



FINAL REPORT

**Foundation Investigation and Design
Tri-Chord Overhead Sign Structures
Highway 417 Aviation Parkway to Ramsayville Road
Ottawa Ontario
*G.W.P. 4099-11-00***

Submitted to:

WSP Canada Group Limited

300-2611 Queensview Drive
Ottawa, Ontario
K2B 8K2

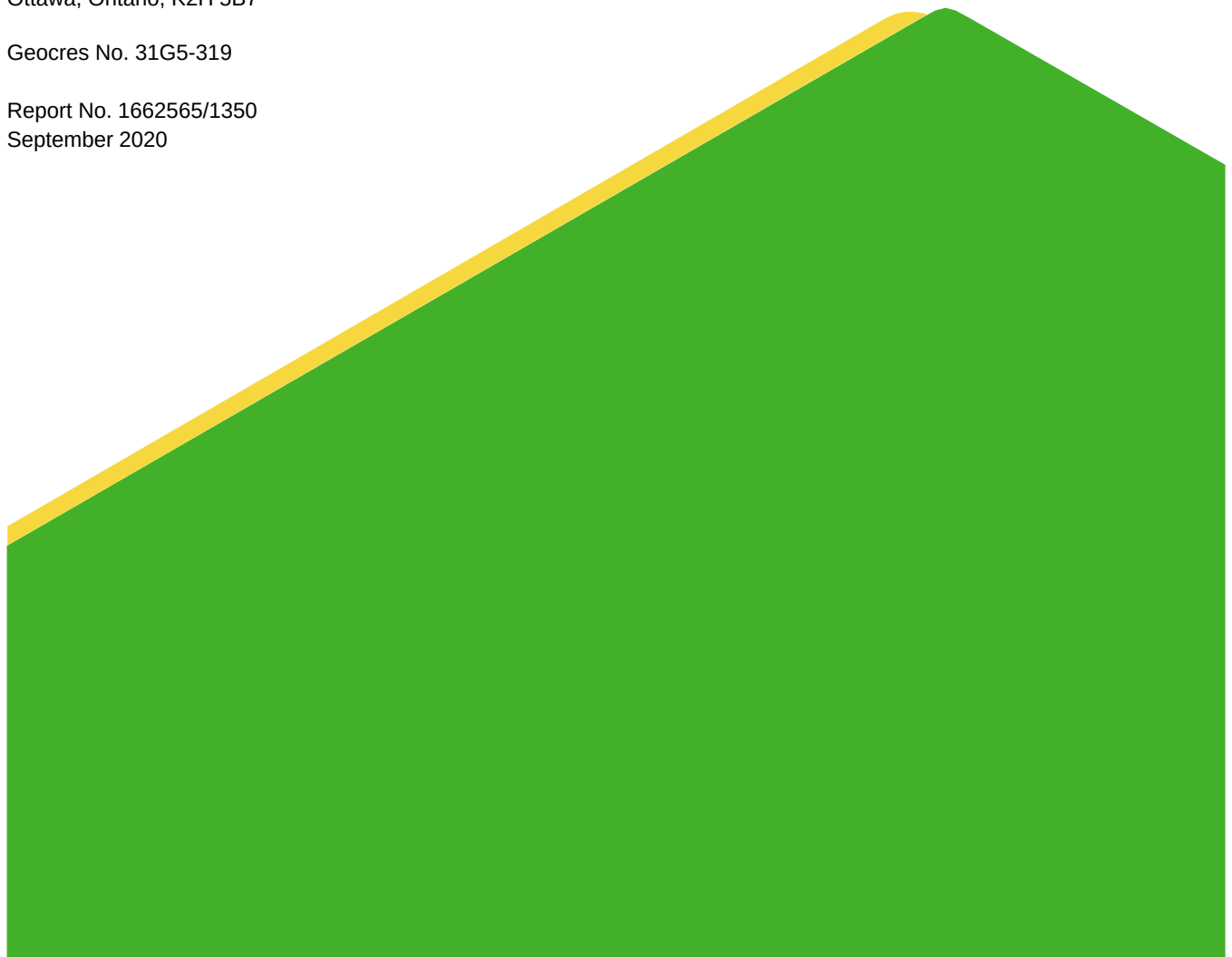
Submitted by:

Golder Associates Ltd.

1931 Robertson Road,
Ottawa, Ontario, K2H 5B7

Geocres No. 31G5-319

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PART A – FOUNDATION INVESTIGATION

**Tri-Chord Overhead Sign Structures
Highway 417 Aviation Parkway to Ramsayville Road
Ottawa, Ontario
G.W.P. 4099-11-00**

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP Canada Group Limited (WSP) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with the rehabilitation and/or replacement of numerous bridges, structural culverts, non-structural culverts, and overhead sign structures on Highway 417 between the Aviation Parkway and Ramsayville Road. The overall assignment also includes widening of Highway 417 from Ottawa Road 174 to Hunt Club Road in Ottawa, Ontario (Assignment number 4016-E-0008).

This report presents the results of the foundation investigation carried out to collect subsurface information required for the design of six proposed replacement tri-chord overhead sign structures on Highway 417 between Ottawa Road 174 and Walkley Road. The design of the new overhead sign structures is to be carried out in accordance with the MTO's Sign Support Manual (MTO, 2019).

The terms of reference and scope of work for the foundation investigation are outlined in the MTO's Request for Proposal, dated May 2016, and subsequent addenda. Golder's scope of work for foundation engineering services associated with the overhead sign structures is contained in Table 17.8.3 of WSP's Technical Proposal for this assignment dated June 28, 2016. The work has been carried out in accordance with Golder's Quality Control Plan for foundation engineering services for this project dated March 13, 2017.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

The locations of the existing monotube or ground mounted signs that are to be replaced by new tri-chord overhead signs are located on Highway 417 between the split with Ottawa Regional (OR) Road 174 and Walkley Road in Ottawa, Ontario. The locations of the new replacement signs are generally within about 100 m of the existing sign locations, with the exception of the proposed Walkley Road (Advance) Exit sign which is to be about 400 m east of the existing ground mounted sign. The proposed sign locations are shown on Drawings 1 to 4 and are summarized in the following table.

Table 1: Summary of Proposed Tri-Chord Overhead Signs

Sign Number	Highway Lane	Station	Sign Description
03X-0896/S0	417 EBL	113+925	Innes Road – Advance
03X-0898/S0	417 EBL	114+316	Innes Road – Exit
03X-0936/S0	417 EBL	116+161	Walkley Road – Advance
03X-0935/S0	417 EBL	116+621	Walkley Road – Exit
03X-0895/S0	417 WBL	213+948	OR 174 E Rockland – Exit
03X-0897/S0	417 WBL	214+408	OR 174 E Rockland – Advance

In the area of interest, Highway 417 is generally at the natural ground surface elevation or built up on nominal embankments for full-width cross fall in areas of overall highway alignment curves. In the area of the proposed signs north of Cyrville Road (EBL Innes Road – Advance, and WBL 174 E Rockland – Exit) the existing ground surface slopes down in the median to an Unnamed Creek drainage feature. The median is similarly sloped for drainage in the area of the proposed signs south of Cyrville Road (EBL Innes – Exit, and WBL 174 E Rockland – Advance). The highway lane embankments are nominal and near the natural ground surface elevation in the area of the proposed signs located south of Innes Road (EBL Walkley Road – Advance, and EBL Walkley Road – Exit).

2.2 Regional Geology

As delineated in Chapman and Putnam (1984), this section of Highway 417 lies on the boundary of the minor physiographic regions known as the Ottawa Valley Clay Plain and the Russell and Prescott Sand plain, which lie within the major physiographic region of the Ottawa-St. Lawrence Lowland.

The Ottawa Valley Clay Plain region is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock (Belanger, 1998). The Russell and Prescott Sand Plains are generally characterized by a sand mantle about 3 to 5 m thick overlying an extensive deposit of sensitive marine clay deposited within the Champlain Sea basin, underlain by glacial till and bedrock.

The Bedrock Geology mapping indicates that the bedrock at the sign locations consists of black shale of the Billings Formation of the Ordovician period. It should be noted that the Billings Formation shale is susceptible to swelling if allowed to weather in the presence of oxygen.

The site falls within the Western Québec (WQ) seismic zone according to the Geological Survey of Canada. The WQ zone constitutes a large area which encompasses the urban areas of Montreal, Ottawa-Hull and Cornwall. Within the WQ zone recent seismic activity has been concentrated in two subzones; one along the Ottawa River and another more active subzone along the Montreal-Maniwaki axis. The two major earthquakes in the WQ zone includes the 1935 Témiscaming event which had a magnitude (i.e., a measure of the intensity of the earthquake, M_{bLg} or MN) of 6.2, and the 1944 Cornwall-Massena event which had a magnitude of 5.6.

3.0 INVESTIGATION PROCEDURES

The field work for the subsurface investigation was carried out between August 5 and 14, 2019. During that time, twelve boreholes (numbered 19-3501 to 19-3512, inclusive) were advanced in the project area. The borehole locations are shown on Drawings 1 to 4.

The boreholes were advanced using 108 mm inside diameter (200 mm outside diameter) continuous flight hollow stem auger on both, truck and track mounted drill rigs, supplied and operated by George Downing Estate Drilling Ltd. of Grenville-sur-la-rouge, Québec. Traffic control required to close the driving lanes of Highway 417 at the site was supplied by Beacon Lite Ltd. of Ottawa, Ontario.

The boreholes were advanced to about 5.1 m to 10.4 m depth below the ground surface. Samples of the overburden were obtained at regular intervals of depth using 50 mm outside diameter split-spoon samplers in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586).

Upon reaching refusal to casing advancement, Boreholes 19-3501 to 19-3508 (inclusive) were advanced into the bedrock surface to depths ranging from about 2.9 to 3.5 m (i.e., total borehole depths ranging from about 5.1 to 10.4 m), using rotary diamond drilling techniques while retrieving NQ sized core. A water truck was on site to supply the drill rig with water for advancing the casing in the overburden and for coring the bedrock.

Monitoring wells were installed in Boreholes 19-3503, 19-3506, 19-3509, and 19-3511 to observe the stabilised groundwater level at the sites. The monitoring wells consisted of 31.8 mm outside diameter PVC tubing with a 1.5 m long screen. The groundwater level was measured in the monitoring wells on November 6 and 7, 2019 (about three months after drilling). Tables 4, 7, 9, and 10 summarize the depths and the elevations of the

groundwater levels measured in the monitoring wells installed at the sites. All monitoring wells were abandoned on 14 September 2020, in accordance with O.Reg. 903.

The boreholes were backfilled with bentonite within the bedrock and bentonite mixed with soil cuttings within the overburden. The boreholes were backfilled in general accordance with the intent of Ontario MOE Regulation 903, as amended. The site conditions were restored following completion of the field work.

The field work was supervised on a full-time basis by members of Golder's staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, logged the boreholes and examined and cared for the samples. The soil and bedrock samples were identified in the field, placed in labelled containers, and transported to Golder's laboratory in Ottawa for further examination and testing. Index and classification tests consisting of moisture content determinations, Atterberg Limits, and grain size distribution analyses were carried out on selected soil samples at Golder's Ottawa laboratory. Unconfined compressive strength testing was carried out on eight samples of the bedrock core at Golder's Mississauga laboratory. The laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate.

A total of eleven soil samples were submitted to Eurofins Environment Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack).

The borehole locations and elevations were surveyed by Golder using a Trimble R8 GPS unit referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The borehole locations, including northing and easting coordinates, ground surface elevations, and borehole depths are summarized in Table 2 below.

Table 2: Summary of Borehole Locations

Borehole	Overhead Sign	Site (Highway 417 Direction)	Station	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Borehole Depth (m)
				Northing (m)	Easting (m)		
19-3501	OHS-1	Site 03X-0896/S0 (417 Eastbound – Innes Road Advance Sign)	113+925	5031560.1	374061.9	65.6	6.0
19-3502				5031574.3	374079.1	65.9	6.0
19-3503	OHS-2	Site 03X-0895/S0 (417 Westbound – OR 174 Rockland Exit Sign)	213+948	5031680.4	374098.0	71.0	10.4
19-3504				5031664.7	374081.7	69.3	8.4
19-3505	OHS-3	Site 03X-0898/S0 (417 Eastbound – Innes Road Exit Sign)	114+316	5031187.9	374169.6	66.2	6.0
19-3506				5031196.8	374189.2	65.2	5.1
19-3507	OHS-4	Site 03X-0897/S0 (417 Westbound – OR 174 Rockland Advance Sign)	214+408	5031235.0	374219.3	65.6	5.1
19-3508				5031228.4	374197.6	65.2	5.3
19-3509	OHS-5	Site 03X-0936/S0 (417 Eastbound – Walkley Road Advance Sign)	116+161	5030012.4	375401.5	69.0	8.2
19-3510				5030019.1	375416.0	68.6	8.2
19-3511	OHS-6	Site 03X-0935/S0 (417 Eastbound – Walkley Road Exit Sign)	116+621	5029599.2	375608.8	66.0	8.2
19-3512				5029612.1	375628.3	65.7	8.2

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

The subsurface soil, bedrock and groundwater conditions encountered in the boreholes and the results of in-situ testing from the current investigation are given on the Record of Borehole and Drillhole sheets presented in Appendix A. The results of the laboratory testing carried out during the current investigation are presented on the Record of Borehole sheets as well as on Figures B1 to B21 in Appendix B. The borehole locations and ground surface elevations at each overhead sign are provided on Drawings 1 to 4.

Photographs of the core recovered from the bedrock are shown on Figures A1 to A16 provided in Appendix A. The results of basic chemical analysis completed on select soil samples are provided in Appendix C.

The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from observations of drilling progress and noncontinuous sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

4.2 Overburden

In general, the subsurface conditions at the borehole locations advanced at the proposed overhead sign locations consist of asphaltic concrete pavement or topsoil, overlying fill materials underlain by native deposits of clay and silty clay, overlying glacial till over shale bedrock.

The groundwater level was measured at the sites at depths ranging from about 1.0 to 6.4 m, corresponding to Elevations 64.6 to 63.3 m.

A more detailed description of the overburden soil deposits, bedrock geology and groundwater conditions encountered during the field investigation is provided in the following sections.

4.3 Site 03X-0896/S0: OHS-1

Boreholes 19-3501 and 19-3502 were advanced at the proposed location of the OHS-1 sign. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following section.

4.3.1 Pavement Structure and Embankment Fill

Borehole 19-3501 was advanced through the pavement structure of Highway 417. The pavement structure at this location consists of about 200 mm of asphaltic concrete overlying about 0.3 m thick gravelly sand base layer underlain by about 0.9 m thick sandy gravel subbase layer.

Borehole 19-3502 was advanced on the grassed area beside the north shoulder of Highway 417 eastbound lane (EBL). Embankment fill exists at ground surface at the location of this borehole and consists of silty sand containing organic matter.

The pavement structure and/or embankment fill in Boreholes 19-3501 and 19-3502 extends to depths of about 1.4 and 0.6 m below the existing ground surface (i.e., Elevations of about 64.2 and 65.3 m) respectively.

One SPT 'N' value of 39 blows per 0.3 m of penetration was measured in the granular pavement structure, indicating a dense state of packing.

The result of grain size distribution testing carried out on one sample of the granular pavement structure is provided on Figure B1.

The measured water content of 3 samples of the pavement structure and embankment fill range from about 4 to 6 %.

4.3.2 Sandy Gravel and Silty Sand (Till)

A deposit of glacial till overlying bedrock was encountered below the pavement structure and/or embankment fill in both the boreholes. The till generally consists of a heterogeneous mixture of gravel, cobbles and boulders in a soil matrix of silty sand to sandy gravel. The till contains cobbles, boulders, and weathered shale bedrock. The lower portion of the till is likely a material increasingly transitioned into the highly weathered shale. The thickness of the till layer encountered at both these locations was 1.7 m.

The glacial till in Boreholes 19-3501 and 19-3502 extends to depths of about 3.1 and 2.3 m below the existing ground surface (i.e., Elevations 62.6 and 63.6 m) respectively.

SPT 'N' values ranging from 25 to greater than 50 blows per 0.3 m of penetration were measured in the till deposit, indicating a compact to very dense state of packing.

The measured water content of two samples of this till was about 5 %.

The results of grain size distribution testing carried out on two samples of this till are provided on Figure B2.

4.3.3 Auger Refusal and Bedrock

The bedrock was encountered below the overburden in both boreholes.

The surface of the bedrock in Boreholes 19-3501 and 19-3502 was encountered at depths of about 3.1 and 2.3 m below the existing ground surface (i.e., Elevations 62.6 and 63.6 m) and was cored for lengths of about 2.9 and 3.7 m, respectively, while retrieving NQ sized bedrock core.

The following table summarizes the bedrock surface depths and elevations as encountered at the borehole location from the current investigation.

Table 3: Summary of Bedrock Depth and Elevation for OHS-1

Borehole Number	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (Highly Weathered/Intact) (m)	Bedrock Surface Elevation (Highly Weathered/Intact) (m)
19-3501	65.6	** /3.1	** /62.6
19-3502	65.9	2.3/2.9	63.6/63.0

NOTE: ** A highly weathered bedrock surface may be present.

The bedrock encountered at the site consists of highly weathered to fresh, very thinly to thinly bedded, black, fine grained, non-porous shale. The Rock Quality Designation (RQD) value of the cored bedrock in borehole 19-3501 ranges from about 15 to 42 % indicating a very poor to poor quality rock, while the RQD value in borehole 19-3502 ranges from about 71 to 88 % indicating a fair to good quality rock, although an SPT sample was advanced within a highly weathered zone.

Photos of the bedrock core obtained from both the boreholes during the current investigation are provided in Appendix A on Figures A1 to A4.

Results of unconfined compressive strength testing carried out on two bedrock core sample are presented in Figure B21. The samples tested had UCS values of 26.6 and 36.8 MPa, indicating a medium strong bedrock.

4.4 Site 03X-0895/S0: OHS-2

Boreholes 19-3503 and 19-3504 were advanced at the proposed location of the OHS-2 sign. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following sections.

4.4.1 Pavement Structure and Embankment Fill

Boreholes 19-3503 and 19-3504 were advanced through the pavement structure of Highway 417. The pavement structure at these locations consists of about 100 to 200 mm of asphaltic concrete overlying about a 0.3 to 0.5 m thick gravelly sand base layer.

The pavement structure in Boreholes 19-3503 and 19-3504 extends to depths of about 0.6 and 0.5 m below the existing ground surface (i.e., Elevations of about 70.4 and 68.8 m) respectively.

The embankment fill in Boreholes 19-3503 and 19-3504 extends to depths of about 4.6 and 3.0 m below the existing ground surface (i.e., Elevations of about 66.4 and 66.3 m) respectively. The embankment fill varies in composition from silty sand to silt and sand with varying amounts of gravel. The embankment fill also contains shale fragments and cobbles.

SPT 'N' values ranging from 8 to 33 blows per 0.3 m of penetration were measured in the embankment fill, indicating a loose to dense state of packing.

The results of grain size distribution testing carried out on four samples of embankment fill are provided on Figures B3 and B4.

The measured water content of 6 samples of the pavement structure and embankment fill range from about 3 to 15 %.

4.4.2 Silty Gravelly Sand (Till)

A deposit of glacial till was encountered below the embankment fill in both the boreholes. The till generally consists of a heterogeneous mixture of gravel, cobbles and boulders in a soil matrix of silty sand to sandy silt. The till is classified as silty gravelly sand and contains cobbles and shale fragments.

The glacial till in Boreholes 19-3503 and 19-3504 extends to depths of about 6.9 and 4.6 m below the existing ground surface (i.e., Elevations 64.1 and 64.7 m) respectively.

SPT 'N' values ranging from 39 to greater than 50 blows per 0.3 m of penetration were measured in the till deposit, indicating a dense to very dense state of packing.

The measured water content of three samples of till ranges from about 5 to 8 %.

The results of grain size distribution testing carried out on two samples of till are provided on Figure B5.

4.4.3 Auger Refusal and Bedrock

The bedrock was encountered below the overburden in both the boreholes, and NQ sized bedrock core was retrieved.

The surface of the bedrock in Boreholes 19-3503 and 19-3504 was encountered at depths of about 6.9 and 5.2 m below the existing ground surface (i.e., Elevation 64.1 m) and was cored for lengths of about 3.5 and 3.2 m, respectively, while retrieving NQ sized bedrock core.

The following table summarizes the bedrock surface depths and elevations as encountered at the borehole location from the current investigation.

Table 5: Summary of Bedrock Depth and Elevation for OHS-2

Borehole Number	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (Highly Weathered/Intact) (m)	Bedrock Surface Elevation (Highly Weathered/Intact) (m)
19-3503	71.0	** /6.9	** /64.1
19-3504	69.3	4.6/5.2	64.7/64.1

NOTE: ** A highly weathered bedrock surface may be present.

The bedrock encountered at the site consists of highly weathered to fresh, thinly bedded, black, fine grained, non-porous shale. The Rock Quality Designation (RQD) value of the cored bedrock in borehole 19-3503 ranges from about 21 to 33 % indicating a very poor to poor quality rock, while the RQD value in borehole 19-3504 ranges from about 71 to 83 % indicating a fair to good quality rock, although an SPT sample was advanced within a highly weathered zone.

Photos of the bedrock core obtained from both the boreholes during the current investigation are provided in Appendix A on Figures A5 to A8.

Results of unconfined compressive strength testing carried out on two bedrock core sample are presented in Figure B21. The samples tested had UCS values of 30.3 and 34.0 MPa, indicating a medium strong bedrock.

4.4.4 Groundwater Conditions

A monitoring well was installed in Borehole 19-3503 to monitor the groundwater level at the site. The water level measured in the monitoring well in Borehole 19-3503 on November 6, 2019 is summarized in the table below.

Table 4: Summary of Groundwater Conditions for OHS-2

Borehole Number	Existing Ground Surface Elevation (m)	Water Level Depth (m)	Screened Interval	Water Level Elevation (m)	Date
19-3503	71.0	6.4	Till	64.6	November 6, 2019

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.5 Site 03X-0898/S0: OHS-3

Boreholes 19-3505 and 19-3506 were advanced at the proposed location of the OHS-3 sign. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following sections.

4.5.1 Pavement Structure and Fill

Borehole 19-3505 was advanced through the pavement structure of Highway 417. The pavement structure at that location consists of about 100 mm of asphaltic concrete over 0.6 m thick base/subbase layer consisting of silty sand and gravel.

