FINAL

FOUNDATION INVESTIGATION REPORT
RAINY RIVER TRIBUTARY CULVERT REPLACEMENT
TOWNSHIP OF WORTHINGTON, DISTRICT OF RAINY RIVER
AGREEMENT NO.: 2014-E-0059
SITE NO.: 45-213/C
GEOCRES NO. 52D-024
GWP 6182-04-0

FEBRUARY 12, 2016
GS-TB-020823

PREPARED FOR:
Ministry of Transportation
Planning and Design
159 William Hearst Avenue,
Toronto, ON M3M 0B7

3 Copies - Ministry of Transportation, Toronto, ON
1 Copy - DST Consulting Engineers

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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RAINY RIVER TRIBUTARY CULVERT REPLACEMENT
HIGHWAY 11
TOWNSHIP OF WORTHINGTON, DISTRICT OF RAINY RIVER
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GEOCRES NO. 52D-024
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FACTUAL INFORMATION

1. INTRODUCTION

DST Consulting Engineers Inc. (DST) has been retained by the prime consultant, Ainley Group, to conduct a foundation investigation report for the proposed Rainy River Tributary culvert replacement approximately 4.3 km West of Highway 621 and provided foundation investigation report to the Ministry of Transportation (MTO), Planning and Design, Central Region. This work was carried out under Agreement No.: 2014-E-0059. This report addresses the field investigation, laboratory test program, factual report on conditions for design and construction for the proposed culvert replacement.

2. SITE DESCRIPTION

The site is located on Highway 11, approximately 4.3 km West of Highway 621 (latitude 48.722221, longitude -94.486637), Township of Worthington, District of Rainy River, Northwestern Ontario.

Existing structure at this location is a 6.1 m wide X 1.85 m in height X 18.1 m in length Open Footing Box culvert with a thickness of soil cover of approximately 1.0 m. The culvert has wide cracks on both walls and soffit at centre, spall on West wall at bottom of crack with erosion occurring on the East wall. The walls of the culvert are slightly leaning outwards at the top with the base of the walls kicking in. Cracks were also identified at the inlet and outlet of the culvert with the top of the culvert deteriorating with exposed corroded rebars. The walls of the inlet and outlet were leaning 2.6° and 1.4° to the East and 3.1° and 1.4° to 3.8° to the West. The embankment at the culvert location is about 3 m high.

The surrounding area is moderately vegetated (Figures 2.1 and 2.2). Photographs were taken by others. Geological information is available from published *Ontario Geological Survey Map #52DNE* by the *Ontario Ministry of Natural Resources* for the Stratton area.

Glaciolacustrine clay and silt deposits, representative of deposition in Glacial Lake Agassiz II (Johnston 1915), occur throughout the Stratton area and are generally varved. In many places, thin beds and lenses of gravel and sand occur. Also, isolated boulders are scattered throughout the area. This terrain unit is till-like in many places and could be the calcareous till referred to by Johnston (1915) and Hills and Morwick (1944). Further discrimination is not possible at this scale of air photo interpretation. Deposits are thick in places, ranging from 10 to 20 m in the Southwest, and thin out over planar bedrock in the middle of the map-area. Near Lake of the Woods and along the Rainy River, the glaciolacustrine deposits appear to be more sandy. Commonly associated subordinate landforms include bedrock knobs and plains, organic terrain, and glaciolacustrine beaches. Eolian sand dunes also occur in minor pockets close to the Sable Islands in the northwestern part of the area.

Figure 2.1 Location of existing culvert on Highway 11 (looking South)

Figure 2.2 Location of existing culvert on Highway 11 (looking North)

3. INVESTIGATION PROCEDURES AND LABORATORY TESTING

Field drilling was carried out during September 19th to September 21st, 2015 utilizing a CME 750 drill rig equipped for geotechnical drilling. A total of four (4) boreholes were advanced to depths ranging from 4.8 m to 16 m. The specified depth of 10 m below culvert invert level could not be achieved at BH 4 location due to site accessibility. Borehole 4 was hand augured to the depth of 4.8 m below the existing ground surface. The borehole locations and stratigraphic sections are shown on the Borehole Location Plan on Drawing 1 in Appendix C.

Borehole 1 was advanced 1.6 m East of the existing culvert, 6.2 m South of the outlet (Sta. 12+029) and advanced to a depth of 15.4 m below existing surface. Borehole 2 was advanced 3.2 m East of the existing culvert, 4.2 m North of the culvert inlet (Sta. 12+029) and advanced to a depth of 16m below the existing surface. Borehole 3 was advanced 8.8 m West of the existing culvert outlet, 1.5 m North of outlet (Sta. 12+015) and advanced to a depth of 14.5 m below the existing surface. Borehole 4 was advanced 1.0 m South of the existing culvert inlet (Sta. 12+024) and advanced to a depth of 4.8 m below the existing surface.

The ground surface elevations at the borehole locations were surveyed by DST personnel and referenced to an existing stake at the North-West corner of the existing culvert with an elevation of 334.92 m (Rainy River Tributary Creek Crossing at Tributary Creek and Hwy 11, Plan E-576-11-1). Table 3.1 summarizes the detail of borehole locations and depths.

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

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 relative density 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 analyses.

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, Atterberg limits and particle size analyses. A total of fifty-four (54) moisture contents, two (2) particle size analyses, and twelve (12) Atterberg limits have been carried out for this assignment. Laboratory test results are presented in the Boreholes Logs and graphical plots attached in Appendix D (Enclosures).

