



**FOUNDATION INVESTIGATION REPORT**  
**for**  
**RETAINING WALLS**  
**HIGHWAY 403 EBL NEW BRIDGE OVER DESJARDINS CANAL**  
**GWP 2357-09-00**  
**HAMILTON AREA, ONTARIO**

PETO MacCALLUM LTD.  
165 CARTWRIGHT AVENUE  
TORONTO, ONTARIO  
M6A 1V5  
Phone: (416) 785-5110  
Fax: (416) 785-5120  
Email: toronto@petomaccallum.com

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**FOUNDATION INVESTIGATION REPORT**  
for  
Retaining Walls  
Highway 403 EBL New Bridge over Desjardins Canal  
GWP 2357-09-00  
Hamilton Area, Ontario

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**1. INTRODUCTION**

This report summarises the results of a foundation investigation carried out for construction of retaining walls associated with a replacement of existing eastbound bridge over the Desjardins Canal located on Highway 403 near Hamilton, Ontario. The investigation was conducted for Morrison Hershfield Limited on behalf of the Ministry of Transportation of Ontario (MTO).

Highway 403 passes over the Desjardins Canal at approximate Station 25+586, Highway 403 chainage (ref. General Arrangement Drawing 'Desjardins Canal Bridge EBL Structure Replacement' prepared by Morrison Hershfield Limited in November 2015). It is intended to replace the existing bridge on a new alignment 17 to 19 m east of the existing EBL centreline.

The project involves construction of retaining walls for the new EBL bridge north and south of the Desjardins Canal. The investigation program was developed based on a drawing 'Highway 403 / Desjardins Canal. New Construction' prepared by Morrison Hershfield and showing two retaining walls envisaged to be about 230 m long south of the Desjardins Canal (Sta. 15+330 to 15+560) and 210 m long north of the canal (Sta. 15+615 to 15+825). The south retaining wall was later shortened as a result of optimising the grading at the site. The updated version of the drawing received in November 2015 indicates that six retaining walls are planned as follows:

**Table 1 – Retaining Wall Locations**

<b>WALL No.</b>	<b>RETAINING WALLS</b>	<b>STATIONS (new chainage)</b>	<b>LENGTH (m)</b>
RW1	Southwest RSS Wall	Sta. 25+535.5 to 25+555.0	19.5
RW2	Northwest RSS Wall	Sta. 25+617.4 to 25+627.2	9.8
RW3	Southeast RSS Wall	Sta. 25+527.5 to 25+556.0	28.5
RW4	Northeast RSS Wall	Sta. 25+616.4 to 25+629.9	13.5
RW5	Soldier Pile Wall	Sta. 25+629.9 to 25+725.4	95.5
RW6	Toe Wall	Sta. 25+725.4 to 25+821.9	96.5



The existing road grade on Highway 403 at the bridge location is at approximate elevation 86.0. The existing approach embankments are about 8 m high. The water level in the canal is at elevation 75.0.

The report provides subsurface information pertaining to the proposed retaining walls.

All elevations in this report are expressed in meters.

## **2. SITE DESCRIPTION AND GEOLOGY**

The structure to be replaced carries Highway 403 eastbound traffic over the Desjardins Canal connecting Hamilton Harbour and Lake Cootes Paradise near Hamilton. At the location of the bridge, Highway 403 runs approximately in the south-north direction.

The proposed retaining walls will support new high fill / deep cut sections. South of the Desjardins Canal, there is an adjacent railway embankment to the east of the new EBL embankment. The retaining walls to the north of the canal will be erected for up to 7 m high fill / 4.5 m deep cut between the new EBL embankment and York Boulevard, with an approximately 40 m long cut sloping up to 19 m high banks at York Boulevard.

The Desjardins Canal is about 30 m wide and 3 m deep. A pedestrian trail running under the bridge along its south abutment is at approximate elevation 77.5.

The project site is located just west of Lake Ontario. The land surface adjacent to the canal is flat to gently undulating.

The site forms part of the Lake Iroquois offshore deposits consisting mainly of fine grained sands becoming silty with depth and resting on early Lake Iroquois clays. The deposits are generally stratified.

Bedrock in the vicinity of the site is at depths exceeding 35 m.



### **3. INVESTIGATION PROCEDURES**

The field work for this study was carried out during the period of April 29 to August 29, 2015 and comprised nine boreholes advanced to depths of 3.5 to 31.5 m. The borehole locations are indicated on Drawing RW-1, attached. Boreholes EB-2 to EB-5 drilled for the design and construction of the new EBL bridge were also used for the retaining walls.

The locations of the boreholes were established in the field by Peto MacCallum Ltd. The coordinates and ground surface elevations at the boreholes were provided by Callon-Dietz Inc.

The boreholes were advanced using continuous flight hollow and solid stem augers, powered by track- and truck-mounted drill rigs, supplied and operated by specialist drilling contractors, working under the full-time supervision of a member of our engineering staff. A mud rotary technique was used to extend one borehole.

Representative soil samples were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests (SPT) were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

Groundwater conditions at the borehole locations were assessed during drilling by visual examination of soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. A piezometer was installed in borehole RW-8, with three sets of readings taken. The boreholes were backfilled with bentonite/cement grout where required in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determination. Atterberg limits testing (1) and grain size distribution analyses (17) were conducted on selected soil samples. The laboratory test results are presented in Figures RW-GS-1 to RW-GS-5, RW-PC-1 and on the corresponding logs.



#### **4. SUMMARISED SUBSURFACE CONDITIONS**

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, boundary elevations, standard penetration test data and groundwater observations. The results of laboratory Atterberg limits testing, grain size distribution analyses and natural moisture content determinations are also shown on the Record of Borehole sheets.

The borehole locations and stratigraphic profile prepared from the borehole data are shown on Drawing RW-1. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised topsoil over fill overlying sandy soils underlain by discontinuous clayey silt and sandy silt / silt. Cobbles and probable boulders were encountered in five boreholes. The groundwater was at elevation 74.9 to 75.3. The water level in the Desjardins Canal was at elevation 75.0 on August 30, 2015.

The strata encountered are summarised below.

##### **4.1 Topsoil**

Surficial topsoil was present in boreholes RW-2 to RW-5, RW-7, EB-2, EB-3 and EB-5. The silty topsoil was 150 to 300 mm thick and penetrated at elevation 82.8 to 87.2.

##### **4.2 Fill**

Granular fill consisting of sand and gravel was present surficially in boreholes RW-6, RW-8 and RW-9. The granular fill was covered by asphalt in borehole RW-8 put down on the shoulder of York Boulevard. The sand and gravel fill was loose to dense (SPT-'N' values of 8 to 48), 5 to 13% in moisture content and extended to depths of 1.4 to 1.8 m (elevation 85.3 to 102.8). It is noteworthy that cobbles were encountered in the granular fill in boreholes RW-6 and RW-8.



Sand / silty sand fill was present surficially in boreholes RW-1, EB-4 and below the topsoil or sand and gravel fill at depths of 0.2 to 1.4 m (elevation 82.8 to 87.2) in boreholes RW-2, RW-3, RW-5, RW-7, RW-9 and EB-2. The fill was very loose to dense (SPT-'N' values of 2 to 42) and had a moisture content ranging from 3 to 15%. The sand / silty sand fill was penetrated at depths of 0.6 to 5.2 m (elevation 79.5 to 86.4).

The results of grain size distribution analyses performed on 2 samples of the sand fill are presented in Figure RW-GS-1.

#### **4.3 Sandy Soils**

Overlain by the topsoil or fill at depths of 0.3 to 5.2 m (elevation 79.5 to 102.8) in all the boreholes were sandy soils of various granulometric composition (sand, silty sand, sand and silt, gravelly sand). This stratum was very loose to compact becoming dense to very dense, with a moisture content of 3 to 24%. Containing seams of clayey silt / silty clay, the sandy soils had a thickness of 3.0 to 26.3 m in boreholes RW-8, RW-9, EB-2 to EB-5 and were penetrated at depths of 7.3 to 28.1 m (elevation 60.1 to 79.4). The remaining boreholes were terminated in the stratum at depths of 3.5 to 6.7 m (elevation 78.4 to 84.0). It is worth noting that the sandy soils contained cobbles in boreholes RW-8 and EB-3.

The results of grain size distribution analyses conducted on 13 samples of the stratum are presented in Figures RW-GS-2 and RW-GS-3.

#### **4.4 Sandy Silt / Silt**

Underlying the sandy soils or clayey silt at depths of 7.3 to 30.0 m (elevation 60.1 to 79.4) in boreholes RW-8, RW-9, EB-2 to EB-5 was sandy silt / silt. This unit was compact to very dense (SPT-'N' values of 26 to over 103) and had a moisture content of 5 to 24%. The sandy silt / silt was not penetrated upon termination of drilling at depths of 9.6 to 31.5 m (elevation 53.8 to 77.1).



The results of grain size distribution analysis performed on a sample of the silt are presented in Figure RW-GS-4.

#### 4.5 Clayey Silt

A layer of clayey silt was revealed below the sand at a depth of 28.1 m (elevation 76.5) in borehole RW-8. This layer was 1.9 m in thickness and hard in consistency as assessed by an SPT-'N' value of 51. The clayey silt was penetrated at 30.0 m depth (elevation 74.6).

The results of Atterberg limits testing and grain size distribution analysis conducted on the cohesive sample from borehole 101 are presented in respective Figures RW-PC-1 and RW-GS-5. The liquid and plastic limits of the clayey silt were 28 and 15 respectively, thus giving the plasticity index of 13.

#### 4.6 Groundwater

In the process of augering, water was detected at depths of 3.0 to 10.2 m (elevation 74.5 to 80.0) in boreholes RW-2, RW-9, EB-2 to EB-5 and at 14.5 m depth (elevation 90.1) in borehole RW-8 put down on York Boulevard. No groundwater was present in boreholes RW-1 to RW-9 upon completion of drilling.

Two piezometers were installed in boreholes EB-3 and EB-4. Three sets of piezometer readings subsequently taken showed water levels to be at the following depths / elevations:

**Table 4.6.1 – Groundwater Readings in Piezometers in Boreholes EB-3 and EB-4**

Borehole No.	June 10, 2015		July 9, 2015		August 30, 2015	
	Depth, m	Elevation	Depth, m	Elevation	Depth, m	Elevation
EB-3	10.4	74.9	10.1	75.2	10.2	75.1
EB-4	–	–	10.1	75.3	10.3	75.1





A piezometer with a tip at elevation 87.2 was also installed in borehole RW-8. Three sets of piezometer readings showed water levels to be at the following depths / elevations:

**Table 4.6.2 – Groundwater Readings in Piezometer in Borehole RW-8**

Borehole No.	September 4, 2015		September 7, 2015		November 26, 2015	
	Depth, m	Elevation	Depth, m	Elevation	Depth, m	Elevation
RW-8	17.2	87.4	17.1	87.5	>17.2 (Dry)	<87.4

The water level in the Desjardins Canal was at elevation 75.0 on August 30, 2015. The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns, generally reflecting the water level in the adjacent Desjardins Canal.



## 5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, Senior Technician, under the coordination of Mr. K. Daly, B.Eng, and direction of Mr. C.M.P. Nascimento, P.Eng., Project Manager. The equipment was supplied by Elite Drilling Services and Altech Drilling & Investigative Services Ltd.

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. C.M.P. Nascimento, P.Eng., Project Manager and MTO Designated Principal Contact.

Yours very truly,

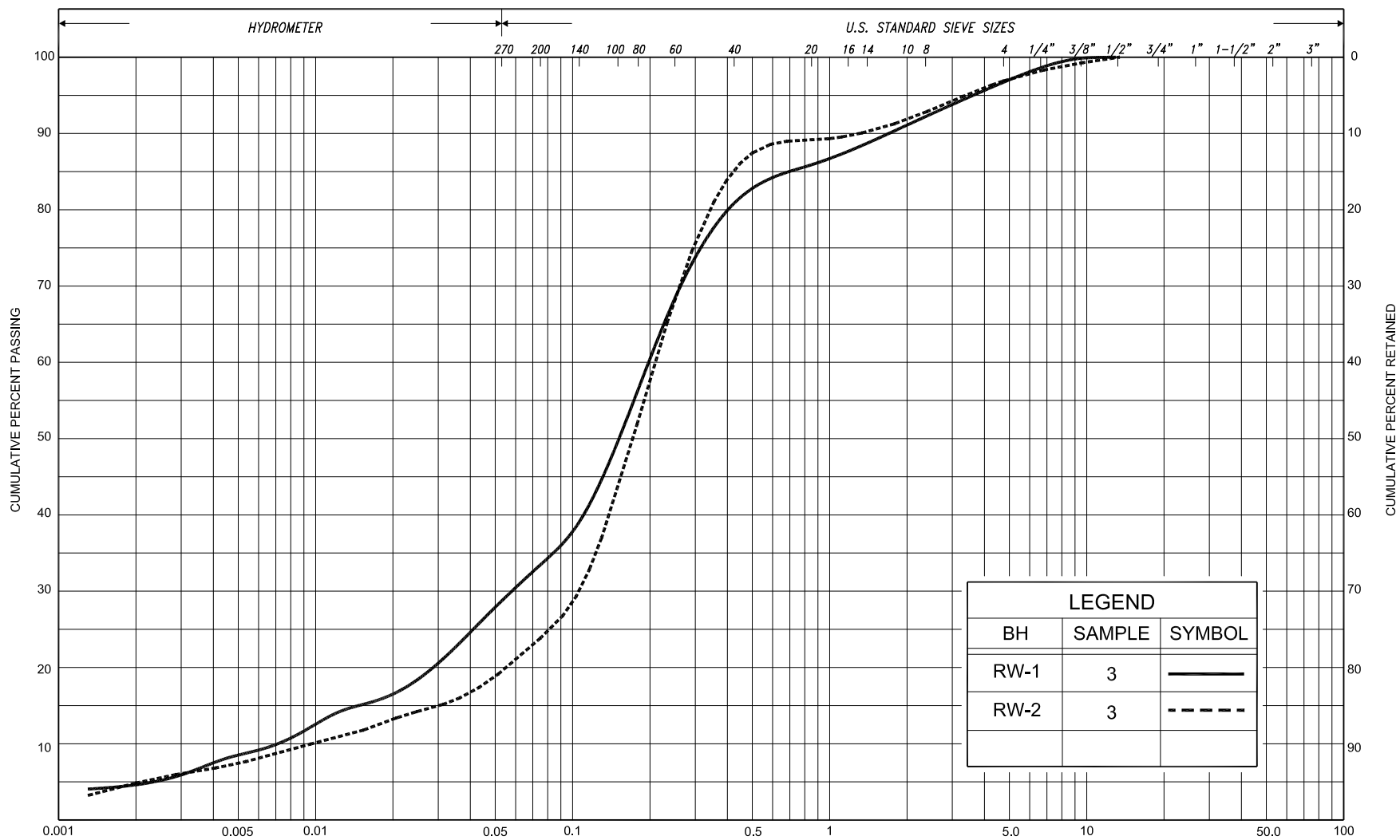
Peto MacCallum Ltd.



Grigory O. Degil, PhD, P.Eng.  
Senior Foundation Engineer



Carlos M.P. Nascimento, P.Eng.  
Project Manager and  
MTO Designated Principal Contact



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED		
					SAND								M.I.T.			
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	
	SILT							SAND								
CLAY			SILT			V. FINE	FINE	MED.	COARSE	GRAVEL					U.S. BUREAU	
					SAND											

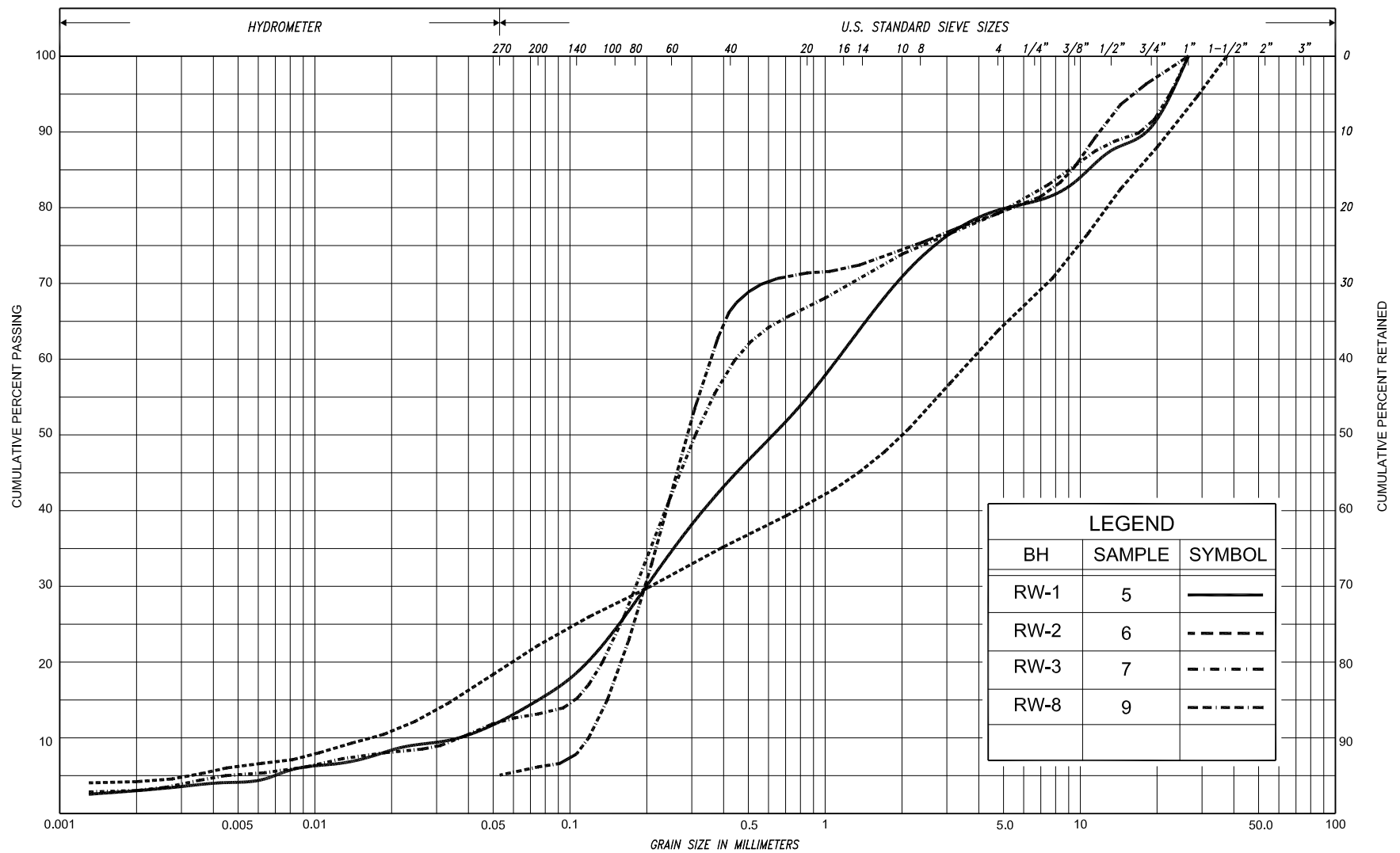


# GRAIN SIZE DISTRIBUTION SAND, some to with silt, trace clay, trace gravel (FILL)

FIG No. RW-GS-1

HWY: 403

W.P. No. 2357-09-01



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COB BLES	UNIFIED		
					SAND											
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT					SAND										
CLAY		SILT			V. FINE	FINE	MED.	COARSE		GRAVEL					U.S. BUREAU	



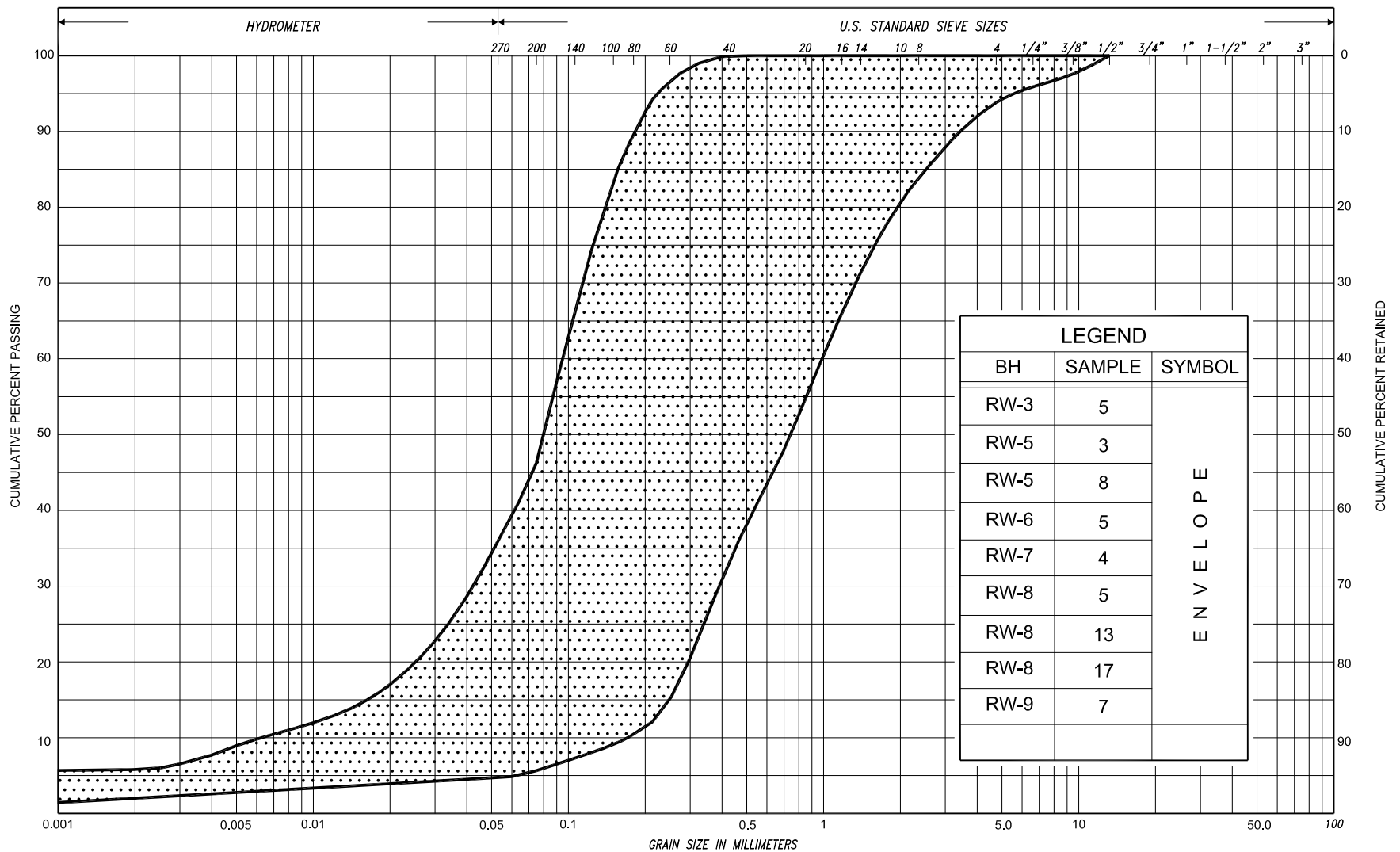
## GRAIN SIZE DISTRIBUTION

SAND, some gravel to gravelly, trace to some silt, trace clay

FIG No. RW-GS-2

HWY: 403

W.P. No. 2357-09-01



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COB BLES	UNIFIED		
					SAND											
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT															
CLAY			SILT			V. FINE	FINE	MED.	COARSE		GRAVEL					U.S. BUREAU
						SAND										



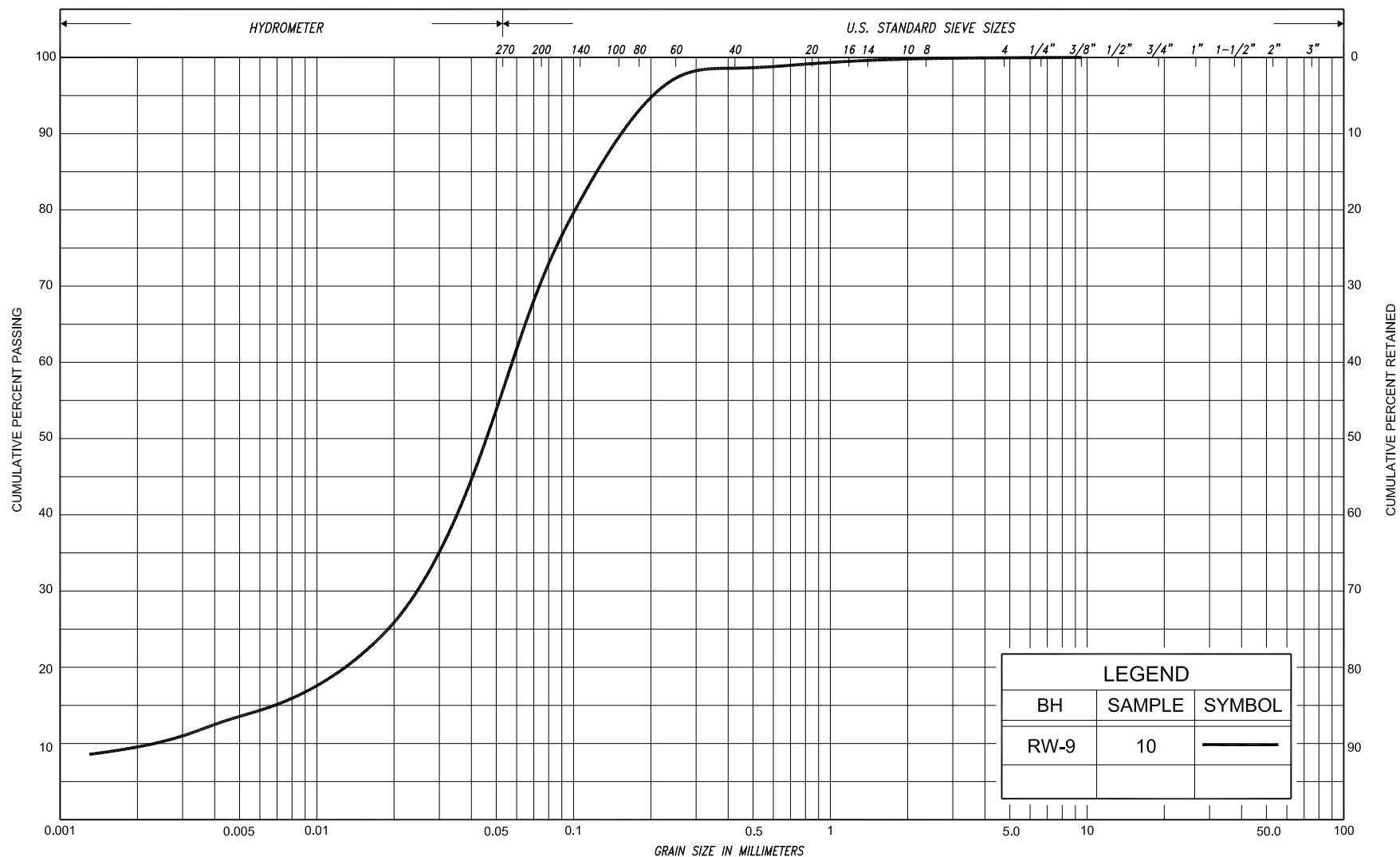
## GRAIN SIZE DISTRIBUTION

SAND, trace silt to silty, trace clay, trace gravel

FIG No. RW-GS-3

HWY: 403

W.P. No. 2357-09-01



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL				COB BLES	UNIFIED		
					SAND												
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL				COBBLES	M.I.T.
	SILT																
CLAY		SILT			V. FINE	FINE	MED.	COARSE	GRAVEL							U.S. BUREAU	
					SAND												



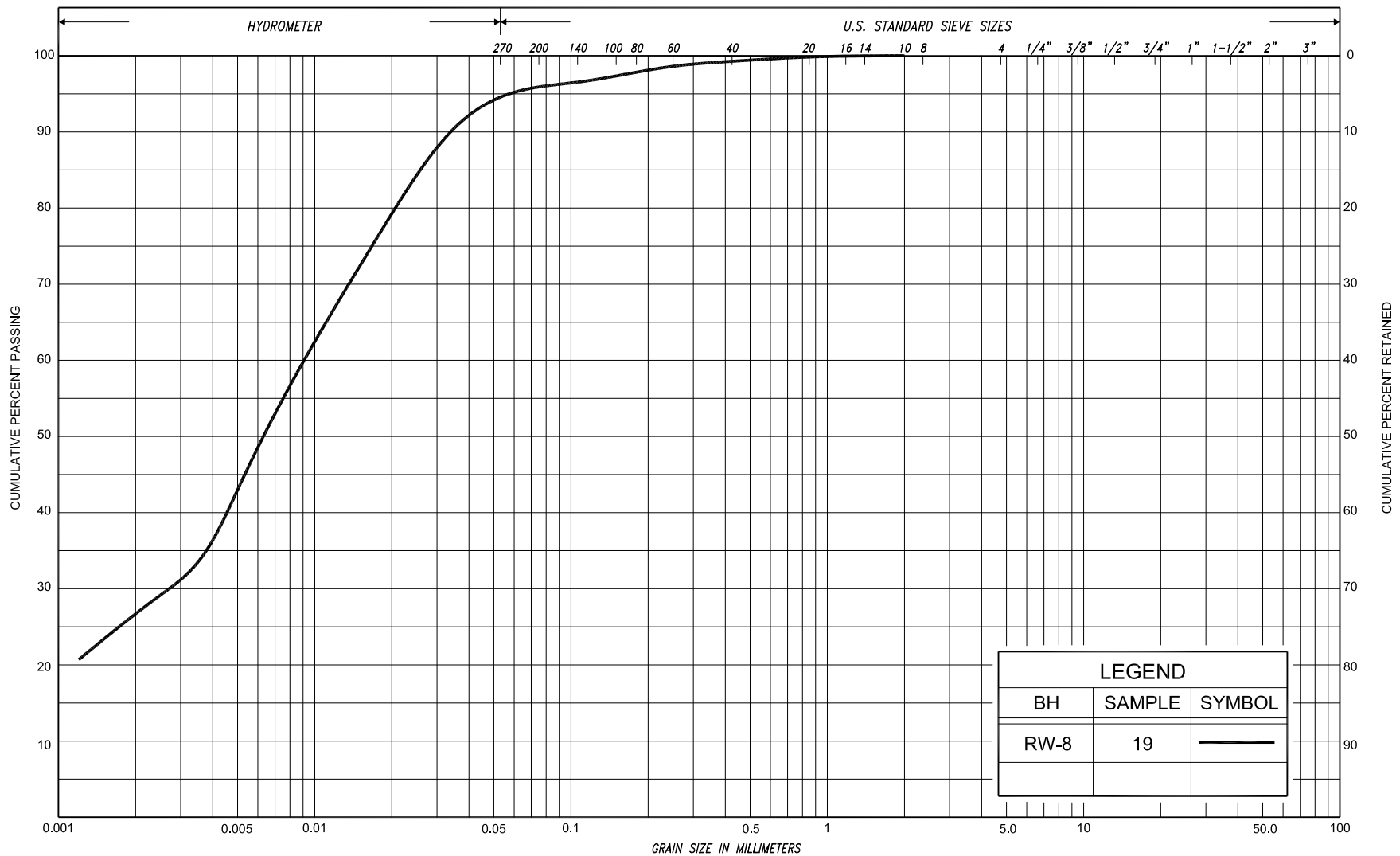
## GRAIN SIZE DISTRIBUTION

SILT, with sand, trace clay

FIG No. RW-GS-4

HWY: 403

W.P. No. 2357-09-01



SILT & CLAY				FINE	MEDIUM	COARSE	GRAVEL	COBBLES	UNIFIED
				SAND					
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL	COBBLES	M.I.T.
				SAND					
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL	U.S. BUREAU
				SAND					



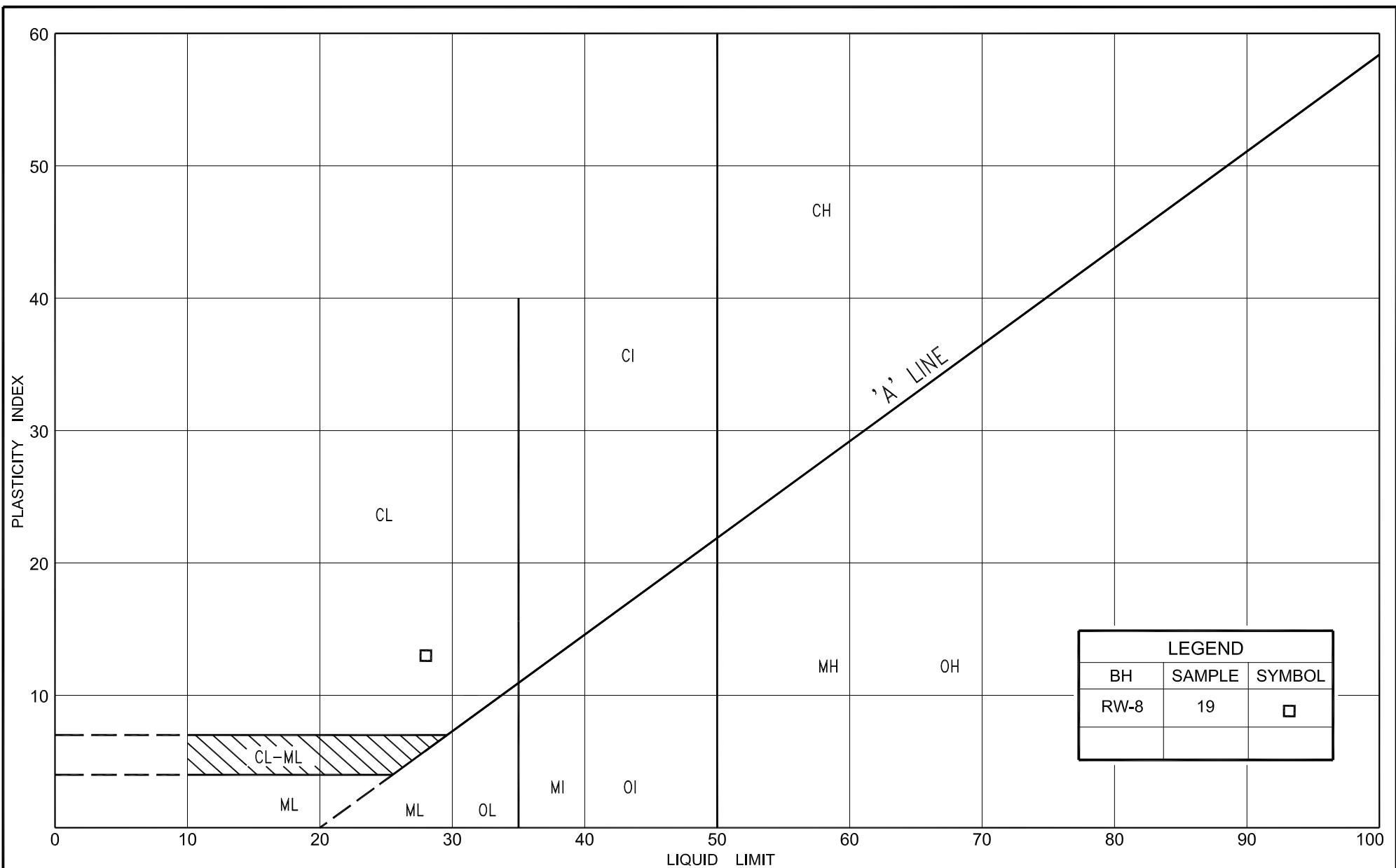
## GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand (CL)

FIG No. RW-GS-5

HWY: 403

W.P. No. 2357-09-01



LEGEND		
BH	SAMPLE	SYMBOL
RW-8	19	□



**PLASTICITY CHART**  
CLAYEY SILT, trace sand (CL)

FIG No.	RW-PC-1
HWY:	403
W.P. No.	2357-09-01



## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m 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:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm 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 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**COMPOSITION:** SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	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, 100mm+ IN LENGTH EXPRESSED AS A PERCENT 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

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
$E$	kPa	MODULUS OF LINEAR DEFORMATION
$G$	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
$H$	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
$U$	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_i$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL












$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	$n$	1, %	POROSITY	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	$w$	1, %	WATER CONTENT	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$S_r$	%	DEGREE OF SATURATION	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$w_L$	%	LIQUID LIMIT	$D$	mm	GRAIN DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_p$	%	PLASTIC LIMIT	$D_n$	mm	n PERCENT - DIAMETER
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_s$	%	SHRINKAGE LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	$q$	m <sup>3</sup> /s	RATE OF DISCHARGE
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	$v$	m/s	DISCHARGE VELOCITY
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL				$i$	1	HYDRAULIC GRADIENT
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	$k$	m/s	HYDRAULIC CONDUCTIVITY
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	$j$	kN/m <sup>3</sup>	SEEPAGE FORCE
$e$	1, %	VOID RATIO	WTPL		WETTER THAN PLASTIC LIMIT			

**RECORD OF BOREHOLE No RW-1**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 156.9 N ; 272 964.3 E      **ORIGINATED BY** S.A.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Solid Stem Augers      **COMPILED BY** K.D.  
**DATUM** Geodetic      **DATE** April 29, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED      + FIELD VANE									
								● QUICK TRIAXIAL      × LAB VANE									
					WATER CONTENT (%)												
					20    40    60    80    100					20    40    60							
83.0	Ground Surface																
0.0	Sand, with silt trace clay, trace gravel organic inclusions  Loose to Brown Moist very loose  (FILL)		1	SS	5												
																	
			2	SS	2												
																	
			3	SS	3												
80.9	Sand, some gravel some silt, trace clay  Loose Brown Moist																
2.1			4	SS	5												
																	
																	
			5	SS	9												
79.3	End of borehole																
3.7																	
	* Borehole dry																

**RECORD OF BOREHOLE No RW-2**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 192.0 N ; 272 973.1 E      **ORIGINATED BY** S.A.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Solid Stem Augers      **COMPILED BY** K.D.  
**DATUM** Geodetic      **DATE** April 29, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
83.0	Ground Surface							20	40	60	80	100								
0.0	Topsoil Silty sand topsoil inclusions		1	SS	6	▽*	82							○			3 73 19 5			
	Loose Brown Moist																			
	Sand, some silt trace clay, trace gravel		2	SS	6										○					
	Loose Reddish Moist brown		3	SS	6										○					
	(FILL)														○					
	organics		4	SS	4										○					
80.0	Dark brown					▽*	80							○			36 42 18 4			
3.0	Sand, some gravel some silt, trace clay		5	SS	9															
	Loose Brown Wet																			
	gravelly		6	SS	8	79								○						
78.6	End of borehole																			
4.4																				

\* 2015 04 29  
 ▽ Water level observed  
 during drilling

**RECORD OF BOREHOLE No RW-3**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 265.5 N ; 272 994.3 E      **ORIGINATED BY** S.A.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Solid Stem Augers      **COMPILED BY** K.D.  
**DATUM** Geodetic      **DATE** April 29, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE												
86.0	Ground Surface						20	40	60	80	100									
0.0	Topsoil Sand, trace silt topsoil pockets		1	SS	3															
	Very loose Reddish Moist to loose brown																			
84.8	(FILL)		2	SS	4															
1.2	Sand, trace silt clayey silt seams to 2.1m																			
	Loose to Reddish Moist very loose brown		3	SS	4															
			4	SS	3															
	some silt, trace clay trace gravel																			
			5	SS	3															
	some to with gravel																			
			6	SS	6															
			7	SS	10															
80.8	Compact																			
5.2	End of borehole																			

**RECORD OF BOREHOLE No RW-4**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 303.2 N ; 273 002.1 E      **ORIGINATED BY** S.A.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Solid Stem Augers      **COMPILED BY** K.D.  
**DATUM** Geodetic      **DATE** April 29, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
					WATER CONTENT (%)												
86.1	Ground Surface						20	40	60	80	100						
0.0	Topsoil	△	1	SS	8		86										
0.3	Sand, trace silt	•															
	Loose Reddish Moist brown	•															
	sandy silt layers	•	2	SS	7		85										
	Very loose Brown Wet to to loose moist	•															
		•	3	SS	4		84										
		•															
		•	4	SS	3		83										
		•															
		•	5	SS	5		82										
		•															
		•	6	SS	5		81										
		•															
		•	7	SS	5		80										
		•															
		•	8	SS	9												
		•															
79.4	End of borehole																
6.7																	
	* Borehole dry																

**RECORD OF BOREHOLE No RW-5**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 423.7 N ; 272 996.9 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** July 02, 2015      **CHECKED BY** G.D.


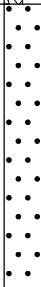
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
85.0 0.0	Ground Surface							20	40	60	80	100								
84.4 0.6	Topsoil	⊗	1	SS	18									○						
	Sand, some silt	⊗																		
	Compact Brown Moist (FILL)	•••••	2	SS	9		84							○						
	Sand some silt, trace clay	•••••																		
	Loose to Brown Moist very dense	•••••	3	SS	14		83							○			0 80 16 4			
		•••••																		
		•••••	4	SS	23		82							○						
		•••••																		
		•••••	5	SS	25		81							○						
		•••••																		
		•••••	6	SS	27		80							○						
		•••••																		
		•••••	7	SS	31		79							○			0 77 19 4			
		•••••																		
		•••••	8	SS	52									○						
		•••••																		
		•••••	9	SS	34									○						
78.4 6.6	End of borehole																			
	* Borehole dry																			

**RECORD OF BOREHOLE No RW-6**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 425.9 N ; 272 990.0 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** June 22, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																	
87.4	Ground Surface						20	40	60	80	100														
0.0	Sand and gravel, cobbles		1	SS	17		87																		
	Compact Brown Moist																								
	(FILL)		2	SS	15																				
86.0							86																		
1.4	Sand, some silt to silty trace clay, trace gravel		3	SS	39																				
	Compact Brown Moist to dense																								
			4	SS	25												85								
			5	SS	32												84								
83.1			6	SS	42																				
4.3	End of borehole																								

## RECORD OF BOREHOLE No RW-7

1 of 1

METRIC

<b>G.W.P.</b> 2357-09-01	<b>LOCATION</b>	Coords: 4 793 535.5 N ; 272 989.6 E	<b>ORIGINATED BY</b> F.P.
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<b>DIST</b>	Niagara	<b>HWY</b>	403	<b>BOREHOLE TYPE</b>	Continuous Flight Solid Stem Augers	<b>COMPILED BY</b>	G.D.
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**DATUM** Geodetic **DATE** June 19, 2015 **CHECKED BY** G.D.

[illegible]



**RECORD OF BOREHOLE No RW-8**

1 of 3

**METRIC**

G.W.P. 2357-09-00 LOCATION Coords: 4 793 451.3 N ; 273 042.7 E ORIGINATED BY F.P.  
DIST Niagara HWY 403 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + Mud Rotary COMPILED BY G.D.  
DATUM Geodetic DATE August 29, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa									
							20 40 60 80 100									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
							20 40 60 80 100					WATER CONTENT (%) 20 40 60				
104.6	Ground Surface															
0.0	Asphalt over sand and gravel		1	SS	48											
	Dense Brown Moist		2	SS	36											
	(PAVEMENT FILL)															
102.8	cobbles		3	SS	24/10cm											
	Sand trace to with gravel trace silt cobbles		4	SS	10											
	Compact to Brown Moist very dense		5	SS	56											
1.8	cobbles		6	SS	50/8cm											
	(Probable fill to El. 90.0)		7	SS	66											
			8	SS	50/10cm											
			9	SS	78											
			10	AS	50/8cm											
			11	SS	50/15cm											
			12	AS	50/15cm											
			13	SS	50/15cm											
	with silt to silty															
	Wet Cont'd															

## RECORD OF BOREHOLE No RW-8

2 of 3

## METRIC

G.W.P.	2357-09-00	LOCATION	Coords: 4 793 451.3 N ; 273 042.7 E	ORIGINATED BY	F.P.
DIST	Niagara	HWY	403	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers + Mud Rotary
DATUM	Geodetic	DATE	August 29, 2015	COMPILED BY	G.D.
				CHECKED BY	G.D.

[illegible]

## RECORD OF BOREHOLE No RW-8

3 of 3

METRIC

G.W.P.	2357-09-00	LOCATION	Coords: 4 793 451.3 N ; 273 042.7 E	ORIGINATED BY	F.P.
DIST	Niagara	HWY	403	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers + Mud Rotary
DATUM	Geodetic	DATE	August 29, 2015	COMPILED BY	G.D.
				CHECKED BY	G.D.

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)																		
						○ UNCONFINED			+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE																		
74.6 30.0	Silt, trace to some clay Very dense Brown Wet																												
73.1 31.5	End of borehole		20	SS	56																								
<div><div><div>*20150829</div><div>▽Water level observed during drilling</div></div><div><div>Monitoring Well Readings:</div><table><tr><td>Date</td><td>Depth (m)</td><td>Elev.</td></tr><tr><td>09/04/'15</td><td>17.2</td><td>87.4</td></tr><tr><td>09/07/'15</td><td>17.1</td><td>87.5</td></tr><tr><td>11/12/'15</td><td>Dry</td><td>----</td></tr></table><div><div>Monitoring Well Legend:</div><div><div><div><div></div><div></div><div></div></div><div>Flush mount cover + concrete</div></div><div><div><div></div><div></div><div></div></div><div>Bentonite seal</div></div><div><div><div><div></div><div></div><div></div></div><div>Filter sand</div></div><div><div><div><div></div><div></div><div></div></div><div>50mm dia. PVC screen</div></div></div></div></div></div></div></div>																		Date	Depth (m)	Elev.	09/04/'15	17.2	87.4	09/07/'15	17.1	87.5	11/12/'15	Dry	----
Date	Depth (m)	Elev.																											
09/04/'15	17.2	87.4																											
09/07/'15	17.1	87.5																											
11/12/'15	Dry	----																											

**RECORD OF BOREHOLE No RW-9**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 463.8 N ; 272 994.4 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** June 22, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa									
							○ UNCONFINED + FIELD VANE									
							● QUICK TRIAXIAL × LAB VANE									
					WATER CONTENT (%)											
86.7	Ground Surface					20	40	60	80	100	20	40	60			
0.0	Sand and gravel topsoil inclusions		1	SS	8						○					
	Loose Brown Moist															
			2	SS	9						○					
	Sand, trace gravel															
	Compact Brown Moist to dense		3	SS	19											
	(FILL)															
			4	SS	42											
			5	SS	35						○					
			6	SS	38						○					
82.4																
4.3	Sand, some silt trace clay, trace gravel															
	Dense to Brown Moist compact		7	SS	36						○				1 81 12 6	
			8	SS	29						○					
			9	SS	28						○					
79.4																
7.3	Silt with sand, trace clay															
	Very dense Brown Moist		10	SS	52						○				0 29 62 9	
	Dense Wet															
			11	SS	39						○					
77.1																
9.6	End of borehole															

# RECORD OF BOREHOLE No EB-1

1 of 1

## METRIC

G.W.P.	2357-09-01	LOCATION	Coords: 4 793 308.3 N ; 272 992.1 E	ORIGINATED BY	S.A.
DIST	Niagara	HWY	403	BOREHOLE TYPE	Continuous Flight Solid Stem Augers
DATUM	Geodetic	DATE	April 28, 2015	COMPILED BY	K.D.
				CHECKED BY	G.D.

[illegible]

**RECORD OF BOREHOLE No EB-2**

1 of 3

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 333.9 N ; 272 988.2 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** June 12, 15 and 16, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa									
							○ UNCONFINED      + FIELD VANE									
							● QUICK TRIAXIAL      × LAB VANE									
					WATER CONTENT (%)											
84.7	Ground Surface						20	40	60	80	100					
0.0	Topsoil		1	SS	6											
	Sand, trace silt topsoil inclusions to 0.8m															
	Loose to Brown Moist compact		2	SS	7											
			3	SS	12											
	trace gravel		4	SS	4											
	(FILL)		5	SS	9											
			6	SS	7											
			7	SS	19											
79.5																
5.2	Sand		8	SS	7											
	some to with silt trace to some clay															
	Loose to Brown Moist compact		9	SS	9											
			10	SS	1											
			11	SS	23											
	trace gravel															
	Dense to very dense		12	SS	41											
			13	SS	80											
			14	SS	34											
69.7																

## RECORD OF BOREHOLE No EB-2

2 of 3

METRIC

<b>G.W.P.</b> 2357-09-00	<b>LOCATION</b>	Coords: 4 793 333.9 N ; 272 988.2 E	<b>ORIGINATED BY</b> F.P.
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<b>DIST</b>	Niagara	<b>HWY</b>	403	<b>BOREHOLE TYPE</b>	C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test	<b>COMPILED BY</b>	G.D.
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**DATUM** Geodetic **DATE** June 12, 15 and 16, 2015 **CHECKED BY** G.D.

[illegible]

## RECORD OF BOREHOLE No EB-2

3 of 3

METRIC

<b>G.W.P.</b>	2357-09-00	<b>LOCATION</b>	Coords: 4 793 333.9 N ; 272 988.2 E	<b>ORIGINATED BY</b>	F.P.
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<b>DIST</b>	Niagara	<b>HWY</b>	403	<b>BOREHOLE TYPE</b>	C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test	<b>COMPILED BY</b>	G.D.
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**DATUM** Geodetic **DATE** June 12, 15 and 16, 2015 **CHECKED BY** G.D.

[illegible]



**RECORD OF BOREHOLE No EB-3**

1 of 3

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 328.5 N ; 273 002.8 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers + Mud Rotary      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** April 30, May 01 and June 10 to 12, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
85.3	Ground Surface							20	40	60	80	100					
0.0	Topsoil		1	SS	3		85										
85.0	Sand, trace silt topsoil seams to 1.2m																
0.3	Very loose Brown Moist to loose		2	SS	4		84										
	some silt to silty trace clay, trace gravel																
			3	SS	3												
			4	SS	3		83										2 61 31 6
			5	SS	3		82										
			6	SS	7		81										
			7	SS	8		80										
			8	SS	8		79										
	cobbles to 6.7m						78										
	Compact to dense		9	SS	15		77										5 82 (13)
			10	SS	35		76										
			11	SS	30		75										
	Wet		12	SS	23		74										3 79 14 4
			13	SS	25		73										
			14	SS	32		72										
							71										0 87 (13)
70.3																	

**RECORD OF BOREHOLE No EB-3**

2 of 3

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 328.5 N ; 273 002.8 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers + Mud Rotary      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** April 30, May 01 and June 10 to 12, 2015      **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		SHEAR STRENGTH kPa					W <sub>p</sub>	W	W <sub>L</sub>		
70.3						20	40	60	80	100					
15.0	Sand some silt, trace clay		15	SS	28										
	Compact to Brown Wet very dense (Cont'd.)														
			16	SS	33										
			17	SS	36										
	clayey silt layers		18	SS	53										
	Moist														
	with silt														
	Dense Wet														
			19	SS	40										
60.7	Silt some clay, trace sand														
24.6	Compact Grey Moist to dense		20	SS	26										
	some to with sand														
	Very dense Grey Moist		21	SS	81										
55.3	Cont'd														

**RECORD OF BOREHOLE No EB-3**

3 of 3

**METRIC**

G.W.P. 2357-09-01 LOCATION Coords: 4 793 328.5 N ; 273 002.8 E ORIGINATED BY F.P.  
DIST Niagara HWY 403 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + Mud Rotary COMPILED BY G.D.  
DATUM Geodetic DATE April 30, May 01 and June 10 to 12, 2015 CHECKED BY G.D.

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)									
						○ UNCONFINED      + FIELD VANE					○									
						● QUICK TRIAXIAL      × LAB VANE														
55.3								20	40	60	80	100	20	40	60	kN/m³	GR SA SI CL			
30.0	Silt with sand, trace clay					55														
54.4	Very dense Grey      Moist (Cont'd.)		22	SS	57									0						
30.9	End of borehole																			
*      2015   04   30   /   05   01																				
▽      Water level observed during drilling																				
▼      Water level measured after drilling																				
Water Level Readings:																				
Date                      Depth                      Elev.																				
(m)																				
06/10/'15              10.4              74.9																				
07/09/'15              10.1              75.2																				
08/30/'15              10.2              75.1																				
Piezometer Legend:																				
■      Bentonite Seal																				
▨      Bentonite Grout																				
⦿      Filter Sand																				
⦿      Screen																				

## RECORD OF BOREHOLE No EB-4

1 of 3

**METRIC**

G.W.P.	2357-09-01	LOCATION	Coords: 4 793 410.5 N ; 272 993.4 E	ORIGINATED BY	F.P.
DIST	Niagara	HWY	403	BOREHOLE TYPE	Continuous Flight Hollow Stem Augers + Mud Rotary
DATUM	Geodetic	DATE	July 02 & 03, 2015	CHECKED BY	G.D.

[illegible]

## RECORD OF BOREHOLE No EB-4

2 of 3

METRIC

G.W.P. 2357-09-01	LOCATION	Coords: 4 793 410.5 N ; 272 993.4 E	ORIGINATED BY F.P.
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DIST Niagara HWY 403 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + Mud Rotary COMPILED BY G.D.

DATUM Geodetic DATE July 02 & 03, 2015 CHECKED BY G.D.

[illegible]

## RECORD OF BOREHOLE No EB-4

3 of 3

METRIC

G.W.P. 2357-09-01	LOCATION	Coords: 4 793 410.5 N ; 272 993.4 E	ORIGINATED BY F.P.
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DIST Niagara HWY 403 BOREHOLE TYPE Continuous Flight Hollow Stem Augers + Mud Rotary COMPILED BY G.D.

DATUM Geodetic DATE July 02 & 03, 2015 CHECKED BY G.D.

[illegible]

## RECORD OF BOREHOLE No EB-5

1 of 3

METRIC

<b>G.W.P.</b> 2357-09-01	<b>LOCATION</b>	Coords: 4 793 409.4 N ; 273 008.7 E	<b>ORIGINATED BY</b> F.P.
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<b>DIST</b> Niagara	<b>HWY</b> 403	<b>BOREHOLE TYPE</b> C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test	<b>COMPILED BY</b> G.D.
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**DATUM** Geodetic **DATE** June 26, 29 & 30, 2015 **CHECKED BY** G.D.

[illegible]

**RECORD OF BOREHOLE No EB-5**

2 of 3

**METRIC**

G.W.P. 2357-09-01 LOCATION Coords: 4 793 409.4 N ; 273 008.7 E ORIGINATED BY F.P.

DIST Niagara HWY 403 BOREHOLE TYPE C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test COMPILED BY G.D.

DATUM Geodetic DATE June 26, 29 & 30, 2015 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE										○		
								● QUICK TRIAXIAL × LAB VANE												
70.8							20	40	60	80	100									
	Sand with silt, trace clay		15	SS	48								○							
	Dense to Brown Wet to very dense moist																			
69.6							70													
16.2	Sand and silt, trace clay		16	SS	99/23cm								○				0 44 49 7			
	Very dense Brown Moist																			
							69													
							68													
			17	SS	50/10cm								○							
							67													
							66						○							
			18	SS	106/23cm															
							65													
							64													
64.3	Sandy silt, trace clay						63													
21.5	Very dense Brown Wet to moist		19	SS	68								○				0 35 60 5			
							62													
							61													
							60						○							
			20	SS	50/15cm		59													
							58													
							57													
			21	SS	50/15cm		56													
56.2																				
29.6	Silt, some sand, trace clay Cont'd																			



## RECORD OF BOREHOLE No EB-5

3 of 3

METRIC

<b>G.W.P.</b> 2357-09-00	<b>LOCATION</b>	Coords: 4 793 409.4 N ; 273 008.7 E	<b>ORIGINATED BY</b> F.P.
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<b>DIST</b>	Niagara	<b>HWY</b>	403	<b>BOREHOLE TYPE</b>	C.F.H.S.A. + Mud Rotary and Dynamic Cone Penetration Test	<b>COMPILED BY</b>	G.D.
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**DATUM** Geodetic **DATE** June 26, 29 & 30, 2015 **CHECKED BY** G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE      LIQUID CONTENT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE	20	40	60	80	100	W <sub>p</sub>	W		
55.8																	
	Silt, some sand, trace clay																
	Very dense Grey      Moist		22	SS	53								C			0   14   77   9	
54.9	Switched to dynamic cone																
30.9	penetration test																
	Probable silt																
	Very dense																
53.1																	
32.7	End of dynamic cone																
	penetration test																
	Refusal on probable boulder																

**RECORD OF BOREHOLE No EB-6**

1 of 1

**METRIC**

**G.W.P.** 2357-09-01      **LOCATION** Coords: 4 793 425.9 N ; 272 990.0 E      **ORIGINATED BY** F.P.  
**DIST** Niagara      **HWY** 403      **BOREHOLE TYPE** Continuous Flight Hollow Stem Augers      **COMPILED BY** G.D.  
**DATUM** Geodetic      **DATE** July 08 & 09, 2015      **CHECKED BY** G.D.

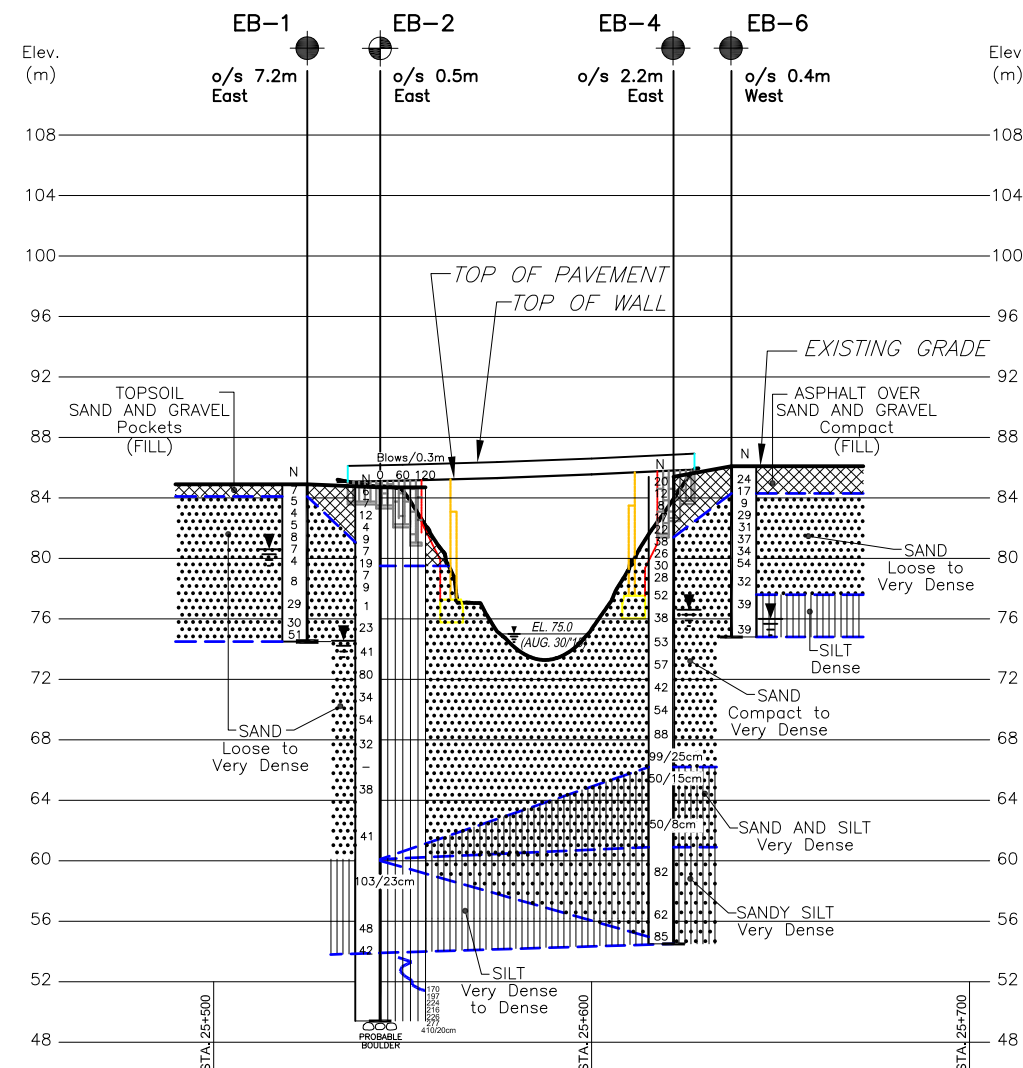
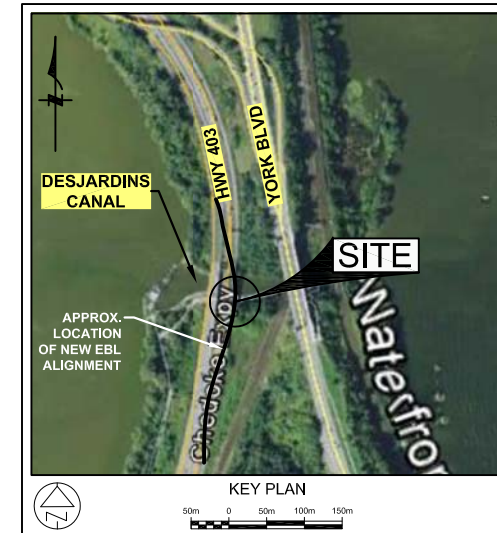
SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa												
						20 40 60 80 100												
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
					WATER CONTENT (%)					20 40 60								
86.1	Ground Surface																	
0.0	150mm asphalt over sand and gravel																	
	Compact Brown Moist																	
	(FILL)		1	SS	24													
84.3			2	SS	17													
1.8	Sand some silt, trace clay																	
	Loose to Brown Moist very dense		3	SS	9												0 81 16 3	
			4	SS	29													
			5	SS	31													
			6	SS	37													
			7	SS	34												0 84 14 2	
			8	SS	54													
	silty clay seams																	
			9	SS	32													
77.6																		
8.5	Silt some sand, some clay																	
	Dense Brown Moist to wet		10	SS	39												0 13 73 14	

\* 2015 07 09

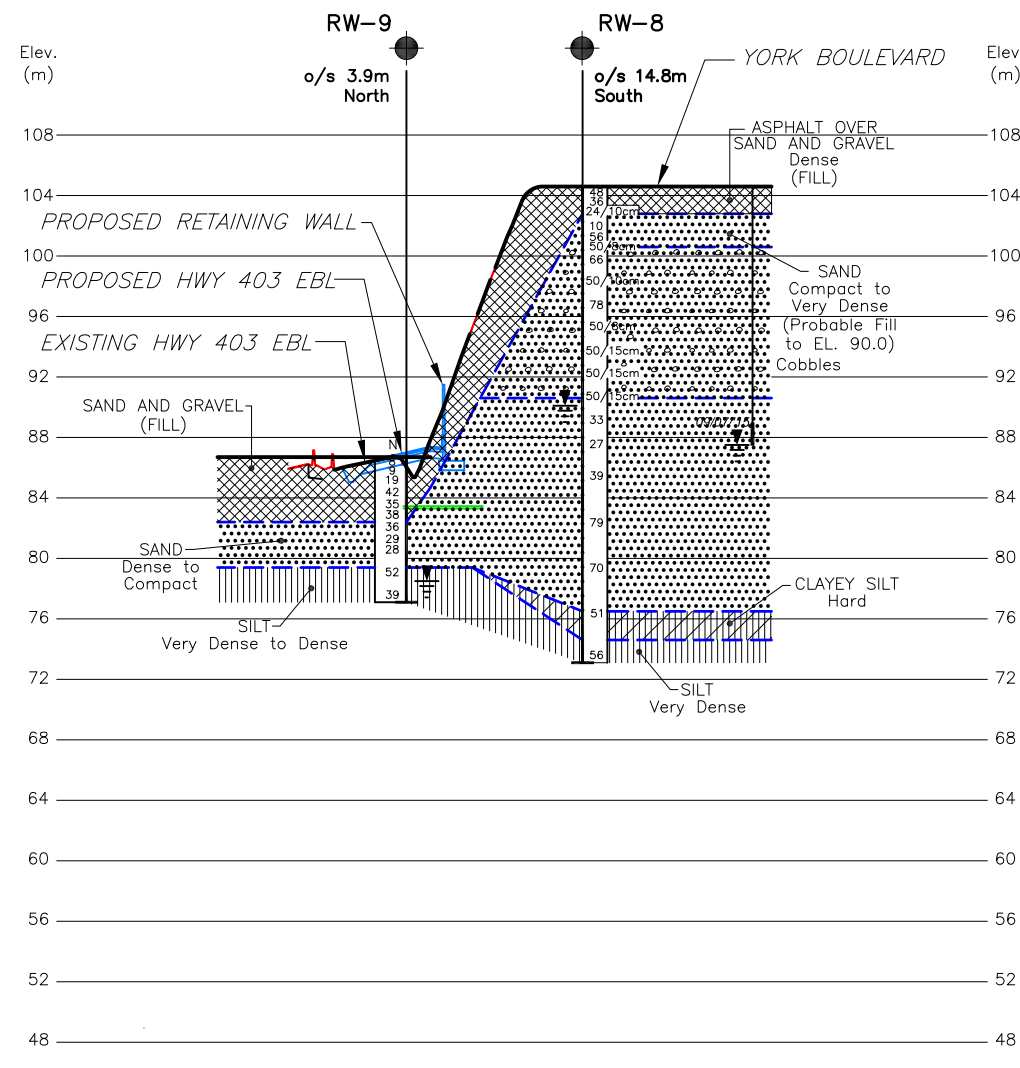
▽ Water level observed during drilling

▽ Water level measured after drilling

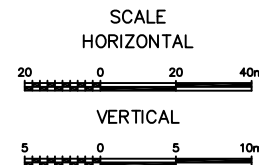




PROFILE B-B



SECTION C-C  
(AT STA. 25+675)



NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- REFER TO DRAWING RW-1 FOR BOREHOLE AND SECTION LOCATIONS.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
- STATIONS ARE IN KILOMETRES AND METRES.

LEGEND			
	Borehole		
	Borehole and Cone		
	Dynamic Cone Penetration Test (Cone)		
	N Blows/0.3m (Std. Pen Test, 475 J/blow)		
	CONE Blows/0.3m (60 Cone, 475 J/blow)		
	WL at time of investigation April to November 2015		
	WH Penetration due to weight of hammer		
	* Water level not established		
	Head		
	ARTESIAN WATER		
	Encountered		
	PIEZOMETER		

BH No	ELEVATION	NORTHINGS	EASTINGS
FOR DETAILS, REFER TO DWG RW-1			

— NOTE —  
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 30M5-321			
HWY No	403	DIST	Central
SUBM'D	NA	CHECKED	GD
DATE	JAN. 18, 2016	SITE	36-36/1
DRAWN	NA	CHECKED	GD
APPROVED	CN	DWG	RW-2



Reference Morrison Hershfield LTD. Drawings:  
ACAD-Desjardins Detail Sections.dwg dated August 25 2015;  
x1130336\_Hwy 403\_Base.dwg and 36-36-RW1