



## **FINAL REPORT**

### **FOUNDATION INVESTIGATION REPORT**

**Whitewood Creek Culvert Replacement, Highway 590, Site No. 48W-168/C,  
Township of Marks, District of Thunder Bay**

**Agreement No. 6014-E-0017**

**Assignment No. 2**

**GWP 6349-14-00**

**Geocres No. 52A-213**

**Prepared for:**

**Ontario Ministry of Transportation**  
Regional Director's Office -NW Region  
615 James Street South  
Thunder Bay, ON P7E 6P6  
Attn: Mike Satten

**Ontario Ministry of Transportation**  
Pavements and Foundations Section  
Foundations Group  
Building 'C', Room 223  
1201 Wilson Avenue  
Downsview, ON M3M 1J8  
Attn: K.Ahmad

**exp Services Inc.**

April 15, 2016

# Ontario Ministry of Transportation

## Foundation Investigation Report

Agreement No. 6014-E-0017

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Geocres No. 52A-213

## Type of Document:

Final

## Project Name:

Foundation Investigation and Design Report for Whitewood Culvert Replacement  
HWY 590, Site No. 48W-168/C, Township of Marks, District of Thunder Bay

## Project Number:

ADM-00223648-B0

## Prepared By:

Ahileas Mitsopoulos, P.Eng.  
Demetri N. Georgiou, M.A.Sc. P.Eng.  
Nimesh Tamrakar, M.Eng, EIT.  
Silvana Micic, Ph.D., P.Eng.

## Reviewed By:

TaeChul Kim, M.E.Sc. P.Eng.  
Stan E. Gonsalves, M.Eng., P.Eng.

## exp Services Inc.

56 Queen St, East, Suite 301  
Brampton, ON L6V 4M8  
Canada



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Silvana Micic, Ph.D., P.Eng.  
Senior Geotechnical Engineer  
Project Manager



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Stan E. Gonsalves, M.Eng., P.Eng.  
Executive Vice President  
Designated MTO Contact

## Date Submitted:

April 15, 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 Whitewood Creek Culvert on Highway 590, located approximately 14 km west of the junction of Highway 590 and Highway 11/17 at Whitewood Creek, in the Township of Marks, the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 2 (GWP 6349-14-00). The terms of reference (TOR) were as presented in the MTO letter dated January 23, 2015.

Based on preliminary information provided, it is understood the existing culvert is a corrugated steel pipe (CSP) culvert with a length of about 41.8 m and diameter of about 3.0 m. It is understood that the existing culvert was constructed/installed in 1977, and is intended to be replaced with a new culvert along the same alignment.

The purpose of the investigation was to evaluate the subsurface conditions along the alignment, to permit detailed design for the 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**

As shown on Drawing 1 (Appendix B), the Whitewood Creek Culvert replacement site is located on Hwy 590, approximately 14 km west of the junction of Hwy 590 and Hwy 11/17, in the Township of Marks. At the site, Hwy 590 is a two lane roadway, with a speed limit of 80 km/h and is about 6.5 m wide from edge of pavement to edge of pavement, with narrow sand and gravel shoulders. Based on drawings provided, the roadway embankment is about 7 m high with side slopes of about 2H:1V west of the roadway and 2.5H:1V east of the roadway.

During the fieldwork on March 5, 6, 11, 12 and 18, 2015, the general site conditions were assessed; however, the site was generally snow covered which limited visual observations. Hwy 590 runs in a north to south direction and Whitewood Creek, flows from northwest to southeast across the highway, and ultimately discharges towards Kakabeka Falls, which is about 12 km east of the site. At the time of this investigation, Whitewood Creek was frozen and the approximate creek elevations (top of ice) at the inlet and outlet were about 425.32 m and 424.99 m, respectively. The elevation of highway centerline pavement at the culvert centerline is about 431.91 m. Overhead wires were observed along the east side of the roadway.

The vicinity of the inlet and outlet of the culvert was snow covered but the visible vegetation was generally grass and small shrubs. The inlet and outlet appeared to be clear of debris, as such the flow does not appear to be impeded. However, immature trees/brush were present immediately in front (west) of the culvert inlet. No trees or shrubs were noted immediately in front of the culvert outlet.

Select photographs are provided in Appendix A.

### 1.2.2 Geological Setting

According to the MNR Northern Ontario Engineering Geology Terrain Data Base Map, Ontario Geological Survey Map 5047. Scale 1:100,000, dated 1979, the underlying native soil at the sites consists of silt till ground moraine with mainly low local relief, undulating to rolling and dry surface conditions.

The Precambrian Geology Compilation Series, Map 2664, Thunder Bay Sheet, indicates that the bedrock geology of the site is of the Neo to Mesoproterozoic Era (2.5 to 3.4 Ga), and generally consist of granite-granodiorite. The granite-granodiorite is generally expected to be of a massive to foliated texture; locally porphyritic (phenocrysts include quartz, feldspar, biotite and amphibole minerals) and containing quartz diorite and diorite in some plutons or plutons complexes.

## 1.3 Investigation Procedures

### 1.3.1 Site Investigation and Field Testing

The field investigation was performed on March 5, 6, 11, 12 and 18, 2015. The field program consisted of drilling four (4) sampled boreholes (BH301 to BH304). Two (2) boreholes were located within the roadway, BH301 and BH302. BH301 was located about 3 m south of the culvert as near as possible to the edge of pavement in the southbound lane and BH302 was located about 4 m north of the culvert as near as was possible to the centerline of Hwy 590 within the northbound lane. An additional two (2) boreholes (BH303 and BH304) were advanced off the roadway, near the culvert inlet and outlet. BH303 was located about 5 m north of the culvert (inlet side) and BH304 was located about 5 m south of the culvert (outlet side). The borehole locations are shown on Drawing 1 in Appendix B.

The roadway boreholes (BH301 and BH302) and the off-road borehole at the outlet side of the culvert (BH304) were advanced using a CME 55 truck mounted drill rig and/or CME 850 track mounted drill rig. The remaining off-road borehole at the culvert inlet (BH303) was advanced using a CME 45 rubber track mounted drill rig. A T340XL crane was used to lower/lift the CME 45 drill rig at BH303. All drill rigs were equipped with hollow and solid stem continuous flight augers, and standard soil sampling equipment (includes 51 mm outside diameter split spoon samplers and *in situ* shear vane testing equipment). In addition, the CME 850 drill rig was equipped with rock coring equipment, NQ size. The roadway boreholes BH301 and BH302 were advanced to refusal depths of about 14.6 m and 13.4 m below ground surface, respectively, and the off-road boreholes BH303 and BH304, were advanced to refusal depths of about 7.8 m and 6.8 m below ground surface, respectively. Refusal was encountered at elevations ranging between about 417.3 m and 418.9 m.

At BH302 only, rock coring was conducted to an additional 5.7 m beyond auger/SPT refusal to about 19.4 m below asphalt surface (elevation 412.6 m) to determine the nature of refusal.

The borehole locations were referenced to the MTM ON-15 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/ice at the upgradient and downgradient sides of the highway, were referenced to a geodetic benchmark (BM) provided by the client (nail in Pine tree north of the existing culvert). The elevation of the BM is 434.147 m, and location of the BM is shown on Drawing 1, in Appendix B.

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), and were generally performed at intervals of about 0.75 m. The original field (uncorrected) SPT "N" values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual and used to provide an assessment of *in-situ* compactness (cohesionless) or consistency (cohesive) soils. In select boreholes, when refusal was encountered, sampling of the refusing stratum was performed by diamond core drilling using a 1.5 m long NQ double tube wireline core barrel.

Upon completion of the boreholes, groundwater level measurements were carried out in boreholes in accordance with the Ministry of Transportation guidelines. The measured groundwater levels after completion of drilling boreholes were recorded on borehole log sheets in Appendix C. The boreholes were backfilled with a mixture of bentonite and auger cuttings and cold patch was used to repair the asphalt surface damaged by the augers. The borehole decommissioning was in general 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 a member 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. All of the recovered soil samples were placed in labelled moisture-proof bags and rock cores were brought to **exp**'s Thunder Bay laboratory for additional visual, textual and olfactory examination, and for subsequent examination by a geotechnical engineer and laboratory testing.

### 1.3.2 Laboratory Testing

All samples brought 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, at the **exp** laboratory in Thunder Bay, Ontario.

The laboratory test results are provided on the attached borehole log sheets in Appendix C as well as graphically in Appendix D.

In addition, chemical testing of two select soil samples was conducted. The soil samples were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified

and accredited laboratory in Mississauga, Ontario. Details of the chemical testing are discussed below and the lab results are included in Appendix E.

## 1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the Borehole Records in Appendix C. Laboratory test results are provided in Appendix D. The “Explanation of Terms Used on Borehole Records” preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report. In addition, photographs of the bedrock core obtained are included in Appendix C.

A borehole location plan and stratigraphic sections are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic sections 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 layers of fill material composed of poorly graded sand, sandy silt, silty sand and well graded gravel. The fill layers are underlain by clayey silt and/or silty sand, which is overlying silty sand with gravel till, overlying cobbles and gravel, and overlying bedrock. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

### 1.4.1 Fill

Fill material was encountered beneath the asphalt at BH301 and BH302. The asphalt thickness was about 50 mm at both borehole locations. The fill generally comprised a conglomeration of gravel, sand, silt and clay layers with descriptions ranging between well graded gravel with sand to sandy silt with some clay. Where not frozen, the fill was generally described as compact to very dense, moist and brown. SPT sampling was not conducted in the upper 1.5 m of fill due to the frozen soil; at these depths samples were collected from the augers. SPT sampling was conducted semi continuously from about 1.5 m below ground surface with “N” values ranging between 5 and 110. The fill at BH301 and BH302 extended to about 6.9 m (425.0 m elevation) and 5.3 m (426.6 m elevation) below ground surface, respectively.