Table 3-1 Detail of Borehole Location

Borehole ID	Station	Elevation (m)	Depth (m)	Offset (m)
BH1	12 + 029	336.8	15.4	1.7 Lt
BH2	12 + 029	336.6	16	6.0 Rt
BH3	12 + 015	335.2	14.5	10.9 Lt
BH4	12 + 024	334.5	4.8	10.2 Rt

4. DESCRIPTION OF SUBSURFACE CONDITIONS

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

The generalized stratigraphy of the existing embankment and culvert inlet and outlet, based on the conditions encountered in the boreholes consists of sand fill at surface underlain by clay in Boreholes 1and 2 which was again underlain by till in Borehole 1. Clay was encountered at surface in Borehole 3 and 4. Summary of soil stratigraphy is presented in Tables 4-1 and 4-2.

Table 4-1 Summary of soil strata at the culvert inlet and outlet locations (BH2, BH3 and BH4)

Layer	Depth (m)	Elevation (m)	Comments
Fill – Sand	0.0 to 2.3	335.7 to 333.4	BH2
Clay	2.3 to 16 0.0 to 14.5 0.0 to 4.8	333.4 to 319.7 334.2 to 319.7 333.6 to 328.8	BH2 BH3 BH4

Table 4-2 Summary of soil strata at the culvert location through the embankment (BH1)

Layer	Depth (m)	Elevation (m)	Comments
Fill – Sand	0.0 to 2.3	335.8 to 333.5	BH1
Clay	2.3 to 13.7	333.5 to 322.1	BH1
Till	13.7 to 15.4	322.1 to 320.4	BH1

4.1 Fill – Sand

Sand fill with some gravel and fines was encountered in Borehole 1 and 2 at depths from 0.0 to 2.3 m (Elev. 336.8 to 334.5 m) and (Elev. 336.6 to 334.3 m) with a thicknesses of 2.3 m.

The SPT ‘N’ values vary from 6 to 9, indicating a loose condition. The moisture content of a sample tested was found to be 7 %. The sieve analysis laboratory test results are summarized in Table 4-3.

Table 4-3: Summary of Sieve Analysis - Fill - Sand

Laboratory Results – Sieve Analysis	
Gravel %	15
Sand %	74
Fines %	11

4.2 Clay

Clay was encountered at surface in Boreholes 3 and 4 and below the fill in Boreholes 1 and 2 at depths from 0.0 to 14.5m (Elev. 335.2 to 320.7 m), 0.0 to 4.8 m (Elev. 334.5 to 329.7 m), 2.3 to 13.7 m (Elev. 334.5 to 323.1 m), and 2.3 to 16 m (Elev. 334.3 to 320.6 m) with thicknesses of 14.5 m, 4.8 m, 11.4 m, and 13.7 m respectively.

Atterberg limits tests carried out on samples from Boreholes indicate that the clay has low to high plasticity. Field vane tests completed in Boreholes show shear strength between 30 to 100+ kPa indicating a firm to very stiff consistency. The moisture contents of samples tested was found to be between 18 to 28 %. The Atterberg limits laboratory test results are summarized in Table 4-4.

Table 4-4: Summary of Atterberg Limits- Clay

Laboratory Results – Atterberg Limits	
Liquid Limit %	26 to 55
Plastic Limit %	13 to 25
Plastic Index %	9 to 36

4.3 Till

Till was encountered below the clay in Borehole 1 at the depth of 13.7 to 15.4 m (Elev. 323.1 to 321.4) with a thickness of 1.7 m. No recovery of sample was obtained, SPT 'N' values range from 57 to 62, indicating a very dense condition.

4.4 Groundwater

At the time of the field investigation, groundwater was only observed in Borehole 3. No groundwater was encountered in Boreholes 1, 2 or 4. However, the groundwater levels can be expected to vary with the season and precipitation events.

Table 4-5: Groundwater depth

Borehole	Groundwater Depth (m)	Groundwater Elev. (m)
Borehole 3	1.30	332.9

4.5 Chemical Tests

Selected soil samples were submitted to ALS Laboratories Thunder Bay for chemical analyses (pH, sulphate, conductivity, resistivity and Chloride) to assess the potential for corrosion and sulphate attack on buried structures.

The results are presented below in Table 4-6 and a copy of the Laboratory Certificate of Analysis is provided in Appendix D.

Table 4-6: Chemical Test Results

Sample ID	Moisture (%)	Sulphate (mg/kg)	Chloride (mg/kg)	pH	Conductivity (ohms/cm)	Resistivity (ohm - cm)
BH1 @ 2.4 m depth	3.42	29	224	8.02	480	2080

The analytical results of the soil samples were compared with applicable Canadian Standards Association (CSA) standards as shown in Table 4-7 below

The chemical sulphate content analyses for representative soil sample tested indicate a sulphate concentration of 29 mg/kg or 0.0029 % in soil. The results were compared with Canadian Standards Association (CSA) Standards A23.1 for sulphate attack potential on concrete structures and possess a “negligible” risk for sulphate attack on concrete material and accordingly, conventional GU or MS Portland cement may be used in the construction of the proposed concrete elements.

The pH value for the soil samples was reported to be 8.02, indicating a durable condition against corrosion. These results were evaluated using Table 2 of Building Research Establishment (BRE) Digest 363 (July 1991). The pH is greater than 5.5 indicating the concrete will not be exposed to attack from acids. The chloride content of the selected soil sample was also compared with the threshold level and present negligible concrete corrosion potential. Soil resistivity and conductivity was found to be 2080 ohm-cm and 480 ohms / cm respectively for the sample analysed from BH1.

