



## **FINAL REPORT**

### **FOUNDATION INVESTIGATION REPORT- SUPPLEMENTAL FOUNDATION INVESTIGATION**

**Agreement # 5009-E-0060**

**GWP 5242-10-00**

**MTO GEOCRES No. 31E-311**

**Hwy 11 Centreline Culvert – 750 m South of Alpine Ranch Road  
Macaulay Township, Huntsville Area**

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# Ministry of Transportation

Foundation Investigation Report – Supplemental Foundation Investigation  
Agreement # 5009-E-0060  
GWP 5242-10-00  
MTO GEOCRES No. 31E-311

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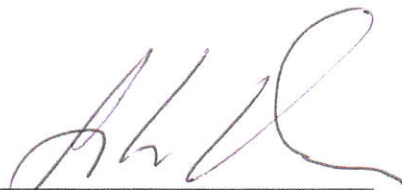
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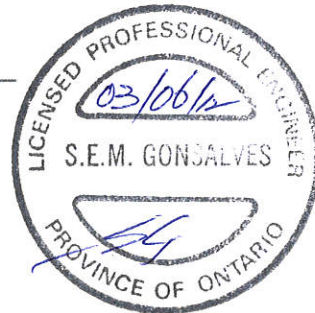
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# FOUNDATION INVESTIGATION REPORT- SUPPLEMENTAL FOUNDATION INVESTIGATION

## 1.1 Introduction

This report presents the results of geotechnical investigations completed by **exp. Services Inc. (exp.)** for the replacement of a Highway 11 centreline culvert located 750 m south of Alpine Ranch Road in MacAulay Township, Huntsville Area. The existing culvert was installed in 1975 and consists of two parts: (i) a concrete box structure lined with 900 mm ID smooth wall plastic pipe, and (ii) a 1.8 m diameter Corrugated Steel Pipe (CSP). The concrete box culvert is approximately 70 m long and it goes through the SBL highway embankment. The CSP culvert has three sections – 15 m, 23 m and 93 m in length going under the NBL highway embankment. The existing culvert is experiencing distress and bracing has been installed to control movement. In this investigation two alignments were explored; the current and a proposed more direct alignment. The site plan showing both alignments is included in Appendix B.

The field work was initially undertaken under Agreement No. 5009-E-0060, Assignment No. 3, in May 2011. The terms of reference were as presented in the Request for Quotation (RFQ) by Ministry of Transportation (MTO) dated February 24, 2011. In addition, the supplemental foundation investigation was initiated by MTO in the Request for Proposal dated December 09, 2011, under Agreement No. 5009-E-0060, Assignment No. 7.

The purpose of the initial investigation performed in May 2011 was to examine the soil conditions at the location of the existing culvert alignment and new proposed culvert alignment. The site specific geotechnical investigation consisted of test borings, borehole logging, and field and laboratory testing. The Foundation Investigation Report covering the factual results of that investigation and the accompanying laboratory testing was issued in June 28, 2011, while the Foundation Investigation and Design Report with recommendations was submitted in August 31, 2011. The purposes of the supplemental foundation investigation were: (i) to supplement the initial foundation investigation in order to reduce subsurface uncertainty in between existing boreholes located at the proposed culvert realignment, and (ii) to verify water conditions within the embankment fill. This foundation investigation report presents the combined results of the initial and supplemental foundation investigations.

## 1.2 Site Description and Geological Setting

### 1.2.1 Site Description

The site is located on Highway 11 in MacAulay Township, District of Muskoka, Huntsville Area, approximately 750 m south of Alpine Ranch Road. It is distanced approximately 8.5 km north of the Town of Bracebridge, Ontario. At the location of the existing culvert both lanes of the roadway (SBL and NBL) are within a fill section. The culvert crosses the SBL and NBL highway embankments and conveys collected surface water from the valley at the west side of the embankment. The drainage in the area generally consists of roadside ditches which drain into nearby streams. It appears that the culvert connects a meandering stream feeding the North Branch Muskoka River. The site plan is shown on Drawing 1 in Appendix B.

The existing culvert consists of a 70 m long concrete box lined with 900 mm ID plastic pipe under the SBL embankment and a 1800 mm diameter by 131 m long CSP under the NBL embankment. Two sections of the CSP culvert experienced distress and were braced in 2009 at 12 locations to prevent further movement. The third section of the CSP culvert is now also showing signs of distress.

In 2008 and 2010, sinkholes occurred in the east embankment adjacent to the NBL coinciding in location with the 45 degree bend in the CSP culvert. These sinkholes have since been filled. The photo exhibiting that area is shown in Appendix A.

The terrain in the area of the culvert is steeply undulating. Within the right of way, the slopes of the embankment are covered with large size stones and some vegetation. The inlet (west) side is relatively clear of trees and bushes. The outlet (east) side is very steep, with rock fill on the surface and is covered with bushes and trees. The embankment is approximately 15 m high. The NBL and SBL are separated by a large grassy ditch. Photos showing the site are included in Appendix A.

### 1.2.2 Geological Setting

The Ontario Geological Survey Map of Precambrian Geology in the Bracebridge area (Map P.3411) shows the area to be Mafic-Rich Gray Gneiss bedrock covered by sediments from the Pleistocene and Holocene Epoch. The area is identified as Lacustrine Plain consisting of thick sand sequences and fine-textured glaciolacustrine deposits (massive to well laminated silts and rhythmically laminated or varved silts and clays). A review of the Quarternary Geology of the Huntsville-Penetanguishene Area Report by the Ministry of Northern Development and Mines, Ontario (MNDM) in 1994 indicates that because of the specific topography within gneissic bedrock area it may contain organic deposits as well.

## 1.3 Investigation Procedures

### 1.3.1 General

The field work for the initial investigation was performed between May 11 and May 30, 2011, during which time ten (10) boreholes were advanced at the site to depths of between 6.1 m and 23.3 m. Five (5) boreholes were drilled along the existing culvert (BH-2, BH-3, BH-4, BH-5 and BH-10) two (2) boreholes were drilled in the inlet/outlet (common vicinity for existing and proposed alignments) (BH-1 and BH-6), and the remaining three (3) boreholes were drilled along the proposed new alignment (BH-7, BH-8 and BH-9). The supplemental field work was carried out between February 14 and 17, 2012, and three (3) additional boreholes were drilled along the proposed new alignment (BH-11, BH-12 and BH-13) to depths of approximately 20 m. Borehole BH-13A was first drilled to 2.9 m depth where a boulder was encountered, and then a new borehole BH-13 was redrilled offset 1.7 m north-west from the original location, and sampling and testing continued below that depth (see Photos 7 and 8, Appendix A). Drawing 1 in Appendix B shows the locations of the thirteen boreholes.

Boreholes on the embankment crest (i.e. BH-2, BH-3, BH-4, BH-7, BH-8 and BH-9) were advanced using a CME 750 rubber tire off-road drill rig, equipped with a hollow stem auger and standard soil sampling equipment operated by a specialist drilling contractor, Ontario Soil Drilling. Due to difficult access, boreholes at the toes of embankment (i.e. BH-1, BH-5, BH-6 and BH-10) were advanced by hand drilling/sampling equipment operated by Sonic Soil Sampling (Ontario) Inc. Supplementary boreholes BH-11, BH-12 and BH-13 were advanced with hollow stem augers using a rubber track-mounted CME 75

drill rig equipped for continuous soil and rock sampling. The drilling equipment was owned and operated by Aardvark Drilling Inc., Ontario.

During the drilling of the boreholes on the crest in May 2011 (i.e. BH-2, BH-3, BH-4, BH-7, BH-8 and BH-9), soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D 1586), at intervals 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 (pg. 40) and used to provide an assessment of in-situ consistency or relative density of non-cohesive soils. In addition, dynamic cone penetration testing was utilized in all boreholes to verify the soil consistency condition established by the SPT tests. The resistance to penetration is measured as the number of blows for each 0.3 m advance of the conical point into the undisturbed ground and plotted on the borehole log sheets in Appendix C.

During the drilling of the boreholes at the toes of embankment in May 2011 (i.e. BH-1, BH-5, BH-6 and BH-10), soil samples were obtained using a 70-pound pionjar, at intervals shown on the attached borehole logs (Appendix C). Dynamic cone penetration tests were performed besides the drilled boreholes and the number of blows was recorded and used to assess relative density of the soil deposit. Since the manual hammer of 31.7 kg was used for hand testing, which is half of the conventional hammer weight (63.5 kg), the corresponding blow counts plotted on the borehole logs (Appendix C) were factored by 0.5.

During the drilling of the supplementary boreholes (i.e. BH-11, BH-12 and BH-13) in February 2012, soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing. Semi-continuous sampling at 0.75 m intervals was carried out within the first 3 m of overburden followed with sampling at 1.5 m intervals up to Elevation 285 m; whereas, continuous sampling was done from Elevation 285 m up to the end of those boreholes. NQ-sized coring equipment was used to core the boulder encountered in BH-13A.

The groundwater levels in the open boreholes were observed and recorded throughout the drilling operations. A stand pipe piezometer consisting of 19 mm diameter PVC pipe with a 3 m slotted screen enclosed in sand was installed in BH-12 to permit longer term groundwater level monitoring. After completion all other boreholes were sealed by a cement-bentonite mixture in accordance with accepted practice for decommissioning of boreholes (Ontario Reg 903 as amended by Ontario Reg. 372).

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 ASTM D 2487-06, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), and retrieved soil samples for subsequent laboratory testing and identification. All of the recovered soil samples were placed in labelled moisture-proof bags and returned to exp's Markham and Brampton laboratories for additional visual, textual and olfactory examination.

Details of the soil strata encountered in the boreholes are included in attached borehole log sheets in Appendix C, and plotted on the profiles in Appendix B.

The locations of the boreholes were determined by MTO and exp on a site plan, and these locations were surveyed and staked in the field by exp prior to drilling. The borehole locations (referenced to the MTM

NAD27 coordinate system) and ground surface elevations (referenced to the geodetic datum- MTO BM 294-67, Elev. 314.642 m) are shown on Drawing 1 in Appendix B.

### 1.3.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included natural water content and grain size distribution tests on approximately 25% of the collected soil samples. To address concerns regarding pipe corrosion, chemical tests (i.e. pH, electrical conductivity/resistivity, and sulphate and chloride levels) on selected soil and water samples were performed. All of the laboratory tests were carried out to 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 are presented in Appendix D.

### 1.3.3 Previous Investigation

No foundation reports were available in the MTO GEOCREST library for this site.

## 1.4 Subsurface Conditions

### 1.4.1 General

The detailed subsurface soil and groundwater conditions as encountered in the boreholes advanced during these investigations, together with the results of the laboratory tests carried out on selected soil samples, are presented on the borehole log sheets in Appendix C. Laboratory test results are also 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. ASTM D 2487-06, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), was used for classification of soils encountered on the site (Appendix E).

A borehole location plan and cross section soil profiles along the existing and proposed culvert alignments are provided in Appendix B. The stratigraphy of ground below the culvert inlet and outlet was confirmed by BH-1 and BH-6, respectively. The stratigraphy within highway embankments along the existing and proposed alignments and ground below was verified through drilling BH-2, BH-3, BH-4, BH-5, BH-7, BH-8, BH-9, BH-10, BH-11, BH-12 and BH-13.

A boulder was encountered at 2.9 m depth in BH-13A. After coring by a NQ double tube wireline corebarrel it was confirmed that the boulder was made of gneiss with grain size of approximately 0.28 m diameter. The photo of the boulder core is shown in Appendix A, Photo 6. No boulder encountered in other boreholes during these field investigations.

It should be noted that the stratigraphic boundaries indicated on the borehole logs and cross section soil profiles are in some cases inferred from non-continuous and continuous sampling, observations of drilling progress and results of Standard Penetration Tests and Dynamic Cone Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be regarded as



exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

A summary of the soil and groundwater conditions encountered in the boreholes is provided below.

#### 1.4.2 Subsurface Conditions at Culvert Inlet and Outlet

BH-1 and BH-6 were drilled at inlet and outlet locations, respectively, which are common vicinity for existing and proposed culvert alignments. In general, the subsurface conditions at these locations consist of a thin layer of silty sand fill underlain by native sandy silt deposits. The deposits typically contain trace organics and root fibers.

##### 1.4.2.1 Silty Sand Fill

Silty sand fill was encountered at the ground level at the inlet and outlet locations of the existing culvert. This silty sand fill layer has a thickness about 0.8 m. It extends to approximate elevations of 281.7 m at the inlet and 279.4 m at the outlet.

The fill consists of silt and sand, and trace organics. The layer is dark brown in color, and wet. The results of the dynamic cone penetration tests classify this silty sand fill as very loose in compactness condition.

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

Moisture Content:

- 23.3% to 30.8%

Grain Size Distribution:

- 71% sand; and
- 29% silt and clay.

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

##### 1.4.2.2 Sandy Silt

Sandy silt deposits were encountered below the fill in BH-1 and BH-6 drilled at the inlet and outlet of the existing/proposed culvert, respectively. This sandy silt layer extends to the depth of approximately 6.1 m, corresponding to approximate elevations of 276.4 m at the inlet side and 274.1 m at the outlet side. Both boreholes were terminated in this layer.

The deposit consists of sand and silt, trace gravel and organics. The sandy silt is brown to grey in color, and wet. Dynamic cone penetration tests performed within the sandy silt deposit indicate a 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:

- 17.3% to 23.1%

Grain Size Distribution:

- 19% to 58% sand;
- 41% to 80% silt; and
- 1% clay.

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

#### 1.4.3 Subsurface Conditions within Highway Embankment along the Existing Culvert Alignment

Boreholes BH- 2, BH-3, BH-4, BH-5, and BH-10 were located and drilled along the existing culvert. The results of drilling of these boreholes show that the subsurface conditions within the highway embankment along the existing culvert consist of a surficial layer of sand and gravel fill followed by silty sand fill, and then underlain by native sandy silt deposits.

