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**FOUNDATION INVESTIGATION REPORT
SANDY CREEK CULVERT REPLACEMENT
HIGHWAY 105
UNSURVEYED TERRITORY, KENORA DISTRICT
AGREEMENT NO.: 6013-E-0023
ASSIGNMENT NO.: 7
SITE NO.: 41N-242/C
GWP 256-90-00**

**JULY 2, 2015
GS-TB-020532**

PREPARED FOR:
Ministry of Transportation
Geotechnical Section
Northwestern Region Office
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Thunder Bay, ON P7E 6P6

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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 triple culvert replacement on Highway 105. This work was carried out under Agreement No.: 6013-E-0023, 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 105 (Figure 2-1), approximately 110.0 km North of Highway 17 and Highway 105 junction (latitude 50.685, longitude -93.3002) at Station 18+280, in the unsurveyed territory, in the District of Kenora.

It is understood that the total span width of the culverts is 6.0 m (2.0 m diameter each CSP), having a length of 35.6 m and 4.0 m of fill cover. The existing culverts were inspected on February 21, 2012 and reported in Ontario Structure Inspection Manual. The report indicates the following:

- There is minor settlement and slight to moderate sag in all CSP (worse in centre),
- There is also a gap between Centre and North CSP at outlet,
- Panels pulled apart from rivets in several locations,
- Stagnant streams and waterways due to blocked culvert with debris.

Photographs were taken by DST personnel (Figures 2-1 to 2-3) during the field investigation.

Geological information is available from published *Ontario Geological Survey Map #52KNW* by the *Ontario Ministry of Natural Resources* for the culvert area. The map indicates that the local area landform is identified as glaciolacustrine plain primarily with sand, sandy material. The topography in the area is mainly low local relief; plain with mixed wet and dry drainage conditions.



Figure 2-1: Highway 105, looking West



Figure 2-2: Inlet, looking West



Figure 2-3: Outlet, looking West

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out on the week of April 12th 2015, utilizing a CME 750 all-terrain vehicle mounted drill rig, as well as hand auger, equipped for geotechnical drilling and operated by DST. A total of four boreholes were advanced to depths ranging from 0.60 m to 17.4 m. The minimum number and depths of boreholes as was specified by the Ministry of Transportation (MTO) are four (4) boreholes to 10.0 m below the native soil or auger refusal (rock coring for 3.0 m).

The borehole locations and stratigraphic section are shown on the Drawing 1 and 2 respectively. Borehole 1 was advanced East of the existing culverts at Station 18+274, 3.9 m right of centreline, and advanced to a depth of 17.4 m below existing surface. Borehole 2 was advanced West of the culverts at Station 18+281, 3.9 m left of centreline, and advanced to a depth of 17.4 m below existing surface. Borehole 3 was advanced East of the existing culvert near the outlet at Station 18+254, 11.0 m left of centreline, and advanced to a depth of 10.2 m below existing surface. Borehole 4 was advanced East of the existing culvert near the inlet at Station 18+272, 12.0 m right of centreline, and advanced to a depth of 0.6 m below existing surface with hand auger.

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 Bench Mark (Round Iron Bar) at Northing 5616490.690 and Easting 283671.858 on the drawing provided by MTO. The elevation of the BM was 352.95 m. Table 3-1 summarizes the detail of borehole locations and depths.

Table 3-1 Detail of borehole locations

Borehole ID	Station	Offset (m)	Elevation (m)	Depth (m)
BH1	18+274	3.9 Rt	351.9	17.4
BH2	18+281	3.9 Lt	351.9	17.4
BH3	18+254	11.0 Lt	347.2	10.2
BH4	18+272	12.0 Rt	347.7	0.6

All boreholes were abandoned using a 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. Field vane tests were performed when clay was encountered using appropriately sized vanes. The two types of vanes used were 'MTO' Vane (H=6.0", D=2.5") and 'B' Vane (H=4.0", D=2.0"). Each vane is tapered at both ends. The soil samples collected during drilling were visually identified in the field, placed in labelled containers and transported to DST's laboratory in Thunder Bay for further analysis.

Visual classification and index tests were subsequently performed in the laboratory on samples collected from the boreholes to aid in the selection of engineering property tests for selected samples. Laboratory tests included moisture contents, sieve analyses, particle size analyses and Atterberg limits including plastic limit and liquid limit. A total of forty (40) moisture contents, thirteen (13) sieve analyses, seventeen (17) particle size analyses and five (5) Atterberg limits tests including plastic limit and liquid limit have been carried out for this assignment. Laboratory test results are presented in the Borehole Logs and in graphical plots attached Appendix D (Enclosures).

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during power auger drilling and hand auger drilling (Borehole 4) at the borehole locations only. The generalized stratigraphy at each borehole location is described below.

4.1 Asphalt

Asphaltic concrete was encountered at surface in Boreholes 1 and 2 with thickness of approximately 100 mm (Elev. 351.9 to 351.8 m in both boreholes).

4.2 Topsoil

Topsoil was encountered at surface in Boreholes 3 and 4 with a thickness of approximately 200 mm (Elev. 347.2 to 347.0 m and Elev. 347.7 to 347.5 m respectively).

4.3 Fill - Sand

Gravelly sand to fine sand fill containing trace of silt was encountered in Boreholes 1 and 2 below the asphalt with a thickness of 6.0 m and 6.2 m at depths from 0.1 to 6.1 m (Elev. 351.8 to 345.8 m) and 0.1 to 6.3 m (Elev. 351.8 to 345.6 m) respectively.

SPT 'N' values vary from 11 to 61, indicating a compact to very dense condition. The moisture contents of samples tested range from 4 to 19 %. The sieve analysis results of laboratory tests are summarized in Table 4-1.

