



**FOUNDATION INVESTIGATION REPORT
LOG RIVER TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 71
TOWNSHIP OF MENARY, RAINY RIVER DISTRICT
AGREEMENT NO.: 6013-E-0023
SITE NO.: 45-278/C
GEOCRES NO. 52C-32
GWP NO. 6946-10-00**

**JUNE 20, 2014
GS-TB-018733**

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 Log River Tributary 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 the sub surface conditions at the culvert location.

2. SITE DESCRIPTION

The site is located on Highway 71, approximately 37.8 km North of Highway 11, approximate GPS coordinates latitude 48.9800 and longitude -93.9264, Station 17+542, in the Township of Menary, in the Rainy River District.

It is understood that the existing 25.3 m long centerline culvert is a Reinforced Box Culvert (RFB) approximately 5.9 m wide and approximately 2.4 m in height. The existing culvert (Figure 2.3 and 2.4) was inspected by others indicates severe spalling throughout and delamination. The fill height at the culvert location is approximately 1.5 m and the side slope of the embankment is approximately 2H:1V. The surrounding area is moderately vegetated (Figure 2.1 and 2.2). The 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 sand, peat alluvial plain. 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 (East)



Figure 2.4 Culvert outlet (West)

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 3.0 m to 5.3 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, at Station 17+533, 4.0 m right of centreline, and advanced to a depth of 5.3 m below surface. Borehole 2 was advanced North of the existing culvert, at Station 17+549, 4.0 m left of centreline, and advanced to a depth of 5.3 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 inlet, at Station 17+534, 17.0 m right of centreline, and advanced to a depth of 3.0 m below surface. Borehole 4 was advanced West of the outlet, Station 17+549, 15.0 m left of centreline, and advanced to a depth of 3.0 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 17+532. A nail on a telephone pole Northeast of the existing 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.

The fieldwork was supervised on a full-time basis by DST personnel who located the boreholes in the field, performed sampling and in-situ testing and logged the boreholes. In-situ tests included Standard Penetration Test (SPT) and Cone Penetration Test (CPT). 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 thirteen (13) moisture contents, six (6) sieve analyses, and two (2) Atterberg limits have been done for this assignment. Laboratory test results are presented in the Boreholes Logs (Enclosures 1 to 4), and graphical plots attached (Enclosures 5 to 6).

Table 3.1 Detail of borehole locations

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	17+533	100.9	5.3	4.0 Rt
BH2	17+549	100.9	5.3	4.0 Lt
BH3 (HA)	17+534	98.7	3.0	17.0 Rt
BH4 (HA)	17+549	98.1	3.0	15.0 Lt

4. DESCRIPTION OF SUBSURFACE CONDITIONS

The subsurface conditions are presented based on the information obtained during field and laboratory testing.

The generalized stratigraphy of the existing embankment, based on the conditions encountered in Boreholes 1 and 2, consists of asphalt overlying sand and crushed gravel fill underlain by sands and gravels fill with some silt, occasional cobbles, that is underlain by sand fill with silt, gravel, and trace of clay which is again underlain by rockfill which is overlain by a silty clay layer with rocks and boulders. The water level in the creek at the time of the investigation was at approximate elevations of 98.99 m and 98.95 m at the inlet and outlet, respectively.

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 and Crushed Gravel	0.0 to 0.8	100.9 to 100.1	
Fill –Sand and Gravel	0.8 to 2.3	100.1 to 98.6	Occasional Cobbles noted during drilling
Fill - Sand	2.3 to 2.8	98.6 to 98.1	
Rock Fill	2.8 to 3.3	98.1 to 97.6	
Clay with Rocks and Boulders	3.3 to 5.5	97.6 to 95.6	
Sand	0.0 to 0.9	98.1 to 97.3	Original ground at inlet and outlet
Clay – Silty to Sandy	0.9 to 3.0	97.3 to 95.1	Original ground at inlet and outlet

4.1 Asphalt

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

4.2 Topsoil

Topsoil was noted at surface at Borehole 3 and 4 with a thickness of approximately 0.3 m at a depth of 0.0 m to 0.3 m (Elev. 98.7 to 98.4) and 0.0 m to 0.3 m (Elev. 98.1 to 97.8 m).

4.3 Fill – Sand with Crushed Gravel some Silt

Sand and crushed gravel fill was encountered in Boreholes 1 and 2 with a thickness of 0.8 m at depth between 0.0 m to 0.8 m (Elev. 100.9 to 100.1 m). The moisture content of tested samples was found to be 4 %. The results of the laboratory tests are summarized in Table 4.2.

Table 4.2 Summary of sand and crushed gravel fill sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	24
Sand %	63
Fines %	14

4.4 Fill – Sand and Gravel

Sand and gravel fill with some silt was encountered in Boreholes 1 and 2 with a thickness of approximately 1.5 m at depths of 0.8 m to 2.3 m (Elev. 100.1 m to 98.6 m). Within the fill occasional cobbles were noted during the drilling process in Borehole 1.

SPT 'N' values of the fill vary between 18 and 30, indicating a condition of compact to dense. Moisture contents of tested samples ranged from 3 % to 14 %. The results of the laboratory tests are summarized in Table 4.3.