##### 1.4.3.1 Asphalt

At BH-2 drilled on the crest of SBL highway embankment, asphaltic concrete was encountered at ground surface. The thickness of the asphaltic concrete layer was 20 mm and the top elevation of this layer is approximately 298.7 m.

##### 1.4.3.2 Sand and Gravel Fill

Sand and gravel fill was encountered in the boreholes drilled at the shoulders of the highway, i.e. BH-2 (SBL) and BH-4 (NBL). At BH-2 the sand and gravel fill was found below surface asphalt, while at BH-4, the sand and gravel fill was encountered at the ground surface. The thickness of the sand and gravel fill ranges from 0.6 m (BH-2) to 0.9 m (BH-4). This layer at the SBL highway embankment extends from elevation of about 298.7 m to 298.1 m. At the NBL embankment the layer extends from elevation of approximately 296.6 m to 295.7 m.

The composition of this layer is sand and gravel. It is brown in color, and moist. SPT “N” value was around 16 to 17 blows per 300 mm penetration, classifying the material as compact in compactness condition.

The moisture contents of the sand and gravel fill samples are between 4.9% and 8.0%. The results of the moisture content are provided on the record of borehole sheet in Appendix C.

#### 1.4.3.3 Silty Sand Fill

Silty sand fill was encountered in all boreholes drilled through the highway embankment along the existing alignment. At BH-2 and BH-4, this layer was found below the pavement base, while at BH-3, BH-5 and BH-10 it was encountered at the ground surface. This silty sand fill layer has a thickness ranging from about 1.4 m (BH-5 and B-10) at the east toe of the embankment to 16.2 m (BH-2) at the crest of the embankment. It extends to depths between 1.4 m and 16.8 m, corresponding to approximate elevations of 281.6 and 281.9 m, respectively.

The fill consists of silt and sand, trace to some gravel, and trace to some organics. The layer is brown to grey in color, and moist to wet. SPT “N” values range from 6 to 42 blows per 300 mm, classifying this silty sand fill as loose to dense in compactness condition.

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

Moisture Content:

- 5.8% to 20.2%

Grain Size Distribution:

- 51% to 82% sand;
- 18% to 49% silt, and
- 1% clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The results of the grain size distribution tests are also provided on Figures 3 and 4 in Appendix D.

#### 1.4.3.4 Sandy Silt

Beneath the fill material, a native sandy silt deposit was encountered in all boreholes drilled within the highway embankment along the existing culvert. This sandy silt layer has a thickness ranging from about 4.7 m to 10.8 m. It extends to depths between 6.1 m and 23.3 m, corresponding to approximate elevations of 277.8 and 275.4 m, respectively. All boreholes were terminated in this layer.

The deposit consists of silt and sand, and some root fibers (BH-3). The layer is brown to grey in color, and moist to wet. SPT “N” values range from 5 to 27 blows per 300 mm, classifying the sand as loose to compact in compactness condition.

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

Moisture Content:

- 11.3% to 26.6%

Grain Size Distribution:

- 15% to 42% sand;
- 58% to 85% silt, and
- 1% clay.

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

#### 1.4.4 Subsurface Conditions within Highway Embankment along the Proposed Culvert Alignment

BH-7, BH-8 and BH-9 were initially drilled through the highway embankment along the proposed culvert alignment. BH-11, BH-12 and BH-13 were drilled supplementary along the same alignment to reduce subsurface uncertainty in between previously drilled boreholes. Likewise along the existing culvert, the subsurface conditions within the highway embankment along the proposed alignment generally consist of a layer of silty sand embankment fill underlain by native sandy silt deposits. A detail description is provided in subsequent sections.

##### 1.4.4.1 Asphalt

At BH-11 and BH-13 drilled on the crest of SBL and NBL highway embankments, respectively, asphaltic concrete was encountered at ground surface. In BH-11 the thickness of the asphaltic concrete layer was 280 mm and the top elevation of this layer is approximately 298.1 m. In BH-13 the thickness of the asphalt layer was 150 mm having a top elevation of approximately 295.7 m.

##### 1.4.4.2 Topsoil

A 300 mm thick layer of topsoil was encountered at the ground surface in BH-12 drilled in the ditch between SBL and NBL highway embankments. The topsoil was sandy, brown, moist and very loose.

##### 1.4.4.3 Sand and Gravel Fill

Sand and gravel fill was encountered in BH-9 and BH-13 drilled at the NBL embankment crest, and in BH-11 drilled at the SBL embankment along the proposed alignment. At BH-11 and BH-13 the sand and gravel fill was found below surface asphalt, while at BH-9, the sand and gravel fill was encountered at the ground surface. The thickness of the sand and gravel fill ranges from 0.12 m (BH-11) to 0.9 m (BH-9). This layer at the NBL highway embankment extends from elevation of about 296.5 m to 294.9 m. At the SBL embankment the layer extends from elevation of approximately 297.8 m to 297.65 m.

The composition of this layer is sand and gravel. It is brown in color, and moist. SPT “N” values range from 26 to 73 blows per 300 mm penetration, classifying the material as compact to very dense in compactness condition.

The moisture content of a sand and gravel fill sample is between 3.3% and 5.1%. The result of the moisture content is provided on the record of borehole sheet in Appendix C.

#### 1.4.4.4 Silty Sand Fill

Silty sand fill was encountered in all boreholes drilled through the highway embankment along the proposed alignments. At locations of BH-7 and BH-8 this layer was found at the ground surface, while at BH-12 it was found below the topsoil. In BH-9, BH-11 and BH-13 it was encountered below the sand and gravel fill. Along the proposed alignment the silty sand fill layer has a thickness ranging from about 12.2 m to 15.2 m. It extends to depths between 12.2 m and 15.2 m, corresponding to approximate elevations between 282.4 and 283.5 m.

The fill consists of silt and sand, brown in color, and moist to wet. A 0.26 m diameter gneiss boulder was encountered in BH-13A at 2.9 m depth. Boulders were not found in other boreholes. Some perched water over clayey silt layers was observed (i.e. BH-11 and BH-12). SPT “N” values range from 6 to 41 blows per 300 mm, classifying the sand as loose to dense in compactness condition. SPT “N” values in the bottom part of this layer, approximately between elevation 282.5 m and 285.0 m, were in the range of 17 to 29 blows per 300 mm, corresponding to compact conditions.

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

Moisture Content:

- 3.3% to 22.9%

Grain Size Distribution:

- 42% to 73% sand;
- 27% to 64% silt; and
- 0% clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The results of the grain size distribution tests are also provided on Figures 7, 8 and 9 in Appendix D.

#### 1.4.4.5 Sandy Silt

Beneath the fill material, a native soil material of sandy silt was encountered in all boreholes drilled through the highway embankment along the proposed culvert alignment. The sandy silt layer extends to depths between 20.3 m and 23.3 m, corresponding to approximate elevations of 274.3 and 274.5 m, respectively. All boreholes were terminated in this layer.

The deposit consists of silt and sand, with some clay seams. The layer is grey in color and wet. SPT “N” values range from 2 to 28 blows per 300 mm, classifying the sandy silt as very loose to compact in compactness condition, but more typically compact conditions.

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

Moisture Content:

- 17.5% to 25.2%

Grain Size Distribution:

- 7% to 42% sand;
- 56% to 92% silt; and
- 1% clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The results of the grain size distribution tests are also provided on Figures 10 and 11 in Appendix D.

## 1.5 Soil and Water Chemical Quality

Soil samples from BH-1, BH-5 and BH-6 were selected for pH, chloride, sulphate and electrical conductivity testing. The same chemical tests were performed on the water samples collected at the inlet and outlet of the existing culvert. The test results are shown on Table 1.1 below.

Table 1.1 Summary of chemical analyses

Sample Type	Sample Location	Chloride (mg/L)	Sulphate (mg/L)	pH	Electrical Resistivity (ohm-cm)
Soil	BH-1; SS2	167.9	60.3	6.30	2193
	BH-5; SS4	439.9	66.5	5.28	987
	BH-6; SS2	503.9	88.7	4.55	844
Surface Water	Inlet	65.4	20.2	6.53	22222
	Outlet	634.9	29.1	6.25	7692

The following indicates some acceptable/permissible levels:

- Chlorides primarily attack exposed metal, whether it be steel pipe or reinforcing steel in concrete pipe. The maximum permissible levels of chlorides in water for galvanized steel and aluminized type 2 steel culverts are 150 mg/L and 193 mg/L, respectively, according to the Canadian Performance Guideline for CSP Culverts (CSA G401).
- Sulphates are typically more damaging to the concrete culvert, although high sulphate concentrations can lower pH and can be a concern to metal culverts (AASHTO 2000). According to AASHTO, concrete pipe is normally sufficient to withstand sulphate concentrations to 1000 mg/L or less. The sulphate concentrations up to 150 mg/L are considered negligible for sulphate corrosion.

- Soil that are extremely acidic (pH less than 5.5) or very strongly alkaline (pH greater than 8.5) are generally associated with significant corrosion rates (AASHTO 2000). Therefore, according to AASHTO (2000) soil and water pH levels between 5.5 and 8.5 are considered to be non-corrosive.
- According to the Canadian Performance Guideline for CSP Culverts (CSA G401), the minimum permissible levels of resistivity for galvanized steel and aluminized type 2 steel culverts are 2000 ohm-cm and 1500 ohm-cm, respectively. Generally, if the soil resistivity is less than 2000 ohm-cm, the soil corrosiveness is considered as severe (MTO Gravity Pipe Design Guidelines, pg. 25).

## 1.6 Groundwater Conditions

The groundwater levels at the site were measured in open holes upon completion of drilling operations and in the piezometer installed in BH-12. The ground water levels encountered in the boreholes are shown in Table 1.2 and on the borehole logs in Appendix C. One week after the piezometer installed, the groundwater level in the embankment was found to be at approximately 14.8 m depth (i.e Elevation 282.8 m), which corresponds to the interpreted level of the boundary between fill and native materials. It should be noted that the groundwater level is subject to seasonal fluctuations with higher levels expected during the spring. Some perched water over clayey silt, less permeable layers was observed during the supplemental foundation investigation as recorded in Borehole logs (i.e. BH-11 and BH-12).

Table 1.2 Groundwater levels at the site

Borehole No.	Type of Recording	Date of Drilling	Water Level	
			Depth (m)	Elevation (m)
BH-1	Open hole	May/11/2011	0.6	281.9
BH-2	Open hole	May/25/2011	14.6	284.1
BH-3	Open hole	May/27/2011	10.0	282.9
BH-4	Open hole	May/19/2011	13.6	283.0
BH-5	Open hole	May/17/2011	1.1	281.9
BH-6	Open hole	May/12/2011	0.6	279.6
BH-7	Open hole	May/30/2011	14.3	283.5
BH-8	Open hole	May/20/2011	10.8	283.8
BH-9	Open hole	May/24/2011	13.4	282.3
BH-10	Open hole	May/13/2011	2.4	281.5
BH-11	Open hole	February/16/2012	14.8	283.3
BH-12	Piezometer	February/17/2012	14.7	282.9
		February/24/2012	14.8	282.8
BH-13	Open hole	February/15/2012	12.8	282.9

## 1.7 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 – Supplemental Foundation Investigation Report has been prepared by Silvana Micic, Ph.D., P.Eng and Teasang Ahn, Ph.D., and reviewed by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The initial field investigation was conducted by Raymond Lam, while the supplemental field investigation was conducted by Dan Urian, M.E.Sc., E.I.T.


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.**

  
Teasang Ahn, Ph.D.  
Technical Specialist

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

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

Encl.





## **Appendix A – Photographs**



Photo 1. Inlet of the existing culvert (west side of Hwy 11)



Photo 2. Inlet of the existing culvert (facing west)





Photo 3. East side of Hwy 11 (facing north)



Photo 4. Outlet of the existing culvert (facing east)



Photo 5. The SBL of Hwy 11 (facing south)



Photo 6. Locations of boreholes for supplemental field work (facing north-west)



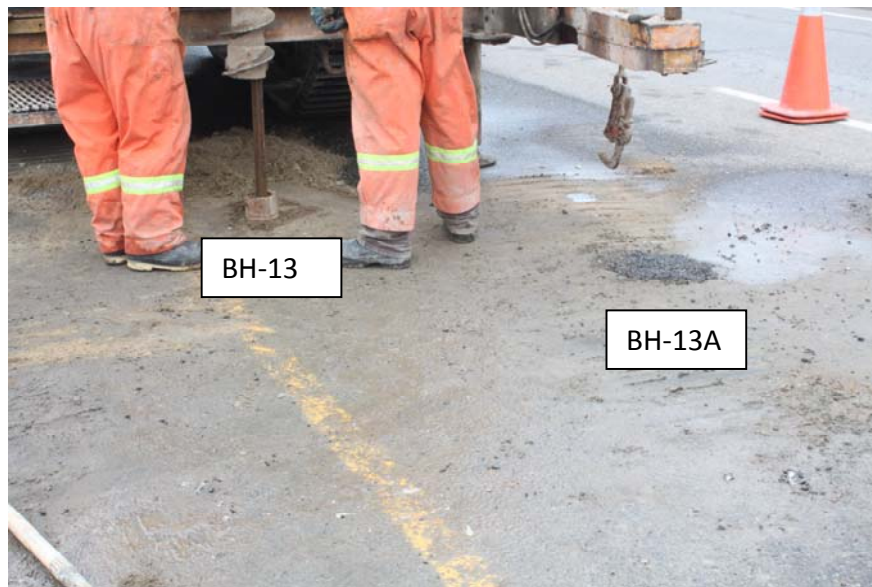


Photo 7. Locations of boreholes BH-13 and BH-13A



Photo 8. The core of gneiss boulder recovered from BH-13A



Photo 9. Sinkhole in the east embankment

## **Appendix B – Drawings**



METRIC

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

Agreement No. 5009-E-0060  
Assignment No. 7  
GWP 5242-10-00



HWY 11 CENTRELINE CULVERT -  
750 m South of Alpine Ranch Road  
MACAULAY TOWNSHIP

SHEET  
1



EXP Services Inc.

