

## **FINAL REPORT**

### **FOUNDATION INVESTIGATION REPORT**

**Trapp Creek Culvert (Site 46-329C), Hwy 101, Chapleau, Sault Ste. Marie Area**

**Agreement No. 5013-E-0008**

**Assignment No. 8**

**WO 2015-11011**

**Geocres No. 410-13**

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# Ministry of Transportation

## Foundation Investigation Report

Agreement No. 5013-E-0008

Assignment No. 8

W.O. 2015- 11011

MTO Geocres No. 410-13

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### Project Name:

Foundation Investigation and Design for Trapp Creek Culvert (Site 46-329C) Hwy 101, Chapleau, Sault Ste. Marie area

### Project Number:

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10/08/2015

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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 detail design required at the Trapp Creek Culvert, located on Highway 101 near Chapleau in the Sault Ste. Marie Area. The site is approximately 140 m east of Highway 101/129 North Junction (LHRS 40430 o/s 15.22) at Sta. 10+138 IR No. 74A. the Ministry of Transportation (MTO) Northeastern Region. The work was undertaken under Agreement # 5013-E-0008, Assignment No. 8 (WO 2015-11011). The terms of reference (TOR) were as presented in the MTO letter dated April 2, 2015.

It has been reported by MTO that during construction, a settlement of  $480 \pm$  mm was experienced on the north half of the culvert. The MTO Sault Ste. Marie Area Office has completed selective resurfacing to repair distortions within the fill embankment since the last rehabilitation in 2000. Prior to 2009, HMA patch was placed from approximately Sta. 10+150 to Sta. 10+210 in the WBL. Further selective resurfacing was completed in 2009 from Sta. 10+080 to Sta. 10+210 covering both EBL and WBL to address a longitudinal meandering crack spanning the length of embankment. In 2012, the Sault Ste. Marie Area office completed remedial work to repair a sinkhole that developed in the EBL within the east and west culvert haunches. As part of the 2012 repair, 30 bags of concrete were placed to fill voids around the culvert footing. Since 2012, settlements have redeveloped.

The purpose of this investigation is to evaluate/obtain the subsurface information at the culvert alignment and immediate approach embankment, verify the adequacy of the existing foundation at the culvert (in comparison to the assumed bearing capacity utilized for the initial culvert construction), investigate the cause of settlement and provide detailed recommendations with the appropriate alternatives to mitigate settlement and for the roadway distress treatment of Highway 101 from Sta. 10+080 to Sta. 10+210. 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 Trapp Creek Culvert site is located on Hwy 101 (Station 10+138 IR No. 74A) near Chapleau, approximately 140 m east of Hwy 101/129 North Junction. At this site Hwy 101 is two lanes, east/west roadway with a speed limit of 80 km/h and is about 7.3 m wide from edge of pavement to edge of pavement, with narrow sand and gravel shoulders and guardrails subsequently on both sides. It is estimated that the highway embankment at the investigated location is between 2.4 to 3

m high having side slopes of about 2.5H:1V. The location of the culvert and a cross section of the existing culvert alignment are shown on Drawing 1 in Appendix B.

According to TOR provided, the existing Super-Cor culvert was constructed on an 800mm deep x 1200 mm wide clear stone footing with a specified gradation of 12.5 mm to 100 mm, as part of contract 2000-0242. The steel footings were designed based on an assumed 200 kPa bearing capacity. Photographs of the site and inlet and outlet of the existing culvert are presented in Appendix A.

The surrounding terrain of the culvert location is relatively flat, with Hwy 101 sloping towards the culvert on east side of the culvert then flat towards the CPR track on the west side of the culvert. The area is densely covered with trees beyond the culvert flood plain. At the site location, creek water flows from south to north crossing Hwy 101 via culvert. During the field work, the flood plain of Trap Creek was full of water due to spring flood with water level as high as of Elevation 427.63 m. The water in the surrounding area was approximately 0.6 m to 1.24 m deep at the time; see photographs in Appendix A.

The general site conditions were assessed during the site reconnaissance in April, 2015. However, since the surrounding area of culvert was full of water, our observations were limited. It was observed that a portion of roadway along the culvert alignment and the WBL of Hwy 101 on west side of the culvert alignment was depressed forming a longitudinal crack approximately 1.7 m wide 20 m long from edge of pavement, along the embankment. However, longitudinal meandering cracks were also observed on east side and both (east/west) side of culvert alignment on WBL and EBL respectively but major depressions in the embankment were not observed in these areas. It was also observed that the surface of EBL roadway portion on east and west sides of the culvert alignment had been treated with asphalt. Based on this limited observation, it could be speculated that the roadway distress treatment was performed in the past. On the north slope of the embankment (i.e., outlet side), washed out surface fill material forming erosion channel and a pothole of depth about 0.3 m (measured in April 2015) was observed at the culvert location and at approximate Sta. 10+115. Selective photographs of the roadway distresses and slope distresses are presented in Appendix A.

At the time of site investigation, Trapp Creek was flowing freely and approximate elevations at the inlet and outlet were 427.74 m and 427.6 m respectively. The elevation of highway centerline pavement was 429.9 m.

### 1.2.2 Geological Setting

The Map 2543 (Bedrock Geology of Ontario, East-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the bedrock formation of the project area is known to be in Neo to Mesoproterozoic Group, mainly of gneissic tonalite suite intrusive rocks comprised of minor supracrustal inclusions. The Map 2555 (Quaternary Geology of Ontario, East-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the surface conditions in the vicinity of site consist of bedrock of undifferentiated igneous and metamorphic rock, exposed at surface or covered by discontinuous, thin layer of drift.

## 1.3 Investigation Procedures

### 1.3.1 Site Investigation and Field Testing

The field investigation was performed between April 27, 2015 and May 1, 2015. The field program consisted of drilling six (6) sampled boreholes (BH-1, BH-2, BH-3, BH-4, BH-5 and BH-6) and probing of surrounding and founding areas. The boreholes were strategically located along the existing culvert alignment and immediate approach embankments to provide subsurface information along the existing culvert and immediate approach embankments. BH-1, BH-2, BH-3 and BH-4 were advanced from the embankment crest and BH-5 and BH-6 were advanced (from the water using barge; see photographs 9 in Appendix A) at toe of embankment on outlet and inlet side of culvert, respectively. Among the boreholes drilled from embankment crest BH-1 and BH-4 were located at west/east approach embankment (approximately 25.75/25.9 m away from centerline of culvert alignment), respectively. Similarly, BH-2 and BH-3 were located about 9.75 m west/9.6 m east of centerline of culvert alignment within WBL/EBL, respectively. Two probe hole, PB1 (east of culvert alignment on WBL) and PB2 (west of culvert alignment on EBL) were advanced up to 7.62 m to confirm peat layer just beside the culvert foundation. Probe holes PB1 and PB2 were located about 5.5 m from the centerline of culvert alignment. The borehole locations are shown on Drawing 1 in Appendix B.

Boreholes drilled from the embankment crest (BH-1, BH-2, BH-3 and BH-4) were advanced using a truck mounted CME-55 drill rig, equipped with a hollow stem auger and standard soil sampling equipment operated by a specialist drilling contractor, Landcore Drilling Inc. Due to difficulties to access the inlet and outlet sides with the drill rig and the high water level in vicinity of culvert, boreholes at these locations (BH-5 and BH-6) were advanced using hand drilling/sampling equipment (a portable tripod with hammer) and barge operated also by Landcore Drilling Inc.

The boreholes drilled through the embankment BH-1, BH-2, BH-3 and BH-4 were advanced up to desired depths of 9.76 m, 20.43 m, 15.85 m and 9.76 m, respectively. BH-5 and BH-6 drilled through water using a barge at the toe of embankment were advanced to depths of 8.07 m and 11 m from water surface respectively.

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel. The ground surface elevations, including top of culvert and top of water, were referenced to a temporary bench mark assumed (top of Hwy 101 and CPR track crossing platform on south-east corner). Elevation of the bench mark (Elev. 430 m) was assumed based on the drawing sheet no. 29 (CONT NO. 200-0242, WP No. 467-00-01), provided by the MTO.

During the drilling of the boreholes, 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. One Shelby

tube samples was obtained in the peat layer. Since the conventional hammer of 63.5 kg was used for sampling done by a portable tripod, the corresponding blow counts were not factored.

Upon completion of the boreholes, ground water level measurements were carried out from the boreholes (BH-1 and BH-4) in accordance with the Ministry of Transportation guidelines. The measured ground water levels after completion of drilling boreholes were recorded on borehole log sheets in Appendix C. Since the wash boring technique was used to drilled boreholes (BH-2 and BH-3), the stabilized ground water level could not be established by short term observation in boreholes. BH-5 and BH-6 were drilled below the water level. 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** Brampton 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 test were carried out for cohesive soils. Organic content test and consolidation test were carried out for peat soils. 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.

### 1.3.3 Previous Investigation

No foundation reports are available in the MTO GEOCRE library for this particular site. However, one foundation report from January 1966 related to the adjacent site on Hwy 129 and named "Soil Conditions and Foundations Proposed Nebskwashi River Bridge, Chapeau, Ontario" (WP # 102-65) is provided by MTO.

## 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 logs and stratigraphic sections are inferred from semi-continuous sampling, observations of drilling progress and results of Standard



**Penetration Tests.** These boundaries typically represent interpreted transitions from one soil type to another and should not be viewed 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 sand and gravel to gravelly sand fill underlain by native deposits of sand to silty sand layer followed by peat layer and sandy silt to sand layer. The subsurface conditions at the toe of the embankment (inlet and outlet) consist of native deposits of gravelly sand underlain by peat layer followed by silt to silty sand layer. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

The results of the laboratory testing were plotted on the individual record of borehole sheets and also summarized on Figure 1 to 6 inclusive all of which are appended to this report.

The following are the detailed description of soil strata encountered.

#### **1.4.1 Fill: Sand and Gravel to Gravelly Sand**

Sand and gravel to gravelly sand layer was encountered at the road embankment below the 76 mm (BH-3) to 300 mm (BH-4) thick layer of asphalt in BH-1, BH-2, BH-3 and BH-4. The thickness of this layer ranged from 3.0 m to 3.3 m extending from Elevation 429.8 to Elevation 426.9 m.

The composition of this fill layer is sand and gravel with occasional cobbles, and trace to few silt and clay size particles. The material is brown to greyish brown in color, and moist to wet. The SPT “N” values within this layer typically ranged from 8 to 33 blows per 300 mm penetration, suggesting loose to compact relative density. One SPT “N” value of 60 blows per 50 mm penetration was encountered at BH-4.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture Content:

- 1.7% to 16.2%

Grain Size Distribution:

- 21% to 62% gravel;
- 34% to 72% sand; and
- 4% to 7% silt and clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 1 in Appendix D.

#### **1.4.2 Gravelly Sand**

A layer of gravelly sand was encountered below the 0.6 m to 1.2 m high water table in BH-5 and BH-6. The thickness of this layer is approximately 0.8 m extending from Elevation 426.5 m to Elevation 425.8 m.



The composition of this layer is sand and gravel, trace silt and trace wood pieces. The material is brown to grey in color, and wet. The SPT "N" values within this layer ranged from 3 to 9 blows per 300 mm penetration, suggesting very loose to loose relative density.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture Content:

- 11.8% to 18%

Grain Size Distribution:

- 31 % gravel,
- 68% sand, and
- 1% silt and clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 2 in Appendix D.

