FOUNDATION INVESTIGATION REPORT

CULVERTS FOR PHASE 2 SECTION

HIGHWAY 69 FOUR LANING FOR 21.5 km
FROM 4.5 km NORTH OF HIGHWAY 64
TO 8.7 km NORTH OF HIGHWAY 637

DISTRICT 54, SUDBURY, ONTARIO
G.W.P. NO. 5218-06-00
CONTRACT NO. 2009-5131

ATTACHMENT 1

Ministry Of Transportation

Ontario

TABLE A

ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
15+500 Servos Township	C15	C15-1	4 5 6	2.7 – 3.0 3.0 – 4.1 4.1 – 5.7	92 98 89	58 79 89	2.7 – 5.7	SYENITE/GRANITE: Pink and grey, becoming dark grey at depth, fine grained, with occasional pink bands, medium to coarse crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough planar, tight to slightly altered with red oxidation and/or red, green or black scale on partings, local vertical joints, rough planar, tight, fair to good quality.
		C15-3	4 5 6 7	1.8 – 2.5 2.5 – 3.4 3.4 – 4.1 4.1 – 5.8	80 93 69 90	54 82 47 68	1.8 – 5.8	SYENITE/GRANITE: Pink and grey, becoming dark grey at depth, fine grained, with occasional pink bands, medium to coarse crystalline, high strength, slightly weathered, very close to close spaced flat to dipping cross joints, rough planar, tight to slightly altered with red oxidation stains penetrating up to 1 mm, with red or brown scale, occasional silt, local vertical joints, rough planar, open to 0.5 mm, with white scale and brown silt, poor to good quality.
		C15-5	10 11 12	9.4 – 10.8 10.8 – 12.2 12.2 – 13.1	95 100 100	95 100 100	9.4 – 13.1	MIGMATITE: Black and white, steeply dipping bands, fine grained, high strength, unweathered, close to moderate (locally wide) spaced flat to dipping cross joints, rough to smooth planar, tight to slightly altered with red oxidation stains on partings, excellent quality.

Originated: JFW
Compiled: FP
Checked: IS / CN

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ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
10+180 (Hwy 637)	C637	C637-1	4 5 6	2.6 – 3.1 3.1 – 4.7 4.7 – 6.1	100 100 97	33 100 88	2.6 – 6.1	GRANODIORITE: Light grey and black, medium grained, high strength, slightly weathered to unweathered, with compound fissure to 2.9 m depth, rough planar, open 0.5 to 1.0 mm, dark green oxidation/mineralization with trace silt on parting, close to wide spaced flat cross joints, rough planar, tight to slightly altered with reddish oxidation stains, black mineralization and/or silt on partings, poor becoming good to excellent quality.
		C637-2	6 7 8 9 10	5.2 – 6.0 6.0 – 6.2 6.2 – 7.1 7.1 – 7.5 7.5 – 9.1	88 80 36 94 95	72 0 0 69 64	5.2 – 9.1	GRANODIORITE: Light grey and black, medium grained, medium to high strength, moderately to slightly weathered, very close to close spaced flat to dipping cross joints, rough planar, slightly altered with reddish oxidation stains and/or black silt on partings, highly fractured with poor recovery between 6.0 and 7.1 m depth, vertical fissure below 8.7 m, rough planar, slightly altered with silt on partings, very poor to fair quality.
		C637-3	7 8 9	5.5 – 6.3 6.3 – 8.2 8.2 – 9.0 (*)	81 100 53	71 100 53	5.5 – 5.9 5.9 – 9.0	BIOTITE MIGMATITE: Black, fine grained, medium strength, slightly weathered to unweathered, close spaced flat to dipping cross joints, rough planar, separating on biotite concentrations, and at contact with underlying granodiorite, fair quality GRANODIORITE: Light grey and black, medium grained, high strength, unweathered, moderate to wide spaced flat cross joints, rough planar, excellent quality.

(*) Bottom 420 mm of core lost in borehole.

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ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
17+580 Servos Township	C19	C19-1	4	1.9 – 3.5	98	98	1.9 – 5.1	MIGMATITE: Dark grey, fine to medium grained, slight banding, with black layers, high strength, unweathered, moderate to wide (locally close) spaced flat to dipping cross joints, rough planar, tight, separating on biotite concentrations, excellent quality.
			5	3.5 – 5.1	98	98		
		C19-2	2	0.3 – 1.6	100	97	0.3 – 2.7	GRANITIC GNEISS: Light grey with few light pink zones, very faint banding, occasional black or white seams/layers, high strength, unweathered, close to moderate spaced flat cross joints, rough planar, tight to slightly altered with minor scale on partings, excellent quality.
			3	1.6 – 2.8	100	100		
			4	2.8 – 4.1	89	68		
							2.7 – 4.1	MIGMATITE: Dark grey to black, fine to medium grained, slight banding, with occasional white seams, high strength, unweathered, very close to moderate spaced flat to dipping cross joints, rough planar, tight to slightly altered, with green scale, minor silt on partings, locally separating on biotite concentrations, fair quality.
		C19-3	3	0.9 – 1.6	100	81	0.9 – 4.4	MIGMATITE/GRANODIORITE: Light grey, fine to medium grained, slight banding, with layers of black biotite, and black amphibolite/hornblende, high strength, slightly weathered to unweathered, close to moderate (locally very close) becoming close to wide spaced flat to dipping cross joints, rough planar, tight to slightly altered, with red oxidation or light grey scale on partings, locally separating on biotite concentrations, good to excellent quality.
			4	1.6 – 3.1	100	97		
			5	3.1 – 4.4	100	100		

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ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
18+156 Servos Township	C20	C20-1	1 2 3	0.3 – 1.4 1.4 – 3.0 3.0 – 3.5	98 100 95	91 91 95	0.3 – 3.5	MIGMATITE: Light grey to pink, fine to medium grained, slight banding, with distorted layers and/or irregular concentrations of black biotite and/or hornblende, high strength, unweathered, close to wide spaced flat to dipping cross joints, rough planar, tight to slightly altered, with red oxidation and/or minor silt on partings, locally separating on biotite concentrations, excellent quality.
		C20-2	3 4 5	1.1 – 1.7 1.7 – 3.0 3.0 – 4.3	100 95 93	100 72 59	1.1 – 4.3	GRANITIC GNEISS/MIGMATITE: Pink, fine grained (occasional medium grained layers) with green to black medium grained hornblende (possible augite), dipping bands, high strength, slightly weathered to unweathered, close to moderate spaced dipping cross joints, rough planar, slightly altered, with red to brown oxidation and/or minor silt on partings, some vertical partings, open to 0.5 mm, with brown scale and silt on parting, locally separating on biotite concentrations, fair to excellent quality.
		C20-3	1 2 3	0.5 – 1.8 1.8 – 3.3 3.3 – 4.1	92 100 100	77 98 100	0.5 – 4.1	MIGMATITE: Light grey to pink, with occasional dark grey to black dipping bands, fine grained, high strength, slightly weathered to unweathered, close to moderate (locally very close) spaced dipping cross joints, rough planar, slightly altered, with red oxidation, scale and/or minor silt on partings, some vertical partings, slightly altered with red oxidation and scale on parting, good to excellent quality.

Originated: JFW
Compiled: FP
Checked: IS / CN

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ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
18+325 Servos Township	C21	C21-1	7	4.9 – 6.4	100	87	4.9 – 7.9	MIGMATITE: Light grey with dark grey to black dipping bands/layers, fine grained, high strength, unweathered, close to moderate spaced dipping (locally flat) cross joints, rough (locally smooth) planar, slightly altered with red or black scale on partings, good quality.
			8	6.4 – 7.9	97	80		
		C21-2	7	4.1 – 4.8	96	94	4.1 – 7.6	MIGMATITE: Light grey to pink with dark grey to black dipping bands/layers, fine grained, high strength, slightly weathered to unweathered, close to very close spaced dipping (locally flat) cross joints, rough planar, slightly altered with red, black or white scale on partings, excellent, becoming fair to poor quality.
			8	4.8 – 6.3	100	66		
			9	6.3 – 7.6	92	36		
18+435 Servos Township	JUC	JUC-1	3	1.6 – 1.8	100	100	1.6 – 4.4	GRANITIC GNEISS: Pink, becoming light grey at depth, slight dipping bands, fine grained, high strength, unweathered, moderate to wide spaced flat cross joints, rough planar, tight, excellent quality.
			4	1.8 – 3.4	100	100		
			5	3.4 – 4.4	100	100		
		JUC-2	1	0.0 – 1.6	96	69	0.0 – 3.1	GRANITIC GNEISS: Pink, slight banding becoming more pronounced at depth, fine becoming fine to medium grained, high strength, unweathered, close to moderate (locally very close) spaced flat to dipping cross joints, rough planar, tight, some vertical partings, rough planar, slightly altered with red oxidation stains or silt on surface, fair to good quality.
			2	1.6 – 2.6	92	76		
			3	2.6 – 3.1	100	90		
		JUC-3	4	1.6 – 3.1	95	91	1.6 – 3.8	HORNBLENDE MIGMATITE/AMPHIBOLITE: Black, fine to medium grained, with 200 mm thick layers of light grey to white quartzite, fine grained, high strength, slightly weathered, close to moderate spaced (locally very close) flat to dipping cross joints, slightly altered with yellow oxidation and/or silt on partings, good to excellent quality.
			5	3.1 – 3.8	98	88		
			6	3.8 – 4.7	88	63		
							3.8 – 4.7	GRANITIC GNEISS: Pink and light grey, banded, fine grained, high strength, unweathered, close to moderate spaced flat cross joints, smooth planar, tight, fair quality.

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Checked: IS / CN

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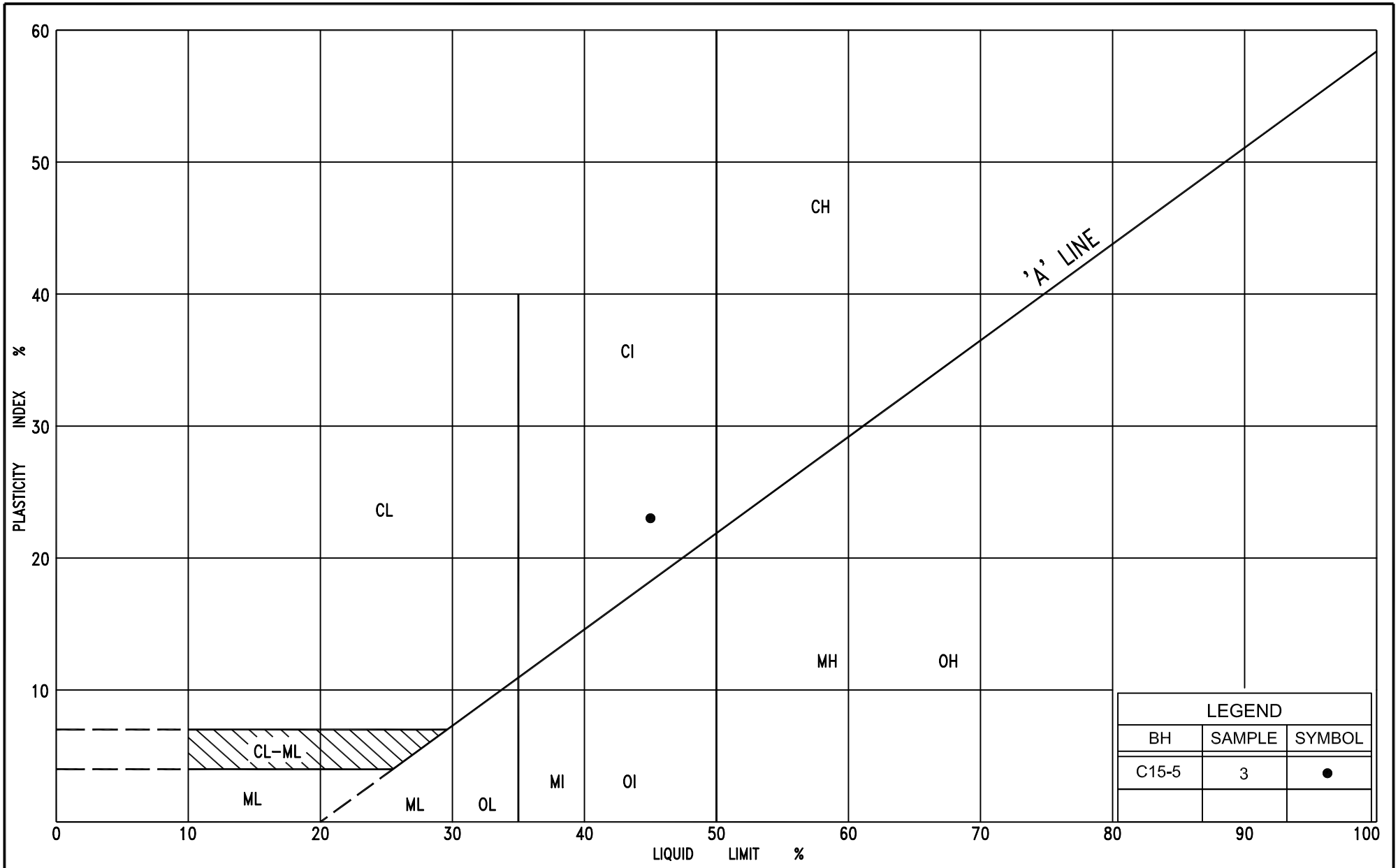
ROCK CORE DESCRIPTIONS