The new identity of Trow Associates



KEY MAP

not to scale

LEGEND

- Approx. Borehole Location (Found. Investigation May2011)
- Approx. Borehole Location (Found. Investigation Feb2012)

Geodetic datum-MTO BM 294-67, Elev. 314.642 m

BH No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
1	282.5	4 997 654	319 602
2	298.7	4 997 657	319 636
3	292.9	4 997 664	319 657
4	296.6	4 997 656	319 685
5	283.0	4 997 652	319 720
6	280.2	4 997 545	319 724
7	297.8	4 997 612	319 633
8	294.6	4 997 574	319 673
9	295.7	4 997 558	319 687
10	283.9	4 997 615	319 716
11	298.1	4 997 609	319 646
12	297.6	4 997 600	319 653
13A/13	295.6	4 997 581	319 679

NOTE

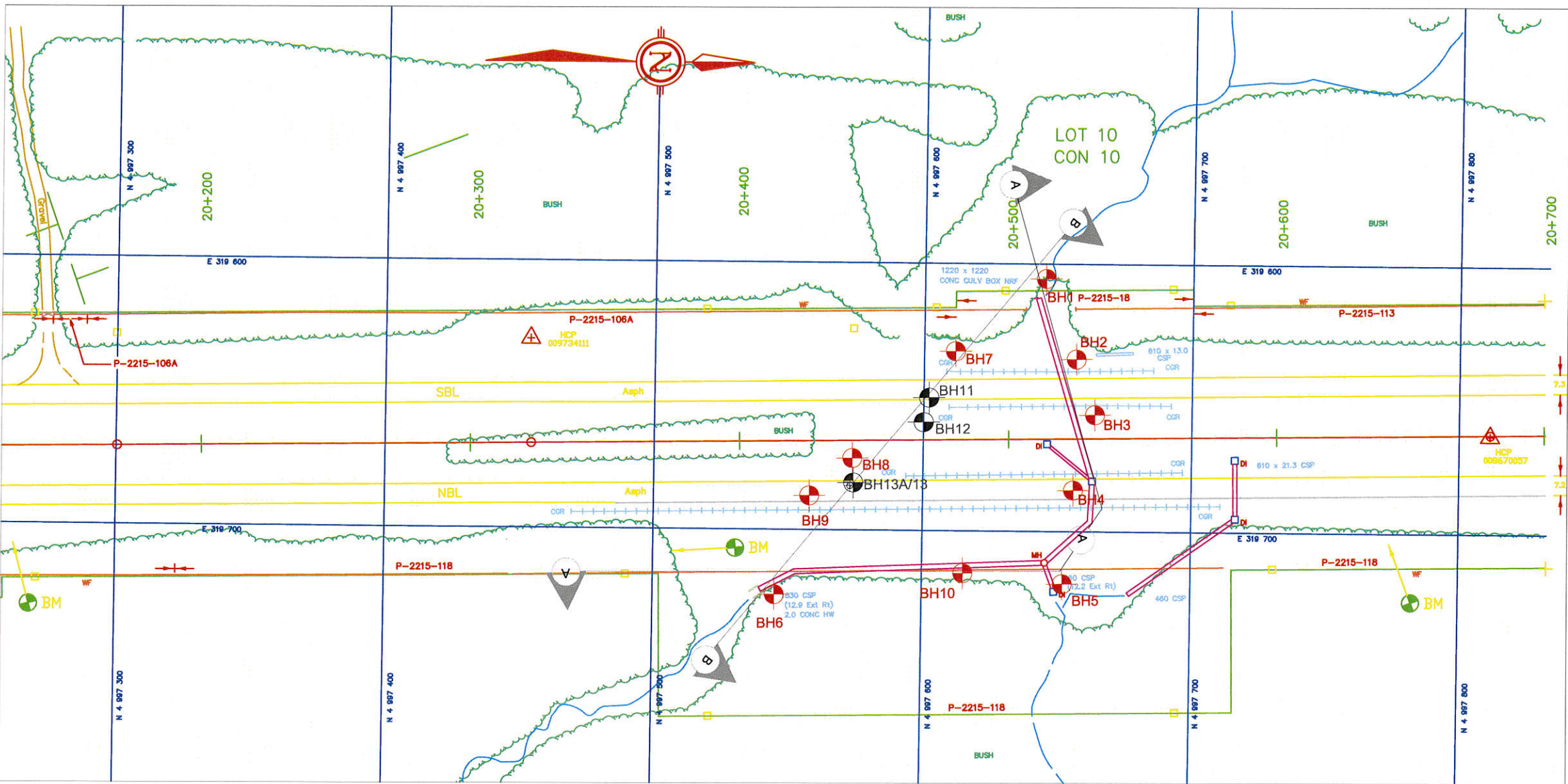
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents

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 this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV. No.	DATE	BY	DESCRIPTION
06/03/2012	SM		

Geocres No. 31E-311

HWY No.11	Project No. ADM 00204515-A0	DIST. MUSKOKA
SUBM'D: SM	CHECKED: SG	DATE: March 2012
DRAWN: TA	CHECKED: SM	APPROVED: SG
		DWG. 01



PLAN

Note:  
BH-13A was initially drilled to 2.9m depth and a boulder was encountered at that depth. This boulder was cored. A new BH-13 was redrilled approximately 1.7m NW from the original location, and sampling and testing continued below that depth





METRIC

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

Agreement No. 5009-E-0060  
Assignment No. 7  
GWP 5242-10-00

HWY 11 CENTRELINE CULVERT -  
750 m South of Alpine Ranch Road  
MACAULAY TOWNSHIP



SHEET  
2



EXP Services Inc.  
The new identity of Trow Associates



KEY MAP  
not to scale

LEGEND

- Approx. Borehole Location (Found. Investigation May2011)
- 'N' Blows/0.3m (Standard Penetration Test, 475 J/blow)
- Water Level in Open Hole
- Approximate Invert Level of the Culvert

BH No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
1	282.5	4 997 654	319 602
2	298.7	4 997 657	319 636
3	292.9	4 997 664	319 657
4	296.6	4 997 656	319 685
5	283.0	4 997 652	319 720
6	280.2	4 997 545	319 724
10	283.9	4 997 615	319 716

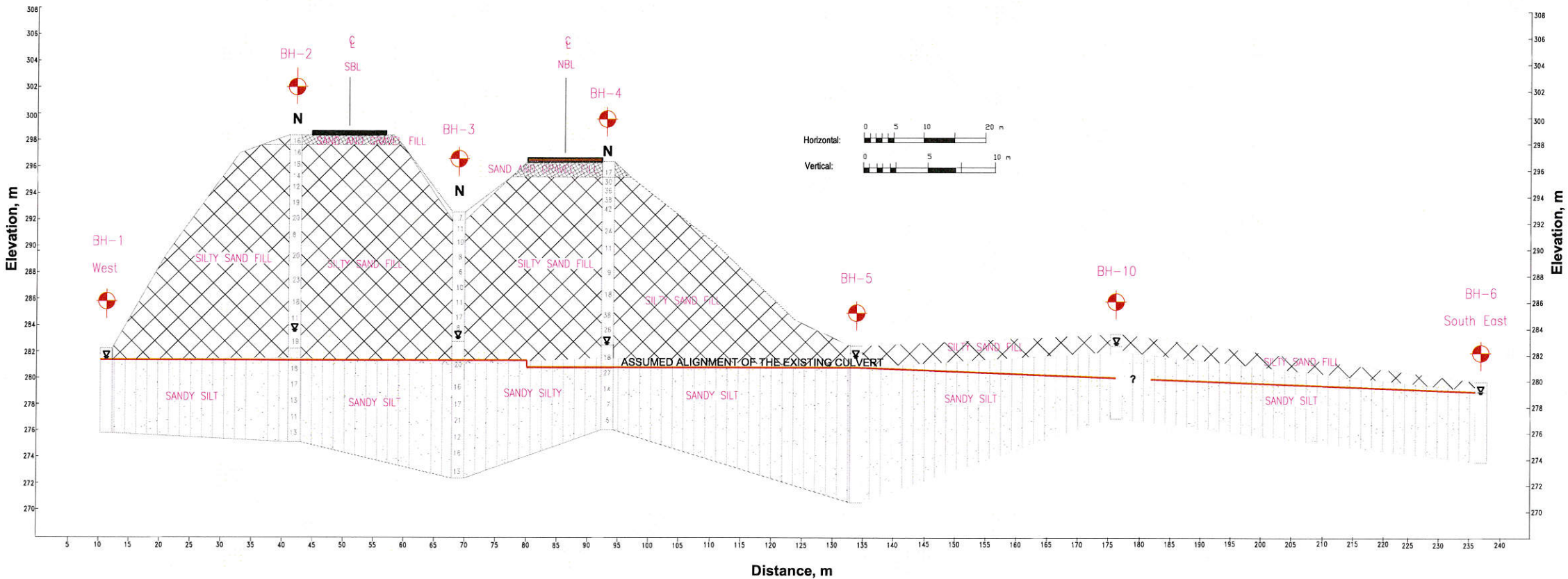
=NOTE=

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 this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV. No.	DATE	BY	DESCRIPTION
06/03/2011	SM		

Geocres No. 31E-311			
HWY No.11	Project No. ADM 00204515-A0	DIST. MUSKOKA	
SUBM'D: SM	CHECKED: SG	DATE: June 2011	SITE:
DRAWN: TA	CHECKED: SM	APPROVED: SG	DWG. 02



SECTION A-A  
1





METRIC

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

Agreement No. 5009-E-0060  
Assignment No. 7  
GWP 5242-10-00



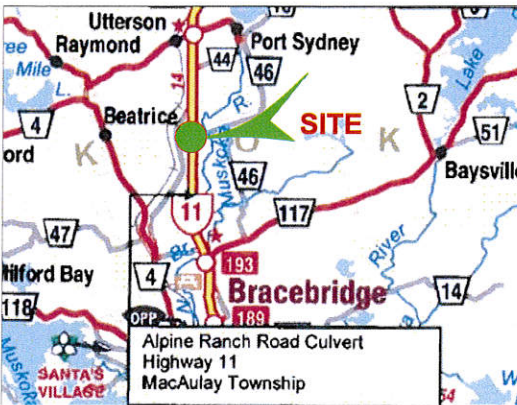
HWY 11 CENTRELINE CULVERT -  
750 m South of Alphine Ranch Road  
MACAULAY TOWNSHIP

SHEET  
3



EXP Services Inc.

The new identity of Trow Associates



KEY MAP

not to scale

LEGEND

- Approx. Borehole Location (Found. Investigation May 2011)
- Approx. Borehole Location (Found. Investigation Feb 2012)
- 'N' Blows/0.3m (Standard Penetration Test, 475 J/blow)
- Water Level in Open Hole
- Water Level in Piezometer (February 2012)
- Piezometer

BH No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
1	282.5	4 997 654	319 602
6	280.2	4 997 545	319 724
7	297.8	4 997 612	319 633
8	294.6	4 997 574	319 673
9	295.7	4 997 558	319 687
11	298.1	4 997 609	319 646
12	297.6	4 997 600	319 653
13A/13	295.6	4 997 581	319 679

=NOTE=

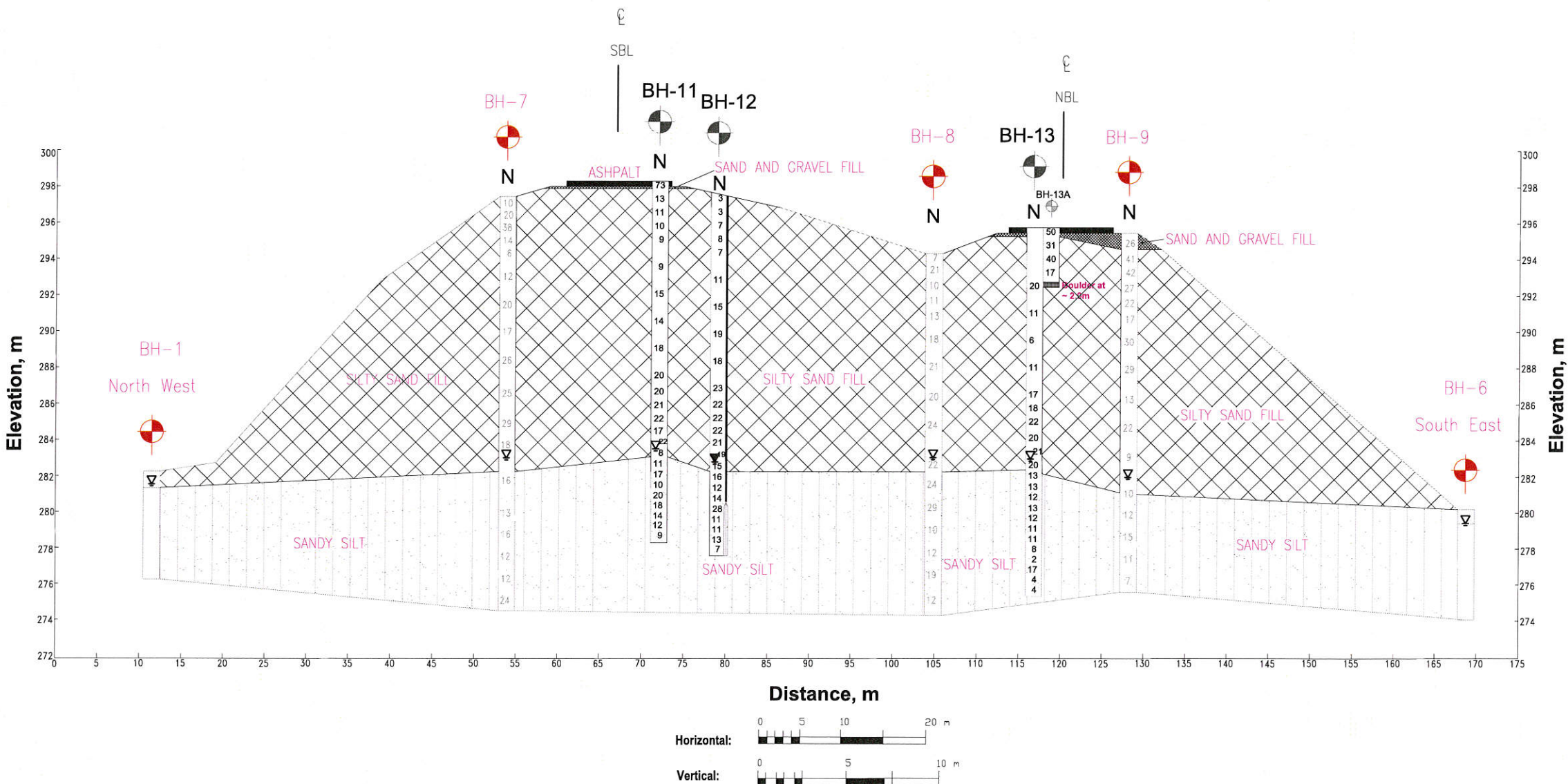
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REV. No.	DATE	BY	DESCRIPTION
06/03/2012	SM		