### **1.4.3 Sand to Silty Sand**

A layer of sand to sandy silt was encountered below the sand and gravel to gravelly sand fill in BH-1, BH-2, BH-3 and BH-4. The thickness of this layer ranged from 2.0 m 3.3 m extending from Elevation 426.9 m to Elevation 423.3 m.

The composition of this layer is sand and silt, trace gravel and occasional cobbles. The material is brown to grey in color, and wet. The SPT "N" values within this layer ranged from 1 to 26 blows per 300 mm penetration, suggesting very loose to compact relative density.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture content:

- 12.6% to 17.8%

Grain Size Distribution:

- 2% to 3% gravel,
- 68% to 90% sand, and
- 8% to 29% silt and clay

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

#### 1.4.4 Peat

A layer of peat was encountered below the sand and silty sand layer in BH-1, BH-2, BH-3 and BH-4 and below gravelly sand layer in BH-5 and BH-6. The thickness of this layer ranged from 0.9 m to 2.0 m below the embankment extending from Elevation 424.7 m to Elevation 422.2 m and at inlet and outlet side the thickness of this layer ranged from 2.4 m to 2.7 m extending from Elevation 425.8 m to Elevation 423.0 m.

The peat consisted mostly of organics, some silt, and some sand, trace gravel and trace clay. The material is dark brown in color, and wet to saturate. The SPT "N" values within this layer measured below the embankment ranged from 4 to 7 blows per 300 mm penetration, suggesting very loose to loose relative density and the SPT "N" values within this layer measured at inlet and outlet side ranged from 1 to 3 blows per 300 mm penetration, suggesting very loose relative density.

Laboratory testing performed on selected samples consisted of moisture content, grain size distribution tests, organics content test and one consolidation test. The test results are as follows:

Moisture Content:

- 55.2% to 381.5%

Grain Size Distribution:

- 0% to 20% gravel
- 32% to 62% sand
- 35% to 65% silt and
- 1% to 3% clay.

Organic Content Test:

BH No.	Sample No.	Moisture Content (%)	Organic content (%)
BH-1	SS-8	229.2	37.0
BH-3	SS-8	238.4	34.3
BH-4	TW-9	323.8	55.2
BH-5	SS-3	219.4	32.2
BH-6	SS-4	238.1	28.6

One Consolidation Test was performed on Shelby Tube sample (BH-4, TW-9) obtained underneath the embankment and the results are as follows:

- Moisture Content = 323.8 %
- Initial Void Ratio ( $e_0$ ) = 5.318
- Pre-consolidation pressure ( $p'_c$ ) = 115 kPa
- Recompression Index ( $C_r$ ) = 0.459

- Compression Index ( $C_c$ ) = 2.78

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests (Figure 4) and consolidation tests are also provided in Appendix D.

#### 1.4.5 Clayey Silt

A layer of clayey silt was encountered below the peat layer in BH-3 and BH-4. The thickness of this layer ranged from 0.3 m to 0.6 m, extending from Elevation 422.9 m to Elevation 422.3 m.

The composition of this layer is silt and clay, trace peat and trace sand. The material is brown in color, and wet. The SPT "N" values within this layer ranged from 3 to 6 blows per 300 mm penetration, suggesting soft to firm in consistency.

Laboratory testing performed on selected samples consisted of moisture content. The test results are as follows:

Moisture content:

- 34.6% to 50.6%

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

#### 1.4.6 Sandy Silt to Sand

A layer of sandy silt to sand was encountered below the peat layer in BH-1, BH-2, BH-5 and BH-6 and below the clayey silt layer in BH-3 and BH-4. The thickness of this layer ranged from 1.9 m to 12.8 m extending from Elevation 423.3 m to Elevation 409.4 m. All boreholes are terminated within this layer after reaching desire depth of investigation.

The composition of this layer is mainly sand and silt, trace peat, trace to some gravel, and trace clay and occasional cobbles. The material is brown to grey in color, and wet. The SPT "N" values within this layer ranged from 2 to 28 blows per 300 mm penetration, suggesting very loose to compact relative density.

Laboratory testing performed on selected samples consisted of moisture content, grain size distribution tests and Atterberg Limit tests. The test results are as follows:

Moisture content:

- 11.6% to 77.4%

Grain Size Distribution:

- 0% to 22% gravel,
- 10% to 97% sand, and
- 3% to 86% silt and
- 1% to 4% clay

#### Atterberg Limits:

- Selected samples (BH-2-SS9, BH-3-SS10 and BH-5-SS5) found non plastic

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

## 1.5 Ground Water Conditions

Information of groundwater levels at the site was obtained by measuring the water levels in the open boreholes (BH-1 and BH-4) after completion of drilling. The groundwater levels encountered in the boreholes are shown on the borehole logs. Since the wash boring method was used for drilling of BH-2 and BH-3, an accurate groundwater level at these holes was not able to be measured in the open holes at the time of drilling operations. BH-5 and BH-6 were drilled through the creek using barge and at the time of investigation (April 2015) the water level at BH-5 and BH-6 were 0.61 m and 1.24 m high at Elevation 427.2 m and 427.7 m respectively.

The water level measured at the time of investigation through the open boreholes (BH-1 and BH-4) was at Elevation 427.42 m and 427.36 m respectively. Water levels measured in open boreholes might not be stabilized due to short term observation. However, based on moisture content of the soil samples observed during drilling and measured subsequently in the lab, the inferred ground water level within the embankment was estimated to be at approximate Elevation of 427.7 m or slightly higher. This is in a good agreement with the water level observed in the culvert at the time of investigation which was at Elevation 427.74 m at the inlet and 427.60 m at the outlet.

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.

August 10, 2015

## 1.6 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 Report has been prepared by Silvana Micic, Ph.D., P.Eng. and Nimesh Tamrakar, M.Eng. and reviewed by TaeChul Kim, M.E.Sc., P.Eng. and Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was conducted by Nimesh Tamrakar, M.Eng.

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

Yours truly,

**exp Services Inc.**



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## **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.

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## **Appendix A – Photographs**



Photo 1. Facing west on Hwy 101 from the culvert alignment



Photo 2. Facing east on Hwy 101 from the culvert alignment





Photo 3. Facing south on inlet side of existing culvert



Photo 4. Facing north on outlet side of existing culvert





Photo 5. Outlet side of existing culvert facing south



Photo 6. Inlet side of existing culvert facing north





Photo 7. Embankment slope on south side (inlet) facing east



Photo 8. Embankment slope on north side (outlet) facing east





Photo 9. Barge with Portable Tripod



Photo 10. Washed away embankment slope on outlet side facing west





Photo 11. Washed away portion of embankment slope on outlet side



Photo 12. WBL roadway portion depressed on north-west half of embankment





Photo 13. Typical crack on roadway along the WBL facing west



Photo 14. Typical crack on roadway along the EBL facing west

## **Appendix B – Drawings**



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

Agreement No. 5013-E-0008  
Assignment No. 8  
WO 2015-11011

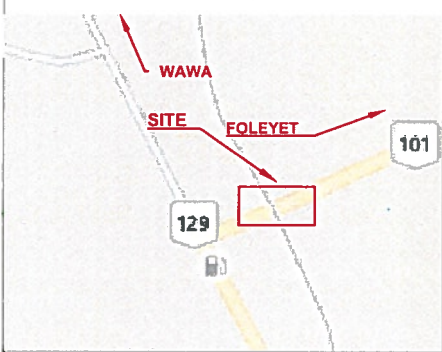


TRAPP CREEK CULVERT REPLACEMENT  
(HWY 101, Township of Chapleau)  
SITE PLAN/ BOREHOLE LOCATIONS

SHEET  
1

exp. Services Inc.

KEY PLAN



LEGEND

- Approximate Borehole Locations
- TBM (Temporary Bench Mark)
- Approximate Probe Borehole Locations

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
TBM	430.0	5297258	350412
BH 1	429.7	5297258	350442
BH 2	429.8	5297280	350468
BH 3	429.9	5297290	350482
BH 4	430.1	5297303	350494
BH 5	426.5	5297298	350452
BH 6	426.7	5297276	350474
PB 1	429.8	5297303	350476
PB 2	429.8	5297258	350460

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.

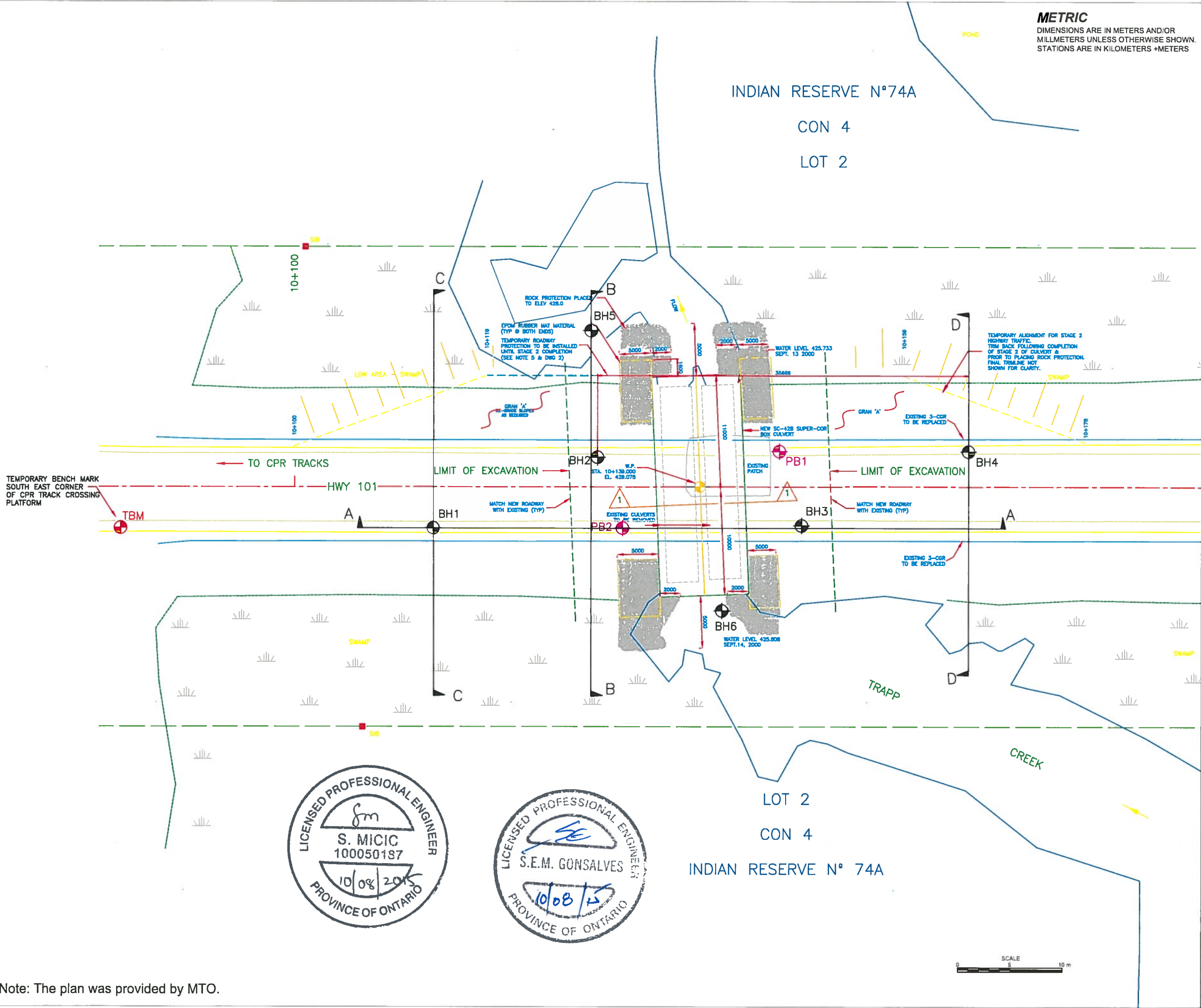
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section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