Table 4-7: Additional requirements for concrete subjected to Sulphate Attack

Class of Exposer	Degree of Exposer	Water soluble Sulphate in soil sample (%)	Cementing Material to be used
S-1	Very Severe	> 2.0	HS or HSb
S-2	Severe	0.20 – 2.0	HS or HSb
S-3	Moderate	0.10 – 0.20	MS, MSb, LH, HS, or HSb

* Information from Table 3 of CSA Standards A23.1-04

5. MISCELLANEOUS

Site work was carried out during September 19th to September 21st, 2015 utilizing a CME 750 all-terrain drill supervised by DST. 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 Selorm Danku, P.Eng and reviewed by Dr Masud Karim, P.Eng who is the 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:

Selorm Danku, P.Eng.
Geotechnical Engineer

Reviewed by:

Dr. ASM Masud Karim, P.Eng.
Regional Manager – Infrastructure

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DST C□NSULTING ENGINEERS INC□

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The discussions, conclusions and recommendations which are presented in this report and the results 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 test holes 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 test holes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, 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 of design 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 test holes 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 conclusions 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 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

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

AG	No 2014-E-0059
WP	No 6182-04-01
SITE	No 45-213C
GEOCRES	No 52D-024

REPLACEMENT OF
RAINY RIVER TRIBUTARY
STA 11+990 TO STA 12+050
Survey_____ Revised_____

SHEET

LICENSED PROFESSIONAL ENGINEER
Feb. 17, 2016
A.S.M.M. KARIM
100223054
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Feb, 16, 2016
S. K. DANKU
100153904
PROVINCE OF ONTARIO

11+990
12+000
12+050
12+056.691

UM TBAY TEL

RAINY RIVER TRIBUTARY CREEK

N 5399273.508
E 195427.011

BH3
BH1
BH2
BH4

W/L 333.300
NOV 8, 2013

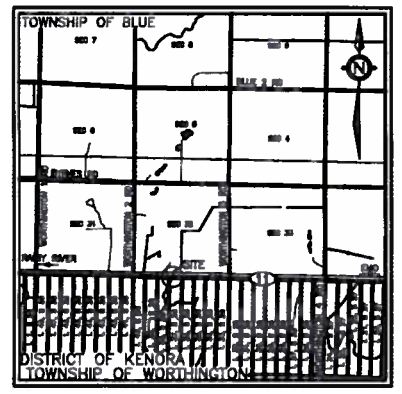
RAINY RIVER ← HWY 11 Asphalt Asphalt HWY 11 → EMO (30km)

PWF
P-2650-8
P-2650-8
PWF

RFO 17.98 x 12.130 x 6.100

O H

PLAN
5 0 5



KEY PLAN
1.0 km 0 1.0 km

LEGEND
Borehole

No.	Elevation	Northing	Easting	Station	Offset
BH1	336.8	5399285 m N	195433 m E	12+029	1.7 m LT
BH2	336.6	5399258 m N	195432 m E	12+029	6.0 m RT
BH3	336.2	5399275 m N	195418 m E	12+015	10.8 m LT
BH4	334.5	5399253 m N	195429 m E	12+024	10.2 m RT

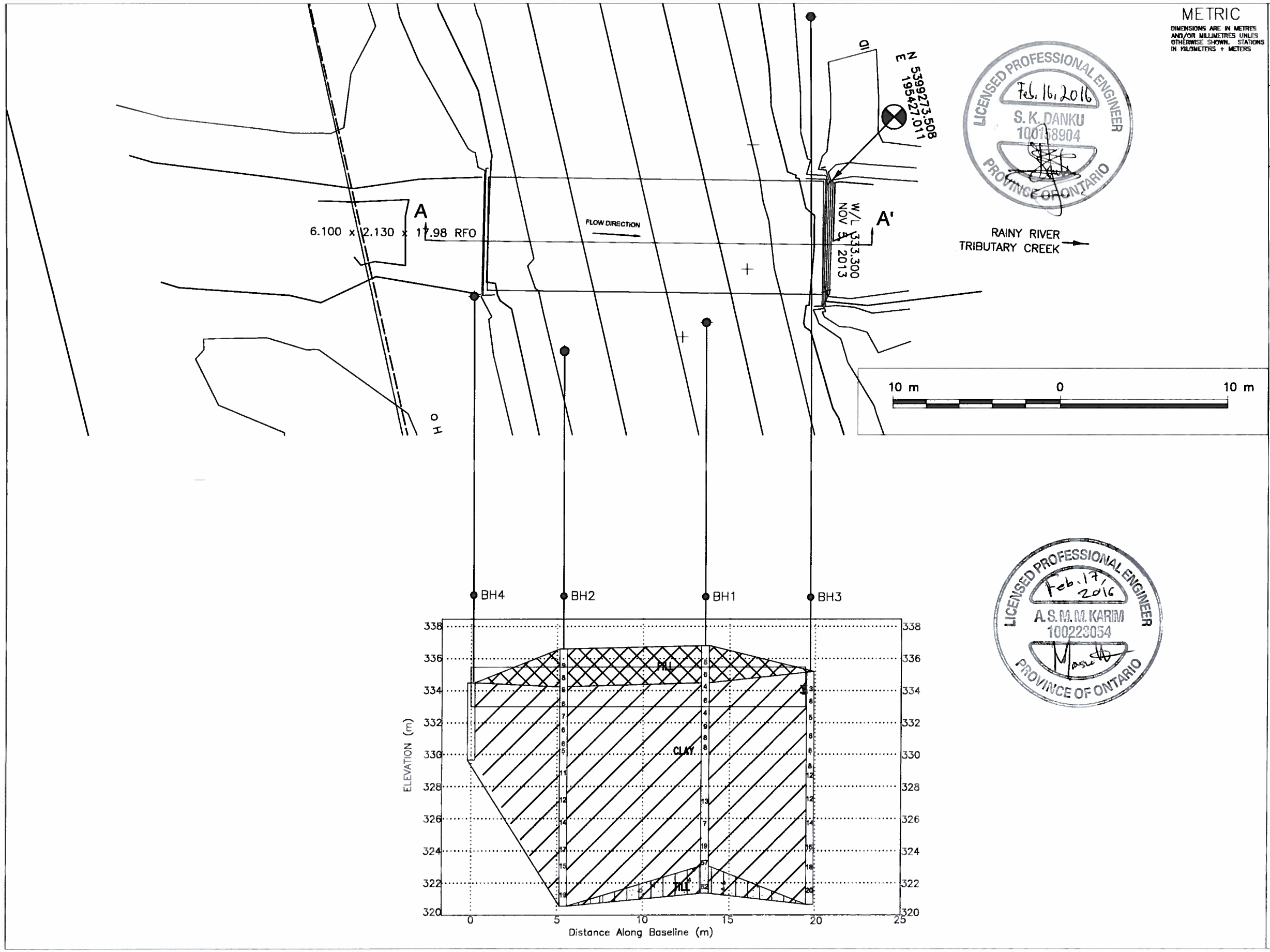
NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

