



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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Carried Out by Shaheen & Peaker Ltd. (GEOCREs No. 42A-66)

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

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 (GEOCREC 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 GEOCREC 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 _c	C _r	e _o
					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

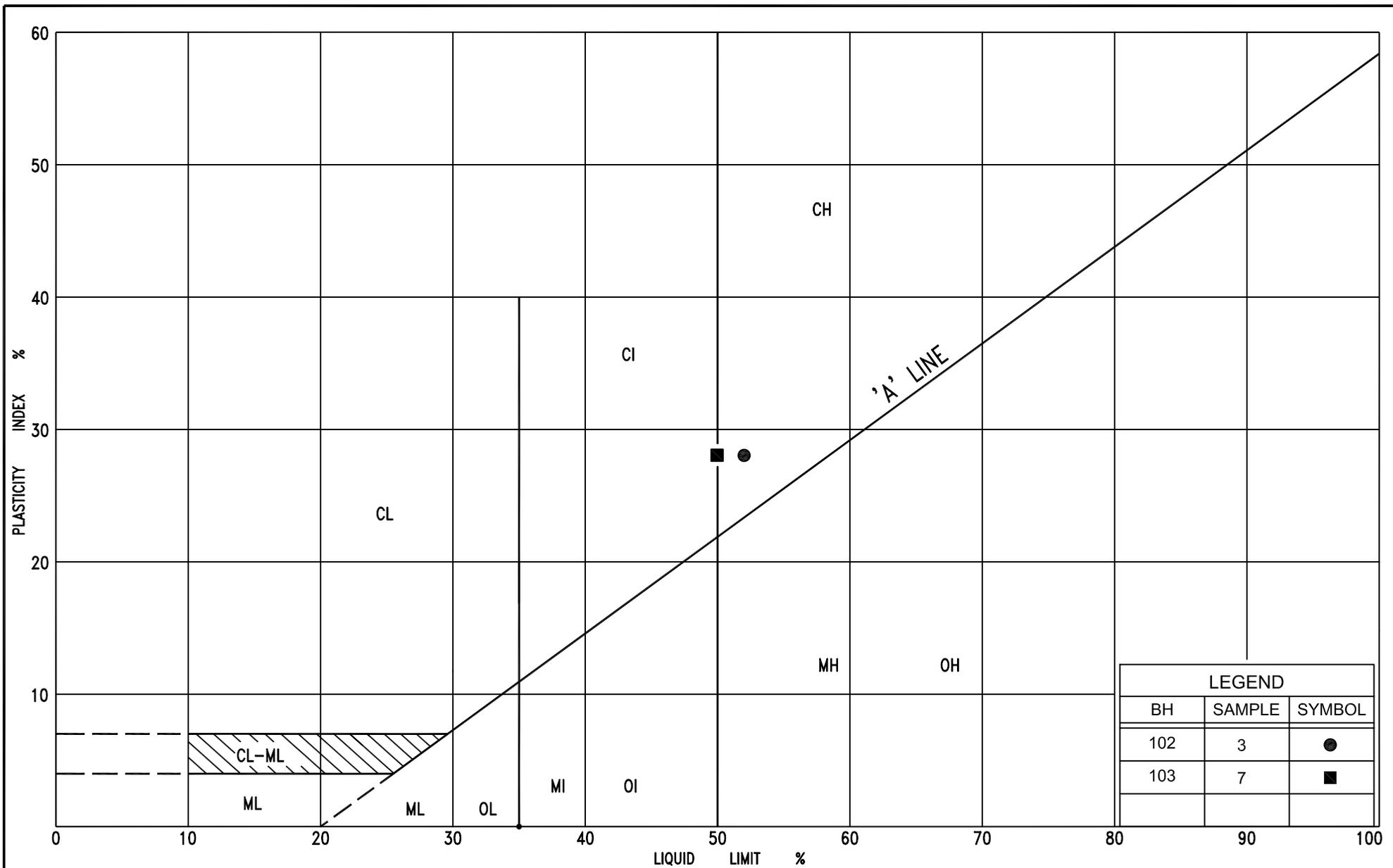


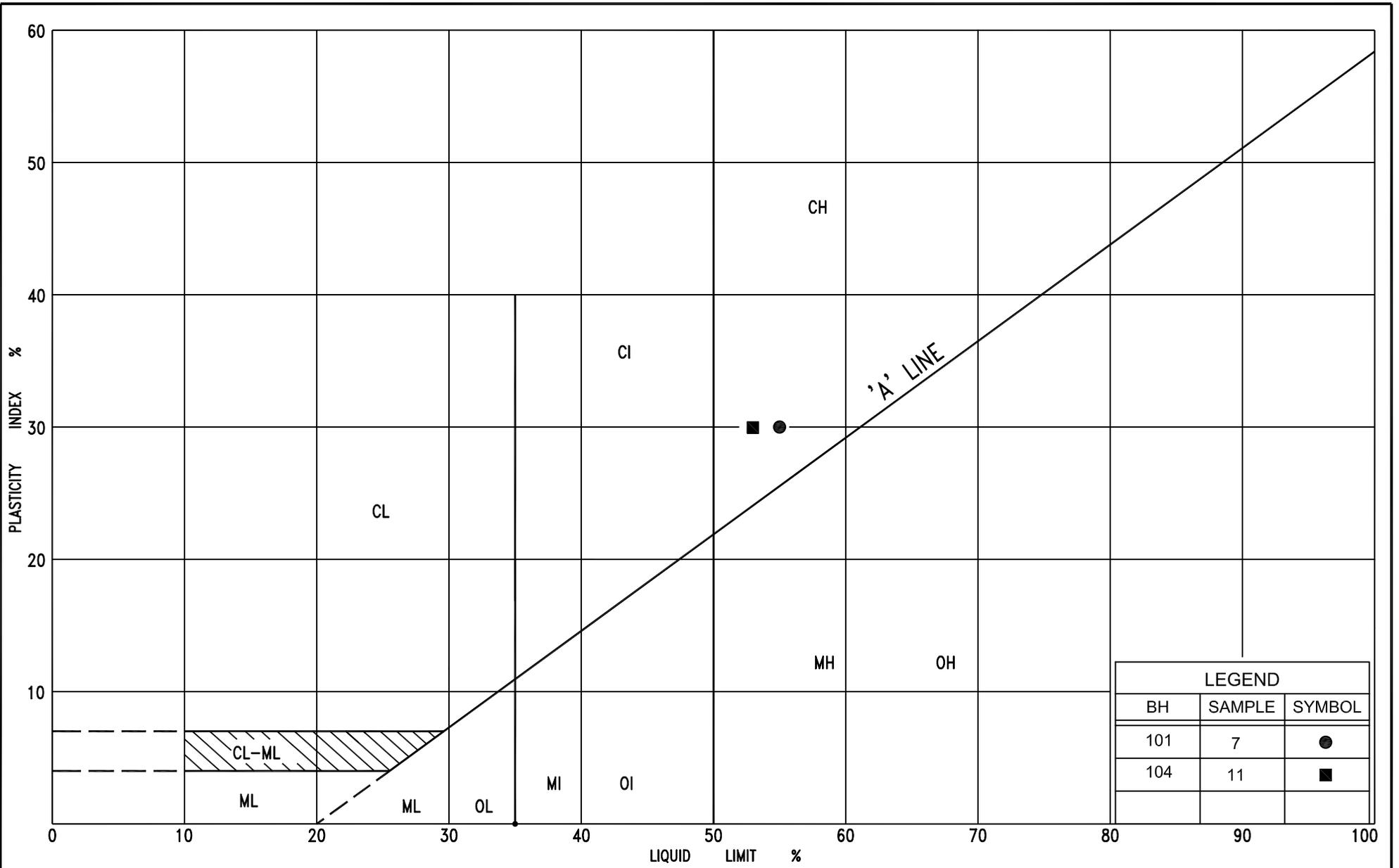
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Senior Project Engineer



Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

GD/CN/BRG:gd-mi

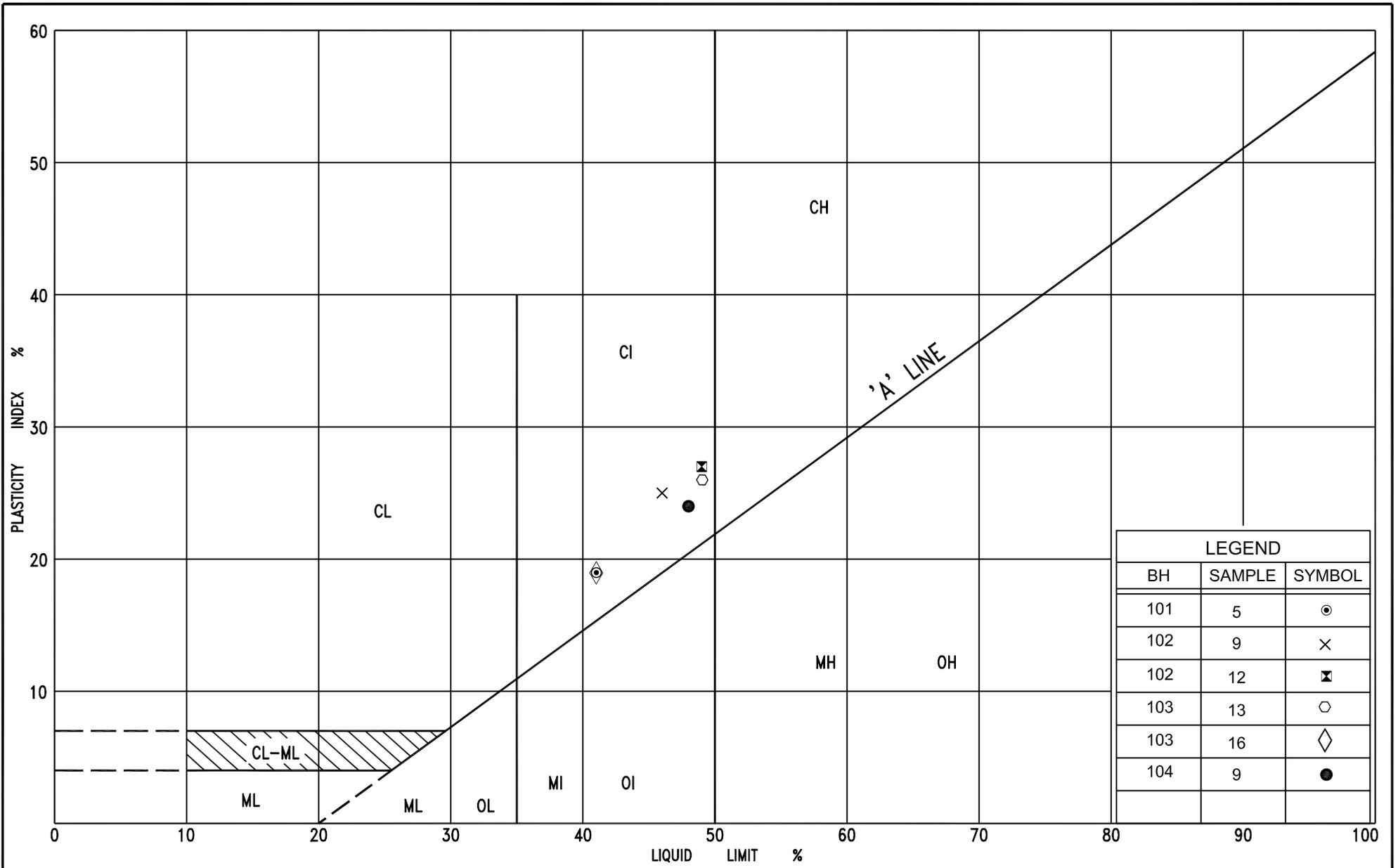




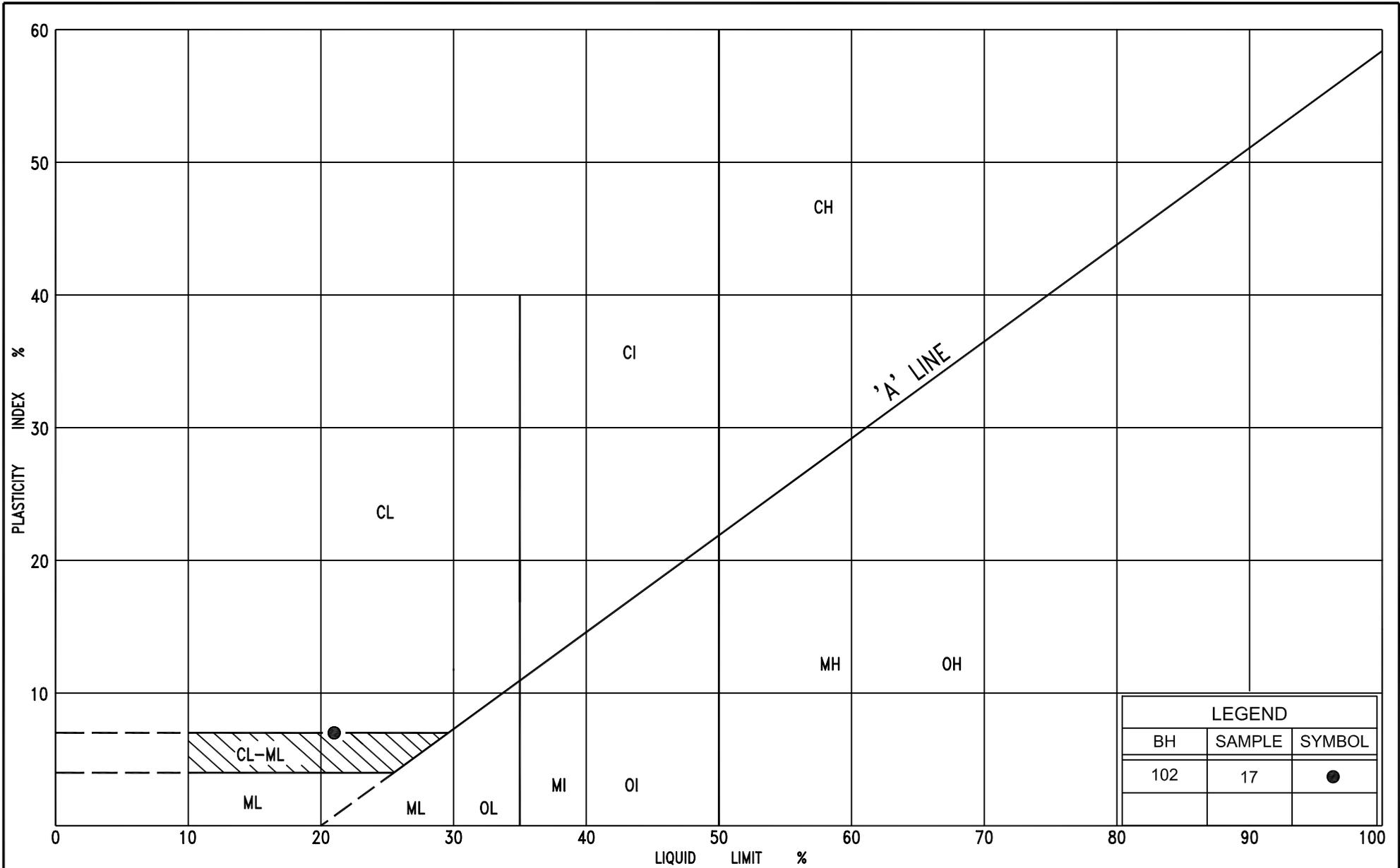
LEGEND		
BH	SAMPLE	SYMBOL
101	7	●
104	11	■

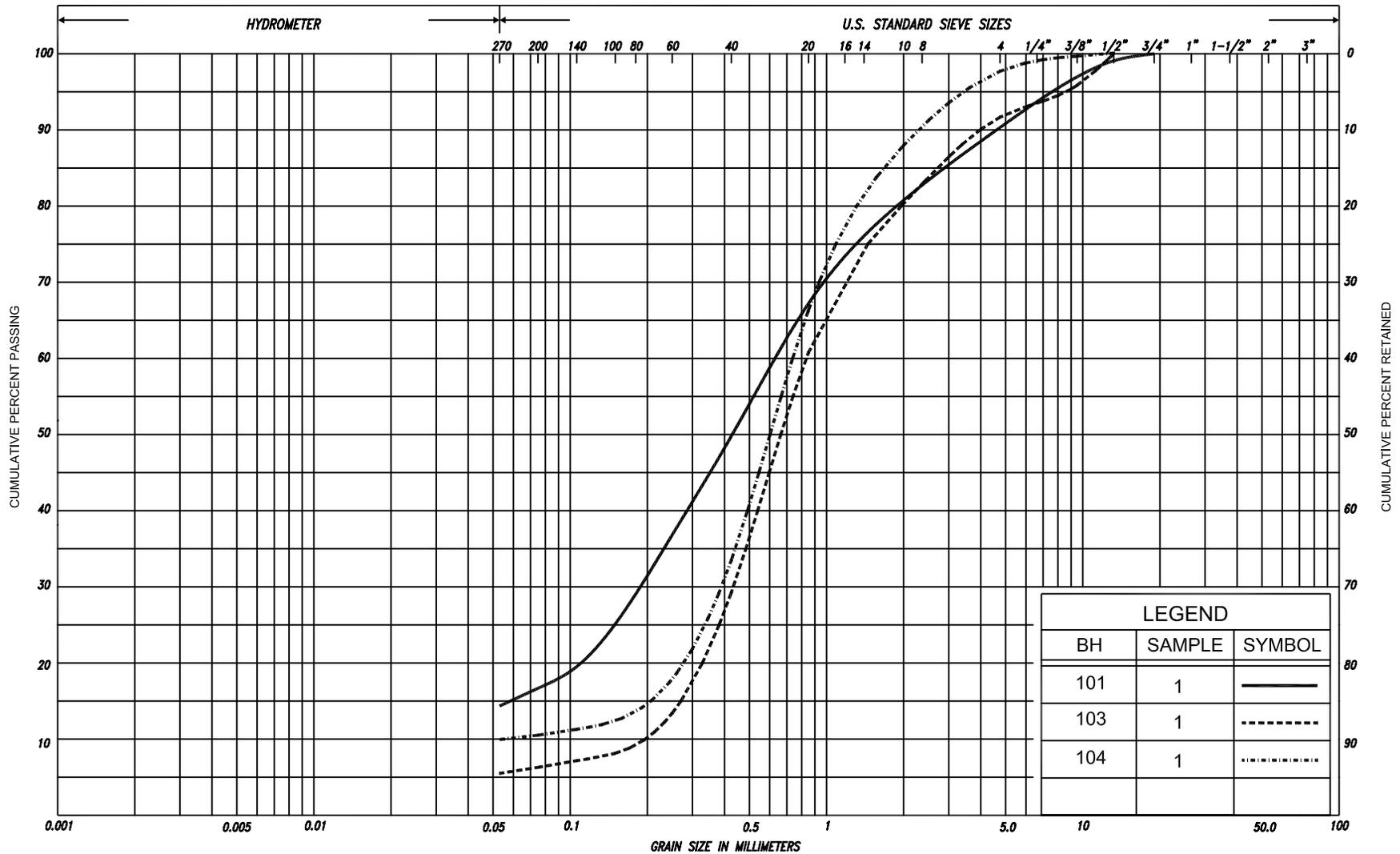
PLASTICITY CHART

CLAY, trace sand



LEGEND		
BH	SAMPLE	SYMBOL
101	5	⊙
102	9	×
102	12	⊠
103	13	⊙
103	16	◇
104	9	●



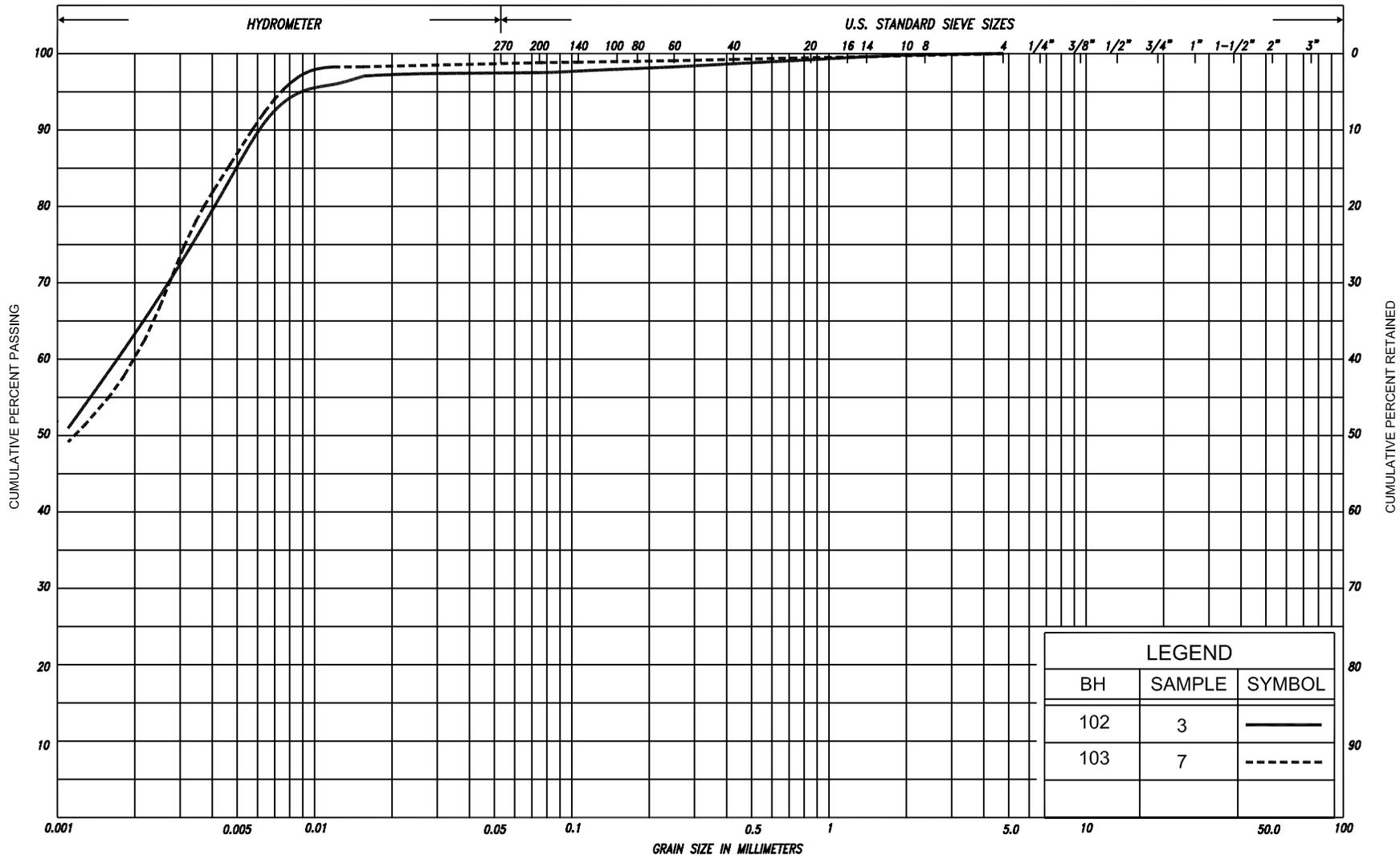


SILT & CLAY			FINE SAND		MEDIUM SAND	COARSE SAND	GRAVEL	COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL	COBBLES	M.I.T.
CLAY	SILT		V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL		U.S. BUREAU

