



**DETAIL FOUNDATION INVESTIGATION REPORT**

**for**

**REPLACEMENT OF MEADOW CREEK BRIDGE**

**HIGHWAY 577, SITE 39E-077**

**G.W.P. 181-92-00**

**COCHRANE DISTRICT, IROQUOIS FALLS**

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## TABLE OF CONTENTS

1. INTRODUCTION .....	1
2. SITE DESCRIPTION AND GEOLOGY .....	1
3. INVESTIGATION PROCEDURES .....	2
4. SUMMARISED SUBSURFACE CONDITIONS .....	3
4.1 Fill.....	4
4.2 Clay / Silty Clay / Clayey Silt .....	5
4.3 Cohesionless.....	6
4.4 Groundwater .....	6
5. CLOSURE.....	7

Figures PC-1-1 to PC-1-4 – Plasticity Charts

Figures GS-1-1 to GS-1-6 – Results of Grain Size Distribution Analyses

Figures C-1-1 and C-1-2 – Results of Consolidation Tests

Figures CU-1-1 and CU-1-2 – Results of Consolidated-Undrained Triaxial Tests

Explanation of Terms Used in Report

Record of Borehole Sheets

Drawings 1-1 and 1-2 – Borehole Locations and Soil Strata

Appendix A – Record of Borehole Sheets and Drawings from Preliminary Investigation  
Carried Out by Shaheen & Peaker Ltd. (GEOCRES No. 42A-66)

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**1. INTRODUCTION**

This report summarises the results of a detail foundation investigation carried out for the proposed replacement of an existing bridge over Meadow Creek located on Highway 577 (Monteith Road) south of the Town of Iroquois Falls, Ontario. The investigation was conducted for Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation of Ontario.

Highway 577 passes over Meadow Creek at approximate Station 19+893, Highway 577 chainage (ref. A Preliminary General Arrangement drawing prepared by Stantec in December 2008). The existing single-lane bridge is a 12-span structure on timber pile bents with a total length of 74.2 m and width of 6.1 m. A preliminary investigation was carried out by Shaheen & Peaker Ltd. in 2006 (GEOCRES No. 42A-66).

The report provides subsurface information pertaining to the proposed structure foundations and approaches within about 20 m of the abutments. The investigation carried out for the approaches beyond these limits was reported separately under PML report 08TF009-2.

**2. SITE DESCRIPTION AND GEOLOGY**

The existing single-lane structure carries Highway 577 traffic over Meadow Creek. At the location of the bridge, Highway 577 runs in the approximate south-north direction. The flow of water in the creek is from west to east towards the Abitibi River, with the confluence some 900 m downstream. The existing approach embankments are about 4 m in height.

The Meadow Creek channel at the bridge is about 60 m wide. The overall width of the creek valley at this location is 100 to 120 m. Constructed by placing clayey fill in the creek floodplain, the approach embankments to the bridge are 20 to 40 m long.



The subject site is located in the Abitibi Uplands, part of the Canadian Shield physiographic province. The Abitibi Uplands is a peneplain that straddles the Hudson Bay / St. Lawrence drainage divide with modern drainage towards James Bay. The local topography is very flat so that low relief results in small stream gradients.

The typical soils of the Cochrane Till are non-sorted, non-stratified silty clay, silty clay loam or silt loam. Overlain by clayey deposits at about 25 m depth are sandy soils containing cobbles and boulders.

Bedrock is described as paragneiss and migmatitic paragneiss, commonly with abundant granitic and pegmatitic rocks. These rocks are primarily igneous in origin and tend to be relatively hard. The bedrock is at depths of more than 30 m at the site.

### **3. INVESTIGATION PROCEDURES**

The field work for this study was carried out during the period of October 15 to 30, 2008 and comprised four boreholes drilled to depths of 10.1 to 33.4 m at the locations shown on Drawing 1-1. It is noted that the current boreholes put down at the bridge were numbered in the 100-series to distinguish them from boreholes that were drilled at the site during the preliminary investigation in 2006 (the borehole logs and drawings from the GEOCRESS No. 42A-66 preliminary report are reproduced in Appendix A).

The locations of the boreholes for the current investigation were established in the field by Peto MacCallum Ltd. The ground surface elevations at the boreholes were provided by Talbot Survey Ltd. All elevations in this report are geodetic and expressed in metres.

The boreholes were advanced using continuous flight hollow stem augers, powered by a track-mounted Morooka MST-1100 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

Representative samples of the soil cover were recovered at frequent depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted



simultaneously with the sampling operation to assess the strength characteristics of the substrata. A dynamic cone penetration test was also carried out from the bottom of borehole 102 to supplement the test data. Penetrometer and in-situ vane shear testing was performed to assess the shear strength of the cohesive soils. The penetrometer readings may be lower than the actual shear strength values due to sample disturbance.

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 open boreholes. Two piezometers were installed in boreholes 101 and 104, with piezometer readings taken over a 9-day period. Water levels were also measured in a piezometer that was installed in borehole 5 during the preliminary investigation. The boreholes were backfilled with a bentonite/cement mixture where required in accordance with the MTO guidelines and MOE Reg. 903 for borehole abandonment procedures.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determination. Further, 11 Atterberg limits tests, 15 grain size distribution analyses, 2 consolidation tests and 2 consolidated-undrained (with pore pressure measurement) triaxial tests were conducted on selected samples, with the results presented in Figures PC-1-1 to PC-1-4, GS-1-1 to GS-1-6, C-1-1, C-1-2, CU-1-1 and CU-1-2. In addition, 2 unconfined compression tests were performed. The laboratory test results are shown on the Record of Borehole sheets.

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

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classification, inferred stratigraphy, boundary elevations, standard and dynamic cone penetration test data, penetrometer and in-situ vane shear strength values, piezometer details and groundwater observations. The results of laboratory unconfined compressive strength tests, Atterberg limits testing, grain size distribution analyses and moisture content determination are also shown on the Record of Borehole sheets. The borehole locations are indicated on Drawing 1-1.



The stratigraphic profile and cross-sections are presented on Drawings 1-1 and 1-2. 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 for the current investigation was generally consistent with the results of the preliminary investigation (relevant boreholes 3, 4, 5 and 7) and comprised surficial fill overlying a cohesive deposit of clay to clayey silt underlain by cohesionless sandy soils containing cobbles and boulders. The strata encountered are summarised below.

#### **4.1 Fill**

Fill was encountered in the approach embankments. The fill had a total thickness of 0.7 to 9.1 m and was penetrated at elevation 242.4 to 252.3. It is noteworthy that a 700 mm thick layer of rockfill was encountered on the creek bed in borehole 4 (elevation 243.4 to 242.7).

Surficial fill was present in boreholes 101 to 104 and was composed of the pavement materials (sand in boreholes 101, 103, 104; sand and gravel covered with 50 mm of asphaltic concrete in borehole 102) which extended to depths of 0.7 to 1.0 m (elevation 250.5 to 252.6).

The pavement fill material was very loose to loose in relative density (SPT-'N' values of 1 to 5) and had a moisture content of 5 to 13%.

The sandy fill overlays 2.3 to 8.1 m of clay / silty clay fill with organic inclusions in boreholes 102 to 104. The clayey fill was firm to stiff in consistency (SPT-'N' values of 3 to 9) and 22 to 36% in moisture content.

The results of grain size distribution analyses performed on 3 samples of the sand fill are presented in Figure GS-1-1. The results of Atterberg limits testing and grain size distribution analyses conducted on 2 cohesive samples are presented in respective Figures PC-1-1 and GS-1-2. The clay / silty clay fill had liquid limits of 50 and 52, plastic limits of 22 and 24, its plasticity index being 28.



## 4.2 Clay / Silty Clay / Clayey Silt

Directly beneath the fill at depths of 0.7 to 9.1 m (elevation 242.4 to 252.3) in boreholes 101 to 104 was a cohesive deposit of clay / silty clay / clayey silt. Having a thickness of 14.5 m in borehole 102 and 16.8 m in borehole 103, the deposit was penetrated at respective depths of 21.8 and 25.9 m (elevation 229.4 and 225.6). Boreholes 101 and 104 were terminated in the clay at 10.1 m depth (elevation 242.9 and 243.2). The consistency of this deposit was firm to stiff. The results of in-situ vane testing carried out in the clay / silty clay yielded undisturbed shear strength values in a range of 32 to 84 kPa (soil sensitivity of 2 to 6). Penetrometer tests on samples of the silty clay indicated a shear strength of 13 to 100 kPa. Unconfined compression testing on two Shelby tube samples of the clay / silty clay gave an undrained shear strength of 40 and 46 kPa (strain at failure of 3.3 and 4.8%).

The results of Atterberg limits testing, grain size distribution analyses, consolidation tests and consolidated-undrained (with pore pressure measurement) triaxial tests conducted on 9 cohesive samples are presented in respective Figures PC-1-2 to PC-1-4, GS-1-3 to GS-1-5, C-1-1, C-1-2, CU-1-1 and CU-1-2. The liquid and plastic limits of the clay were 53 and 23 in one determination, 55 and 25 in another, with the plasticity index of 30. The silty clay had a liquid limit of 41 to 49, plastic limit of 21 to 24 and plasticity index values of 19 to 27. The liquid and plastic limits of the clayey silt were 21 and 14 respectively, thus giving the plasticity index of 7. The moisture content of the deposit varied between 24 and 62%.

The results of the consolidation tests carried out on samples of boreholes 102 and 103 obtained at similar depths indicate variable results typical of alluvial deposits. The results are summarized as follows:

Borehole	Sample	Depth (m)	Elevation (m)	Initial Pressure (kPa)	Preconsolidation		C <sub>c</sub>	C <sub>r</sub>	e <sub>o</sub>
					Pressure (kPa)	Ratio			
102	12	12.2 – 12.8	239.0 – 238.4	140	500	3.6	0.50	0.08	1.18
103	16	12.2 – 12.8	239.3 – 238.7	140	400	2.9	0.40	0.06	1.00



The values of cohesion and angle of internal friction measured with consolidated-undrained triaxial tests on two samples from two boreholes (Figures CU-1-1 and CU-1-2) were as follows:

Borehole	Sample	Estimated Cohesion (kPa)	Estimated Angle of Internal Friction (degrees)
102	12	26	7
103	16	9	29

#### **4.3 Cohesionless Soils**

Underlying the clayey silt in boreholes 102 and 103 at respective depths of 21.8 and 25.9 m (elevation 229.4 and 225.6) was a stratum of cohesionless soils with variable granulometric composition (silt, sandy silt, silty sand, sand, gravelly sand). The drilling was terminated within the stratum due to refusal on probable boulders at 33.4 m depth (elevation 217.8) in borehole 102 and a depth of 32.5 m (elevation 219.0) in borehole 103. This stratum was compact to very dense and contained cobbles and boulders.

The moisture content of the sand in borehole 103 was about 16%. The results of grain size distribution analysis performed on a sample of the sand are presented in Figure GS-1-6.

#### **4.4 Groundwater**

In the course of the field work, groundwater was observed in boreholes 101 to 104. In the process of augering, water was detected at depths of 2.1 to 9.1 m (elevation 242.4 to 250.9) in all the boreholes. Upon completion of drilling, groundwater was measured at a depth of 3.1 m (elevation 250.2) in borehole 104.





Two piezometers were installed in boreholes 101 and 104. Piezometer readings subsequently taken showed water levels to be at the following depths/elevations:

Date	Borehole 101		Borehole 104	
	Depth (m)	Elev.	Depth (m)	Elev.
October 22, 2008	9.1	243.9	–	–
October 25, 2008	9.0	244.0	–	–
October 26, 2008	8.8	244.2	2.2	251.1
October 27, 2008	8.8	244.2	1.6	251.7
October 28, 2008	8.7	244.3	1.8	251.5
October 30, 2008	8.6	244.4	2.0	251.3
October 31, 2008	8.4	244.6	2.0	251.3

Water level measurements were also taken in one piezometer installed in borehole 5 during the preliminary investigation. The piezometric water level was at 5.3 m depth (elevation 246.3) on October 15, 2008 and a depth of 5.1 m (elevation 246.5) on October 30, 2008. The water level in this borehole was measured at a depth of 5.2 m (elevation 246.4) on September 14, 2006.

The water level in the Meadow Creek is controlled by dams located both upstream and downstream of the site and was reported at elevation 248.0 in September 2006.

Groundwater levels may fluctuate subject to seasonal variations and precipitation patterns and to the dam control upstream and downstream of the bridge site.

## 5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, Senior Technician, and direction of Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer. The drilling equipment was supplied by Abraflex (2004) Ltd. The testing of selected soil samples was carried out in the PML laboratory in Toronto.



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., Senior Project Engineer. Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.



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

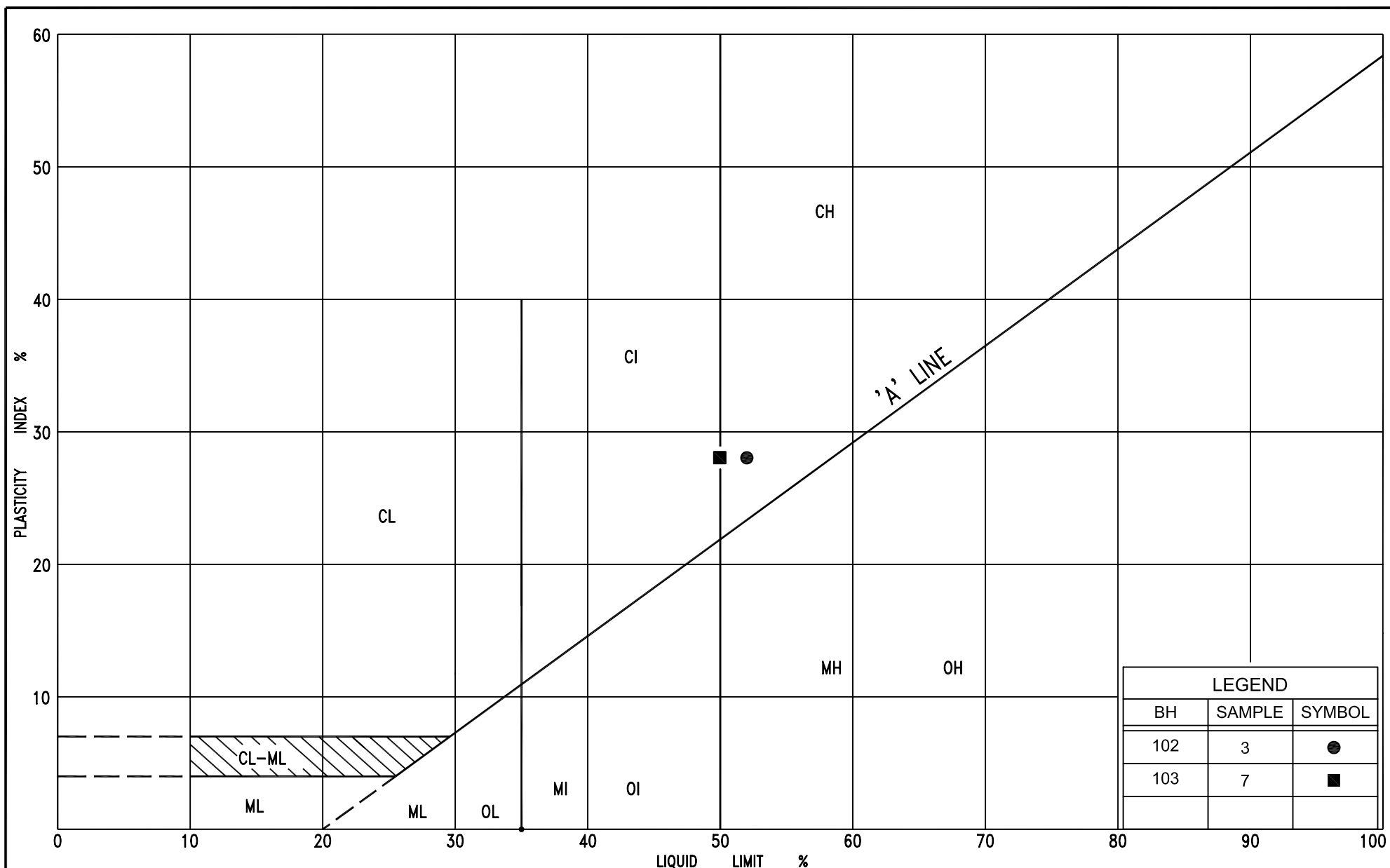


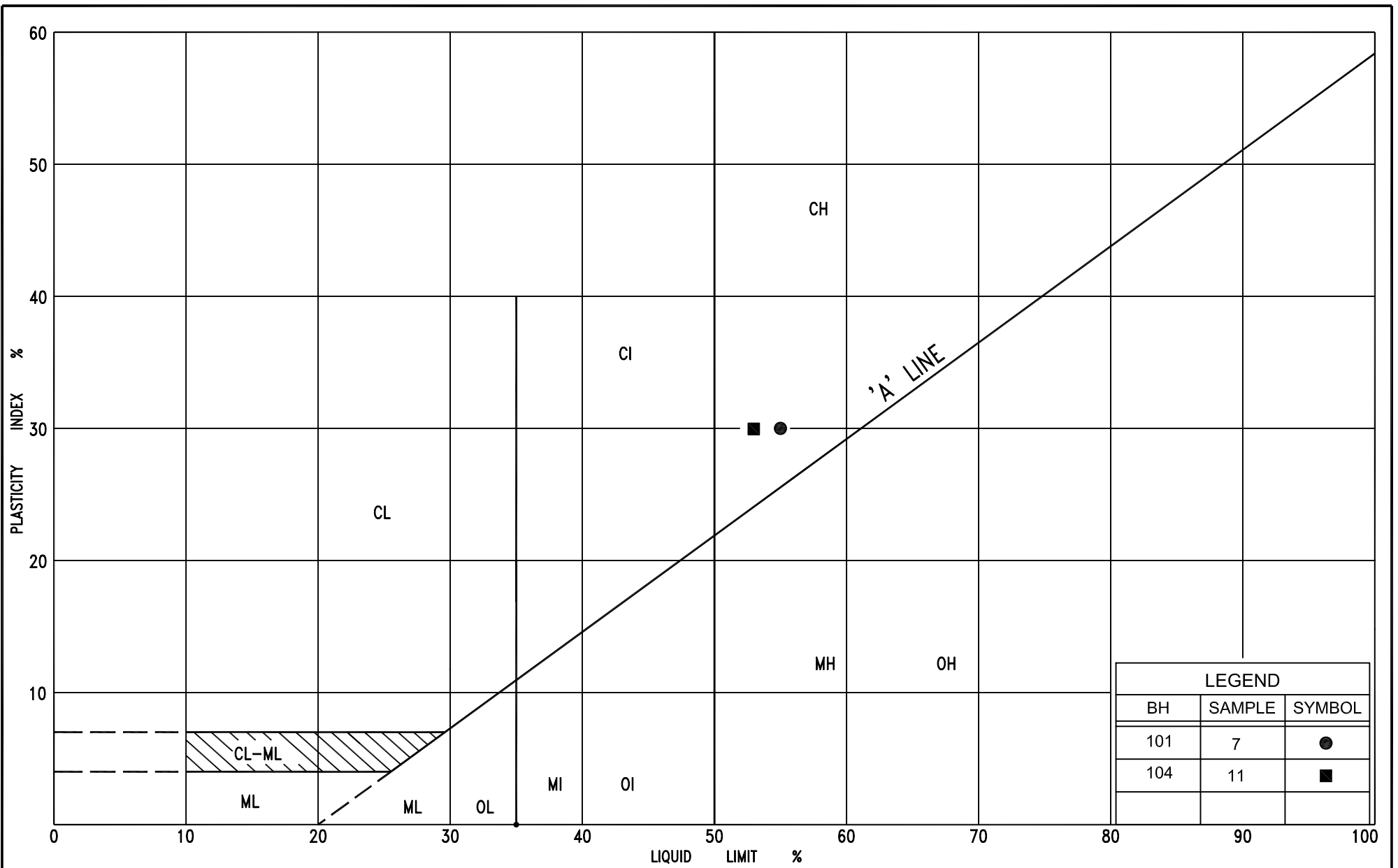
C. M. P. Nascimento, P.Eng.  
Senior Project Engineer

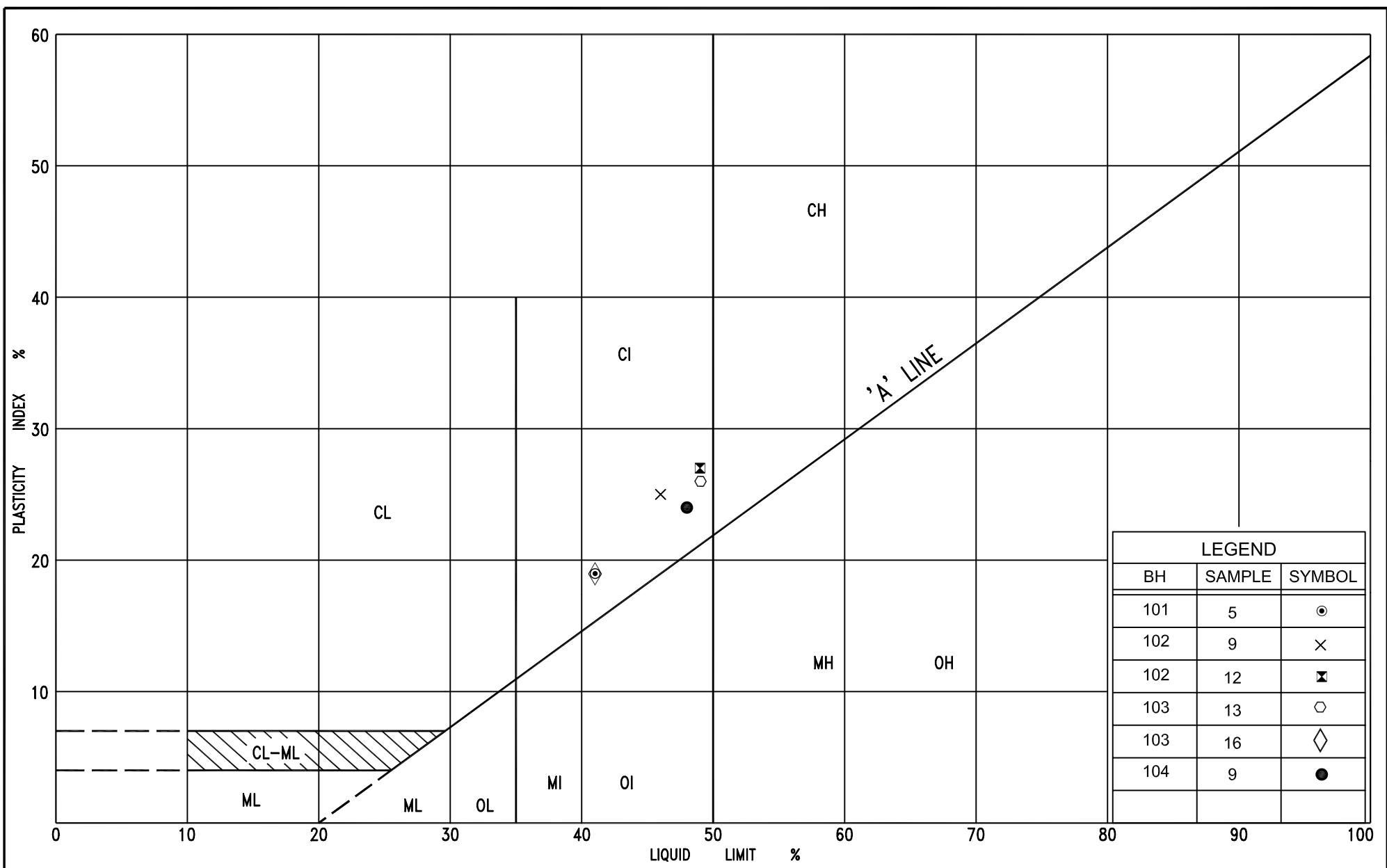


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MTO Designated Principal Contact

GD/CN/BRG:gd-mi







Ministry of  
Transportation  
Ontario

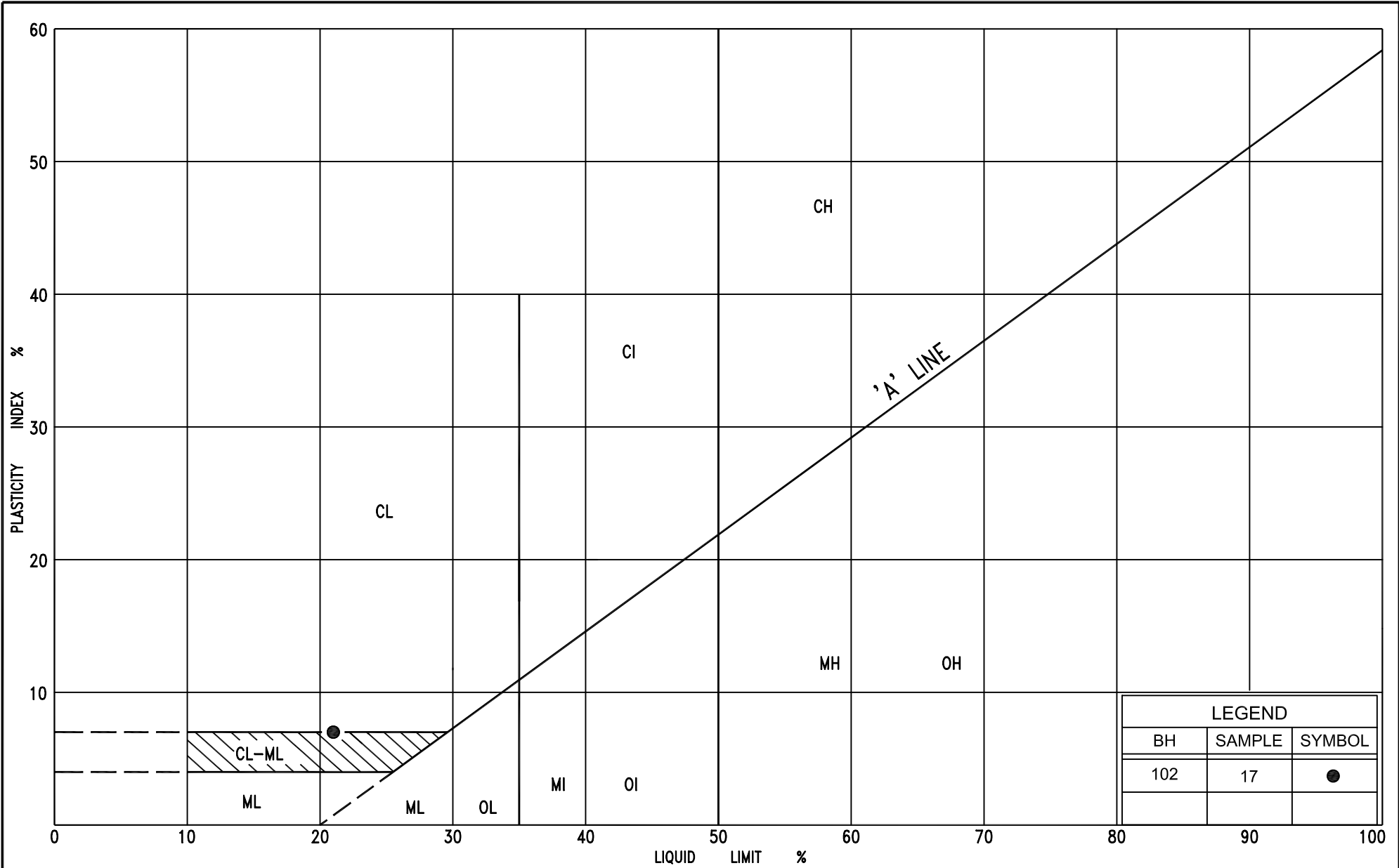
## PLASTICITY CHART

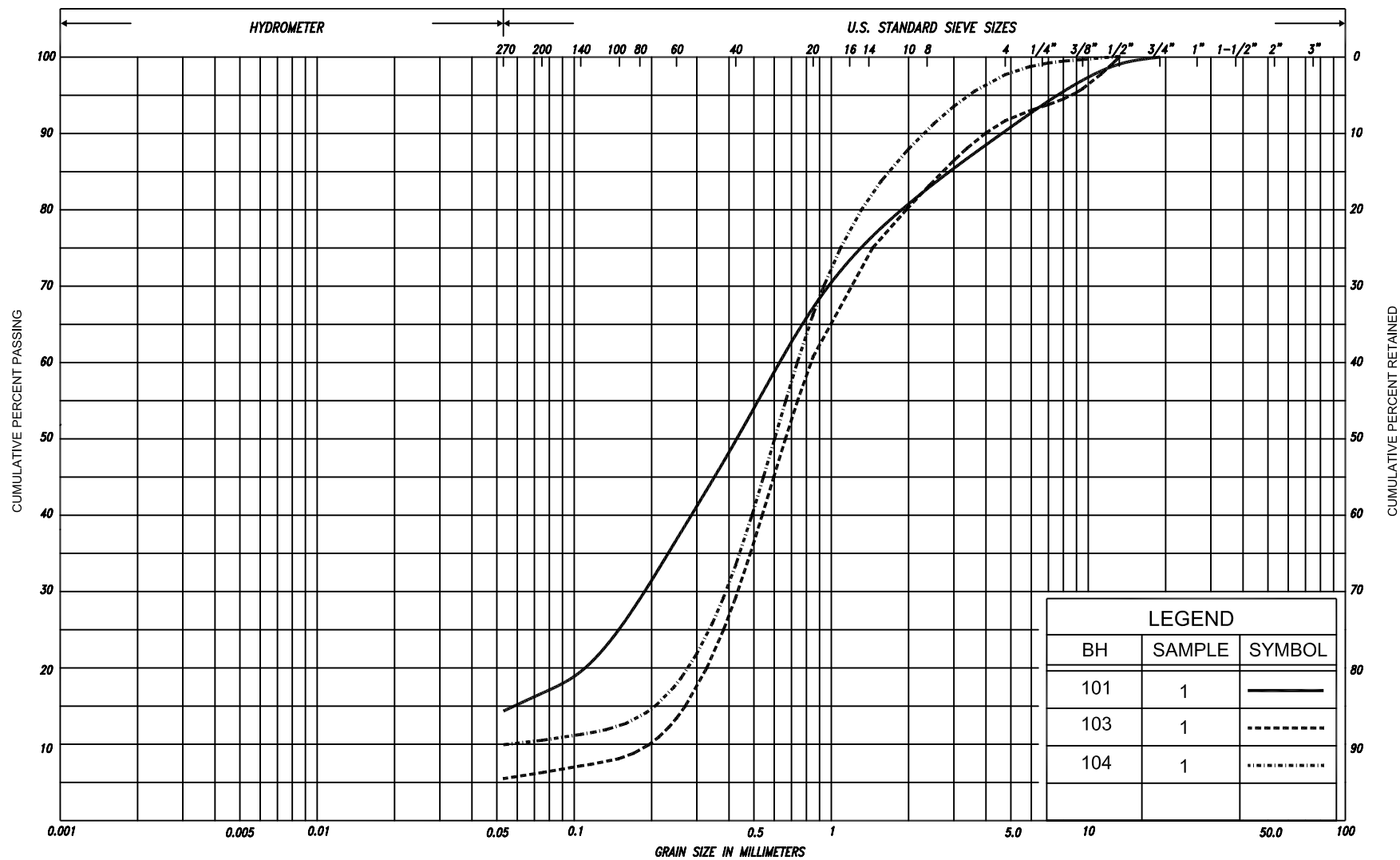
SILTY CLAY, trace sand

FIG No. PC-1-3

HWY: 577

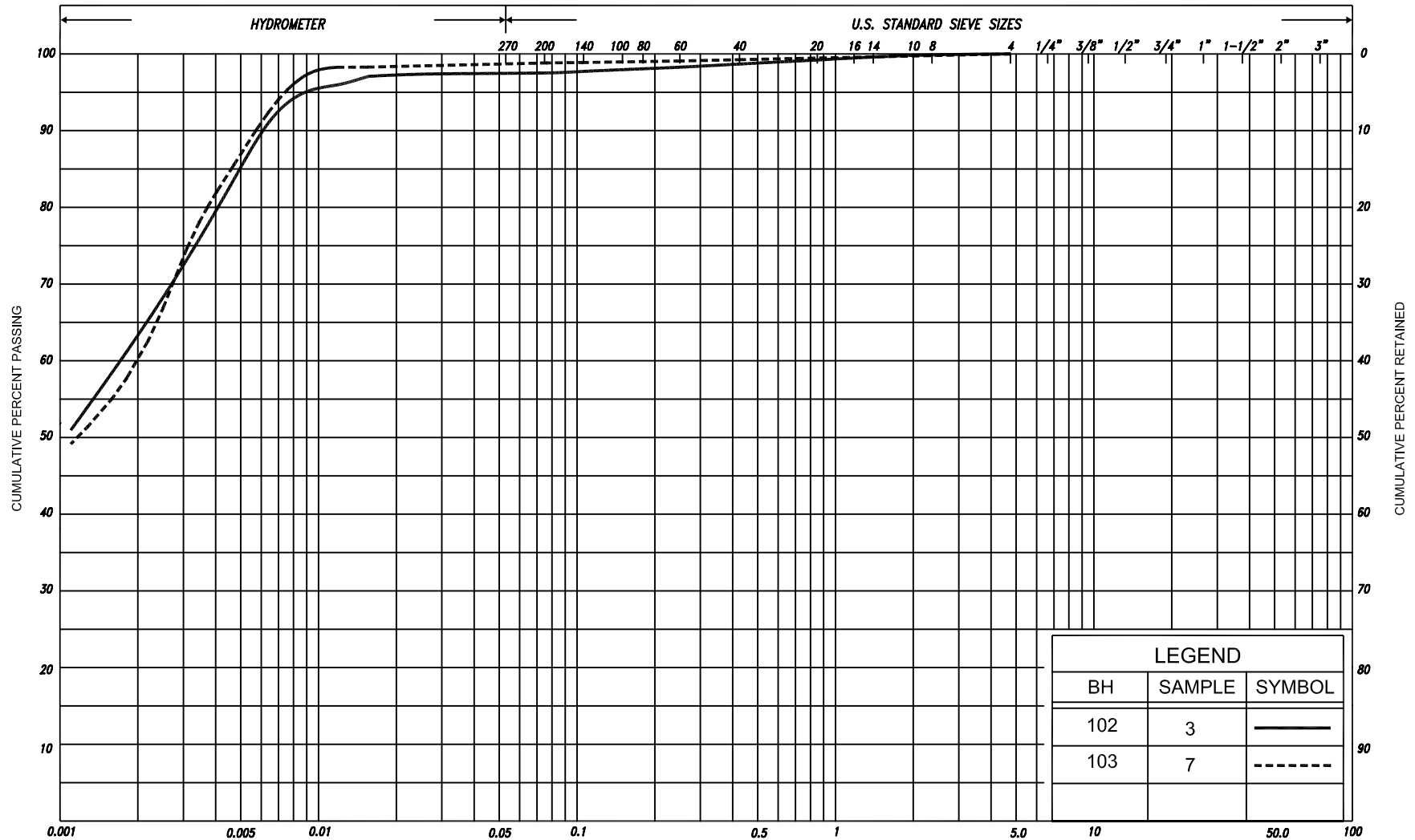
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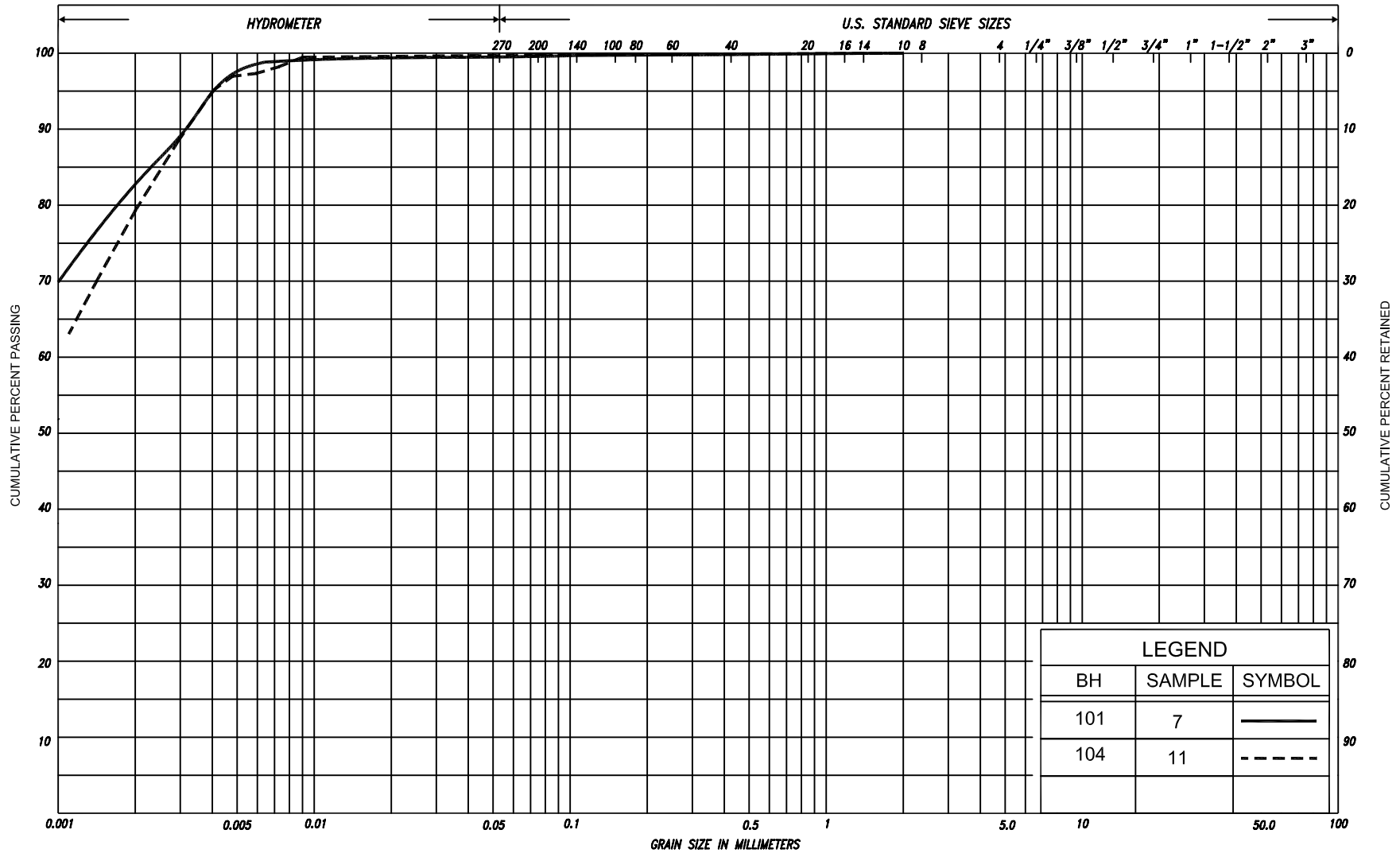
SILT & CLAY				FINE		MEDIUM		COARSE		GRAVEL		COBBLES	UNIFIED			
				SAND												
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL	COBBLES	M.I.T.	
CLAY			SILT			V. FINE		FINE		MED.		COARSE		GRAVEL		U.S. BUREAU
						SAND										

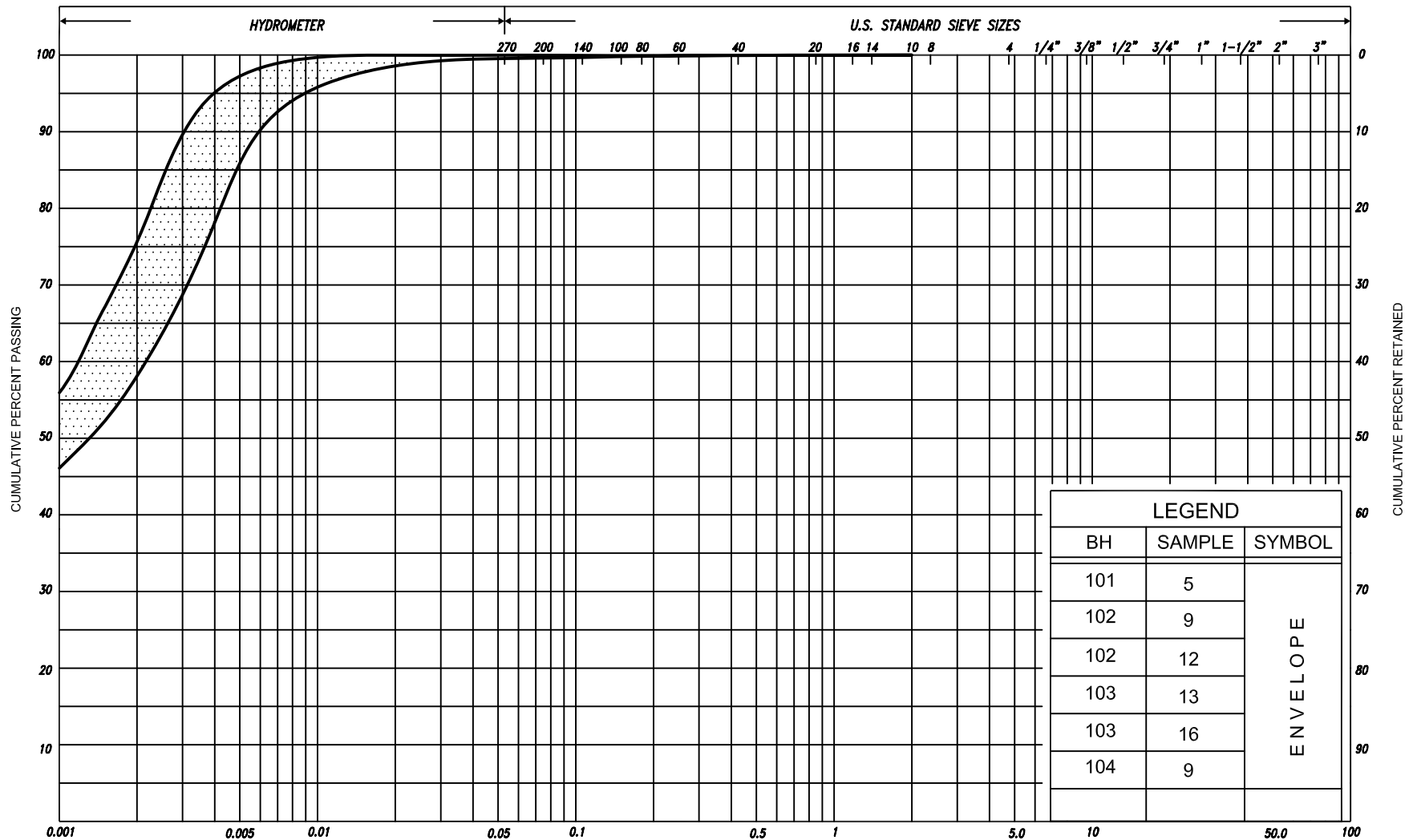
# GRAIN SIZE DISTRIBUTION SAND, trace to some silt, trace gravel (FILL)



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

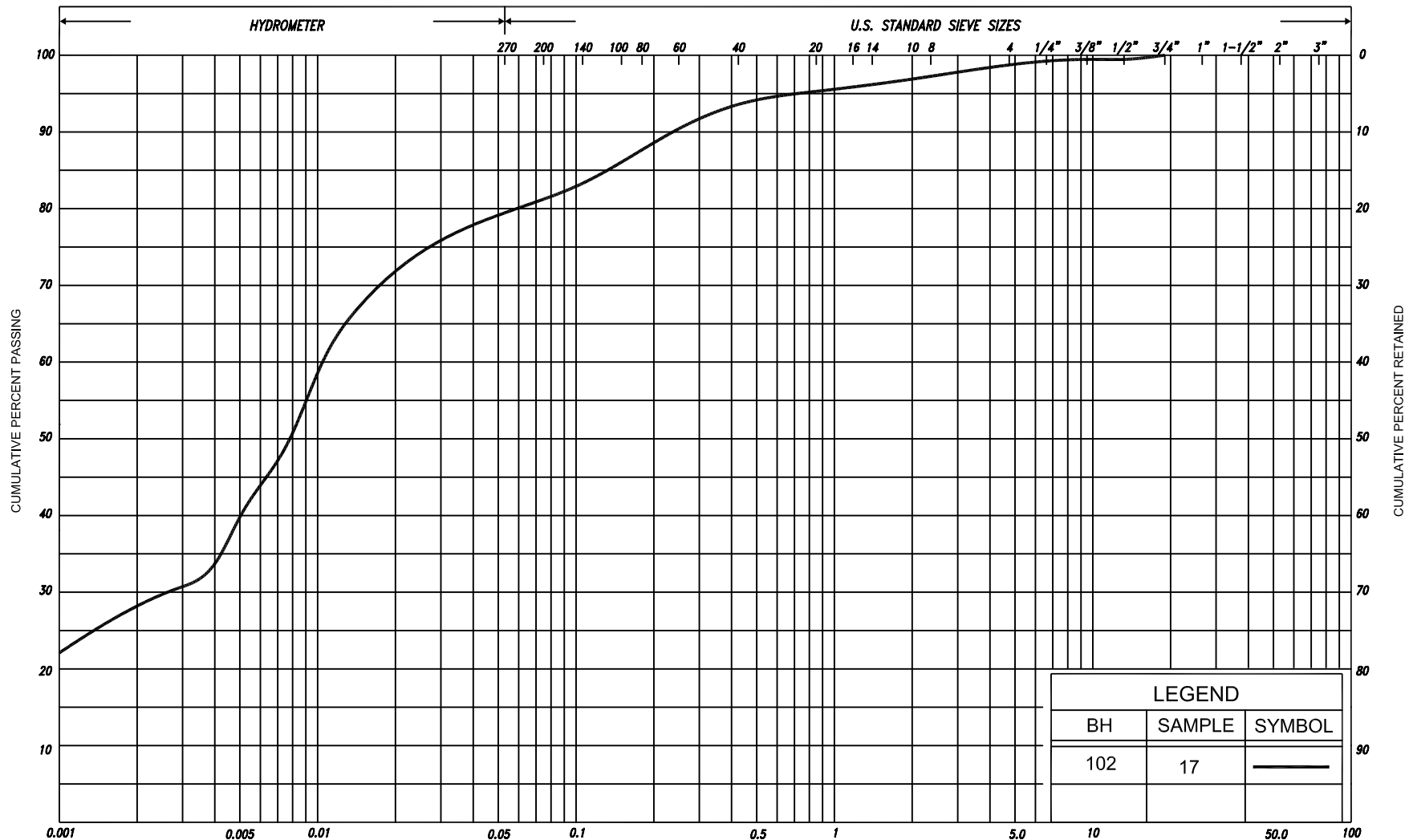






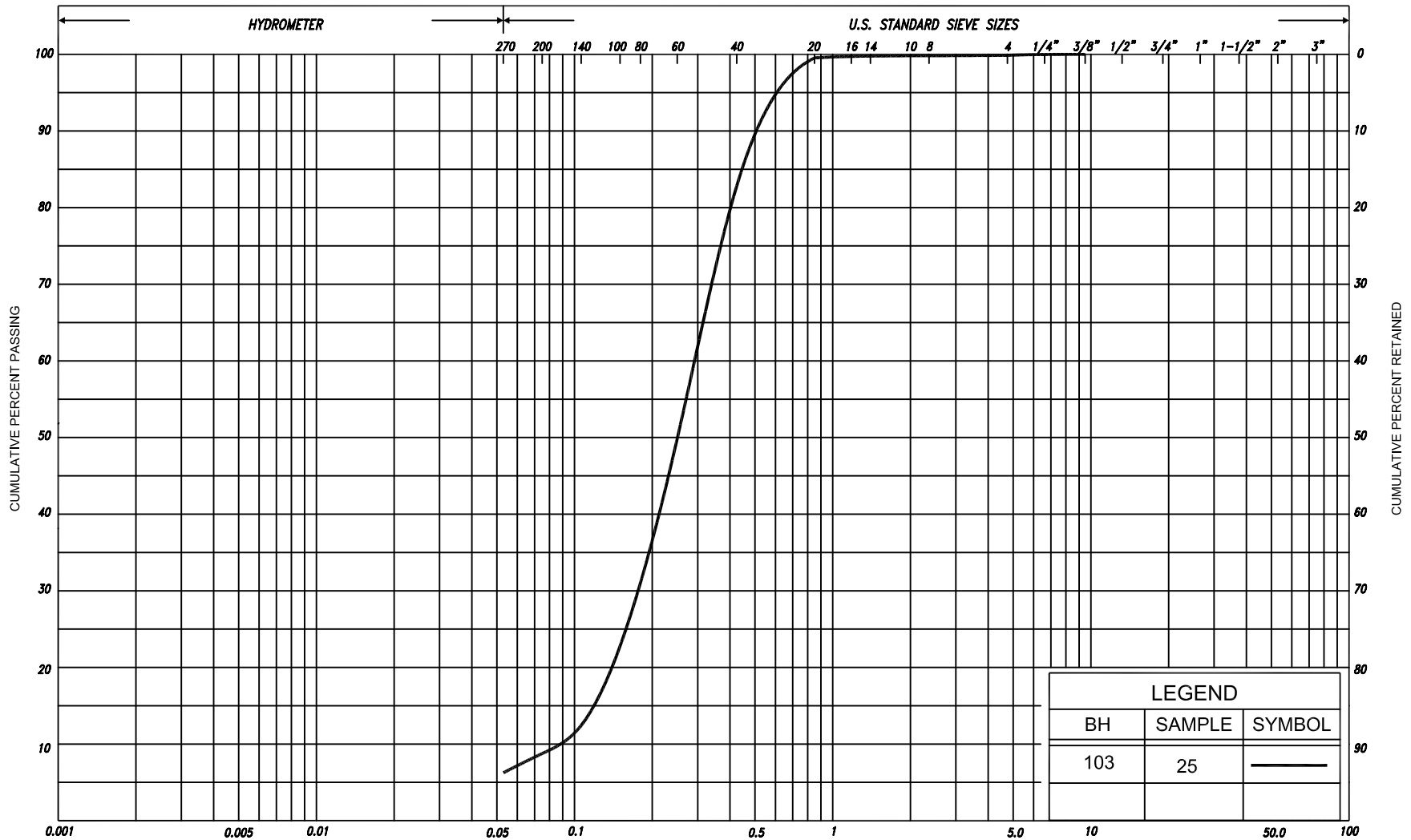
LEGEND		
BH	SAMPLE	SYMBOL
101	5	ENVELOPE
102	9	
102	12	
103	13	
103	16	
104	9	

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



LEGEND		
BH	SAMPLE	SYMBOL
102	17	—

SILT & CLAY				GRAIN SIZE IN MILLIMETERS			COBBLES		UNIFIED
				FINE	MEDIUM	COARSE	GRAVEL		
				SAND					
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL		M.I.T.
SILT				Y. FINE	FINE	MED.	COARSE	GRAVEL	
				SAND					U.S. BUREAU

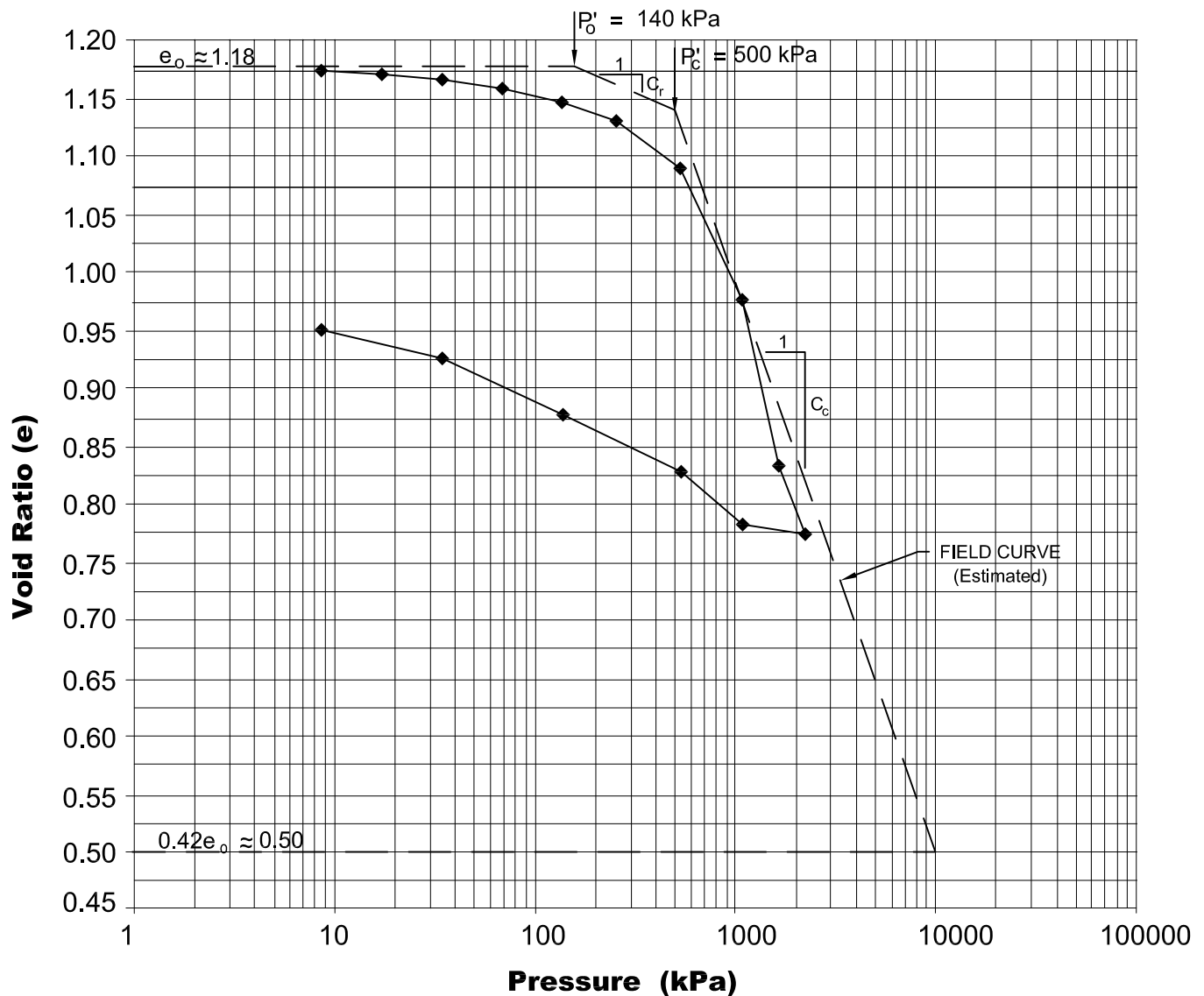


SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES		M.I.T.	
	SILT			SAND									
CLAY		SILT		V. FINE	FINE	MED.	COARSE	GRAVEL					U.S. BUREAU

Laboratory Consolidation Test Results

Meadow Creek Bridge  
District Cochrane, Ontario

Borehole 102, Sample 12,  
Depth 12.2 - 12.8 m (El.239.0 to 238.4)



SOIL TYPE: SILTY CLAY

$e_o \approx 1.18$

$W_o = 45\%$

$\gamma = 18.2$  kN/m<sup>3</sup>

$P'_o = 140$  kPa

$P'_c = 500$  kPa

$C_c = 0.50$

$C_r = 0.08$

$W_L = 49$

$W_P = 22$

PI = 27

FIGURE No: C-1-1

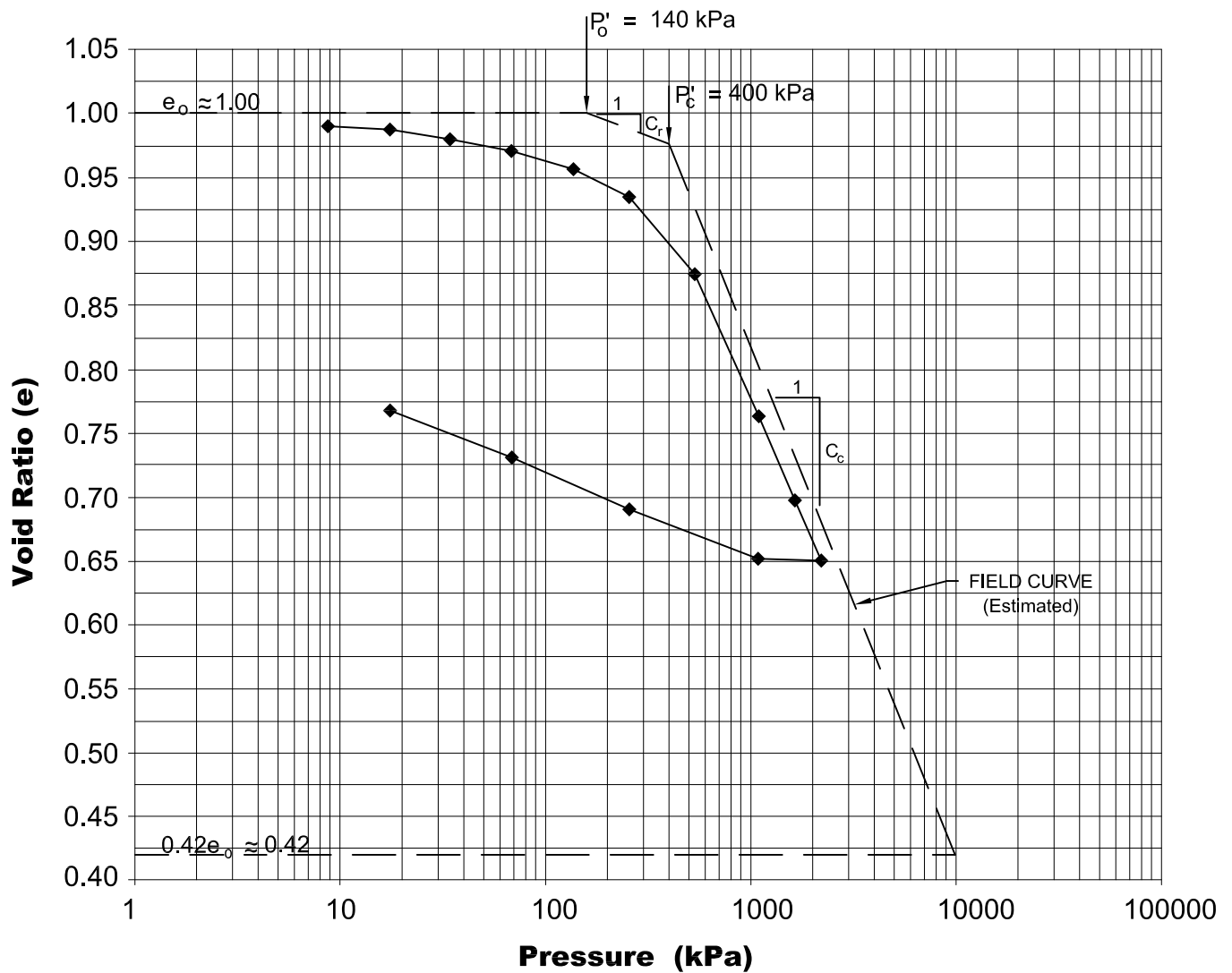
HIGHWAY: 577

G.W.P. 181-92-00

Laboratory Consolidation Test Results

Meadow Creek Bridge  
District Cochrane, Ontario

Borehole 103, Sample 16,  
Depth 12.2 - 12.8 m (El. 239.3 to 238.7)



SOIL TYPE: SILTY CLAY, trace sand

$e_0 \approx 1.00$

$W_0 = 39\%$

$\gamma = 18.4 \text{ kN/m}^3$

$P'_0 = 140 \text{ kPa}$

$P'_c = 400 \text{ kPa}$

$C_c = 0.40$

$C_r = 0.06$

$W_L = 41$

$W_P = 22$

$PI = 19$

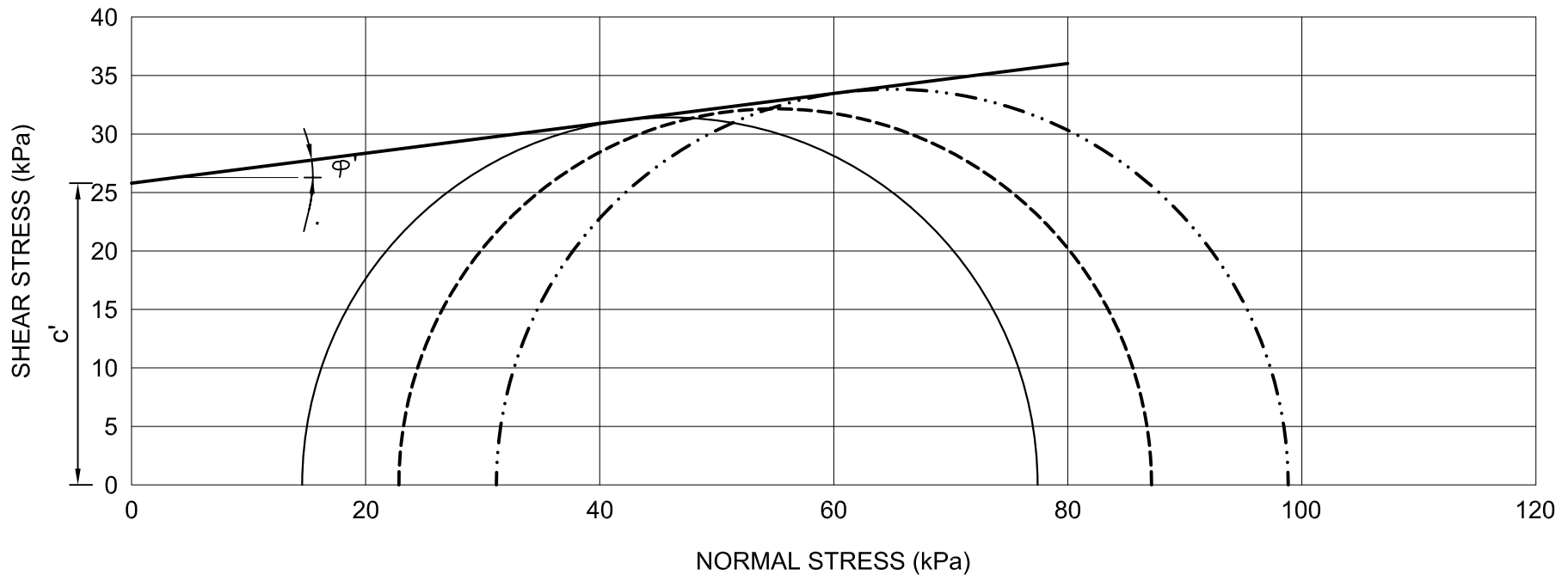
FIGURE No: C-1-2

HIGHWAY: 577

G.W.P. 181-92-00

### EFFECTIVE STRESS MOHR CIRCLES

Borehole 102, Sample 12  
Depth 12.2 - 12.8 m (El. 239.0 to 238.4)



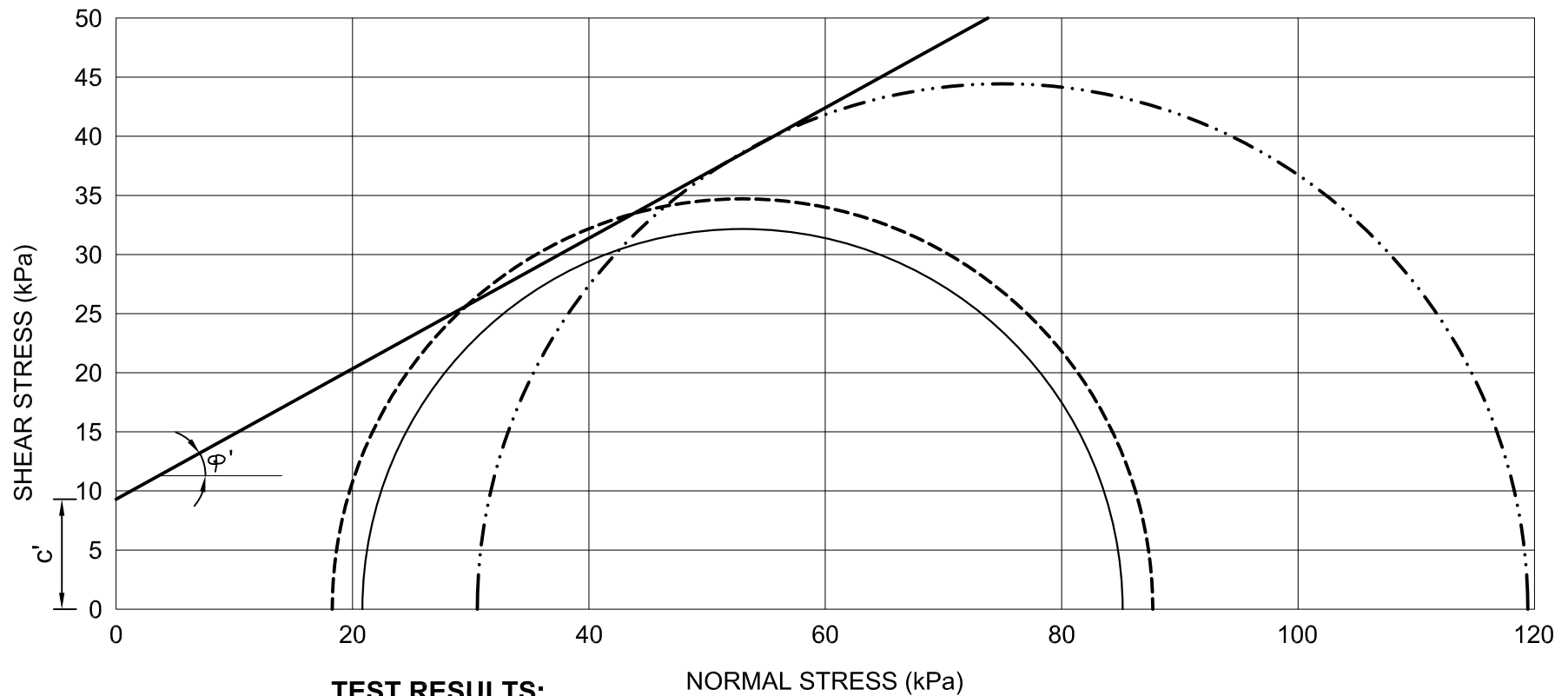
### TEST RESULTS:

	CONSOLIDATION PRESSURE (kPa)	PORE PRESSURE (kPa)	UNIT WEIGHT (kN/m <sup>3</sup> )	VOID RATIO	MOISTURE CONTENT (%)
————	15	1	18.8	0.49	37.7
-----	30	7	19.0	0.49	38.4
- · - · -	60	29	18.4	0.51	36.3

SOIL TYPE: SILTY CLAY  $C' = 26$ kPa ; $\phi' = 7^\circ$	FIGURE No: CU-1-1
	HIGHWAY: 577 / MEADOW CREEK
	G.W.P. 181-92-00

### EFFECTIVE STRESS MOHR CIRCLES

Borehole 103, Sample 16  
Depth 12.2 - 12.8 m (El. 239.3 to 238.7)



#### TEST RESULTS:

	CONSOLIDATION PRESSURE (kPa)	PORE PRESSURE (kPa)	UNIT WEIGHT (kN/m <sup>3</sup> )	VOID RATIO	MOISTURE CONTENT (%)
————	15	-6	18.2	0.52	41.0
-----	30	12	18.5	0.51	40.9
- . . -	60	29	18.2	0.52	38.2

SOIL TYPE: SILTY CLAY	FIGURE No: CU-1-2
C' = 9 kPa ;     ϕ' = 29 <sup>0</sup>	HIGHWAY: 577 / MEADOW CREEK
	G.W.P. 181-92-00



## 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.

**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:

RQD (%)	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

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	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
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL



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

# RECORD OF BOREHOLE No 101

1 of 2

**METRIC**

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577  
Co-ords: 5 401 261 N; 328 281 E ORIGINATED BY F.P.  
DIST 54 HWY 577 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE October 15, 2008 CHECKED BY C.N.

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									
253.0	Ground Surface																
0.0	Sand some silt, trace gravel		1	SS	5												10 73 (17)
252.3	Loose Brown Wet (FILL)		2	SS	5												
0.7	Silty clay		3	SS	3												
	Stiff Brown Moist to firm		4	SS	2												
	Grey		5	SS	2												0 0 42 58
			FV														
			6	SS	2												
			FV														
247.3	Clay, trace sand		7	TW	PH												
5.7	Firm Grey Wet		FV														
			8	SS	1												
			FV														
			9	TW	PH												
			FV														
242.9	End of borehole																
10.1																	
	* 2008 10 15																
	** 2008 10 31 (Piez.)																
	▽ Water level observed during drilling																
	▼ Water level measured in piezometer																
	■ Penetrometer test																
	<u>Piezometer Legend :</u>																
	 Bentonite seal																
	 Native cuttings																
	Cont'd																

\* 2008 10 15  
\*\* 2008 10 31 (Piez.)  
▽ Water level observed during drilling  
▼ Water level measured in piezometer  
■ Penetrometer test  
Piezometer Legend :  
Bentonite seal  
Native cuttings

Cont'd

<b>RECORD OF BOREHOLE No 101</b>										<b>2 of 2</b>		<b>METRIC</b>																												
<b>G.W.P.</b> 181-92-00			<b>LOCATION</b> Meadow Creek/ HWY 577 Co-ords: 5 401 261 N; 328 281 E			<b>ORIGINATED BY</b> F.P.																																		
<b>DIST</b> 54 <b>HWY</b> 577			<b>BOREHOLE TYPE</b> Continuous Flight Hollow Stem Augers			<b>COMPILED BY</b> G.D.																																		
<b>DATUM</b> Geodetic			<b>DATE</b> October 15, 2008			<b>CHECKED BY</b> C.N.																																		
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)																										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%) W <sub>p</sub> — W — W <sub>L</sub>			γ	GR SA SI CL																									
238.0																																								
	<div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; border: 1px solid black; margin-right: 5px;"></div> <div>Filter sand</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; border: 1px solid black; margin-right: 5px;"></div> <div>Screen</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; border: 1px solid black; margin-right: 5px;"></div> <div>Sand bed</div> </div> <div> <b>Water Level Readings:</b> </div> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Date</th> <th style="text-align: left;">Depth (m)</th> <th style="text-align: left;">Elev.</th> </tr> </thead> <tbody> <tr><td>10/22/2008</td><td>9.1</td><td>243.9</td></tr> <tr><td>10/25/2008</td><td>9.0</td><td>244.0</td></tr> <tr><td>10/26/2008</td><td>8.8</td><td>244.2</td></tr> <tr><td>10/27/2008</td><td>8.8</td><td>244.2</td></tr> <tr><td>10/28/2008</td><td>8.7</td><td>244.3</td></tr> <tr><td>10/30/2008</td><td>8.6</td><td>244.4</td></tr> <tr><td>10/31/2008</td><td>8.4</td><td>244.6</td></tr> </tbody> </table>	Date	Depth (m)	Elev.	10/22/2008	9.1	243.9	10/25/2008	9.0	244.0	10/26/2008	8.8	244.2	10/27/2008	8.8	244.2	10/28/2008	8.7	244.3	10/30/2008	8.6	244.4	10/31/2008	8.4	244.6															
Date	Depth (m)	Elev.																																						
10/22/2008	9.1	243.9																																						
10/25/2008	9.0	244.0																																						
10/26/2008	8.8	244.2																																						
10/27/2008	8.8	244.2																																						
10/28/2008	8.7	244.3																																						
10/30/2008	8.6	244.4																																						
10/31/2008	8.4	244.6																																						

**RECORD OF BOREHOLE No 102**

1 of 3

**METRIC**

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577  
Co-ords: 5 401 283 N; 328 269 E ORIGINATED BY F.P.  
DIST 54 HWY 577 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY G.D.  
DATUM Geodetic DATE October 27 to 30, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL 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					W <sub>p</sub>	w	W <sub>L</sub>		
251.2	Ground Surface						20	40	60	80	100						
0.0	50mm asphaltic concrete over sand and gravel		1	SS	5												
	Loose      Brown																
	Clay, trace sand		2	SS	7												
	Stiff to Brown Moist firm																
			3	SS	5												
	organic inclusions		4	SS	4												
	Brown/ grey																
	(FILL)		5	SS	3												
			6	SS	3												
			7	SS	3												
				FV													
			8	TW	PH												
				FV													
243.9	Silty clay																
7.3	Firm to Brown Wet stiff		9	SS	4												
				FV													
			10	TW	PH												
				FV													
	Grey		11	SS	3												
				FV													
			12	TW	PH												
				FV													
			13	SS	3												
				FV													

Cont'd

**METRIC**

**+<sup>7</sup>, ×<sup>5</sup>:** Numbers refer to Sensitivity

20  
15 — ○ — 5  
10

(%) STRAIN AT FAILURE

<b>RECORD OF BOREHOLE No 102</b>										<b>3 of 3</b>		<b>METRIC</b>				
G.W.P. 181-92-00			LOCATION Meadow Creek/ HWY 577			Co-ords: 5 401 283 N; 328 269 E			ORIGINATED BY F.P.							
DIST 54 HWY 577			BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test						COMPILED BY G.D.							
DATUM Geodetic			DATE October 27 to 30, 2008						CHECKED BY C.N.							
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/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa								
221.2 30.0	Gravelly sand, trace silt cobbles and boulders  Dense to Grey Wet very dense					221										
			23	SS	62											
			24	SS	89/28cm											
219.7 31.5	End of borehole  Probable gravelly sand  Compact to very dense					220										
						219										
						218										
217.8 33.4	End of dynamic cone penetration test  Refusal on probable boulder    Samples 19, 20 & 24: Sampler bouncing    * 2008 10 27  ▽ Water level observed during drilling   ** C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers						56/13cm									

**RECORD OF BOREHOLE No 103**



1 of 3

**METRIC**

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577  
Co-ords: 5 401 387 N; 328 274 E ORIGINATED BY F.P.  
DIST 54 HWY 577 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE October 21 to 24, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub>	w	w <sub>L</sub>		GR	SA	SI	CL
251.5	Ground Surface							20	40	60	80	100								
0.0	Sand trace silt, trace gravel Very loose Brown Moist		1	SS	2		251							o					8 86 (6)	
	Silty clay, trace sand organic inclusions Firm to Grey Moist stiff		2	SS	4		250							o						
	(FILL)																			
			3	SS	4		249								o					
			4	SS	4		248							o						
			5	SS	9		247							o						
	Brown/grey		6	SS	8		246							o						
			7	SS	7		245								o					
			8	SS	5		244							o						
			9	SS	6		243							o						
			10	SS	4		242							o						
			11	SS	4		241							o						
			12	SS	7		240							o						
242.4	Silty clay, trace sand Stiff Grey Moist to wet		13	SS	8		239													
9.1																				
			14	TW	PH		238							o						
				FV																
			15	SS	5		237													
				FV																
			16	TW	PH		236													
				FV																
			17	SS	1		235							o						
				FV																

**METRIC**

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
236.5											

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT   NATURAL 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				w <sub>p</sub>	w	w <sub>L</sub>		
								○ UNCONFINED      + FIELD VANE								
								● QUICK TRIAXIAL    × LAB VANE								
236.5						20	40	60	80	100						
	layers of clayey silt  Stiff to firm		18	TW	PH	236										
				FV												
			19	SS	1											
				FV												
			20	SS	1											
				FV												
231.3																
20.2	Clayey silt layers of silt  Stiff      Grey      Wet					232										
	21	SS	10													
225.6																
25.9	Silt trace sand, trace clay  Compact      Grey      Wet to dense					227										



RECORD OF BOREHOLE No 103										3 of 3		METRIC					
G.W.P. 181-92-00			LOCATION Meadow Creek/ HWY 577			Co-ords: 5 401 387 N; 328 274 E			ORIGINATED BY F.P.								
DIST 54 HWY 577			BOREHOLE TYPE Continuous Flight Hollow Stem Augers						COMPILED BY G.D.								
DATUM Geodetic			DATE October 21 to 24, 2008						CHECKED BY C.N.								
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 × LAB VANE					W <sub>p</sub> W W <sub>L</sub>				
221.5																	
			24	SS	50/5cm		221										
220.2																	
31.3	Sand, trace silt Compact Grey Wet						220										
219.0			25	SS	29		219										
32.5	End of borehole Refusal on probable boulder  Samples 23 & 24: Sampler bouncing  * 2008 10 21  ▽ Water level observed during drilling																

**RECORD OF BOREHOLE No 104**

1 of 2



**METRIC**

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577  
Co-ords: 5 401 417 N; 328 274 E ORIGINATED BY F.P.  
DIST 54 HWY 577 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE October 24 & 25, 2008 CHECKED BY C.N.

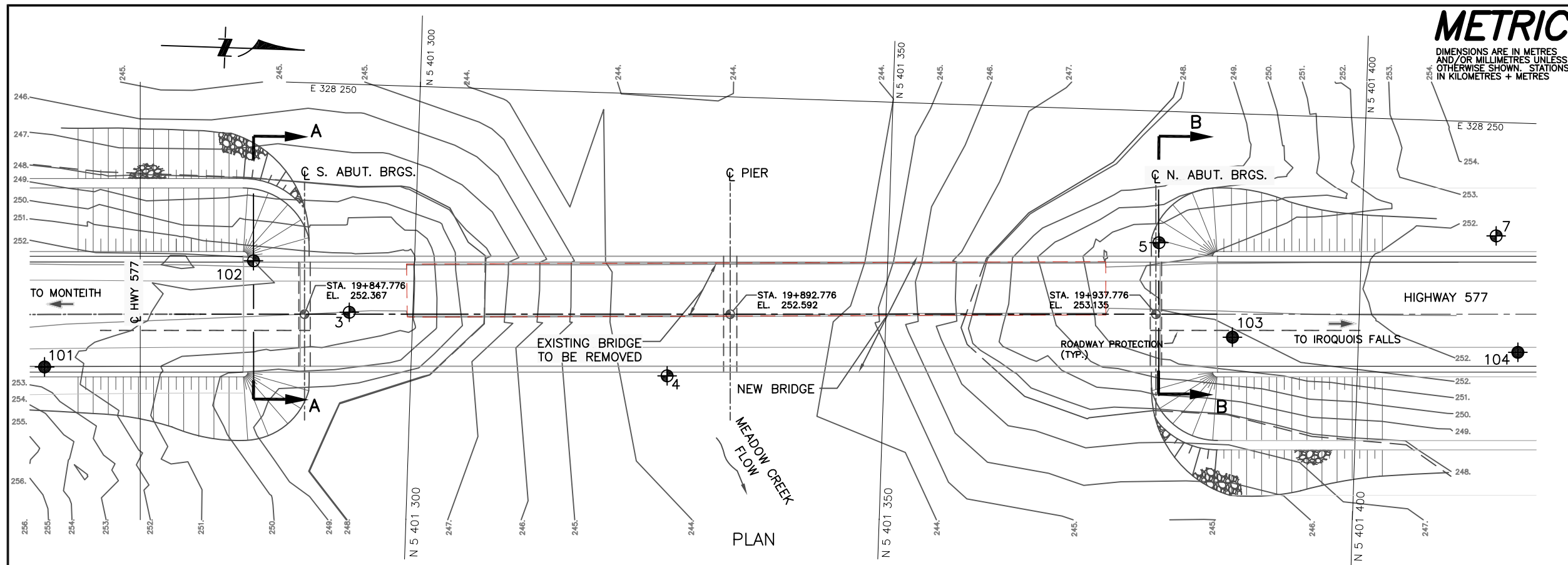
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
253.3 0.0	Ground Surface							20	40	60	80	100					
	Sand some silt, trace gravel		1	SS	1		253										2 87 (11)
	Very loose Brown Moist																
	Silty clay, trace sand		2	SS	3												
	Firm Brown Moist																
	organic inclusions		3	SS	5												
	Brown/ grey (FILL)		4	SS	6												
250.3 3.0	Silty clay		5	SS	9		250										
	Stiff Brown Moist to firm to wet																
			6	SS	5												
			7	SS	2												
				FV													
	Grey		8	SS	2												
				FV													
			9	TW	PH											19.0	0 0 26 74
				FV													
			10	TW	PH												
				FV													
244.6 8.7	Clay																
	Stiff Grey Moist to wet		11	SS	4		244										0 0 21 79
243.2 10.1	End of borehole																
	* 2008 10 24 & 25 ** 2008 10 31 (Piez.)																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																
	■ Penetrometer test																
	Piezometer Legend :																
	■ Bentonite seal																
	▨ Native cuttings																
	Cont'd																

Cont'd

**METRIC**

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
238.3											

[illegible]



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

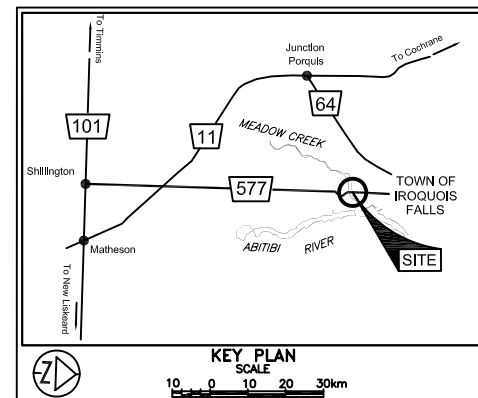
CONT No  
GWP No 181-92-00

**MEADOW CREEK BRIDGE**  
HIGHWAY 577  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET

**PMI** **Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



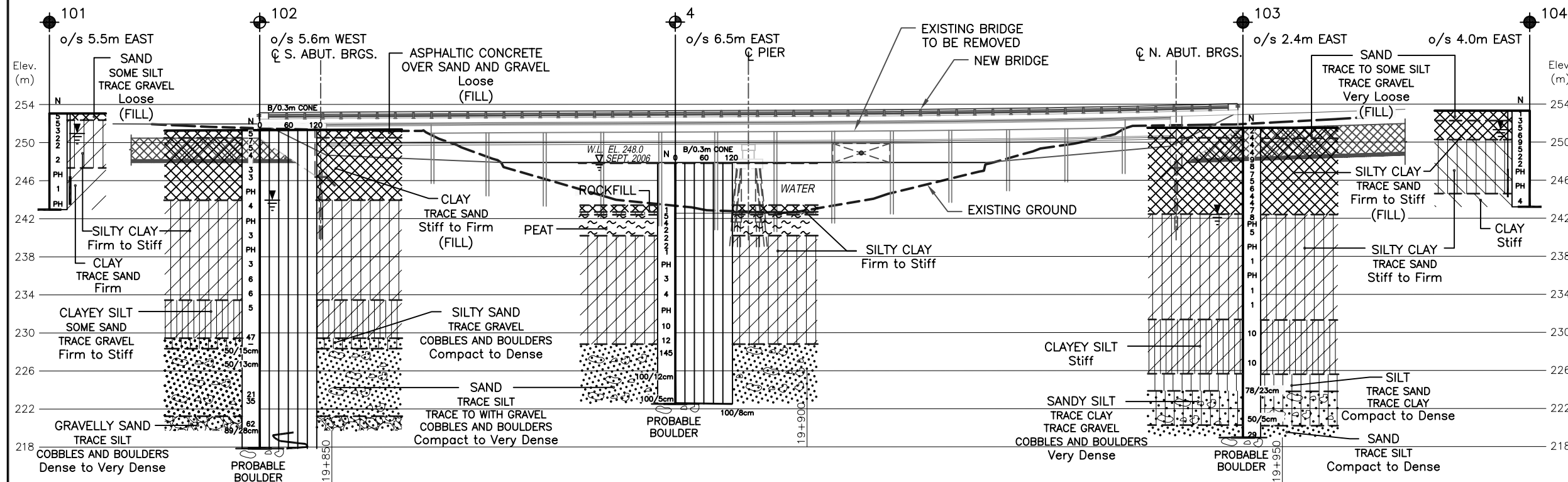
LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- PH Thinwall Sample - Advanced Hydraulically
- W L at time of investigation Oct 2008 and Aug-Sept 2006
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
101	253.0	5 401 261	328 281
102	251.2	5 401 283	328 269
103	251.5	5 401 387	328 274
104	253.3	5 401 417	328 274
3	251.5	5 401 293.3	328 274.1
4	247.8	5 401 327.1	328 279.7
5	251.5	5 401 378.6	328 263.9
7	253.6	5 401 414.2	328 262.0

NOTE

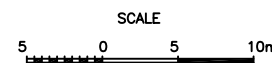
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.



PROFILE (HIGHWAY 577)

NOTES:

- REFER TO DRAWING 2 FOR SECTIONS A-A AND B-B.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- BOREHOLES 3,4,5,7 WERE DRILLED FOR THE PRELIMINARY INVESTIGATION IN 2006 BY SHAHEEN & PEAKER (GEOCRE No. 42A-66)



REF No. STANTEC DRAWING: 165000672\_MeadowCreek-GA.dwg;  
DATED DECEMBER 2008

DATE	BY	DESCRIPTION

Geocres No. 42A-75

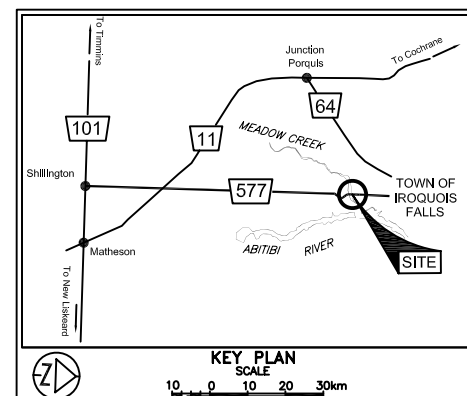
HWY No	577	DIST	COCHRANE
SUBM'D	GD	CHECKED	GD
DRAWN	NA	CHECKED	CN
DATE	JUNE 01, 2009	APPROVED	BRG
SITE	39E-077	DWG	1-1

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









**MEADOW CREEK BRIDGE**  
HIGHWAY 577  
**SOIL STRATA**



**Peto MacCallum Ltd**  
CONSULTING ENGINEERS



### LEGEND

- |   |  |
|---|--|
|    | Borehole   |
|    | Dynamic Cone Penetration Test (Cone)                       |
|    | Borehole & Cone  |
| N   | Blows/0.3m (Std. Pen Test, 475 J/blow)                     |
| CONE  | Blows/0.3m (60° Cone, 475 J/blow)                          |
| PH  | Thinwall Sample – Advanced Hydraulically                   |
|    | W L at time of investigation Oct 2008<br>and Aug–Sept 2006 |
|    | Head   |
|   | ARTESIAN WATER   |
|  | Encountered  |
|  | PIEZOMETER   |

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
		SEE DRAWING 1 FOR DETAILS	

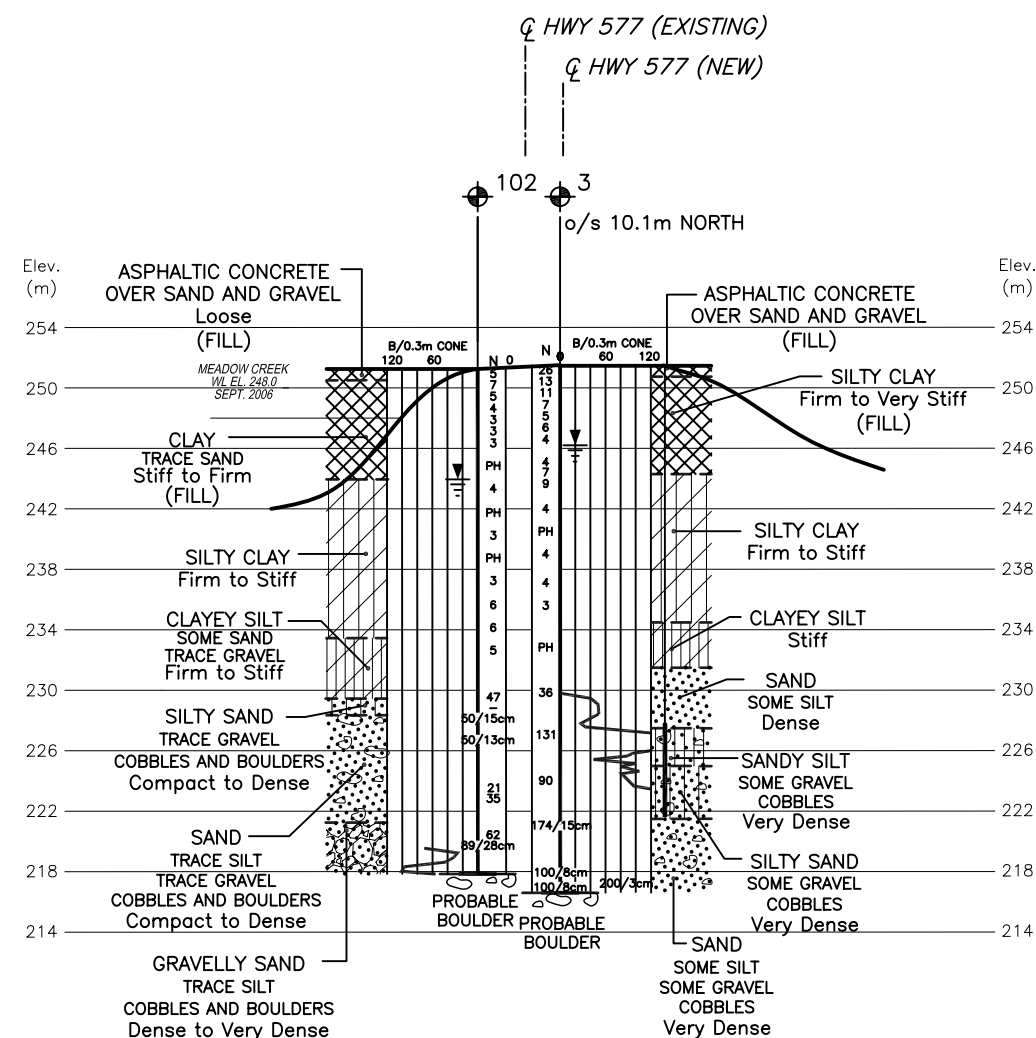
**- NOTE -**

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

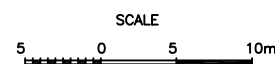
REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No. 42A-75

HWY No 577				DIST COCHRAN	
SUBM'D	GD	CHECKED	GD	DATE	JUNE 01, 2009
DRAWN	NA	CHECKED	CN	APPROVED	BRG
				SITE	39E-07
				DWG	1-2

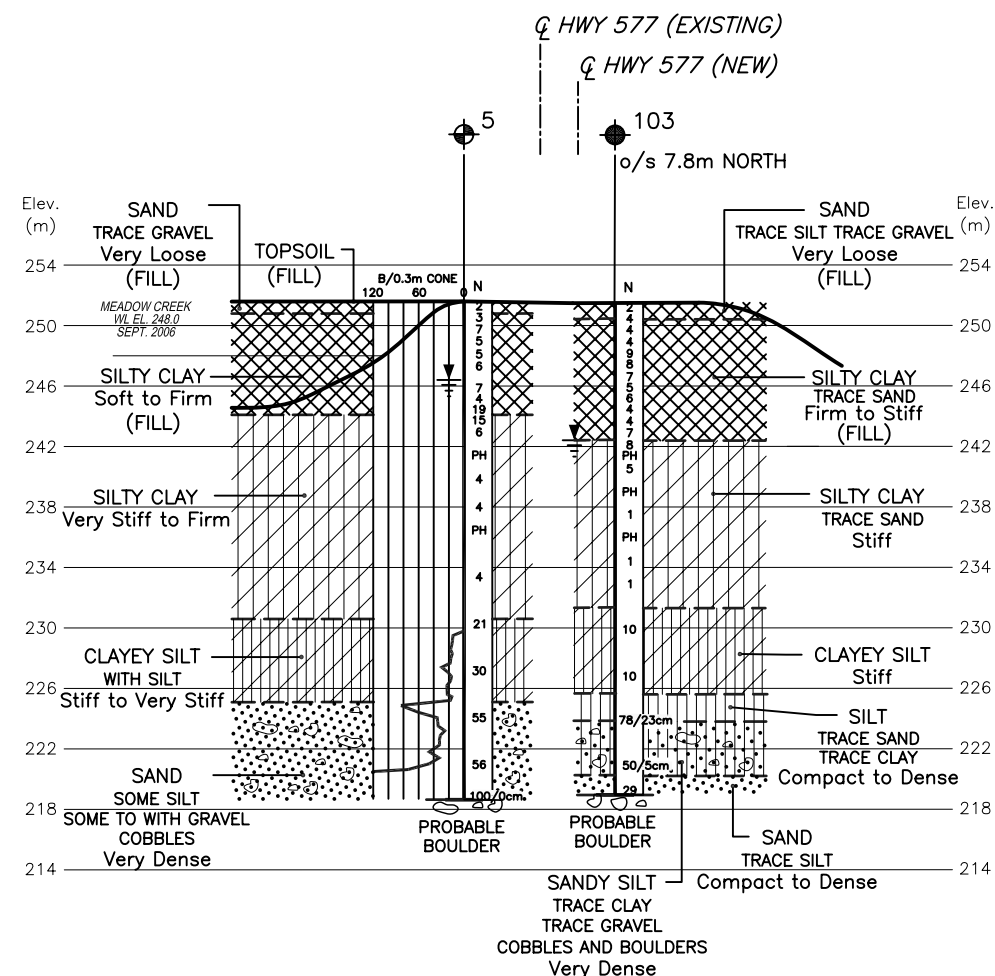


SECTION A-A

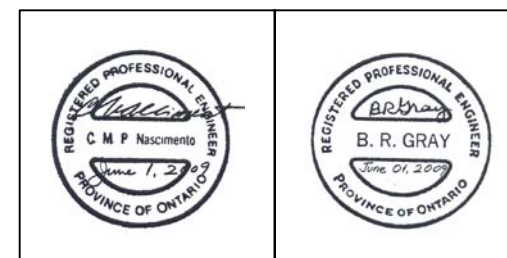


NOTES:

1. REFER TO DRAWING 1 FOR BOREHOLE LOCATIONS PLAN AND CENTRELINE PROFILE.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. BOREHOLES 3 AND 5 WERE DRILLED FOR THE PRELIMINARY INVESTIGATION IN 2006 BY SHAHEEN & PEAKER (GEOCRESS No. 42A-66)



SECTION B-B



REF No. STANTEC DRAWING: 165000672\_MeadowCreek-GA.dwg;  
DATED DECEMBER 2008



## **APPENDIX A**

RECORD OF BOREHOLE SHEETS AND  
DRAWINGS FROM PRELIMINARY INVESTIGATION  
CARRIED OUT BY SHAHEEN & PEAKER LTD. (GEOCRES NO. 42A-66)

# RECORD OF BOREHOLE No 3

1 OF 3

METRIC

GWP 181-92-00

LOCATION Meadow Creek Bridge, Iroquois Falls, ON. Coords: N 5 401 293.3; E 328 274.1

ORIGINATED BY GI

DIST HWY 577

BOREHOLE TYPE Hollow Stem Augers, N - Casing & Wash Boring

COMPILED BY JZ

DATUM Geodetic

DATE 8/23/2006

CHECKED BY RM

[illegible]

Continued Next Page

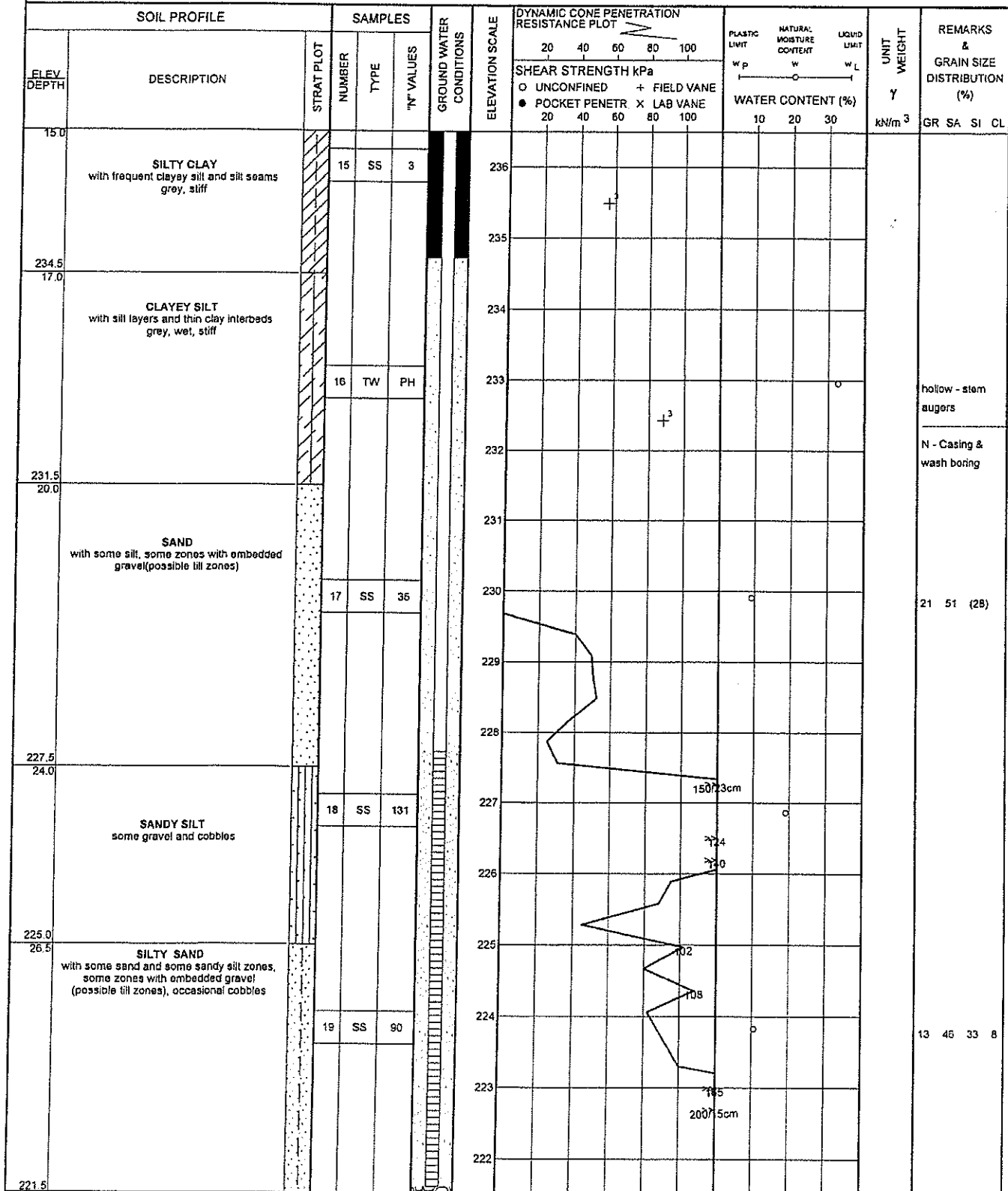
+ 3, X 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 3

2 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 293.3; E 328 274.1 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers, N - Casing & Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/23/2006 CHECKED BY RM





SPT1167

## 3 OF 3

METRIC

GWP	<u>181-92-00</u>	LOCATION	<u>Meadow Creek Bridge, Iroquois Falls, ON. Coords: N 5 401 293.3; E 328 274.1</u>	ORIGINATED BY	<u>GI</u>
DIST	<u>      </u>	HWY	<u>577</u>	BOREHOLE TYPE	<u>Hollow Stem Augers, N - Casing &amp; Wash Boring</u>
				COMPILED BY	<u>JZ</u>
DATUM	<u>Geodetic</u>	DATE	<u>8/23/2006</u>	CHECKED BY	<u>RM</u>

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			
FLEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● POCKET PENETR.						x LAB VANE		
30.0	SAND some silt, gravel, occasional cobbles		20	SS	174/15										Sample 21: No recovery, bouncing on a cobble			
216.6			21	SS	100/8										Sample 21: No recovery, bouncing on a cobble			
34.9			22	SS	100/3													
End of Borehole	Sampler bouncing, refusal to casing advance and tricone.														Sample 22: No recovery, bouncing (probably boulder)			
	Dynamic Cone Penetration Test (DCPT) from 21.8 to 24.2m from 24.8 to 27.2m from 27.8 to 28.8m from 30.5 to 31.2m from 33.7 to 34.9m																	
	Water level at 5.2m(not stabilized) and hole open to 23.5m upon completion																	
	Piezometer installed to 29.8m Date W.L.m.Piezometer 8/25/06 5.2m(EL.246.3m) 8/26/06 5.2m(EL.246.3m) 9/04/06 5.6m(EL.245.9m) 9/06/06 5.4m(EL.246.1m) 9/07/06 5.5m(EL.246.0m) 9/09/06 5.5m(EL.246.0m) 9/09/06 5.3m(EL.246.0m) 9/12/06 5.3m(EL.246.2m) 9/14/06 5.3m(EL.246.2m)																	

$$+ 3 \times 3$$

Numbers refer to  
Sensitivity

20  
15  $\phi$   
10

{%} STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 2

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 327.1; E 328 279.7 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE N-casing and Wash Boring COMPILED BY HL  
DATUM Geodetic DATE 9/7/2006 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ 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				
247.8 0.0	Water Surface					20 40 60 80 100						
	Water					○ UNCONFINED + FIELD VANE ● POCKET PENETR × LAB VANE						
						20 40 60 80 100						
						WATER CONTENT (%)						
						PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>						
						20 40 60						
243.4 4.4	ROCK FILL with silt & sand infill		1	SS	1							
242.7 5.1	SILTY CLAY somewhat organic dark grey, firm		2	SS	5							
242.4 5.4	PEAT with ORGANIC SILT/CLAY some silty clay layers, dark grey/blackish soft to firm, wet		3	SS	4							
			4	SS	2							
240.2 7.6	trace of organic		5	SS	2							
	darkish grey		6	SS	2							
	grey		7	SS	1							
	SILTY CLAY grey, firm to stiff		8	TW	PH							
			9	SS	3							
			10	SS	4							
232.8	some clayey silt layers											

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity  
20  
15  
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(%) STRAIN AT FAILURE

SPT1167

RECORD OF BOREHOLE No 4

2 OF 2

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 327.1; E 328 279.7 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE N - casing and Wash Boring COMPILED BY HL  
DATUM Geodetic DATE 9/7/2006 CHECKED BY RM

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 ● POCKET PENETR. × LAB VANE								WATER CONTENT (%)
15.0	SILTY CLAY some clayey silt layers grey, firm to stiff		11	TW	PH		232									
			12	SS	10		231									
			13	SS	12		230									
228.6 19.0	SAND with GRAVEL, COBBLES and BOULDERS grey, very dense, wet						229									
			14	SS	145		228									
							227									
							226									
			15	SS	100/12		225									
							224									
							223									
222.6 25.2	Refusal to casing penetration and tricone (Possible bedrock or boulder).  Dynamic Cone Penetration Test (DCPT) performed from 25.2m, 100 blows for 8cm penetration		16	SS	100/5											

× 3 Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

1 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 378.6; E 328 263.9 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers, N-casing and Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/14/2006 to 8/15/2006 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
FILEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
251.6	Ground Surface														
0.0	0.15m Sandy TOPSOIL FILL: SAND trace gravel brown, moist, very loose		1	SS	2		251								
250.8			2	SS	3										
0.8	FILL: SILTY CLAY trace organics & rootlets brown/ greyish brown soft to firm		3	SS	7		250								
249.4			4	SS	5		249								
2.2	FILL: SILTY CLAY with Clayey Silt Zones brown and grey some dark grey to blackish, slightly organic to organic zones, occasional thin peat seams/lenses firm		5	SS	5		248								
			6	SS	5		247								
			7	SS	6		246								
			8	SS	7		245								
			9	SS	4		244								
244.1	SILTY CLAY somewhat organic, some peat and decayed wood dark grey to black, very stiff		10	SS	19		243								
7.5			11	SS	15		242								
243.2	clayey silt zone stiff		12	SS	6		241								
8.4			13	TW	PH		240								
	brown grey		14	SS	4		239								
	SILTY CLAY occasional clayey silt & silt seams firm to stiff		15	SS	4		238								
							237								
236.6															

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Sensitivity 20  
15 10 5  
(%) STRAIN AT FAILURE

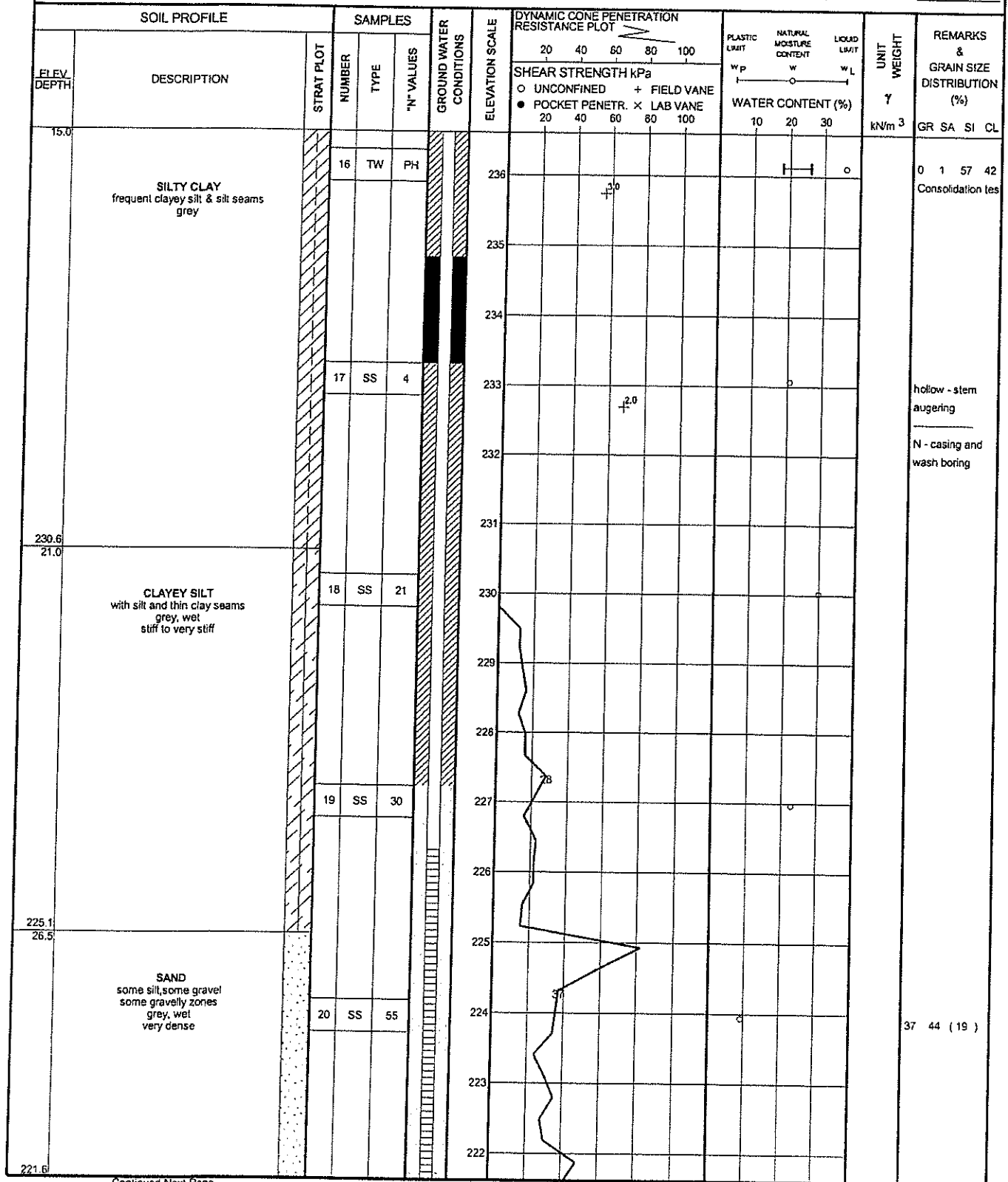
SPT1167

RECORD OF BOREHOLE No 5

2 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 378.6; E 328 253.9 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers, N-casing and Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/14/2006 to 8/15/2006 CHECKED BY RM



+ 3, x 3

Numbers refer to  
Sensitivity

20  
15  
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(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

3 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bndge, Iroquois Falls, ON, Coords: N 5 401 378.6; E 328 263.9  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers, N-casing and Wash Boring  
DATUM Geodetic DATE 8/14/2006 to 8/14/2006  
ORIGINATED BY GI  
COMPILED BY JZ  
CHECKED BY RM

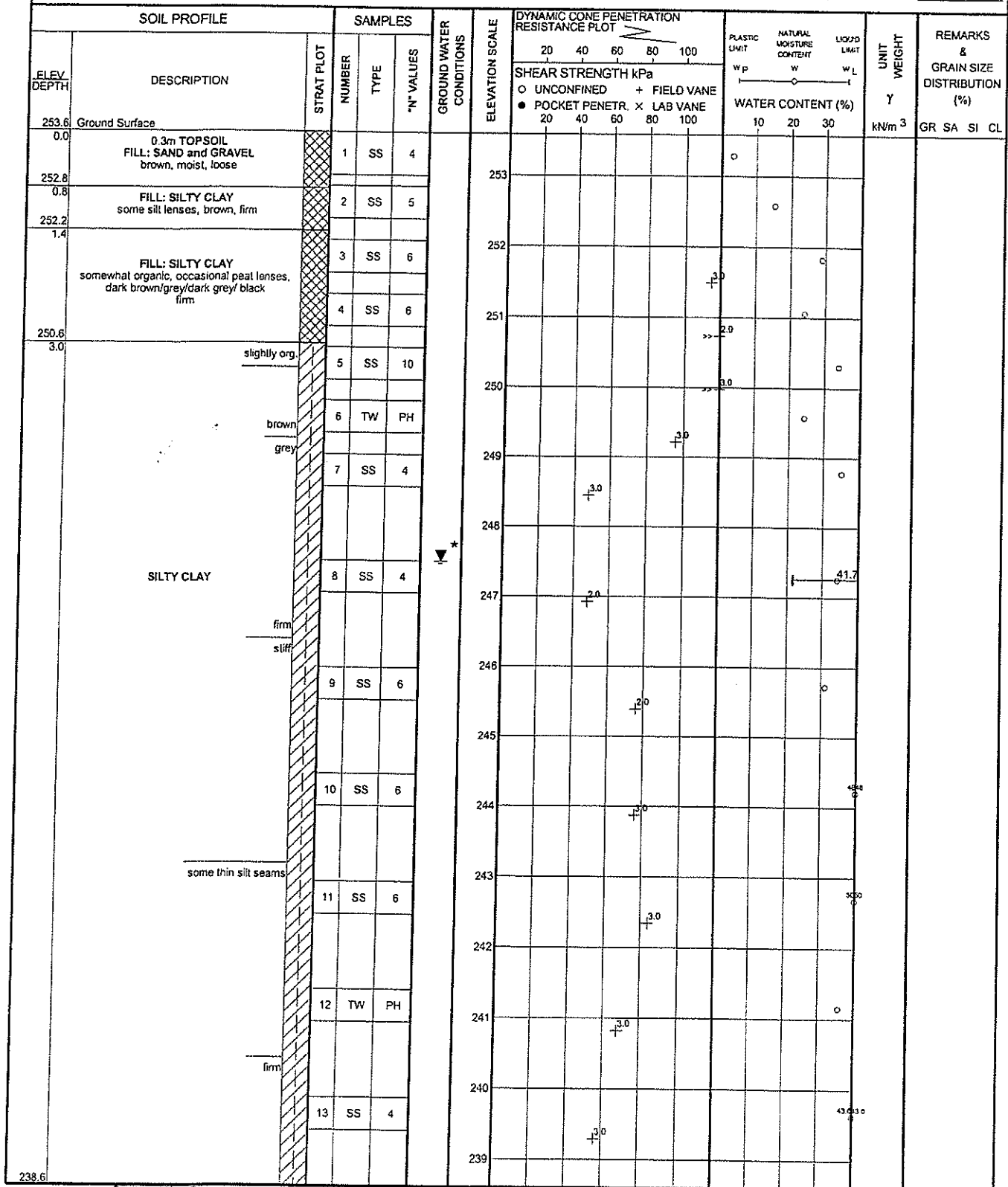
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE	WATER CONTENT (%)					
30.0	SAND with gravel, some silt, some cobbles grey, wet very dense	21	SS	56		221							
218.7		22	SS	100/0		220							
32.9	End of Borehole Sample bouncing, refusal to advancing with casing and Tricone on a boulder or on bedrock  Dynamic Cone Penetration Test (DCPT) conducted: from 21.7 to 24.4m from 24.7 to 27.4m from 27.8 to 30.4m from 31.0 to 31.8m  Water level in open borehole at 5.2m (not stabilized) and hole open to 32m upon completion Date Water Level(m) Pizometer 8/16/06 5.2m (El. 246.4m) 8/18/06 5.3m (El. 246.3m) 8/23/06 5.2m (El. 246.4m) 8/25/06 5.2m (El. 246.4m) 8/26/06 5.2m (El. 246.4m) 9/04/06 5.2m (El. 246.4m) 9/05/06 5.3m (El. 246.3m) 9/07/06 5.2m (El. 246.4m) 9/09/06 5.1m (El. 246.5m) 9/12/06 5.4m (El. 246.2m) 9/14/06 5.2m (El. 246.4m)					219							no recovery (sampler bouncing)

RECORD OF BOREHOLE No 7

1 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 414.2; E 328 262.0 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers & Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/16/2005 to 8/18/2005 CHECKED BY RM



Continued Next Page

+ 3 x 3 Numbers refer to  
Sensitivity 20  
15 10 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

2 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 414.2, E 328 262.0 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers & Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/16/2006 to 8/18/2006 CHECKED BY RM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. x LAB VANE WATER CONTENT (%) 10 20 30 PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
FLV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					
15.0	SILTY CLAY grey		14	SS	5		238	2.0		
							237			
							236			
							235	3.0		43 243.5
							234			
	CLAYEY SILT with some silt and silty clay seams, traces of embedded sand and gravel grey, stiff		15	SS	4		233			
							232	2.0		
							231			
							230			
							229	3.0		
227.6	SAND, some gravel		16	SS	10		228			
26.0							227			
							226	2.0		
							225			
							224			
224.1			17	SS	12		229	3.0		
29.5			18	SS	10		226			

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Numbers refer to  
Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE



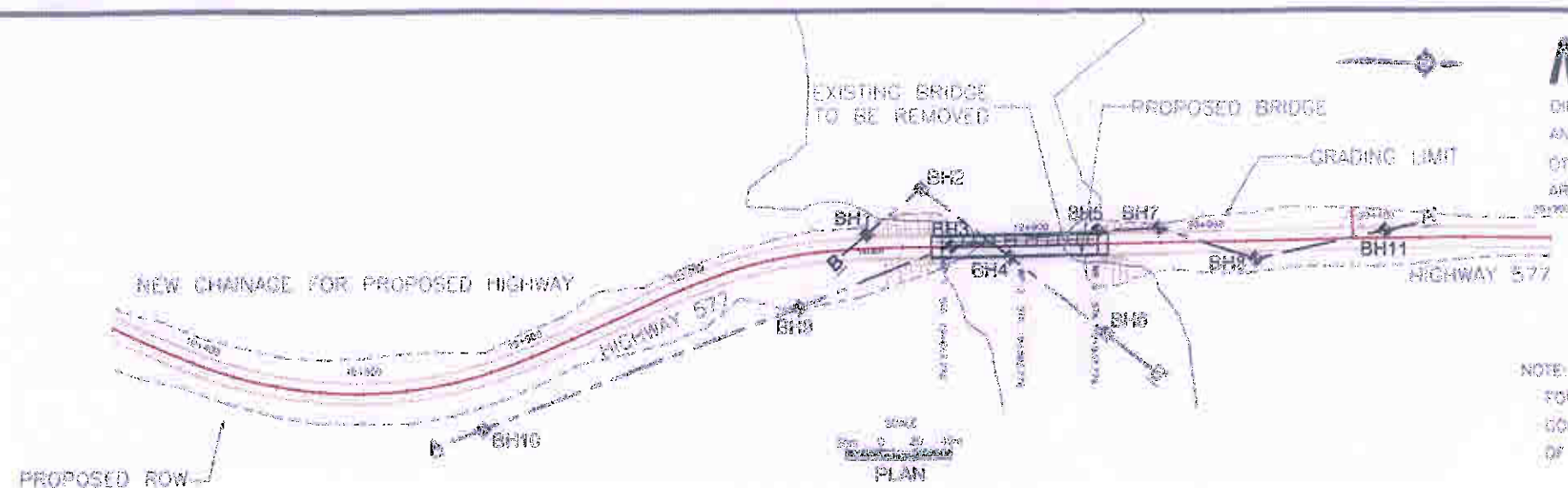
RECORD OF BOREHOLE No 7

3 OF 3

METRIC

GWP 181-92-00 LOCATION Meadow Creek Bridge, Iroquois Falls, ON, Coords: N 5 401 414.2; E 328 262.0 ORIGINATED BY GI  
DIST HWY 577 BOREHOLE TYPE Hollow Stem Augers & Wash Boring COMPILED BY JZ  
DATUM Geodetic DATE 8/16/2005 to 8/18/2005 CHECKED BY RM

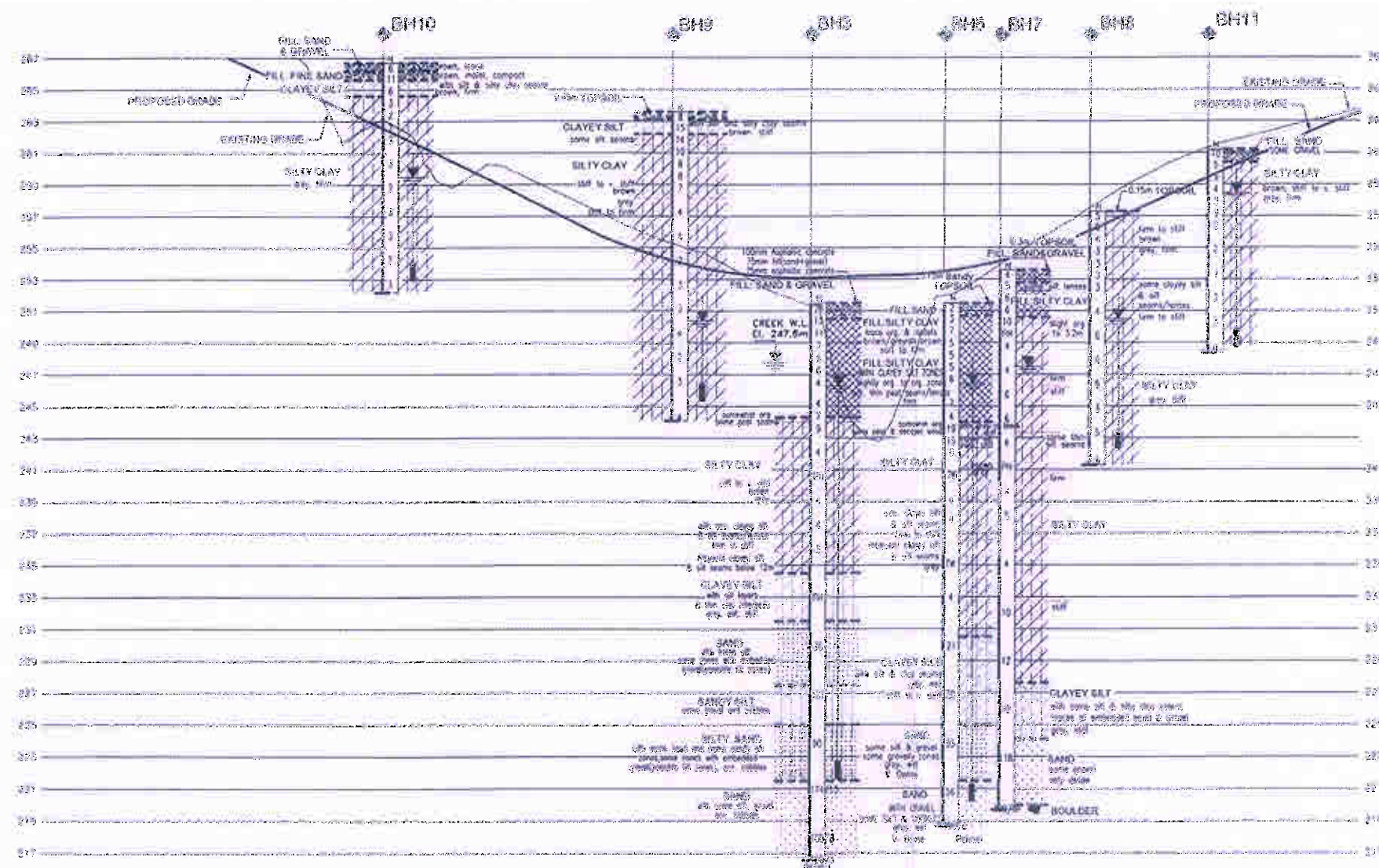
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	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						
	SAND with some silt and gravel, occasional cobbles grey, wet, very dense		19	SS	118		223				16 73 (11)
220.0							222				
33.6	Sampler bouncing on probable boulder.		20	SS	100/5		221				
33.9	End of borehole		21	RC			220				cored through a boulder from 33.6 to 33.9m
Dynamic Cone Penetration Test (DCPT) conducted from 28.0m to 30.5m. DCPT conducted from 30.9 to 31.5m. * Water level at 6.0m (not stabilized) and hole open to 27m upon completion											



## METRIC

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

NOTE:  
FOR DETAILED SUBSURFACE  
CONDITIONS REFER TO RECORD  
OF BOREHOLE SHEETS

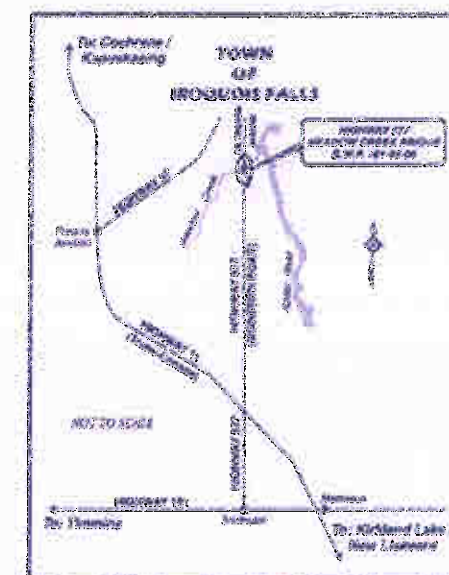


STRATIGRAPHIC PROFILE ALONG SECTION AA'






CONT No.  
GWP: 181-92-00

**Meadow Creek Bridge, Inyo Falls**  
**SECTION AT STA. 19+890 TO 20+100**  
**BORE HOLE LOCATIONS & SOIL STRATA**

SHAHEEN & PEAKER LIMITED



### LEGEND

- |   |   |
|---|---|
|  | Barhole   |
|  | Borehole ID (Std. Pen. Test, 475 J/blow)                            |
|  | Water Level at Time of Investigation<br>Sept. 2006 (Not Stabilized) |
|  | Water Level in Piezometer   |
|  | Piezometer  |

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH 5	281.5	5 401 293.3	328 274.7
BH 6	281.5	5 401 572.8	328 263.9
BH 7	253.8	5 401 414.2	328 262.0
BH 8	257.3	5 401 470.6	328 278.8
BH 9	263.6	5 401 206.7	328 310.6
BH 10	268.7	5 401 025.4	328 392.8
BH 11	261.2	5 401 545.4	328 281.7

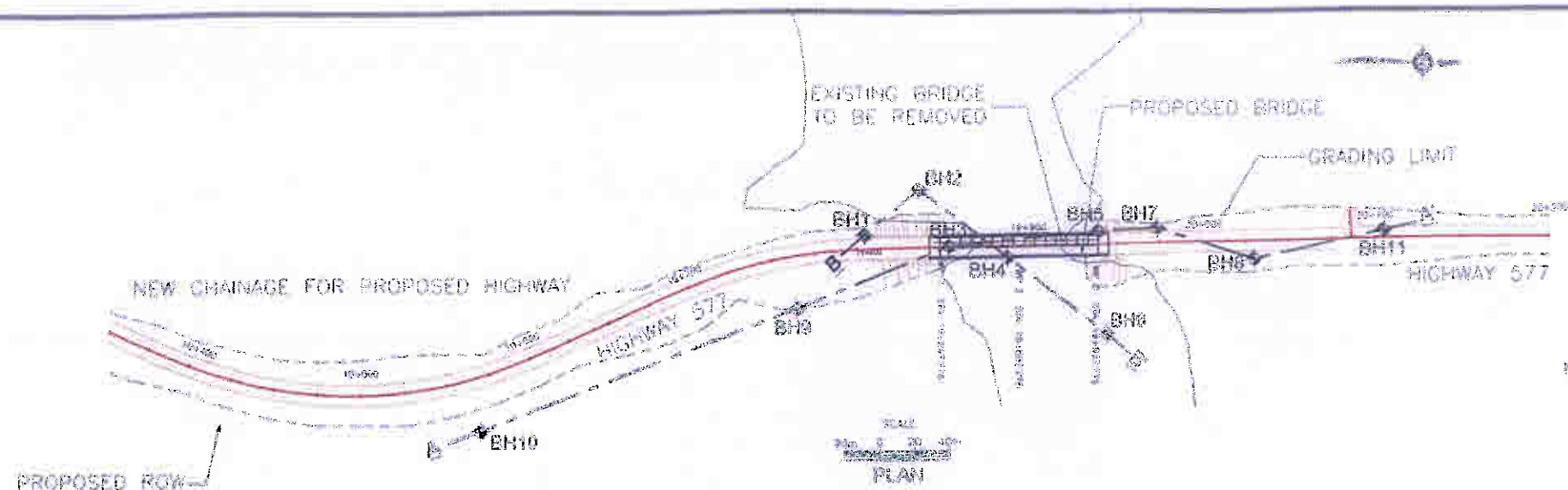
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The boundaries between the states have been delineated only at Bare Hole locations. Between Bare Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be approved at the Materials Engineering and Research Office, however, information contained in this report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of CPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION
Geocore No. 42A-50			
MEADOW CREEK BRIDGE-HWYS77			DIST
SUBM'D TO CHECKED RM		DATE Nov. 2000	SITE 358-077
DRAWN AS CHECKED FS		APPROVED ZO	DWG 1





**METRIC**

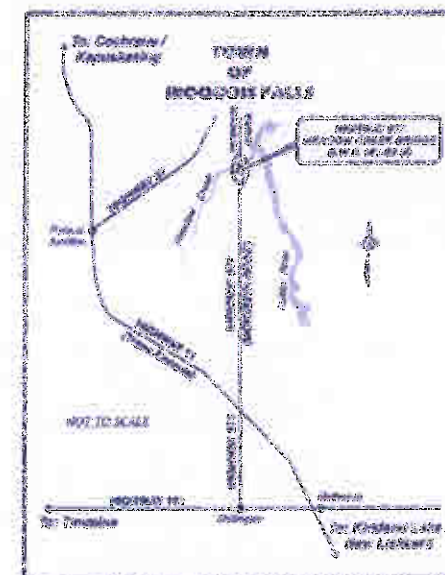
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
ARE IN KILOMETRES+METRES.

NOTE:  
FOR DETAILED SUBSURFACE  
CONDITIONS REFER TO RECORD  
OF BOREHOLE SHEETS

CONT No.  
GWP: 181-92-00

Meadow Creek Bridge, Ingersoll Falls  
SECTION AT STA. 10+501 TO 20+149  
BORE HOLE LOCATIONS & SOIL STRATA

**SHAHEEN & PEAKER LIMITED**



KEY PLAN (N. T. S.)

**LEGEND**

- Borehole
- Borehole/0.3m (Std. Pen. Test, 475 J/blow)
- ▽ Water Level at Time of Investigation  
Sept. 2006 (Not Stabilized)
- ▽ Water Level in Piezometer
- Piezometer

No.	ELEV.	CO-ORDINATES	
		NORTH	EAST
BH 1	253.3	5 401 244.2	328 258.2
BH 2	247.8	5 401 275.1	328 241.6
BH 4	247.8	5 401 327.1	328 279.7
BH 6	246.1	5 401 365.1	328 322.5

**NOTE:**

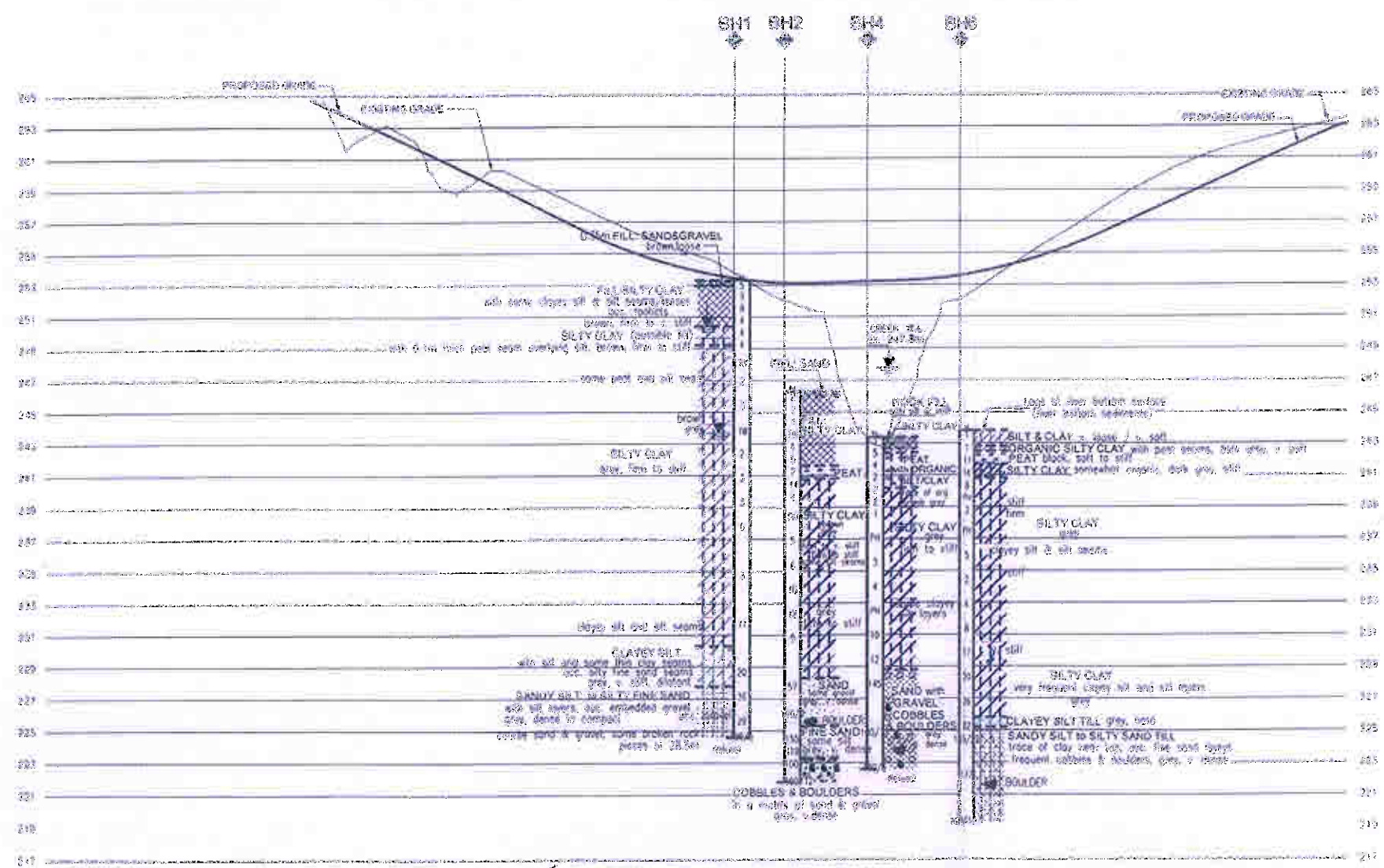
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: 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 are specifically excluded in accordance with the conditions of Section 20.1 of GPS Gen. Cond.

DATE	BY	DESCRIPTION
------	----	-------------

Geocres No. 42A-66

MEADOW CREEK BRIDGE-HWY 577		DIST	
SUBM'D ZO	CHECKED RM	DATE Nov.2006	SITE 39E-077
DRAWN XS	CHECKED FS	APPROVED ZO	DWG 2



STRATIGRAPHIC PROFILE ALONG SECTION B-B