Table 4.3 Summary of sand and gravel sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	45
Sand %	37
Fines %	17

4.5 Fill - Sand

Sand fill with silt and gravel material was encountered in Boreholes 1 and 2 with a thickness of approximately 0.5 m at depths of 2.3 m to 2.8 m (Elev. 98.6 m to 98.1 m).

SPT 'N' values were more than 100, indicating a condition of very dense. However, some SPT values obtained may be artificially high due to the presence of cobbles and/or boulders within the stratum. Moisture contents of tested samples ranged from 14 % to 16 %. The results of the laboratory tests are summarized in Table 4.4.

Table 4.4 Summary of fill sand sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	13 to 22
Sand %	53 to 60
Fines %	25 to 27

4.6 Rock Fill

Rock fill with some clay and sand and gravel was encountered in Boreholes 1 and 2 with thickness of 0.5 m at depths of 2.8 m to 3.3 m (Elev. 98.1 m to 97.6 m) and 2.8 m to 3.3 m (Elev.98.1 m to 97.6 m) respectively.

4.7 Sand

Sand silty to with silt, organics, with to some gravel was noted in Boreholes 3 and 4 with thicknesses of approximately 0.6 m to 0.5 m at depths of 0.3 m to 0.9 m (Elev. 98.4 m to 97.8 m) and 0.3 m to 0.8 m (Elev. 97.8 m to 97.3 m), respectively.

The moisture content sample result of the silty sand and organic material is from 31 % to 40 %. The results of the laboratory tests are summarized in Table 4.5.

Table 4.5 Summary of sand sieve analyses

Laboratory Results - Sieve Analyses	
Gravel %	11 to 29
Sand %	45 to 57
Fines %	26 to 32

4.8 Clay - Silty to Sandy

A clay material silty to some silt, sandy to trace sand was encountered in Boreholes 3 and 4 with at depths of 0.9 m (Elev. 97.8 m) and 0.8 m (Elev. 97.3 m).

Silty clay with rocks and boulders was encountered in Boreholes 1 and 2 at depths of 3.3 m (Elev. 97.6 m). The rock coring was carried out through this stratum in Boreholes 1 and 2 due to presence of rocks and boulders within this stratum.

Atterberg limits tests carried out on samples from Boreholes 3 and 4 indicate the clay has medium plasticity with liquid limits of 41 % and 40 % and plasticity indexes of 25 % and 21 %

respectively. The moisture content of the clay ranges from 30 % to 31 %. Field vane tests completed in Borehole 3 and 4 indicate a stiff to very stiff consistency.

Table 4.6 Summary of medium plasticity clay Atterberg limits

Laboratory Results – Atterberg Limits	
Liquid Limit %	40 to 41
Plastic Limit %	16 to 19
Plastic Index %	21 to 25

4.9 Groundwater

At the time of the field investigation groundwater was observed in Boreholes 1 and 2 at depth of 0.7 m (Elev. 100.2 m). The groundwater levels can be expected to vary with seasons and precipitation events. During the time of investigation, water levels in creek were at 98.99 m and 98.95 m at the inlet and outlet, respectively. The estimated groundwater table levels at the site during the field investigations are given in Table 4.7.

Table 4.7 Elevation of water table at boreholes

Borehole	May 2014	
	Depth Measured (m)	Elevation (m)
BH 1	0.7	100.2
BH 2	0.7	100.2

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 trailer 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.

Prepared by:



Deep Bansal, P. Eng
Project Manager

Reviewed by:



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

Reviewed by:

A handwritten signature in black ink, appearing to read "Bernardo Villegas".

Bernardo Villegas, M.Sc.
Manager

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As a result, the `getenv` function or other functions that read environment variables may return `NULL` or may return an incorrect value. In addition, the `setenv` function may not work as expected. The `setenv` function may not set the environment variable, or it may set it to an incorrect value. The `setenv` function may also not update the environment variable in the process's environment.

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



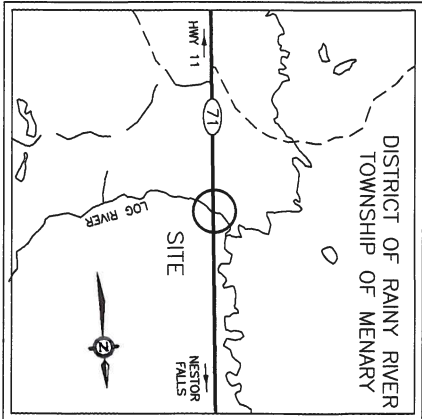
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CONT	No	6013-E-0023
WP	No	6946-10-00
SITE	No	45-278C
Geocres	No	52C-32

