



## **FINAL REPORT**

### **FOUNDATION INVESTIGATION REPORT** **Donnegana River Culvert Replacement, Hwy 560 Township of Garvey**

**Agreement No. 5013-E-0008**  
**Assignment No. 5**  
**WO 2014-11034**  
**Geocres No. 41P-62**

#### **Prepared for:**

**Ontario Ministry of Transportation**  
Regional Director's Office -NE Region  
447 McKeown Avenue, Suite 301  
North Bay, ON P1B 9S9  
Attn: J. P. Perron

**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.**  
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# Ministry of Transportation

## Foundation Investigation Report

Agreement No. 5013-E-0008  
Assignment No. 5  
WO 2014-11034  
GEOCRES No. 41P-62

### Type of Document:

FINAL

### Project Name:

Donnegana River Culvert Replacement, Hwy 560 Township of Garvey

### Project Number:

ADM-00028245-F0

### Prepared By:

Taesang Ahn, Ph.D., P.Eng  
Nimesh Tamrakar, M.Eng.

### Reviewed By:

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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Taesang Ahn, Ph.D., P.Eng.  
Geotechnical Engineer



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

### Date Submitted:

23/10/2014

# Table of Contents

## Part I FOUNDATION INVESTIGATION

1.1	Introduction .....	3
1.2	Site Description and Geological Setting .....	3
1.2.1	Site Description .....	3
1.2.2	Geological Setting .....	4
1.3	Investigation Procedures .....	4
1.3.1	Site Investigation and Field Testing .....	4
1.3.2	Laboratory Testing .....	5
1.3.3	Previous Investigation .....	5
1.4	Subsurface Conditions .....	6
1.4.1	Subsurface Conditions at Existing Culvert Location .....	6
1.4.1.1	Fill: Sand and Gravel .....	6
1.4.1.2	Organic Sand .....	7
1.4.1.3	Silty Sand .....	7
1.4.1.4	Sand .....	8
1.4.1.5	Silt .....	8
1.4.1.6	Gravelly Sand to Sand .....	9
1.4.2	Subsurface Conditions at Proposed Culvert Location .....	10
1.4.2.1	Fill: Sand and Gravel .....	10
1.4.2.2	Fill: Silty Sand .....	10
1.4.2.3	Organic Sand .....	11
1.4.2.4	Sand to Silty Sand .....	12
1.4.2.5	Silt .....	12
1.4.2.6	Sand and Gravel .....	13
1.5	Water Conditions .....	14
Part II	CLOSURE .....	15

## Appendices

APPENDIX A: PHOTOGRAPHS

APPENDIX B: DRAWING

APPENDIX C: BOREHOLE LOGS

APPENDIX D: LABORATORY DATA

## **Part I FOUNDATION INVESTIGATION**

### **1.1 Introduction**

This report presents the results of a geotechnical investigation completed by **exp** Services Inc. for Donnegana River Culvert Replacement. The Donnegana River Culvert is located on Hwy 560, approximately 1.3 km west of Hwy 560A, in the Township of Garvey. The existing culvert is an arched corrugated steel pipe (CSP) culvert with dimensions 5.3 m x 3.5 m, constructed in early 1980s. The culvert will be replaced on the existing alignment with two 3 m x 3 m box culverts. In order to divert the flow during construction, a second culvert will be constructed approximately 77 m west of the existing culvert. Based on MTO's memorandum from October 3 2014, the second culvert is proposed to be a 2 m diameter culvert, and it will be left in place after construction.

The purpose of the investigation is to evaluate the subsurface conditions along both culvert alignments to provide detailed design and recommendations for the culvert foundation options, dewatering and methods of culvert replacement. The site specific geotechnical investigation consisted of test borings, borehole logging, and field and laboratory testing.

This 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. The work was undertaken under Agreement # 5013-E-0008, Assignment No. 5. The terms of reference were as presented in MTO letter dated August 26, 2014.

### **1.2 Site Description and Geological Setting**

#### **1.2.1 Site Description**

The Donnegana River Culvert is located on Hwy 560, approximately 1.3 km west of Hwy 560A in the Township of Garvey, Ontario. Photographs of the culvert and surrounding area are included in Appendix A. The site plan and cross section profile of the Donnegana River culvert are as shown on drawings in Appendix B.

Donnegana River is a stream which meanders between Sudbury to Timmins. It is crossing under Hwy 560 flows from south to north. The river is bounded by banks with vegetation and swamps/muskegs on both sides to the east and west as shown on Photographs 4 and 6.

During the field investigation in September 2014, the water flowing through the culvert structure was 1.3 m deep. The water depths at the location of the new proposed bypass culvert at the inlet and outlet were about 1.2 m and 1.0 m, respectively.

At the Donnegana River culvert location, Hwy 560 is two lanes, east/west highway with approximately 2.0 m wide granular shoulders with swamps and tree stumps on both sides of the road. The surface of the road at the culvert location is in a fairly good shape, with a number of localized cracks on the asphalt. The height of embankment at the culvert location is approximately

4.6 m (see Photographs 7 and 8). The vegetation in the area consists of deciduous and coniferous trees with occasional smaller low lying shrubs.

### 1.2.2 Geological Setting

The Map 2543 (Bedrock Geology of Ontario, East-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the bedrock formation of the project area is intrusive rocks of Neo to Mesoproterozoic Group, mainly of gneissic tonalite suite comprised of tonalite to granodiorite with minor supracrustal inclusions. Map 2555 (Quaternary Geology of Ontario, East-Central Sheet, 1991) of the Ministry of Northern Development and Mines, indicates that the surface conditions in the vicinity of site consist of Glaciofluvial Ice-Contact deposits consist of gravel and sand and minor till.

## 1.3 Investigation Procedures

### 1.3.1 Site Investigation and Field Testing

The field work for this investigation was performed between September 08, 2014 and September 12, 2014. The field investigation program consisted of drilling four (4) sampled boreholes on each proposed and existing culvert locations. The boreholes were strategically located to provide the appropriate subsurface information about the investigated sites. Additional two (2) boreholes were drilled on each location of river upstream and downstream for the dewatering and cofferdam design recommendations.

Boreholes on the embankment crest (i.e. BH-EC-1, BH-EC-2, BH-PC-1 and BH-PC-2) were advanced using a CME 55 track mounted drill rig operated by a specialist drilling contractor, Landcore Drilling Inc. The diamond drilling equipment and NW casing were used to advance boreholes from the top of the embankment using the wash boring method. The rig was also equipped with a CME automatic trip hammer for split barrel (split spoon sampling device) soil sampling (see Photograph 9). Due to difficulty in access, boreholes at the inlets and outlets, upstream and downstream of river (i.e. BH-EC-3, BH-EC-4, BH-PC-3, BH-PC-4, BH-EC-5, BH-EC-6, BH-PC-5, and BH-PC-6) were advanced by a portable tripod drill rig operated also by Landcore Drilling Inc. (see Photograph 10).

BH-EC-1, BH-EC-2, BH-PC-1 and BH-PC-2 were advanced at depths approximately 15 m from the crest of the embankment. BH-EC-1 and BH-PC-1 were drilled at the outlet sides of the existing and proposed culvert locations, respectively, while BH-EC-2 and BH-PC-2 were drilled at the inlet sides. BH-EC-3, BH-PC-3, BH-EC-4 and BH-PC-4 were advanced at depth approximately 10 m at the proximity of inlet and outlet locations of existing and proposed culvert locations. BH-EC-5/BH-PC-5 and BH-EC-6/ BH-PC-6 were advanced to depth of about 10 m on the downstream and upstream, respectively. The locations of boreholes at each location of culverts are shown on Drawing No.1 in Appendix B.

During the drilling of the boreholes on the crest by the track mounted drill rig, 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. When a hard stratum was reached sampling of rock fill was performed by diamond core drilling, using a 1.5 m long NQ double tube wireline corebarrel.

During the drilling of the boreholes at the inlets and outlets and river banks by the tripod drill rig, soil samples were obtained using a 140-pound (63.5 kg) hammer, at intervals shown on the attached borehole logs (Appendix C). Since the conventional hammer was used for the portable tripod the blow counts were not factored.

Since wash boring technique was used, the stabilized ground water level could not be established by short term observation in boreholes. The drilled boreholes at the embankment were decommissioned by bentonite/cement mixtures in accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the Ontario Water Resources Act)

The borehole locations (referenced to the MTM NAD83 coordinate system) and their ground surface elevations were surveyed by **exp** personnel, with reference to the closest benchmark to the site (station No. 00819768104; Elevation 337.473 m).

The fieldwork was supervised by a member of **exp**'s engineering staff who directed the drilling and sampling operations, logged borehole data in accordance with MTO and ASTM Standards, and retrieved soil and rock samples for subsequent laboratory testing and identification.

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

### 1.3.2 Laboratory Testing

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

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

### 1.3.3 Previous Investigation

No foundation reports are available in the MTO GEOCRES library for this site.

## 1.4 Subsurface Conditions

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

A borehole location plan and stratigraphic sections are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole logs and sections are inferred from non-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. Further, subsurface conditions may vary between and beyond the borehole locations.

### 1.4.1 Subsurface Conditions at Existing Culvert Location

Six boreholes including two boreholes for cofferdam (BH-EC-1, BH-EC-2, BH-EC-3, BH-EC-4, BH-EC-5 and BH-EC-6) were drilled at the existing culvert location. The investigation revealed that the subsurface conditions along the existing culvert alignment consist of a layer of sand and gravel fill underlain by silty sand, followed by sand, silt, and gravelly sand to sand layer. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

#### 1.4.1.1 Fill: Sand and Gravel

Sand and gravel fill was encountered at the road embankment below the 12 mm thick layer of asphalt in BH-EC-1 and BH-EC-2. The thickness of the sand and gravel layer was approximately 4.6 m extending from Elevation 384.0 m to 379.1 m.

This layer consists of sand, gravel (with occasional cobbles and boulders), and trace to some silt. The material is brown in color, and moist to wet. The SPT “N” values within this layer ranged from 12 to 73 blows per 300 mm penetration, suggesting compact to very dense relative density of this layer.

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

Moisture Content:

- 2% to 11%

Grain Size Distribution:

- 9% to 60% gravel;
- 38% to 58% sand; and

- 1% to 33% silt and clay.

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

#### 1.4.1.2 Organic Sand

An organic sand layer was encountered at the ground surface below the 0.5 m to 0.6 m thick layer of topsoil in BH-EC-3, BH-EC-4, BH-EC-5 and BH-EC-6. The thickness of organic sand layer ranged from approximately 0.9 m to 1.8 m extending from Elevation 380.9 m to Elevation 379.1 m.

This layer consists of sand, few gravel, few silt with organics (e.g. peat) and roots inclusion. It is dark brown in color and wet. The SPT "N" values within this layer ranged from 0 and 5 blows per 300 mm penetration, suggesting very loose to loose relative density of this layer.

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

Moisture Content:

- 50% to 198%

Grain Size Distribution:

- 89% to 94% sand; and
- 6% to 11% silt and clay.

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

#### 1.4.1.3 Silty Sand

A layer of silty sand was encountered below the sand and gravel fill in BH-EC-1 and BH-EC-2 and below organic sand in BH-EC-3 and BH-EC-6. The thickness of silty sand layer was approximately 3.0 m extending from Elevation 379.8 m to Elevation. 376.1 m.

This layer consists of sand and silt, with some peat and some gravel. It is dark brown to grey in color and wet. The SPT "N" values within the layer ranged from 3 to 22 blows per 300 mm penetration, suggesting very loose to compact relative density of this layer.

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

Moisture Content:



- 10% to 34%

Grain Size Distribution:

- 0% to 1% gravel;
- 52% to 96% sand; and
- 4% to 47% silt and clay.

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

#### 1.4.1.4 Sand

A layer of sand was encountered below the silty sand layer in BH-EC-1, BH-EC-2, BH-EC-3 and BH-EC-6 and below organic sand layer in BH-EC-4 and BH-EC-5. The thickness of sand layer ranged from approximately 3.0 m to 6.1 m extending from Elevation 379.6 m to Elevation 373.1 m.

This layer consists of sand, trace silt, and trace gravel. It is grey in color and wet. The SPT "N" values within the sand layer ranged from 1 to 12 blows per 300 mm penetration, suggesting very loose to compact relative density of this layer.

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

Moisture Content:

- 15% to 25%

Grain Size Distribution:

- 1% to 5% gravel;
- 93% to 98% sand; and
- 1% to 2% silt and clay.

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

#### 1.4.1.5 Silt

A layer of silt was encountered below sand layer in all boreholes. The thickness of the layer ranged from approximately 1.5 m to 3.0 m extending from Elevation 373.7 m to 370.0 m. BH-EC-3, BH-EC-5 and BH-EC-6 was terminated within this layer.

This layer consists of silt with occasional clayey seams, trace gravel and trace sand. It is grey in color and wet. SPT “N” values within this layer ranged from 7 to 15 blows per 300 mm penetration, suggesting loose to compact relative density of this layer.

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

Moisture Content:

- 22% to 34%

Grain Size Distribution:

- 0% to 2% gravel;
- 1% to 3% sand;
- 87% to 97% silt, and
- 6% to 11% clay.

Atterberg Limits:

- Liquid Limits : 20%
- Plastic Limits : 17%
- Plasticity Index : 3%

The results of the laboratory tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution test and Atterberg limits tests are provided on Figure 5 and Figure 12, respectively, in Appendix D.

#### 1.4.1.6 Gravelly Sand to Sand

A layer of gravelly sand to sand was encountered below the layer of silt in BH-EC-1, BH-EC-2 and BH-EC-4. The thickness of the layer ranged from approximately 0.7 m to 2.2 m extending from Elevation 372.0 m to 367.8 m. The boreholes BH-EC-1, BH-EC-2 and BH-EC-4 were terminated within this layer. Therefore the actual thickness of this layer could not be determined.

This layer consists of sand, trace to little gravel and trace to little silt. The material is grey in color, and wet. The SPT “N” values within this layer ranged from 17 to 56 blows per 300 mm penetration, suggesting compact to very dense relative density of this layer.

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

Moisture Content:

- 7% to 11%

#### Grain Size Distribution:

- 4% to 22% gravel;
- 58% to 89% sand; and
- 7% to 20% silt and clay.

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

### 1.4.2 Subsurface Conditions at Proposed Culvert Location

Six boreholes including two boreholes for cofferdam (BH-PC-1, BH-PC-2, BH-PC-3, BH-PC-4, BH-PC-5 and BH-PC-6) were drilled at the proposed culvert location. The investigation revealed that the subsurface conditions along the proposed culvert alignment consist of a layer of sand and gravel fill underlain by silty sand fill followed by sand to silty sand and silt layer. A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

#### 1.4.2.1 Fill: Sand and Gravel

Sand and gravel fill was encountered at the road embankment below the 12 mm thick layer of asphalt in BH-PC-1 and BH-PC-2. The thickness of the layer was approximately 0.8 m extending from Elevation 383.4 m to 382.7 m.

This layer consists of sand and gravel with occasional cobbles. The material is brown in color, and moist to wet. The SPT "N" value taken in one sample within this layer is 51 blows per 300 mm penetration, suggesting very dense relative density of this layer.

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

#### Moisture Content:

- 3% to 4%

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

#### 1.4.2.2 Fill: Silty Sand

A layer of silty sand fill was encountered below the layer of sand and gravel fill in BH-PC-1 and BH-PC-2. The thickness of silty sand fill layer ranged from approximately 3.8 m to 3.9 m extending from Elevation 382.7 m to Elevation 378.8 m.

This layer consists of sand and silt, trace gravel with occasional cobbles and boulders. It is brown in color and damp to wet. The SPT “N” values within the silty sand fill layer typically ranged from 16 to 43 blows. One SPT “N” value of 7 blows and one SPT “N” value of 100 blows per 300 mm penetration were encountered. Typically SPT “N” value suggest compact to dense relative density of this layer.