DATE	BY	DESCRIPTION
2015 07 17	SM	FINAL SUBMISSION
2015 05 29	SM	SUBMISSION FOR MTO REVIEW
GEOCRES NO. 410-13		
PROJECT NO. ADM-00028245-J0		
SUBMD SM	CHECKED SM	DATE 2015 07 17
DRAWN NT	CHECKED SG	APPROVED DWG. 01

INDIAN RESERVE N°74A

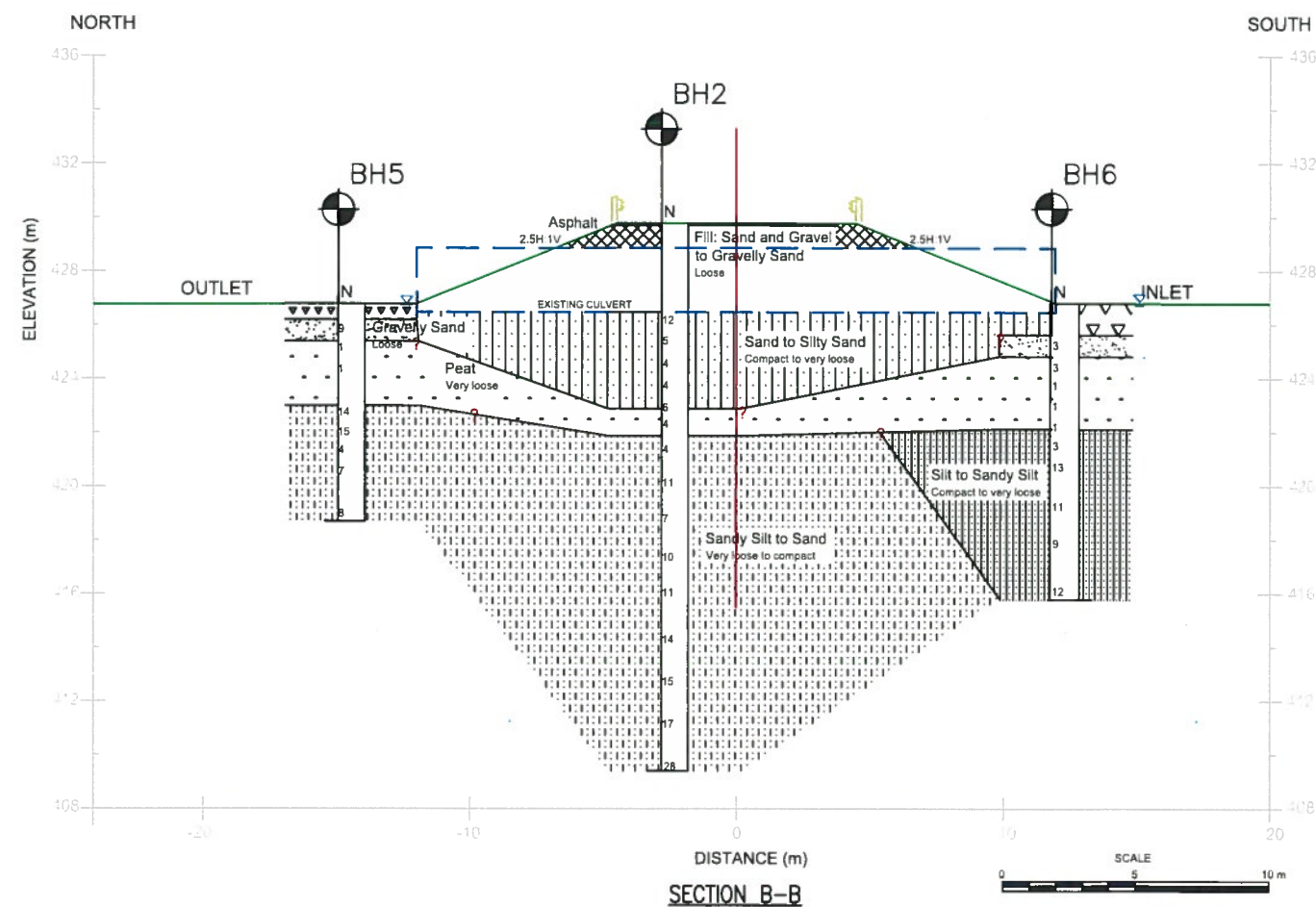
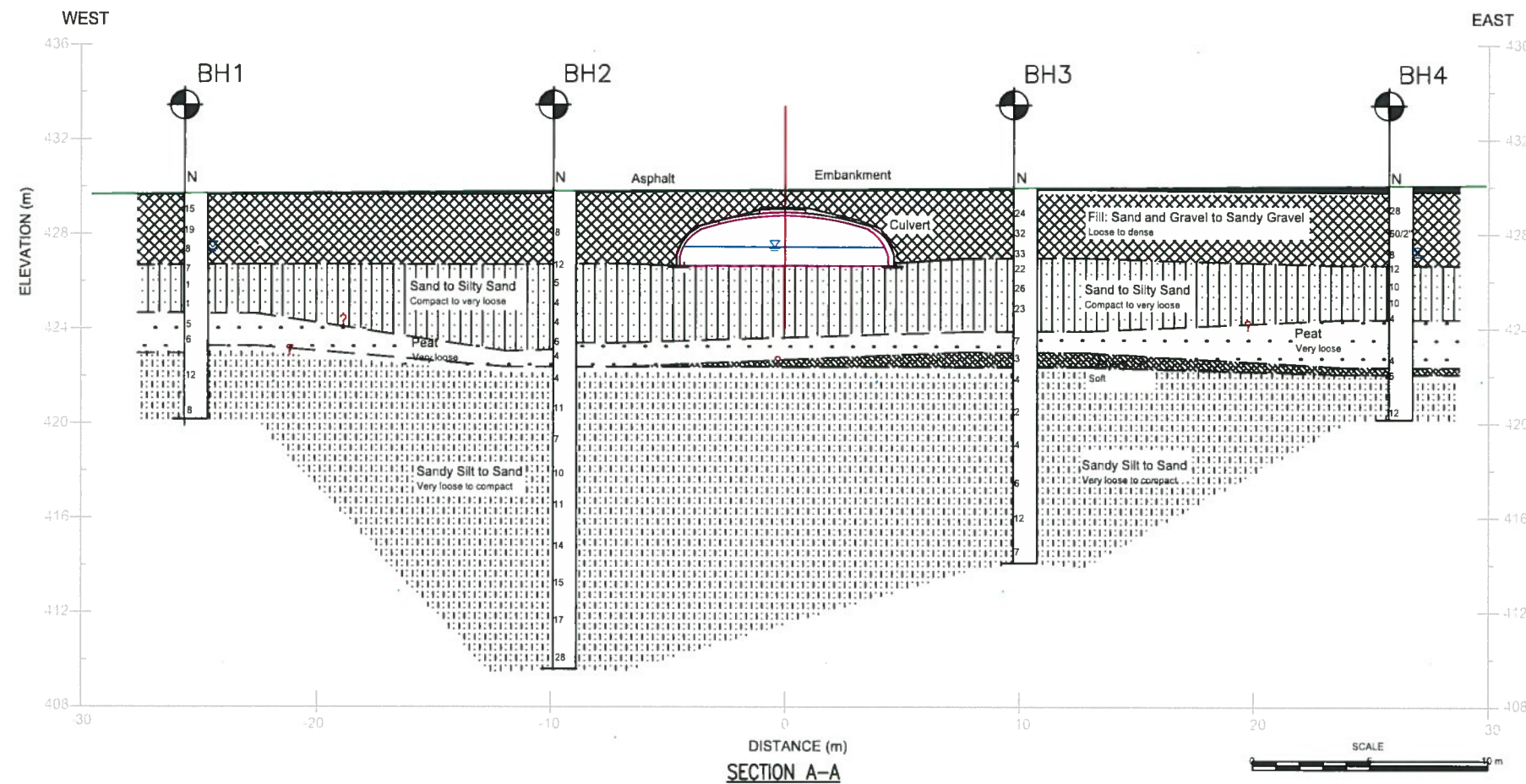
CON 4

LOT 2



Note: The plan was provided by MTO.





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

Agreement No. 5013-E-0008  
Assignment No. 8  
WO 2015-11011



**TRAPP CREEK CULVERT REPLACEMENT**  
(HWY 101, Township of Chapleau)

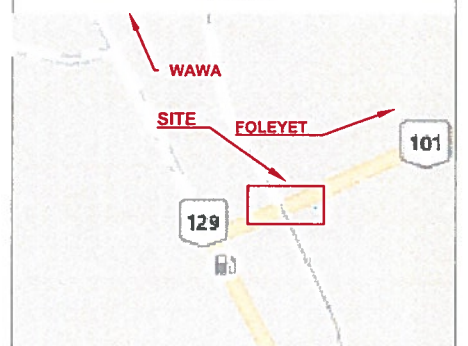
**SOIL STRATA**

SHEET  
2



exp Services Inc.

KEY PLAN



LEGEND

- Approximate Borehole Locations
- Standard Penetration Test (Blows/0.3 m)
- Water Level

SOIL STRATA SYMBOLS

- FILL
- SAND TO SILTY SAND
- PEAT
- SANDY SILT TO SAND
- WATER
- CLAYEY SILT
- GRAVELLY SAND
- SILT TO SANDY SILT
- ASPHALT

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
TBM	430.00	5297258	350412
BH 1	429.71	5297258	350442
BH 2	429.80	5297280	350468
BH 3	429.88	5297290	350482
BH 4	430.13	5297303	350494
BH 5	427.15	5297298	350452
BH 6	428.07	5297276	350474

NOTE

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2015.07.17	SM	FINAL SUBMISSION			
2015.05.29	SM	SUBMISSION FOR MTO REVIEW			
DATE	BY	DESCRIPTION			
		GEOCRES NO. 410-13			
		PROJECT NO. ADM-00028245-J0			
SUBM'D	SM	CHECKED	SM	DATE	2015.07.17
DRAWN	SA	CHECKED	SG	APPROVED	DWG. 02

Note: The plan was provided by MTO.



