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FOUNDATION INVESTIGATION AND DESIGN REPORT

OPEN CUT INSTALLATION OF NEW STORM SEWERS, HIGHWAY 11/ALGONQUIN AVE. GWP 5186-14-00, NORTH BAY, ONTARIO

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REPORT





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PART A

FOUNDATION INVESTIGATION REPORT

OPEN CUT INSTALLATION OF NEW STORM SEWERS, HIGHWAY 11/ALGONQUIN AVE.

GWP 5186-14-00, NORTH BAY, ONTARIO



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide Foundation Engineering services for the rehabilitation/replacement of various sections of storm sewers on Highway 11 (Algonquin Avenue) in North Bay, Ontario. The limits of the project are on Highway 11 from 0.1 km South of the North Junction of the Highway 11/17 Intersection to Airport Road/McKeown Avenue for 0.6 km, as part of G.W.P. 5186-14-00, under Assignment Number 5016-E-0031. The Foundation Engineering scope of work includes detailed investigation and recommendations for the installation of new storm sewers by trenchless installation and cut and cover methods.

The project Pre-Design Report prepared by MH and dated October 2016¹, provided recommendations for improving the existing storm sewer network with a combination of replacement, re-routing, and lining methods. The Pre-Design Report outlined the location, size and length of storm sewers requiring rehabilitation, replacement, and the installation of new storm sewers and catch basins. Based on the Pre-Design Report, three new storm sewer sections are proposed to be installed by cut and cover methods. An additional three storm sewer sections are to be installed by trenchless methods.

Golder previously carried out a preliminary geotechnical investigation in this area and the results are summarized in the report titled: "Preliminary Foundation Investigation and Design Report, Storm Sewer Replacement, Highway 11 Algonquin Ave, WP 5137-14-00, North Bay Ontario, Northeastern Region Multi-Services, Retainer Agreement No. 5014-E-0030, Assignment # 3," Golder Associates Ltd., dated February 29, 2016 (Geocres No. 31L-192). The results of the investigation were incorporated into MH's Pre-Design Report.

This report addresses the investigation carried out for three new storm sewer sections to be installed by cut and cover methods at the following locations:

- About STA 10+300 to STA 10+420 on Highway 11 (Algonquin Ave.) from proposed maintenance hole 01 (MH01) to proposed maintenance hole 03 (MH03);
- About STA 10+426 to STA 10+504 on Highway 11 (Algonquin Ave.) from proposed maintenance hole 04 (MH04) to proposed maintenance hole 05 (MH05); and,
- About STA 10+504 on Highway 11 (Algonquin Ave.) to STA 10+080 on Airport Road from proposed maintenance hole 05 (MH05) to proposed maintenance hole 06 (MH06).

The proposed new maintenance hole and sewer alignments / profiles are shown on Drawings 1 to 3. The foundation investigation associated with the other new sewer sections (including trenchless installations), which forms part of the overall Foundation assignment for this project are presented under separate reports.

2.0 SITE DESCRIPTION

The subject area consists of the portion of Highway 11 which runs from the Highway 11/17 intersection to the intersection with Airport Road/McKeown Ave. The proposed new sewer alignments are generally located under

¹ Pre-Design Report, P.O 5014-E-0030, W.P. 5137-14-01, Highway 11 – Highway 11/17 to Airport Road, Rehabilitation of Storm Sewers on Highway 11/Algonquin Ave., 2015 Retainer Work Item # 3, North Bay, October 2016, Prepared by Morrison Hershfield Ltd.



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or beside Highway 11 between Shirreff Avenue and Airport Road/ McKeown Ave. One proposed sewer alignment crosses below a grassy boulevard area southeast of the Highway 11 / Airport Road intersection.

This portion of Highway 11 is used as a city thoroughway, and consists of an urban cross-section with sidewalks, businesses and parking lots on either side of the roadway. Street lights and traffic lights are present along this stretch of roadway. The land use is dense commercial within the project limits and the daily traffic volume is high (2016 Annual Average Daily Traffic ranges from 22,300 to 27,900 for this section of highway). The existing pavement is in fair condition and the main pavement distresses include extensive centreline, longitudinal and mid-lane cracking. Many utilities are also present within and crossing the roadway alignments. Site photographs are shown on Figures 1 to 5.



Figure 1: Heavy Traffic on Highway 11 looking from Champlain Ave. towards Shirreff Ave.



Figure 2: Traffic at Intersection of Highway 11 and Shirreff Ave., looking south from east side of the street

The site topography is a gentle sloping valley ranging from about Elevation 236 m near the south end of the site at the intersection with Highway 11/17 down to Elevation 233 m between Champlain Street and Josephine Street and up to Elevation 235 m near the north end of the site at Airport Road.

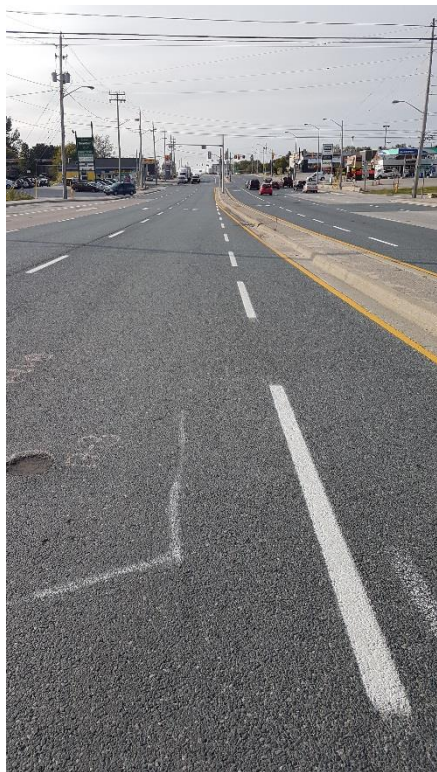


Figure 3: Looking south on Highway 11 at approximate location of MH03



Figure 4: Looking south on grassed boulevard east of Highway 11 at approximate location of MH05



Figure 5: Looking southwest from grassed boulevard south of Airport Road at approximate location of MH06

Golder conducted a review of the Contract Drawings for Contract 1995-2015² for the original sewer installation in this area. The drawings indicate that a pocket of muskeg was present and specified for removal between Champlain Street and Josephine Street, underneath the existing highway (between about STA 10+360 and 10+460) and extending approximately as deep as Elevation 230 m. In the vicinity of MH03 and MH04, muskeg removal is specified to Elevations ranging between 231.5 m and 232 m which is approximately consistent with fill depths encountered in boreholes advanced near the maintenance holes.

3.0 PREVIOUS INVESTIGATION

As noted above Golder completed a preliminary foundation investigation for this assignment, the results of which were incorporated into the Pre-Design Report, prepared by MH. The field work for the previous investigation was carried out between December 8 and 10, 2015, during which time five boreholes (Boreholes BH15-1 to BH15-5) were completed. Boreholes BH15-3 and BH15-4 are considered relevant for this report and the locations are shown on Drawing 1.

² Ministry of Transportation, Ontario. Contract Drawings, Contract No. 95-215, Sheet 6.



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The northing and easting coordinates (MTM NAD83 Zone 10), ground surface elevations referenced to Geodetic datum and borehole depths for BH15-3 and BH15-4 are presented on the Record of Borehole sheets (Appendix A) and summarized below.

Borehole Number	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)
BH15-3	5132526.9	307409.5	233.1	9.5
BH15-4	5132480.3	307395.4	233.6	9.8

4.0 INVESTIGATION PROCEDURES

The field work for the current investigation was carried out between August 13 and 21, 2017, during which time eight boreholes, labeled 17-1 to 17-5 and 17-7 to 17-9, were advanced at the locations shown on Drawing 1. All boreholes were advanced with an ATV mounted CME 550 using 108 mm inner-diameter continuous flight hollow stem augers. All drilling equipment was supplied and operated by Landcore Drilling Ltd. from Chelmsford, Ontario.

Soil samples were obtained using 50 mm outer diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). Generally, from surface to a depth of one pipe diameter below the proposed sewer invert, 0.75 m sampling intervals were employed. Below this depth, sampling was at approximately 1.5 m intervals. The groundwater level in the open boreholes was observed during the drilling operations. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 40 mm, therefore, particles or objects that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. The results of the in situ field tests (i.e., SPT 'N'-values) as presented on the Record of Borehole sheets and in subsequent sections of this report are uncorrected.

Upon completion of drilling, Boreholes 17-2, 17-3, 17-5, 17-7, and 17-9 were backfilled in accordance with Ontario Regulation 903 Wells (as amended). Standpipe piezometers, 50 mm in diameter, were installed in Borehole 17-1, 17-4 and 17-8 upon completion of drilling to monitor groundwater levels over time.

The field work was supervised on a full-time basis by a member of Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; arranged traffic control requirements; supervised the drilling and sampling operations; logged the boreholes; and examined and cared for the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Mississauga for further examination and laboratory testing. Index and classification testing consisting of water content determinations, grain size distributions, Atterberg limits, and organic content determination were carried out on selected soil samples. The geotechnical laboratory testing was completed according to ASTM and MTO LS standards, as applicable. The results of geotechnical laboratory testing are contained on the Record of Borehole Sheets in Appendix A as well as in Appendix B. In addition to index and classification testing, one representative soil sample from within the proposed sewer profile, was delivered to Maxxam Analytics to undergo a suite of corrosivity tests.

Prior to drilling, the proposed sewer alignments were laid out in the field by the project surveyor. The borehole locations were marked based on the proposed sewer alignments as well as site constraints due to access, traffic



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control requirements and underground utilities. The as-drilled borehole locations were measured by Golder staff relative to existing site features, and highway stationing. As-drilled borehole locations were overlaid with the digital terrain model of the site provided by MH, and coordinates and elevations of each borehole location were obtained. The northing and easting coordinates in MTM NAD83 Zone 10, Latitude and Longitude coordinates, ground surface elevations referenced to Geodetic datum and borehole depths at each borehole location are presented on the Record of Borehole sheets and summarized below.

Borehole Number	Northing (m)	Easting (m)	Lat.	Long.	Ground Surface Elevation (m)	Borehole Depth (m)
17-1	5132503.0	307412.6	46.332238	-79.466066	233.4	6.7
17-2	5132546.0	307414.6	46.332625	-79.466039	233.0	7.2
17-3	5132600.9	307416.9	46.333119	-79.466010	233.2	8.0
17-4	5132607.0	307430.1	46.333174	-79.465838	233.8	8.2
17-5	5132648.8	307436.4	46.333550	-79.465755	234.2	9.8
17-7	5132684.9	307441.0	46.333875	-79.465696	234.8	8.2
17-8	5132702.1	307454.8	46.334029	-79.465516	235.2	11.3
17-9	5132737.3	307486.8	46.334347	-79.465101	235.3	11.3

5.0 SITE GEOLOGY AND SUBSURFACE INFORMATION

5.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)³ mapping, the subsoils in the vicinity of the site generally consist of glaciolacustrine deposits comprised of mainly sandy and silty materials.

Based on geological mapping by the Ministry of Northern Development and Mines (Map 2543)⁴, the site is underlain by very strong bedrock comprised of layered biotite gneisses and migmatites and locally includes quartzofeldspathic gneisses, orthogneisses and paragneisses. Bedrock was not encountered as part of this investigation.

5.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are provided on the Record of Borehole sheets contained in Appendix A. The results of geotechnical laboratory testing are contained in Appendix B. The results of the corrosivity testing are contained in Appendix C. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic profile on Drawings 1 to 3 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The soil and groundwater conditions will vary between and beyond the borehole locations.

³ Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping. Map 52KSW.

⁴ Ministry of Northern Development of Mines. Bedrock Geology of Ontario – East Central Sheet, Ontario Geological Survey – Map 2543.



In general, the subsurface conditions encountered at the site are variable, consisting of asphalt (where boreholes were advanced through the road surface) underlain by fill, which in turn is generally underlain by peat and/or organic soils. Deposits of silt to silty sand, with relative density ranging from very loose to dense, and clayey silt with consistency ranging from soft to stiff, generally underlay the peat and/or organic soils encountered. Silty sand to sand till was encountered underlying the silt to silty sand and clayey silt deposits in some boreholes advanced on Highway 11. Detailed descriptions of the major soil layers encountered during the investigation are provided in the sections below.

5.2.1 Asphalt Pavement

Boreholes 15-3, 15-4, 17-1, 17-2, 17-3 were advanced within the roadway of Highway 11 and Borehole 17-9 was advanced within the roadway of Airport Road. Asphalt thickness ranged from 150 mm to 300 mm. Borehole 17-4 was advanced within the raised asphalt boulevard between the sidewalk and Highway 11 and the asphalt thickness was 100 mm.

5.2.2 Fill

A layer of non-cohesive fill was encountered below the asphalt in Boreholes 15-3, 15-4, 17-1 to 17-4 and 17-9 and at ground surface in Boreholes 17-5, 17-7, and 17-8. The gradation of the fill ranged from sand to gravelly sand to sand and gravel, trace to some silt and trace clay. The fill was generally brown in colour and the observed field moisture conditions was generally dry to moist. The thickness of the fill encountered at these boreholes varies between approximately 1.1 m and 3.7 m. The surface of the fill deposit ranged from Elevation 232.8 m to 235.2 m.

The presence of cobbles is inferred within the fill encountered in Boreholes 17-1 and 17-4, based on observations of auger grinding and difficulties advancing augers during borehole advancement.

The results of the SPTs completed within the fill resulted in SPT 'N'-values ranging from 4 blows to 32 blows per 0.3 m of penetration, suggesting a loose to dense relative density.

The natural water content measured on 12 samples of the fill layer range from approximately 2 per cent to 19 per cent.

The results of grain size distribution tests completed on 5 samples of the fill layer are shown on Figure B1 in Appendix B.

5.2.3 Peat

A deposit of silty to amorphous peat was encountered beneath the fill layer in Boreholes 15-3, 17-3, and 17-4. The peat was noted as black in colour and the field moisture content was characterized as moist to wet. The thickness of the peat deposit ranges between approximately 0.5 m and 0.8 m. The surface of the peat deposit ranged from Elevation 231.6 m to 231.7 m.

The results of the SPTs completed within the silty peat resulted in SPT 'N'-values ranging from 3 blows to 6 blows per 0.3 m of penetration, suggesting a very loose to loose relative density. The result of one SPT completed within the amorphous peat near the transition with the underlying granular layer in 15-3 resulted in an SPT 'N'-value of 12 blows per 0.3 m of penetration, suggesting a stiff consistency.

The natural water content measured on three samples of the silty to amorphous peat deposit range from approximately 81 to 304 per cent.



Organic testing completed on one sample of the silty peat deposit measured an organic content of approximately 58 per cent.

5.2.4 Organic Deposits

Organic deposits were encountered beneath the fill layer in Boreholes 17-1, 17-8 and 17-9 and beneath the silty peat deposit in Boreholes 17-3 and 17-4.

In Boreholes 17-4 and 17-9 the organic deposit was characterized as organic silty sand to organic silt and sand, trace to some clay. The deposit was noted as grey to brown in colour and field moisture content characterized as moist. The thickness of the organic silty sand to organic silt and sand ranges between approximately 0.7 m and 1.6 m. The surface of the deposit ranges from Elevation 230.8 m to 231.6 m. The results of the SPTs completed within the organic silty sand to organic silt and sand resulted in SPT 'N'-values ranging from 2 blows to 5 blows per 0.3 m of penetration, suggesting a very loose to loose relative density. The natural water content measured on two samples of the organic silty sand to organic silt and sand were approximately 32 and 46 per cent. Organic testing completed on one sample of the organic silty sand to organic silt and sand deposit measured an organic content of approximately 7 per cent. The results of two grain size distribution tests completed on samples of the organic silty sand to organic silt and sand layer are shown on Figure B2 in Appendix B. The results of an Atterberg limit test completed on one sample of the organic silt and sand deposit indicate the organic deposit is non-plastic.

In Boreholes 17-1, 17-3, and 17-8 the organic deposit was characterized as organic clayey silt, some sand to organic silt, some sand, trace gravel to sandy organic silt, some clay, trace gravel. The colour of the organic deposits ranged from black to dark brown to grey and field moisture content was characterized as moist to wet. The thickness of the organic clayey silt, organic silt, and sandy organic silt ranges between approximately 0.7 m and 1.6 m. The surface of the deposit ranges from Elevation 231.0 m to 232.0 m. The presence of cobbles is inferred within the organic silt encountered in Borehole 17-1, based on auger grinding noted during borehole advancement. The SPTs completed within the organic clayey silt, organic silt, and sandy organic silt resulted in SPT 'N'-values ranging from 1 blow to 9 blows per 0.3 m of penetration, suggesting a very loose to loose relative density for the organic silt and sandy organic silt and a very soft to soft consistency for the organic clayey silt. The natural water content measured on four samples of the organic clayey silt, organic silt, and sandy organic silt range from approximately 26 to 72 per cent. Organic testing completed on two samples of the deposit measured organic content of approximately 7 per cent and 12 per cent. The results of three grain size distribution tests completed on samples of the organic clayey silt, organic silt, and sandy organic silt layers are shown on Figure B3 in Appendix B. The results of Atterberg limit testing on two samples of the organic silt and organic clayey silt are shown on Figure B4 in Appendix B and resulted in plastic limits of approximately 21 per cent and 23 per cent and liquid limits of 35 per cent and 31 per cent, corresponding to plasticity indices of approximately 14 per cent and 8 per cent. The results confirm that the soil is classified as low plasticity.

5.2.5 Upper Silt to Silty Sand

An upper (generally above the clayey silt deposit) non-cohesive deposit comprised of silt to sandy silt to silt and sand to silty sand was encountered in all boreholes except for Boreholes 15-3, 15-4, 17-1, 17-2, and 17-3. The deposit typically contains trace to some clay, trace organics and in some instances trace gravel. Field moisture content ranged from moist to wet and the deposit was noted as grey to dark brown to black in colour.



The top of this deposit ranges between about Elevation 229.9 m to 232.0 m and the thickness of the deposit, where fully penetrated (i.e. in all Boreholes except 17-4), ranges between 0.7 m to 3.0 m. Boreholes 17-4 was terminated in this deposit after penetrating approximately 4.5 m.

In Borehole 17-5 an approximately 0.7 m thick layer of wet, grey, sandy clayey silt, trace organics was encountered within the upper silty sand to sandy silt deposit, at approximately 3.7 m below ground surface (Elevation 230.5 m).

The SPT 'N'-values measured within the upper silt to sandy silt to silt and sand to silty sand deposit range from 2 blows to 17 blows per 0.3 m of penetration, indicating a very loose to compact relative density. One SPT 'N'-value measured in the clayey silt interlayer was 7 blows per 0.3 m of penetration, indicating a firm consistency.

The natural water content measured on six samples of this deposit generally ranges between about 16 per cent and 27 per cent. The natural water content measured on one sample of silty sand recovered from Borehole 17-5 is about 42 per cent and the natural water content measured on one sample of sandy silt recovered from Borehole 17-7 is about 39 per cent. The higher water content can be attributed to the presence of organics at this depth. An organic content measured on a sample of the sandy silt recovered from Borehole 17-7 is about 4.3 per cent by weight. The natural water content measured on a sample of the clayey silt interlayer in Borehole 17-5 was measured at about 40 per cent.

The results of grain size distribution tests carried out on three samples of the upper silt to sandy silt to silt and sand are shown on Figure B5 of Appendix B. Atterberg limits tests carried out on four samples of the deposits confirm that the material is classified as non-plastic.

The results of grain size distribution tests carried on a sample of the clayey silt interlayer in Borehole 17-5 is shown on Figure B6 of Appendix B. Atterberg limits tests carried out on the sample of clayey silt measured values for plastic limit of 18 per cent and liquid limit of 34 per cent, resulting in a plasticity index of 16 per cent, confirming the material is of low plasticity. The results of the Atterberg limits test is shown on Figure B7 in Appendix B.

5.2.6 Clayey Silt

A deposit of grey clayey silt, trace to some sand to sandy was encountered underlying the fill, organic deposits and/or the upper silt to silty sand deposit in Boreholes 17-2, 17-3, 17-5, and 17-7 to 17-9. Trace organics were noted in some of the clayey silt samples. The field moisture content for the clayey silt deposit is generally wet, except in Borehole 17-2 where it was classified as moist directly underlying the fill.

