FOUNDATION INVESTIGATION REPORT
PINE LAKE ARCH CULVERT REPLACEMENT
HIGHWAY 71
TOWNSHIP OF POTTS, RAINY RIVER DISTRICT
AGREEMENT NO.: 6013-E-0023
SITE NO.: 45-163/C
MTO GEOCRES NO. 52C-31
GWP NO. 6946-10-00

JUNE 20, 2014
GS-TB-018734

PREPARED FOR:

Ministry of Transportation
Geotechnical Section
Northwestern Region Office
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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. (DST) has been retained by the Ministry of Transportation (MTO), Geotechnical Section, Northwestern Region to conduct a foundation investigation for the proposed culvert replacement on Highway 71 at Pine Lake culvert location. This work was carried out under Agreement No.: 6013-E-0023 - Geotechnical Retainer - Assignment No. 1.

This report addresses the field investigation, laboratory test program, factual report on subsurface conditions at culvert location.

2. SITE DESCRIPTION

The site is located on Highway 71, approximately 25.1 km North of Highway 11, approximate GPS coordinates of 48.8685 and longitude -93.9159, Station 14+831, in the Township of Potts, Rainy River District.

It is understood that the existing 17.8 m long centreline culvert is a concrete arch culvert approximately 5.48 m wide and approximately 2.44 m in height. The existing culvert (Figures 2.3 and 2.4) was originally built in 1899 and inspected by others indicates very severe spalling, concrete disintegration, and corroded reinforcement. The fill height at the culvert location is approximately 1.1 m and the side slope of the embankment is approximately 1H:1V. The surrounding area is moderately vegetated (Figure 2.3 and 2.4). Photographs were taken by others (Figures 2.1 to 2.4).

Geological information is available from published *Ontario Geological Survey Map #52CNW* by the *Ontario Ministry of Natural Resources* for the Rainy River area. The map indicates that the local area landform is identified as clay, silt glaciolacustrine plain that borders peat, muck organic terrain. The topography in the area is mainly low local relief, plain like with mixed wet and dry drainage conditions.

Figure 2.1 Location of existing culvert at Highway 71 (looking South)

Figure 2.2 Location of existing culvert at Highway 71 (looking North)

Figure 2.3 Culvert inlet (West)

Figure 2.4 Culvert outlet (East)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out during the week of May 5th, 2014 utilizing a CME 55 drill rig equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced to depths ranging from 2.0 m to 4.6 m. The minimum numbers and depths of the boreholes were specified by the Ministry of Transportation (MTO).

The borehole locations and stratigraphic section are shown on the Borehole Location Plan, Drawings 1 to 3. Borehole 1 was advanced South of the existing culvert, 4.9 m right of centreline, and advanced to a depth of 4.6 m below surface. Borehole 2 was advanced North of the existing culvert, 4.4 m left of centreline, and advanced to a depth of 2.0 m below surface. The remaining two boreholes were advanced with portable hand equipment at the inlet and outlet of the existing culvert. Borehole 3 was advanced East of the outlet, 8.5m right of centreline, and advanced to a depth of 2.0 m below surface. Borehole 4 was advanced West of the inlet, 7.3 m left of centreline, and advanced to a depth of 2.0 m below surface.

The borehole locations are referenced to the MTO Station numbering system as indicated on the drawings provided by the Ministry. The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to the existing culvert at Station 14+831. A telephone pole on the Southeast side of the culvert was assigned as temporary benchmark with elevation of 100.0 m (Drawing 1). Table 3.1 summarizes the detail of borehole locations and depths.

All boreholes were abandoned using suitable abandonment barrier as described in Ontario Regulation 903 and its amendments. Boreholes were decommissioned by backfilling to the bottom of the road base with cuttings and bentonite chips. From the bottom of the road base, granular materials were replaced to the bottom of the asphalt.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples were obtained from the auger flights and from the split spoon sampler used for the standard penetration test (SPT). The SPT involves driving a 51 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the sampler 305 mm is known as the standard penetration blow count (N) which provides an indication of the condition or consistency of the soil. The soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis.

Classification and index tests were subsequently performed in the laboratory on samples collected from the boreholes to aid in the selection of engineering properties. Laboratory tests included moisture contents, particle size analyses and Atterberg limits including plastic limit and liquid limit. A total of twelve (12) moisture contents, five (5) sieve analyses, three (3) hydrometer, and one (1) Atterberg limits have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs (Enclosures 1 to 4), and graphical plots attached (Enclosures 5 to 7).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	14+826	99.7	4.6	4.9 Rt
BH2	14+834	99.6	2.0	4.4 Lt
BH3 (HA)	14+827	97.5	2.0	8.5 Rt
BH4 (HA)	14+827	97.5	2.0	7.3 Lt

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during power auger drilling and hand auger drilling.

The generalized stratigraphy of the existing embankment, based on the conditions encountered in Boreholes 1 and 2, consists of asphalt overlying fill sand with various mixture of silt, gravel and clay. The sand fill is underlain by clay silty which is overlaying sand. The following table shows various soil layers in Borehole 1.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt			80 to 90 mm estimated
Fill –Sand & Crushed Gravel	0.0 to 0.3	99.7 to 99.4 m	
Fill -Sand	0.3 to 3.8	99.4 to 95.9 m	
Clay	3.8 to 4.4	95.9 to 95.3 m	
Sand	4.4 to 4.6	95.3 to 95.1 m	

4.1 Asphalt

The Boreholes were drilled in the shoulder where no asphaltic concrete was encountered. The estimated asphalt concrete thickness is 80 to 90 mm within the culvert vicinity.

4.2 Fill – Sand and Crushed Gravel

Sand fill with crushed gravel, some silt was encountered in Boreholes 1 and 2 with a thickness of 0.3 m at depths between 0.0 m to 0.3 m (Elev. 99.7 m to 99.4 m and 99.6 m to 99.3 m). The moisture content of a tested sample was found to be 7 %. The results of the laboratory test is summarized in Table 4.2.

