FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 2018-3010

REPORT NO. 1

Ministry Of Transportation

Ontario

FINAL REPORT

FOUNDATION INVESTIGATION REPORT

Culvert Replacement, Highway 3, Simcoe to Renton

Agreement No. 3015-E-0017
Assignment No. 1
GWP 3062-14-00
GEOCRES No. 40I16-26

Prepared for:

Ontario Ministry of Transportation
Regional Director's Office -Western Region
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exp Services Inc.
November 16, 2016

Ministry of Transportation
Western Region – Geotechnical Section

Foundation Investigation Report
Agreement No. 3015-E-0017
Assignment No. 1
GWP 3062-14-00
Geocres No. 40I16-26

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Foundation Investigation and Design Report for Culvert Replacement
Highway 3, Simcoe to Renton

Project Number:
ADM-00235197-A0

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November 16, 2016

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Part I: FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This foundation investigation report presents the results of a geotechnical investigation completed by **exp** Services Inc. for the replacement of an existing concrete culvert located on Hwy 3 at Station 16+070, about 4.2 km east from Ireland Road, Simcoe to Renton, the Ministry of Transportation (MTO) West Region. The work was undertaken under Agreement # 3015-E-0017, Assignment No. 1 (GWP 3062-14-00). The terms of reference (TOR) were as presented in the MTO letter dated September 12, 2016.

The purpose of the investigation is to determine the subsurface conditions along the culvert alignment and to permit detailed design for the culvert replacement including temporary protection systems for culvert replacement. The site specific geotechnical investigation consisted of borings, soil sampling, borehole logging, and field and laboratory testing.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The culvert replacement site is located on Hwy 3 at Station 16+070, about 4.2 km east from Ireland Road, Simcoe to Renton, Ontario. At this site, Hwy 3 is a surface treated two lanes roadway and is about 7 m wide from edge to edge of pavement, with narrow sand and gravel shoulders. Based on drawings provided, the roadway embankment is about 6.5 m high with side slope of about 2H:1V.

As noted in the TOR the existing culvert is a 2.8 m × 1.5 m ×37.9 m concrete rigid framed- open footing structure. The existing culvert is intended to be replaced with a new culvert along the same alignment and it is understood that precast box culvert with an estimated span of between 4 and 5 m, and 41.5 m length is likely to be considered to replace the existing culvert. The site plan and cross-section profiles for the proposed culvert alignment are as shown on Drawings 1 and 2 in Appendix B. Select photographs of the site/ existing culvert are presented in Appendix A.

At the vicinity of the inlet and outlet of the culvert some vegetation was noted at both culvert ends. The surrounding terrain of the culvert location is generally a flat tract of land; however, at culvert location the grade is gently rolling and there are occasional trees. A mix of low lying vegetation/shrubs and long grasses were observed on the bank of the stream along the water flow path at both inlet and outlet sides; however, no visible sign of flow restriction was observed due to long grasses. Hwy 3 runs in an east-west direction and water in culvert flow from north to south beneath the highway. At the time of investigation, the approximate water elevations in culvert at inlet and outlet were about 209.4 m and 208.9 m, respectively. The elevation of highway pavement centerline at the culvert centerline is about 215.7 m. Cable guide rails were observed on both sides of the roadway and overhead wires were observed along the north side of the roadway.

The general site conditions in the immediate vicinity of the culvert were assessed during the site reconnaissance and drilling operations on October 12, 2016 and October 14, 2016, respectively. The

embankments were noted in an overall stable configuration with no obvious indications of recent slope movement. The longitudinal meandering cracks were observed on a portion of roadway along the culvert alignment and on the EBL of Hwy 3 approximately 20 m in length on east side of the culvert alignment, but major depressions in the embankment were not observed in these areas. Due to the water in the culvert, existing foundation observation was restricted. However, based on visual observation, the culvert appeared to be in satisfactory condition with some deterioration of culvert at inlet and outlet with crumbling of concrete exposed edges and revealed rebars (see Photograph 1 and 4, in Appendix A).

1.2.2 Geological Setting

The Map P.2715 (Physiography of Southern Ontario, Third Edition,1984) Bedrock Geology of Ontario, Southern Sheet, 1991) of the Ministry of Natural Resources indicates that the project area is located at the boundary of Sand Plain and Clay Plain. The Map 2556 (Quaternary Geology of Ontario, Southern Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the surface conditions consist of glaciolaustrine deposits including silt and clay, minor sand; basin and quiet water deposits. The Map 2544 (Bedrock Geology of Ontario, Southern Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the bedrock formation of the project area consists of limestone, dolostone and shale, middle devonian.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed on October 14, 2016. To expedite the site investigation program two drill rigs were used. The field program consisted of drilling five (5) sampled boreholes (BH-1, BH-2, BH-3, BH-4 and BH-5). Three (3) boreholes were strategically located along the existing culvert alignment to provide subsurface information for the design of the proposed new culvert. Borehole BH-2 was advanced within the travelled westbound lane and located about 5 m west of the culvert centerline and 2.8 m north of the highway centerline. Boreholes BH-1 and BH-3 were advanced at accessible locations near the inlet and outlet of the culvert, respectively. Two (2) additional boreholes were strategically located on the embankment to provide subsurface information for the temporary roadway protection. Boreholes BH-4 and BH-5 were advanced at approximately 25 m west and east side of the existing culvert and approximately 2.1 m and 2.4 m south of the highway centerline, respectively. The borehole locations are shown on Drawing No. 1 in Appendix B.

Boreholes on the embankment crest (BH-2 and BH-5) were advanced using a truck mounted CME-75 drill rig and, equipped with hollow stem augers and standard soil sampling equipment operated by a specialist drilling contractor, Geo-Environmental Drilling Inc. Due to difficulty in access, boreholes at the inlets and outlets (BH-1 and BH-3) were advanced using a rubber track mounted CME-55 drill rig also operated by Geo-Environmental Drilling Inc. One of the boreholes from the embankment crest (BH-4) was also advanced using rubber track mounted CME-55 drill rig. The roadway boreholes, BH-2, BH-4 and BH-5 were advanced to depths of about 15.9 m below ground surface. The off-road boreholes (BH-1 and BH-3) were advanced to depth of about 9.8 m below ground surface.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel using the Temporary Benchmark set on (MTO # 92 on

concrete post, see Photograph 10 in Appendix A) approximately 120 m east of the culvert alignment on south of highway. The TBM elevation (216.3 m) is assumed based on the information provided on site plan drawings provided by the MTO. The temporary benchmark location is shown on Drawing. 1 in Appendix B.

For the drilling program, soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586) at intervals ranging from 0.75 m to 1.5 m in depth as shown on the attached borehole logs (Appendix C). The original field (uncorrected) SPT "N" values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual (CFEM, pg. 40) and used to provide an assessment of in-situ consistency or relative density of non-cohesive soils. Field vane testing was conducted in cohesive soils to measure the *in-situ* undrained shear strength of those soils. Field vane test was conducted in accordance with ASTM D2573-08. One Shelby tube sample was obtained below the culvert invert level.

Upon completion of the boreholes, ground water level measurements were carried out in boreholes in accordance with the Ministry of Transportation guidelines. The measured ground water levels after completion of drilling boreholes were recorded on the borehole log sheets in Appendix C. The boreholes were decommissioned by bentonite/cement mixtures in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the *Ontario Water Resources Act)*.

The fieldwork was supervised by members of **exp**'s engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification.

All of the recovered soil samples placed in labelled moisture-proof bags returned to **exp**'s Hamilton laboratory for additional visual, textual, olfactory examination and selective testing.

1.3.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content and particle size distribution for approximately 25% of the collected soil samples. Atterberg Limits tests were carried out on select cohesive soil samples. All of the laboratory tests were carried out in accordance with MTO and/or ASTM Standards as appropriate.

The laboratory test results are provided on the attached borehole log sheets in Appendix C. The results of the grain size analyses and plasticity chart are presented graphically in Appendix D.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix C. Laboratory test results are provided in Appendix D. The "Explanation of Terms Used in Report" preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A borehole location plan and stratigraphic section are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic section are inferred from

semi-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be interpreted as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions along the proposed culvert alignment consist of a layer of granular fill overlying silty clay fill followed by native silty clay. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

1.4.1 Asphalt

Asphalt was encountered at the surface of boreholes BH-2, BH-4 and BH-5 and ranged in thickness from approximately 0.33 m to 0.43 m. Asphalt thicknesses may further vary beyond the borehole locations.

1.4.2 Topsoil

Topsoil was encountered at the surface of boreholes BH-1 and BH-3 and ranged in thickness from approximately 0.125 m to 0.2 m. Topsoil thicknesses may further vary beyond the borehole locations.

1.4.3 Granular Fill

Granular fill was encountered below the asphalt in all boreholes drilled from road surface (BH-2, BH-4 and BH-5). The granular fill layer extended to depths ranging between 0.8 m to 1.1 m below road surface with elevations ranging between 214.5 m to 214.7 m. The explored thickness of this layer was between 0.5 m to 0.7 m.

The composition of this fill layer is sand and gravel trace silt, some asphalt inclusion. The material is brown in color, and moist. The SPT “N” values within this layer ranged from 8 to 34 blows per 300 mm penetration, suggesting loose to dense compactness condition.

Laboratory testing performed on selected samples consisted of seven (7) moisture content tests. The test results are as follows:

Moisture Content:

- 3% to 5%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.4 Fill: Silty Clay

A layer of silty clay fill was encountered in all boreholes below granular fill in boreholes drilled from road surface (BH-2, BH-4 and BH-5) and below topsoil in boreholes drilled off-road (BH-1 and BH-3). The silty clay fill extended to depths ranging between 1.2 m to 1.5 m below ground surface in off-road boreholes with elevations ranging between 208.2 m to 208.6 m. The explored thickness of this layer in off-road boreholes was between 1.0 m to 1.3 m. In boreholes drilled from road surface it is extended to depths ranging between 3.8 m to 4.6 m below road surface with elevations ranging between 210.9 m to 211.9 m. The explored thickness of this layer was between 2.7 m to 3.8 m.

