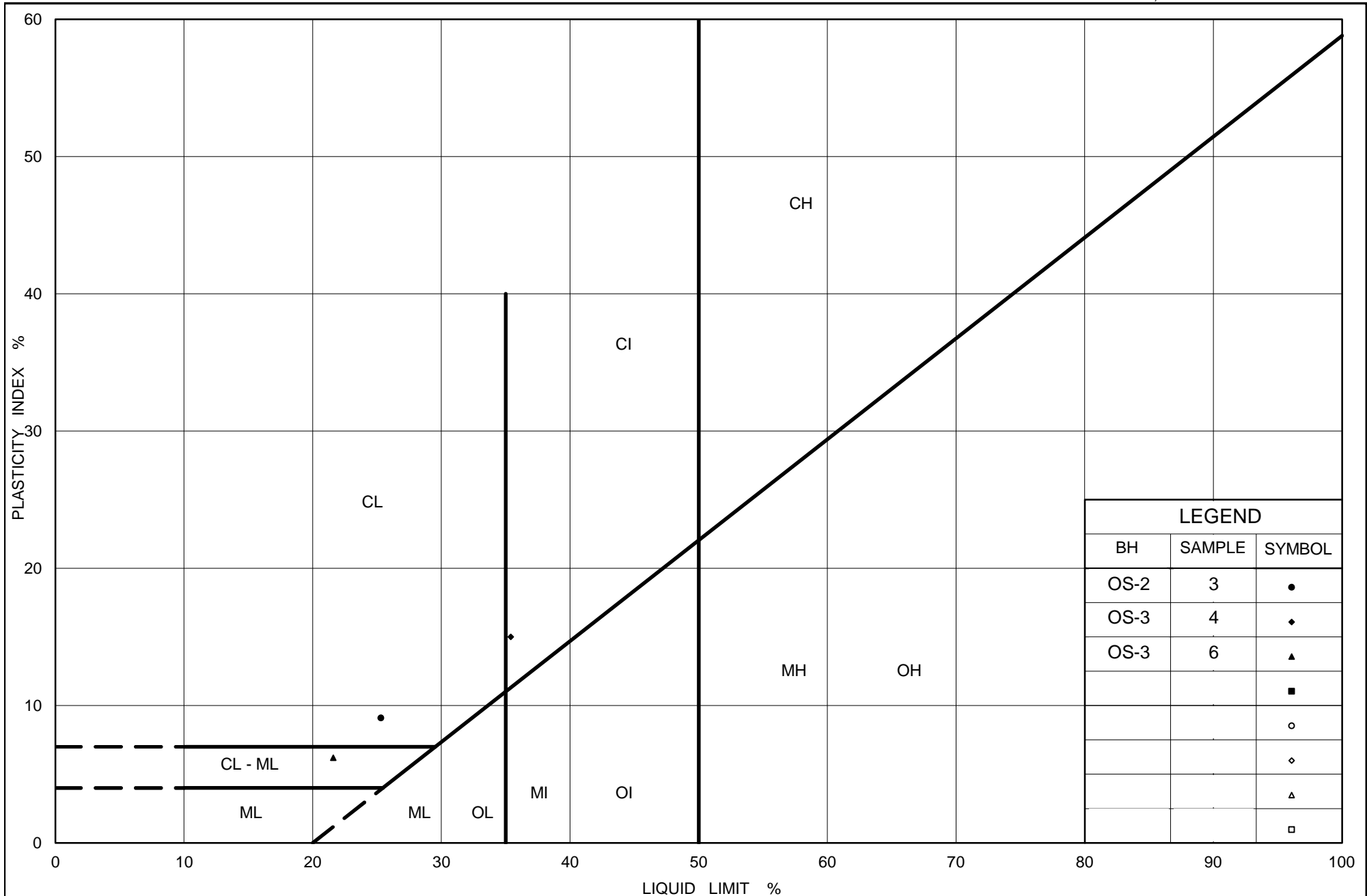
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	OS-2	3	81.3
■	OS-3	4	87.3
◆	OS-3	6	86.1