METRIC  
DIMENSIONS ARE IN METERS AND/OR  
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STATIONS ARE IN KILOMETERS +METERS

Agreement No. 5013-E-0008  
Assignment No. 8  
WO 2015-11011

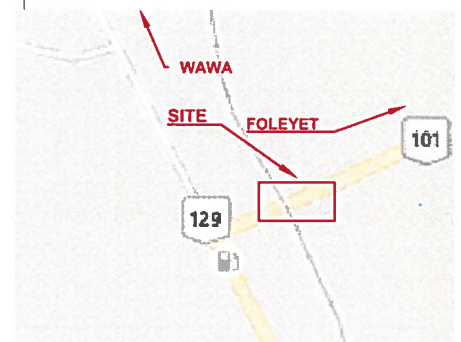


TRAPP CREEK CULVERT REPLACEMENT  
(HWY 101, Township of Chapleau)  
**SOIL STRATA**

SHEET  
3

exp. Services Inc.

KEY PLAN



LEGEND

- Approximate Borehole Locations
- Standard Penetration Test (Blows/0.3 m)
- Water Level

SOIL STRATA SYMBOLS

- FILL
- CLAYEY SILT
- SAND TO SILTY SAND
- GRAVELLY SAND
- PEAT
- SILT TO SANDY SILT
- SANDY SILT TO SAND
- ASPHALT
- WATER

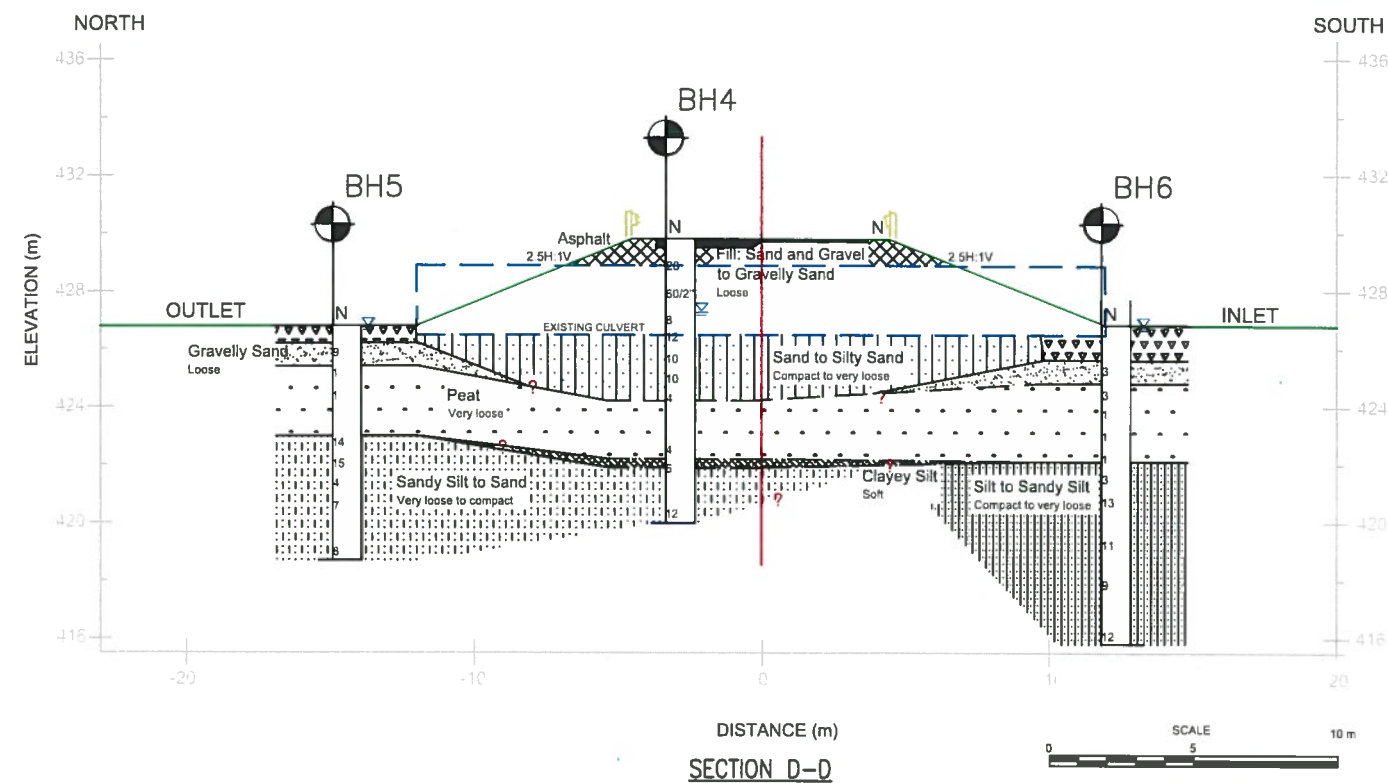
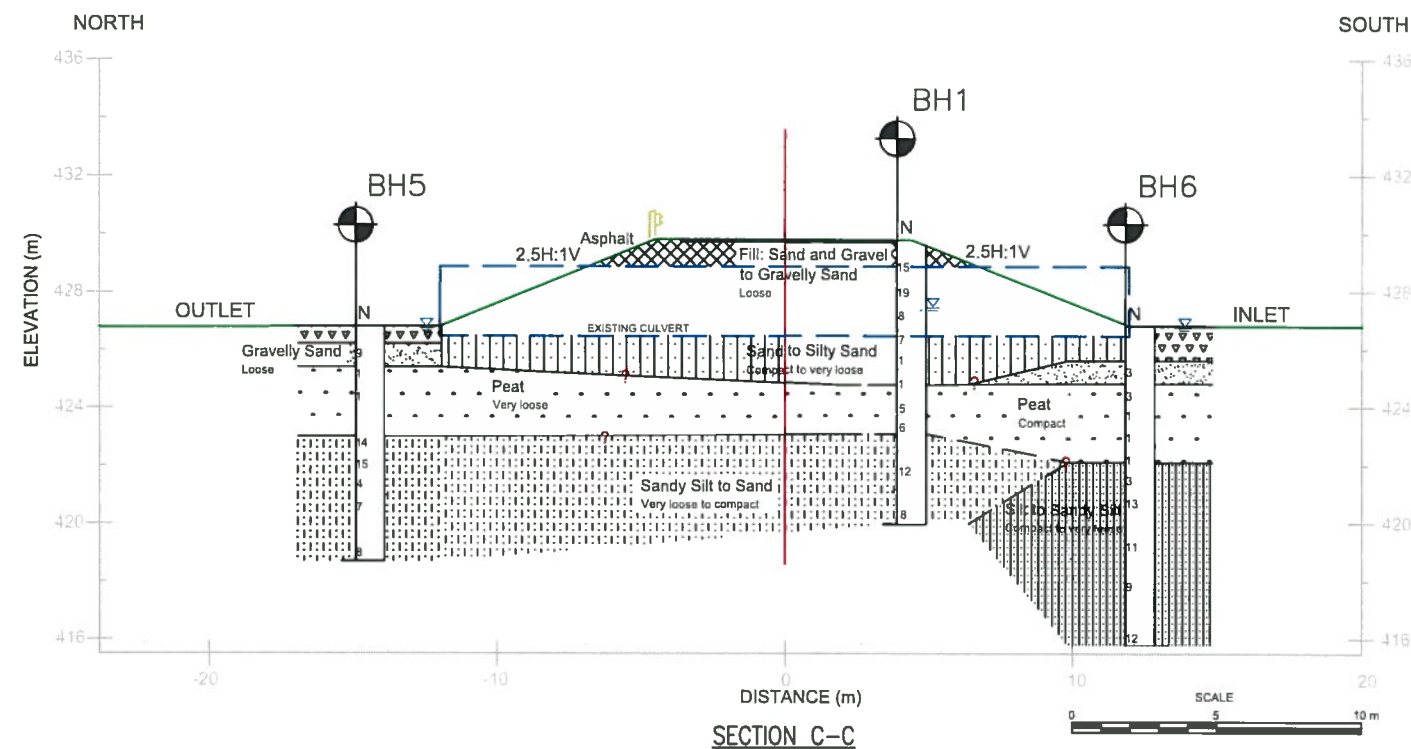
BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
TBM	430.00	5297258	350412
BH 1	429.71	5297258	350442
BH 2	428.80	5297280	350468
BH 3	429.88	5297290	350482
BH 4	430.13	5297303	350494
BH 5	427.15	5297298	350452
BH 6	428.07	5297276	350474

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 Contract 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. Downview 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.

2015.07.17	SM	FINAL SUBMISSION
2015.05.29	SM	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
GEOCRE NO. 410-13		
PROJECT NO. ADM-00028245-J0		
SUBM'D SM	CHECKED SM	DATE 2015.07.17
DRAWN SA	CHECKED SG	APPROVED DWG. 03



Note: The plan was provided by MTO.



## **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.

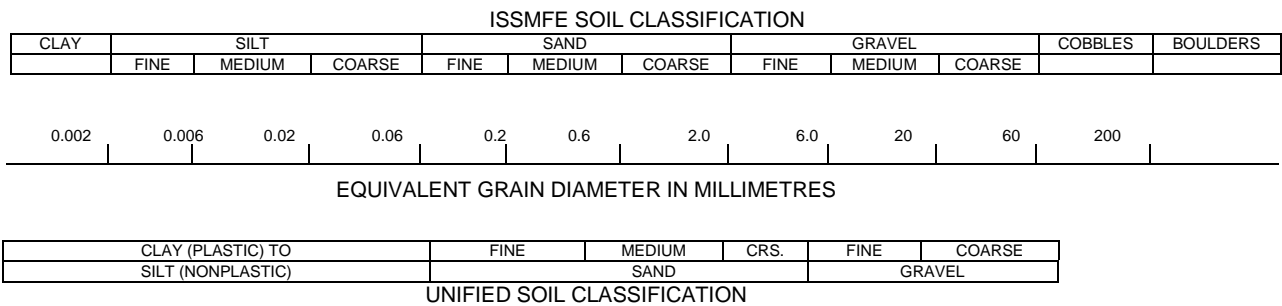
*Seam:* a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

*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 the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). 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.