Table 4.2 Summary of sand and crushed gravel sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	13
Sand %	70
Fines %	17

4.3 Fill – Sand

Sand fill with gravel to gravelly, some silt was encountered in Boreholes 1 and 2 with thicknesses of approximately 1.7 m to 3.0 m at depths 0.3 m to 3.8 m (Elev. 99.4 to 95.9 m) and 0.3 m to 2.0 m (Elev. 99.3 m to 97.6 m) respectively.

SPT 'N' values vary from 45 to more than 100, indicating a dense to very dense condition. The moisture contents of the sand material vary from 4 to 8 %. The results of the laboratory tests are summarized in Table 4.3.

Table 4.3 Summary of sand fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	13 to 50
Sand %	40 to 61
Fines %	10 to 46

4.4 Clay – Silty

Silty clay with some sand was encountered in Borehole 1, 3 and 4 at a depth of 3.8 m (Elev. 95.9), 0.0 m (Elev. 97.5 m) and 0.0 m (Elev. 97.5 m) respectively. The thickness of this stratum for Borehole 1 and Borehole 4 was found to be 0.6 m (Elev. 95.9 m to 95.3 m) and 1.8 m (Elev. 97.5 m to 95.7 m) respectively. The thickness of this stratum was not defined for Borehole 3 as borehole terminus was reached within this stratum due to auger refusal on possible boulder.

SPT 'N' value of 38 was recorded for this layer indicating a very stiff condition. The moisture content of the tested samples vary from 17 to 39 %. Since stiff clay was encountered within the boreholes therefore SPT or CPT test were carried out instead of field vane shear tests and results are reported in a borehole logs. The results of the laboratory tests are summarized in Table 4.4.

Table 4.4 Summary of silty clay silty atterberg limits and sieve analyses

Laboratory Results – Atterberg Limits	
Liquid Limit %	57
Plastic Limit %	24
Plastic Index %	33

Sieve Analysis	
Gravel %	0
Sand %	14 to 33
Silt %	26 to 35
Clay %	32 to 60

4.5 Sand

Silty sand with trace clay and gravel was encountered in Boreholes 1 and 4, at depths of 4.4 m (Elev. 95.3 m) and 1.8 m (Elev. 95.7 m) with undetermined thicknesses due to auger refusal on possible boulders.

4.6 Groundwater

Ground water was observed in Boreholes 1 to 4 at elevations between 95.5 m to 98.2 m. The groundwater levels can be expected to vary with the season and precipitation events. The estimated groundwater table levels at the site during the field investigations are given in Table 4.5. The water level in the creek at time of investigation was 97.6 m.

Table 4.5 Elevation of water table at boreholes

Borehole	May 7, 2014	
	Depth Measured (m)	Elevation (m)
BH 1	2.5	97.2
BH 2	1.4	98.2
BH 3	2.0	95.5
BH 4	1.4	96.1

5. MISCELLANEOUS

Site work was carried out during the week of May 5th, 2014 utilizing a CME 55 truck mounted drill rig and the field crew returned to the site during the week of May 19th, 2014 to further the investigations utilizing a CME 55 truck mounted drill rig operated by DST personnel. Fieldwork was supervised on a full time basis by Joe Forgues who located the boreholes in the field, performed sampling, in-situ testing and logged the boreholes. Soil samples collected during drilling were identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis. Interpretation of the data and preparation of the report was completed by Deep Bansal, P.Eng and reviewed by Prof. Myint Win Bo, P.Eng a designated principal contact for MTO projects.

6. LIMITATIONS OF REPORT

A description of limitations which are inherent in carrying out site investigation studies is given in Appendix 'A', and this forms an integral part of this report.

For DST CONSULTING ENGINEERS INC.

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C.Geol, C. Eng, Eur Geol, Eur Eng
Senior Principal / Senior Vice President

Reviewed by:

Bernardo Villegas, M.Sc.
Manager

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M

Appendix B

DESCRIPTION OF TERMS

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

TEXTURAL CLASSIFICATION OF SOILS

BOULDERS	COBBLES	GRAVEL	SAND	SILT	CLAY
GREATER THAN 200 mm	75 TO 200 mm	4.75 TO 75 mm	0.075 TO 4.75 mm	0.002 TO 0.075 mm	LESS THAN 0.002 mm

COARSE GRAIN SOIL DESCRIPTION (50% GREATER THAN 0.075 mm)

TERMINOLOGY	TRACE OR OCCASIONAL	SOME	WITH	ADJECTIVE (e.g. SILTY OR SANDY)	AND (e.g. SAND AND SILT)
	LESS THAN 10%	10 TO 20%	20 TO 30%	30 TO 40%	40 TO 60%

CONSISTENCY*: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (C_U) AND SPT 'N' VALUES AS FOLLOWS

C_U (kPa)	0 – 12	12 – 25	25 – 50	50 - 100	100 - 200	> 200
N (BLOWS / 0.3 m)	<2	2 - 4	4 - 8	8 - 15	15 - 30	>30
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

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

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

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

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100 mm+ IN LENGTH EXPRESSED AS A PERCENTAGE OF THE LENGTH OF THE CORING RUN.

THE ***ROCK QUALITY DESIGNATION*** *(R.Q.D)* FOR MODIFIED RECOVERY IS:

R.Q.D (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

LEGEND OF RECORDS FOR BOREHOLES: SYMBOLS AND ABBREVATIONS FOR SAMPLE TYPE

SS	SPLIT SPOON SAMPLE	WS	WASH SAMPLE
TW	THIN WALL SHELBY TUBE SAMPLE	AS	AUGER (GRAB) SAMPLE
PH	SAMPLER ADVANCED BY HYDRAULIC PRESSURE	TP	THIN WALL PISTON SAMPLE
WH	SAMPLER ADVANCED BY SELF STATIC WEIGHT	PM	SAMPLER ADVANCED BY MANUAL PRESSURE
SC	SOIL CORE	RC	ROCK CORE
▼	WATER LEVEL	$SENSITIVITY = \frac{UNDISTURBED\ SHEAR\ STRENGTH}{REMOLDED\ SHEAR\ STRENGTH}$	

*HIERARCHY OF SOIL STRENGTH PREDICTION: **1)** LABORATORY TRIAXIAL TESTING. **2)** FIELD INSITU VANE TESTING. **3)** LABORATORY VANE TESTING. **4)** SPT VALUES. **5)** POCKET PENETROMETER.

