FOUNDATION INVESTIGATION REPORT
SHEBANDOWAN CREEK TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 102
TOWNSHIP OF DAWSON ROAD LOTS, THUNDER BAY DISTRICT
AGREEMENT NO.: 6013-E-0021
ASSIGNMENT NO.: 7
SITE NO.: 48W-310/C
GWP 6019-05-00

MAY 6, 2015
GS-TB-020530

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 102. This work was carried out under Agreement No.: 6013-E-0021, Geotechnical Retainer, Assignment No. 7.

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

2. SITE DESCRIPTION

The site is located on Highway 102, approximately 0.3 km South of Highway 11/17 (latitude 48.5346, longitude -89.6450), Station 10+321, in the Township of Dawson Road Lots, in the District of Thunder Bay.

It is understood that the existing twin barrel CSP Culvert is 31.3 m long. The twin barrels have a combined total span of 4.2 m (2.1 m diameter each barrel). The existing culvert (Figure 2.3 and 2.4) was inspected by others and the report indicates there is a 0.3 m sag in both CSP barrels, moderate to severe rusting at the water level, and the east inlet is fully blocked by debris. The fill thickness above the culvert is approximately 1.0 m and the side slope of the embankment is approximately 2H:1V. The surrounding area is moderately vegetated and wooded (Figure 2.1 and 2.2). Photographs were taken by DST during the field investigations (Figures 2.1 to 2.4).

Geological information is available from published *Ontario Geological Survey Map #52ANW* by the *Ontario Ministry of Natural Resources* for the Dawson Road Lots Township area. The map indicates that the local area landform is identified as clay, clayey glaciolacustrine plain. The topography in the area is mainly moderate local relief; undulating to rolling with dry drainage conditions.

Figure 2.1 North Embankment, Highway 102 (Looking East)

Figure 2.2 South Embankment Highway 102 (Looking East)

Figure 2.3 Culvert Inlet (Looking South)

Figure 2.4 Culvert Outlet (Looking Southwest)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between March 28, 2015 and March 31, 2015 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced to depths ranging from 10.2 m to 14.0 m. The minimum number and depth of the boreholes was specified by the Ministry of Transportation (MTO).

The borehole locations and stratigraphic sections are shown on the Drawings 1 to 3. Borehole 1 was advanced east of the existing culverts at Station 10+323, 5.0 m left of centreline, and advanced to a depth of 14.0 m below existing surface. Borehole 2 was advanced west of the culverts at Station 10+315, 4.8 m right of centreline, and advanced to a depth of 14.0 m below existing surface. Borehole 3 was advanced at the inlet at Station 10+337, 11.0 m right of centreline, and advanced to a depth of 10.2 m below existing surface. Borehole 4 was advanced at the outlet at Station 10+305, 10.0 m left of centreline, and advanced to a depth of 10.2 m below existing surface.

The borehole locations are referenced to the MTO station numbering system as indicated on the drawings provided by MTO. The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to the existing culverts at Station 10+321. A nail in a telephone pole at Station 10+341, 11.0 m left on the East side of the culverts, along the north side of the highway, was assigned as temporary benchmark with an elevation of 100.0 m. 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/or bentonite chips. From the bottom of the road base, granular materials were replaced to the bottom of the asphalt and the asphalt was sealed with a cold patch.

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 forty nine (49) moisture contents, two (2) sieve analyses, eight (8) particle size analyses and ten (10) Atterberg limits have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs and in graphical plots attached Appendix D (Enclosures).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	10+323	100.7	14.0	5.0 Lt
BH2	10+315	100.7	14.0	4.8 Rt
BH3	10+337	99.1	10.2	11.0 Rt
BH4	10+305	99.2	10.2	10.0 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 a sand with gravel layer that is underlain by silty clay stratum, followed by a silt layer.

Table 4.1 Summary of soil strata at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt	0 to 0.08 0 to 0.07	100.7 to 100.6 100.7 to 100.6	
Fill - Sand	0.08 to 1.5 0.07 to 2.3	100.6 to 99.2 100.6 to 98.4	
Silty Clay	1.5 to 6.1 2.3 to 6.1	99.2 to 94.6 98.4 to 94.6	
Silt (layered)	6.1 to 14.0 6.1 to 14.0	93.1 to 86.7 93.1 to 86.7	

4.1 Asphalt

Asphaltic concrete was encountered at surface in Boreholes 1 and 2 with thickness of approximately 70 to 80 mm.

4.2 Topsoil

Topsoil was encountered at surface in Boreholes 3 and 4 with a thickness of approximately 0.2 m (Elev. 99.1 to 98.9 m) and (Elev. 99.2 m to 99.0 m) respectively.

4.3 Fill – Sand

Sand fill and gravel to with gravel and trace of silt was encountered in Boreholes 1 and 2 below the asphalt with a thickness of 1.4 m and 2.2 m at depths between 0.08 m to 1.5 m (Elev. 100.6 to 99.2 m) and depths between 0.07 to 2.3 m (Elev. 100.6 to 98.4 m) respectively. Some cobbles were found in Borehole 2 at depths between 0.7 m to 1.5 m (Elev. 100.0 m to 99.2 m) within this stratum.

SPT 'N' values vary from 36 to 75, indicating a dense to very dense condition. The moisture contents of samples tested range from 5 to 10 %. The sieve analysis results of laboratory tests are summarized in Table 4.2.

Table 4.2 Summary of sand fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	43 to 44
Sand %	45 to 55
Fines %	1 to 12

4.4 Silty Clay

Silty clay with sand to some sand and some gravel was encountered in Boreholes 1, 2, 3 and 4 at strata depths of 1.5 m to 6.1 m (Elev. 99.2 m to 94.6 m), 2.3 m to 6.1 m (Elev. 98.4 m to 94.6 m), 0.2 m to 3.8 m (Elev. 98.9 m to 95.3 m) and 0.2 m to 4.6 m (Elev. 99.0 m to 94.6 m) respectively. Some organics were encountered in Borehole 4 at depths between 0.2 m to 0.8 m (Elev. 99.0 m to 98.4 m) and some cobbles were found in Borehole 1 at depths between 1.5 m to 4.0 m (Elev. 99.2 m to 96.7 m) within this stratum.

Atterberg limits tests carried out on samples from Boreholes 1, 2, 3 and 4 indicate that the silty clay has liquid limits ranging from 72 to 85 % and plasticity indexes ranging from 22 to 52 %. This range of plasticity index values indicates a medium to highly plastic soil. The moisture content of the silty clay ranges from 29 to 100 %. Field vane tests completed in Boreholes 1, 2, 3 and 4 show results ranging from 29 kPa to 100 kPa indicating a firm to stiff consistency. The laboratory test results are summarized in the following Table 4.3.