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

FIG No. GS-1-1
 HWY: 577
 G.W.P. No. 181-92-00



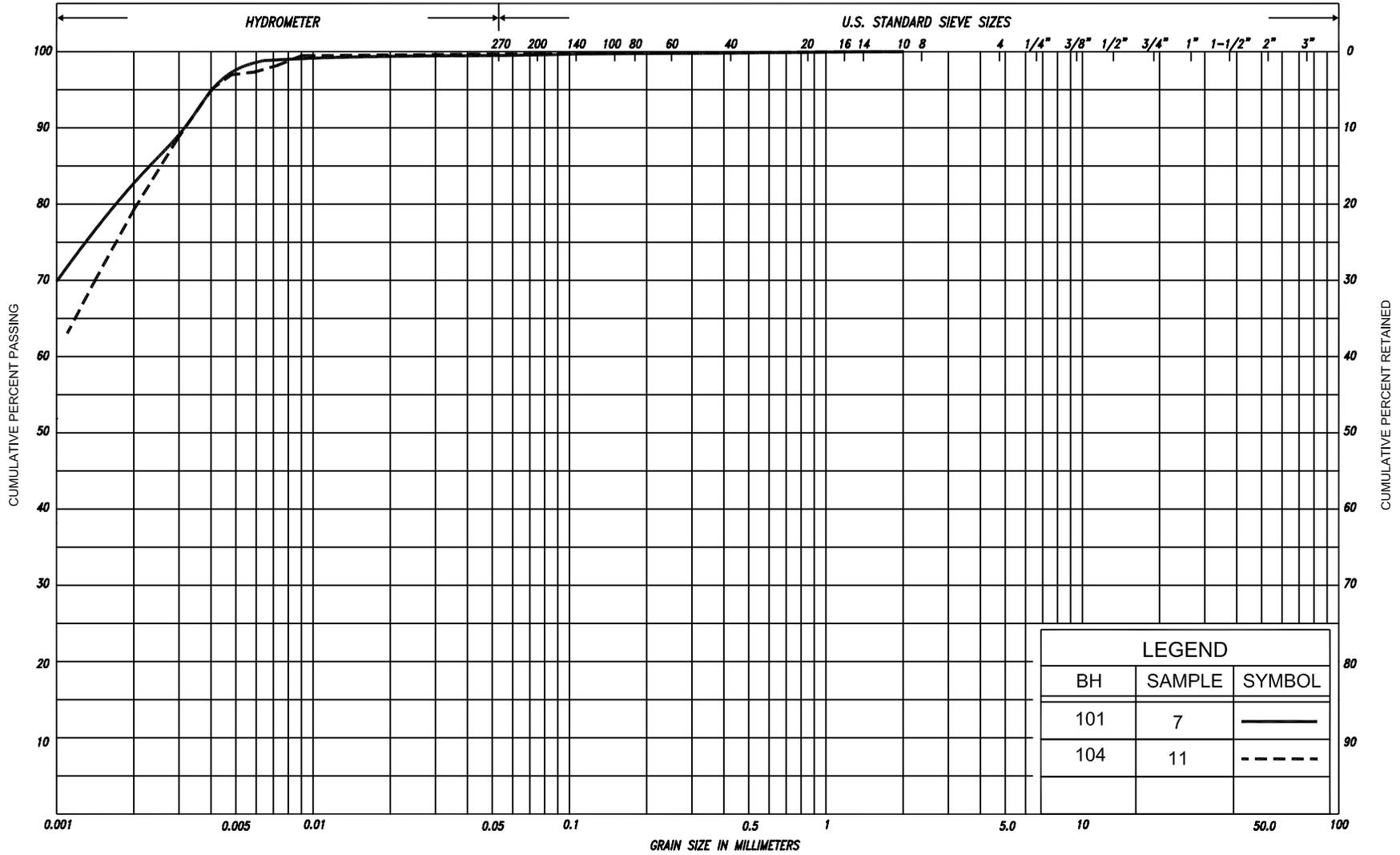


SILT & CLAY			FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			COBBLES	UNIFIED
CLAY	FINE SILT		MEDIUM SILT		COARSE SILT	FINE SAND		MEDIUM SAND		COARSE SAND		GRAVEL			COBBLES	M.I.T.
CLAY		SILT			V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND		GRAVEL						U.S. BUREAU



GRAIN SIZE DISTRIBUTION
 CLAY / SILTY CLAY, trace sand
 (FILL)

FIG No. GS-1-2
 HWY: 577
 G.W.P. No. 181-92-00



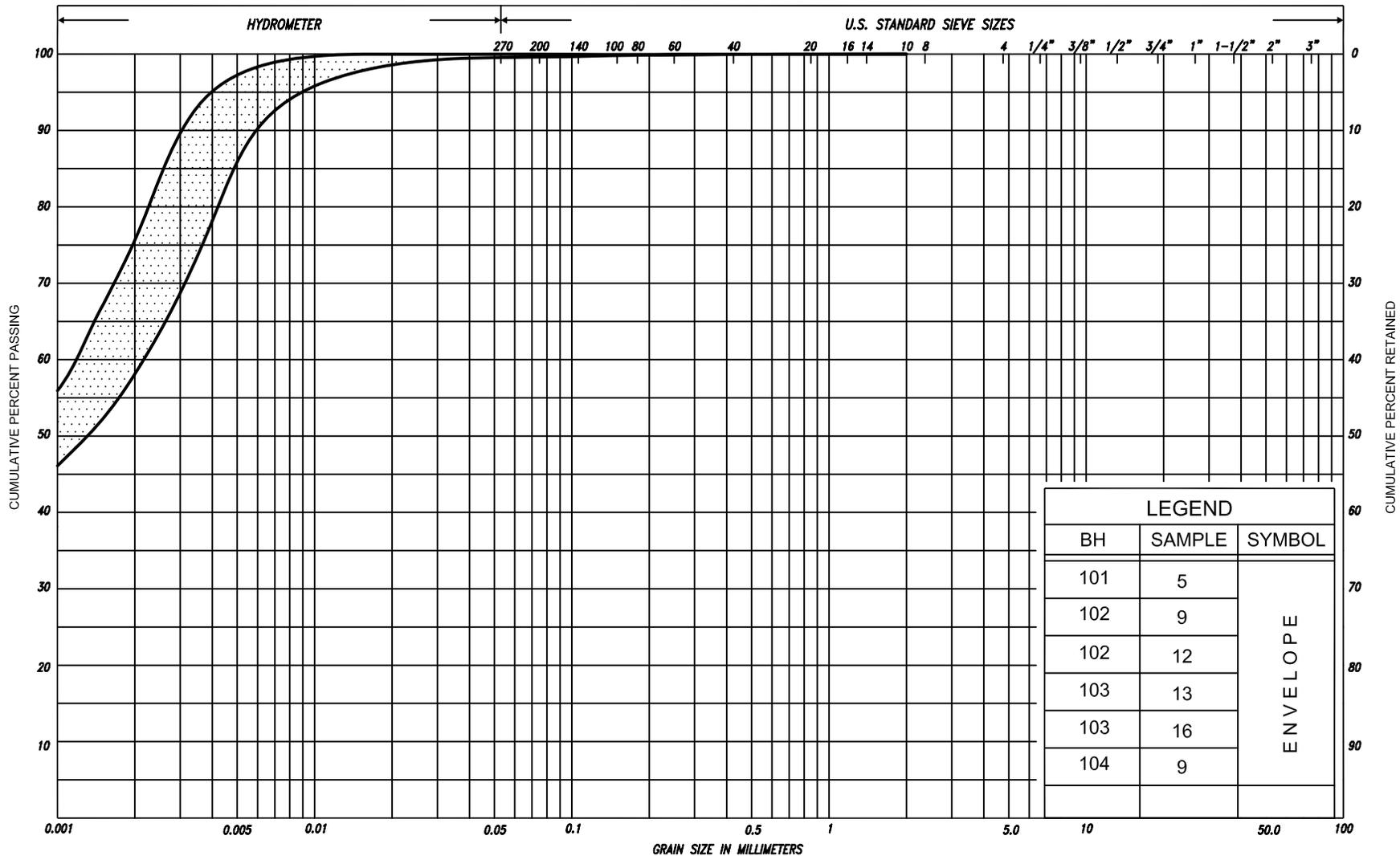
LEGEND		
BH	SAMPLE	SYMBOL
101	7	————
104	11	-----