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

Moisture Content:

- 6% to 25%

Grain Size Distribution:

- 1% to 10% gravel;
- 45% to 58% sand; and
- 32% to 54% silt and clay.

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

#### 1.4.2.3 Organic Sand

An organic sand layer was encounter at the ground surface below the 0.5 m to 0.6 m thick layer of topsoil in BH-PC-3, BH-PC-4, BH-PC-5 and BH-PC-6. The thickness of organic sand layer ranged from approximately 1.7 m to 1.8 m extending from Elevation 379.2 m to Elevation 377.2 m.

This layer consists of sand, trace to some silt, trace gravel, and trace clay with organics (e.g. peat) and roots inclusion. It is dark brown in color and wet. The SPT “N” values within this layer ranged from 0 and 3 blows per 300 mm penetration, suggesting very loose to loose relative density of this layer.

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

Moisture Content:

- 45% to 168%

Grain Size Distribution:

- 0% to 1% gravel;
- 47% to 96% sand; and
- 4% to 53% silt and clay.

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

#### 1.4.2.4 Sand to Silty Sand

A layer of sand to silty sand was encountered below the silty sand fill in BH-PC-1 and BH-PC-2. The thickness of sand to silty sand layer ranged from approximately 1.7 m to 3.0 m extending from Elevation 378.8 m to Elevation 375.8 m.

This layer consists of sand, silt, some peat and trace gravel. It is brown to grey in color and wet. The SPT “N” values within this layer ranged from 7 to 17 blows per 300 mm penetration, suggesting loose to compact relative density of this layer.

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

Moisture Content:

- 14% to 23%

Grain Size Distribution:

- 92% sand; and
- 8% silt and clay.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 9 in Appendix D.

#### 1.4.2.5 Silt

A layer of silt was encountered below the sand to silty sand layer in BH-PC-1 and BH-PC-2 and below the organic sand layer in BH-PC-3, BH-PC-4, BH-PC-5 and BH-PC-6. The thickness of this layer ranged from approximately 4.4 m to 8.8 m extending from Elevation 377.3 m to 368.2 m. BH-PC-3, BH-PC-4, BH-PC-5 and BH-PC-6 was terminated within this layer.

This layer consists of silt, trace to few sand, trace gravel and few clay. It is grey in color and wet. SPT “N” values within this layer ranged from 3 to 17 blows per 300 mm penetration, suggesting very loose to compact relative density of this layer.

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

Moisture Content:

- 20% to 28%

Grain Size Distribution:

- 0% to 2% gravel;
- 1% to 13% sand;
- 86% to 97% silt, and
- 6% to 10% clay.

Atterberg Limits:

Selected samples (BH PC1-SS9 and BH PC5-SS5) found non plastic

The results of the laboratory tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution test and Atterberg limit tests are provided on Figure 10a, 10b and Figure 12 in Appendix D.

#### 1.4.2.6 Sand and Gravel

A layer of sand and gravel layer was encountered below the layer of silt layer in BH-PC-1 and BH-PC-2. The thickness of the sand and gravel layer ranged from approximately 0.7 m to 2.2 m extending from Elevation 369.7.0 m to 367.6 m. The boreholes PC-1 and PC-2 were terminated within this layer. Therefore actual thickness of this layer could not be determined.

This layer consists of sand, gravel and few silt. The material is grey in color, and wet. The SPT "N" values within this layer ranged from 23 to 54 blows per 300 mm penetration, suggesting compact to very dense relative density of this layer.

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

Moisture Content:

- 7 % to 9 %

Grain Size Distribution:

- 19% to 51% gravel;
- 43% to 74% sand; and
- 6% to 7% silt and clay.

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

## 1.5 Water Conditions

Since the wash boring method was used for drilling with rig and portable tripod equipment, accurate groundwater levels at the boreholes could not be measured in the open holes at the time of drilling operation.

The water level in the Donnegana river was measured at the time of investigation (September 2014) and it was approximately at Elevation 380.5 m at the inlet side and 380.4 m at the outlet side at the existing culvert location and at the proposed culvert location the water level in the river was approximately at Elevation 379.3 m at inlet side and 379.25 m at outlet side (see Photographs 3 to 6 in Appendix A). Groundwater levels would be expected to reflect levels in the adjacent open water and to fluctuate seasonally.

October 23, 2014

## Part II CLOSURE

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

The borehole investigation program for this project was supervised by Shane Tobias and Nimesh Tamrakar, M.Eng with **exp** Services Inc. This Foundation Investigation Report has been prepared by T. Ahn, Ph.D., P.Eng., and reviewed by S. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact.

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.

### exp Services Inc.

Nimesh Tamrakar, M.Eng.  
Technical Specialist

Taesang Ahn, Ph.D. P.Eng.  
Geotechnical Engineer

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

Encl.





## Appendix A – Photographs



Photo 1. Hwy 560 looking toward East to the Elk Lake.



Photo 2. Hwy 560 looking toward West to Hwy 144.





Photo 3. Outlet of Donnegana River Culvert, North Side of Hwy 560.



Photo 4. South Side of Hwy 560 (Upstream) at the Proposed Culvert Location.





Photo 5. Inlet of Donnegana River Culvert, South Side of Hwy 560.



Photo 6. North Side of Hwy 560 (Downstream) at the Proposed Culvert Location.





Photo 7. South Side (Upstream) of Embankment looking at West.



Photo 8. North Side (Downstream) of Embankment, approximately 4 m in Height.





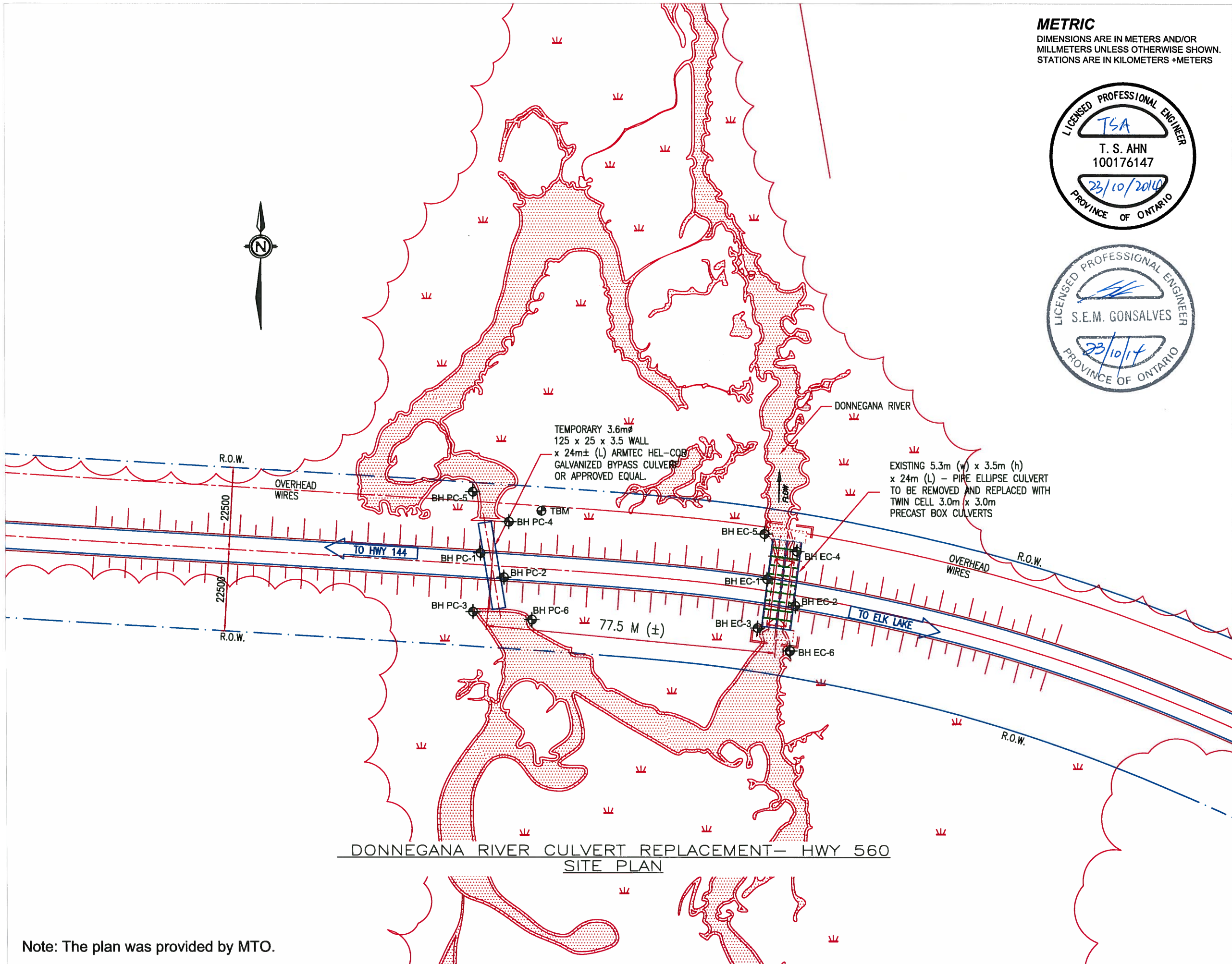
Photo 9. Track Mounted Drill Rig.



Photo 10. Portable Tripod Equipment.

## Appendix B – Drawings





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



Agreement No. 5013-E-0008  
Assignment No. 5  
WO 2014-11034

SHEET  
1

DONNEGANA RIVER CULVERT REPLACEMENT  
(HWY 560, Township of Garvey)

**SITE PLAN**

exp

exp Services Inc.

KEY PLAN

LEGEND

Approximate Investigated Borehole Locations

TBM (Temporary Bench Mark)

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BM	381.52	5259604	269584
BH EC-1	384.09	5259586	269636
BH EC-2	383.67	5259574	269641
BH EC-3	380.71	5259569	269631
BH EC-4	381.12	5259591	269653
BH EC-5	381.36	5259595	269632
BH EC-6	381.29	5259564	269643
BH PC-1	383.44	5259595	269566
BH PC-2	383.40	5259589	269570
BH PC-3	379.56	5259585	269557
BH PC-4	379.60	5259607	269575
BH PC-5	379.52	5259610	269556
BH PC-6	379.71	5259581	269575

NOTE

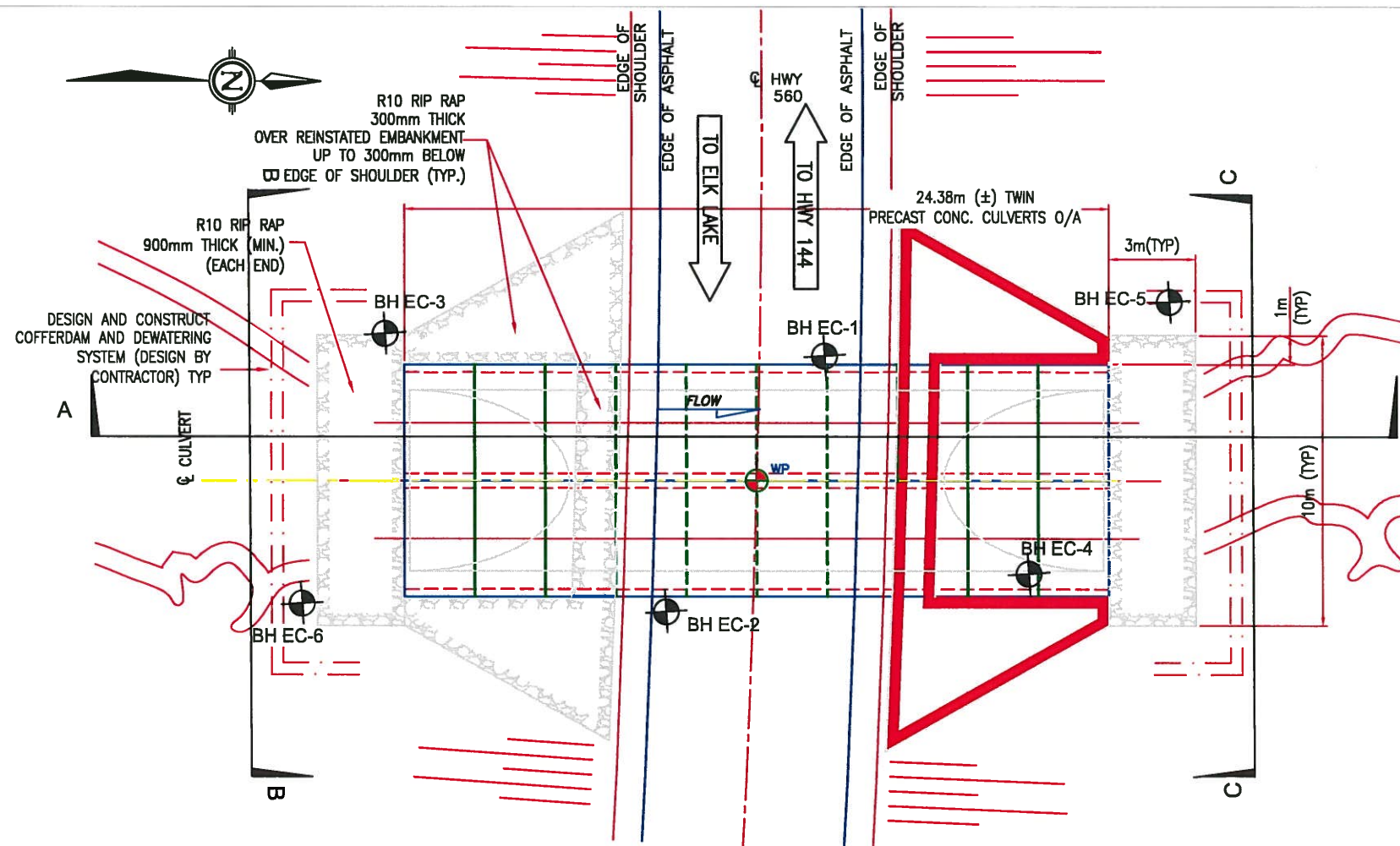
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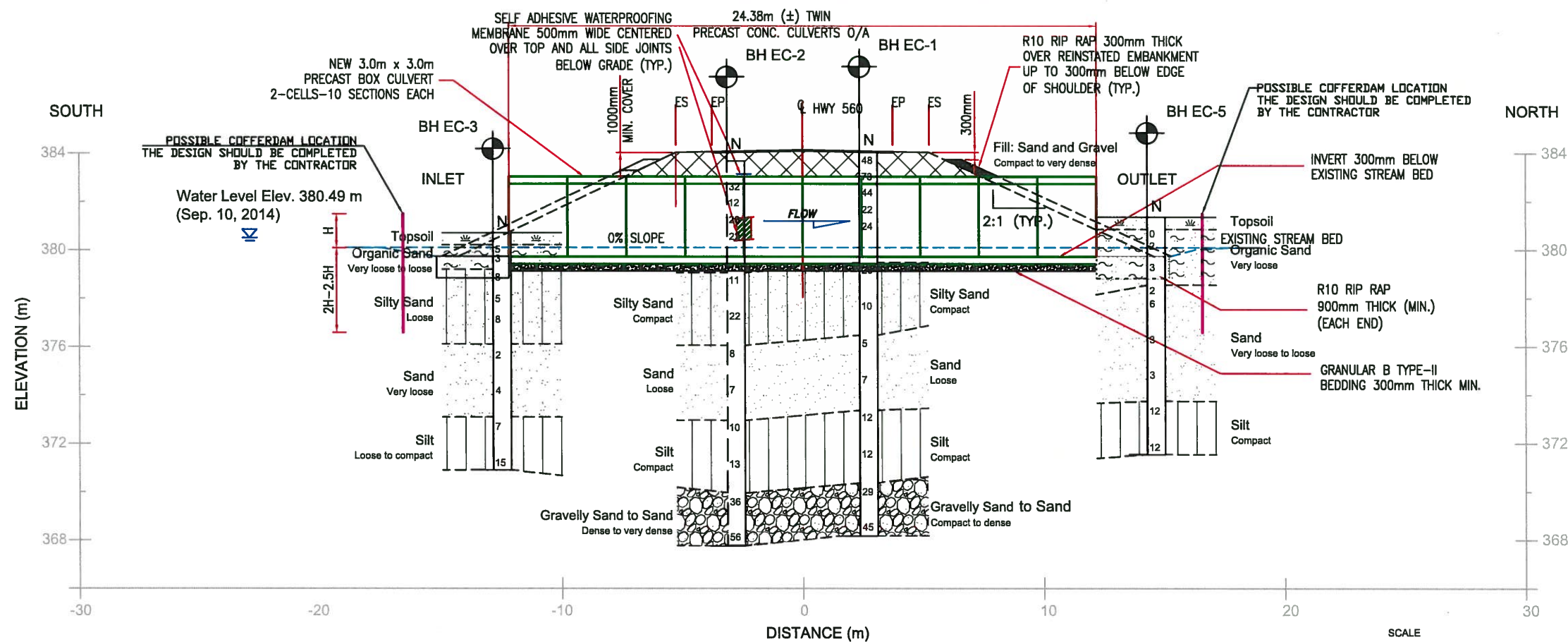
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2014.09.24	TSA	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRES NO. 41P-62
SCALE	1:1000	PROJECT NO. ADM-00028245-F0
SUBM'D TSA	CHECKED TSA	DATE 2014.10.01
DRAWN JH	CHECKED SG	APPROVED SG DWG. 01

Note: The plan was provided by MTO.





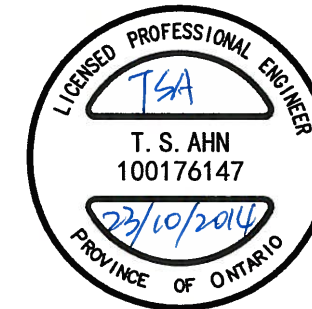
PIPE ELLIPSE CULVERT REPLACEMENT - PLAN



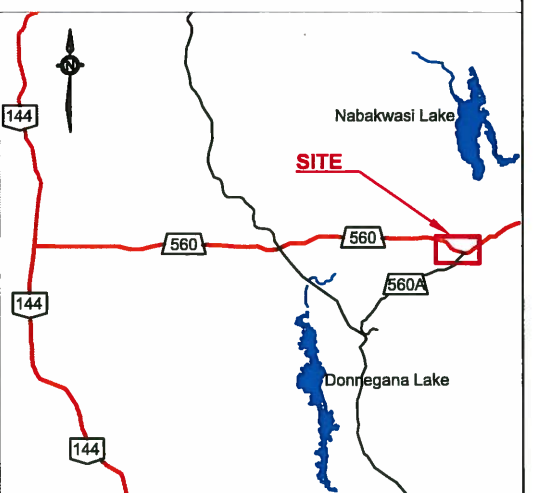
























PIPE ELLIPSE CULVERT REPLACEMENT - SECTION A-A

# **METRIC**

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



Agreement No. 5013-E-0008 Assignment No. 5 WO 2014-11034																			
DONNEGANA RIVER CULVERT REPLACEMENT (HWY 560, Township of Garvey) PIPE ELLIPSE CULVERT REPLACEMENT PLAN AND SECTION A-A		SHEET  2																	
		exp Services Inc.																	
KEY PLAN																			
																			
LEGEND																			
 Approximate Investigated Borehole Locations  N Standard Penetration Test (Blows/0.3 m)																			
SOIL STRATA SYMBOLS																			
<table><tr><td></td><td>FILL</td><td></td><td>TOPSOIL</td></tr><tr><td></td><td>SAND</td><td></td><td>SILT</td></tr><tr><td></td><td>SILTY SAND</td><td></td><td>GRAVELLY SAND TO SAND</td></tr><tr><td></td><td>ORGANICS SAND</td><td></td><td></td></tr></table>					FILL		TOPSOIL		SAND		SILT		SILTY SAND		GRAVELLY SAND TO SAND		ORGANICS SAND		
	FILL		TOPSOIL																
	SAND		SILT																
	SILTY SAND		GRAVELLY SAND TO SAND																
	ORGANICS SAND																		
BH No.		APPROX. ELEV.		MTM CO-ORDINATES															
				NORTH	EAST														
BH EC-1		384.09		5259586	269636														
BH EC-2		383.67		5259574	269641														
BH EC-3		380.71		5259569	269631														
BH EC-4		381.12		5259591	269653														
BH EC-5		381.36		5259595	269632														
BH EC-6		381.29		5259564	269643														
NOTE																			
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2014.10.01		TSA		FINAL SUBMISSION															
2014.09.24		TSA		SUBMISSION FOR MTO REVIEW															
DATE		BY		DESCRIPTION															
				GEOCRES NO. 41P-62															
SCALE		SEE SCALE BAR		PROJECT NO. ADM-00028245-F0															
SUBM'D TSA		CHECKED TSA		DATE 2014.10.01															
DRAWN JH		CHECKED SG		APPROVED SG															
				DWG. 02															

Note: The plan and section were provided by MTO.

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STATIONS ARE IN KILOMETERS +METERS

Agreement No. 5013-E-0008  
Assignment No. 5  
WO 2014-11034

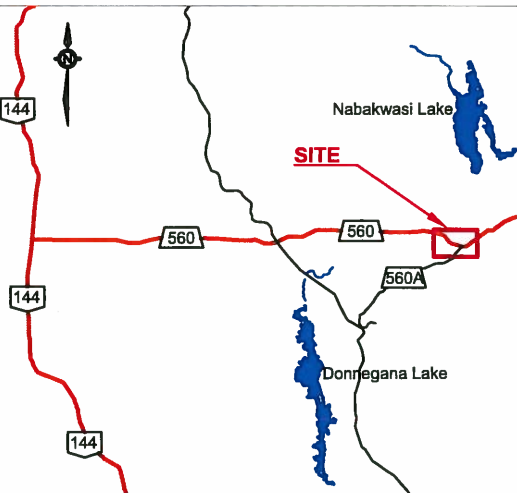
DONNEGANA RIVER CULVERT REPLACEMENT  
(HWY 560, Township of Garvey)  
PIPE ELLIPSE CULVERT REPLACEMENT  
SECTION B-B AND C-C

SHEET  
3



exp Services Inc.

KEY PLAN



LEGEND



Approximate Investigated Borehole Locations

N

Standard Penetration Test (Blows/0.3 m)

SOIL STRATA SYMBOLS



TOPSOIL



SAND



GRAVELLY SAND  
TO SAND



SILT



SILTY SAND



ORGANICS  
SAND

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH EC-1	384.09	5259586	269636
BH EC-2	383.67	5259574	269641
BH EC-3	380.71	5259569	269631
BH EC-4	381.12	5259591	269653
BH EC-5	381.36	5259595	269632
BH EC-6	381.29	5259564	269643

NOTE

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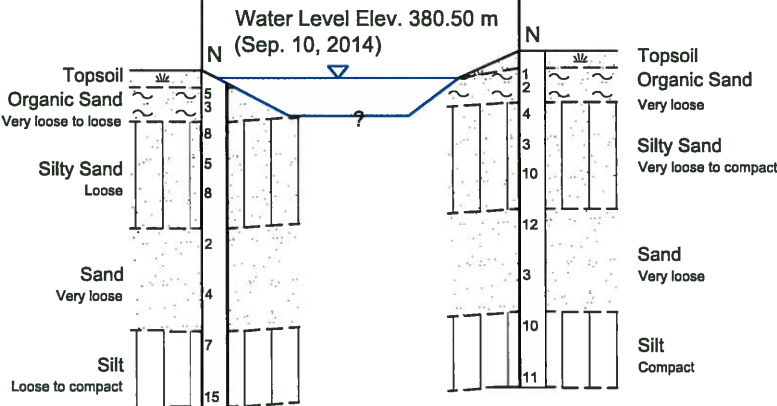
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2014.10.01	TSA	FINAL SUBMISSION
2014.09.24	TSA	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRES NO. 41P-62
SCALE	SEE SCALE BAR	PROJECT NO. ADM-00028245-F0
SUBM'D TSA	CHECKED TSA	DATE 2014.10.01
DRAWN JH	CHECKED SG	APPROVED SG DWG. 03

WEST



BH EC-3 BH EC-6



DISTANCE (m)

PIPE ELLIPSE CULVERT REPLACEMENT - SECTION B-B



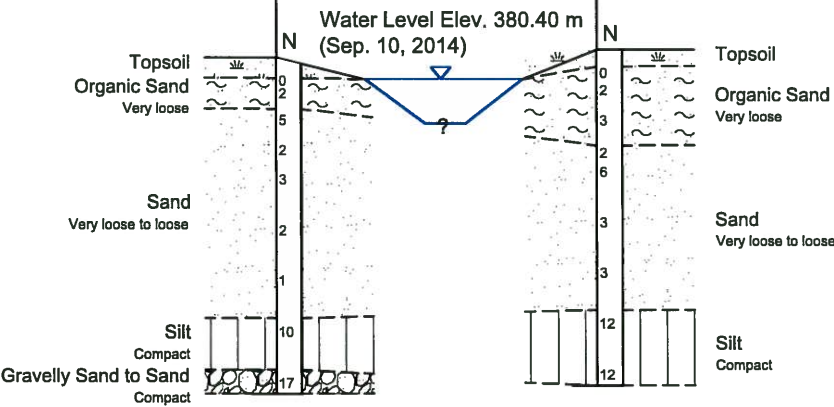
EAST



EAST

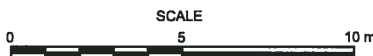


BH EC-4 BH EC-5



DISTANCE (m)

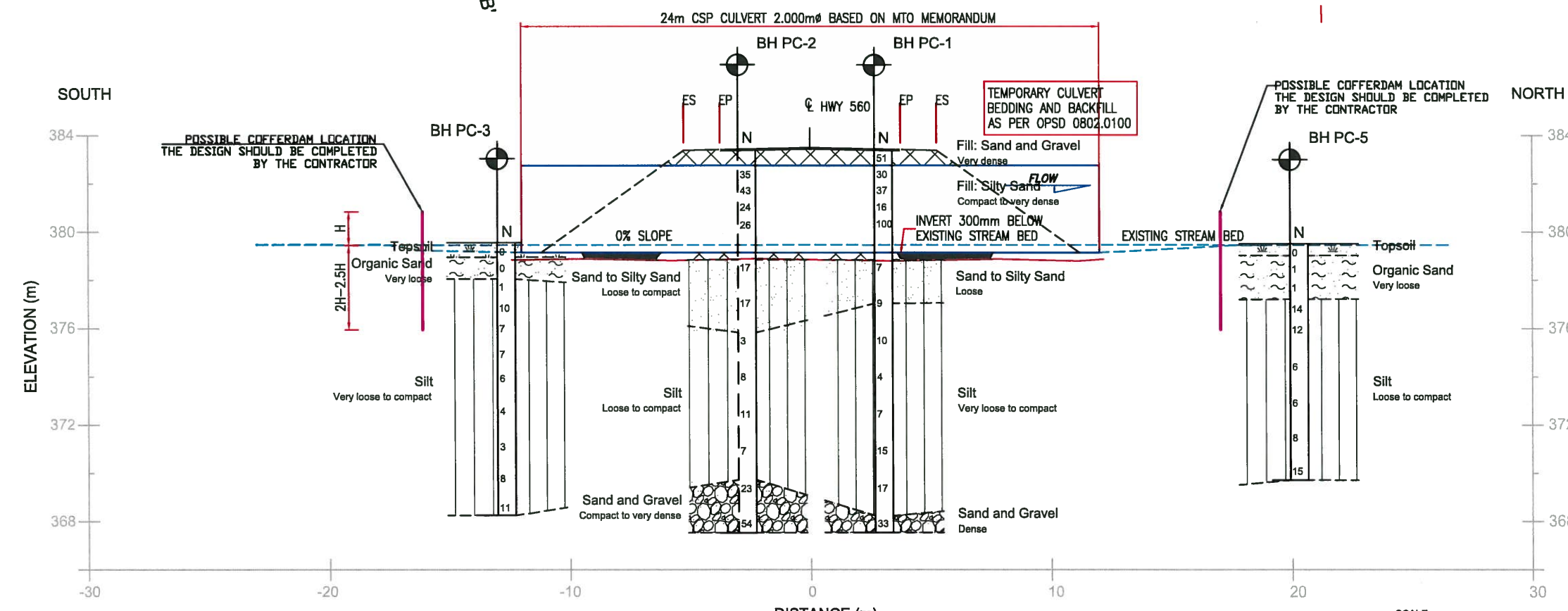
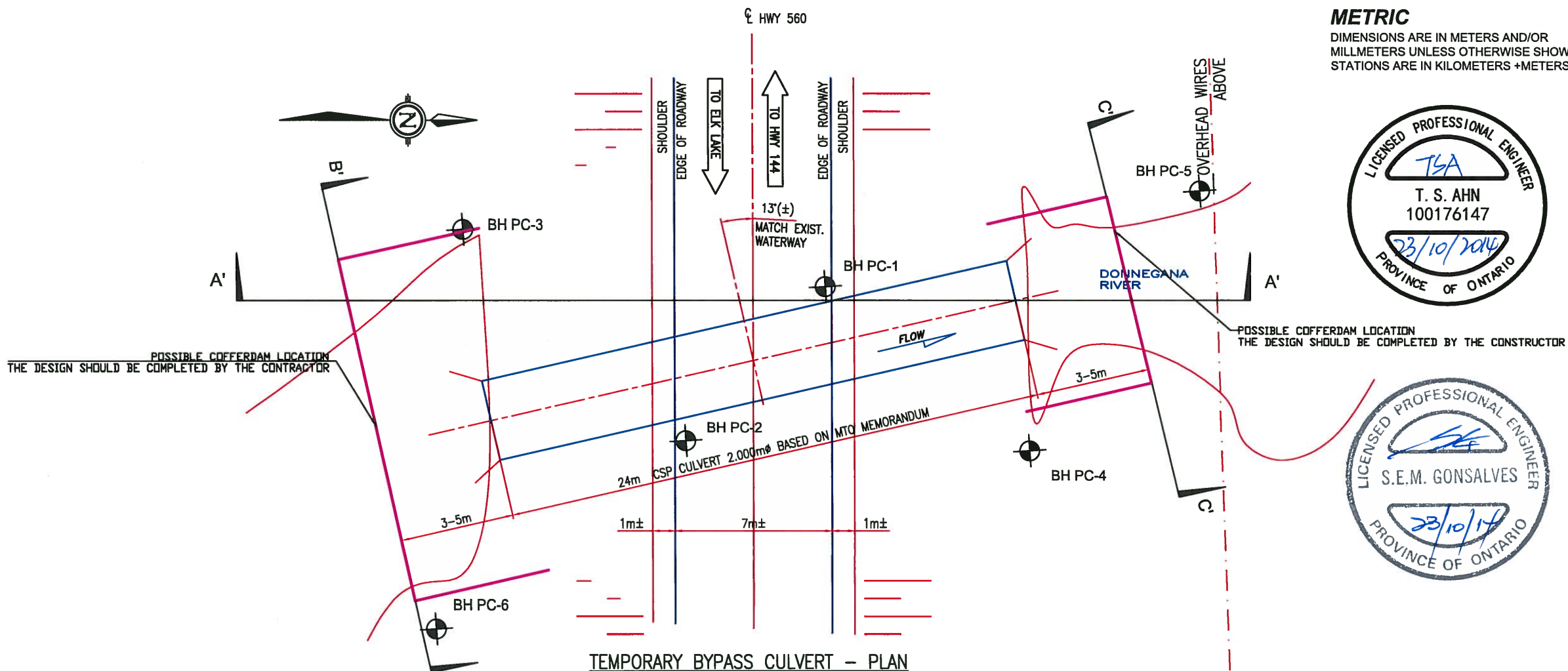
PIPE ELLIPSE CULVERT REPLACEMENT - SECTION C-C



WEST







Note: The plan and section were provided by MTO.

**METRIC**  
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STATIONS ARE IN KILOMETERS + METERS

LICENSED PROFESSIONAL ENGINEER  
T. S. AHN  
100176147  
23/10/2014  
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER  
S.E.M. GONSALVES  
23/10/14  
PROVINCE OF ONTARIO

Agreement No. 5013-E-0008  
Assignment No. 5  
WO 2014-11034

SHEET  
4

DONNEGANA RIVER CULVERT REPLACEMENT  
(HWY 560, Township of Garvey)  
TEMPORARY BYPASS CULVERT - PLAN AND SECTION A'-A'

exp Services Inc.

KEY PLAN

LEGEND

Approximate Investigated Borehole Locations  
N Standard Penetration Test (Blows/0.3 m)

SOIL STRATA SYMBOLS

FILL  
 SAND  
 SAND TO SILTY SAND  
 ORGANICS SAND

TOPSOIL  
 SILT  
 SAND AND GRAVEL

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH PC-1	383.44	5259595	269566
BH PC-2	383.40	5259589	269570
BH PC-3	379.56	5259585	269557
BH PC-4	379.60	5259607	269575
BH PC-5	379.52	5259610	269556
BH PC-6	379.71	5259581	269575

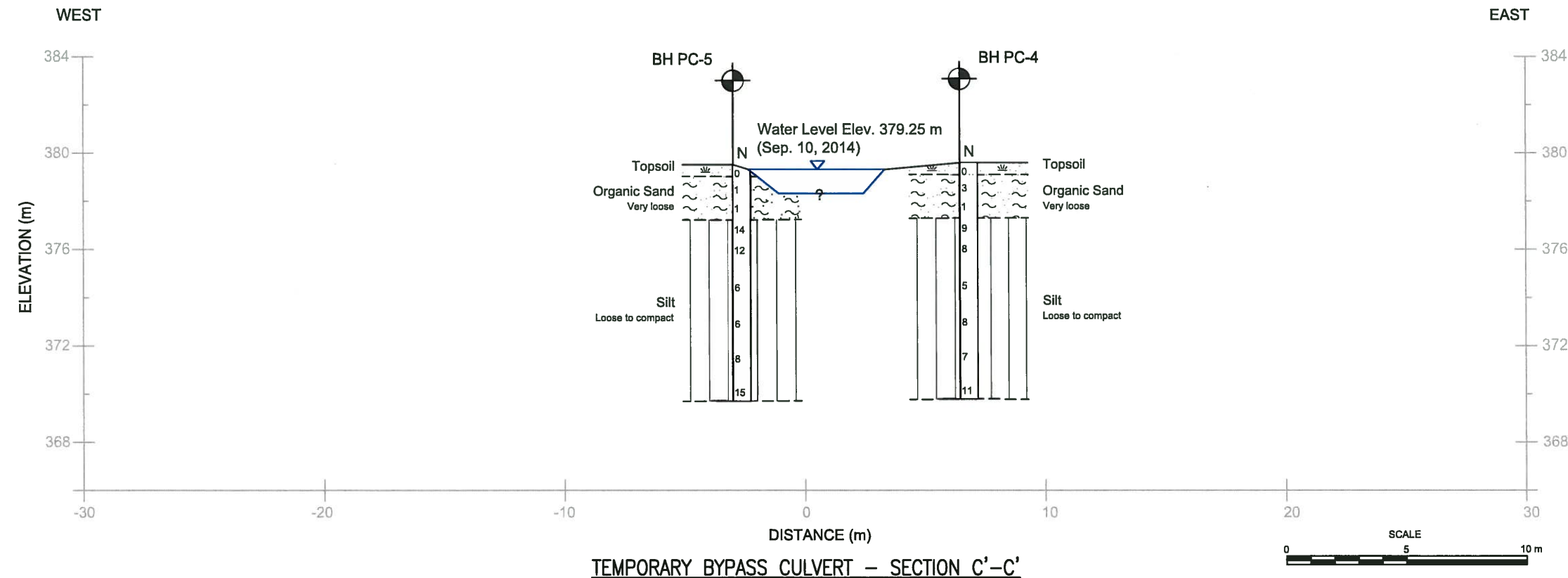
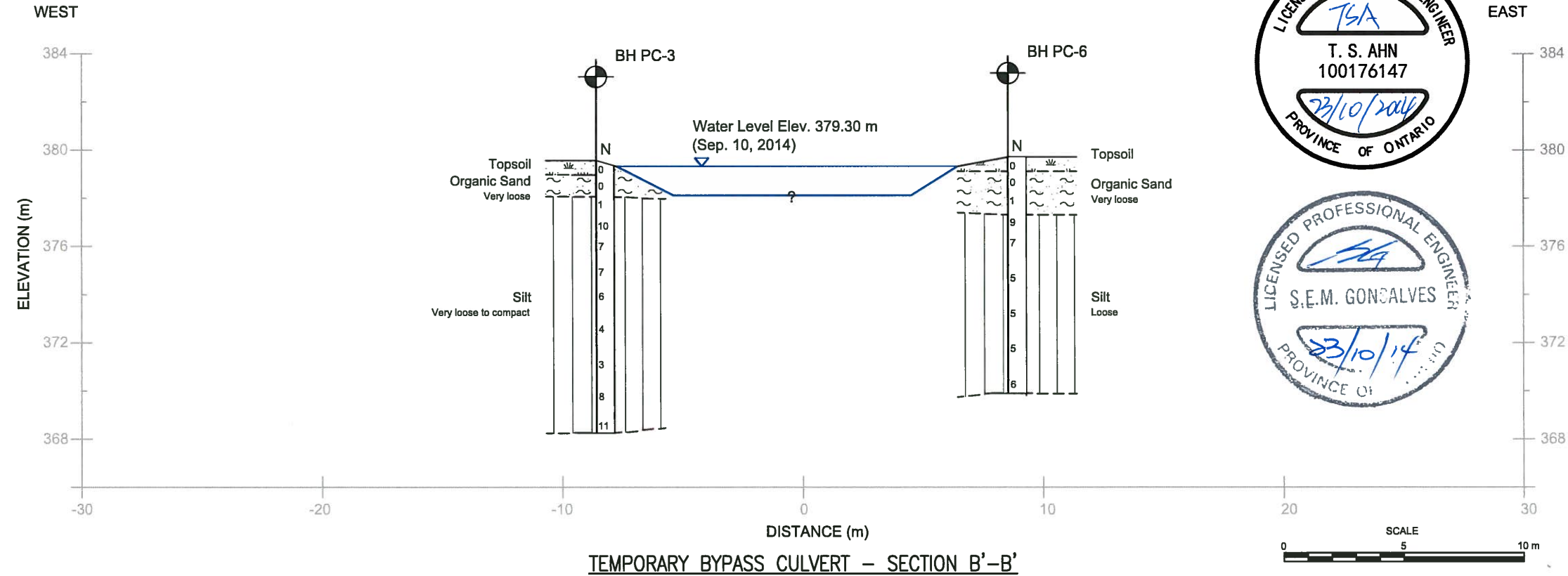
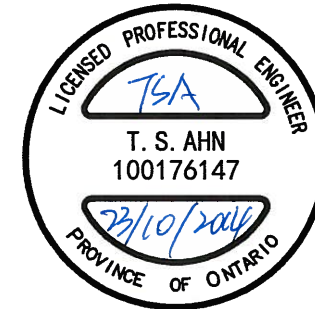
NOTE

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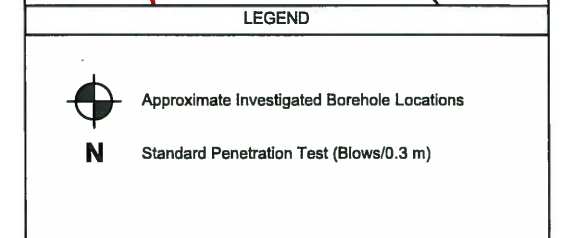
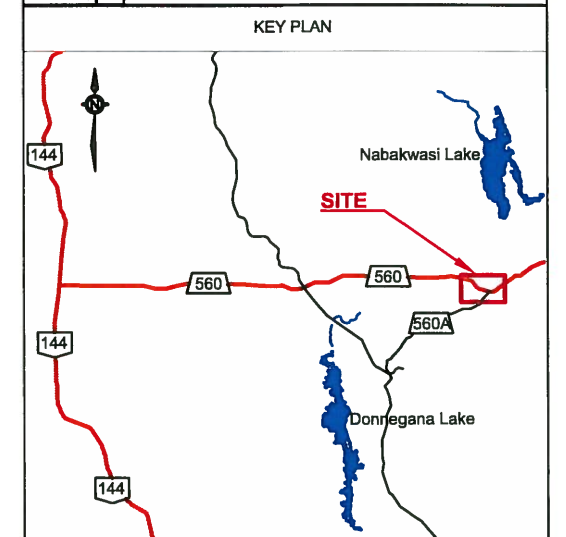
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DATE	BY	DESCRIPTION		
2014.10.01	TSA	FINAL SUBMISSION		
2014.09.24	TSA	SUBMISSION FOR MTO REVIEW		
SCALE	SEE SCALE BAR	PROJECT NO. ADM-00028245-F0		
SUBM'D	TSA	CHECKED TSA	DATE 2014.10.01	
DRAWN	JH	CHECKED SG	APPROVED SG	DWG. 04

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Agreement No. 5013-E-0008	
Assignment No. 5	
WO 2014-11034	
DONNEGANA RIVER CULVERT REPLACEMENT (HWY 560, Township of Garvey)	SHEET
TEMPORARY BYPASS CULVERT - SECTION B'-B' AND C'-C'	5



SOIL STRATA SYMBOLS			
	SAND		TOPSOIL
	SILT		ORGANICS SAND

BH No.	APPROX. ELEV.	MTM CO-ORDINATES	
		NORTH	EAST
BH PC-1	383.44	5259595	269566
BH PC-2	383.40	5259589	269570
BH PC-3	379.56	5259585	269557
BH PC-4	379.60	5259607	269575
BH PC-5	379.52	5259610	269556
BH PC-6	379.71	5259581	269575

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2014.09.24	TSA	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRE NO. 41P-62
SCALE	SEE SCALE BAR	PROJECT NO. ADM-00028245-F0
SUBM'D TSA	CHECKED TSA	DATE 2014.10.01
DRAWN JH	CHECKED SG	APPROVED SG
		DWG. 05

## **Appendix C – Borehole Logs**

# Explanation of Terms Used on Borehole Records

## SOIL DESCRIPTION

Terminology describing common soil genesis:

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

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

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

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

Terminology describing soil structure:

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

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

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

*Fissured:* material breaks along plane of fracture.

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

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

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

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

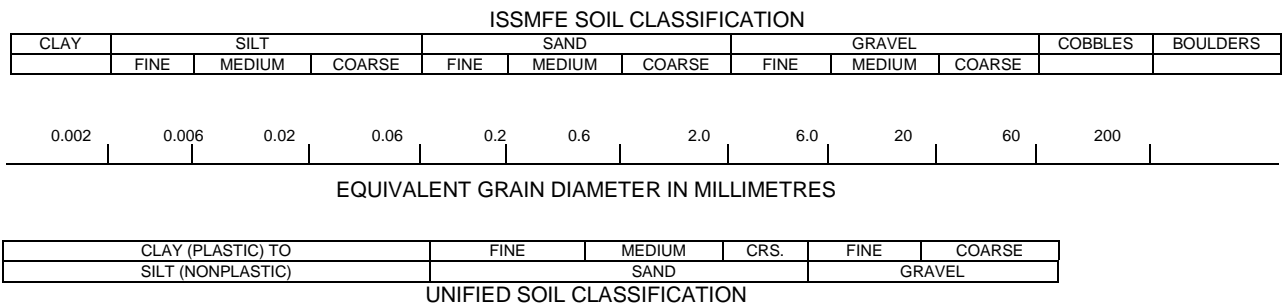
*Seam:* a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

*Homogeneous:* same color and appearance throughout.

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

*Uniformly Graded:* predominantly on grain size.

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



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

Table a: Percent or Proportion of Soil, Pp

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

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

Table b: Apparent Density of Cohesionless Soil

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



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

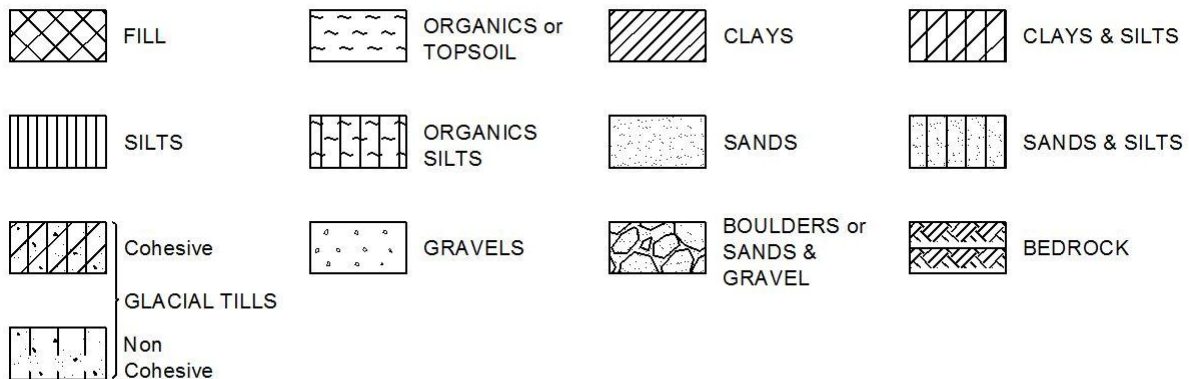
Table c: Consistency of Cohesive Soil

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

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

## STRATA PLOT

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



## WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe



## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	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 EC-1

1 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269636 N5259586 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/10 - 2014/09/11 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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
384.1	Ground Surface																
380.0	ASPHALT 12 mm thickness Fill: SAND AND GRAVEL (SW-GW) with cobbles (rounded), brown, moist, compact to very dense  -becoming more sand, some silt		1	SS	48		384										
			2	SS	73		383										9 58 (33)
			3	SS	44		382										
			4	SS	22		381										44 55 (1)
			5	SS	24		380										
379.5	SILTY SAND (SM) some peat, trace gravel, dark brown, wet, compact		6	SS	20		379										
4.6			7	SS	10		378										
	-becoming more silt, grey						377										
376.5	SAND (SW) trace gravel, trace silt, brown, loose		8	SS	5		376										
7.6			9	SS	7		375										5 93 (2)
	-becoming few gravel						374										
373.4	SILT (ML) trace sand, few clay, grey, wet, compact		10	SS	12		373										
10.7																	

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASS'G. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No EC-1

2 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269636 N5259586 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/10 - 2014/09/11 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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	<b>SILT (ML)</b> trace sand, few clay, grey, wet, compact ( <i>continued</i> )		11	SS	12		372										0 1 93 6
370.4							371										
13.7	<b>GRAVELLY SAND TO SAND (SW-GM)</b> trace silt, grey, wet, compact to dense		12	SS	29		370										
	-becoming little silt		13	SS	45		369										22 58 (20)
368.2																	
15.9	<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. Interpretation assistance by exp is required before use by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASS'G. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No EC-2

1 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269641 N5259574 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV. 381.5m MTM Z12 E269584 N5259604 DATE 2014/09/09 - 2014/09/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
383.7	Ground Surface																
380.0	ASPHALT 12 mm thickness FILL: SAND AND GRAVEL (SW-GW) with cobbles (rounded), trace silt, brown, wet, compact to dense		1	GS			383										
			2	SS	32		382										
	-cored 310 mm due to large boulders		3	SS	12		381										
			4	SS	20		380										
			5	SS	22		379										
379.1							378										
4.6	SILTY SAND (SM) some peat, trace gravel, dark brown to grey, wet, compact		6	SS	11		377										
			7	SS	22		376										
376.1							375										
7.6	SAND (SW) trace gravel, trace silt, grey, wet, loose		8	SS	8		374										
			9	SS	7		373										
373.0							372										
10.7	SILT (ML) trace gravel, trace sand, grey, wet, compact		10	SS	10												

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No EC-2

2 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269641 N5259574 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/09 - 2014/09/09 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: Cu, KPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE															
								× QUICK TRIAXIAL LAB VANE															
							20	40	60	80	100		10	20	30								
	<b>SILT (ML)</b> trace gravel, trace sand, grey, wet, compact ( <i>continued</i> )		11	SS	13									○									
370.0																							
13.7	<b>GRAVELLY SAND TO SAND (SW-GW)</b> some silt, grey, wet, dense to very dense		12	SS	36								○										
367.8			13	SS	56																		
15.9	<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. Interpretation assistance by exp is required before use by others. 3. No groundwater level was measured because wash boring technique was used.																						

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No EC-3

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269631 N5259569 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/11 - 2014/09/11 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: Cu, KPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE										
							20	40	60	80	100									
							×	QUICK TRIAXIAL		LAB VANE										
380.7	Ground Surface																			
	TOPSOIL 500 mm thickness																			
380.2																				
0.5	ORGANIC SAND some peat, roots inclusion, dark brown, wet, very loose to loose -becoming more peat		1	SS	5															
			2	SS	3															
379.2																				
1.5	SILTY SAND (SM) trace roots, grey, wet, loose		3	SS	8															
			4	SS	5															
			5	SS	8															
376.1																				
4.6	SAND (SW) trace gravel, trace silt, grey, wet, very loose		6	SS	2															
			7	SS	4															
373.1																				
7.6	SILT (ML) trace sand, trace clay, grey, wet, loose to compact		8	SS	7															
			9	SS	15															
371.0																				
9.8	END OF BOREHOLE																			
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																			

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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

Brampton, Ontario

## RECORD OF BOREHOLE No EC-4

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269653 N5259591 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/10 - 2014/09/10 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
381.1	Ground Surface																
	TOPSOIL 600 mm thickness						381										
380.5																	
0.6	ORGANIC SAND some peat, few silt, dark brown, wet, very loose -becoming more peat		1	SS	0											50.1	0 89 (11)
			2	SS	2		380									198.4	
379.6																	
1.5	SAND (SW) trace gravel, trace silt, grey, wet, very loose to loose  -becoming some gravel		3	SS	5		379										1 97 (2)
			4	SS	2		378										
			5	SS	3												
							377										
			6	SS	2		376										
							375										
			7	SS	1		374										
373.5																	
7.6	SILT (ML) trace clay, grey, wet, compact		8	SS	10		373										
372.0							372										
9.1	GRAVELLY SAND TO SAND (SW-GW) few silt, grey, wet, compact		9	SS	17												4 89 (7)
371.4																	
9.8	END OF BOREHOLE																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No EC-5

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269632 N5259595 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/10 - 2014/09/10 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: Cu, KPa												
								○ UNCONFINED	+	FIELD VANE	×	QUICK TRIAXIAL	LAB VANE							
381.4	Ground Surface																			
	TOPSOIL 500 mm thickness																			
380.9	ORGANIC SAND some peat, roots inclusion, few silt, brown to dark brown, moist to wet, very loose		1	SS	0															
0.5			2	SS	2															
			3	SS	3															
379.1	SAND (SW) trace peat, trace gravel, trace silt, grey, wet, very loose to loose		4	SS	2															
2.3			5	SS	6															
			6	SS	3															
			7	SS	3															
373.7	SILT (ML-CL) with occassional clayey seams, trace gravel, trace sand, grey, wet, compact		8	SS	12															
7.6																				
			9	SS	12															
371.6	END OF BOREHOLE																			
9.8	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring techuque was used.																			

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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



Brampton, Ontario

## RECORD OF BOREHOLE No EC-6

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269643 N5259564 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/11 - 2014/09/11 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			20	40	60	80	100					
381.3	Ground Surface																
	TOPSOIL 500 mm thickness						381										
380.8	ORGANIC SAND some peat, roots inclusion, few silt, dark brown, wet, very loose		1	SS	1											79.6	0 94 (6)
0.5			2	SS	2											54.1	
379.8	SILTY SAND (SM) grey, wet, very loose to compact						380										
1.5			3	SS	4												
			4	SS	3		379										
	-becoming some silt																
			5	SS	10		378										0 73 (27)
							377										
376.7	SAND (SW) some gravel, trace silt, brownish grey, wet, very loose to compact																
4.6			6	SS	12		376										
							375										
			7	SS	3												
							374										
373.7	SILT (ML-CL) trace gravel, trace sand, few clay, grey, moist, compact																
7.6			8	SS	10		373										
	-becoming occasional clayey seams						372										
			9	SS	11												1 1 90 8
371.5	END OF BOREHOLE																
9.8	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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

Brampton, Ontario

## RECORD OF BOREHOLE No PC-1

1 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269566 N5259569 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/11 - 2014/09/11 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			20	40	60	80	100					
383.4	Ground Surface																
380.0	ASPHALT 12 mm thickness		1	SS	51		383										
382.7	FILL: SAND AND GRAVEL (SW-GM) with cobbles, brown, moist, very dense																
0.8	FILL: SILTY SAND (SM) trace gravel, brown, moist to wet, compact to very dense		2	SS	30		382										
			3	SS	37												
			4	SS	16		381										
	-becoming cobbles and boulders in spoon tip, NQ core to 4.57 m		5	SS	100		380										
378.8	-becoming more gravel		6	SS	7		379										
4.7	SAND TO SILTY SAND (SM) trace gravel, brown to grey, wet, loose						378										
377.0	-becoming trace wood, some gravel, some silt		7	SS	9		377										
6.4	SILT (ML) trace sand, few clay, grey, wet, very loose to compact																
							376										
			8	SS	10												
							375										
			9	SS	4		374										
							373										
			10	SS	7												
							372										

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No PC-1

2 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269566 N5259569 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/11 - 2014/09/11 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 $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
	<b>SILT (ML)</b> trace sand, few clay, grey, wet, very loose to compact (continued)		11	SS	15		371										
	-becoming trace gravel, more sand		12	SS	17		370										
							369										
368.2																	
15.2	<b>SAND AND GRAVEL (SW-GW)</b> few silt, grey, wet, dense		13	SS	33		368										19 74 (7)
367.6																	
15.9	<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. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASS'G. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No PC-2

1 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269570 N5259589 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/08 - 2014/09/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
383.4	Ground Surface																
380.0	ASPHALT 12 mm		1	AG			383										
382.6	FILL: SAND AND GRAVEL (SW-GW) with cobbles, brown, moist, very dense																
0.8	-auger refusal and cored		2	SS	35		382										10 58 (32)
	FILL: SILTY SAND (SM) few gravel, brown, damp to wet, compact																
	-cobbles, 25 mm recovery in spoon		3	SS	43		381										
			4	SS	24		380										
			5	SS	26		379										
378.8																	
4.6	SAND TO SILTY SAND (SM) some peat, brown to grey, wet, loose to compact		6	SS	17		378										0 92 (8)
	-becoming more silt		7	SS	17		377										
							376										
375.8																	
7.6	SILT (ML) trace sand, few clay, grey, wet, very loose to compact		8	SS	3		375										0 1 93 6
			9	SS	8		374										
							373										
			10	SS	11		372										

Continued Next Page

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

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3



Brampton, Ontario

## RECORD OF BOREHOLE No PC-2

2 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269570 N5259589 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE CME-55X, Diamond Drill, Cased Hole COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/08 - 2014/09/09 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: Cu, KPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE															
								× QUICK TRIAXIAL LAB VANE															
20	40	60	80	100	20	40	60	80	100	10	20	30											
369.7	SILT (ML) trace sand, few clay, grey, wet, very loose to compact (continued)		11	SS	7		371										51	43	(6)				
13.7	SAND AND GRAVEL (SW-GW) few silt, grey, wet, compact to very dense   -becoming more silt		12	SS	23		370																
367.6			13	SS	54		369																
15.9	END OF BOREHOLE						368																
	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																						

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## 1 OF 2

METRIC

[illegible]

DPG EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Continued Next Page

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

Brampton, Ontario

## RECORD OF BOREHOLE No PC-3

2 OF 2

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269575 N5259581 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/08 - 2014/09/08 CHECKED BY SM

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

Brampton, Ontario

## RECORD OF BOREHOLE No PC-4

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269575 N5259607 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/09 - 2014/09/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
379.6	Ground Surface																
	TOPSOIL 500 mm thickness		1	SS	0		379									57.3	
379.1	ORGANIC SAND some peat, roots inclusion, trace silt, dark brown, moist to wet, very loose		2	SS	3		378									45	
0.5			3	SS	1											57.3	0 96 (4)
377.3	SILT (ML) trace sand, grey, wet, loose to compact  -becoming trace clay    -becoming trace gravel    -becoming few clay		4	SS	9		377										
2.3			5	SS	8		376										
			6	SS	5		375										
							374										
			7	SS	8		373										0 2 89 9
							372										
			8	SS	7		371										
			9	SS	11		370										
369.9	END OF BOREHOLE																
9.8	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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



Brampton, Ontario

## RECORD OF BOREHOLE No PC-5

1 OF 1

METRIC

W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269557 N5259585 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/09 - 2014/09/10 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
379.5	Ground Surface																
	TOPSOIL 500 mm thickness		1	SS	0		379									53.2	
379.0	ORGANIC SAND some peat, roots inclusion, trace gravel, few silt, dark brown to grey, moist to wet, very loose		2	SS	1											79	1 91 (8)
0.5			3	SS	1		378										
			4	SS	14		377										
377.2	SILT (ML) trace gravel, trace sand, few clay, grey, wet, loose to compact		5	SS	12		376										
2.3			6	SS	6		375										
	-becoming sand and gravel pocket		7	SS	6		374										
			8	SS	8		373										
	-becoming trace clay		9	SS	15		372										
							371										
	-becoming few to little sand						370										
369.8	END OF BOREHOLE																
9.8	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASSIG. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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

Brampton, Ontario

## RECORD OF BOREHOLE No PC-6

1 OF 1

METRIC

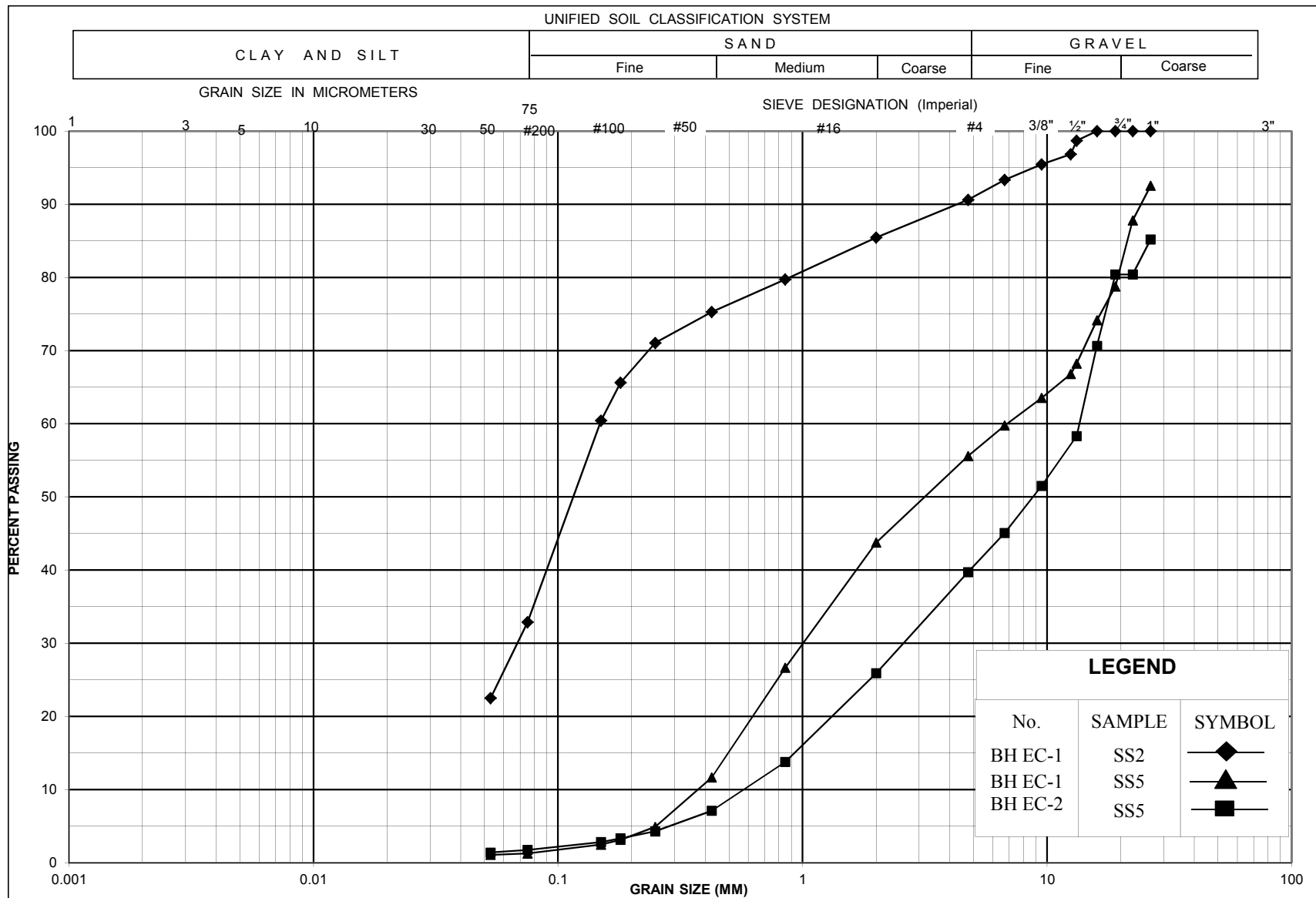
W. P. WO 2014-11034 LOCATION Donnegana River, ON, MTM Z12 E269575 N5259581 ORIGINATED BY ST  
 DIST HWY 560 BOREHOLE TYPE Portable Tirpod SPT by hand drilling/sampling equipment COMPILED BY JH  
 DATUM BM ELEV.381.5m MTM Z12 E269584 N5259604 DATE 2014/09/08 - 2014/09/09 CHECKED BY SM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
379.7	Ground Surface																
	TOPSOIL 500 mm thickness		1	SS	0		379									60.2	
379.2	ORGANIC SAND some peat, roots inclusion, trace gravel, trace silt, dark brown to grey, wet, very loose		2	SS	0											58.3	
0.5			3	SS	1		378										1 96 (3)
			4	SS	9		377										
377.4	SILT (ML) trace gravel, trace to few sand, few clay, grey, wet, loose		5	SS	7		376										0 1 90 9
2.3			6	SS	5		375										
			7	SS	5		374										
			8	SS	5		373										
			9	SS	6		372										
	-becoming more clay						371										1 6 (93)
370.0	END OF BOREHOLE						370										
9.8	NOTES: 1. This drawing is to be read with the subject report and project numbers as presented above. 2. Interpretation assistance by exp is required before used by others. 3. No groundwater level was measured because wash boring technique was used.																

OPG\_EXP RECORD OF BOREHOLE 5013-E-0008 ASS'G. 5 - BH LOGS.GPJ ONTARIO MOT.GDT 14/10/3

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

## Appendix D – Laboratory Data

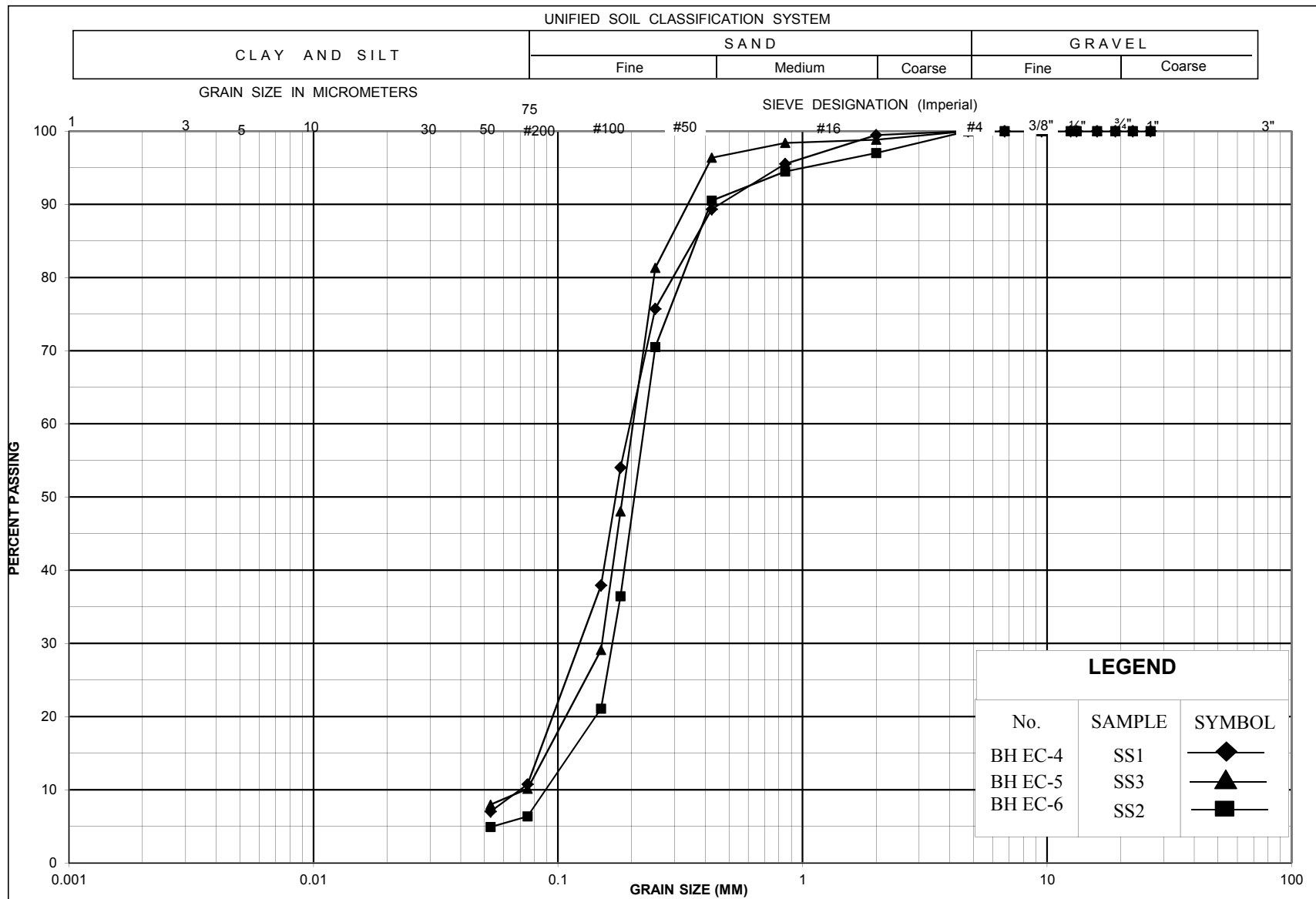


**GRAIN SIZE DISTRIBUTION**  
**FILL: SAND AND GRAVEL**  
**Existing Culvert**

FIGURE 1

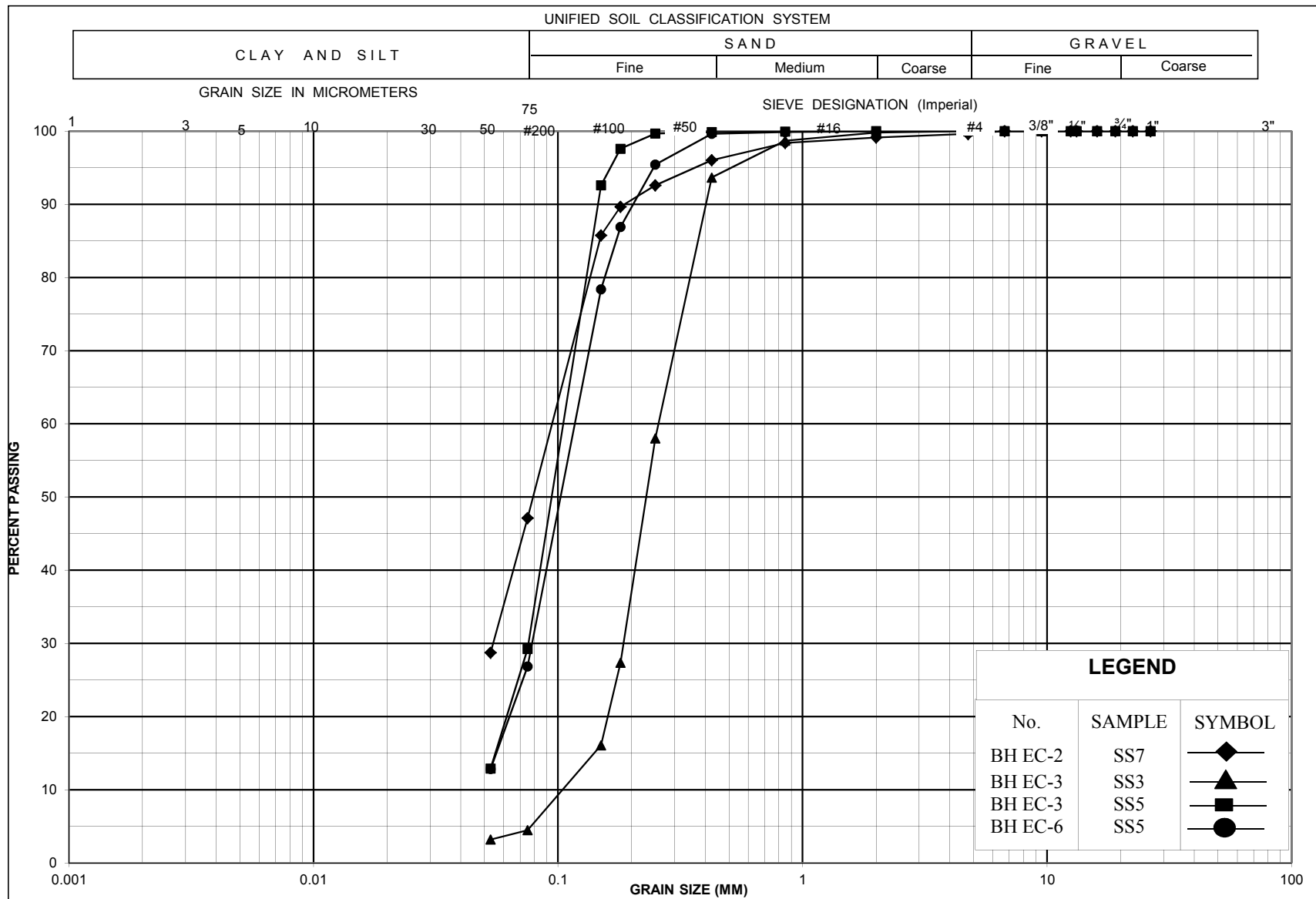
WO-2014-11034

DATE    October 2014



GRAIN SIZE DISTRIBUTION  
**ORGANIC SAND**  
*Existing Culvert*

FIGURE 2  
 WO-2014-11034  
 DATE    October 2014

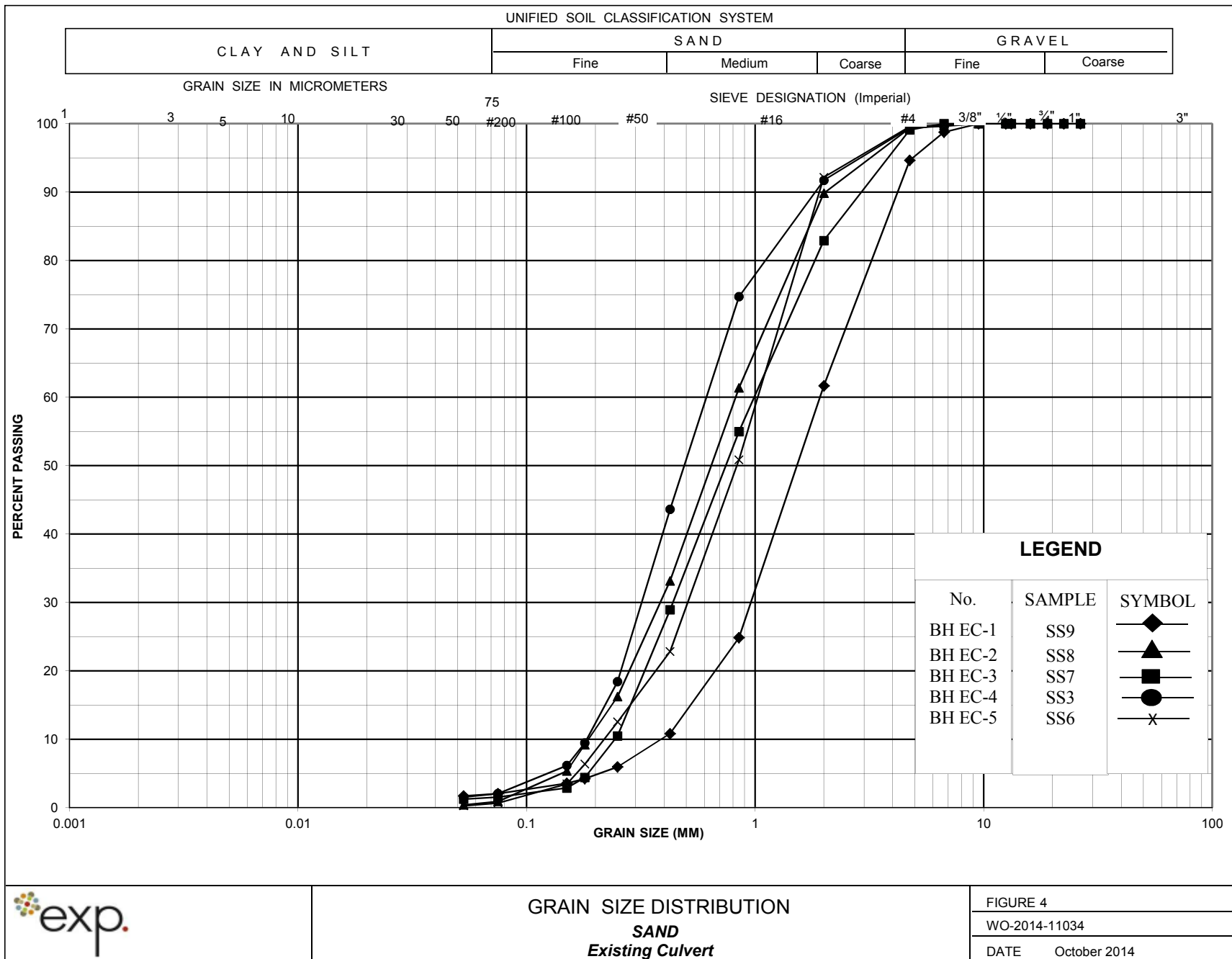


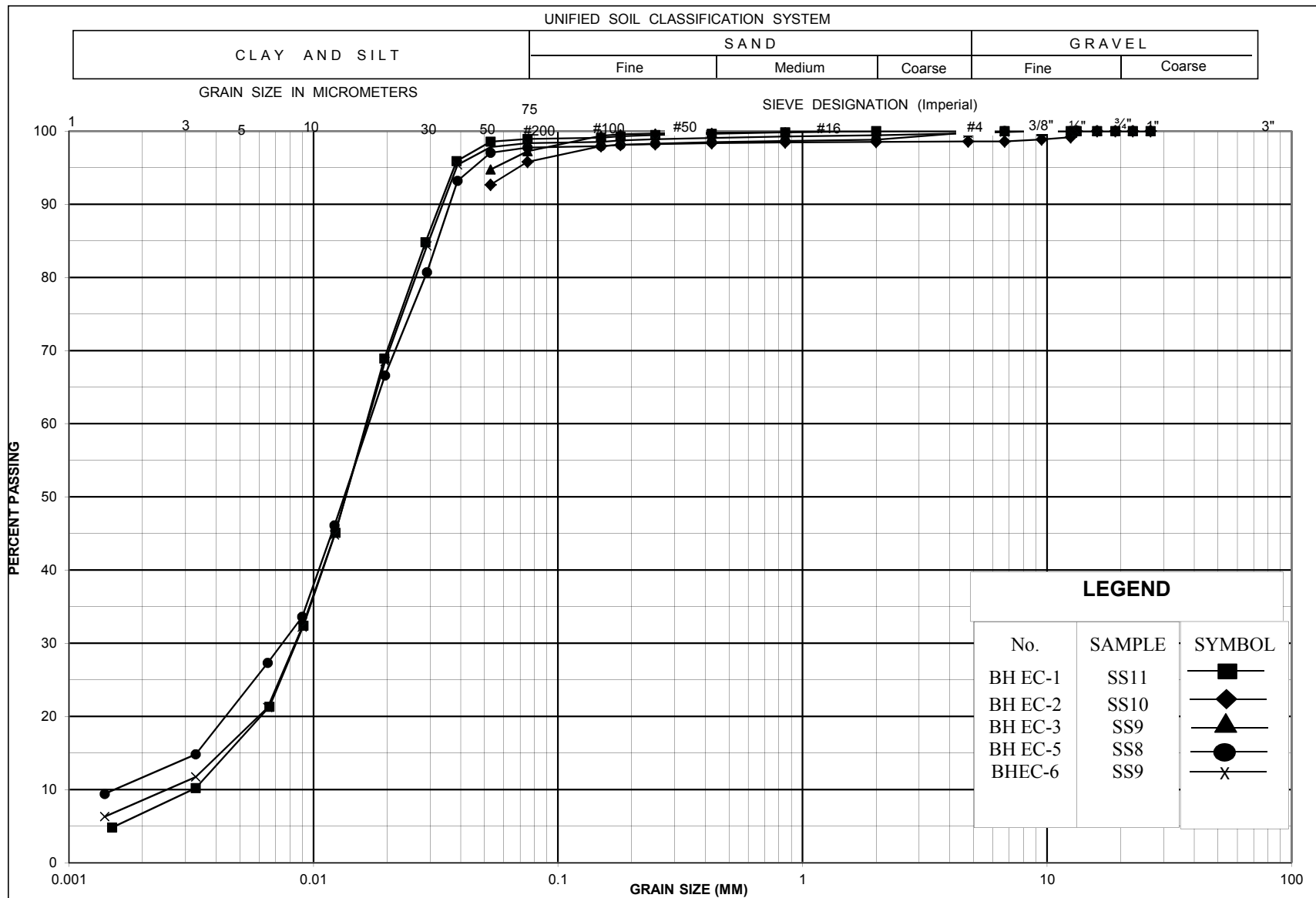
GRAIN SIZE DISTRIBUTION  
**SILTY SAND**  
*Existing Culvert*

FIGURE 3

WO-2014-11034

DATE    October 2014

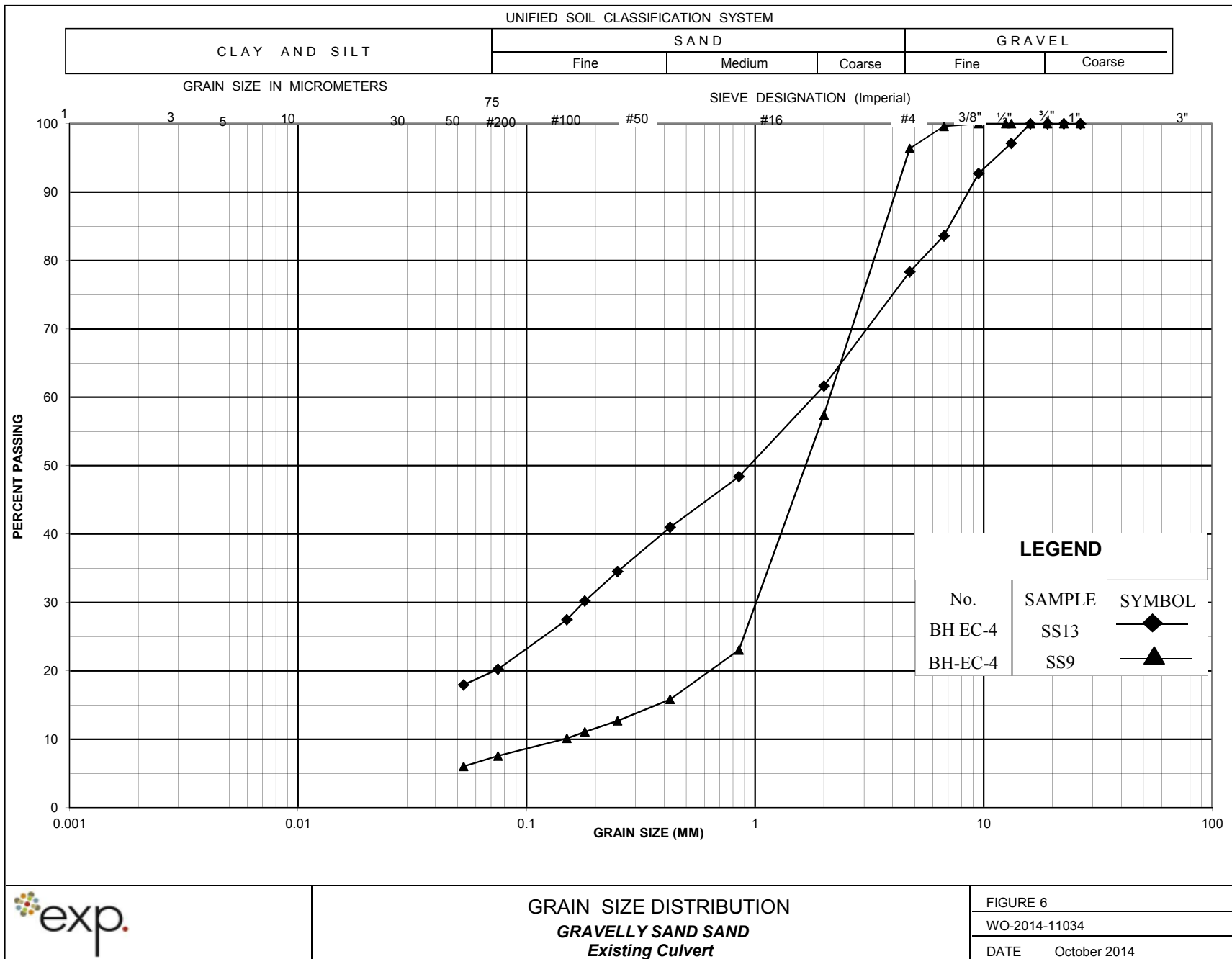


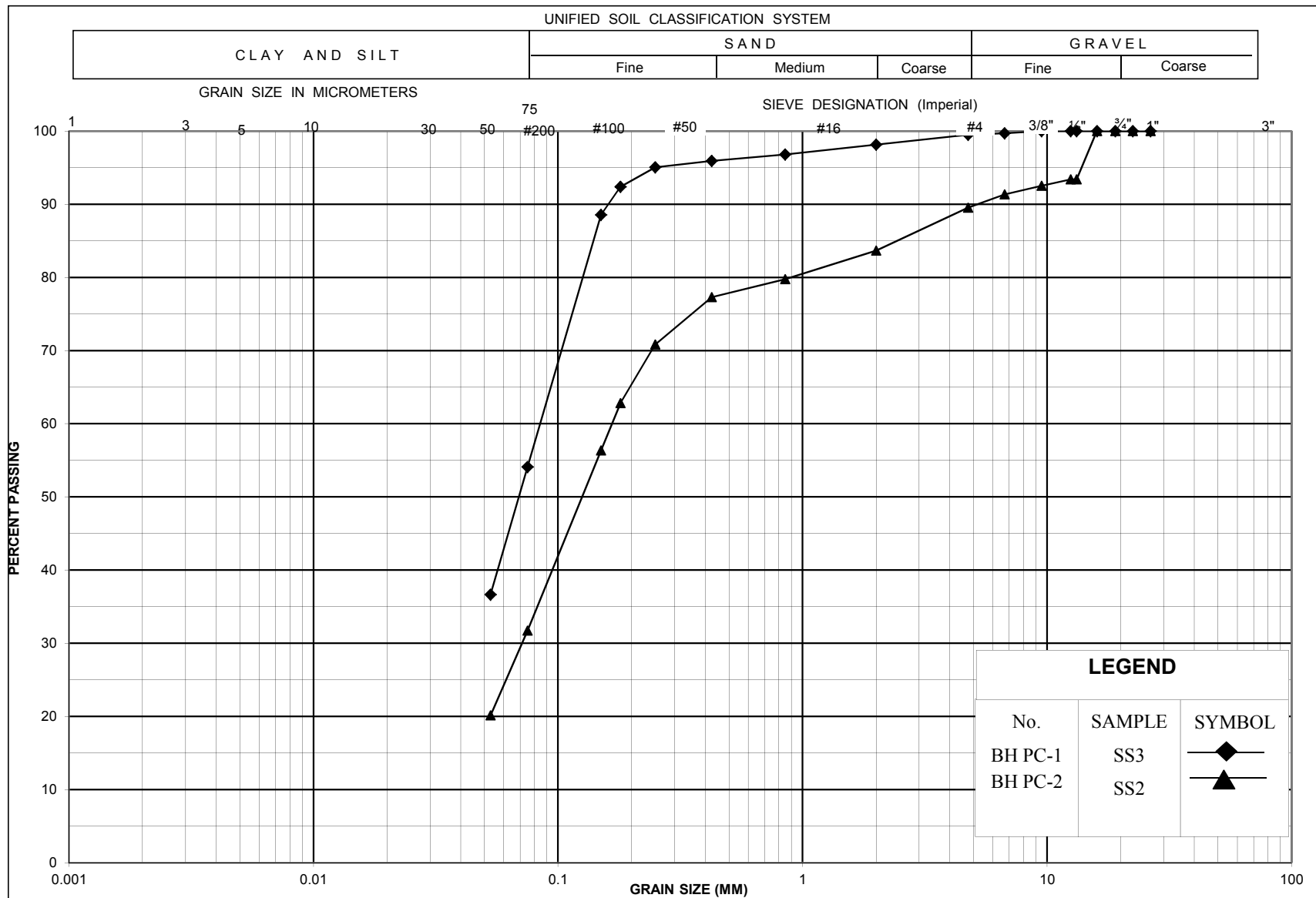


GRAIN SIZE DISTRIBUTION  
*SILT*  
*Existing Culvert*

FIGURE 5  
WO-2014-11034  
DATE    October 2014

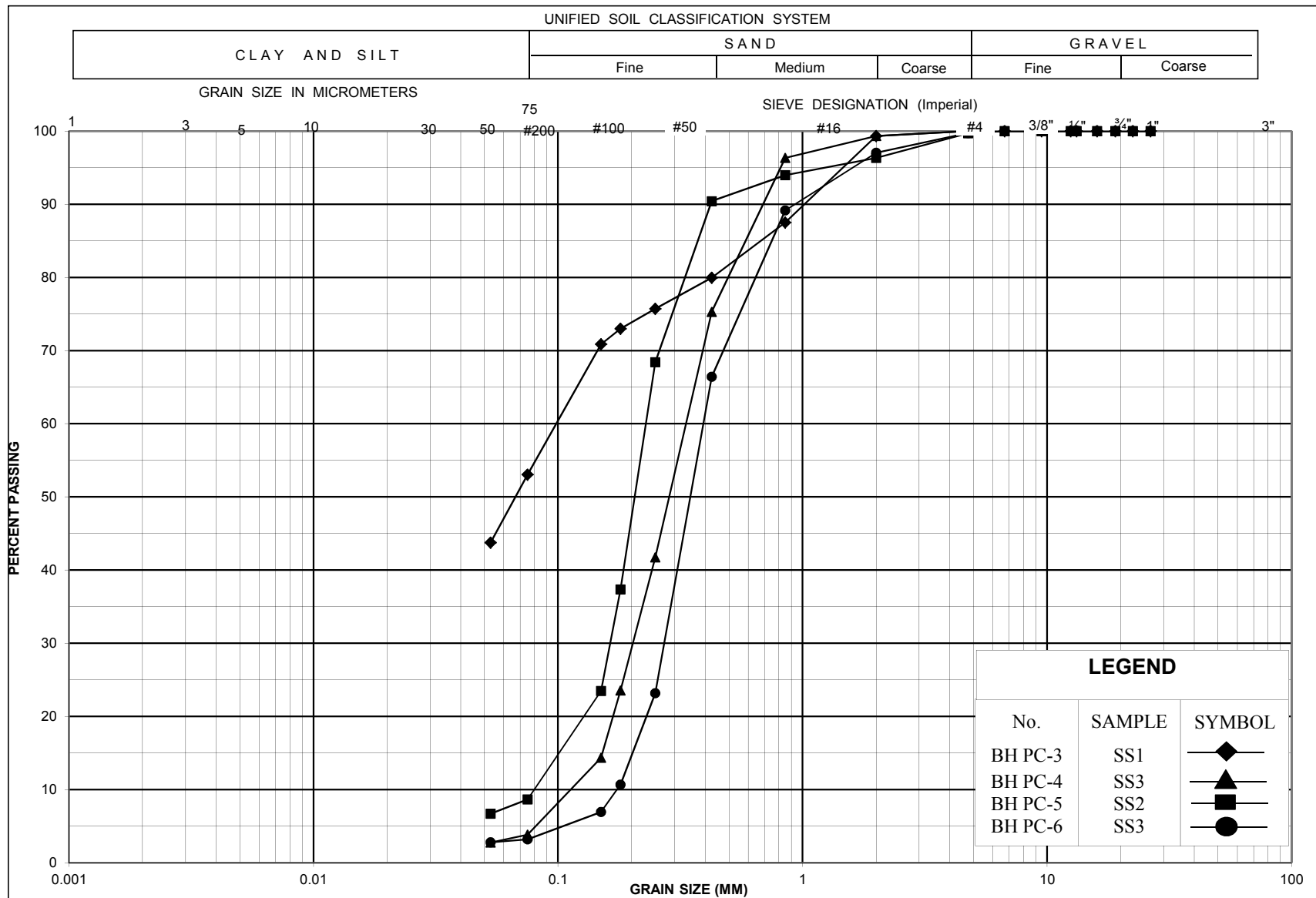






**GRAIN SIZE DISTRIBUTION**  
**FILL: SILTY SAND**  
**Proposed Culvert**

FIGURE 7  
 WO-2014-11034  
 DATE    October 2014

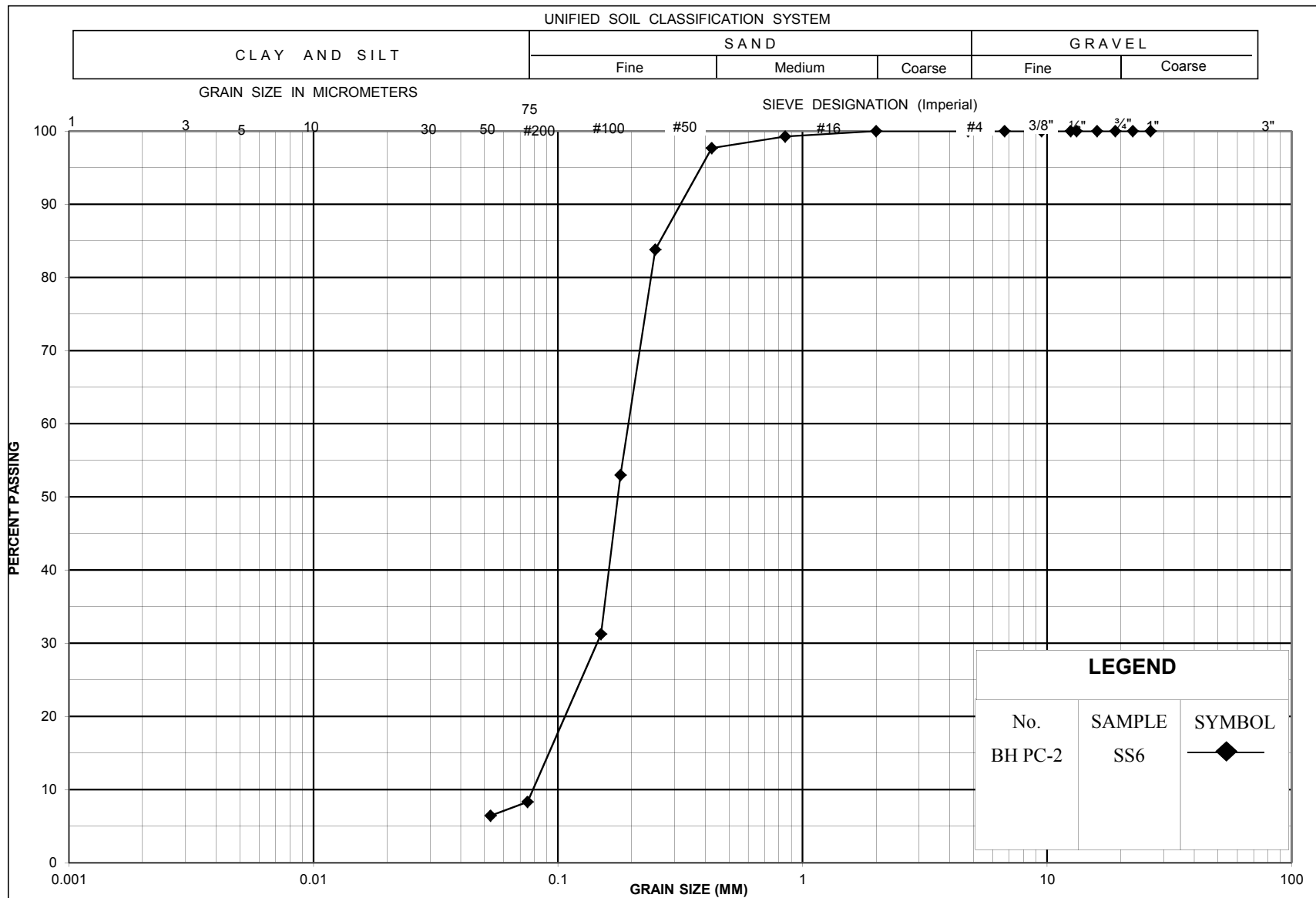


**GRAIN SIZE DISTRIBUTION**  
**ORGANIC SAND**  
*Proposed Culvert*

FIGURE 8

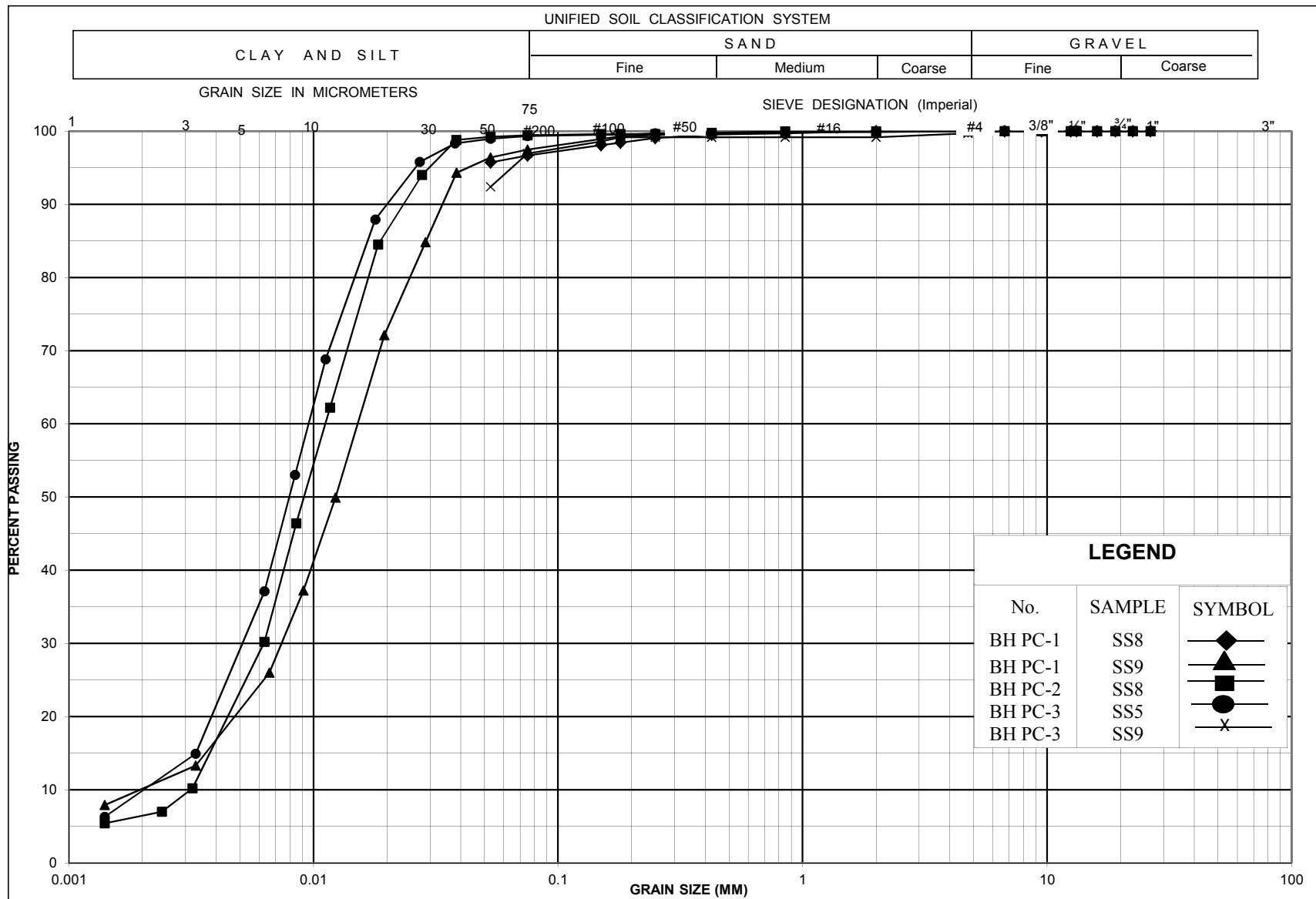
WO-2014-11034