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	$5 \leq Pp \leq 10\%$
Little	$15 \leq Pp \leq 25\%$
Some	$30 \leq Pp \leq 45\%$
Mostly	$50 \leq Pp \leq 100\%$

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	$5 \leq N < 10$
Compact	$10 \leq N < 30$
Dense	$30 \leq N < 50$
Very Dense	$50 \leq N$

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:

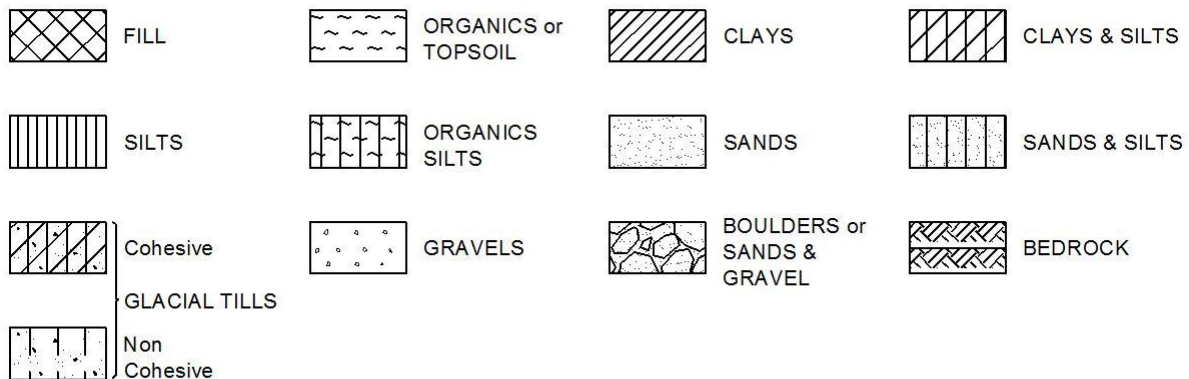
Table c: Consistency of Cohesive Soil

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



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

## 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
$\sigma$	kPa	Total normal stress
$\sigma'$	kPa	Effective normal stress
$\tau$	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
$\varepsilon$	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
$\mu$	1	Coefficient of friction

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	Coefficient of volume change
$c_c$	1	Compression index
$c_s$	1	Swelling index
$c_r$	1	Recompression index
$c_v$	$\text{m}^2/\text{s}$	Coefficient of consolidation
H	m	Drainage path
$T_v$	1	Time factor
U	%	Degree of consolidation
$\sigma'_{v0}$	kPa	Effective overburden pressure
$\sigma'_p$	kPa	Preconsolidation pressure
$\tau_f$	kPa	Shear strength
$c'$	kPa	Effective cohesion intercept
$\phi'$	$-\circ$	Effective angle of internal friction
$c_u$	kPa	Apparent cohesion intercept
$\phi_u$	$-\circ$	Apparent angle of internal friction
$\tau_R$	kPa	Residual shear strength
$\tau_r$	kPa	Remoulded shear strength
$S_t$	1	Sensitivity = $c_u/\tau_r$

### PHYSICAL PROPERTIES OF SOIL

$P_s$	$\text{kg}/\text{m}^3$	Density of solid particles
$\gamma_s$	$\text{kN}/\text{m}^3$	Unit weight of solid particles
$\rho_w$	$\text{kg}/\text{m}^3$	Density of water
$\gamma_w$	$\text{kN}/\text{m}^3$	Unit weight of water
$\rho$	$\text{kg}/\text{m}^3$	Density of soil
$\gamma$	$\text{kN}/\text{m}^3$	Unit weight of soil
$\rho_d$	$\text{kg}/\text{m}^3$	Density of dry soil
$\gamma_d$	$\text{kN}/\text{m}^3$	Unit weight of dry soil
$\rho_{sat}$	$\text{kg}/\text{m}^3$	Density of saturated soil
$\gamma_{sat}$	$\text{kN}/\text{m}^3$	Unit weight of saturated soil
$\rho'$	$\text{kg}/\text{m}^3$	Density of submerged soil
$\gamma'$	$\text{kN}/\text{m}^3$	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	$\text{m}^3/\text{s}$	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	$\text{kN}/\text{m}^3$	Seepage force

Brampton, Ontario

## RECORD OF BOREHOLE No BH-1

1 OF 1

METRIC

W. P. WO 2015-11011 LOCATION Chapleau, Sault Ste. Marie are, ON, MTM Z13 350477.15E 5297280.17N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE CME-55X, Hollow stem auger, not cased COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 5297280.17N DATE 2015/04/28 - 2015/04/28 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
429.7	Ground Surface																
429.6	ASPHALT 85 mm thickness		1	AS													
	FILL: SAND AND GRAVEL TO GRAVELLY SAND(GW-SW) trace silt, occasional cobbles, brown to greyish brown, moist to wet, compact to loose		2	SS	15												
			3	SS	19												
	- Becoming wet, loose		4	SS	8												
426.7																	
3.0	SAND TO SILTY SAND(SW-SM) trace gravel, trace clay, greyish brown to grey, wet, dilatant, loose to very loose		5	SS	7												
			6	SS	1												
			7	SS	1												
424.7																	
5.0	PEAT silty sand, with roots and rootlets, trace clay, dark brown, wet, very loose to compact		8	SS	5												
			9	SS	6												
423.0																	
6.7	SANDY SILT(SM) Greyish brown to grey, wet, dilatant, tr gravel, tr clay, loose to very loose		10	SS	12												
			11	SS	8												
420.0																	
9.8	END OF BOREHOLE																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. Groundwater level was measured in open hole.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

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

Brampton, Ontario

## RECORD OF BOREHOLE No BH-2

1 OF 2

METRIC

W. P. WO 2015-11011 LOCATION Chapleau, Sault Ste. Marie are, ON, MTM Z13 E N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE CME-55X, Diamond drill, Cased hole COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 52972 DATE 2015/04/28 - 2015/04/28 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa										
								○ UNCONFINED		+ FIELD VANE								
								× QUICK TRIAXIAL		LAB VANE								
								WATER CONTENT (%)										
								20	40	60	80	100	10	20	30			
429.8	Ground Surface																	
429.7	ASPHALT 85 mm thickness		1	AS									○					
	FILL: SAND AND GRAVEL TO GRAVELLY SAND(GW-SW) trace silt, occasional cobbles, brown , moist , loose		2	SS	8								○					22 71 (7)
426.8	- Wash bore from 3.05 m		3	SS	12									○				
3.0	SAND TO SILTY SAND(SW-SM) trace gravel, occasional cobbles, greyish brown to grey, wet, compact to very loose		4	SS	5									○				4 87 (9)
			5	SS	4									○				
			6	SS	4									○				
			7	SS	6									○				
423.3	PEAT sandy silt,with roots and rootlets, trace clay, dark brown, wet, very loose		8	SS	4											69.2		
6.6																89.2		
422.2	SANDY SILT TO SAND(SM-SW) some silt, trace peat, trace clay, dark brown to grey, wet, very loose to compact		9	SS	4												77.4	
7.6																		0 31 68 1 Non Plastic
			10	SS	11										○			
			11	SS	7										○			0 51 47 2
			12	SS	10										○			
			13	SS	11										○			
			14	SS	14										○			
	- becoming sand, some silt, brownish grey, wet compact		15	SS	15										○			1 84 (15)
			16	SS	17										○			
			17	SS	28										○			
409.4	- becoming trace gravel, occasional cobbles																	
20.4	END OF BOREHOLE																	

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

Brampton, Ontario

## RECORD OF BOREHOLE No BH-2

2 OF 2

METRIC

W. P. WO 2015-11011 LOCATION Chapleau, Sault Ste. Marie are, ON, MTM Z13 E N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE CME-55X, Diamond drill, Cased hole COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 52972 DATE 2015/04/28 - 2015/04/28 CHECKED BY SM

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
<b>NOTES:</b> 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured since washboring technique was used to advance borehole																	

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

Brampton, Ontario

## RECORD OF BOREHOLE No BH-3

1 OF 1

METRIC

W. P. WO 2015-11011 LOCATION Chapeau, Sault Ste. Marie are, ON, MTM Z13 E N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE CME-55X, Diamond drill, Cased hole COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 52972 DATE 2015/04/27 - 2015/04/27 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa											
								○ UNCONFINED		+ FIELD VANE									
								× QUICK TRIAXIAL		LAB VANE									
								WATER CONTENT (%)											
								20	40	60	80	100	10	20	30				
429.9	Ground Surface																		
429.8	ASPHALT 76 mm thickness		1	AS													44 50 (6)		
	FILL: SAND AND GRAVEL TO SANDY GRAVEL(GW) trace silt, occasional cobbles, brown , moist to wet, compact to dense		2	SS	24														
			3	SS	32														
	- Wash bore from 2.28 m		4	SS	33												62 34 (4)		
426.8																			
3.0	SAND TO SILTY SAND(SW-SM) trace gravel, occassional cobbles, greyish brown to grey, wet, compact		5	SS	22														
			6	SS	26														
			7	SS	23														
423.8																			
6.1	PEAT sandy silt, with roots and rootlets, trace clay, dark brown, wet, compact		8	SS	7												0 32 66 2 Organic Content = 34 %		
422.9																			
7.0	CLAYEY SILT(ML) trace peat, , trace sand, brown, wet, soft		9	SS	3														
422.3																			
7.6	SANDY SILT TO SAND(SM-SW) some silt, trace gravel, trace clay, greyish brown to grey, wet, very loose to compact		10	SS	4												0 43 56 1 Non Plastic		
			11	SS	2														
			12	SS	4														
			13	SS	6												0 97 (3)		
			14	SS	12														
	- becoming gravelly sand		15	SS	7												21 78 (1)		
414.0	END OF BOREHOLE																		
15.9	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured since washboring technique was used to advance borehole																		

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



Brampton, Ontario

## RECORD OF BOREHOLE No BH-4

1 OF 1

METRIC

W. P. WO 2015-11011 LOCATION Chapleau, Sault Ste. Marie are, ON, MTM Z13 E N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE CME-55X, Hollow stem auger, not cased COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 52972 DATE 2015/04/29 - 2015/04/29 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
430.1	Ground Surface																
429.8	ASPHALT 300 mm thickness						430										
0.3	FILL: SAND AND GRAVEL TO GRAVELLY SAND(GW-SW) asphalt mix, trace silt, trace cobbles, black/brown to brown, moist to wet, loose to compact - Asphalt mix up to 1.55m - hit cobbles/ boulder, grab auger sample		1	AS			429										36 58 (6)
			2	SS	28		428										21 72 (7)
			3	SS	60/2"		427										
			4	SS	8		426										
426.9	SAND TO SILTY SAND(SW-SM) trace gravel, grey, wet, compact		5	SS	12		425										2 90 (8)
3.3			6	SS	10		424										
			7	SS	10		423										
424.5	PEAT sandy silt, with roots and rootlets, trace clay, dark brown, wet, very loose		8	SS	4		422										
5.6			9	TW			421										
			10	SS	4												
422.5	CLAYEY SILT(ML) trace peat, , trace sand, brown, wet, soft		11	SS	6												
422.0	SANDY SILT TO SAND(SM-SW) trace gravel, trace clay, grey, wet, loose to compact																
7.9																	
420.4	- becoming brown gravelly sand		12	SS	12												22 74 (4)
9.8	END OF BOREHOLE																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. Groundwater level was measured in open hole.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

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

Brampton, Ontario

1 OF 1

**METRIC**

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa					w <sub>p</sub>	w	w <sub>L</sub>		
								○ UNCONFINED	+ FIELD VANE	×	QUICK TRIAXIAL	LAB VANE					
							20	40	60	80	100		10	20	30		GR SA SI CL
427.2	Water Surface																
426.5	Water	△															
0.6	GRAVELLY SAND (SW) trace wood pieces, grey, wet, loose	○	1	SS	9									○			
425.8		○															
1.4	PEAT sand and sit, some gravel, trace clay, with roots and rootlets, brown, saturated to wet, very loose	⋈	2	SS	1											381.5	
		⋈														141.2	
		⋈	3	SS	1												
		⋈														269.2	
	- Attempted Shelby, no recovery, grab split spoon sample	⋈	4	GS													
423.3		⋈															
3.8	SANDY SILT (ML) trace clay, grey, wet, dilatant, compact to very loose	⋈	5	SS	14												
		⋈	6	SS	15									○			
		⋈															
	- becoming silt, dilatant	⋈	7	SS	4									○			
		⋈															
		⋈	8	SS	7									○			
		⋈															
419.1		⋈	9	SS	8									○			

**NOTES:**

1. This drawing is to be read with the subject report and project numbers as presented above.
2. Interpretation assistance by exp is required before used by others.
3. Groundwater level was measured in open hole.