Borehole 19-3506 was advanced on the grassed area beside the north shoulder of Highway 417 EBL. The embankment fill exists beneath a 0.2 m thick layer of topsoil in Borehole 19-3506 and beneath the pavement structure in Borehole 19-3505. The embankment fill in Boreholes 19-3505 and 19-3506 extends to depths of about 1.4 and 0.8 m below the existing ground surface (i.e., elevations of about 64.8 and 64.4 m) respectively. The embankment fill varies in composition from sand and gravel to silty clay.

One SPT 'N' value of 15 blows per 0.3 m of penetration was measured in the embankment fill, indicating a compact state of packing.

The results of grain size distribution testing carried out on two samples of pavement structure/embankment fill are provided on Figure B6.

The measured water content of two samples of the pavement structure/embankment fill range from about 2 to 18 %.

The results of Atterberg Limits testing on one sample of silty clay fill gave a plasticity index of about 12.4 % and a liquid limit of about 30.7 %, which indicates a silty clay of low plasticity. The results of the Atterberg limit testing are provided on Figure B7.

4.5.2 Gravelly Sand (Till)

A deposit of glacial till was encountered below the embankment fill in Borehole 19-3505. The till generally consists of a heterogeneous mixture of gravel, cobbles and boulders in a soil matrix of silty sand to sandy silt. The till is classified as gravelly sand and contains cobbles and shale fragments.

The glacial till extends to a depth of about 2.1 m below the existing ground surface (i.e., Elevation 64.1 m).

One SPT 'N' value of 15 blows per 0.3 m of penetration was measured in the till, indicating a compact state of packing.

4.5.3 Auger Refusal and Bedrock

The bedrock was encountered below the overburden in both the boreholes, and NQ sized bedrock core was retrieved.

The surface of the bedrock in Boreholes 19-3505 and 19-3506 was encountered at depths of about 3.0 and 1.6 m below the existing ground surface (i.e., Elevations 63.2 and 63.6 m) and was cored for lengths of about 3.0 and 3.5 m, respectively, while retrieving NQ sized bedrock core.

The following table summarizes the bedrock surface depths and elevations as encountered at the borehole location from the current investigation.

Table 6: Summary of Bedrock Depth and Elevation for OHS-3

Borehole Number	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (Highly Weathered/Intact) (m)	Bedrock Surface Elevation (Highly Weathered/Intact) (m)
19-3505	66.2	2.1/3.0	64.1/63.2
19-3506	65.2	0.8/1.6	64.4/63.6

The bedrock encountered at the site consists of highly weathered to fresh, thinly bedded, black, fine grained, non-porous shale. The Rock Quality Designation (RQD) values of the cored bedrock are about 16 to 86 %, indicating a very poor to good quality rock.

Photos of the bedrock core obtained from both the boreholes during the current investigation are provided in Appendix A on Figures A9 to A12.

Results of unconfined compressive strength testing carried out on two bedrock core samples are presented in Figure B21. The samples tested had UCS values of 56.7 and 61.6 MPa, indicating a strong bedrock.

4.5.4 Groundwater Conditions

A monitoring well was installed in Borehole 19-3506 to monitor the groundwater level at the site. The water level measured in the monitoring well on November 7, 2019 is summarized in the table below.

Table 7: Summary of Groundwater Conditions for OHS-3

Borehole Number	Existing Ground Surface Elevation (m)	Water Level Depth (m)	Screened Interval	Water Level Elevation (m)	Date
19-3506	65.2	1.0	Bedrock	64.2	November 7, 2019

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.6 Site 03X-0897/S0: OHS-4

Boreholes 19-3507 and 19-3508 were advanced at the proposed location of the OHS-4. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following sections.

4.6.1 Pavement Structure and Fill

Borehole 19-3507 was advanced through the pavement structure of Highway 417. The pavement structure at this location consists of about 100 mm of asphaltic concrete overlying about 0.4 m thick gravelly sand base layer.

Embankment fill exists at ground surface at the location of Borehole 19-3508 and varies in composition from sand to silty sand to gravel. At the location of Borehole 19-3507, the embankment fill exists below the pavement structure and consists of gravelly silty sand.

The embankment fill in Boreholes 19-3507 and 19-3508 extends to depths of about 1.7 and 1.9 m below the existing ground surface (i.e., Elevations of about 64.0 and 63.3 m) respectively.

SPT 'N' values ranging from 8 to greater than 50 blows per 0.3 m of penetration were measured in the embankment fill, indicating a loose to very dense state of packing.

The results of grain size distribution testing carried out on two samples of the embankment fill are provided on Figure B8.

The measured water content of three samples of the pavement structure and embankment fill range from about 5 to 14 %.

4.6.2 Auger Refusal and Bedrock

The bedrock was encountered below the overburden in both the boreholes, and NQ sized bedrock core was retrieved.

The surface of the bedrock in Boreholes 19-3507 and 19-3508 was encountered at depths of about 1.7 and 1.9 m below the existing ground surface (i.e., Elevations 64.0 and 63.3 m) and was cored for lengths of about 3.5 and 3.4 m, respectively, while retrieving NQ sized bedrock core.

The following table summarizes the bedrock surface depths and elevations as encountered at the borehole locations from the current investigation.

Table 8: Summary of Bedrock Depth and Elevation for OHS-4

Borehole Number	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (Highly Weathered/Intact) (m)	Bedrock Surface Elevation (Highly Weathered/Intact) (m)
19-3507	65.6	** /1.7	** /64.0
19-3508	65.2	** /1.9	** /63.3

NOTE: ** A highly weathered bedrock surface or crushed shale from the embankment fill may be present

The bedrock encountered at the site consists of fresh, thinly to medium bedded, dark grey to black, fine to medium grained shale with interbeds of limestone. The Rock Quality Designation (RQD) values of the cored bedrock are about 26 to 81 %, indicating a poor to good quality rock.

Photos of the bedrock core obtained from the boreholes during the current investigation are provided in Appendix A on Figures A13 to A16.

Results of unconfined compressive strength testing carried out on two bedrock core samples are presented in Figure B21. The samples tested had UCS values of 38.1 and 85.5 MPa, indicating a medium strong to strong bedrock.

4.7 Site 03X-0936/S0: OHS-5

Boreholes 19-3509 and 19-35010 were advanced at the proposed location of the OHS-5 sign. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following sections.

4.7.1 Topsoil and Fill

Boreholes 19-3509 and 19-3510 were advanced on the grassed area beside the south and north shoulders of Highway 417 EBL, respectively. At the location of Borehole 19-3510, the embankment fill is overlain by a 200 mm thick layer of topsoil while the fill exists at ground surface at the location of Borehole 19-3509.

The embankment fill extends to depths of about 2.3 and 3.7 m below the existing ground surface (Elevations of about 66.7 and 64.9 m) and varies considerably in composition consisting of silty sand, sandy silty gravel, gravelly silty sand, clayey silt to silty clay, and sandy silty gravel. The fill also contains shale fragments.

SPT 'N' values ranging from 9 to 21 blows per 0.3 m of penetration were measured in the embankment fill, indicating a loose to compact state of packing.

The results of grain size distribution testing were carried out on three samples of the embankment fill and are provided on Figures B9 and B10.

4.7.2 Silty Clay

A deposit of silty clay exists within the glacial till in Borehole 19-3509 and below the embankment fill in Borehole 19-3510. In Boreholes 19-3509 and 19-3510, the silty clay extends to depths of about 5.7 and 4.9 m below the existing ground surface (Elevations of about 63.3 and 63.7 m), respectively.

SPT 'N' values ranging from 2 to 3 blows per 0.3 m of penetration were measured in this deposit, indicating a stiff consistency. In situ shear vane testing carried out within this deposit measured undrained shear strengths ranging from about 65 to 77 kPa, indicating a stiff consistency. Based on the ratio of the measured in-situ intact shear strength to the remoulded shear strength, the sensitivity ranges from 9 to 13 and the clay is classified as extra-sensitive.

The results of Atterberg Limit testing carried out on two samples of the silty clay gave plasticity index values of about 20 and 25 % and liquid limit values of about 39 and 45 % indicating a silty clay of intermediate plasticity. The measured water contents of two samples of the silty clay are 41 and 47 %. The results of the Atterberg limit testing performed on the silty clay are provided on Figure B13. The results of grain size distribution testing carried out on silty clay are provided on Figure B12.

4.7.3 Gravelly or Silty Sand/Silt (Till)

In Borehole 19-3509, a 2.2 m thick deposit of glacial till was encountered between the embankment fill and native silty clay, followed by another deposit below the native silty clay. The glacial till was also encountered in Borehole 19-3510 below the native silty clay deposit. The till generally consists of a heterogeneous mixture of gravel, cobbles and boulders in a soil matrix of silty sand. The till at the locations of Boreholes 19-3509 and 19-3510 varies considerably, consisting of gravelly silty sand, silty sand, silt, and gravelly sand.

The glacial till in Boreholes 19-3509 and 19-3510 was proven to extend to a depth of about 8.2 m below the existing ground surface (i.e., Elevations 60.4 and 60.8 m).

SPT 'N' values ranging from 4 to 37 blows per 0.3 m of penetration were measured in the till deposit, indicating a very loose to dense, but generally compact state of packing.

The measured water content of six samples of till ranges from about 7 to 24 %.

The results of grain size distribution testing carried out on four samples of till are provided on Figures B11, B14, and B15.

4.7.4 Groundwater Conditions

A monitoring well was installed in Borehole 19-3509 to monitor the groundwater level at the site. The water level measured in the monitoring well on November 6, 2019 is summarized in the table below.

Table 9: Summary of Groundwater Conditions for OHS-5

Borehole Number	Existing Ground Surface Elevation (m)	Water Level Depth (m)	Screened Interval	Water Level Elevation (m)	Date
19-3509	69.0	5.7	Glacial Till	63.3	November 6, 2019

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.8 Site 03X-0935/S0: OHS-6

Boreholes 19-3511 and 19-35012 were advanced at the proposed location of the OHS-6 sign. A detailed description of the subsurface conditions encountered in these boreholes is provided in the following sections.

4.8.1 Pavement Structure and Fill

Borehole 19-3511 was advanced on the right shoulder of the EBL (exit ramp) of Highway 417 and Borehole 19-3512 was advanced on the grassed area to the north of the EBL of Highway 417.

At the location of Borehole 19-3512, the embankment fill is overlain by 200 mm thick layer of topsoil while the fill exists at ground surface at the location of Borehole 19-3511.

The embankment fill extends to a depth of about 1.7 m below the existing ground surface (Elevations ranging from about 64.3 to 64.0 m) and varies in composition, consisting of gravelly sand, gravel and sand, and silty sand to sandy silt. The fill also contains shale fragments.

SPT 'N' values ranging from 19 to 20 blows per 0.3 m of penetration were measured in the embankment fill, indicating a compact state of packing.

The result of grain size distribution testing carried out on one sample of the embankment fill are provided on Figure B16.

4.8.2 Clay

A deposit of clay exists below the embankment fill in both boreholes. In Boreholes 19-3511 and 19-3512, the clay extends to depths of about 6.9 and 5.2 m below the existing ground surface (Elevations of about 59.1 and 60.5 m), respectively.

The upper portion of the clay has been weathered to form a grey brown crust. The thickness of the crust ranges from about 2.8 to 3.5 m and extends to a depth of about 4.5 to 5.2 m (i.e., Elevation 60.8 and 61.2 m). Standard penetration tests carried out within the weathered crust gave 'N' values ranging from 3 to 14 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. In situ shear vane testing carried out where possible within this deposit measured undrained shear strengths of 65 to 83 kPa, indicating a stiff consistency.

The results of grain size distribution testing carried out on two samples of the weathered crust are shown on Figure B17. The results of Atterberg limit testing carried out on three samples of the weathered clay are shown on Figure B18 and indicate plasticity index values ranging from 37 to 43 % and liquid limit values ranging from 55 to 65 %, reflecting a clay of high plasticity. The measured water content of the weathered clay ranges from approximately 26 to 55 %.

Standard penetration tests carried out within the unweathered portion of the deposit (below the crust) gave 'N' values ranging from 4 to 5 blows per 0.3 m of penetration. In situ shear vane testing carried out within this deposit measured undrained shear strengths ranging from about 40 to 46 kPa, indicating a firm consistency. Based on the ratio of the measured in-situ intact shear strength to the remoulded shear strength, the sensitivity ranges from 6 to 7 and the clay is classified as sensitive.

The result of Atterberg limit testing carried out on one sample of the unweathered clay is shown on Figure B19 and gave a plasticity index value of about 16 % and a liquid limit value of about 37 %, indicating an intermediate plasticity clay. The measured water content of the unweathered portion of the deposit was 33 %.

4.8.3 Silty Sand (Till)

A deposit of glacial till was encountered below the clay in both the boreholes. The till generally consists of a heterogeneous mixture of gravel, cobbles and boulders in a soil matrix of silty sand to sandy silt. The till is classified as silty sand and contains a varying amount of gravel.

The glacial till in Boreholes 19-3511 and 19-3512 was proven to a depth of about 8.2 m below the existing ground surface (i.e., Elevations 57.8 and 57.5 m) respectively.

SPT 'N' values ranging from 2 to 8 blows per 0.3 m of penetration were measured in the till deposit, indicating a very loose to loose state of packing.

The measured water content of three samples of till ranges from about 11 to 21 %.

The results of grain size distribution testing carried out on three samples of till are provided on Figure B20.

4.8.4 Groundwater Conditions

A monitoring well was installed in Borehole 19-3511 to monitor the groundwater level at the site. The water level measured in the monitoring well on November 6, 2019 is summarized in the table below.

Table 10: Summary of Groundwater Conditions for OHS-6

Borehole Number	Existing Ground Surface Elevation (m)	Water Level Depth (m)	Screened Interval	Water Level Elevation (m)	Date
19-3511	66.0	2.8	Glacial Till and Silty Clay	63.3	November 6, 2019

It should be noted that groundwater levels in the area are subject to fluctuations both seasonally and with precipitation events.

4.9 Steel Corrosion and Sulphate Attack, Chemical Analysis

Eleven soil samples were submitted to Eurofins Environment Testing for chemical analysis related to the potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix C and are summarized in Table 11.

Table 11: Steel Corrosion and Sulphate Attack, Chemical Analysis

Borehole	Sample	Sample Depth (m)	Sample Type	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
19-3501	SS4	2.3 – 2.6	Till	0.017	0.10	1.14	8.2	880
19-3502	SS2	0.8 – 1.4	Till	0.008	0.06	0.71	8.0	1,400
19-3503	SS3	1.5 – 2.1	Fill	0.015	0.16	1.54	7.5	651
19-3504	SS3	1.5 – 2.1	Fill	0.188	0.12	0.79	7.5	1,270
19-3505	SS3	1.5 – 2.1	Till	0.105	0.10	0.90	7.4	1,110
19-3507	SS3	1.5 – 1.8	Fill	0.035	0.04	0.23	9.7	4,390
19-3508	SS1	0.2 – 0.5	Fill	0.005	0.02	0.31	7.9	3,240
19-3509	SS4	2.3 – 2.9	Till	0.065	0.07	2.15	7.8	464
19-35010	SS5	3.1 – 3.7	Fill	0.019	0.03	0.68	8.5	1,470
19-35011	SS3	1.5 – 2.1	Clay	0.053	0.03	1.20	7.1	833
19-35012	SS3	1.5 – 2.1	Clay	0.038	< 0.01	0.80	6.7	1,250

5.0 CLOSURE

This report was prepared by Mr. Chaitanya Goyal, Geotechnical Consultant. It was reviewed by Mr. Michael Snow, P.Eng., a Senior Geotechnical Engineer and Principal of Golder. Mr. William Cavers, P.Eng., a Senior Geotechnical Engineer and Associate of Golder, and the Designated MTO Foundations Contact for this project, conducted an independent quality control review of this report.

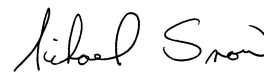
Golder Associates Ltd.



Chaitanya Goyal
Geotechnical Consultant



William Cavers, P.Eng.
Designated MTO Foundations Contact



Michael Snow, P.Eng.
Principal, Senior Geotechnical Engineer



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PART B – FOUNDATION DESIGN

**Tri-Chord Overhead Sign Structures
Highway 417 Aviation Parkway to Ramsayville Road
Ottawa, Ontario
G.W.P. 4099-11-00**

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical input for the proposed tri-chord overhead sign structures to replace the existing monotube and ground mounted signs on Highway 417 between the split with Ottawa Road 174 and Walkley Road in Ottawa, Ontario. The input provided herein is based on interpretation of the factual data obtained from the boreholes advanced during the current subsurface investigation, and in accordance with the current MTO Sign Support Manual, dated February 2019, and in accordance with the current Canadian Highway Bridge Design Code CAN/CSA-S6-14 (CHBDC).

The foundation investigation report, discussion, and recommendations are intended for the use of the Ministry of Transportation, Ontario (MTO) and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor. The contractor must make their own interpretation based on the factual data in Part A (Foundation Investigation) of the report. Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the factual information provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

6.2 Design of Sign Support Foundations

Based on the information provided by WSP to Golder (on 3 December 2019) and the information detailed in the MTO Sign Support Manual, the new overhead signs will consist of Tri-Chord Type I structures.

As per Ontario Provincial Standard Drawing (OPSD) 3090.101 (*Foundation Frost Penetration Depths for Southern Ontario*), the design frost penetration depth at these sites is 1.8 m below the existing ground surface.

Caisson foundations for trichord overhead signs should be designed in accordance with the standard design methods for Tri-Chord Static Sign Supports, contained in Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5 of MTO's Sign Support Manual (MTO, 2019).

The standard sign foundation designs presented on the Standard Drawings have been developed based on the minimum soil conditions given in Section 4.5.4 *Foundations* of the Sign Support Manual and are summarized below:

- **Case 1 (Cohesionless Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.
- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kPa surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and that with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

In the standard design of simply-supported tri-chord signs, caissons are extended to depths below the design frost depth ranging from 5 m (Type I footings) to 6.4 m (Type II, Class 3). The typical caisson founding level could therefore be up to 8.2 m below the ground surface. The standard foundation design provided in MTO's Sign Support Manual does not apply to sites where extensive poor fill materials or materials looser or softer than those of Case 1 or Case 2 are present. The standard foundation design is also not applicable where rock fill or bedrock is encountered within the standard foundation depth. For such subsurface conditions, a site-specific design is required.

The following table summarizes the depth to bedrock and the bedrock surface elevation in the boreholes at each of the proposed sign support locations where bedrock was encountered within 8.2 metres depth, as determined by bedrock coring:

Table 12: Summary of Depths to Bedrock Surface

Sign Number	Description	Borehole	Bedrock Depth ⁽¹⁾ (m)	Intact Bedrock Surface Elevation (m)	Bedrock Type
03X-0896/S0 (OHS-1)	Innes Road – Adv	19-3501	3.1	62.6	Black Shale
		19-3502	2.9	63.0	Black Shale
03X-0895/S0 (OHS-2)	174 E Rockland – Exit	19-3503	6.9	64.1	Black Shale
		19-3504	5.2	64.1	Black Shale
03X-0898/S0 (OHS-3)	Innes Road – Exit	19-3505	3.0	63.2	Black Shale
		19-3506	1.6	63.6	Black Shale
03X-0897/S0 (OHS-4)	174 E Rockland – Adv	19-3507	1.7	64.0	Black Shale
		19-3508	1.9	63.3	Black Shale
03X-0936/S0 (OHS-5)	Walkley Road – Adv	19-3509	> 8.2	N/A ⁽²⁾	N/A ⁽²⁾
		19-3510	> 8.2	N/A ⁽²⁾	N/A ⁽²⁾
03X-0935/S0 (OHS-6)	Walkley Road – Exit	19-3511	> 8.2	N/A ⁽²⁾	N/A ⁽²⁾
		19-3512	> 8.2	N/A ⁽²⁾	N/A ⁽²⁾

Notes: 1) Depth below existing ground surface at borehole location to intact bedrock (i.e. slightly weathered to fresh).

2) Bedrock not encountered within the advancement depth.

The overburden at the sign locations (where bedrock was not encountered within the standard caisson depth) consists of both cohesive and granular materials within the caisson length below the frost depth. The granular and cohesive materials at these locations generally have friction angles and shear strengths, respectively, which meet or exceed the input parameters used in modelling the standard caisson foundations for both Cases 1 and 2 of the Sign Support Manual (MTO, 2019). As such, a site-specific design will only be required where the bedrock will be encountered at a depth less than 5 m below the frost depth.

Based on the review of the borehole information, the subsurface conditions at the proposed sign locations have been compared to the standard design requirements and it has been assessed that five out of the twelve foundations elements can be designed based on the Standard Foundation Design Drawings as outlined in the Sign Support Manual. Table 13 outlines foundation design approach required at each site.

Table 13: Summary of Foundation Design Approach

Borehole	Overhead Sign	Foundation Design Approach
19-3501	03X-0896/S0 (OHS-1)	Site-Specific Bedrock Foundation
19-3502		
19-3503	03X-0895/S0 (OHS-2)	Standard (Case 1)
19-3504		Site-Specific Bedrock Foundation
19-3505	03X-0898/S0 (OHS-3)	Site-Specific Bedrock Foundation
19-3506		
19-3507	03X-0897/S0 (OHS-4)	Site-Specific Bedrock Foundation
19-3508		
19-3509	03X-0936/S0 (OHS-5)	Standard (Case 1)
19-3510		Standard (Case 1)
19-3511	03X-0935/S0 (OHS-6)	Standard (Case 1)
19-3512		

6.2.1 Site-Specific Caisson Foundation Design in Soil

A site-specific caisson foundation design may be carried out by the structural engineer to optimize the standard foundation design. Table 14, following the text of this report, summarizes geotechnical parameters for the soils and bedrock encountered at the borehole locations that can be used for site-specific design. The parameters presented in Table 14 are based on field and laboratory test data as well as accepted correlations (NAVFAC 1986, Bowles, 1984 and Kulhawy and Mayne, 1990) and the analysis was tempered by engineering judgment based on experience in similar soils.

For the overturning analysis of a sign foundation subjected to lateral loading, the Sign Support Manual (MTO, 2019) refers to the guidance provided in the MTO document - "Guidelines for the Design of High Mast Pole Foundations, Fourth Edition (BRO-009), 2004".