Table 4-1 Summary of sand fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	9 to 40
Sand %	38 to 81
Fines %	5 to 25

4.4 Sand

Fine to coarse sand with gravel, cobble and small boulder (from visual classification at the site) was encountered in Borehole 4 below the topsoil. The thickness of this layer was not identified since it

was drilled with hand auger after numerous attempts due to inaccessibility of drill rig at the site and refused at 0.6 m (Elev. 347.1 m).

4.5 Clay

Silty clay containing trace of sand was encountered in Boreholes 1, 2 and 3 below the fill sand or topsoil with a thickness of 4.9, 4.4 and 4.9 m at depths from 6.1 to 11.0 m (Elev. 345.8 to 340.9 m), 6.3 to 10.7 m (Elev. 345.6 to 341.2 m) and 0.2 to 5.1 m (Elev. 347.0 to 342.1 m) respectively.

Atterberg limits tests carried out on samples from Boreholes 1, 2 and 3 indicate that the silty clay has liquid limits ranging from 32 to 57 % and plasticity indexes ranging from 14 to 32 %. This range of plasticity index values indicates a medium to high plasticity soil. The moisture content of the silty clay ranges from 23 to 57 %. SPT 'N' values vary from 1 to 7. Field vane tests completed in Boreholes 1, 2 and 3 show results ranging from 22 kPa to 50 kPa indicating a soft to firm consistency. The particle size analysis and Atterberg limits test results are summarized in the following Table 4-2 and Table 4-3.

Table 4-2 Summary of clay particle size analyses

Laboratory Results – Particle Size Analyses	
Gravel %	0
Sand %	0 to 10
Silt %	32 to 65
Clay%	35 to 62

Table 4-3 Summary of clay Atterberg limits test

Laboratory Results – Atterberg Limits	
Liquid Limit %	32 to 57
Plastic Limit %	16 to 30
Plastic Index %	14 to 32

4.6 Silt

Silt in a form of silt some clay containing trace of sand, sandy silt, silt containing trace of sand and

clay, silt with sand containing trace of clay was encountered in Boreholes 1, 2 and 3 below the silty clay layer with a thickness of 5.8, 5.1 and 5.1 m at depths from 11.0 to 16.8 m (Elev. 340.9 to 335.1 m), 10.7 to 15.8 m (Elev. 341.2 to 336.1 m) and 5.1 to 10.2 m (Elev. 342.1 to 337.0 m) respectively.

The moisture content of the silt layer ranges from 18 to 39 %. SPT 'N' values vary from 1 to 7, indicating a very loose to loose condition. The particle size analysis results are summarized in the following Table 4-4.

Table 4-4 Summary of silt particle size analyses

Laboratory Results – Particle Size Analyses	
Gravel %	0
Sand %	0 to 29
Silt %	66 to 92
Clay%	5 to 16

4.7 Sand and Silt

Sand and silt and silty sand containing trace of clay was encountered in Boreholes 1 and 2 below the silt layer with unknown thickness as borehole terminus was reached within these stratum at depths of 16.8 m (Elev. 335.1 m) and 15.8 m (Elev. 336.1 m) respectively.

SPT 'N' values vary from 13 to 15, indicating a compact condition. The moisture contents of samples tested range from 18 to 19 %. The particle size analysis results of laboratory tests are summarized in Table 4-5.

Table 4-5 Summary of sand and silt sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	0
Sand %	47 to 59
Silt %	41 to 50
Clay %	3

The summary of soil strata for Borehole 1, 2, 3 and 4 at the culvert location are listed in Table 4-6.

Table 4-6 Summary of soil strata of Borehole 1, 2, 3 and 4 at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt	0 to 0.1	351.9 to 351.8	
	0 to 0.1	351.9 to 351.8	
	-	-	
	-	-	
Topsoil	-	-	
	-	-	
	0 to 0.2	347.2 to 347.0	
	0 to 0.2	347.7 to 347.5	
Fill - Sand	0.1 to 6.1	351.8 to 345.8	Bulk Unit Weight ($\gamma = 21 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 33$ Degrees) Moisture Content between 4% and 19%
	0.1 to 6.3	351.8 to 345.6	
	-	-	
	-	-	
Sand	-	-	Based on visual classification only
	-	-	
	-	-	
	0.2 to 0.6	347.5 to 347.1	
Clay	6.1 to 11.0	345.8 to 340.9	Bulk Unit Weight ($\gamma = 19 \text{ kN/m}^3$) Drained Friction Angle ($\phi = 20$ to 26 Degrees) Undrained Shear Strength ($C_u = 20$ to 50 kPa) Moisture Content between 23% and 57%
	6.3 to 10.7	345.6 to 341.2	
	0.2 to 5.1	347.0 to 342.1	
	-	-	
Silt	11.0 to 16.8	340.9 to 335.1	Bulk Unit Weight ($\gamma = 20 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 30$ Degrees) Moisture Content between 18% and 39%
	10.7 to 15.8	341.2 to 336.1	
	5.1 to 10.2	342.1 to 337.0	
	-	-	
Sand and Silt	16.8 to 17.4	335.1 to 334.5	Bulk Unit Weight ($\gamma = 21 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 30$ Degrees) Moisture Content between 18% and 19%
	15.8 to 17.4	336.1 to 334.5	
	-	-	
	-	-	

4.8 Groundwater

At the time of the field investigation groundwater was observed in Borehole 1, 2 and 3 at depths of 4.9 m (Elev. 347.0 m), 4.9 m (Elev. 347.0 m) and 0.3 m (Elev. 346.9 m) respectively and summarized in Table 4-7. The groundwater levels can be expected to vary with the season and precipitation events.