Project Number: 1780055

Checked By: MN

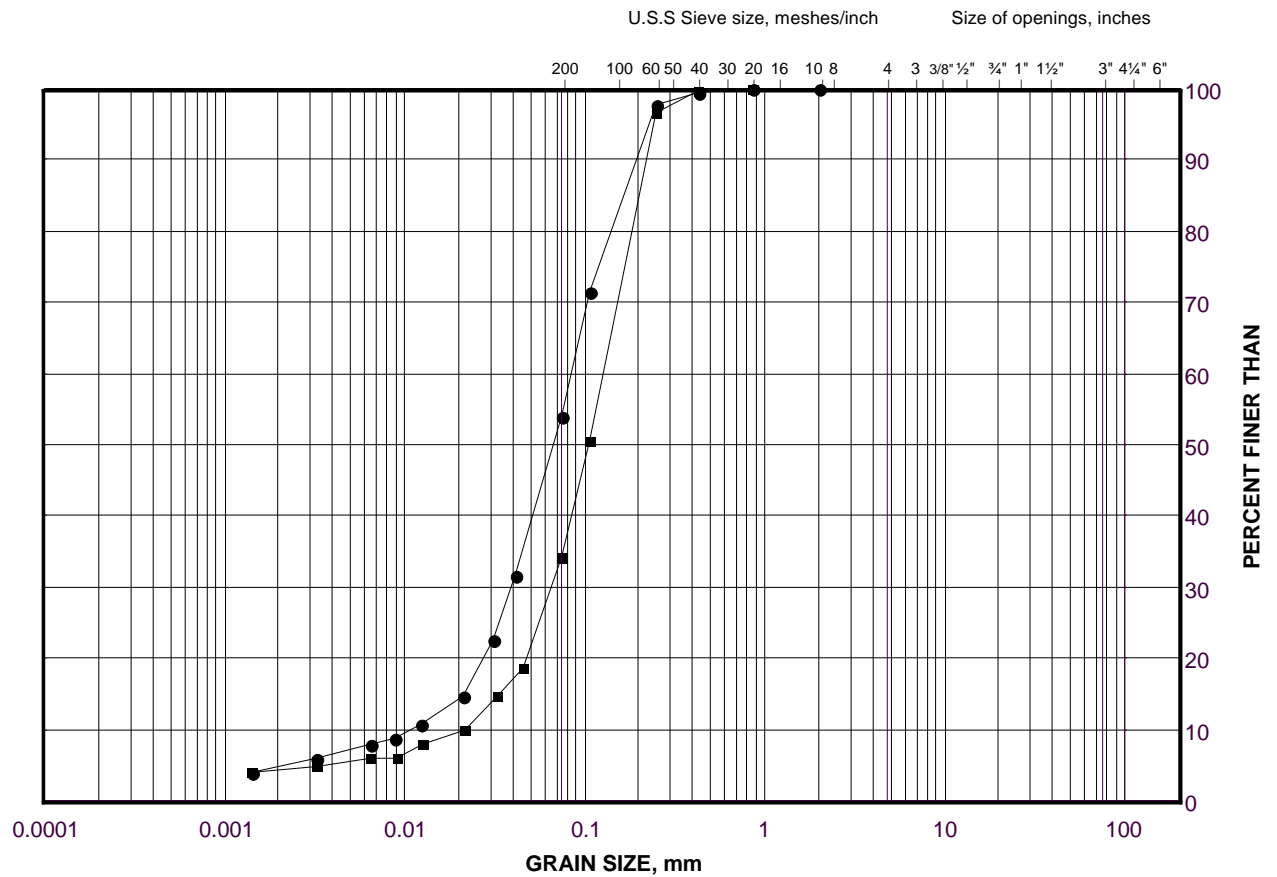
Golder Associates

Date: 17-Dec-19



Silty Sand (SM) to Silt (ML) and Sand

FIGURE B4



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	OS-2	4	80.7
■	OS-3	9	84.3

Project Number: 1780055

Checked By: MN

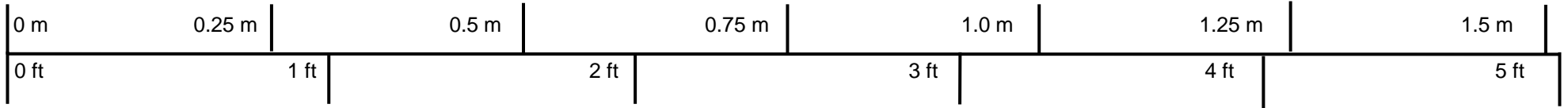
Golder Associates

Date: 17-Dec-19


Borehole OS-2



Box 1: 3.40 m – 5.33 m



Scale

PROJECT					
Gananoque South CVIF - Breakaway Signs					
TITLE					
Bedrock Core Photographs Borehole OS-2 (3.4 m – 5.3 m)					
	PROJECT No. 1780055			FILE No. 1780055/3002	
	DRAFT	AB	MAY 2019	SCALE	AS SHOWN
	CADD	--		FIGURE B5	
	CHECK	MN	MAY 2019		
	REVIEW	LCC	MAY 2019		

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS

ASTM D7012

SAMPLE IDENTIFICATION

PROJECT NUMBER	1780055	SAMPLE NUMBER	SA-01
PROJECT NAME	Dillon/Eastern CVIF Ret/4017E0003	SAMPLE DEPTH, m	3.66-3.86
BOREHOLE NUMBER	OS-2	DATE:	Jan. 6, 2020

TEST CONDITIONS

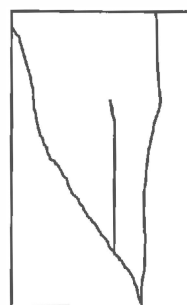
MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.13

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.47	WATER CONTENT, (specimen) %	0.10
SAMPLE DIAMETER, cm	4.91	UNIT WEIGHT, kN/m ³	25.42
SAMPLE AREA, cm ²	18.94	DRY UNIT WT., kN/m ³	25.39
SAMPLE VOLUME, cm ³	198.23	SPECIFIC GRAVITY	-
WET WEIGHT, g	513.96	VOID RATIO	-
DRY WEIGHT, g	513.45		

VISUAL INSPECTION

FAILURE SKETCH



TEST RESULTS

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	69.3
----------------------	-----	---------------------------	------

REMARKS:



BEFORE COMPRESSION



AFTER COMPRESSION

CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727

ATTENTION TO: Yusuf Soliman

PROJECT: 1780055