Appendix C

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO RR-0-707 88-05

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLES OTHERWISE SHOWN. STATIONS IN KILOMETERS + METERS

CONT	No	6013-E-0023
WP	No	6946-10-00
SITE	No	45-163C
Geocres. No		52C-31

CULVERT REPLACEMENT
PINE LAKE CULVERT
STA 14+820 TO STA 14+840
Survey 12-07 Revised

SHEET

P-2435-13

P-2435-11

CREEK

PI = 14+841.85

BM
100.00m
Hydro Pole

BH4

BH2

BH1

BH3

4500 x 2000 x 17.55 CONC. ARCH

HIGHWAY 71

ASPHALT

14+800 14+820 14+840 14+860 14+880

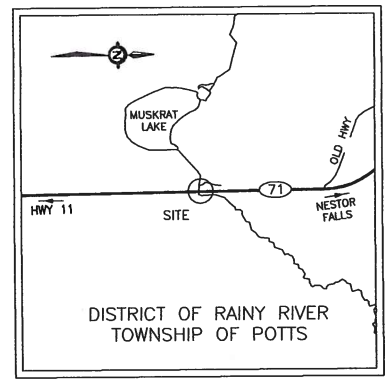
377.0 377.5 378.0 378.5 379.0

376.5 375.5

P-2435-13 P-2435-11

PLAN

5 0 5



KEY PLAN

0.5 km 0 0.5 km

LEGEND

- Borehole
- Borehole with CPT
- Asphalt Core
- Rock Probe
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.

Fill, Organics, Topsoil, Till, Bedrock
Sand, Silt, Clay, Sand & Gravel, Boulders

No.	Elevation	Northing	Easting	Station	Offset
BH1	99.714	5414894 m N	237619 m E	14+826	4.9 m RT
BH2	99.587	5414902 m N	237610 m E	14+834	4.4 m LT
BH3	97.490	5414893 m N	237623 m E	14+827	8.5 m RT
BH4	97.482	5414895 m N	237607 m E	14+827	7.3 m LT

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PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
June 20, 2014
M. W. BO
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NOTE:
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DRAWING 1

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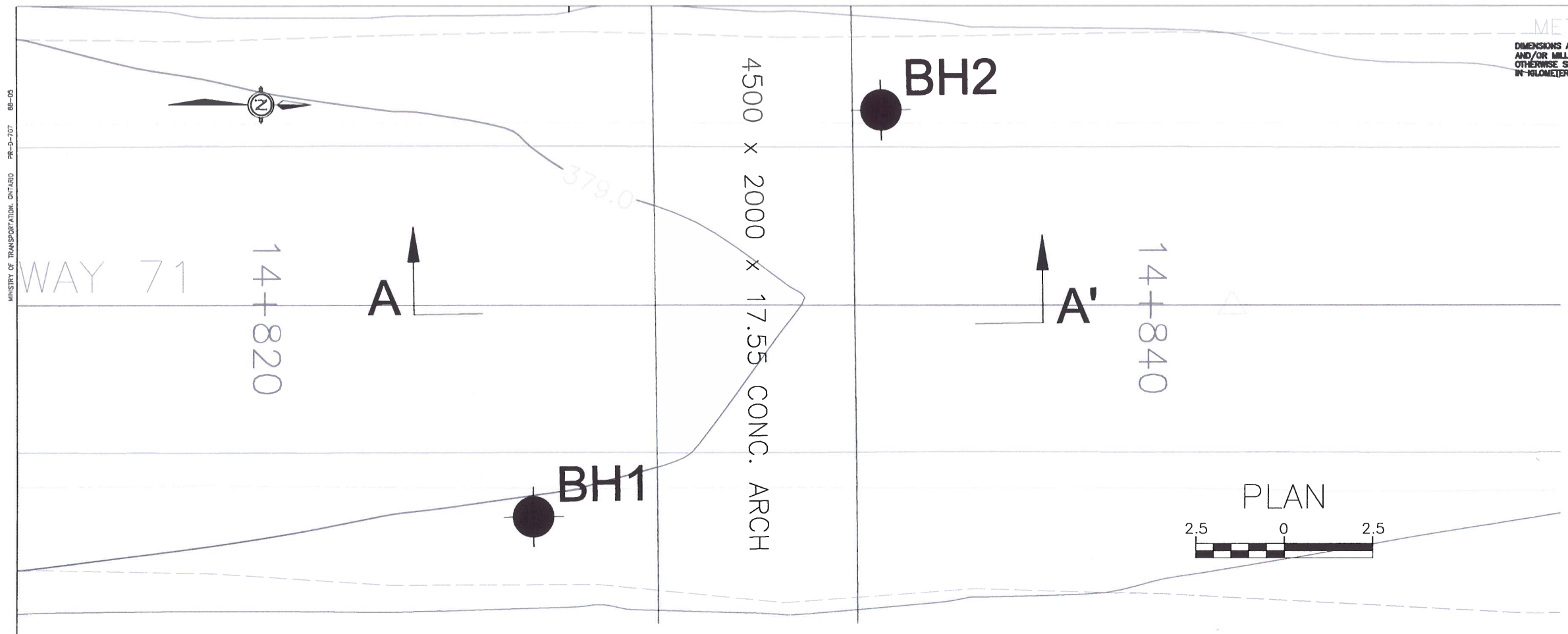