Geocres No. 31E-311

HWY No.11	Project No. ADM 00204515-A0	DIST. MUSKOKA
SUBM'D: SM	CHECKED: SG	DATE: March 2012 SITE:
DRAWN: TA	CHECKED: SM	APPROVED: SG DWG. 03



SECTION B-B



## **Appendix C – Borehole Logs**

## EXPLANATION OF TERMS USED IN REPORT

**N-VALUE:** THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$C_u$ (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINT AND BEDDING:**

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

### 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
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	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
$c_a$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	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
$S_i$	1	SENSITIVITY = $c_u / \tau_r$

## PHYSICAL PROPERTIES OF SOIL

$P_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	$e$	1, %	VOID RATIO	$e_{\text{min}}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	$n$	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\text{max}} - e}{e_{\text{max}} - e_{\text{min}}}$
$P_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	$w$	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF WATER	$s_r$	%	DEGREE OF SATURATION	$D_n$	mm	N PERCENT – DIAMETER
$P$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$P_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $(w_L - w_p)$	v	$\text{m}/\text{s}$	DISCHARGE VELOCITY
$P_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $(w_L - w) / I_p$	k	$\text{m}/\text{s}$	HYDRAULIC CONDUCTIVITY
$P'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\text{max}}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kN}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kN}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

Brampton, Ontario

# RECORD OF BOREHOLE No BH-01

1 OF 1

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE Hand Drilling COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.11.11 - 5.11.11 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 kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE							
282.5	Ground Surface						20 40 60 80 100	● QUICK TRIAXIAL	× LAB VANE							
0.0	SILTY SAND FILL (SM), trace organics, root fibers, dark brown, wet, very loose		1	SS		▽	282							0 71 (29)		
281.7			2	SS			281									
0.8	SANDY SILT (ML), trace clay, brown, wet, very loose		3	SS			280									
	- becomes grey, loose		4	SS			279									
			5	SS			278									
	- seams and particles of top soils		6	SS			277									
			7	SS										0 19 80 1		
	- loose		8	SS												
276.4	END OF BOREHOLE															
6.1	NOTES: 1. Borehole advanced by hand drilling/sampling equipment. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.															

MTD\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12



Brampton, Ontario

1 OF 2

**METRIC**

W.P.	GWP 5242-10-00	LOCATION	Highway 11, Bracebridge, ON	ORIGINATED BY	RL
DIST	Muskoka	HWY	11	BOREHOLE TYPE	CME Hollow Stem Auger
				COMPILED BY	AG
DATUM	Geodetic - MTO BM 294.67	DATE	5.25.11 - 5.25.11	CHECKED BY	SM

[illegible]

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12



Brampton, Ontario

# RECORD OF BOREHOLE No BH-02

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
DATUM Geodetic - MTO BM 294.67 DATE 5.25.11 - 5.25.11 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 kPa								WATER CONTENT (%)		
								○ UNCONFINED	+	FIELD VANE						● QUICK TRIAXIAL	×	LAB VANE
	SILTY SAND FILL (SM), brown, moist, compact (continued)		12	SS	11		284											
			13	SS	19		283											
281.9								282										
16.8	SANDY SILT (ML), brown to greyish brown, wet, compact		14	SS	18		281									0 23 76 1		
							280											
							279											
	- compact		15	SS	17		278											
							277											
			16	SS	13		276											
			17	SS	11													
275.4			18	SS	13													
23.3	END OF BOREHOLE																	
	NOTES: 1. Borehole advanced with continuous flight hollow stem auger. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.																	

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

MTD\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-03

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.27.11 - 5.27.11 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 kPa							
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
292.9	Ground Surface						20 40 60 80 100								
0.0	SILTY SAND FILL (SM), brown, moist, loose		1	SS	7		292								
	- compact		2	SS	11		291								
	- occasional bands of top soils, moist, compact		3	SS	10		290								
	- decayed wood pieces, dark brown, moist - loose		4	SS	8		289								
			5	SS	6		288								
	- compact		6	SS	10		287								
			7	SS	11		286								
	- compact		8	SS	17		285								
	- loose		9	SS	8		284								
282.2	SANDY SILT (ML), root fibers, brown, wet, compact		10	SS	20		283								
10.7							282								
	- compact		11	SS	16	281									
						280									
	- grey, compact					279									

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-03

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.27.11 - 5.27.11 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 kPa									WATER CONTENT (%)		
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE											
	SANDY SILT (ML), root fibers, brown, wet, compact ( <i>continued</i> )		12	SS	17														
			13	SS	21														
			14	SS	12														
			15	SS	18														
			16	SS	13														
272.6 20.3	END OF BOREHOLE																		
	NOTES: 1. Borehole advanced with continuous flight hollow stem auger. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.																		

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-04

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.19.11 - 5.19.11 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			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
296.6	Ground Surface						20	40	60	80	100	10	20	30	kN/m <sup>3</sup>	GR SA SI CL		
0.0	SAND and GRAVEL FILL (SW), brown, moist, compact		1	SS	17							○						
295.7	SILTY SAND FILL (SM), brown, moist to very moist, dense		2	SS	30								○					
	- dense		3	SS	36								○					
	- occasional bands of topsoil, moist		4	SS	38								○					
	- trace gravel																	
	- dense		5	SS	42								○					
	- compact		6	SS	24								○			0 56 (44)		
			7	SS	11								○					
	- loose		8	SS	9								○			0 66 (34)		
	- occasional bands of top soil, occasional saturated silt seams, compact		9	SS	18								○					
	- dense		10	SS	38								○			0 58 41 1		
	- compact		11	SS	26								○					
282.9	SANDY SILT (ML), trace clay, brown to grey, wet, compact													○		0 42 (58)		
13.7																		

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

MTO EXP RECORD OF BOREHOLE BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

**METRIC**

**NOTES:**

1. Borehole advanced with continuous flight hollow stem auger.
2. Ground water level measured in the open hole upon completion of drilling operation.
3. This drawing is to be read with the subject report and project number as presented above.
4. Interpretation assistance by exp. is required before use by others.

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

Brampton, Ontario

# RECORD OF BOREHOLE No BH-05

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE Hand Drilling COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.16.11 - 5.17.11 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 kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
283.0	Ground Surface																	
0.0	SILTY SAND FILL (SM), dark brown, moist to very moist, loose		1	SS											0 76 (24)			
281.6	- seams of top soil		2	SS														
1.4	SANDY SILT (ML) brown, wet, loose		3	SS														
			4	SS														
			5	SS														
	- becomes grey		6	SS														
			7	SS														
			8	SS														
			9	SS														
			10	SS														
			11	SS														
			12	SS														
	- compact		13	SS														
			14	SS														
			15	SS														
	- compact		16	SS														
270.8	END OF BOREHOLE																	
12.2	NOTES: 1. Borehole advanced by hand drilling/sampling equipment. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is																	

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-05

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE Hand Drilling COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.16.11 - 5.17.11 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	SHEAR STRENGTH kPa					WATER CONTENT (%)			
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	required before use by others.															

MTD\_EXP RECORD OF BOREHOLE BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12



Brampton, Ontario

# RECORD OF BOREHOLE No BH-06

1 OF 1

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE Hand Drilling COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.12.11 - 5.12.11 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  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							W <sub>P</sub>	W	W <sub>L</sub>							
								20	40	60	80	100			20	40	60	80	100	10	20	30		
280.2	Ground Surface							○ UNCONFINED	+ FIELD VANE											kN/m <sup>3</sup>	GR	SA	SI	CL
0.0	SILTY SAND FILL (SM), dark brown, wet, very loose		1	SS			280																	
279.4							279																	
0.8	SANDY SILT (ML), trace clay, brown, wet, very loose  - trace gravel		2	SS			279																	
			3	SS			278													0 58 41 1				
	- occasional root fibers, becomes grey, loose		4	SS			278																	
			5	SS			277													0 37 (63)				
			6	SS			276																	
	- loose		7	SS			275																	
			8	SS																				
274.1	END OF BOREHOLE																							
6.1	NOTES: 1. Borehole advanced by hand drilling/sampling equipment. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.																							

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-07

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.30.11 - 5.30.11 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 $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
297.8	Ground Surface							20 40 60 80 100						
0.0	SILTY SAND FILL (SM), dark brown, moist, loose							20 40 60 80 100						
			1	SS	10		297							
	- compact		2	SS	20		296							
	- dense		3	SS	33		295							
	- compact		4	SS	14		294							
	- loose		5	SS	6		293							
	- compact		6	SS	12		292							
			7	SS	20		291							0 42 (58)
			8	SS	17		290							
			9	SS	26		289							
	- compact		10	SS	25		288							
			11	SS	29		287							0 66 (34)
							286							
							285							
							284							

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-07

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.30.11 - 5.30.11 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 kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	×						
							20 40 60 80 100	20 40 60 80 100		10 20 30						
	SILTY SAND FILL (SM), dark brown, moist, loose (continued)		12	SS	18		283									
282.6																
15.2	SANDY SILT (ML), brown, wet, compact		13	SS	16		282							0 25 74 1		
			14	SS	13		281									
							280									
			15	SS	16		279									
	- compact		16	SS	12		278							0 42 (58)		
							277									
			17	SS	12		276									
	- compact		18	SS	24		275									
274.5 23.3	END OF BOREHOLE															
	NOTES: 1. Borehole advanced with continuous flight hollow stem auger. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.															

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-08

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.20.11 - 5.20.11 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 kPa									
								20 40 60 80 100									
								20 40 60 80 100									
294.6	Ground Surface																
0.0	SILTY SAND FILL (SM), trace root fibers, dark brown, moist, loose		1	SS	7		294										
	- compact		2	SS	21												
							293										
	- moist, compact		3	SS	10												
	- compact		4	SS	11		292										
			5	SS	13		291										
	- compact		6	SS	18		290										
							289										
			7	SS	21		288									0 62 (38)	
	- silt seams, compact		8	SS	20		287										
							286										
			9	SS	24		285										
							284										
			10	SS	22		283										
282.4	SANDY SILT (ML), grey, wet, compact		11	SS	24		282									0 44 (56)	
12.2							281										

Continued Next Page

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

MTD\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

## 2 OF 2

METRIC

W.P.	GWP 5242-10-00	LOCATION	Highway 11, Bracebridge, ON	ORIGINATED BY	RL
DIST	Muskoka	HWY	11	BOREHOLE TYPE	CME Hollow Stem Auger
				COMPILED BY	AG
DATUM	Geodetic - MTO BM 294.67	DATE	5.20.11 - 5.20.11	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 kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
	SANDY SILT (ML), grey, wet, compact ( <i>continued</i> )		12	SS	29										
	- compact						280								
			13	SS	10		279							0 21 78 1	
							278								
			14	SS	12		277								
	- compact						276								
			15	SS	19		275								
274.3 20.3	END OF BOREHOLE		16	SS	12										
NOTES: 1. Borehole advanced with continuous flight hollow stem auger. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.															

WTO EXP RECORD OF BOREHOLE BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12

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



Brampton, Ontario

# RECORD OF BOREHOLE No BH-09

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.24.11 - 5.24.11 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 kPa							
295.7	Ground Surface							○ UNCONFINED	+	FIELD VANE					
0.0	SAND and GRAVEL FILL (SW), brown, moist		1	SS	26			● QUICK TRIAXIAL	×	LAB VANE					
294.9	SILTY SAND FILL (SM), brown, moist, dense		2	SS	41										
0.9			3	SS	42										
	- compact		4	SS	27										
	- compact		5	SS	22										
	- compact		6	SS	17										0 49 (51)
	- dense		7	SS	30										
	- compact		8	SS	29										0 53 (47)
			9	SS	13										
			10	SS	22										
	- loose		11	SS	9										
															0 61 38 1

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-09

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.24.11 - 5.24.11 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 kPa							
○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE															
							20 40 60 80 100								
281.0	SILTY SAND FILL (SM), brown, moist, dense (continued)		12	SS	10										
14.7	SANDY SILT (ML), grey, wet, compact														
			13	SS	12										
	- compact		14	SS	15										
			15	SS	11										
			16	SS	7										
275.4	END OF BOREHOLE														
20.3	NOTES: 1. Borehole advanced with continuous flight hollow stem auger. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.														