AGAT WORK ORDER: 19T553152

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

TRACE ORGANICS REVIEWED BY: Neli Popnikolova, Senior Chemist

DATE REPORTED: Dec 20, 2019

PAGES (INCLUDING COVER): 11

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

SAMPLING SITE:

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2019-12-06

DATE REPORTED: 2019-12-20

		SAMPLE DESCRIPTION:		OS-1 Sa#3	OS-2 Sa#3	OS-3 Sa#3	TC-2 Sa7
		SAMPLE TYPE:		Soil	Soil	Soil	Soil
		DATE SAMPLED:		2019-11-19	2019-11-18	2019-11-18	2019-11-04
Parameter	Unit	G / S	RDL	778086	778091	778092	778093
Chloride (2:1)	µg/g	NA	2	35	16	36	163
Sulphate (2:1)	µg/g		2	6	9	15	9
pH (2:1)	pH Units		NA	7.98	8.08	8.17	8.27
Electrical Conductivity (2:1)	mS/cm	0.57	0.005	0.145	0.414	0.495	0.415
Resistivity (2:1) (Calculated)	ohm.cm		1	6900	2420	2020	2410
Redox Potential 1	mV		NA	77	139	188	202
Redox Potential 2	mV		NA	89	163	194	205
Redox Potential 3	mV		NA	102	165	189	211

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

778086-778092 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

778093 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Redox potential measured on as received sample. Due to the potential for rapid change in sample equilibrium chemistry with exposure to oxidative/reduction conditions laboratory results may differ from field measured results.

2019/12/20: This is a revision of a previous report issued in 2019/12/17: The certificate of analysis has been revised to amend the previously Electrical Conductivity (2:1) data reported. The results were corrected accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Divine Basily



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

SAMPLING SITE:

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-12-06

DATE REPORTED: 2019-12-20

		SAMPLE DESCRIPTION:		TC-2 Sa7	
		SAMPLE TYPE:		Soil	
		DATE SAMPLED:		2019-11-04	
Parameter	Unit	G / S	RDL	778093	
Antimony	µg/g	1.3	0.8	<0.8	
Arsenic	µg/g	18	1	<1	
Barium	µg/g	220	2	18	
Beryllium	µg/g	2.5	0.5	<0.5	
Boron	µg/g	36	5	<5	
Boron (Hot Water Soluble)	µg/g	NA	0.10	<0.10	
Cadmium	µg/g	1.2	0.5	<0.5	
Chromium	µg/g	70	2	8	
Cobalt	µg/g	21	0.5	3.1	
Copper	µg/g	92	1	8	
Lead	µg/g	120	1	2	
Molybdenum	µg/g	2	0.5	<0.5	
Nickel	µg/g	82	1	5	
Selenium	µg/g	1.5	0.4	<0.4	
Silver	µg/g	0.5	0.2	<0.2	
Thallium	µg/g	1	0.4	<0.4	
Uranium	µg/g	2.5	0.5	<0.5	
Vanadium	µg/g	86	1	17	
Zinc	µg/g	290	5	13	
Chromium VI	µg/g	0.66	0.2	<0.2	
Cyanide	µg/g	0.051	0.040	<0.040	
Mercury	µg/g	0.27	0.10	<0.10	
Electrical Conductivity	mS/cm	0.57	0.005	0.415	
Sodium Adsorption Ratio	NA	2.4	NA	3.79	
pH, 2:1 CaCl2 Extraction	pH Units		NA	7.90	

Certified By:

Divine Basily



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

SAMPLING SITE:

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

O. Reg. 153(511) - Metals & Inorganics (Soil)

DATE RECEIVED: 2019-12-06

DATE REPORTED: 2019-12-20

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use

Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

778093 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl₂ extract prepared at 2:1 ratio. SAR is a calculated parameter.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Divine Basily



Certificate of Analysis

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

SAMPLING SITE:

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

O. Reg. 153(511) - PAHs (Soil)

DATE RECEIVED: 2019-12-06

DATE REPORTED: 2019-12-20

		SAMPLE DESCRIPTION:		TC-2 Sa7
		SAMPLE TYPE:		Soil
		DATE SAMPLED:		2019-11-04
Parameter	Unit	G / S	RDL	778093
Naphthalene	µg/g	0.09	0.05	<0.05
Acenaphthylene	µg/g	0.093	0.05	<0.05
Acenaphthene	µg/g	0.072	0.05	<0.05
Fluorene	µg/g	0.12	0.05	<0.05
Phenanthrene	µg/g	0.69	0.05	<0.05
Anthracene	µg/g	0.16	0.05	<0.05
Fluoranthene	µg/g	0.56	0.05	<0.05
Pyrene	µg/g	1	0.05	<0.05
Benz(a)anthracene	µg/g	0.36	0.05	<0.05
Chrysene	µg/g	2.8	0.05	<0.05
Benzo(b)fluoranthene	µg/g	0.47	0.05	<0.05
Benzo(k)fluoranthene	µg/g	0.48	0.05	<0.05
Benzo(a)pyrene	µg/g	0.3	0.05	<0.05
Indeno(1,2,3-cd)pyrene	µg/g	0.23	0.05	<0.05
Dibenz(a,h)anthracene	µg/g	0.1	0.05	<0.05
Benzo(g,h,i)perylene	µg/g	0.68	0.05	<0.05
2-and 1-methyl Naphthalene	µg/g	0.59	0.05	<0.05
Moisture Content	%		0.1	12.8
Surrogate	Unit	Acceptable Limits		
Naphthalene-d8	%	50-140		72
Acenaphthene-d10	%	50-140		84
Chrysene-d12	%	50-140		72

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Table 1: Full Depth Background Site Condition Standards - Soil - Residential/Parkland/Institutional/Industrial/Commercial/Community Property Use
Guideline values are for general reference only. The guidelines provided may or may not be relevant for the intended use. Refer directly to the applicable standard for regulatory interpretation.

778093 Results are based on the dry weight of the soil.
Note: The result for Benzo(b)Fluoranthene is the total of the Benzo(b)&j)Fluoranthene isomers because the isomers co-elute on the GC column.
2- and 1-Methyl Naphthalene is a calculated parameter. The calculated value is the sum of 2-Methyl Naphthalene and 1-Methyl Naphthalene.