The composition of this fill layer is clay and silt and trace to few sand. The material is brown in color, and moist. The SPT "N" values within this layer ranged from 4 to 8 blows per 300 mm penetration, suggesting firm consistency.

Laboratory testing performed on selected samples consisted of sixteen (13) moisture content, four (2) grain size distribution and three (2) Atterberg Limit tests. The test results are as follows:

Moisture Content:

- 20% to 31%

Grain Size Distribution:

- 0% gravel;
- 6% to 9% sand;
- 46% to 47% silt; and
- 44% to 48% clay

Atterberg Limits:

- Liquid Limit: 36% to 43%
- Plastic Limit: 18% to 20%
- Plasticity Index: 18% to 23%

The results of the moisture content, gain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests and Atterberg Limits tests are also provided on Figure 3, and 7 in Appendix D.

1.4.5 Fill: Silty Sand

A layer of silty sand fill was encountered below silty clay fill in boreholes drilled from road surface. The silty sand fill extended to depths ranging between 5.3 m to 6.1 m below ground surface with elevations ranging between 209.4 m to 210.3 m. The explored thickness of this layer was between 0.7 m to 2.3 m.

The composition of this fill layer is silt and sand, trace to some clay, trace to some gravel, occasional cobbles. The material is brown in color, and moist. The SPT "N" values within this layer ranged from 17 to 22 blows per 300 mm penetration, suggesting compact relative density. One SPT "N" value within this layer in BH-5 recorded to be 100 blows per 300 mm penetration, this could be influence of presence of cobbles in the fill.

Laboratory testing performed on selected samples consisted of sixteen (4) moisture content, four (2) grain size distribution and three (1) Atterberg Limit tests. The test results are as follows:

Moisture Content:

- 10% to 19%

Grain Size Distribution:

- 12% to 19% gravel;

- 43% to 49% sand;
- 25% to 27% silt; and
- 12% to 13% clay

Atterberg Limits:

- Liquid Limit: 21%
- Plastic Limit: 15%
- Plasticity Index: 6%

The results of the moisture content, gain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests and Atterberg Limits tests are also provided on Figure 4, and Figure 8 in Appendix D.

1.4.6 Silty Clay

A native silty clay layer was encountered in all boreholes below silty clay fill layer. The silty clay layer extended to depths ranging between 9.8 m to 15.9 m below ground surface with elevations ranging between 199.6 m to 200.3 m. All the boreholes were terminated within this layer. The explored thickness of this layer was between 8.3 m to 10.6 m.

The composition of this layer is clay and silt, trace to some sand, some organic fibers. The material is grey to brown in color, and moist to wet. The SPT “N” values within this layer ranged from 0 to 10 blows per 300 mm penetration, suggesting very soft to stiff in consistency. In addition, in situ shear vane tests were performed and field results ranged between about 28 kPa to 91 kPa.

Laboratory testing performed on selected samples consisted of thirty-six (36) moisture content, eleven (11) grain size distribution and eleven (11) Atterberg Limit tests. The test results are as follows:

Moisture Content:

- 19% to 40%

Grain Size Distribution:

- 0% to % gravel;
- 0% to 20% sand;
- 46% to 79% silt; and
- 21% to 44% clay

Atterberg Limits:

- Liquid Limit: 23% to 47%
- Plastic Limit: 17% to 26%
- Plasticity Index: 3% to 25%

The results of the moisture content, gain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests and Atterberg Limits tests are also provided on Figure 1, 2, 5 and 6 in Appendix D.

1.5 Groundwater and Surface Water Conditions

Information on groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.1.

Table 1.1. Groundwater data

Borehole	Date Completed	Date Measured	Ground Surface Elevation[2]	Depth to Water[3]	Groundwater Elevation
BH-1	Oct. 14/16	Oct. 14/16	210.1	5.8	204.2
BH-2	Oct. 14/16	Oct. 14/16	215.6	Dry	Dry
BH-3	Oct. 14/16	Oct. 14/16	209.4	4.0	205.4
BH-4	Oct. 14/16	Oct. 14/16	215.5	8.2	207.3
BH-5	Oct. 14/16	Oct. 14/16	215.7	9.0	206.7
Stream WL Upstream (North) Side	--	Oct. 14/16			209.4[4]
Stream WL Downstream (South) Side	--	Oct. 14/16	--	--	208.9[4]

Notes:
1) All units in metres.
2) Elevations surveyed are referenced to a temporary benchmark (TBM) set on (MTO # 92 concrete post, see photograph 10 in Appendix A) approximately 120 m east of the culvert alignment on south of highway. The TBM elevation (216.3 m) is assumed based on the information provided on site plan drawings provided by the MTO.
3) Depths are relative to ground surface.
4) Indicates top of surface water elevation at culvert location.

Note that water levels measured in open boreholes might not be stabilized due to short term observation.

Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods. Some perched water could exist in the embankment fill as well.

1.6 Chemical Analyses

One soil sample was selected for chemical analyses and was sent via courier, in a secure cooler under chain of custody, to AGAT Laboratories., a CALA-certified and accredited laboratory in Mississauga,

Ontario. The analytical laboratory results are presented in Appendix D, and are summarized in Table 1.2, below.

Table 1.2. Corrosivity chemical analysis

Sample Identification	pH (unitless)	Soluble Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)	Redox Potential (mV)
BH3-SS2 Silty Clay Fill	7.98	62	16	4,480	0.223	273

Part II: Closure

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report has been prepared by Nimesh Tamrakar, M.Eng, EIT., and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Nimesh Tamrakar, M.Eng and Aziz Abdelmessih.

We trust that these comments provide you with sufficient information to for your present requirements. Should you have any questions, please do not hesitate to contact this office

Yours truly,

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Encl.





Part III: LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been

prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.

USE OF REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. No other party may use or rely upon the Report in whole or in part without the written consent of exp. Any use of the Report, or any portion of the Report, by a third party are the sole responsibility of such third party. exp is not responsible for damages suffered by any third party resulting from unauthorised use of the Report.

REPORT FORMAT

Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

Appendix A –
Site Photographs



Photo 1: South embankment slope looking west from the culvert outlet



Photo 2: Inside culvert looking north from outlet side



Photo 3: South embankment slope looking east from culvert outlet



Photo 4: Culvert inlet looking south



Photo 5: Looking north from culvert inlet



Photo 6: North embankment slope looking east from culvert inlet



Photo 7: North embankment slope looking west from culvert inlet



Photo 8: Looking east from culvert location



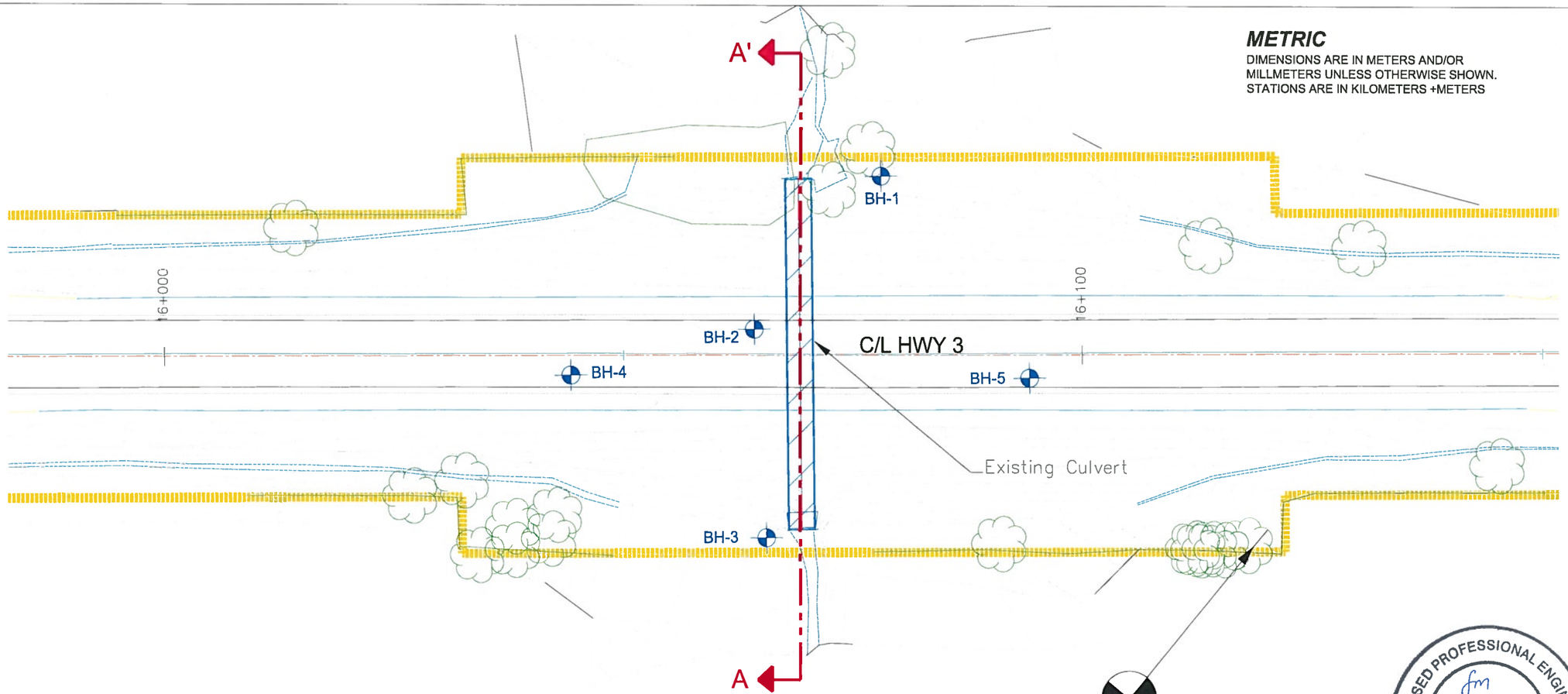
Photo 9: Looking west from culvert location