CULVERT REPLACEMENT
LOG RIVER CULVERT

STA 17+520 TO STA 17+580
Survey 12-07 Revised

SHEET



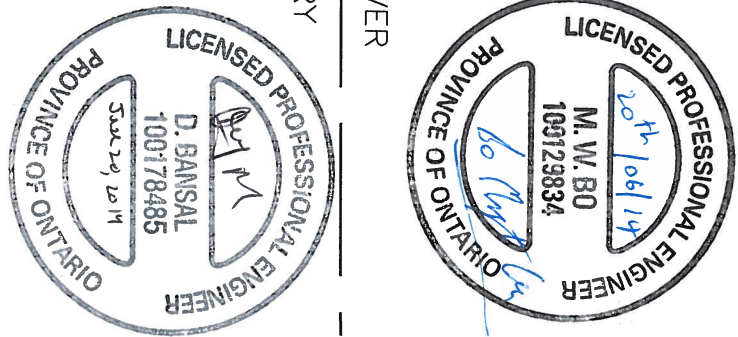
LEGEND

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

	Fill		Sand
	Organics		Silt
	Topsoil		Clay
	Bedrock		Sand & Gravel
	Rockfill		Rockfill

No.	Elevation	Northing	Eastng	Station	Offset
BH1	100.852	5427286 m N	237009 m E	17+533	4.0 m RT
BH2	100.855	5427284 m N	237003 m E	17+546	4.0 m LT
BH3	98.682	5427287 m N	237023 m E	17+554	17.0 m RT
BH4	98.116	5427286 m N	236992 m E	17+549	15.0 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.

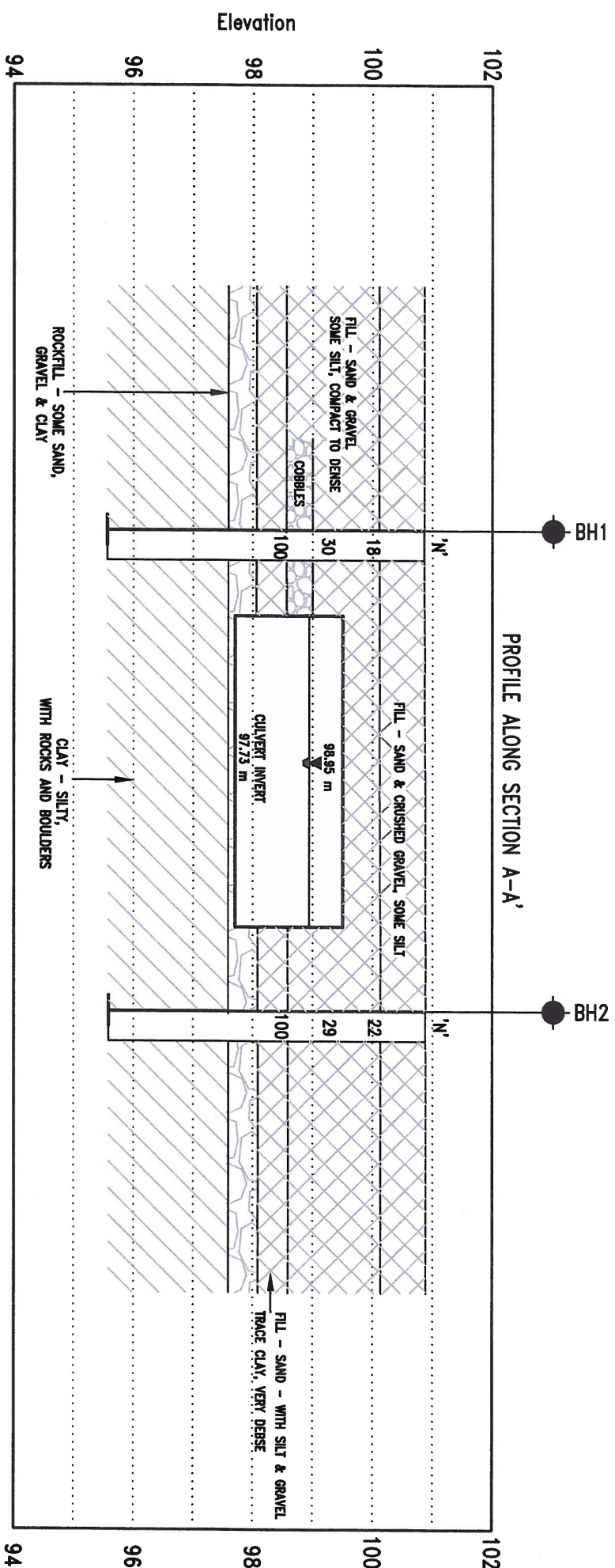
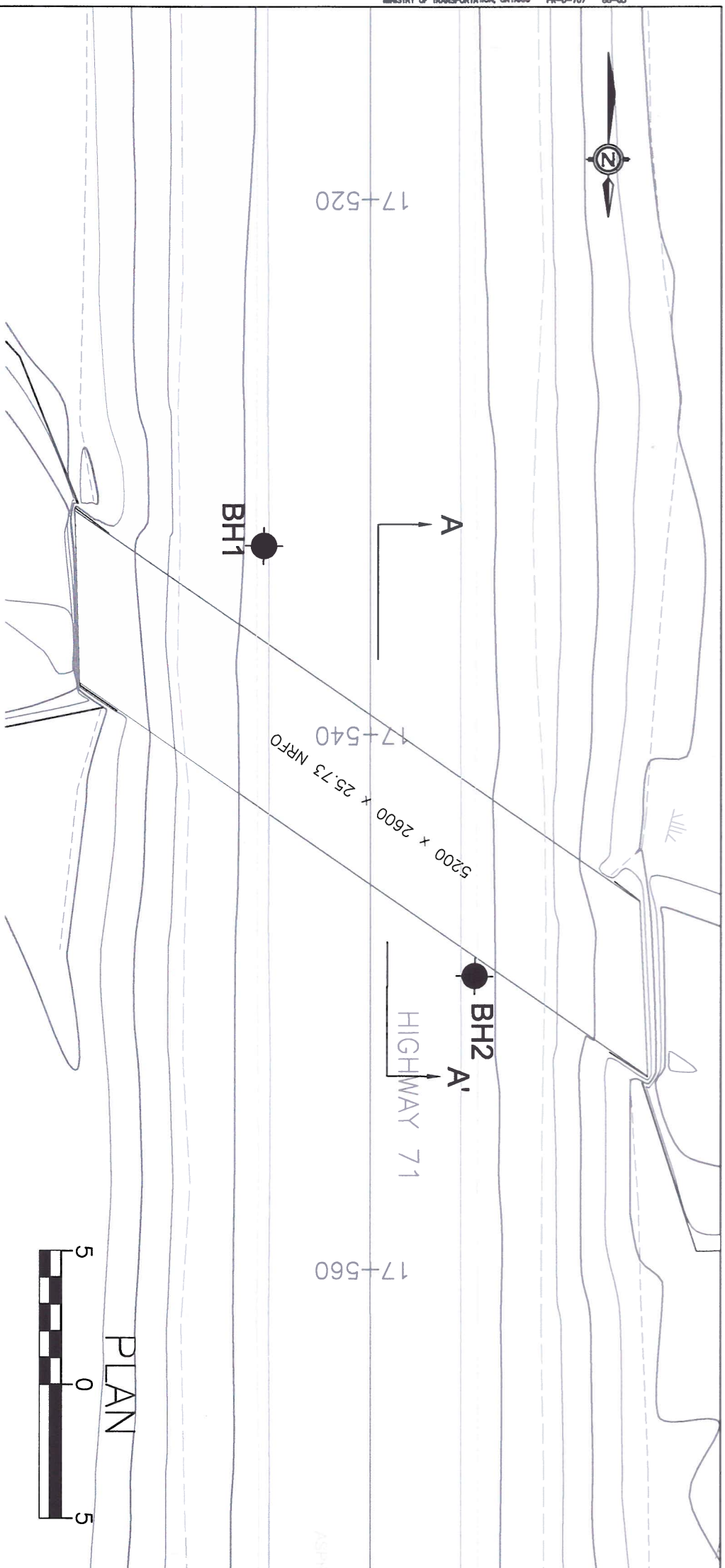