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

Brampton, Ontario

## RECORD OF BOREHOLE No BH-6

1 OF 1

METRIC

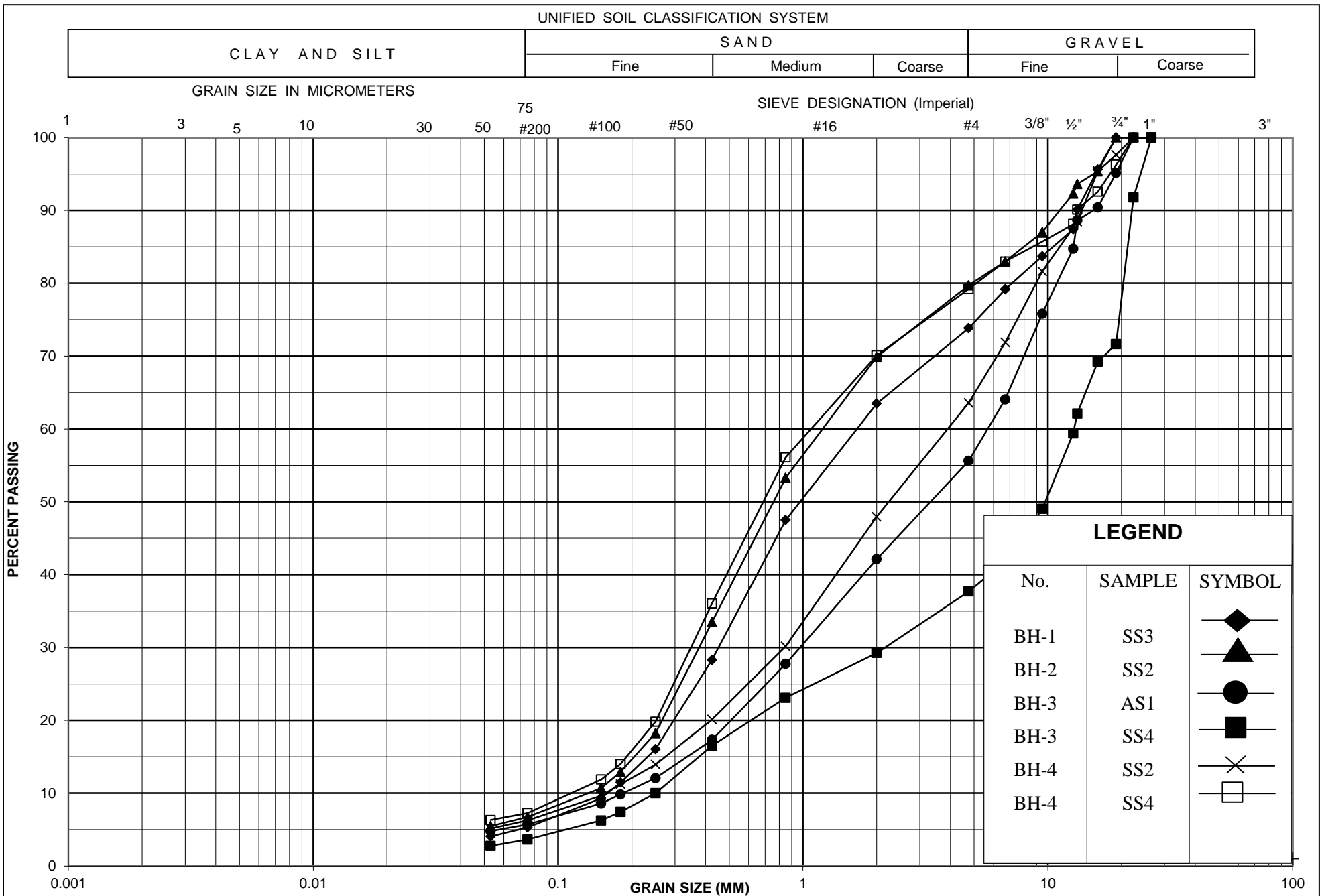
W. P. WO 2015-11011 LOCATION Chapleau, Sault Ste. Marie are, ON, MTM Z13 E N ORIGINATED BY NT  
 DIST HWY 101 BOREHOLE TYPE Portable Tripod, Wash boring, Cased hole COMPILED BY NT  
 DATUM BM ELEV. 430.5 m MTM Z13 350411.87E 52972 DATE 2015/04/30 - 2015/04/30 CHECKED BY SM

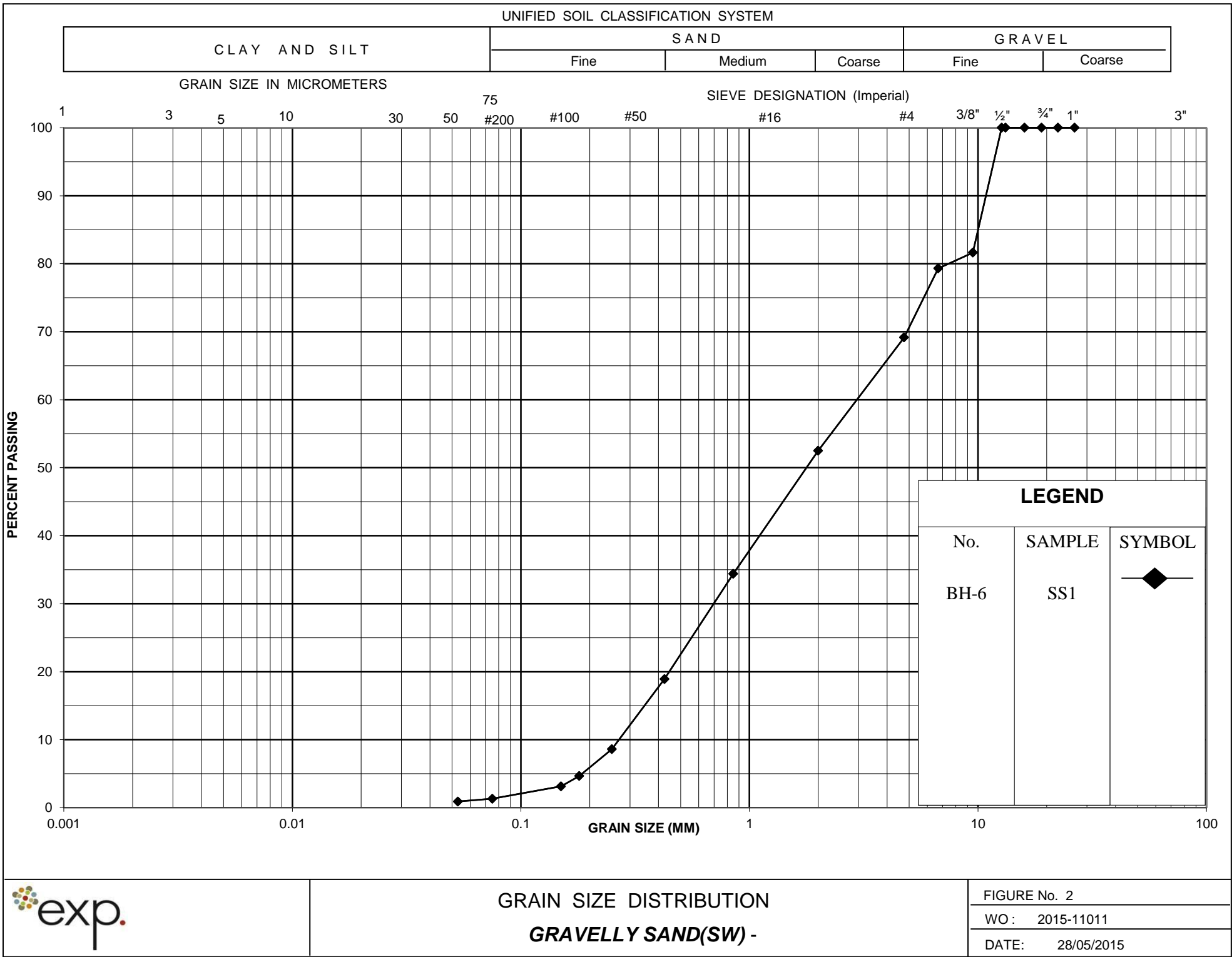
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
427.7	Water Surface	△				▽											
	Water	△					427										
426.5		△															
1.2	GRAVELLY SAND (SW) brown/grey, wet, loose	○	1	SS	3		426							○			31 68 (1)
425.8		○															
2.0	PEAT sand and sit, trace clay, with roots and rootlets, dark brown, wet, very loose	⋈	2	SS	3		425									119.2	
		⋈														55.2	
		⋈	3	SS	1		424									174.7	
		⋈														175.2	
		⋈	4	SS	1		423									42.1	0 57 42 1 Organic Content = 27%
423.0		⋈															
4.7	SILT TO SILTY SAND (ML) trace clay, grey, wet, dilatant, compact to very loose	⋈	5	SS	1		422										
		⋈															
		⋈	6	SS	3		421										
		⋈															
		⋈	7	SS	13		420							○			0 10 86 4
		⋈															
	- becoming brownish grey, silty sand	⋈	8	SS	11		419							○			
		⋈															
		⋈	9	SS	9		418							○			
		⋈															
		⋈					417							○			
416.8		⋈	10	SS	12												
11.0	END OF BOREHOLE																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. Water level above the ground surface																