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No BH-10

1 OF 1

METRIC

W.P. GWP 5242-10-00 LOCATION Highway 11, Bracebridge, ON ORIGINATED BY RL  
 DIST Muskoka HWY 11 BOREHOLE TYPE Hand Drilling COMPILED BY AG  
 DATUM Geodetic - MTO BM 294.67 DATE 5.13.11 - 5.13.11 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 kPa									WATER CONTENT (%)	
								20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		10 20 30							
283.9	Ground Surface																	
0.0	SILTY SAND FILL (SM), trace organics, root fibers, dark brown, wet, very loose		1	SS			283											
282.5			2	SS														
1.4	SANDY SILT (ML), brown, moist, loose - dark brown, very loose - very loose		3	SS			282								0 39 (61)			
	- loose		4	SS			281											
			5	SS			280								0 33 (67)			
	- loose - grey, compact		6	SS			279											
	- compact		7	SS														
	- compact		8	SS			278											
277.8	END OF BOREHOLE																	
6.1	NOTES: 1. Borehole advanced by hand drilling/sampling equipment. 2. Ground water level measured in the open hole upon completion of drilling operation. 3. This drawing is to be read with the subject report and project number as presented above. 4. Interpretation assistance by exp. is required before use by others.																	

MTO\_EXP RECORD OF BOREHOLE - BOREHOLE LOGS - VERSION 8.GPJ ONTARIO MOT.GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No 11

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Southbound Lane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.16.12 - 2.16.12 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 (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED		+ FIELD VANE							● QUICK TRIAXIAL		× LAB VANE				
298.1	Ground Surface							20	40	60	80	100											
0.0	ASPHALT (280mm)						298																
297.8																							
290.7	SAND AND GRAVEL FILL (SW) (125mm), brown, moist, very dense		1	SS	73								○										
0.4	SILTY SAND FILL (SM) - brown, moist, compact		2	SS	13		297						○										
			3	SS	11		296						○										
	- loose		4	SS	10		295						○										
			5	SS	9		294																
	- perched water over silt seam		6	SS	9		293							○									
	- compact						292						○										
			7	SS	15		291																
			8	SS	14		290							○									
							289							○				0	64 (36)				
							288																
			10	SS	20		287						○					0	66 34 0				
			11	SS	20									○									

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11 CENTRELINER CULVERT.GPJ ONTARIO.MOT.GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No 11

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Southbound Lane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.16.12 - 2.16.12 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 kPa										WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE														
								20	40	60	80	100										
								20	40	60	80	100										

MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11, CENTRELINE CULVERT, GPJ, ONTARIO MOT, GDT, 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No 12

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Centerlane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.17.12 - 2.17.12 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
297.6	Ground Surface							20	40	60	80	100					GR SA SI CL
0.0	TOPSOIL (300mm), with sand, brown, moist, very loose																
297.3																	
0.3	SILTY SAND FILL (SM) - brown, moist, loose		1	SS	3		297							10	20	30	
			2	SS	8									10	20	30	
			3	SS	7		296							10	20	30	
			4	SS	8		295							10	20	30	
			5	SS	7									10	20	30	
							294										
			6	SS	11		293							10	20	30	
	- perched water over silt seam, compact																
							292										
			7	SS	15		291							10	20	30	
	- perched water over clayey silt/silt seam																
							290							10	20	30	
	- perched water over red silt seam		8	SS	19									10	20	30	
							289										
			9	SS	18		288							10	20	30	
							287							10	20	30	
			10	SS	23												
							286							10	20	30	
			11	SS	22												
		</															

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11, CENTRELINE CULVERT, GPJ, ONTARIO MOT, GDT, 3/8/12



Brampton, Ontario

# RECORD OF BOREHOLE No 12

2 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Centerlane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.17.12 - 2.17.12 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 (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20					40	60	80				
								20	40	60	80	100											
	<b>SILTY SAND FILL (SM)</b> - brown, moist, loose ( <i>continued</i> )		12	SS	22		285																
	- becomes wet		13	SS	22		284																
			14	SS	21																		
			15	SS	19																		
283.0								283															
14.6	<b>SANDY SILT (ML)</b> - grey, wet, compact		16	SS	15			282															
			17	SS	16																		
			18	SS	12																		
			19	SS	14																		
			20	SS	28																		
			21	SS	11																		
			22	SS	11																		
			23	SS	13																		
	- loose		24	SS	7																		
277.5	<b>END OF BOREHOLE</b>																						
20.1	<b>NOTES:</b>  1. Borehole advanced using hollow-stem augering method. 2. Piezometer installation consists of a 19 mm diameter PVC pipe with a 3 m slotted screen. Water Level Readings: Date                      Depth(m) 02/17/2012              14.7 02/24/2012              14.8 3. This drawing is part of subject report, project number as referenced, and must only be read in conjunction with that report.																						

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

MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11, CENTRELINE CULVERT, GPJ, ONTARIO MOT, GDT, 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No 13A/13

1 OF 2

METRIC

W.P. GWP 5242-10-00 LOCATION Northbound Lane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.14.12 - 2.15.12 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			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE								● QUICK TRIAXIAL		
295.7	Ground Surface						20	40	60	80	100									
295.6	ASPHALT (150mm)																			
295.3	SAND AND GRAVEL FILL (SW) (200mm). brown, moist, dense		1	SS	50															
0.4	SILTY SAND FILL (SM) - brown, moist, dense		2	SS	31															
			3	SS	40															
	- compact		4	SS	17															
	- gneiss boulder (~0.28m diameter size) encountered in BH 13A - see Note 2		5	SS	20															
			6	SS	11															
	- loose		7	SS	6															
			8	SS	11															
	- compact		9	SS	17															
			10	SS	18															
			11	SS	22															
			12	SS	20															
	- very moist																			

Continued Next Page

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

MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11 CENTRELINE CULVERT.GPJ ONTARIO.MOT.GDT 3/8/12

Brampton, Ontario

# RECORD OF BOREHOLE No 13A/13

2 OF 2

METRIC

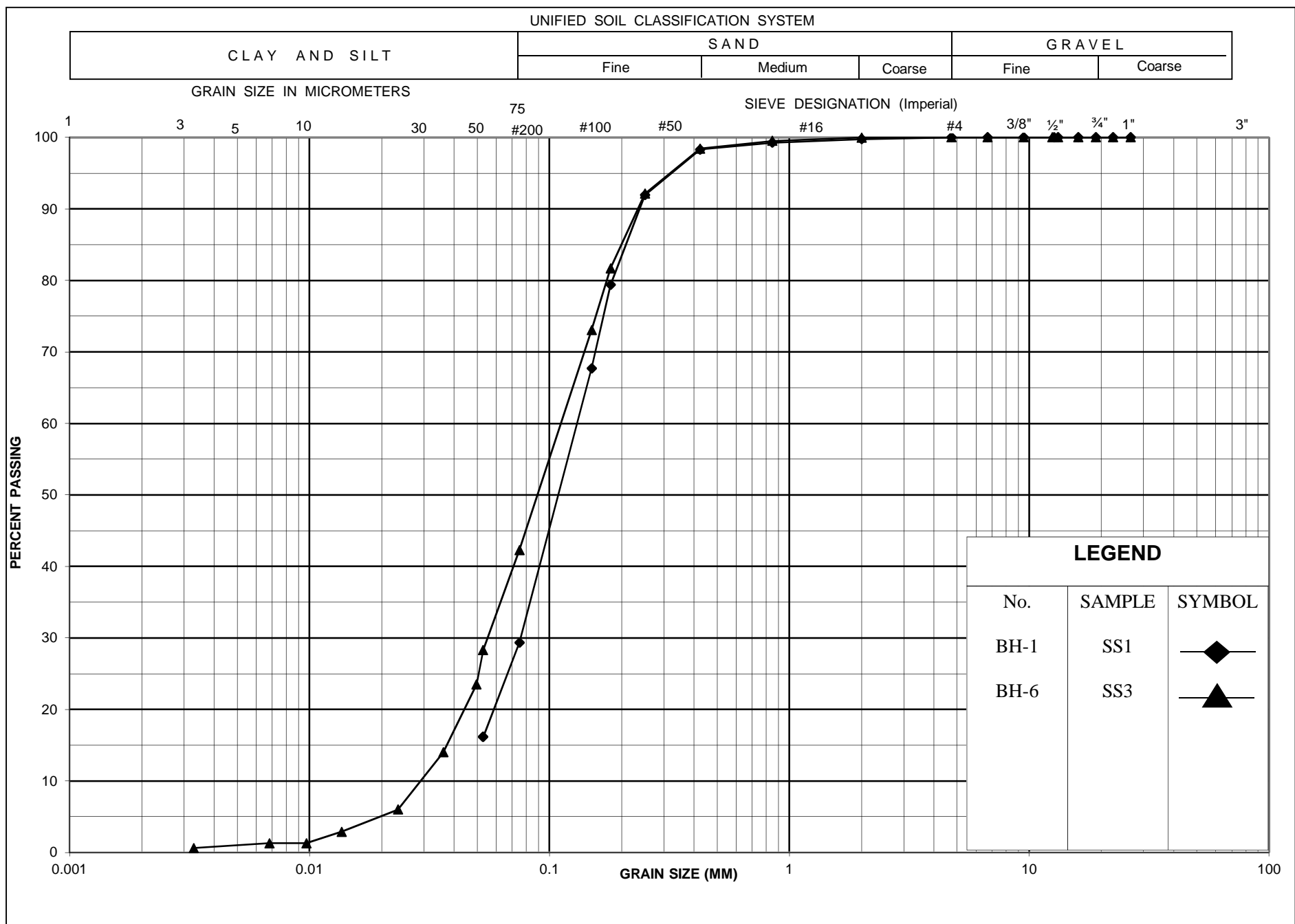
W.P. GWP 5242-10-00 LOCATION Northbound Lane Highway 11, ~750m south of Alpine Ranch Road, Bracebridge, ON ORIGINATED BY TA/DU  
 DIST Muskoka HWY 11 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY DU  
 DATUM Geodetic - MTO BM 294-67: 314.642m DATE 2.14.12 - 2.15.12 CHECKED BY SM

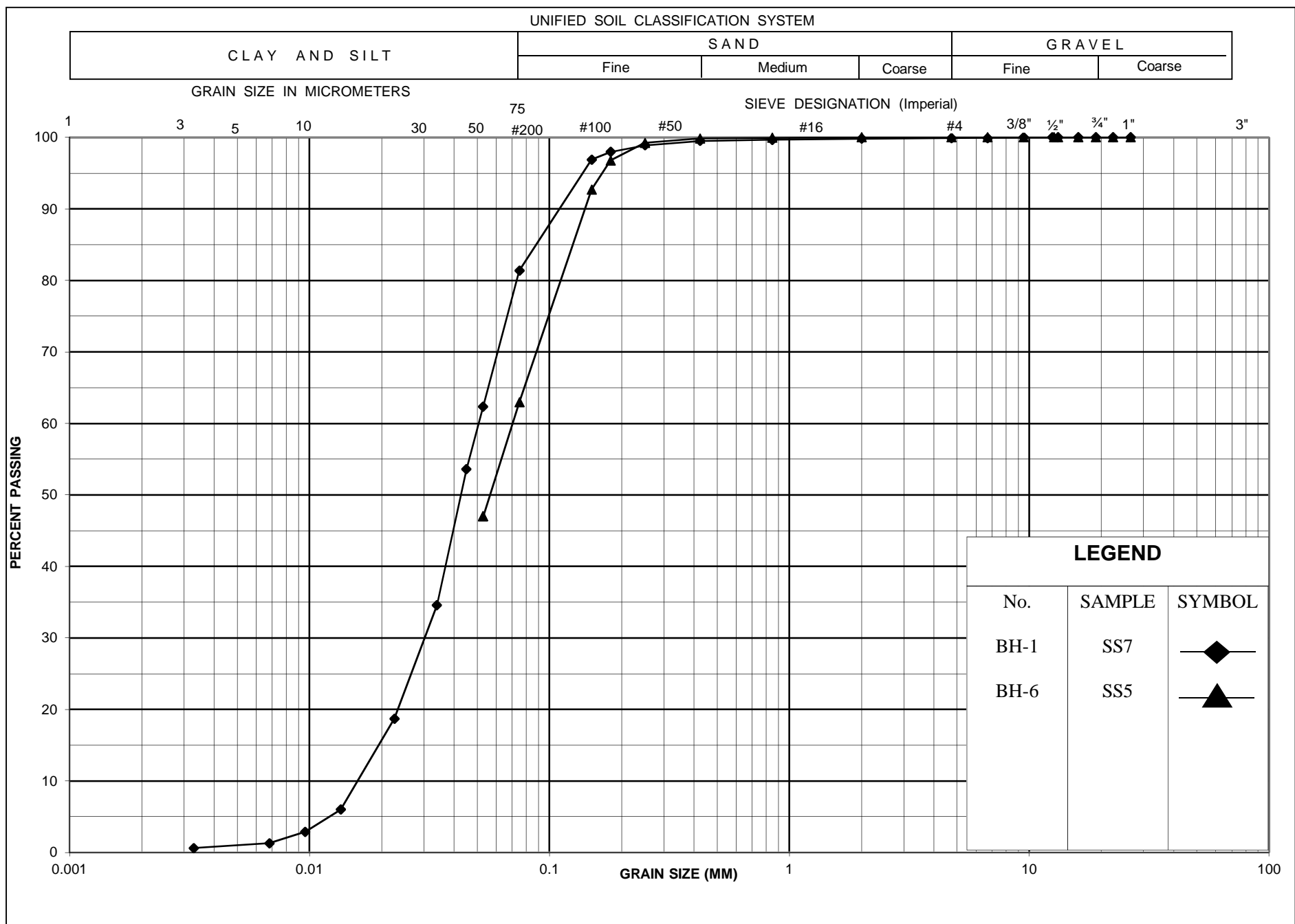
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)			
								○ UNCONFINED		+ FIELD VANE								● QUICK TRIAXIAL		× LAB VANE	
								20	40	60	80	100					GR	SA	SI	CL	
282.6	SILTY SAND FILL (SM) - brown, moist, dense (continued)		13	SS	21		283								○			0	31	69	0
			14	SS	20									○							
13.1	SANDY SILT (ML) - silt seams, grey, wet, compact		15	SS	13		282								○			0	12	87	1
			16	SS	13									○							
			17	SS	12									○							
			18	SS	13									○							
			19	SS	12									○							
			20	SS	11									○							
			21	SS	11									○							
			22	SS	8									○							
			23	SS	2									○							
			24	SS	17									○							
			25	SS	4									○							
			26	SS	4									○							
275.2	END OF BOREHOLE																				
20.4	NOTES:  1. Borehole advanced using hollow-stem augering method. 2. BH-13A was initially drilled to 2.9 m depth and a boulder was encountered at that depth. This boulder was cored. A new BH-13 was redrilled approximately 1.7 m NW from the original location, and sampling and testing continued below that depth. 3. This drawing is part of subject report, project number as referenced, and must only be read in conjunction with that report.																				