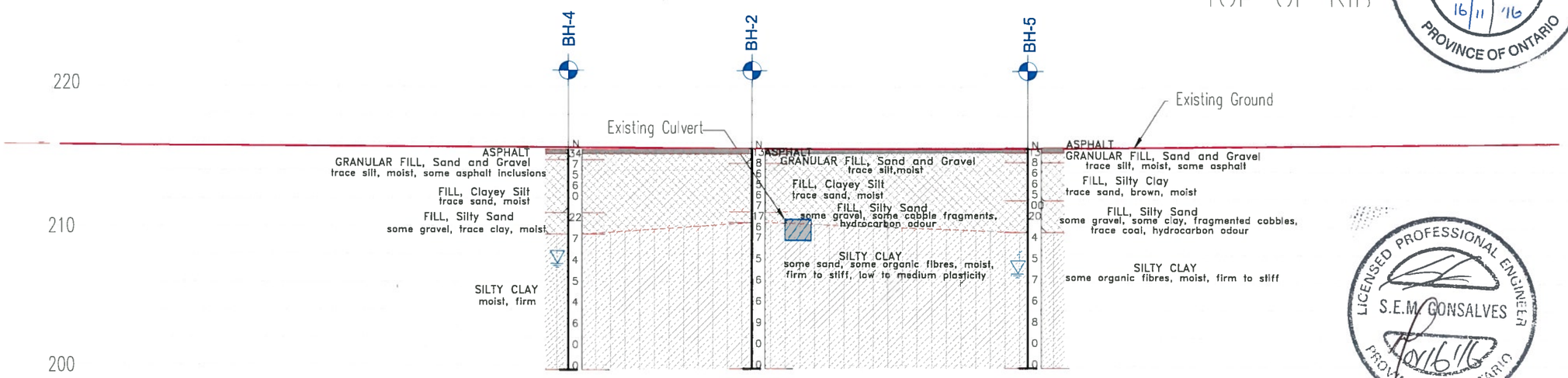
Photo 10: Temporary benchmark on MTO control point# 92

Appendix B – Drawings

METRIC
DIMENSIONS ARE IN METERS AND/OR MILLMETERS UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETERS +METERS



PLAN



PROFILE ALONG C/L HWY 3

Agreement No. 3015-E-0017
Assignment No. 1
WO

CULVERT REPLACEMENT-
STATION 16+070 HWY 3- SIMCO TO RENTON
BOREHOLE LOCATION PLAN AND PROFILE

SHEET 1

exp Services Inc.

KEY PLAN



- Location of Drilled Boreholes
- N Standard Penetration Test (Blows/0.3 m)
- Water Level in Open Borehole

SOIL STRATA SYMBOLS

- ASPHALT
- TOPSOIL
- FILL
- SILTY CLAY

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH 1	210.1	4746671.32	244790.92
BH 2	215.6	4746652.44	244780.58
BH 3	209.4	4746630.62	244786.26
BH 4	215.5	4746643.69	244761.94
BH 5	215.7	4746653.09	244811.02

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16/11/16
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.E.M. GONSALVES
16/11/16
PROVINCE OF ONTARIO

NOTE

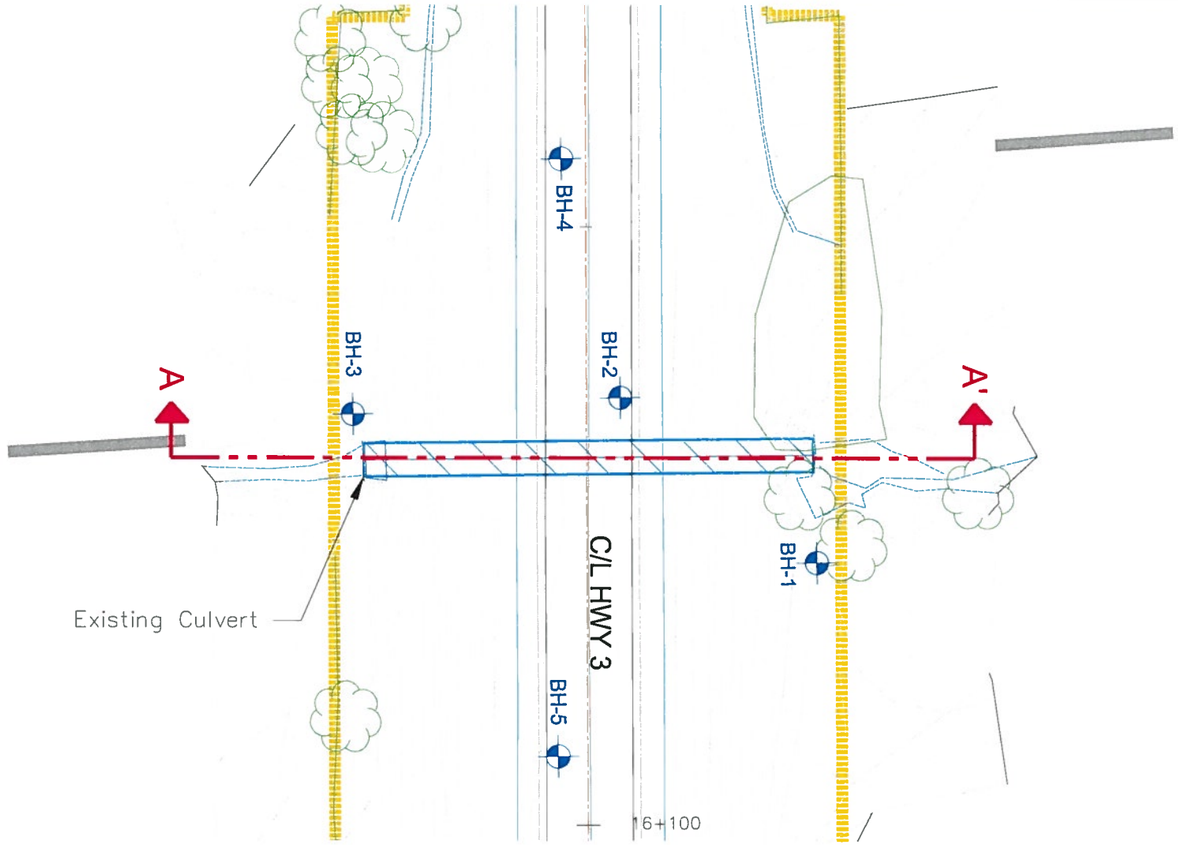
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

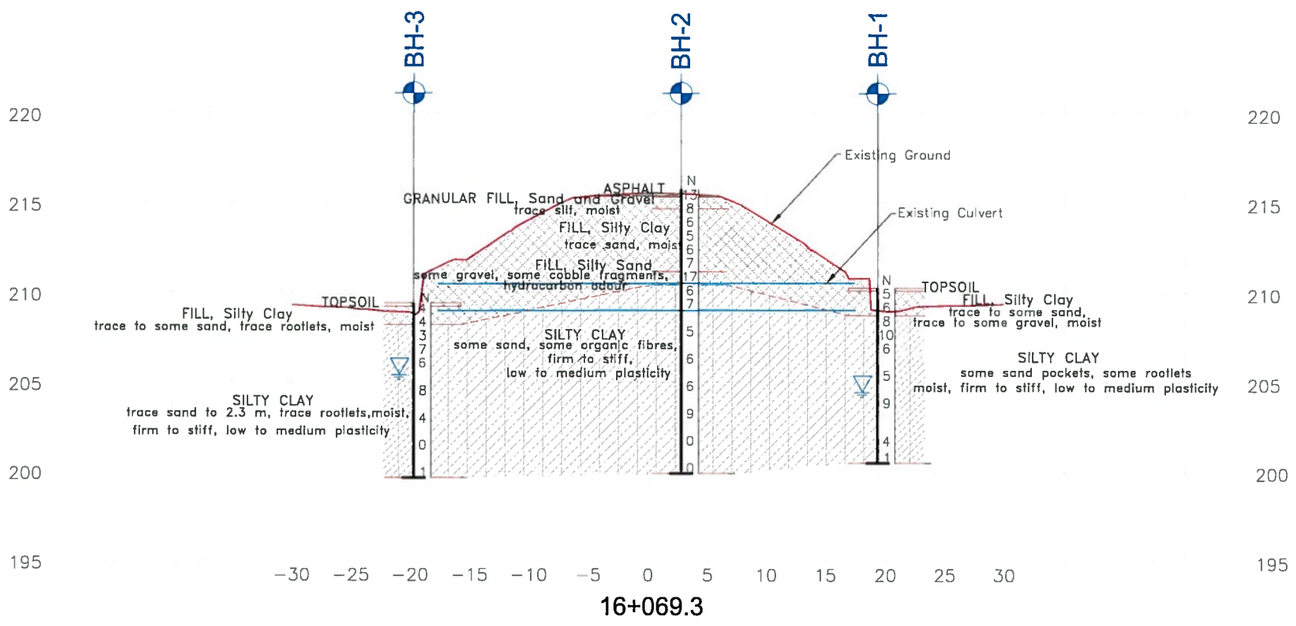
HOR 0 5 10 15 m
VERT 0 10 m

DATE	BY	DESCRIPTION
16/11/2016	SM	SUBMISSION FOR MTO REVIEW
		GEOCRES NO. 40I16-26
		PROJECT NO. ADM-00235197-A0

SUBM'D SM	CHECKED SM	DATE	16/11/2016
DRAWN SH	CHECKED SG	APPROVED	DWG. 1



PLAN



SECTION A-A' Station 16+069.3

METRIC

DIMENSIONS ARE IN METERS AND/OR MILLMETERS UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETERS +METERS

Agreement No. 3015-E-0017
Assignment No. 1

CULVERT REPLACEMENT-
STATION 16+070 HWY 3- SIMCO TO RENTON
BOREHOLE LOCATION PLAN AND SECTION

SHEET 1

exp Services Inc.