Table 4.3 Summary of Atterberg limits- silty clay

Laboratory Results – Atterberg Limits	
Liquid Limit %	72 to 85
Plastic Limit %	26 to 38
Plastic Index %	22 to 52

4.5 Silt (Layered)

Layered silt with trace of clay to some fine sand was encountered in Boreholes 1, 2, 3 and 4 at depths of 6.1 m (Elev. 94.6 m), 6.1 m (Elev. 94.6 m), 3.8 m (Elev. 95.3 m) and 4.6 m (Elev. 94.6 m) respectively. The thickness of this stratum is not defined as borehole terminus was reached within this stratum.

Atterberg limits tests carried out on samples from Boreholes 1, 2, and 3 indicate that the layered silt has liquid limits ranging from 24 to 33 % and plasticity indexes ranging from 0 to 9 %. This range of plasticity index values indicates a low plasticity soil. The moisture content of the layered silt ranges from 16 to 39%. Field vane tests completed in Boreholes 1, 2, 3, and 4 show undrained shear strength ranging from 36 kPa to 100 kPa indicating a firm to stiff consistency. The particle size analysis and Atterberg limits test results are summarized in the following Table 4.4 and Table 4.5.

Table 4.4 Summary of silt particle size analyses

Laboratory Results – Particle Size Analysis	
Gravel %	0
Sand %	0 to 44
Silt %	50 to 94
Clay %	6 to 19

Table 4.5 Summary of Atterberg limits- silt

Laboratory Results – Atterberg Limits	
Liquid Limit %	24 to 33
Plastic Limit %	21 to 24
Plastic Index %	0 to 9

4.6 Groundwater

At the time of the field investigation groundwater was only observed in Borehole 1 at a depth of 2.9 m (Elev. 97.8 m) as summarized in Table 4.6. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4.6 Groundwater depths

Borehole #	Groundwater Depth (m)	Groundwater Elev. (m)
Borehole 1	2.9	97.8
Borehole 2	N/A	N/A
Borehole 3	N/A	N/A
Borehole 4	N/A	N/A

5. MISCELLANEOUS

Site work was carried out between March 28, 2015 and March 31, 2015 utilizing a CME 750 drill rig equipped for geotechnical drilling and operated by DST. Fieldwork was supervised on a full time basis by Peter Raynak 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.

Prepared by:

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Geotechnical Engineer

Reviewed by:

Bernardo Villegas, M.Sc
Manager

Reviewed By:

Dr. M W Bo, PhD., P. Eng, P.Geo, Int PE,
C.Geol, C. Eng, Eur Geol, Eur Eng
Senior Vice President / Senior Principal

APPENDIX 'A'

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

GEOTECHNICAL STUDIES

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 PR-D-707 88-05

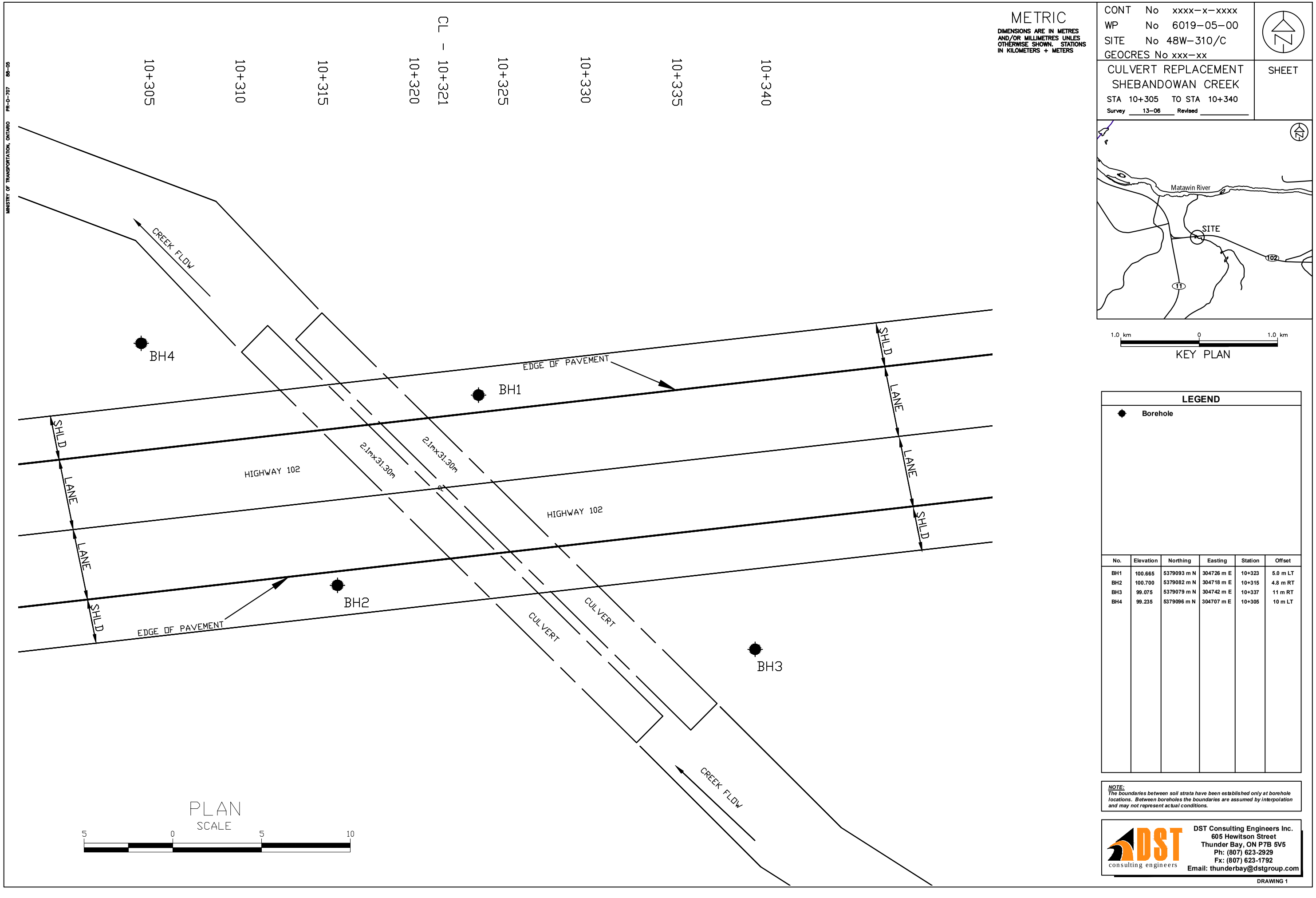
METRIC

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

CONT	No	xxxx-x-xxxx
WP	No	6019-05-00
SITE	No	48W-310/C
GEOCRES No xxx-xx		

CULVERT REPLACEMENT
SHEBANDOWAN CREEK
STA 10+305 TO STA 10+340
Survey 13-06 Revised

