



DRAFT

**FOUNDATION INVESTIGATION REPORT
SAM LAKE TIMBER CULVERT REPLACEMENT
HIGHWAY 664
TOWNSHIP OF DRAYTON, KENORA DISTRICT
AGREEMENT NO.: 6013-E-0023
ASSIGNMENT NO.: 7
SITE NO.: 41S-257/C
GWP 30-94-00**

**JUNE 15, 2015
GS-TB-020533**

PREPARED FOR:

Ministry of Transportation
Geotechnical Section
Northwestern Region Office
615 South James Street
Thunder Bay, ON P7E 6P6

1 Copy - Ministry of Transportation, Thunder Bay, ON
2 Copies - Ministry of Transportation, Downsview, ON
2 Copies - Ministry of Transportation, St. Catharines, ON
1 Copy - DST Consulting Engineers, Thunder Bay, ON

DST CONSULTING ENGINEERS INC.
605 Hewitson Street, Thunder Bay, Ontario P7B 5V5
Phone: 1-807-623-2929 Fax: 1-807-623-1792

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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 664. 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 664 (Figure 2-1), approximately 4.7 km West of Highway 71 and Highway 664 junction (latitude 50.0781, longitude -92.0292) at Station 14+700, in the Township of Drayton, in the District of Kenora.

It is understood that the total span of the wooden culverts is 2.6 m (1.3 m each cell), having a length of 38.6 m and 4.0 m of fill cover. The existing culvert (Figure 2-2 and 2-3) was inspected on January 24, 2014 and reported in Ontario Structure Inspection Manual. The report indicates the following:

- There is a 0.2 m sag 10 m into West barrels,
- North side wall leaning to West and South side wall leaning to East,
- Timber at water level of South wall is split and
- Exterior top of culvert is weathered with minor split and decay.
- The side slope of the embankment is steep and stable.
- There is vegetation debris on both sides of the embankment.

The culvert site was snow covered at the time of the filed investigation. Photographs were taken by DST personnel (Figures 2-1 to 2-3).

Geological information is available from published *Ontario Geological Survey Map #52KSE* by the *Ontario Ministry of Natural Resources* for the Drayton Township area. The map indicates that the local area landform is identified bedrock ridge. The topography in the area is mainly high local relief; ridged with dry drainage conditions.



Figure 2-1: Highway 664, looking East



Figure 2-2: Inlet, looking South



Figure 2-3: Outlet, looking North

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Site work was carried out between April 19, 2015 and April 22, 2015 utilizing a CME 750 all-terrain vehicle mounted drill rig equipped for geotechnical drilling including bedrock coring and operated by DST. A total of four boreholes were advanced to depths ranging from 0.45 m to 8.5 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 sections are shown on the Drawings 1 to 2. Borehole 1 was advanced West of the inlet of existing culverts at Station 14+690, 21.0 m right of centreline, and advanced to a depth of 0.45 m below existing surface due to refusal on possible bedrock. Borehole 2 was advanced East of the outlet of culverts at Station 14+696, 21.0 m left of centreline, and advanced to a depth of 0.6 m below existing surface due to refusal on possible bedrock. Borehole 3 was advanced East of the existing culvert at Station 14+686, 4.1 m right of centreline, and advanced to a depth of 8.5 m below existing surface. Borehole 4 was advanced West of the existing culvert at Station 14+698, 4.4 m left of centreline, and advanced to a depth of 7.8 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 Bench Mark (TSP) between station 14+600 and 14+700 on the drawing provided by MTO. The elevation of the BM was considered as 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. Approximately 3.0 m bedrock coring was performed in case of auger refusal above the specified depth. 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.

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 and point load testing. A total of ten (10) moisture contents, nine (9) sieve analyses and seven (7) point load tests 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	Offset (m)	Elevation (m)	Depth (m)
BH1	14+690	21.0 Rt	95.90	0.45
BH2	14+696	21.0 Lt	95.20	0.60
BH3	14+686	4.1 Rt	99.80	8.50
BH4	14+698	4.4 Lt	100.20	7.80

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during power auger drilling 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 3 and 4 with thickness of approximately 100 mm.

4.2 Topsoil

Topsoil was encountered at surface in Boreholes 1 with a thickness of approximately 100 mm (Elev. 95.9 to 95.8 m).

4.3 Sand and Gravel (Road Structure)

Coarse to fine sand and gravel containing trace of silt was encountered in Boreholes 3 and 4 below the asphalt with a thickness of 1.3 m at depths between 0.10 m to 1.4 m (Elev. 99.7 to 98.4 m) and depths between 0.10 to 1.4 m (Elev. 100.1 to 98.8 m) respectively.

SPT 'N' values vary from 55 to 60, indicating a very dense condition. The moisture contents of samples tested range from 4 to 6 %. The sieve analysis results of laboratory tests are summarized in Table 4-1.

Table 4-1 Summary of sieve analyses – Sand and Gravel (Road Structure)

Laboratory Results - Sieve Analyses	
Gravel %	32 to 48
Sand %	45 to 61
Fines %	1 to 7

4.4 Rock Fill (Embankment Fill)

Possible rock fill was encountered in Boreholes 3 and 4 with a thickness of 1.7 m and 0.4 m at depths between 1.4 m to 3.1 m (Elev. 98.4 to 96.7 m) and depths between 1.4 to 1.8 m (Elev. 98.8 to 98.4 m) respectively.

4.5 Sand with Gravel

Native sand with gravel containing trace of silt and some cobbles was encountered in Boreholes 1, 2 and 3 at strata depths of 0.1 m to 0.5 m (Elev. 95.9 m to 95.4 m), 0.0 m to 0.6 m (Elev. 95.2 m to 94.6 m) and 3.1 m to 5.4 m (Elev. 96.7 m to 94.4 m) respectively.

SPT 'N' values vary from 6 to 20, indicating a loose to compact condition. The moisture contents of samples tested in Borehole 1 and 2 ranges from 21 to 22% and in Borehole 3 range from 3 to 13%. The sieve analysis results of laboratory tests are summarized in Table 4-2.

Table 4-2 Summary of sieve analyses – Sand with Gravel

Laboratory Results – Sieve Analyses	
Gravel %	15 to 28
Sand %	64 to 78
Fines %	6 to 8

4.6 Sand and Gravel

Native sand and gravel containing trace of silt was encountered in Boreholes 4 at strata depths of 1.8 m to 4.4 m (Elev. 98.4 m to 95.8 m).

SPT 'N' values vary from 7 to 24, indicating a loose to compact condition. The moisture content of samples tested to be 13%. The sieve analysis results of laboratory tests are summarized in Table 4-3.

Table 4-3 Summary of sieve analyses – Sand and Gravel

Laboratory Results – Sieve Analyses	
Gravel %	50
Sand %	46
Fines %	4

4.7 Bedrock

Bedrock was encountered in Boreholes 3 and 4 at depths of 5.4 m to 8.4 m (Elev. 94.4 m to 91.4 m) and 4.4 m to 7.5 m (Elev. 95.8 m to 92.7 m) respectively. In both cases Total Core Recovery (TCR) and Solid Core Recovery (SCR) ranges from 88 to 100%. Rock Quality Designation (RQD) was

found 53 to 75% for total 3.0 m of core run for Borehole 3 and 62 to 96% for total 3.0 m of core run for Borehole 4 indicating Fair to Excellent Rock. The type of Bedrock is Limestone and grey in colour.

The summary of soil strata for Borehole 1 and 2 and Borehole 3 and 4 are listed in Table 4-4 and 4-5 respectively.

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

Layer	Depth (m)	Elevation (m)	Comments
Topsoil	0 to 0.1 -	95.9 to 95.8 -	
Sand with Gravel	0.1 to 0.5 0.0 to 0.6	95.8 to 95.4 95.2 to 94.6	

Table 4-5 Summary of soil strata of Borehole 3 and 4 at the culvert location

Layer	Depth (m)	Elevation (m)	Comments
Asphalt	0 to 0.1 0 to 0.1	99.8 to 99.7 100.2 to 100.1	
Sand and Gravel (Road Structure)	0.1 to 1.4 0.1 to 1.4	99.7 to 98.4 100.1 to 98.8	Unit Weight ($\gamma = 22 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 40$ Degrees) Moisture Content between 4% to 6%
Rock Fill (Embankment Fill)	1.4 to 3.1 1.4 to 1.8	98.4 to 96.7 98.8 to 98.4	No Recovery of Sample
Sand with Gravel	3.1 to 5.4 -	96.7 to 94.4 -	Unit Weight ($\gamma = 21 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 30$ Degrees) Moisture Content between 3% to 12%
Sand and Gravel	- 2.3 to 4.4	- 94.4 to 95.8	Unit Weight ($\gamma = 22 \text{ kN/m}^3$) Internal Friction Angle ($\phi = 30$ Degrees) Moisture Content approximately 13%
Bedrock – Limestone	5.4 to 8.4 4.4 to 7.5	94.4 to 91.4 95.8 to 92.7	RQD* = 53 to 75%, UCS# = 68 to 171 MPa RQD* = 62 to 96%, UCS# = 150 to 162 MPa

#UCS= Unconfined Compressive Strength derived from Point Load Test

*RQD=Rock Quality Designation

4.8 Groundwater

At the time of the field investigation groundwater was only observed in Borehole 1 and Borehole 2 at a depth of 0.0 m (Elev. 95.9 m) and 0.3 m (Elev. 94.9 m) respectively 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	0.0	95.9
Borehole 2	0.3	94.9
Borehole 3	N/A	N/A
Borehole 4	N/A	N/A

5. MISCELLANEOUS

Site work was carried out between April 19, 2015 and April 22, 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 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.

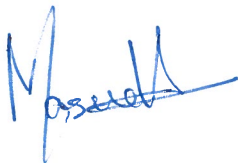
For DST Consulting Engineers Inc.

Prepared By:



Syed Ahmed, M.Sc.
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 'A'
LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

GEOTECHNICAL STUDIES

The data, conclusions and recommendations which are presented in this report, and the quality thereof, are based on a scope of work authorized by the Client. Note that no scope of work, no matter how exhaustive, can identify all conditions below ground. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. Conditions can also change with time. It is recommended practice that DST Consulting Engineers be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavation, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs, e.g. the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

Any results from an analytical laboratory or other subcontractor reported herein have been carried out by others, and DST Consulting Engineers Inc. cannot warranty their accuracy. Similarly, DST cannot warranty the accuracy of information supplied by the client.

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

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

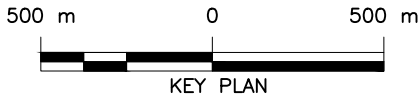
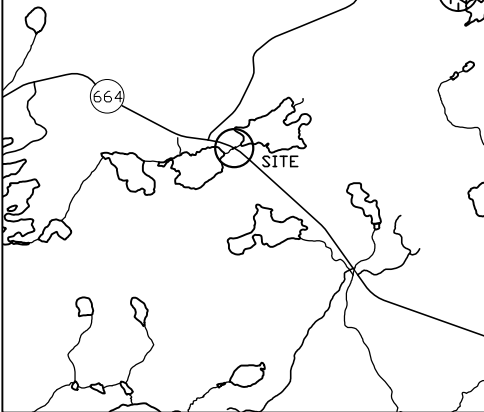
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WP No 6019-05-00
SITE No 48W-310/C
GEOCRES No xxx-xx



CULVERT REPLACEMENT
SAM LAKE TIMBER

SHEET

Survey 13-06 Revised



LEGEND

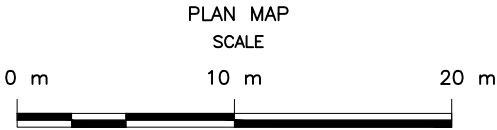
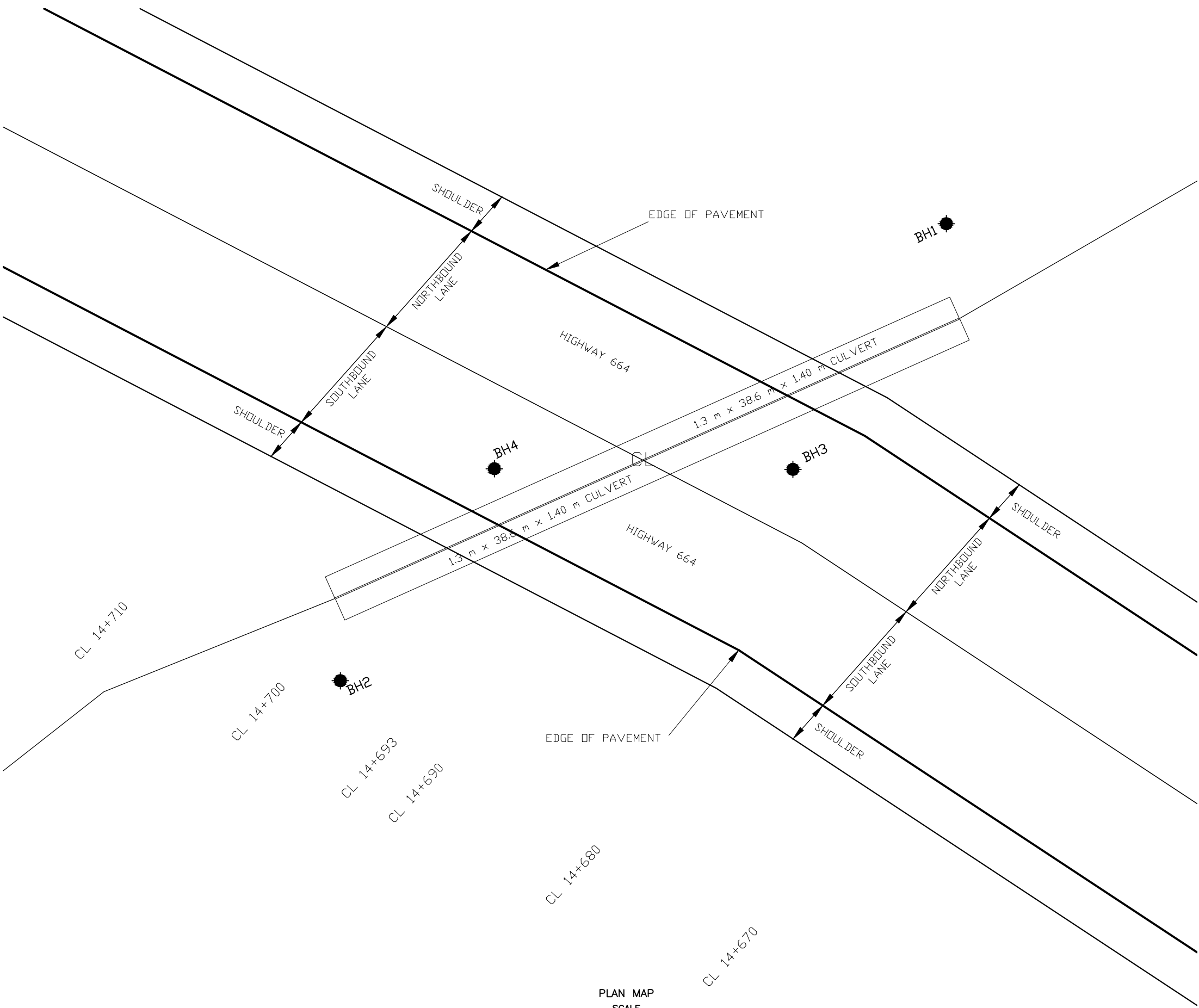
● Borehole

No.	Elevation	Northing	Easting	Station	Offset
BH1	95.89	5547779 m N	569479 m E	14+690	21.0 m RT
BH2	95.24	5547762 m N	569451 m E	14+696	21.0 m LT
BH3	99.79	5547766 m N	569473 m E	14+686	4.1 m RT
BH4	100.21	5547767 m N	569460 m E	14+698	4.4 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.



DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com



METRIC

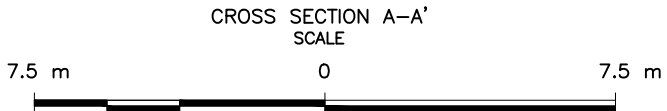
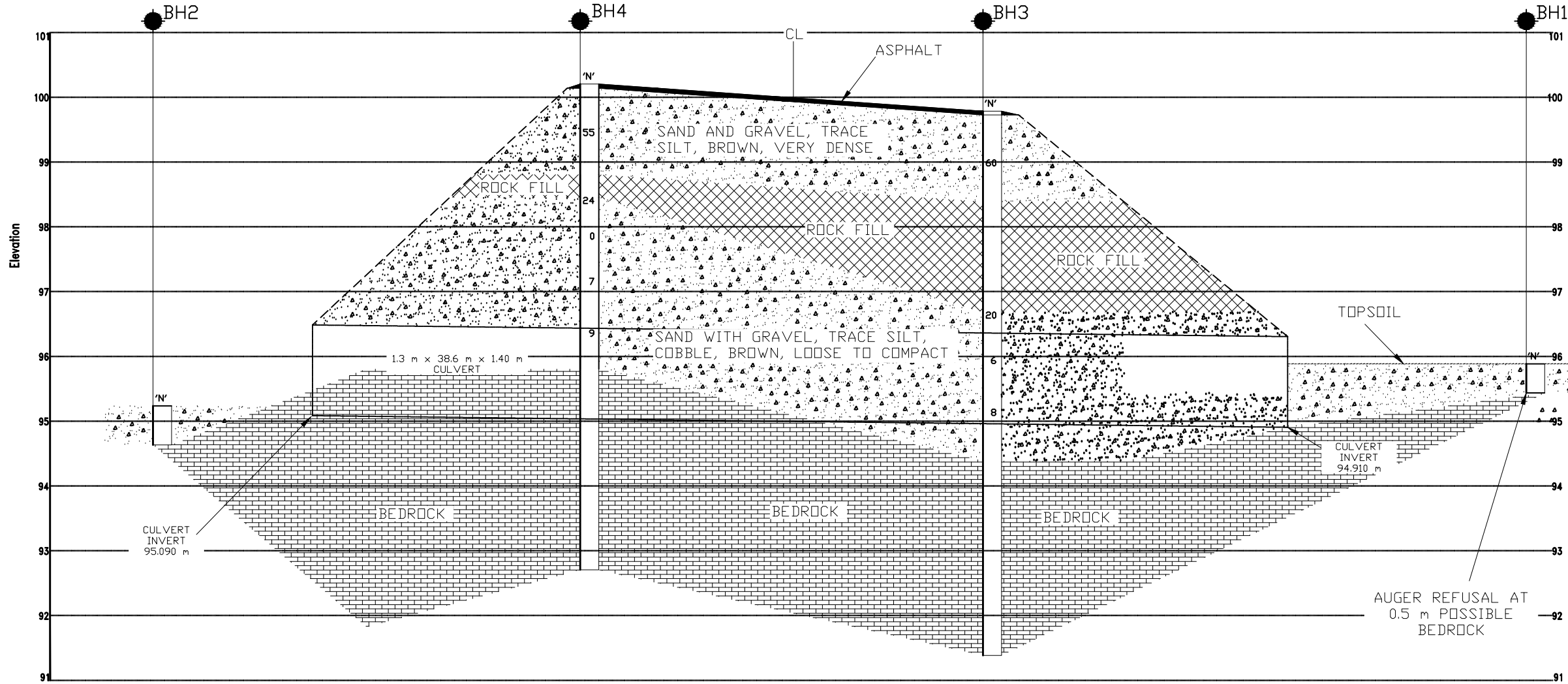
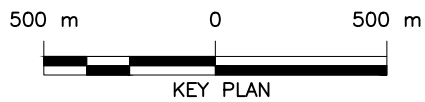
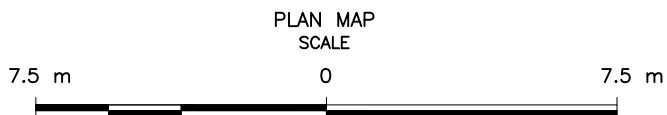
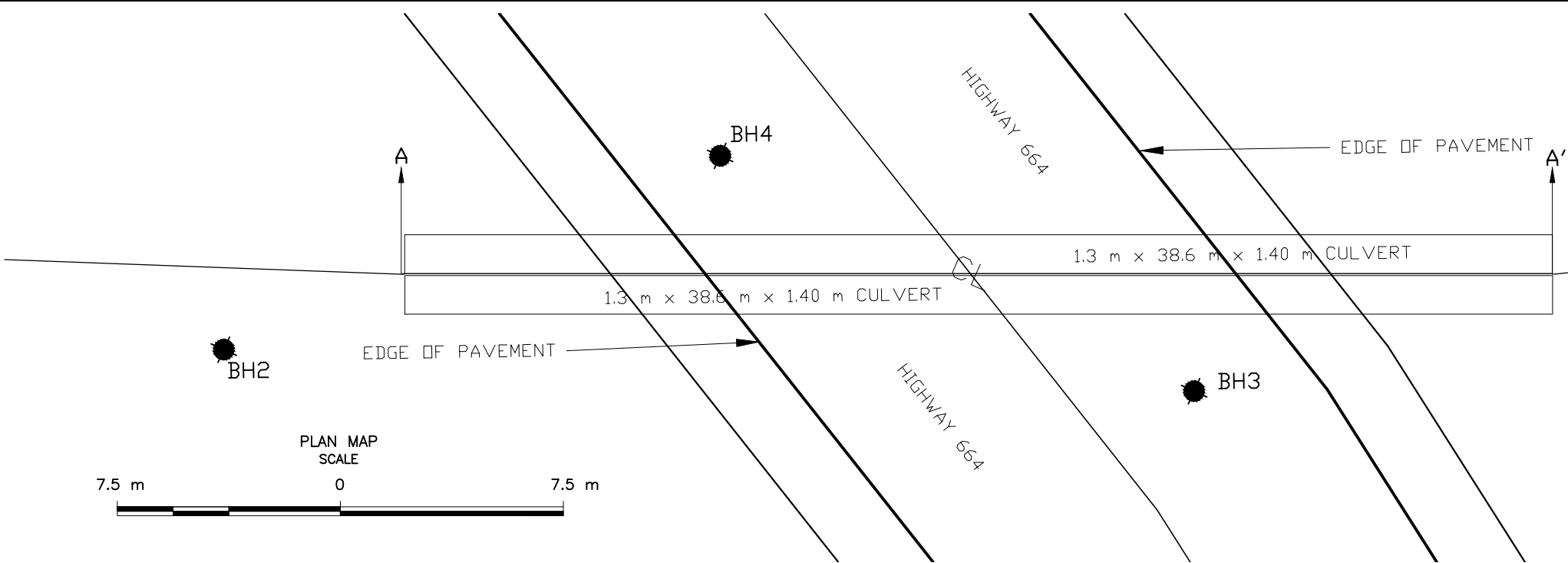
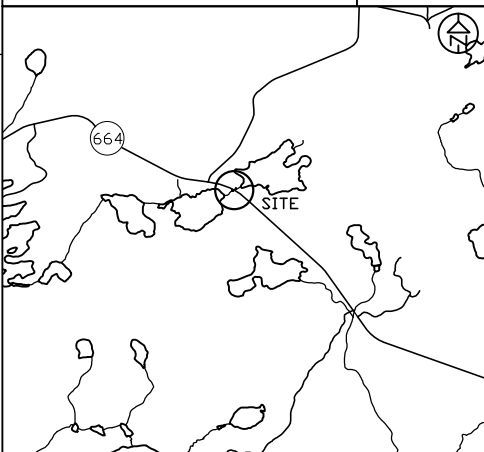
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WP No 6019-05-00
SITE No 48W-310/C
GEOCRES No xxx-xx



CULVERT REPLACEMENT
SAM LAKE TIMBER

SHEET

Survey 13-06 Revised



LEGEND					
◆ Borehole					
'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)					
Fill			Sand		
Organics			Silt		
Topsoil			Clay		
Till			Sand & Gravel		
Bedrock			Boulders		
No.	Elevation	Northing	Easting	Station	Offset
BH1	95.89	5547779 m N	569479 m E	14+690	21.0 m RT
BH2	95.24	5547762 m N	569451 m E	14+696	21.0 m LT
BH3	99.79	5547766 m N	569473 m E	14+686	4.1 m RT
BH4	100.21	5547767 m N	569460 m E	14+698	4.4 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.

DST
consulting engineers

DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-1792
Email: thunderbay@dstgroup.com

Appendix D
ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION STA 14+690, RT 21.0 m: UTM Zone 15 569479 mE, 5547779 mN ORIGINATED BY PR
 DIST HWY HIGHWAY 664 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
 DATUM LOCAL DATE 2015 04 19 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
95.9	GROUND SURFACE													
96.0	TOPSOIL		AS1	AS										25 68 (7)
95.4	SAND WITH GRAVEL, COBBLES, BROWN													PROBABLE BEDROCK
0.5	END OF BOREHOLE AT 0.45 m.													

ONL MOT-HIGH VANES GS-TB-020533 SAM LAKE TIMBER CULVERTY - BH LOGS.GPJ DST_MIN.GDT 28/5/15

+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 14+696, LT 21.0 m: UTM Zone 15 569451 mE, 5547762 mN ORIGINATED BY PR
DIST HWY HIGHWAY 664 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 19 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		
95.2	GROUND SURFACE													
94.6	SAND, SOME GRAVEL, TRACE SILT, COBBLE, BROWN		AS1	AS			95							15 78 (7)
0.6	END OF BOREHOLE AT 0.6 m.													PROBABLE BEDROCK

ONL MOT-HIGH VANES GS-TB-020533 SAM LAKE TIMBER CULVERTY - BH LOGS.GPJ DST_MIN.GDT 28/5/15

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

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION STA 14+686, RT 4.1 m: UTM Zone 15 569473 mE, 5547766 mN ORIGINATED BY PR
DIST HWY HIGHWAY 664 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 21 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			SHEAR STRENGTH kPa									
								20	40	60	80	100			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L
						○ UNCONFINED + FIELD VANE □ QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)						
99.8	GROUND SURFACE																
99.7	ASPHALT		AS1	AS													42 57 (1)
	SAND AND GRAVEL, TRACE SILT, BROWN, VERY DENSE		SS2	SS	60		99										48 45 (7)
98.4	ROCK FILL																NO CIRCULATION
1.4							98										
							97										
96.7							96										21 73 (6)
3.1	SAND WITH GRAVEL, TRACE SILT, COBBLE, BROWN, LOOSE TO COMPACT		SS3	SS	20												
			SS4	SS	6		96										
			SS5	SS	8		95										28 64 (8)
							94										
94.4	BEDROCK - LIMESTONE		RC1	RC													
5.4	TCR = 88% SCR = 88% RQD = 67%		RC2	RC			93										
	TCR = 92% SCR = 92% RQD = 75%		RC3	RC			92										
91.4																	
8.4	END OF BOREHOLE AT 8.4 m.																

ONL MOT-HIGH VANES GS-TB-020533 SAM LAKE TIMBER CULVERTY - BH LOGS.GPJ DST_MIN.GDT 28/5/15

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

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

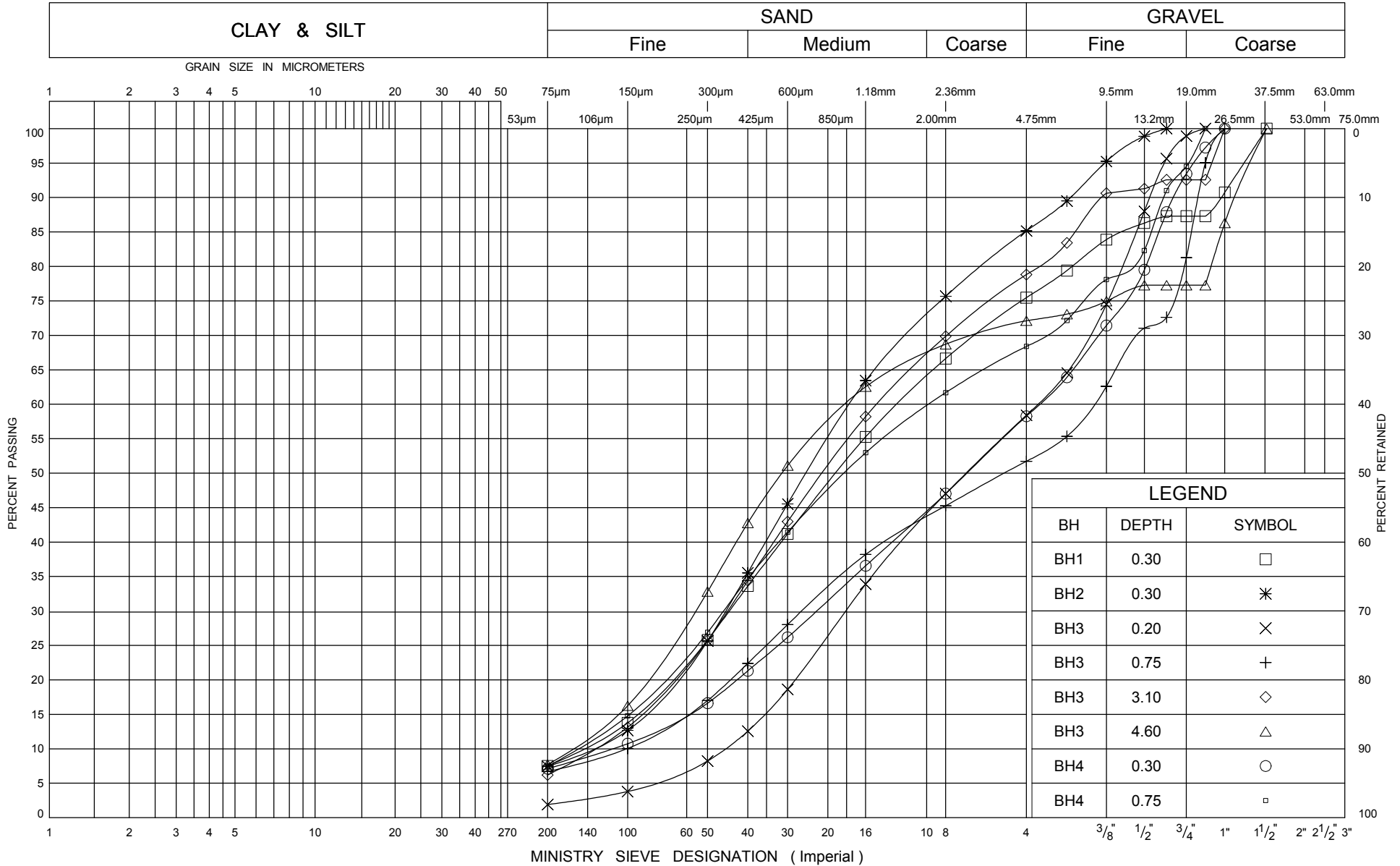
W.P. 6013-E-0023 LOCATION STA 14+698, LT 4.4 m: UTM Zone 15 569460 mE, 5547767 mN ORIGINATED BY PR
DIST HWY HIGHWAY 664 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY MD
DATUM LOCAL DATE 2015 04 21 CHECKED BY BV

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		
100.2	GROUND SURFACE													
100.1	ASPHALT		AS1	AS			100							42 51 (7)
	SAND AND GRAVEL, TRACE SILT, BROWN, VERY DENSE		SS1	SS	55		99							32 61 (7)
98.8	ROCK FILL													
98.5														
1.8	SAND AND GRAVEL, TRACE SILT, BROWN, LOOSE TO COMPACT		SS2	SS	24		98							
			SS3	SS	0									
			SS4	SS	7		97							50 46 (4)
			SS5	SS	9		96							
95.8	BEDROCK - LIMESTONE		RC1	RC			95							
4.4	TCR = 100% SCR = 100% RQD = 62%		RC2	RC										
	TCR = 100% SCR = 100% RQD = 96%						94							
	TCR = 97% SCR = 97% RQD = 70%		RC3	RC			93							
92.7	END OF BOREHOLE AT 7.5 m.													
7.5														

ONL MOT-HIGH VANES GS-TB-020533 SAM LAKE TIMBER CULVERTY - BH LOGS.GPJ DST_MIN.GDT 28/5/15

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

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation
Ontario

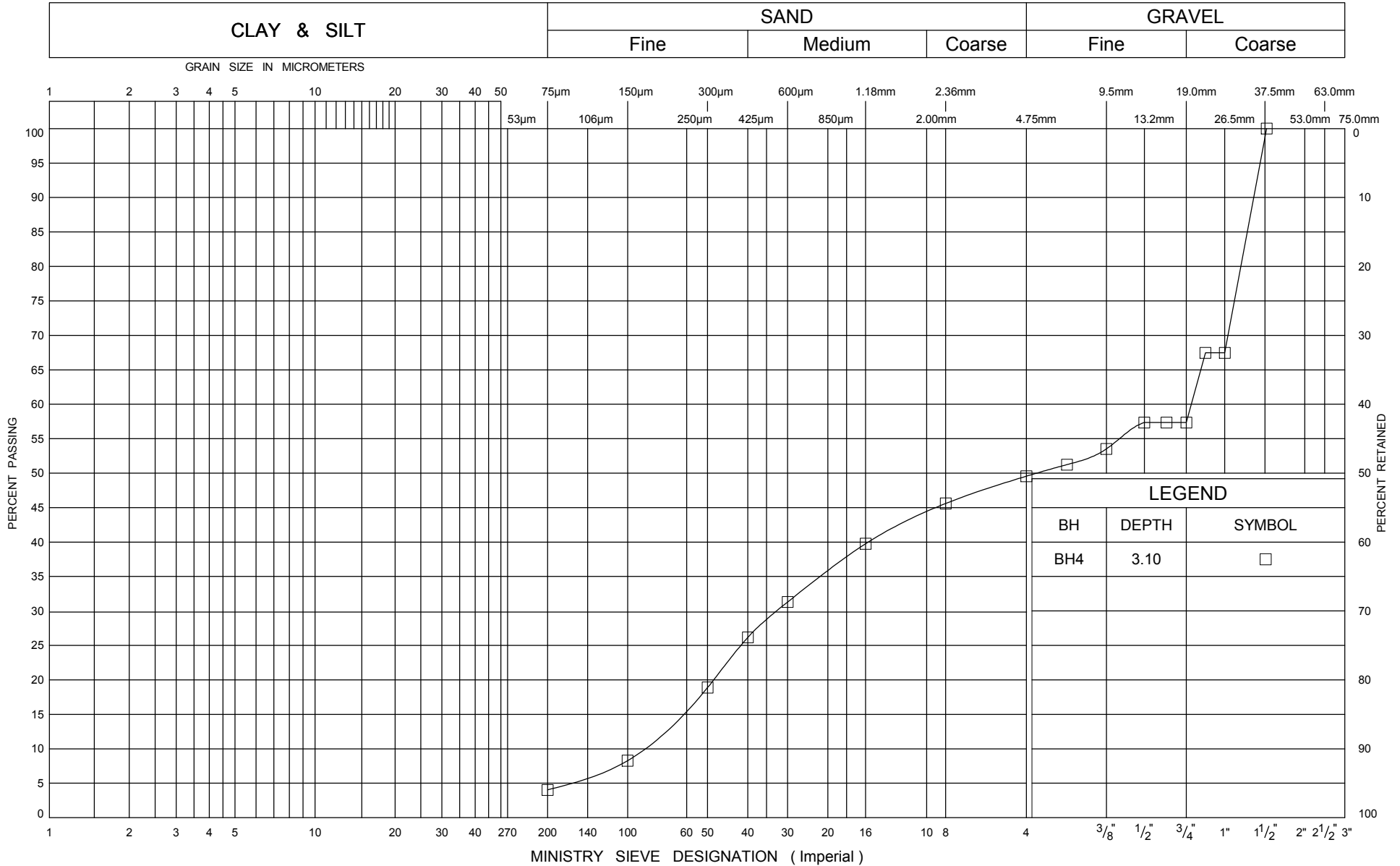
GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 1

W P 6013-E-0023

HIGHWAY 664

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION SOIL DESCRIPTION

ENCLOSURE 2

W P 6013-E-0023

HIGHWAY 664