PLAN

DISTRICT OF RAINY RIVER
TOWNSHIP OF MENARY


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DRAWING 1

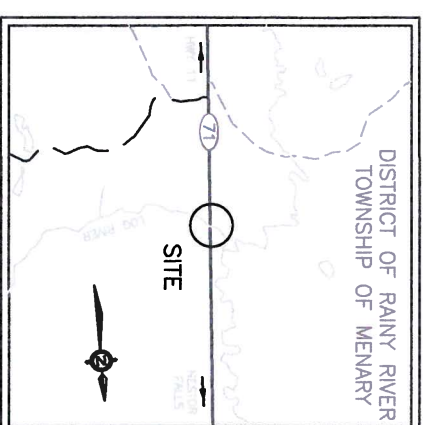
















METRIC

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CULVERT REPLACEMENT LOG RIVER CULVERT	SHEET

STA 17+520 TO STA 17+580
 Survey 12-07 Revised



LEGEND					
	Borehole				
	Borehole with CPT				
	Asphalt Core				
	Rock Probe				
	Blows/0.3m (Std. Pen Test, 4/75 J/Blow)				
	Water level at time of investigation.				
	Fill		Sand		
	Organics		Silt		
	Topsoil		Clay		
	Bedrock		Sand & Gravel		
No.	Elevation	Northing	Easting	Station	Offset
BH1	100.862	5427268 m N	237009 m E	17-533	4.0 m RT
BH2	100.885	5427284 m N	237003 m E	17-549	4.0 m LT
BH3	98.692	5427267 m N	237023 m E	17-534	17.0 m RT
BH4	98.718	5427266 m N	236992 m E	17-548	15.0 m LT