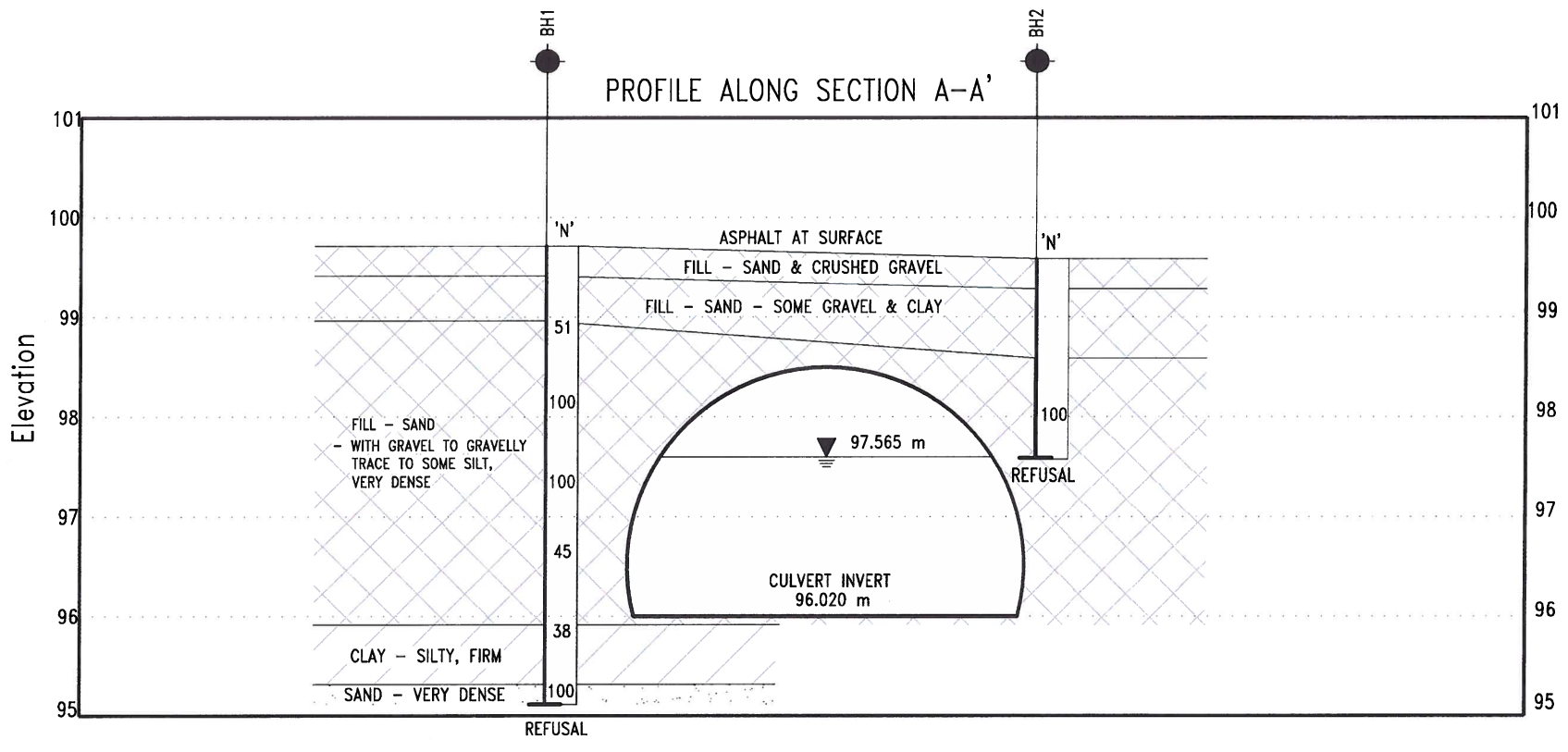

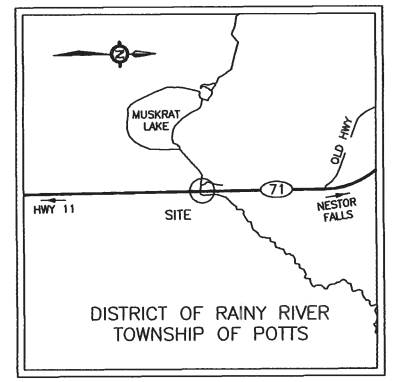

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- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.
- Fill
- Organics
- Topsoil
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

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DRAWING 2

MINISTRY OF TRANSPORTATION, ONTARIO PR-0-707 88-05

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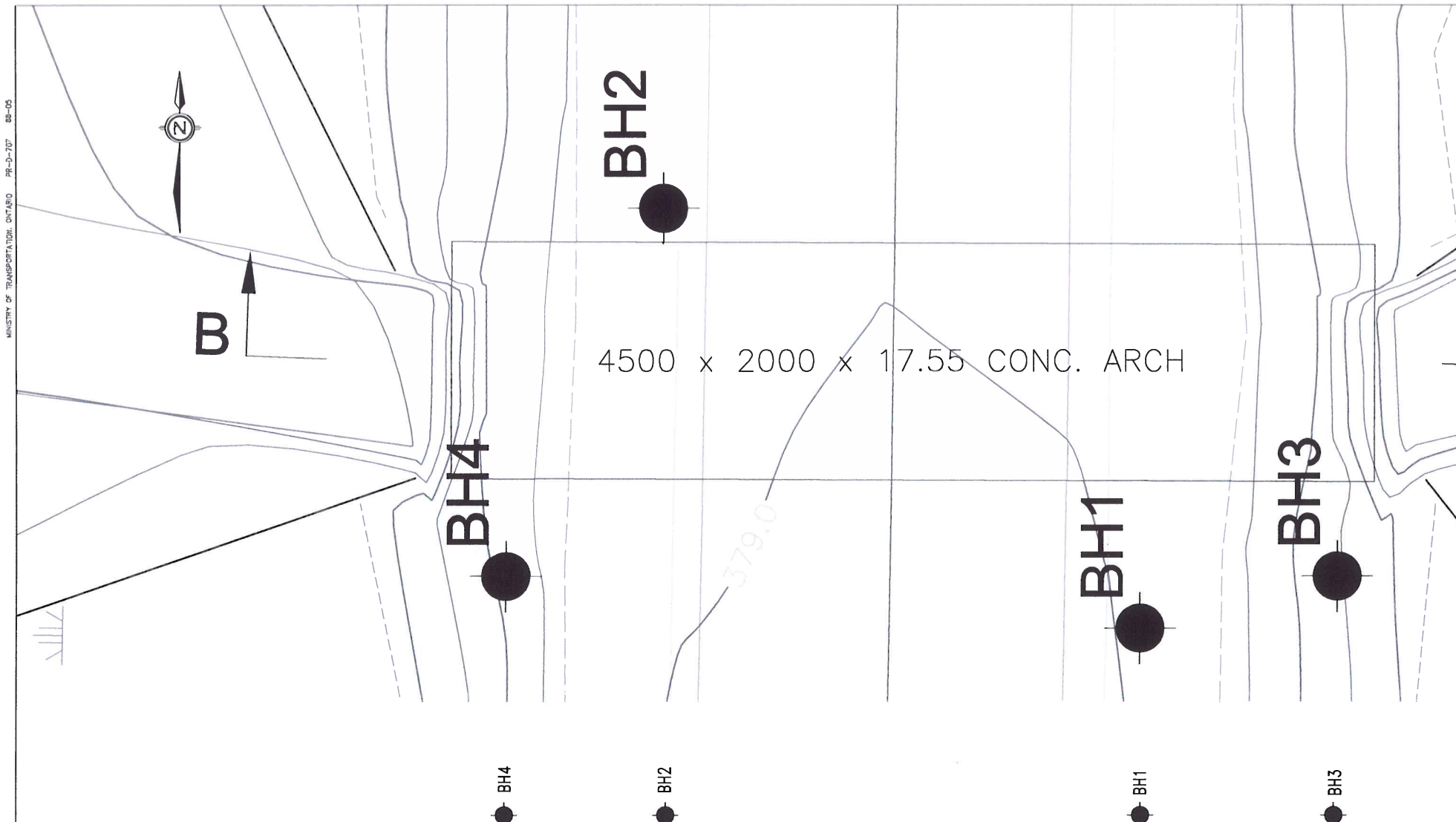