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

GRAIN SIZE DISTRIBUTION
CLAY, trace sand



FIG No. GS-1-3
 HWY: 577
 G.W.P. No. 181-92-00



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

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



GRAIN SIZE DISTRIBUTION
SILTY CLAY, trace sand

FIG No. GS-1-4
HWY: 577
G.W.P. No. 181-92-00



LEGEND		
BH	SAMPLE	SYMBOL
102	17	—

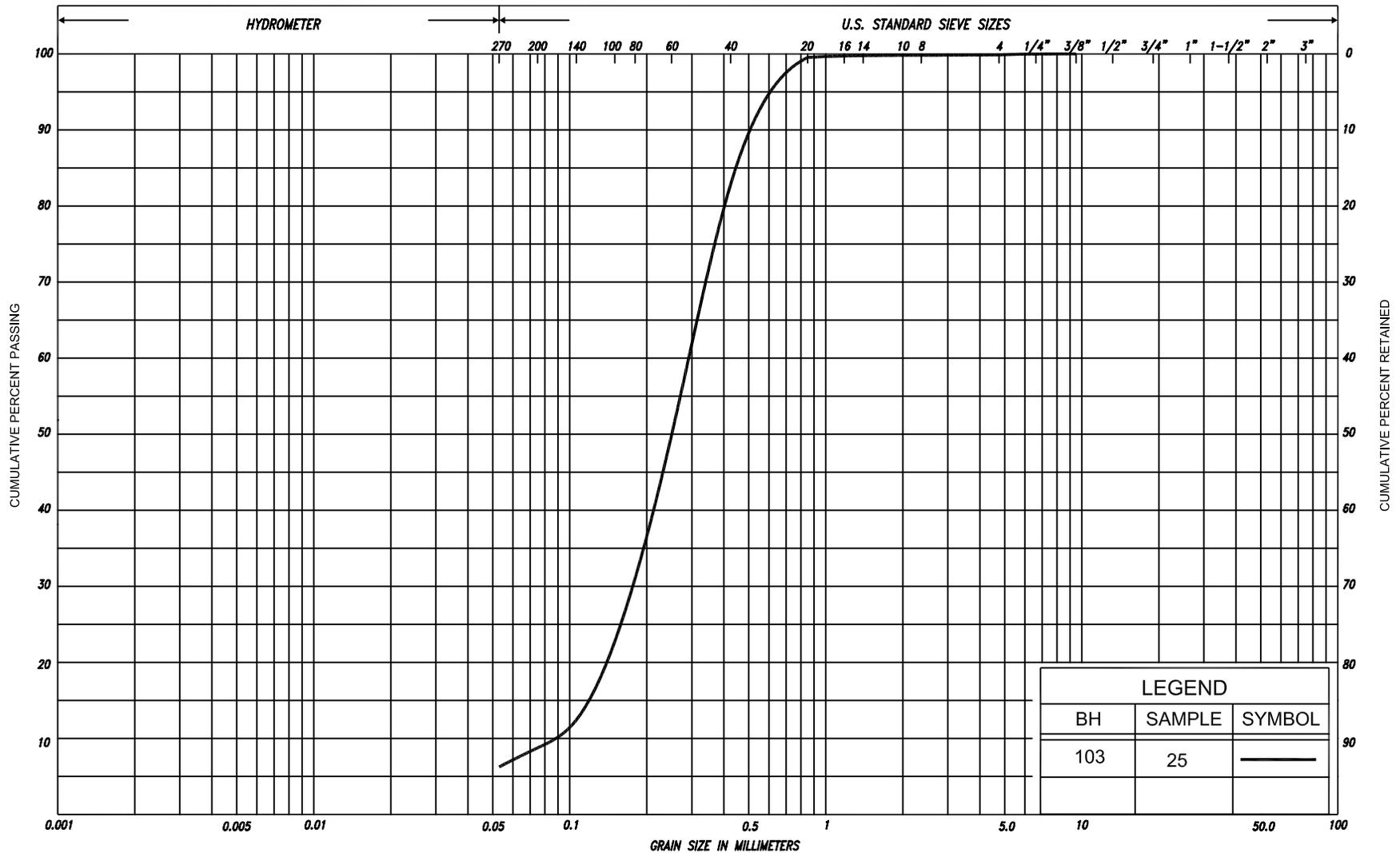
SILT & CLAY			FINE SAND			COARSE SAND	GRAVEL		COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		COBBLES	M.I.T.
CLAY	SILT			Y. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL		U.S. BUREAU



GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand, trace gravel

FIG No. GS-1-5
 HWY: 577
 G.W.P. No. 181-92-00



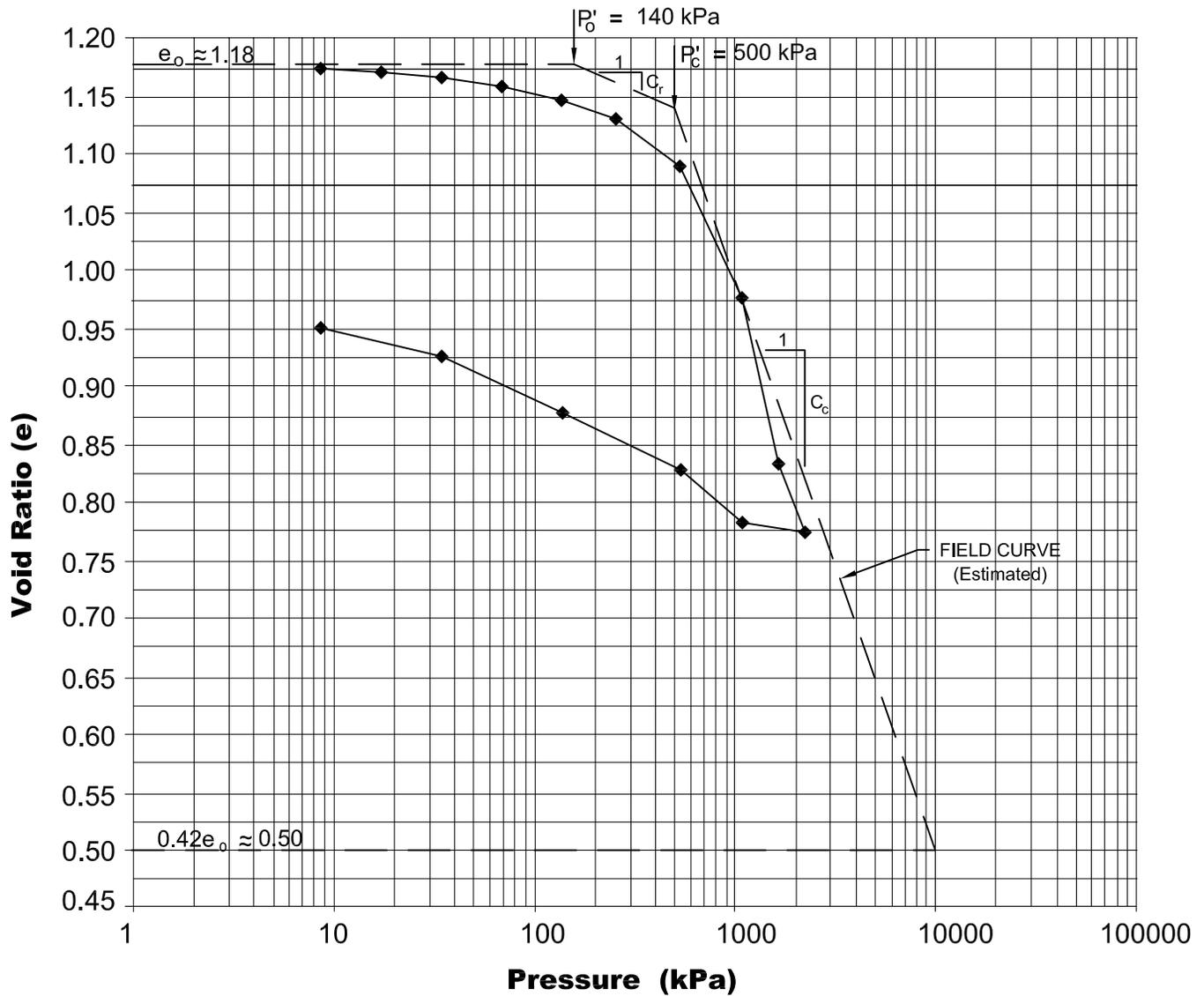
SILT & CLAY			FINE SAND			COARSE SAND	GRAVEL		COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL		COBBLES	M.I.T.
CLAY	SILT		V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL			U.S. BUREAU

GRAIN SIZE DISTRIBUTION
SAND, trace silt

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

$e_0 \approx 1.18$

$P'_0 = 140$ kPa

$W_L = 49$

FIGURE No: C-1-1

$W_o = 45\%$

$P'_c = 500$ kPa

$W_P = 22$

HIGHWAY: 577

$\gamma = 18.2$ kN/m³

$C_c = 0.50$

$PI = 27$

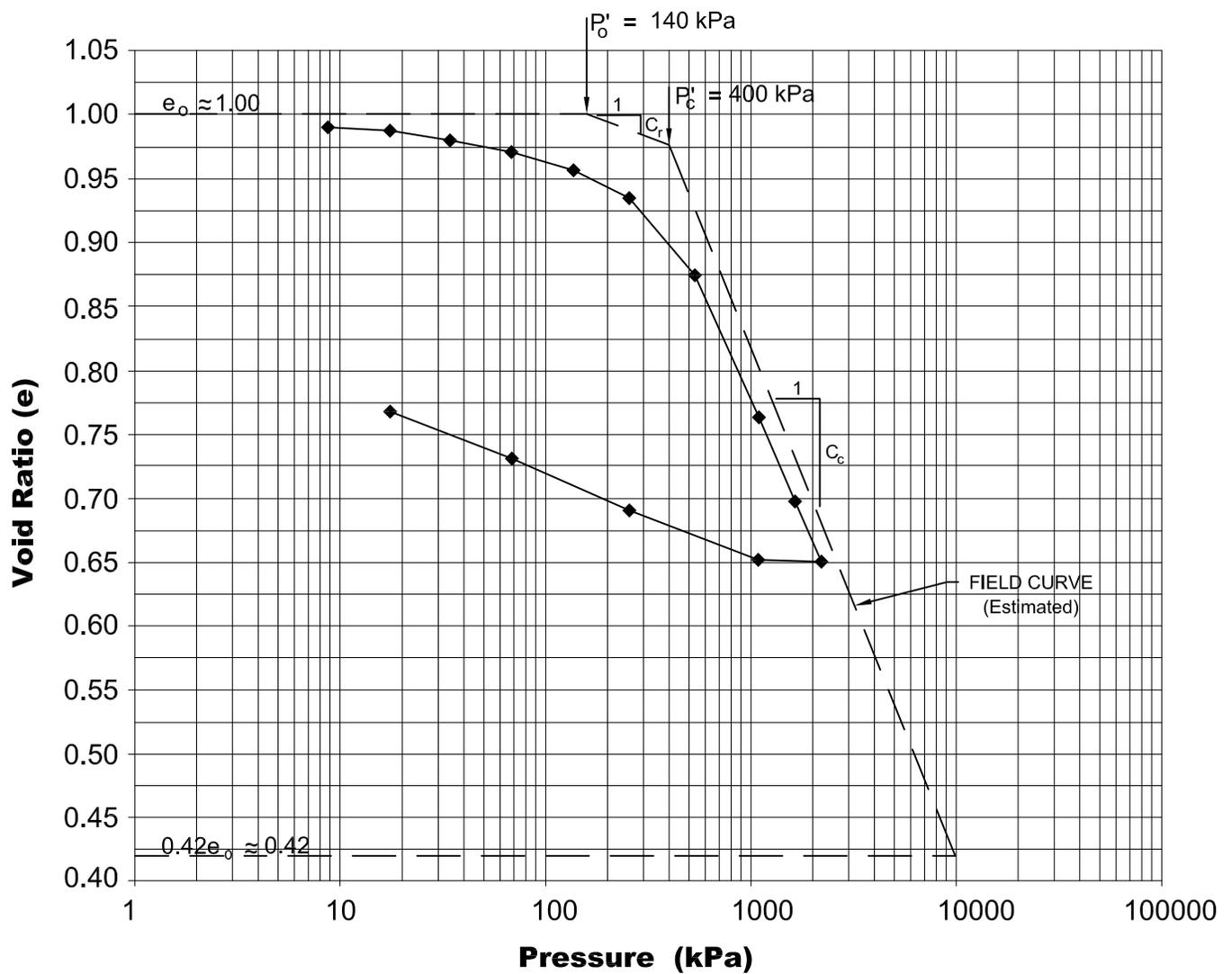
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$C_r = 0.08$