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

Moisture content:

- 2.6% to 21.2%

Grain size distribution:

- 5% to 48% gravel;
- 26% to 52% sand;

- <9% to 55% silt; and
- 6% to 20% clay size.

The results of the 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 Figures 1, 2 and 3 in Appendix D.

#### 1.4.2 Topsoil

Topsoil was encountered surfacing BH303 and BH304. Where not frozen, the topsoil was generally described as very loose/soft at depth, brown, and moist to wet at depth. The SPT "N" values ranged between about 1 and 25 blows per 300 mm penetration. The topsoil extended to about 0.8 m below ground surface (425.8 m elevation) at BH303, and about 0.9 m below ground surface (424.8 m elevation) at BH304.

Silt and peat was encountered underlying the topsoil at BH304, and was described as soft, dark brown to black, and wet. The SPT "N" value was 2. The silt and peat extended to about 1.5 m depth (424.2 m elevation).

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

Moisture content:

- 28.5% to 46.5%

#### 1.4.3 Silty Sand with Gravel

A layer of silty sand with gravel was encountered underlying the fill at BH302. The native sand was generally described as compact, grey and moist. Trace organics were noted at about 6.1 m depth. The SPT "N" values ranged between about 12 and 24 blows per 300 mm penetration. The sand at BH302 extended to depth of about 7.6 m below ground surface (424.3 m elevation).

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

Moisture content:

- 14.5% to 27.1%

Grain size distribution:

- 32% gravel,
- 37% sand;
- 25% silt; and
- 6% clay size.



The results of the moisture content and grain size distribution are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figures 4 in Appendix D.

#### 1.4.4 Clayey Silt with Sand

Clayey silt with sand was encountered beneath the fill at BH301, beneath the silty sand with gravel at BH302, and beneath the topsoil/silt and peat at BH303 and BH304. The clayey silt with sand was generally described as firm to hard, grey to brown, and moist to wet. The SPT "N" values ranged between about 4 and 100 blows per 300 mm penetration. The clayey silt with sand extended to depths of about 3.1 m and 13.1 m below ground surface. The clayey silt with sand extended to elevations of about 418.9 m and 422.7 m.

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

Moisture content:

- 10.1% to 34.3%

Grain size distribution:

- <1% to 16% gravel,
- 3% to 36% sand,
- 33% to 73% silt, and
- 17% to 28% clay size.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 18.5 to 22.9 kN/m<sup>3</sup>. Atterberg Limit testing was performed on three representative of the clayey silt with sand (BH301-S12, BH301-S14, BH302-S13, BH302-S15 and BH303-S5) and indicated that the soil is of low plasticity. The data is shown on the plasticity chart, Figure 7. The liquid limit, plastic limit and plasticity index ranged between about 24% to 29%, 15% to 19%, and 8% to 14%, respectively.

The results of the moisture content, grain size distribution and Atterberg Limit tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figures 5 in Appendix D, and Atterberg Limit tests are provided on Figure 7 in Appendix D.

#### 1.4.5 Silty Sand with Gravel Till

Silty sand with gravel till was encountered underlying the lean clay to sandy lean clay. The till was generally described as dense to very dense, brown to grey, moist. The SPT "N" values of the till ranged between 20 and 100 (i.e. SPT refusal), per 300 mm penetration. The till extended to the depths ranging between about 6.8 m and 14.6 m below ground surface, and extended to elevations ranging between about 417.3 m and 418.9 m. BH301, BH303 and BH304 were terminated within the till.

Although no specifically identified in the boreholes, typically till by nature of their deposition likely contain cobbles and boulders and the presence of these materials should be expected.

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

Moisture content:

- 5.2% to 26.7%

Grain size distribution:

- 16% to 29% gravel,
- 36% to 40% sand,
- 29% to 37% silt, and
- 6% to 7% clay size

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 19.5 to 24.5 kN/m<sup>3</sup>. The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The result of the grain size distribution tests also provided on Figure 6 in Appendix D.

#### **1.4.6 Cobbles and Gravel**

Rock coring techniques were initiated at BH302 only to determine the nature of refusal. Cobbles and gravel were encountered underlying the till at BH302. The cobbles and gravel were described as very dense, grey, wet, containing some sand and some boulders. An SPT "N" value of 100 (i.e. SPT refusal), per 300 mm penetration occurred. The cobbles and gravel extended to about 16.6 m below ground surface (elevation 415.3 m).

Laboratory testing was performed on a select sample to determine moisture content. The test result is as follows:

Moisture content:

- 7.0%

#### **1.4.7 Bedrock**

As noted above, rock coring was initiated within the cobbles and gravel strata, and rock coring techniques, NQ size, were continued at BH302, to about 2.8 m depth into bedrock. Bedrock was encountered at about 415.3 m elevation, and about 16.6 m below asphalt surface.

The bedrock was generally described as a medium strong (25 MPa to 50 MPa compressive strength), very severely fractured to severely fractured, white and pink, medium to coarse grained granite. Photographs of the bedrock core samples are presented in Appendix C, after the Borehole Logs.

Gross recoveries ranged between about 99% and 100%. The Rock Quality Designation (RQD), which is a modified core recovery, ranged from 24% to 26% (very severely fractured to severely fractured).

## 1.5 Groundwater and Surface Water Conditions

Information of 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.

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.

Table 1.1. Groundwater data

Borehole	Date Completed	Date Measured	Ground Surface Elevation <sup>2</sup>	Depth to Water <sup>3</sup>	Groundwater Elevation
BH301	Mar. 5/15	Mar. 11/15 <sup>4</sup>	431.84	6.42	425.42
BH302	Mar. 11/15	Mar. 11/15	431.97	6.10	425.87
BH303	Mar. 18/15	Mar. 18/15	426.57	1.52	425.05
BH304	Mar. 12/15	Mar. 12/15	425.70	5.26	420.44
Whitewood Creek WL Upstream (West) Side	--	Mar. 18/15	--	--	425.29 <sup>5</sup>
Whitewood Creek WL Downstream (East) Side	--	Mar. 5/15	--	----	424.96 <sup>5</sup>
Whitewood Creek WL Downstream (East) Side	--	Mar. 12/15	--	----	424.99 <sup>5</sup>
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to a geodetic benchmark (BM) provided by the client (nail in Pine tree north of the existing culvert). The elevation of the BM is 434.147 m. 3) Depths are relative to ground surface. 4) Augers were left in at the borehole location until March 11, 2015. Between March 5 and 11, BH301 was covered with asphalt on top of a wooden board which was resting on the augers. 5) Indicates top of ice elevation at Whitewood Creek.					

## 1.6 Chemical Analysis of Soil

Two soil samples were selected for chemical analyses and were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix E, and are summarized in Table 1.2, below.

Table 1.2. Corrosivity Chemical Analysis

Borehole	pH (unitless)	Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (mS/cm)
BH302-S10	6.20	370	<20	1,500	0.69
BH303-S4	7.63	79	140	2,400	0.42

April 15, 2016

## 1.7 Closure

A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation Report has been prepared by Ahileas Mitsopoulos, P.Eng., Nimesh Tamrakar, M.Eng, EIT., Demetri N. Georgiou, MAsc. P.Eng., 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 Elwin Farkas.

Yours truly,

**exp Services Inc.**



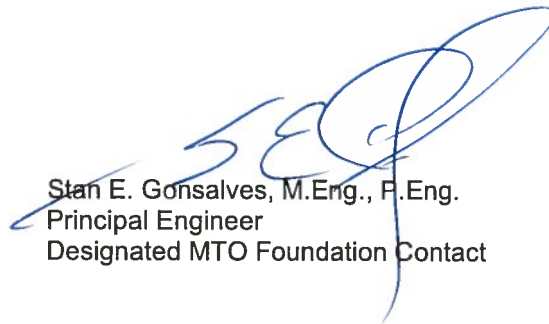
Nimesh Tamrakar, M.Eng., EIT.  
Technical Specialist



TaeChul Kim, M.E.Sc., P.Eng.  
Senior Geotechnical/Foundation Specialist



Silvana Micic, PhD., P.Eng.  
Senior Geotechnical Engineer  
Project Manager



Stan E. Gonsalves, M.Eng., P.Eng.  
Principal Engineer  
Designated MTO Foundation Contact

Encl.