KEY PLAN



LEGEND

- Location of Drilled Boreholes
- N — Standard Penetration Test (Blows/0.3 m)
- Water Level in Open Borehole

SOIL STRATA SYMBOLS

- ASPHALT
- TOPSOIL
- FILL
- SILTY CLAY

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH 1	210.1	4746671.32	244790.92
BH 2	215.6	4746652.44	244780.58
BH 3	209.4	4746630.62	244786.26
BH 4	215.5	4746643.69	244761.94
BH 5	215.7	4746653.09	244811.02

NOTE

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 complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

HOR 0 5 10 15 m
VERT 0 10 m

DATE	BY	DESCRIPTION
16/11/2016	SM	SUBMISSION FOR MTO REVIEW
		GEOCRES NO. 40I16-26
		PROJECT NO. ADM-00235197-A0

SUBM'D SM	CHECKED SM	DATE	16/11/2016
DRAWN SH	CHECKED SG	APPROVED	DWG. 2

LICENSED PROFESSIONAL ENGINEER
S. MICIC
100050187
16/11/'16
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.E.M. GONSALVES
16/11/16
PROVINCE OF ONTARIO

Appendix C – Borehole Logs

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		

0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60	200

EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Note 16 in ASTM D2488-09a:

Table a: Percent or Proportion of Soil, Pp

	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5≤Pp≤10%
Little	15≤Pp≤25%
Some	30≤Pp≤45%
Mostly	50≤Pp≤100%

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	N<5
Loose	5≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤N

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

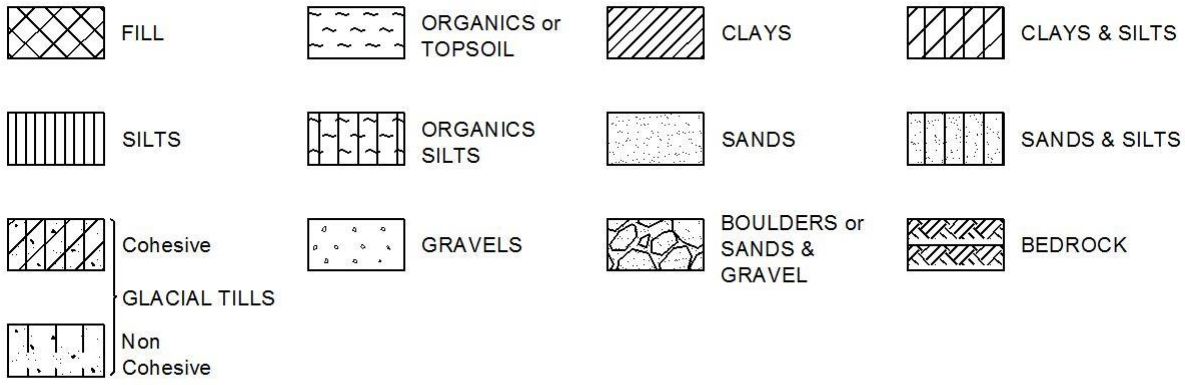
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICALL PROPERIES OF SOIL

m_v	kPa^{-1}	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m^2/s	Coefficient of consolidation
H	m	Drainage path
T_V	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_P	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	$-^\circ$	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	$-^\circ$	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	Density of solid particles
γ_s	kN/m^3	Unit weight of solid particles
ρ_w	kg/m^3	Density of water
γ_w	kN/m^3	Unit weight of water
ρ	kg/m^3	Density of soil
γ	kN/m^3	Unit weight of soil
ρ_d	kg/m^3	Density of dry soil
γ_d	kN/m^3	Unit weight of dry soil
ρ_{sat}	kg/m^3	Density of saturated soil
γ_{sat}	kN/m^3	Unit weight of saturated soil
ρ'	kg/m^3	Density of submerged soil
γ'	kN/m^3	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_P	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_P$
I_C	%	Consistency index = $(W_L - W)/I_P$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m^3/s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m^3	Seepage force

RECORD OF BOREHOLE No BH-1

1 OF 1

METRIC

W. P. 3062-14-00 | LOCATION 244790.92 E, 4746671.32 N | ORIGINATED BY NT
DIST West | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY JG
DATUM Geodetic | DATE 2016/10/14 - 2016/10/14 | CHECKED BY SM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DNYAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED, × QUICK TRIAXIAL, + FIELD VANE, LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.1											
210.0 / 0.2	**TOPSOIL:** (~125 mm thick)						210				
	FILL: silty clay, trace to some sand, trace to some gravel, brown, moist		1	SS	5						
			2	SS	6		209				
208.6									46		
1.5	**SILTY CLAY:** trace sand pockets/veins to 3.1 m, some rootlets, brown and light brown, mottled, moist, firm to stiff, low to medium plasticity		3	SS	8						0 6 54 40
			4	SS	10		208				
	interbedded silt and fine sand seams, grey, wet below 3.1 m depth		5	SS	6		207				0 20 48 32
			6	SS	5		206				0 1 74 25
			7	SS	9	▽	205				
			8	SH			204				
	soft to very soft below 8.2 m depth		9	SS	4		203	3.3			
			10	SS	1		202				
200.3							201				
9.8	**End of Borehole at 9.8 m depth. Water level at 5.8 m upon completion of drilling.**										

Notes:
1. This drawing is to be read with the subject report and project numbers as presented above.
2. Groundwater level was measured in open hole upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

OPG_EXP RECORD OF BOREHOLE BHLOGS MTO.GPJ ONTARIO MOT.GDT 11/16/16

RECORD OF BOREHOLE No BH-2

1 OF 1

METRIC

W. P. 3062-14-00 | LOCATION 244780.58 E, 4746652.44 N | ORIGINATED BY AA

DIST West | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY JG

DATUM Geodetic | DATE 2016/10/14 - 2016/10/14 | CHECKED BY SM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.6 / 215.2	**ASPHALT:** (~430 mm thick)	1	SS	13		215	
0.4 / 214.5	**GRANULAR FILL:** sand and gravel, trace silt, brown, moist (~660 mm thick)	2	SS	8			
1.1	**FILL:** silty clay, trace sand, brown, moist some black organic staining at 1.5 m depth	3	SS	6		214	
		4	SS	5		213	
		5	SS	6		212	
	some sand pockets at 3.8 m depth	6	SS	7			
211.0						211	
4.6 / 210.3	**FILL:** silty sand, some gravel, some cobble fragments, hydrocarbon odour below 4.6 m depth	7	SS	17			
5.3	**SILTY CLAY:** some sand to 7.6 m, dark grey, some organic fibres, moist, firm to stiff, low to medium plasticity	8	SS	6		210	0 12 46 42
		9	SS	7		209	
	brown and light brown, mottled, moist below 7.6 m depth	10	SS	5		208	0 1 68 31
	interbedded silt seams, grey, wet below 9.2 m depth	11	SS	6		207	0 0 74 26
		12	SS	6		206	
		13	SS	9		205	
	very soft to firm below 13.7 m depth	14	SS	0		204	
199.8		15	SS	0		203	
15.9	**End of Borehole at 15.9 m depth.**					202	
						201	
						200	

DNYAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH: Cu, KPa
○ UNCONFINED + FIELD VANE
× QUICK TRIAXIAL LAB VANE
(20 40 60 80 100)

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

+3.8
+3.7
+2.3
47

Notes:
1. This drawing is to be read with the subject report and project numbers as presented above.
2. Borehole open to 8.4 m upon completion of drilling.
3. Borehole remained dry upon completion of drilling.

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

OPG_EXP RECORD OF BOREHOLE BHLOGS MTO.GPJ ONTARIO MOT.GDT 11/16/16

RECORD OF BOREHOLE No BH-3

1 OF 1

METRIC

W. P. 3062-14-00 | LOCATION 244786.26 E, 4746630.00 N | ORIGINATED BY NT
DIST West | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY JG
DATUM Geodetic | DATE 2016/10/14 - 2016/10/14 | CHECKED BY SM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DNYAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED, + FIELD VANE, × QUICK TRIAXIAL, LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
209.4											
209.2	**TOPSOIL:** (~200 mm thick)										
0.2	**FILL:** silty clay, trace to some sand, trace rootlets, brown, moist		1	SS	4		209				
208.2			2	SS	4						
1.2	**SILTY CLAY:** trace sand to 2.3 m, trace rootlets, brown, moist, firm to stiff, low to medium plasticity		3	SS	3		208				0 8 57 35
	interbedded silt seams, grey, wet below 2.3 m depth		4	SS	7		207				0 1 63 36
			5	SS	6	▽	206				
			6	SS	8		205				
			7	SS	4		204				
							203	+4.0			
	very soft below 7.6 m depth		8	SS	0		202				0 0 56 44
			9	SS	1		201				
199.6							200				
9.8	**End of Borehole at 9.8 m depth. Water level at 4.0 m upon completion of drilling.**										

Notes:
1. This drawing is to be read with the subject report and project numbers as presented above.
2. Groundwater level was measured in open hole upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

OPG_EXP RECORD OF BOREHOLE BHLOGS MTO.GPJ ONTARIO MOT.GDT 11/16/16

RECORD OF BOREHOLE No BH-4

1 OF 1 **METRIC**

W. P. 3062-14-00 LOCATION 244761.94 E, 4746643.69 N ORIGINATED BY NT

DIST West BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY JG

DATUM Geodetic DATE 2016/10/14 - 2016/10/14 CHECKED BY SM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DNYAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH: Cu, KPa (○ UNCONFINED + FIELD VANE × QUICK TRIAXIAL LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.5											
215.2	**ASPHALT:** (~330 mm thick)		1	SS	34		215				
0.3 / 214.7	**GRANULAR FILL:** sand and gravel, trace silt, brown, moist, some asphalt inclusions (~430 mm thick)										0 9 47 44
0.8	**FILL:** silty clay, trace sand, brown, moist		2	SS	7		214				
			3	SS	5		213				
			4	SS	6		212				
			5	SS	6		211				
210.9											
4.6	**FILL:** silty sand, some gravel, trace clay, dark brown, moist		6	SS	22						19 43 25 13
209.4							210				
6.1	**SILTY CLAY:** brown, moist, firm		7	SS	7		209				
	interbedded silt seams, grey, wet below 9.2 m depth		8	SS	4	▽	208				
			9	SS	5		207				
			10	SS	4		206				
			11	SS	6		205				
	very soft to firm below 13.7 m depth		12	SS	0		204				0 0 79 21
			13	SS	0		203	+2.7			
199.7							202				
15.9	**End of Borehole at 15.9 m depth. Water level at 8.2 m upon completion of drilling.**						201				
							200				