In the design of the sign foundations, the passive resistance within the upper 1.8 m below ground surface should be neglected to account for frost action. For cohesive soils, the factored lateral passive resistance should be calculated consistent with Figure 4.1(b) of the 2004 Guidelines and assuming an unconfined compressive strength (q_u) equal to two times the undrained shear strength of the soil (s_u) given in Table 14. For cohesionless soils, the factored lateral passive resistance should be calculated according to Figure 5.1(b) of the 2004 Guidelines using the coefficient of passive resistance (K_p) provided in Table 14. assuming an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this unfactored lateral passive resistance (CHBDC 6.6.2.1) to obtain the factored ultimate lateral geotechnical resistance.

Based on site observations, the OHS foundations will be constructed in areas of relatively flat ground; however, in the event that the OHS foundations are located on the highway embankment slope or within about 2 diameters of the crest of the slope in the direction of loading, there would be unbalanced earth pressures around the foundation due to it being located within sloping ground (assumed 2H:1V embankment). For this case, the passive earth pressure coefficient ($K_{p2:1}$), in accordance with Figure C6.18 of the CHBDC and its Commentary to be used in the foundation design is also included in Table 14.

The SLS geotechnical response of the soil in front of the caissons under lateral loading may be calculated using subgrade reaction theory where the coefficient of horizontal subgrade reaction (k_h in kPa/m) is determined based on the equations given below, as described by Terzaghi (1955) and the Canadian Foundation Engineering Manual (3rd Edition):

For cohesionless soils:

$$k_h = \frac{n_h z}{B} \quad \text{Where} \quad \begin{array}{l} n_h \text{ is the constant of horizontal subgrade reaction (kPa/m);} \\ z \text{ is the depth (m); and} \\ B \text{ is the caisson diameter (m)} \end{array}$$

For cohesive soils:

$$k_h = \frac{67 S_u}{B} \quad \text{Where} \quad \begin{array}{l} S_u \text{ is the undrained shear strength of the soil (kPa); and} \\ B \text{ is the caisson diameter (m)} \end{array}$$

Table 14 outlines the range for the values of n_h and S_u that may be used in the preliminary structural analysis for the site. The ranges in values reflect the variability in the subsurface conditions, the soil properties and the approximate nature of the analysis and the non-linear nature of the soil behaviour (such that k_h is a function of deflection).

The spring constant, K , for structural analysis may be obtained by the expression:

$$K = k_h \times L \times B \text{ (kN/m),}$$

Where k_h = coefficient of horizontal subgrade reaction (kPa/m);
 B = buried caisson diameter, (m); and
 L = length of the caisson segment used in the analysis (m).

6.2.2 Site-Specific Caisson Foundation Design in Bedrock

In accordance with MTO's Sign Support Manual, and with MTO approval, where bedrock is encountered at a depth, Y , less than the minimum of 5 m below the bottom of the frost penetration depth, a reduced caisson length, L_{caisson} , may be calculated as follows:

$$L_{\text{caisson}} = Y + [(L - Y) / 2]$$

Where L_{caisson} = length of caisson below frost penetration depth (m),
 Y = the overburden thickness below the depth of frost penetration (m); and
 L = required length of caisson below frost depth where bedrock is not present (m).
 (See Standard Drawings SS118-3, SS118-4 and SS118-5 Design Information Tables)

Based on the results of the foundation investigation, bedrock drilling will be required to meet the minimum caisson length below the frost penetration depth for most foundation elements at OHS-1, 2, 3, and 4, as noted in Table 13. At these locations a shorter caisson length may be designed as per the above formula. However, if MTO does not approve this approach, then the bedrock socket should be extended to meet the minimum required length.

From a geotechnical perspective, the rock sockets could have a diameter less than the "standard" caisson diameter of 1,200 mm; in this case, the actual rock socket diameter should be determined based on site-specific design by the structural engineers, using the passive lateral resistance (f_{horiz} , in kPa) for the rock mass as provided in Table 14.

6.3 Construction Considerations

6.3.1 Groundwater and Surface Water Control

The water-bearing cohesionless soils at this site should be expected to run or flow into the caisson hole during or after drilling of the caisson foundations for the OHS supports. Therefore, appropriate equipment and procedures will be required to minimize ground loss during drilling and concrete placement, such as by using temporary or permanent caisson liners, and/or using drilling mud. Foundations for the OHS supports should be constructed consistent with OPSS.PROV 915 (Sign Support Structures) and OPSS 903 (Construction Specification for Deep Foundations), respectively. Suggested wording for a Non-Standard Special Provision (NSSP) to alert the Contractor of this condition has been provided in Appendix D.

However, the selection and design of a temporary unwatering/dewatering system is the responsibility of the Contractor. The Contract Documents must alert the Contractor to this responsibility and to design the system in accordance with Special Provision (SP) FOUN0003 (Dewatering Structure Excavations) which amends OPSS 902.

In accordance with SP FOUN0003, the temporary dewatering system shall be designed and carried out in accordance with OPSS.PROV 517 (Dewatering) with amendments as per SP 517F01 (Dewatering System). Given the groundwater and soil conditions at this site, dewatering is expected to be of low complexity, and it is therefore not a requirement to carry out a preconstruction survey or to require a dewatering design engineer for the dewatering system as per Table A of SP 517F01.

6.3.2 Obstructions in Overburden

Increased difficulty with the installation of caissons at the location of some of the OHS should be anticipated due to the presence of cobbles and boulders within the till materials and the relatively shallow depth to the bedrock surface. Recommended wording for an NSSP alerting the Contractor to this condition and the requirement to use appropriate equipment and installation techniques is provided in Appendix D.

6.4 Corrosion and Cement Type

Eleven soil samples from the current investigation were submitted to Eurofins Environmental Testing for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The results of the testing are provided in Appendix C and are summarized in Section 4.9.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The sulphate results in Table 11 of this report, were compared with Table 3 of Canadian Standards Association Standards A23.1-14 (CSA A23.1) and generally indicate a low degree of sulphate attack potential on concrete structures at this site. Accordingly, GU cement could be specified for concrete in below grade applications.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. Generally, the results provided in Table 11 indicate a moderate to high potential for corrosion of exposed ferrous metal at the site which should be considered in the design.

7.0 CLOSURE

This report was prepared by Mr. Chaitanya Goyal, Geotechnical Consultant. It was reviewed by Mr. Michael Snow, P.Eng., a Senior Geotechnical Engineer and Principal of Golder. Mr. William Cavers, P.Eng., a Senior Geotechnical Engineer and Associate of Golder, and the Designated MTO Foundations Contact for this project, conducted an independent quality control review of this report.

Golder Associates Ltd.



Chaitanya Goyal
Geotechnical Consultant



William Cavers, P.Eng.
Designated MTO Foundations Contact



Michael Snow, P.Eng.
Principal, Senior Geotechnical Engineer



CRG/MSS/FH/hdw

[https://golderassociates.sharepoint.com/sites/11263g/shared documents/01_foundations/6 - reports/1350 overhead signs/3-final/1662565-1350-001-r-reva-final overhead signs 2020-09-21.docx](https://golderassociates.sharepoint.com/sites/11263g/shared%20documents/01_foundations/6%20-%20reports/1350%20overhead%20signs/3-final/1662565-1350-001-r-reva-final%20overhead%20signs%202020-09-21.docx)

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ASTM International:

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

Ontario Provisional Standard Drawing:

- OPSD 3090.101 Foundation, Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specification:

- OPSS 903 Construction Specification for Deep Foundations
- OPSS 915 Construction Specification for Sign Support Structures

Ontario Water Resources Act:

- Ontario Regulation 903 Wells

Ministry of Transportation, Ontario

Ministry of Transportation Ontario. Sign Support Manual. Provincial Highways Management Division, Highway Standards Branch, Bridge Office. February 2019.

Table 14: Geotechnical Design Parameters for Overhead Sign Foundations

Site (Overhead Sign)	Highway 417 Stationing Direction ¹	Borehole	Foundation Design Approach	Bottom of Caisson Elevation (m)	Deposit Description	Approximate Deposit Elevation ² (m)	Soil Design Parameters ^{3,4}								Design Groundwater Elevation (m)	Auger Refusal Elevation (m)
							S _u (kPa)	φ ₃ (°)	K _p ⁵	K _{p,2:1}	n _h (kPa/m)	f _{horz} (kPa)	γ (kN/m ³)	γ ₃ (kN/m ³)		
03X-0896/S0 (OHS-1)	113+925 Eastbound	19-3501	Site-Specific Bedrock foundation	58.8	TILL – Gravel and Sand Shale Bedrock	63.8 to 62.6 < 62.6	- -	34 -	3.5 -	1.4 -	6,000 to 8,000 -	- 1,500	21 -	11.2 -	64.6	62.6
		19-3502		59.1	TILL – Silty Gravelly Sand Shale Bedrock (Highly Weathered at Surface)	64.1 to 63.6 < 63.6	- -	34 -	3.5 -	1.4 -	6,000 to 8,000 -	- 1,500	21 -	11.2 -		63.0
03X-0895/S0 (OHS-2)	213+948 Westbound	19-3503	Standard	64.2	FILL – Silty Sand FILL – Silt and Sand TILL – Silty Gravelly Sand Shale Bedrock	69.2 to 68.1 68.1 to 66.4 66.4 to 64.1 < 64.1	- - - -	32 30 34 -	3.3 3.0 3.5 -	1.3 1.2 1.4 -	6,000 to 8,000 4,000 to 6,000 6,000 to 8,000 -	- - - 1,500	20 19 21 -	- - 11.2 -	64.6	64.1
		19-3504	Site-Specific Bedrock foundation	62.5	FILL – Sand and Silt TILL – Gravelly sand Shale Bedrock (Highly Weathered at Surface)	67.8 to 66.3 66.3 to 64.7 < 64.7	- - -	30 34 -	3.0 3.5 -	1.2 1.4 -	4,000 to 6,000 8,000 to 10,000 -	- - 1,500	19 21 -	- - -		64.1
03X-0898/S0 (OHS-3)	114+316 Eastbound	19-3505	Site-Specific Bedrock foundation	59.4	TILL – Gravelly Sand Shale Bedrock (Highly Weathered at Surface)	64.4 to 64.1 < 64.1	- -	34 -	3.5 -	1.4 -	6,000 to 8,000 -	- 1,500	21 -	11.2 -	64.2	63.3
		19-3506		58.4	Shale Bedrock	< 63.6	-	-	-	-	-	1,500	-	-		63.6
03X-0897/S0 (OHS-4)	214+408 Westbound	19-3507	Site-Specific Bedrock foundation	58.8	Shale Bedrock	< 64.0	-	-	-	-	-	1,500	-	-	64.2	63.9
		19-3508		58.4	FILL – Gravel Shale Bedrock	63.4 to 63.3 <63.3	- -	32 -	3.3 -	1.3 -	4,000 to 6,000 -	- 1,500	21 -	11.2 -		63.3
03X-0936/S0 (OHS-5)	116+161 Eastbound	19-3509	Standard	62.2	FILL – Sandy Silty Gravel TILL - Gravelly Silty Sand Silty Clay TILL - Silty Sand	67.2 to 66.7 66.7 to 64.3 64.3 to 63.2 63.2 to 60.8	- - 77 -	30 34 - 34	3.0 3.5 - 3.5	1.2 1.4 - 1.4	4,000 to 6,000 8,000 to 10,000 - 6,000 to 8,000	- - - -	19 21 18 21	- - 8.2 11.2	63.3	NA
		19-3510	Standard	61.8	FILL – Clayey Silt to Silty Clay FILL – Sandy Silty Gravel Silty Clay TILL – Silt TILL – Gravelly Sand	66.8 to 66.5 66.5 to 64.9 64.9 to 63.7 63.7 to 61.8 61.8 to 60.4	100 - 65 - -	- 28 - 30 34	- 2.8 - 3.0 3.5	- 1.0 - 1.2 1.4	- 2,000 to 4,000 - 3,000 to 4,000 6,000 to 8,000	- - - - -	18 19 18 20 21	- - - 10.2 11.2		NA

Table 14: Geotechnical Design Parameters for Overhead Sign Foundations - continued

Site (Overhead Sign) ¹	Highway 417 Stationing Direction ¹	Borehole	Foundation Design Approach	Bottom of Caisson Elevation (m)	Deposit Description	Approximate Deposit Elevation ² (m)	Soil Design Parameters ^{3,4}								Design Groundwater Elevation (m)	Auger Refusal Elevation (m)
							S _u (kPa)	ϕ' (°)	K _p ⁵	K _{p,2:1}	n _h (kPa/m)	f _{horz} (kPa)	γ (kN/m ³)	γ' (kN/m ³)		
03X-0935/S0 (OHS-6)	116+621 Eastbound	19-3511	Standard	59.2	Clay (Weathered Crust)	64.2 to 60.8	74	-	-	-	-	-	18	-	63.3	NA
					Silty Clay	60.8 to 59.1	43	-	-	-	-	-	18	8.2		
					TILL – Silty Gravelly Sand	59.1 to 57.8	-	32	3.3	1.3	4,000 to 6,000	-	21	11.2		
		19-3512	Standard	58.9	Clay (Weathered Crust)	63.9 to 61.2	74	-	-	-	-	-	18	-	63.3	NA
					Silty Clay	61.2 to 60.5	43	-	-	-	-	-	18	8.2		
					TILL – Silty Sand	60.5 to 57.5	-	34	3.5	1.4	6,000 to 8,000	-	21	11.2		

NOTES:

- *Deposit thickness for design to be considered ½ of the fill thickness presented.
1. Approximate stationing, direction, and description provided by WSP on December 3, 2019.
 2. Approximate deposit elevations are provided starting from the frost depth elevation (1.8 m below the existing ground surface elevations at the proposed sign support location).
 3. Design parameters:

S_u

= undrained shear strength (kPa)

ϕ'

= effective (drained) friction angle (degrees)

K_p

= passive earth pressure coefficient

K_{p,2:1}

= passive earth pressure coefficient for 2 H:1V sloping ground surface

n_h

= constant of horizontal subgrade reaction (kPa/m)

γ

= bulk unit weight (kN/m³)

γ'

= effective unit weight (below the groundwater level) (kN/m³)
 4. The resistance in the upper 1.8 m below ground surface should be neglected to account for frost action.
 5. The passive earth pressure coefficients provided assume a vertical foundation element, zero interface friction between the soil and the foundation element, and a horizontal backslope.



GOLDER



BOREHOLE CO-ORDINATES NAD83 (CSRS) MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
19-3501	65.6	5031560.1	374061.9
19-3502	65.9	5031574.3	374079.1
19-3503	71.0	5031680.4	374098.0
19-3504	69.3	5031664.7	374081.7
19-3505	66.2	5031187.9	374169.6
19-3506	65.2	5031196.8	374189.2
19-3507	65.6	5031235.0	374219.3
19-3508	65.2	5031228.4	374197.6
19-3509	69.0	5030012.4	375401.5
19-3510	68.6	5030019.1	375416.0
19-3511	66.0	5029599.2	375608.8
19-3512	65.7	5029612.1	375628.3

REFERENCE

Base plans provided in digital format by WSP, drawing file nos. XA1-NAD 83.dwg and XB1-NAD 83 (CSRS).dwg, received APR. 19, 2017.

NO.	DATE	BY	REVISION				
Geocres No. 31G5-319							
HWY. 417			PROJECT NO. 1662565-1350			DIST. EASTERN	
SUBM'D. SG		CHKD. MJK		DATE: 9/2/2020		SITE:	
DRAWN: JM		CHKD. CRG		APPD. MSS		DWG. 1	





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

CONT No.
GWP No. 4099-11-00



OVERHEAD SIGNS
HWY 417 - AVIATION PARKWAY TO RAMSAYVILLE ROAD
SITE NOS. 03X-0898/SO AND 03X-0897/SO
BOREHOLE LOCATIONS
LAT. 45.417277 LONG. -75.613366

SHEET



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

● Borehole - Current Investigation

BOREHOLE CO-ORDINATES NAD83 (CSRS) MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
19-3501	65.6	5031560.1	374061.9
19-3502	65.9	5031574.3	374079.1
19-3503	71.0	5031680.4	374098.0
19-3504	69.3	5031664.7	374081.7
19-3505	66.2	5031187.9	374169.6
19-3506	65.2	5031196.8	374189.2
19-3507	65.6	5031235.0	374219.3
19-3508	65.2	5031228.4	374197.6
19-3509	69.0	5030012.4	375401.5
19-3510	68.6	5030019.1	375416.0
19-3511	66.0	5029599.2	375608.8
19-3512	65.7	5029612.1	375628.3

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 Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by WSP, drawing file nos. XA1-NAD 83.dwg and XB1-NAD 83 (CSRS).dwg, received APR. 19, 2017.

PLAN

SCALE
10 0 10 20 m



NO.	DATE	BY	REVISION
Geocres No. 31C5-319			
HWY. 417		PROJECT NO. 1662565-1350	DIST. EASTERN
SUBM'D. SG	CHKD. MJK	DATE: 9/2/2020	SITE:
DRAWN: JM	CHKD. CRG	APPD. MSS	DWG. 2

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

HWY 417 - AVIATION PARKWAY TO RAMSAYVILLE ROAD
SITE NO. 03X-0936/SO
BOREHOLE LOCATIONS
LAT. 45.406555 LONG. -75.597900



SCALE



0 1 2 km

● Borehole – Current Investigation

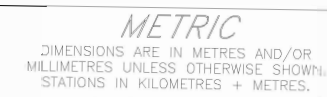
BOREHOLE CO-ORDINATES NAD83 (CSRS) MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
19-3501	65.6	5031560.1	374061.9
19-3502	65.9	5031574.3	374079.1
19-3503	71.0	5031680.4	374098.0
19-3504	69.3	5031664.7	374081.7
19-3505	66.2	5031187.9	374169.6
19-3506	65.2	5031196.8	374189.2
19-3507	65.6	5031235.0	374219.3
19-3508	65.2	5031228.4	374197.6
19-3509	69.0	5030012.4	375401.5
19-3510	68.6	5030019.1	375416.0
19-3511	66.0	5029599.2	375608.8
19-3512	65.7	5029612.1	375628.3

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Base plans provided in digital format by WSP, drawing file nos. XA1-NAD 83.dwg and XB1-NAD 83 (CSRS).dwg, received APR. 19, 2017.

[illegible]



BOREHOLE CO-ORDINATES NAD83 (CSRS) MTM ZONE 9			
No.	ELEVATION	NORTHING	EASTING
19-3501	65.6	5031560.1	374061.9
19-3502	65.9	5031574.3	374079.1
19-3503	71.0	5031680.4	374098.0
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19-3507	65.6	5031235.0	374219.3
19-3508	65.2	5031228.4	374197.6
19-3509	69.0	5030012.4	375401.5
19-3510	68.6	5030019.1	375416.0
19-3511	66.0	5029599.2	375608.8
19-3512	65.7	5029612.1	375628.3

NOTES

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REFERENCE

Base plans provided in digital format by WSP, drawing file nos. XA1–NAD 83.dwg and XB1–NAD 83 (CSRS).dwg, received APR. 19, 2017.

NO.	DATE	BY	REVISION		
socrates No. 31G5-319					
WY. 417		PROJECT NO. 1662565-1350		DIST. EASTERN	
SUBM'D. SG		CHKD. MJK	DATE: 9/2/2020		SITE:
DRAWN: JM		CHKD. CRG	APPD. MGS		DWG. 4



APPENDIX A

Borehole and Drillhole Records

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Records of Boreholes 19-3501 to 19-3512

Figures A1 to A16 – Bedrock Core Photographs

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3501		SHEET 1 OF 2		METRIC								
G.W.P.		4099-11-00		LOCATION		N 5031560.1; E 374061.9 NAD 83 MTM ZONE 9 (LAT. 45.420556; LONG. -75.614980)		ORIGINATED BY JS								
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS								
DATUM		Geodetic		DATE		August 14, 2019		CHECKED BY CRG								
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								
65.6	GROUND SURFACE															
65.0	ASPHALTIC CONCRETE															
0.2	(SW) Gravelly sand, some silt (FILL)		1	GS	-											
65.1	Brown Moist															
0.5	(SM/GM) Sandy gravel, some silt (FILL)		2	SS	39											
64.2	Dense Dark brown Moist															
1.4	(GW/SW) GRAVEL and SAND, some silt, contains cobbles and weathered shale bedrock (TILL)		3	SS	85											
64.2	Very dense Black to dark grey brown Wet to Moist															
62.6			4	SS	50/0.13											
3.1	Shale (BEDROCK)		5	SS	50/0.10											
	Bedrock cored from depths 3.1 m to 6.0 m															
	For bedrock coring details refer to Record of Drillhole 19-3501		1	RC	REC 100%											
			2	RC	REC 93%											
59.6																
6.0	END OF BOREHOLE															

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3501

SHEET 2 OF 2

LOCATION: N 5031560.1 ;E 374061.9

DRILLING DATE: August 14, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							TOTAL CORE % 000000 000000	SOLID CORE % 000000 000000				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³	10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³	W1 W2 W3 W4 W5 W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
		BEDROCK SURFACE		62.57																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

DEPTH SCALE

1 : 50



LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER.GDS\CTXP\PROFILES\NAZSAUVE\CTXREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3502		SHEET 1 OF 2		METRIC									
G.W.P.		4099-11-00		LOCATION		N 5031574.3; E 374079.1 NAD 83 MTM ZONE 9 (LAT. 45.420682; LONG. -75.614758)		ORIGINATED BY JS									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS									
DATUM		Geodetic		DATE		August 13, 2019		CHECKED BY CRG									
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									
65.9	GROUND SURFACE							20	40	60	80	100					
0.0	(ML) Silty sand, trace gravel, contains organic matter (rootlets) (FILL) Brown Dry		1	GS	-												
65.3																	
0.6	(SM) SILTY gravelly SAND, contains cobbles (TILL) Dense Dark brown to grey Moist		2	SS	43												22 44 27 7
			3	SS	25												
63.6																	
2.3	Shale (BEDROCK) Highly weathered		4	SS	50/0.13												
63.0																	
2.9	Shale (BEDROCK)																
	Bedrock cored from depths 2.9 m to 6.0 m																
	For bedrock coring details refer to Record of Drillhole 19-3502		1	RC	REC 98%												RQD = 71%
			2	RC	REC 100%												RQD = 88%
60.0																	
6.0	END OF BOREHOLE																

GTA-MTO 001 \GOLDER\GDS\CTXP\FILES\NAZSAUVE\CTXPREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-GTA.GDT 9/2/20 ZS

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Downing Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER.GDS\CTX\PROFILES\NAZSAUVE\CTXREDIRECT\DESKTOP\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT 1662565-1350		RECORD OF BOREHOLE No 19-3503		SHEET 1 OF 3		METRIC											
G.W.P. 4099-11-00		LOCATION N 5031680.4; E 374098.0 NAD 83 MTM ZONE 9 (LAT. 45.421635; LONG. -75.614502)		ORIGINATED BY JS													
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS													
DATUM Geodetic		DATE August 6-7, 2019		CHECKED BY CRG													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL
71.0	GROUND SURFACE																
0.0	ASPHALTIC CONCRETE																
0.1	(SW) Gravelly sand, some silt (FILL) Compact Brown/grey Moist		1	GS	-												
70.4																	
0.6	(SM) Silty sand, some gravel to gravelly, contains shale fragments and cobbles (FILL) Compact Brown-grey Moist		2	SS	21		70							21	44	24	11
			3	SS	17		69										
			4	SS	30												
68.1																	
2.9	(ML/SM) Silt and sand, some clay, contains cobbles (FILL) Loose to compact Brown Moist		5	SS	8		68										
			6	SS	12		67							5	36	42	17
66.4																	
4.6	(SM) SILTY gravelly SAND, contains weathered shale cobbles (TILL) Very dense to dense Grey Moist		7	SS	56		66							21	44	28	7
			8	SS	97		65										
			9	SS	39									30	47	17	6
64.1																	
6.9	Shale (BEDROCK) Bedrock cored from depths 6.9 m to 10.4 m For bedrock coring details refer to Record of Drillhole 19-3503		10	SS	50/0.03		64										
			1	RC	REC 99%		63										RQD = 26%
			2	RC	REC 100%		62										RQD = 33%
			3	RC	REC 100%												RQD = 21%

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 \GOLDER\GDS\CTXPFILES\NAZSAUVECTXPREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-GTA.GDT 9/2/20 ZS

PROJECT		RECORD OF BOREHOLE				No 19-3503		SHEET 2 OF 3		METRIC							
G.W.P. 4099-11-00		LOCATION				N 5031680.4; E 374098.0 NAD 83 MTM ZONE 9 (LAT. 45.421635; LONG. -75.614502)				ORIGINATED BY JS							
DIST Eastern HWY 417		BOREHOLE TYPE				Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core				COMPILED BY ZS							
DATUM Geodetic		DATE				August 6-7, 2019				CHECKED BY CRG							
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									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
60.6	END OF BOREHOLE		3	RC	REC 100%												RQD = 21%
10.4	NOTES: 1. Water level in well screen at a depth of 6.4 m below ground surface (Elev. 64.6 m), measured on Nov. 6, 2019.																