Table 4-7 Groundwater depths

Borehole #	Groundwater Depth (m)	Groundwater Elev. (m)
Borehole 1	4.9	347.0
Borehole 2	4.9	347.0
Borehole 3	0.3	346.9
Borehole 4	N/A	N/A

5. MISCELLANEOUS

Site work was carried out on the week of April 12th 2015, utilizing a CME 750 drill rig, as well as hand auger, 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 Syed Ahmed, EIT and reviewed by Dr. 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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Engineer in Training

Reviewed By:



Dr. ASM Masud Karim, P. Eng.
Senior Geotechnical Engineer

Reviewed By:



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

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 \bar{N} .

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 ABBREVIATIONS 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 08-06

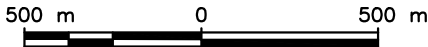
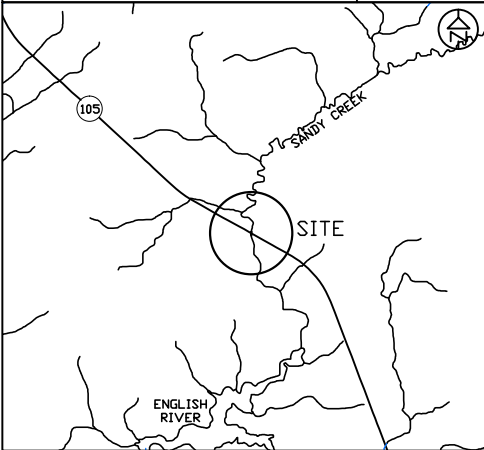
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

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



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

SHEET



KEY PLAN

LEGEND

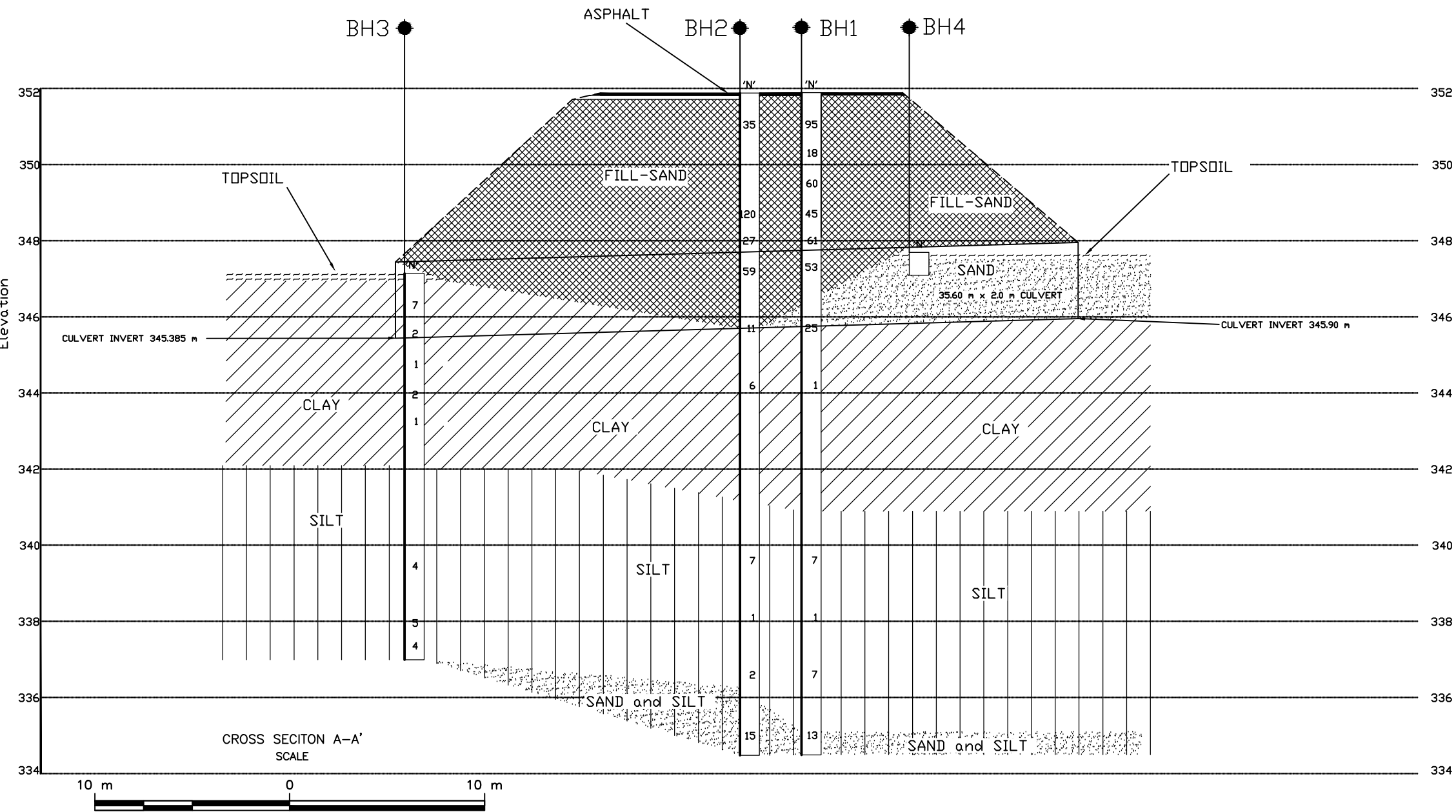
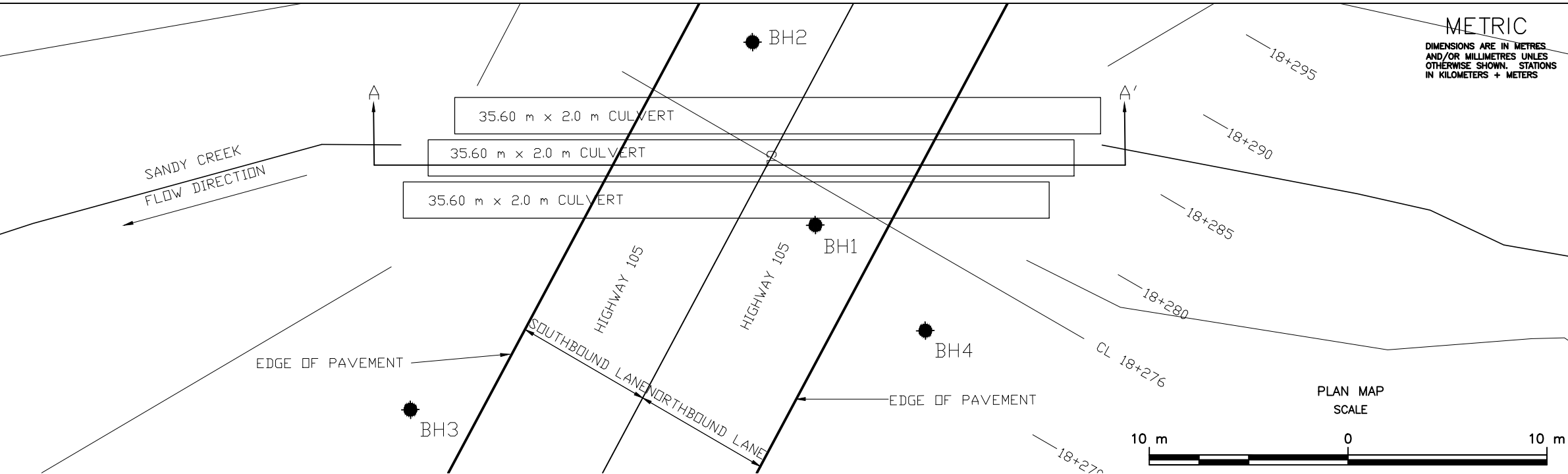
● Borehole