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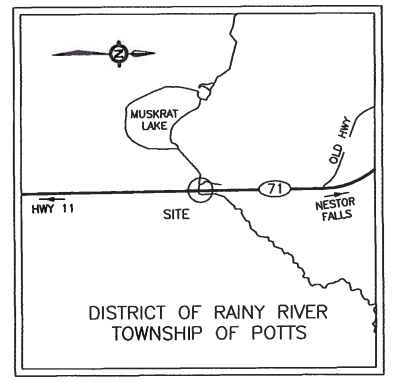

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Fill, Organics, Topsoil, Till, Bedrock
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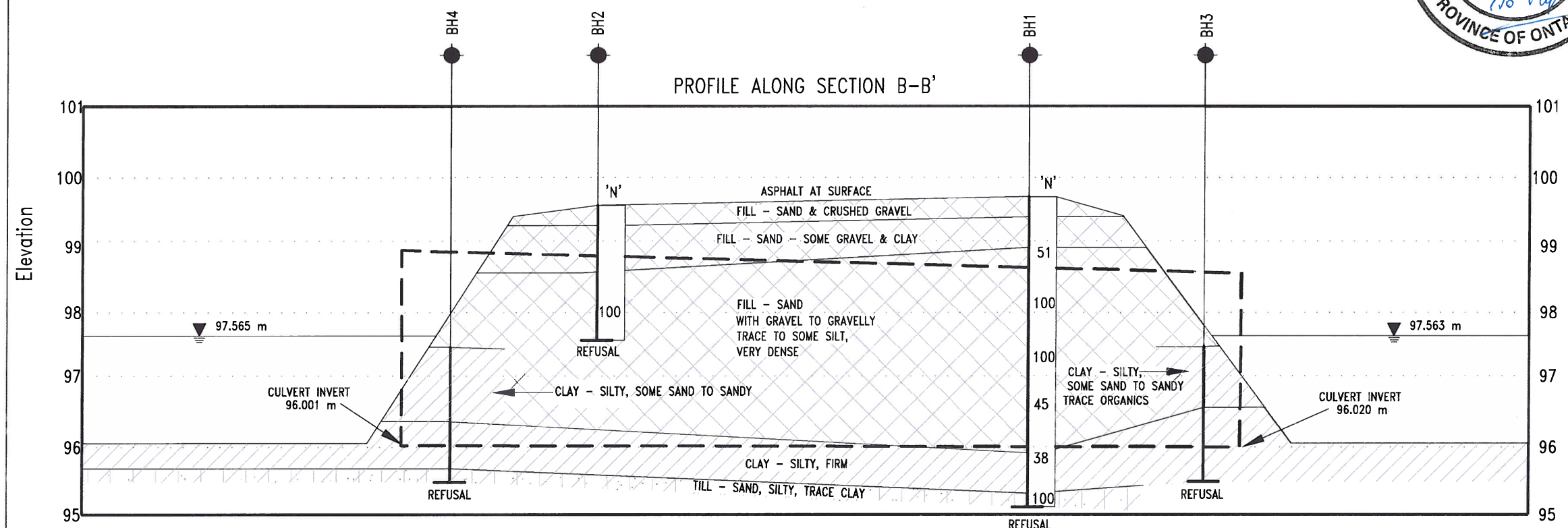
PROFILE ALONG SECTION B-B'



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DRAWING 3

Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION PINE LAKE CULVERT: STA. 14+826, 4.9 m RT ORIGINATED BY JF

DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML

DATUM LOCAL DATE 2014 05 07 CHECKED BY DB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.7	GROUND SURFACE										
99.4	FILL - SAND & CRUSHED GRAVEL - brown										Water level at 2.5 m on completion
0.3	FILL - SAND - some gravel and clay, brown		AS1	AS							
99.0							99				
0.8	FILL - SAND - with gravel to gravelly, trace to some silt, brown, very dense		SS2	SS	51						
			SS3	SS	100+		98				26 55 (19) SPT 50/125 mm
	- - - - - Gravel with sand		SS4	SS	100+	▽	97				50 40 (□□□) SPT 50/125 mm
	- - - - - Silty		SS5	SS	45						20 6□ (19)
95.9							96				
3.8	CLAY - Silty, trace gravel, grey, hard		SS6	SS	38						
95.3											
4.4	SAND - trace gravel and sand, very dense		SS7	SS	100+						SPT 50/120 mm
95.1											
4.6	End of Borehole at 4.6 m Auger Refusal on possible boulders										