Notes:
1. This drawing is to be read with the subject report and project numbers as presented above.
2. Groundwater level was measured in open hole upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

OPG_EXP RECORD OF BOREHOLE BHLOGS MTO.GPJ ONTARIO MOT.GDT 11/16/16

RECORD OF BOREHOLE No BH-5

1 OF 1

METRIC

W. P. 3062-14-00 | LOCATION 244811.02 E, 4746653.09 N | ORIGINATED BY AA

DIST West | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY JG

DATUM Geodetic | DATE 2016/10/14 - 2016/10/14 | CHECKED BY SM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.7									
215.3	**ASPHALT:** (~380 mm thick)		1	SS	13		215		
0.4 / 214.6	**GRANULAR FILL:** sand and gravel, trace silt, brown, moist, some asphalt inclusions (~685 mm thick)		2	SS	8				
1.1	**FILL:** silty clay, trace sand, brown, moist		3	SS	6		214		
			4	SS	6		213		0 6 46 48
211.9			5	SS	5		212		
3.8	**FILL:** silty sand, some gravel, some clay, fragmented cobbles, trace coal, hydrocarbon odour		6	SS	100				
	split spoon refusal on assumed cobble at 4.1 m depth		7	SS	20		211		12 49 27 12
209.6							210		
6.1	**SILTY CLAY:** dark grey, some organic fibres, moist, firm to stiff		8	SS	4		209		
	interbedded silt seams, brown, moist below 7.6 m depth		9	SS	5		208		0 1 63 36
	grey, wet below 9.2 m depth		10	SS	7	▽	207		
			11	SS	6		206		
			12	SS	8		205		
	very soft to stiff below 13.7 m depth		13	SS	0		204		
199.8			14	SS	0		203		
15.9	**End of Borehole at 15.9 m depth. Water level at 9.0 m upon completion of drilling.**						202		
	Notes: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Borehole open to 9.2 m upon completion of drilling. 3. Groundwater level was measured in open hole upon completion of drilling.						201		
							200		

DNYAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: Cu, KPa
○ UNCONFINED + FIELD VANE
× QUICK TRIAXIAL LAB VANE
20 40 60 80 100

+3.3 +3.7 +3.5

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

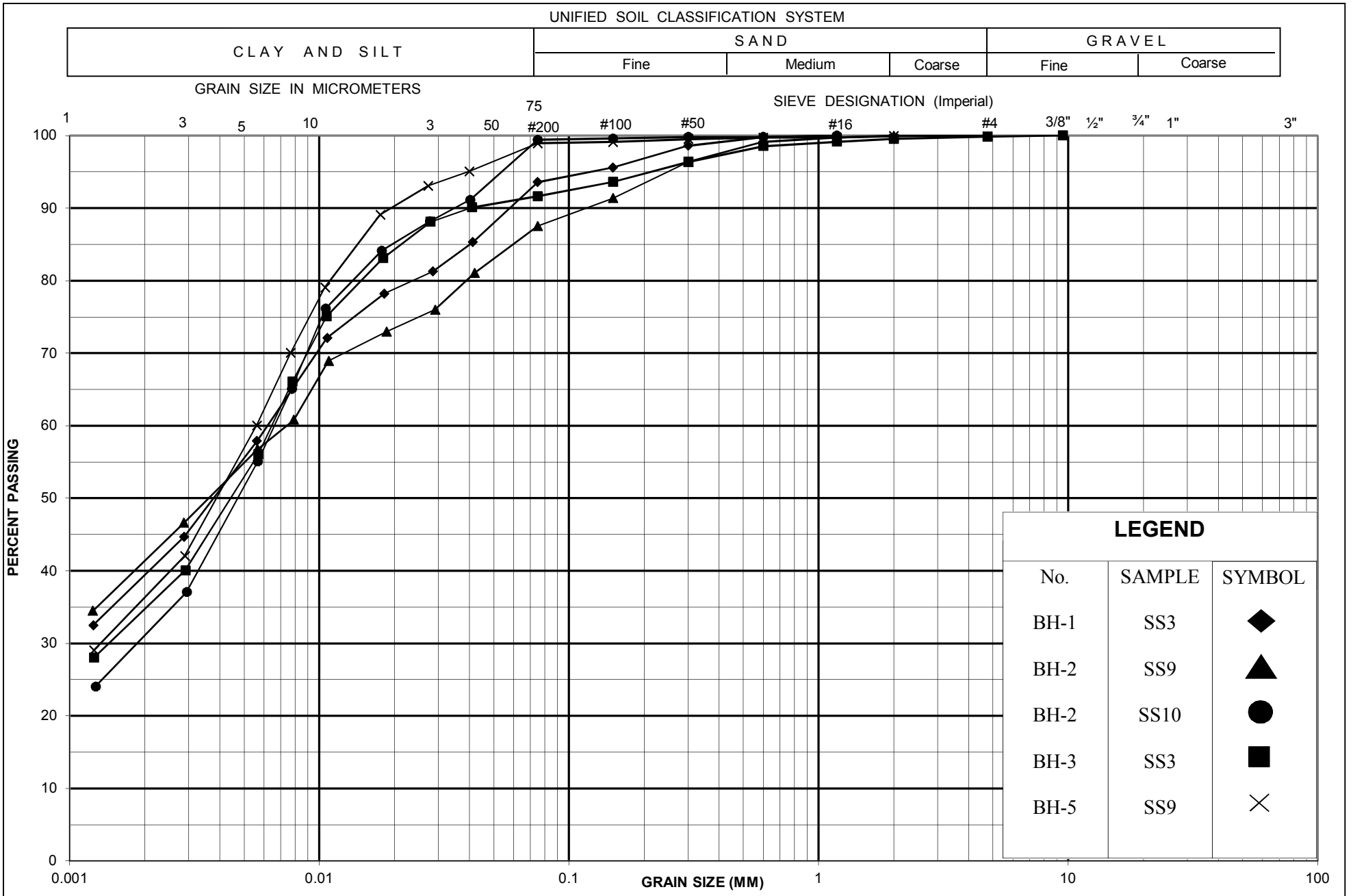
WATER CONTENT (%): 10 20 30

43

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

OPG_EXP RECORD OF BOREHOLE BHLOGS MTO.GPJ ONTARIO MOT.GDT 11/16/16

Appendix D – Laboratory Data



GRAIN SIZE DISTRIBUTION

SILTY CLAY (CL and CI)