## **Appendix A – Site Photographs**



Photo 1. Inlet of existing culvert at west side of Highway 590



Photo 2. Outlet of existing culvert at east side of Highway 590





Photo 3. Facing north on Hwy 590 before the existing culvert



Photo 4. Facing south on Hwy 590 before the existing culvert



April 15, 2016

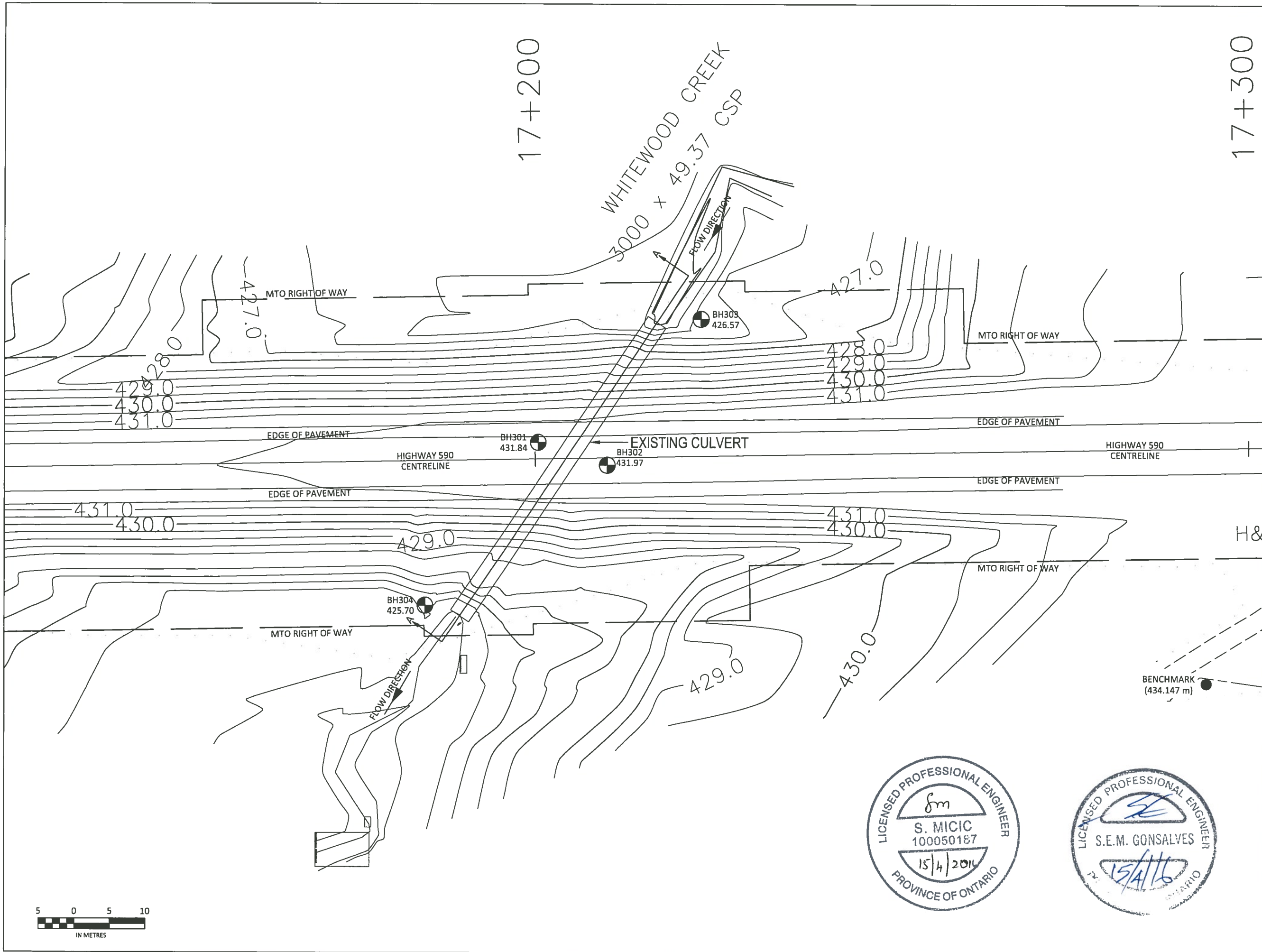


Photo 5. Embankment slope on east side facing north



Photo 6. Embankment slope on west side facing south

## **Appendix B – Drawings**



Agreement No. 6014-E-0017  
Assignment No. 2  
GWP 6349-14-00

WHITEWOOD CREEK CULVERT  
(Highway 590, Marks Township)  
PLAN

DWG  
1

\*exp.

exp Services Inc.

KEY PLAN

LEGEND

BH301 BOREHOLE LOCATION  
431.84 GROUND SURFACE ELEVATION IN METRES

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH301	431.84	5,359,723	320,570
BH302	431.97	5,359,736	320,573
BH303	426.57	5,359,749	320,557
BH304	425.70	5,359,711	320,594

NOTES

- ALL DIMENSIONS ARE IN METRES.
- BASE MAP PROVIDED BY CLIENT.
- BOREHOLE LOCATIONS ARE BASED ON FIELD MEASUREMENTS FROM EXISTING CULVERT AND/OR PROJECTED MTM COORDINATES FOR ZONE ON-15 AS PER PROVIDED FIGURE.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