DST consulting engineers
DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fax (807) 623-1782
Email: thunderbay@dstgroup.com

DRAWING 1

METRIC

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



LICENSED PROFESSIONAL ENGINEER
Feb. 16, 2016
S. K. DANKU
100158904
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
Feb. 17, 2016
A.S.M.M. KARIM
100223054
PROVINCE OF ONTARIO

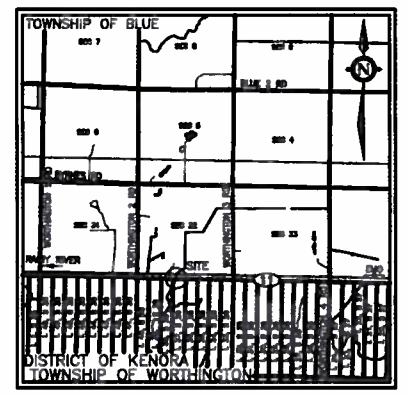
AG	No 2014-E-0059
WP	No 6182-04-01
SITE	No 45-213C
GEOCRES	No 52D-024

REPLACEMENT OF RAINY RIVER TRIBUTARY

STA 11+990 TO STA 12+050

Survey_____ Revised_____

SHEET



KEY PLAN

1.0 km 0 1.0 km

LEGEND

- Borehole
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Groundwater Elevation
- Fill
- Organics
- Topsoil
- Till
- Bedrock
- Sand
- Silt
- Clay
- Sand & Gravel
- Boulders

No.	Elevation	Northing	Easting	Station	Offset
BH1	338.8	5399288 m N	195433 m E	12+029	1.7 m LT
BH2	338.6	5399288 m N	195432 m E	12+029	5.0 m RT
BH3	335.2	5399275 m N	195418 m E	12+015	16.8 m LT
BH4	334.8	5399283 m N	195423 m E	12+024	10.3 m RT

NOTE:
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DST consulting engineers

DST Consulting Engineers Inc.
605 Hewitson Street
Thunder Bay, ON P7B 5V5
Ph: (807) 623-2929
Fx: (807) 623-7782
Email: thunderbay@dstgroup.com

DRAWING 2

Appendix D

ENCLOSURES

RECORD OF BOREHOLE No BH1

1 OF 1

METRIC

W.P. 6182-04-01 LOCATION RAINY RIVER TRIBUTARY ORIGINATED BY CH

DIST Rainy River HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID COMPILED BY SA

DATUM GE□DETIC DATE 2015 09 21 CHECKED BY BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL	REMARKS & GRAIN SIZE DISTRIBUTION (%)
335.8	GROUND SURFACE												
	FILL - SAND, SOME GRAVEL, TRACE SILT, TRACE CLAY LOOSE		AS1	AS									
			SS1	SS	8		335		15	74		(11)	
			SS2	SS	6		334						
333.5													
2.3	CLAY, TRACE SILT, TRACE SAND, TRACE GRAVEL FIRM TO STIFF GREY		SS3	SS	4				0	7		(92)	
			SS4	SS	6		333						
			SS5	SS	4		332						
			SS6	SS	9		331						
			SS7	SS	8		330						
			SS8	SS	8								
							329						
			ST1	TW			328						
							327						
			SS9	SS	13								
							326						
			SS10	SS	7		325						
							324						
			SS11	SS	19								
322.1							323						
13.7	TILL - GRAVEL, SOME CLAY VERY DENSE (FIELD OBSERVATION DURING DRILLING OPERATION)		SS12	SS	57		322						NO SAMPLE RECOVERY
			SS13	SS	62		321						NO SAMPLE RECOVERY
320.4													
15.4	END OF BOREHOLE AT 15.4 m												AUGER REFUSAL