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3503

SHEET 3 OF 3

LOCATION: N 5031680.4 ;E 374098.0

DRILLING DATE: August 6-7, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY																FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
				ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER-GDS\CTXP\FILES\NA\ZSAUVE\CTXREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3504		SHEET 1 OF 2		METRIC									
G.W.P.		4099-11-00		LOCATION		N 5031664.7; E 374081.7 NAD 83 MTM ZONE 9 (LAT. 45.421495; LONG. -75.614712)		ORIGINATED BY JS									
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS									
DATUM		Geodetic		DATE		August 7, 2019		CHECKED BY CRG									
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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
69.3	GROUND SURFACE																
0.0	ASPHALTIC CONCRETE																
0.2	(SW) Gravelly sand, some silt, angular (FILL)		1	GS	-												
68.8	Grey Moist																
0.5	(SM) Silty sand, some gravel (FILL)																
	Compact Brown/grey Moist		2	SS	26												19 55 21 5
67.8																	
1.5	(SM/ML) Sand and silt, some gravel (FILL)																
	Compact to dense Dark brown to brown, mottled Moist		3	SS	13												
66.3																	
3.0	(SM) Gravelly SILTY SAND, contains shale fragments (TILL)																
	Very dense Dark grey/black Moist		5	SS	54												
66.3																	
			6	SS	94/0.10												27 51 17 5
64.7																	
4.6	Shale (BEDROCK) Highly weathered		7	SS	50/0.13												
64.1																	
5.2	Shale (BEDROCK)																
	Bedrock cored from depths 5.2 m to 8.4 m		1	RC	REC 100%												RQD = 71%
	For bedrock coring details refer to Record of Drillhole 19-3504																
			2	RC	REC 100%												RQD = 83%
			3	RC	REC 100%												RQD = 71%
60.9																	
8.4	END OF BOREHOLE																

SHEET 2 OF 2

DATUM: Geodetic

DRILLING CONTRACTOR: Downing Drilling

[illegible]

DEPTH SCALE

1 : 50



GOLDER

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \GOLDER.GDS\CTX\PROFILES\A\ZSAUVE\CTX\REDIRECT\DESKTOP\1662565-1350\GPJ GAL-MISS.GDT 9/2/20 ZS

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3505

SHEET 2 OF 2

LOCATION: N 5031187.9 ;E 374169.6

DRILLING DATE: August 14, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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							TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Js	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	W1	W2		W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER-GDS\CTXP\FILES\NAZSAUVE\CTXREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3506		SHEET 1 OF 2		METRIC																
G.W.P.		4099-11-00		LOCATION		N 5031196.8; E 374189.2 NAD 83 MTM ZONE 9 (LAT. 45.417270; LONG. -75.613400)		ORIGINATED BY JS																
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS																
DATUM		Geodetic		DATE		August 8, 2019		CHECKED BY CRG																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
65.2	0.0	GROUND SURFACE																						
	0.2	(ML) Clayey silt, some sand (TOPSOIL) Brown Moist		1	GS	-																		
	0.4	(CL) Silty clay, some sand, contains wood fibers (FILL) Brown Moist		2	SS	50/0.10																		
	0.8	Shale (BEDROCK) Highly Weathered																						
	1.6	Shale (BEDROCK)																						
		Bedrock cored from depths 1.6 m to 5.1 m		1	RC	REC 100%																		RQD = 61%
		For bedrock coring details refer to Record of Drillhole 19-3506		2	RC	REC 100%																		RQD = 51%
				3	RC	REC 100%																		RQD = 86%
60.1	5.1	END OF BOREHOLE																						
		NOTES:																						
		1. Water level in well screen at a depth of 1.0 m below ground surface (Elev. 64.2 m), measured on Nov. 7, 2019.																						

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3506

SHEET 2 OF 2

LOCATION: N 5031196.8 ;E 374189.2

DRILLING DATE: August 8, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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							TOTAL CORE %	SOLID CORE %			DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Js	10 ⁻⁵	10 ⁻³	10 ⁻¹	10 ¹	W1	W2		W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER\GDS\CTXP\FILES\NA\ZSAUVE\CTXP\REDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		RECORD OF BOREHOLE No 19-3507				SHEET 1 OF 2		METRIC									
G.W.P. 4099-11-00		LOCATION N 5031235.0; E 374219.3 NAD 83 MTM ZONE 9 (LAT. 45.417615; LONG. -75.613015)				ORIGINATED BY JS											
DIST Eastern HWY 417		BOREHOLE TYPE Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core				COMPILED BY ZS											
DATUM Geodetic		DATE August 6, 2019				CHECKED BY CRG											
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									
65.6	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALTIC CONCRETE																
0.1	(SW) Gravelly sand, some silt (FILL)																
65.1	Compact Brown Moist																
0.5	(SM) Gravelly silty sand (FILL)																
	Loose Brown, mottled Moist		2	SS	8												
64.0			3	SS	50/0.13												25 41 21 13
1.7	Shale (BEDROCK)																
	Bedrock cored from depths 1.7 m to 5.1 m																
	For bedrock coring details refer to Record of Drillhole 19-3507		1	RC	REC 91%												RQD = 61%
			2	RC	REC 100%												RQD = 73%
			3	RC	REC 100%												RQD = 81%
60.5																	
5.1	END OF BOREHOLE																
	NOTES:																
	1. Water level in well screen at a depth of 2.5 m below ground surface (Elev. 62.7 m), measured on Jan. 22, 2020.																

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3507

SHEET 2 OF 2

LOCATION: N 5031235.0 ;E 374219.3

DRILLING DATE: August 6, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
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DEPTH SCALE

1 : 50

**GOLDER**

LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER\GDS\CTXP\FILES\NA\ZSAUVE\CTXP\REDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3508		SHEET 1 OF 2		METRIC										
G.W.P.		4099-11-00		LOCATION		N 5031228.4; E 374197.6 NAD 83 MTM ZONE 9 (LAT. 45.417558; LONG. -75.613293)		ORIGINATED BY JS										
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)/Rotary Drill, NQ Core		COMPILED BY ZS										
DATUM		Geodetic		DATE		August 13, 2019		CHECKED BY CRG										
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										WATER CONTENT (%)
65.2	GROUND SURFACE							20	40	60	80	100						
0.0	(SW) Sand, trace gravel, trace silt (FILL) Dark brown Moist		1	GS	-		65											
64.7																		
0.5	(SM) Silty sand, trace gravel (FILL) Compact Light brown Moist		2	SS	17		64											5 57 32 6
63.8																		
1.4	(GW) Gravel, some sand (FILL) Brown Wet		3	SS	50/0.05													
63.3																		
1.9	Interbedded Shale and Limestone (BEDROCK) Bedrock cored from depths 1.9 m to 5.3 m For bedrock coring details refer to Record of Drillhole 19-3508		1	RC	REC 92%		63											RQD = 41%
			2	RC	REC 100%		62											RQD = 76%
							61											
			3	RC	REC 100%													RQD = 26%
59.9							60											
5.3	END OF BOREHOLE																	

PROJECT: 1662565-1350

RECORD OF DRILLHOLE: 19-3508

SHEET 2 OF 2

LOCATION: N 5031228.4 ;E 374197.6

DRILLING DATE: August 13, 2019

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Downing Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
		BEDROCK SURFACE		63.33																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

DEPTH SCALE

1 : 50



LOGGED: JS

CHECKED: CRG

GTA-RCK 031 \\GOLDER.GDS\CTXP\FILES\NAZSAUVE\CTXREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-MISS.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3509		SHEET 1 OF 1		METRIC								
G.W.P.		4099-11-00		LOCATION		N 5030012.4; E 375401.5 NAD 83 MTM ZONE 9 (LAT. 45.406497; LONG. -75.598086)		ORIGINATED BY JS								
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS								
DATUM		Geodetic		DATE		August 5, 2019		CHECKED BY CRG								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
69.0	GROUND SURFACE															
0.0	(SM) Silty sand, some gravel (FILL) Grey Moist		1	GS	-											
68.4	(GW/GM) Sandy silty gravel, contains shale fragments (FILL) Compact to loose Grey-brown to grey Moist		2	SS	16											36 32 25 7
			3	SS	9											
66.7	(SM) Gravelly SILTY SAND, contains shale fragments (TILL) Dense to compact Grey to black Moist to wet		4	SS	37											32 36 25 7
2.3			5	SS	13											
			6	SS	17											
64.4	(CI) SILTY CLAY Stiff Grey w>PL		7	SS	2											0 2 68 30
4.6																
63.3	(SM) SILTY SAND, some gravel, contains clayey silt layers (TILL) Compact Grey Wet		8	SS	11											
5.7			9	SS	16											14 62 21 3
			10	SS	16											
60.8	END OF BOREHOLE															
8.2	NOTES: 1. Water level in well screen at a depth of 5.7 m below ground surface (Elev. 63.3 m), measured on Nov. 6, 2019.															

PROJECT		RECORD OF BOREHOLE				No 19-3510		SHEET 1 OF 1		METRIC							
G.W.P.		4099-11-00		LOCATION		N 5030019.1; E 375416.0 NAD 83 MTM ZONE 9 (LAT. 45.406556; LONG. -75.597900)				ORIGINATED BY		JS					
DIST		Eastern		HWY		417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)				COMPILED BY		ZS	
DATUM		Geodetic		DATE		August 11, 2019				CHECKED BY		CRG					
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								WATER CONTENT (%)	
68.6	GROUND SURFACE																
0.0	(SM) Silty sand, some gravel (TOPSOIL)																
0.2	Brown Moist		1	GS	-												
	(SM) Gravelly silty sand (FILL) Compact grey Dry		2	SS	21		68								35 39 20 6		
67.2																	
1.4	(CL/CI) Clayey silt to silty clay, some sand, trace gravel (FILL) Very stiff Brown		3	SS	12		67										
66.5																	
2.1	(GM) Sandy silty gravel (FILL) Compact to loose Grey-brown to grey Moist to wet		4	SS	21		66								52 26 16 6		
			5	SS	9												
64.9							65										
3.7	(CI) SILTY CLAY, some sand Stiff Grey-brown Wet		6	SS	3												
							64										
63.7																	
4.9	(ML) SILT, some sand, some clay (TILL) Loose Grey to grey-brown Wet		7	SS	5		63								3 19 61 17		
			8	SS	4												
61.8							62										
6.8	(SW) Gravelly SAND (TILL) Compact to dense Grey Wet		9	SS	9										18 80 2 0		
			10	SS	32		61										
60.4																	
8.2	END OF BOREHOLE																

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 \GOLDER\GDS\CTXP\FILES\NAZSAUVE\CTXPREDIRECT\DESKTOP\1662565-1350\1662565-1350.GPJ GAL-GTA.GDT 9/2/20 ZS

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3511		SHEET 1 OF 1		METRIC					
G.W.P.		4099-11-00		LOCATION		N 5029599.2; E 375608.8 NAD 83 MTM ZONE 9 (LAT. 45.402758; LONG. -75.595498)		ORIGINATED BY JS					
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS					
DATUM		Geodetic		DATE		August 5, 2019		CHECKED BY CRG					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	25 50 75		
66.0	GROUND SURFACE												
0.0	(SW) Gravelly sand (FILL) Brown Moist		1	GS	-								
65.2													
0.8	(GM/SM) Gravel and sand, some silt, contains shale fragments (FILL) Compact Grey-brown Moist		2	SS	19								40 36 19 5
64.3													
1.7	(CH) CLAY, trace fine sand, fissured (WEATHERED CRUST) Very stiff to stiff Brown, mottled w>PL		3	SS	8								
			4	SS	9								0 5 51 44
			5	SS	5								
			6	SS	3								
60.8													
5.2	(CI) SILTY CLAY, some sand Firm Grey w>PL		7	SS	4								
59.1													
6.9	(SM) SILTY gravelly SAND (TILL) Very loose Grey Moist		8	SS	2								18 41 32 9
			9	SS	3								
57.8													
8.2	END OF BOREHOLE												
NOTES: 1. Water level in well screen at a depth of 2.8 m below ground surface (Elev. 63.2 m), measured on Nov. 6, 2019.													

PROJECT		1662565-1350		RECORD OF BOREHOLE No 19-3512		SHEET 1 OF 1		METRIC								
G.W.P.		4099-11-00		LOCATION		N 5029612.1; E 375628.3 NAD 83 MTM ZONE 9 (LAT. 45.402872; LONG. -75.595247)		ORIGINATED BY JS								
DIST		Eastern HWY 417		BOREHOLE TYPE		Power Auger, 200 mm Diam. (Hollow Stem)		COMPILED BY ZS								
DATUM		Geodetic		DATE		August 11, 2019		CHECKED BY CRG								
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								
65.7	GROUND SURFACE															
0.0	(ML) Sandy silt (TOPSOIL) Brown															
0.2	(SM/ML) Silty sand to sandy silt, some clay (FILL) Compact Brown Moist		1	AS	-											
			2	SS	20											
64.0																
1.7	(CH) CLAY, trace to some fine sand, fissured (WEATHERED CRUST) Very stiff to stiff Brown to grey, mottled w>PL		3	SS	10											
			4	SS	14											
			5	SS	6											
			6	SS	4											
61.2																
4.5	(CI) SILTY CLAY, contains silt seams Very stiff Grey w>PL		7	SS	5											
60.5																
5.2	(SM) SILTY SAND, trace to some gravel (TILL) Loose Grey to dark brown Moist to wet		8	SS	5											
			9	SS	5											
			10	SS	8											
			11	SS	8											
57.5																
8.2	END OF BOREHOLE															

BH 19-3501 (Dry)
Cored Length of 62.57 to 59.60 metres
Core Box 1 to 2 of 2

Elevation 62.57 m Top of intact bedrock



Elevation 59.60 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3501 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A1

BH 19-3501 (Wet)
Cored Length of 62.57 to 59.60 metres
Core Box 1 to 2 of 2

Elevation 62.57 m Top of intact



Elevation 59.60 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



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DESIGN	MS
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APPROVED	

PROJECT
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Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3501 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI A

1 in

0

BH 19-3502 (Dry)
Cored Length of 63.00 to 59.99 metres
Core Box 1 to 2 of 2

Elevation 63.00 m Top of intact bedrock



Elevation 59.99 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

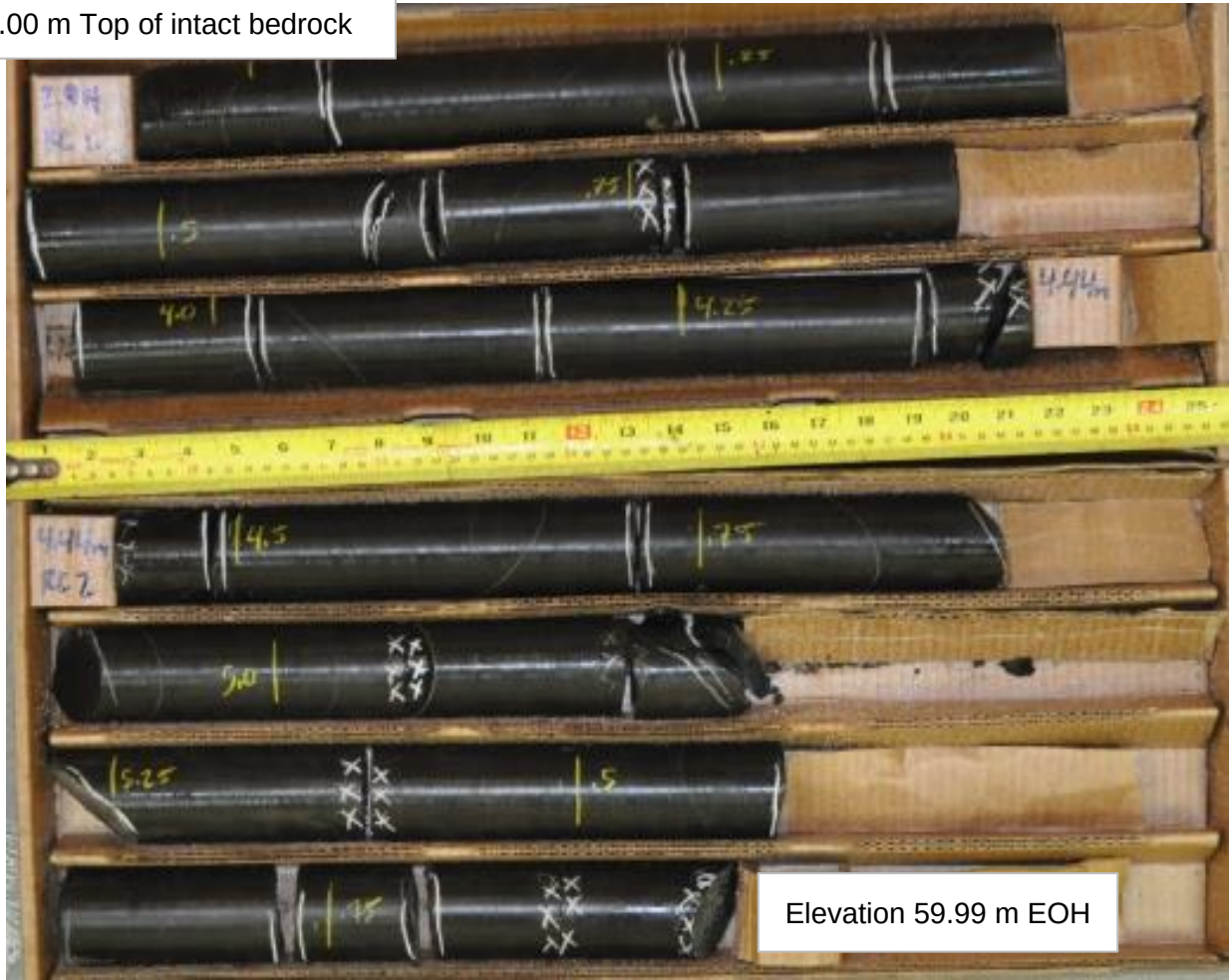
PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3502 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A3

BH 19-3502 (Wet)
Cored Length of 63.00 to 59.99 metres
Core Box 1 to 2 of 2

Elevation 63.00 m Top of intact bedrock



Elevation 59.99 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
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DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3502 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A4

BH 19-3503 (Dry)
Cored Length of 64.14 to 60.61 metres
Core Box 1 to 2 of 2

Elevation 64.14 m Top of intact bedrock



Elevation 60.61 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3503 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A5

BH 19-3503 (Wet)
Cored Length of 64.14 to 60.61 metres
Core Box 1 to 2 of 2

Elevation 64.14 m Top of intact bedrock



Elevation 60.61 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3503 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A6

BH 19-3504 (Dry)
Cored Length of 64.12 to 60.92 metres
Core Box 1 to 2 of 2

Elevation 64.12 m Top of intact bedrock



Elevation 60.92 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3504 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A7

BH 19-3504 (Wet)
Cored Length of 64.12 to 60.92 metres
Core Box 1 to 2 of 2

Elevation 64.12 m Top of intact bedrock



Elevation 60.92 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3504 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A8

BH 19-3505 (Dry)
Cored Length of 63.27 to 60.27 metres
Core Box 1 to 2 of 2

Elevation 63.27 m Top of intact bedrock



Elevation 60.27 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3505 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A9

BH 19-3505 (Wet)
Cored Length of 63.27 to 60.27 metres
Core Box 1 to 2 of 2

Elevation 63.27 m Top of intact bedrock



Elevation 60.27 m EOH

CLIENT
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PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3505 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A10