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

$e_0 \approx 1.00$

$P'_0 = 140$ kPa

$W_L = 41$

FIGURE No: C-1-2

$W_0 = 39\%$

$P'_c = 400$ kPa

$W_P = 22$

HIGHWAY: 577

$\gamma = 18.4$ kN/m³

$C_c = 0.40$

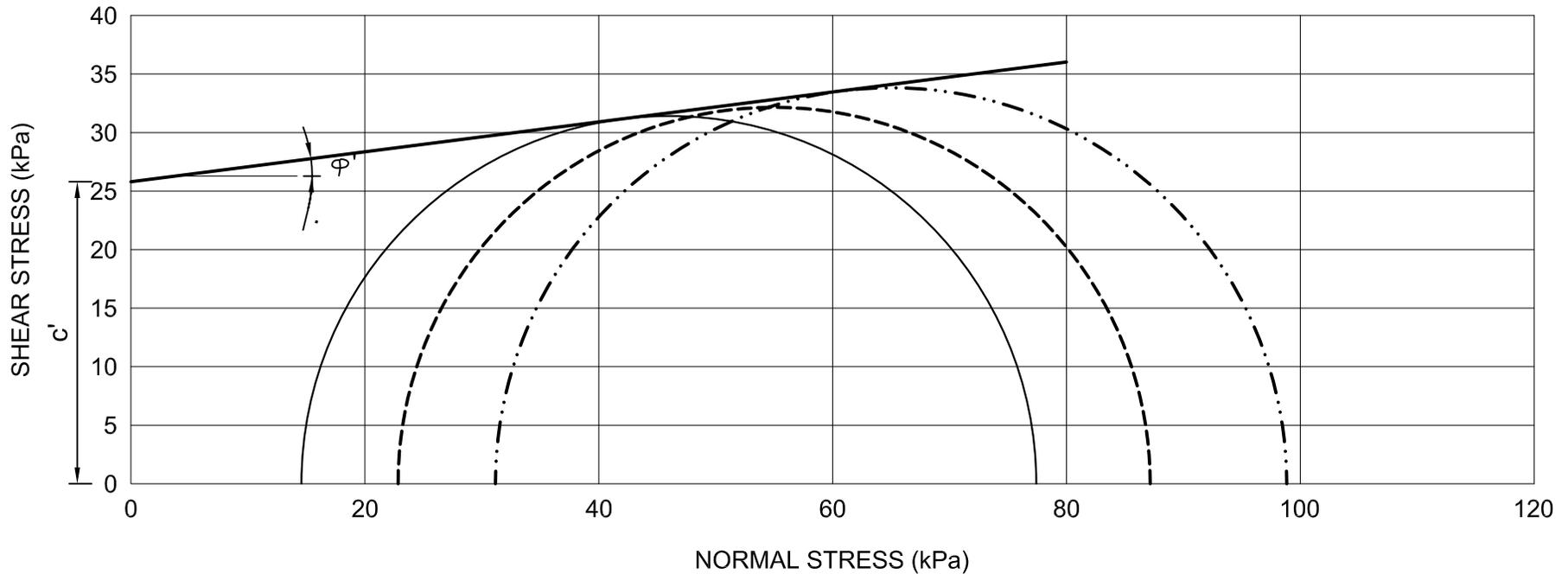
PI = 19

G.W.P. 181-92-00

$C_r = 0.06$

EFFECTIVE STRESS MOHR CIRCLES

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



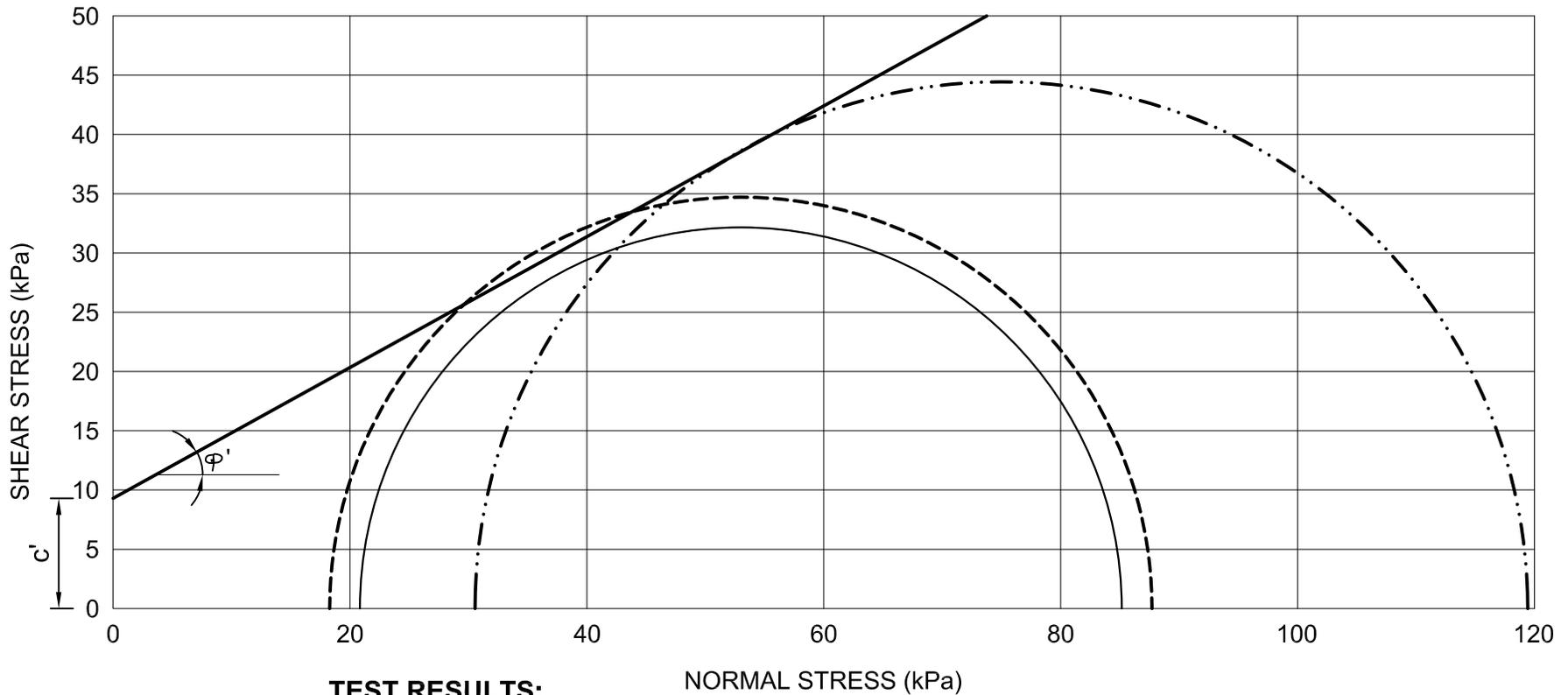
TEST RESULTS:

	CONSOLIDATION PRESSURE (kPa)	PORE PRESSURE (kPa)	UNIT WEIGHT (kN/m ³)	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 ; φ' = 7°	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 ³)	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 $c' = 9$ kPa ; $\phi' = 29^\circ$	FIGURE No: CU-1-2
	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
WS	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
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	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_α	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
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	e_{max}	1, %	VOID RATIO IN LOOSEST STATE
γ_s	kn/m^3	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	e_{min}	1, %	VOID RATIO IN DENSEST STATE
ρ_w	kg/m^3	DENSITY OF WATER	S_r	%	DEGREE OF SATURATION	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
γ_w	kn/m^3	UNIT WEIGHT OF WATER	w_L	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_p	%	PLASTIC LIMIT	D_n	mm	n PERCENT - DIAMETER
γ	kn/m^3	UNIT WEIGHT OF SOIL	w_s	%	SHRINKAGE LIMIT	C_u	1	UNIFORMITY COEFFICIENT
ρ_d	kg/m^3	DENSITY OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
γ_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
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
γ_{sat}	kn/m^3	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
γ'	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 _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa
											○ UNCONFINED	+	FIELD VANE					
											● QUICK TRIAXIAL	×	LAB VANE	WATER CONTENT (%)				
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 to firm Brown Moist		4	SS	2													
	Grey		5	SS	2													0 0 42 58
				FV														
			6	SS	2													
				FV														
247.3	Clay, trace sand		7	TW	PH													17.4 0 1 16 83
5.7	Firm Grey Wet			FV														
			8	SS	1													
				FV														
			9	TW	PH													
242.9				FV														
10.1	End of borehole																	

* 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

RECORD OF BOREHOLE No 101

2 of 2

METRIC

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 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 _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa																					
238.0																																							
	 Filter sand  Screen  Sand bed Water Level Readings: <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>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 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 W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
251.2	Ground Surface																	
0.0	50mm asphaltic concrete over sand and gravel		1	SS	5													
	Loose Brown Clay, trace sand		2	SS	7													
	Stiff to 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 stiff		9	SS	4													
				FV														
			10	TW	PH													
				FV														
			11	SS	3													
				FV														
			12	TW	PH													
				FV														
			13	SS	3													
				FV														

Cont'd

+7, X⁵: Numbers refer to Sensitivity
 20
 15—○—5 (% STRAIN AT FAILURE)
 10

RECORD OF BOREHOLE No 102 2 of 3 METRIC

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 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 W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
236.2	clayey silt seams		14	SS	6											
				FV												
			15	SS	6											
233.4	Clayey silt some sand, trace gravel silt seams															
17.8	Firm to stiff Grey Wet		16	SS	5											
229.4	Silty sand, trace gravel cobbles and boulders		17	SS	47											1 18 53 28
21.8	Compact to dense Grey Wet		18	RC NQ	-											
228.3	Sand trace silt, trace gravel cobbles and boulders		19	SS	50/15cm											
22.9	Compact to dense Grey Wet															
			20	SS	50/13cm											
			21	SS	21											
			22	SS	35											
221.2																

RECORD OF BOREHOLE No 102

3 of 3

METRIC

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 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 W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
221.2 30.0	Gravelly sand, trace silt cobble and boulders Dense to Grey Wet very dense															
			23	SS	62											
			24	SS	89/28cm											
219.7 31.5	End of borehole Probable gravelly sand Compact to very dense															
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															

RECORD OF BOREHOLE No 103

1 of 3

METRIC

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 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 W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20 40 60 80 100	○ UNCONFINED	+	FIELD VANE							
						20 40 60 80 100	● QUICK TRIAXIAL	×	LAB VANE							
251.5	Ground Surface															
0.0	Sand trace silt, trace gravel Very loose Brown Moist		1	SS	2											8 86 (6)
	Silty clay, trace sand organic inclusions Firm to Grey Moist stiff		2	SS	4											
	(FILL)		3	SS	4											
			4	SS	4											
			5	SS	9											
			6	SS	8											
	Brown/grey		7	SS	7											0 1 39 60
			8	SS	5											
			9	SS	6											
			10	SS	4											
			11	SS	4											
			12	SS	7											
242.4	Silty clay, trace sand Stiff Grey Moist to wet		13	SS	8											0 1 39 60
9.1			14	TW	PH											
				FV												
			15	SS	5											
				FV												
			16	TW	PH											18.4 0 1 28 71
				FV												
			17	SS	1											
				FV												