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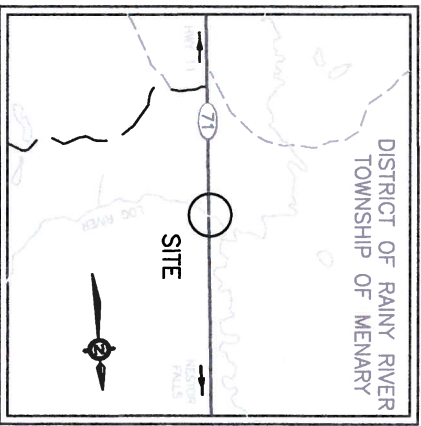
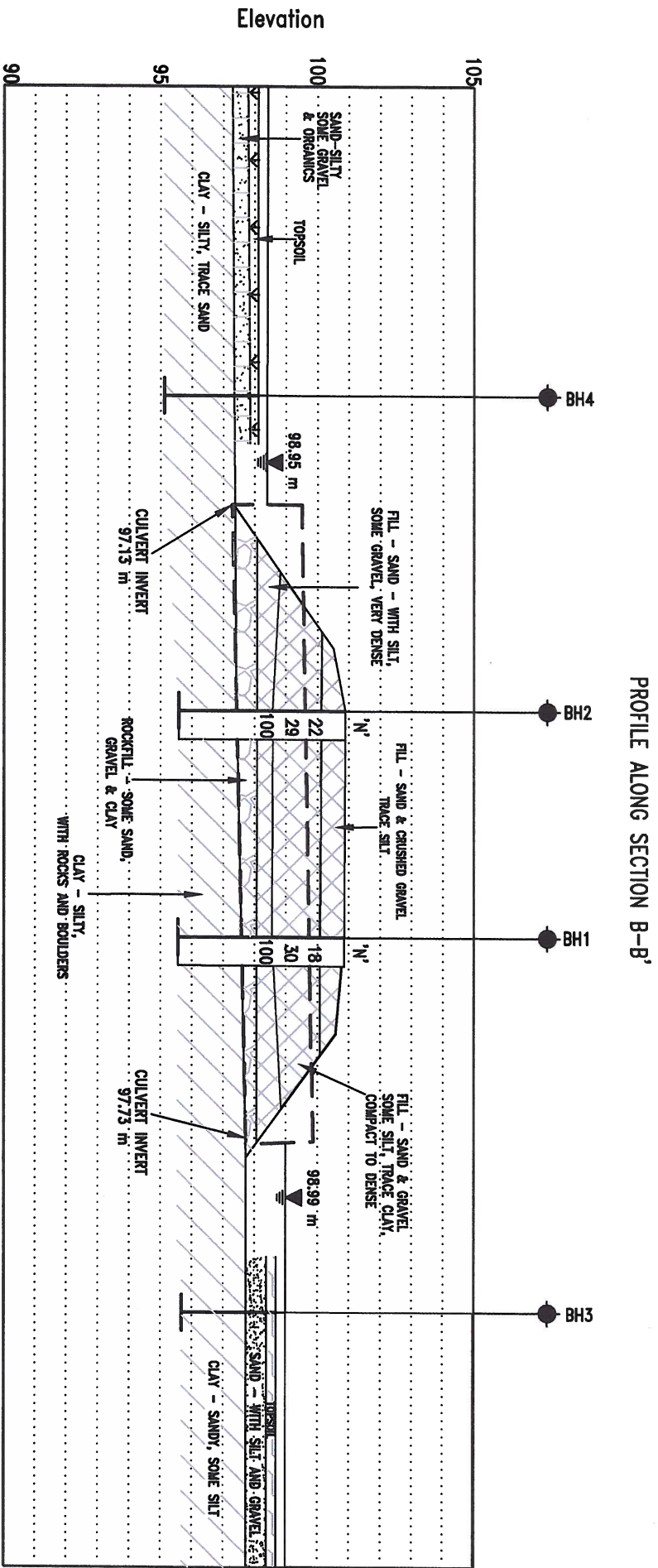
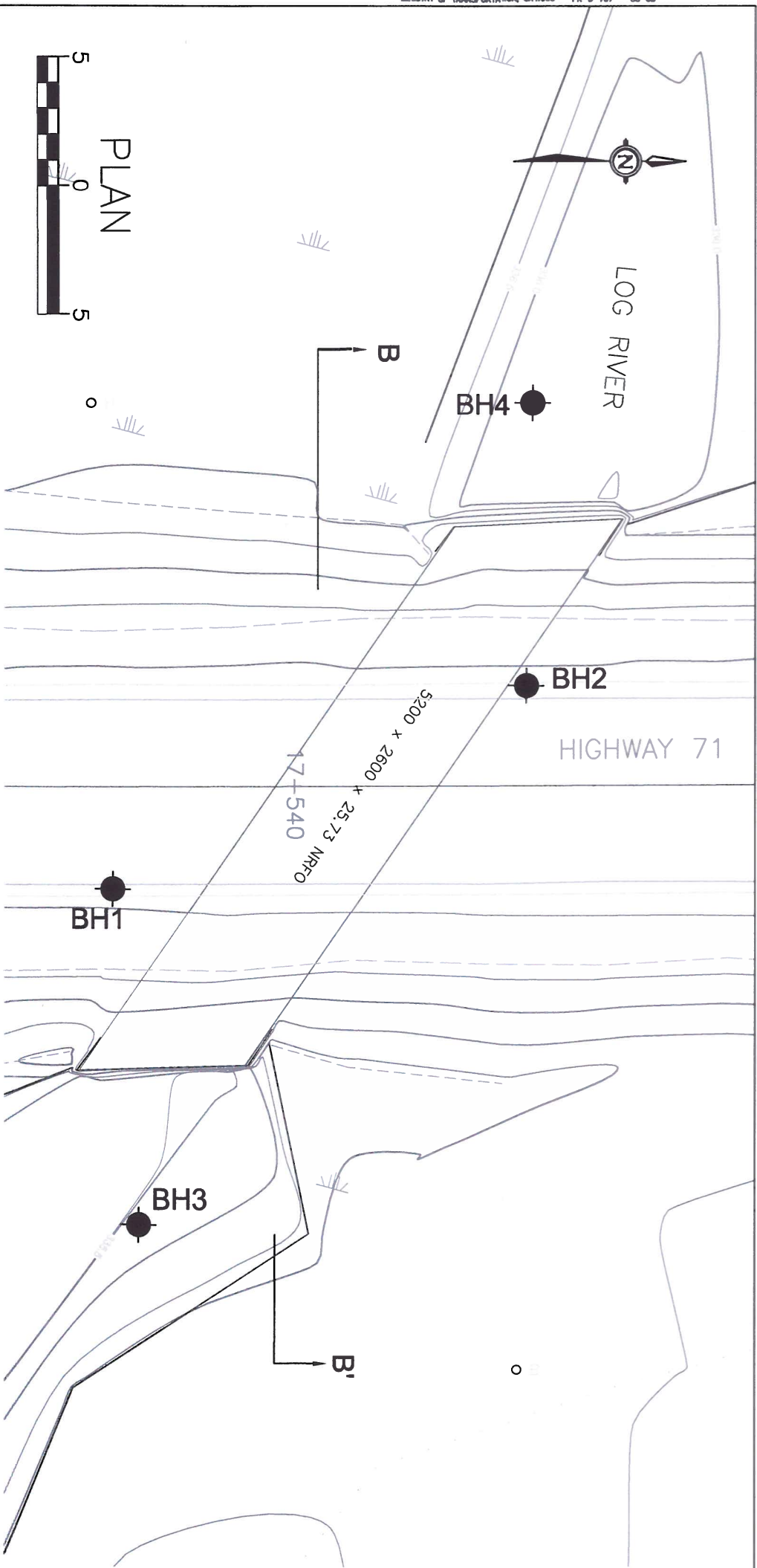
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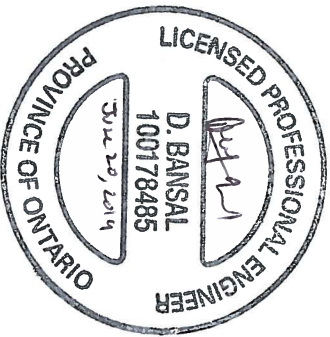