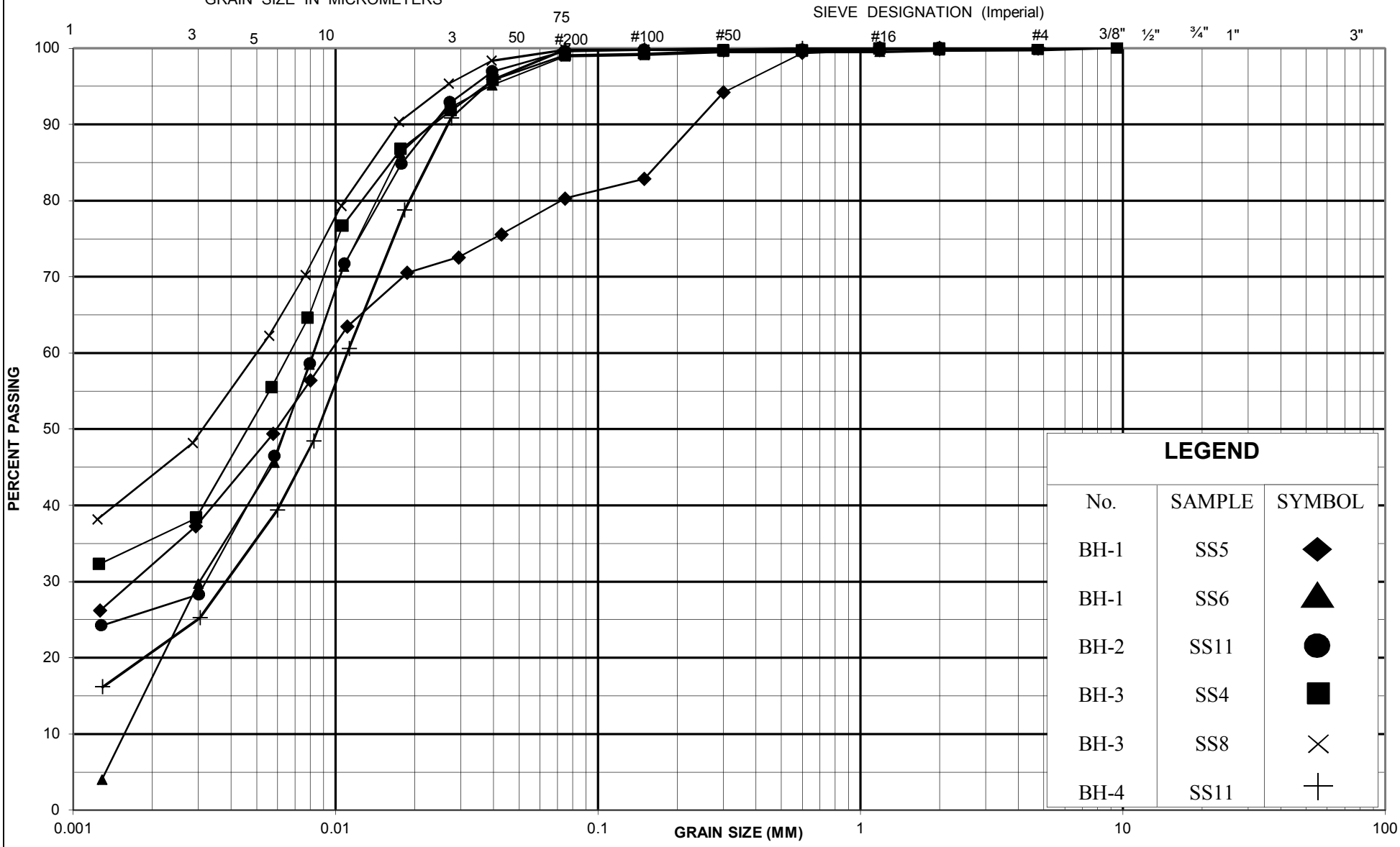
FIGURE NO.: 1

GWP: 3062-14-00

DATE: OCTOBER 2016

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

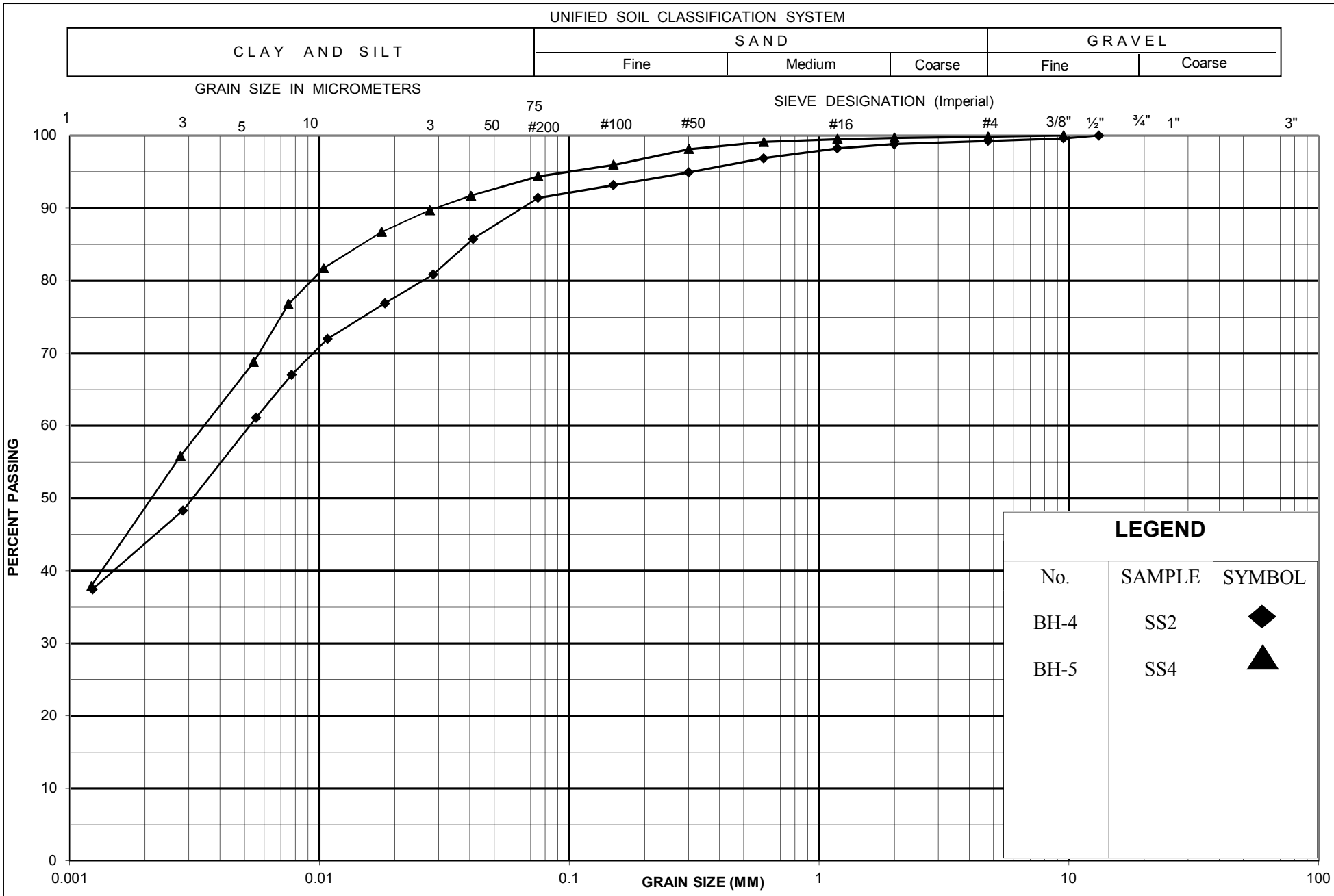
SILTY CLAY with interbedded SILT/SAND seams

(CL, CL-ML, and ML)

FIGURE NO.: 2

GWP: 3062-14-00

DATE: OCTOBER 2016



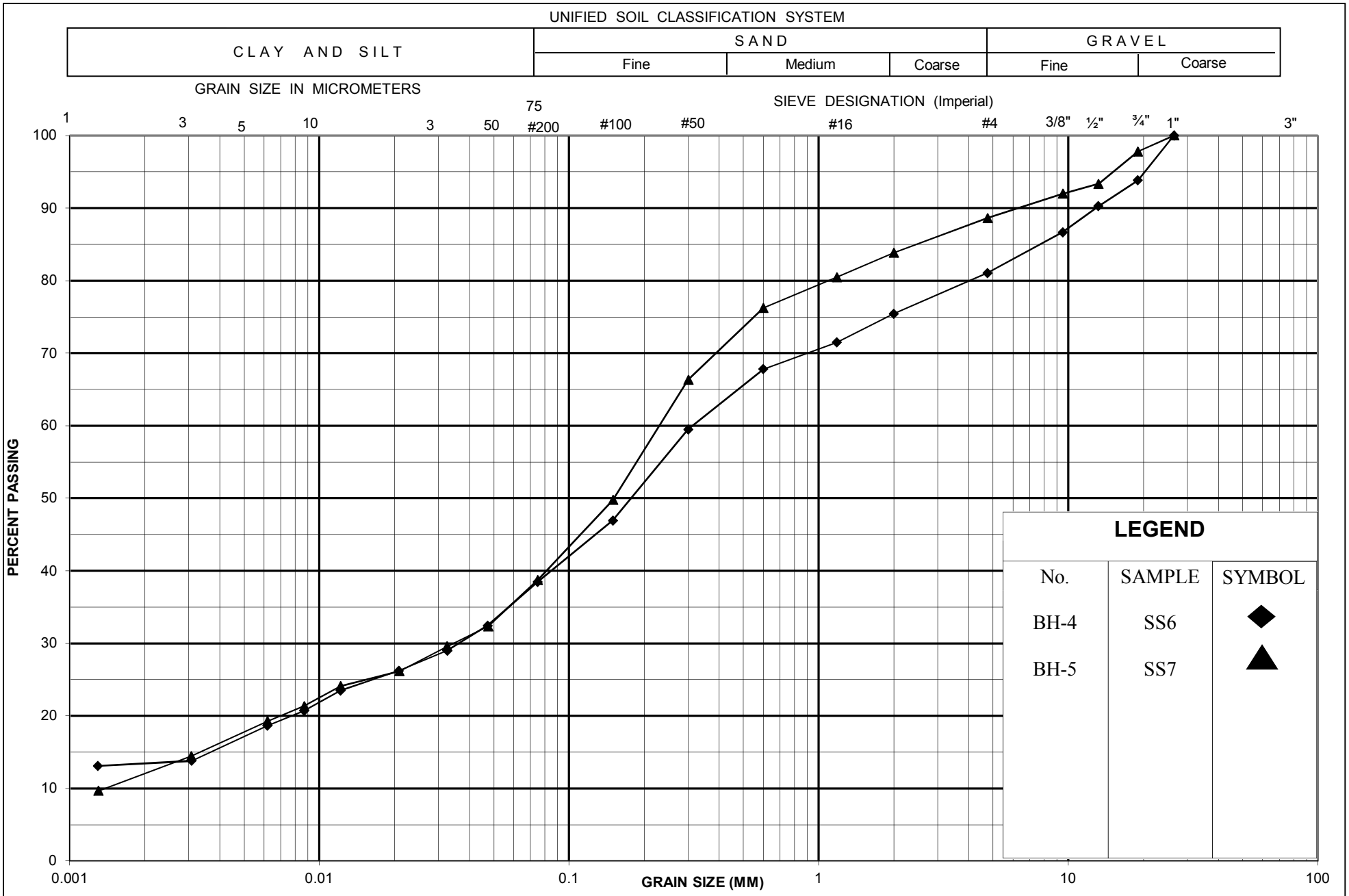
GRAIN SIZE DISTRIBUTION

FILL: SILTY CLAY (CI)