Cont'd

RECORD OF BOREHOLE No 103

3 of 3

METRIC

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 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 W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
221.5			24	SS	50/5cm											
220.2 31.3	Sand, trace silt Compact Grey Wet															
219.0 32.5	End of borehole Refusal on probable boulder Samples 23 & 24: Sampler bouncing * 2008 10 21 ∇ Water level observed during drilling		25	SS	29											0 91 (9)

RECORD OF BOREHOLE No 104

1 of 2

METRIC

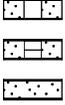
G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 ORIGINATED BY F.P.
 DIST 54 HWY 577 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.
 DATUM Geodetic DATE October 24 & 25, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60			
253.3	Ground Surface															
0.0	Sand some silt, trace gravel	[Cross-hatched]	1	SS	1											
	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	Silty clay Stiff to firm Brown Moist to firm to wet	[Diagonal lines]	5	SS	9											
3.0			6	SS	5											
			7	SS	2											
			FV													
	Grey		8	SS	2											
			FV													
244.6	Clay Stiff Grey Moist to wet	[Dotted]	9	TW	PH									19.0	0 0 26 74	
8.7			FV													
			10	TW	PH											
		FV														
243.2	End of borehole															
10.1																
	* 2008 10 24 & 25 ** 2008 10 31 (Piez.)															
	▽ Water level observed during drilling															
	▼ Water level measured after drilling															
	■ Penetrometer test															
	<u>Piezometer Legend :</u>															
	■ Bentonite seal															
	▨ Native cuttings															

Cont'd

RECORD OF BOREHOLE No 104 2 of 2 **METRIC**

G.W.P. 181-92-00 LOCATION Meadow Creek/ HWY 577 ORIGINATED BY F.P.
 Co-ords: 5 401 417 N; 328 274 E
 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 _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100																						
238.3	 Filter sand Screen Sand bed Water Level Readings: <table border="1"> <tr> <td>Date</td> <td>Depth (m)</td> <td>Elev.</td> </tr> <tr> <td>10/26/2008</td> <td>2.2</td> <td>251.1</td> </tr> <tr> <td>10/27/2008</td> <td>1.6</td> <td>251.7</td> </tr> <tr> <td>10/28/2008</td> <td>1.8</td> <td>251.5</td> </tr> <tr> <td>10/30/2008</td> <td>2.0</td> <td>251.3</td> </tr> <tr> <td>10/31/2008</td> <td>2.0</td> <td>251.3</td> </tr> </table>	Date	Depth (m)	Elev.	10/26/2008	2.2	251.1	10/27/2008	1.6	251.7	10/28/2008	1.8	251.5	10/30/2008	2.0	251.3	10/31/2008	2.0	251.3															
Date	Depth (m)	Elev.																																
10/26/2008	2.2	251.1																																
10/27/2008	1.6	251.7																																
10/28/2008	1.8	251.5																																
10/30/2008	2.0	251.3																																
10/31/2008	2.0	251.3																																

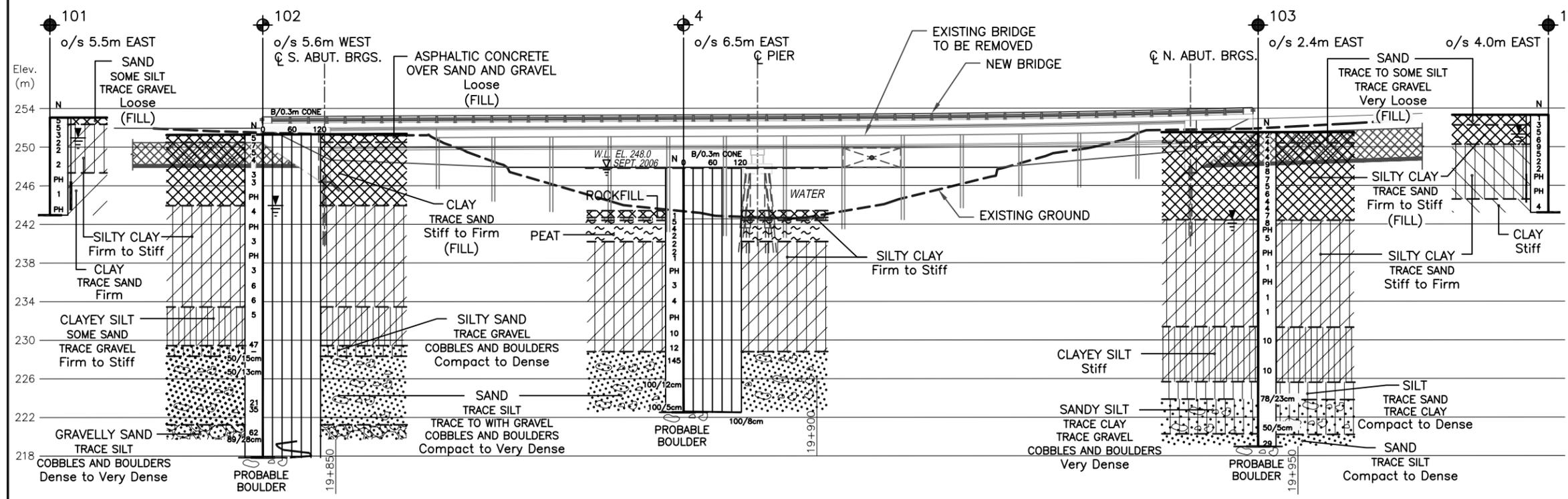
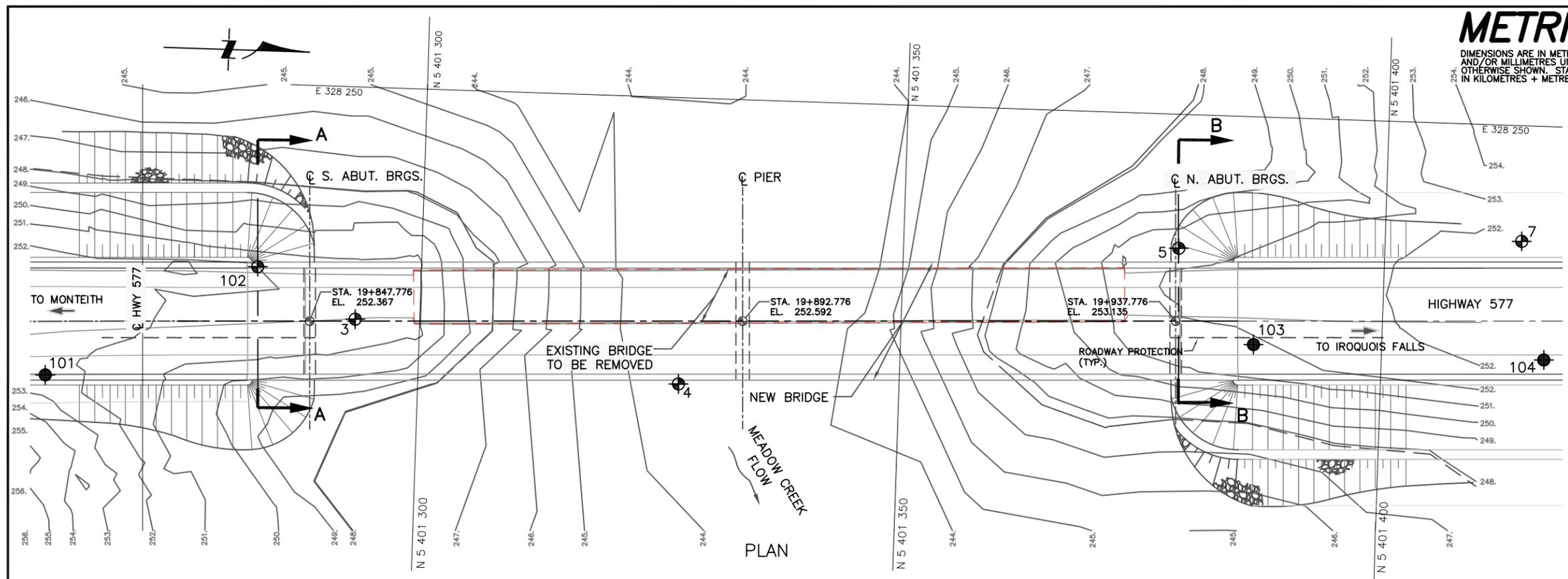
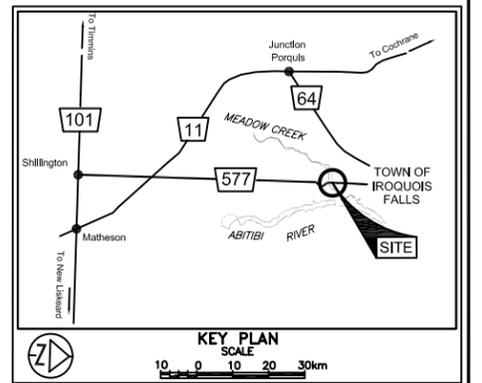
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES UNLESS
 OTHERWISE SHOWN. STATIONS
 IN KILOMETRES + METRES

CONT No
 GWP No 181-92-00



MEADOW CREEK BRIDGE
 HIGHWAY 577
 BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



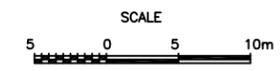
LEGEND

- 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.

- 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 (GEOCREs No. 42A-66)



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

DATE	BY	DESCRIPTION

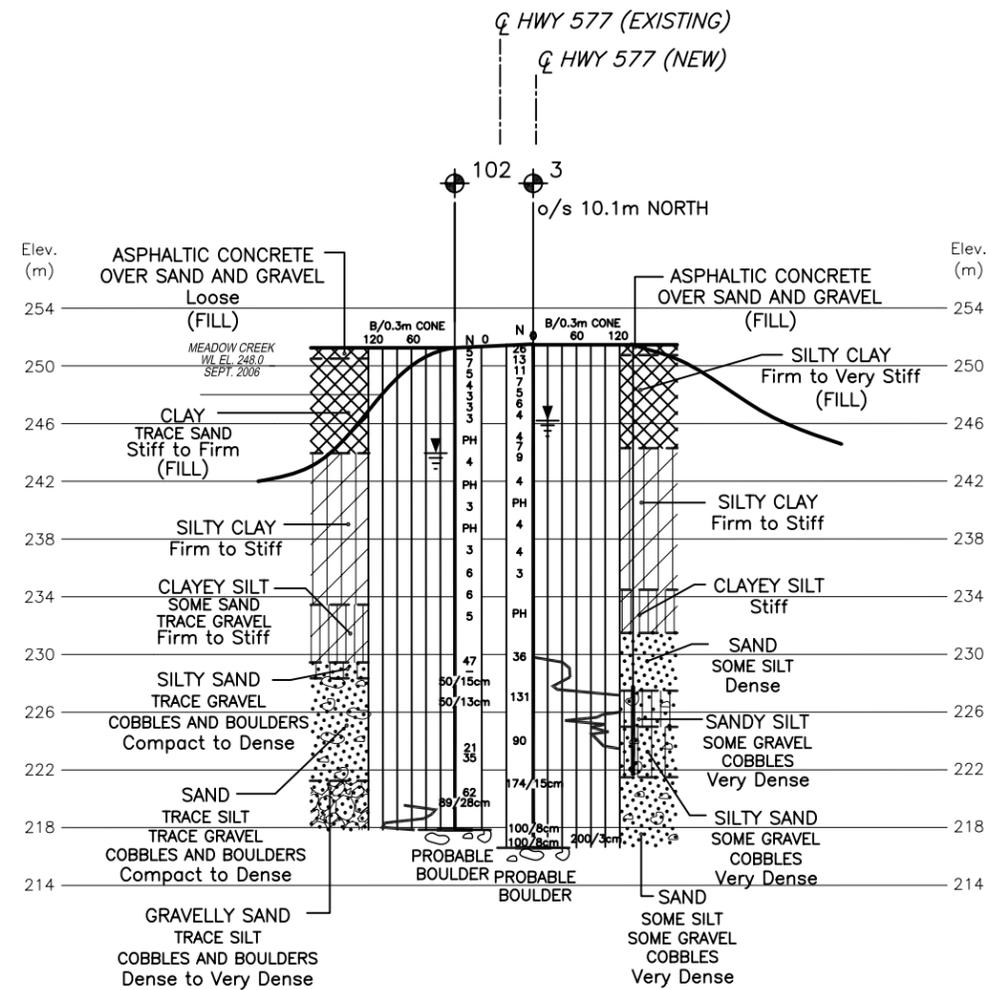
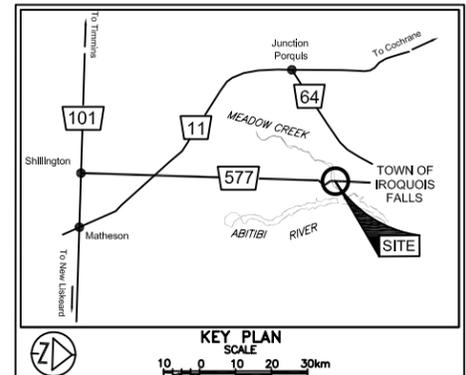
Geocres No. 42A-75