No.	Elevation	Northing	Easting	Station	Offset
BH1	351.90	5614838 m N	478811 m E	18+274	3.9 m RT
BH2	351.935	5614835 m N	478796 m E	18+281	3.9 m LT
BH3	351.935	5614810 m N	478818 m E	18+254	11.0 m RT
BH4	351.89	5614850 m N	478807 m E	18+272	12.0 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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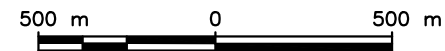
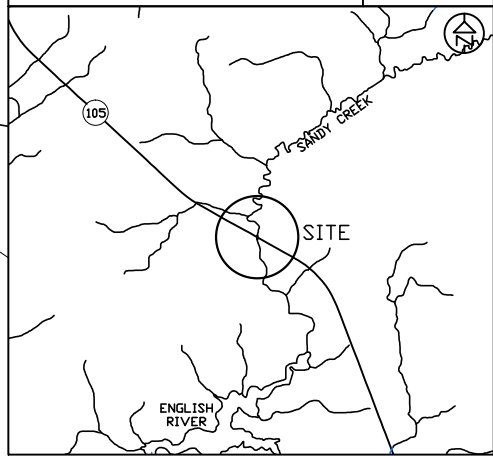


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

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



SHEET



KEY PLAN

LEGEND

- Borehole
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)



No.	Elevation	Northing	Easting	Station	Offset
BH1	351.90	5614838 m N	478811 m E	18+274	3.9 m RT
BH2	351.935	5614835 m N	478796 m E	18+281	3.9 m LT
BH3	351.935	5614810 m N	478818 m E	18+254	11.0 m RT
BH4	351.89	5614850 m N	478807 m E	18+272	12.0 m LT

NOTE:
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Appendix D
ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION STA: 18+274, RT 3.9 m: UTM Zone 15 478811 mE, 5614838 mN ORIGINATED BY PR
DIST HWY HIGHWAY 105 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 18 CHECKED BY BV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
351.9	GROUND SURFACE													
350.4	ASPHALT													
	FILL - GRAVELLY SAND, TRACE SILT, COMPACT TO VERY DENSE, BROWN		AS1	AS										34 57 (9)
			SS2	SS	95									29 63 (8) SPT on COBBLES
			SS3	SS										28 64 (8)
			SS4	SS										
			SS5	SS										29 62 (9)
348.1														12 75 (13)
3.8	FILL - SAND, TRACE TO SOME GRAVEL AND SILT, COMPACT TO VERY DENSE, BROWN TO GREY		SS6	SS	61									9 81 (10)
			SS7	SS	53									
345.8														0 52 (48)
6.1	SILTY CLAY, TRACE SAND, FIRM, GREY		SS8	SS	25									0 2 57 41
			SS9	SS	1									0 0 65 35
			SS10	SS										
			SS11	SS										0 0 90 10
340.9														0 2 83 15
11.0	SILT SOME CLAY, TRACE SAND, LOOSE, GREY													0 29 66 5
			SS12	SS	7									
338.2														0 47 50 3
13.7	SANDY SILT, TRACE CLAY, VERY LOOSE TO LOOSE, GREY		SS13	SS	1									
			SS14	SS	7									
335.1														
16.8	SAND AND SILT, TRACE CLAY, LOOSE TO COMPACT, GREY		SS15	SS	13									
334.5														
17.4	END OF BOREHOLE AT 17.4 m.													