REVISIONS

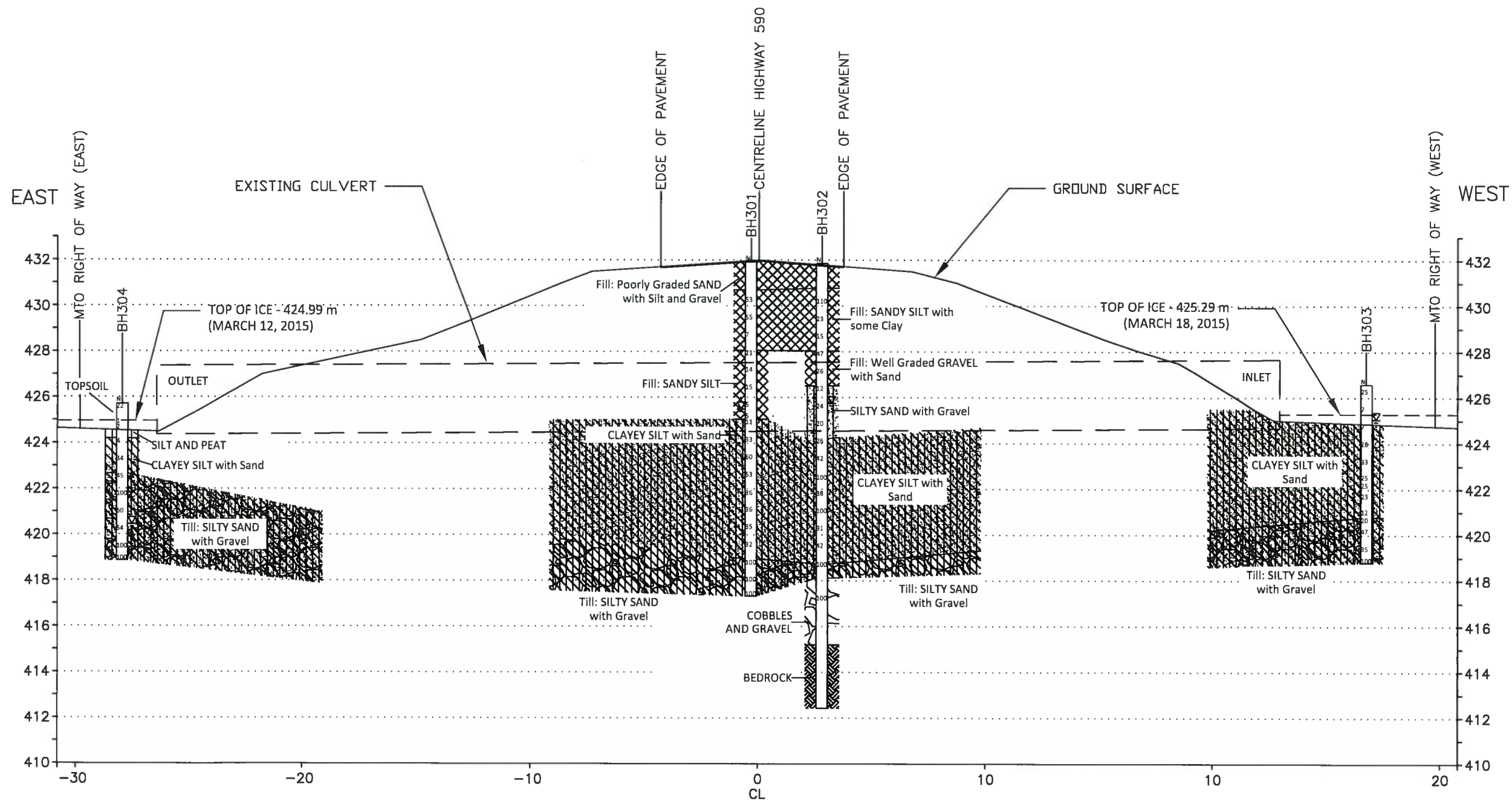
DATE	BY	DESCRIPTION

GEOCREs No. 52A-213  
Date: April 24, 2015  
Drawn By: RM

Project No. ADM-00223648-B0  
Scale : 1:500  
Checked By: AM  
Checked By: DG







A-A  
PROFILE OF WHITEWOOD CREEK CULVERT



Agreement No. 6014-E-0017 Assignment No. 2 GWP 6349-14-00																																	
WHITEWOOD CREEK CULVERT (Highway 590, Marks Township) CROSS SECTION		DWG 2																															
exp.		exp Services Inc.																															
KEY PLAN																																	
LEGEND																																	
N STANDARD PENETRATION TEST (BLOWS/0.3 m)																																	
MEASURED WATER LEVEL																																	
SOIL STRATA SYMBOLS																																	
<div><div></div><div>FILL</div><div></div><div>SILT &amp; PEAT</div><div></div><div>CLAYEY SILT with Sand</div><div></div><div>SILTY SAND</div><div></div><div>SILTY SAND TILL</div><div></div><div>COBBLES &amp; BOULDERS</div><div></div><div>BEDROCK</div></div>																																	
<table><tr><th rowspan="2">BH No.</th><th rowspan="2">APPROX. ELEV. (m)</th><th colspan="2">MTM COORDINATES</th></tr><tr><th>NORTH</th><th>EAST</th></tr><tr><td>BH301</td><td>431.84</td><td>5,359,723</td><td>320,570</td></tr><tr><td>BH302</td><td>431.97</td><td>5,359,736</td><td>320,573</td></tr><tr><td>BH303</td><td>426.57</td><td>5,359,749</td><td>320,557</td></tr><tr><td>BH304</td><td>425.70</td><td>5,359,711</td><td>320,594</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr></table>				BH No.	APPROX. ELEV. (m)	MTM COORDINATES		NORTH	EAST	BH301	431.84	5,359,723	320,570	BH302	431.97	5,359,736	320,573	BH303	426.57	5,359,749	320,557	BH304	425.70	5,359,711	320,594								
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BH304	425.70	5,359,711	320,594																														
NOTES																																	
<div><div>1.</div><div>ALL DIMENSIONS ARE IN METRES.</div><div>2.</div><div>BASE MAP PROV DED BY CLIENT.</div><div>3.</div><div>MTM COORDINATES BASE ON MTM ZONE ON-15 PROJECTION, AS PER PROVIDED FIGURE.</div><div>4.</div><div>BOREHOLES ARE PROJECTED PERPENDICULAR TO SECTION LINE A-A. BH301 &amp; BH302 ARE PROJECTED/APPEAR ON THE OPPOSITE SIDE OF THE ROAD. SEE DRAWING 1.</div><div>5.</div><div>THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.</div></div>																																	
REVISIONS																																	
<table><tr><th>DATE</th><th>BY</th><th>DESCRIPTION</th></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td></tr></table>				DATE	BY	DESCRIPTION																											
DATE	BY	DESCRIPTION																															
GEOCRE No. 52A-213		Project No. ADM-00223648-B0																															
Date: May 15, 2015		Horizontal Scale : 1:200																															
Drawn By: RM		Vertical Scale : 1:200																															
Checked By: DG		Checked By: AM																															

## **Appendix C – Borehole Logs and Bedrock Core Photos**

# 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	$5 \leq Pp \leq 10\%$
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:

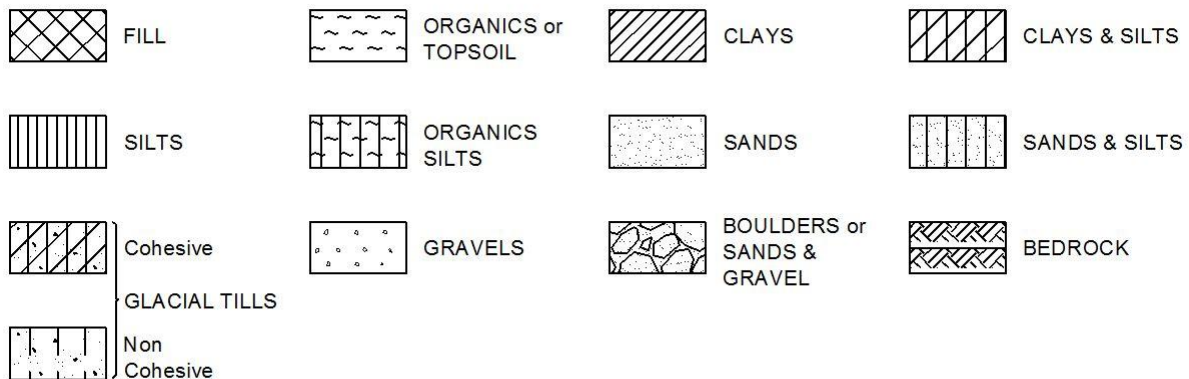
Table c: Consistency of Cohesive Soil

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

$m_v$	kPa <sup>-1</sup>	Coefficient of volume change
$c_c$	1	Compression index
$c_s$	1	Swelling index
$c_r$	1	Recompression index
$c_v$	m <sup>2</sup> /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
$\phi'$	—°	Effective angle of internal friction
$c_u$	kPa	Apparent cohesion intercept
$\phi_u$	—°	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

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

Brampton, Ontario

## RECORD OF BOREHOLE No BH301

1 OF 1

METRIC

W. P. GWP No. 6349-14-00 LOCATION Whitewood Creek Culvert (Site No. 48W-168/C) MTM ON-15 320,570E 5,359,723N ORIGINATED BY EF  
 DIST Thunder Bay, Hwy 590 BOREHOLE TYPE CME 55 Truck Mount / HSA COMPILED BY RM  
 DATUM Geodetic DATE 2015/03/05 - 2015/03/05 CHECKED BY DG/AM

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					
431.8	Asphalt																
430.8	ASPHALT - about 50 mm		S1	AUGER			431										
	Poorly Graded SAND with Silt and Gravel (SP-SM) Fill - frozen, brown		S2	AUGER													
430.6			S3	AUGER													
1.2	SANDY SILT with some Clay (ML) Fill - very dense, frozen, brown, trace gravel		S4	AUGER			430										5 26 49 20
			S5	SS	53												
			S6	SS	55		429										
			S7	SS	7												
428.0							428										
3.9	SANDY SILT (ML) Fill - compact, brown, moist, trace to little gravel, trace to few clay		S8	SS	21												
			S9	SS	14		427										11 28 55 6
			S10	SS	15												
							426										
	- becoming moist to wet at about 6.1 m depth		S11A	SS	5												
			S11B	SS	5												
425.0	- trace organics at about 6.6 m depth						425										
6.9	CLAYEY SILT with Sand (CL) - stiff to hard, brown to grey, moist, some gravel		S12	SS	11												16 36 33 15
			S13	SS	33		424										
			S14	SS	60												
			S15	SS	53		423										0 17 66 17
			S16	SS	36												
			S17	SS	36		422										
			S18	SS	35												
			S19	SS	32		421										0 3 71 26
418.9																	
13.0	Silty SAND with Gravel (SM) Till - very dense, grey, moist		S20	SS	100		420										
			S21	SS	100												
417.3							419										
14.6	END OF BOREHOLE - refusal to SPT and auger		S22	SS	100		418										
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level at 6.4 m depth upon completion of borehole.																

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

OPG\_EXP RECORD OF BOREHOLE F-15103-CG - ADM-00223648-B0 - MTO 2 - WHITEWOOD CREEK CULVERT.GPJ ONTARIO MOT.GDT 16/4/14

Brampton, Ontario

## RECORD OF BOREHOLE No BH302

1 OF 2

METRIC

W. P. GWP No. 6349-14-00 LOCATION Whitewood Creek Culvert (Site No. 48W-168/C) MTM ON-15 320,573E 5,359,736N ORIGINATED BY EF  
 DIST Thunder Bay, Hwy 590 BOREHOLE TYPE CME 55 Truck Mount & CME 850 Track Mount / HSA / NQ COMPILED BY RM  
 DATUM Geodetic DATE 2015/03/06 - 2015/03/11 CHECKED BY DG/AM

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					
432.0	Asphalt																
430.9	ASPHALT - about 50 mm		S1	AUGER													
	Poorly Graded SAND with Silt and Gravel (SP-SM) Fill - frozen, brown		S2	AUGER													38 52 (10)
430.9							431										
1.1	SILTY SAND with Gravel (SM) Fill - compact to very dense, frozen, brown, some clay		S3	AUGER													
	- becoming very stiff to stiff, moist at about 2.3 m depth		S4	SS	110		430										
			S5	SS	23												
			S6	SS	15		429										
428.2																	17 41 33 9
3.8	Well graded GRAVEL with Sand (GW) Fill - dense to compact, brown, moist		S7	SS	47		428										
			S8	SS	26		427										48 43 (9)
426.6																	
5.3	Silty SAND with Gravel (SM) - compact, grey, moist		S9	SS	12		426										
	- trace organics at about 6.1 m depth		S10	SS	24												32 37 25 6
			S11	SS	20		425										
424.3																	
7.6	CLAYEY SILT with Sand (CL) - very stiff to hard, grey, moist to wet, trace gravel		S12	SS	26		424										
			S13	SS	42		423										1 8 70 21
			S14	SS	100												
			S15	SS	38		422										0 1 73 26
			S16	SS	100		421										
			S17	SS	91		420										
			S18	SS	42												
418.9			S19A	SS	49		419										
13.1	Silty SAND with Gravel (SM) Till - very dense, brown, moist		S19B	SS	100												
418.2	- refusal to SPT at about 13.4 m depth																
13.7	- rock coring initiated at 13.7 m depth		S20	CORE			418										
	COBBLES AND GRAVEL - very dense, grey, wet, some sand, occasional boulders		S21	SS	100		417										
			S22	CORE													
			S23	CORE			416										
415.3																	

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE F-15103-CG - ADM-00223648-B0 - MTO 2 - WHITEWOOD CREEK CULVERT.GPJ ONTARIO MOT.GDT 16/4/14

Brampton, Ontario

## RECORD OF BOREHOLE No BH302

2 OF 2

METRIC

W. P. GWP No. 6349-14-00 LOCATION Whitewood Creek Culvert (Site No. 48W-168/C) MTM ON-15 320,573E 5,359,736N ORIGINATED BY EF  
 DIST Thunder Bay, Hwy 590 BOREHOLE TYPE CME 55 Truck Mount & CME 850 Track Mount / HSA / NQ COMPILED BY RM  
 DATUM Geodetic DATE 2015/03/06 - 2015/03/11 CHECKED BY DG/AM

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 $\gamma$ 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					
16.6	<b>BEDROCK</b> - medium strong, very severely to severely fractured, white and pink, medium to coarse grained, granite ( <i>continued</i> )		S24	CORE			415										Recovery=99%, RQD=24%
							414										
			S25	CORE			413										
412.6 19.4	<b>END OF BOREHOLE</b>  <b>NOTES:</b> 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level at 6.1 m depth upon completion of borehole.																