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

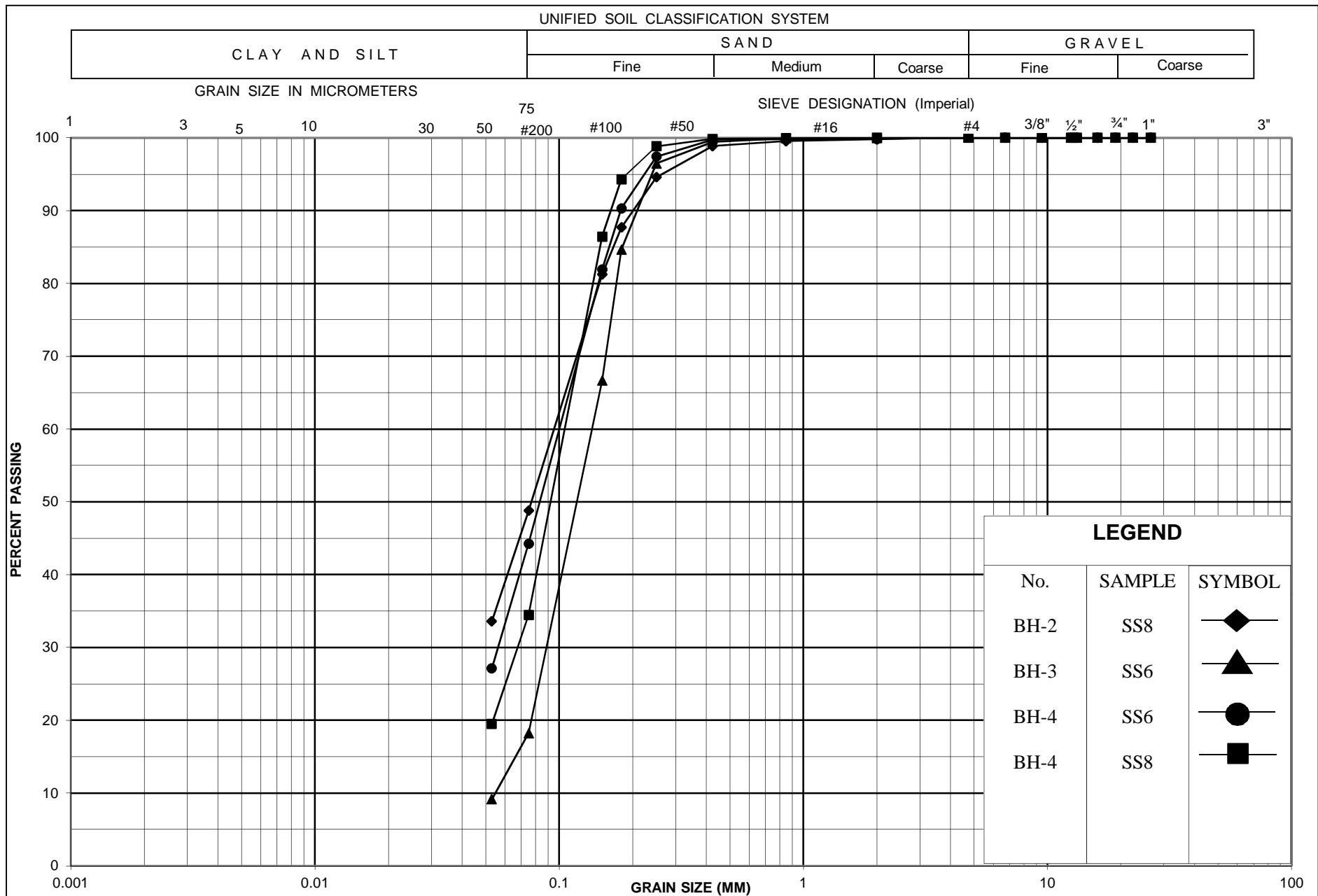
MTO\_EXP RECORD OF BOREHOLE BH 11, 12, 13 - HWY 11 - CENTRELINE CULVERT.GPJ ONTARIO.MOT.GDT 3/8/12