SHEET



PLAN
SCALE
5 0 5 10

1.0 km 0 1.0 km
KEY PLAN

LEGEND

- Borehole

No.	Elevation	Northing	Easting	Station	Offset
BH1	100.665	5379093 m N	304726 m E	10+323	5.0 m LT
BH2	100.700	5379082 m N	304718 m E	10+315	4.8 m RT
BH3	99.075	5379079 m N	304742 m E	10+337	11 m RT
BH4	99.235	5379096 m N	304707 m E	10+305	10 m LT

NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

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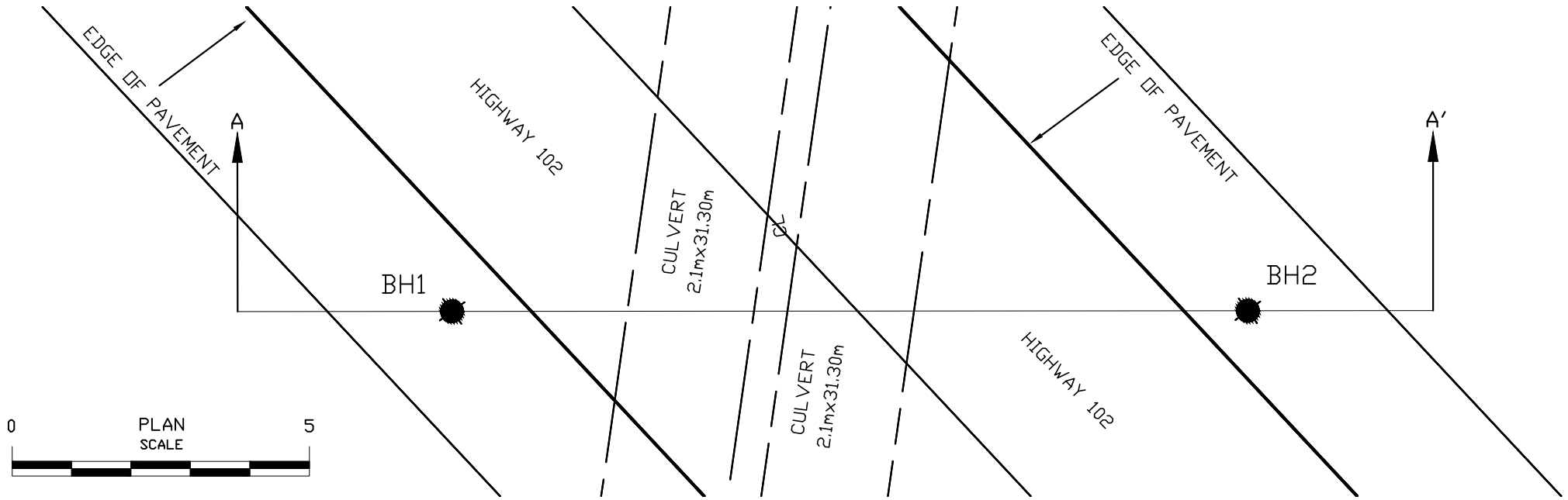
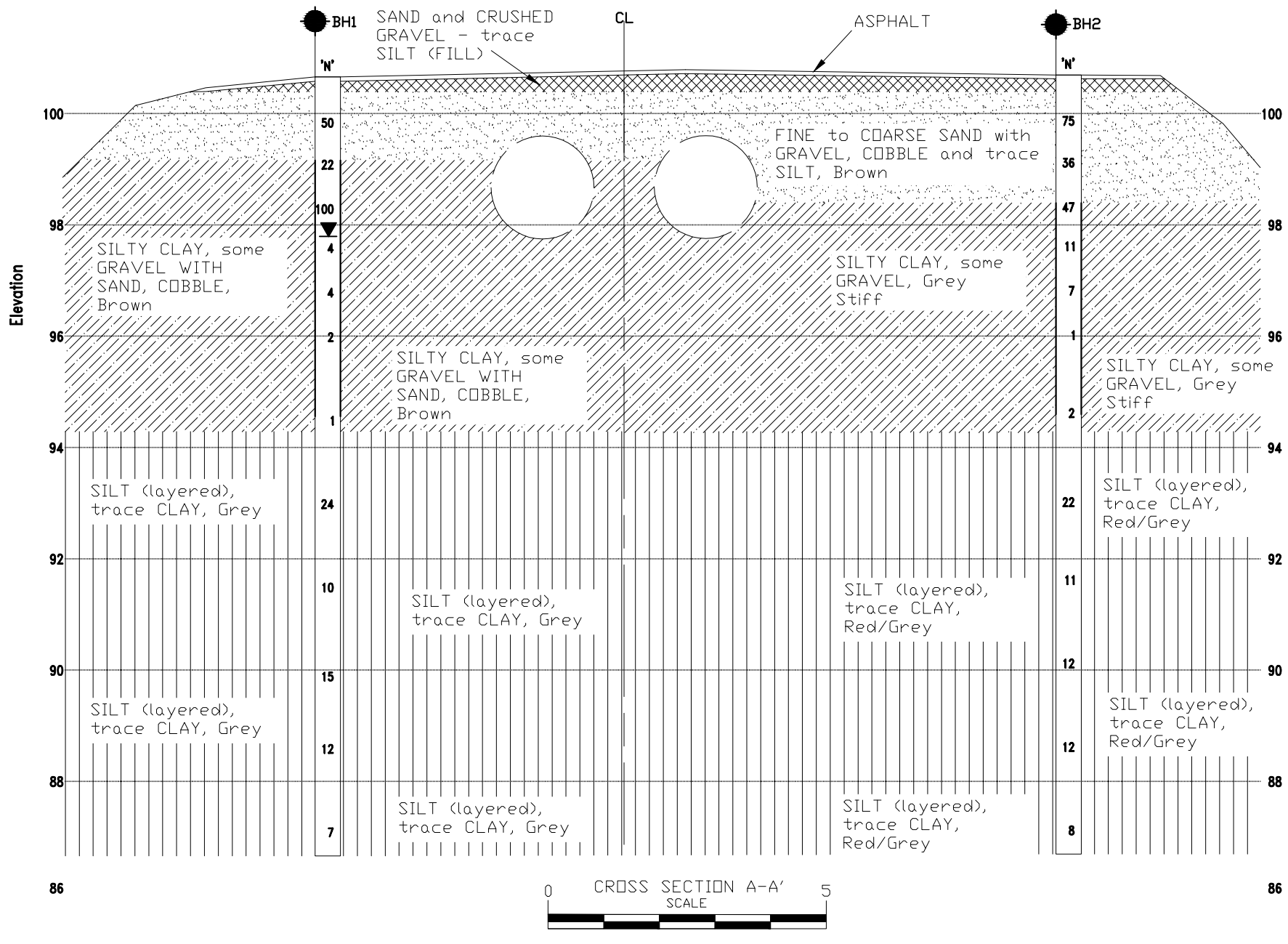
DRAWING 1