NR = NO RECOVERY $+^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT_GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 6/3/14

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION PINE LAKE CULVERT: STA. 14+834, 4.4 m LT ORIGINATED BY JF

DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML

DATUM LOCAL DATE 2014 05 07 CHECKED BY DB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
99.6	GROUND SURFACE										
99.3	FILL - SAND & CRUSHED GRAVEL - trace silt, brown		AS1	AS							Water Level at 1.4 m on completion
0.3	FILL - SAND - some gravel and clay, brown		AS2	AS			99		●		13 70 (17)
98.6											13 41 26 20
1.0	FILL - SAND - Gravelly, some silt, trace clay, brown, very dense					▽			●		
			SS3	SS	100+		98		●		35 47 (18)
97.6											
2.0	End of Borehole at 2.0 m Auger Refusal on Boulders										SPT 50/130 mm

NR = NO RECOVERY $+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT_GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 6/3/14

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION PINE LAKE CULVERT: STA. 14+827, 8.5 m RT ORIGINATED BY JF

DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML

DATUM LOCAL DATE 2014 05 07 CHECKED BY DB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L ◆ ● ▲ WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.5	GROUND SURFACE										
	CLAY - Silty, some sand to sandy, trace gravel, grey										Water Level at 2.0 m on completion
							97				0 33 35 32
			AS1	AS							CPT 1380 kPa
							96				0 14 26 60
			AS2	AS							
95.5						▽					
2.0	End of Borehole at 2.0 m Auger Refusal on Boulders										

NR = NO RECOVERY $+^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT_GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 6/3/14

ENCLOSURE 3

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION PINE LAKE CULVERT: STA. 14+827, 7.3 m LT ORIGINATED BY JF

DIST HWY 17 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML

DATUM LOCAL DATE 2014 05 07 CHECKED BY DB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.5	GROUND SURFACE										
	CLAY - Silty, some sand to sandy, trace gravel and organics, grey		AS1	AS		▽	97				Water Level at 1.4 m on completion
							96				
95.7											
1.8	SAND - Silty, trace clay, grey										
95.5											
2.0	End of Borehole at 2.0 m Auger Refusal on Boulders										

NR = NO RECOVERY

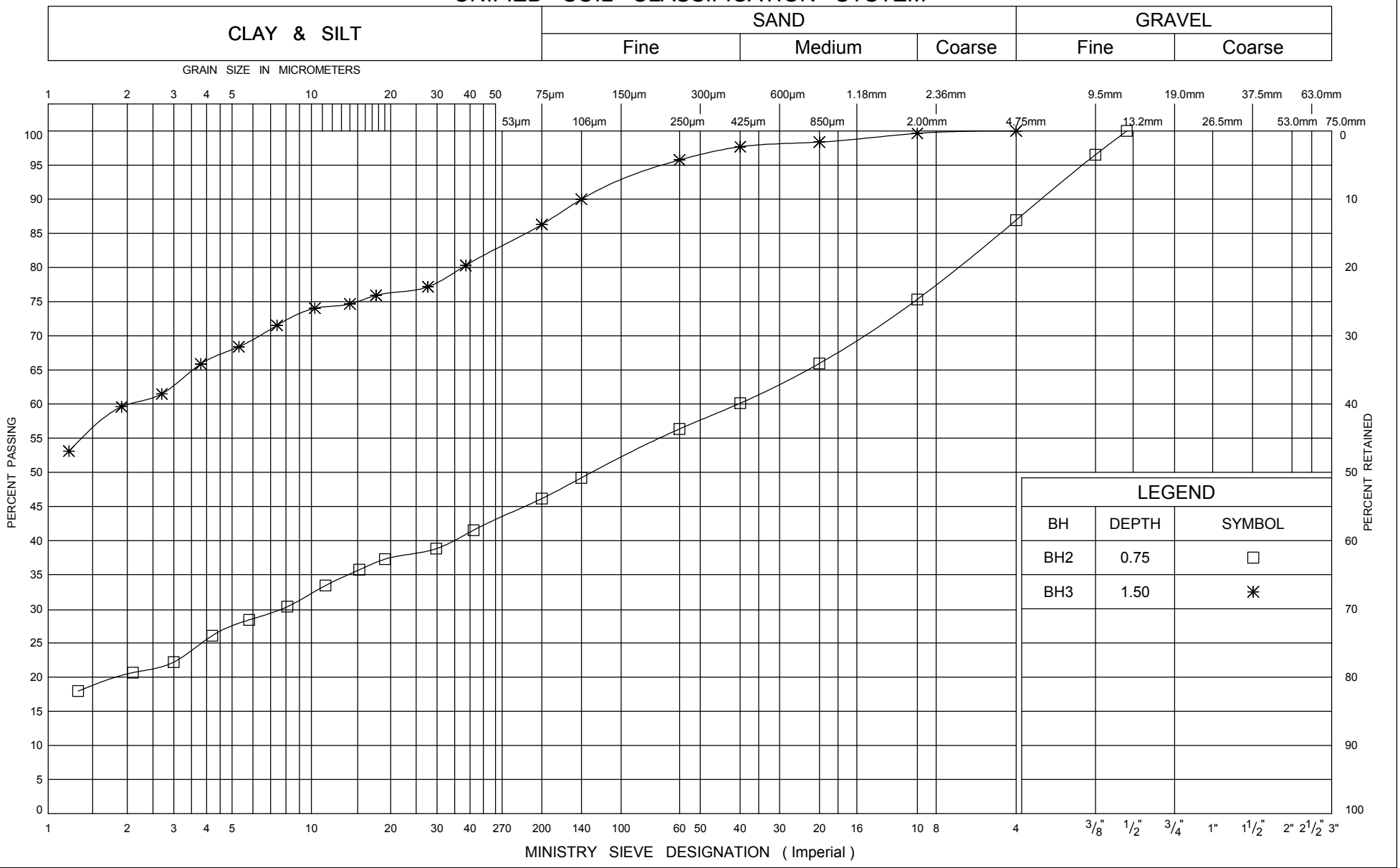
$+^3$, $\times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT_GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 6/3/14