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 50 100 150 200 250

○ UNCONFINED + FIELD VANE

□ QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

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

ON_MOT-HIGH VANES RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 2/2/16

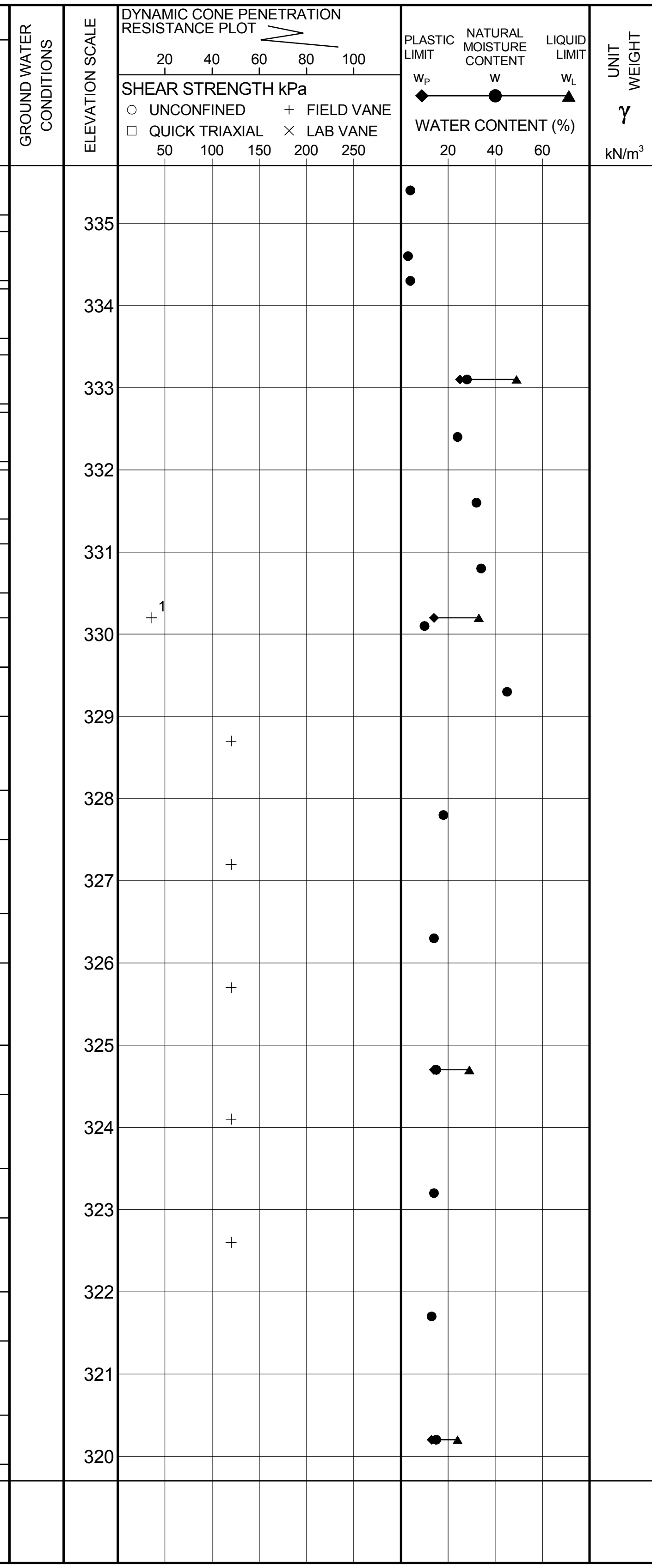
ENCLOSURE 1

RECORD OF BOREHOLE No BH2

METRIC

W.P. 6182-04-01	LOCATION RAINY RIVER TRIBUTARY		ORIGINATED BY CH
DIST Rainy River HWY 11	BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID		COMPILED BY SA
DATUM GE□DETIC	DATE 2015 09 19		CHECKED BY BV

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
335.7	GROUND SURFACE				
	FILL - SAND, TRACE GRAVEL, LOOSE, BROWN	AS1	AS		17 69 (15)
		SS1	SS	9	
		SS2	SS	8	
333.4 / 2.3	CLAY, TRACE SILT, TRACE GRAVEL, FIRM TO VERY STIFF, GREY	SS3	SS	6	
		SS4	SS	6	
		SS5	SS	7	
		SS6	SS	6	
		SS7	SS	6	
		SS8	SS	5	
		SS9	SS	11	
		SS10	SS	12	
		SS11	SS	14	
		SS12	SS	17	
		SS13	SS	15	
		SS14	SS	19	
319.7 / 16.0	END OF BOREHOLE AT 16.0 m				



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

ON_MOT-HIGH VANES RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 2/2/16

RECORD OF BOREHOLE No BH3

1 OF 1

METRIC

W.P. 6182-04-01 LOCATION RAINY RIVER TRIBUTARY ORIGINATED BY CH

DIST Rainy River HWY 11 BOREHOLE TYPE HOLLOW STEM AUGER - 80 mm ID COMPILED BY SA

DATUM GE□DETIC DATE 2015 09 20 CHECKED BY BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
334.2	GROUND SURFACE						
	CLAY SOFT TO VERY STIFF GREY		AS1	AS			334
			SS1	SS	3	▽	333
			SS2	SS	8		
			SS3	SS	5		332
			ST1	TW			331
			SS4	SS	6		330
			SS5	SS	8		329
			SS6	SS	8		
			SS7	SS	12		328
			SS8	SS	12		327
			SS9	SS	14		326
			SS10	SS	16		325
			SS11	SS	18		324
			SS12	SS	20		323
319.7							322
14.5	END OF BOREHOLE AT 14.5 m						321
							320