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

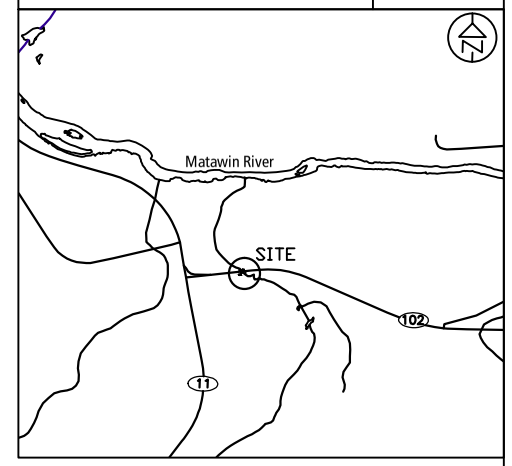




METRIC

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

CONT No xxx-x-xxxx WP No 6019-05-00 SITE No 48W-310/C GEOCRES No xxx-xx		
CULVERT REPLACEMENT SHEBANDOWAN CREEK STA 10+305 TO STA 10+340 Survey 13-06 Revised		SHEET



1.0 km 0 1.0 km

KEY PLAN

LEGEND

- Borehole
- '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	100.665	5379093 m N	304726 m E	10+323	5.0 m LT
BH2	100.700	5379082 m N	304718 m E	10+315	4.8 m RT

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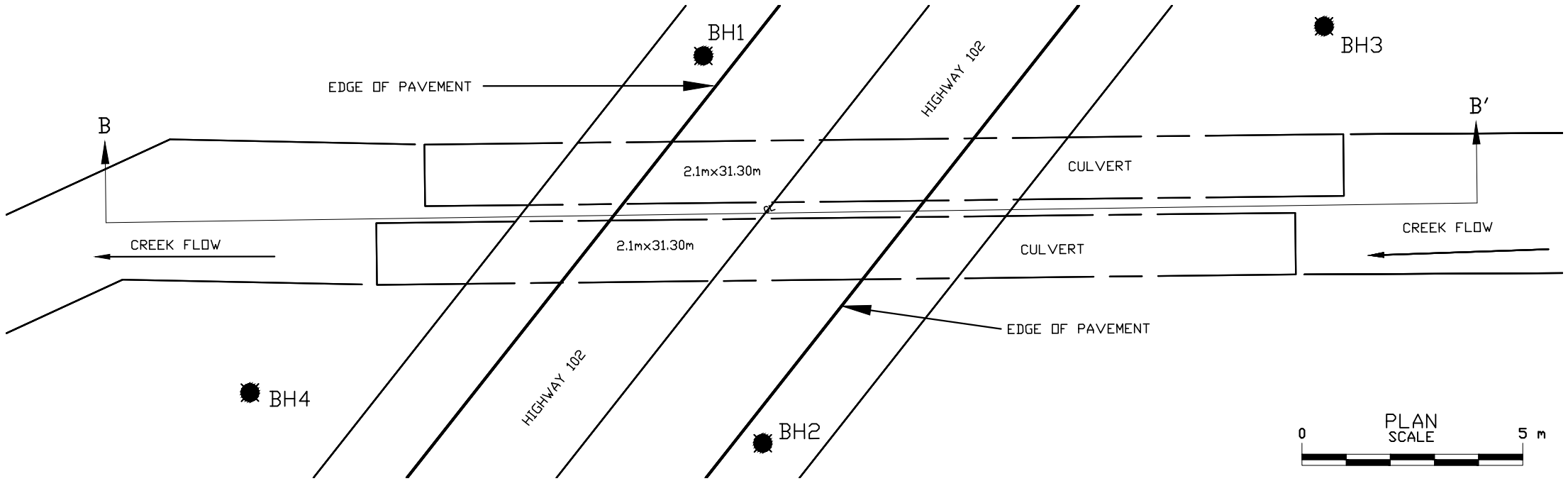
DRAWING 2