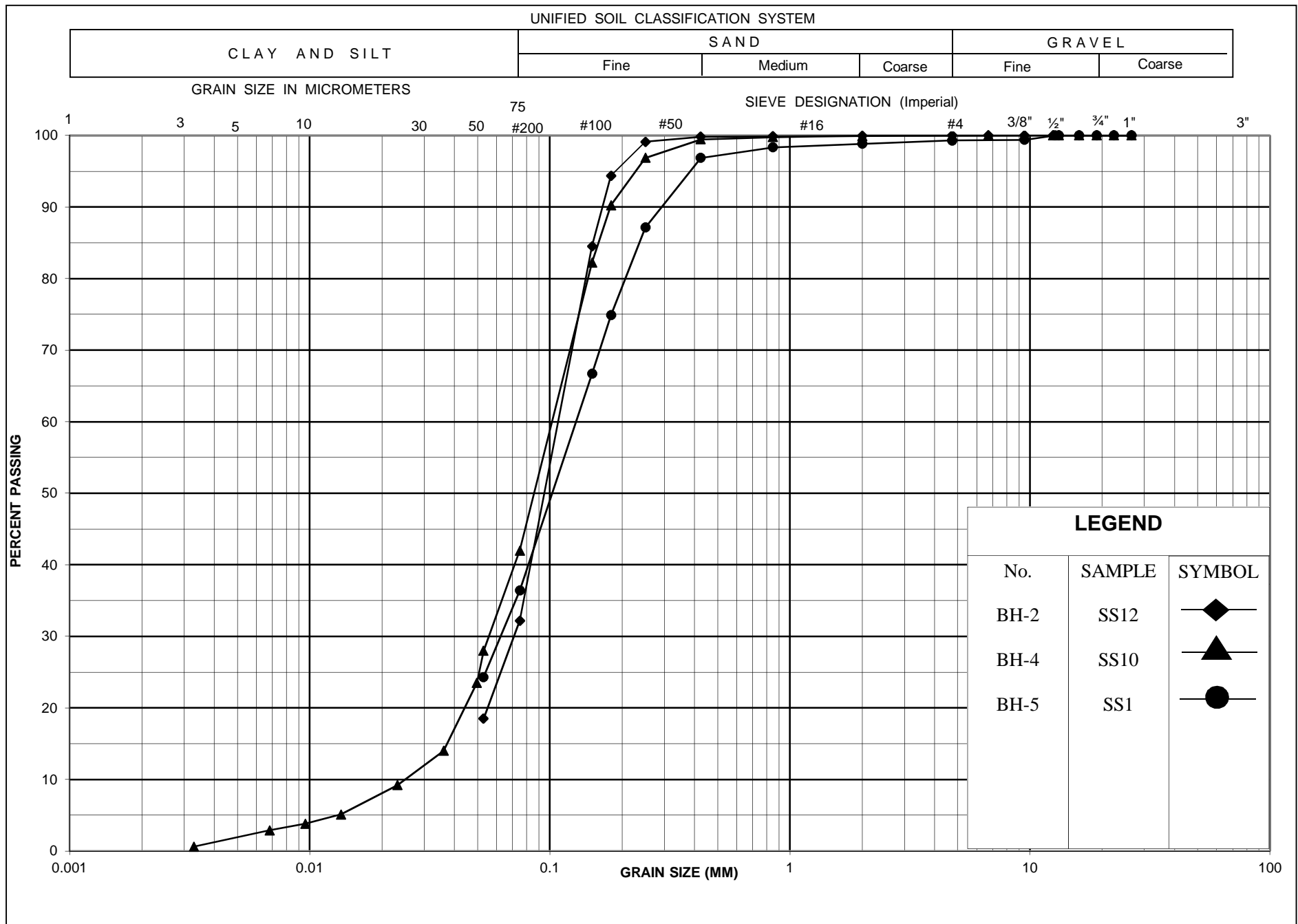
## **Appendix D – Laboratory Data**

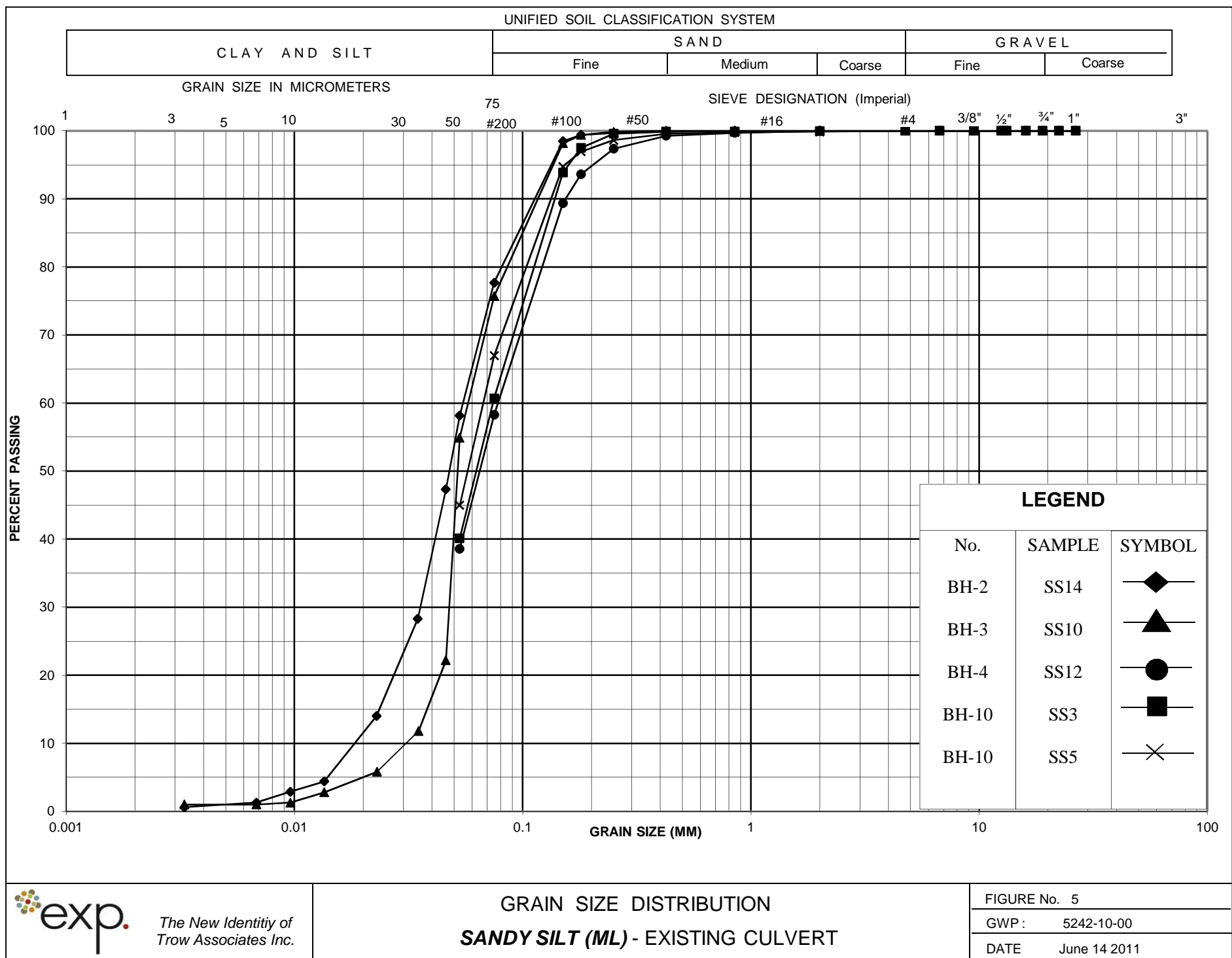


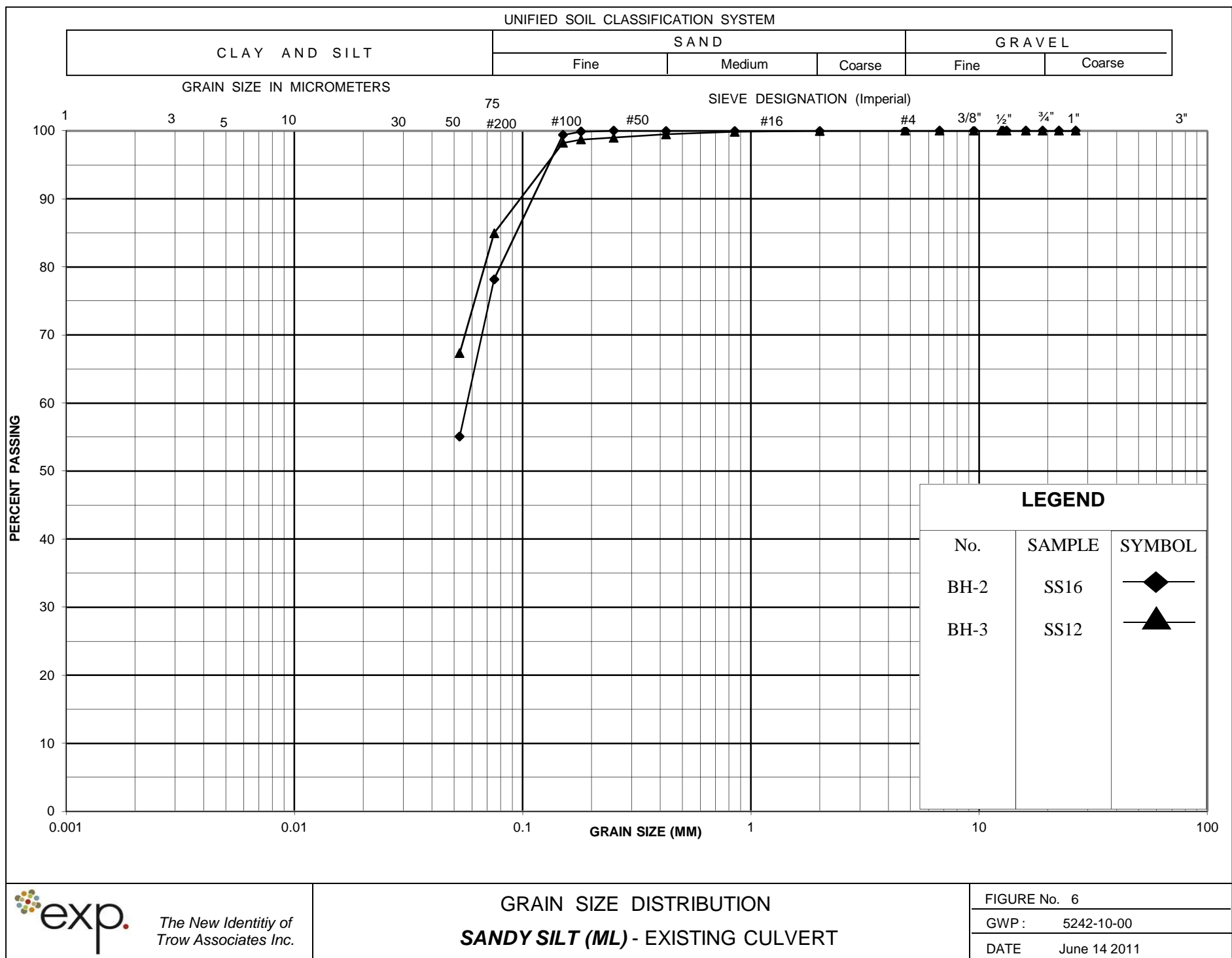


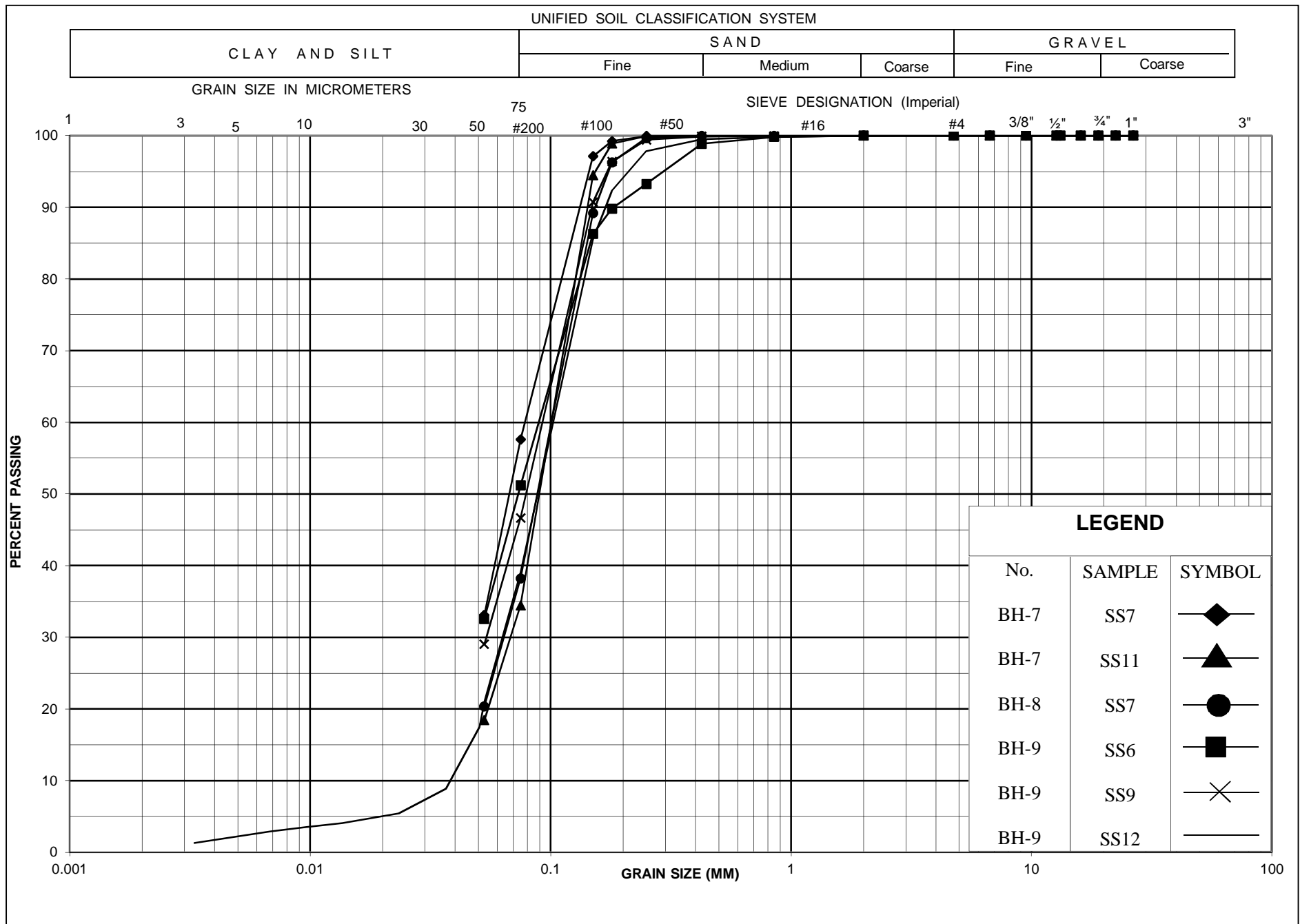












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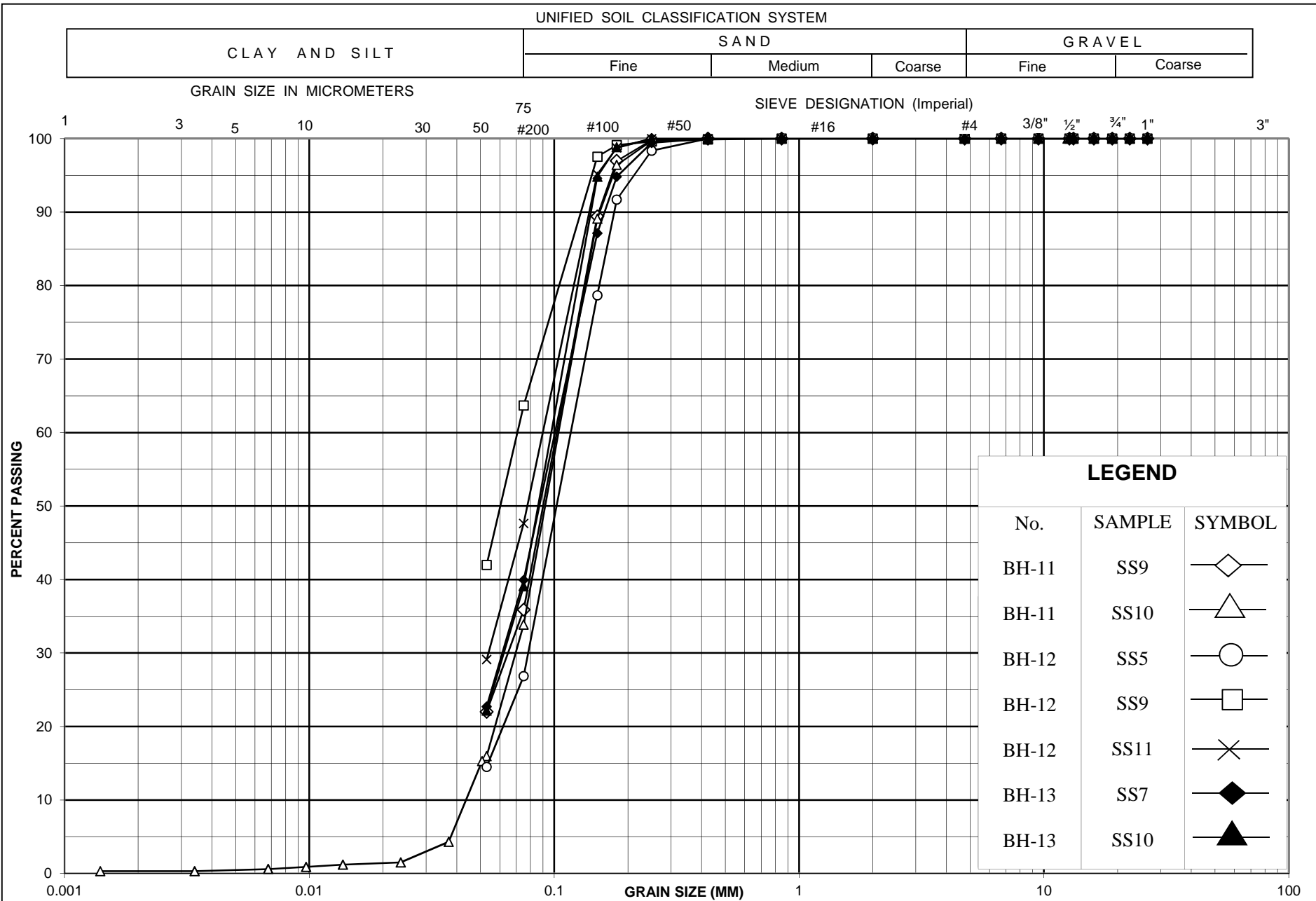
**SILTY SAND FILL (SM) - PROPOSED ALIGNMENT (May 2011)**