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

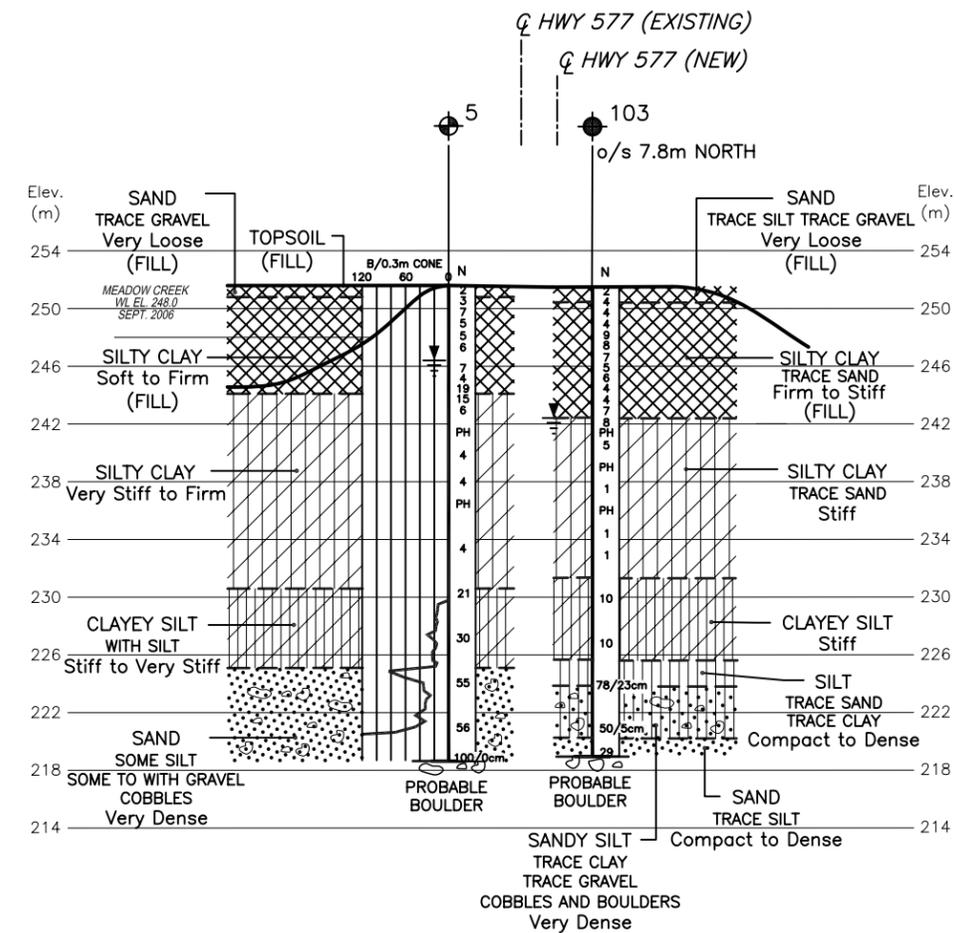
METRIC

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

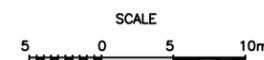
CONT No	
GWP No 181-92-00	
MEADOW CREEK BRIDGE	SHEET
HIGHWAY 577	
SOIL STRATA	



SECTION A-A



SECTION B-B



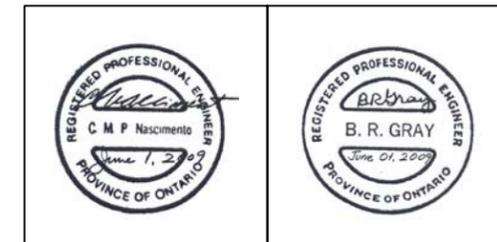
NOTES:

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

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
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



APPENDIX A

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

SPT1167

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 8/23/2005 CHECKED BY RM

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W		
251.5	Ground Surface											
0.0	100mm Asphaltic concrete 75mm fill (sand+gravel) 75mm asphaltic concrete FILL:SAND and GRAVEL		1	SS	26							
250.5			2	SS	13							
1.0	FILL:SILTY CLAY trace organics and rootlets brown, stiff to firm		3	SS	11							
			4	SS	7							
248.5			5	SS	5							
3.0	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 to very stiff		6	SS	6							
			7	SS	4							
			8	SS	4							
244.3			9	SS	7							
7.2	SILTY CLAY somewhat organic, some peat seams dark grey to black, firm		10	SS	9							
244.0			11	SS	4							
7.5			12	TW	PH							
			13	SS	4							
			14	SS	4							
235.5												

Continued Next Page

+³ . x³ : Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

0 0 23 77
 Consolidation
 Test

SPT1167

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 6/23/2006 CHECKED BY RM

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)								
						20	40	60	80	100	20	40	60	80	100	10	20	30	GR	SA	SI	CL	
15.0	SILTY CLAY with frequent clayey silt and silt seams grey, stiff	[Hatched pattern]	15	SS	3																		
234.5																							
17.0	CLAYEY SILT with silt layers and thin clay interbeds grey, wet, stiff	[Hatched pattern]	16	TW	PH																		
231.5																							
20.0	SAND with some silt, some zones with embedded gravel(possible till zones)	[Dotted pattern]	17	SS	35																		
231.5																							
20.0	SANDY SILT some gravel and cobbles	[Dotted pattern]	18	SS	131																		
227.5																							
24.0	SANDY SILT some gravel and cobbles	[Dotted pattern]	19	SS	90																		
225.0																							
26.5	SILTY SAND with some sand and some sandy silt zones, some zones with embedded gravel (possible till zones), occasional cobbles	[Dotted pattern]	19	SS	90																		
221.5																							

Continued Next Page

+³ × 3. Numbers refer to 20 Sensitivity 15 5 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			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						
						20 40 60 80 100	20 40 60 80 100	20 40 60						
247.8 0.0	Water Surface													
	Water													
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

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (% STRAIN AT FAILURE)

SPT1167

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

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60					
251.6	Ground Surface														
0.0	0.15m Sandy TOPSOIL FILL: SAND trace gravel brown, moist, very loose		1	SS	2										
250.8	FILL: SILTY CLAY trace organics & rootlets brown/ greyish brown soft to firm		2	SS	3										
249.4			3	SS	7										
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		4	SS	5										
			5	SS	5										
			6	SS	5										
			7	SS	6										
			8	SS	7										
			9	SS	4										
244.1	SILTY CLAY somewhat organic, some peat and decayed wood dark grey to black, very stiff		10	SS	19										
243.2			11	SS	15										
8.4	clayey silt zone stiff		12	SS	6										
			13	TW	PH										
	SILTY CLAY occasional clayey silt & silt seams firm to stiff		14	SS	4										
			15	SS	4										
236.6															

Continued Next Page

+³ × 3³ Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

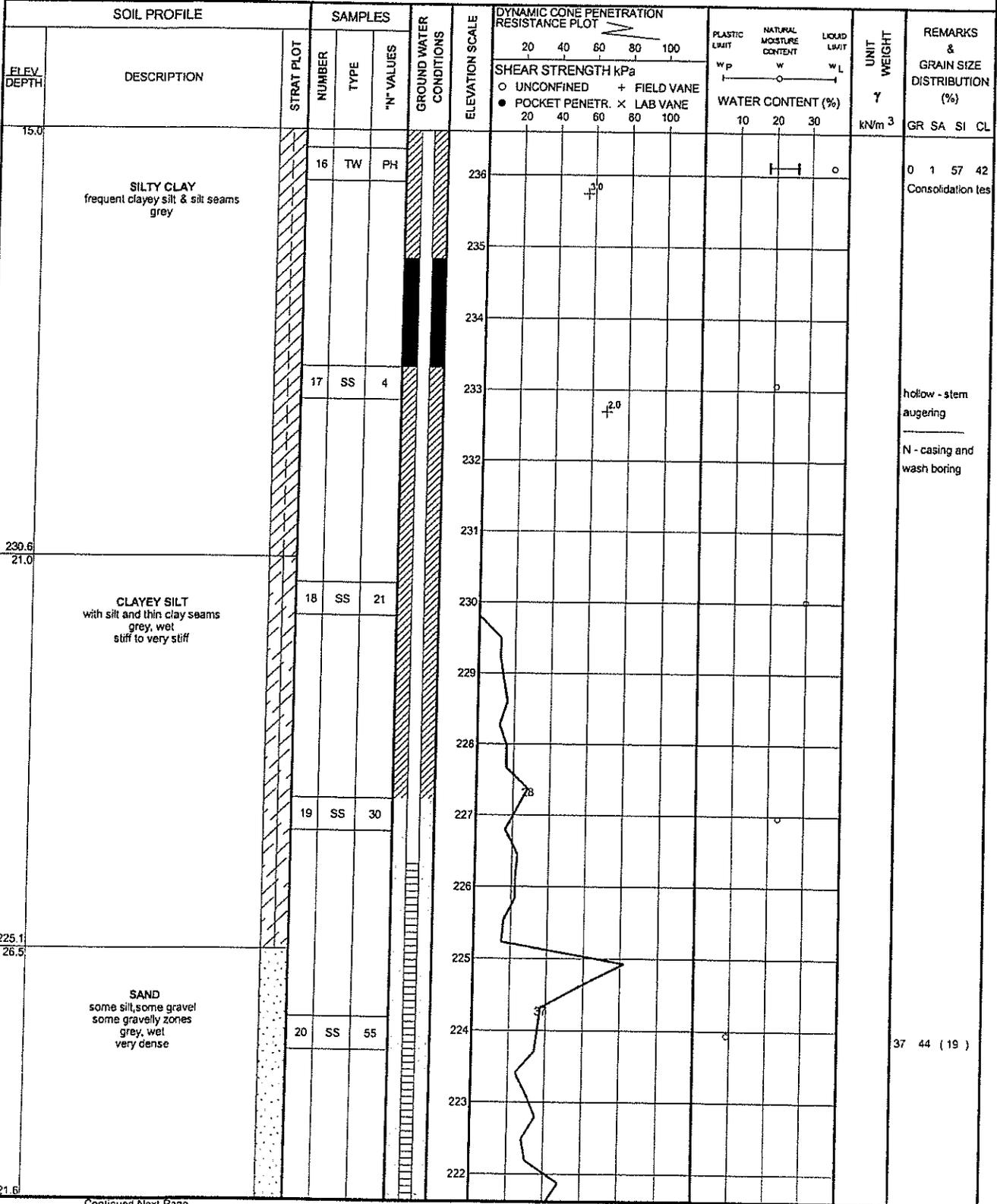
SPT1167

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



Continued Next Page

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

SPT1167

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 _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
30.0	SAND with gravel, some silt, some cobbles grey, wet very dense		21	SS	56			10	20	30	kN/m ³	no recovery (sampler bouncing)
218.7			22	SS	100/0							
32.9	End of Borehole Sample bouncing, refusal to advancing with casing and Iricone 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)											

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

SPT1167

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

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
			NUMBER	TYPE	"N" VALUES			20	40	60			80
253.6	Ground Surface												
0.0	0.3m TOPSOIL FILL: SAND and GRAVEL brown, moist, loose		1	SS	4								
252.8													
0.8	FILL: SILTY CLAY some silt lenses, brown, firm		2	SS	5								
252.2													
1.4	FILL: SILTY CLAY somewhat organic, occasional peat lenses, dark brown/grey/dark grey/black firm		3	SS	6								
			4	SS	6								
250.6													
3.0		slightly org.	5	SS	10								
		brown	6	TW	PH								
		grey	7	SS	4								
	SILTY CLAY		8	SS	4								
		firm											
		stiff	9	SS	6								
			10	SS	6								
		some thin silt seams	11	SS	6								
			12	TW	PH								
		firm	13	SS	4								
238.6													

Continued Next Page

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

RECORD OF BOREHOLE No 7

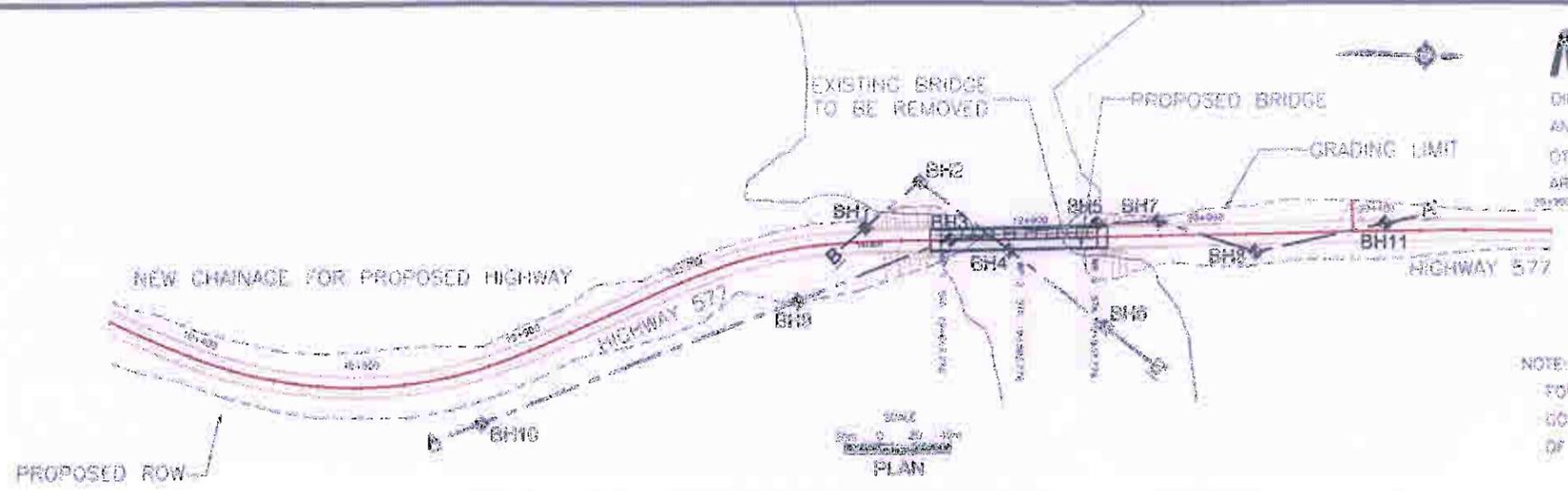
3 OF 3

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 8/16/2006 to 8/18/2006 CHECKED BY RM

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80					
	SAND with some silt and gravel, occasional cobbles grey, wet, very dense		19	SS	118		223									16 73 (11)
							222									
								221								
220.0							220									
33.6	Sampler bouncing on probable boulder.		20	SS	100/5											cored through a boulder from 33.6 to 33.9m
219.7																
33.9	End of borehole		21	RC												
	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															

3, 3 Numbers refer to Sensitivity 20 15 10 (% STRAIN AT FAILURE



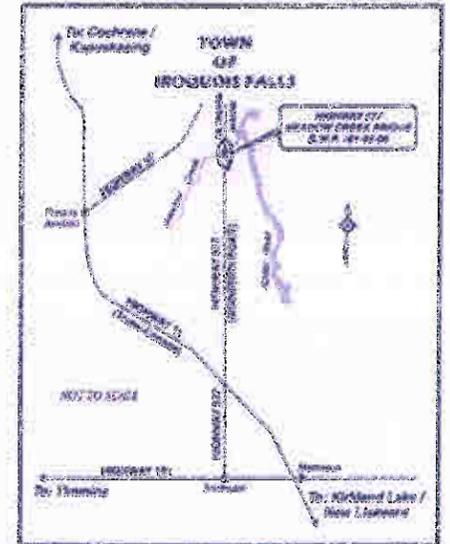
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES UNLESS
 OTHERWISE SHOWN. STATIONS
 ARE IN KILOMETRES+METRES

CONT No.
GWP: 181-92-00
 Meadow Creek Bridge, Ingersoll Falls
 SECTION AT STA. 10+630 TO 20+150
 BORE HOLE LOCATIONS & SOIL STRATA

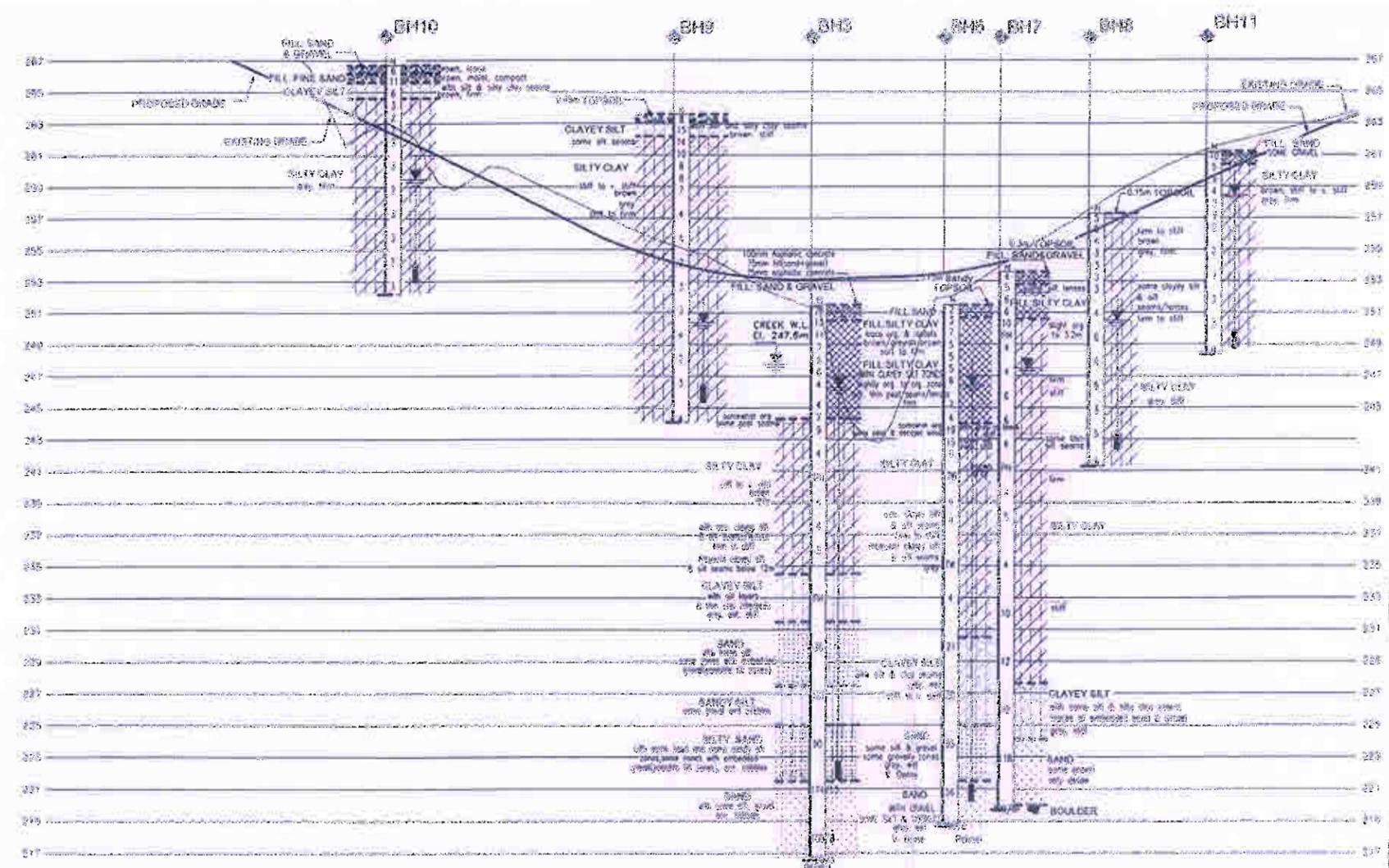


SHAHEEN & PEAKER LIMITED

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



KEY PLAN (N. T. S)



STRATIGRAPHIC PROFILE ALONG SECTION AA'

LEGEND

- Borehole
- Blows/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 3	251.5	5 401 193.3	328 274.1
BH 5	251.5	5 401 378.6	328 263.9
BH 7	253.9	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	266.7	5 401 025.4	328 392.8
BH 11	261.2	5 401 545.4	328 261.7



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 approved 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 GC 2.01 of OPS Gen. Cond.

DATE	BY	DESCRIPTION

Geocres No. 42A-58

MEADOW CREEK BRIDGE-HWYS77	DIST
SUBM'D TO CHECKED RM	DATE Nov.2006 SITE 396-073
DRAWN KS	CHECKED TS APPROVED ZO DWG 1