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



PLAN SCALE 0 5 m

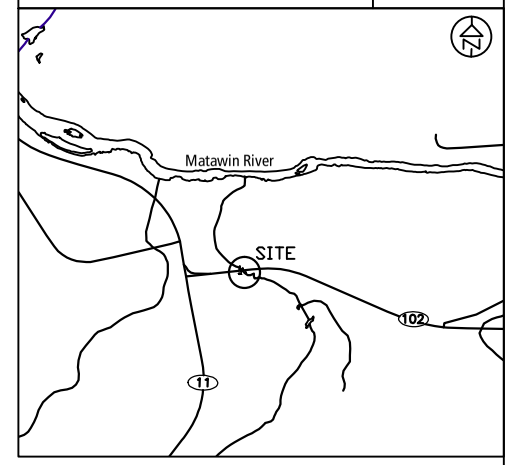
METRIC

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

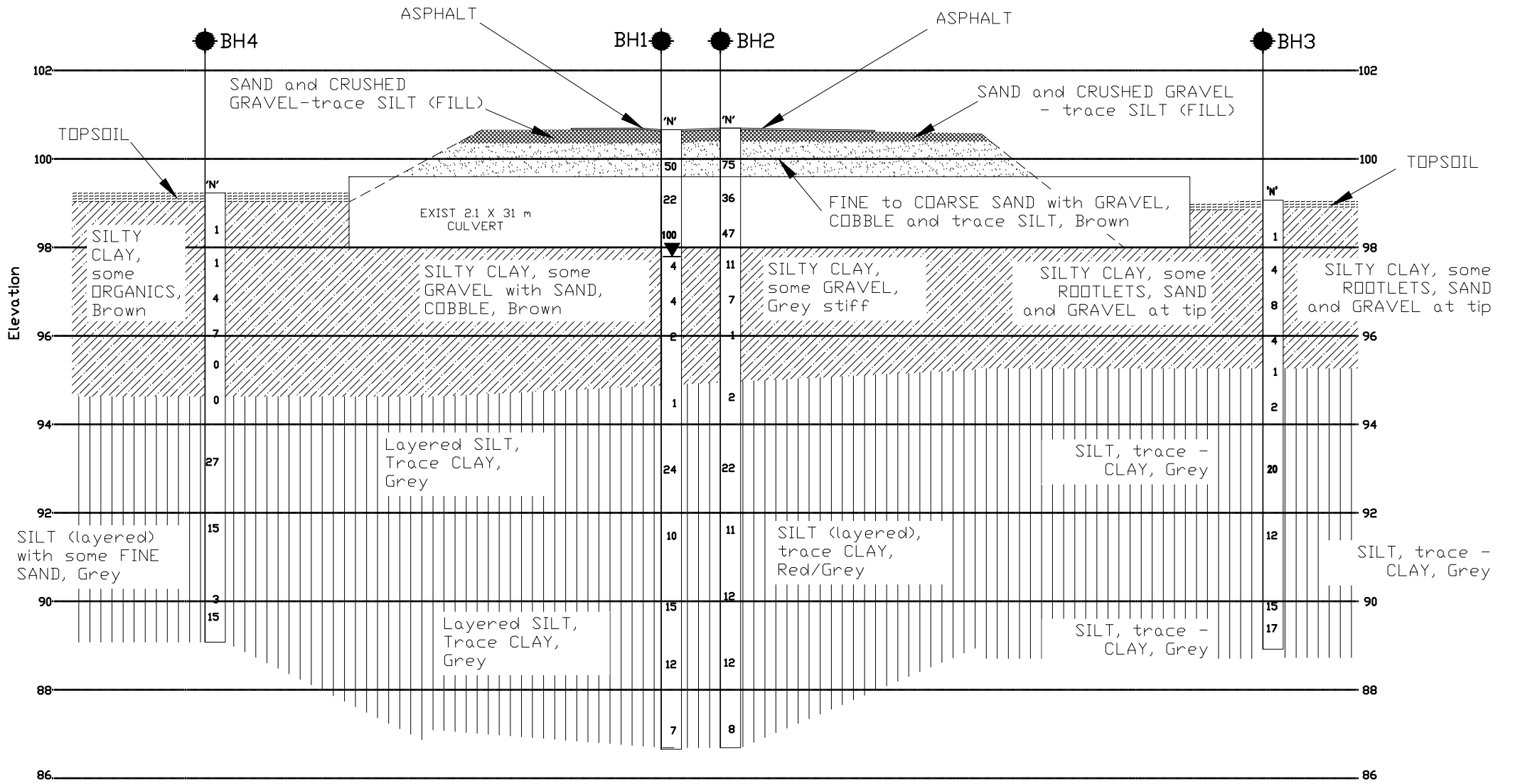
CONT No xxxx-x-xxxx
WP No 6019-05-00
SITE No 48W-310/C
GEOCRES No xxx-xx

CULVERT REPLACEMENT
SHEBANDOWAN CREEK
STA 10+305 TO STA 10+340
Survey 13-06 Revised

SHEET



1.0 km 0 1.0 km
KEY PLAN



CROSS SECTION B-B'
0 SCALE 5 m

LEGEND

- Borehole
- '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	100.665	5379093 m N	304726 m E	10+323	5.0 m LT
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NOTE:
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DRAWING 3

Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

METRIC

W.P. 6013-E-0021 LOCATION HIGHWAY 102 ORIGINATED BY MD

DIST HWY HIGHWAY 102 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY SA

DATUM LOCAL DATE 2015 03 28 - 28.3.15 CHECKED BY BV

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) (50 100 150 200 250)	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
100.7	GROUND SURFACE										
100.6	ASPHALT										
100.4 / 0.1	FILL - SAND and CRUSHED GRAVEL - trace SILT		AS1	AS							
0.3	FINE to COARSE SAND with GRAVEL, trace SILT, Brown		SS2	SS	50		100				44 55 □1□
99.2											
1.5	SILTY CLAY, some GRAVEL with SAND, COBBLE, Brown		SS3	SS	22		99				□ □9 □0 1□
			SS4	SS	100		98				
			SS5	SS	4	▽					
			SS6	SS	4		97				
			SS7	SS	2		96				
94.6							95				
6.1	Layered SILT, □race CLAY, Grey		SS8	SS	1		94				
			SS9	SS	24		93				
			SS10	SS	10		92				
			SS11	SS	15		91				
			SS12	SS	12		90				
			SS13	SS	7		89				0 0 94 6
86.7							88				
1□0							87				

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

ON_MOT-HIGH VANES GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DATA TEMPLATE.GDT 5/5/15

ENCLOSURE 1

RECORD OF BOREHOLE No BH2

METRIC

W.P. 6013-E-0021 LOCATION HIGHWAY 102 ORIGINATED BY MD

DIST HWY HIGHWAY 102 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY SA

DATUM LOCAL DATE 2015 03 30 - 30.3.15 CHECKED BY BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"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 50 100 150 200 250	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
100.7	GROUND SURFACE										
100.6 / 100.4 / 0.1	ASPHALT		AS1	SS							
0.3	FILL - SAND and CRUSHED GRAVEL - trace SILT										
	FINE to COARSE SAND with GRAVEL, COBBLE and trace SILT, Brown		SS1	SS	75		100				43 45 12
			SS3	SS	36		99				
98.4											
2.3	SILTY CLAY, some GRAVEL, Grey Stiff		SS4	SS	47		98				
			SS5	SS	11						
			SS6	SS	7		97				FEELS GRAVELLY
			SS7	SS	1		96		85		
94.6											
6.1	SILT (layered), trace CLAY, Red/Grey		SS8	SS	2		95				
			SS9	SS	22		94				0 0 1
			SS10	SS	11		93				
			SS11	SS	12		92				
			SS12	SS	12		91				
			SS13	SS	8		90				
86.7							89				0 0 90 10 SATURATED
1□0							88				
							87				

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

ON_MOT-HIGH VANES GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DATA TEMPLATE.GDT 5/5/15

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

METRIC

W.P. 6013-E-0021 LOCATION HIGHWAY 102 ORIGINATED BY MD

DIST HWY HIGHWAY 102 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY SA

DATUM LOCAL DATE 2015 03 30 - 30.3.15 CHECKED BY BV

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) (50 100 150 200 250)	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
99.1	GROUND SURFACE										
98.9	TOPSOIL										
0.2	SILTY CLAY, some ROOTLETS, SAND and GRAVEL at tip, Grey		AS1	AS							
	Red		SS2	SS	1				90		
			SS3	SS	4						
			SS4	SS	8						VANE NO GOOD (GRAVEL)
			SS5	SS	4						
95.3											
3.8	SILT, □□□ □CLAY, Grey		SS6	SS	1						
			SS7	SS	2						0 0 □0 □0
			SS8	SS	20						
			SS9	SS	12						0 0 8□ 1□
			SS10	SS	15						
			SS11	SS	17						
88.9											