FIGURE NO.: 3

GWP: 3062-14-00

DATE: OCTOBER 2016



GRAIN SIZE DISTRIBUTION

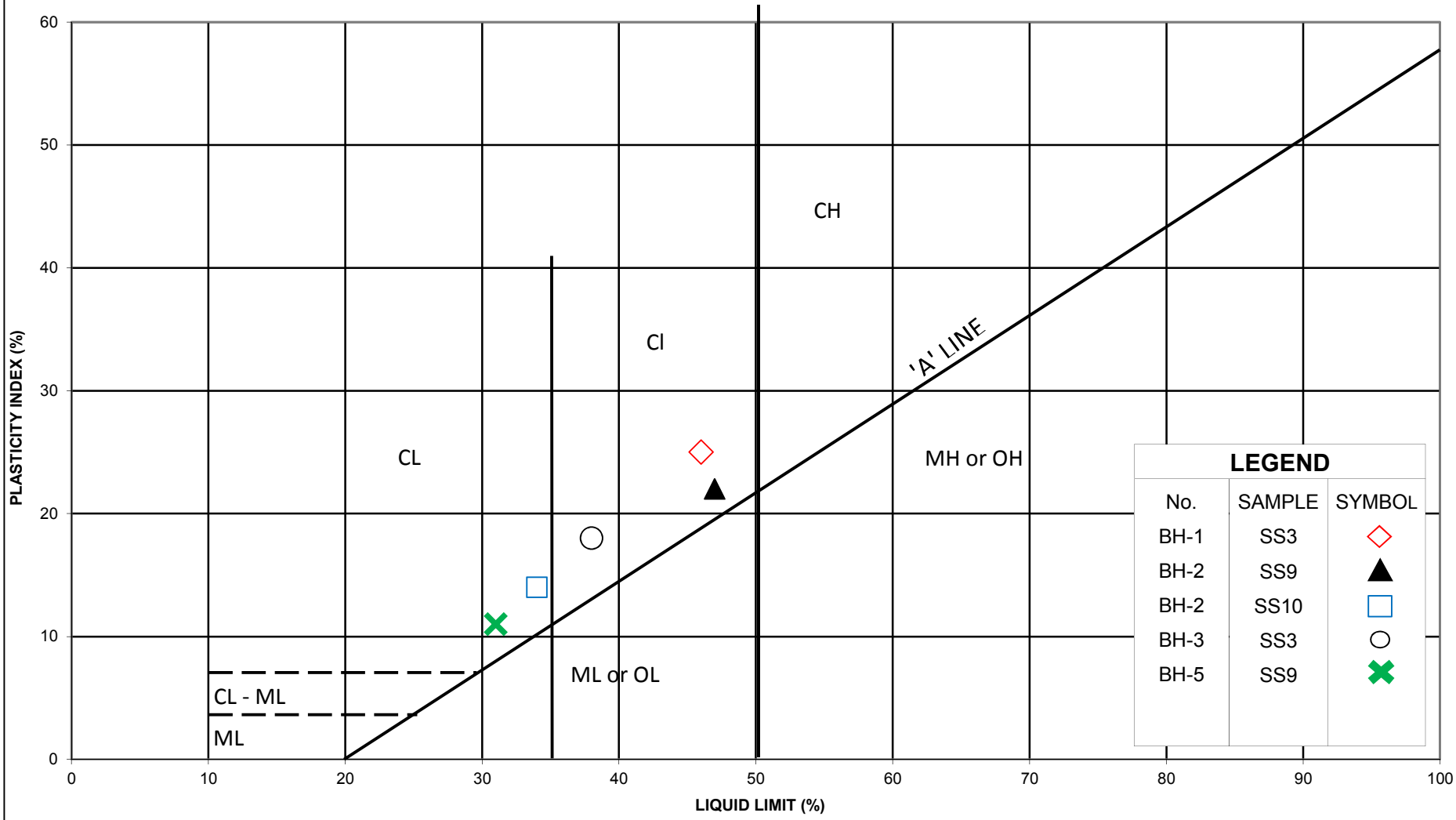
FILL: SILTY SAND (SM-SC)

FIGURE NO.: 4

GWP: 3062-14-00

DATE: OCTOBER 2016

CULVERT REPLACEMENT
STA. 16+070, Highway 3, Simcoe, ON

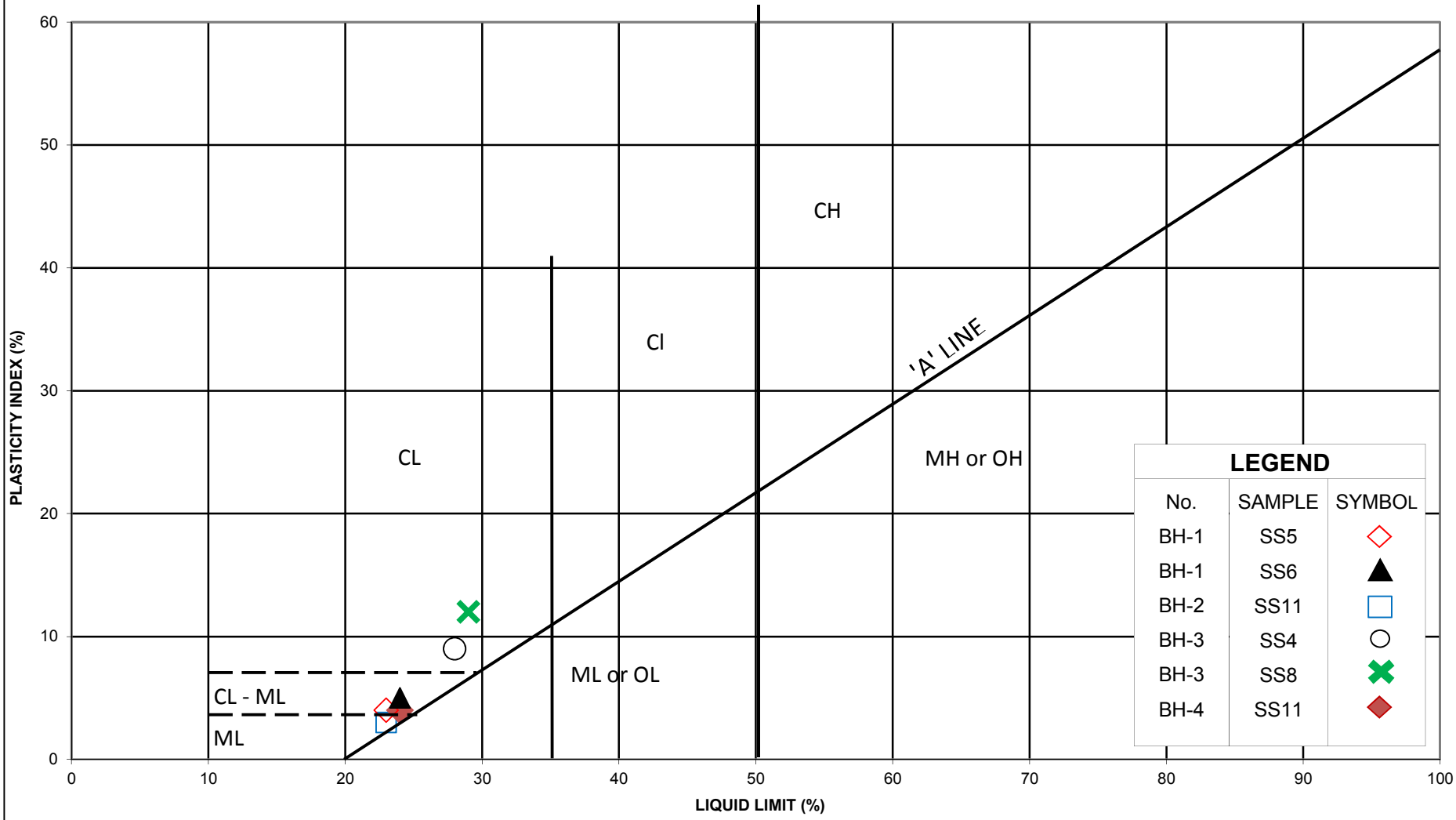


PLASTICITY CHART

SILTY CLAY (CL and CI)

FIGURE NO.: 5
GWP: 3062-14-00
DATE: OCTOBER 2016

CULVERT REPLACEMENT
STA. 16+070, Highway 3, Simcoe, ON

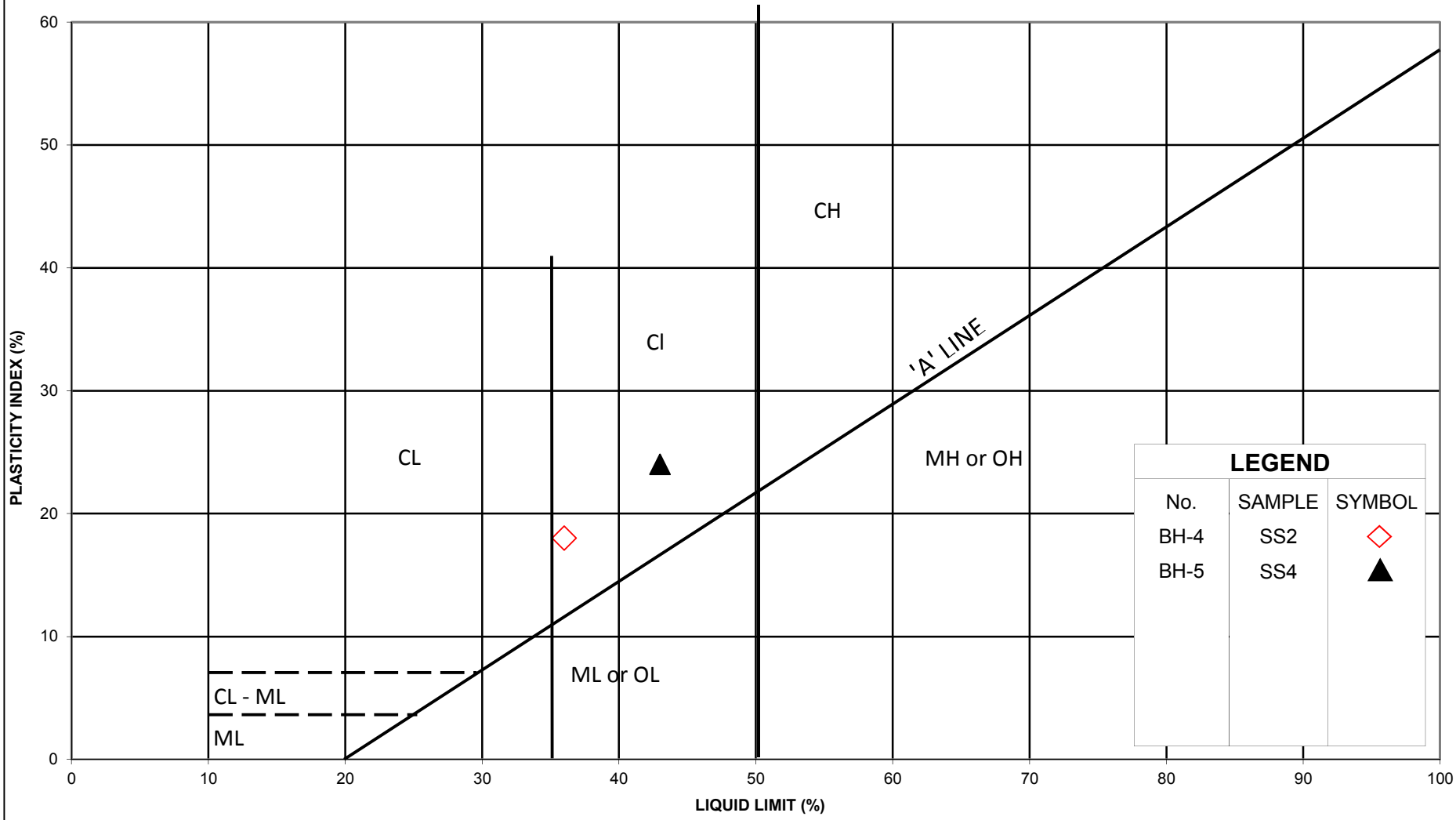


PLASTICITY CHART

SILTY CLAY with interbedded SILT seams (CL, CL-ML, and ML)

FIGURE NO.: 6
GWP: 3062-14-00
DATE: OCTOBER 2016

CULVERT REPLACEMENT
STA. 16+070, Highway 3, Simcoe, ON



exp.