LEGEND

◆ Borehole	
⊕ Borehole with CPT	
⊙ Asphalt Core	
● Rock Probe	
▽ Blows/0.3m (Std. Pen Test, 475 J/Blow)	
Water level at time of investigation.	
Fill	Sand
Organics	Silt
Topsoil	Clay
Till	Sand & Gravel
Bedrock	Rockfill

No.	Elevation	Northing	Easting	Station	Offset
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BH2	100.885	5427284 m N	237003 m E	17+549	4.0 m LT
BH3	98.682	5427287 m N	237023 m E	17+554	17.0 m RT
BH4	98.118	5427286 m N	236992 m E	17+549	15.0 m LT

NOTE:
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DRAWING 3

Appendix D
ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION Log River Culvert: STA. 17+533, 4.0 m RT ORIGINATED BY JF
 DIST HWY 71 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML
 DATUM LOCAL DATE 2014 05 05 CHECKED BY DB

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						
								UNCONFINED		FIELD VANE				
								QUICK TRIAXIAL	LAB VANE	WATER CONTENT (%)				
100.9	GROUND SURFACE					20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
	FILL - SAND & CRUSHED GRAVEL - some silt, brown		AS1	AS										GR SA SI CL
100.1														Water level at 0.7 m on completion
0.8	FILL - SAND & GRAVEL - some silt, occasional cobbles, brown, compact to dense		SS2	SS	18									2 62 (14)
			SS3	SS	30									
98.6	FILL - SAND - with silt and gravel, trace clay, brown, very dense - COBBLES		SS4	SS	100+									SPT 50/112 mm
														22 5 (25)
98.1	ROCKFILL - some clay, sand and gravel		RC1	RC										
97.6	CLAY - Silty, with rocks and boulders TCR - 40%		RC2	RC										
													</	

ON_MOT GS-TB-018733 LOG RIVER CULVERT.GPJ DST_MIN.GDT 6/4/14

NR = NO RECOVERY

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE







ENCLOSURE 1

RECORD OF BOREHOLE No BH2

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION Log River Culvert: STA. 17+549, 4.0 m LT ORIGINATED BY JF
 DIST HWY 71 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML
 DATUM LOCAL DATE 2014 05 05 CHECKED BY DB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
								20 40 60 80 100								
100.9	GROUND SURFACE															
100.1 0.8	FILL - SAND & CRUSHED GRAVEL - trace silt, brown		AS1	AS		▽										GR SA SI CL Water level at 0.7 m on completion
	FILL - SAND & GRAVEL - some silt, trace clay, brown, compact		SS2	SS	22	100										4 □ 38 (17)
			SS3	SS	29	99										SPT 50/40 mm 1 □ 60 (27)
98.6 2.3	FILL - SAND - with silt, some gravel, trace clay, brown, very dense - COBBLES		SS4	SS	100+											
98.1 2.8	ROCKFILL - some clay, sand and gravel TCR - 37%		RC1	RC		98										
97.6 3.3	CLAY - Silty, with rocks and boulders TCR - 36%		RC2	RC												
							97									
							96									
						</										