OPG\_EXP RECORD OF BOREHOLE F-15103-CG - ADM-00223648-B0 - MTO 2 - WHITEWOOD CREEK CULVERT.GPJ ONTARIO MOT.GDT 16/4/14

Brampton, Ontario

## RECORD OF BOREHOLE No BH303






1 OF 1

METRIC

W. P. GWP No. 6349-14-00 LOCATION Whitewood Creek Culvert (Site No. 48W-168/C) MTM ON-15 320,557E 5,359,749N ORIGINATED BY EF

DIST Thunder Bay, Hwy 590 BOREHOLE TYPE CME 45 Yanmar Track Mount / HSA COMPILED BY RM

DATUM Geodetic DATE 2015/03/18 - 2015/03/18 CHECKED BY DG/AM

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 (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH: Cu, KPa									WATER CONTENT (%)			GR	SA	SI
								○ UNCONFINED	+	FIELD VANE	×	QUICK TRIAXIAL	LAB VANE									
426.6	Topsoil		S1	SS	25		426															
425.8	CLAYEY SILT with Sand(CL) - firm to hard, brown, moist, some organics in upper 1.5 m		S2	SS	7		425															
0.8			S3	SS	7		424															
			S4	SS	28		423															
			S5	SS	33		422															
			S6A	SS	25		421															
			S6B	SS	25		420															
			S7	SS	23		419															
420.8	- becoming clayey silt very stiff to stiff, grey, moist		S8A	SS	12		420															
5.8			S8B	SS	20		419															
			S9	SS	47		420															
			S10	SS	35	419																
418.8	Silty SAND with Gravel (SM) Till - compact to very dense, brown, moist		S11	SS	100																	
7.8	END OF BOREHOLE - refusal to SPT and auger																					
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level at 1.5 m depth upon completion of borehole.																					

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

OPG\_EXP RECORD OF BOREHOLE F-15103-CG - ADM-00223648-B0 - MTO 2 - WHITEWOOD CREEK CULVERT.GPJ ONTARIO MOT.GDT 16/4/14

Brampton, Ontario

## RECORD OF BOREHOLE No BH304

1 OF 1

METRIC

W. P. GWP No. 6349-14-00 LOCATION Whitewood Creek Culvert (Site No. 48W-168/C) MTM ON-15 320,594E 5,359,711N ORIGINATED BY EF  
 DIST Thunder Bay, Hwy 590 BOREHOLE TYPE CME 850 Track Mount / HSA COMPILED BY RM  
 DATUM Geodetic DATE 2015/03/12 - 2015/03/12 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>		WATER CONTENT (%)	GR	SA	SI	CL		
425.7	Topsoil		S1	SS	22	▽																	
424.8	- becoming very loose/soft, moist to wet at about 0.8 m depth		S2A	SS	1																		
0.9			S2B	SS	2																		
424.2	SILT AND PEAT - soft, dark brown to black, wet		S3	SS	4								○					0	24	57	19		
1.5	CLAYEY SILT with Sand (CL) - firm to hard, grey to brown, moist to wet		S4	SS	34									○									
422.7	Silty SAND with Gravel (SM) Till - very dense, brown to grey, moist		S5A	SS	45									○									
3.1			S5B	SS											○								
			S5C	SS											○								
			S6	SS	100										○					16	40	37	7
			S7	SS	60										○								
			S8	SS	54									○									
		S9	SS	100									○						29	36	29	6	
418.9			S10	SS	100								○										
6.8	END OF BOREHOLE - refusal to SPT and auger																						
<b>NOTES:</b> 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Groundwater level at 5.3 m depth upon completion of borehole.																							

OPG\_EXP.RECORD OF BOREHOLE F-15103-CG - ADM-00223648-B0 - MTO 2 - WHITEWOOD CREEK CULVERT.GPJ ONTARIO MOT.GDT 16/4/14

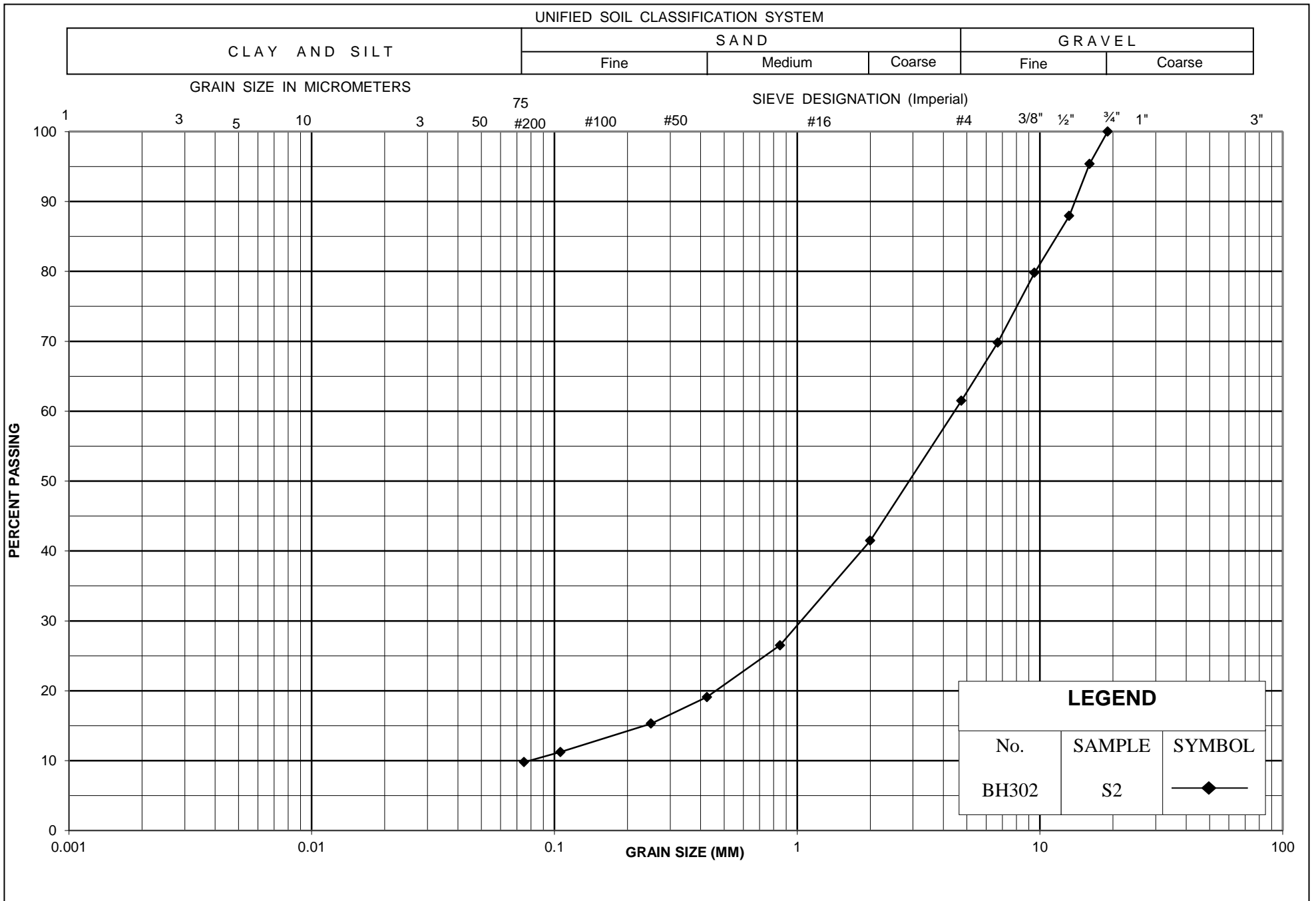
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