ENCLOSURE 4

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 5/29/14

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION

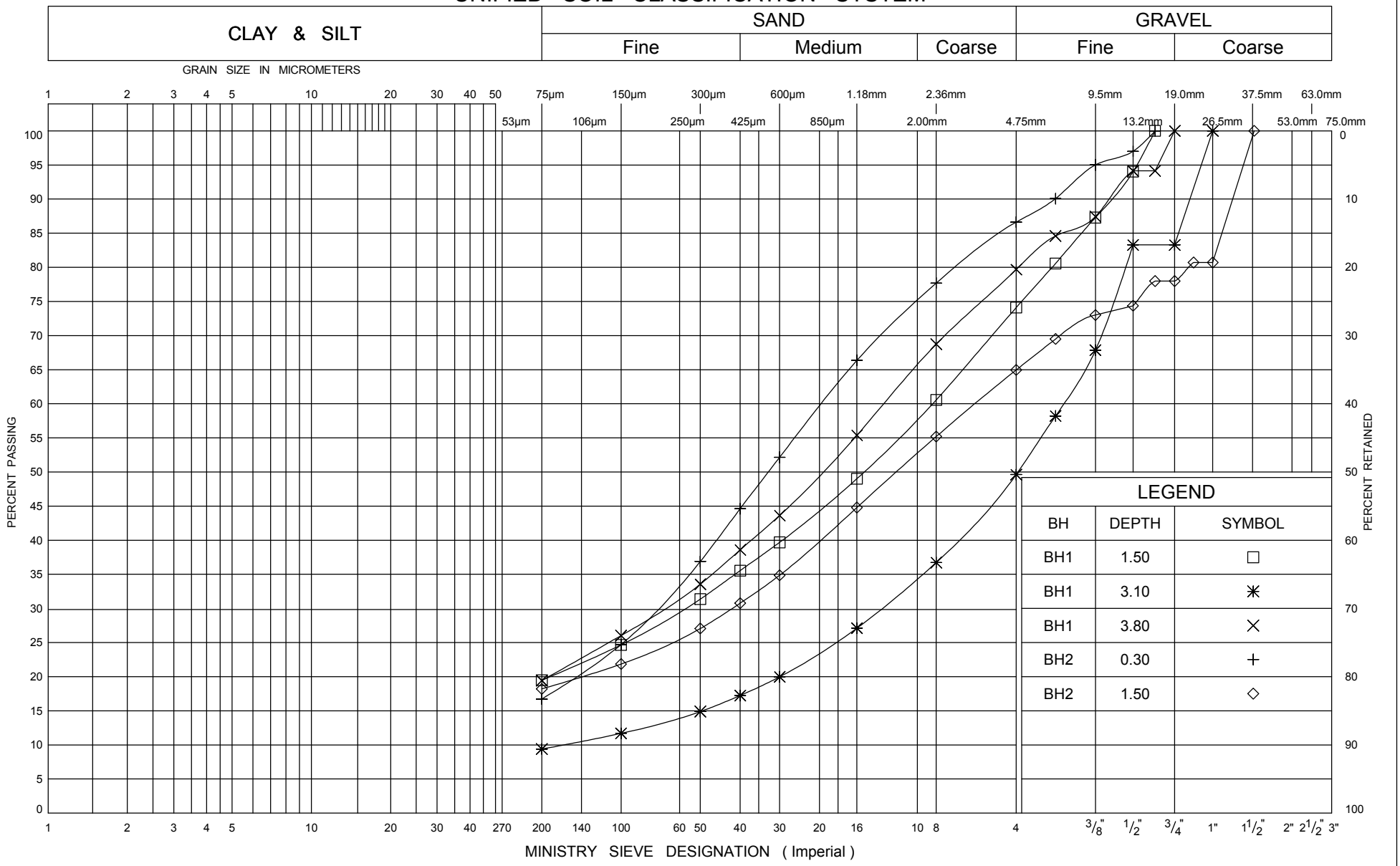
□□AY

ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 17

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION

□A□□

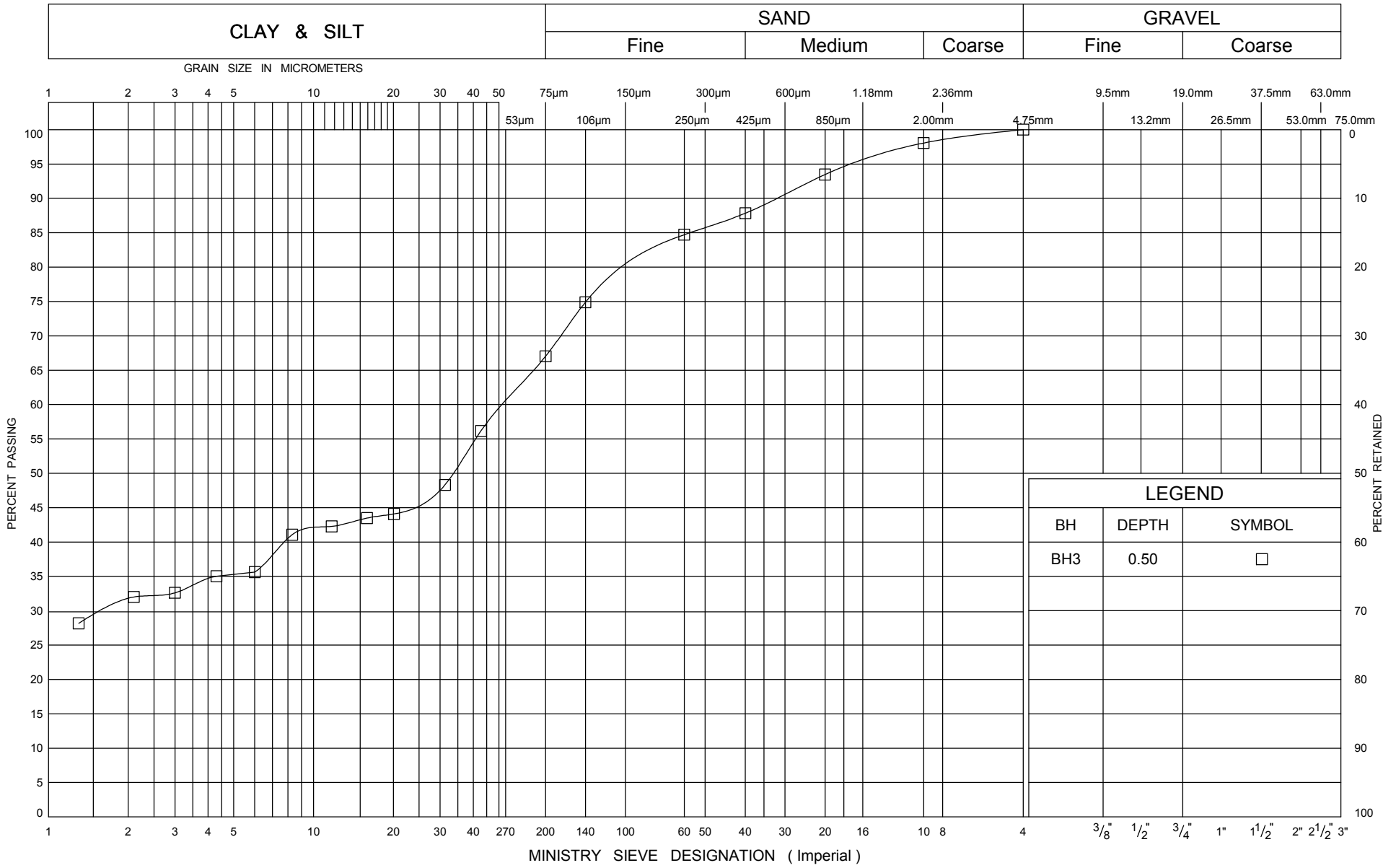
ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 17