ON_MOT_GS-TB-018733 LOG RIVER CULVERT.GPJ DST_MIN.GDT 6/4/14

NR = NO RECOVERY

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 2

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION Log River Culvert: STA. 17+534, 17.0 m RT ORIGINATED BY JF
 DIST HWY 71 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML
 DATUM LOCAL DATE 2014 05 05 CHECKED BY DB

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						
98.7	GROUND SURFACE							20 40 60 80 100					GR SA SI CL	
	TOPSOIL													
98.4 0.3	SAND - with silt and gravel, some clay and organics, grey		AS1	AS		98							29 45 (26)	
97.8 0.9	CLAY - Sandy, some silt, grey, stiff													
			AS2	AS		97								
			AS3	AS		96							CPT 1033 kPa CPT 1378 kPa	
95.7 3.0	End of Borehole at 3.0 m													

ON_MOT_GS-TB-018733 LOG RIVER CULVERT.GPJ DST_MIN.GDT 6/4/14

NR = NO RECOVERY

+³, X³: Numbers refer to
Sensitivity

○^{3%} STRAIN AT FAILURE

ENCLOSURE 3

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6013-E-0023 LOCATION Log River Culvert: STA. 17+549, 15.0 m LT ORIGINATED BY JF
 DIST HWY 71 BOREHOLE TYPE Hollow Stem Auger - 80 mm ID COMPILED BY ML
 DATUM LOCAL DATE 2014 05 05 CHECKED BY DB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
98.1	GROUND SURFACE													
	TOPSOIL						98							
97.8														
0.3	SAND - Silty, some gravel and organics, brown													11 57 (32)
97.3			AS1	AS										
0.8	CLAY - Silty, trace sand, grey, very stiff						97							CPT 896 kPa
			AS2	AS										CPT 1205 kPa
							96							
			AS3	AS										
95.1														
3.0	End of Borehole at 3.0 m													