PLASTICITY CHART

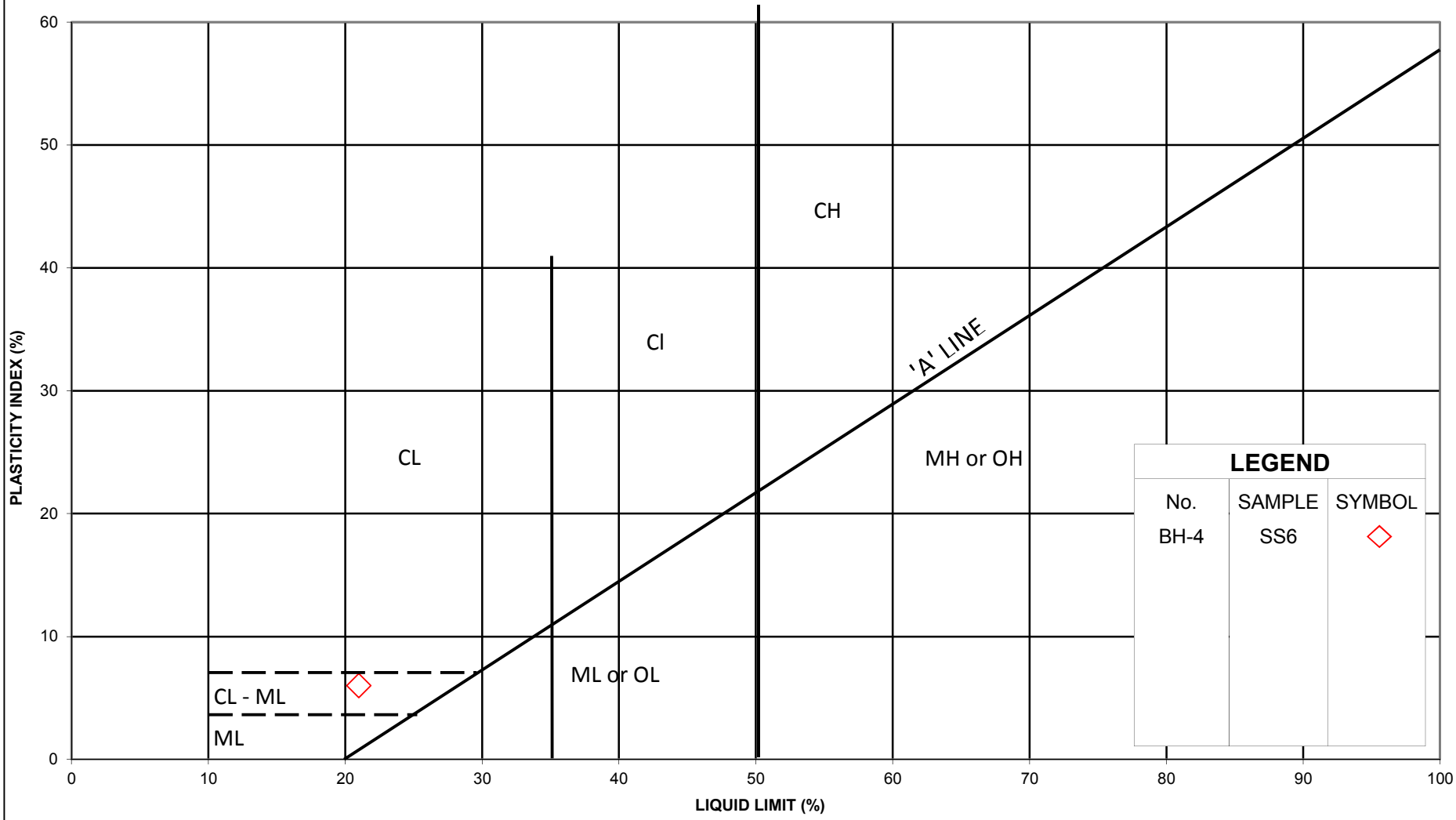
FILL: SILTY CLAY (CI)

FIGURE NO.: 7

GWP: 3062-14-00

DATE: OCTOBER 2016

CULVERT REPLACEMENT
STA. 16+070, Highway 3, Simcoe, ON



exp.

PLASTICITY CHART

FILL: SILTY SAND (SM-SC)

FIGURE NO.: 8
GWP: 3062-14-00
DATE: OCTOBER 2016

AGAT Laboratories

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

CLIENT NAME: EXP. SERVICES INC.
80 BANCROFT STREET
HAMILTON, ON L8E2W5
(905) 573-4000

ATTENTION TO: Jeff Golder

PROJECT: Colvert Replacement

AGAT WORK ORDER: 16T156323

SOIL ANALYSIS REVIEWED BY: Amanjot Bhela, Inorganic Coordinator

DATE REPORTED: Nov 09, 2016

PAGES (INCLUDING COVER): 5

VERSION*: 1

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

*NOTES

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

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)
Western Enviro-Agricultural Laboratory Association (WEALA)
Environmental Services Association of Alberta (ESAA)

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested
All reportable information as specified by ISO 17025:2005 is available from AGAT Laboratories upon request

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TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 16T156323

PROJECT: Colvert Replacement

CLIENT NAME: EXP. SERVICES INC.

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2016-11-03

DATE REPORTED: 2016-11-09

		SAMPLE DESCRIPTION:		BH-3 SS2
		SAMPLE TYPE:		Soil
		DATE SAMPLED:		2016-10-14
Parameter	Unit	G / S	RDL	7985344
Sulphide	%		0.05	<0.05
Chloride (2:1)	µg/g		2	62
Sulphate (2:1)	µg/g		2	16
pH (2:1)	pH Units		NA	7.98
Electrical Conductivity (2:1)	mS/cm		0.005	0.223
Resistivity (2:1)	ohm.cm		1	4480
Redox Potential (2:1)	mV		5	273

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7985344 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Certified By: Amanjot Bhela

Results relate only to the items tested and to all the items tested

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http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 16T156323

PROJECT: Colvert Replacement

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Nov 09, 2016			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Sulphide	7985344	7985344	<0.05	<0.05	NA	< 0.05	98%	80%	120%	NA			NA		
Chloride (2:1)	7983417		249	249	0.0%	< 2	101%	80%	120%	104%	80%	120%	100%	70%	130%
Sulphate (2:1)	7983417		81	81	0.0%	< 2	94%	80%	120%	98%	80%	120%	105%	70%	130%
pH (2:1)	7983417		7.52	7.58	0.8%	NA	101%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	7992374		0.318	0.318	0.0%	< 0.005	99%	90%	110%	NA			NA		
Redox Potential (2:1)	7983109		274	272	0.7%	< 5	101%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

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Results relate only to the items tested and to all the items tested

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TEL (905)712-5100
FAX (905)712-5122
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Method Summary

CLIENT NAME: EXP. SERVICES INC.

AGAT WORK ORDER: 16T156323

PROJECT: Colvert Replacement

ATTENTION TO: Jeff Golder

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

Results relate only to the items tested and to all the items tested

AGAT Laboratories
5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water intended for human consumption)

Laboratory Use Only
Work Order #: 16T156323
Cooler Quantity:
Arrival Temperatures: 10.2
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes:

Report Information:
Company: exp Services Inc.
Contact: Jeffrey Golder
Address: 80 Bancroft Street
Hamilton, ON L8E 2W5
Phone: 905.573.4000 x5022 Fax:
Reports to be sent to:
1. Email: jeffrey.golder@exp.com
2. Email:

Regulatory Requirements:
☐ No Regulatory Requirement
(Please check all applicable boxes)

☐ Regulation 153/04
Table (Indicate One) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (Check One) ☐ Coarse ☐ Fine

☐ Sewer Use
☐ Sanitary ☐ Storm
Region (Indicate One)

☐ Regulation 558
☐ CCME
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
(Indicate One)

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Turnaround Time (TAT) Required:
Regular TAT ☐ 5 to 7 Business Days
Rush TAT (Rush Surcharges Apply)
☐ 3 Business Days ☐ 2 Business Days ☐ 1 Business Day
OR Date Required (Rush Surcharges May Apply):
Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

Project Information:
Project: CULVERT REPLACEMENT
Site Location: HWY 3
Sampled By: AA
AGAT Quote #: PO: ADM-00235 197-A0
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:
Bill To Same: Yes ☒ No ☐
Company:
Contact:
Address:
Email:

Sample Matrix Legend
B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI (Please Circle) Y / N	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	(Check Applicable) ORPs: ☐ B-HWS ☐ Cl⁻ ☐ CN⁻ ☐ Cr⁶⁺ ☐ EC ☐ FOC ☐ NO_3/NO_2 ☐ Total N ☐ Hg ☐ pH ☐ SAR	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use	CORROSIVITY PACK
BH-3 SS2	Oct 14	—	1	S																X

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Jeff Golder	Nov 3/16	9:00 AM			
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time

Page ____ of ____

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT