



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

**Otasawian River Bridge, Highway 11 (Site No. 39W-002)
Township of Kohler – New Liskeard (Cochrane) Area, ON**

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October 19, 2011

Ministry of Transportation

Foundation Investigation Report

Type of Document:
FINAL

Project Name:
Otasawian River Bridge, Highway 11 (Site No. 39W-002)
Township of Kohler – New Liskeard (Cochrane) Area, ON
GEOCRES No. 42F-23

Project Number:
ADM-00201207-AO
THB-00011156-AG

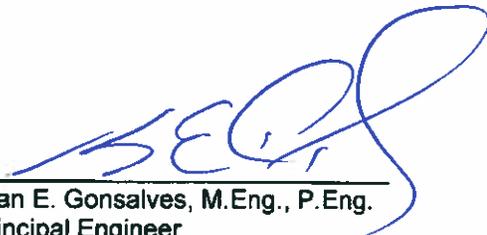
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Legal Notification

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1 Part I: FOUNDATION INVESTIGATION

1.1 Introduction

This report presents the results of a geotechnical investigation completed by **exp** Services Inc. (**exp**) for the Otasawian River Bridge Rehabilitation (Site No. 39W-002), on Highway 11, in the Township of Kohler, about 40.2 km west of the Highway 631 junction, in New Liskeard (Cochrane) Area, Ontario; see Figure 1 – Site Location Plan.

The work was undertaken under Agreement # 5006-E-0060, Assignment No. 5. The terms of reference were as presented by MTO in a letter dated June 13, 2011.

The purpose of the foundation investigation was to examine the existing subsurface conditions within the area of the existing bridge and foundation supports as well as to evaluate the capacity of the existing timber piles. The site specific geotechnical investigation consisted of test borings, borehole logging, and field and laboratory testing. This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the field investigation and the associated laboratory testing.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located on Highway 11, in the Township of Kohler, about 40.2 km west of the Highway 631 junction, in New Liskeard (Cochrane) Area, Ontario. Based on information provided by the MTO, the Otasawian River bridge consists of a three-span supported, reinforced concrete slab on steel girder bridge. The length of the bridge is about 49 m and the individual span lengths are about 16.3 m, 16.5 m and 16.3 m. Based on the MTO records, the bridge was constructed in 1956 and rehabilitated in 1982. The rehabilitation in 1982 was limited to the replacement of expansion joints, deck drain modification, patching of the concrete deck surface, waterproofing and paving. It is understood that the proposed structural rehabilitation will include the replacement of the bridge deck superstructure, which is to be supported on the existing bridge substructure and existing foundations.

Highway 11 runs in an east/west direction and the Otasawian River is generally located in a north/south direction; the river flow direction is to the north. The area is generally forested with mature trees and shrubs and the roadway structure is elevated from the natural topography. Immature vegetation was observed on the slopes/embankments (appears to be vegetated erosion blankets/grids), and beneath the bridge on both sides of the river, blast rock / boulders were observed around the piers. North of the bridge, within the river, 20 timber plies were noted.

The site plan is as shown on the drawings in Appendix A.

1.2.2 Geological Setting

According to the Ontario Ministry of Natural Resources (MNR), Map 5082 and 5083, the regional surficial geology in the area of the river consists of alluvial plain deposits with mainly low local relief and wet surface conditions. In addition, sand alluvial plain deposits with mainly low local relief, channelled and dry surface conditions with a high water table were noted.

According to Bedrock Geology of Ontario Map 2543 (Ministry of Northern Development and Mines, Ontario), the bedrock at the site is from the Paleoproterozoic (1.6 to 2.5 Ga), mafic and ultramafic intrusive rock consisting of Matachewan and Hearst swarms (2454 Ma); diabase dikes.

1.3 Investigation Procedures

1.3.1 Site Description

On July 2, 2011, **exp** personnel visited the site to conduct a site assessment of the existing topographic conditions, accessibility, and to locate possible borehole locations.

To assess the subsurface soil conditions at the site for the bridge rehabilitation, **exp** geotechnical personnel returned to the site between July 12 and 20, inclusive, and monitored the advancement of four (4) boreholes (BH1 to BH4), at the locations shown on Figure 2. The boreholes were advanced near the east and west abutments and east and west piers; drill rig access based on the site topography generally determined the borehole locations. Site photographs of borehole locations are provided in Appendix B.

The drilling was conducted by Thunder Bay Testing & Engineering, an MOE licensed well contractor, using a sub-contracted CME 55 track mounted drill rig, equipped with hollow stem continuous flight augers, a 50 mm outside diameter split spoon sampler, *in situ* shear vane testing equipment and rock coring equipment. The boreholes were advanced to auger and/or split spoon refusal, ranging between about 20.0 m and 37.5 m below ground surface. Upon refusal at BH2 and BH4, rock coring techniques (NQ core size) were used to advance the boreholes about an additional 3.4 m and 3.2 m, respectively. In addition, rock coring techniques were used at BH3 at about 19.4 m to 19.7 m depth to advance the borehole.

During the drilling, soil samples were obtained using a split-spoon sampler with automatic trip hammer, in accordance with Standard Penetration Test (SPT) procedures (ASTM D 1586), at intervals shown on the attached borehole logs (Appendix C). The SPT "N" values were recorded and used to provide an assessment of in-situ consistency or compactness of the non-cohesive soils. *In situ* shear vane tests were performed in the cohesive soil at BH1 and BH2 at about 7.2 m and 8.7 m below ground surface.

Representative samples of the various soil strata encountered in the boreholes were taken to our laboratory in Thunder Bay for further examination by a geotechnical engineer and for laboratory classification testing.

After completion, the boreholes were backfilled with the soil cuttings, generally to about 2.0 m below ground surface and then backfilled with bentonite hole plug material to about 0.3 m below ground surface. The remaining 0.3 m was backfilled with soil cuttings.

Groundwater level measurements were obtained using an electric tape, prior to fully backfilling the boreholes. Following the fieldwork, ground surface elevations at the boreholes and the top of surface water at the Otasawian River were surveyed. The boreholes were measured to local structures/features and using a handheld GPS unit. The ground surface elevations were referenced to a local benchmark; highway centerline at deck on concrete expansion joint at the east end of the bridge (assumed elevation 100.00 m). The elevation and location of the benchmark are detailed on Figure 2.

The locations of the existing timber piles just north of the bridge (assumed to be an abandoned pile bent) were measured to local structures/features and the diameter, stick-up from river bottom and distance below top of river water were measured.

The fieldwork was supervised by a member of **exp**'s geotechnical personnel, Mr. Elwin Farkas, who directed the drilling and sampling operation, logged borehole data in accordance with MTO Soils Classification System, and retrieved soil samples for subsequent laboratory testing and identification.

1.3.2 Laboratory Testing

Following the field investigation representative soil samples were selected for laboratory Atterberg Limit testing (10 samples – LS703/704), hydrometer (5 samples – LS702) and grain size analyses (24 samples – LS602) and natural moisture content determinations (all samples – LS701) for soil type classification purposes as well as to allow estimation of the geotechnical properties. The results are provided in the Appendix A and C, and are discussed herein. Samples remaining after the testing will be stored for one year from issue date of report, after which they may be discarded unless we are requested otherwise.

1.4 Subsurface Conditions

Details of the subsurface conditions encountered at the borehole locations are provided on the Borehole Logs included in Appendix C of this report. The general subsurface soil conditions are summarized in the following sections.

1.4.1 Sand and Silt

Sand and silt was generally encountered surfacing the boreholes. The sand and silt soils were generally described as very loose to loose, brown, moist to wet at depth containing trace to some gravel and roots and rootlets (upper 0.3 m). Occasional cobbles were noted at BH1 and BH4 and trace to some clay was noted at BH1 (3.8 m depth) and BH2 (4.6 m depth). At BH1, a sheet metal piece was noted at about 0.6 m depth; at BH2, wood pieces were noted at about 3.1 m depth; and at BH4, asphalt and wood pieces were noted within the upper 0.1 m. In

addition, trace organics were noted at BH1 (3.8 m depth) and BH2 (3.1 to 3.8 m depth). The sand and silt extended to depths ranging between about 0.1 m and 9.2 m below ground surface.

Eight grain size analyses were performed on representative samples of the sand and silt (BH1-S3, BH1-S6, BH1-S9, BH2-S2, BH2-S3, BH2-S5, BH2-S6, BH2-S8); the results are presented on Figure 4A and 4B. In addition, one hydrometer analysis was performed of the sand and silt (BH2-8); the results are presented on Figure 4B.

All samples within the sand and silt stratum were submitted for moisture contents determinations. The moisture contents ranged between about 4.2 % and 29.6 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 20 kN/m³ to 23 kN/m³.

1.4.2 Silty Clay to Clayey Silt

A cohesive stratum, ranging generally between silty clay and clayey silt was encountered beneath the sand and silt. This cohesive complex was generally described as firm to very stiff, grey, moist to wet, containing trace to some gravel and trace to some sand. Occasional cobbles were noted during augering at BH1 at depths of about 10.4 m to 10.7 m and 12.8 m to 13.1 m below ground surface. At BH2, the soil was described as hard at about 10.7 m to 13.7 m depth as well as at BH3 at about 13.7 m to 15.2 m depth. Two *in situ* shear vane tests were performed and the results were > 100 kPa at BH1 (7.2 m depth) and 20 kPa at BH2 (8.5 m depth). This cohesive soil extended to depths ranging between about 13.7 m and 15.2 m below ground surface.

Two grain size and two hydrometer analyses were performed on representative samples (BH3-S10, BH3-S14); the results are presented on Figure 4C.

All samples within the silty clay and clayey silt were submitted for moisture contents determinations. The moisture contents ranged between about 10.7 % and 21.1 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 20.5 kN/m³ to 23 kN/m³.

At BH4, a mixture of sand, silt and clay layers were encountered underlying the sand and silt upper layer. The sand, silt and clay layers were generally described as brown to grey at depth, moist to wet at depth. The cohesionless soils were described as very loose to compact and the cohesive soils were described as stiff to soft. Trace organics, and roots and rootlets were noted at 1.5 m and 2.3 m depth, respectively and occasional cobbles were noted during augering at about 2.1 m to 2.3 m depth. The sand, silt and clay layers extended to about 9.2 m below ground surface. It is considered that the soil in the upper 4 m to 5 m may be fill from the construction of the embankment.

Four grain size analyses were performed on representative samples of the sand, silt and clay layers (BH4-S3, BH4-S6B, BH4-S7, BH4-S9); the results are presented on Figure 4D. In addition, one hydrometer analysis was performed of the sand, silt and clay (BH4-S3); the results are presented on Figure 4D.

All samples within the sand, silt and clay were submitted for moisture contents determinations. The moisture contents ranged between about 4.1 % and 33.2 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 18.5 kN/m³ to 22.5 kN/m³.

Atterberg limit testing was performed on ten representative samples of the silt and/or clay and indicated that the soil is of low to medium plasticity. The natural moisture contents of the silt and clay were generally below the liquid limits, except at BH4-11B where they were equal. The data is shown on the Plasticity Charts, Figures 5A to 5D, and summarized in the following Table 1-1.

Table 1-1: Summary of Atterberg Limit Testing										
Borehole / Sample	BH1 S10	BH1 S12	BH2 S11	BH3 S3	BH3 S6	BH3 S9	BH3 S15	BH4 S4	BH4 S11A	BH4 S11B
Depth	6.6 m	9.6 m	9.5 m	1.1 m	3.4 m	5.7 m	14.0 m	1.8 m	7.8 m	8.1 m
Liquid Limit, w_L	24	16	16	23	27	16	19	18	36	21
Plastic Limit, w_P	15	13	12	16	15	14	14	15	18	13
Plasticity Index, I_P	9	3	4	7	12	2	5	3	18	8
Moisture Content (%)	18.4	12.0	12.7	14.8	16.8	12.0	13.3	13.1	33.2	21.3

1.4.3 Silt and Sand

Silt and sand was encountered underlying the cohesive soils at BH3 and BH4. The silt and sand was generally described loose to compact, grey, wet containing trace gravel and trace to some clay. The silt and sand extended to 17.2 m at BH3 and 15.6 m at BH4.

Two grain size analyses were performed on representative samples of the silt and/or sand (BH4-S12, BH4-S14); the results are presented on Figure 4D.

All samples within the silt and/or sand were submitted for moisture contents determinations. The moisture contents ranged between about 7.7 % and 18.1 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 21 kN/m³ to 23.5 kN/m³.

Sand and gravel was generally encountered beneath the silt and sand depth at BH3 and was generally described as compact to very dense, grey, wet, containing trace to some silt and some cobbles. A boulder, about 300 mm, was encountered beneath the sand and gravel. The sand and gravel, including the boulder, extended to about 19.7 m below ground surface.

Two grain size analyses were performed on representative samples of the sand and gravel (BH3-S17B, BH3-S18); the results are presented on Figure 4C.

All samples within the sand and gravel were submitted for moisture contents determinations. The moisture contents ranged between about 7.5 % and 9.8 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 23 kN/m³ to 24 kN/m³.

1.4.4 Sand and Silt Till

Sand and silt till was generally encountered beneath all of the above noted overlying soils. The till was generally described as very dense, grey, moist, containing trace gravel to gravelly and trace to some clay. During augering, cobbles were noted at BH1 (18.0 m and 26.2 m depth), BH2, (23.8 m) and BH4 (18.3 m). The till extended to depths of about 20.0 m and 37.5 m below ground surface.

Six grain size analyses were performed on representative samples of the till (BH1-S15, BH1-S18, BH2-S14, BH3-S20, BH4-S16B, BH4-S17); the results are presented on Figures 4A, 4B, 4C and 4E. In addition, one hydrometer analysis was performed of the till (BH1-S18); the results are presented on Figure 4A.

All samples within the till were submitted for moisture contents determinations. The moisture contents ranged between about 4.5 % and 16.9 %.

Based on the saturated moisture contents, unit weights are estimated to range from about 21 kN/m³ to 24.5 kN/m³.

1.4.5 Refusal and Bedrock

Refusal to further augering and/or split spoon penetration was encountered at depths ranging between about 20.0 m and 37.5 m below ground surface. Rock coring techniques (NQ size) were used at BH2, BH3 and BH4; however, bedrock was only proven at BH2. At BH3, rock

This Foundation Investigation Report has been prepared by Ahileas Mitsopoulos, P.Eng. and Demetri N. Georgiou, P.Eng., and reviewed by S.E. Gonsalves, P.Eng., Designated MTO Foundations Contact for **exp**.

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

Yours truly,
exp Services Inc.



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coring techniques indicated the presence of a boulder, about 300 mm, and till beneath the boulder. At BH4, rock coring was used to advance the borehole 3.2 m (25.2 m below ground surface) but only indicated the presence of cobbles and boulders.

The bedrock that was cored in BH2 was described as medium strong rock (25 MPa to 50 MPa compressive strength), very severely fractured to fractured at depth, greenish grey, coarse grained with pink stringers, some quartz pockets and stringers. The gross recovery ranged between about 89% and 100% and the Rock Quality Designation (RQD), which is a modified core recovery ranged between 18% and 64% (very severely fractured to fractured). The RQD increased at depth. Borehole BH2 was advanced about 3.4 m into the bedrock and was terminated at about 40.9 m below ground surface.

1.5 Groundwater Conditions

Groundwater measurements were taken prior to backfilling the boreholes. Groundwater levels are shown on the Borehole Logs in Appendix C and are summarized in Table 1-2, below.

It must be noted that the depth to the groundwater table may fluctuate seasonally, or after periods of extended precipitation or drought, and as such may differ at other times.

Table 1-2: Groundwater Data					
Borehole (UTM Coordinates – NAD 83)	Date Borehole Completed	Date Measured	Ground Surface Elevation²	Depth to Water³	Groundwater Elevation
BH1 (16 U 639240 5513544)	July 15/11	July 17/11	94.59	4.12	90.47
BH2 (16 U 639251 5513544)	July 13/11	July 14/11	92.27	1.90	90.37
BH3 (16 U 639278 5513525)	July 17/11	July 17/11	94.16	2.64	91.52
BH4 (16 U 639291 5513541)	July 19/11	July 20/11	98.95	6.41	92.54
River	N/A	July 14/11	N/A	N/A	90.57
River	N/A	July 17/11	N/A	N/A	90.44
Notes: 1) All units in meters. 2) Elevations surveyed are referenced to highway centerline at deck on concrete expansion joint at the east end of the bridge with assumed elevation (100.00 m). 3) Depths are relative to ground surface. 4) UTM Coordinates from handheld GPS unit and are approximate.					

1.6 Existing Timber Piles

Existing timber piles (20) were noted in the river, north of the bridge. These are assumed to be from an abandoned pile bent at the time of original construction. The piles were located in two rows (i.e. pairs) in north / south direction and the lengths separating the piles in the east / west direction and north / south direction ranged between about 1.1 m and 1.4 m, and 0.6 m and 1.8 m, respectively. In addition, the pile located furthest north and furthest south were single piles (i.e. not paired). Details of the timber piles are shown on Figure 7 and are summarized in Table 1-3 below:

Table 1-3: Existing Timber Piles		
Timber Pile No.	Diameter (mm)	Stick-Up (mm)
1	300	350
2	350	300
3	280	650
4	350	350
5	350	750
6	350	350
7	350	800
8	300	500
9	280	850
10	350	700
11	270	850
12	350	900
13	320	900
14	290	900
15	300	900
16	300	900
17	300	950
18	300	900
19	250	950
20	250	950

There were 20 timber piles noted and ranged in diameter between about 250 mm and 350 mm and the stick-ups ranged between about 300 mm and 950 mm above the river bottom.

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 Report has been prepared by Ahileas Mitsopoulos, P.Eng. and Demetri N. Georgiou, P.Eng., and reviewed by S.E. Gonsalves, P.Eng., Designated MTO Foundations Contact for **exp**.

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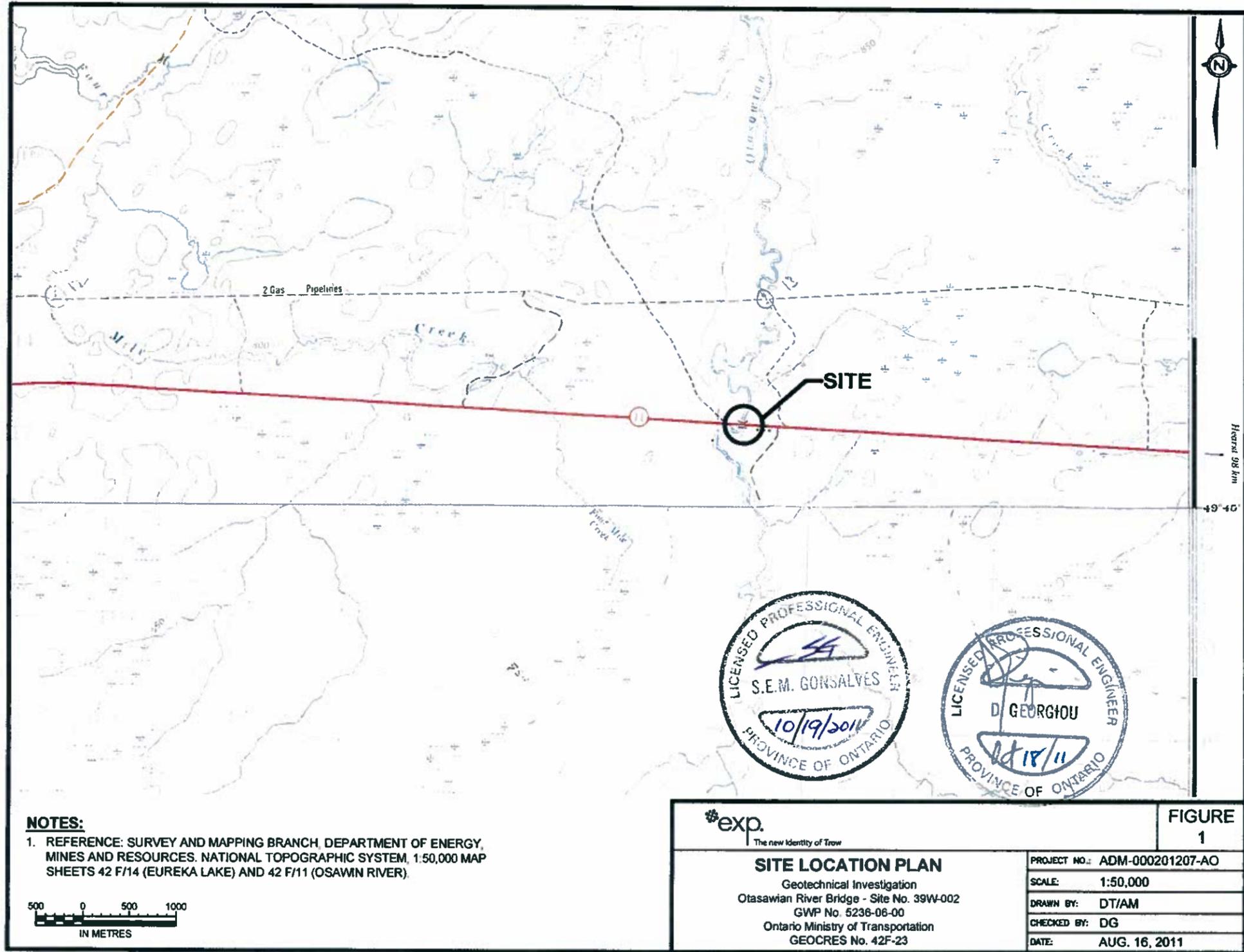
Yours truly,
exp Services Inc.

Ahileas Mitsopoulos, P.Eng.
Project Engineer

Demetri N. Georgiou, M.A.Sc., P.Eng.
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Principal Engineer
Designated MTO Foundations Contact

Appendix A – Figures

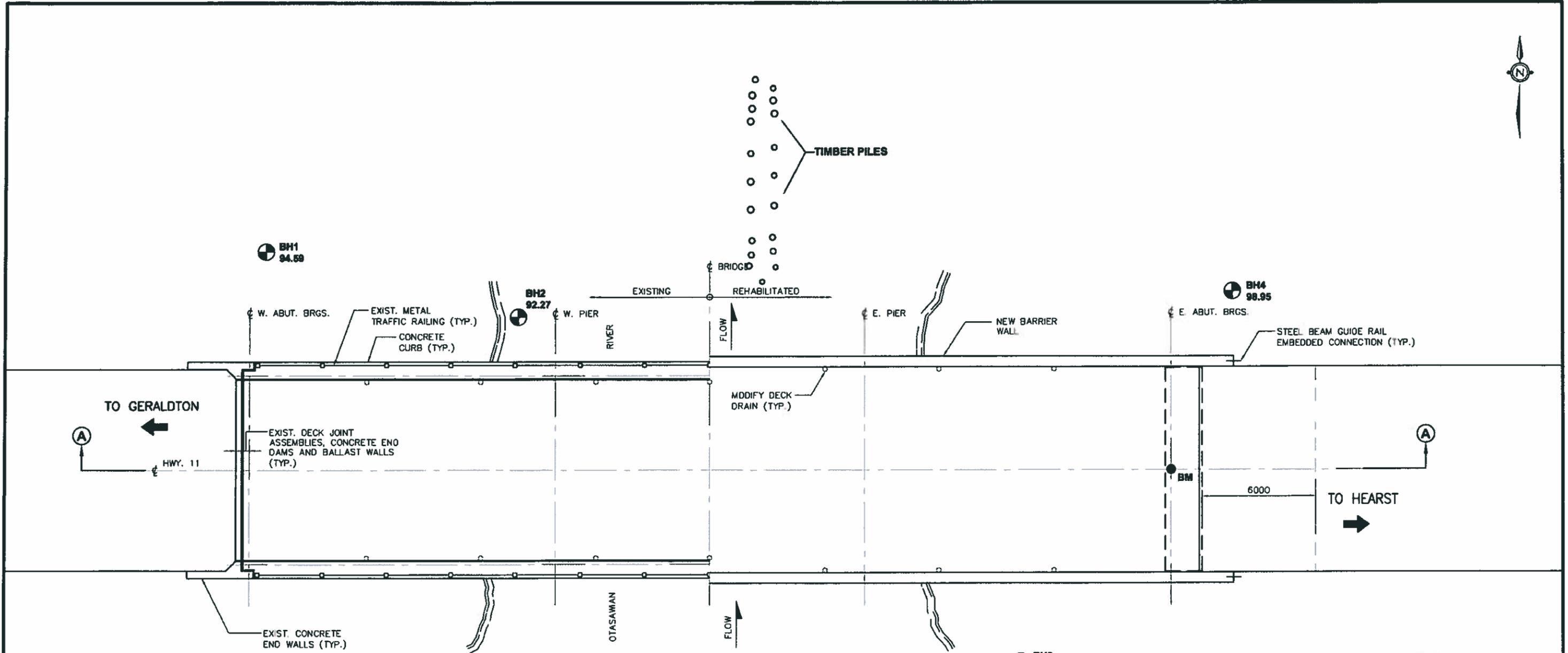


NOTES:

1. REFERENCE: SURVEY AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES. NATIONAL TOPOGRAPHIC SYSTEM, 1:50,000 MAP SHEETS 42 F/14 (EUREKA LAKE) AND 42 F/11 (OSAWIN RIVER).



 The new Identity of Trax	FIGURE	
	1	
SITE LOCATION PLAN Geotechnical Investigation Otasawian River Bridge - Site No. 39W-002 GWP No. 5236-06-00 Ontario Ministry of Transportation GEOCRES No. 42F-23	PROJECT NO.: ADM-000201207-AO SCALE: 1:50,000 DRAWN BY: DT/AM CHECKED BY: DG DATE: AUG. 16, 2011	



LEGEND:

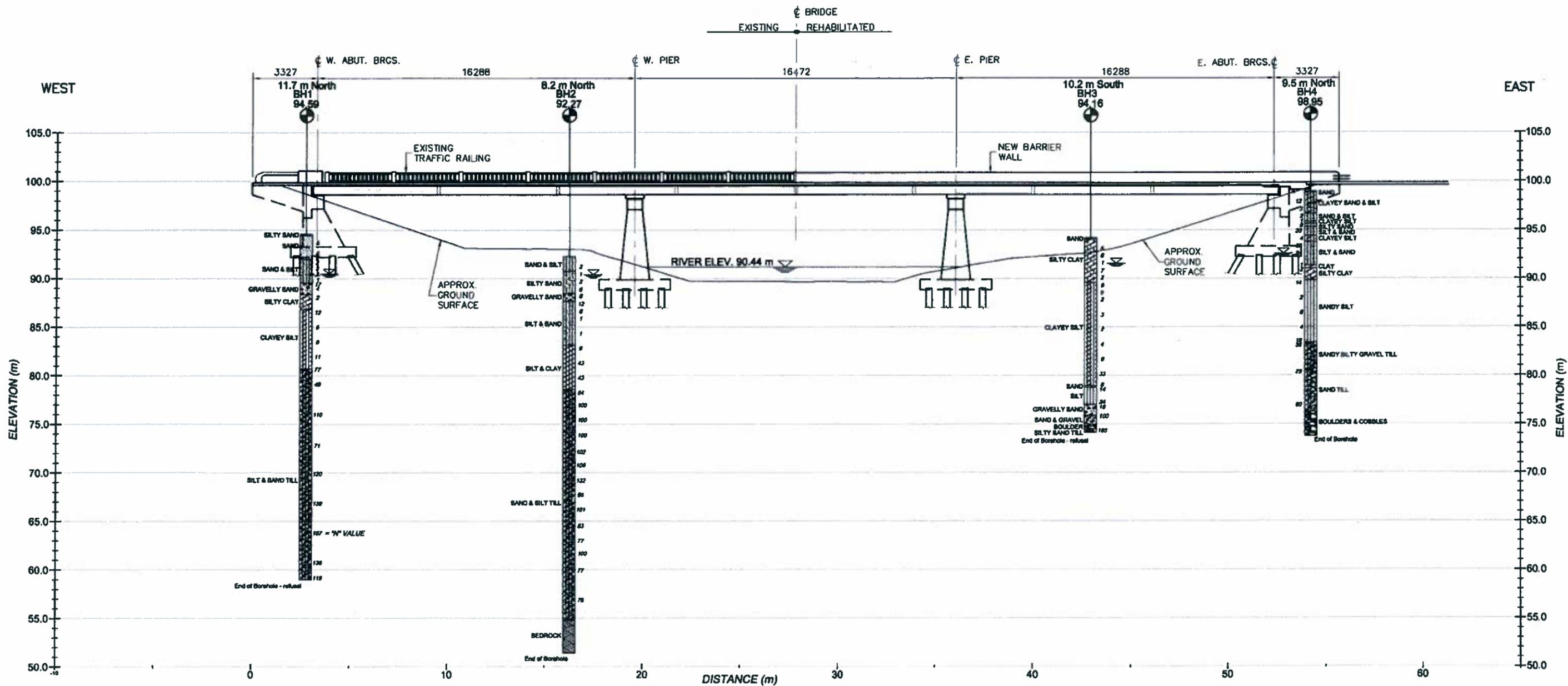
- BH1** 94.59 BOREHOLE LOCATION ELEVATION IN METRES
- BM** 100.00m BENCHMARK LOCATION ELEVATION IN METRES

NOTES:

1. REFERENCE: BASE PLAN PROVIDED BY CLIENT.
2. BENCHMARK (BM): CENTRE LINE OF HWY 11 OF CONCRETE BRIDGE DECK AT EXPANSION JOINT AT EAST ABUTMENT. ASSUMED LOCAL ELEVATION OF 100.000m.



The new identity of Trow BOREHOLE LOCATION PLAN Geotechnical Investigation Otasawan River Bridge - Site No. 39W-002 GWP No. 5236-06-00 Ontario Ministry of Transportation GEOCREs No. 42F-23	FIGURE 2
	PROJECT NO.: ADM-000201207-AO SCALE: 1:200 DRAWN BY: DT/AM CHECKED BY: DG DATE: AUG. 16, 2011



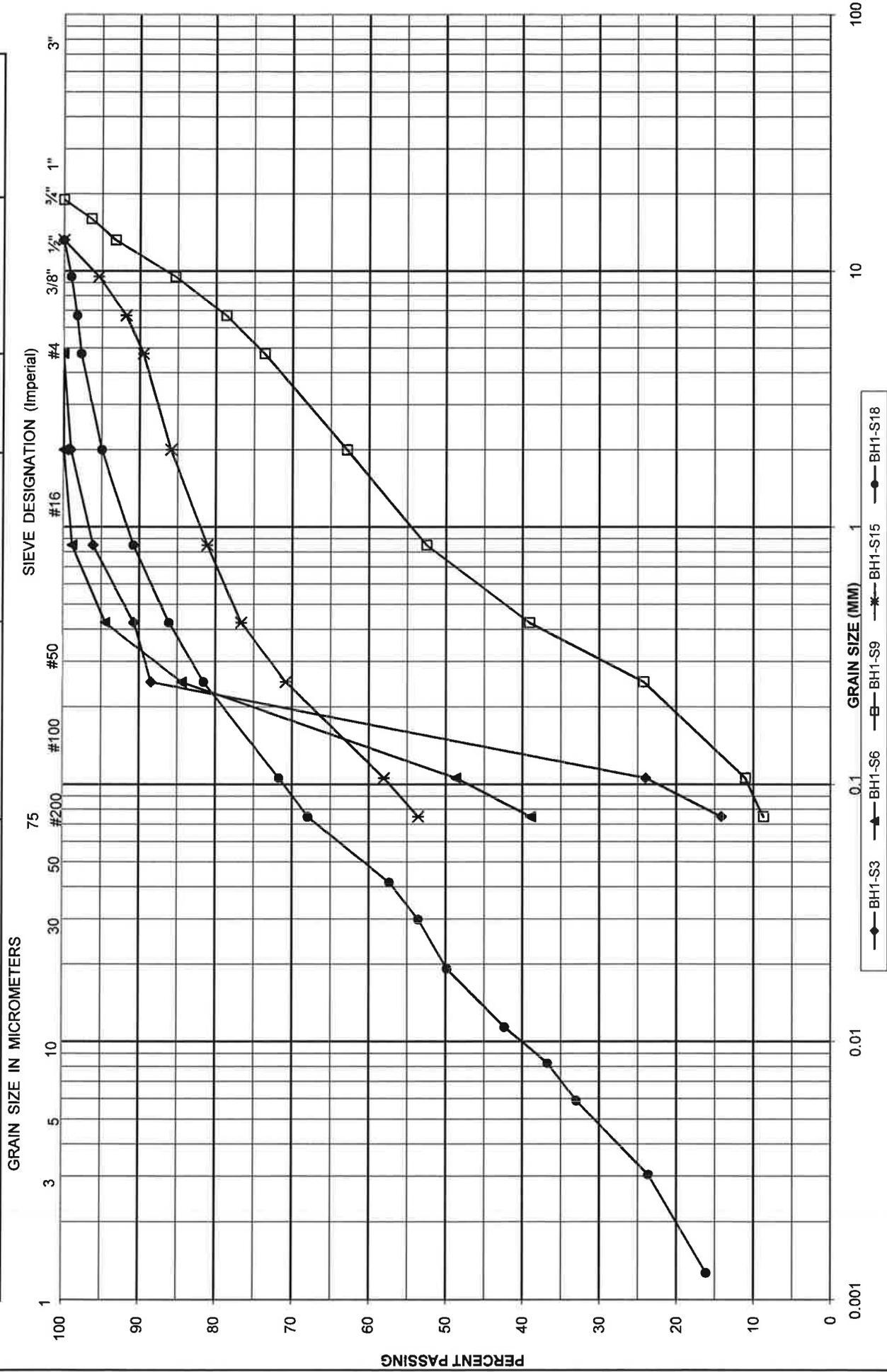
LEGEND:
 BH1 94.59 BOREHOLE LOCATION
 ELEVATION IN METRES

NOTES:
 1. REFERENCE: BASE PLAN PROVIDED BY CLIENT.
 2. BENCHMARK (BM): CENTRE LINE OF HWY 11 OF CONCRETE BRIDGE DECK AT EXPANSION JOINT AT EAST ABUTMENT. ASSUMED LOCAL ELEVATION OF 100.000m.
 3. RIVER ELEVATION SURVEYED ON JULY 17, 2011.
 4. GROUNDWATER ELEVATIONS AT BH1, BH2, BH3 AND BH4 WERE MEASURED ON JULY 17, 14, 17 AND 20, 2011, RESPECTIVELY.

	FIGURE 3
	STRATIGRAPHIC SECTION A-A Geotechnical Investigation Otasawian River Bridge - Site No. 39W-002 GWP No. 5236-06-00 Ontario Ministry of Transportation GEOCRETS No. 42E-23
PROJECT NO: ADM-000201207-AO	SCALE: 1:200H / 1:400V
DRAWN BY: DT/AM	CHECKED BY: DG
DATE: AUG. 24, 2011	

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse			
			Fine	Coarse		Fine	Coarse	



GRAIN SIZE DISTRIBUTION - BH1
 Otasawian River Bridge - Site No. 39W-002 - GEOCRETS No. 42F-23

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

Fine

Coarse

Fine

Coarse

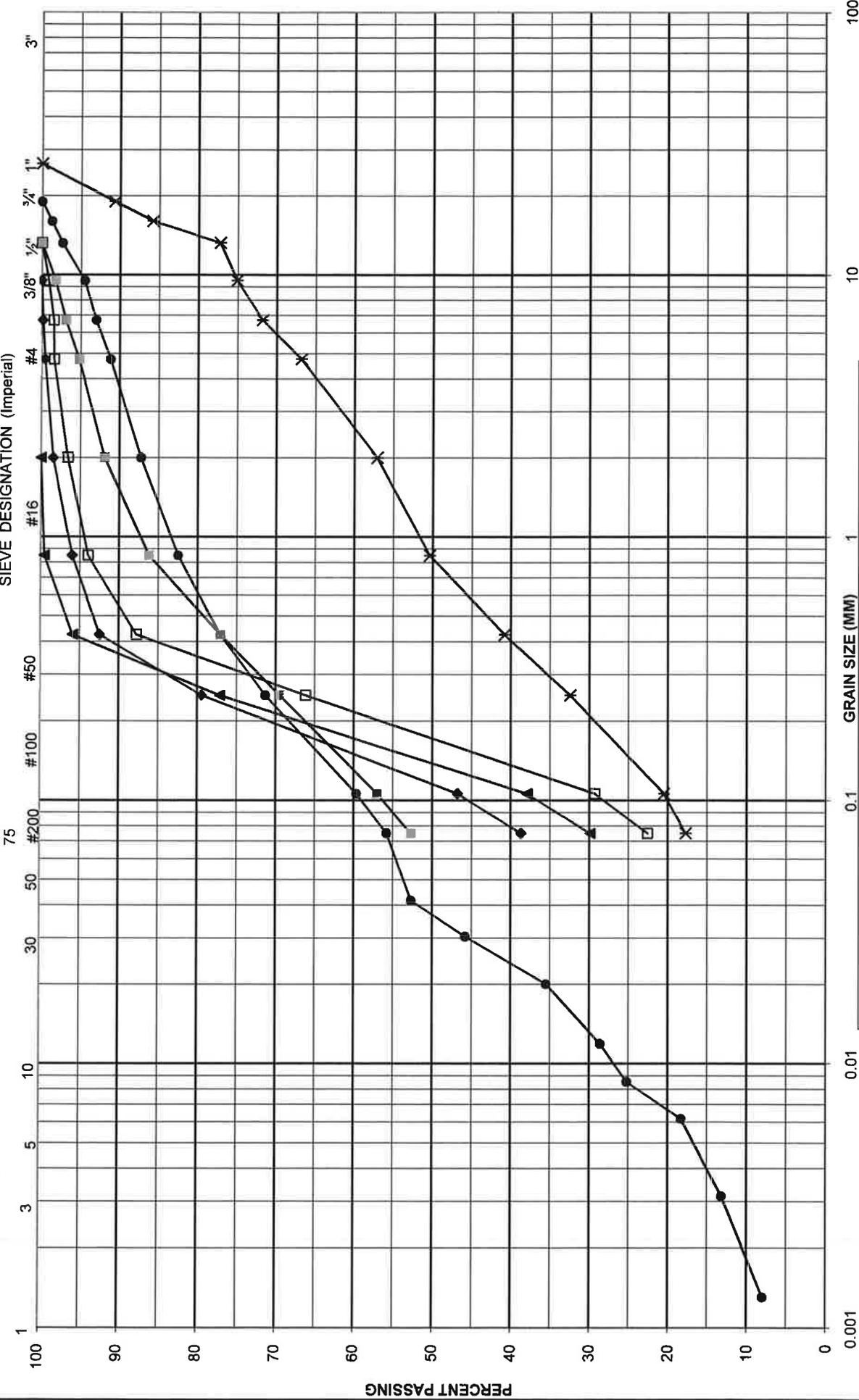
Medium

Fine

Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



GRAIN SIZE DISTRIBUTION - BH2
 Otasawian River Bridge - Site No. 39W-002 - GEOCRES No. 42F-23

FIGURE No. 4B
 Ref. No. ADM-00201207-AO
 DATE August 19, 2011

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

Coarse

Fine

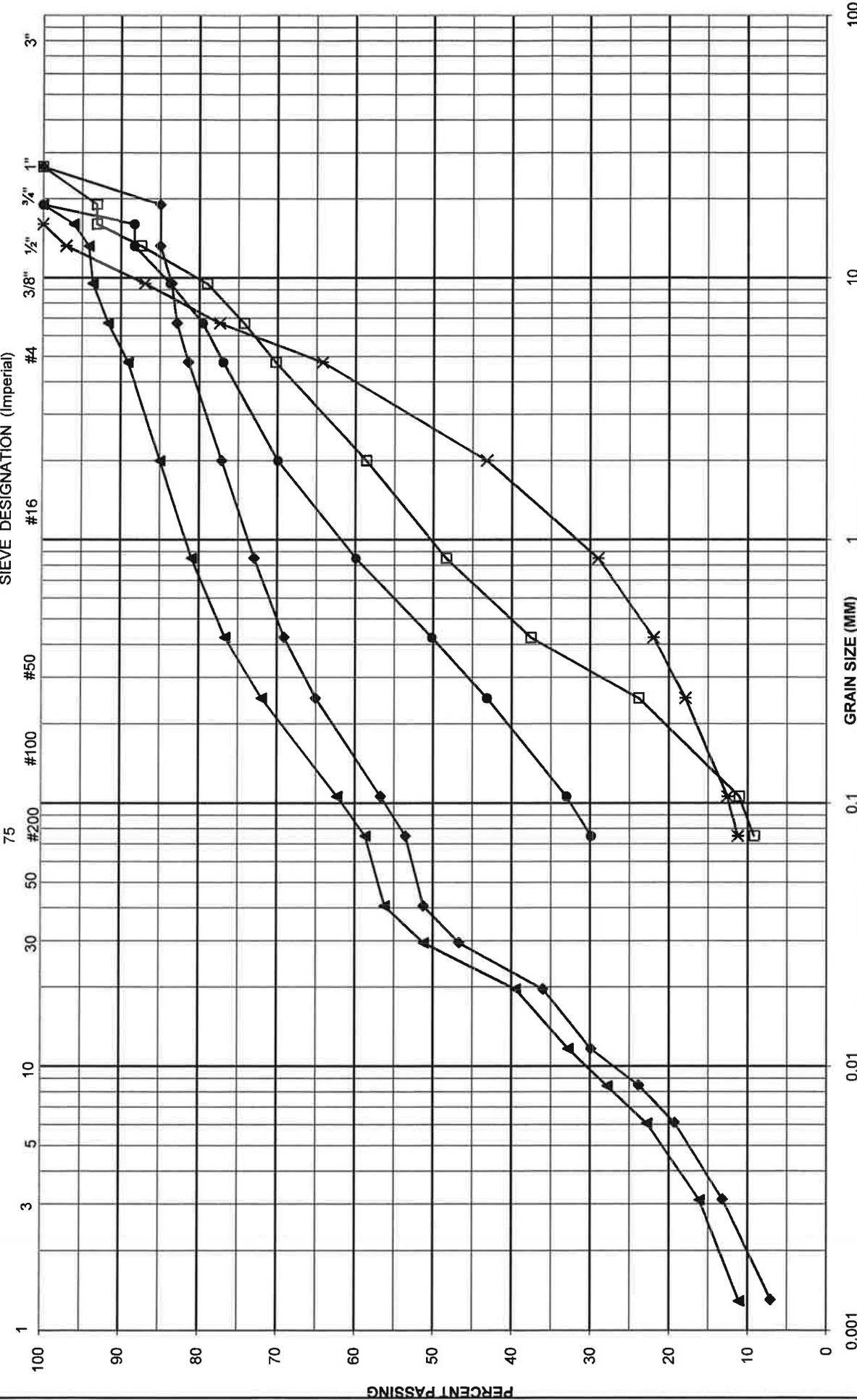
Coarse

Medium

Fine

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)

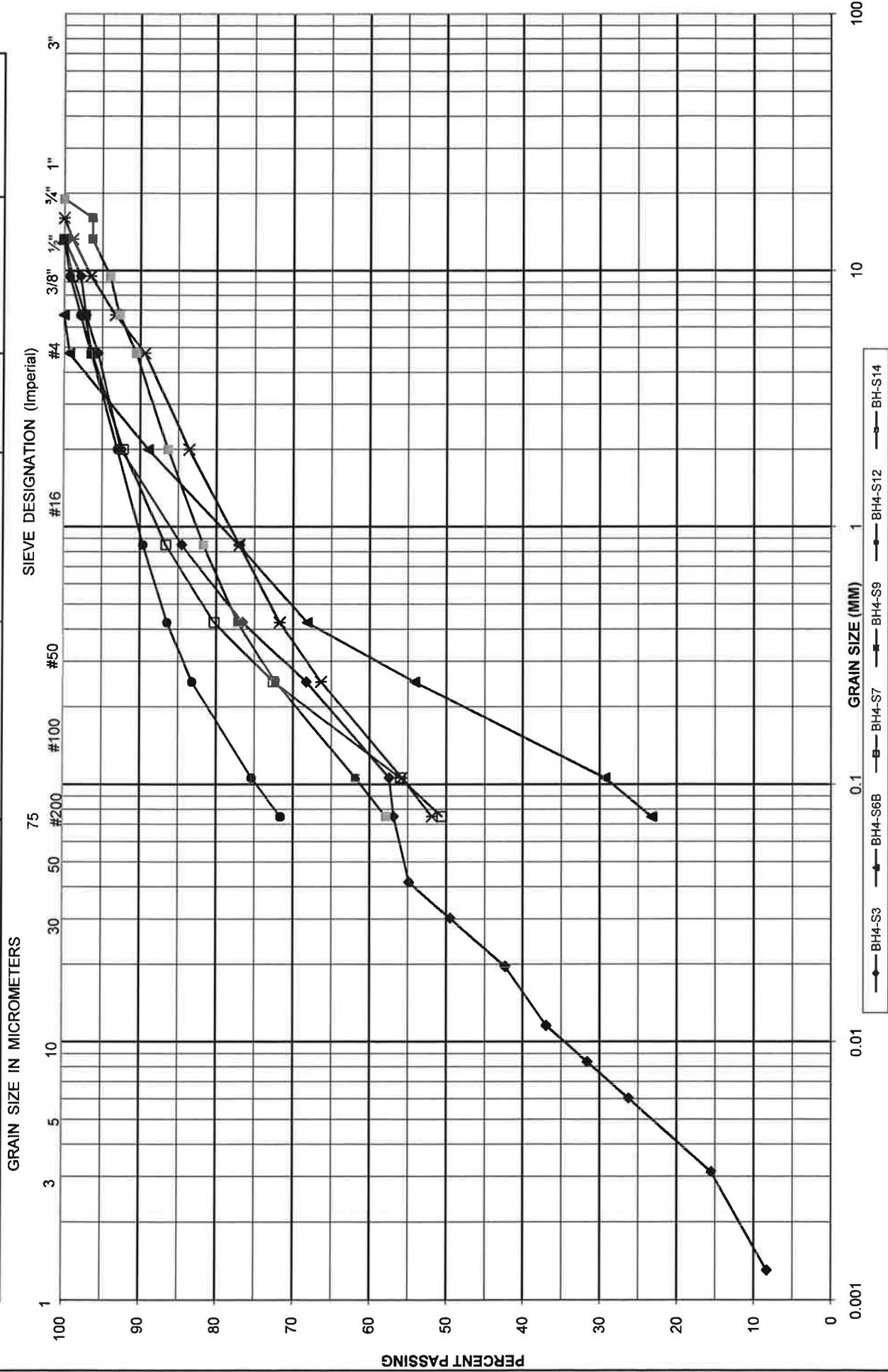


GRAIN SIZE DISTRIBUTION - BH3
 Otasawian River Bridge - Site No. 39W-002 - GEOCRETS No. 42F-23

FIGURE No. 4C
 Ref. No. ADM-00201207-AO
 DATE August 19, 2011

UNIFIED SOIL CLASSIFICATION SYSTEM

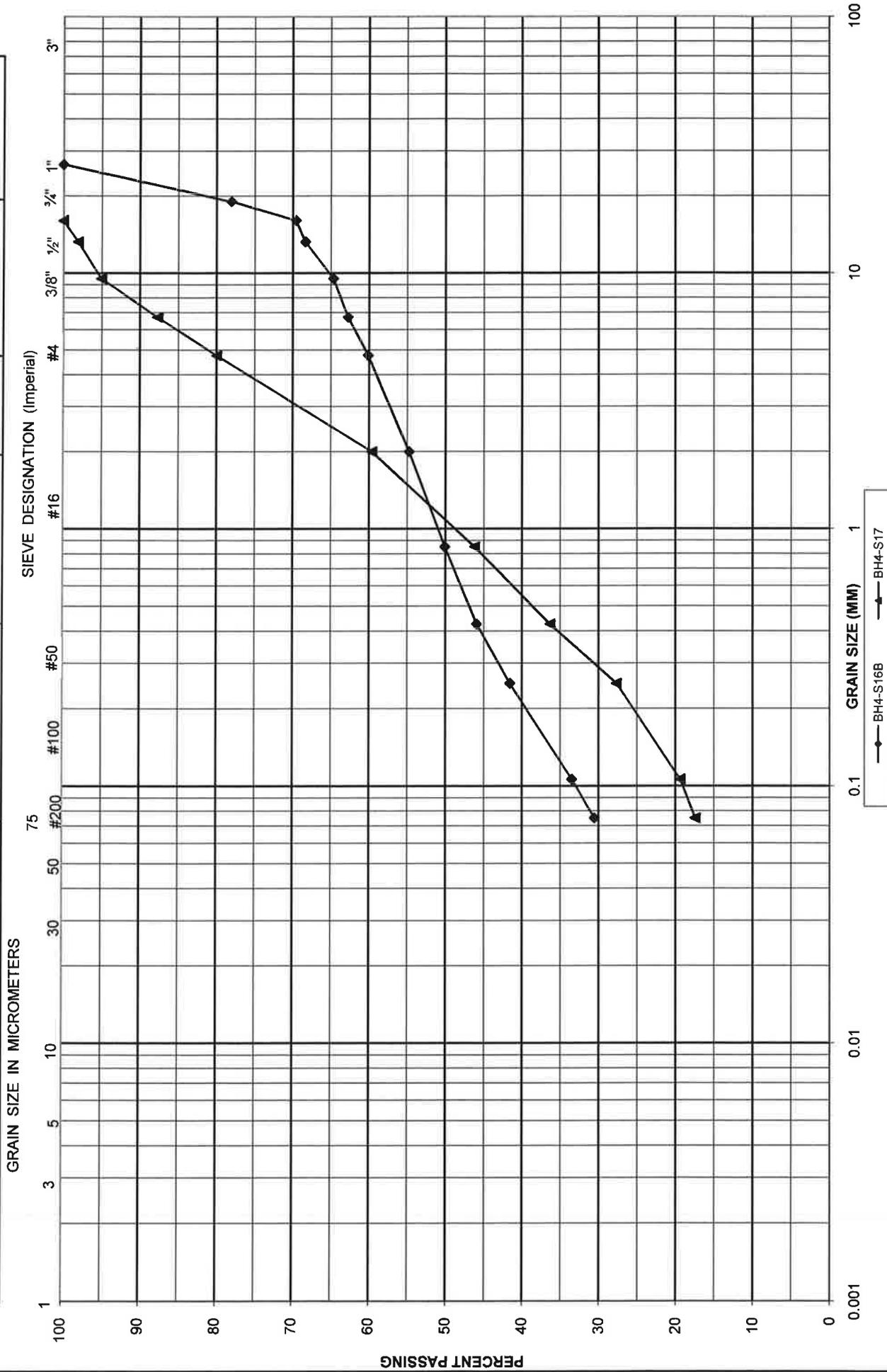
CLAY AND SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION - BH4
 Otasawian River Bridge - Site No. 39W-002 - GEOCRCS No. 42F-23

UNIFIED SOIL CLASSIFICATION SYSTEM

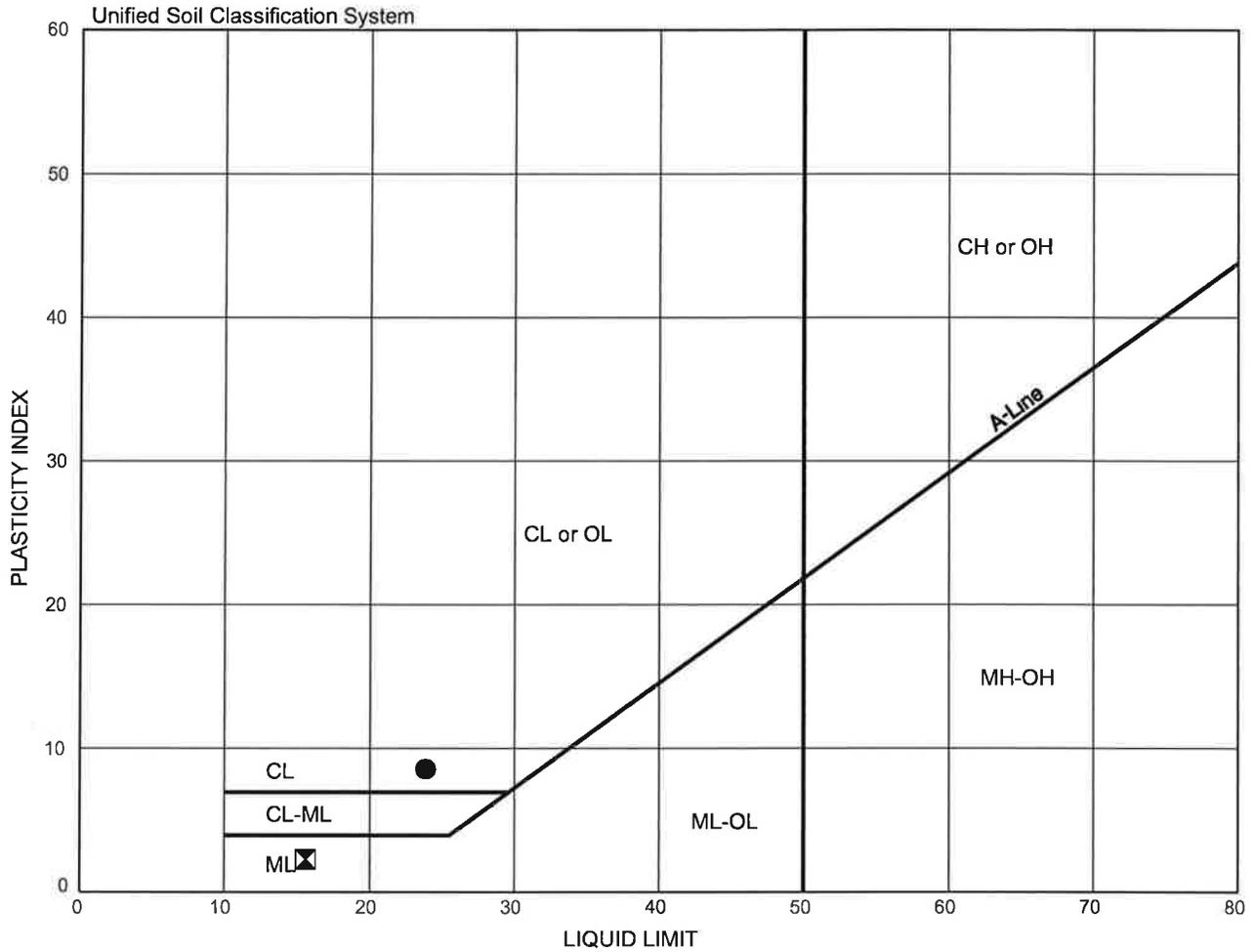
CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION - BH4 (CONTINUED)
 Otasawian River Bridge - Site No. 39W-002 - GEORES No. 42F-23

FIGURE No. 4E
 Ref. No. ADM-00201207-AO
 DATE August 19, 2011

Plasticity Chart



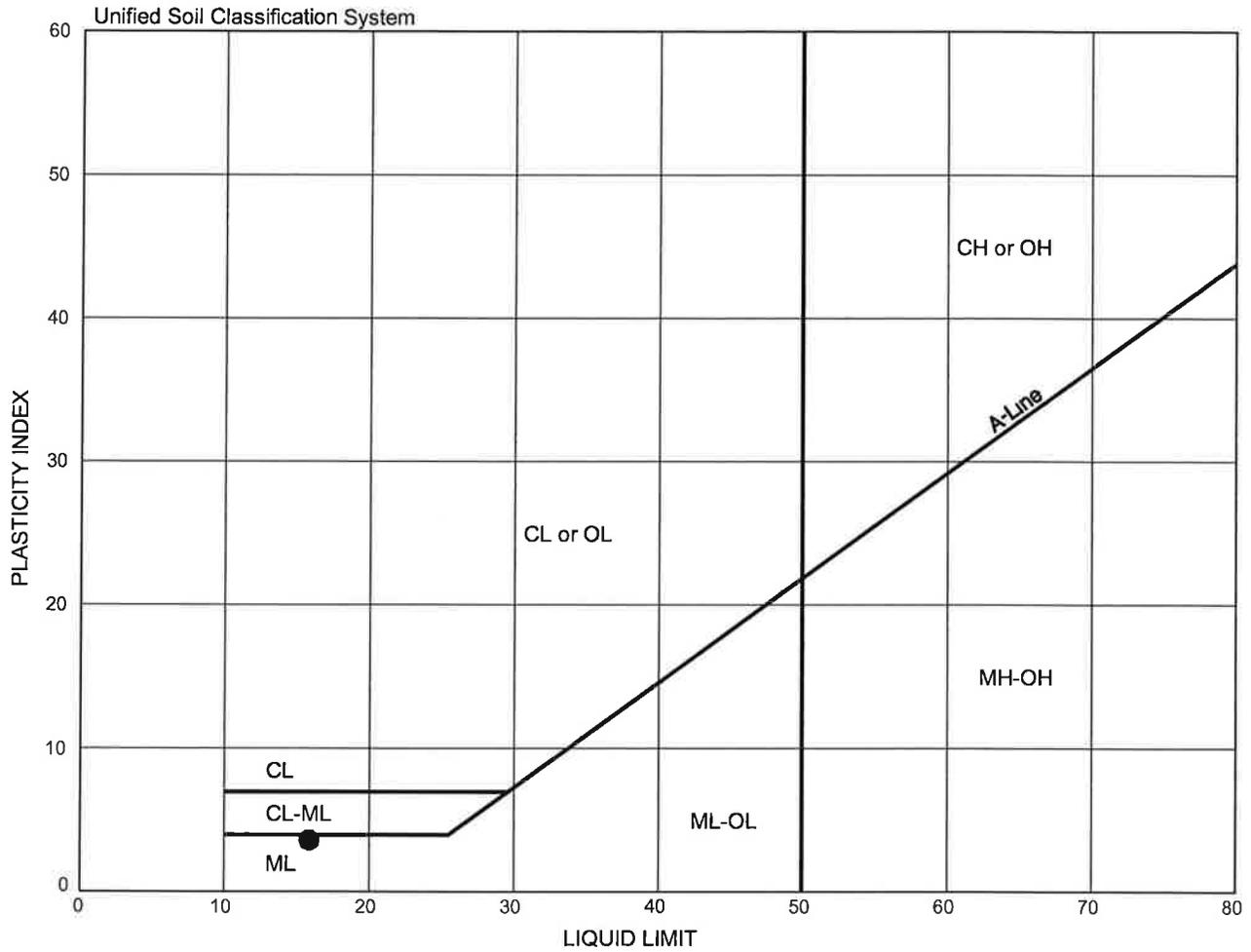
Symbol	Location	Sample No.	Depth (m)	Elevation (m)	W	W _P	W _L	PI
●	BH1	S10	6.56	88.03	18.4	15.3	23.9	8.6
⊠	BH1	S12	9.61	84.98	12.0	13.3	15.6	2.3



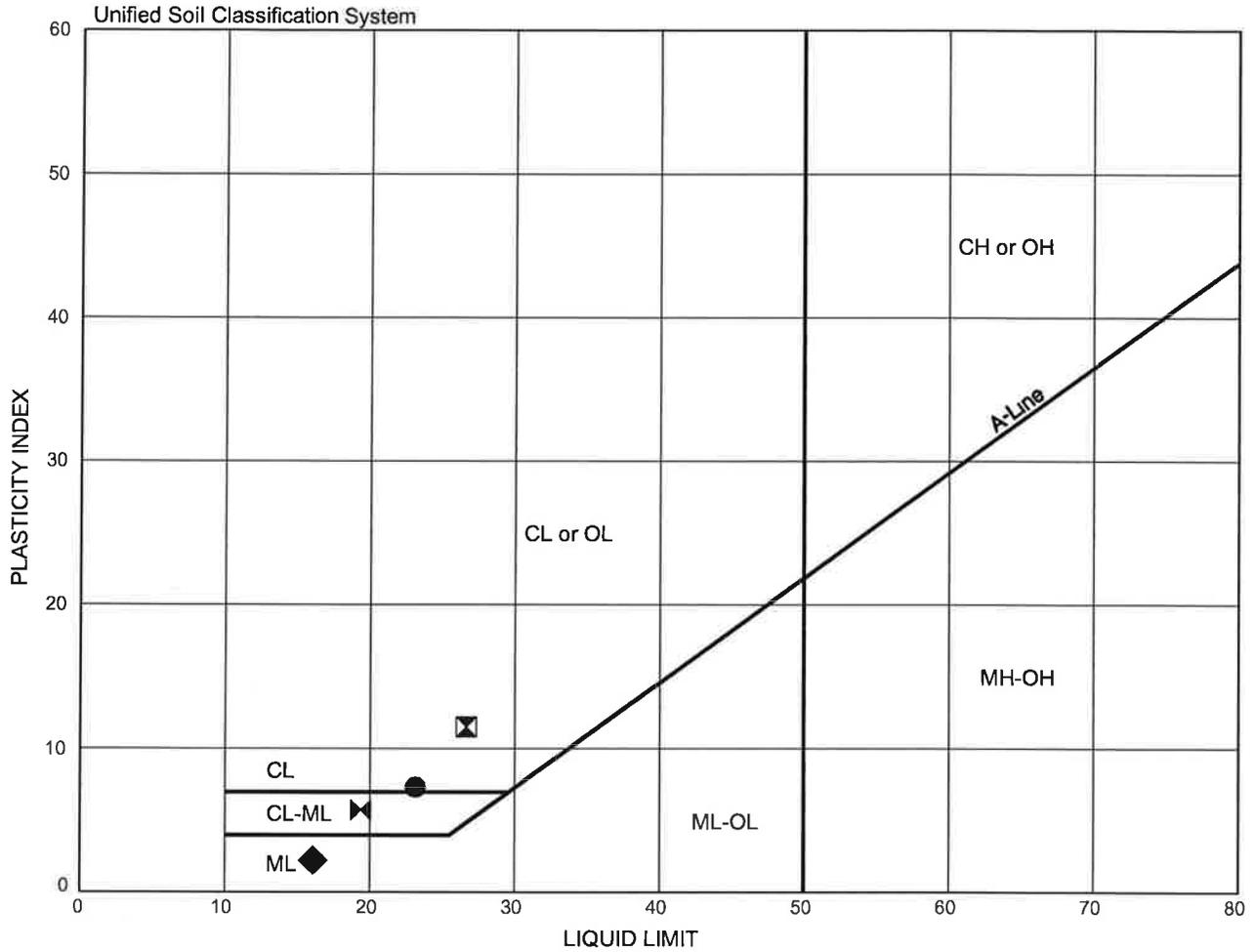
The new identity of Trow

Plasticity Chart

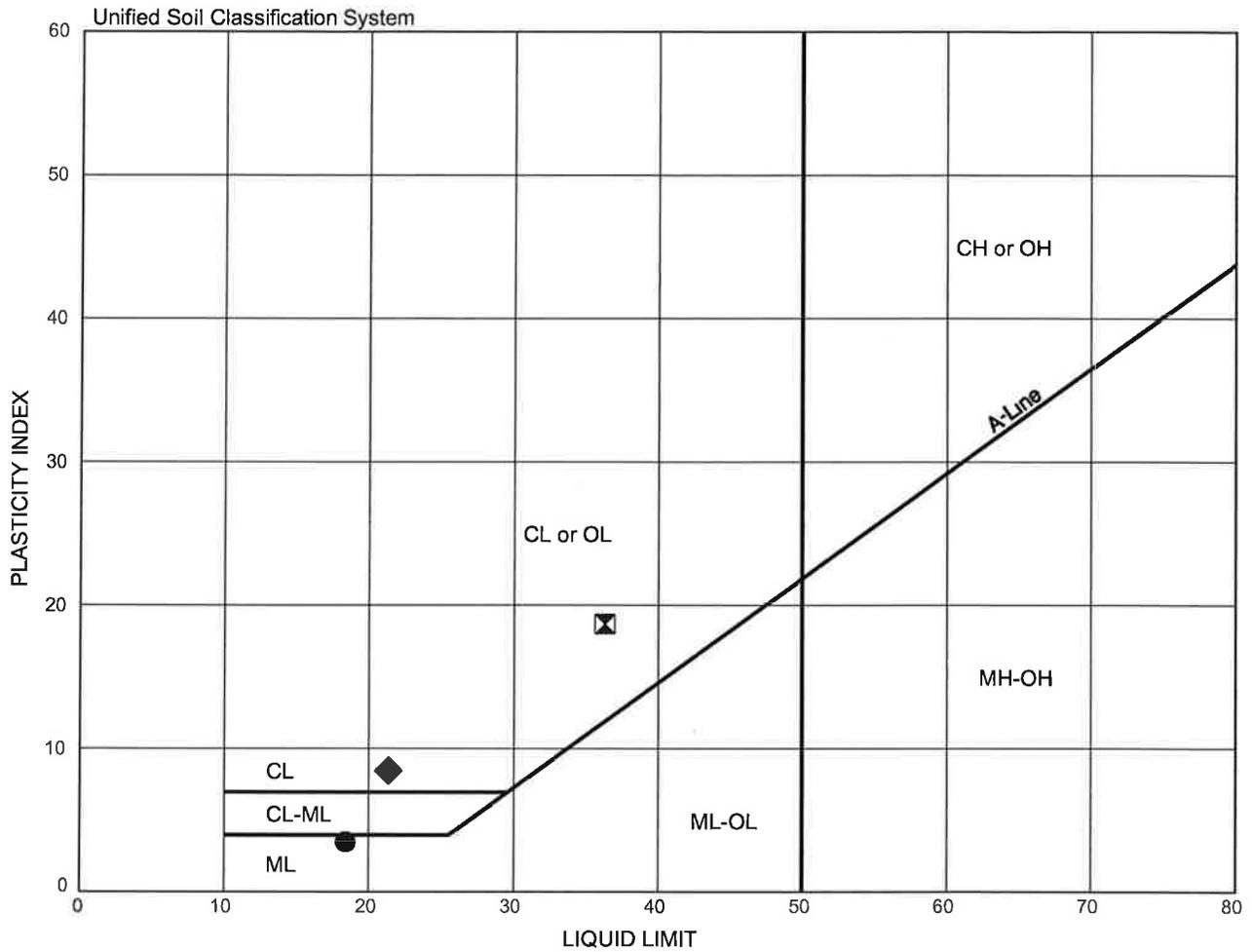
Figure 5B



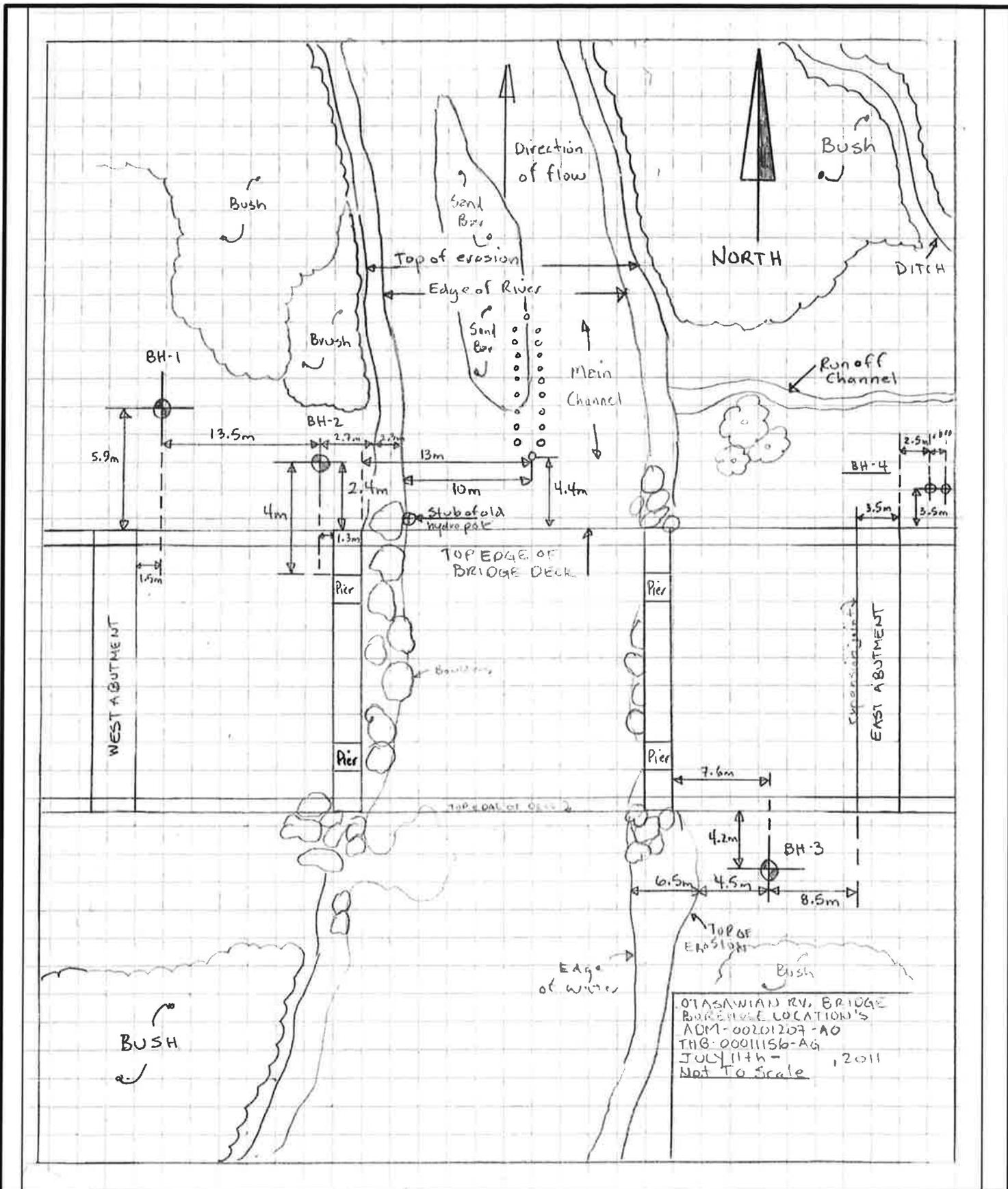
Symbol	Location	Sample No.	Depth (m)	Elevation (m)	W	W _P	W _L	PI
●	BH2	11	9.46	82.81	12.7	12.3	15.9	3.6



Symbol	Location	Sample No.	Depth (m)	Elevation (m)	W	W _P	W _L	PI
●	BH3	S3	1.07	93.09	14.8	15.9	23.2	7.3
⊠	BH3	S6	3.41	90.75	16.8	15.2	26.7	11.5
◆	BH3	S9	5.66	88.50	12.0	13.9	16.1	2.2
⊞	BH3	S15	14.03	80.13	13.3	13.7	19.4	5.7



Symbol	Location	Sample No.	Depth (m)	Elevation (m)	W	W _P	W _L	PI
●	BH4	S4	1.84	97.11	13.1	14.9	18.4	3.5
⊠	BH4	S11A	7.78	91.17	33.2	17.6	36.3	18.7
◆	BH4	S11B	8.09	90.86	21.3	12.8	21.3	8.5



Notes:

1. REFERENCE: Field sketch prepared by exp personnel.



BOREHOLE LOCATION & SURROUNDING FEATURES FIELD SKETCH
 Geotechnical Investigation
 Otawasian River Bridge - Site No. 39W-002
 Ontario Ministry of Transportation
 GWP No. 5236-06-00 / GEOCREs No. 42F-23

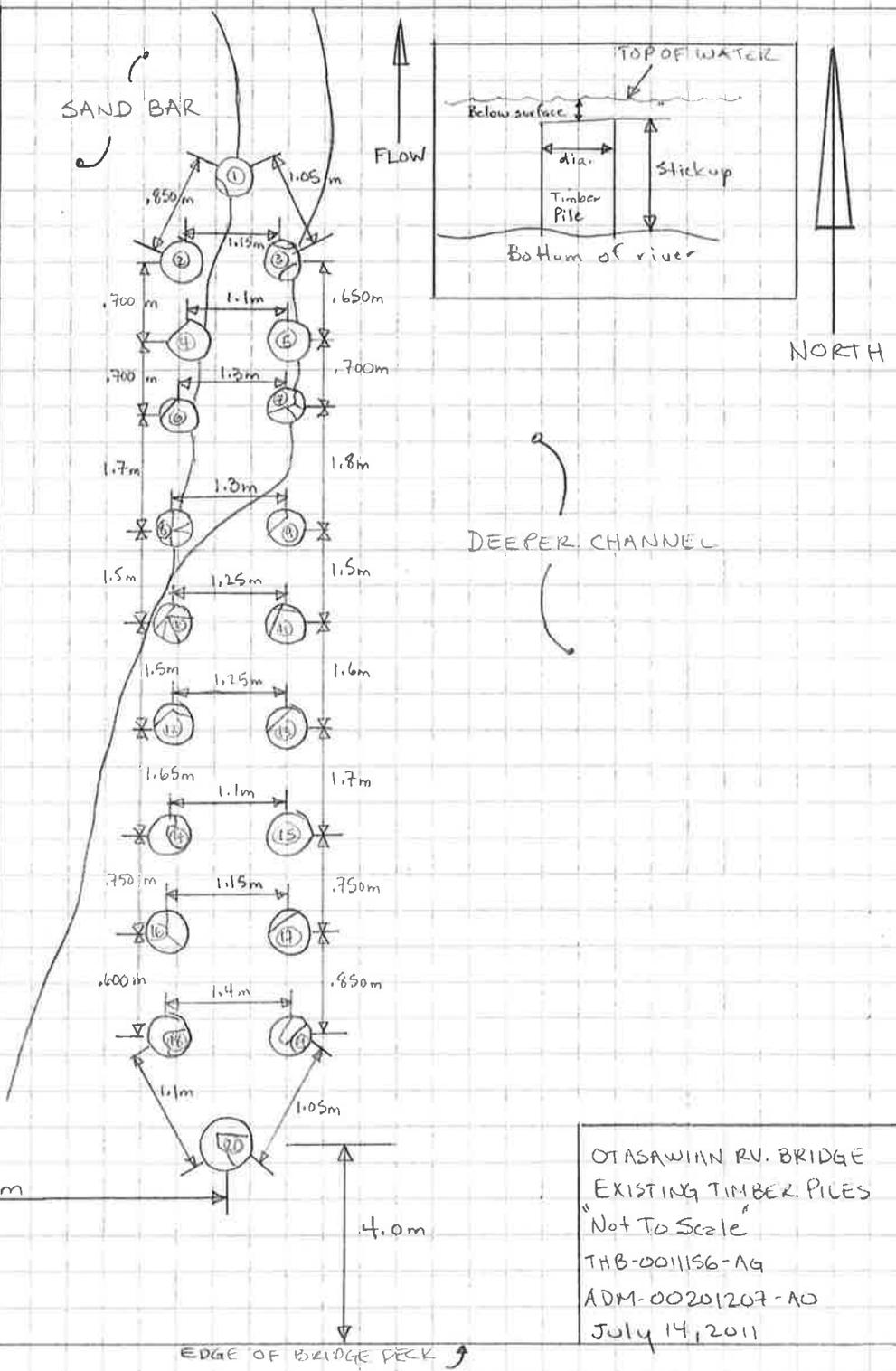
Thunder Bay, Ontario

FIGURE 6

PROJECT NO.:	ADM-00201207-AO
SCALE:	NOT TO SCALE
DRAWN BY:	DMT
CHECKED BY:	DG
DATE:	Aug. 25, 2011

OTASAWIAN RV. BRIDGE ADM-00201207-AO THB-001156-A9
 July 14, 2011, EXISTING TIMBER PILE DETAILS

TIMBER PILES	
①	.300 dia .070 below surface .350m Stickup
②	.350m dia .070 below surface .300m Stickup
③	.280m dia .060m below surface .650m Stickup
④	.350m dia .070m below surface .350m Stickup
⑤	.350m dia .050m below surface .750m Stickup
⑥	.350m dia .050 below surface .350m Stickup
⑦	.350m dia .050 below surface .800m Stickup
⑧	.300 dia .070 below surface .500m Stickup
⑨	.280 dia .050 below surface .850m Stickup
⑩	.350 dia .050 below surface .700m Stickup
⑪	.270 dia .070 below surface .850m Stickup
⑫	.350 dia .050 below surface .900m Stickup
⑬	.320 dia .050 below surface .900m Stickup
⑭	.290 dia .050 below surface .900m Stickup
⑮	.300 dia .030 below surface .900m Stickup
⑯	.300 dia .060 below surface .900m Stickup
⑰	.300 dia .050 below surface .950m Stickup
⑱	.300 dia .060 below surface .900m Stickup
⑲	.250 dia .050 below surface .950m Stickup
⑳	.250 dia .040 below surface .950m Stickup



OTASAWIAN RV. BRIDGE
 EXISTING TIMBER PILES
 "Not To Scale"
 THB-001156-A9
 ADM-00201207-AO
 July 14, 2011

Notes:

1. REFERENCE: Field sketch prepared by exp personnel.



FIGURE

7

Thunder Bay, Ontario

EXISTING TIMBER PILE FIELD SKETCH

Geotechnical Investigation
 Otasawian River Bridge - Site No. 39W-002
 Ontario Ministry of Transportation
 GWP No. 5236-06-00 / GEOCREs No. 42F-23

PROJECT NO.: ADM-00201207-AO

SCALE: NOT TO SCALE

DRAWN BY: DMT

CHECKED BY: DG

DATE: Aug. 25, 2011

Appendix B – Photographs

Photograph 1: Looking west at the bridge.
East pier shown.

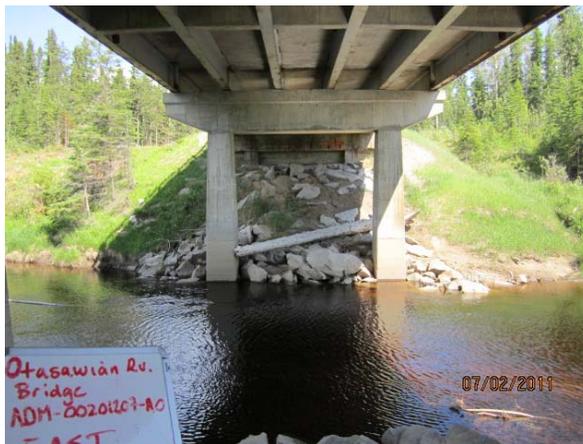


Photograph 2: Looking southwest under the
bridge. East and west piers shown. BH2
location is located across river on right side
(north) of bridge.

Photograph 3: Looking north from on top of
bridge. The existing timber piles (11 or 20) are
noted in river.



Photograph 4: Looking south from on top of bridge.



Photograph 5: Looking east at east pier. BH3 location located on right side (south).

Photograph 6: Looking south at BH4 (located on east side of bridge and north side of Hwy 11).



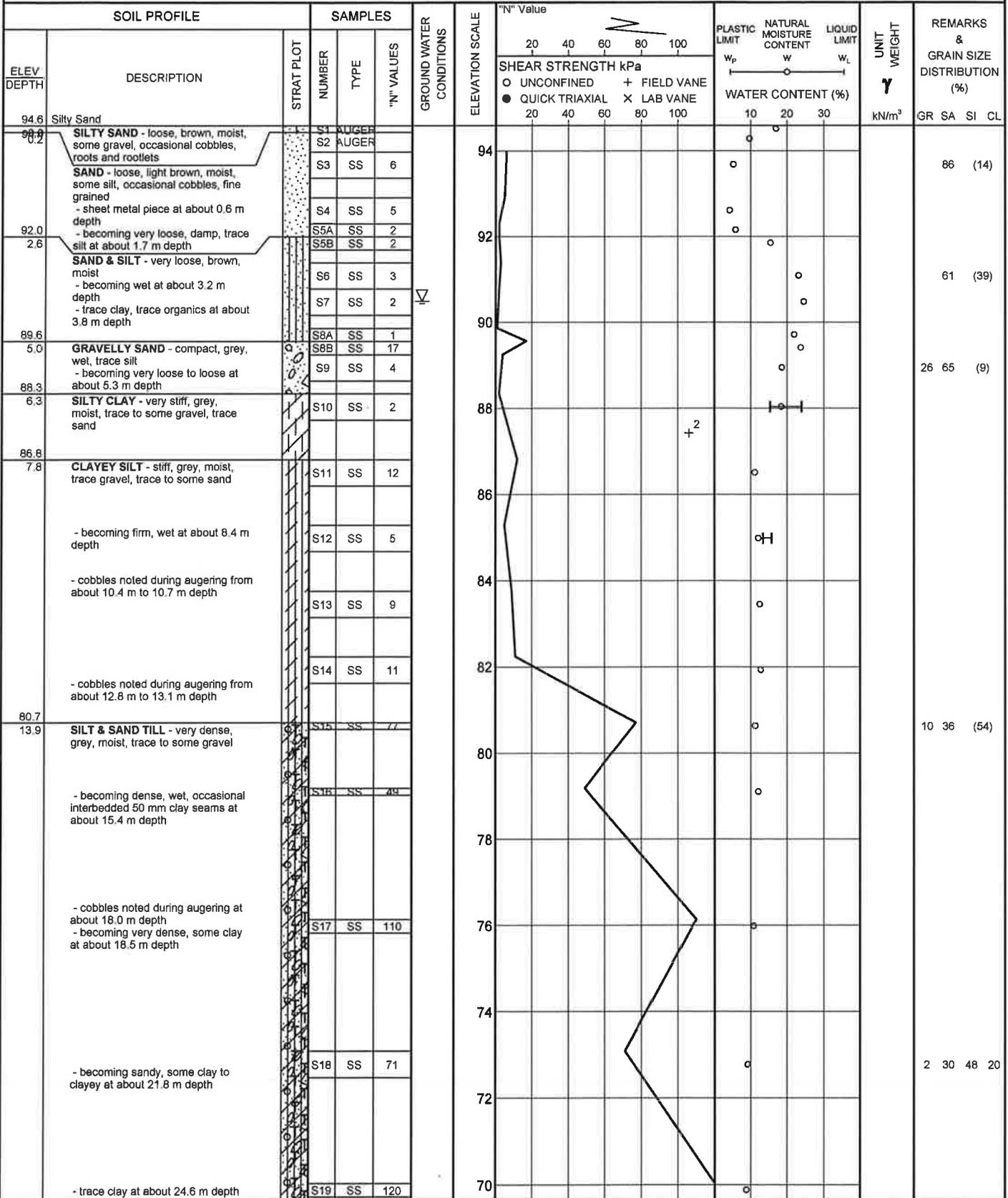
Appendix C – Borehole Logs

RECORD OF BOREHOLE No BH1

1 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Ottawian River Bridge (Site No. 39W-002) - GEOCRETS No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA COMPILED BY DMT
 DATUM Local DATE 7.13.11 - 7.17.11 CHECKED BY AM



ON_MOT F-11156-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON.GPJ ON_MOT.GDT 10/18/11

Continued Next Page

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

RECORD OF BOREHOLE No BH1

2 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Otasawan River Bridge (Site No. 39W-002) - GEOCRETS No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA COMPILED BY DMT
 DATUM Local DATE 7.13.11 - 7.17.11 CHECKED BY AM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	"N" Value		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60
59.0	SILT & SAND TILL continued - cobbles noted during augering at about 26.2 m depth		S20	SS	139										
					S21	SS	107								
					S22	SS	138								
					S23	AUGER									
35.6	End of Borehole - refusal to auger and SPT Notes: - borehole caved below about 7.0 m depth - borehole backfilled with cuttings to about 2.1 m depth - borehole backfilled with bentonite between about 0.3 m and 2.1 m depth - borehole backfilled with cuttings from ground surface to 0.3 m depth		S24	SS	119										

ON_MOT_F-11156-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON GPJ_ON_MOT_GDT_10/18/11

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

RECORD OF BOREHOLE No BH2

1 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Otasawan River Bridge (Site No. 39W-002) - GEOCREs No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA / NQ COMPILED BY DMT
 DATUM Local DATE 7.12.11 - 7.14.11 CHECKED BY AM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	"N" Value		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	10
92.3	Sand & Silt																	
0.0	SAND & SILT - very loose, light brown, wet, trace gravel, fine grained, roots and rootlets - becoming dark brown at about 0.5 m depth		S1	AUGER														
90.7			S2	SS	2													61 (39)
1.5	- becoming brown, trace organics at about 0.8 m depth SILTY SAND - very loose to loose, brown, wet, trace organics		S3	SS	1													70 (30)
			S4	SS	2													
88.5	- becoming dark brown, trace gravel, wood pieces at about 3.1 m depth		S5	SS	6													2 75 (23)
3.8	GRAVELLY SAND - loose, brown, wet, some silt		S6	SS	9													33 49 (18)
87.7			S7	SS	12													
4.6	SILT & SAND - compact, grey, wet, trace gravel, trace to some clay - becoming loose at about 5.3 m depth - becoming very loose at about 6.1 m depth		S8	SS	6													9 35 46 10
			S9	SS	1													
			S10	SS	1													
83.1			S11	SS	6													
9.2	SILT & CLAY - firm, grey, wet, trace to some sand - becoming hard at about 10.7 m depth - becoming wet, occasional seams of hard clay at about 12.2 m depth		S12	SS	43													
			S13	SS	43													
78.5			S14	SS	54													5 42 (53)
13.7	SAND & SILT TILL - very dense, grey, moist, trace gravel, some clay - difficult drilling, some soft interbedded layers noted at about 14.3 m depth		S15	SS	100													
			S16	SS	100													
			S17	SS	100													
			S18	SS	102													
	- trace to some gravel at about 19.8 m depth - difficult drilling, some soft interbedded layers noted at about 20.4 m depth		S19	SS	106													
			S20	SS	132													
	- cobbles noted during augering from about 23.8 m to 24.1 m depth - 130 mm very dense interbedded silt seam at about 24.4 m depth		S21	SS	95													

ON_MOT_F-11156-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON GPJ_ON_MOT_GDT_10/18/11

Continued Next Page

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

RECORD OF BOREHOLE No BH2

2 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Otasawan River Bridge (Site No. 39W-002) - GEOCRETS No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA / NQ COMPILED BY DMT
 DATUM Local DATE 7.12.11 - 7.14.11 CHECKED BY AM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	"N" Value		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
	SAND & SILT TILL continued												
			S22	SS	101								
			S23	SS	83								
			S24	SS	77								
			S25	SS	100								
			S26	SS	77								
			S27	SS	78								
54.7	- refusal to euger and SPT at about 37.5 m depth												
37.5	BEDROCK - medium strong, severely fractured (RQD = 18%), greenish grey, coarse grained, pink stringers, some quartz pockets and stringers, recovery = 89% - becoming severely fractured to fractured (RQD = 50%), recovery = 100% at about 38.7 m depth - becoming fractured (RQD = 64%), recovery = 100% at about 39.8 m depth		S28	CORE									
			S29	CORE									
51.4			S30	CORE									
40.9	End of Borehole												
	Notes: - borehole backfilled with cuttings to about 2.0 m depth - borehole backfilled with bentonite between about 0.3 m and 2.0 m depth - borehole backfilled with cuttings from ground surface to 0.3 m depth												

ON_MOT_F-11156-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON GPJ_ON_MOT_GDT_10/18/11

+³, X³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. GWP No. 5236-06-00 LOCATION Ottawaian River Bridge (Site No. 39W-002) - GEOCREs No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA / NQ COMPILED BY DMT
 DATUM Local DATE 7.16.11 - 7.17.11 CHECKED BY AM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	"N" Value			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
94.2	Sand		S1	AUGER										
90.2	SAND - very loose, brown, damp, trace gravel, some silt, roots and rootlets SILTY CLAY - firm, brown, moist, trace gravel, trace sand - becoming brown to grey, trace organics in upper 2.3 m at about 0.8 m depth - becoming soft, moist to wet at about 2.3 m depth - becoming firm at about 3.1 m depth - becoming soft, varved, fine grey sand seams at about 3.8 m depth		S2	AUGER										
			S3	SS	5									
			S4	SS	6									
			S5	SS	1									
			S6	SS	7									
89.6			S7	SS	2									
4.6	CLAYEY SILT - firm to stiff, grey, wet, trace gravel, trace to some sand - becoming soft, some gravel, sandy at about 6.1 m depth - becoming soft at about 7.6 m depth		S8	SS	6									
			S9	SS	9									
			S10	SS	2								19 27 44 10	
			S11	SS	3									
			S12	SS	2									
			S13	SS	4									
			S14	SS	5								11 30 46 13	
			S15	SS	33									
78.9			S16A	SS	8									
15.4	SAND - loose, grey, wet, trace to some silt, fine grained SILT - compact, grey, wet, trace gravel, trace sand, some clay - 80 mm seam of hard grey clay at about 16.8 m depth		S16B	SS	14									
			S17A	SS	24								30 61 (9)	
77.0			S17B	SS	18									
17.2	GRAVELLY SAND - compact, grey, wet, trace silt		S18	SS	100								36 53 (11)	
75.9			S19	CORE										
18.3	SAND & GRAVEL - very dense, grey, wet, some silt, some cobbles at about 18.3 m depth		S20	SS	193								23 47 (30)	
74.8	BOULDER - about 300 mm													
70.5	SILTY SAND TILL - very dense, grey, moist, gravelly													
70.7	End of Borehole - refusal to SPT													
20.0														

ON_MOT_F-11156-AG - OTTAWIAN RIVER BRIDGE - MTO - BRAMPTON GPJ_ON_MOT_GDT_10/18/11

Notes:
 - borehole backfilled with cuttings to about 2.0 m depth
 - borehole backfilled with bentonite between about 0.3 m and 2.0 m depth
 - borehole backfilled with cuttings from ground surface to 0.3 m depth

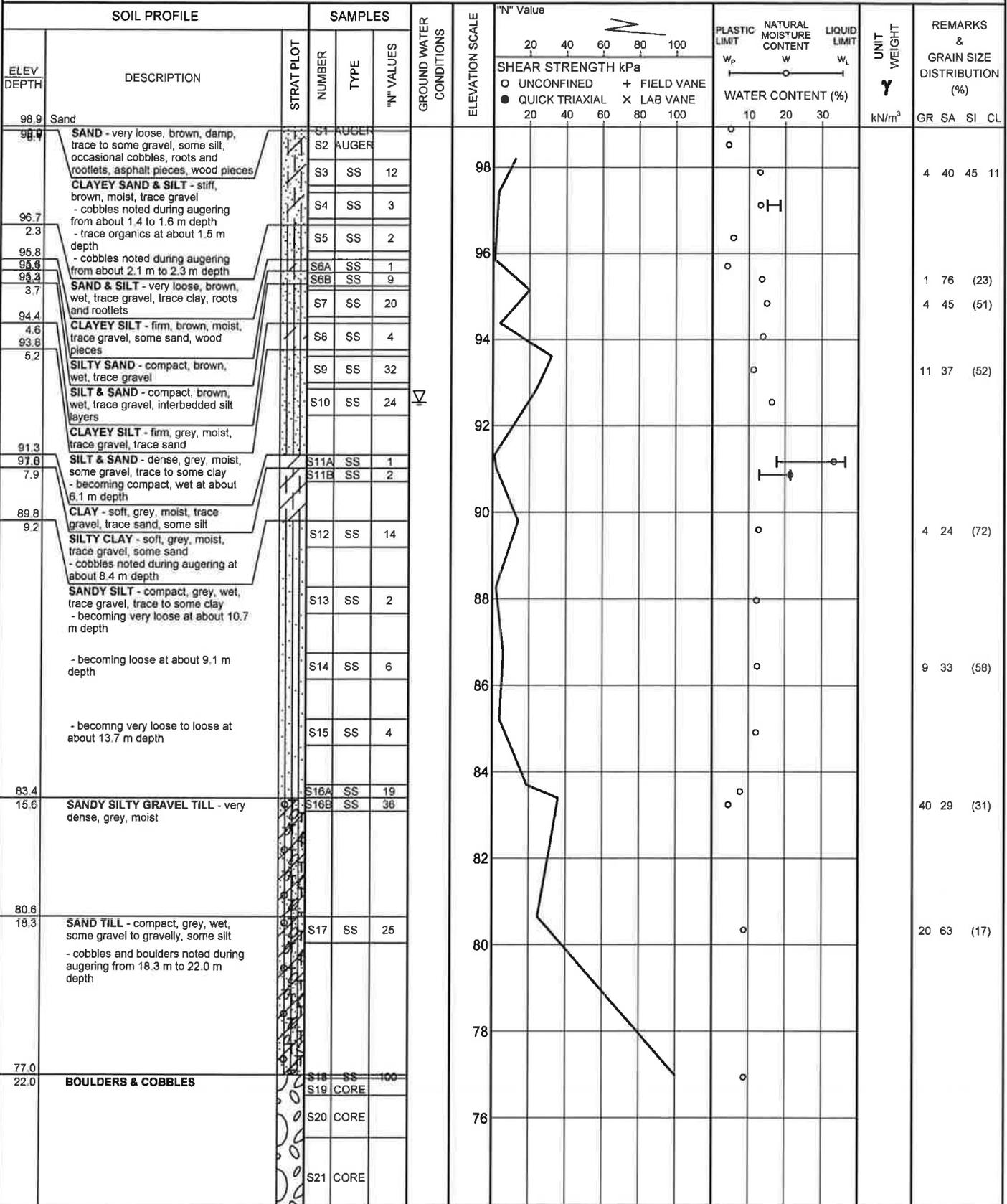
+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH4

1 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Otasawan River Bridge (Site No. 39W-002) - GEOCRES No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA / NQ COMPILED BY DMT
 DATUM Local DATE 7.18.11 - 7.20.11 CHECKED BY AM



ON MOT F-11156-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON.GPJ ON MOT.GDT 10/18/11

Continued Next Page

+³, X³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH4

2 OF 2

METRIC

W.P. GWP No. 5236-06-00 LOCATION Otasawan River Bridge (Site No. 39W-002) - GEOCRETS No. 42F-23 ORIGINATED BY EF
 DIST Twp Kohler HWY 11 BOREHOLE TYPE CME 55 Trailer Mount / HSA / NQ COMPILED BY DMT
 DATUM Local DATE 7.18.11 - 7.20.11 CHECKED BY AM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	"N" Value		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40						60
72.2 25.2	End of Borehole													
	Notes: - borehole caved below about 11.1 m depth - borehole backfilled with cuttings to about 7.0 m depth - borehole backfilled with bentonite between about 5.8 m and 7.0 m depth - borehole backfilled with cuttings to about 1.5 m depth - borehole backfilled with bentonite between about 0.3 m and 1.5 m depth - borehole backfilled with cuttings from ground surface to 0.3 m depth													
						72								

ON_MOT F-11155-AG - OTASAWAN RIVER BRIDGE - MTO - BRAMPTON GPJ ON_MOT.GDT 10/18/11