ON LOT-HIGH VANES GS-TB-020532 6013-E-0023 SANDY CREEK CULVERT - HIGHWAY 105.GPJ DST_MIN.GDT 2/7/15

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

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION STA: 18+281, LT 3.9 m: UTM Zone 15 478796 mE, 5614835 mN ORIGINATED BY PR
DIST HWY HIGHWAY 105 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 18 CHECKED BY BV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
351.9	GROUND SURFACE													
350.8	ASPHALT FILL - GRAVELLY SAND, TRACE SILT, COMPACT TO VERY DENSE, BROWN		AS1	AS			351							38 57 (5)
			SS2	SS	35									37 38 (25) SPT on COBBLES
			SS3	SS			350							
			SS4	SS										30 63 (7)
			SS5	SS	120		349							SPT in Frozen Ground
			SS6	SS	27		348							28 65 (7)
			SS7	SS	59		347							SPT in Frozen Ground
345.6			SS8	SS	11		346							40 51 (9)
6.3	SILTY CLAY, TRACE SAND, FIRM, GREY						345							
			SS9	SS	6		344							0 10 55 35
							343							0 0 61 39
			SS10	SS			342							
341.2							341							
10.7	SILT, TRACE CLAY AND SAND, VERY LOOSE TO LOOSE, GREY		SS11	SS			340							0 0 92 8
			SS12	SS	7		339							
			SS13	SS	1		338							0 2 84 14
							337							
336.1			SS14	SS	2		336							
15.8	SILTY SAND, VERY LOOSE TO COMPACT, GREY						335							0 59 (41)
334.5			SS15	SS	15									
17.4	END OF BOREHOLE AT 17.4 m.													

ON LOT-HIGH VANES GS-TB-020532 6013-E-0023 SANDY CREEK CULVERT - HIGHWAY 105.GPJ DST_MIN.GDT 2/7/15

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

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION STA: 18+254, LT 11.0 m: UTM Zone 15 478818 mE, 5614810 mN ORIGINATED BY PR
DIST HWY HIGHWAY 105 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 18 CHECKED BY BV

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
347.2	GROUND SURFACE													
347.0	TOPSOIL													
0.2	SILTY CLAY, TRACE SAND, FIRM, BROWN TO GREY		AS1	AS			347							
			SS2	SS	7		346							
			SS3	SS	3		345							
			SS4	SS	1		344							
			SS5	SS	2		343							
			SS6	SS	1		342							
			SS7	SS			341							
342.1	SILT, TRACE CLAY AND SAND, VERY LOOSE, GREY		SS8	SS			340							
5.1			SS9	SS	4		339							
339.1	SILT WITH SAND, TRACE CLAY, VERY LOOSE TO LOOSE, GREY		SS10	SS	5		338							
8.1			SS11	SS	4		337							
337.0	END OF BOREHOLE AT 10.2 m.													
10.2														

ONL MOT-HIGH VANES GS-TB-020532 6013-E-0023 SANDY CREEK CULVERT - HIGHWAY 105.GPJ DST_MIN.GDT 2/7/15

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

RECORD OF BOREHOLE No BH4

1 OF 1

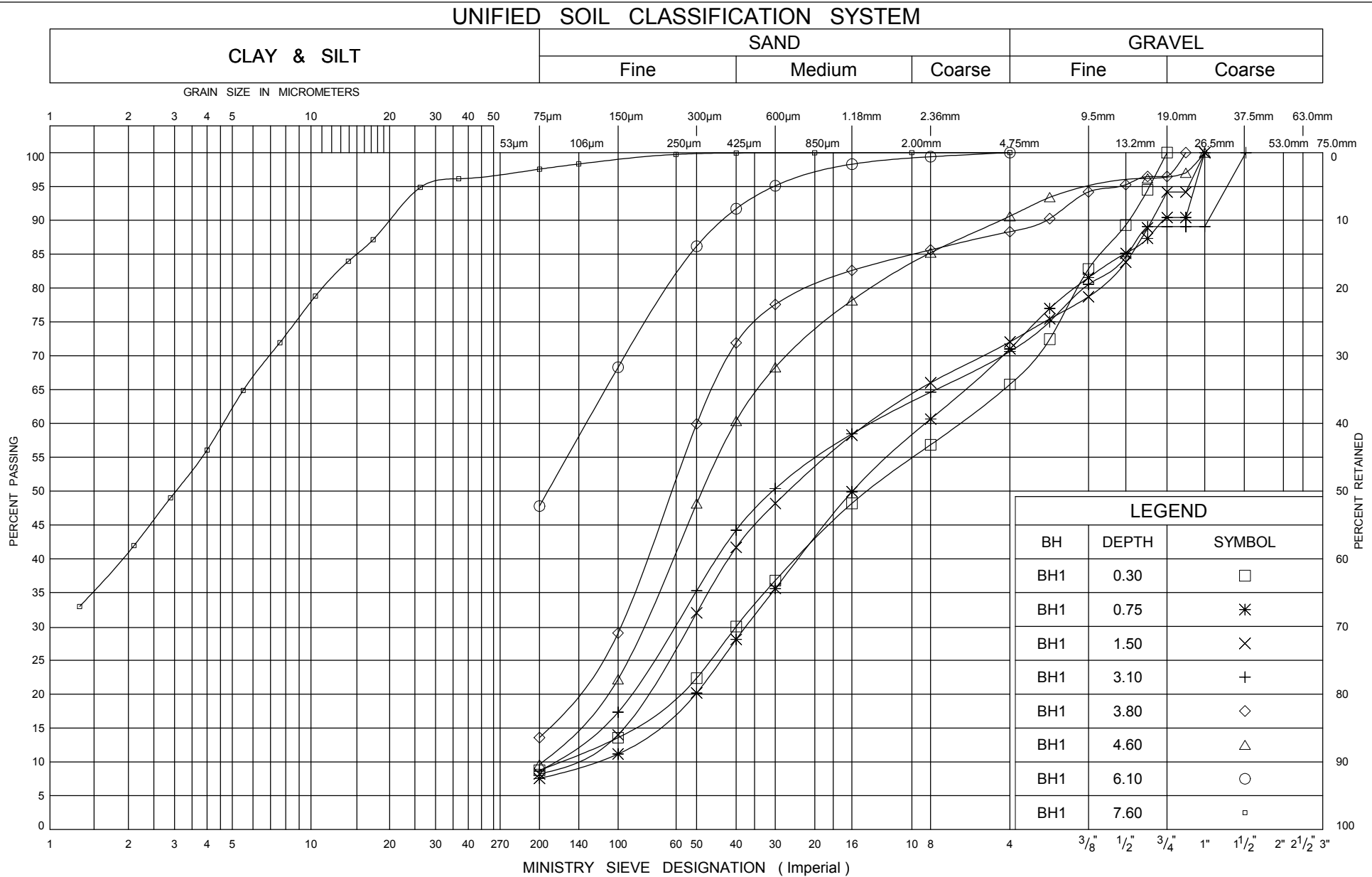
METRIC

W.P. 6013-E-0023 LOCATION STA: 18+272, RT 12.0 m: UTM Zone 15 478807 mE, 5614850 mN ORIGINATED BY PR
 DIST HWY HIGHWAY 105 BOREHOLE TYPE Hand Auger (No Access for Drill Rig) - 100 mm ID COMPILED BY MD
 DATUM LOCAL DATE 2015 04 18 CHECKED BY BV