ELEVATION SCALE: 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89

10□□

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

ON_MOT-HIGH VANES GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DATA TEMPLATE.GDT 5/5/15

ENCLOSURE 3

RECORD OF BOREHOLE No BH4

1 OF 2

METRIC

W.P. 6013-E-0021 LOCATION HIGHWAY 102 ORIGINATED BY MD

DIST HWY HIGHWAY 102 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY SA

DATUM LOCAL DATE 2015 03 31 - 31.3.15 CHECKED BY BV

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) (50 100 150 200 250)	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
99.2	GROUND SURFACE										
99.0	TOPSOIL										
0.2	SILTY [illegible], some SAND AND ORGANICS, Brown		AS1	AS							
	Grey		SS2	SS	1						0 1 2 33 55
	Red		SS3	SS	1						
			SS4	SS	4						
			SS5	SS	7						
			SS6	SS	0						
94.6											
4.6	SILT (layered), trace FINE SAND and [illegible], Grey		SS7	SS	0						
			SS8	SS	27						
			SS9	SS	15						0 7 81 12 SATURATED
			SS10	SS	3						
			SS11	SS	15						
89.1											
10.2											

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

ON_MOT-HIGH VANES GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DATA TEMPLATE.GDT 5/5/15

ENCLOSURE 4

Borehole	Depth	Water Content
BH1	0.3	4 %
BH1	0.8	5 %
BH1	1.5	12 %
BH1	2.3	14 %
BH1	3.1	□□ %
BH1	3.8	51 %
BH1	4.6	73 %
BH1	6.1	30 %
BH1	7.6	24 %
BH1	7.6	16 %
BH1	9.1	28 %
BH1	10.7	27 %
BH1	12.2	29 %
BH1	13.7	38 %
BH2	0.3	4 %
BH2	0.8	4 %
BH2	1.5	5 %
BH2	2.3	13 %
BH2	3.1	38 %
BH2	3.8	65 %
BH2	4.6	□□ %
BH2	6.1	37 %
BH2	7.6	23 %
BH2	9.1	29 %
BH2	10.7	33 %
BH2	12.2	24 %
BH2	13.7	□□ %
BH3	0.3	70 %
BH3	0.8	90 %
BH3	1.5	46 %
BH3	2.3	44 %
BH3	3.1	64 %
BH3	3.8	62 %
BH3	4.6	□7 %
BH3	6.1	28 %
BH3	7.6	30 %
BH3	9.1	27 %
BH3	9.7	27 %
BH4	0.3	100 %
BH4	0.8	69 %
BH4	1.5	57 %
BH4	2.3	45 %

DST consulting engineers
DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay On P7B 5V5
Telephone: 807-626-1326
Fax: 807-623-1792

Summary of Water Content

Project: 6013-E-0021

Location: Highway 102

Number: GS-TB-020530

ENCLOSURE □

Borehole	Depth	Water Content
BH4	3.1	70 %
BH4	3.8	65 %
BH4	4.6	57 %
BH4	6.1	22 %
BH4	7.6	25 %
BH4	9.1	30 %
BH4	9.7	29 %

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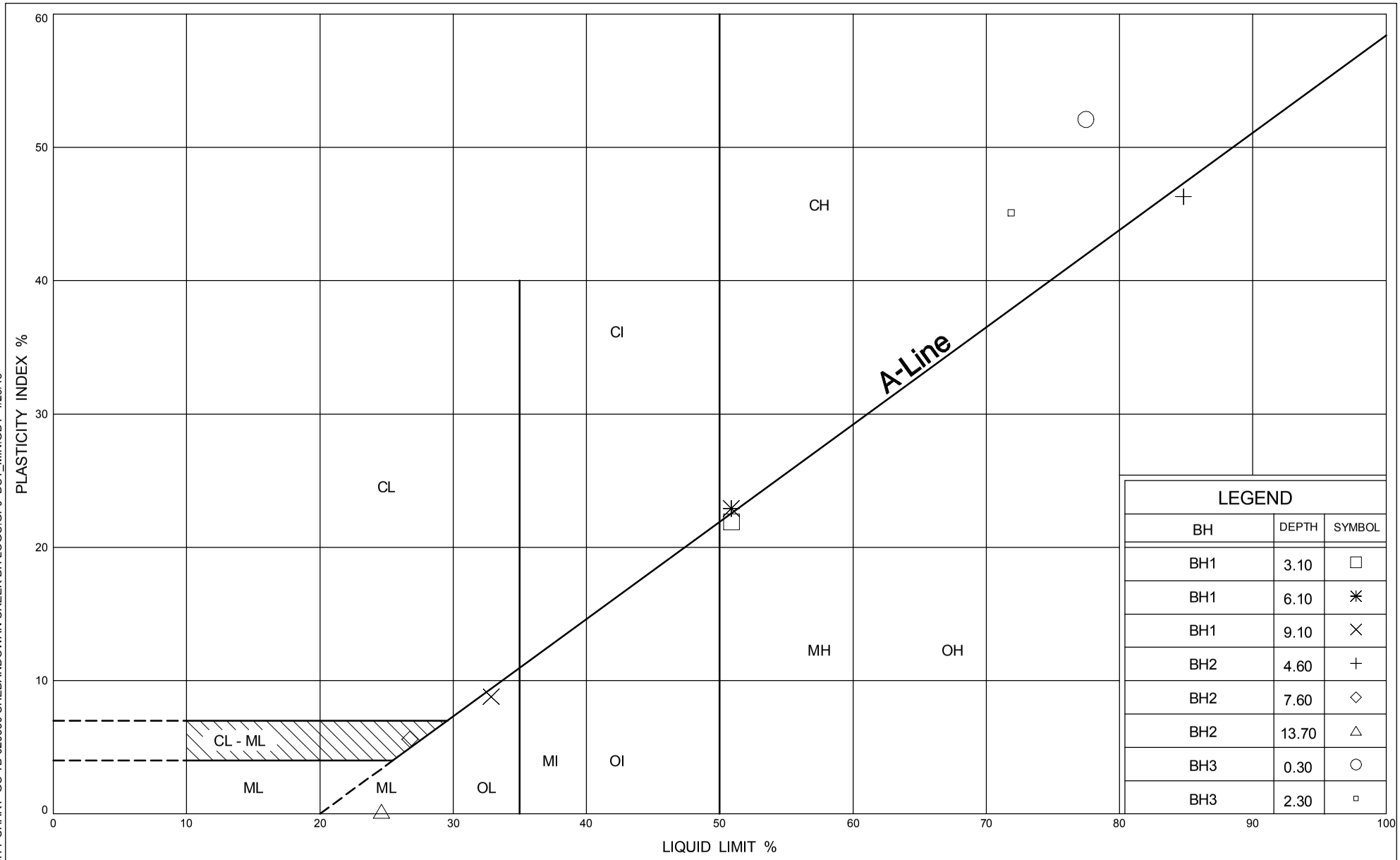
Summary of Water Content