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

N Popmukolof



AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	UNIT	GUIDEVALUE	RESULT
778093	TC-2 Sa7	ON T1 S RPI/ICC	O. Reg. 153(511) - Metals & Inorganics (Soil)	Sodium Adsorption Ratio	NA	2.4	3.79

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 1780055

SAMPLING SITE:

AGAT WORK ORDER: 19T553152

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

Soil Analysis															
RPT Date: Dec 20, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Chloride (2:1)	778086	778086	35	33	5.9%	< 2	94%	80%	120%	102%	80%	120%	101%	70%	130%
Sulphate (2:1)	778086	778086	6	6	NA	< 2	97%	80%	120%	101%	80%	120%	104%	70%	130%
pH (2:1)	778086	778086	7.98	8.10	1.5%	NA	101%	90%	110%						
Electrical Conductivity (2:1)	777252		0.380	0.372	2.1%	< 0.005	NA	90%	110%						
Redox Potential 1	1					NA	101%	90%	110%						
O. Reg. 153(511) - Metals & Inorganics (Soil)															
Antimony	777252		<0.8	<0.8	NA	< 0.8	111%	70%	130%	103%	80%	120%	89%	70%	130%
Arsenic	777252		2	2	NA	< 1	108%	70%	130%	113%	80%	120%	113%	70%	130%
Barium	777252		188	188	0.0%	< 2	103%	70%	130%	107%	80%	120%	98%	70%	130%
Beryllium	777252		0.7	0.7	NA	< 0.5	94%	70%	130%	117%	80%	120%	81%	70%	130%
Boron	777252		47	46	2.2%	< 5	83%	70%	130%	111%	80%	120%	91%	70%	130%
Boron (Hot Water Soluble)	777252		0.47	0.47	NA	< 0.10	96%	60%	140%	99%	70%	130%	98%	60%	140%
Cadmium	777252		<0.5	<0.5	NA	< 0.5	102%	70%	130%	108%	80%	120%	101%	70%	130%
Chromium	777252		23	22	4.4%	< 2	101%	70%	130%	113%	80%	120%	93%	70%	130%
Cobalt	777252		9.5	9.6	1.0%	< 0.5	97%	70%	130%	108%	80%	120%	98%	70%	130%
Copper	777252		9	9	0.0%	< 1	93%	70%	130%	119%	80%	120%	93%	70%	130%
Lead	777252		4	4	NA	< 1	105%	70%	130%	111%	80%	120%	100%	70%	130%
Molybdenum	777252		<0.5	<0.5	NA	< 0.5	95%	70%	130%	101%	80%	120%	99%	70%	130%
Nickel	777252		23	23	0.0%	< 1	96%	70%	130%	110%	80%	120%	96%	70%	130%
Selenium	777252		<0.4	<0.4	NA	< 0.4	122%	70%	130%	105%	80%	120%	109%	70%	130%
Silver	777252		<0.2	<0.2	NA	< 0.2	85%	70%	130%	100%	80%	120%	94%	70%	130%
Thallium	777252		<0.4	<0.4	NA	< 0.4	115%	70%	130%	106%	80%	120%	98%	70%	130%
Uranium	777252		0.6	0.6	NA	< 0.5	110%	70%	130%	102%	80%	120%	101%	70%	130%
Vanadium	777252		28	28	0.0%	< 1	102%	70%	130%	108%	80%	120%	100%	70%	130%
Zinc	777252		45	45	0.0%	< 5	100%	70%	130%	116%	80%	120%	100%	70%	130%
Chromium VI	786742		< 0.2	< 0.2	NA	< 0.2	98%	80%	120%	83%	70%	130%	93%	70%	130%
Cyanide	774865		<0.040	<0.040	NA	< 0.040	100%	70%	130%	97%	80%	120%	103%	70%	130%
Mercury	777252		<0.10	<0.10	NA	< 0.10	108%	70%	130%	107%	80%	120%	103%	70%	130%
Electrical Conductivity	777252		0.380	0.372	2.1%	< 0.005	100%	90%	110%						
Sodium Adsorption Ratio	778086	778086	3.27	3.37	3.0%	NA									
pH, 2:1 CaCl2 Extraction	788487		7.68	7.74	0.8%	NA	100%	80%	120%						

Comments: NA signifies Not Applicable.

Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Certified By:





Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

PROJECT: 1780055

SAMPLING SITE:

AGAT WORK ORDER: 19T553152

ATTENTION TO: Yusuf Soliman

SAMPLED BY:

Trace Organics Analysis

RPT Date: Dec 20, 2019

RPT Date: Dec 20, 2019			DUPLICATE			Method Blank	REFERENCE MATERIAL		METHOD BLANK SPIKE			MATRIX SPIKE			
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - PAHs (Soil)

Naphthalene	771146		< 0.05	< 0.05	NA	< 0.05	113%	50%	140%	76%	50%	140%	76%	50%	140%
Acenaphthylene	771146		< 0.05	< 0.05	NA	< 0.05	118%	50%	140%	80%	50%	140%	81%	50%	140%
Acenaphthene	771146		< 0.05	< 0.05	NA	< 0.05	119%	50%	140%	84%	50%	140%	85%	50%	140%
Fluorene	771146		< 0.05	< 0.05	NA	< 0.05	118%	50%	140%	84%	50%	140%	86%	50%	140%
Phenanthrene	771146		< 0.05	< 0.05	NA	< 0.05	117%	50%	140%	76%	50%	140%	80%	50%	140%
Anthracene	771146		< 0.05	< 0.05	NA	< 0.05	110%	50%	140%	84%	50%	140%	89%	50%	140%
Fluoranthene	771146		< 0.05	< 0.05	NA	< 0.05	119%	50%	140%	82%	50%	140%	88%	50%	140%
Pyrene	771146		< 0.05	< 0.05	NA	< 0.05	119%	50%	140%	88%	50%	140%	97%	50%	140%
Benz(a)anthracene	771146		< 0.05	< 0.05	NA	< 0.05	91%	50%	140%	74%	50%	140%	78%	50%	140%
Chrysene	771146		< 0.05	< 0.05	NA	< 0.05	116%	50%	140%	90%	50%	140%	85%	50%	140%
Benzo(b)fluoranthene	771146		< 0.05	< 0.05	NA	< 0.05	118%	50%	140%	103%	50%	140%	101%	50%	140%
Benzo(k)fluoranthene	771146		< 0.05	< 0.05	NA	< 0.05	101%	50%	140%	97%	50%	140%	98%	50%	140%
Benzo(a)pyrene	771146		< 0.05	< 0.05	NA	< 0.05	109%	50%	140%	111%	50%	140%	90%	50%	140%
Indeno(1,2,3-cd)pyrene	771146		< 0.05	< 0.05	NA	< 0.05	66%	50%	140%	80%	50%	140%	80%	50%	140%
Dibenz(a,h)anthracene	771146		< 0.05	< 0.05	NA	< 0.05	95%	50%	140%	72%	50%	140%	84%	50%	140%
Benzo(g,h,i)perylene	771146		< 0.05	< 0.05	NA	< 0.05	75%	50%	140%	79%	50%	140%	84%	50%	140%

Comments: When the average of the sample and duplicate results is less than 5x the RDL, the Relative Percent Difference (RPD) will be indicated as Not Applicable (NA).

Certified By:

N Popmukohof

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential 1	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 2	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Redox Potential 3	INOR-93-6066	G200-09, SM 2580 B	REDOX POTENTIAL ELECTRODE
Antimony	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Arsenic	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Barium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Beryllium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Boron (Hot Water Soluble)	MET-93-6104	EPA SW 846 6010C; MSA, Part 3, Ch.21	ICP/OES
Cadmium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Cobalt	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Copper	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Lead	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Molybdenum	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Nickel	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Selenium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Silver	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Thallium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Uranium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Vanadium	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Zinc	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Chromium VI	INOR-93-6068	SW 846 Method 3060A; Method 7196A	SPECTROPHOTOMETER
Cyanide	INOR-93-6052	MOE CN-3015 & E 3009 A;SM 4500 CN	TECHNICON AUTO ANALYZER
Mercury	MET-93-6103	EPA SW-846 3050B & 6020A	ICP-MS
Electrical Conductivity	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Sodium Adsorption Ratio	INOR-93-6007	McKeague 4.12 & 3.26 & EPA SW-846 6010C	ICP/OES
pH, 2:1 CaCl ₂ Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 19T553152