FIGURE No. 7

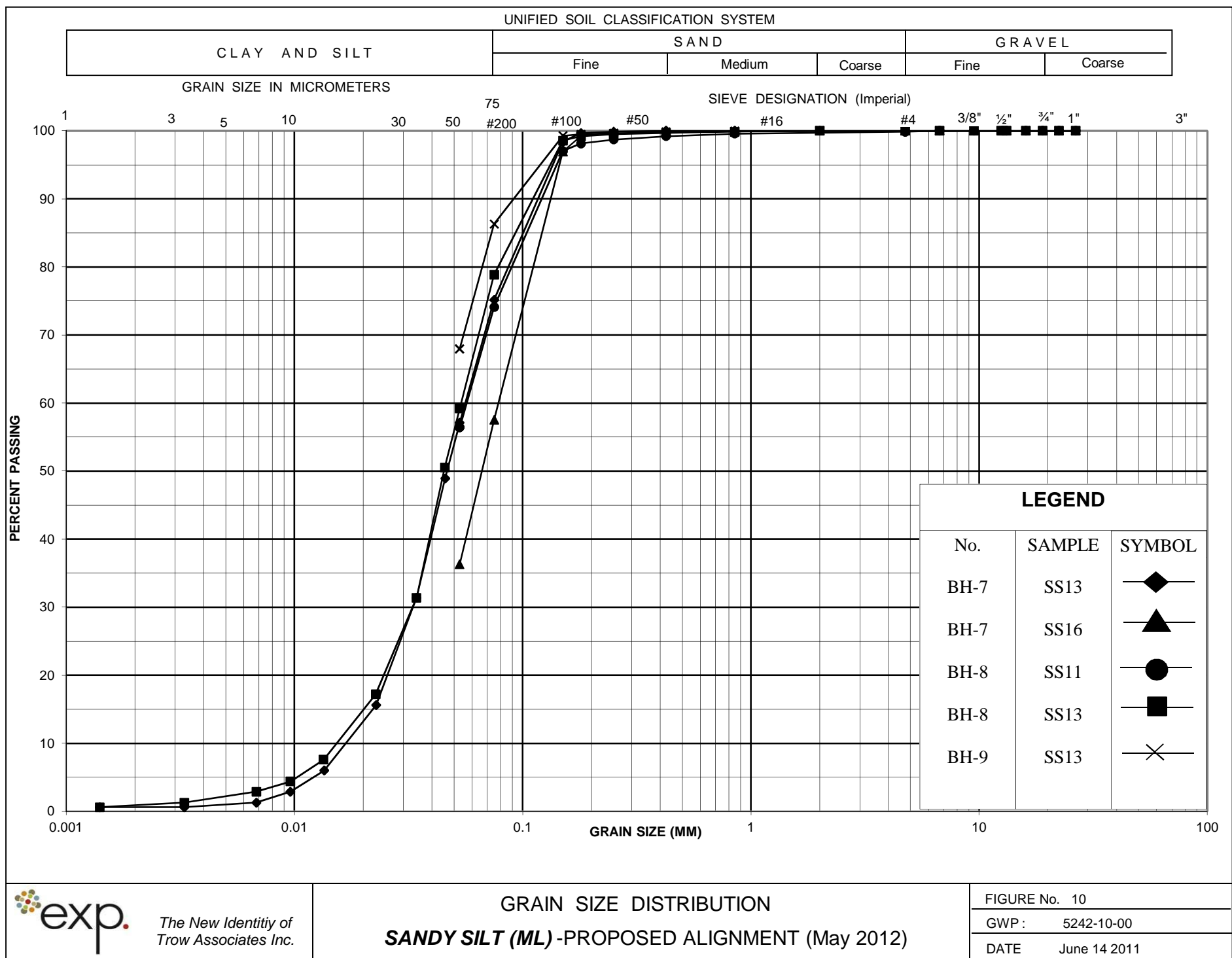
GWP: 5242-10-00

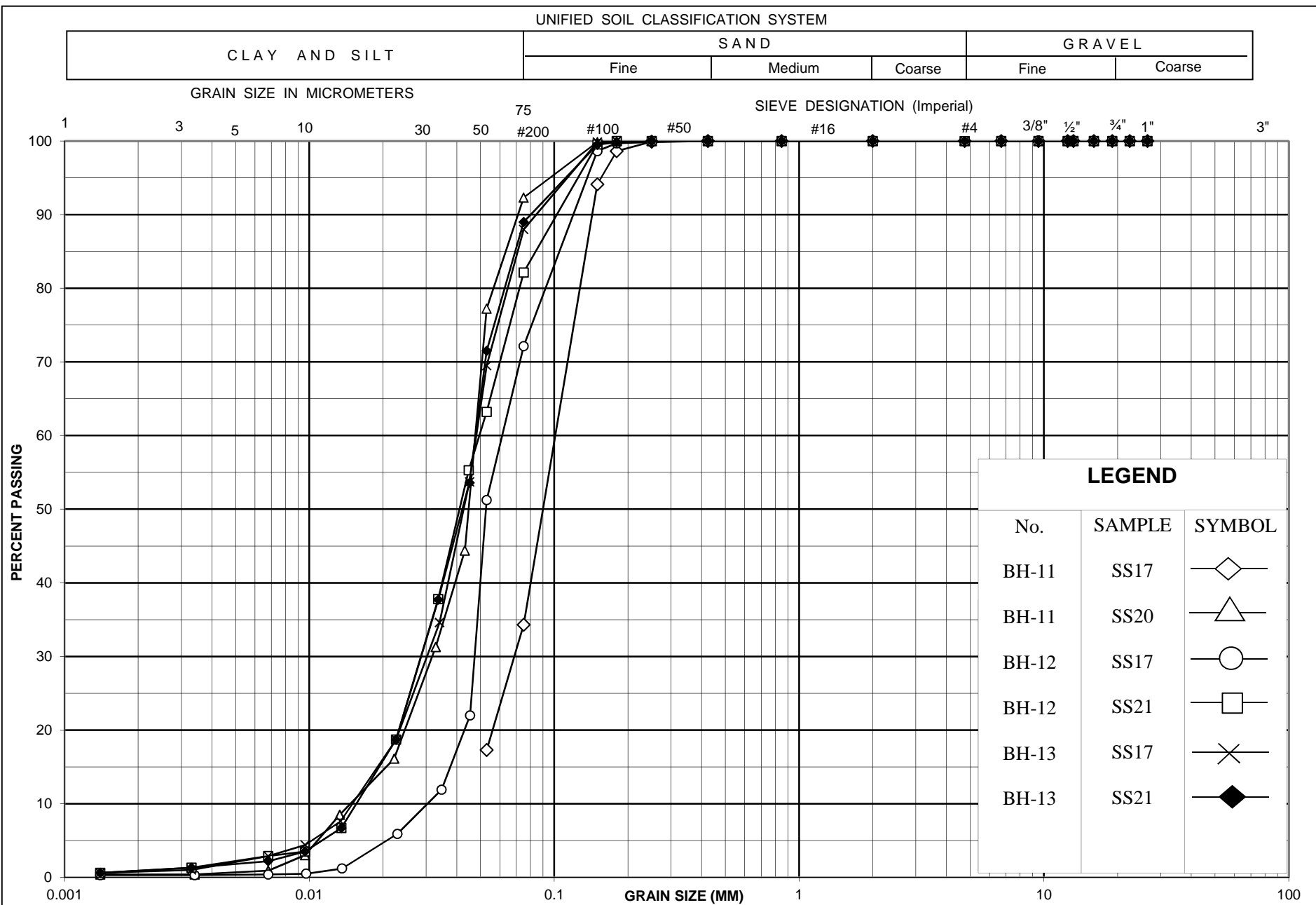
DATE June 14 2011











**Appendix E –  
USCS FLOW CHARTS (ASTM D 2487 – 06)**



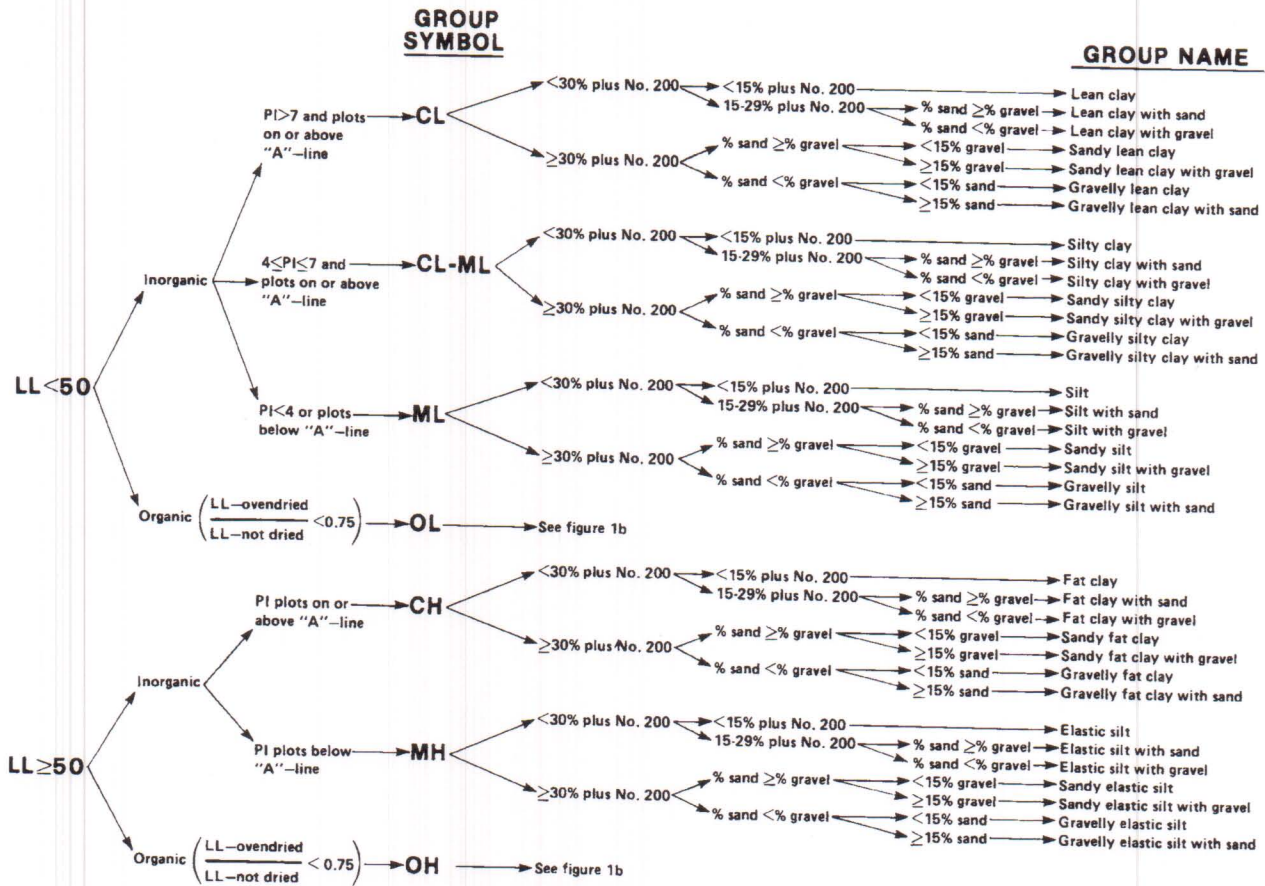


FIG. 1 Flow Chart for Classifying Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

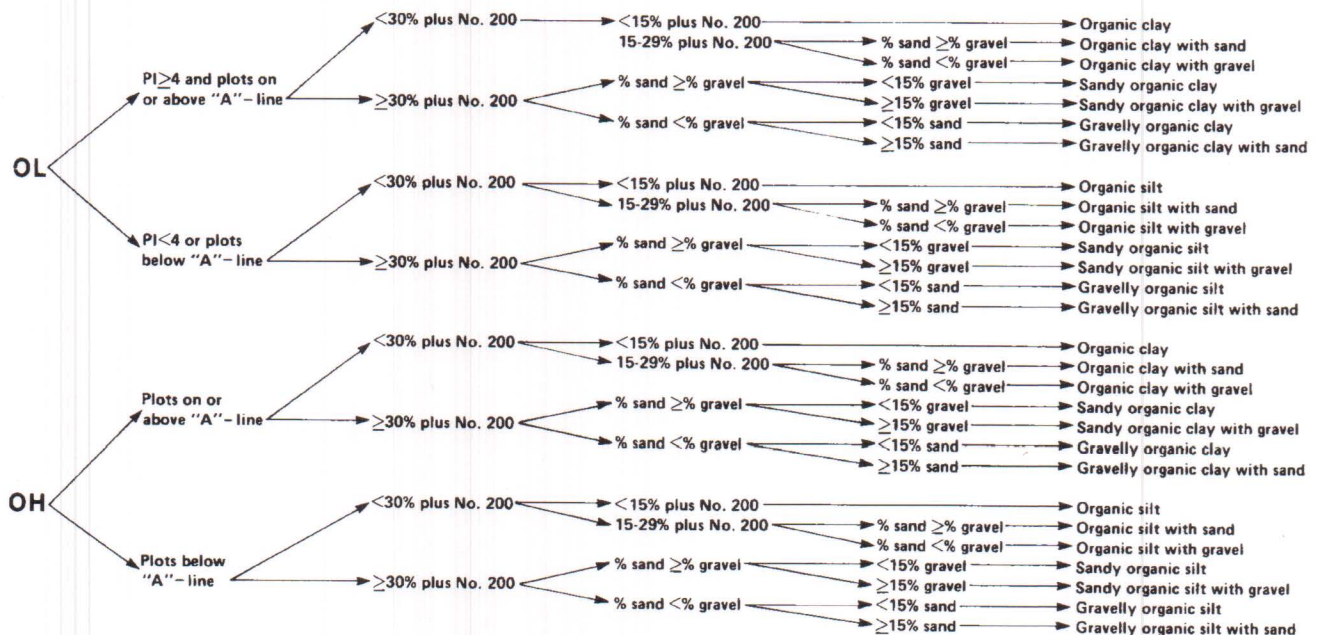
**GROUP SYMBOL****GROUP NAME**

FIG. 1 Flow Chart for Classifying Organic Fine-Grained Soil (50 % or More Passes No. 200 Sieve)

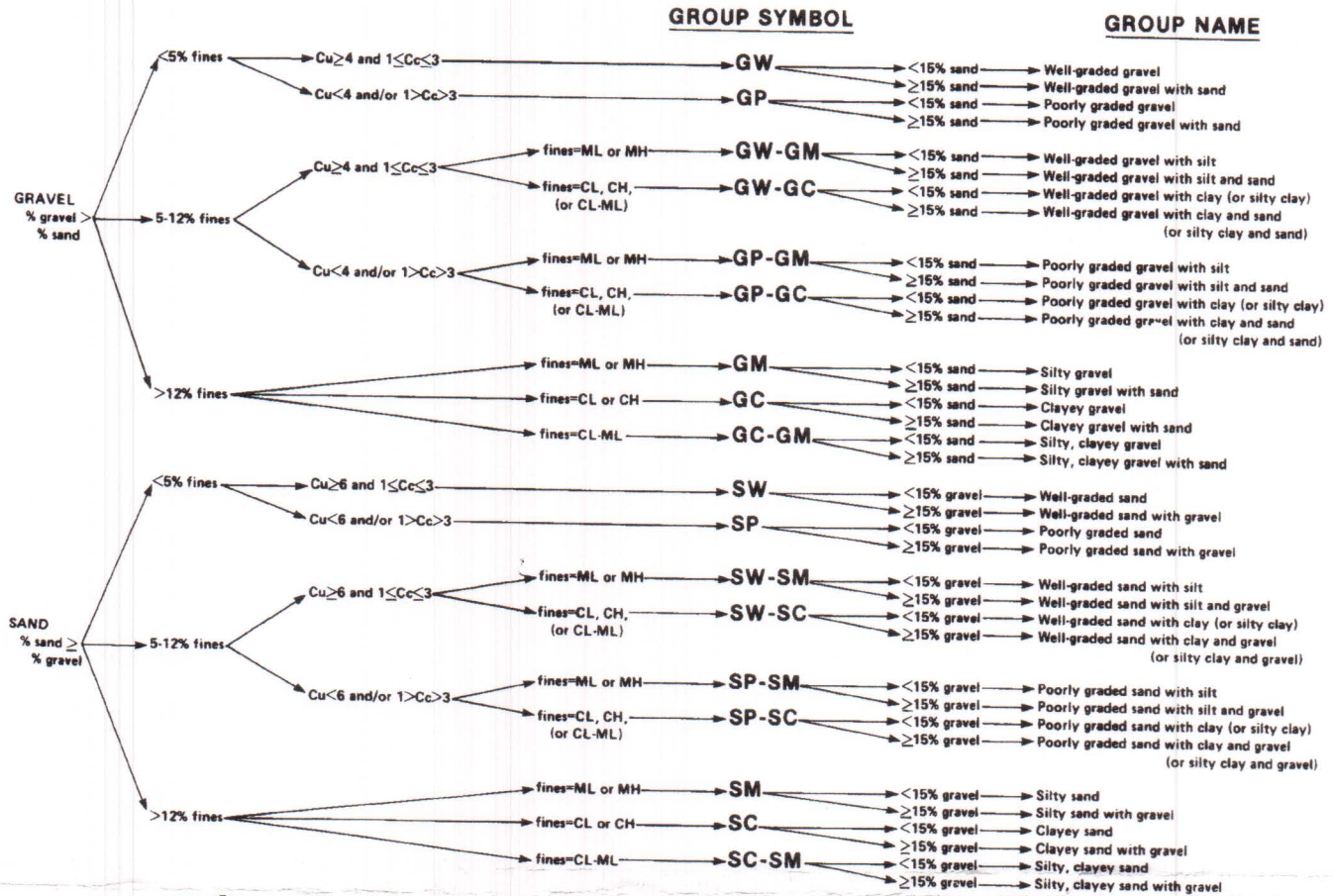


FIG. 2 Flow Chart for Classifying Coarse-Grained Soils (More Than 50 % Retained on No. 200 Sieve)