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
						20	40	60	80	100	W _p	W	W _L			
347.7	GROUND SURFACE															
347.5	TOPSOIL															
0.2 347.1	SAND WITH GRAVEL, BROWN															
0.6	END OF BOREHOLE AT 0.6 m.															
															Numerous Attempts Taken, No Access for Drill Rig, Drill with Hand Auger	

ONL MOT-HIGH VANES GS-TB-020532 6013-E-0023 SANDY CREEK CULVERT - HIGHWAY 105.GPJ DST_MIN.GDT 2/7/15

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



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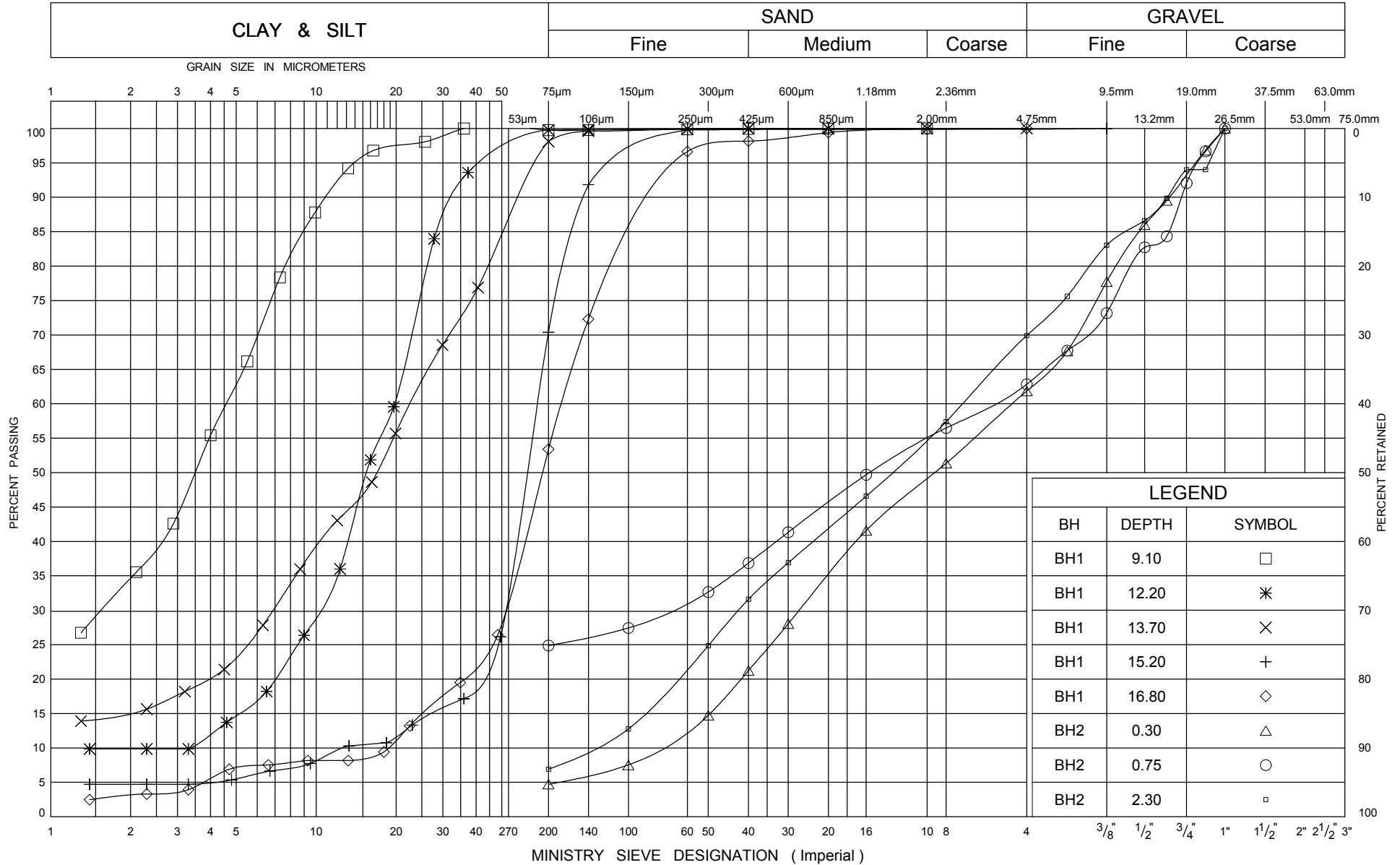
GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 105

