



October 7, 2016

FOUNDATION INVESTIGATION REPORT

**SAVANNE RIVER TRIBUTARY AND RAITH CREEK CULVERTS
SITE NOS. 48W-194/C AND 48W-17/C
HIGHWAY 17, DISTRICT OF THUNDER BAY
FALLIS TOWNSHIP AND ROBSON TOWNSHIP
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 6334-14-00, WP 6335-14-01 & WP 6334-14-01**

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REPORT





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PART A

**FOUNDATION INVESTIGATION REPORT
SAVANNE RIVER TRIBUTARY AND RAITH CREEK CULVERTS
(48W-194/C & 48W-17/C)
HIGHWAY 17, DISTRICT OF THUNDER BAY
TOWNSHIPS OF FALLIS AND ROBSON
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 6334-14-00, WP 6335-14-01 & WP 6334-14-01**



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Hatch Ltd. (Hatch), on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the dewatering protection system associated with the rehabilitation of the Savanne River Tributary and the Raith Creek culverts, Sites 48W-194/C and 48W-17/C, respectively. The Savanne River Tributary and Raith Creek culverts are located in the District of Thunder Bay in the Townships of Fallis and Robson, respectively, on Highway 17. The site location plan showing the general location of the culverts is presented on Figure 1.

2.0 SITE DESCRIPTION

The existing Savanne River Tributary and Raith Creek culverts consist of Concrete Boxes, the details of which (size, length, type, etc.) are summarized in Table 1 following the text of this report.

It should be noted that the orientation (i.e., north, south, east, west) stated in the text of the report is typically referenced to project north and therefore may differ from magnetic north shown on the drawings. For the purposes of this report, Highway 17 is oriented in a northwest-southwest direction for this section of roadway with the culverts essentially perpendicular to the highway in an east-west orientation.

The Savanne River Tributary and Raith Creek generally flow in a southwest and west direction, respectively, discharging into the Savanne River, which ultimately flows into Lac des Milles Lacs.

2.1 Savanne River Tributary Culvert

The Savanne River Tributary culvert is located in the District of Thunder Bay in the Township of Fallis on Highway 17 at about STA 16+008, approximately 14.5 m northwest of Raith, Ontario.

In general, the topography in the area is relatively flat to gently undulating with the exception of the steep roadway and railway embankments at the creek location. The topography consists of large networks of wetlands and creeks. Dense tree cover surrounds the wetlands in non-swamp areas. At the Savanne River Tributary culvert location, the highway grade is at Elevation 461.2 m. The existing culvert invert is at Elevation 457.12 m at the inlet (east end) and at Elevation 457.09 m at the outlet (west end). The Savanne River Tributary water level near the downstream end of the culvert was at Elevation 458.2 m, as measured by others in September 2013. Ground surface conditions at the culvert location are shown on Photographs A-1 to A-4 in Appendix A.

2.2 Raith Creek Culvert

The Raith Creek culvert is located the District of Thunder Bay in the Township of Robson on Highway 17 at approximately STA 15+257, about 7.2 km northwest of Raith, Ontario.

In general, the topography in the area is relatively flat to gently undulating with the exception of the steep roadway and railway embankments at the creek location. The topography consists of large networks of wetlands and creeks. Dense tree cover surrounds the wetlands in non-swamp areas. At the Raith Creek culvert, the highway grade is at Elevation 471.46 m. The existing culvert invert is at Elevation 468.14 m at the inlet (east end) and Elevation 468.05 m at the outlet (west end). The Raith Creek water level near the upstream side of the culvert was at



Elevation 469.3 m, measured by others in September 2013. Ground surface conditions at the culvert location are shown on Photographs B-1 to B-4 in Appendix B.

3.0 INVESTIGATION PROCEDURES

The fieldwork for the investigation for the Savanne River Tributary and Raith Creek culvert sites was carried out between January 12 and 27, 2016, during which period a total of eight (8) boreholes were drilled at the two culvert sites: four boreholes were drilled at the Savanne River Tributary culvert (Boreholes SV-1 to SV-4); and four boreholes were advanced at the Raith Creek culvert (Boreholes RT-1 to RT-4). A summary of the boreholes advanced at each culvert site is presented in Table 1 and the locations of the boreholes and culvert sites are shown on Drawings A1 and B1 in Appendices A and B, respectively.

The field investigation was carried out using a track-mounted CME 850 drill rig supplied and operated by Cartwright Drilling Ltd. of Thunder Bay, Ontario and portable tripod equipment supplied and operated by Landcore Drilling Inc. of Chelmsford, Ontario.

The boreholes were advanced using a combination of 108 mm inside diameter hollow stem augers and NW casing with wash boring techniques. Soil samples were obtained in the boreholes at 0.75 m and 1.5 m intervals of depth using 50 mm outer diameter split-spoon samplers driven by an automatic hammer, in accordance with the Standard Penetration Test (SPT) procedures (ASTM D1586). The boreholes advanced by portable equipment employed a full weight hammer lifted manually and dropped from the SPT height. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Shear Strength Test) using MTO Standard 'N'-size vanes. The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A and B.

The boreholes were advanced to depths ranging from 8.3 m to 9.8 m below existing ground surface or ice surface. The open portion of the boreholes was backfilled upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The field work was supervised on a full-time basis by members of Golder's technical staff who: located the boreholes in the field; arranged for the clearance of underground services; supervised the drilling and sampling operations; logged the boreholes; and examined and cared for the soil samples. The soil samples were identified in the field, placed in labelled containers and transported to Golder's geotechnical laboratory in Sudbury for further examination and laboratory testing. Index and classification testing consisting of water content determinations, Atterberg limits and grain size distributions were carried out on selected soil samples. The geotechnical laboratory testing was completed according to MTO LS standards.

A sample of the Savanne River Tributary and Raith Creek waters was obtained during the field investigation at each culvert location, using appropriate sampling protocols and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of parameters.

The as-drilled borehole locations and elevations were measured and surveyed by members of Golder's technical staff, referenced to the highway centreline and existing culverts. The locations were subsequently converted into MTM NAD 83 coordinates in AutoCAD. The borehole elevations were converted to Geodetic datum using the highway centreline elevation provided by MTO on Drawings BC-1026-17-4 and BC-1037-17-3. The borehole locations given on the Record of Borehole sheets and shown on Drawings A1 and B1 are positioned relative to



MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations, and drilled depths are as follows:

Culvert Location (Township)	Borehole	MTM NAD 83 Coordinates (m)		Ground Surface Elevation (m)	Borehole Depth (m)
		Northing	Easting		
Savanne River Tributary Culvert, Site 48W-194/C, STA 16+008 (Fallis)	SV-1	5,419,285.9	300,755.7	458.5	9.8
	SV-2	5,419,281.2	300,766.2	458.7	9.8
	SV-3	5,419,260.4	300,743.2	458.5	9.8
	SV-4	5,419,254.7	300,753.6	458.6	9.8
Raith Creek Culvert Site 48W-17/C, STA 15+257 (Robson)	RT-1	5,414,830.7	306,511.3	469.3	8.3
	RT-2	5,414,819.2	306,515.2	469.5	9.8
	RT-3	5,414,821.8	306,484.4	469.4	9.8
	RT-4	5,414,807.2	306,490.0	470.2	9.8

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

Based on Northern Ontario Engineering Geology Terrain (NOEGTS)¹ mapping, the subsoils in the vicinity of the Savanne River Tributary culvert consist of outwash plain and valley train deposits comprised primarily of sand. These deposits are bordered in the vicinity of the Raith Creek culvert by organic terrain deposits comprised of peat and muck and ground moraine deposits comprised mainly of till.

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM)², the Savanne River Tributary and Raith Creek culvert sites are underlain by massive to foliated tonalite to granodiorite to granite bedrock, containing potassium feldspar megacrystic units. The site is bordered by foliated to gneissic tonalite to granodiorite bedrock with minor supracrustal inclusions.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole sheets contained in Appendix A and Appendix B for Savanne River Tributary and Raith Creek culvert sites, respectively. The results of the in situ field tests (i.e., SPT 'N'-values and undrained shear strengths from field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic cross-sections on Drawings A1 and B1 are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

¹ Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Electronic Mapping.

² Ministry of Northern Development of Mines. Bedrock Geology of Ontario – West Central Sheet, Ontario Geological Survey – Map 2542



4.2.1 Savanne River Tributary Culvert

A total four boreholes, Boreholes SV-1 through SV-4, were advanced at the Savanne River Tributary culvert site. The borehole locations, ground surface elevations and interpreted stratigraphic conditions are shown in Drawing A1.

In summary, the subsoil conditions encountered at the site consist of peat or organic silt underlain by a deposit of clayey silt to silty clay, further underlain by a deposit of silt. A deposit of silty sand was encountered underlying the peat layer in Borehole SV-4. A more detailed description of the soil deposits and groundwater conditions encountered in the boreholes is presented below.

Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Surface Elevation (m)	N Values (blows)/ S_u Shear Strength (kPa)	Laboratory Testing
				Relative Density or Consistency	
Fibrous peat; black; wet.	SV-1	0.7	458.5	N = 2 Very soft	n/a
Clayey organic silt to organic silt, trace fibrous peat, brown to black, frozen.	SV-2 to SV-4	0.7	458.7 - 458.5	n/a	n/a
Silty sand, trace organics; brown; wet.	SV-4	1.1	457.9	N = 2 Very loose	n/a
Clayey silt to silty clay¹, trace sand, silt to sandy silt laminations; grey; wet.	SV-1 to SV-4	1.2 - 2.7	458.0 - 456.8	N = 3 - 10 S_u = 72 - 81 S = 2, 3 Soft to stiff	w = 26% - 43% w_p = 21% - 23% w_L = 31% - 37% I_p = 9% - 15% 4 - MH (Fig. A1) 4 - AL (Fig. A2)
Silt², trace to some clay; grey; wet	SV-1 to SV-4	>6.3 - >6.8	455.6 - 455.0	N = WH - 14 Very loose to compact	w = 27% - 32% 6 - MH (Fig. A3) 4 - N.P.

N = SPT 'N'-value; number of blows for 0.3 m of penetration

S_u = Undrained Shear Strength (kPa)

S = Sensitivity

MH = Combined Sieve and Hydrometer analysis

w = Natural Moisture Content (%)

w_p = Plastic Limit (%)

w_L = Liquid Limit (%)

I_p = Plasticity Index (%)

AL = Atterberg Limits Test

N.P. = Non-Plastic Atterberg Limits Test Result



Notes:

¹ Trace organics, trace sand, and trace gravel were encountered to a depth of 1.4 m in Borehole SV-1.

² Sandy silt laminations observed to a depth of 4.4 m and silty clay laminations observed below 9.1 m depth in Borehole SV-2.

Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized below. The water level at the Savanne River Tributary culvert was at Elevations 458.2 m, measured by others in September 2013. Groundwater and Tributary creek water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Groundwater Level (m)	Groundwater Elevation (m)
SV-1	0.0	458.5
SV-2	Dry	-
SV-3	Dry	-
SV-4	Dry	-

Analytical Testing of Creek Water

The results of an analytical test on a sample of Tributary creek water taken at the culvert site are presented in Table 2. The suite of parameters tested include pH, sulphate, chloride, resistivity and conductivity.

4.2.2 Raith Creek Culvert

A total of four boreholes, Boreholes RT-1 to RT-4, were advanced at the Raith Creek culvert site. The borehole locations, ground surface elevations and interpreted stratigraphic conditions are shown in Drawing B1.

In summary, the subsoil conditions encountered at the site consist of peat and sand fill in places, underlain by deposits of silt and silty clay to clay, layers of sandy silt and clay in places, all underlain by a deposit of sandy silt to silt and sand. A more detailed description of the soil deposits and groundwater conditions encountered in the boreholes is below.

Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Surface Elevation (m)	N Values (blows)/ S _u Shear Strength (kPa)	Laboratory Testing
				Relative Density or Consistency	
Silty to Sandy Peat to Fibrous Peat; brown to brown-black to brown-grey; frozen to wet.	RT-1, RT-3 and RT-4	1.2 – 1.8	470.2 - 468.7	N = 1- 6*	n/a
				Very loose to loose	



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Deposit/Layer Description	Boreholes	Deposit Thickness (m)	Deposit Surface Elevation (m)	N Values (blows)/ s _u Shear Strength (kPa)	Laboratory Testing
				Relative Density or Consistency	
(FILL) Sand , trace organics; brown; wet	RT-2	0.7	469.5	n/a	w = 13%
Silt and Sand ; trace clay; grey; wet	RT-4	1.5	468.7	N = 9, 10	w = 22%
				Loose to compact	1 – MH (Fig B5)
Silt ¹ , trace to some sand, trace to some clay, thin clay laminations; grey; wet.	RT-1 to RT-4	1.5 – 6.9	468.8 – 467.2	N = 4 – 23	w = 24% - 28% w _p = 18% - 22% w _l = 22% - 34% I _p = 3% - 12%
				Loose to compact	7 – MH (Fig. B1) 4 – AL (Fig. B2)
Silty Clay to Clay ² , trace to some silt, trace sand; red-brown; wet.	RT-1, RT-2, and RT-4	1.0 – 2.2	463.9 – 463.0	N = WH - 4 s _u = 48, >100 S = 2	w = 53%, 55% w _p = 22%, 25% w _l = 58%, 71% I _p = 36%, 46%
				Very soft to very stiff	2 – MH (Fig. B3) 2 – AL (Fig. B4)
Sandy silt to Silt and Sand ³ ; trace to some gravel; grey; wet	RT-1 to RT-4	>0.3 - >4.3	465.7 – 460.7	N = 7 – 31	w = 11%
				Loose to dense	1 – MH (Fig. B5)

Where:

N = SPT 'N'-value; number of blows for 0.3 m of penetration

s_u = Undrained Shear Strength (kPa)

S = Sensitivity

MH = Combined Sieve and Hydrometer analysis

w = Natural Moisture Content (%)

w_p = Plastic Limit (%)

w_l = Liquid Limit (%)

I_p = Plasticity Index (%)

AL = Atterberg Limits Test

Notes:

* Frozen

¹ A layer of clayey silt was encountered in Borehole RT-3 from 3.0 m to 3.7 m.

² Sandy silt laminations observed in this deposit in Borehole RT-2.

³ Interlayers of this deposit were encountered between peat, silt, and clay in Borehole RT-4.

Groundwater Conditions

Unstabilized groundwater levels measured in the open boreholes upon completion of drilling are summarized below. The water level at the Raith Creek culvert was at Elevations 469.3 m, measured by others in



September 2013. Groundwater and creek water levels in the area are subject to seasonal fluctuations and variations due to precipitation events.

Borehole No.	Depth to Groundwater Level (m)	Groundwater Elevation (m)
RT-1	0.0	469.3 (ice/water)
RT-2	0.2	469.3
RT-3	0.0	469.4
RT-4	0.8	469.4

Analytical Testing of Creek Water

The results of an analytical test on a sample of creek water taken at the culvert site are presented in Table 2. The suite of parameters tested include pH, sulphate, chloride, resistivity and conductivity.

5.0 CLOSURE

The drilling program was supervised by Mr. Mathew Riopelle and Mr. Shane Albert under the direction of Mr. David Muldowney, P.Eng. This report was prepared by Ms. Sarah Nhan, E.I.T. The technical aspects were reviewed by Ms. Nikol Kochmanová, P.Eng., and Mr. Jorge M. A. Costa, P.Eng., a Senior Consultant and Golder's Designated MTO Contact for this project, carried out a quality control review of the report.

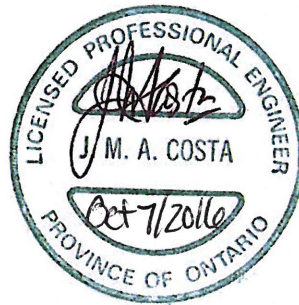


Report Signature Page

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SN/NK/DAM/JMAC/kp

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SAVANNE RIVER TRIBUTARY AND RAITH CREEK CULVERTS,
GWP 6334-14-00, WP 6335-14-01 & WP 6334-14-01**

Table 1: Summary of Details of Existing Culverts

Culvert Location Highway 17 (Township)	Approximate Existing Embankment Height ¹ (m)	Existing Culvert			Approximate Inlet/Outlet Invert Elevation (m)	Boreholes	Reference Appendix
		Type	Height x Span (m)	Length (m)			
Savanne River Tributary Culvert, Site 48W-194/C, STA 16+008 (Fallis)	3 (1 m over culvert)	Cast-in-Place Reinforced Concrete Box	1.8 x 3.7	26	457.12/457.09	4 Boreholes (SV-1 to SV-4)	A
Raith Creek Culvert, Site 48W-17/C, STA 15+257 (Robson)	3.5 (2 m over culvert)	Cast-in-Place Reinforced Concrete Box	±3.66 x 6.3	24.5	468.14/468.05	4 Boreholes (RT-1 to RT-4)	B

Note: 1. Embankment height is relative to existing ground surface level near toe of embankment adjacent to culvert.

Prepared by: SN
Reviewed by: NK



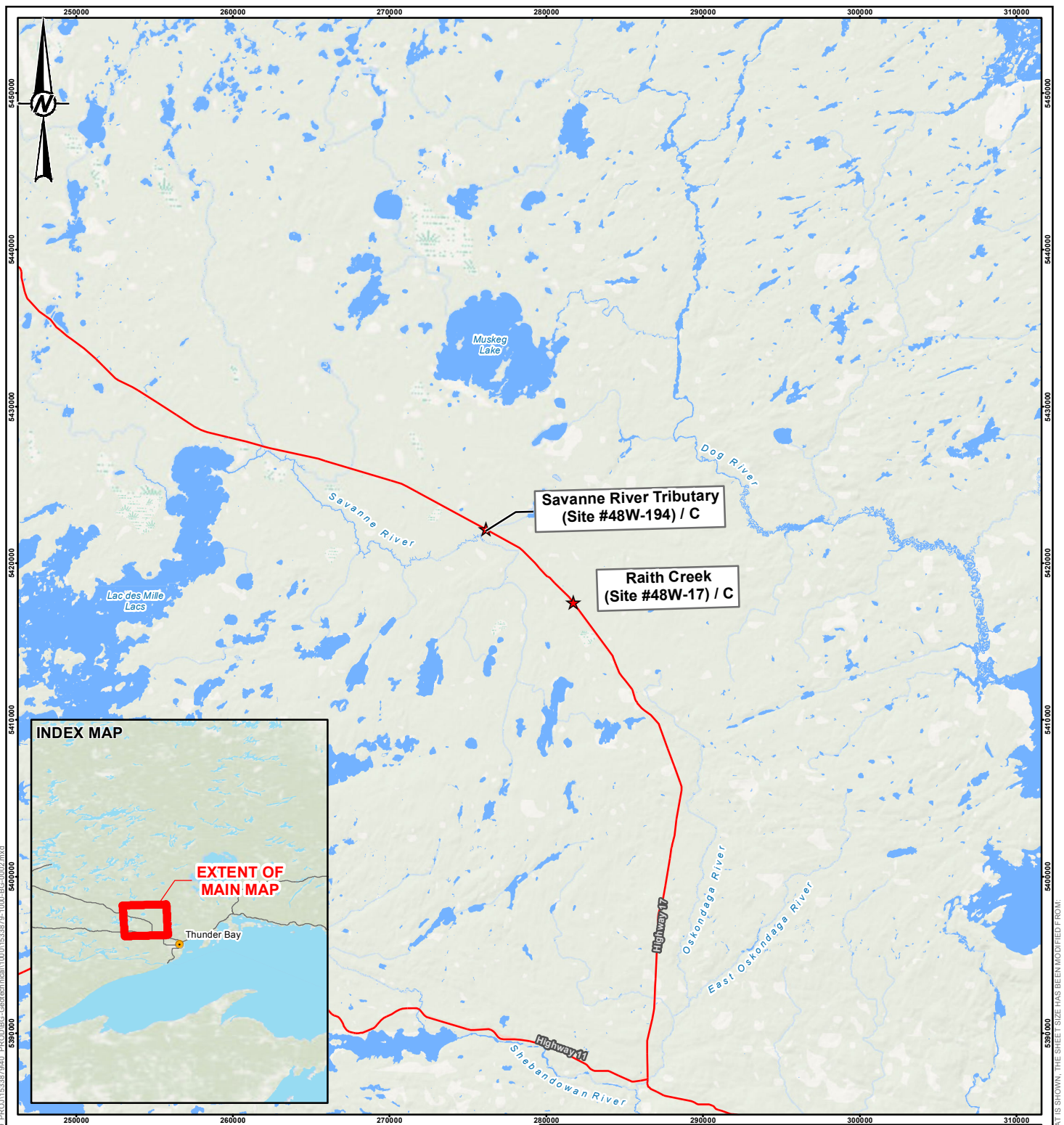
**FOUNDATION REPORT - HIGHWAY 17 CULVERT REPLACEMENTS
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Table 2: Summary of Analytical Testing of Creek Water

Culvert Location Highway 17 (Township)	Parameter (Units, Detection Limit)				
	Chloride (mg/L, 0.1)	Sulphate (mg/L, 0.3)	Conductivity (μS/cm, 3)	Resistivity (ohm-cm, 0.33)	pH (0.1)
Savanne River Tributary Culvert , Site 48W-194/C, STA 16+008 (Fallis)	18.5	0.5	118	8,480	6.1
Raith Creek Culvert, Site 48W-17/C, STA 15+257 (Robson)	5.3	0.6	73	13,600	6.4

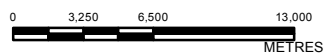
Notes: 1. Samples obtained January 25, 2016.
2. Analytical testing carried out by ALS Environmental.

Prepared by: SN
Reviewed by: NK



Legend

- ★ Site Location
- Highway
- Waterbodies



NOTE(S)
THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING
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REFERENCE(S)
SERVICE LAYER CREDITS: ESRI, DELORME, GEBCO, NOAA NGDC, AND OTHER CONTRIBUTORS
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PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 17 VERTICAL DATUM: CGVD28

CLIENT
ONTARIO MINISTRY OF TRANSPORTATION

PROJECT
SAVANNE RIVER TRIBUTARY AND RAITH CREEK CULVERTS
REHABILITATION

TITLE
LOCATION PLAN

CONSULTANT



YYYY-MM-DD 2016-04-22

DESIGNED RRD

PREPARED RRD

REVIEWED AC

APPROVED JMAC

PROJECT NO.
1533879

CONTROL
1000

REV.
1

FIGURE
1

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a)	Index Properties
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	C_u, S_u	
	kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

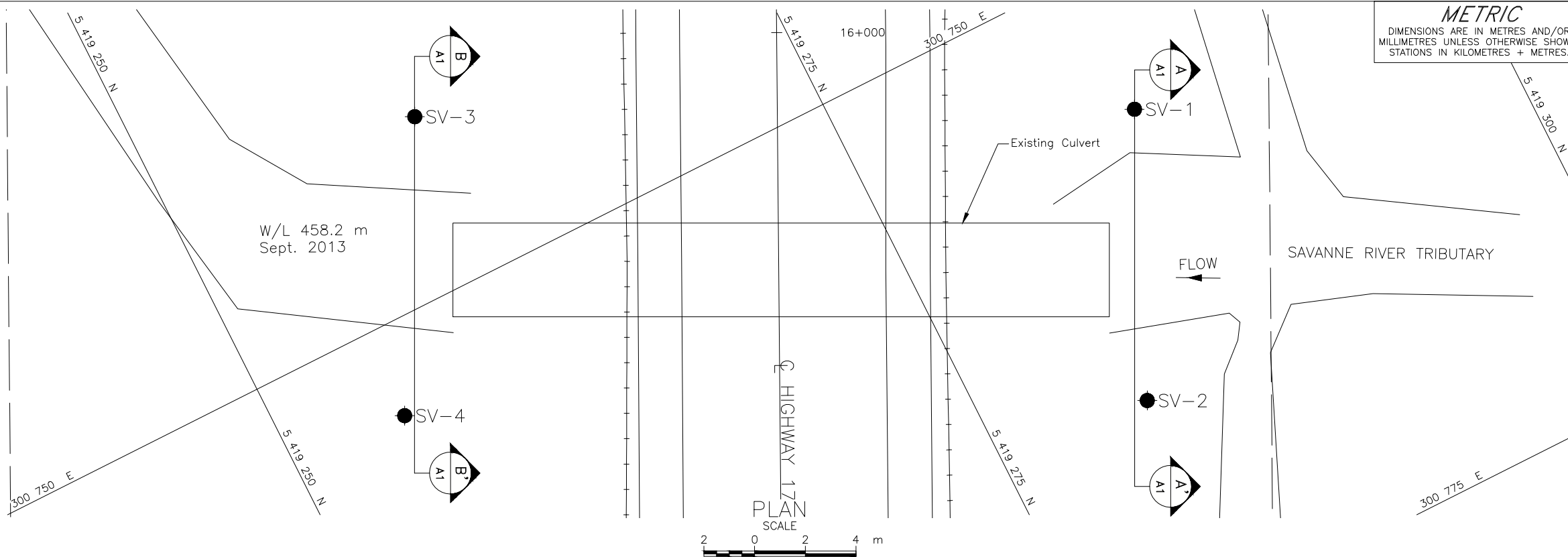
V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



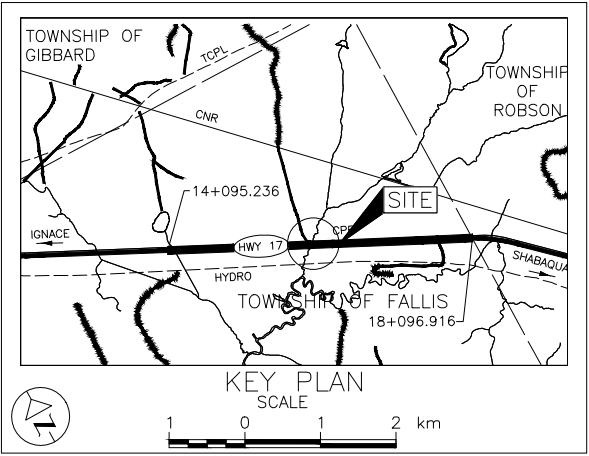
APPENDIX A

Savanne River Tributary Culvert, Site 48W-194/C (Fallis Township)



CONT No.
GWP No.6334-14-00

HIGHWAY 17
SAVANNE RIVER TRIBUTARY CULVERT STA 16+008
BOREHOLE LOCATIONS AND
SOIL STRATA



LEGEND

Borehole - Current Investigation

N

Standard Penetration Test Value

16

Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)

WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
SV-1	458.5	5419285.9	300755.7
SV-2	458.7	5419281.2	300766.2
SV-3	458.5	5419260.4	300743.2
SV-4	458.6	5419254.7	300753.6

NOTES

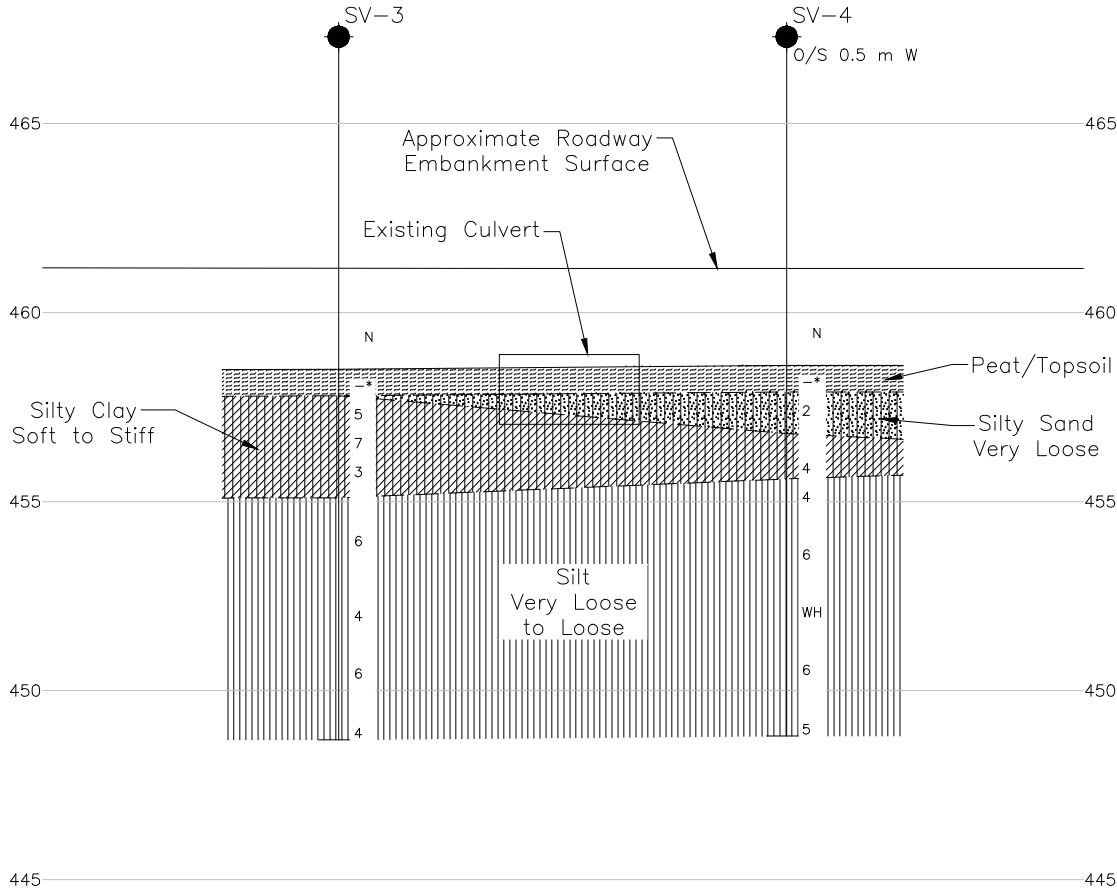
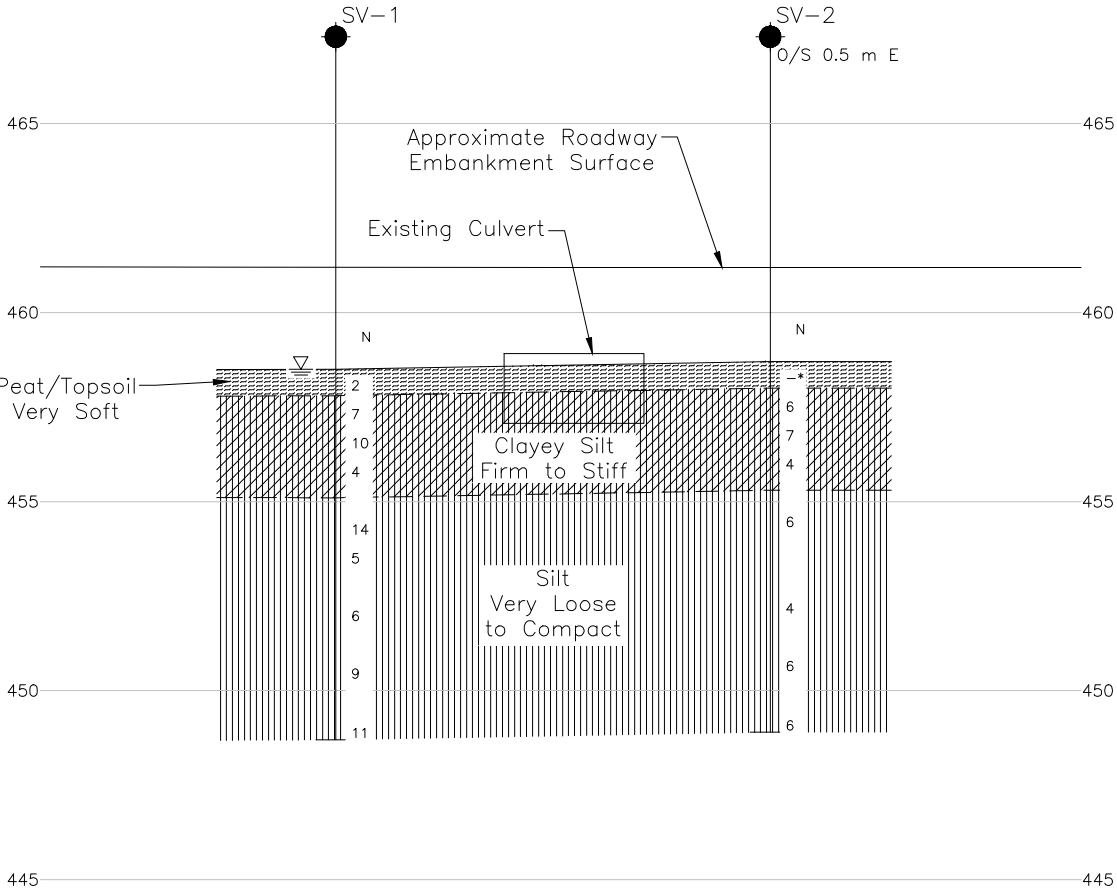
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by MTO, drawing file nos. BC1026174.dwg received Dec. 11, 2015.



NO.	DATE	BY	REVISION
Geocres No. 52B-27			
HWY. 17	PROJECT NO. 1533879		DIST. .
SUBM'D. SN	CHKD. .	DATE: 10/7/2016	SITE: 48W-194/C
DRAWN: TB	CHKD. NK	APPD. JMAC	DWG. A1



PHOTOGRAPHS

**Photograph A1: Savanne River Tributary Culvert
Looking West at Culvert Inlet Area (December 2015)**



**Photograph A2: Savanne River Tributary Culvert
Looking West at Culvert Outlet Area (December 2015)**





PHOTOGRAPHS

**Photograph A3: Savanne River Tributary Culvert
Looking South at North End of Culvert (Inlet) (December 2015)**



**Photograph A4: Savanne River Tributary Culvert
Looking North at South End of Culvert (Outlet) (December 2015)**







PROJECT 1533879		RECORD OF BOREHOLE No SV-1				1 OF 1 METRIC								
G.W.P. 6334-14-00		LOCATION N 5419285.9; E 300755.7				ORIGINATED BY SA								
DIST _____ HWY 17		BOREHOLE TYPE Portable Equipment, NW Casing, HQ Coring				COMPILED BY SN								
DATUM GEODETIC		DATE January 27, 2016				CHECKED BY NK								
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						
458.5	GROUND SURFACE													
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	2									
457.8														
0.7	CLAYEY SILT, trace organics to 1.4 m depth, fine silt laminations Firm to stiff Grey Wet		2	SS	7									
	Trace sand, trace gravel in Sample 2.		3	SS	10									
			4	SS	4									
455.0														
3.5	SILT, trace to some clay Loose to compact Grey Wet		5	SS	14									
			6	SS	5									
			7	SS	6									
			8	SS	9									
			9	SS	11									
448.7														
9.8	END OF BOREHOLE													
	Note: 1. Water level at ground surface (Elev. 458.5 m) upon completion of drilling. 2. Borehole caved to 7.6 m (Elev. 450.9 m) upon removal of casing.													

SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

PROJECT 1533879		RECORD OF BOREHOLE No SV-2				1 OF 1 METRIC								
G.W.P. 6334-14-00		LOCATION N 5419281.2; E 300766.2				ORIGINATED BY MR								
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY SN								
DATUM GEODETIC		DATE January 18, 2016				CHECKED BY NK								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L		
458.7	GROUND SURFACE													
0.0	Clayey ORGANIC SILT Brown Frozen*		1	AS	-*									
458.0							458							
0.7	CLAYEY SILT Firm to stiff Grey Wet		2	SS	6									
							457							0 0 74 26
	Sandy silt laminations in Sample 4.		3	SS	7									
							456							
			4	SS	4									
455.3														
3.4	SILT, some clay Very loose to loose Grey Wet						455							
	Sandy silt laminations in Sample 5.		5	SS	6								NP	0 1 89 10
							454							
							453							
			6	SS	4									
							452							
							451						NP	0 0 85 15
			7	SS	6									
							450							
	Silty clay laminations in Sample 8.													
			8	SS	6									
448.9							449							
9.8	END OF BOREHOLE													
	Note: 1. Borehole dry upon completion of drilling. 2. Borehole caved to 5.2 m (Elev. 453.5 m) upon completion of drilling.													

SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

PROJECT 1533879		RECORD OF BOREHOLE No SV-3				1 OF 1 METRIC											
G.W.P. 6334-14-00		LOCATION N 5419260.4; E 300743.2				ORIGINATED BY MR											
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY SN											
DATUM GEODETIC		DATE January 17, 2016				CHECKED BY NK											
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									
458.5	GROUND SURFACE							20	40	60	80	100					
0.0	ORGANIC SILT Brown Frozen*		1	AS	-*												
457.8	SILTY CLAY, trace sand Soft to stiff Grey Wet		2	SS	5												
			3	SS	7												
	Sandy silt laminations in Sample 4.		4	SS	3												0 1 71 28
455.1	SILT, some clay Very loose to loose Grey Wet		5	SS	6												
3.4			6	SS	4												
			7	SS	6												0 0 83 17
			8	SS	4												
448.7	END OF BOREHOLE																
9.8	Note: 1. Borehole dry upon completion of drilling. 2. Borehole caved to 6.6 m (Elev. 451.8 m) upon completion of drilling.																

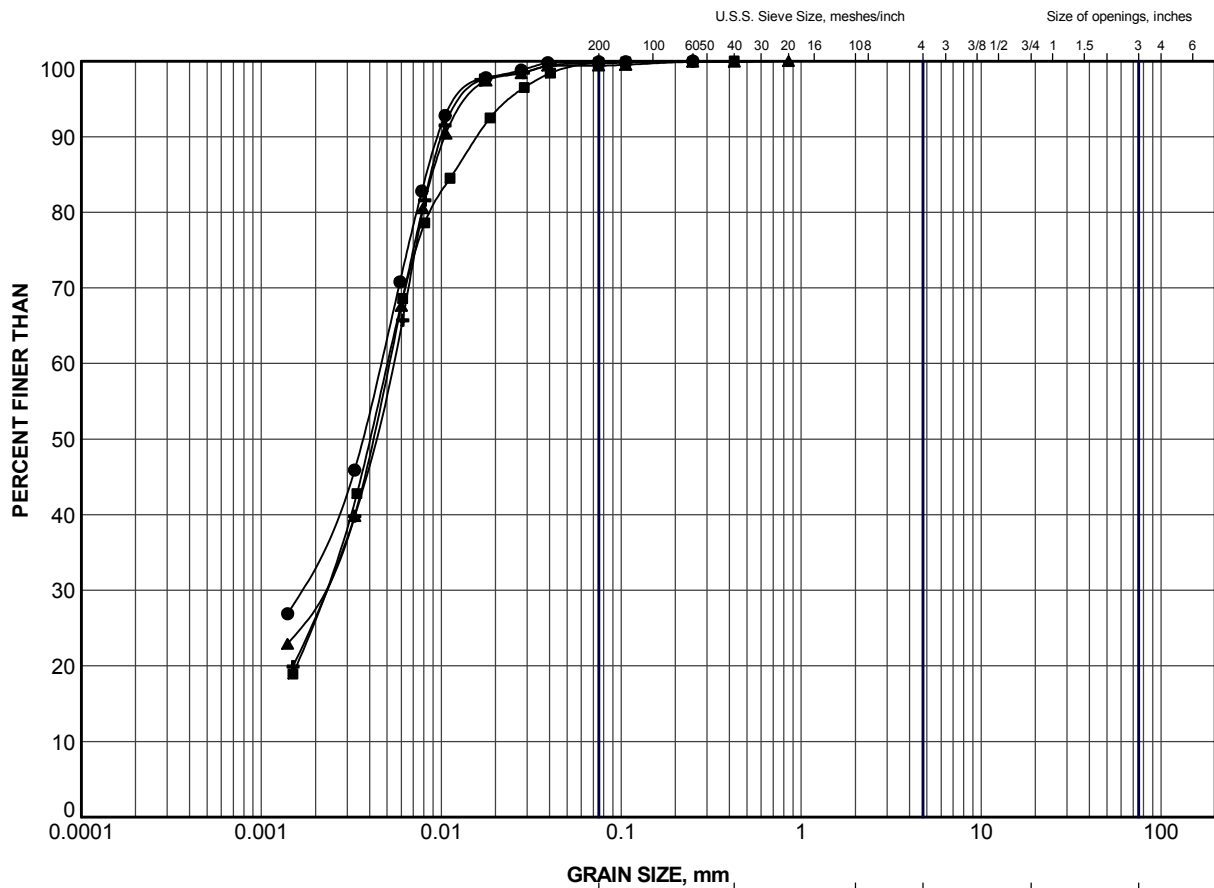
SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

PROJECT 1533879		RECORD OF BOREHOLE No SV-4		1 OF 1 METRIC	
G.W.P. 6334-14-00		LOCATION N 5419254.7; E 300753.6		ORIGINATED BY MR	
DIST HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY SN	
DATUM GEODETIC		DATE January 17, 2016		CHECKED BY NK	

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				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
458.6	GROUND SURFACE																
0.0	ORGANIC SILT, trace fibrous peat Black Frozen*		1	AS	-*												
457.9							458										
0.7	SILTY SAND, trace organics Very loose Brown Wet		2	SS	2												
							457										
456.8																	
1.8	SILTY CLAY, sandy silt laminations Firm to stiff Grey Wet		3	SS	4												
							456								0 0 74 26		
455.6																	
3.0	SILT, some clay Very loose to loose Grey Wet		4	SS	4		455										
							454								0 1 87 12		
			5	SS	6												
							453										
			6	SS	WH		452										
							451								0 0 87 13		
			7	SS	6												
							450										
			8	SS	5		449										
448.8																	
9.8	END OF BOREHOLE																
	Note: 1. Borehole dry upon completion of drilling. 2. Borehole caved to 5.6 m (453.0 m) upon completion of drilling.																

SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

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

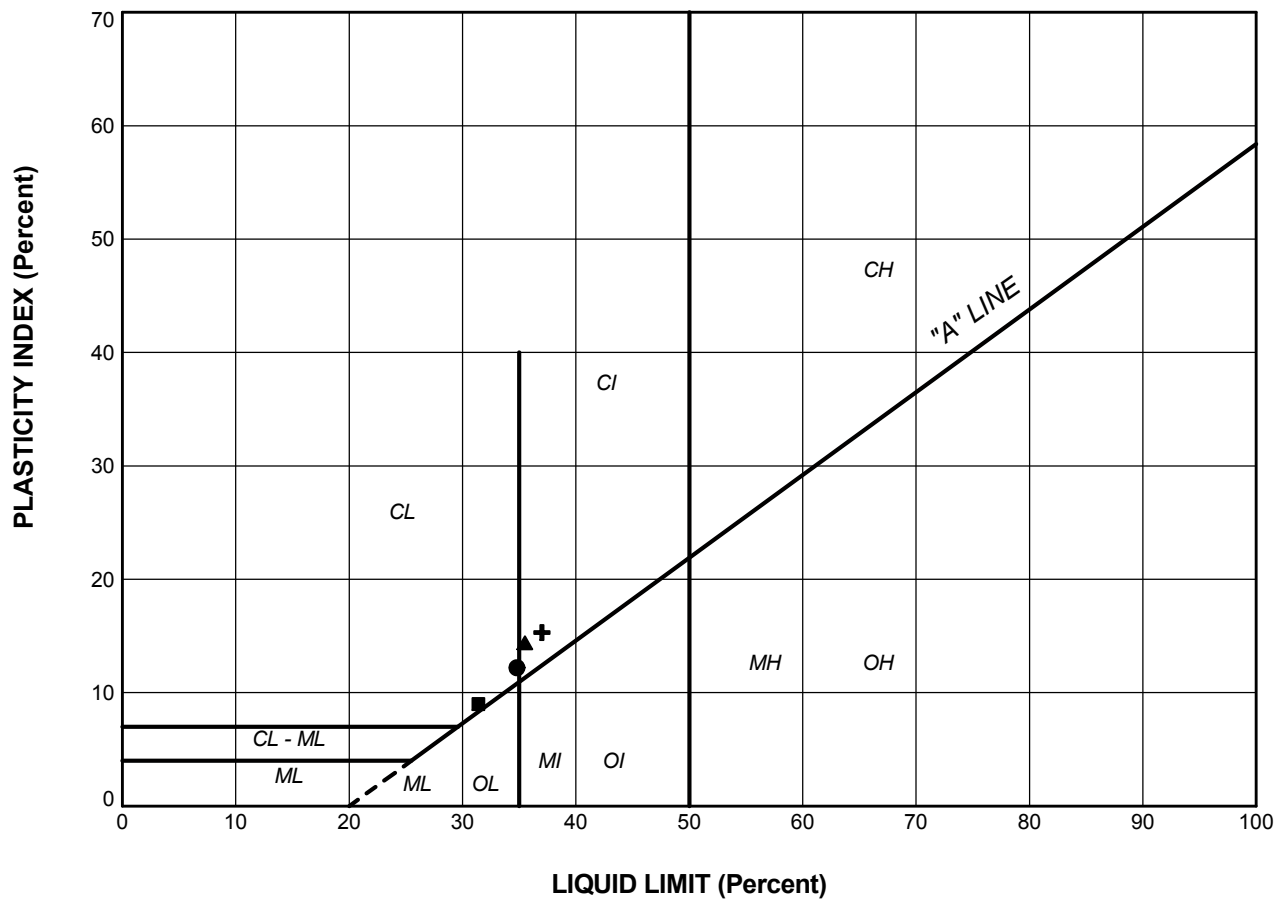


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	SV-1	4	455.9
■	SV-2	3	456.9
▲	SV-3	4	455.9
+	SV-4	3	456.0

PROJECT					
HIGHWAY 17 SAVANNE RIVER TRIBUTARY CULVERT STA 16+009					
TITLE					
GRAIN SIZE DISTRIBUTION CLAYEY SILT to SILTY CLAY					
PROJECT No.		1533879		FILE No. 1533879.GPJ	
DRAWN	JJL	Mar 2016	SCALE	N/A	REV.
CHECK	NK	Mar 2016			
APPR	JMAC	Mar 2016			
			FIGURE A1		



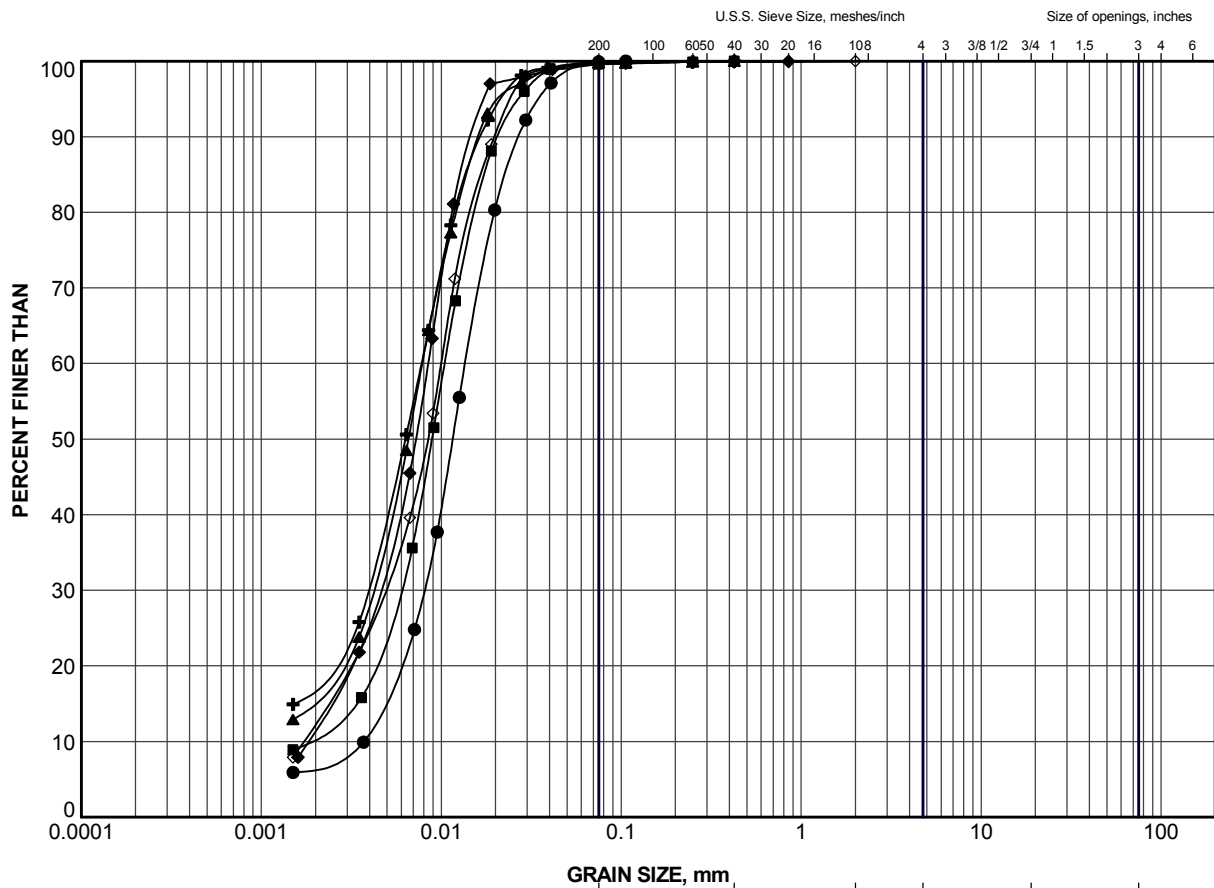


LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	SV-1	4	34.8	22.6	12.2
■	SV-2	3	31.4	22.4	9.0
▲	SV-3	4	35.5	21.1	14.4
+	SV-4	3	37.0	21.7	15.3

PROJECT					
HIGHWAY 17 SAVANNE RIVER TRIBUTARY CULVERT STA 16+009					
TITLE					
PLASTICITY CHART CLAYEY SILT to SILTY CLAY					
PROJECT No.		1533879		FILE No.	
DRAWN		J.J.L.		Mar 2016	
CHECK		NK		Mar 2016	
APPR		JMAC		Mar 2016	
SCALE		N/A		REV.	
FIGURE		A2			





LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	SV-1	9	449.0
■	SV-2	5	454.6
▲	SV-2	7	450.8
+	SV-3	7	450.6
◆	SV-4	5	453.8
◇	SV-4	7	450.7

PROJECT

HIGHWAY 17
SAVANNE RIVER TRIBUTARY CULVERT STA 16+009

TITLE

GRAIN SIZE DISTRIBUTION

SILT



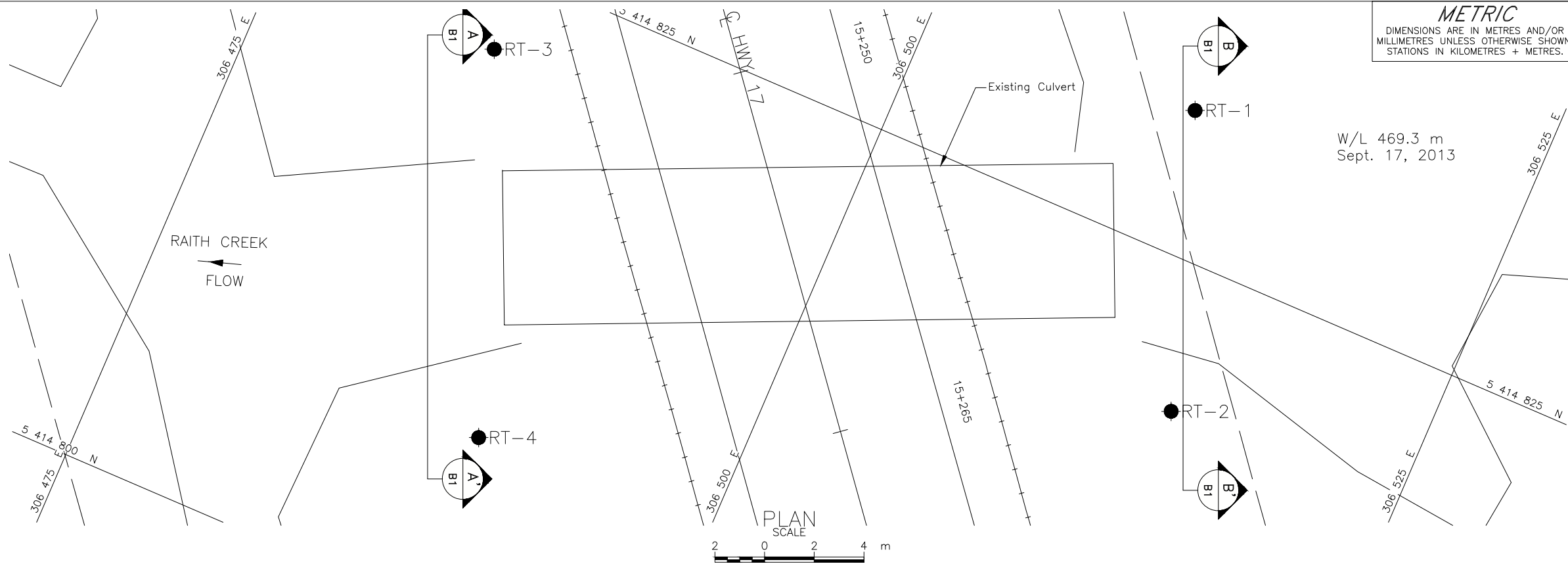
**Golder
Associates**
SUDBURY, ONTARIO

PROJECT No. 1533879			FILE No. 1533879.GPJ		
DRAWN	JJL	Mar 2016	SCALE	N/A	REV.
CHECK	NK	Mar 2016	FIGURE A3		
APPR	JMAC	Mar 2016			



APPENDIX B

Raith Creek Culvert, Site 48W-17/C (Robson Township)

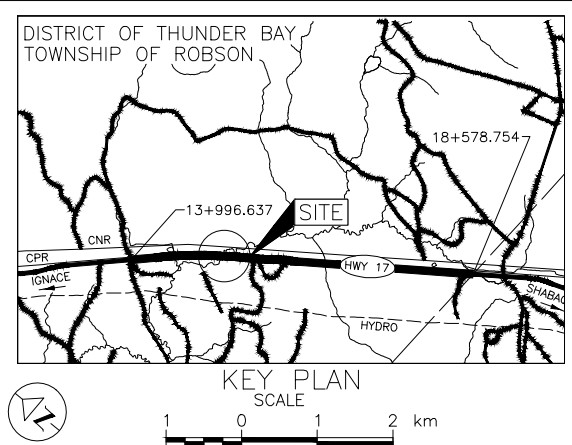


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

W/L 469.3 m
Sept. 17, 2013

CONT No. .
GWP No.6334-14-00

HIGHWAY 17
RAITH CREEK CULVERT STA 15+257
BOREHOLE LOCATIONS AND
SOIL STRATA



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- ▽ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
RT-1	469.3	5414830.7	306511.3
RT-2	469.5	5414819.2	306515.2
RT-3	469.4	5414821.8	306484.4
RT-4	470.2	5414807.2	306490.0

NOTES

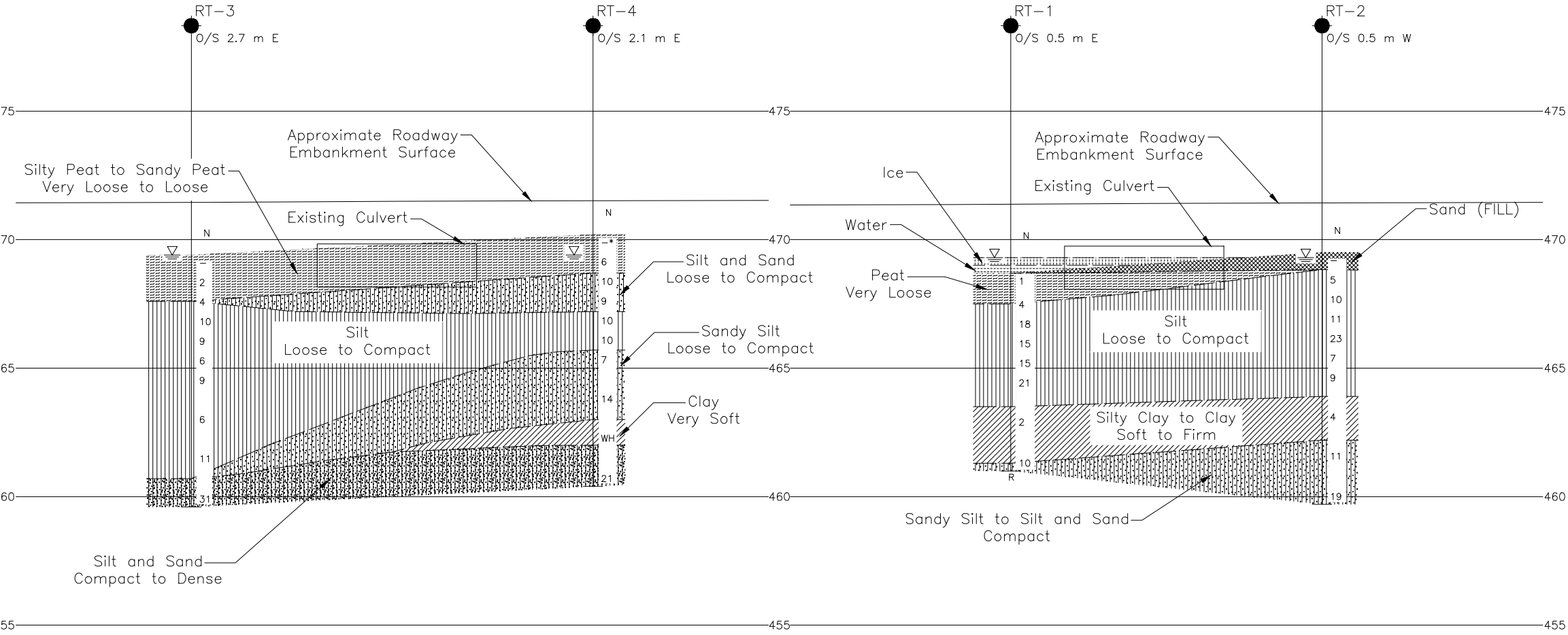
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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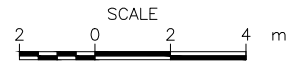
REFERENCE

Base plans provided in digital format by MTO, drawing file nos. BC1037173.dwg received Dec. 11, 2015.



HORIZ. SCALE 1:100
VERT. SCALE 1:100

CROSS-SECTION



HORIZ. SCALE 1:100
VERT. SCALE 1:100

CROSS-SECTION





PHOTOGRAPHS

**Photograph B1: Raith Creek Culvert
Looking North at Culvert Outlet Area (December 2015)**



**Photograph B2: Raith Creek Culvert
Looking South at Culvert Inlet Area (December 2015)**





PHOTOGRAPHS

**Photograph B3: Raith Creek Culvert
Looking West at East End of Culvert (Inlet) (December 2015)**







**Photograph B4: Raith Creek Culvert
Looking East at West End of Culvert (Outlet) (December 2015)**



[illegible]

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

PROJECT 1533879		RECORD OF BOREHOLE No RT-2				1 OF 1 METRIC											
G.W.P. 6334-14-00		LOCATION N 5414819.2; E 306515.2				ORIGINATED BY MR											
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY SN											
DATUM GEODETIC		DATE January 12, 2016				CHECKED BY NK											
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									
469.5	GROUND SURFACE							20	40	60	80	100					
0.0	Sand, trace organics (FILL) Loose Brown Wet		1	AS	-												
468.8																	
0.7	SILT, trace sand Loose to compact Grey Wet		2	SS	5												
	Very fine (<1 mm) clay laminations in Sample 4.																
	No recovery, other than one piece of gravel in Sample 5.																
	0.7 m thick CLAYEY SILT layer.																
			3	SS	10												
			4	SS	11												
			5	SS	23												
			6	SS	7												
			7	SS	9												
463.9																	
5.6	SILTY CLAY, sandy silt laminations Soft Red-brown Wet		8	SS	4												
462.2																	
7.3	Sandy SILT to SILT and SAND Compact Grey Wet		9	SS	11												
			10	SS	19												
459.7																	
9.8	END OF BOREHOLE																
	Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 469.3 m) upon completion of drilling. 2. Borehole caved to 0.7 m (Elev. 468.8 m) upon completion of drilling.																

SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

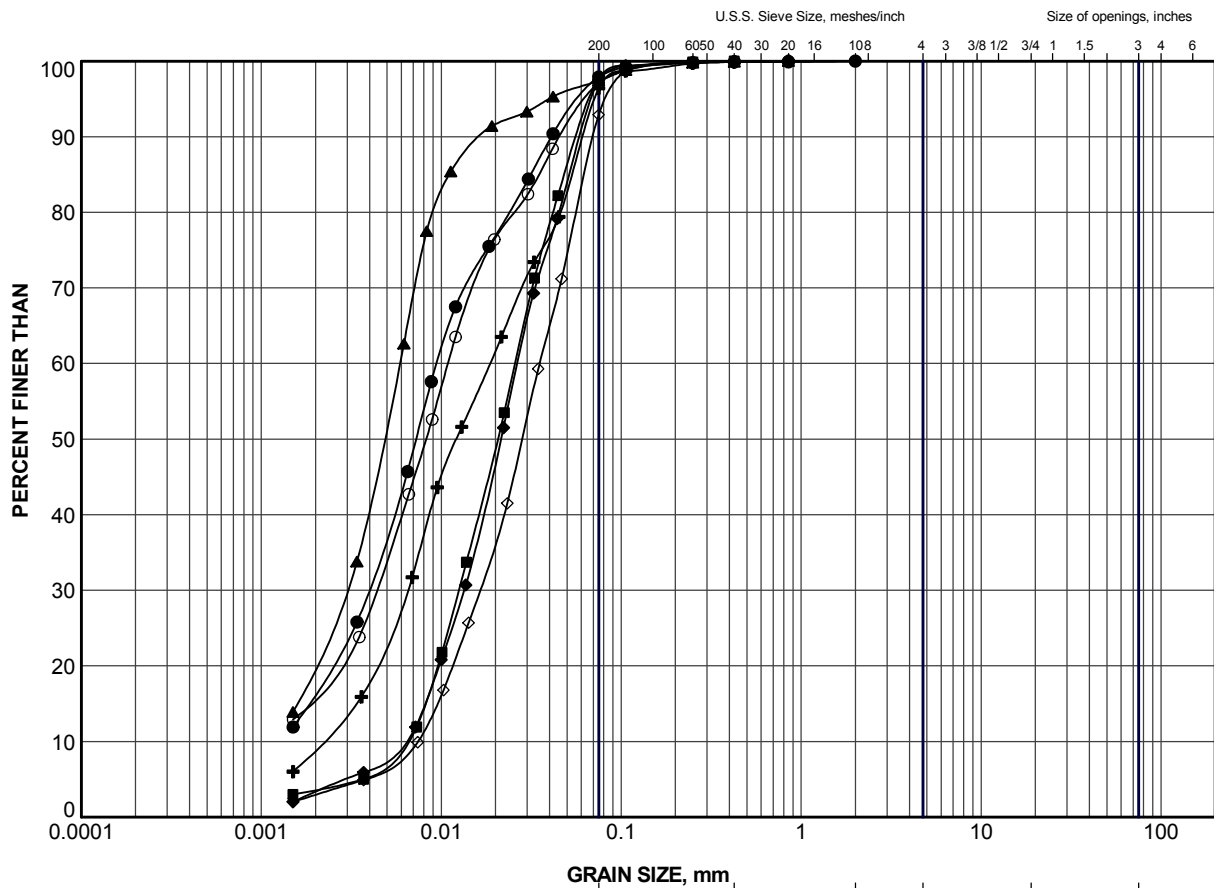
PROJECT 1533879		RECORD OF BOREHOLE No RT-3				1 OF 1 METRIC											
G.W.P. 6334-14-00		LOCATION N 5414821.8; E 306484.4				ORIGINATED BY MR											
DIST _____ HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY SN											
DATUM GEODETIC		DATE January 12, 2016				CHECKED BY NK											
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									WATER CONTENT (%)
469.4	GROUND SURFACE							20	40	60	80	100					
0.0	SILT PEAT to SANDY PEAT Very loose Brown-black to brown Wet		1	AS	-		469										
			2	SS	2		468										
467.6	SILT, trace to some sand, trace to some clay Loose to compact Grey Wet		3	SS	4		467										
1.8	Very fine (<1 mm) clay laminations in Sample 4. Clayey silt layer from 3.0 m to 3.7 m depth.		4	SS	10		466										0 4 87 9
			5	SS	9		465										
			6	SS	6		464										
			7	SS	9		463										0 3 94 3
			8	SS	6		462										
			9	SS	11		461										
460.7	SILT and SAND, trace gravel Dense Grey Wet		10	SS	31		460										0 7 90 3
8.7																	
459.6	END OF BOREHOLE																
9.8	Note: 1. Water level at ground surface (Elev. 469.4 m) upon completion of drilling. 2. Borehole caved to 1.6 m (Elev. 467.8 m) upon completion of drilling.																

SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

PROJECT 1533879		RECORD OF BOREHOLE No RT-4		1 OF 1 METRIC	
G.W.P. 6334-14-00		LOCATION N 5414807.2; E 306490.0		ORIGINATED BY MR	
DIST HWY 17		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY SN	
DATUM GEODETIC		DATE January 13, 2016		CHECKED BY NK	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _p	W	W _L						
470.2	GROUND SURFACE																				
0.0	SILTY PEAT to SANDY PEAT Loose Brown to brown-grey Frozen*		1	AS	-*	▽	470														
							469														
468.7			2	SS	6																
1.5	SILT and SAND, trace clay Loose to compact Grey Wet		3	SS	10													0	65	32	3
			4	SS	9																
467.2																					
3.0	SILT, fine clay laminations Compact Grey Wet		5	SS	10			467													
			6	SS	10			466										0	3	81	16
465.7																					
4.5	Sandy SILT Loose to compact Grey Wet		7	SS	7			465													
							464														
			8	SS	14																
463.0							463														
7.2	CLAY Very soft Red-brown Wet		9	SS	WH		462														
462.0																					
8.2	SILT and SAND Compact Grey Wet						461														
			10	SS	21												0	53	45	2	
460.4																					
9.8	END OF BOREHOLE																				
	Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 469.4 m) upon completion of drilling. 2. Borehole caved to 1.9 m (Elev. 468.3) upon completion of drilling.																				


SUD-MTO 001 1533879.GPJ GAL-MISS.GDT 22/04/16 DATA INPUT:

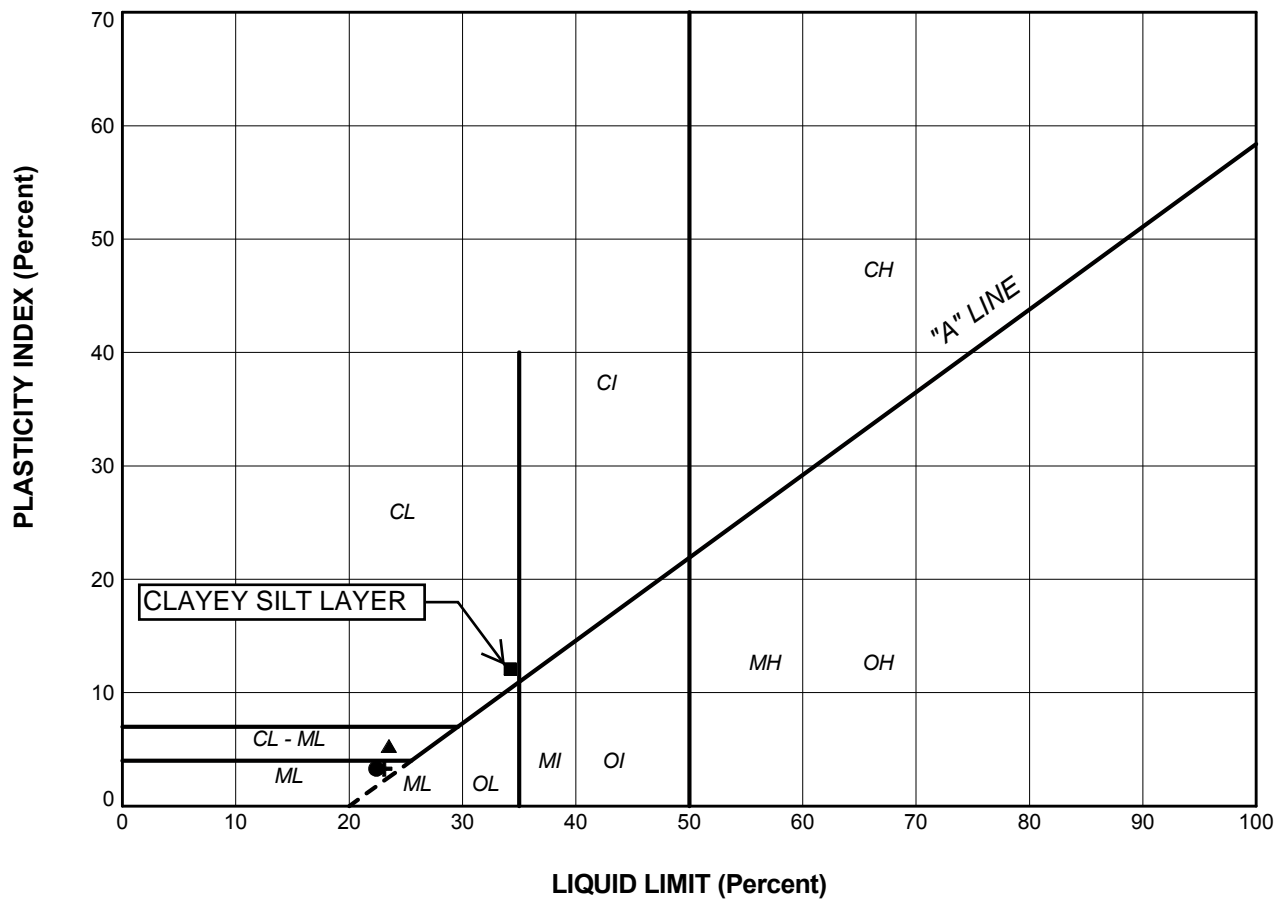


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	RT-1	3	466.7
■	RT-1	5	465.2
▲	RT-2	4	466.9
+	RT-3	4	466.8
◆	RT-3	6	465.3
◇	RT-3	8	463.0
○	RT-4	6	466.1

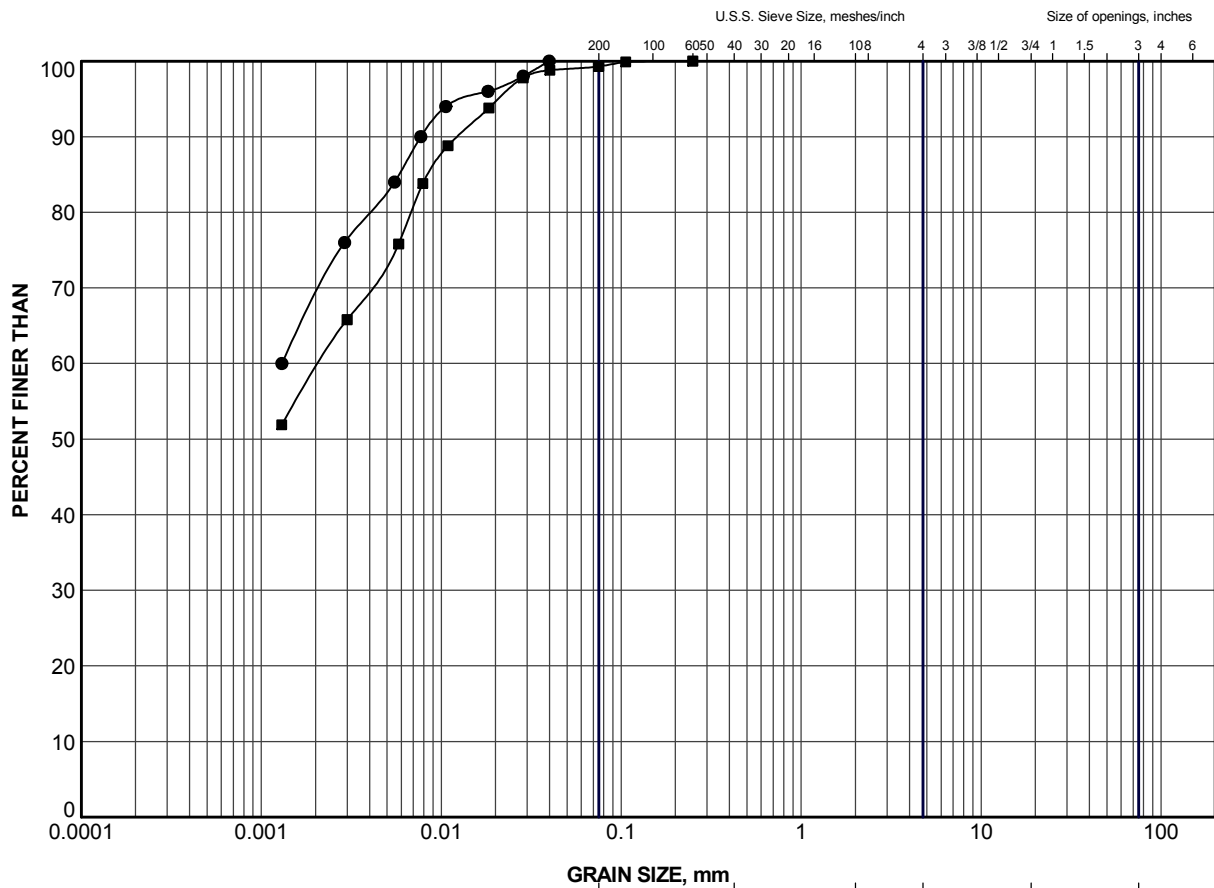
PROJECT						HIGHWAY 17 RAITH CREEK CULVERT STA 15+257					
TITLE						GRAIN SIZE DISTRIBUTION SILT					
PROJECT No.			1533879			FILE No.			1533879.GPJ		
DRAWN	JJL	Mar 2016	SCALE	N/A	REV.						
CHECK	NK	Mar 2016									
APPR	JMAC	Mar 2016									
 Golder Associates SUDBURY, ONTARIO			FIGURE B1								



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	RT-1	3	22.4	19.1	3.3
■	RT-2	4	34.2	22.1	12.1
▲	RT-3	4	23.5	18.2	5.3
+	RT-4	6	23.1	19.8	3.3


PROJECT					
HIGHWAY 17 RAITH CREEK CULVERT STA 15+257					
TITLE					
PLASTICITY CHART SILT (and CLAYEY SILT LAYER)					
PROJECT No.		1533879		FILE No.	
DRAWN		JLL		Apr 2016	
CHECK		NK		Apr 2016	
APPR		JMAC		Apr 2016	
SCALE		N/A		REV.	
Golder Associates SUDBURY, ONTARIO		FIGURE B2			

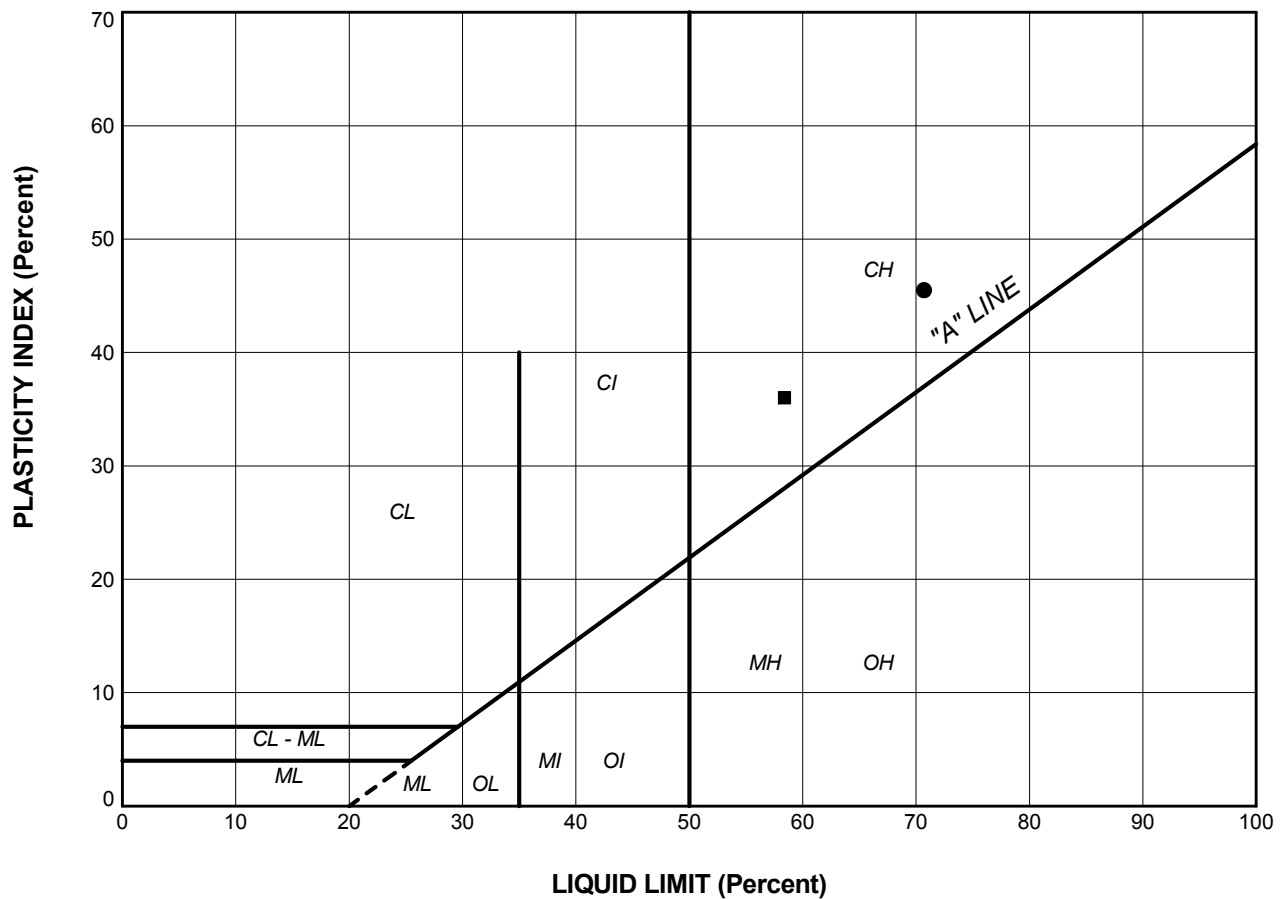


CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND


SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	RT-1	7	462.9
■	RT-2	8	463.1

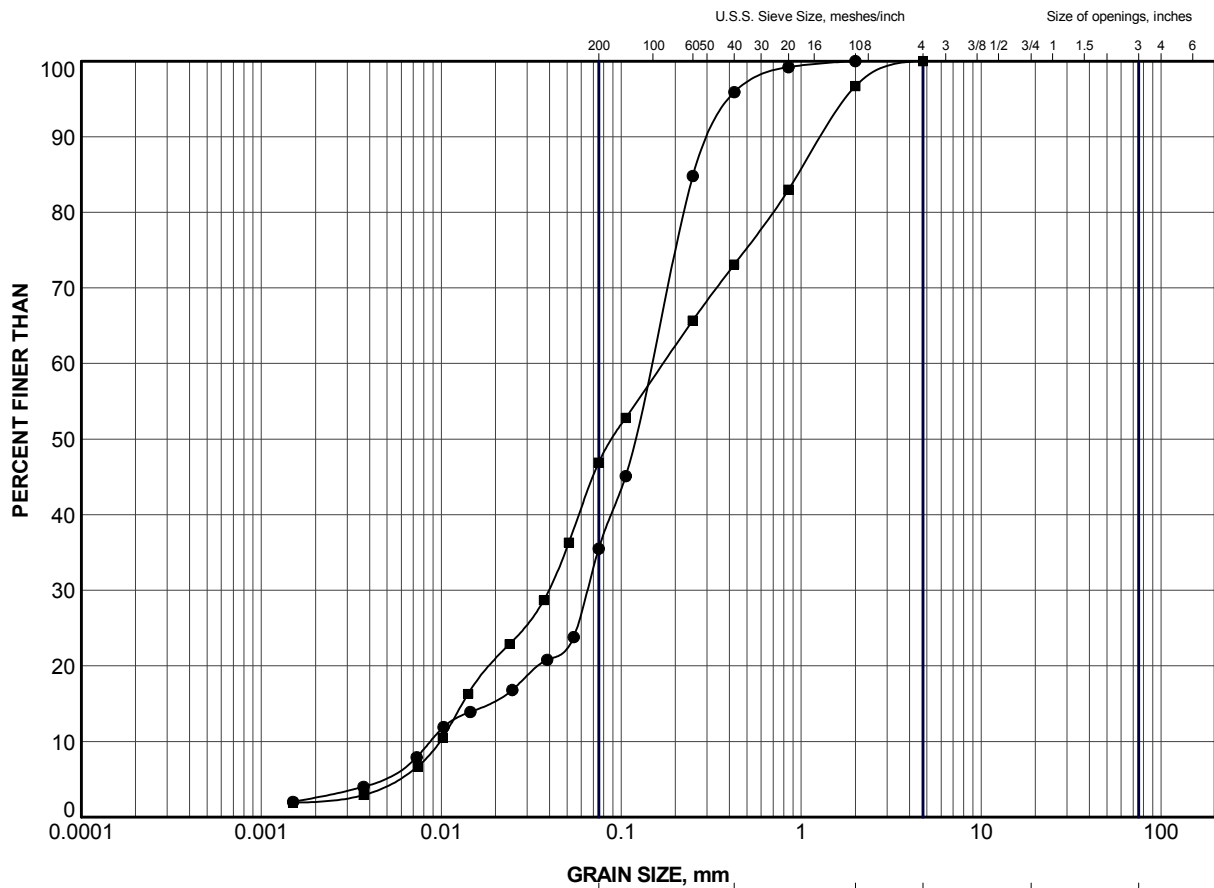
PROJECT					
HIGHWAY 17 RAITH CREEK CULVERT STA 15+257					
TITLE					
GRAIN SIZE DISTRIBUTION SILTY CLAY to CLAY					
PROJECT No.		1533879		FILE No. 1533879.GPJ	
DRAWN	JJL	Mar 2016	SCALE	N/A	REV.
CHECK	NK	Mar 2016			
APPR	JMAC	Mar 2016			
 Golder Associates SUDBURY, ONTARIO			FIGURE B3		



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	RT-1	7	70.7	25.2	45.5
■	RT-4	9	58.4	22.4	36.0

PROJECT					
HIGHWAY 17 RAITH CREEK CULVERT STA 15+257					
TITLE					
PLASTICITY CHART CLAY					
PROJECT No. 1533879			FILE No. 1533879.GPJ		
DRAWN	JJL	Apr 2016	SCALE	N/A	REV.
CHECK	NK	Apr 2016			
APPR	JMAC	Apr 2016			
 Golder Associates SUDBURY, ONTARIO			FIGURE B4		



GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	RT-4	3	468.4
■	RT-4	10	460.7

PROJECT					
HIGHWAY 17 RAITH CREEK CULVERT STA 15+257					
TITLE					
GRAIN SIZE DISTRIBUTION SILT and SAND					
PROJECT No.		1533879		FILE No. 1533879.GPJ	
DRAWN	JJL	Apr 2016	SCALE	N/A	REV.
CHECK	NK	Apr 2016	FIGURE B5		
APPR	JMAC	Apr 2016			



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