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

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

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

ON_MOT-HIGH VANES RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 2/2/16

ENCLOSURE 3

RECORD OF BOREHOLE No BH4

1 OF 1

METRIC

W.P. 6182-04-01 LOCATION RAINY RIVER TRIBUTARY ORIGINATED BY CH

DIST Rainy River HWY 11 BOREHOLE TYPE HAND AUGER COMPILED BY SA

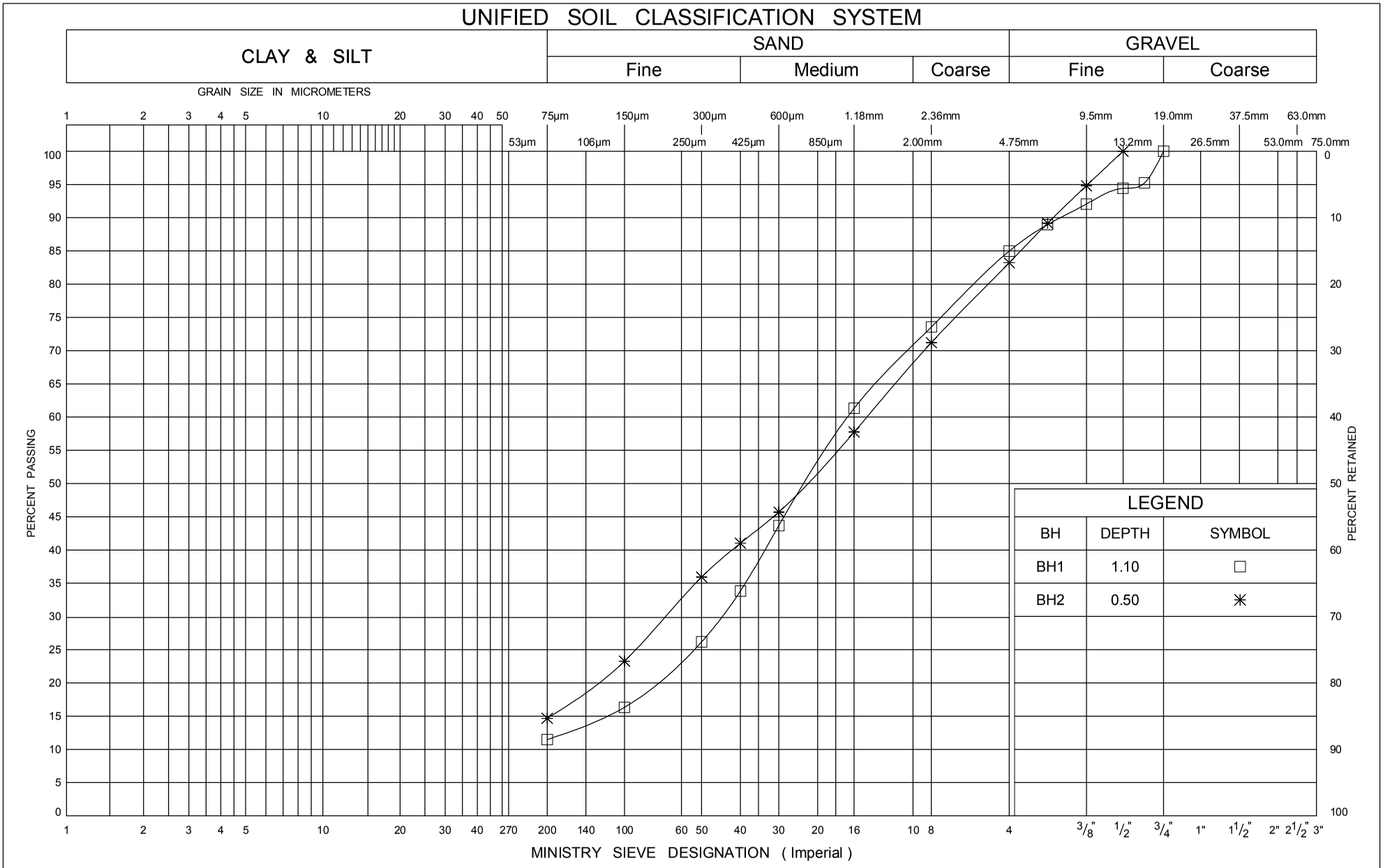
DATUM GE□DETIC DATE 2015 09 21 CHECKED BY BV

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
333.6	GROUND SURFACE										
	CLAY, TRACE SILT		AS1	AS							
			AS2	AS							
			AS3	AS			333				
			AS4	AS							
			AS5	AS							
			AS6	AS			332				
			AS7	AS							
			AS8	AS							
			AS9	AS			331				
			AS10	AS							
			AS11	AS			330				
			AS12	AS							
328.8							329				
4.8	END OF BOREHOLE AT 4.8 m										

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

ON_MOT-HIGH VANES RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 2/2/16

ENCLOSURE 4



ONTARIO MOT GRAIN SIZE RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 31/12/15