BH 19-3506 (Dry)
Cored Length of 63.50 to 60.04 metres
Core Box 1 to 2 of 2

Elevation 63.5 m Top of intact bedrock



Elevation 60.04 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY 2019-08-21
PREPARED MS
DESIGN MS
REVIEW CRG
APPROVED

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3506 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A11

BH 19-3506 (Wet)
Cored Length of 63.50 to 60.04 metres
Core Box 1 to 2 of 2

Elevation 63.5 m Top of intact bedrock



Elevation 60.04 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

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PREPARED MS
DESIGN MS
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APPROVED

PROJECT
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Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3506 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A12

BH 19-3507 (Dry)
Cored Length of 63.67 to 60.45 metres
Core Box 1 to 2 of 2

Elevation 63.67 m Top of intact bedrock



Elevation 60.45 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3507 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A13

BH 19-3507 (Wet)
Cored Length of 63.67 to 60.45 metres
Core Box 1 to 2 of 2

Elevation 63.67 m Top of intact bedrock



Elevation 60.45 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
PREPARED	MS
DESIGN	MS
REVIEW	CRG

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3507 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
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BH 19-3508 (Dry)
Cored Length of 63.33 to 59.91 metres
Core Box 1 to 2 of 2

Elevation 63.33 m Top of intact bedrock



Elevation 59.91 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY	2019-08-21
PREPARED	MS
DESIGN	MS
REVIEW	CRG
APPROVED	

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3508 (DRY)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A15

BH 19-3508 (Wet)
Cored Length of 63.33 to 59.91 metres
Core Box 1 to 2 of 2

Elevation 63.33 m Top of intact bedrock



Elevation 59.91 m EOH

CLIENT
Ministry Of Transportation Ontario (MTO)

CONSULTANT



DD/MM/YYYY 2019-08-21
PREPARED MS
DESIGN MS
REVIEW CRG
APPROVED

PROJECT
Highway 417 Aviation Parkway to Ramsayville Road
Overhead Signs
Ottawa, Ontario

TITLE
**BOREHOLE 19-3508 (WET)
CORE PHOTOGRAPHS**

PROJECT No.	PHASE	Rev.	FIGURE
1662565	1350	A	A16

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN ADJUSTED FROM A16 TO A17

APPENDIX B

Laboratory Test Results

Figure B1 – Grain Size Distribution Test Results – Sandy Gravel Some Silt (FILL)

Figure B2 – Grain Size Distribution Test Results – Silty Gravel and Sand (TILL)

Figure B3 – Grain Size Distribution Test Results – Silty Gravelly Sand (FILL)

Figure B4 – Grain Size Distribution Test Results – Silt and Sand (FILL)

Figure B5 – Grain Size Distribution Test Results – Silty Gravelly Sand (TILL)

Figure B6 – Grain Size Distribution Test Results – Sand and Gravel (TILL)

Figure B7 – Plasticity Chart – Clayey Silt

Figure B8 – Grain Size Distribution Test Results – Gravelly Silty Sand (FILL)

Figure B9 – Grain Size Distribution Test Results – Sandy Silty Gravel (FILL)

Figure B10 – Grain Size Distribution Test Results – Gravelly Silty Sand (FILL)

Figure B11 – Grain Size Distribution Test Results – Gravelly Silty Sand (TILL)

Figure B12 – Grain Size Distribution Test Results – Silty Clay

Figure B13 – Plasticity Chart – Silty Clay

Figure B14 – Grain Size Distribution Test Results – Silt (TILL)

Figure B15 – Grain Size Distribution Test Results – Sand Some Gravel (TILL)

Figure B16 – Grain Size Distribution Test Results – Gravel and Sand (FILL)

Figure B17 – Grain Size Distribution Test Results – Clay

Figure B18 – Plasticity Chart – Clay

Figure B19 – Plasticity Chart – Silty Clay

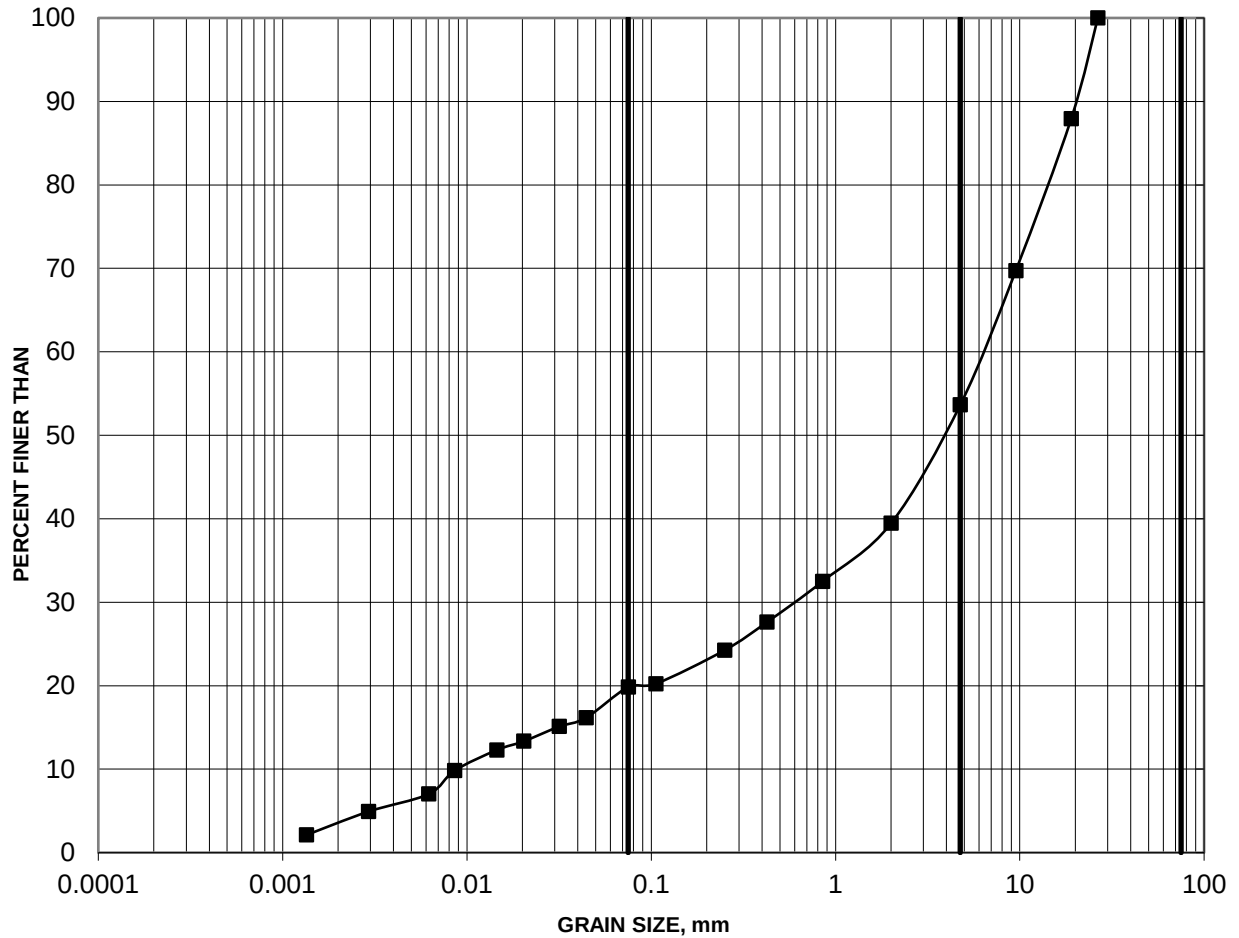
Figure B20 – Grain Size Distribution Test Results – Silty Sand (TILL)

Figure B21 – Summary of Unconfined Compressive Strength Testing

GRAIN SIZE DISTRIBUTION

FIGURE B1

SANDY GRAVEL SOME SILT (FILL)



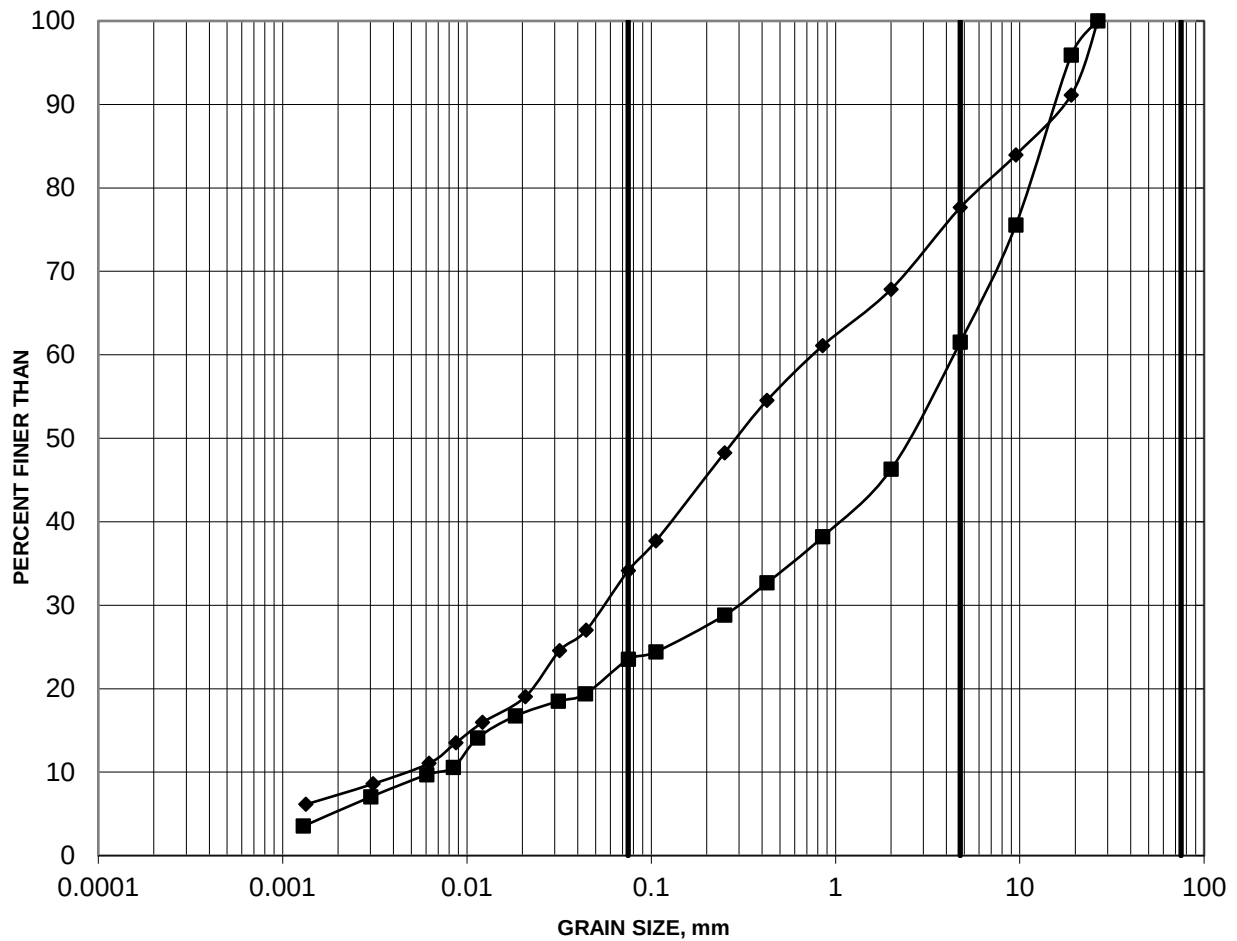
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3501	2	0.76-1.37

GRAIN SIZE DISTRIBUTION

FIGURE B2

SANDY GRAVEL AND SILTY SAND (TILL)



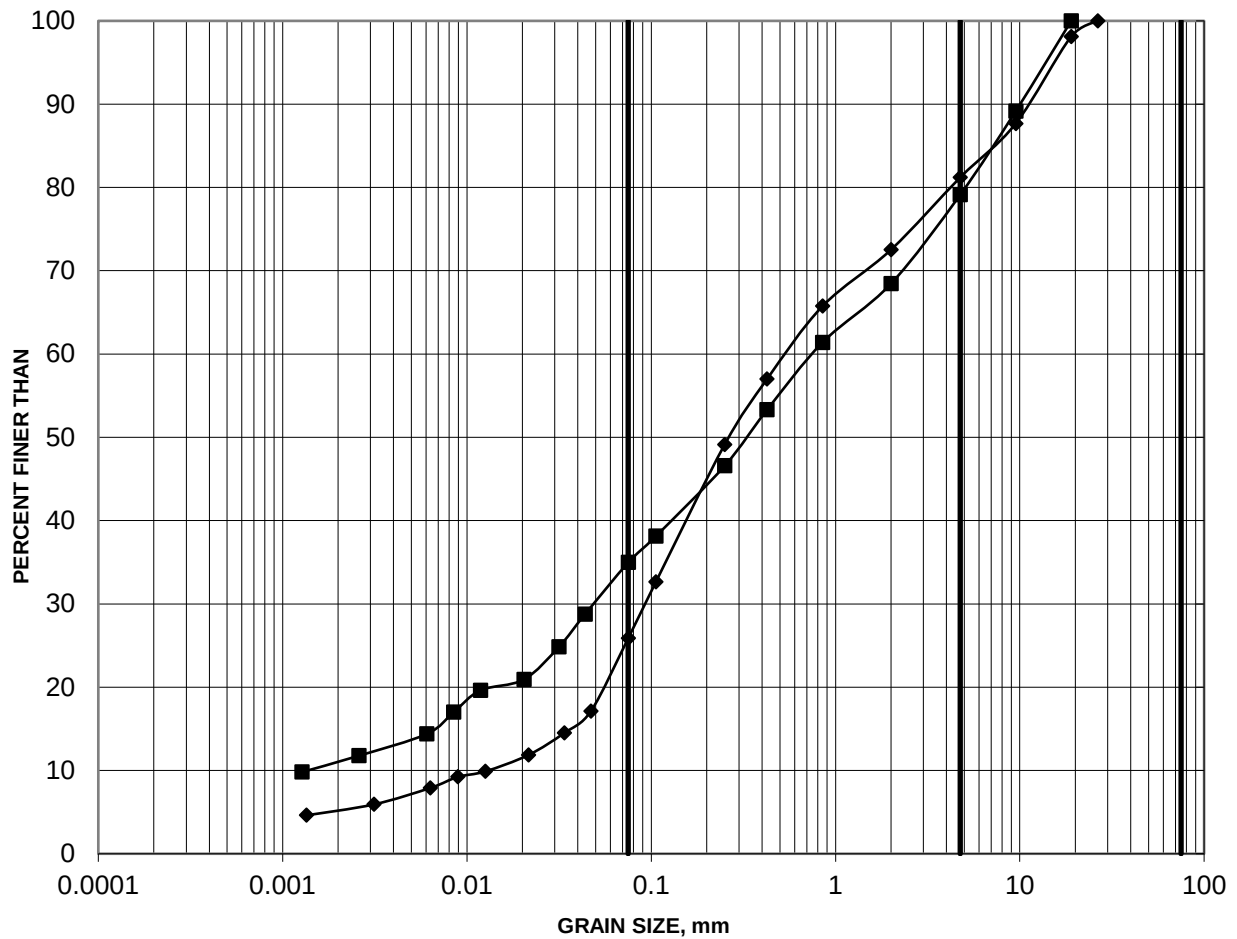
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3501	3	1.52-2.13
19-3502	2	0.76-1.37

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY SAND (FILL)

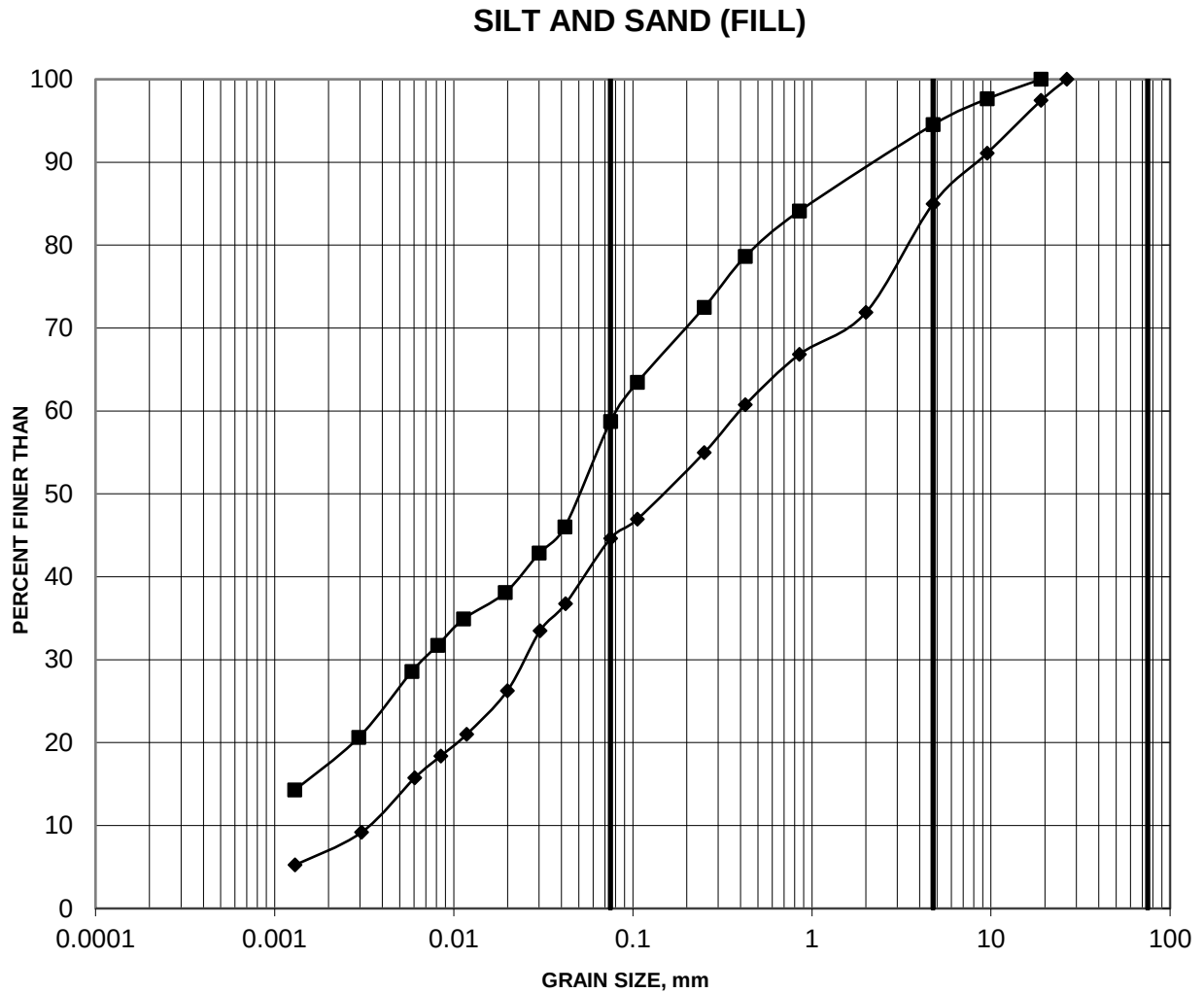


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3503	2	0.76-1.37
19-3504	2	0.76-1.37

GRAIN SIZE DISTRIBUTION

FIGURE B4



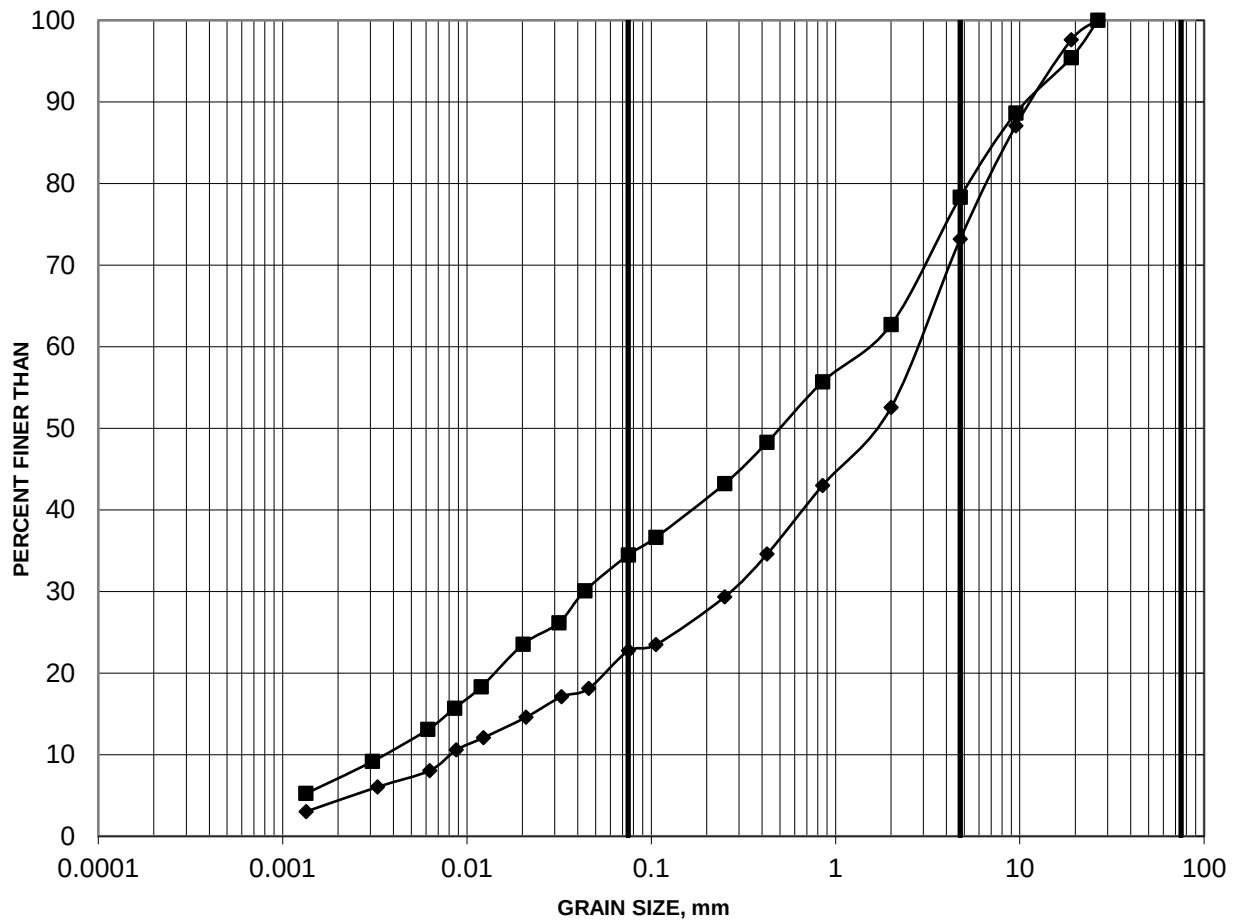
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
■ 19-3503	6	3.81-4.42
◆ 19-3504	4	2.29-2.90

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY GRAVELLY SAND (TILL)



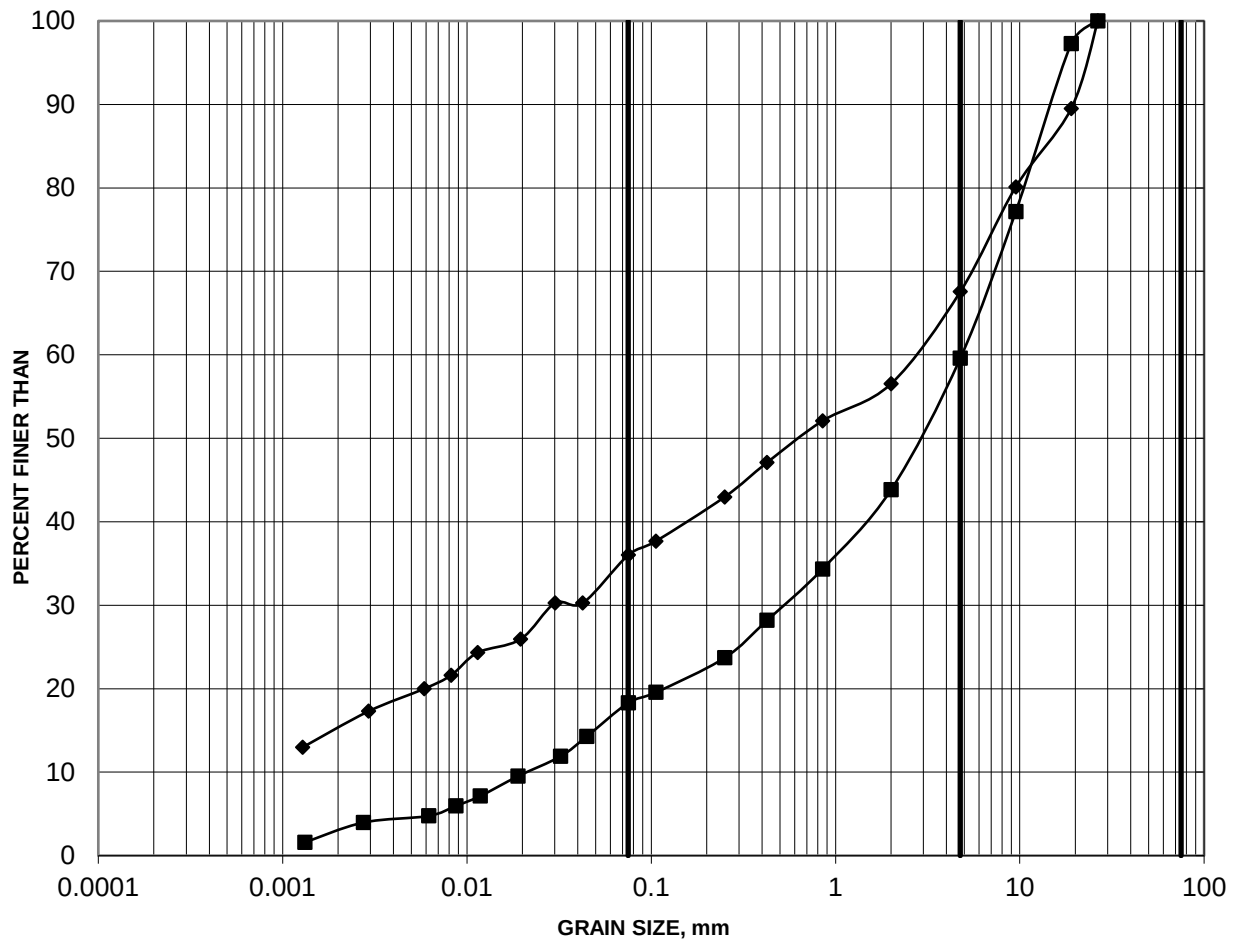
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3503	7	4.57-5.18
19-3504	6	3.81-4.42

GRAIN SIZE DISTRIBUTION

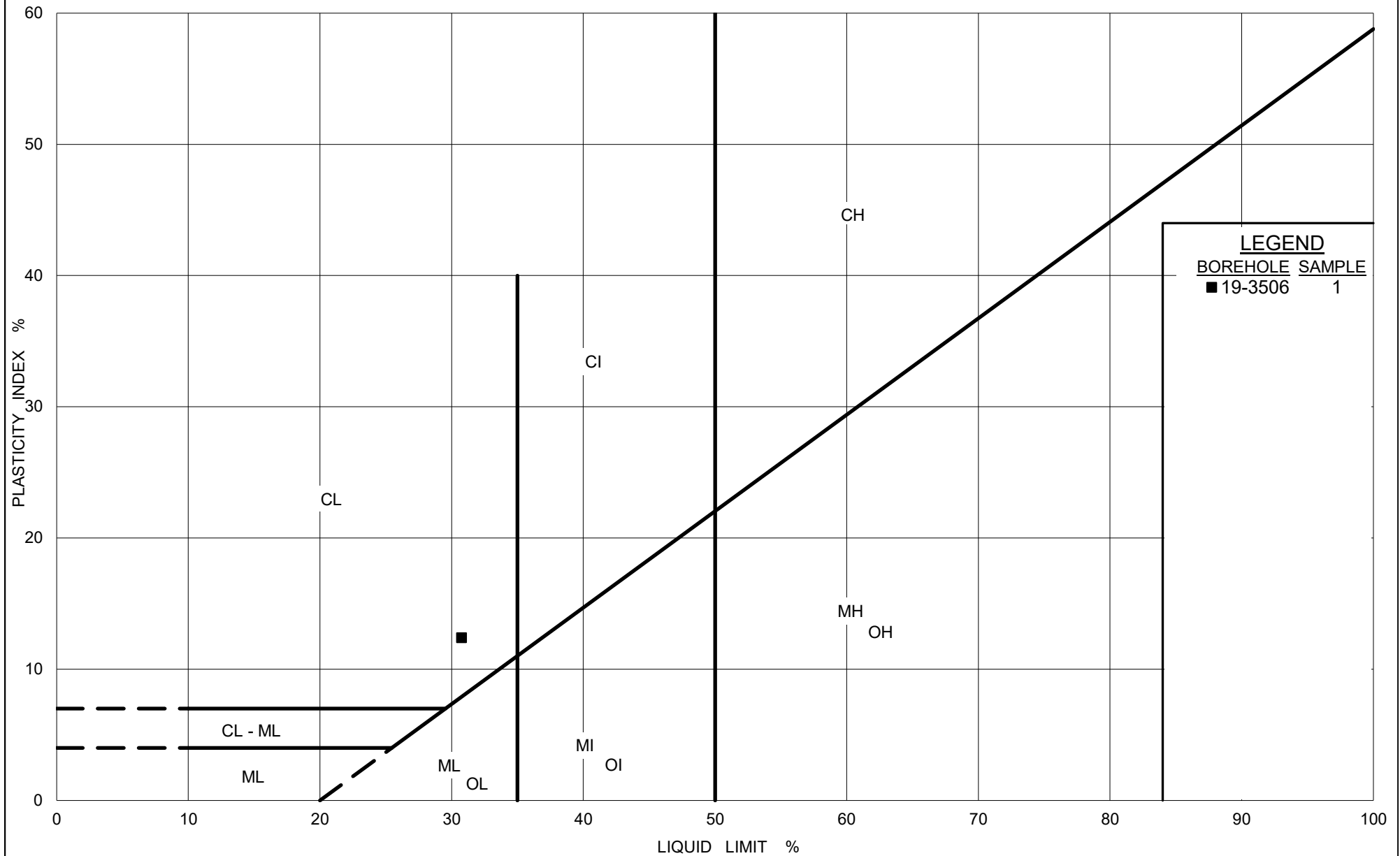
FIGURE B6

SAND AND GRAVEL SOME SILT / GRAVELLY SILTY SAND (FILL)



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

Borehole	Sample	Depth (m)
19-3505	1	0.25-0.55
19-3505	2	0.76-1.37



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PLASTICITY CHART CLAYEY SILT

FIGURE B7

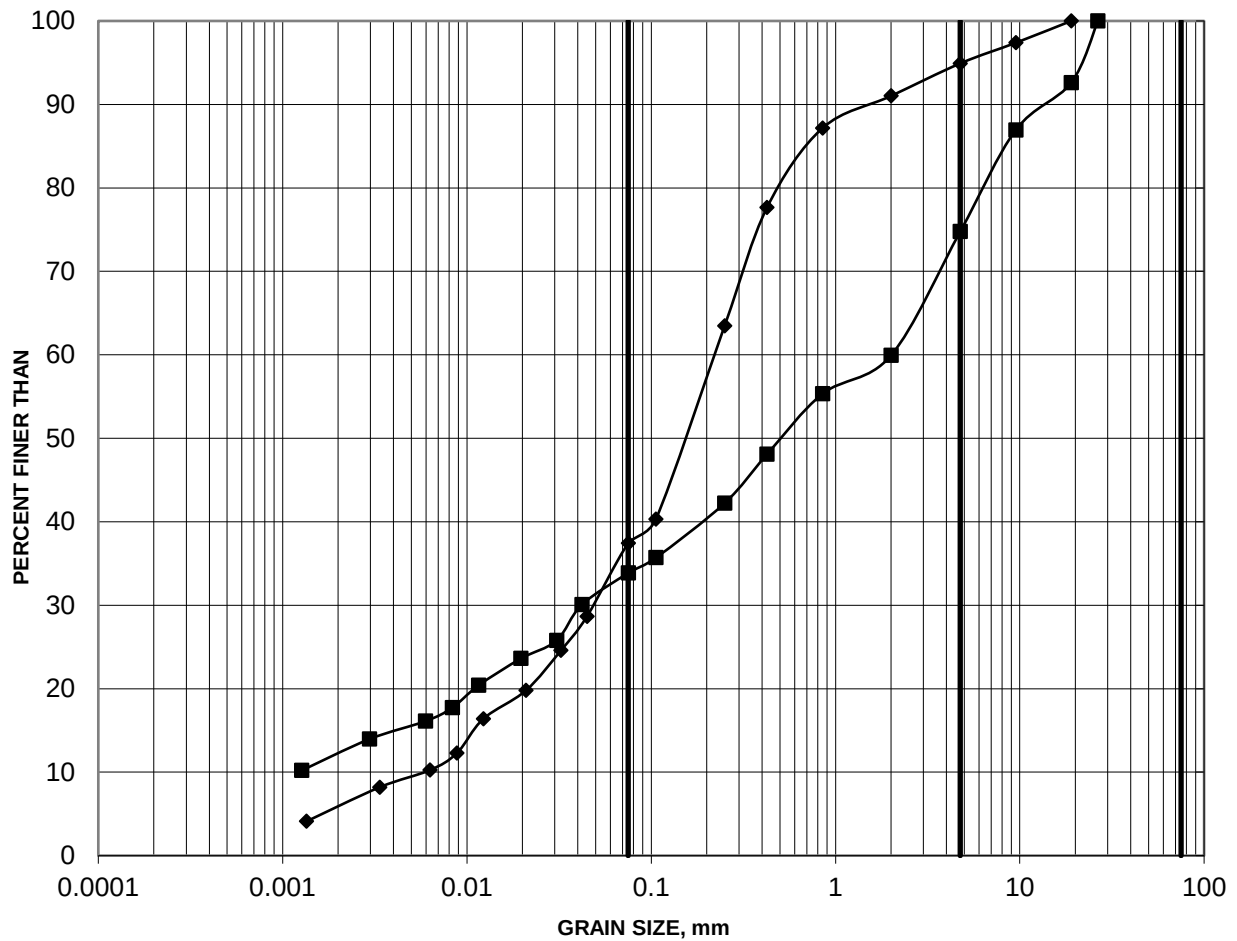
Project No. 1662565/1350

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GRAIN SIZE DISTRIBUTION

FIGURE B8

GRAVELLY SILTY SAND / SILTY SAND (FILL)



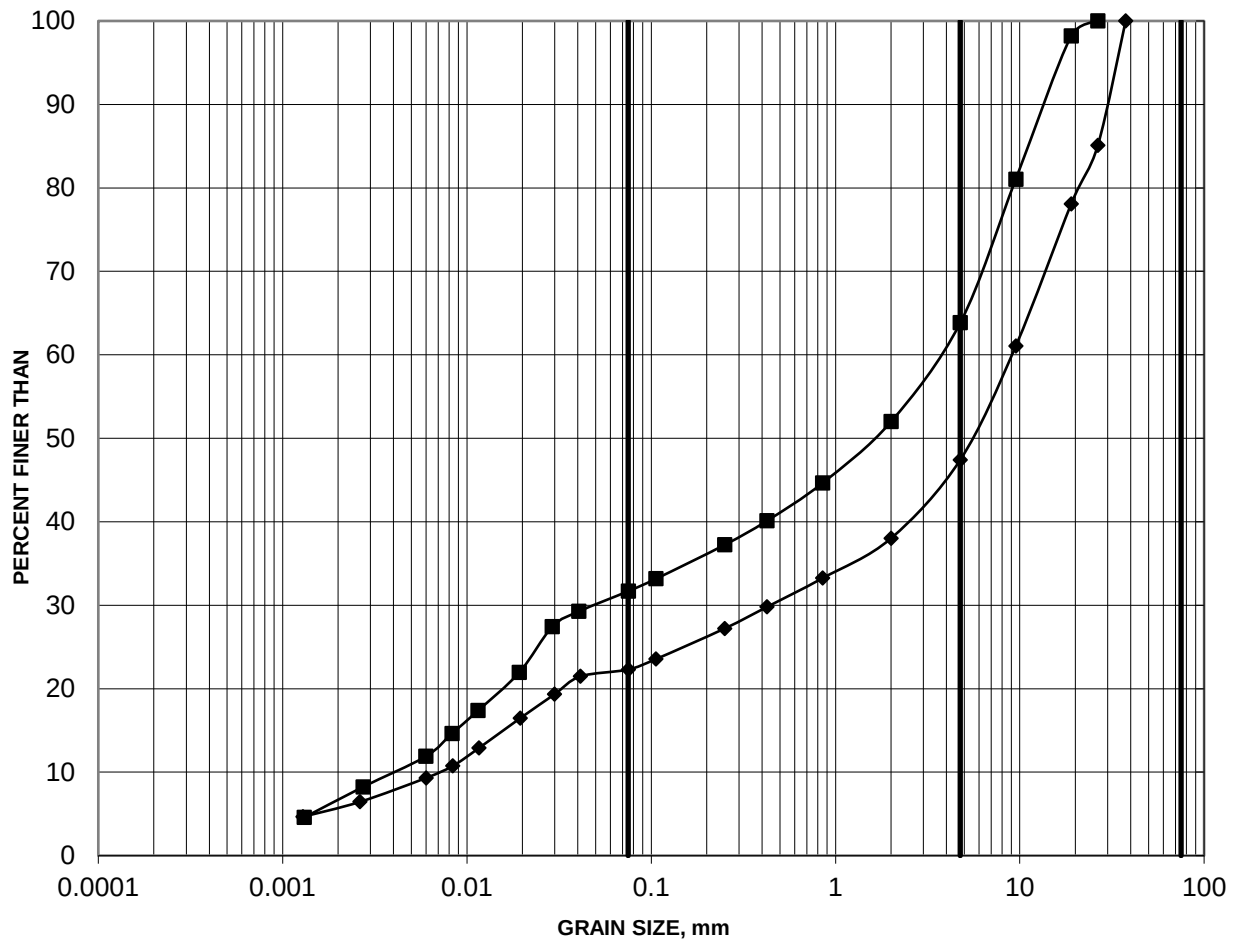
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3507	2	0.76-1.37
19-3508	2	0.76-1.37

GRAIN SIZE DISTRIBUTION

FIGURE B9

SANDY SILTY GRAVEL (FILL)



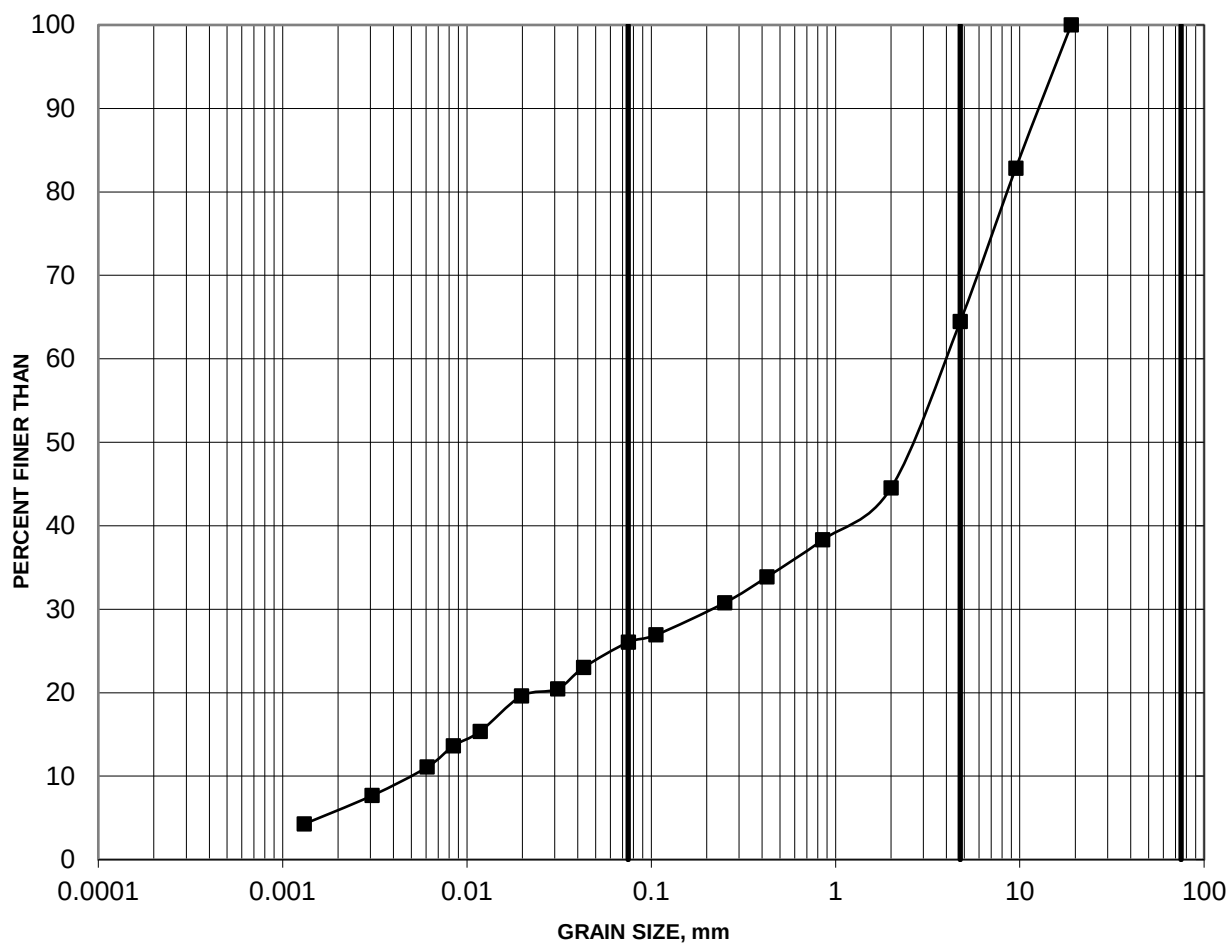
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3509	2	0.76-1.37
19-3510	4	2.29-2.90

GRAIN SIZE DISTRIBUTION

FIGURE B10

GRAVELLY SILTY SAND (FILL)



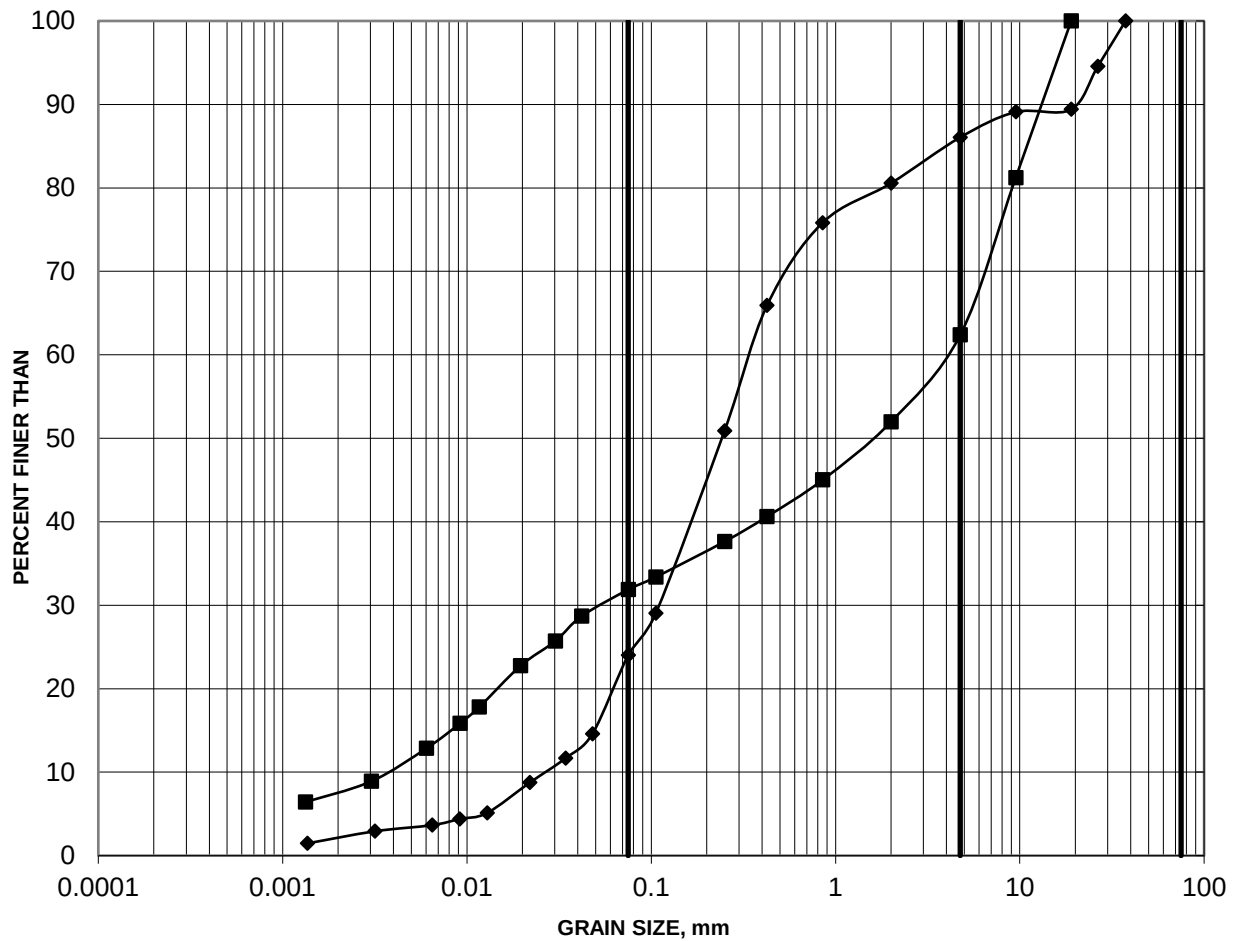
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
■ 19-3510	2	0.76-1.37

GRAIN SIZE DISTRIBUTION

FIGURE B11

GRAVELLY SILTY SAND (TILL)

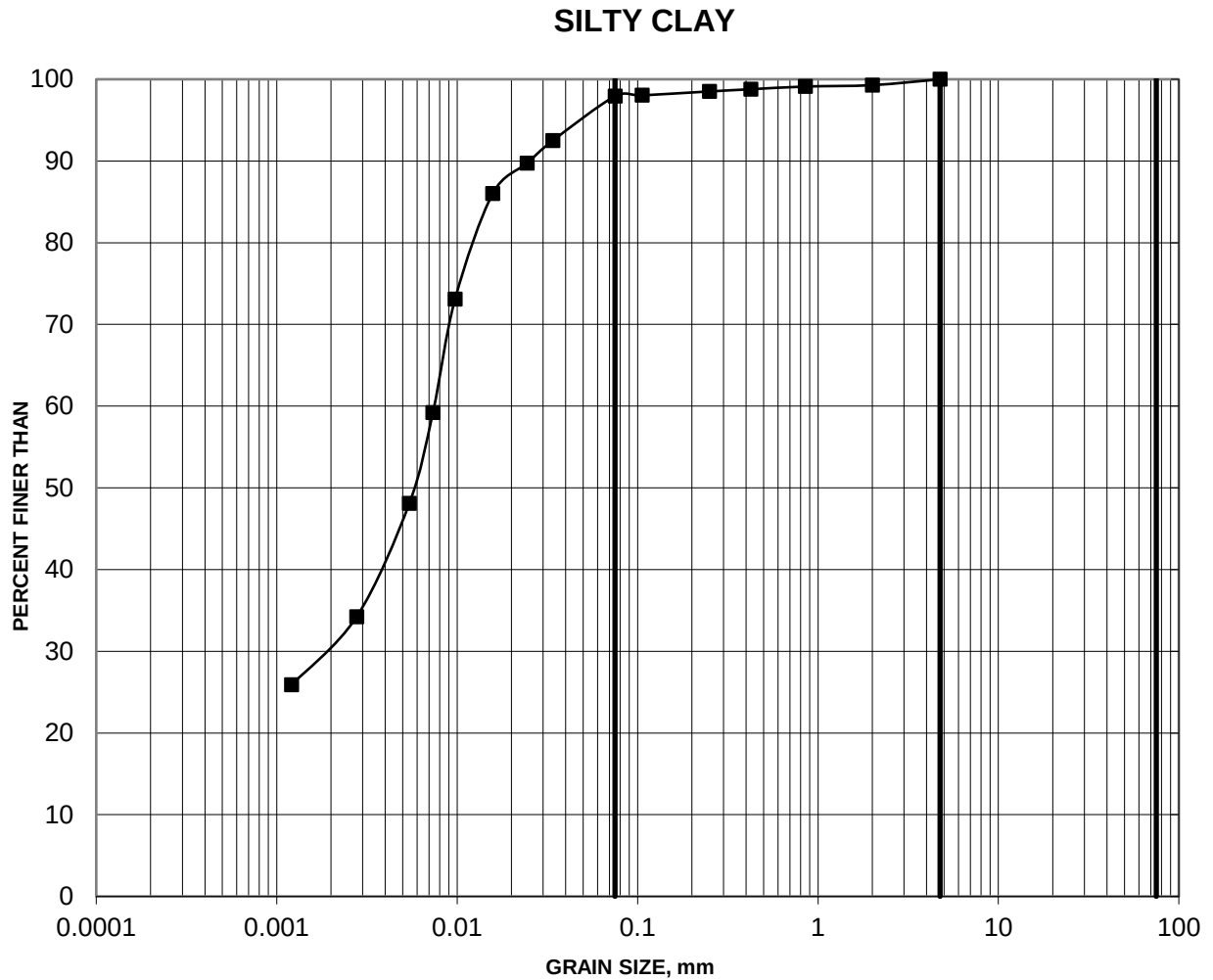


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3509	4	2.29-2.90
19-3509	9	6.86-7.47

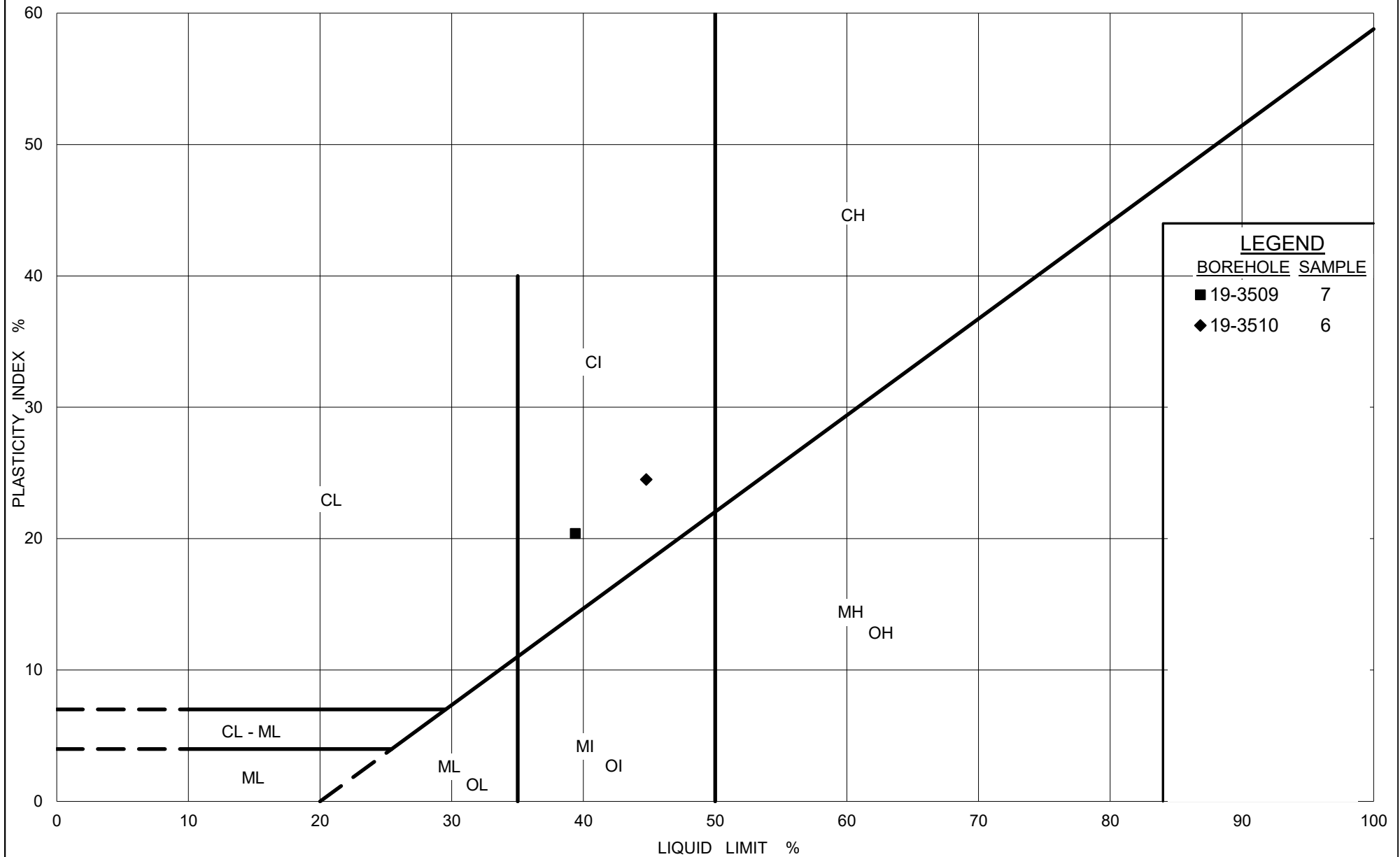
GRAIN SIZE DISTRIBUTION

FIGURE B12



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

Borehole	Sample	Depth (m)
■ 19-3509	7	4.57-5.18



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PLASTICITY CHART SILTY CLAY

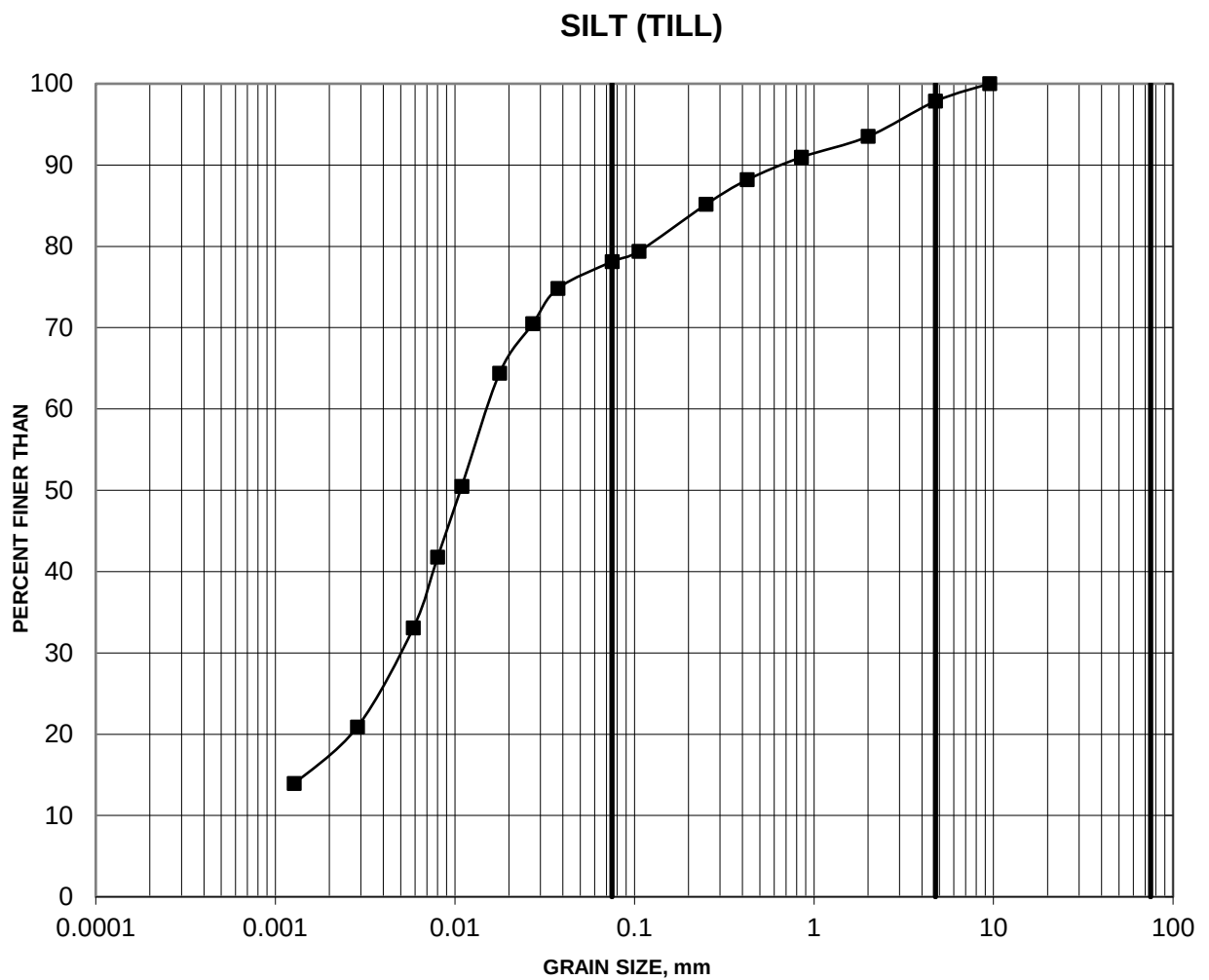
FIGURE B13

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GRAIN SIZE DISTRIBUTION

FIGURE B14



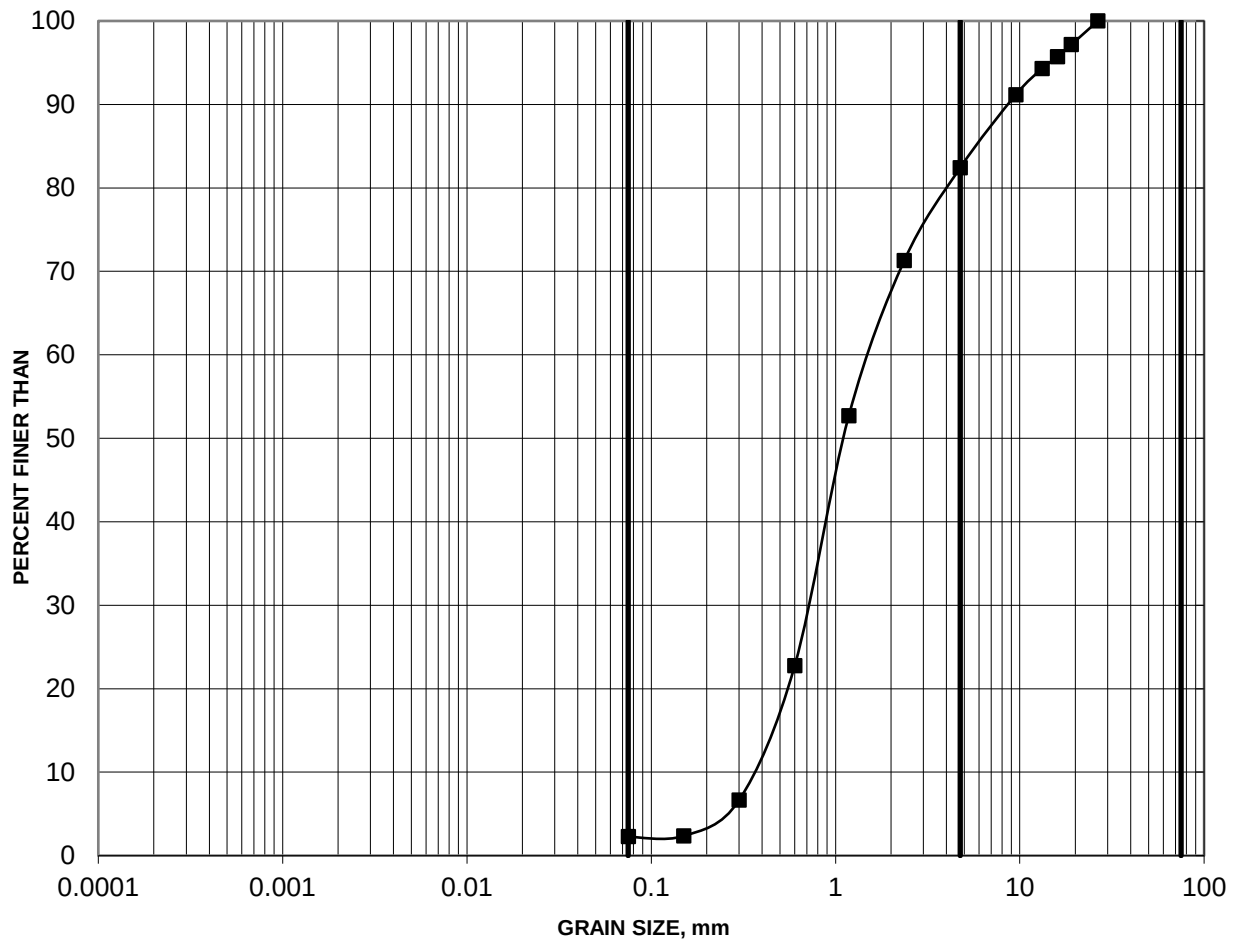
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
—■— 19-3510	7	5.33-5.94

GRAIN SIZE DISTRIBUTION

FIGURE B15

SAND SOME GRAVEL (TILL)



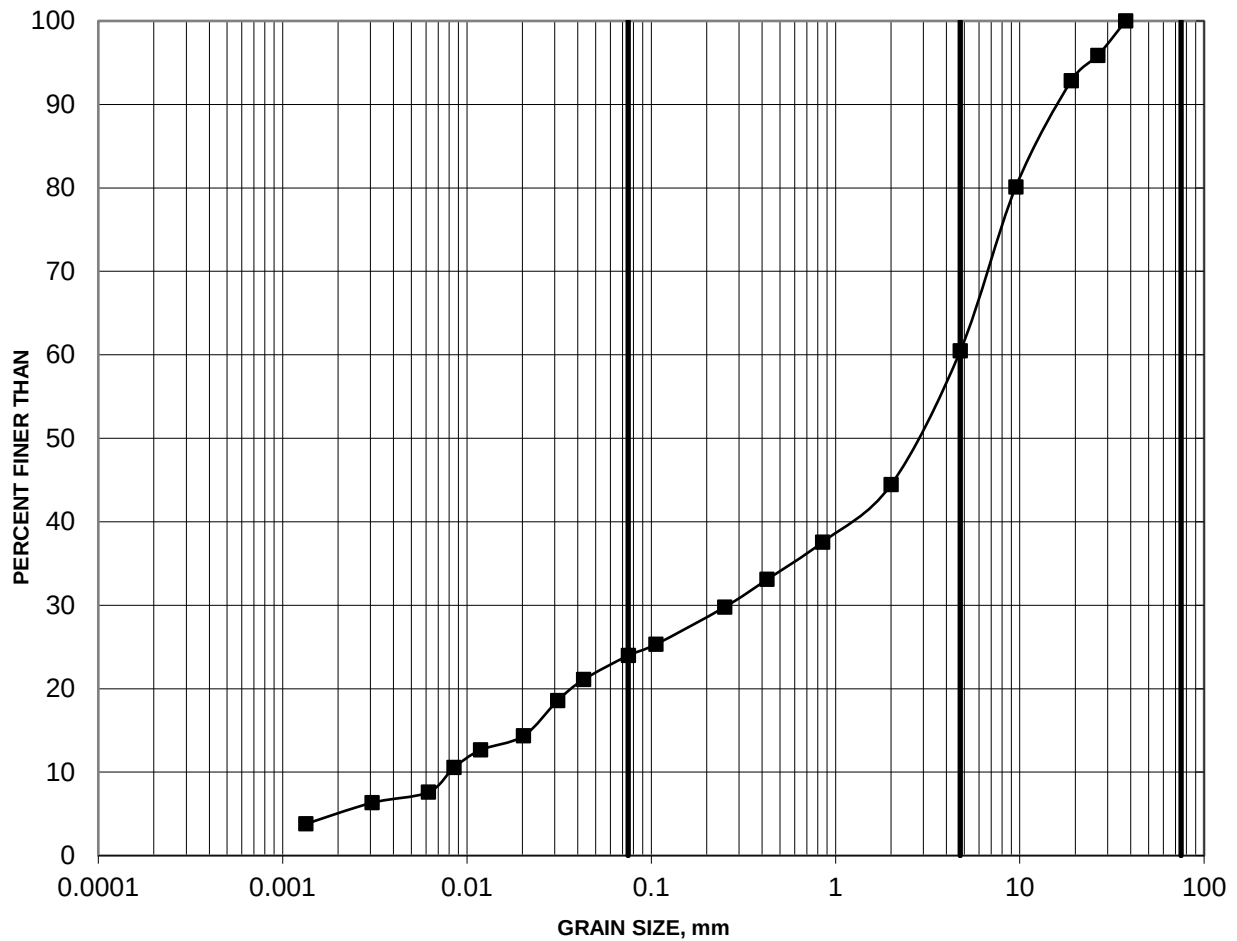
SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3510	9	6.86-7.47

GRAIN SIZE DISTRIBUTION

FIGURE B16

GRAVEL AND SAND (FILL)