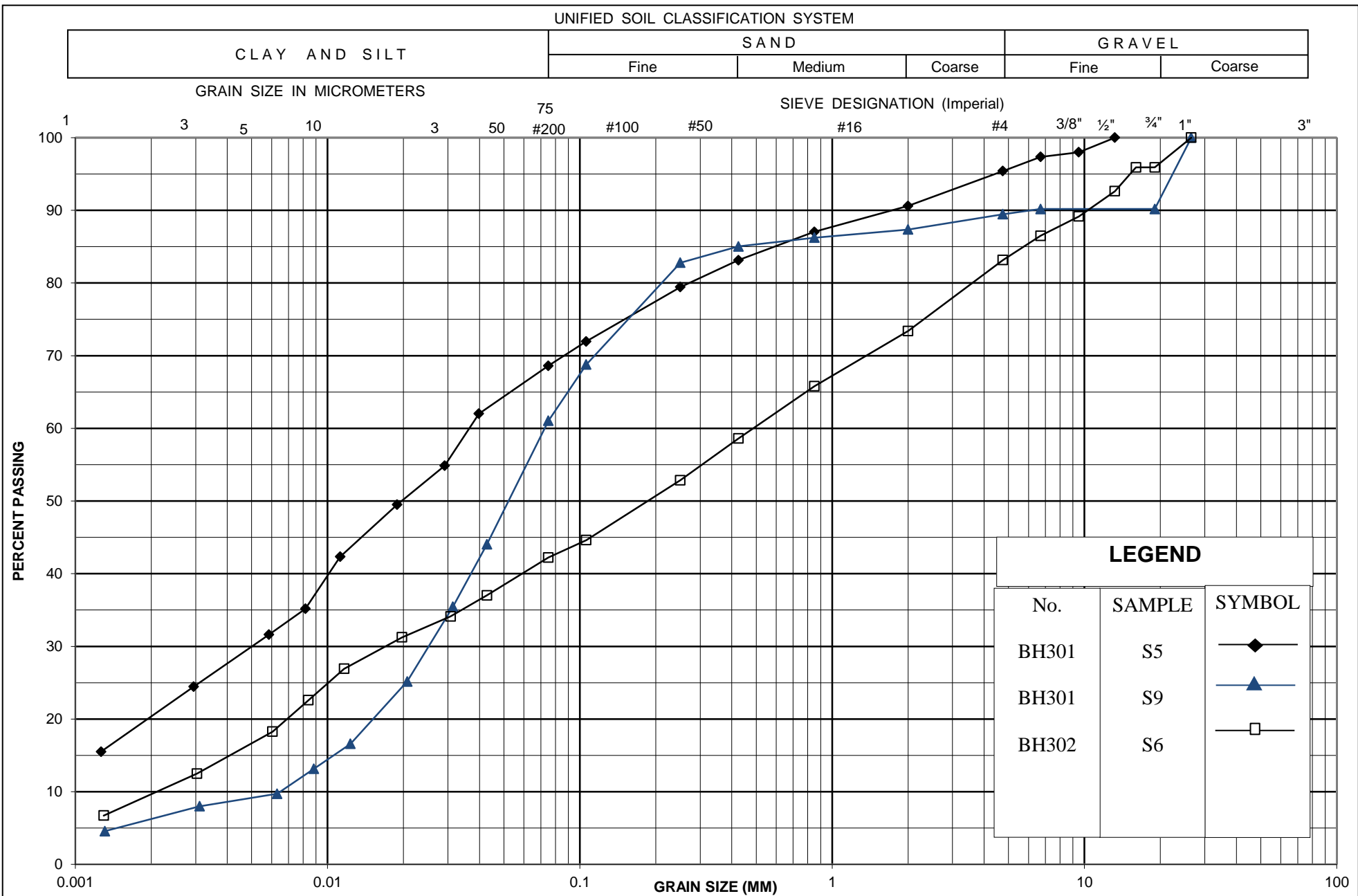


BH302 - Bedrock Core Samples with Depths and Elevations

## **Appendix D – Laboratory Data**







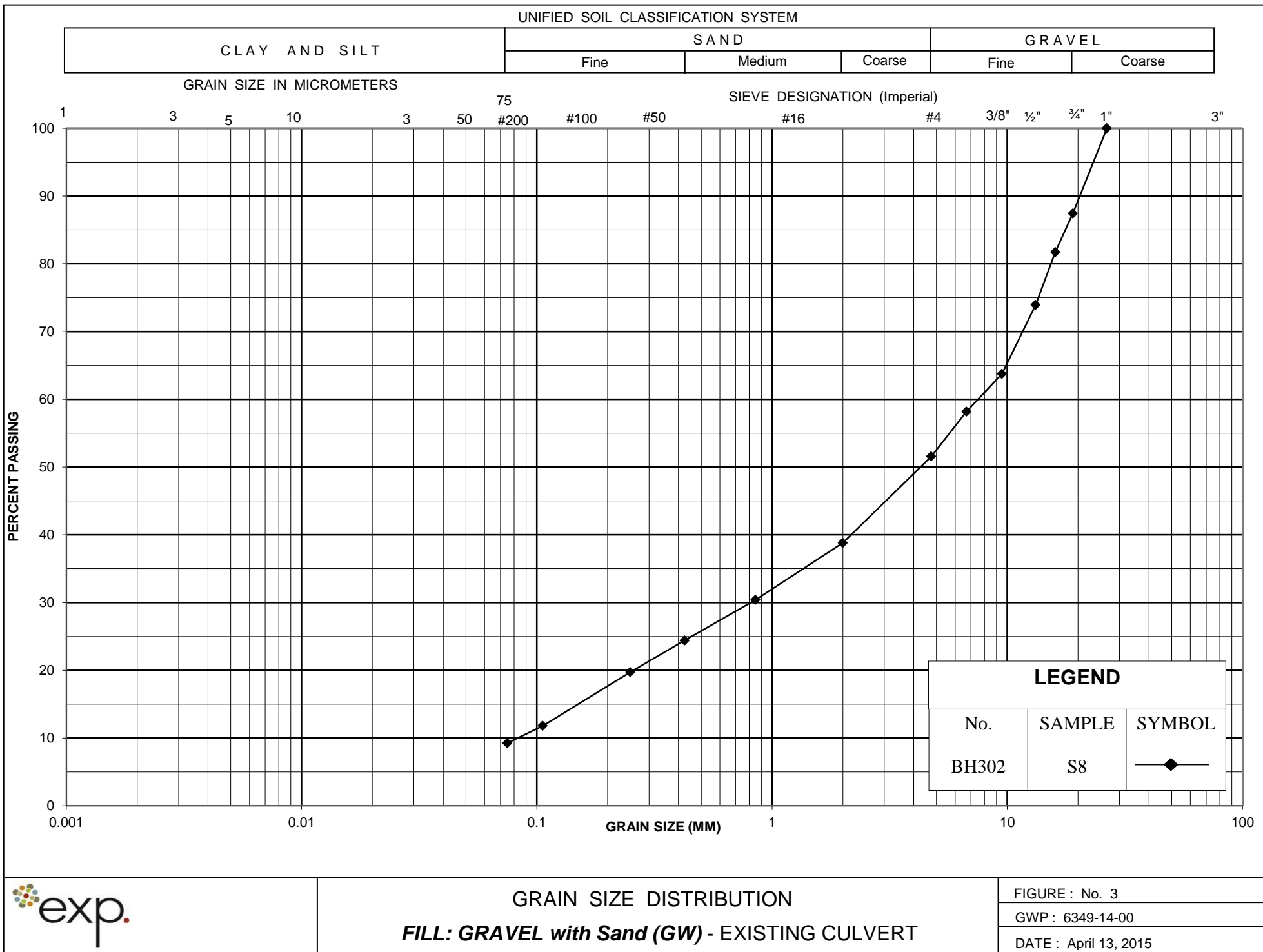
**GRAIN SIZE DISTRIBUTION**

***FILL: SANDY SILT/ SILTY SAND (ML-SM) - EXISTING CULVERT***

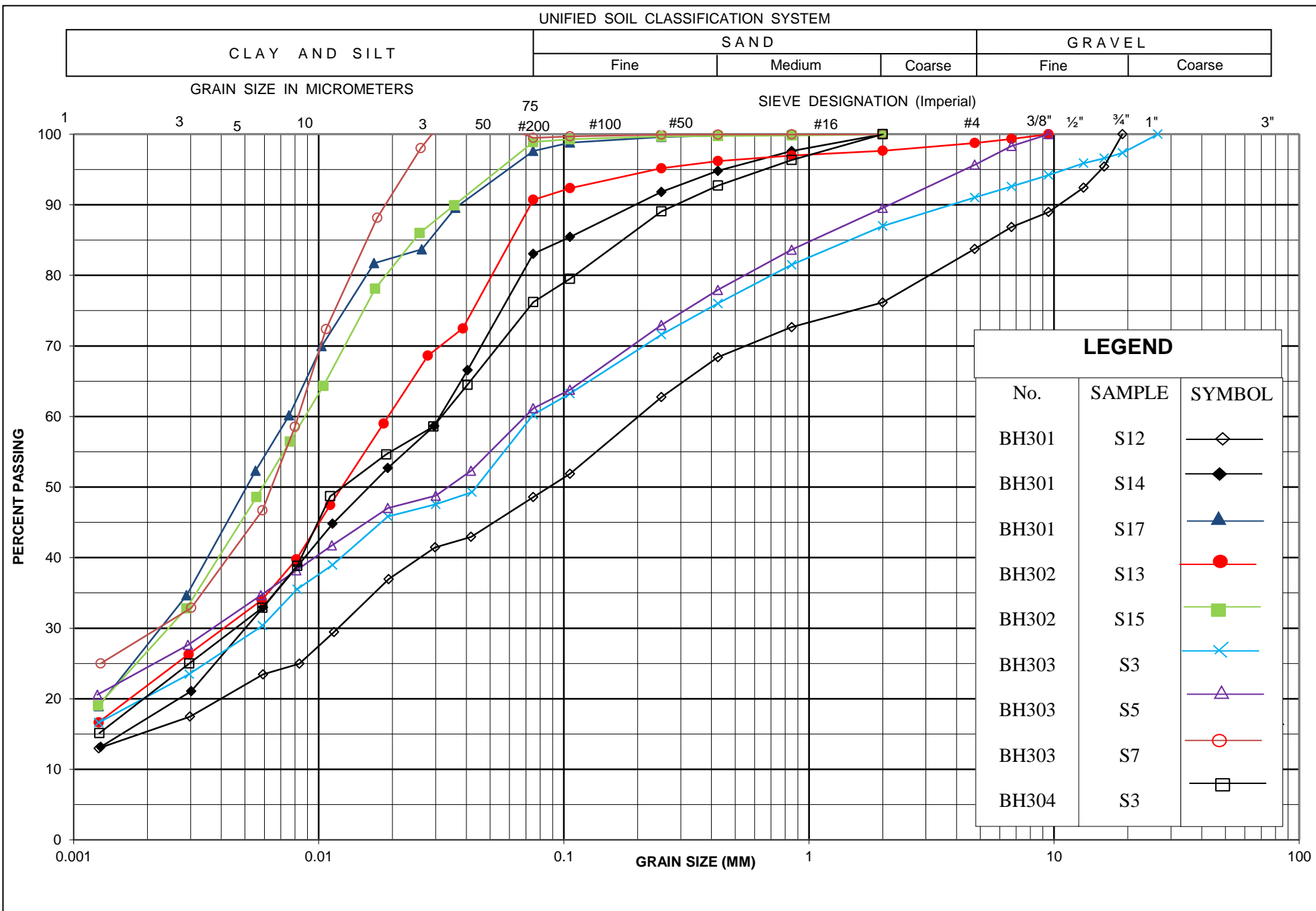
FIGURE : No. 2

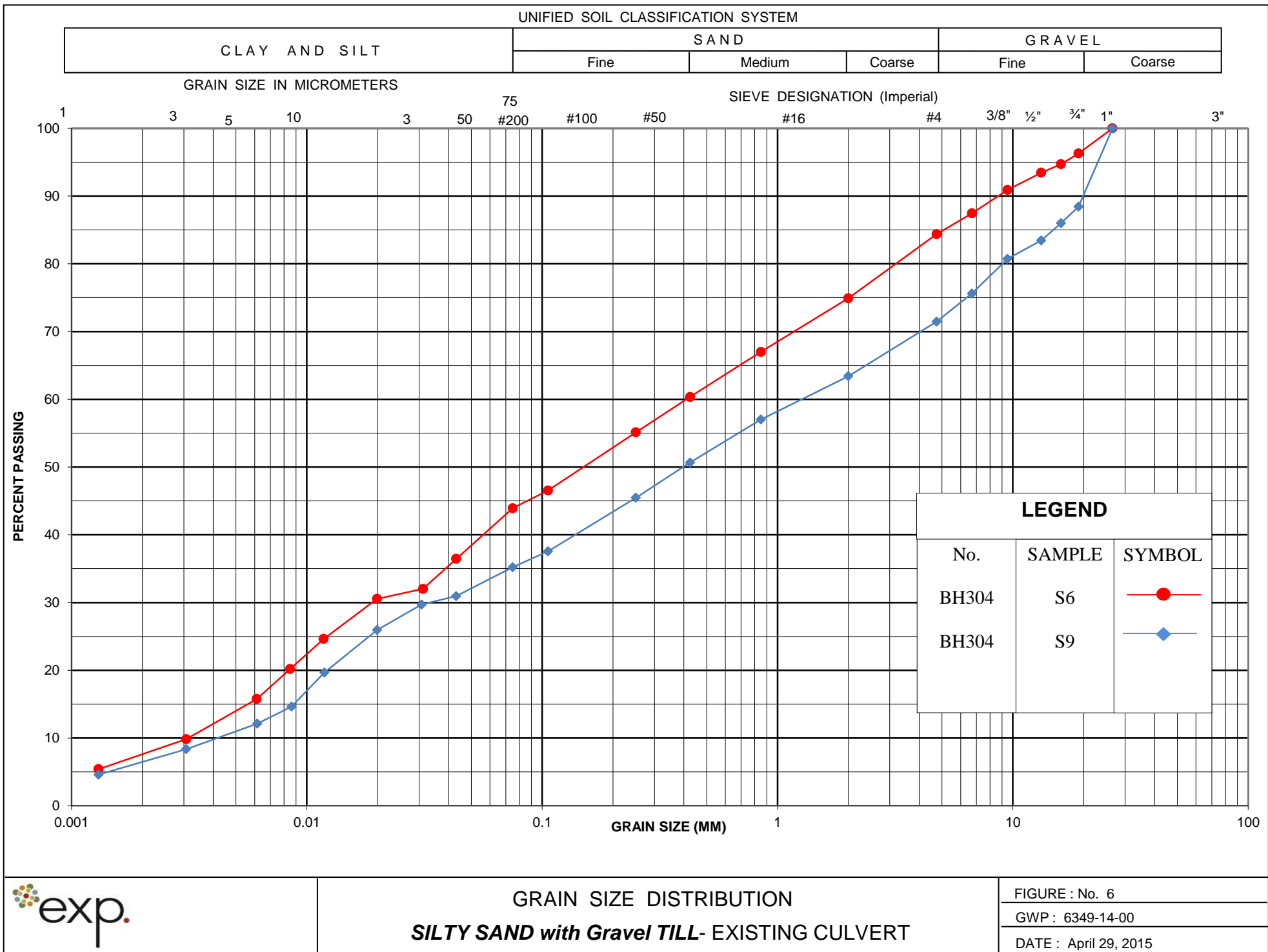
GWP : 6349-14-00

DATE : April 13, 2015







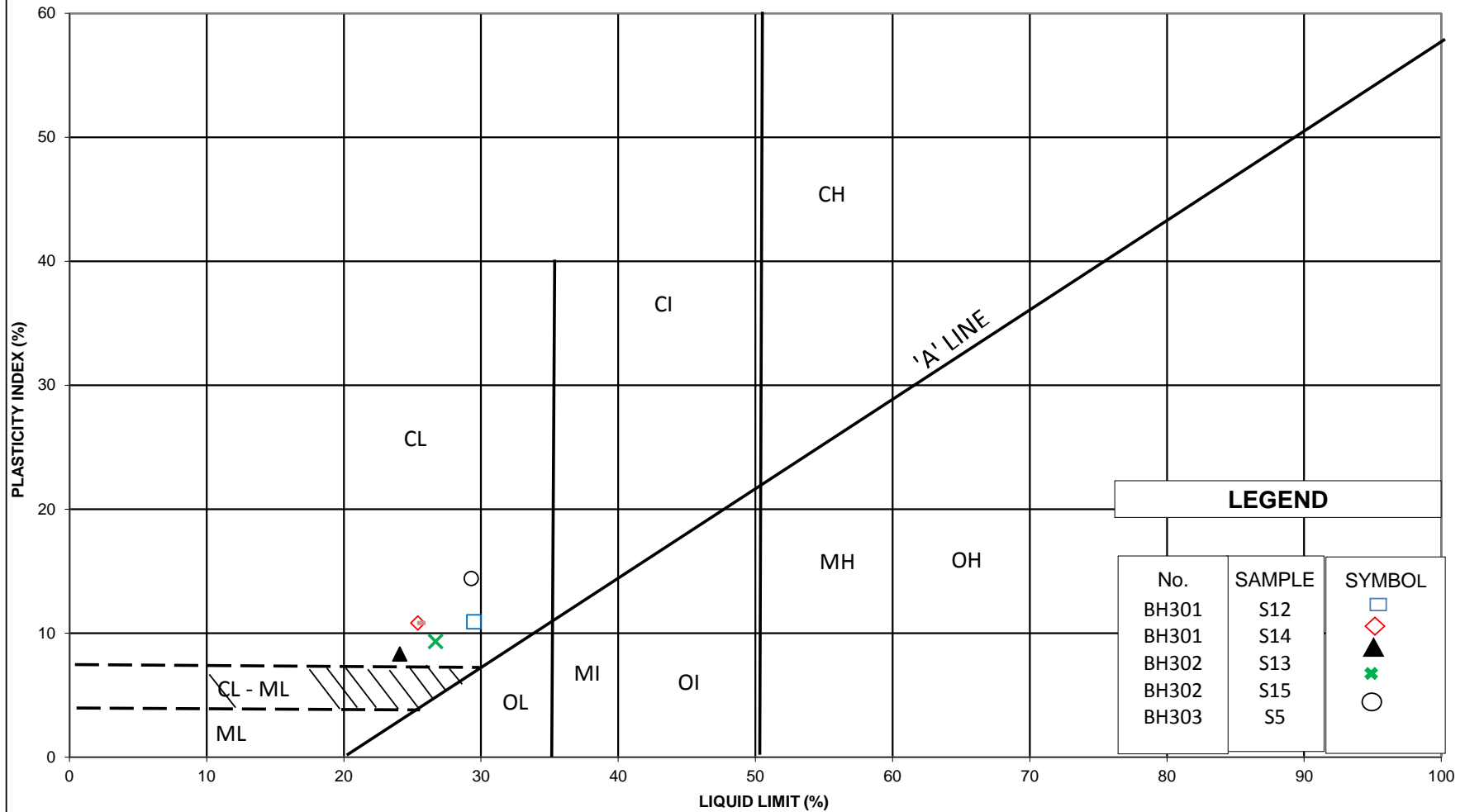


GRAIN SIZE DISTRIBUTION  
**SILTY SAND with Gravel TILL- EXISTING CULVERT**

FIGURE : No. 6  
GWP : 6349-14-00  
DATE : April 29, 2015



Whitewood Creek Culvert (Site No. 48W-168/C)  
GWP No. 6346-14-00, Highway 590, Marks Township, Ontario



## **Appendix E – Chemical Analyses**



Your Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO  
Your C.O.C. #: na

**Attention: Ahileas Mitsopoulos**

exp Services Inc  
Thunder Bay Branch  
1142 Roland St  
Thunder Bay, ON  
P7B 5M4

**Report Date: 2015/04/01**  
Report #: R3378881  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B553991**

**Received: 2015/03/27, 10:00**

Sample Matrix: Soil  
# Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	8	N/A	2015/04/01	CAM SOP-00463	EPA 325.2 m
Conductivity	8	N/A	2015/04/01	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	8	2015/03/31	2015/03/31	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	8	2015/03/27	2015/04/01	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	8	N/A	2015/04/01	CAM SOP-00464	EPA 375.4 m