Ministry of Transportation Ontario

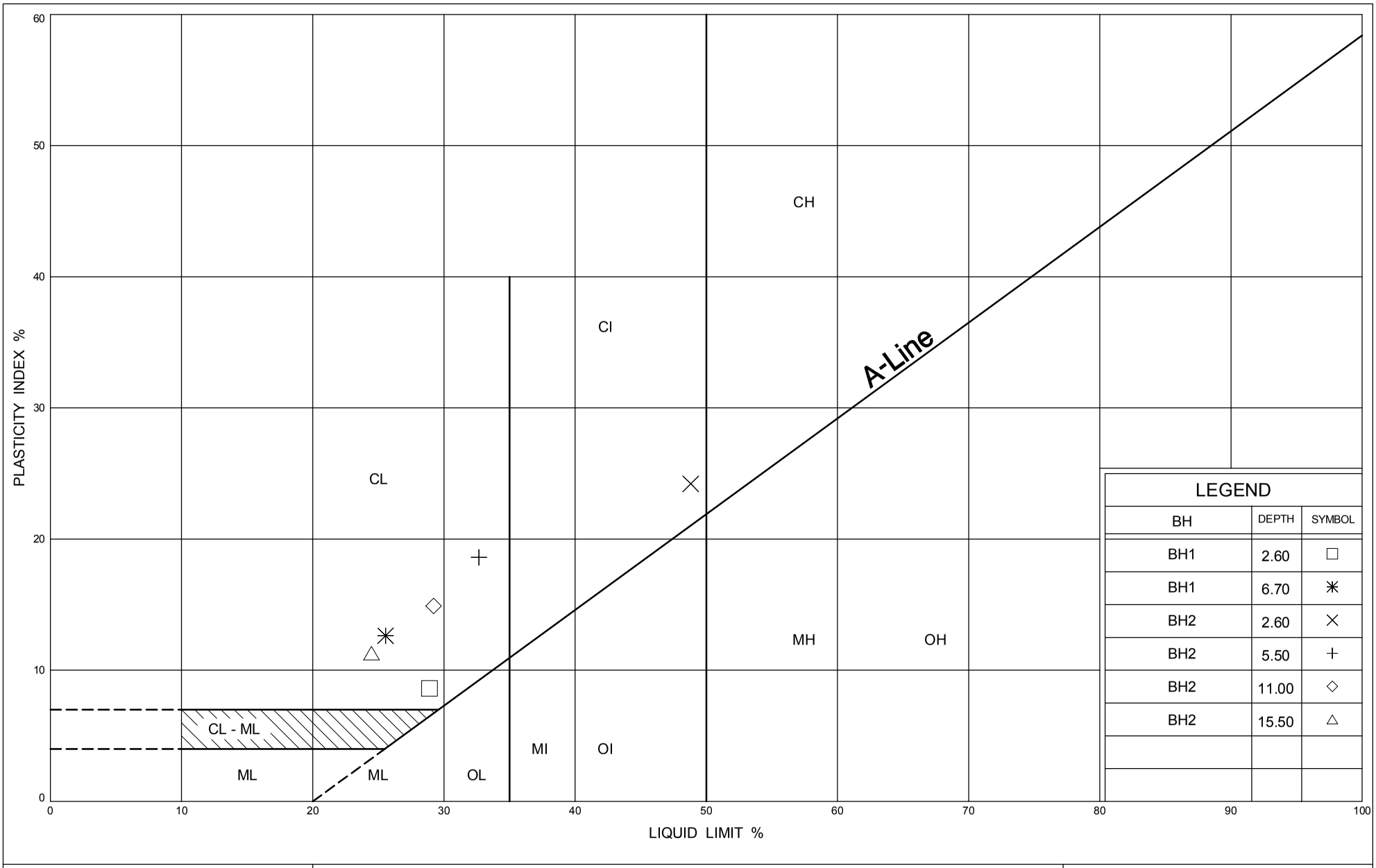
GRAIN SIZE DISTRIBUTION

SOIL DESCRIPTION
FILL - SAND

ENCLOSURE □

DST REF□□ GS-T□-□2□823

RAIN□ RIVER TRI□UTAR□



ONTARIO MOT PLASTICITY CHART RAINY RIVER - GS-TB-020823.GPJ DATA TEMPLATE.GDT 31/12/15

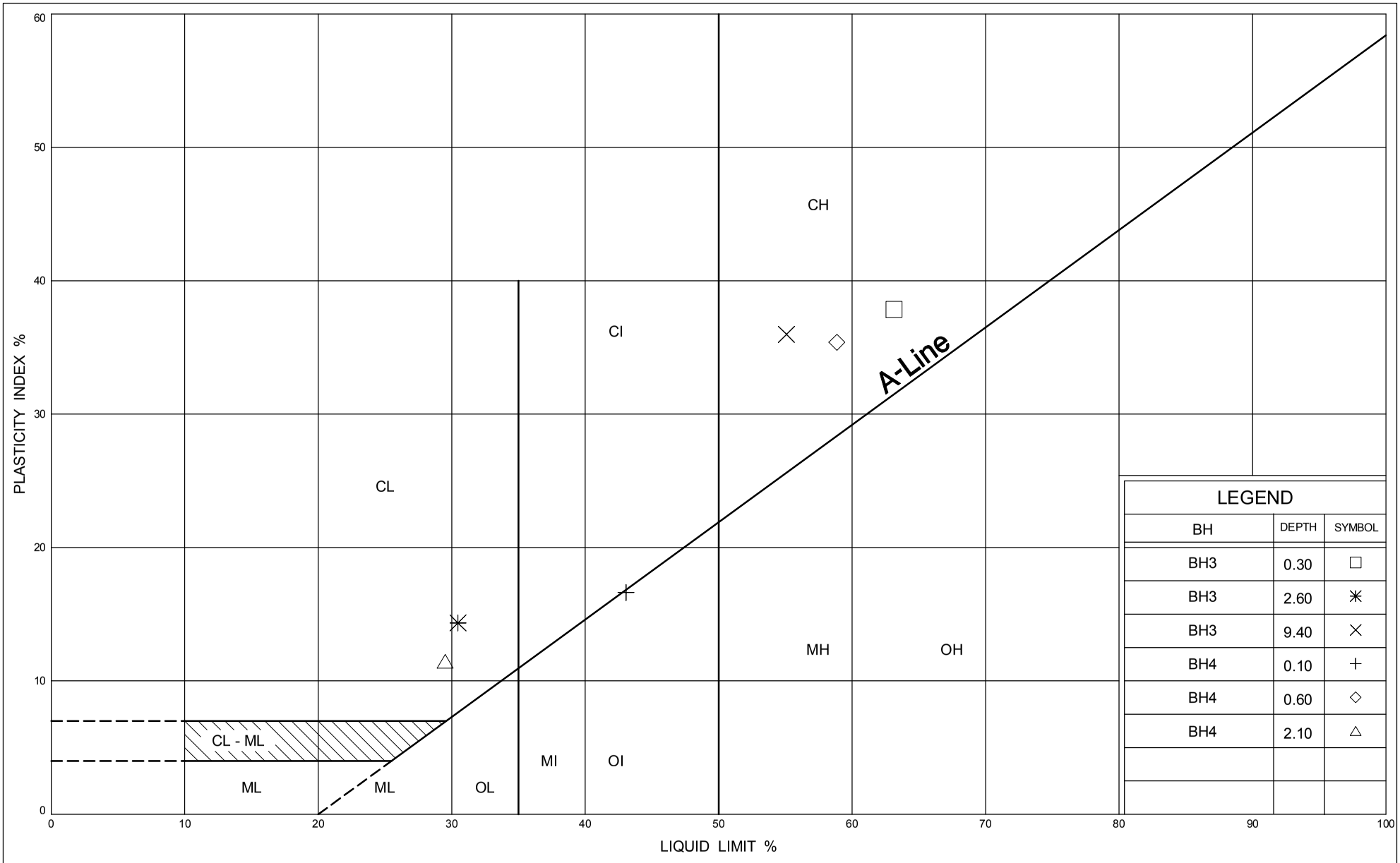
Ministry of Transportation Ontario

PLASTICITY CHART
LOW-INTERMEDIATE PLASTIC CLA□

ENCLOSURE □

DST REF□□ GS-T□-□2□823

RAIN□ RIVER TRI□UTAR□



LEGEND		
BH	DEPTH	SYMBOL
BH3	0.30	□
BH3	2.60	✳
BH3	9.40	×
BH4	0.10	+
BH4	0.60	◇
BH4	2.10	△

Ministry of Transportation Ontario

PLASTICITY CHART
LOW T□ HIGH PLASTIC CLA□

ENCL□SURE □

DST REF□□ GS-TB-020823

RAIN□ RIVER TRI□UTAR□

DST Thunder Bay
ATTN: Selorm Danku
DST Consulting Engineers Inc.
1120 Premier Way , Suite 200
Thunder Bav ON P7B 0A3

Date Received: 01-DEC-15
Report Date: 10-DEC-15 08:02 (MT)
Version: FINAL

Client Phone: 807-345-3620

Certificate of Analysis

Lab Work Order #: L1709005

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Rikki Thomson
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1709005-1 RAINY RIVER TRIB. CULVERT Sampled By: Client on 01-DEC-15 @ 00:01 Matrix: Soil							
Physical Tests							
Conductivity	480		4.0	umhos/cm	07-DEC-15	07-DEC-15	R3325981
% Moisture	3.42		0.10	%	04-DEC-15	05-DEC-15	R3325347
pH	8.02		0.10	pH units		07-DEC-15	R3326423
Resistivity	2080		100	ohm cm	07-DEC-15	07-DEC-15	R3325976
Leachable Anions & Nutrients							
Chloride	224		20	mg/kg	04-DEC-15	08-DEC-15	R3327616
Anions and Nutrients							
Sulphate	29		20	mg/kg	04-DEC-15	08-DEC-15	R3327616

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-WT	Soil	Chloride in Soil	EPA 300.0
EC-WT	Soil	Conductivity (EC)	EPA 9050A
		A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.	
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
PH-WT	Soil	pH	MOEE E3137A
		Soil samples are mixed in the deionized water and the supernatant is analyzed directly by the pH meter.	
RESISTIVITY-WT	Soil	Resistivity	MOECC E3138