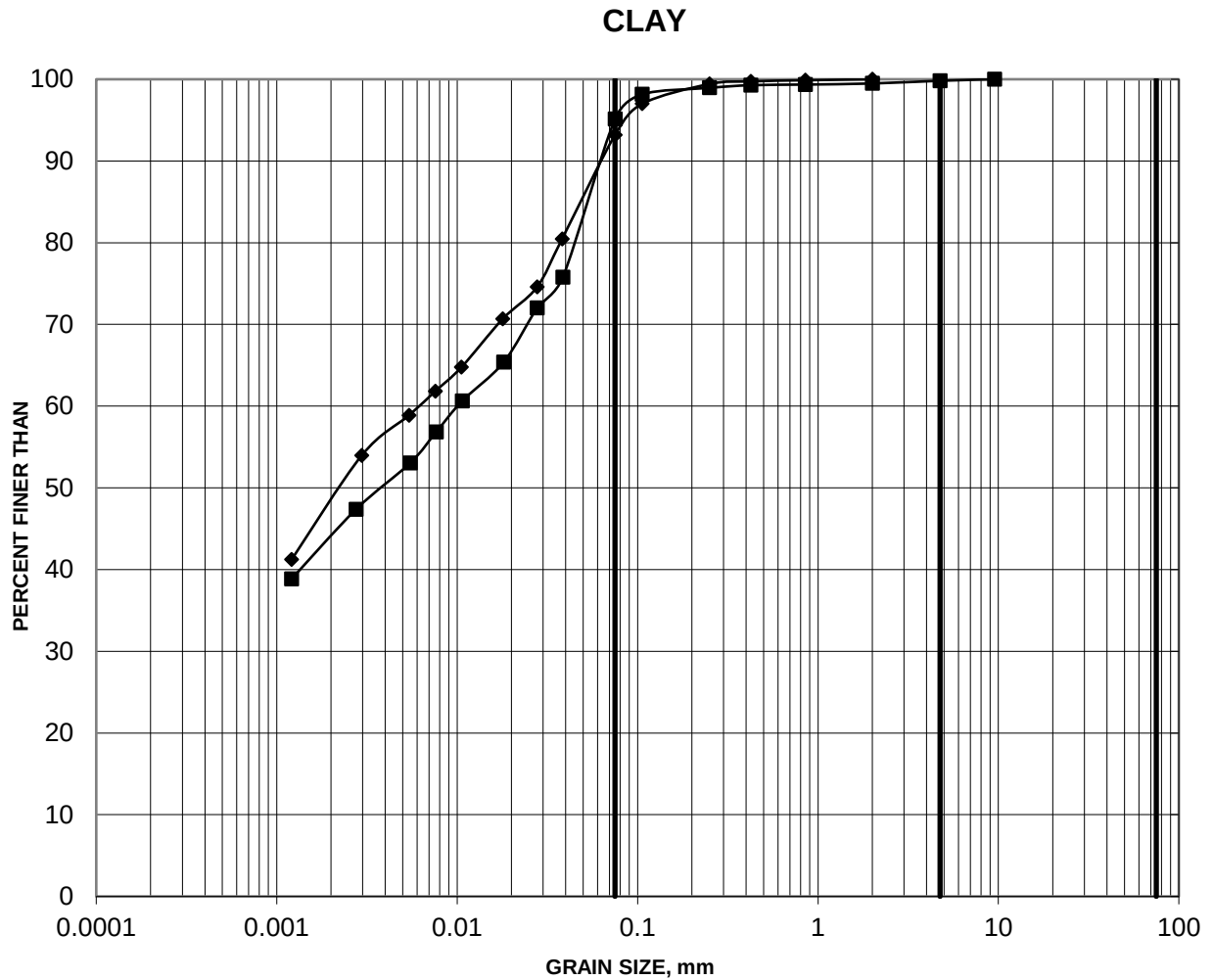


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3511	2	0.76-1.37

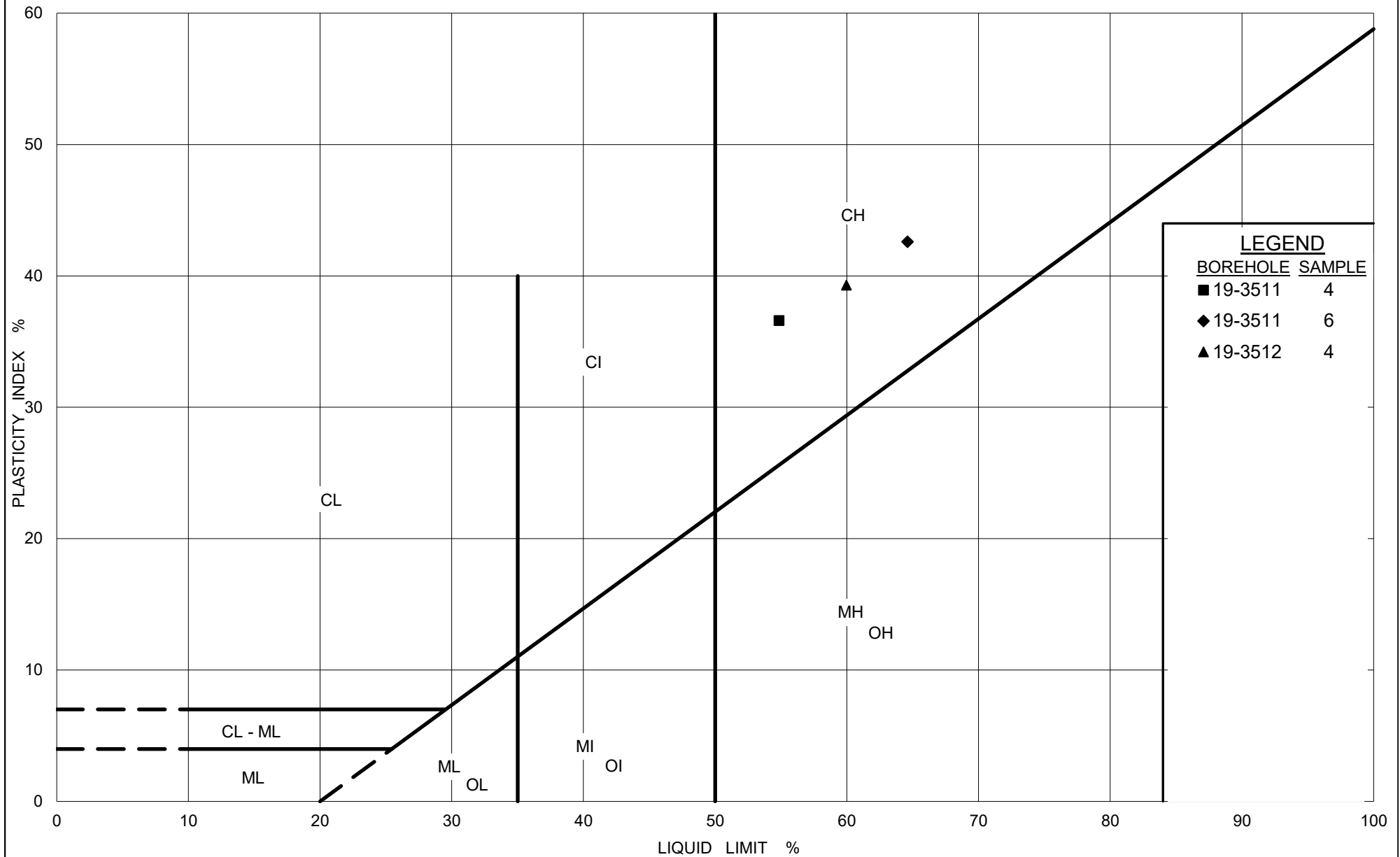
GRAIN SIZE DISTRIBUTION

FIGURE B17



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

Borehole	Sample	Depth (m)
19-3511	4	2.29-2.90
19-3512	4	2.29-2.90



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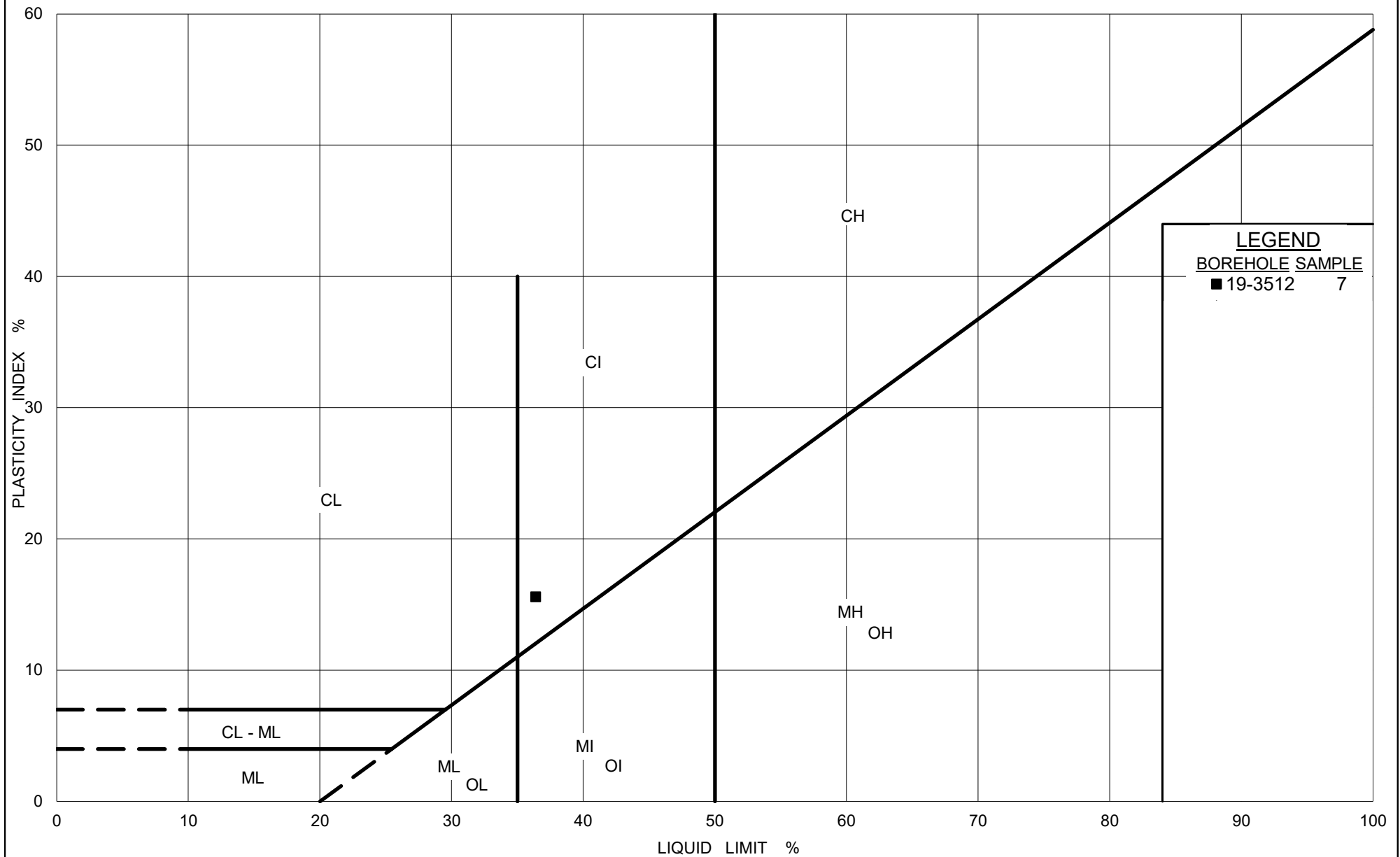
Ontario

PLASTICITY CHART CLAY

FIGURE B18

Project No. 1662565/1350

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PLASTICITY CHART SILTY CLAY

FIGURE B19

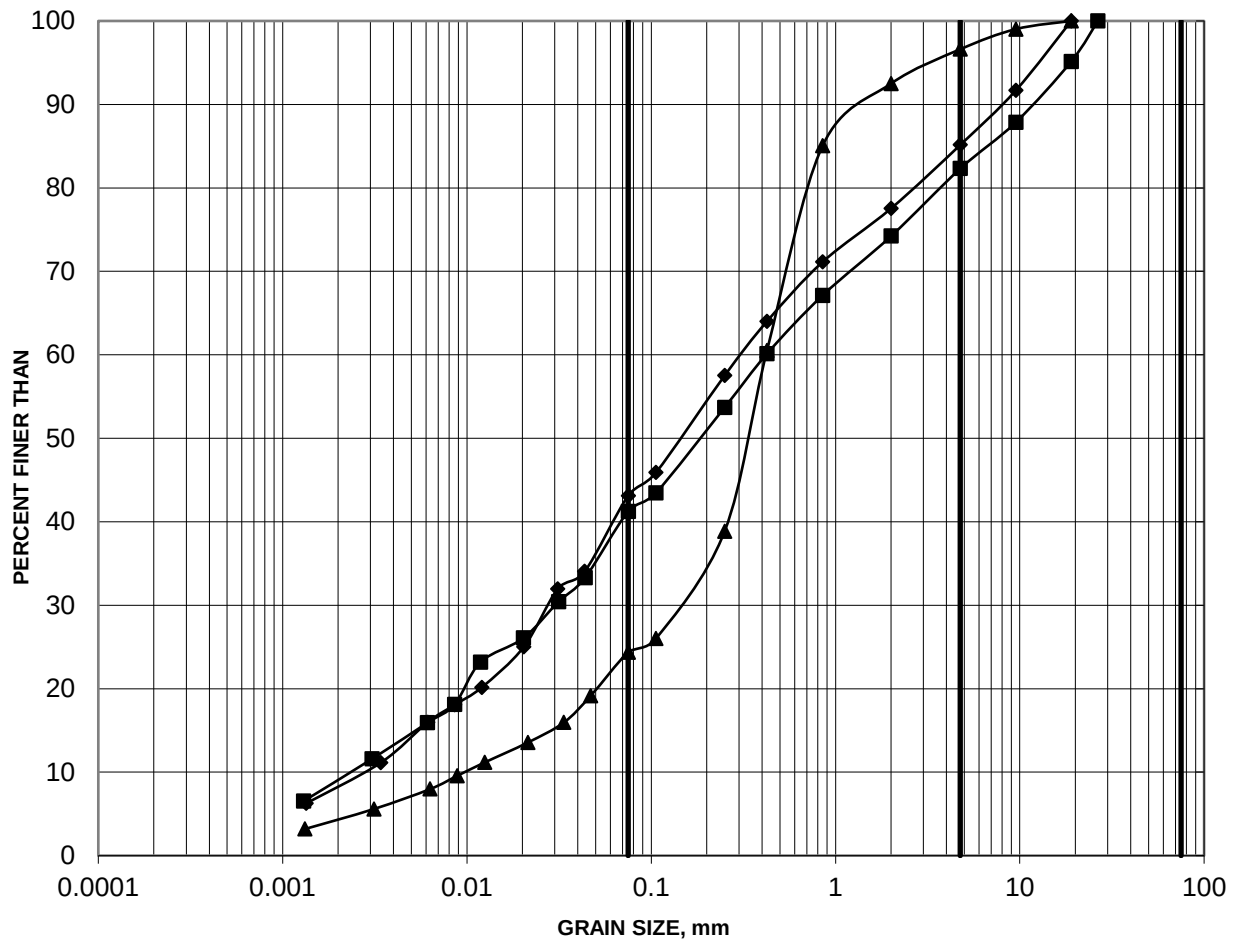
Project No. 1662565/1350

Compiled By : MS Checked By: MI

GRAIN SIZE DISTRIBUTION

FIGURE B20

SILTY SAND SOME GRAVEL (TILL)

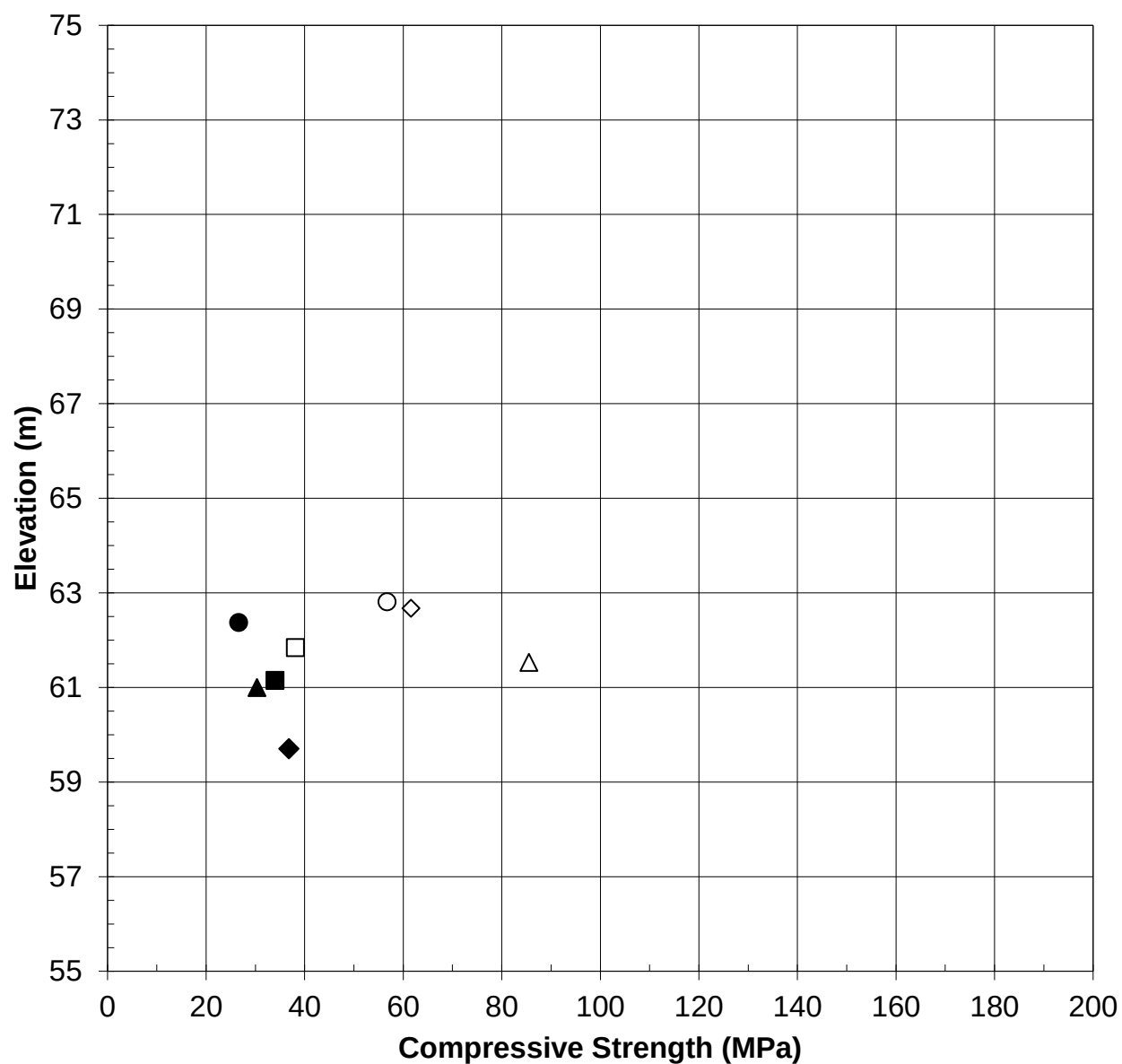


SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

Borehole	Sample	Depth (m)
19-3511	8	6.86-7.47
19-3512	9	6.10-6.71
19-3512	11	7.62-8.23

SUMMARY OF LABORATORY COMPRESSIVE STRENGTH UNCONFINED COMPRESSION TESTS

FIGURE B21



◆ 19-3501 ● 19-3502 ▲ 19-3503 ■ 19-3504
 ◇ 19-3505 ○ 19-3506 △ 19-3507 □ 19-3508

APPENDIX C

Basic Chemical Analyses
Eurofins Report No. 1917178

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Mr. Matt Kennedy
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1917178
Date Submitted: 2019-09-19
Date Reported: 2019-09-26
Project: 1662565/1350
COC #: 849213

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1454754 Soil 2019-08-13 19-3508 sa1 / 0.5-1.5'	1454755 Soil 2019-08-05 19-3509 sa4 / 7.5-9.5'	1454756 Soil 2019-08-11 19-3510 sa5 / 10-12'	1454757 Soil 2019-08-20 19-3511 sa3 / 5-7'
Anions	Cl	0.002	%			0.005	0.065	0.019	0.053
	SO4	0.01	%			0.02	0.07	0.03	0.03
General Chemistry	Electrical Conductivity	0.05	mS/cm			0.31	2.15	0.68	1.20
	pH	2.00				7.89	7.78	8.54	7.12
	Resistivity	1	ohm-cm			3240	464	1470	833

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1454758 Soil 2019-08-11 19-3512 sa3 / 5-7'	1454759 Soil 2019-08-14 19-3501 sa4 / 7.5-8.5'	1454760 Soil 2019-08-13 19-3502 sa2 / 2.5-4.5'	1454761 Soil 2019-08-06 19-3503 sa3 / 5-7'
Anions	Cl	0.002	%			0.038	0.017	0.008	0.015
	SO4	0.01	%			<0.01	0.10	0.06	0.16
General Chemistry	Electrical Conductivity	0.05	mS/cm			0.80	1.14	0.71	1.54
	pH	2.00				6.70	8.17	7.96	7.53
	Resistivity	1	ohm-cm			1250	880	1400	651

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



Environment Testing

Certificate of Analysis

Client: Golder Associates Ltd. (Ottawa)
1931 Robertson Road
Ottawa, ON
K2H 5B7
Attention: Mr. Matt Kennedy
PO#:
Invoice to: Golder Associates Ltd. (Ottawa)

Report Number: 1917178
Date Submitted: 2019-09-19
Date Reported: 2019-09-26
Project: 1662565/1350
COC #: 849213

					Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1454762 Soil 2019-08-07 19-3504 sa3 / 5-7'	1454763 Soil 2019-08-14 19-3505 sa3 / 5-7'	1454764 Soil 2019-08-06 19-3507 sa3 / 5-7'
Group	Analyte	MRL	Units	Guideline				
Anions	Cl	0.002	%			0.188	0.105	0.035
	SO4	0.01	%			0.12	0.10	0.04
General Chemistry	Electrical Conductivity	0.05	mS/cm			0.79	0.90	0.23
	pH	2.00				7.49	7.42	9.74
	Resistivity	1	ohm-cm			1270	1110	4390

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

Non-Standard Special Provisions

NSSP – Boulder/Obstructions During Excavation

NSSP – Control of Overburden Soil

NON-STANDARD SPECIAL PROVISIONS

RECOMMENDED WORDING FOR “NSSP – 903.07.03.02 EXCAVATION”

Subsection 903.07.03.02 of OPSS 903 is amended by the addition of the following:

Excavations at the site may be impeded by obstructions within the existing fill and glacial till. The contractor shall be prepared to dislodge and remove these obstructions and extend the excavations to the design depths.

RECOMMENDED WORDING FOR “NSSP – 903.07.03 CONTROL OF OVERBURDEN SOILS DURING OVERHEAD SIGN FOUNDATION INSTALLATION”

Subsection 903.07.03 of OPSS 903 is amended by the addition of the following

Excavations for the caisson installation will be advanced through granular fill materials, various interlayers of granular native material through/into glacial till and into the shale bedrock at some locations. The granular soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment will be required to minimize ground loss during drilling, caisson installation and concrete placement.



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