**Remarks:**

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

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

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

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

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

Your Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO  
Your C.O.C. #: na

**Attention:Ahileas Mitsopoulos**

exp Services Inc  
Thunder Bay Branch  
1142 Roland St  
Thunder Bay, ON  
P7B 5M4

**Report Date: 2015/04/01**  
Report #: R3378881  
Version: 1 - Final

**CERTIFICATE OF ANALYSIS**

**MAXXAM JOB #: B553991**  
**Received: 2015/03/27, 10:00**

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.  
Hina Siddiqui, Project Manager –Environmental Customer Service  
Email: HSiddiqui@maxxam.ca  
Phone# (905) 817-5700

=====

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

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

### RESULTS OF ANALYSES OF SOIL

Maxxam ID		AAG172	AAG173	AAG174	AAG175	AAG176	AAG176		
Sampling Date		2015/02/26 15:00	2015/03/20 16:30	2015/03/04 11:15	2015/03/19 10:20	2015/03/11 14:40	2015/03/11 14:40		
COC Number		na	na	na	na	na	na		
	<b>Units</b>	<b>B101-S12</b>	<b>BH105-S4</b>	<b>BH202-S10/S11</b>	<b>BH203-S3</b>	<b>BH302-S10</b>	<b>BH302-S10 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

#### Calculated Parameters

Resistivity	ohm-cm	4300	4100	2400	5200	1500			3963203
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#### Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	<20	<20	57	<20	370		20	3966279
Conductivity	mS/cm	0.23	0.24	0.42	0.19	0.69	0.69	0.002	3967584
Available (CaCl2) pH	pH	6.97	7.79	7.82	7.95	6.20		N/A	3965076
Soluble (20:1) Sulphate (SO4)	ug/g	42	36	240	50	<20		20	3966281

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		AAG177	AAG178	AAG179	AAG179		
Sampling Date		2015/03/18 11:25	2015/03/07 17:10	2015/03/17 10:00	2015/03/17 10:00		
COC Number		na	na	na	na		
	<b>Units</b>	<b>BH303-S4</b>	<b>BH402-S14</b>	<b>BH403-S3</b>	<b>BH403-S3 Lab-Dup</b>	<b>RDL</b>	<b>QC Batch</b>

#### Calculated Parameters

Resistivity	ohm-cm	2400	3000	3100			3963203
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#### Inorganics

Soluble (20:1) Chloride (Cl)	ug/g	79	<20	<20	<20	20	3966279
Conductivity	mS/cm	0.42	0.33	0.32		0.002	3967584
Available (CaCl2) pH	pH	7.63	7.92	7.76	7.85	N/A	3965076
Soluble (20:1) Sulphate (SO4)	ug/g	140	190	170	150	20	3966281

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

N/A = Not Applicable

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

## TEST SUMMARY

**Maxxam ID:** AAG172  
**Sample ID:** B101-S12  
**Matrix:** Soil

**Collected:** 2015/02/26  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG173  
**Sample ID:** BH105-S4  
**Matrix:** Soil

**Collected:** 2015/03/20  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG174  
**Sample ID:** BH202-S10/S11  
**Matrix:** Soil

**Collected:** 2015/03/04  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG175  
**Sample ID:** BH203-S3  
**Matrix:** Soil

**Collected:** 2015/03/19  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG176  
**Sample ID:** BH302-S10  
**Matrix:** Soil

**Collected:** 2015/03/11  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

## TEST SUMMARY

**Maxxam ID:** AAG176  
**Sample ID:** BH302-S10  
**Matrix:** Soil

**Collected:** 2015/03/11  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG176 Dup  
**Sample ID:** BH302-S10  
**Matrix:** Soil

**Collected:** 2015/03/11  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis

**Maxxam ID:** AAG177  
**Sample ID:** BH303-S4  
**Matrix:** Soil

**Collected:** 2015/03/18  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG178  
**Sample ID:** BH402-S14  
**Matrix:** Soil

**Collected:** 2015/03/07  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

**Maxxam ID:** AAG179  
**Sample ID:** BH403-S3  
**Matrix:** Soil

**Collected:** 2015/03/17  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
Conductivity	AT	3967584	N/A	2015/04/01	Lemeneh Addis
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Resistivity of Soil		3963203	2015/04/01	2015/04/01	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

## TEST SUMMARY

**Maxxam ID:** AAG179 Dup  
**Sample ID:** BH403-S3  
**Matrix:** Soil

**Collected:** 2015/03/17  
**Shipped:**  
**Received:** 2015/03/27

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	3966279	N/A	2015/04/01	Deonarine Ramnarine
pH CaCl2 EXTRACT	AT	3965076	2015/03/31	2015/03/31	Neil Dassanayake
Sulphate (20:1 Extract)	KONE/EC	3966281	N/A	2015/04/01	Deonarine Ramnarine

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

### GENERAL COMMENTS

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

Package 1	4.7°C
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Sample AAG172-01 : CONDUCT-SB/PHCACL-S: Sample extracted/analysed past holding time.

**Results relate only to the items tested.**



Maxxam Job #: B553991  
Report Date: 2015/04/01

## QUALITY ASSURANCE REPORT

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
3965076	Available (CaCl <sub>2</sub> ) pH	2015/03/31			100	97 - 103			1.2	N/A
3966279	Soluble (20:1) Chloride (Cl)	2015/04/01	NC	70 - 130	99	70 - 130	<20	ug/g	NC	35
3966281	Soluble (20:1) Sulphate (SO <sub>4</sub> )	2015/04/01	NC	70 - 130	100	70 - 130	<20	ug/g	9.0	35
3967584	Conductivity	2015/04/01			99	90 - 110	<0.002	mS/cm	0.44	10

N/A = Not Applicable

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

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

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

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

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

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

Maxxam Job #: B553991  
Report Date: 2015/04/01

exp Services Inc  
Client Project #: ADM-00223648-B0  
Site Location: HWY 590, KAKABEKA, ONTARIO

### VALIDATION SIGNATURE PAGE

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

*Cristina Carriere*

---

Cristina Carriere, Scientific Services

---

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



6740 Campobello Road, Mississauga, Ontario L5N 2L8 www.maxxam.ca  
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

# CHAIN OF CUSTODY RECORD

Page 1 of 1

INVOICE INFORMATION		REPORT INFORMATION (if differs from invoice)		PROJECT INFORMATION		TURNAROUND TIME (TAT) REQUIRED	
Company Name: exp Services Inc.		Company Name:		Quotation #:		<input checked="" type="checkbox"/> Regular TAT (5-7 days)	
Contact Name: Michael Suslyk, Ahileas Mitsopoulos		Contact Name:		P.O. #:		PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS	
Address: 1142 Roland Street Thunder Bay, ON P7B 5M4		Address:		Project #: ADM-00223648-B0		Rush TAT (Applicable Surcharge)	
Phone: 807.623.9495 Fax: 807.623.8070		Phone: Fax:		Site Location: Hwy 590, Kakabeka, Ontario		<input type="checkbox"/> 1 Day (100%)	
Email: michael.suslyk@exp.com, ahileas.mitsopoulos@exp.com		Email:		Site #:		<input type="checkbox"/> 2 Days (50%)	
				Sampled By: Elwin Farkas		<input type="checkbox"/> 3-4 Days (25%)	
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE MAXXAM DRINKING WATER CHAIN OF CUSTODY				ANALYSIS REQUESTED		Rush Confirmation #:	
REGULATION 153 (2011)		OTHER REGULATIONS				Date Required:	
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> Table		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQO Municipality: <input type="checkbox"/> Other (Specify): <input type="checkbox"/> REG 558 (MINIMUM 3 DAY TAT REQUIRED)		FIELD FILTERED (PLEASE CIRCLE) Metals / Hg / Cu / V		LABORATORY USE ONLY	
FOR RSC (PLEASE CIRCLE) Yes / <input checked="" type="checkbox"/> No				pH		CUSTODY SEAL (Y/N)	
				Water Soluble Sulphate		Present <input checked="" type="checkbox"/>	
				Resistivity		Intact <input checked="" type="checkbox"/>	
				Conductivity		COOLING MEDIA PRESENT (Y / N)	
				Chloride		4	
Include Criteria on Certificate of Analysis (Y/N)? <input checked="" type="checkbox"/> Y						Temperature (°C) on Receipt	
SAMPLES MUST BE KEPT COOL ( < 10 °C ) FROM TIME OF SAMPLING UNTIL DELIVERY TO MAXXAM						4/5/5	
SAMPLE IDENTIFICATION		DATE SAMPLED	TIME SAMPLED	MATRIX	# OF CONT.	COMMENTS / TAT COMMENTS	
1	B101-S12	Feb. 26/15	3:00	Soil	1		
2	BH105-S4	Mar. 20/15	4:30	Soil	1		
3	BH202-S10/S11	Mar. 04/15	11:15	Soil	1		
4	BH203-S3	Mar. 19/15	10:20	Soil	1		
5	BH302-S10	Mar. 11/15	2:40	Soil	1		
6	BH303-S4	Mar. 18/15	11:25	Soil	1		
7	BH402-S14	Mar. 07/15	5:10	Soil	1		
8	BH403-S3	Mar. 17/15	10:00	Soil	1		
9							
10							
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME:	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME:
 Michael Suslyk		26-Mar-15	1:30	 Hina Siddiqui		2015/03/27	10:00

Maxxam Analytics International Corporation o/a Maxxam Analytics

27-Mar-15 10:00  
Hina Siddiqui  
B553991

HP6 ENV-789