ON_MOT_GS-TB-018733 LOG RIVER CULVERT.GPJ DST_MIN.GDT 6/4/14

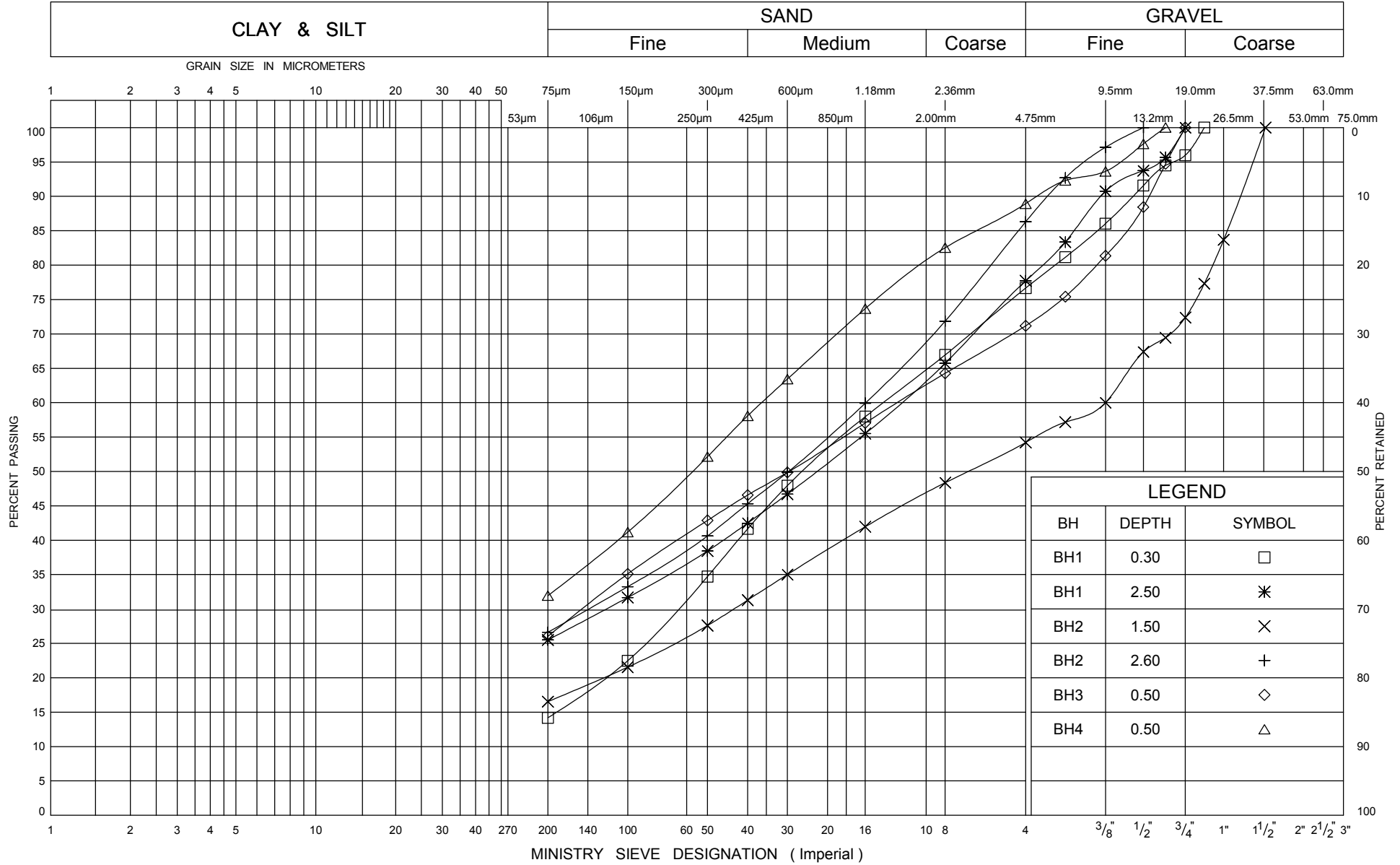
NR = NO RECOVERY

+ ³, X ³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ENCLOSURE 4

UNIFIED SOIL CLASSIFICATION SYSTEM



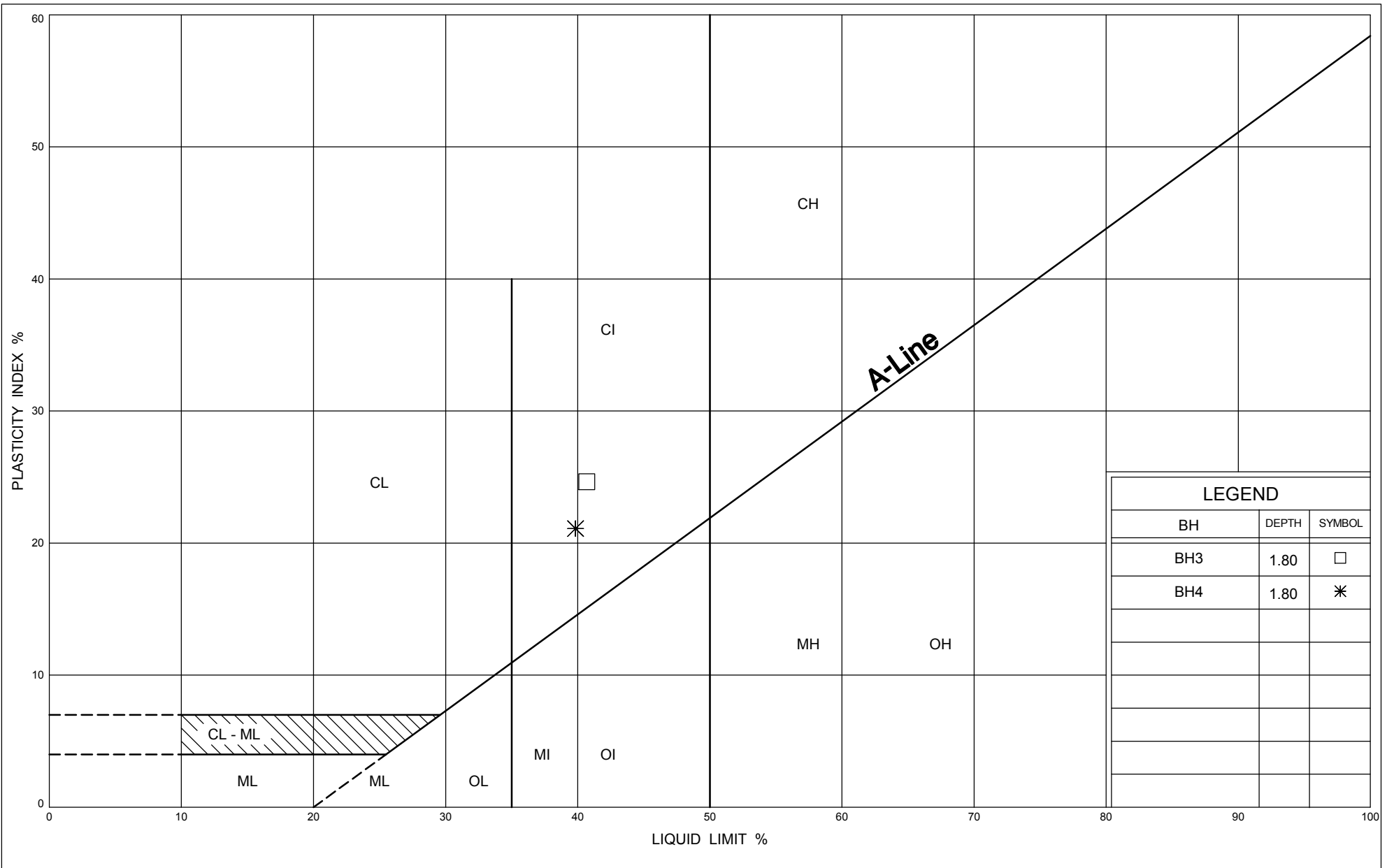
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GRAIN SIZE DISTRIBUTION

ENCLOSURE ☐

W P 6013-E-0023

HIGHWAY 71



Ministry of
Transportation
Ontario

PLASTICITY CHART

ENCLOSURE □

W P 6013-E-0023

HIGHWAY 71