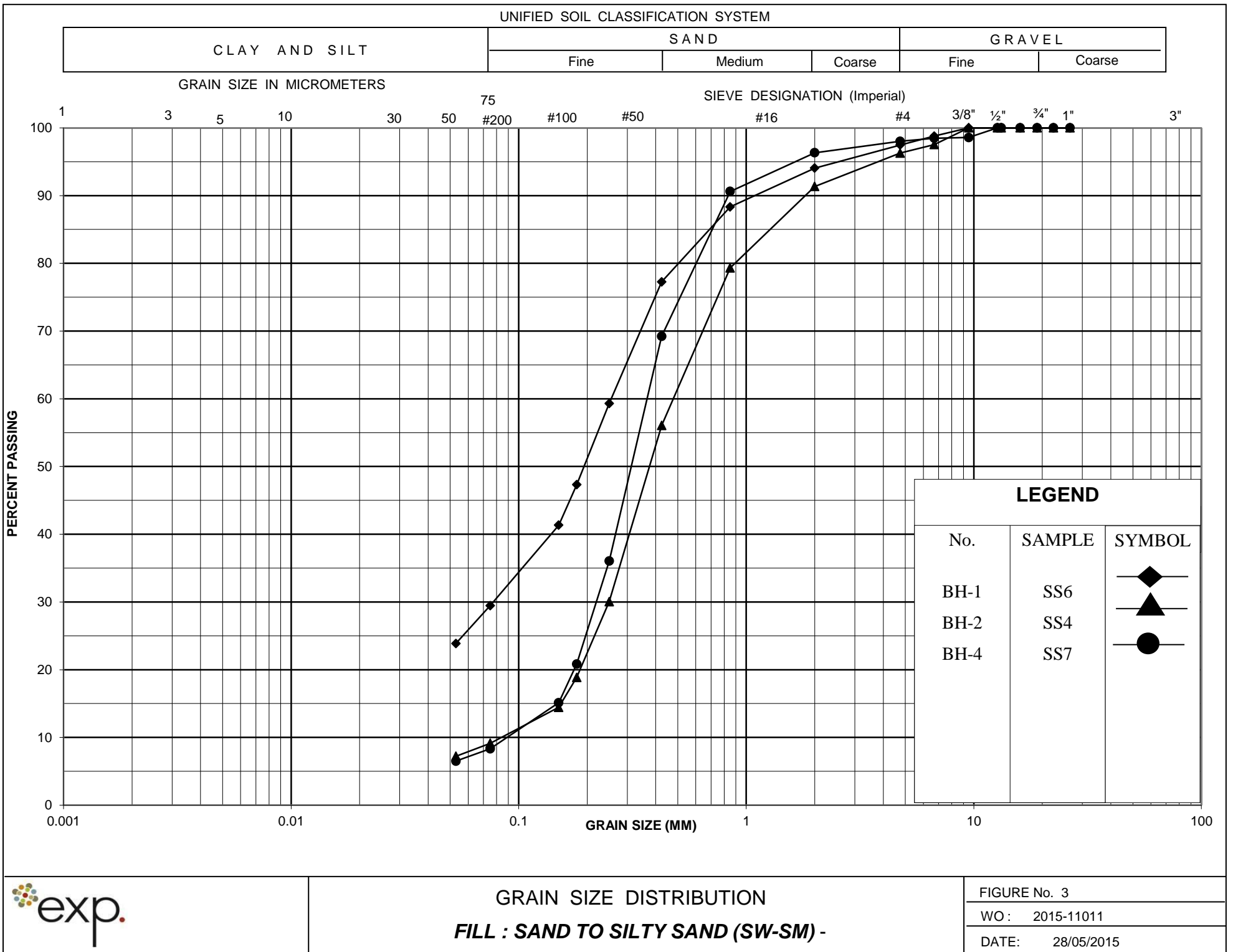
OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 8- BH LOGS.GPJ ONTARIO MOT.GDT 6/10/15

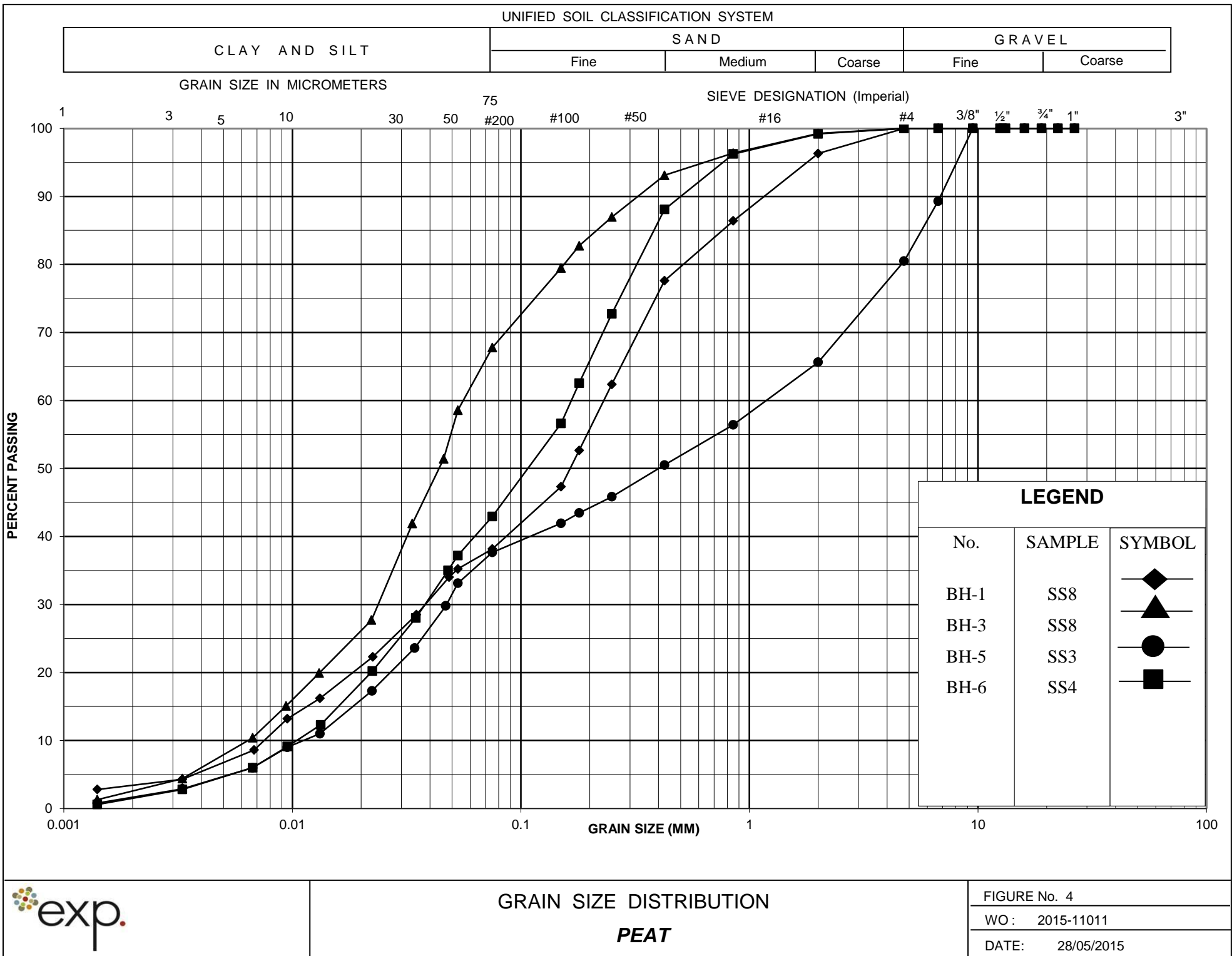
+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