CULVERT LOCATION		BOREHOLE	CORE RECOVERY				CORE DESCRIPTION	
STATION	PML REF. NO.		RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
20+880 (SBL) 20+892 (NBL) Servos Township	C25	C25-1	7 8	4.6 – 6.1 6.1 – 7.6	88 100	80 93	4.6 – 7.6	MIGMATITE: Light grey, fine grained, with isolated inclusions to bands of black biotite, occasional pink feldspar, coarse crystalline, with thin veins of quartz, high strength, slightly weathered to unweathered, close to moderate (locally very close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with green, yellow or grey scale on partings, locally with silt, good to excellent quality.
		C25-1A	8 9 10	5.6 – 6.1 6.1 – 7.7 7.7 – 8.8	100 100 100	100 100 97	5.6 – 8.8	MIGMATITE: Dark grey to black, fine grained, slight banding, high strength, unweathered, close to moderate spaced flat to dipping (locally near vertical) cross joints, rough to smooth planar, tight to slightly altered with dark green to black mineralization and/or scale on partings, locally with silt, excellent quality.
		C25-3	9	6.6 – 8.1	90	73	6.6 – 9.7	MIGMATITE: Dark grey to black, fine grained, slight banding, with minor pyrite, high strength, unweathered, moderate to wide (locally close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with yellow to brown oxidation and/or white scale on partings, fair to excellent quality.

RQD = Rock Quality Designation

Originated: JFW
Compiled: FP
Checked: IS / CN

Culvert at Sta. 15+500 (SBL, NBL and Ramp S-W (Highway 637 I/C)) (C15), Servos Township



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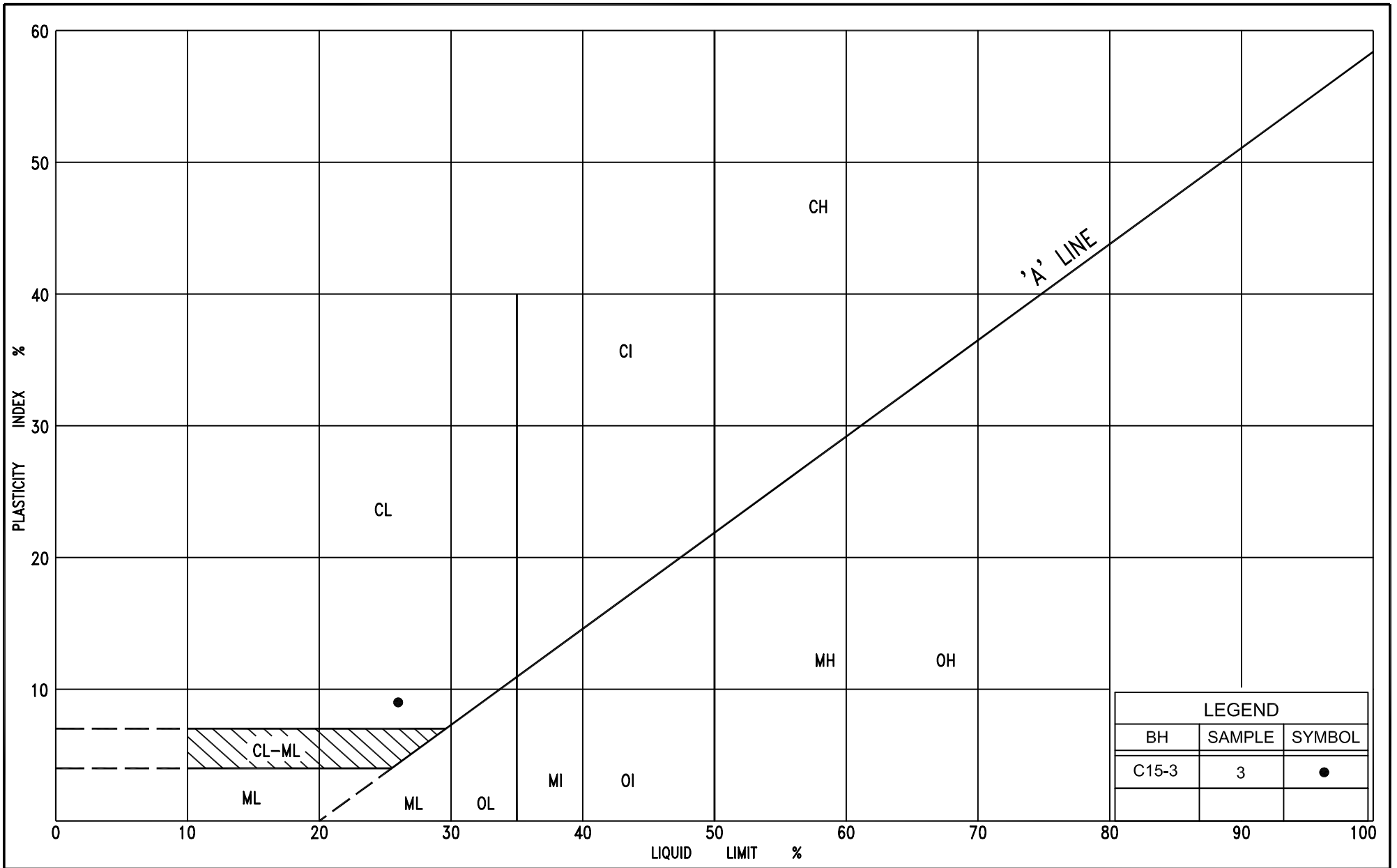
PLASTICITY CHART

SILTY CLAY, trace sand

FIG No.	C15-PC-1
HWY:	69
G.W.P. No.	5218-06-00



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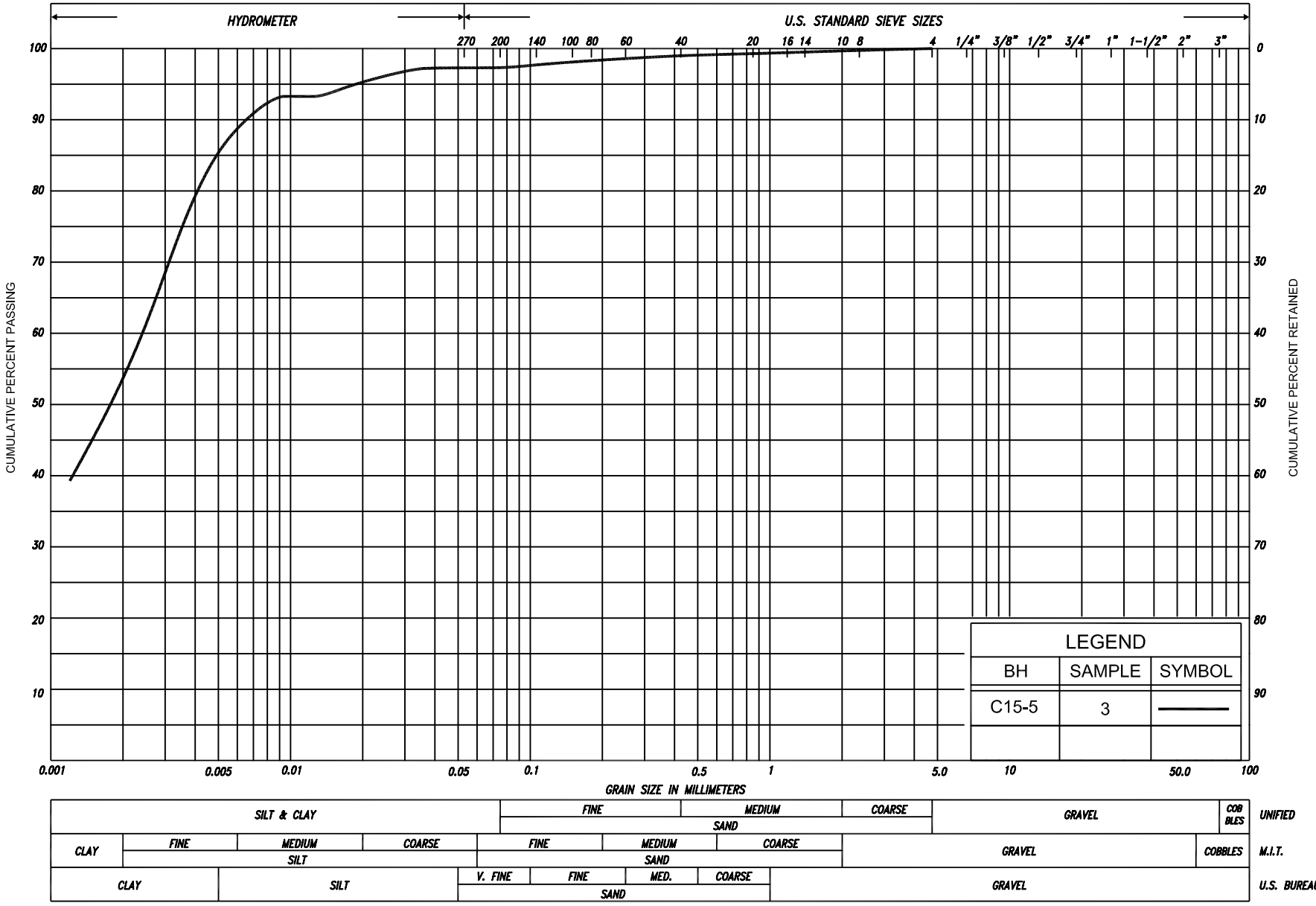
PLASTICITY CHART

CLAYEY SILT, sandy, trace gravel,

FIG No.	C15-PC-2
HWY:	69
G.W.P. No.	5218-06-00



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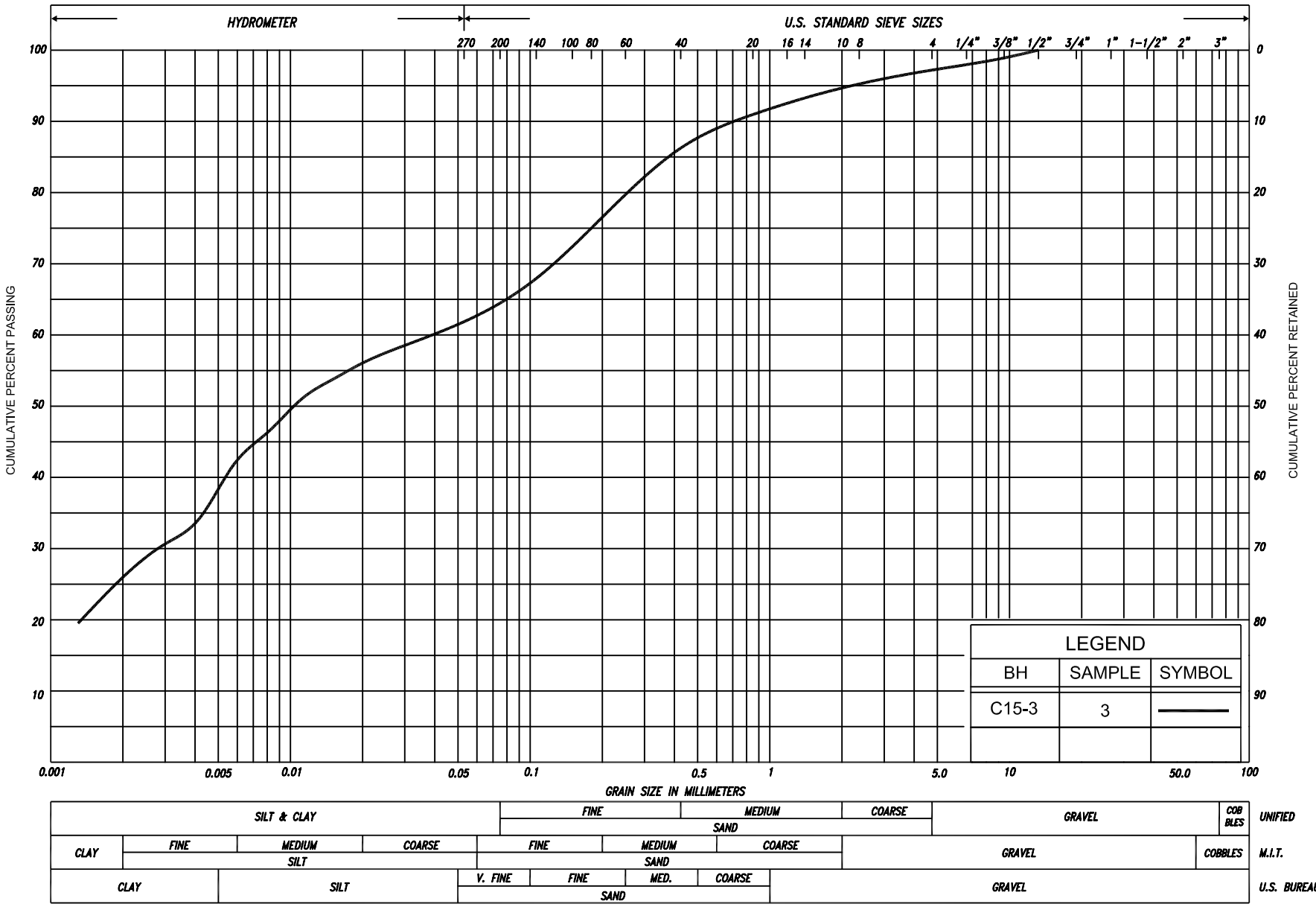
GRAIN SIZE DISTRIBUTION

SILTY CLAY, trace sand

FIG No.	C15-GS-1
HWY:	69
G.W.P. No.	5218-06-00



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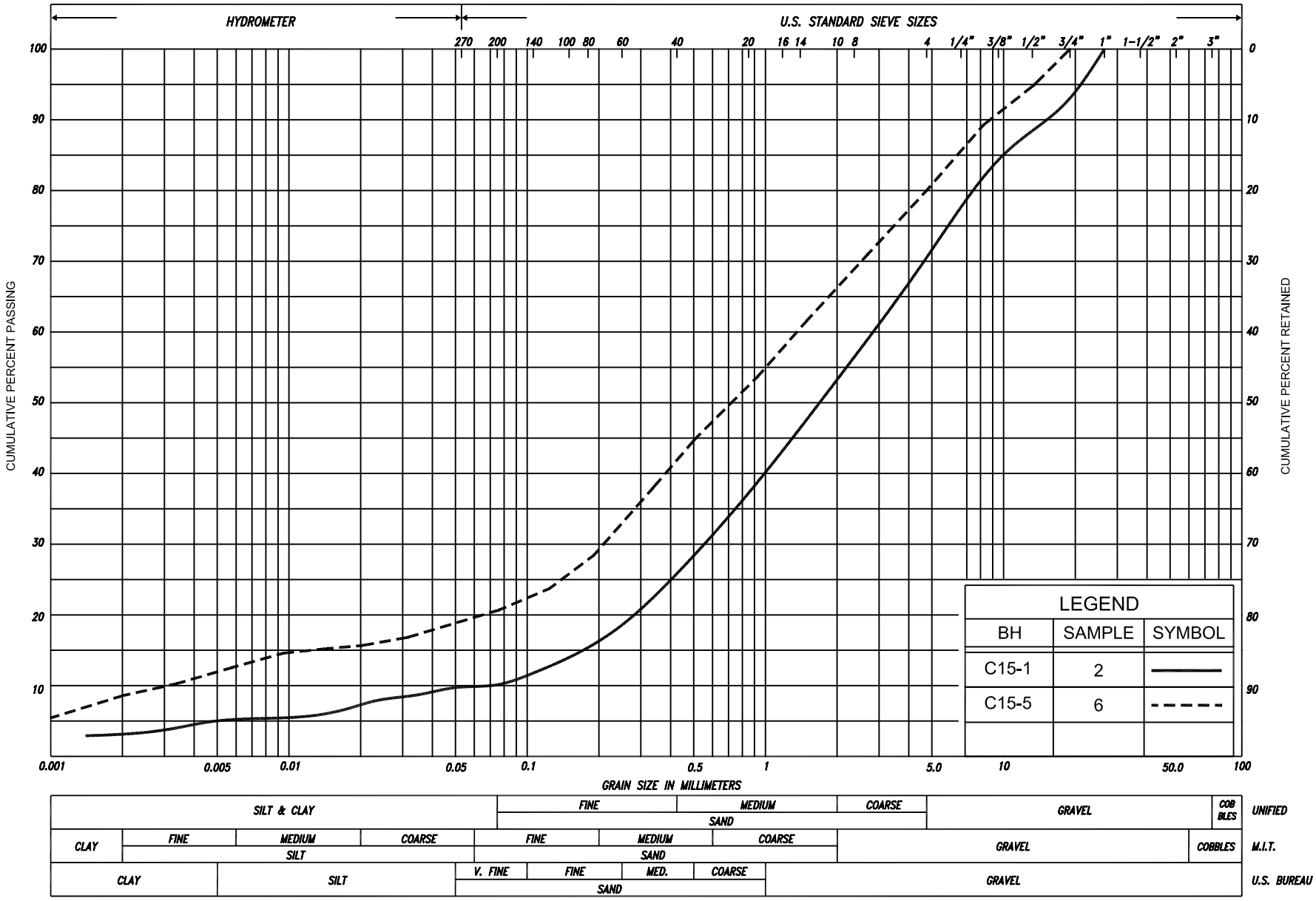
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, sandy, trace gravel,

FIG No.	C15-GS-2
HWY:	69
G.W.P. No.	5218-06-00



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GRAIN SIZE DISTRIBUTION

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

FIG No.	C15-GS-3
HWY:	69
G.W.P. No.	5218-06-00

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 $\tilde{N}$.

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
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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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Foundation Design

RECORD OF BOREHOLE No C15-1 1 of 1 METRIC

Coords: 5 120 632.0 N; 322 421.9 E

G.W.P. 5218-06-00 LOCATION Hwy 69 (New), Sta. 15+491, o/s 45.5m Lt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE December 16, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.4	Ground Surface										
0.0	Sand and gravel, trace silt organics		1	SS	8		216				
215.8	Loose Brown Moist (FILL)										
0.6	Sand, with gravel trace silt, trace clay		2	SS	20/5cm						30 60 7 3
	Very dense Brown Moist to wet						215				
	cobbles and boulders		3	SS	20/3cm						
213.7							214				
2.7	Syenite/ Granite Bedrock		4	RC NQ	REC 92%						RQD 58%
	Slightly weathered to unweathered										
	High strength		5	RC NQ	REC 98%		213				RQD 79%
	Fair to good quality										
							212				
			6	RC NQ	REC 89%						RQD 89%
210.7							211				
5.7	End of borehole										

Samples 2 and 3: sampler bouncing

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No C15-2 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 120 641.9 N; 322 447.3 E Hwy 69 (New), Sta. 15+497, o/s 18.7m Lt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.

DATUM Geodetic DATE January 10, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
216.0	Ground Surface										
0.0	Sandy silt trace clay, trace gravel cobbles Compact Brown Moist to dense		1	CS	28				○		
			2	SS	33		215		○		
214.4			3	SS	30/8cm						
1.6	End of borehole Refusal on probable bedrock Sample 3: Sampler bouncing * Borehole dry					*					

ON_MOT VER3 06TF055 CONTRACT 2.GPJ ON_MOT.GDT 5/27/2009 11:50:59 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No C15-3 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 120 648.7 N; 322 464.9 E Hwy 69 (New), Sta. 15+500 CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE December 15, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.4	Ground Surface										
0.0	Topsoil										
217.2 / 0.2	Clayey silt, sandy Stiff Brown Moist		1	SS	8		217		○		
			2	SS	11				○		
	trace gravel cobbles		3	SS	7	▽*	216		○⊢		3 32 39 26
215.6 / 1.8	Wet Syenite/ Granite Bedrock Slightly weathered High strength Poor to good quality		4	RC NQ	REC 80%						RQD 54%
			5	RC NQ	REC 93%		215				RQD 82%
			6	RC NQ	REC 69%		214				RQD 47%
			7	RC NQ	REC 90%		213				RQD 68%
211.6							212				
5.8	End of borehole										

* 2008 12 15

▽ Water level observed during drilling

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
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RECORD OF BOREHOLE No C15-4 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 120 655.7 N; 322 483.0 E Hwy 69 (New), Sta. 15+503, o/s 19.1m Rt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.

DATUM Geodetic DATE January 10, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
217.8	Ground Surface					*					
0.0	Peat, fine fibrous										
217.6	Dark brown		1	CS	6						
0.2	Sandy silt trace clay, trace gravel										
217.0							217				
0.8	Loose Brown Moist										
	End of borehole										
	Refusal on probable bedrock										

* Borehole dry

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
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RECORD OF BOREHOLE No C15-5 1 of 2 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 120 669.6 N; 322 518.9 E Hwy 69 (New), Sta. 15+509, o/s 57.0m Rt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE January 09, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
218.3	Ground Surface										
0.0 / 218.0	Topsoil		1	CS	5		218				
0.3	Silty clay, trace sand Very stiff to stiff Mottled grey/brown Moist		2	SS	16						
	Brown		3	SS	12		217	150 / 125			0 3 43 54
			4	SS	8		216				
	Firm		5	SS	3		215	6			
214.0				FV		▽	214				
4.3	Sand, with gravel some silt, trace clay Loose to very dense Grey Wet		6	SS	8						20 59 13 8
			7	SS	27		213				
			8	SS	26		212				
	Cobbles and boulders		9	SS	20/5cm		211				
208.9							210				
9.4	Migmatite Bedrock Unweathered High strength Excellent quality		10	RC NQ	REC 95%		209				RQD 95%
			11	RC NQ	REC 100%		208				RQD 100%
205.2			12	RC NQ	REC 100%		207				RQD 100%
13.1	End of borehole Sample 9: Sampler bouncing						206				

Cont'd

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No C15-5 2 of 2 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 120 669.6 N; 322 518.9 E Hwy 69 (New), Sta. 15+509, o/s 57.0m Rt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE January 09, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH 203.3	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	* 2009 01 09 ▽ Water level observed during drilling ■ Penetrometer test C.F.S.S.A. denotes Continuous Flight Solid Stem Augers										

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

METRIC

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

CONT No
GWP No 5218-06-00

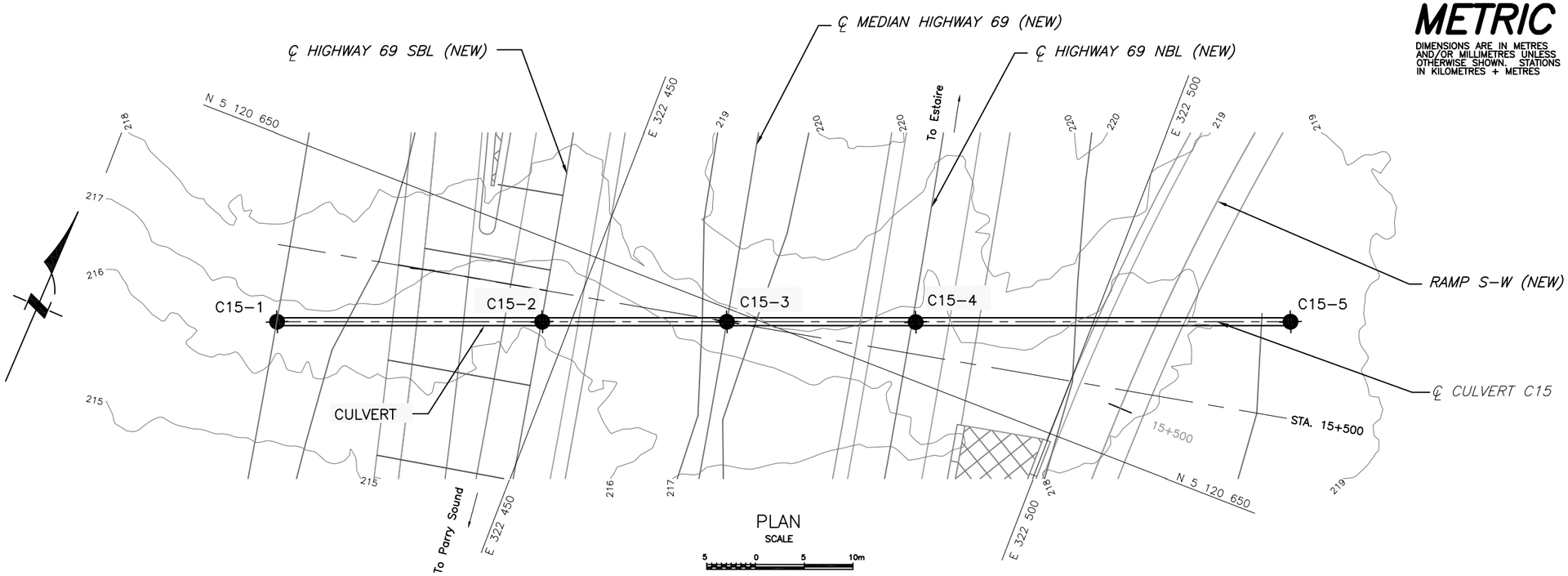
CULVERT AT STA. 15+500 (C15)

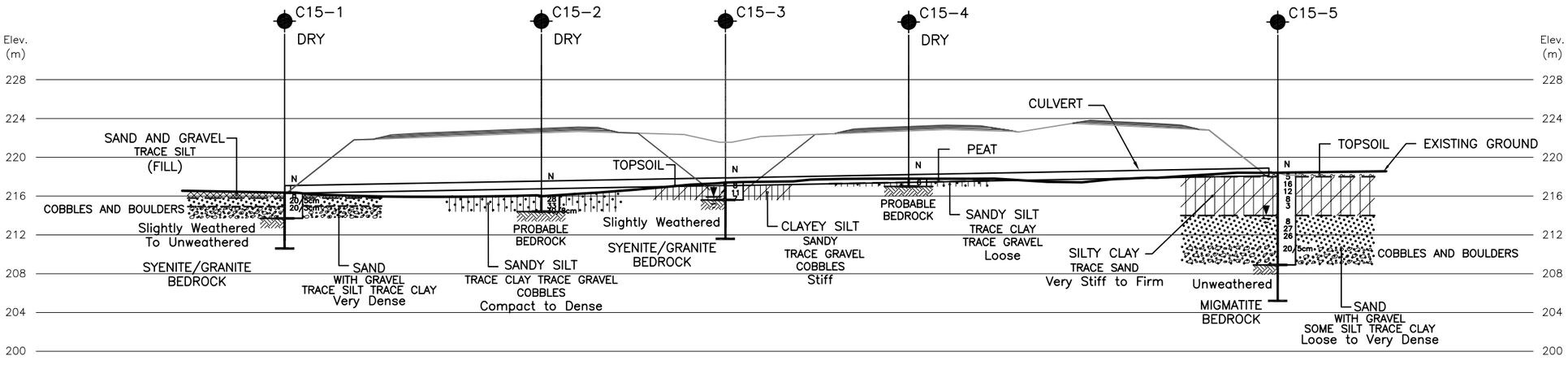
HIGHWAY 69 FOUR-LANING – SERVOS TWP

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET 2

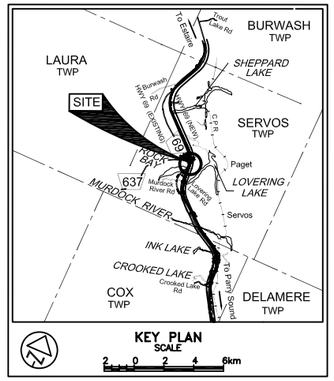
Peto MacCallum Ltd.
CONSULTING ENGINEERS





PROFILE ℄ CULVERT AT STA. 15+500 (C15)

SCALE
5 0 5 10m



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)
- W L at time of investigation Dec 2008 and Jan 2009
- Head ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	COORDINATES EASTINGS
C15-1	216.4	5 120 632.0	322 421.9
C15-2	216.0	5 120 641.9	322 447.3
C15-3	217.4	5 120 648.7	322 464.9
C15-4	217.8	5 120 655.7	322 483.0
C15-5	218.3	5 120 669.6	322 518.9

NOTES:

1. CULVERT AT STA. 15+500 WAS DESIGNATED C15 BY PML.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REGISTERED PROFESSIONAL ENGINEER — C M P Nascimento — MAY 27 '09 — PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER — B. R. GRAY — MAY 27, 2009 — PROVINCE OF ONTARIO

REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and C2-CULVERT-XS-15+500-SERVOS.dwg; Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

– NOTE –

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

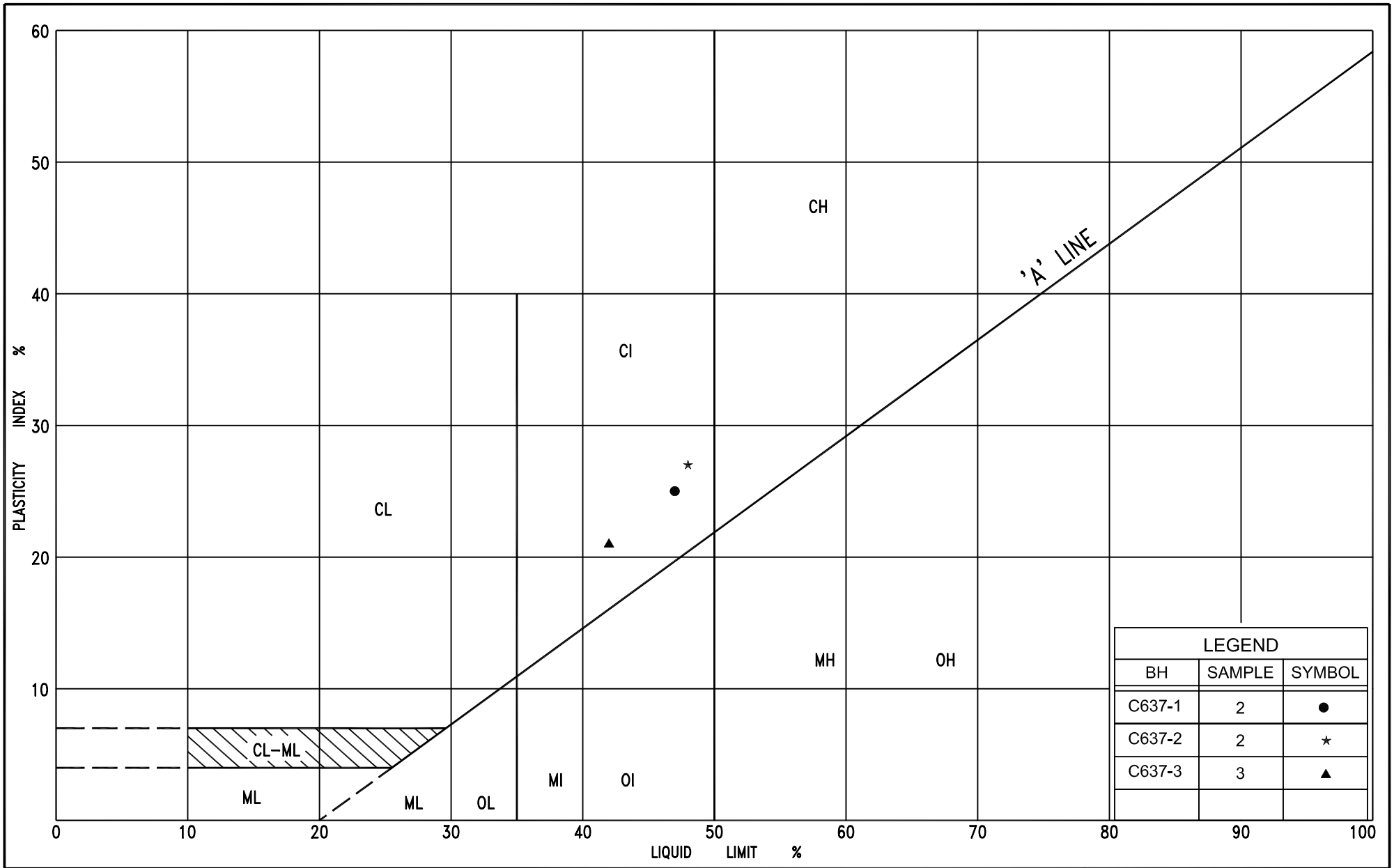
REVISIONS

DATE	BY	DESCRIPTION

Geocres No. 41I-235

HWY No	69			DIST	54
SUBM'D	AS	CHECKED	AS	SITE	--
DRAWN	NA	CHECKED	CN	DWG	C15
		APPROVED	BRG	DATE	MAY 27, 2009

Culvert at Sta. 10+180 Ramp S-W and Ramp W-N (Highway 637) (C637), Servos Township



Ministry of Transportation
Ontario

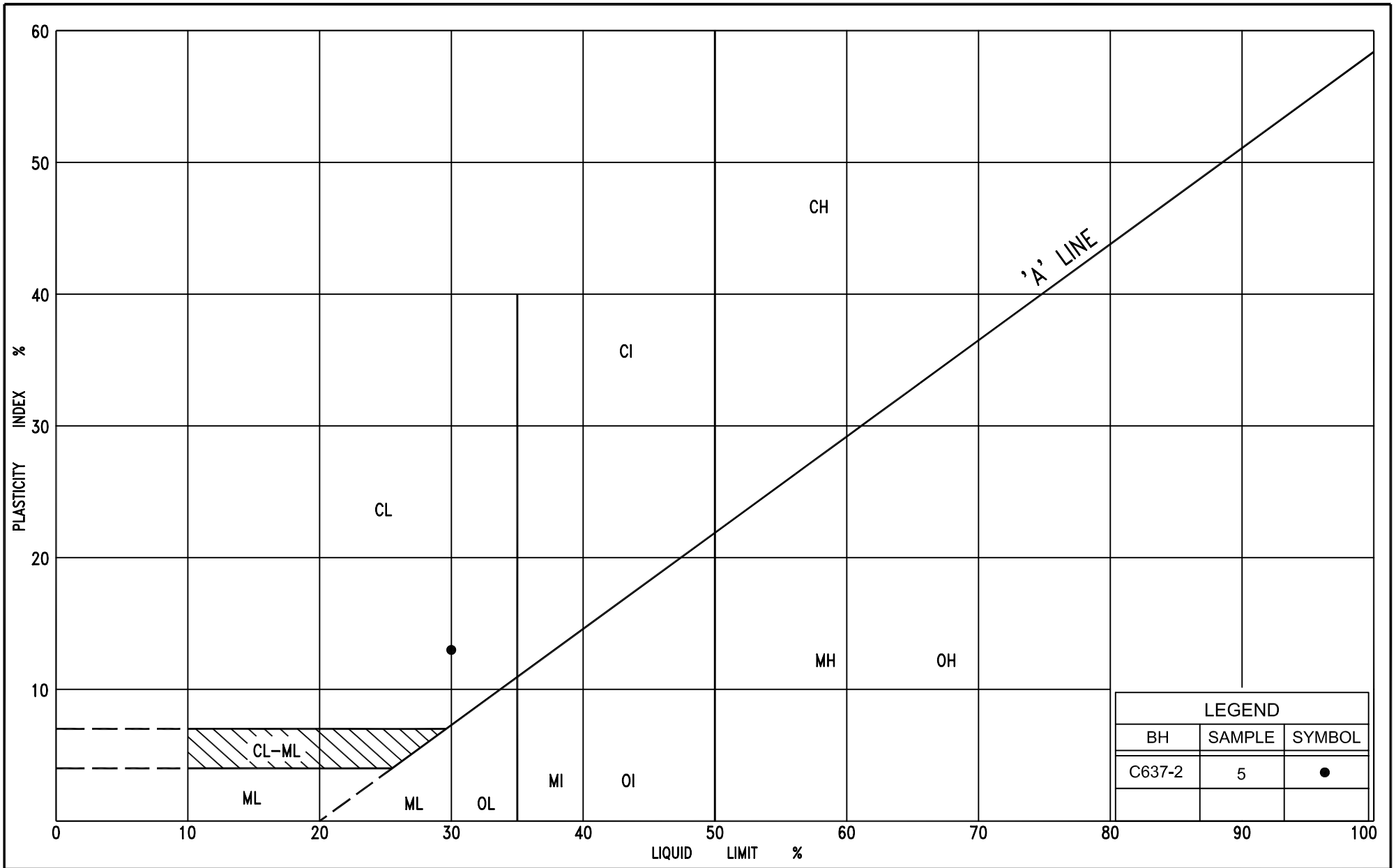
PLASTICITY CHART

SILTY CLAY, trace to some sand, trace gravel

FIG No. C637-PC-1

HWY: 69

G.W.P. No. 5218-06-00



Ministry of Transportation
Ontario

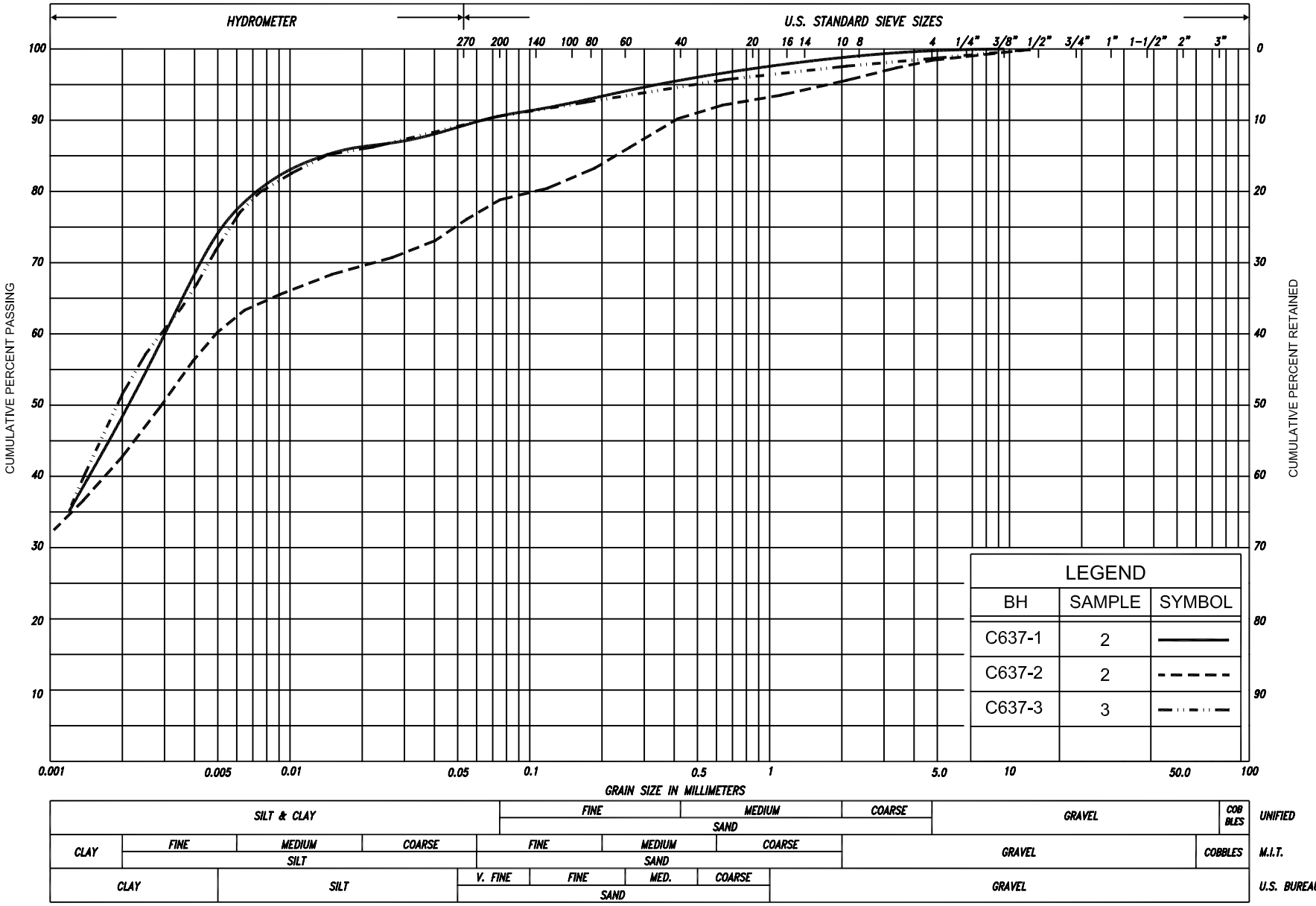
PLASTICITY CHART

CLAYEY SILT, some sand, trace gravel

FIG No. C637-PC-2

HWY: 69

G.W.P. No. 5218-06-00

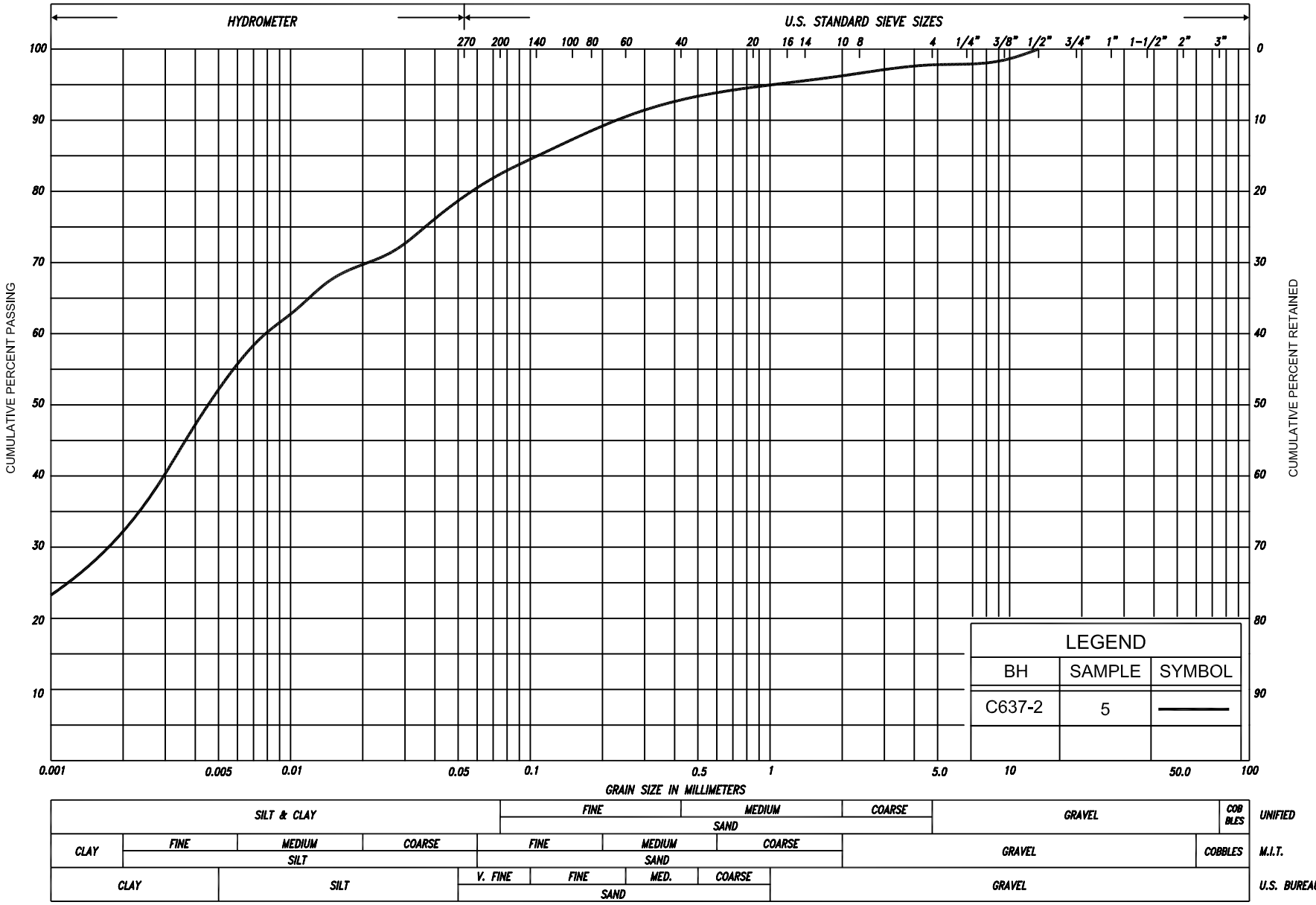


Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, trace to some sand, trace gravel

FIG No.	C637-GS-1
HWY:	69
G.W.P. No.	5218-06-00



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GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand, trace gravel

FIG No.	C637-GS-2
HWY:	69
G.W.P. No.	5218-06-00

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 $\tilde{N}$.

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
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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No C637-1 1 of 1 METRIC

Coords: 5 121 055.5 N; 322 510.3 E

G.W.P. 5218-06-00 LOCATION Hwy 69 (New), Sta. 10+180, o/s 20.0m Lt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE January 08, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.5	Ground Surface										
0.0	Peat, coarse fibrous										
230.3	Dark brown		1	CS	2		230				
0.2	Organic silty clay										
229.9	Very soft Dark Moist brown										
0.6	Silty clay trace sand, trace gravel		2	SS	9						1 8 43 48
	Stiff Mottled Moist grey/brown		3	SS	11		229	125 ■	○		
	cobbles and boulders										
227.9							228				
2.6	Granodiorite Bedrock		4	RC NQ	REC 100%				○		RQD 33%
	Slightly weathered to unweathered										
	Medium strength						227				
	Poor to excellent quality		5	RC NQ	REC 100%						RQD 100%
							226				
			6	RC NQ	REC 97%						RQD 88%
224.4							225				
6.1	End of borehole										

* 2009 01 08

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE (20 / 15 5 / 10)

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No C637-2 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 121 075.1 N; 322 513.1 E Hwy 69 (New), Sta. 10+180 CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE January 06, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.5	Ground Surface										
0.0 / 230.0	Peat, fine fibrous Dark brown		1	CS	-		230				
0.5	Silty clay some sand, trace gravel Firm to stiff Mottled Moist grey/brown		2	SS	4						2 19 36 43
	trace gravel Brown Grey		3	SS	7		229	125			
227.4			4	SS	8		228				
3.1	Clayey silt some sand, trace gravel Stiff Grey Moist		5	SS	4						2 16 50 32
225.3				FV			227	8			
5.2	Granodiorite Bedrock Moderate to slightly weathered Medium to high strength Very poor to fair quality		6	RC NQ	REC 88%		226				RQD 72%
			7	RC NQ	REC 80%		225				RQD 0%
			8	RC NQ	REC 36%		224				RQD 0%
			9	RC NQ	REC 94%		223				RQD 69%
			10	RC NQ	REC 95%		222				RQD 64%
221.4											
9.1	End of borehole										

* Borehole dry

■ Penetrometer test

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No C637-3 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 121 096.1 N; 322 516.1 E Hwy 69 (New), Sta. 10+180, o/s 21.2m Rt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE January 06, 2009 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
230.6	Ground Surface										
0.0 / 230.3	Peat, fine fibrous Dark brown		1	SS	3		230				
0.3	Silty clay trace sand, trace gravel Stiff Mottled Moist grey/brown		2	SS	10						
	Brown		3	SS	8		229				2 7 39 52
	Firm Grey		4	SS	5	▽*	228				
	sand trace gravel layers Grey wet		5	SS	20/3cm						
	cobbles and boulders						227				
			6	SS	10/8cm		226				
225.1											
5.5	Biotite Migmatite Bedrock										
224.7 / 5.9	Slightly weathered to unweathered		7	RC NQ	REC 81%		225				RQD 71%
	Medium strength Fair quality						224				
	Granodiorite Bedrock Unweathered High strength Excellent quality		8	RC NQ	REC 100%						RQD 100%
			9	RC NQ	REC 53%		223				
221.6							222				RQD 53%
9.0	End of borehole										

Samples 5 and 6: Sampler bouncing

RC 9: Bottom 420mm of rock core lost in borehole.

* 2009 01 06

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

METRIC

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

CONT No

GWP No 5218-06-00

CULVERT AT STA. 10+180 (C637)

HIGHWAY 69 FOUR-LANING/HWY 637 - SERVOS TWP

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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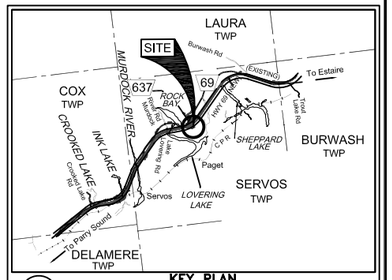
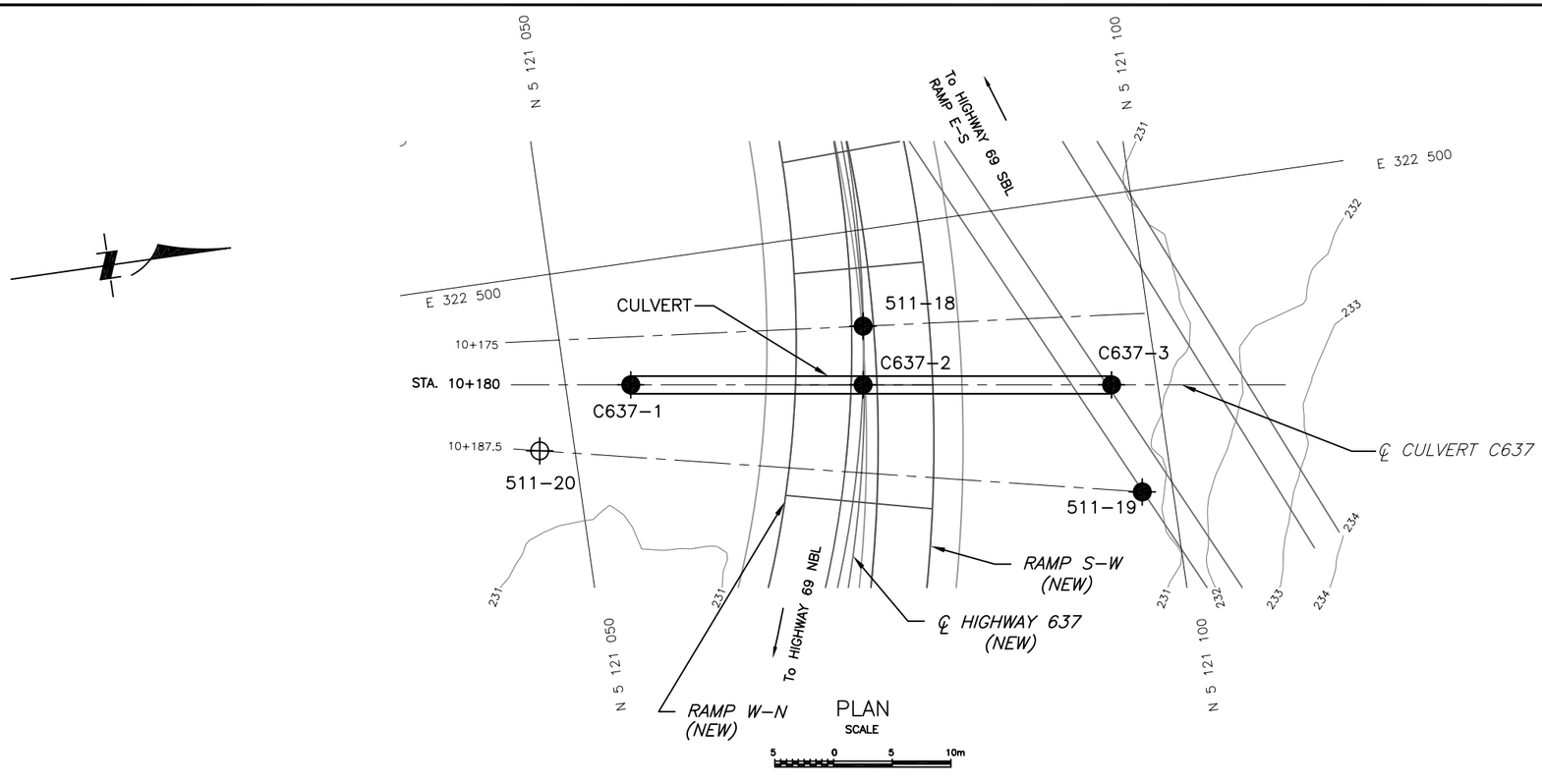
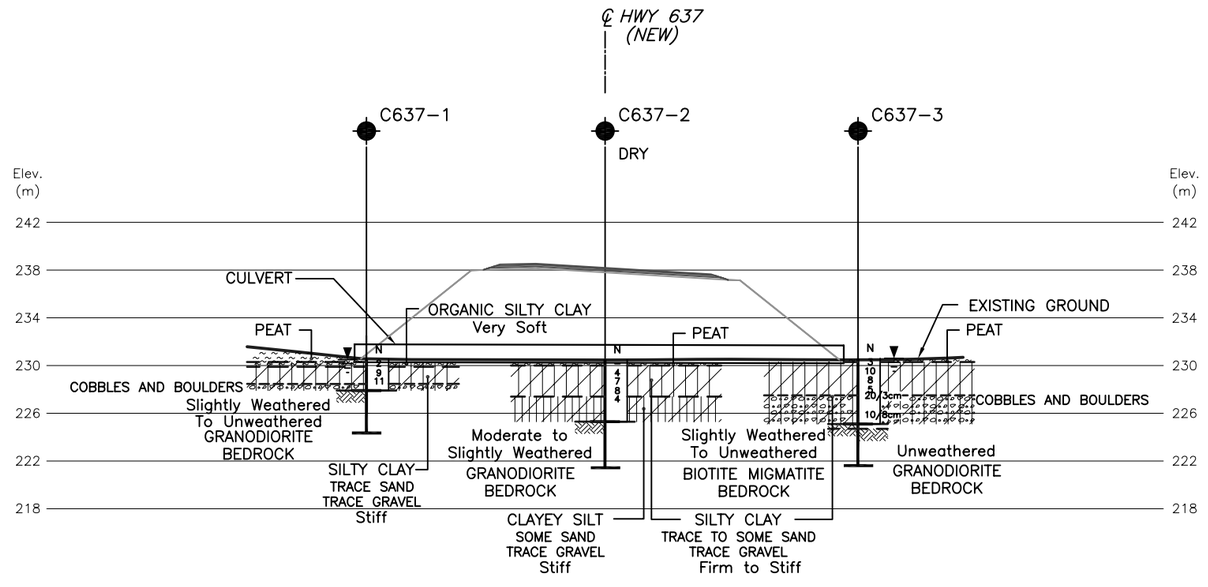






PROFILE ℄ CULVERT AT STA. 10+180 HWY 637 (C637)

SCALE
5 0 5 10m

NOTES:

1. CULVERT AT STA. 10+180 HIGHWAY 637 WAS DESIGNATED C637 BY PML.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

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)
- W L at time of investigation Jan 2009
- 500 Series Feb 2008
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	EASTINGS
C637-1	230.5	5 121 055.5	322 510.3
C637-2	230.5	5 121 075.1	322 513.1
C637-3	230.6	5 121 096.1	322 516.1

BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
511-18	230.5	10+175	CL
511-19	231.2	10+187.5	24.0m Lt.
511-20	230.6	10+187.5	27.5m Rt.

- NOTE -

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

REGISTERED PROFESSIONAL ENGINEER — C M P Nascimento — PROVINCE OF ONTARIO — MAY 27

REGISTERED PROFESSIONAL ENGINEER — B. R. GRAY — MAY 27, 2009 — PROVINCE OF ONTARIO

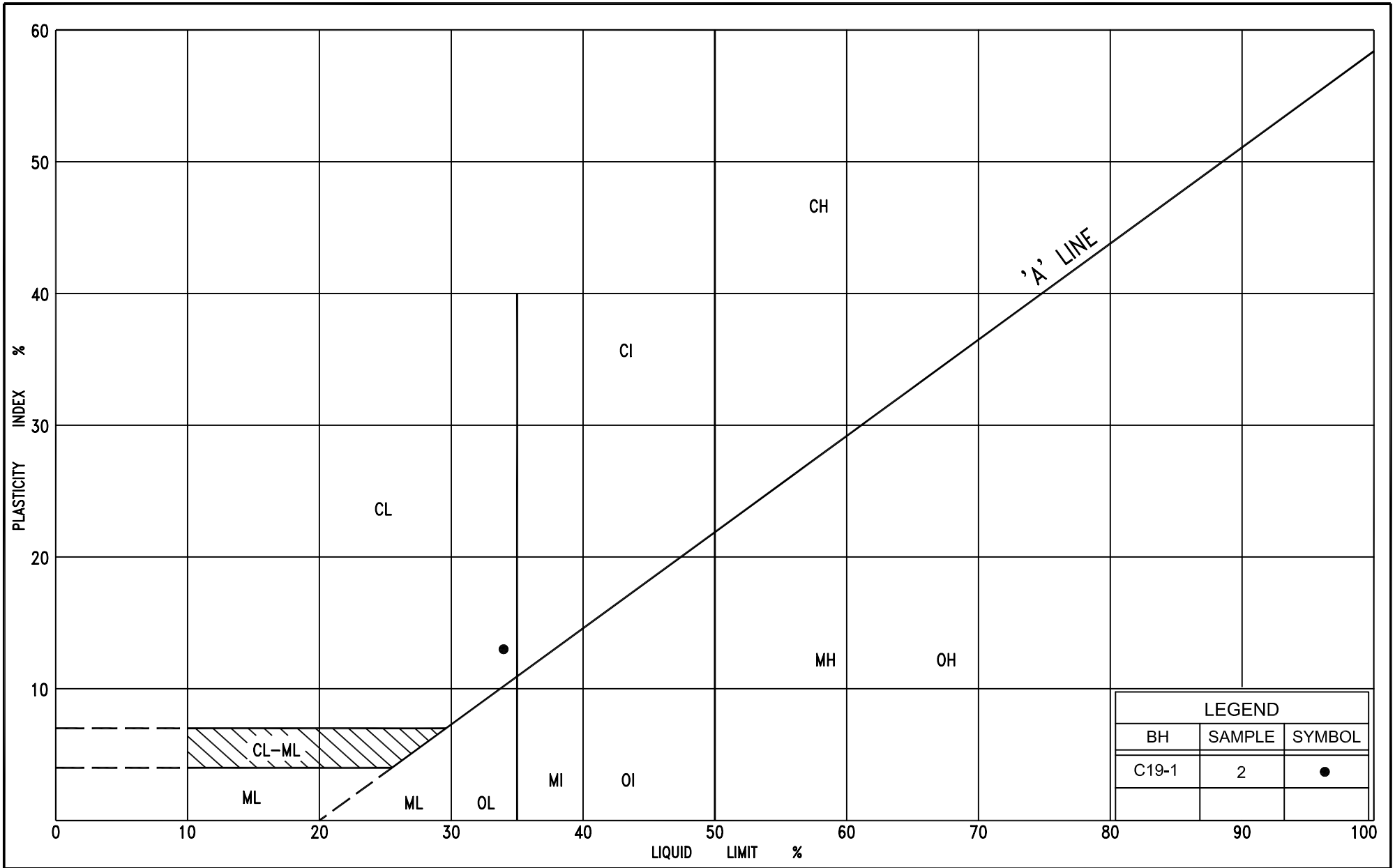
REF No.: TSH DRAWINGS C2-HWY69-DES.dwg and C2-CULVERT-XS-HWY 637-10+180.dwg; Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No. 41I-235

HWY No	69			DIST	54
SUBM'D	AS	CHECKED	AS	DATE MAY 27, 2009	SITE --
DRAWN	NA	CHECKED	CN	APPROVED BRG	DWG C637

Culvert at Sta. 17+580 (SBL and NBL) (C19), Servos Township



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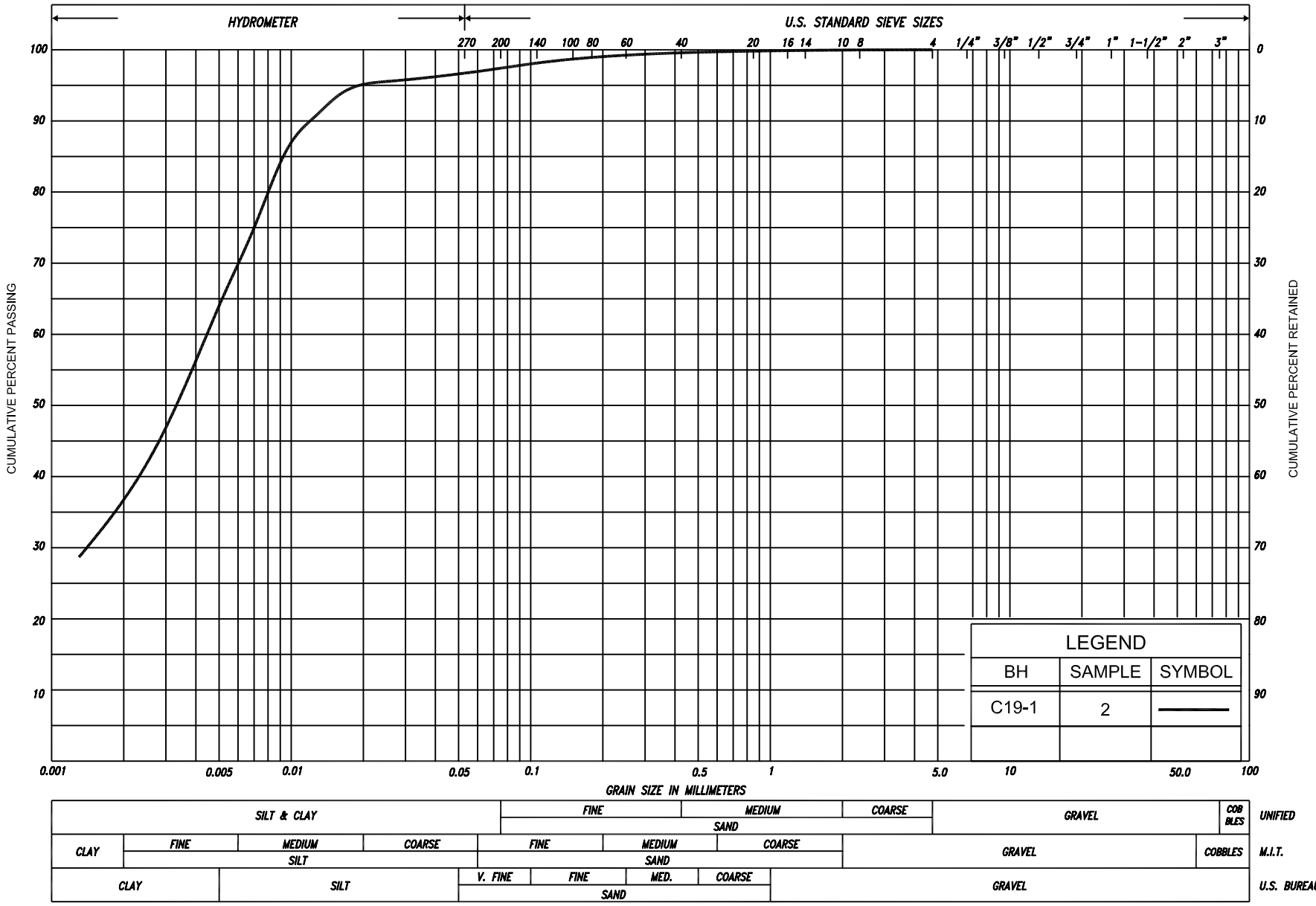
PLASTICITY CHART

CLAYEY SILT, trace sand

FIG No.	C19-PC-1
HWY:	69
G.W.P. No.	5218-06-00



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GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand

FIG No.	C19-GS-1
HWY:	69
G.W.P. No.	5218-06-00

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 $\tilde{N}$.

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
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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

Ministry of Transportation
Ontario

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Foundation Design

RECORD OF BOREHOLE No C19-1 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 208.7 N; 321 168.8 E Hwy 69 (New), Sta. 17+580, o/s 43.5m Lt. CL ORIGINATED BY J.H.

DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE November 12, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
224.2 / 0.0	Ground Surface										
224.1 / 0.1	Topsoil										
	Clayey silt, trace sand Firm Grey/brown Moist		1	SS	5	▼*	224		○		
			2	SS	7		223		⊣○		0 3 60 37
222.3			3	SS	20/13cm				○		
1.9	Migmatite Bedrock Unweathered High strength Excellent quality		4	RC NQ	REC 98%		222				RQD 98%
			5	RC NQ	REC 98%		221 220				RQD 98%
219.1 / 5.1	End of borehole										

* 2008 11 12

▼ Water level measured after drilling

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

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Foundation Design

RECORD OF BOREHOLE No C19-2 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 240.9 N; 321 198.1 E Hwy 69 (New), Sta. 17+580 CL ORIGINATED BY J.H.

DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE November 11, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
223.9	Ground Surface										
0.0 / 223.6	Silt some sand, trace gravel Dark Moist brown		1	SS	10/13cm	*			○		
0.3	Granitic Gneiss Bedrock Unweathered High strength excellent quality		2	RC NQ	REC 100%		223				RQD 97%
			3	RC NQ	REC 100%		222				RQD 100%
	Migmatite Bedrock Unweathered High strength Fair quality		4	RC NQ	REC 89%		221				RQD 68%
219.8							220				
4.1	End of borehole										

Sample 1: sampler bouncing

* Borehole dry

C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No C19-3 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 276.7 N; 321 230.8 E Hwy 69 (New), Sta. 17+580, o/s 48.5m Rt. CL ORIGINATED BY J.H.

DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE November 13 & 17, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
221.2	Ground Surface										
0.0	Clayey silt, trace sand organics Very soft Dark brown Wet		1	SS	1		221		○		
220.3	Grey Moist		2	SS	15/3cm				○		
0.9	Migmatite/ Granodiorite Bedrock Slightly weathered to unweathered High strength Good to excellent quality		3	RC NQ	REC 100%		220				RQD 81%
			4	RC NQ	REC 100%		219				RQD 97%
			5	RC NQ	REC 100%		218				RQD 100%
216.8							217				
4.4	End of borehole										

Sample 2: sampler bouncing

* 2008 11 17

▽ Water level observed during drilling

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

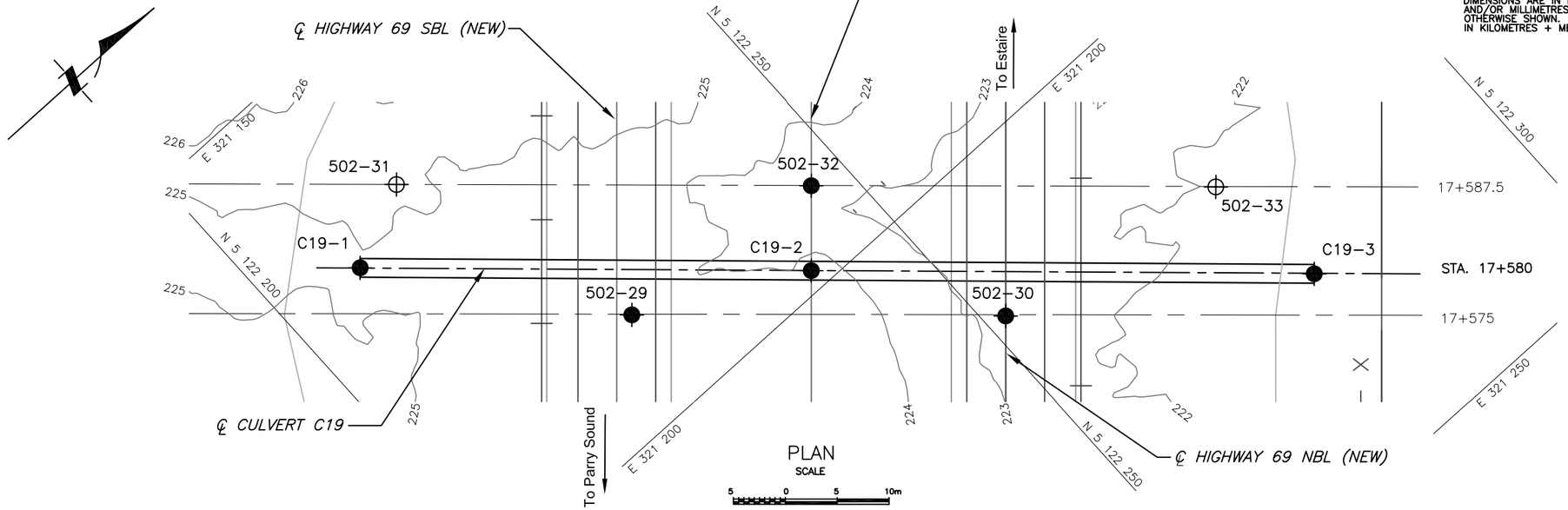
+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

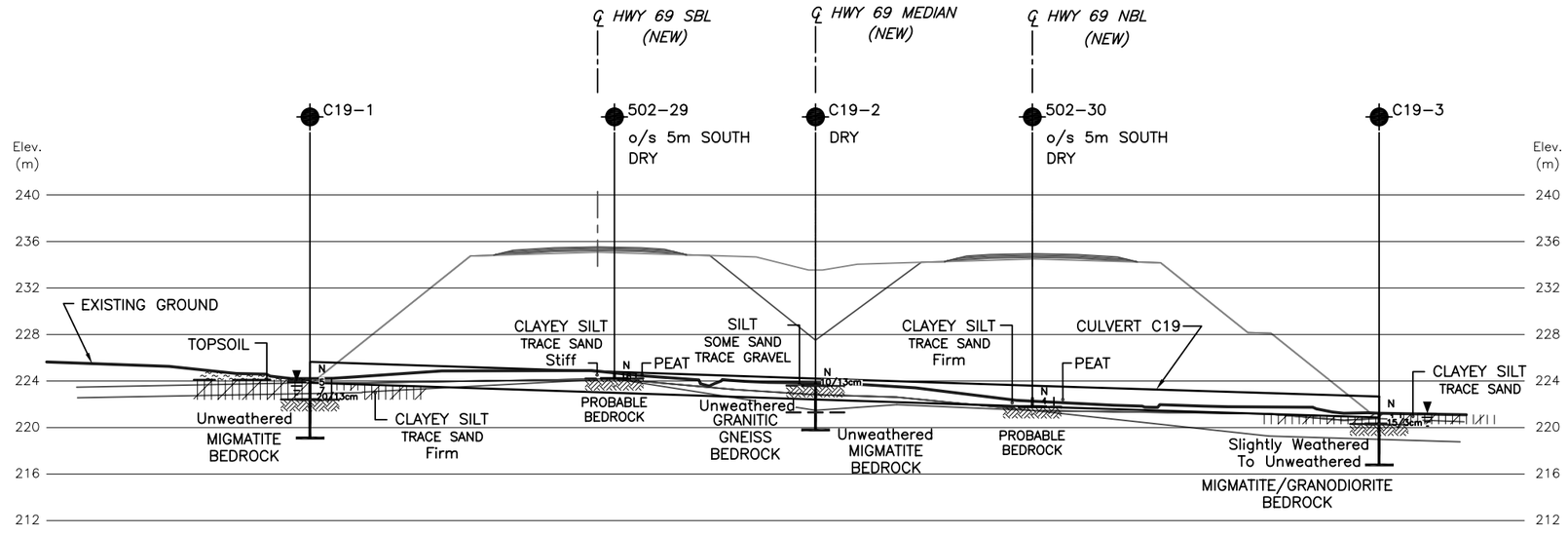
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 5218-06-00
CULVERT AT STA. 17+580 (C19)
HIGHWAY 69 FOUR-LANING – SERVOS TWP
BOREHOLE LOCATIONS AND SOIL STRATA
SHEET