UNIFIED SOIL CLASSIFICATION SYSTEM



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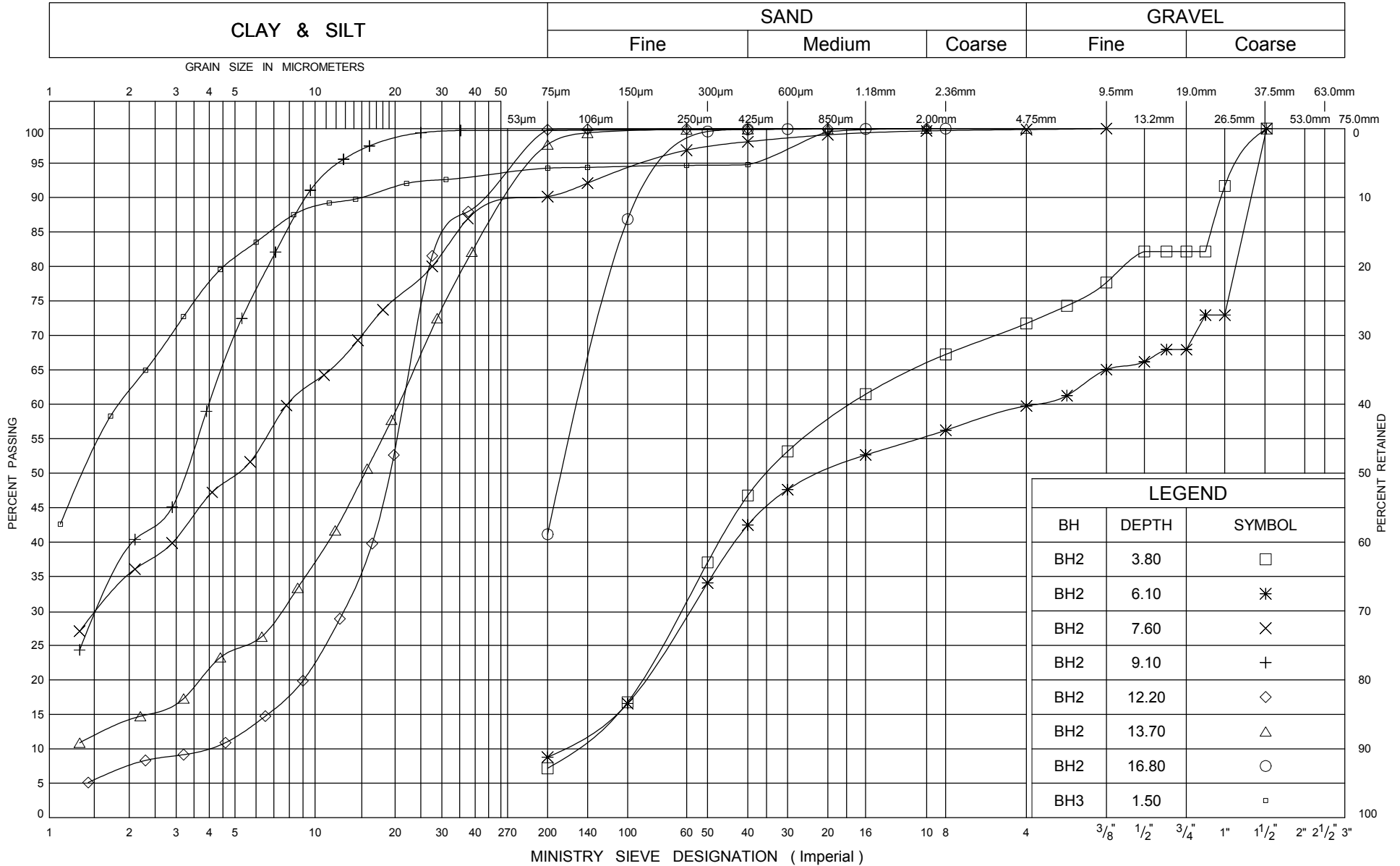
GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 2

W P 6013-E-0023

HIGHWAY 105

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

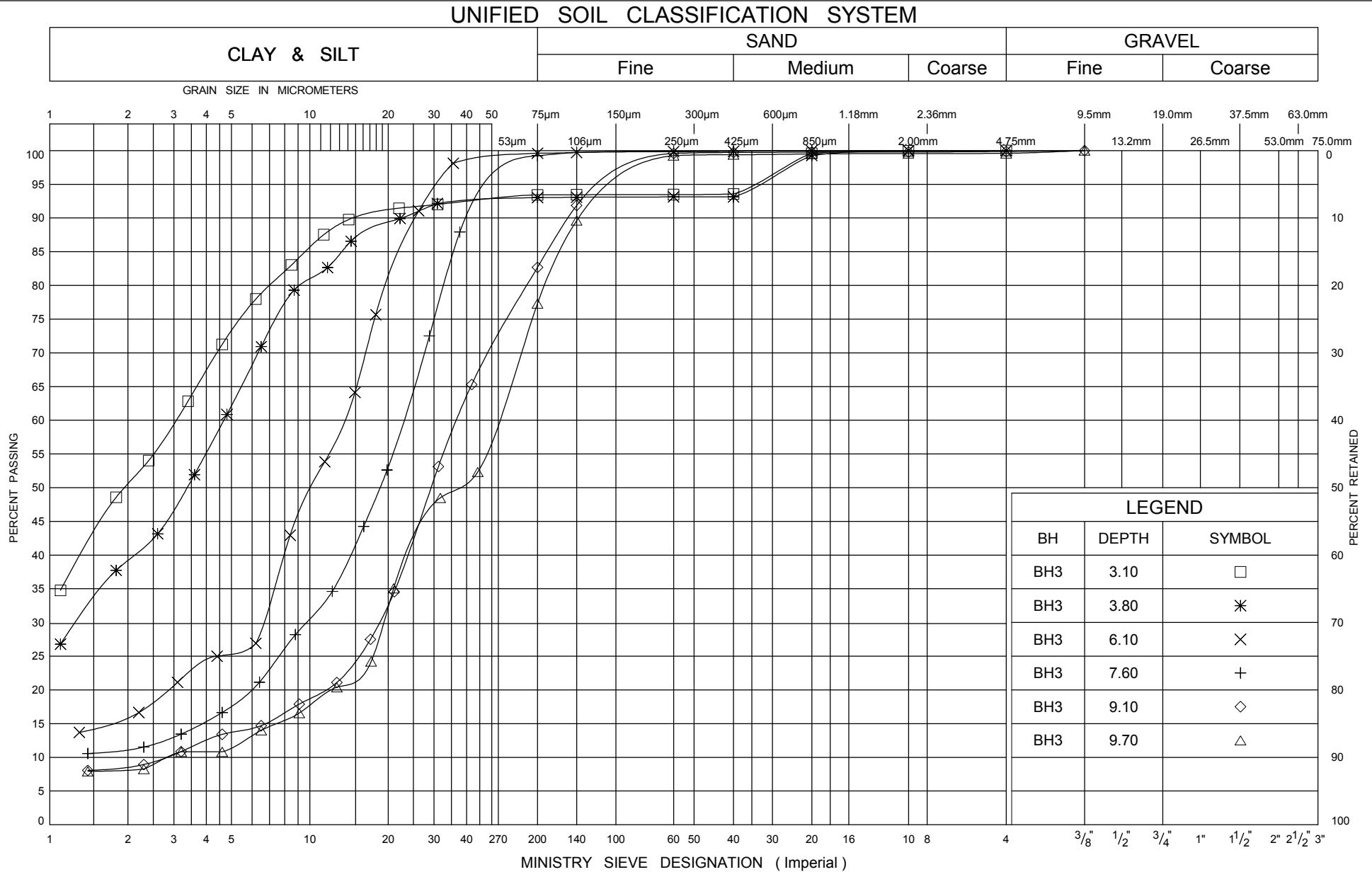
GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 3

W P 6013-E-0023

HIGHWAY 105

ONTARIO MOT GRAIN SIZE GS-TB-020532 6013-E-0023 SANDY CREEK CULVERT - HIGHWAY 105.GPJ DST_MIN.GDT 30/6/15



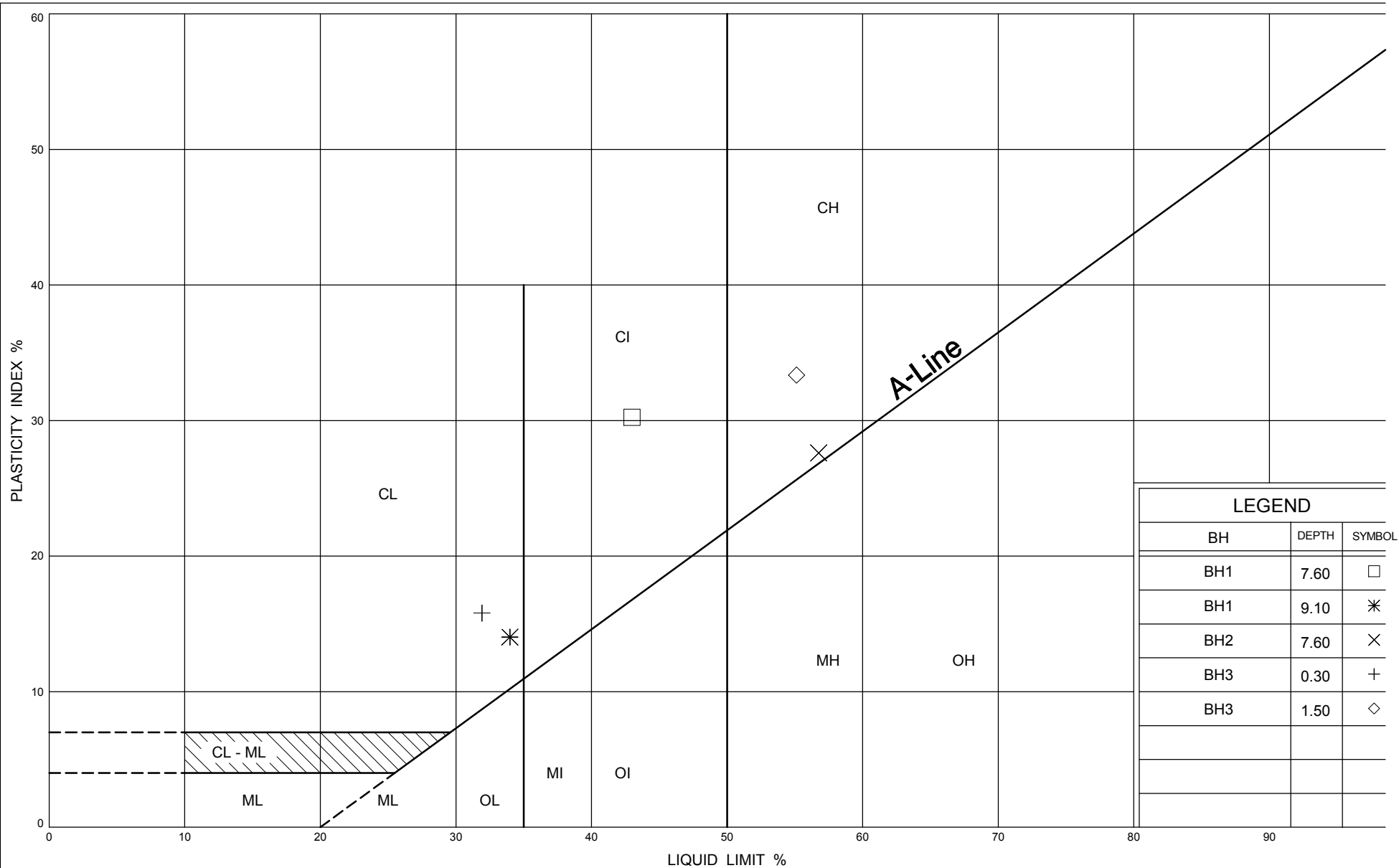
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GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 4

W P 6013-E-0023

HIGHWAY 105



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PLASTICITY CHART LOW-INTERMEDIATE-HIGH PLASTIC

ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 105