Project: 6013-E-0021

Location: Highway 102

Number: GS-TB-020530

ENCLOSURE



LEGEND		
BH	DEPTH	SYMBOL
BH1	3.10	□
BH1	6.10	✳
BH1	9.10	×
BH2	4.60	+
BH2	7.60	◇
BH2	13.70	△
BH3	0.30	○
BH3	2.30	▫

Ministry of Transportation Ontario

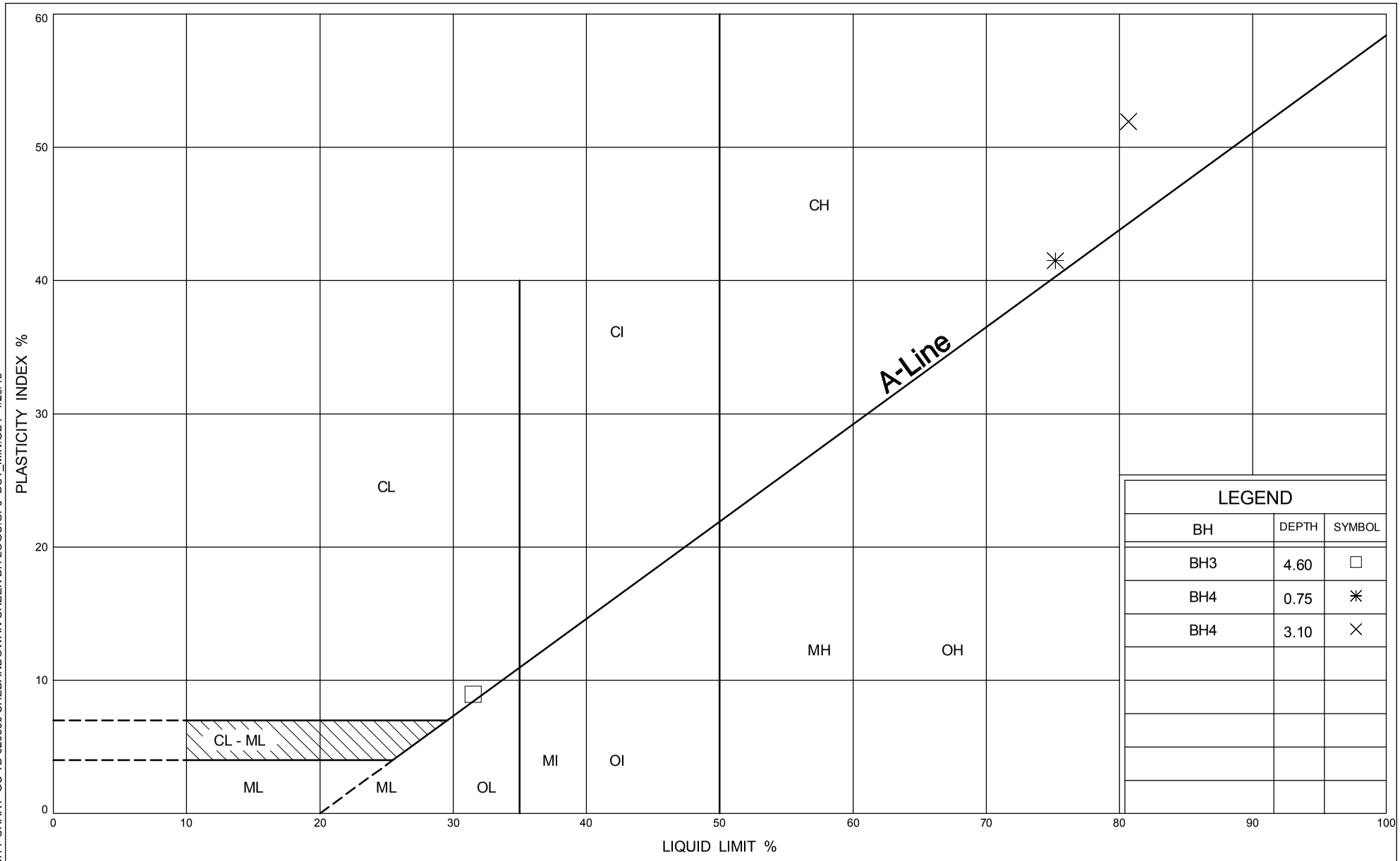
PLASTICITY CHART

ENCLOSURE □

WP 6013-E-0021

HIGHWAY 102

ONTARIO MOT PLASTICITY CHART GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DST_MIN.GDT 4/29/15



ONTARIO MOT PLASTICITY CHART GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DST_MIN.GDT 4/29/15