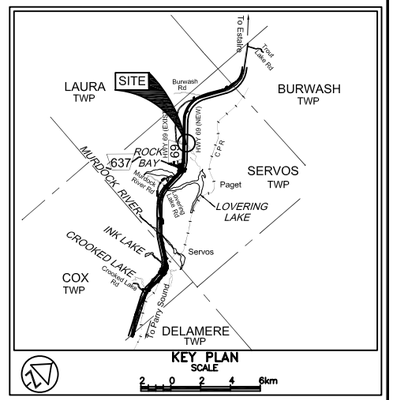
Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN
SCALE 5 0 5 10m



PROFILE ℄ CULVERT AT STA. 17+580 (C19)
SCALE 5 0 5 10m



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)
▼	W L at time of investigation Nov 2008
▽	500 Series Feb 2007
▽	Head
▽	ARTESIAN WATER
▽	Encountered
▮	PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	EASTINGS
C19-1	224.2	5 122 208.7	321 168.8
C19-2	223.9	5 122 240.9	321 198.1
C19-3	221.2	5 122 276.7	321 230.8

BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
502-29	224.7	17+575	17.3m Lt.
502-30	222.6	17+575	18.8m Rt.
502-31	226.1	17+587.5	40.0m Lt.
502-32	223.6	17+587.5	CL
502-33	221.9	17+587.5	39.0m Rt.

NOTES:

1. CULVERT AT STA. 17+580 WAS DESIGNATED C19 BY PML.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento May 27 09 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY May 27, 2009 PROVINCE OF ONTARIO

– 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

REF No.: TSH DRAWINGS C2-CULVERT-XS-17+580-SERVOS and C2-HWY69-DES.dwg; Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;

Geocres No. 41I-235

HWY No	69					DIST	54
SUBM'D	AS	CHECKED	AS	DATE	MAY 27, 2009	SITE	--
DRAWN	NA	CHECKED	CN	APPROVED	BRG	DWG	C19

Culvert at Sta. 18+156 (SBL and NBL) (C20), Servos Township

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 $\tilde{N}$.

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.

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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.

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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
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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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Ontario

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RECORD OF BOREHOLE No C20-1 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 599.2 N; 320 741.7 E Hwy 69 (New), Sta. 18+158, o/s 39.0m Lt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE November 28, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
221.4	Ground Surface										
0.0 / 221.1	Topsoil										
0.3	Migmatite Bedrock Unweathered High strength Excellent quality		1	RC NQ	REC 98%		221				RQD 91%
			2	RC NQ	REC 100%		220				RQD 91%
217.9			3	RC NQ	REC 95%		219				RQD 95%
3.5	End of borehole						218				

* Borehole charged with drilling water

ON_MOT VER3 06TF055 CONTRACT 2.GPJ ON_MOT.GDT 5/27/2009 12:20:52 PM

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

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RECORD OF BOREHOLE No C20-2 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 626.6 N; 320 769.6 E Hwy 69 (New), Sta. 18+156 CL ORIGINATED BY J.H.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE November 18, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
219.3	Ground Surface										
0.0	Silty sand Loose to compact Brown/ dark brown Moist		1	SS	9		219				
218.2	some gravel, trace clay		2	SS	20						
1.1	Granitic Gneiss/Migmatite Bedrock Slightly weathered to unweathered High strength Fair to excellent quality		3	RC NQ	REC 100%		218				RQD 100%
			4	RC NQ	REC 95%		217				RQD 72%
			5	RC NQ	REC 93%		216				RQD 59%
215.0							215				
4.3	End of borehole										

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+, ×: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No C20-3 1 of 1 METRIC

G.W.P. 5218-06-00 LOCATION Coords: 5 122 657.3 N; 320 800.9 E Hwy 69 (New), Sta. 18+153, o/s 43.8m Rt. CL ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. and Rotary Diamond Drilling COMPILED BY A.S.

DATUM Geodetic DATE December 02, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.6	Ground Surface										
0.0 / 214.1	Peat, fine fibrous Dark brown										
0.5	Migmatite Bedrock Slightly weathered to unweathered High strength Good to excellent quality		1	RC NQ	REC 92%		214				RQD 77%
			2	RC NQ	REC 100%		213				RQD 98%
210.5			3	RC NQ	REC 100%		212				RQD 100%
4.1	End of borehole						211				

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers

+ , × : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

METRIC

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

CONT No
GWP No 5218-06-00

CULVERT AT STA. 18+156 (C20)

HIGHWAY 69 FOUR-LANING – SERVOS TWP

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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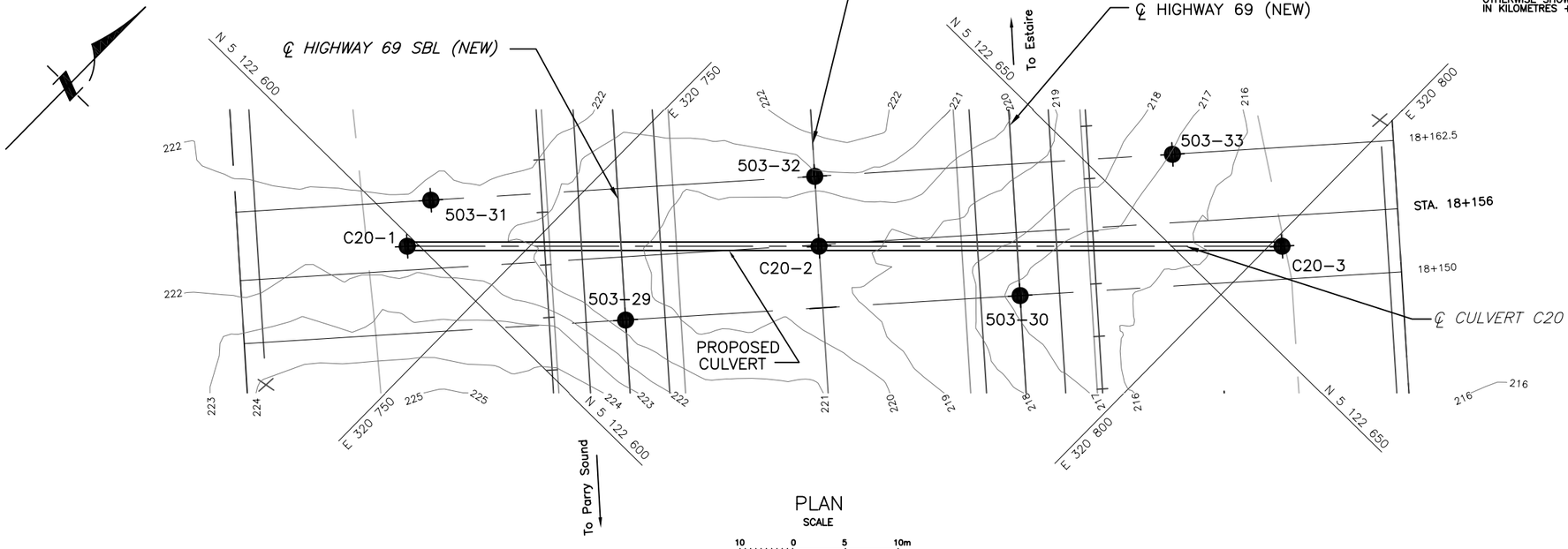
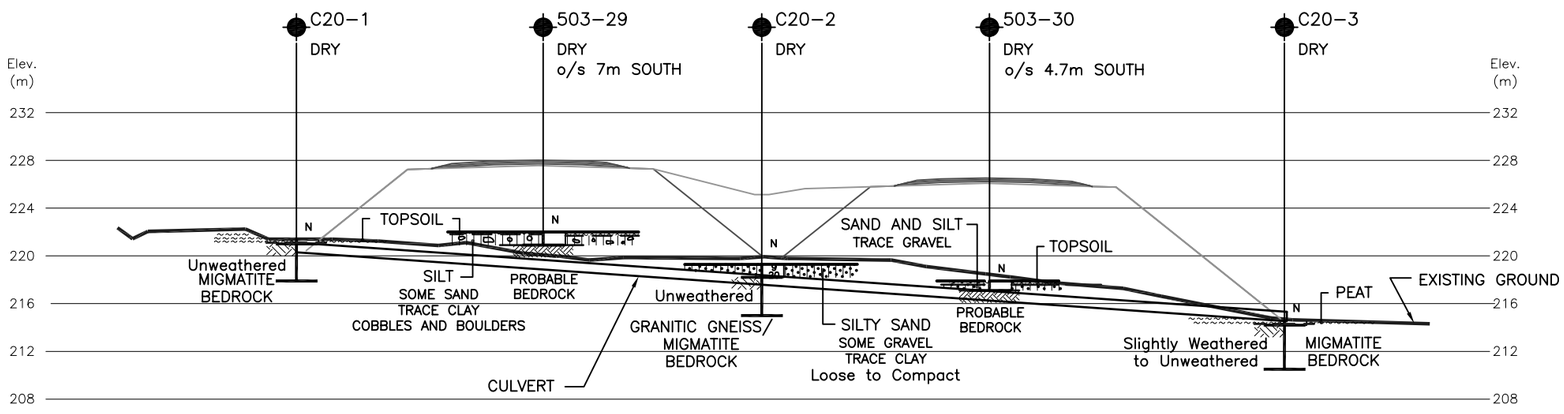
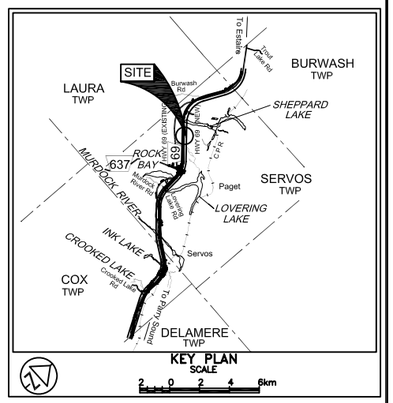
CONSULTING ENGINEERS





PROFILE ℄ CULVERT AT STA. 18+156 (C20)

SCALE
10 0 5 10m



KEY PLAN
SCALE
2 0 2 4 6km

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)
- W L at time of investigation Nov–Dec 2008 500 Series Dec 2006 and Apr 2007
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	EASTINGS
C20-1	221.4	5 122 599.2	320 741.7
C20-2	219.3	5 122 626.6	320 769.6
C20-3	214.6	5 122 657.3	320 800.9

BH No	ELEVATION	STA SERVOS TWP	o/s CL MED
503-29	222.0	18+150	18.8m Lt.
503-30	217.9	18+150	18.8m Rt.
503-31	222.2	18+162.5	36.5m Lt.
503-32	220.5	18+162.5	CL
503-33	216.7	18+162.5	34.0m Rt.

REGISTERED PROFESSIONAL ENGINEER — C M P Nascimento — May 27 '09 — PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER — B. R. GRAY — MAY 27, 2009 — PROVINCE OF ONTARIO

– 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. 41I-235

HWY No	69					DIST	54
SUBM'D	AS	CHECKED	AS	DATE	MAY 27, 2009	SITE	--
DRAWN	NA	CHECKED	CN	APPROVED	BRG	DWG	C20

NOTES:

1. CULVERT AT STA. 18+156 WAS DESIGNATED C20 BY PML.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No.: TSH DRAWINGS C2-CULVERT-XS-18+156-SERVOS.dwg and C2-HWY69-Des.dwg Received on October 07, 2008; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007;