## **Appendix D – Laboratory Data**

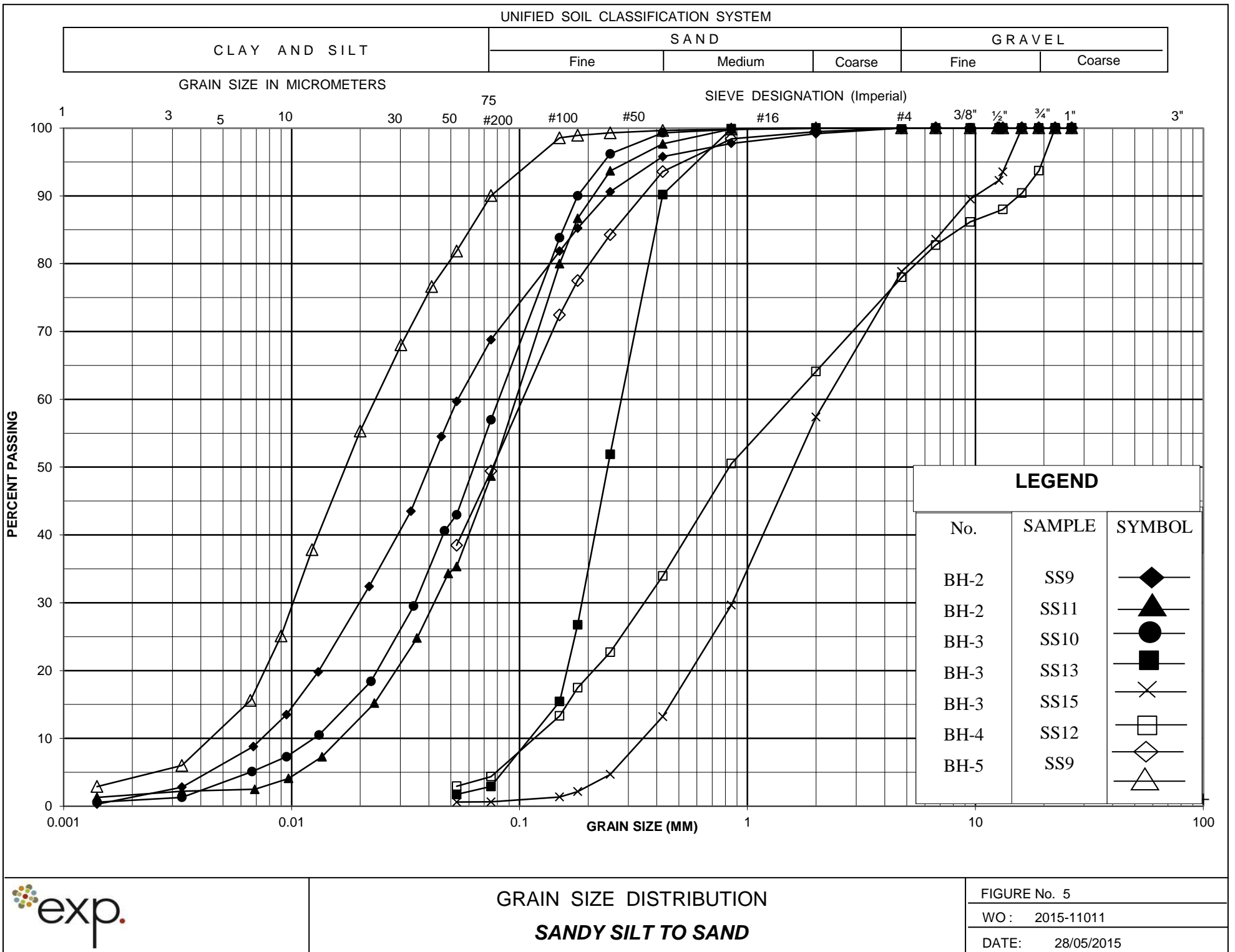




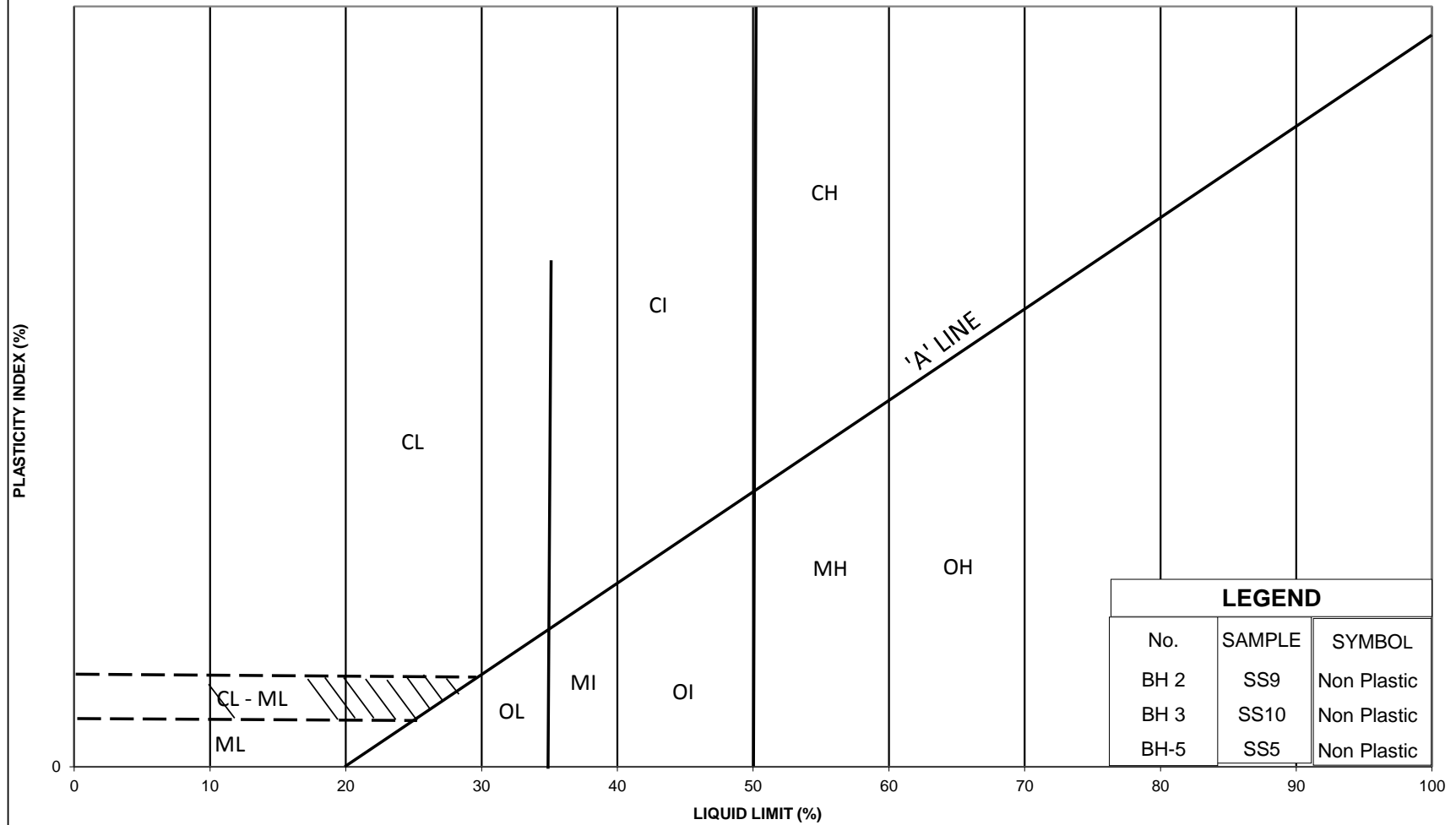








# Trapp Creek Culvert, Hwy 101, Chapleau





exp Services Inc.

1595 Clark Boulevard  
Brampton, ON  
L6T 4V1  
Tel.: 905-793-9800  
Fax: 905-793-0641

**Consolidation Test  
Summary Data Sheet  
(ASTM: D 2435-96)**

Project No.: adm-00028245-j0 adm-100Project Name: TRAPP CREEK CULVERTBorehole No. BH 4

Client Job No.: \_\_\_\_\_

Sample No. TW-9

Sample Location: \_\_\_\_\_

Depth: 6.1 - 6.9mSample Description: Amorphous Black Peat

Water Content Determination	Before Test		After Test
	Specimen	Trimming	Specimen
Wt. of wet sample + Ring (tare) - g	146.38	68.79	126.31
Wt. of dry sample + Ring (tare) - g	96.17	17.94	96.17
Wt. of water ( $W_w$ ) - g	50.21	50.85	30.14
Wt. of Ring - g	78.02	1.95	78.02
Wt. of dry soil ( $W_s$ ) - g	18.15	15.99	18.15
Water Content ( $W$ ) - %	276.6	318.0	166.1
Average ( $W$ ) - %	297.3		166.1

**Apparatus:**

Machine No.	1
Cell No.	1
Ring No.	1
Diameter of Ring (in) :	2.5
Height of Ring - $H_1$ (in):	0.75
Area of Ring ( $\text{in}^2$ ) :	4.9087

Load Factor: 

1.55
500

 lb. on Hanger  
lb/ft<sup>2</sup> on Sample

**Test Data**

Initial Dial Reading (in) :	0.4585
Final Dial Reading (in) :	0.1579
Difference (in) :	0.3006
Machine Correction 0 to 0 (in) :	0.0056
Change in Ht., specimen, $\Delta H$ (in) :	0.2950
Final Ht. of specimen, $H_2 = H_1 - \Delta H$ :	0.4550

Spec. Gr. of Solids ( $G$ ) :	(estimated)	1.9
Spec. Gr. of Solids ( $G$ ) :	(determined)	
Initial Height of Specimen, $H_1$ (in):		0.7500

Calculations	Before Test	After Test
Height of Specimen, $H_1, H_2$ (in):	0.7500	0.4550
Ht of Solids, $H_s$ (in):	0.1187	0.1187
Ht. of Voids, $H_v$ (in):	0.6313	0.3363
Ht. of Water, $H_w$ (in):	0.6240	0.3745
Saturation, $S_r$ (%):	98.8	100.0
Void ratio ( $e$ ):	5.318	2.833

Comments:

Reported By: Willie RodychDate Reported: 20/05/2015



exp Services Inc.

1595 Clark Boulevard

Brampton, ON

L6T 4V1

Tel.: 905-793-9800

Fax: 905-793-0641

**Consolidation Test  
Determination of Void Ratio  
(ASTM: D 2435-96)**

Project No. adm-00028245-j0 adm-100  
 Project Name Foundation Engineering  
 Client Job No.:   
 Sample No. BH 4 TW-9 6.1 - 6.9m  
 Sample Location

Height of Solids (in):	0.119
Initial Height of Voids (in):	0.631
Initial Void Ratio ( $e_o$ ):	5.318
Initial Dial Reading:	0.459

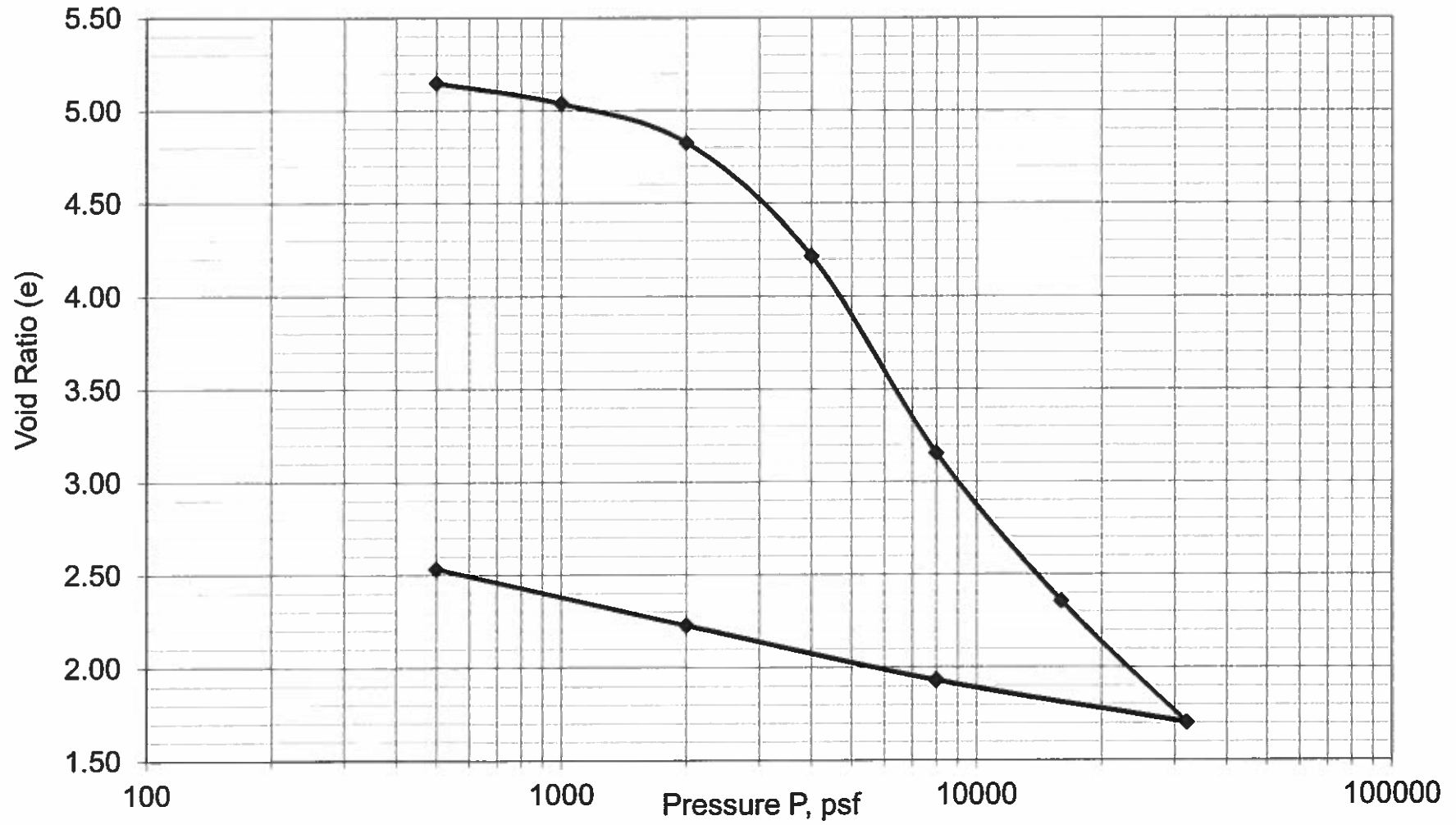
Load No.	Hanger Load (lbs.)	Pressure on sample (lb/ft <sup>2</sup> )	Final Dial Reading	Decrease in Height of Voids (in)	Machine Deflection (in)	Net Decrease in Height of Voids (in)	Height of Voids (in)	Void Ratio (e)
1	1.55	500	0.4371	0.0214	0.0013	0.0201	0.6112	5.149
2	3.1	1000	0.4225	0.0360	0.0026	0.0334	0.5979	5.037
3	6.2	2000	0.3957	0.0628	0.0043	0.0585	0.5728	4.825
4	12.4	4000	0.3211	0.1374	0.0064	0.1310	0.5003	4.214
5	24.8	8000	0.1928	0.2657	0.0087	0.2570	0.3743	3.153
6	49.6	16000	0.0953	0.3632	0.0115	0.3517	0.2796	2.355
7	99.2	32000	0.0146	0.4439	0.0146	0.4293	0.2020	1.702
8	24.8	8000	0.0449	0.4136	0.0115	0.4021	0.2292	1.931
9	6.2	2000	0.0821	0.3764	0.0094	0.3670	0.2643	2.226
10	1.55	500	0.1200	0.3385	0.0078	0.3307	0.3006	2.532
11								
12								
13								
14								
15								

Tested By: Willie Rodych  
 Date: 20/05/2015

Graph - e vs log P

Sample Test No.: 225601-3

Page 3 of 5





exp Services Inc.

**1595 Clark Boulevard  
Brampton, ON  
L6T 4V1  
Tel.: 905-793-9800  
Fax: 905-793-0641**

**Consolidation Test  
Coefficient of Consolidation  
(ASTM: D 2435-96)**

Project No.:	adm-00028245-j0 adm-100
Project Name:	Foundation Engineering
Client Job No.:	
Site Location:	
Sample No.	BH 4 TW-9 6.1 - 6.9m

Initial Height of Sample (in):	0.7500
Initial Dial Reading:	0.4585

[illegible]

Graph -  $C_v$  vs  $\log P$ 