The presence of cobbles and/or boulders are inferred within this deposit due to observations of auger grinding during advancement of Borehole 17-3.

The top of this deposit generally ranges between Elevations 229.0 m to 229.5 m, except in the deposit encountered directly under the fill in Borehole 17-2 where it was encountered at Elevation 231.6. The thickness of the deposit ranges between 0.7 m to 3.5 m.

The SPT 'N'-values measured within the clayey silt deposit range from 2 blows to 12 blows per 0.3 m of penetration, indicating a very soft to stiff consistency.

The natural water content measured on ten samples of this deposit generally range between about 19 per cent and 28 per cent. The natural water content measured on the sample of clayey silt from Borehole 17-2 under the fill is 15 per cent.



The results of grain size distribution tests carried out on six samples of the clayey silt deposit are shown on Figure B6 of Appendix B, along with the results from one sample of the clayey silt interlayer encountered in Borehole 17-5. Atterberg limits tests carried out on six samples of the clayey silt measured plastic limits between 13 per cent and 19 per cent, liquid limits between 19 per cent and 29 per cent, corresponding to plasticity indices between about 6 and 10 per cent. The results are shown on Figure B7 of Appendix B, along with the results of a sample of the clayey silt interlayer encountered in Borehole 17-5, and indicate that the material is classified as low plasticity.

5.2.7 Lower Silt to Silty Sand

A lower non-cohesive deposit comprised of silt to sandy silt to silt and sand to silty sand was encountered generally underlying the clayey silt deposit in Boreholes 17-2, 17-5, 17-7 to 17-9 and directly underlying the organic soils in Boreholes 17-1 and 15-3. The silt to silty sand deposits contain trace to some clay and varying amounts of sand. The field moisture content of the deposit ranges from moist to wet and is generally characterized as grey in colour. Peat layers were noted at the top of this deposit within Borehole 15-3.

In Borehole 17-2, a 0.8 m thick layer of brown sand, some silt, trace clay was encountered between the clayey silt deposit and the lower sandy silt deposit at Elevation 230.8 m.

The top of the lower silt to silty sand deposit ranges between Elevation 231.2 m and 226.7 m and the thickness of the deposit, where fully penetrated, is 1.5 to 3.2 m. In Boreholes 17-5, and 17-7 to 17-9, the boreholes were terminated within the lower silt to silty sand deposit with thicknesses of at least 1.4 m to 3.7 m confirmed.

The SPT 'N'-values measured within the lower silt to silty sand deposit generally range from 7 blows to 43 blows per 0.3 m of penetration, indicating a loose to dense relative density. One SPT 'N'-value of 2 blows per 0.3 m of penetration was measured at the bottom of Borehole 17-5 at approximately 9.6 m below ground surface. In this instance, the SPT 'N'-value may be artificially low due to disturbance of the in-situ deposit at the sampling depth due to "blow back" of the silty sand soils inside the hollow stem augers caused by unbalanced groundwater pressure. One SPT 'N'-value measured in the sand layer encountered in Borehole 17-2 is 11 blows per 0.3 m of penetration (i.e. compact).

The natural water content measured on thirteen samples of this deposit range between about 14 per cent and 26 per cent. The natural water content measured in the sand encountered in Borehole 17-2 is 15 per cent.

The results of grain size distribution tests carried out on eight samples of the lower silt to sandy silt to silt and sand are shown on Figure B8 of Appendix B. Atterberg limits tests carried out on two samples of the lower sandy silt to silt and sand indicate that the material is classified as non-plastic. The result of a grain size distribution test carried out on one sample of the sand encountered in Borehole 17-2 is shown on Figure B9 of Appendix B.

5.2.8 Silty Sand to Sand (Till)

A deposit of silty sand to sand till containing trace clay and trace to some gravel was encountered in Boreholes 15-3, 15-4, and 17-1 to 17-3. The till was generally grey in colour and was characterized as wet. In Borehole 15-4 the till was encountered directly below the fill, while in Boreholes 15-3, 17-1 and 17-2 the till was encountered below the lower silt to silty sand deposit. In Borehole 17-3 the silty sand till was encountered underlying the clayey silt deposit. The presence of cobbles/boulders within the silty sand till was inferred from grinding of the augers and the need to switch to casing/wash boring and coring techniques to advance Borehole 15-4 and below a depth of about 5.2 m in Borehole 15-3. The size of the cobbles is estimated to be between 75 mm and 200 mm based



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on the descriptions from the borehole records for Borehole 15-3 and 15-4. Further, cobbles and boulders are known to be present in the glacially derived tills of Northern Ontario and should be expected within this deposit.

The top of this deposit ranges from approximately Elevations 226.0 m to 231.4 m and the boreholes were terminated in this deposit after penetrating approximately 0.8 m to 7.6 m.

The SPT 'N'-values measured within the silty sand till to sand till range from 24 blows per 0.3 m of penetration to over 100 blows per 0.08 m of penetration indicating a compact to very dense relative density. Several split spoon samples did not penetrate the full sampling length, indicative of a very dense material with the presence of large gravel fragments and/or cobbles/boulders.

The natural water content measured on five samples of this deposit range between about 9 per cent and 15 per cent.

The result of grain size distribution tests carried out on two samples of the silty sand till are shown on Figure B10 of Appendix B.

5.3 Groundwater Conditions

Groundwater levels measured in the open boreholes upon completion of drilling and in the standpipe piezometers installed in Boreholes 17-1, 17-4 and 17-8 are summarized below. It should be noted that groundwater levels measured upon completion of drilling operations, especially for Boreholes 15-3 and 15-4 where the introduction of drilling water to advance NW casing likely impacted the measured groundwater levels, should be considered unstabilized. It is noted that groundwater levels will vary depending on the time of year and precipitation events.

Borehole No.	Depth Below Ground Surface to Groundwater Level (m)	Groundwater Elevation (m)	Date of Measurement
BH15-3	4.8	228.3*	Upon borehole completion
BH15-4	2.1	231.5*	Upon borehole completion
17-1	2.1	231.3	Upon borehole completion
	2.6	230.8	August 15, 2017
	2.7	230.7	August 23, 2017
17-2	3.1	229.9	Upon borehole completion
17-3	4.6	228.6	Upon borehole completion
17-4	4.4	229.4	Upon borehole completion
	2.8	231.0	August 23, 2017
	3.4	230.4	September 15, 2017
17-5	6.1	228.1	Upon borehole completion
17-7	4.6	230.2	Upon borehole completion
17-8	5.2	230.0	Upon borehole completion
	3.5	231.7	August 23, 2017
	3.7	231.5	September 15, 2017
17-9	8.5	226.8	Upon borehole completion

*Introduction of drilling water for casing/coring operations may have impacted groundwater level measurement.



5.4 Analytical Testing

The results of chemical analyses for pH, sulphate, sulphide, chloride, resistivity and electrical conductivity on soil samples collected at the approximate storm sewer / maintenance hole profile depth within the boreholes is summarized below and the analytical test results are included in Appendix C.

Parameter	Units	Borehole No., Sample No, and Soil Classification						
		BH 15-3 SA 4	BH 15-4 SA 2	BH17-2 SA 2	BH17-3 SA 3	BH17-5 SA 8	BH17-7 SA 7	BH17-8 SA 8
		Silt and Sand	Sand Fill	Clayey Silt	Organic Clayey Silt	Clayey Silt	Sandy Silt	Sandy Silt
Chloride (CL)	µg/g	60	820	240	790	590	88	39
Sulphate (SO ₄)	µg/g	<20	170	<100	<100	<100	<100	<100
Conductivity (EC)	µmho/cm	179	1670	702	1640	1080	274	183
Resistivity	ohms-cm	5600	600	1400	610	920	3600	5500
pH	n/a	7.00	5.36	6.27	4.99	7.30	5.30	6.86
Sulphide	µg/g	Not tested	Not tested	<0.50	1.42	1.30	0.71	1.54

6.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Michael Bentley, under the overall direction of Ms. Sarah E. M. Poot, P.Eng., an Associate of Golder. This Foundation Investigation Report was prepared by Ms. Darcy Hansen and Mr. David Marmor, E.I.T., and Ms. Poot provided a technical review of the report. Mr. Kevin Bentley, P.Eng., Interim Designated MTO Foundations Contact and Associate of Golder, conducted an independent quality control review of this report.



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Report Signature Page

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PART B

FOUNDATION DESIGN REPORT

OPEN CUT INSTALLATION OF NEW STORM SEWERS, HIGHWAY 11/ALGONQUIN AVE.

GWP 5186-14-00, NORTH BAY, ONTARIO



7.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

7.1 General

This section of the report provides detail foundation design recommendations for the proposed new sections of storm sewer along Highway 11 (Algonquin Avenue) in North Bay, Ontario. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the current and previous subsurface investigations.

The discussion and recommendations presented are intended only to provide the designers with sufficient information to assess the feasible foundation alternatives and to carry out the detail design of the new storm sewers to be constructed using open cut construction techniques. The foundation investigation and design report with the interpretation 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 or design-build 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 only to highlight those aspects that could affect the design of the project. Contractors and those requiring information on the 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.

7.2 Proposed Sewer Alignments

The project Pre-Design Report (MH, 2016) specifies about 366 m of new storm sewer along with eight proposed catch basins/maintenance holes are to be incorporated into the detailed design of the storm sewer system rehabilitation project. The updated drawings provided to Golder by MH via email on Friday December 8, 2017, specifies the following lengths and diameters for the proposed new storm sewers to be installed by cut and cover methods, as well as the proposed depth of cover and invert elevations:

- Station 10+300 to 10+355 (Hwy 11): approximately 58 m of new storm sewer is proposed between MH01 and MH02 with a diameter of 750 mm, depth of cover between 2.6 m and 2.8 m and invert ranging from Elevation 230.0 m to 229.7 m (see Drawing 1);
- Station 10+355 to 10+420 (Hwy 11): approximately 62 m of new storm sewer is proposed between MH02 and MH03 with a diameter of 1200 mm, depth of cover between 2.6 m and 3.1 m and invert ranging from Elevation 229.3 m to 229.1 m (see Drawing 1);
- Station 10+426 to 10+504 (Hwy 11): approximately 79 m of new storm sewer is proposed between MH04 and MH05 with a diameter of 1200 mm, depth of cover between 2.7 m and 4.9 m and invert ranging from Elevation 229.0 m to 228.7 (see Drawing 2); and,
- Station 10+504 (Hwy 11) to 10+080 (Airport Road): approximately 65 m of new storm sewer is proposed between MH05 and MH06 with a diameter of 1200 mm, depth of cover between 4.3 m and 5.6 m and invert ranging from Elevation 228.7 m to 228.5 m (see Drawing 3).

The proposed new storm sewer alignment from MH01 to MH02 and MH02 to MH03 is located in the median of Highway 11, directly adjacent and parallel to an existing 750 mm and 1,200 mm diameter CSP storm sewer pipe, respectively. It is understood that the existing CSP storm sewer pipes will be left in place and abandoned (grouted).



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The proposed new storm sewer alignment from MH03 to MH04 crosses Highway 11 and is proposed to be installed using trenchless methods. A separate foundation report is being prepared for this trenchless crossing.

The new storm sewer alignment from MH04 to MH05 is located within the boulevard area east of the travelled portion of Highway 11 and the alignment from MH05 to MH06 is located within a grassy boulevard area southeast of the intersection of Highway 11 and Airport Road.

Another trenchless crossing is proposed between MH06 and MH07 and a separate foundation report is being prepared.

7.3 Open Cut Excavation Installation

Based on the results of the foundation investigation and the depths to the pipe invert, the founding soils will be variable for each of the individual storm sewer alignments. A summary of each proposed storm sewer alignment, range in ground surface elevations, range in invert elevations, range in approximate subgrade elevation / depth of excavation, excavated soils, foundation soils and measured groundwater conditions are provided below.

Storm Sewer Alignment (Relevant Boreholes)	¹ Ground Surface Elevation (m)	Sewer Invert Elevation (m)	² Approximate Subgrade Elevation (depth of excavation) (m)	Excavated Soils	Anticipated Founding Soil at Invert / Subgrade	Measured Groundwater Conditions Based on Closest Borehole / Piezometer
MH01 to MH02 (17-1, 15-3, 15-4)	237.7 to 233.1	230.0 to 229.7	229.9 to 229.6 (3.6 to 3.9)	<ul style="list-style-type: none"> Sand to Sand and Gravel (Fill) Organic Silt and Peat Clayey Silt Sand Silt to Silt and Sand Silty Sand to Sand (Till) 	<ul style="list-style-type: none"> Silty Sand to Sand Till, Dense to Very Dense Silt, Silt and Sand, Silty Sand, Compact 	Elev. 230.8 m (Borehole 17-1 piezometer), above the invert level
MH02 to MH03 (17-2, 17-3)	233.1 to 233.2	229.3 to 229.1	229.0 to 228.8 (4.1 to 4.4)	<ul style="list-style-type: none"> Sand to Sand and Gravel (Fill) Silty Peat and Organic Clayey Silt Clayey Silt Sand Silt to Silt and Sand 	<ul style="list-style-type: none"> Sandy Silt, Compact Sand, Compact Clayey Silt, Soft 	Elev. 230.8 m (Borehole 17-1 piezometer) and Elev. 231.0 m (Borehole 17-4 piezometer), above the invert level
MH04 to MH05	232.9 to 234.8	229.0 to 228.7	228.7 to 228.4 (4.2 to 6.4)	<ul style="list-style-type: none"> Sand (Fill) 	<ul style="list-style-type: none"> Silt to Silty Sand, Loose 	Elev. 231.0 m (Borehole 17-4 piezometer),



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Storm Sewer Alignment (Relevant Boreholes)	¹ Ground Surface Elevation (m)	Sewer Invert Elevation (m)	² Approximate Subgrade Elevation (depth of excavation) (m)	Excavated Soils	Anticipated Founding Soil at Invert / Subgrade	Measured Groundwater Conditions Based on Closest Borehole / Piezometer
(17-4, 17-5, 17-7)				<ul style="list-style-type: none"> • Silty Peat and Organic Silty Sand • Silt to Silty Sand • Clayey Silt 	• Clayey Silt, Soft to Firm	above the invert level
MH05 to MH06 (17-7, 17-8, 17-9)	235.0 to 233.6	228.7 to 228.5	228.4 to 228.2 (5.4 to 6.7)	<ul style="list-style-type: none"> • Sand (Fill) • Organic Silt to Organic Silt and Sand • Sandy Silt • Clayey Silt 	• Clayey Silt, Very Soft to Firm	Elev. 231.5 m (Borehole 17-8 piezometer), above the invert level

¹ Minimum and maximum elevation along proposed sewer alignment centerline.

² Depth of excavation is estimated based on the difference between the existing ground surface along the proposed sewer centerline and the proposed invert elevation, plus either 150 mm or 300 mm bedding thickness according to Section 7.3.1. The approximate subgrade elevation/depth of excavation does not include thickness of pipe material and/or possible sub-excavation requirements if unsuitable founding soils are encountered.

Given the potential variability of the soil type and consistency / relative density of the subgrade soils at the founding level, inspection during excavation / construction will be required to confirm that the exposed soils are consistent with the results of the boreholes and that the soils are suitable/stable and relatively undisturbed for support of the sewer pipes and maintenance structures.

In general, the native soils that are free of organics are considered capable of supporting the sewer pipes and maintenance structures. Where soft / loose soils are encountered and where peat / organic soils are present at the subgrade, these materials are considered unsuitable and sub-excavation to competent subgrade will be required. The sub-excavation will need to be backfilled with engineered fill and/or additional thickness of bedding material provided to reach the specified founding subgrade elevation.

7.3.1 Pipe Bedding and Cover

The sewer installation should be completed in accordance with the appropriate Ontario Provincial Standard Drawing (OPSD) Division 800 for storm sewers and should be designed using the latest version of the MTO Gravity Pipe Design Guidelines (2014). According to the preliminary design drawings, the proposed sewer pipe material is concrete. Accordingly, the bedding should be compatible with the type and class of pipe, the surrounding subsoil and anticipated loading conditions. Pipe bedding should consist of OPSS.PROV 1010 (Aggregates) Granular 'A' with a minimum thickness of 0.15D (where D is the pipe diameter) or 150 mm below the base of the pipe, whichever is greater. Based on the design invert elevations, the location of the groundwater level that is typically above the invert, and the founding soils at the base of the excavation (typically Type 3 or Type 4 soil according to OHSA), a



thicker bedding layer up to 300 mm is recommended. During construction, depending on the actual soils exposed at the subgrade level, additional sub-excavation of unsuitable soils and backfill with bedding up to a depth of 450 mm may be required at some locations where wet and softened soil conditions, unsuitable fill, or organic material are present at the base of the excavation. Provided dewatering is adequately performed prior to excavations, the risk of encountering wet softened soil conditions is low.

Therefore, the Contract Documents should specify a minimum of 150 mm of bedding between Stations 10+300 to 10+355 (MH01 to MH02) where subgrade soils are typically compact to very dense and where the pipe diameter is 750 mm; and a minimum of 300 mm of bedding in the other areas (MH02 to MH03, MH04 to MH05, and MH05 to MH06) where subgrade soils are typically very soft firm or loose to compact and where the pipe diameter is 1200 mm. It is recommended that a provision for an additional 150 mm of bedding be included in the Contract, if required.

From the springline to 300 mm above the obvert of the pipe, sand cover (such as OPSS.PROV 1002 [Aggregates – Concrete] fine aggregate) may be used. All bedding and cover materials should be placed and culvert construction carried out in accordance with OPSS.PROV 410 (Pipe Sewer Installation in Open Cut) and OPSS 401 (Trenching, Backfilling and Compacting), and the bedding/cover soil should be compacted in accordance with OPSS.PROV 501 (Compacting).

7.3.2 Trench Backfill

The excavated materials from the site will vary in quality and composition from sand fills to organic soils to native silt to silty sand to clayey silt. The majority of the excavated soils, where encountered above the water table, should be generally near their estimated optimum water contents for compaction provided they are protected from precipitation once they are exposed. Soils encountered below the water table would likely require significant drying in order to reach optimum water content for compaction.

The excavated sand fill, if it is encountered above the groundwater level and maintained at suitable water content, may be reused as trench backfill provided it is free of organics, or other deleterious material and is placed and compacted as outlined below. Excavated granular material from the existing pavement structure may be used as trench backfill, assuming that the requirements in the below standards are met. All oversized cobbles and boulders (i.e., greater than 150 mm in size) should be removed from the backfill.

All excavated organic soils, including the silty peat, organic clayey silt and organic silt should not be used as trench backfill at this site and will likely need to be disposed off site. Native silty soils and/or fine-grained sandy soils should not be used as backfill within the frost depth, especially for the proposed sewer below the Highway 11 median.

All trench backfill should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 95 per cent of their SPMDD, in accordance with OPSS.PROV 501 (Compacting).

Alternatively, if placement water contents at the time of construction are too high, or if there is a shortage of suitable in-situ material, then an approved imported granular material which meets the requirements of OPSS.PROV 1010 (Aggregates) Select Subgrade Material (SSM) or Granular 'B' may be used. This material should be placed in loose lift thicknesses as indicated above and uniformly compacted to at least 95 per cent of its SPMDD, in accordance with OPSS.PROV 501 (Compacting). Backfilling operations during cold weather must avoid inclusions of frozen lumps of material, snow and ice. Consideration should be given to using non-frost susceptible



granular fills / materials for trench backfill to the proposed sewer located within the median of Highway 11 (i.e. MH01 to MH03).

Normal post-construction settlement of the compacted trench backfill should be anticipated, with the majority of such settlement taking place within about six (6) months following the completion of trench backfilling operations. Post-construction settlement of the trench backfill is expected to be less than 25 mm but will be differential relative to the rest of the roadway. The designer should take this into account when considering construction staging options for this project.

7.3.3 Frost Depth Considerations

Based on OPSD 3090.100 (Foundation Frost Penetration Depths for Northern Ontario) the frost depth for the project area is about 2.0 m. The native soils encountered within the proposed pipe horizon and at the invert elevations are generally considered frost susceptible. To protect the proposed sewer pipes from the effects of frost jacking forces or the contents of the pipes from freezing, at least 2.0 m of soil cover should be provided for in the design. Based on Golder's understanding of the design, a minimum depth of cover of 2.6 m is proposed for the sewer alignments between MH01 to MH02, MH02 to MH03, MH04 to MH05, and MH05 to MH06. Where less than 2.0 m of cover is proposed, alternative methods of frost protection should be considered, such as thermal insulation using rigid polystyrene or similar material. In general, for polystyrene insulation, the MTO has adopted an equivalency of 25 mm of insulation for every 0.3 m reduction in soil cover may be considered for design, if required.

7.4 Lateral Earth Pressure for Design

The parameters (unfactored) provided below may be used to calculate the lateral earth pressures acting on ancillary structures such as manholes. Parameters to be used for temporary protection systems are provided in Section 7.4.2.



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Soil Type	Bulk Unit Weight, γ (kN/m ³)	Internal Angle of Friction, ϕ (degrees)	Undrained Shear Strength, s_u (kPa)	Lateral Earth Pressure Coefficients	
				Active, K_a	At-rest, K_o
Compact Sand to Sand and Gravel (Fill)	22	35	-	0.27	0.43
Amorphous Peat	14	26	10	0.39	0.56
Fibrous Silty Peat	12	28	1	0.36	0.53
Very Soft to Soft Organic Clayey Silt	17	27	25	0.38	0.55
Very loose to loose Organic Silt	18	28	-	0.36	0.53
Very loose to compact Organic Silty Sand	19	30	-	0.33	0.50
Very Soft to Stiff Clayey Silt	18	27	25	0.38	0.55
Very Loose to Compact Silt to Silty Sand	18	29	-	0.35	0.52
Compact to Very Dense Silty Sand to Sand Till	21	35	-	0.27	0.43

The unit weight of water may be taken as 9.8 kN/m³. If the structure allows for lateral yielding, active earth pressures may be used in the design of the structure(s). If the structure does not allow for lateral yielding, at-rest earth pressures should be assumed for design. The movement to allow active pressures to develop within the supported material, and thereby assume an unrestrained structure, may be taken as presented in Table C6.6 of the Commentary to the CHBDC (2014).

Construction of the maintenance structures should be in accordance with OPSS.PROV 402 (Maintenance Holes).

7.5 Construction Considerations

7.5.1 Surface Water and Groundwater Control

Based on the groundwater levels measured in the standpipe piezometers installed in Borehole 17-1, 17-4, and 17-8, the local groundwater level is generally expected to be above the pipe invert along the proposed sewer alignments and active groundwater control / depressurization will be required to draw down the water table prior to excavation to reduce the risk of basal instability and allow for installation of the sewers in the dry.

Where excavations will be advanced through or into water-bearing granular soils, appropriate dewatering will be required to maintain the groundwater level below the base of the excavation/subgrade prior to and during excavation and construction. It is recommended that a NSSP be included in the Contract Documents to warn the Contractor of the water-bearing soil conditions and the requirement for dewatering, an example is included in Appendix D. Further, where granular fill or organic/granular soils overlay less permeable materials (e.g., clayey silt and silts), such is the case at this site, subsurface water will tend to accumulate at this interface and will be difficult to remove with conventional dewatering systems and/or sumps and pumps. Use of widely-spaced sump



pits and pumps, shallow drilled wells with submersible pumps or drainage that relies on gravity flow of water may not be adequate to lower groundwater below subgrade / sub-excavation levels. Therefore, we recommend that active dewatering be carried out in advance of excavation using systems such as closely-spaced (e.g., less than 5 m) well points or eductors / vacuum well points to depressurize / actively draw down the groundwater level to approximately 1 m below the base of the excavation along the full sewer alignment. The depth of dewatering should consider the need for localized areas requiring thicker bedding / increased sub-excavation where unsuitable soils, if encountered, will need to be removed below the design subgrade, as discussed in Section 7.3.1. Dewatering should be designed in accordance with OPSS.PROV 517 (Dewatering), as amended by MTO Special Provision SP 571F01, and with reference to the attached NSSP. Required designer fill-ins for SP 517F01 will be developed in conjunction with MH, and included in the contract package.

Consideration should be given to providing a groundwater cut-off system in conjunction with the temporary protection systems, such as sheet piling, installed to an appropriate tip depth to cut off and reduce groundwater flow through the sides of the excavation and reduce the risk of basal instability. This is further discussed in section 7.5.2, below.

The design drawings and construction records (if available) for the existing sewers should also be reviewed in detail prior to completion of design and development of Contract Documents for this project. If granular bedding was used for the existing utilities present near the proposed storm sewer crossing, the bedding may act as a conduit for subsurface water flow and the contractor responsible for the new work should clearly be made aware of such conditions and be required to manage such water accordingly, and the possibility for such will be included in the aforementioned NSSP.

Water takings in excess of 50 m³/day are regulated by the MOECC. Certain takings of groundwater and stormwater for construction dewatering purposes with a combined total less than 400 m³/day qualify for self-registration on the MOECC's Environmental Activity and Sector Registry (EASR). Registry on the EASR replaces the need to obtain a PTTW for water taking and a Section 53 approval for discharge of water to the environment. A "Water Taking Plan" and a "Discharge Plan" are required by the MOECC if water is taken in accordance with an EASR. In all cases, discharge under the EASR must be in accordance with a Discharge Plan (to be developed by the contractor). The contractor will be responsible for obtaining any required discharge approvals. A Category 3 PTTW would be required for water takings in excess of 400 m³/day. Based on the groundwater level(s) at this location, the proposed work, and depending on construction staging, groundwater pumping volumes will likely exceed 50 m³/day and may exceed 400 m³/day during initial drawdown stages and/or during periods of heavy precipitation and depending on the Contractors methods.

Surface water should be directed away from open excavation areas to prevent ponding of water that could result in disturbance and weakening of the subgrade.

7.5.2 Excavations and Temporary Protection Systems / Basal Instability

For open cut excavations, the highest risk associated with construction, from a foundations perspective, is the selection of the temporary shoring and dewatering systems. Trench boxes, while they may protect workers, do not support either the ground beside the box side walls nor any adjacent utilities and structures and thus should not be utilized in areas where buried organics and nearby surface structures (including Highway 11 road surface) are present or where ground losses beneath or adjacent to the roadway would then negatively affect the pavement surface and traffic flow. Instead, a properly designed and engineered shoring system (soldier pile and lagging,



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slide-rail system, braced sheet-piles, etc.) would be required. In addition, dewatering will be required as discussed Section 7.5.1.

Temporary shoring should be designed by a licensed Professional Engineer experienced in shoring design. The temporary excavation support system should be designed and constructed in accordance with OPSS 404 (Support Systems) and OPSS.PROV 539 (Temporary Protection Systems) as appropriate, to meet Performance Level 2. It will also be necessary to assess the effects of excavation, shoring and dewatering work on all settlement/displacement-sensitive structures (including underground utilities / services, light standards, pavement structure, etc.) within the zone of influence of the proposed works.

All temporary excavations must be carried out in accordance with the requirements of the Occupation Health and Safety Act (OHSA) for Construction Projects. The soil types, as defined in the OHSA, for overburden soils present along the proposed pipe alignments are summarized below as an aid for specification and design:

- Fill Above Groundwater – Type 3 soil.
- Amorphous Peat and Silty Peat – Type 4 soil.
- Organic Silt and Clayey Silt – Type 4 soil.
- Organic Silty Sand – Type 4 soil.
- Silty Sand to Sand Till – Type 3 soil.
- Silt to Silty Sand below Groundwater – Type 4 soil.
- Clayey Silt – Type 4 soil.

For open excavations, Type 3 and Type 4 soils must be sloped from the bottom of the excavation. Type 3 soils may have a slope no steeper than 1 horizontal to 1 vertical (1H:1V) and Type 4 soils may have a maximum allowable slope of 3H:1V. Depending upon the construction procedures adopted by the contractor, groundwater seepage conditions and weather conditions at the time of construction, some local flattening of the slopes of open cut excavations may be required, especially in looser/softer zones or where localized seepage is encountered. Further, layering of soils and the effectiveness of the Contractor's dewatering systems could affect the OHSA classification and, therefore, the classification of soils for OHSA purposes must be made at the time the excavation is open and can be directly observed during construction. Classification of the materials under the OHSA categories should not be used as the basis for bidding or construction planning due to the potential influence of the Contractor's selected means and methods.

Given the anticipated space restriction for open cut near or on Highway 11, temporary horizontal support systems will be required. Recommended geotechnical parameters for use in design of temporary shoring are provided below. The geotechnical engineering parameters provided below are considered appropriate for design of the temporary ground support systems with respect to the ultimate conditions and do not account for control of ground displacements. If control of ground displacements is critical it may be necessary to use parameter values that result in higher design loads or undertake an iterative evaluation of assumed ground and water pressure and structural displacement analyses to arrive at an appropriately stiff ground support system.



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Stratigraphic Unit	Bulk Unit Weight, γ (kN/m ³)	Internal Angle of Friction, ϕ (degrees)	Undrained Shear Strength, s_u (kPa)	Lateral Earth Pressure Coefficients ^{1,2}		
				Passive, K_p^3	Active, K_a	At-rest, K_o
Compact Sand (Fill)	22	35	-	3.69	0.27	0.43
Stiff Amorphous Peat	14	26	10	2.56	0.39	0.56
Fibrous Silty Peat	12	28	1	2.77	0.36	0.53
Very soft to soft Organic Clayey Silt	17	27	25	2.66	0.38	0.55
Very loose to loose Organic Silt	18	28	-	2.77	0.36	0.53
Very loose to compact Organic Silty Sand	19	30	-	3.00	0.33	0.50
Very soft to Stiff Clayey Silt	18	27	25	2.66	0.38	0.55
Very Loose to Compact Silt to Silty Sand	18	29	-	2.88	0.35	0.52
Compact to Very Dense Silty Sand to Sand Till	21	35	-	3.69	0.27	0.43

Notes:

1. The lateral earth pressure coefficients presented above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are expected, the coefficients should be corrected accordingly.
2. The total passive resistance below the base of the excavation (i.e. adjacent to the temporary protection system) may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.16 of the CHBDC (2014) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

The loading from adjacent structures and construction equipment as well as any material stockpiles within a distance defined by a 1.5 horizontal to 1 vertical line drawn from the bottom of the excavation to the existing ground surface should be included as a surcharge.

Based on the groundwater levels measured in the closest standpipe piezometers, the design groundwater level can be assumed to be Elevation 231 m for sewer alignments between MH01 and MH03, Elevation 231 m for the sewer alignment between MH04 and MH05, and Elevation 231.5 m for the sewer alignment between MH05 and MH06. Higher groundwater levels should be assumed if construction is anticipated during Spring.

Vibratory equipment for the installation of temporary protection systems may be used at this site as long as this does not impact nearby buried infrastructure, such as existing water mains, sanitary sewers or gas lines, and residential and commercial structures / foundations. The installation of temporary protection systems by vibratory equipment should be monitored to ensure the vibration levels produced are within tolerable limits and in consultation with the infrastructure / utility and property owners within the zone of influence of the site. A vibration monitoring plan should be included in the Contractors work plan for temporary installation works, if applicable.



Design of the temporary support systems should include an evaluation of base stability, soil squeezing stability and hydraulic uplift stability as defined in the CFEM (2006). Provided appropriate dewatering systems, possibly in combination with temporary cut-off walls, are utilized, the excavation bases should be stable with respect to soil strength considerations. Since the excavations are generally below the static groundwater level there is potential for basal instability to occur (e.g. 'piping', 'quick conditions' or 'boiling') should an unbalanced hydrostatic head result in large upward seepage gradients at the base of the excavation. The hydrostatic head should be drawn down to at least 1 m below the base of the excavation to prevent the occurrence of base heave.

As noted in section 7.5.1, to reduce the risk of basal instability, consideration should be given to incorporating a groundwater cut-off system in conjunction with the temporary protection systems, such as sheet piling, installed to an appropriate depth below the base of excavation. However, this technique will not reduce the risk of base heave when a relatively impermeable layer at the base of the excavation (such as clayey silt) is underlain by a pressurized permeable layer (such as silty sand to sandy silt) with a hydrostatic water level above the base of the excavation. Subsequent groundwater level measurements should be carried out to determine the groundwater pressures prior to and during construction to ensure basal stability.

Consideration could be given to either partial or full removal of the temporary protection systems upon completion of construction or each stage of construction (as required). Where feasible, full removal of the temporary shoring system should be considered to mitigate potential impediments to future rehabilitation / reconstruction work at the sewer sites, or related road / infrastructure construction. Although the practicality of removing temporary protection systems depends on the methods used by the Contractor, conventional systems such as trench boxes, slide rail systems, or shallow sheetpiles can likely be removed without difficulty. If soldier piles and lagging or deep sheetpiles are used, consideration should be given to partial removal for practical purposes and to avoid disturbing the surrounding soils after backfilling is complete. Vibration and noise controls during extraction of any temporary systems should meet the same tolerable limits used for installation.

Based on discussions with the designer, the proposed traffic staging plan will require temporary concrete barriers to separate traffic from work zones. With respect to MTO memo DCSO#2017-04, dated September 19, 2017 regarding barriers adjacent to excavation, we understand that all temporary barriers will be located a minimum distance of 1.0 m from the edge of all temporary excavations, including those requiring temporary protection systems at this site.

7.5.3 Obstructions

The sand fill encountered in Borehole 17-1 and 17-4 and the clayey silt deposit underlying the organic clayey silt layer encountered in Borehole 17-3 should be expected to contain cobbles and/or boulders as inferred from auger grinding (as noted on the Record of Borehole sheets), which could affect the installation of temporary protection systems. Cobbles/boulders should also be anticipated to be present in the silty sand to sand (till) deposit that was encountered in Boreholes 17-1 to 17-3, 15-3, and 15-4.

An NSSP to identify to the contractor the possible presence of cobbles and/or boulders within the overburden soils should be included in the contract documents, an example is provided in Appendix D.

7.6 Analytical Testing for Construction Materials

The results of analytical testing on seven samples of the overburden soils encountered in Boreholes 17-2, 17-3, 17-5, 17-7, 17-8, 15-3 and 15-4 are summarized in Section 5.4 and presented in Appendix C. The potential for



sulphate attack and corrosion are discussed in the following paragraphs, however, it is ultimately up to the designer to determine the appropriate construction materials, including the exposure class and ensuring that all aspects of CSA A23.1-14 Section 4.1.1 “*Durability Requirements*” are followed when designing concrete elements.

The analytical test results were compared to CSA A23.1-14 Table 3 (“*Additional requirements for concrete subjected to sulphate attack*”) for the potential sulphate attack on concrete. The water soluble-sulphate concentration measured in the soil samples tested ranges from less than the detectable limit of 0.01 per cent to 0.17 per cent in a sample of sand fill from BH15-3, which is below the exposure class of S-3 (Moderate). Therefore, based on the samples tested, when the designer is selecting the exposure class for the structure, the effects of sulphates from within the soil stratum tested may not need to be considered. However, given the location of the storm sewers under the highway or within the highway right of way, it may be exposed to de-icing salts and selection of the exposure class should take this into consideration.

The analytical test results were also compared to Table 7.1 *Relative Effect of Resistivity on Corrosion Potential /Aggressiveness* and Table 7.2 *Criteria for Assessing Ground Corrosion Potential* as outlined by Lazarate et al., 2015 in Federal Highway Administration (FHWA) Publication No. FHWA-NHI-14-2007 for the potential corrosion of buried steel. Based on the criteria in Table 7.2 (Lazarate et al. 2015) and the measured values of pH, resistivity, chlorides, and sulfates in the soil samples.

The following soil samples meet the threshold for “non-aggressive” corrosion potential:

- Silt and Sand from Borehole 15-3; and,
- Sandy Silt from Borehole 17-7 and 17-8.

Based on the criteria in Table 7.1 (Lazarate et al. 2015) and measured value of resistivity in the samples:

- The organic clayey silt in Boreholes 17-3 and the sand fill in Borehole 15-4 are “very corrosive”;
- The clayey silt in Borehole 17-2 and 17-5 is “corrosive”;
- And the sandy silt to silt and sand soils in Boreholes 17-1, 17-8 and 15-3 are “moderately to mildly corrosive”.

As noted above, given the location of the storm sewers under the highway or within the highway right of way, it is expected that the storm sewer will be exposed to de-icing salts, and therefore consideration should be given to providing corrosion protection to reinforcing elements.

7.7 Standpipe Piezometer Decommissioning

Ontario Regulation (O.Reg.) 903, as amended, of the Ontario Water Resources Act requires that monitoring wells (including standpipe piezometers) are properly decommissioned by qualified personnel. It is recommended that the decommissioning of the piezometers be carried out as part of the construction completion activities at the site so that water level measurements can be taken prior to and during construction, as required. An NSSP should be included in the contract documents to allow use of existing piezometers to monitor groundwater levels prior to and during construction and for decommissioning of the piezometers as part of construction activities; an example is included in Appendix D.



8.0 CLOSURE

This report was prepared by Mr. David Marmor, E.I.T. and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P. Eng., a senior geotechnical engineer and Associate of Golder. Mr. Kevin Bentley, P.Eng, a Designated MTO Foundations Contact and Associate of Golder, conducted an independent quality control review of this report.



FOUNDATION REPORT, STORM SEWER REPLACEMENT, HIGHWAY 11 (ALGONQUIN AVE.), NORTH BAY

Report Signature Page

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- ASTM International
- ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
- Ontario Provincial Standard Specifications
- | | |
|----------------|--|
| OPSS.PROV 401 | Construction Specification for Trenching, Backfilling, and Compacting |
| OPSS.PROV 402 | Construction Specification for Excavating, Backfilling and Compacting For Maintenance Holes |
| OPSS 404 | Construction Specification for Support Systems |
| OPSS.PROV 410 | Construction Specification for Pipe Sewer Installation in Open Cut |
| OPSS.PROV 501 | Construction Specification for Compaction |
| OPSS.PROV 517 | Construction Specification for Dewatering |
| OPSS.PROV 539 | Construction Specification for Temporary Protection Systems |
| OPSS.PROV 1002 | Material Specification for Aggregates – Concrete |
| OPSS.PROV 1010 | Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material |
| SP 517F01 | Special Provision No. 517F01 – Amendment to OPSS 517 |
- Ontario Provincial Standard Drawings
- | | |
|--------------|---|
| OPSD 802.030 | Rigid Pipe Bedding, Cover, and Backfill Type 1 or 2 Soil – Earth Excavation |
| OPSD 802.031 | Rigid Pipe Bedding, Cover, and Backfill Type 3 Soil – Earth Excavation |
| OPSD 802.032 | Rigid Pipe Bedding, Cover, and Backfill Type 4 Soil – Earth Excavation |



FOUNDATION REPORT, STORM SEWER REPLACEMENT, HIGHWAY 11 (ALGONQUIN AVE.), NORTH BAY

Ontario Water Resources Act

Ontario Regulation 903/90

Wells: O. Reg. 468/10 Amendment to Ontario Regulation 903

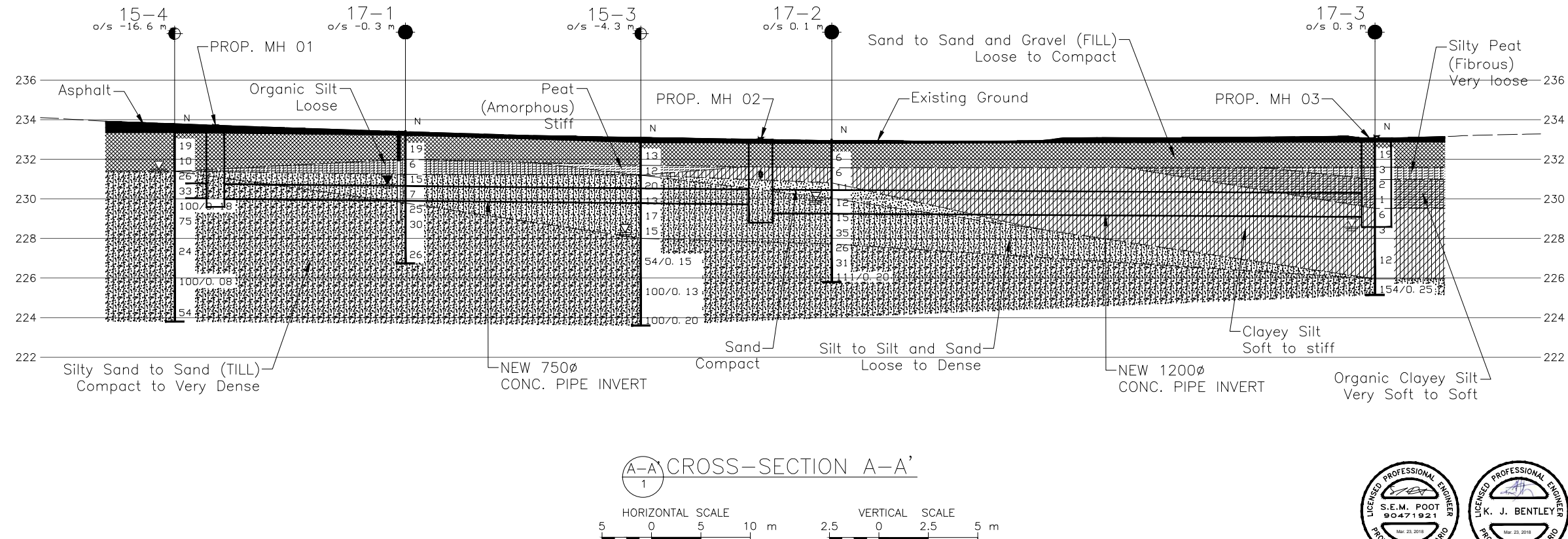
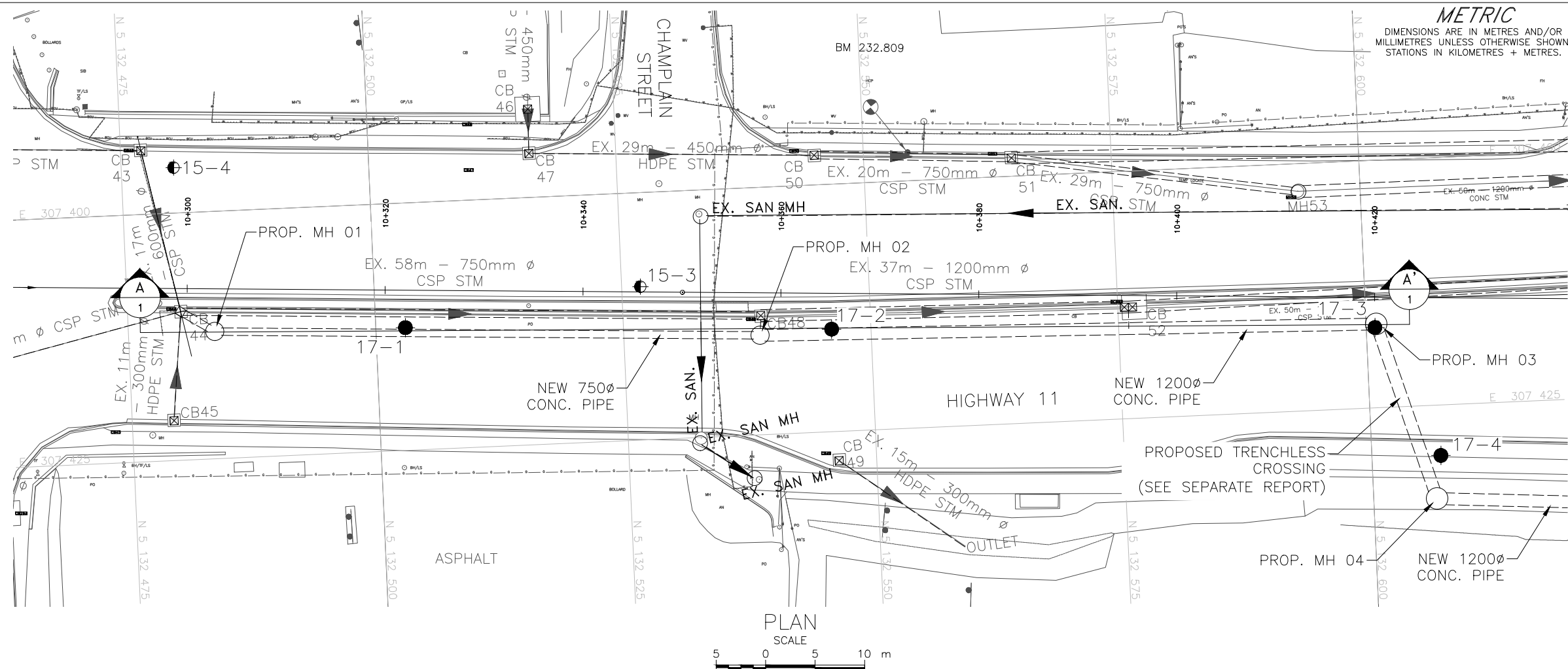
Ontario Occupational Health and Safety Act

Ontario Regulation 213 (Construction Projects)



FOUNDATION REPORT, STORM SEWER REPLACEMENT, HIGHWAY 11 (ALGONQUIN AVE.), NORTH BAY

DRAWINGS



CONT No.
GWP No.5186-14-00

HIGHWAY 11
STORM SEWER
BOREHOLE LOCATIONS AND SOIL STRATA
STA. 10+300 TO 10+420

Golder Associates

KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (Geocres No. 31L-192)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on AUG. 23, 2017
- ≡ WL measured in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
17-1	233.4	5132503.0	307412.6
17-2	233.0	5132546.0	307414.6
17-3	233.2	5132600.9	307416.9
15-3	233.1	5132526.9	307409.5
15-4	233.6	5132480.3	307395.4

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 Morrison Hershfield, drawing file nos. 1150201-XREF-BASE SURVEY.dwg and 1150201-XREF-STM-3D.dwg, received OCT. 06, 2017.

NO.	DATE	BY	REVISION

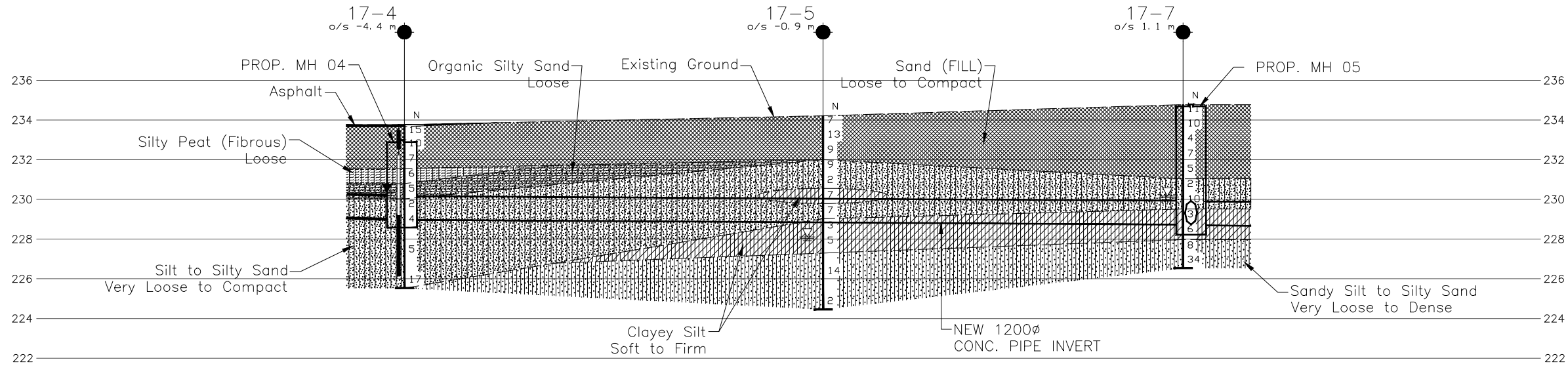
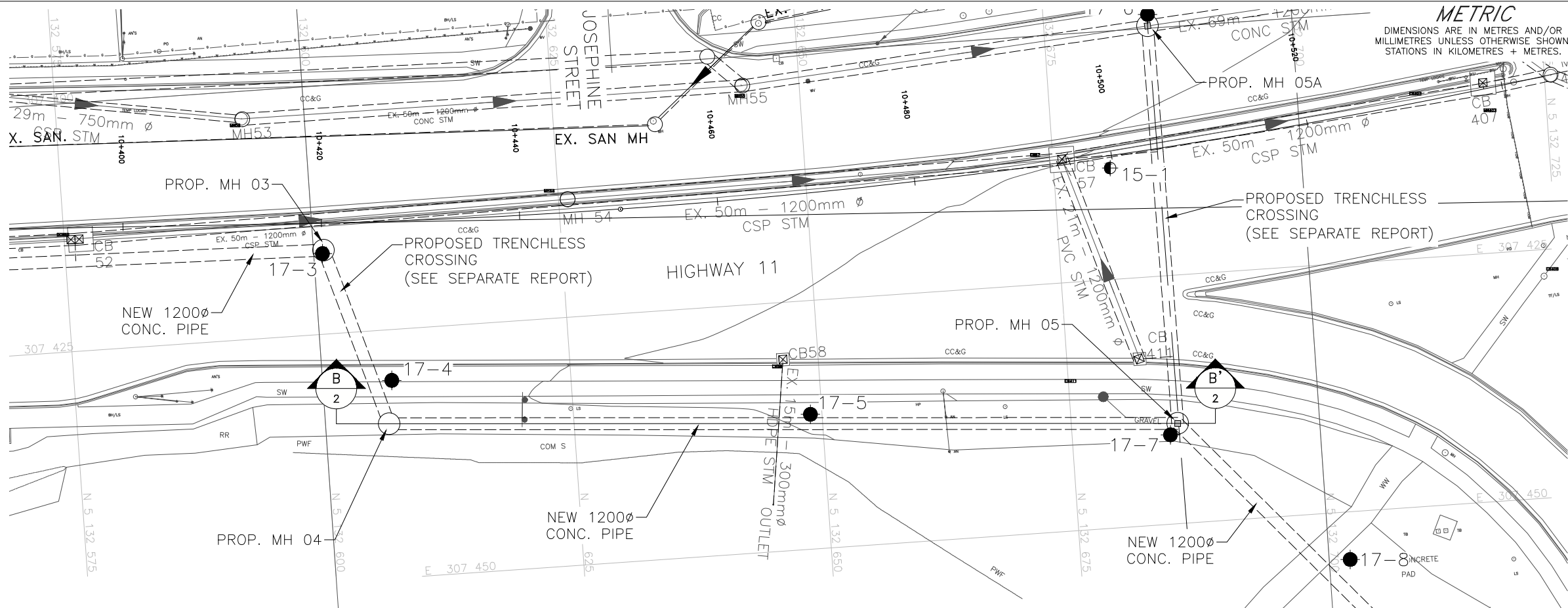
Geocres No. 31L-210

HWY. 11	PROJECT No. 1671122	DIST. NORTHEAST
SUBM'D. DPM	CHKD. DPM	DATE: 03/23/2018
DRAWN: JM	CHKD. SEMP	APPD. KB

DWG. 1

S.E.M. POOT
90471921
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Mar. 23, 2018
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B-B' CROSS-SECTION B-B'



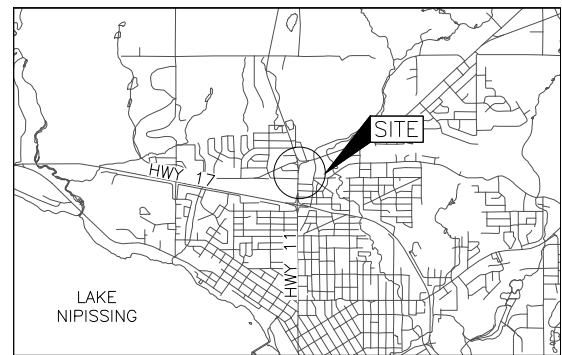
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.5186-14-00



HIGHWAY 11
STORM SEWER
BOREHOLE LOCATIONS AND SOIL STRATA
STA. 10+426 TO 10+504

SHEET



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (Geocres No. 31L-192)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer, measured on SEPT. 15, 2017
- ≡ WL measured in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
17-4	233.8	5132607.0	307430.1
17-5	234.2	5132648.8	307436.4
17-7	234.8	5132684.9	307441.0

NOTES

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

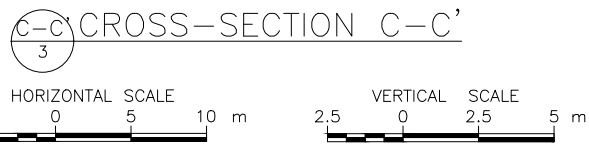
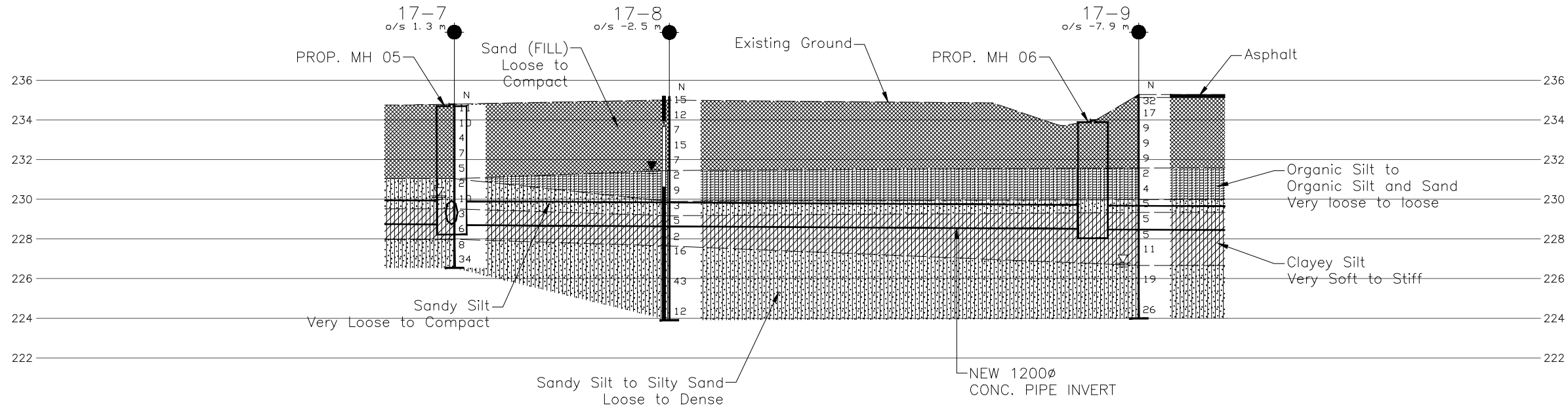
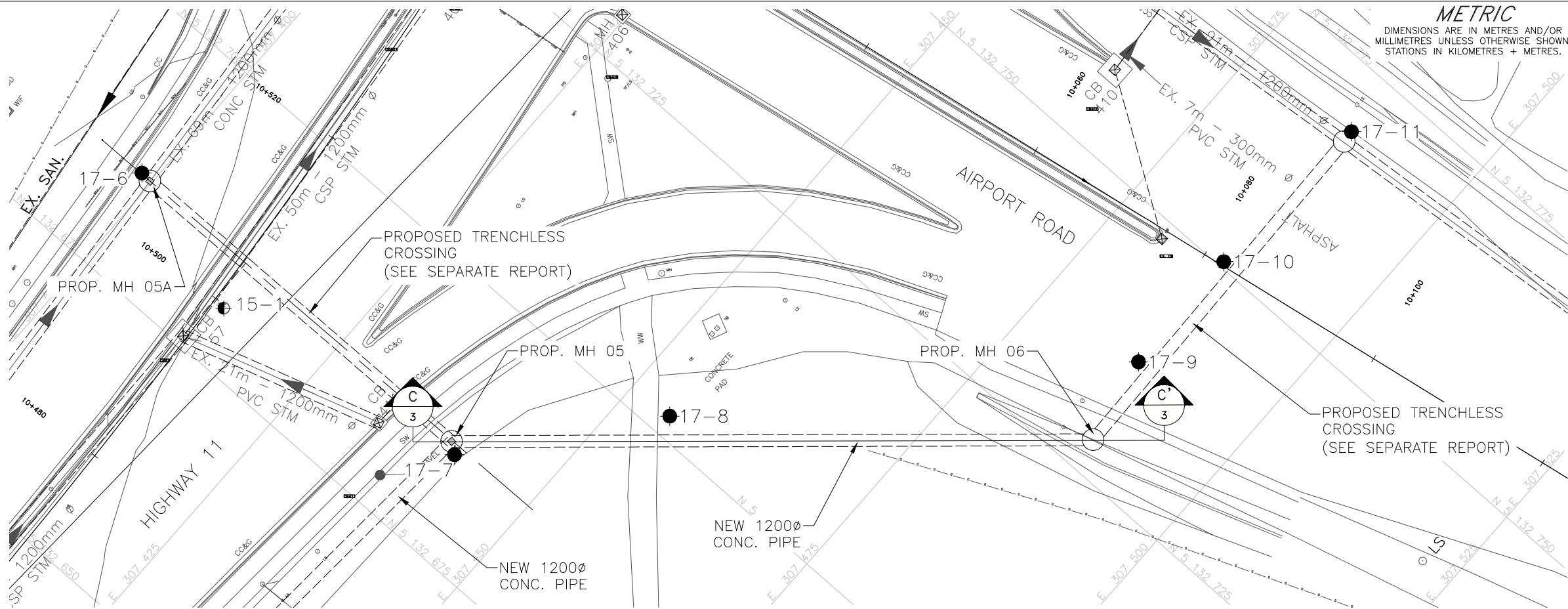
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file nos. 1150201-XREF-BASE SURVEY.dwg and 1150201-XREF-STM-3D.dwg, received OCT. 06, 2017.

NO.	DATE	BY	REVISION
Geocres No. 31L-210			
HWY. 11		PROJECT NO. 1671122	DIST. NORTHEAST
SUBM'D. DPM	CHKD. DPM	DATE: 03/23/2018	SITE: .
DRAWN: JM	CHKD. SEMP	APPD. KB	DWG. 2

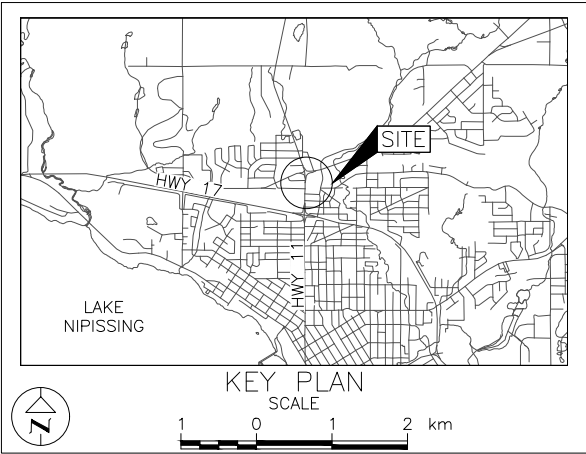




METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.5186-14-00

HIGHWAY 11 – STORM SEWER
BOREHOLE LOCATIONS AND SOIL STRATA
STA. 10+504 (HWY 11) TO
STA. 10+080 (AIRPORT RD)



LEGEND

- Borehole – Current Investigation
- Borehole – Previous Investigation (Geocres No. 31L-192)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on SEPT. 15, 2017
- WL measured in open borehole upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
17-7	234.8	5132684.9	307441.0
17-8	235.2	5132702.1	307454.8
17-9	235.3	5132737.3	307486.8

NOTES

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REFERENCE

Base plans provided in digital format by Morrison Hershfield, drawing file nos. 1150201-XREF-BASE SURVEY.dwg and 1150201-XREF-STM-3D.dwg, received OCT. 06, 2017.

NO.	DATE	BY	REVISION
Geocres No. 31L-210			
HWY. 11		PROJECT NO. 1671122	DIST. NORTHEAST
SUBM'D. DPM	CHKD. DPM	DATE: 03/23/2018	SITE: .
DRAWN: JM	CHKD. SEMP	APPD. KB	DWG. 3





APPENDIX A

Record of Boreholes



LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Condition	N Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	c_u, s_u kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

PROJECT 1671122		RECORD OF BOREHOLE No 15-3				SHEET 1 OF 1		METRIC						
G.W.P. 5137-14-00		LOCATION N 5132526.9; E 307409.5 MTM ZONE 10 (LAT. 46.332453; LONG. -79.466106)				ORIGINATED BY DM								
DIST Northeast HWY 11		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and NQ Coring				COMPILED BY AC								
DATUM Geodetic		DATE December 9, 2015				CHECKED BY SEMP								
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						
233.1	GROUND SURFACE													
0.0	ASPHALT (150 mm)													
0.3	RECYCLED ASPHALT PAVEMENT (100 mm)													
232.3	Gravelly sand (FILL)													
0.8	Brown Moist		1	SS	13									
231.7	Sand, trace silt (FILL)													
1.4	Compact Brown Moist		2A	SS	12									
231.2	PEAT (Amorphous)		2B											
1.9	Stiff Black Wet													
	SILT and SAND, trace clay		3	SS	20									0 56 39 5
	Compact Grey Wet													
	Peat layers encountered in Sample 2B.		4	SS	13									
			5	SS	17									0 30 65 5
228.0			6A	SS	15									
5.1	SILTY SAND, some gravel, trace clay (TILL) Very dense Grey Wet		6B											
	Auger refusal at 5.2 m depth, switched to NW Casing.		7	SS	54/0.15									
			8	SS	100/0.13									
	200 mm cobble encountered at 7.9 m depth.													
223.6			9	SS	100/0.20									
9.5	END OF BOREHOLE													
	Note: 1. Water level at a depth of 4.8 m below ground surface (Elev. 228.3 m) upon completion of drilling.													

PROJECT 1671122		RECORD OF BOREHOLE No 15-4				SHEET 1 OF 1		METRIC									
G.W.P. 5137-14-00		LOCATION N 5132480.3; E 307395.4 MTM ZONE 10 (LAT. 46.332034; LONG. -79.466290)				ORIGINATED BY DM											
DIST Northeast HWY 11		BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and NQ Coring				COMPILED BY AC											
DATUM Geodetic		DATE December 10, 2015				CHECKED BY SEMP											
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									
233.6	GROUND SURFACE																
0.0	ASPHALT (150 mm)																
0.3	RECYCLED ASPHALT PAVEMENT (100 mm)																
	Sand and gravel, trace silt (FILL) Compact Brown Wet		1	SS	19												51 45 (4)
232.2	Sand, trace to some gravel (FILL) Compact Brown Wet		2	SS	10												
231.4	SILTY SAND, some gravel, trace clay (TILL) Compact to very dense Grey Wet		3	SS	26												
	Hydrocarbon odour noted in Sample 3		4	SS	33												
	200 mm cobble encountered at 4.0 m depth.		5	SS	100/0.18												
	150 mm cobble encountered at 5.8 m depth.		6	SS	75												17 54 24 5
	75 mm and 100 mm cobbles encountered at 7.0 m and 7.1 m depth, respectively.		7	SS	24												
	200 mm cobble encountered at 7.6 m depth.		8	SS	100/0.08												
223.8	END OF BOREHOLE		9	SS	54												
9.8	Notes: 1. Water level at a depth of 2.1 m below ground surface (Elev. 231.5 m) upon completion of drilling. 2. Borehole caved at 3.0 m (Elev. 230.6 m) after removal of augers / casing.																


PROJECT		RECORD OF BOREHOLE No 17-1				SHEET 1 OF 1		METRIC						
G.W.P. 1671122		LOCATION N 5132503.0; E 307412.6 MTM ZONE 10 (LAT. 46.332238; LONG. -79.466066)				ORIGINATED BY MB								
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS								
DATUM Geodetic		DATE August 13, 2017				CHECKED BY DPM								
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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
233.4	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30					
0.0	ASPHALT (230 mm)													
0.2	Sand, trace to some silt and gravel (FILL) Compact Brown Dry - Auger grinding at 0.7 m		0	GRAB	-									
232.0			1	SS	19									
1.5	ORGANIC SILT, some sand, trace gravel Loose Dark brown to grey Moist - Auger grinding at 1.8 m		2	SS	6								3 13 68 16	
231.2			3	SS	15								0 35 57 8	
2.2	SILT, some sand to SILT and SAND, trace to some clay Loose to compact Grey Wet		4	SS	7								0 13 79 8	
229.8			5	SS	25									
3.7	Silty SAND to SAND, some silt, trace to some gravel (TILL) Compact Grey Wet - Auger grinding at 4.9 m		6	SS	30									
			7	SS	26									
226.7	END OF BOREHOLE													
6.7	Notes: 1. Water level in open borehole at a depth of 2.1 m below ground surface (Elev. 231.3 m) upon completion of drilling. 2. Water level in standpipe piezometer measured at a depth of 2.6 m below ground surface (Elev. 230.8 m) on Aug. 15, 2017. 3. Water level in standpipe piezometer measured at a depth of 2.7 m below ground surface (Elev. 230.7 m) on Aug. 23, 2017.													

PROJECT 1671122		RECORD OF BOREHOLE No 17-2				SHEET 1 OF 1		METRIC									
G.W.P. 5186-14-00		LOCATION N 5132546.0; E 307414.6 MTM ZONE 10 (LAT. 46.332625; LONG. -79.466039)				ORIGINATED BY MB											
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS											
DATUM Geodetic		DATE August 13, 2017				CHECKED BY DPM											
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									
233.0	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT (230 mm)																
0.2	Sand, some gravel (FILL) Loose Brown Moist		1	SS	6												19 81 0 0
231.6																	
1.5	CLAYEY SILT, trace sand, trace organics Firm Dark grey Moist		2	SS	6												
230.8																	
2.2	SAND, some silt, trace clay Compact Brown Moist		3	SS	11												0 85 12 3
230.0																	
3.0	SANDY SILT, trace clay Compact to dense Grey Wet		4	SS	12												0 30 65 5
			5	SS	15												
			6	SS	35												
227.7																	
5.3	SAND, some silt, trace to some clay, trace gravel (TILL) Compact to very dense Grey Wet		7	SS	26												
			8	SS	31												3 74 17 6
	- Auger grinding at 6.7 m		9	SS	111/0.20												
225.8																	
7.2	END OF BOREHOLE																
	Note: 1. Water level in open borehole at a depth of 3.1 m below ground surface (Elev. 229.9 m) upon completion of drilling.																

PROJECT 1671122		RECORD OF BOREHOLE No 17-3				SHEET 1 OF 1		METRIC						
G.W.P. 5186-14-00		LOCATION N 5132600.9; E 307416.9 MTM ZONE 10 (LAT. 46.333119; LONG. -79.466010)				ORIGINATED BY MB								
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS								
DATUM Geodetic		DATE August 14, 2017				CHECKED BY DPM								
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						
233.2	GROUND SURFACE													
0.0	ASPHALT (300 mm)													
232.9														
0.3	Sand, trace to some silt, some gravel (FILL) Compact Brown Dry		1	SS	19									
231.6														
1.6	Silty PEAT, fibrous Very loose Black Moist		2	SS	3								304	
231.0														
2.2	Organic CLAYEY SILT, some sand Very soft to soft Grey Wet		3	SS	2									
	- Peat layers		4	SS	1								46	0 13 65 22 OC = 6.6%
229.5														
3.7	CLAYEY SILT, some sand to Sandy CLAYEY SILT Soft to stiff Grey Wet		5	SS	6									0 13 60 27
			6	SS	3									0 28 50 22
	- Auger grinding at a depth of 5.5 m													
			7	SS	12									
226.0														
7.2	Silty SAND, trace gravel (TILL) Very dense Grey Wet		8	SS	154/ 0.25									
225.2														
8.0	END OF BOREHOLE													
	Note: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 228.6 m) upon completion of drilling.													

PROJECT 1671122		RECORD OF BOREHOLE No 17-4				SHEET 1 OF 1		METRIC									
G.W.P. 5186-14-00		LOCATION N 5132607.0; E 307430.1 MTM ZONE 10 (LAT. 46.333174; LONG. -79.465838)				ORIGINATED BY MB											
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS											
DATUM Geodetic		DATE August 14, 2017				CHECKED BY DPM											
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												
233.8	GROUND SURFACE																
0.0	ASPHALT (100 mm)		1	SS	15												
	Sand, trace to some silt, trace to some gravel (FILL) Loose to compact Brown Moist		2	SS	10												
	- Auger grinding at a depth of 1.2 m and 1.8 m		3	SS	7												
231.6	Silty PEAT, fibrous Loose Black Moist		4	SS	6												
230.8	Organic Silty SAND, trace to some clay Loose Grey-brown Moist		5	SS	5												
230.0	SILT and SAND to SILT some sand, trace to some clay, trace gravel Very loose to compact Grey Wet		6	SS	2												
3.7	- Trace organics encountered between depths of 3.8 m to 4.4 m		7	SS	4												
			8	SS	5												
			9	SS	17												
225.5	END OF BOREHOLE																
8.2	Notes: 1. Water level in open borehole at a depth of 4.4 m below ground surface (Elev. 229.4 m) upon completion of drilling. 2. Water level in standpipe piezometer measured at a depth of 2.8 m below ground surface (Elev. 231.0 m) on Aug. 23, 2017. 3. Water level in standpipe piezometer measured at a depth of 3.4 m below ground surface (Elev. 230.4 m) on Sept. 15, 2017.																

PROJECT		1671122		RECORD OF BOREHOLE No 17-5				SHEET 1 OF 1		METRIC			
G.W.P.		5186-14-00		LOCATION		N 5132648.8; E 307436.4 MTM ZONE 10 (LAT. 46.333550; LONG. -79.465755)		ORIGINATED BY		MB			
DIST		Northeast HWY 11		BOREHOLE TYPE		CME-550, 108 mm Inside Diameter Hollow Stem Augers		COMPILED BY		ZS			
DATUM		Geodetic		DATE		August 17, 2017		CHECKED BY		DPM			
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	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	WATER CONTENT (%)		
234.2	GROUND SURFACE												
0.0	Sand, trace silt, trace organics (FILL) Loose to compact Brown Moist		1	SS	7								
			2	SS	13								
			3	SS	9								
232.0													
2.2	Silty SAND, trace organics Very loose to loose Dark brown Wet		4	SS	9								
			5	SS	2								
230.6													
3.7	Sandy CLAYEY SILT, trace organics Firm Grey Wet		6	SS	7								
229.8			7	SS	7								
4.4	Sandy SILT, trace to some clay, trace organics Loose Grey Wet		8	SS	3								
229.0			9	SS	5								
5.2	CLAYEY SILT, trace sand Soft to firm Grey Wet												
			10	SS	14								
227.1													
7.1	Sandy SILT to Silty SAND Very loose to compact Grey Moist to wet		11	SS	2								
224.5													
9.8	END OF BOREHOLE												
	Note: 1. Water level in open borehole at a depth of 6.1 m below ground surface (Elev. 228.1 m) upon completion of drilling.												

PROJECT 1671122		RECORD OF BOREHOLE No 17-7				SHEET 1 OF 1		METRIC									
G.W.P. 5186-14-00		LOCATION N 5132684.9; E 307441.0 MTM ZONE 10 (LAT. 46.333875; LONG. -79.465696)				ORIGINATED BY MB											
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS											
DATUM Geodetic		DATE August 21, 2017				CHECKED BY DPM											
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									
234.8 0.0	GROUND SURFACE Sand, trace silt, trace gravel, trace clay (FILL) Loose to compact Brown Moist to wet		1	SS	11	▽											1 96 2 1 OC = 4.3% Non-Plastic 0 7 65 28 Non-Plastic 0 22 72 6
			2	SS	10		234										
			3	SS	4		233										
			4	SS	7		232										
			5	SS	5		231										
231.0 3.7	Sandy SILT, trace organics Very loose to compact Mottled grey and black Wet		6	SS	2		230										
			7	SS	10												
229.5 5.3	CLAYEY SILT, trace to some sand Soft to firm Grey Wet		8	SS	3		229										
			9	SS	6		228										
228.0 6.8	Sandy SILT, trace to some clay Loose to dense Grey Moist		10	SS	8		227										
			11	SS	34												
226.5 8.2	END OF BOREHOLE Note: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 230.2 m) upon completion of drilling.																

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PROJECT 1671122		RECORD OF BOREHOLE No 17-8				SHEET 1 OF 1		METRIC									
G.W.P. 5186-14-00		LOCATION N 5132702.1; E 307454.8 MTM ZONE 10 (LAT. 46.334029; LONG. -79.465516)				ORIGINATED BY MB											
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS											
DATUM Geodetic		DATE August 21, 2017				CHECKED BY DPM											
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									
235.2	GROUND SURFACE																
0.0	Sand, trace to some gravel, trace silt (FILL) Loose to compact Brown Moist		1	SS	15												
			2	SS	12												
			3	SS	7												
			4	SS	15												
			5	SS	7												
231.5	Sandy ORGANIC SILT, some clay, trace gravel Very loose to loose Black Wet		6	SS	2												
			7	SS	9												
229.9	Sandy SILT Very loose Grey Wet		8	SS	3												
229.2	CLAYEY SILT, trace to some sand, trace organics Very soft to firm Grey Wet		9	SS	5												
			10	SS	2												
227.6	Sandy SILT to Silty SAND, trace to some clay Compact to dense Grey Wet		11	SS	16												
			12	SS	43												
			13	SS	12												
223.9	END OF BOREHOLE																
11.3	Notes: 1. Water level in open borehole at a depth of 5.2 m below ground surface (Elev. 230.0 m) upon completion of drilling. 2. Water level in standpipe piezometer measured at a depth of 3.5 m below ground surface (Elev. 231.7 m) on Aug. 23, 2017. 3. Water level in standpipe piezometer measured at a depth of 3.7 m below ground surface (Elev. 231.5 m) on Sept. 15, 2017.																

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PROJECT 1671122		RECORD OF BOREHOLE No 17-9				SHEET 1 OF 1		METRIC								
G.W.P. 5186-14-00		LOCATION N 5132737.3; E 307486.8 MTM ZONE 10 (LAT. 46.334347; LONG. -79.465101)				ORIGINATED BY MB										
DIST Northeast HWY 11		BOREHOLE TYPE CME-550, 108 mm Inside Diameter Hollow Stem Augers				COMPILED BY ZS										
DATUM Geodetic		DATE August 15, 2017				CHECKED BY DPM										
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								
235.3	GROUND SURFACE															
0.0	ASPHALT (150 mm)															
0.2	Sand, trace to some gravel, trace silt, trace clay (FILL) Loose to dense Brown Moist		1	SS	32											
			2	SS	17											
			3	SS	9											
			4	SS	9											
			5	SS	9											
231.6	ORGANIC SILT and SAND, trace to some clay Very loose Grey Moist		6	SS	2											13 80 4 3
3.7			7	SS	4											
230.0	SANDY SILT Loose Grey Wet		8	SS	5											0 46 43 11 OC = 6.9% Non-Plastic
5.3			9	SS	5											Non-Plastic
229.3	CLAYEY SILT, trace to some sand Firm to stiff Grey Wet		10	SS	5											
6.0			11	SS	11											0 7 71 22
226.7	SILT and SAND, trace to to some clay Compact Grey Moist		12	SS	19											0 31 61 8 Non-Plastic
8.6			13	SS	26											
224.0	END OF BOREHOLE															
11.3	Note: 1. Water level in open borehole at a depth of 8.5 m below ground surface (Elev. 226.8 m) upon completion of drilling.															



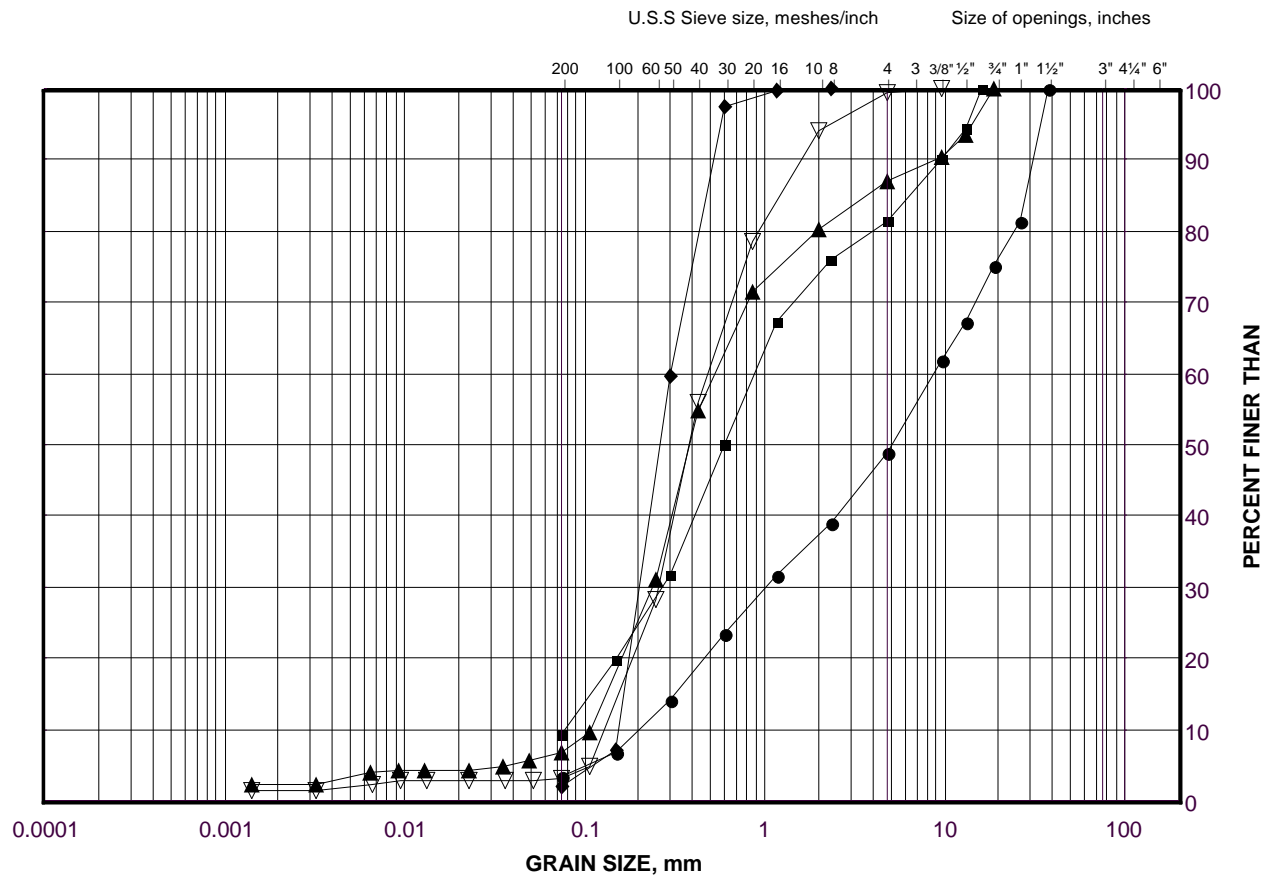
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Sand to Sand and Gravel (FILL)

FIGURE B1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	15-4	1	232.5
■	17-2	1	231.9
◆	17-5	3	232.4
▲	17-9	5	231.9
▽	17-7	5	231.4

Project Number: 1671122.2000 R2

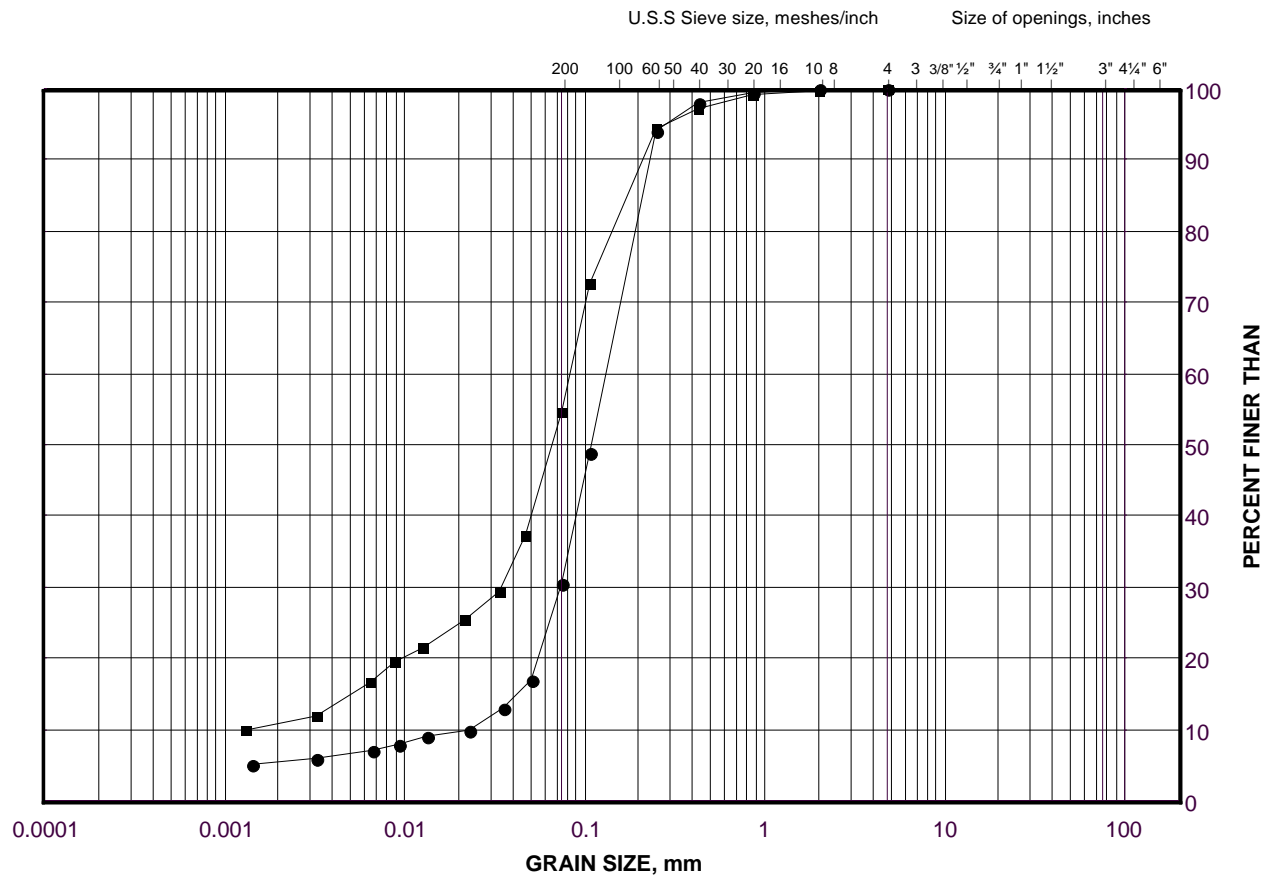
Checked By: DPM

Golder Associates

Date: 27-Oct-17

Organic Silty Sand to Organic Silt and Sand

FIGURE B2



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

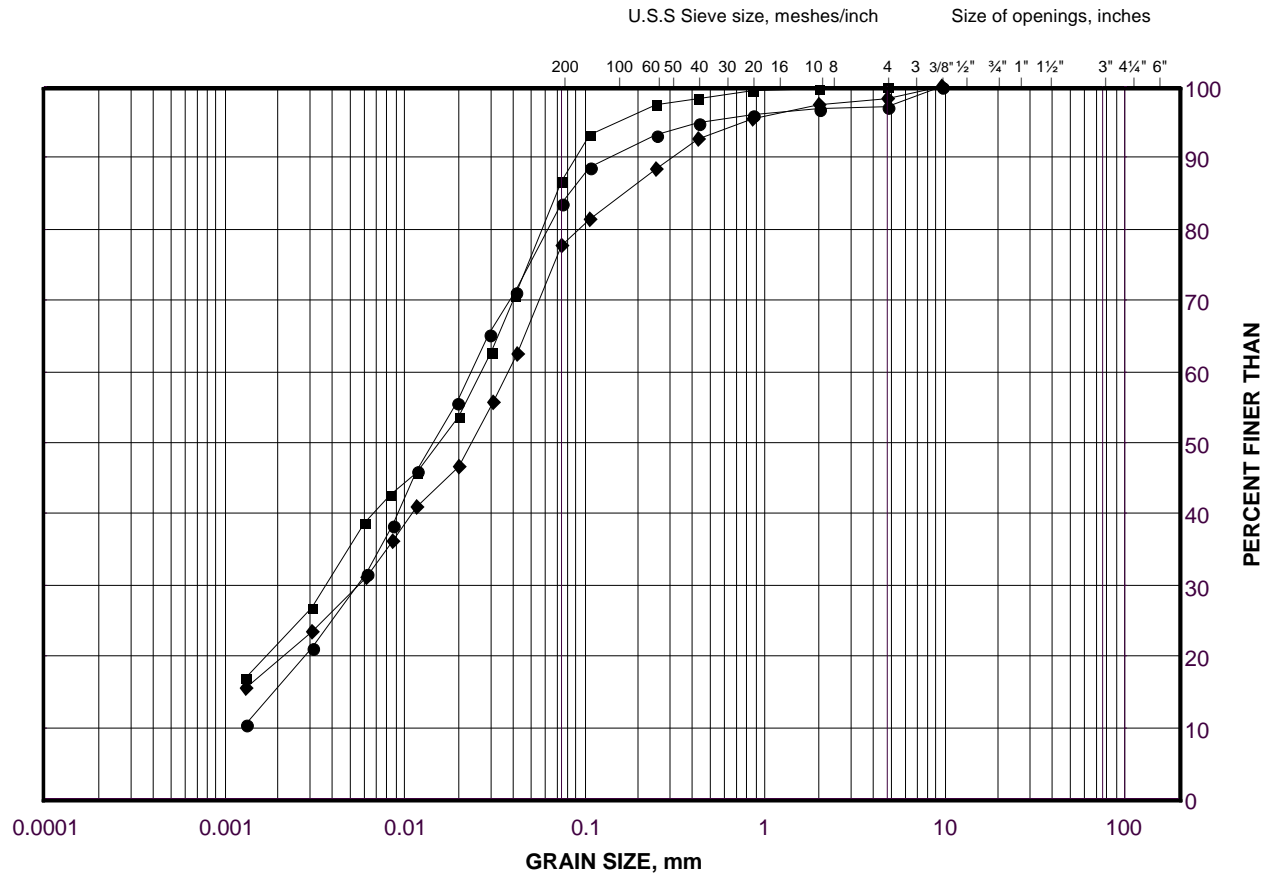
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	17-4	5	230.4
■	17-9	7	230.4

GRAIN SIZE DISTRIBUTION

Organic Clayey Silt to Organic Silt

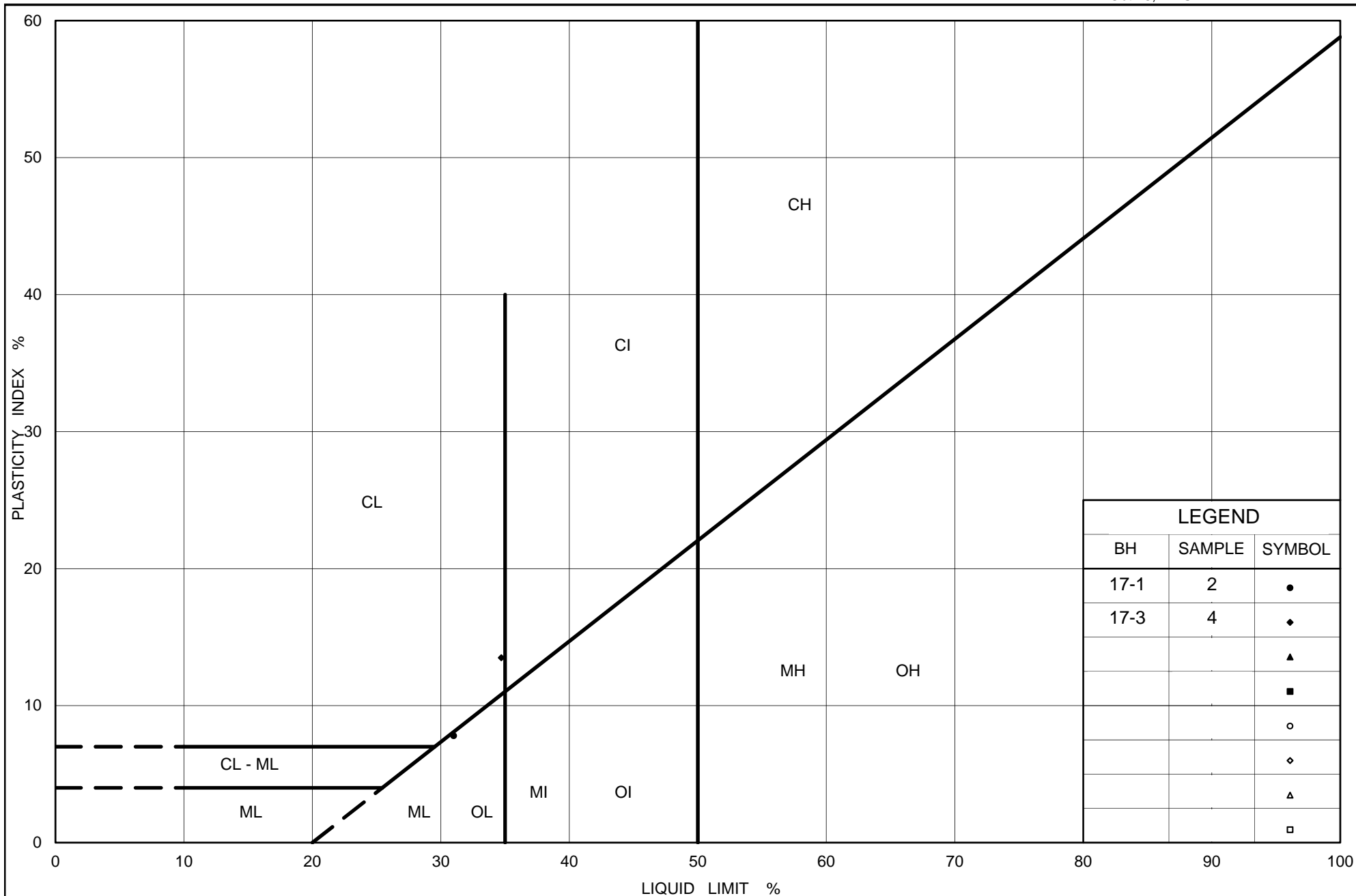
FIGURE B3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	17-1	2	231.6
■	17-3	4	229.8
◆	17-8	7	230.3



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Ontario

PLASTICITY CHART

Organic Clayey Silt to Organic Silt

Figure No. B4

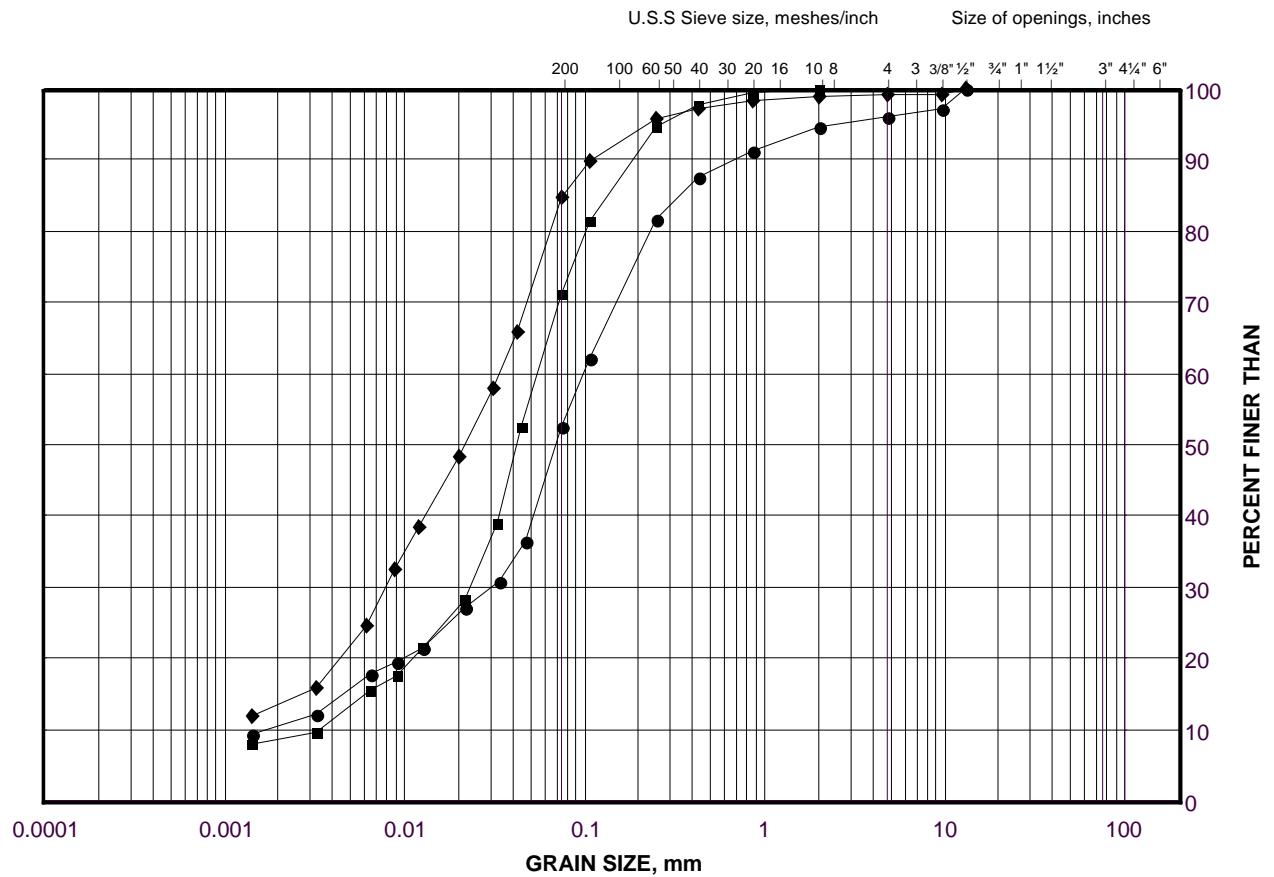
Project No. 1671122.2000 R2

Checked By: DPM

GRAIN SIZE DISTRIBUTION

Upper Silt and Sand to Silt

FIGURE B5



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

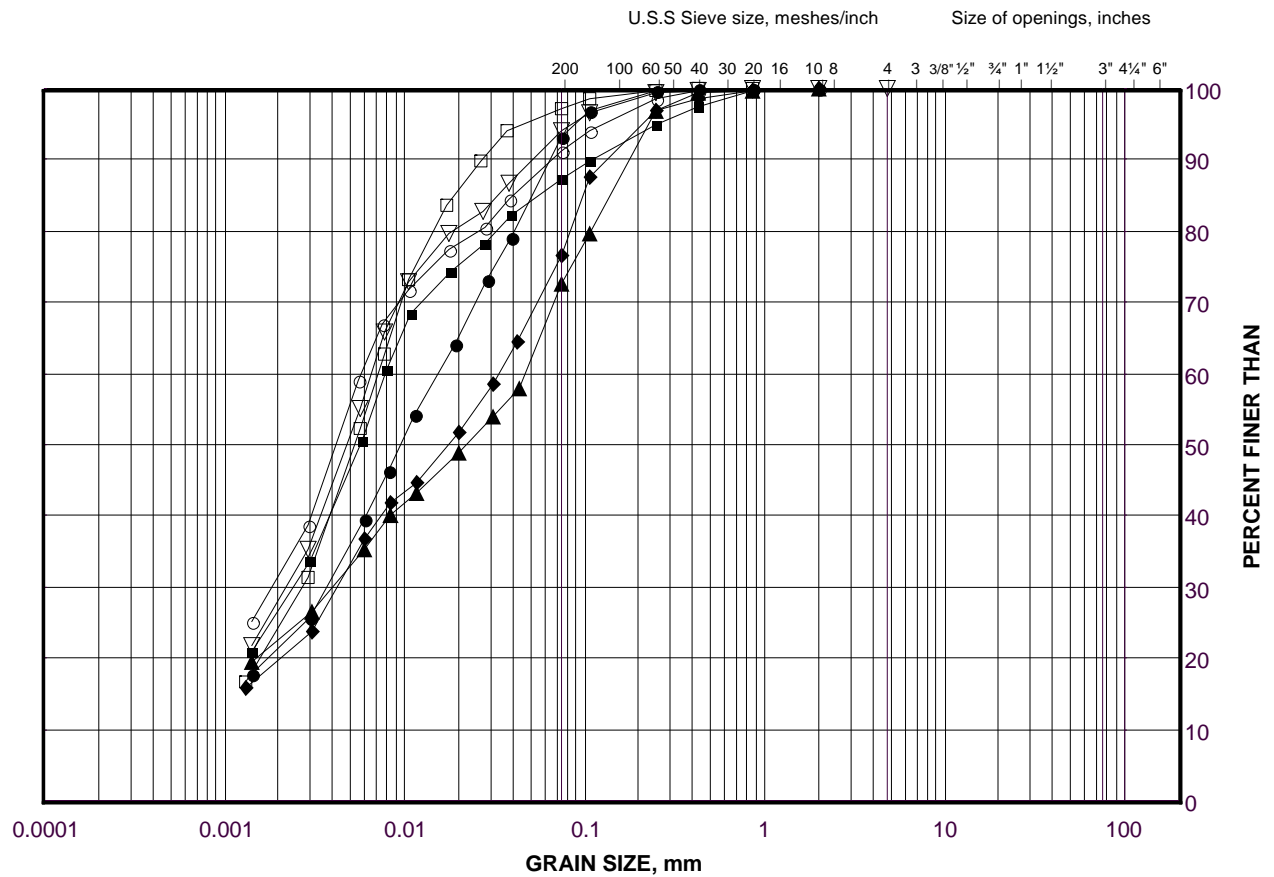
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	17-4	6	229.8
■	17-5	7	229.3
◆	17-4	8	227.4

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE B6



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

LEGEND

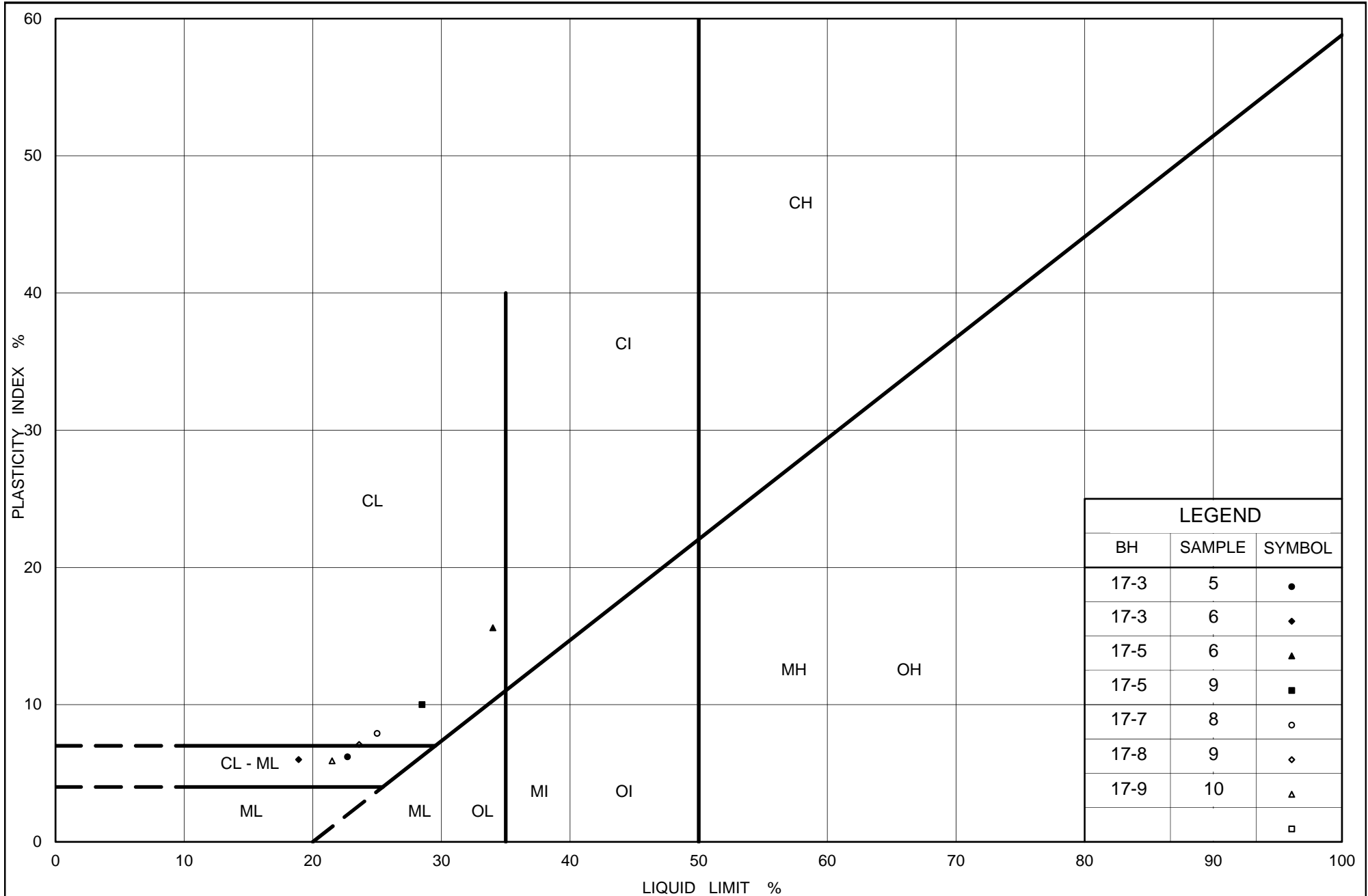
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	17-9	10	228.1
■	17-3	5	229.1
◆	17-5	6	230.2
▲	17-3	6	228.3
▽	17-7	8	229.2
○	17-8	9	228.8
□	17-5	9	227.8

Project Number: 1671122.2000 R2

Checked By: DPM

Golder Associates

Date: 14-Nov-17



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt

Figure No. B7

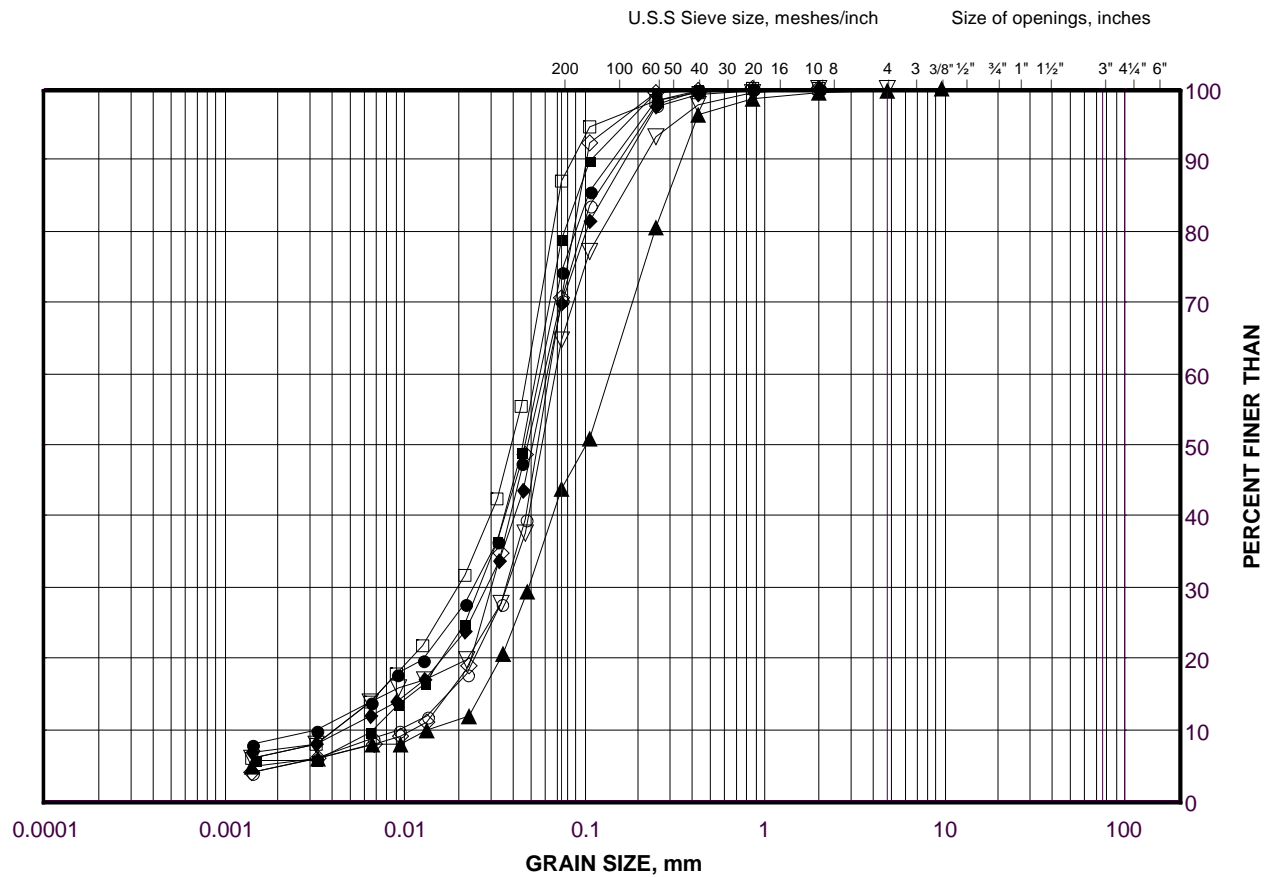
Project No. 1671122.2000 R2

Checked By: DPM

GRAIN SIZE DISTRIBUTION

Lower Silt and Sand to Silt

FIGURE B8



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	17-8	11	227.3
■	17-7	11	226.9
◆	17-9	12	225.9
▲	15-3	3	230.5
▽	17-1	3	230.8
○	17-2	4	229.6
□	17-1	4	230.0
△	15-3	5	229.0

Project Number: 1671122.2000 R2

Checked By: DPM

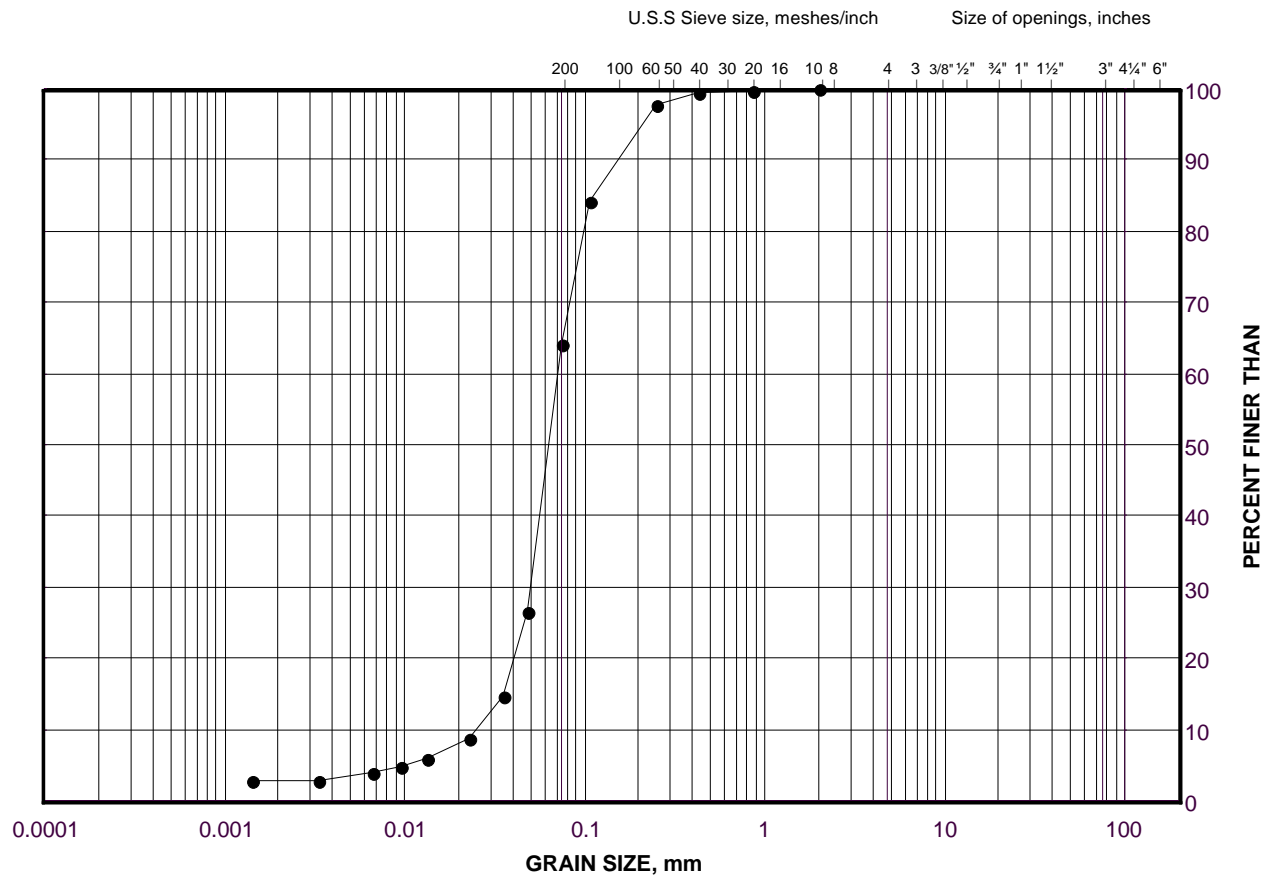
Golder Associates

Date: 27-Oct-17

GRAIN SIZE DISTRIBUTION

Sand

FIGURE B9



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

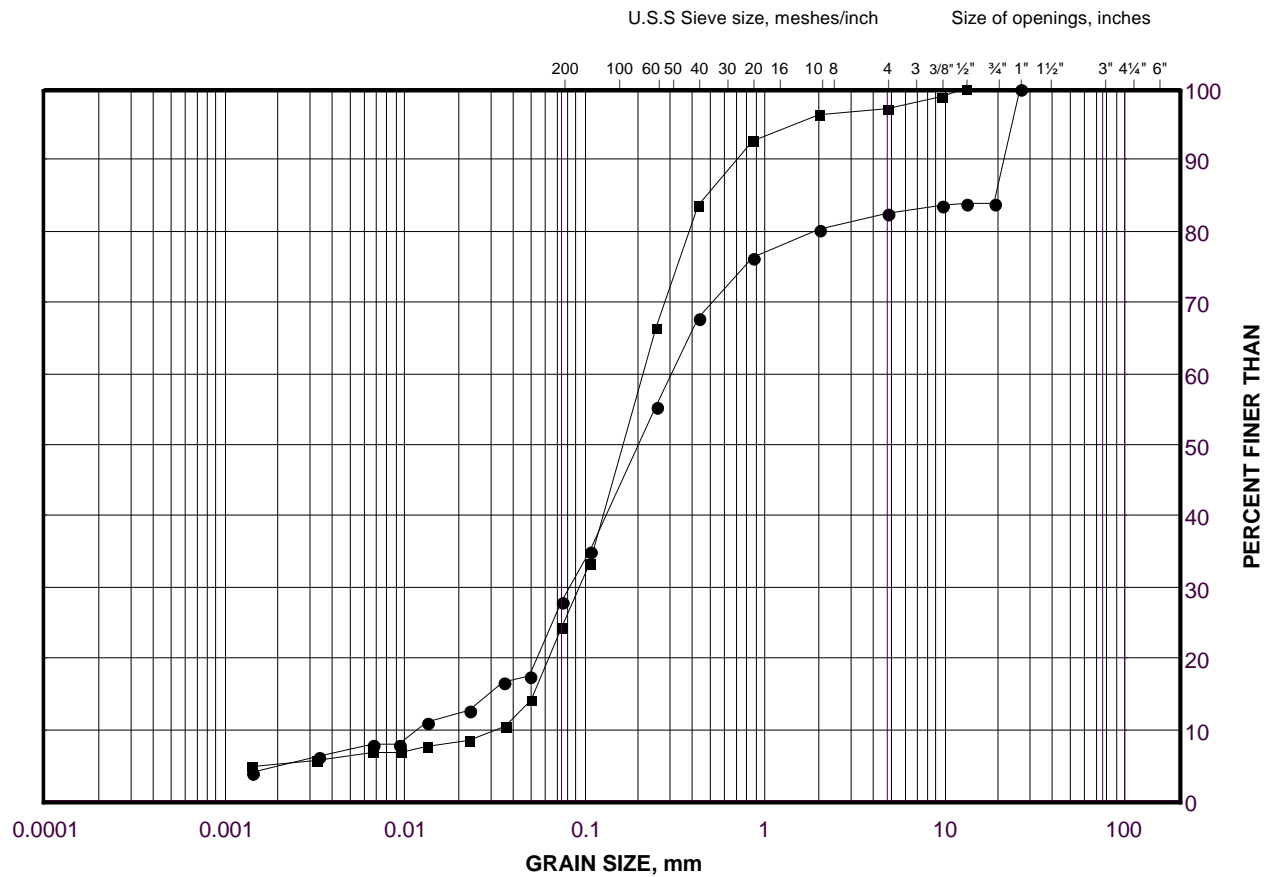
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	17-2	3	230.4

GRAIN SIZE DISTRIBUTION

Sand to Silty Sand (TILL)

FIGURE B10



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	15-4	6	228.7
■	17-2	8	226.6



APPENDIX C

Results of Soil Chemical Analysis

Your Project #: 1418461 PH 1000
Site Location: HWY 11, ALGONQUIN AVE
Your C.O.C. #: na

Attention:Adam Core

Golder Associates Ltd
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2015/12/22

Report #: R3823989

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5Q0165

Received: 2015/12/16, 09:51

Sample Matrix: Soil
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	3	N/A	2015/12/22	CAM SOP-00463	EPA 325.2 m
Conductivity	3	N/A	2015/12/22	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	3	2015/12/21	2015/12/21	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	3	2015/12/17	2015/12/22	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	3	N/A	2015/12/22	CAM SOP-00464	EPA 375.4 m
Redox Potential (1)	3	2015/12/18	N/A	SLA SOP-00101	In house

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

(1) This test was performed by Maxxam Sladeview Petrochemical

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B5Q0165
Report Date: 2015/12/22

Golder Associates Ltd
Client Project #: 1418461 PH 1000
Site Location: HWY 11, ALGONQUIN AVE
Sampler Initials: DPM

RESULTS OF ANALYSES OF SOIL

Maxxam ID		BNV653	BNV654	BNV654	BNV655	BNV655		
Sampling Date		2015/12/12 02:00	2015/12/12 02:00	2015/12/12 02:00	2015/12/12 03:00	2015/12/12 03:00		
COC Number		na	na	na	na	na		
	UNITS	15-5 SA#5 12.5'-14.5'	15-4 SA#2 5'-7'	15-4 SA#2 5'-7' Lab-Dup	15-3 SA#4 10'-12'	15-3 SA#4 10'-12' Lab-Dup	RDL	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	17000	600		5600			4318538
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	ND	820		60		20	4321990
Conductivity	umho/cm	60	1670	1670	179		2	4323370
Available (CaCl2) pH	pH	7.57	5.36		7.00		N/A	4321752
Soluble (20:1) Sulphate (SO4)	ug/g	ND	170		ND	ND	20	4321999
Subcontracted Analysis								
Redox Potential	mV	+182	+173		+184	+182		4319841
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate ND = Not detected								

TEST SUMMARY

Maxxam ID: BNV653
Sample ID: 15-5 SA#5 12.5'-14.5'
Matrix: Soil

Collected: 2015/12/12
Shipped:
Received: 2015/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4321990	N/A	2015/12/22	Deonarine Ramnarine
Conductivity	AT	4323370	N/A	2015/12/22	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4321752	2015/12/21	2015/12/21	Neil Dassanayake
Resistivity of Soil		4318538	2015/12/22	2015/12/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4321999	N/A	2015/12/22	Deonarine Ramnarine
Redox Potential	PH	4319841	2015/12/18		Grace Sison

Maxxam ID: BNV654
Sample ID: 15-4 SA#2 5'-7'
Matrix: Soil

Collected: 2015/12/12
Shipped:
Received: 2015/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4321990	N/A	2015/12/22	Deonarine Ramnarine
Conductivity	AT	4323370	N/A	2015/12/22	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4321752	2015/12/21	2015/12/21	Neil Dassanayake
Resistivity of Soil		4318538	2015/12/22	2015/12/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4321999	N/A	2015/12/22	Deonarine Ramnarine
Redox Potential	PH	4319841	2015/12/18		Grace Sison

Maxxam ID: BNV654 Dup
Sample ID: 15-4 SA#2 5'-7'
Matrix: Soil

Collected: 2015/12/12
Shipped:
Received: 2015/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	4323370	N/A	2015/12/22	Neil Dassanayake

Maxxam ID: BNV655
Sample ID: 15-3 SA#4 10'-12'
Matrix: Soil

Collected: 2015/12/12
Shipped:
Received: 2015/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4321990	N/A	2015/12/22	Deonarine Ramnarine
Conductivity	AT	4323370	N/A	2015/12/22	Neil Dassanayake
pH CaCl2 EXTRACT	AT	4321752	2015/12/21	2015/12/21	Neil Dassanayake
Resistivity of Soil		4318538	2015/12/22	2015/12/22	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4321999	N/A	2015/12/22	Deonarine Ramnarine
Redox Potential	PH	4319841	2015/12/18		Grace Sison

Maxxam ID: BNV655 Dup
Sample ID: 15-3 SA#4 10'-12'
Matrix: Soil

Collected: 2015/12/12
Shipped:
Received: 2015/12/16

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	4321999	N/A	2015/12/22	Deonarine Ramnarine
Redox Potential	PH	4319841	2015/12/18		Grace Sison

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	11.0°C
-----------	--------

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Golder Associates Ltd
Client Project #: 1418461 PH 1000
Site Location: HWY 11, ALGONQUIN AVE
Sampler Initials: DPM

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
4319841	Redox Potential						+123	mV	1.1	20	+247	238 - 248
4321752	Available (CaCl ₂) pH	2015/12/21			99	97 - 103			1.0	N/A		
4321990	Soluble (20:1) Chloride (Cl)	2015/12/22	119	70 - 130	106	70 - 130	ND, RDL=20	ug/g	NC	35		
4321999	Soluble (20:1) Sulphate (SO ₄)	2015/12/22	102	70 - 130	106	70 - 130	ND, RDL=20	ug/g	NC	35		
4323370	Conductivity	2015/12/22			100	90 - 110	ND, RDL=2	umho/cm	0	10		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.



Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.


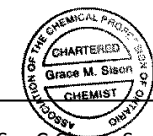
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

Grace Sison, B.Sc., C.Chem, Senior Project Manager - Petroleum Division

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IMMEDIATE TEST



6790 Kitimat Road, Unit 4, Mississauga, Ontario L5N 5L9
Phone: 905-826-3080 Fax: 905-826-4151
BQL FCD-00062/2

RADIOCHEMISTRY AND NEUTRON ACTIVATION ANALYSIS CHAIN OF CUSTODY RECORD

Invoice Information		Report Information (if different from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required	
Company Name: Golder Associates		Company Name:		Quotation #:		Regular TAT (10-15 days) Most analyses*	
Contact Name: Adam Core		Contact Name:		P.O. #/ AFER:		*Lead-210 requires 15 business days	
Address: 33 Mackenzie St		Address:		Project #: 1418461 ph 1000		*Platinum Group Elements require 20 business days	
Phone: 705-524-6861 Fax:		Phone: Fax:		Site Location: Hwy 11, Algonquin Ave		Rush TAT available for certain analyses only. Please contact the Lab for further information	
Email: Adam_Core@Golder.com		Email:		Site #:		Regulations (for Liquid samples)	
				Sampled By: DPM		Check here if these are regulatory samples: MMER: <input type="checkbox"/> OTHER (please indicate): <input type="checkbox"/>	
<p>MODERATELY REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY</p> <p><input type="checkbox"/> Check here to include result uncertainties on the report</p> <p>NOTE: If samples cannot be safely disposed of in municipal waste, they will be returned to the submitter (extra charges apply)</p>							
SAMPLE IDENTIFICATION	DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# of containers submitted	Field Filtered? Y/N/NA	Corrosivity Package	COMMENTS
1 15-5 So #5 12.5'-14.5'	2015/12/16	2:00 pm	Soil			X	
2 15-4 So #2 5'-7'	2015/12/12	2:00 pm	Soil			X	
3 15-3 So #4 10'-12'	2015/12/12	3:00 pm	Soil			X	
4							
5							
6							
7							
8							
9							
10							
RELINQUISHED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)	DATE: (YYYY/MM/DD)	TIME: (HH:MM)	MAXXAM JOB #	
<i>Adam Core</i>	2015/12/16	2:51 am	<i>B. K. / Bradley Kappeler</i> <i>Asst. Asst. Brian</i>	2015/12/16 2015/12/17	9:51 09:30		

16-Dec-15 09:51

Ema Gitej



B5Q0165

HGR ENV-866

Received in Sudbury

BQL FCD-00062/2

6/015

Temperatures: 12, 10, 11°C
No Custody Seal
No Cooling Media

PAGE 1 of 1

Your Project #: 1671122
Your C.O.C. #: 626997-02-01

Attention: Darcy Hansen

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2017/09/18
Report #: R4718982
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7J1297

Received: 2017/09/01, 13:06

Sample Matrix: Soil
Samples Received: 6

Analyses	Date		Date Analyzed	Laboratory Method	Reference
	Quantity	Extracted			
Chloride (20:1 extract)	6	N/A	2017/09/08	CAM SOP-00463	EPA 325.2 m
Conductivity	6	N/A	2017/09/08	CAM SOP-00414	OMOE E3530 v1 m
pH CaCl ₂ EXTRACT	6	2017/09/07	2017/09/07	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	6	2017/09/05	2017/09/08	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	6	N/A	2017/09/08	CAM SOP-00464	EPA 375.4 m
Sulphide (from Campobello) (1)	6	N/A	N/A		

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Campo to Burnaby Subcontract

Your Project #: 1671122
Your C.O.C. #: 626997-02-01

Attention:Darcy Hansen

Golder Associates Ltd
Mississauga - Standing Offer
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2017/09/18
Report #: R4718982
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B7J1297
Received: 2017/09/01, 13:06

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ema Gitej, Senior Project Manager

Email: EGitej@maxxam.ca

Phone# (905)817-5829

=====

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RESULTS OF ANALYSES OF SOIL

Maxxam ID		FBE254	FBE254	FBE255	FBE255	FBE256	FBE257		
Sampling Date		2017/08/21 10:50	2017/08/21 10:50	2017/08/21 15:00	2017/08/21 15:00	2017/08/15 16:00	2017/08/13 16:00		
COC Number		626997-02-01	626997-02-01	626997-02-01	626997-02-01	626997-02-01	626997-02-01		
	UNITS	17-8 S.A.8	17-8 S.A.8 Lab-Dup	17-7 S.A.7	17-7 S.A.7 Lab-Dup	17-10 S.A.5	17-2 S.A.2	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	5500		3600		1300	1400		5149450
-------------	--------	------	--	------	--	------	------	--	---------

Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	39		88	82	430	240	20	5153372
Conductivity	umho/cm	183	183	274		758	702	2	5153551
Available (CaCl2) pH	pH	6.86		5.30		7.23	6.27		5151673
Soluble (20:1) Sulphate (SO4)	ug/g	<100 (1)		<100 (1)	<100	<100 (1)	<100 (1)	100	5153382

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

(1) Detection Limit was raised due to matrix interferences.

Maxxam ID		FBE258	FBE259		
Sampling Date		2017/08/14 11:00	2017/08/17 10:00		
COC Number		626997-02-01	626997-02-01		
	UNITS	17-3 S.A.3	17-5 S.A.8	RDL	QC Batch

Calculated Parameters

Resistivity	ohm-cm	610	920		5149450
-------------	--------	-----	-----	--	---------

Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	790	590	20	5153372
Conductivity	umho/cm	1640	1080	2	5153551
Available (CaCl2) pH	pH	4.99	7.30		5151673
Soluble (20:1) Sulphate (SO4)	ug/g	<100 (1)	<100 (1)	100	5153382

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

(1) Detection Limit was raised due to matrix interferences.

TEST SUMMARY

Maxxam ID: FBE254
Sample ID: 17-8 S.A.8
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

Maxxam ID: FBE254 Dup
Sample ID: 17-8 S.A.8
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake

Maxxam ID: FBE255
Sample ID: 17-7 S.A.7
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

Maxxam ID: FBE255 Dup
Sample ID: 17-7 S.A.7
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine

Maxxam ID: FBE256
Sample ID: 17-10 S.A.5
Matrix: Soil

Collected: 2017/08/15
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

TEST SUMMARY

Maxxam ID: FBE257
Sample ID: 17-2 S.A.2
Matrix: Soil

Collected: 2017/08/13
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

Maxxam ID: FBE258
Sample ID: 17-3 S.A.3
Matrix: Soil

Collected: 2017/08/14
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

Maxxam ID: FBE259
Sample ID: 17-5 S.A.8
Matrix: Soil

Collected: 2017/08/17
Shipped:
Received: 2017/09/01

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	5153372	N/A	2017/09/08	Deonarine Ramnarine
Conductivity	AT	5153551	N/A	2017/09/08	Neil Dassanayake
pH CaCl2 EXTRACT	AT	5151673	2017/09/07	2017/09/07	Tahir Anwar
Resistivity of Soil		5149450	2017/09/08	2017/09/08	Cristina Carriere
Sulphate (20:1 Extract)	KONE/EC	5153382	N/A	2017/09/08	Deonarine Ramnarine
Sulphide (from Campobello)	SPEC	5170216	N/A		Ema Gitej

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.7°C
-----------	-------

Cooler custody seal was present and intact.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
5151673	Available (CaCl ₂) pH	2017/09/07			99	97 - 103			0.46	N/A
5153372	Soluble (20:1) Chloride (Cl)	2017/09/08	NC	70 - 130	104	70 - 130	<20	ug/g	7.1	35
5153382	Soluble (20:1) Sulphate (SO ₄)	2017/09/08	NC	70 - 130	106	70 - 130	<20	ug/g	NC	35
5153551	Conductivity	2017/09/08			100	90 - 110	<2	umho/cm	0.28	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

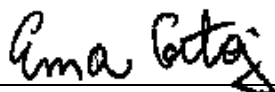
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Cristina Carriere, Scientific Service Specialist



Ema Gitej, Senior Project Manager

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



Maxxam Analytics International Corporation or a Maxxam Analytics
6740 Campbell Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

01-Sep-17 13:06

Ema Gitej

B7J1297

PS4 ENV-1273

Page 1 of 1

se Only:

Bottle Order #:

626997

Project Manager:

Ema Gitej

INVOICE TO:
Company Name: #1326 Golder Associates Ltd
Attention: Accounts Payable
Address: 6925 Century Ave Suite 100
Mississauga ON L5N 7K2
Tel: (905) 567-4444 x Fax: (905) 567-6561 x
Email: AP_CustomerService@golder.com

REPORT TO:
Company Name: Darcy Hansen
Attention: Darcy Hansen
Address: (905) 567-4444 x2064 Fax: Darcy_Hansen@golder.com
Tel: Darcy_Hansen@golder.com
Email:

PROJECT INFORMATION:
Quotation #: B70916
P.O. #: 1671122
Project Name: PS4 ENV-1273
Site #: Sampled By:

C#626997-02-01

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE
SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine	<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw	
<input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse	<input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw	
<input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC	<input type="checkbox"/> MISA <input type="checkbox"/> Municipality	
<input type="checkbox"/> Table	<input type="checkbox"/> PWQO	
	<input type="checkbox"/> Other	

Include Criteria on Certificate of Analysis (Y/N)?

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix
1*	17-8 S.A. 8	2017/09/11	10:50am	
2	17-7 S.A. 7	2017/09/21	3pm	
3	17-10 S.A. 5	2017/08/15	4pm	
4	17-2 S.A. 2	2017/08/13	4pm	
5	17-3 S.A. 3	2017/08/14	11am	
6	17-5 S.A. 8	2017/08/17	10am	
7				
8				
9				
10				

Field Filtered (please circle):
Metals / Hg / Cr / VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Chloride & SO4 (20 L extract)	Conductivity/Resistivity	pH CaCl2 EXTRACT	Sulphide (Maxxam BC)
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓
✓	✓	✓	✓

Turnaround Time (TAT) Required

Please provide advance notice for rush projects

Regular (Standard) TAT:

(will be applied if Rush TAT is not specified):

Standard TAT = 5-7 Working days for most tests.

Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)

Date Required: Time Required:

Rush Confirmation Number: (call lab for #)

of Bottles

Comments

2

2

2

2

2

2

2

2

2

2

2

2

2

2

* RELINQUISHED BY: (Signature/Print)

Date: (YY/MM/DD)

Time

RECEIVED BY: (Signature/Print)

Date: (YY/MM/DD)

Time

Jars used and not submitted

Laboratory Use Only

Time Sensitive

Temperature (°C) on Receipt

Custody Seal Present

Yes

No

5/3/3

Intact

✓

White: Maxxa

Yellow: Client

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO MAXXAM'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.MAXXAM.CA/TERMS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT HTTP://MAXXAM.CA/WP-CONTENT/UPLOADS/ONTARIO-COC.PDF.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM

MM# 382429

Your Project #: MB7J1297
Site Location: 1671122
Your C.O.C. #: B7J1297-M058-01-01

Attention:EMA GITEJ

MAXXAM ANALYTICS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2017/09/11
Report #: R2442038
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B776512

Received: 2017/09/06, 09:00

Sample Matrix: Soil
Samples Received: 6

Analyses	Date		Date Analyzed	Laboratory Method	Analytical Method
	Quantity	Extracted			
Moisture	6	2017/09/07	2017/09/08	BBY8SOP-00017	BCMOE BCLM Dec2000 m
Sulphide in Soil	6	2017/09/07	2017/09/08	BBY6SOP-00006	SM 22 4500 S2- D m

Remarks:

Maxxam Analytics' laboratories are accredited to ISO/IEC 17025:2005 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Maxxam are based upon recognized Provincial, Federal or US method compendia such as CCME, MDDELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Maxxam's profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Maxxam in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported: unless indicated otherwise, associated sample data are not blank corrected.

Maxxam Analytics' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Maxxam has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Maxxam, unless otherwise agreed in writing.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: MB7J1297
Site Location: 1671122
Your C.O.C. #: B7J1297-M058-01-01

Attention:EMA GITEJ

MAXXAM ANALYTICS
CAMPOBELLO
6740 CAMPOBELLO ROAD
MISSISSAUGA, ON
CANADA L5N 2L8

Report Date: 2017/09/11
Report #: R2442038
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B776512
Received: 2017/09/06, 09:00

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Letitia Prefontaine, B.Sc., Senior Project Manager

Email: LPrefontaine@maxxam.ca

Phone# (604)639-2616

=====

This report has been generated and distributed using a secure automated process.

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		RX3048	RX3049	RX3050	RX3050		
Sampling Date		2017/08/21 10:50	2017/08/21 15:00	2017/08/15 16:00	2017/08/15 16:00		
COC Number		B7J1297-M058-01-01	B7J1297-M058-01-01	B7J1297-M058-01-01	B7J1297-M058-01-01		
	UNITS	17-8 S.A.8	17-7 S.A.7	17-10 S.A.5	17-10 S.A.5 Lab-Dup	RDL	QC Batch

MISCELLANEOUS

Sulphide	ug/g	1.54	0.71	0.61 (1)	0.70	0.50	8750518
----------	------	------	------	----------	------	------	---------

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

(1) Matrix spike exceeds acceptance limits due to matrix interference. Re-analysis yields similar results.

Maxxam ID		RX3051		RX3052		RX3053		
Sampling Date		2017/08/13 16:00		2017/08/14 11:00		2017/08/17 10:00		
COC Number		B7J1297-M058-01-01		B7J1297-M058-01-01		B7J1297-M058-01-01		
	UNITS	17-2 S.A.2	RDL	17-3 S.A.3	RDL	17-5 S.A.8	RDL	QC Batch

MISCELLANEOUS

Sulphide	ug/g	<0.50	0.50	1.42 (1)	0.70	1.30	0.50	8750518
----------	------	-------	------	----------	------	------	------	---------

RDL = Reportable Detection Limit

(1) RDL raised due to high sample moisture content.

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

PHYSICAL TESTING (SOIL)

Maxxam ID		RX3048	RX3049	RX3049	RX3050		
Sampling Date		2017/08/21 10:50	2017/08/21 15:00	2017/08/21 15:00	2017/08/15 16:00		
COC Number		B7J1297-M058-01-01	B7J1297-M058-01-01	B7J1297-M058-01-01	B7J1297-M058-01-01		
	UNITS	17-8 S.A.8	17-7 S.A.7	17-7 S.A.7 Lab-Dup	17-10 S.A.5	RDL	QC Batch

Physical Properties

Moisture	%	20	24	24	17	0.30	8750833
----------	---	----	----	----	----	------	---------

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		RX3051	RX3052	RX3053		
Sampling Date		2017/08/13 16:00	2017/08/14 11:00	2017/08/17 10:00		
COC Number		B7J1297-M058-01-01	B7J1297-M058-01-01	B7J1297-M058-01-01		
	UNITS	17-2 S.A.2	17-3 S.A.3	17-5 S.A.8	RDL	QC Batch

Physical Properties

Moisture	%	26	45	21	0.30	8750833
----------	---	----	----	----	------	---------

RDL = Reportable Detection Limit

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: RX3048
Sample ID: 17-8 S.A.8
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam ID: RX3049
Sample ID: 17-7 S.A.7
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam ID: RX3049 Dup
Sample ID: 17-7 S.A.7
Matrix: Soil

Collected: 2017/08/21
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan

Maxxam ID: RX3050
Sample ID: 17-10 S.A.5
Matrix: Soil

Collected: 2017/08/15
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam ID: RX3050 Dup
Sample ID: 17-10 S.A.5
Matrix: Soil

Collected: 2017/08/15
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam ID: RX3051
Sample ID: 17-2 S.A.2
Matrix: Soil

Collected: 2017/08/13
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

TEST SUMMARY

Maxxam ID: RX3052
Sample ID: 17-3 S.A.3
Matrix: Soil

Collected: 2017/08/14
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam ID: RX3053
Sample ID: 17-5 S.A.8
Matrix: Soil

Collected: 2017/08/17
Shipped:
Received: 2017/09/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture	BAL/BAL	8750833	2017/09/07	2017/09/08	Lolita Obusan
Sulphide in Soil	SPEC/COL	8750518	2017/09/07	2017/09/08	Mandheraj Chana

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.7°C
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Sample RX3048 [17-8 S.A.8] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RX3049 [17-7 S.A.7] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RX3050 [17-10 S.A.5] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RX3051 [17-2 S.A.2] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Sample RX3052 [17-3 S.A.3] : Sample was extracted past method specified hold time for Moisture. {Exceedance of hold time increases the uncertainty of test results but does not necessarily imply that results are compromised.} Sample received past method specified hold time for Moisture. Sample analyzed past method specified hold time for Sulphide in Soil. Sample received past method specified hold time for Sulphide in Soil.

Results relate only to the items tested.

Maxxam Job #: B776512
Report Date: 2017/09/11

QUALITY ASSURANCE REPORT

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8750518	Sulphide	2017/09/08	52 (1,2)	75 - 125	93	75 - 125	<0.50	ug/g	15 (3)	30
8750833	Moisture	2017/09/08					<0.30	%	1.7 (4)	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(2) Matrix Spike Parent ID [RX3050-01]

(3) Duplicate Parent ID [RX3050-01]

(4) Duplicate Parent ID [RX3049-01]

Maxxam Job #: B776512
Report Date: 2017/09/11

MAXXAM ANALYTICS
Client Project #: MB7J1297
Site Location: 1671122
Sampler Initials: DH

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Andy Lu, Ph.D., P.Chem., Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



APPENDIX D

Non-Standard Special Provisions

DEWATERING OF EXCAVATION - Item No.

Non-Standard Special Provision

Installation of the storm sewers and appurtenances will require excavations to extend below the groundwater level. The fill, organic, silt to silty sand, clayey silt, silty sand to sand till deposits present below the groundwater level at and below the bedding level will slough, run, boil or cave into the excavation unless appropriate groundwater controls are in place. Further, the bedding from adjacent utilities may act as a conduit for subsurface water flow.

The Contractor is to design and install an appropriate excavation protection and dewatering system to enable construction and to prevent disturbance to the founding soils. The groundwater level should be drawn down to 1 m below the base of the excavation.

The dewatering system should make use of active dewatering, carried out in advance of excavation, using systems such as closely-spaced (e.g., less than 5 m) well points or eductors / vacuum well points to depressurize / actively draw down the groundwater level to approximately 1 m below the base of the excavation along the full sewer alignment. The depth of dewatering should consider the need for localized areas requiring thicker bedding / increased sub-excavation where unsuitable soils, if encountered, will need to be removed below the design subgrade.

The dewatering system design shall be completed by a design Engineer and design-checking Engineer, both of whom shall have a minimum 5 years' experience in designing systems of similar nature and scope to the required work.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

OBSTRUCTIONS

Non-Standard Special Provision

The Contactor shall be alerted to the presence of potential cobbles and boulders within the fill deposits and native organic, clayey silt, and silty sand to sand till deposits at this site as encountered during borehole advancement. Considerations of the presence of these obstructions must be made in the selection of appropriate equipment and procedures for excavation and installation of the sewers and appurtenances.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

END OF SECTION

DECOMMISSION OF PIEZOMETERS - Item No.

Non-Standard Special Provision

Three standpipe piezometers were installed in three separate boreholes at the project site as part of the Foundation Investigation for the Storm Sewer Replacement at various locations along/across Highway 11/Algonquin Street, North Bay. The standpipe piezometers installed as part of the Foundation Investigation are listed below; additional information regarding installation details and location are found within the contract documents and the Foundation Investigation Report.

Standpipe Piezometer Identification	General Location	PVC Pipe and Screen diameter / Borehole diameter	Depth (Below Ground Surface) to Tip of Screen
BH17-1	Highway 11 NBLs (Lane 1), north of Shirreff Avenue	50 mm / 210 mm	4.5 m
BH17-4	Asphalt boulevard between concrete sidewalk and curb east of Highway 11, between Shirreff Avenue and Josephine Street	50 mm / 210 mm	4.5 m
BH17-8	Grass boulevard at the south-east quadrant of the intersection between Highway 11, Airport Road and Mckeown Avenue	50 mm / 210 mm	4.5 m

The standpipe piezometers are registered as a well cluster under Well Tag Number A201853. The registered owner is the Ministry of Transportation, Ontario.

The standpipe piezometers have been left in place to allow for monitoring of groundwater levels up to and / or during construction.

As part of the construction activities the Contractor shall properly decommission the standpipe piezometers. The abandonment method for standpipe piezometers must satisfy the minimum requirements of Ontario Regulation 903 Wells, as amended under the Ontario Water Resources Act. In addition, the Contractor shall provide a written record of the decommissioning procedure to the Contract Administrator. The record shall include plugging material used, depth of plugging material and limit of the PVC standpipe/screen removal.

Basis of Payment

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit golder.com

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