		Resistivity on a soil is a 2:1 extraction of DI water to soil. Sample is tumbled for 30 min. Conductivity of the extraction is taken and the inverse is calculated for resistivity.	
SO4-WT	Soil	Sulphate	EPA 300.0

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1709005 Report Date: 10-DEC-15

Client: DST Thunder Bay
DST Consulting Engineers Inc. 1120 Premier Way , Suite 200
Thunder Bay ON P7B 0A3

Contact: Selorm Danku

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-WT	**Soil**							
Batch R3327616								
WG2226771-3 CRM		**AN-CRM-WT**						
Chloride			102.9		%		70-130	08-DEC-15
WG2226771-2 LCS								
Chloride			95.9		%		70-130	08-DEC-15
WG2226771-1 MB								
Chloride			<20		mg/kg		20	08-DEC-15
EC-WT	**Soil**							
Batch R3325981								
WG2227671-1 MB								
Conductivity			<4.0		umhos/cm		4	07-DEC-15
MOISTURE-WT	**Soil**							
Batch R3325347								
WG2226652-2 LCS								
% Moisture			95.5		%		90-110	05-DEC-15
WG2226652-1 MB								
% Moisture			<0.10		%		0.1	05-DEC-15
PH-WT	**Soil**							
Batch R3326423								
WG2228014-1 LCS								
pH			6.99		pH units		6.7-7.3	07-DEC-15
SO4-WT	**Soil**							
Batch R3327616								
WG2226771-3 CRM		**AN-CRM-WT**						
Sulphate			110.5		%		60-140	08-DEC-15
WG2226771-2 LCS								
Sulphate			96.2		%		70-130	08-DEC-15
WG2226771-1 MB								
Sulphate			<20		mg/kg		20	08-DEC-15

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Appendix 'E'
NSSP

DEWATERING OPERATION REQUIREMENT - Item No. 1

Non-Standard Special Provision

This special provision covers the dewatering operation requirement.

Continuous dewatering operation is required for using 1.5H:1.0V unsupported slope during excavation for the culvert replacement work. There is stability issue for excavation using unsupported slope without dewatering operation.

It should be noted that depending on the season, depth of excavation and amount of water flow through the creek may vary. The contractor should be prepared to tackle this situation. The contractor should be noted of the high water table and surface water fluctuation for dewatering operation.