Ministry of Transportation Ontario

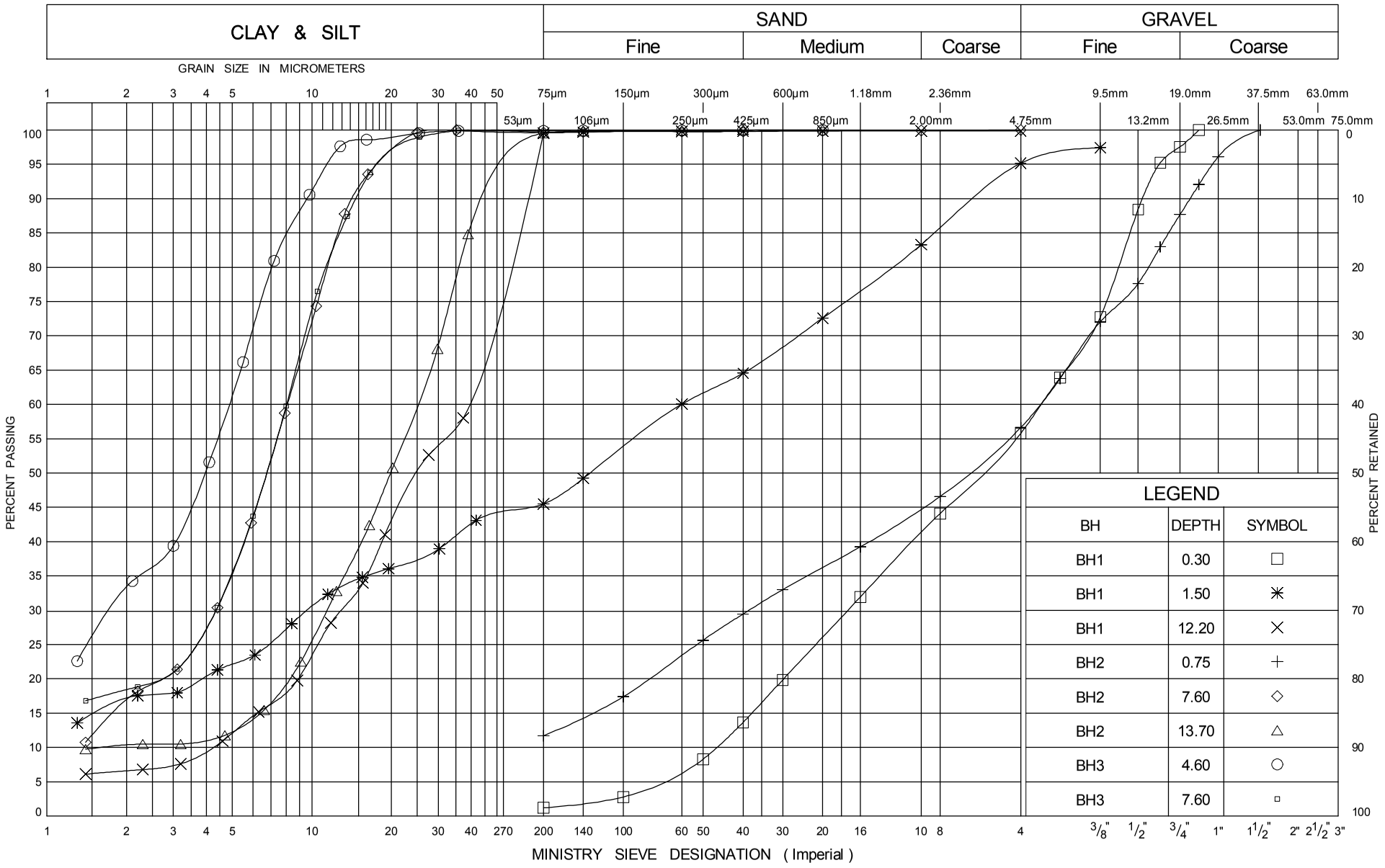
PLASTICITY CHART

ENCLOSURE

WP 6013-E-0021

HIGHWAY 102

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION

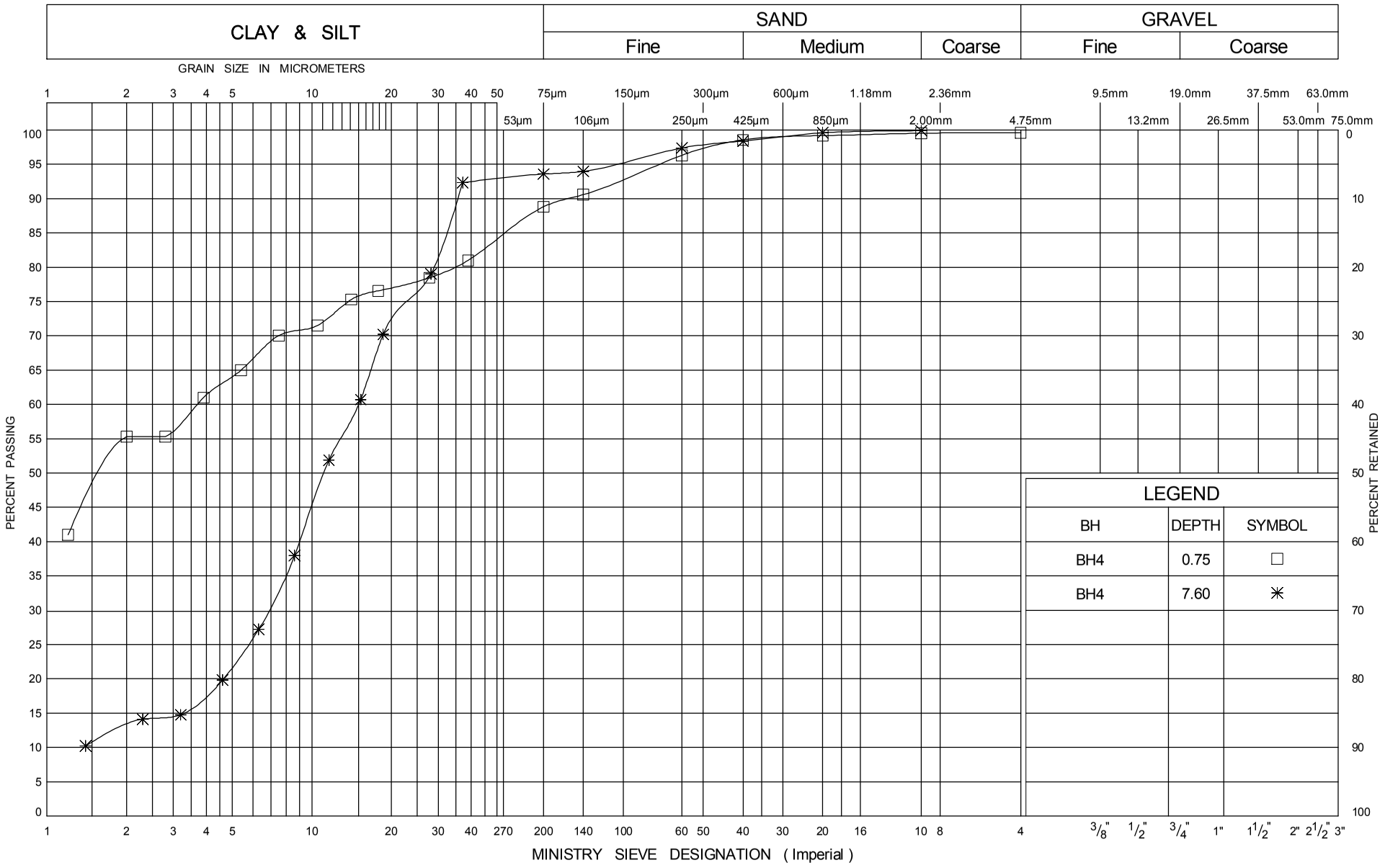
ENCLOSURE 9

WP 6013-E-0021

HIGHWAY 102

ONTARIO MOT GRAIN SIZE TEST - GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DST_MIN.GDT 5/6/15

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO MOT GRAIN SIZE TEST - GS-TB-020530 SHEBANDOWAN CREEK BH LOGS.GPJ DST_MIN.GDT 5/6/15

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION

ENCLOSURE 10

WP 6013-E-0021

HIGHWAY 102