PROJECT: 1780055

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Trace Organics Analysis			
Naphthalene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Acenaphthylene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Acenaphthene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Fluorene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Phenanthrene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Anthracene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Fluoranthene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Pyrene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Benz(a)anthracene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Chrysene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Benzo(b)fluoranthene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Benzo(k)fluoranthene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Benzo(a)pyrene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Indeno(1,2,3-cd)pyrene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Dibenz(a,h)anthracene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Benzo(g,h,i)perylene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
2-and 1-methyl Naphthalene	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Moisture Content	ORG-91-5106	Tier 1 Method	BALANCE
Naphthalene-d8	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Acenaphthene-d10	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS
Chrysene-d12	ORG-91-5106	modified from EPA 3541 and EPA 8270E	GC/MS

CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727

ATTENTION TO: Yusuf Soliman

PROJECT: 19T553152

AGAT WORK ORDER: 19T555421

SOLID ANALYSIS REVIEWED BY: Sherin Moussa, Senior Technician

DATE REPORTED: Dec 16, 2019

PAGES (INCLUDING COVER): 5

Should you require any information regarding this analysis please contact your client services representative at (905) 501-9998

*NOTES

All samples are stored at no charge for 90 days. Please contact the lab if you require additional sample storage time.



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 19T555421

PROJECT: 19T553152

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

DATE SAMPLED: Dec 12, 2019		DATE RECEIVED: Dec 13, 2019		DATE REPORTED: Dec 16, 2019		SAMPLE TYPE: Other
Analyte:		Sulfide				
Unit:		%				
Sample ID (AGAT ID)		RDL:		0.05		
OS-1 Sa#3 (796495)				<0.05		
OS-2 Sa#3 (796496)				<0.05		
OS-3 Sa#3 (796497)				<0.05		
TC-2 Sa7 (796498)				<0.05		

Comments: RDL - Reported Detection Limit

Analysis performed at AGAT Toronto (unless marked by *)

Certified By:

Sherin Moossa



AGAT Laboratories

Quality Assurance - Replicate

AGAT WORK ORDER: 19T555421

PROJECT: 19T553152

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

Parameter	REPLICATE #1				REPLICATE #2											
	Sample ID	Original	Replicate	RPD	Sample ID	Original	Replicate	RPD								
S	796495	0.020	0.018	10.5%	796498	< 0.005	<0.005	0.0%								
Sulfate	796495	< 0.01	<0.01	0.0%	796498	< 0.01	<0.01	0.0%								
Sulfide	796495	< 0.05	<0.05	0.0%	796498	< 0.05	<0.05	0.0%								



AGAT Laboratories

Quality Assurance - Certified Reference materials

AGAT WORK ORDER: 19T555421

PROJECT: 19T553152

5623 McADAM ROAD
MISSISSAUGA, ONTARIO
CANADA L4Z 1N9
TEL (905)501-9998
FAX (905)501-0589
<http://www.agatlabs.com>

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Yusuf Soliman

(201-042) Sulfide

Parameter	CRM #1				CRM #2											
	Expect	Actual	Recovery	Limits	Expect	Actual	Recovery	Limits								
S	0.8	0.789	98%	90% - 110%	0.8	0.796	99%	90% - 110%								
Sulfate	0.01	0.01	100%	90% - 110%	0.01	0.01	100%	90% - 110%								
Sulfide	0.8	0.779	97%	90% - 110%	0.8	0.786	98%	90% - 110%								

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 19T555421

PROJECT: 19T553152

ATTENTION TO: Yusuf Soliman

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Solid Analysis Sulfide	MIN-200-12037		LECO

APPENDIX C

Notice to Contractor

Control of Overburden Soils for Breakaway Sign Foundations – Item No.

Notice to Contractor

The Contractor shall be alerted that the overburden soils at the breakaway sign supports located at Stations 10+014 (Borehole OS-1), 10+450 (Borehole OS-2) and 11+114 (Borehole OS-3) consist of cohesionless and potential water-bearing sands, which are susceptible to sloughing, boiling or caving into the excavation unless appropriate groundwater controls are in place for footing construction. The Contractor is to design and install an appropriate excavation protection system (e.g. temporary liners, drilling fluids) and an unwatering system as may be required to provide for both side wall and basal stability of the soils during foundation construction, and place concrete by tremie methods as may be appropriate.



golder.com