DATE    October 2014



GRAIN SIZE DISTRIBUTION  
SAND TO SILTY SAND  
*Proposed Culvert*

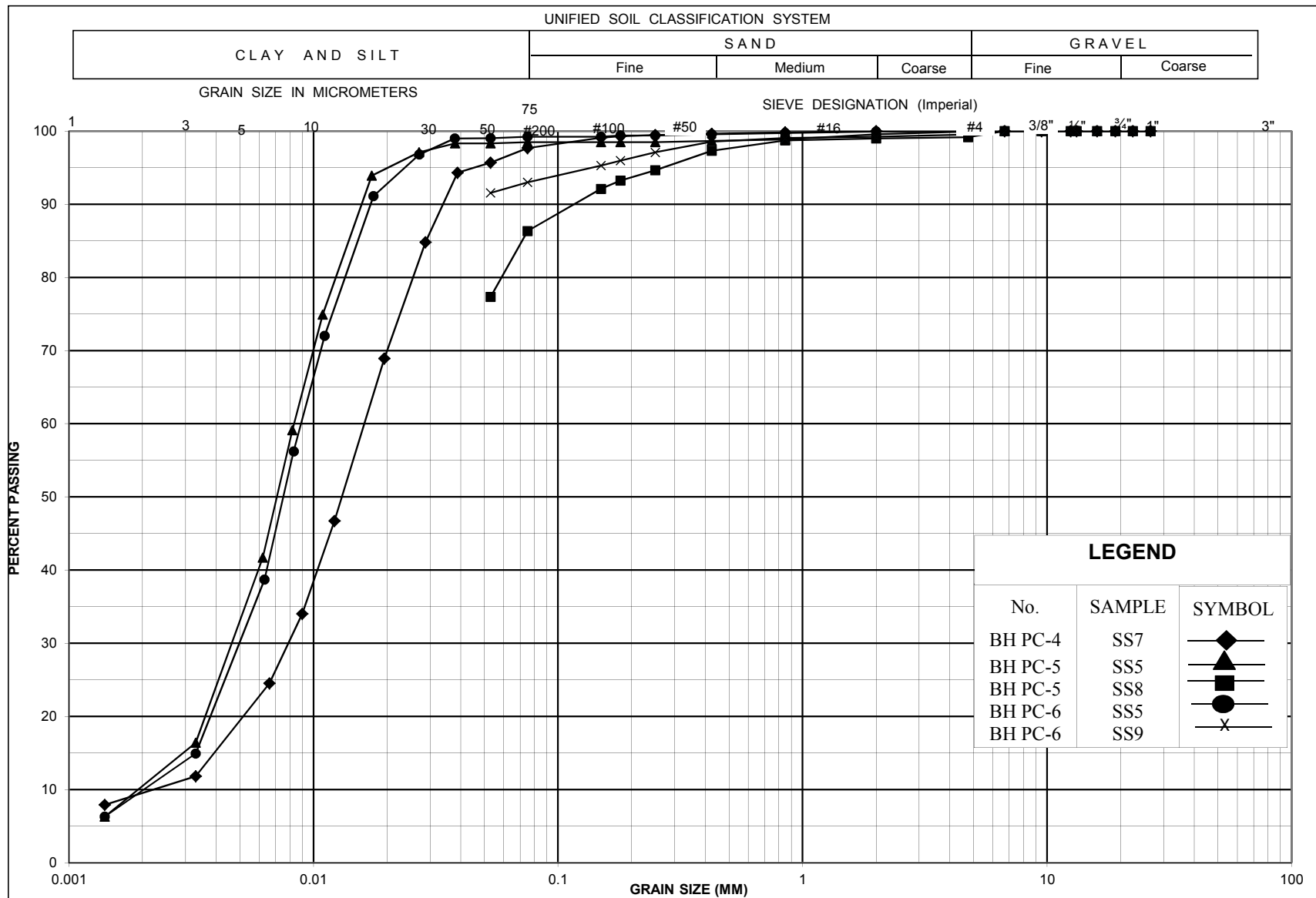
FIGURE 9  
WO-2014-11034  
DATE    October 2014



GRAIN SIZE DISTRIBUTION  
*SILT*  
*Proposed Culvert*

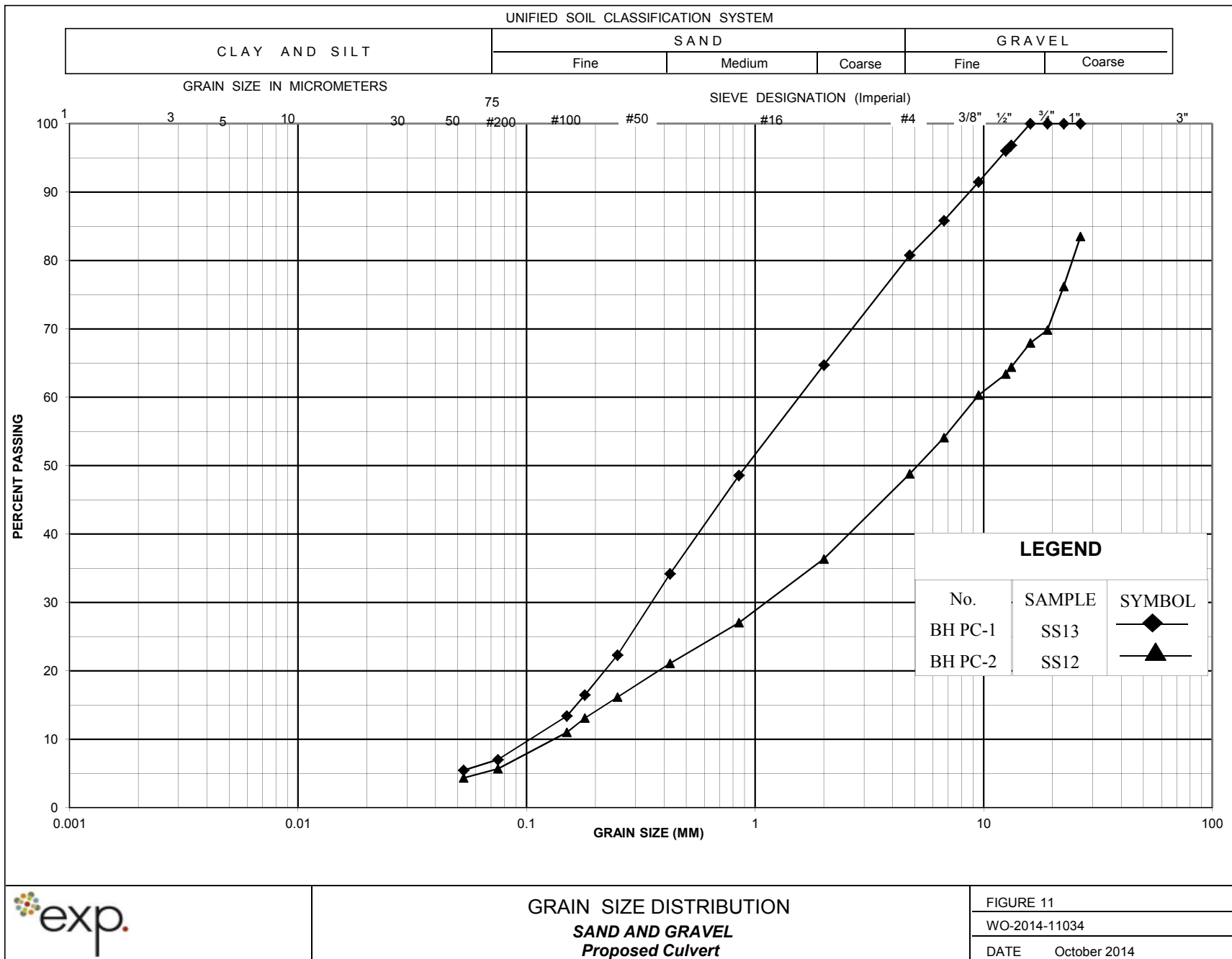
FIGURE 10a  
WO-2014-11034  
DATE    October 2014



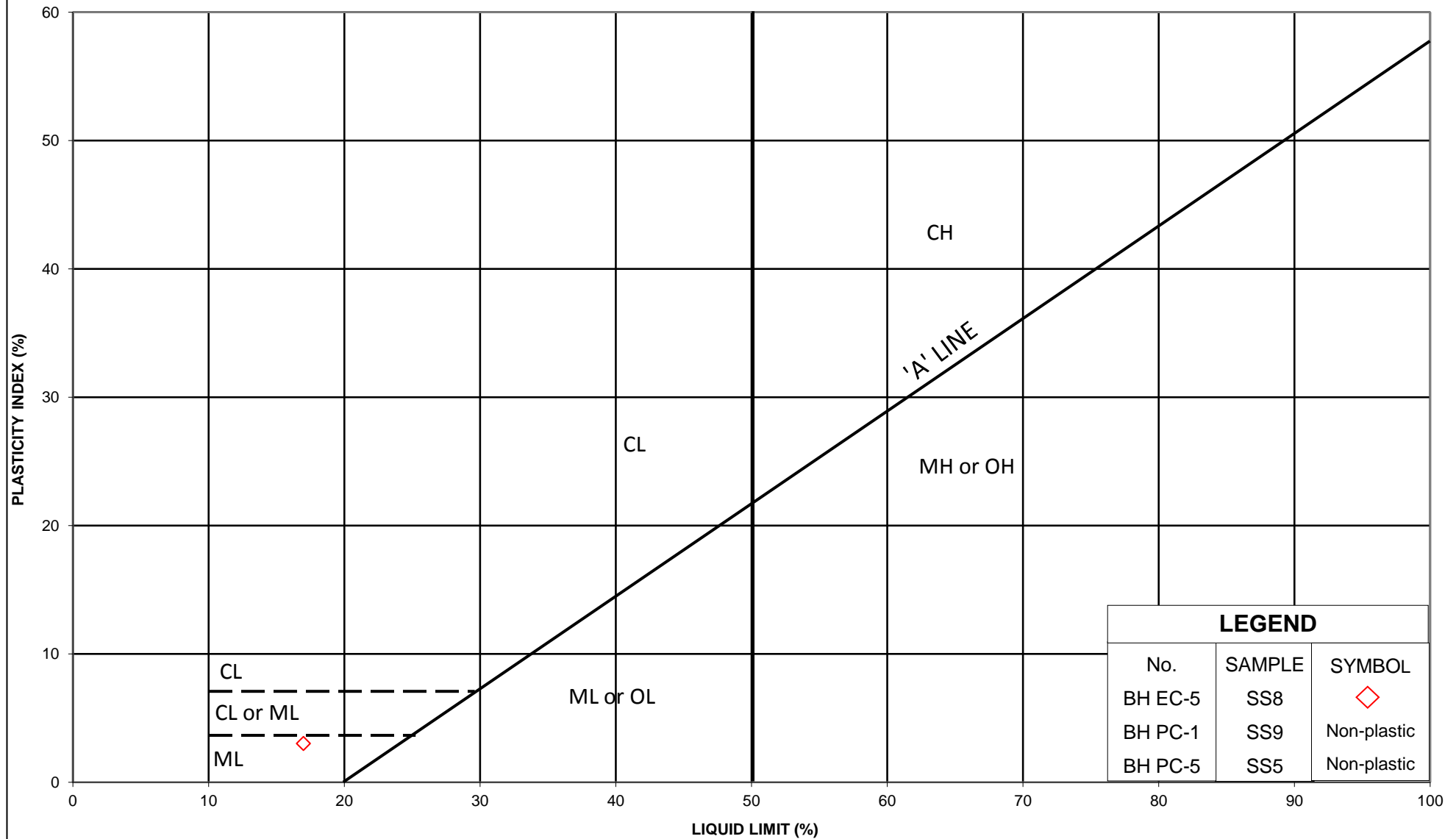


GRAIN SIZE DISTRIBUTION  
**SILT**  
*Proposed Culvert*

FIGURE 10b  
 WO-2014-11034  
 DATE October 2014



# Donnegana River Culvert, Hwy 560



PLASTICITY CHART  
SILT (ML)

FIGURE 12

WO 2014-11034

DATE October 2014