ONTARIO MOT GRAIN SIZE GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 5/29/14

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION

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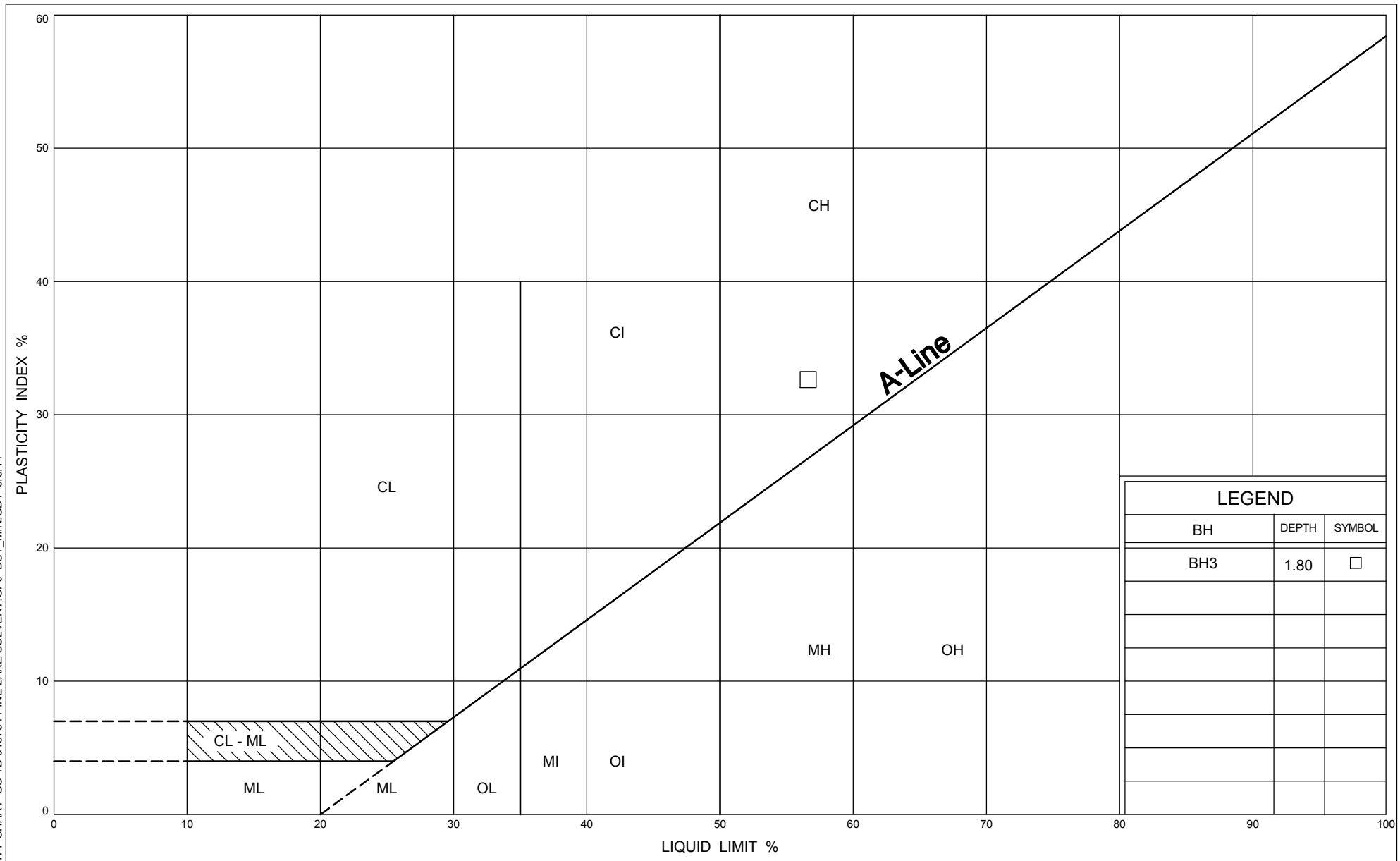
ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 17

ONTARIO MOT GRAIN SIZE GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 5/29/14



ONTARIO MOT PLASTICITY CHART GS-TB-018734 PINE LAKE CULVERT.GPJ DST_MIN.GDT 6/3/14

Ministry of
Transportation
Ontario

PLASTICITY CHART

ENCLOSURE 8

W P 6013-E-0023

HIGHWAY 17