

December 2, 2009

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**GEOCRES No.: 41H-75**

Mr. Francois Doyon, P. Eng.  
Assistant Project Manager  
McCormick Rankin Corporation  
2655 North Sheridan Way  
Mississauga Ontario  
L5K 2P8

Dear Mr. Doyon

**Memorandum**  
**Swamp 310 Swamp Crossing**  
**Highway 69 Four Laning**  
**From 3.8 km North of Highway 522 to 10.7 km North of Highway 522**  
**Township of Mowat**  
**G.W.P. 5203-06-00**  
**District 54, Sudbury, Ontario**

This document provides foundation engineering comments concerning swamp 310. A draft report on the Phase 3 swamps was issued in November 2008. At the time, investigations for swamp 310 were limited to the section from Sta. 13+400 to 13+450 SBL/NBL with 14 test holes completed. It was requested by MTO that the foundation investigations for Highway 69 SBL be extended beyond the project limit southerly to Sta. 13+150.

The contents of this memorandum will be incorporated in the Final Report for the swamps and high fill crossings for the project.

A total of 27 test holes comprising 20 boreholes and 7 dynamic cone penetration tests were carried out in swamp 310 that extends from Sta. 13+150 to 13+450 (southbound lanes) and from Sta. 13+400 to 13+450 (northbound lanes) in the Township of Mowat, new Highway 69 chainage. In addition, three boreholes and four dynamic cone penetration tests previously carried out in the swamp by Trow Associates Ltd. were also considered. The records of the test holes for the project are attached.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised embankment fill and/or peat / topsoil overlying a cohesive deposit of clay / silty clay / clayey silt underlain by cohesionless silty/sandy soils extending to bedrock. Cobbles and boulders were encountered in 6 boreholes. The bedrock surface was contacted at depths of 1.9 to 19.5 m. Groundwater was at elevation 193.2 to 195.2 upon completion of drilling. Referring to the draft borehole logs and plan attached, we note the following:

- Fill was present in boreholes 310-2, 310-8, 310-12 and 310-14 drilled on or at the existing highway. This unit was composed of topsoil, sand and gravel, gravelly sand, sand and had a thickness of 1.4 to 4.3 m. It is noteworthy that cobbles and boulders were encountered in the embankment fill at 1.4 m depth (elevation 194.7 and 194.9) in boreholes 310-2 and 310-8. The unit was loose to dense (SPT-'N' values of 7 to 35) and extended to elevation 191.8 to 194.6. The results of grain size distribution analysis performed on a sample of the sand and gravel fill are presented in Figure 310-GS-1. The sample had a moisture content of about 7%.



- A deposit of peat was present surficially in 16 boreholes (covered with some 300 mm of ice/snow in borehole 310-9) and revealed below the embankment fill at a depth of 4.3 m (elevation 191.8) in borehole 310-2. The fine to coarse fibrous / amorphous peat was 0.3 to 4.8 m thick and had an organic content of 9.5 to 58.0%, its moisture content varying broadly between 80 and 988%. The peat was penetrated at depths of 0.3 to 4.8 m (elevation 189.6 to 195.6).
- Topsoil was identified below the fill at 1.4 m depth (elevation 194.4) in borehole 310-12. The topsoil was about 200 mm thick and extended to a depth of 1.6 m (elevation 194.2).
- Directly beneath the peat at depths of 0.3 and 2.4 m (elevation 195.6 and 192.0) in boreholes 310-15 and 310-19 was organic silt. This unit was 0.9 and 1.1 m in thickness, very loose to loose in relative density and penetrated at respective depths of 1.2 and 3.5 m (elevation 194.7 and 190.9).
- Overlain by the fill, peat or organic silt at depths of 0.5 to 4.8 m (elevation 189.6 to 194.7) in 18 boreholes was a cohesive deposit of clay, silty clay and/or clayey silt. This deposit was 2.0 to 11.6 m in thickness and typically very soft to firm in consistency. The shear strength profile is shown in Figure 310-SS-1. The results of in situ vane testing carried out in the clayey soils yielded undisturbed shear strength values in a range of 3 to 52 kPa (soil sensitivity of 2 to 8), with the lower values believed to be affected by the presence of organics. A penetrometer test on a sample of the clayey silt indicated a shear strength of 75 kPa. The deposit contained cobbles in boreholes 310-2, 310-4, 310-9, 310-18 and was penetrated at depths of 3.2 to 15.0 m (elevation 179.4 to 192.7). The results of Atterberg limits testing and grain size distribution analyses conducted on 18 cohesive samples are presented in respective Figures 310-PC-1 to 310-PC-4 and 310-GS-2 to 310-GS-5. The liquid and plastic limits of the clay were 51 to 70 and 24 to 25 respectively, with the plasticity index of 27 to 45. The silty clay units had a liquid limit of 35 to 45, plastic limit of 20 to 23, their plasticity index being 13 to 22. The liquid and plastic limits of the clayey silt ranged from 30 to 35 (23 to 26 if containing layers of silt) and from 18 to 21 respectively, thus giving the plasticity index of 11 to 15 (3 to 7). The moisture content of the clayey soils varied between 25 and 127%.
- Underlying the embankment fill at a depth of 2.9 m (elevation 193.4) in borehole 310-8 or the cohesive deposit at depths of 9.0 to 15.0 m (elevation 179.4 to 185.3) in boreholes 310-18, 310-20, 310-21, 310-23, 310-25, 310-27 was non- to slightly plastic silt. This unit was 0.9 to 3.4 m thick and very loose to compact in relative density. The silt was penetrated at 3.8 m depth (elevation 192.5) in borehole 310-8 and at depths of 10.2 to 18.0 m (elevation 176.7 to 184.1) in the remaining boreholes. The results of Atterberg limits testing and grain size distribution analyses conducted on 4 samples of the silt with layers of clayey silt are presented in respective Figures 310-PC-5 and 310-GS-6. The liquid and plastic limits of the slightly plastic silt were 21 to 25 and 19 to 20 respectively, with the plasticity index of 2 to 5. The moisture content of the silt varied between 17 and 36%.
- A discontinuous stratum of cohesionless sand / silty sand was revealed below the topsoil or clayey soils at depths of 1.6 to 5.8 m (elevation 189.2 to 194.2) in boreholes 310-7, 310-12, 310-14 and below the silt at 18.0 m depth (elevation 176.7) in borehole 310-21. This stratum was 0.3 to 1.6 m in thickness and loose to compact in relative density. The sand / silty sand was penetrated at depths of 1.9 to 6.6 m (elevation 188.4 to 193.9) in boreholes 310-7, 310-12, 310-14 and a depth of 19.5 m (elevation 175.2) in borehole 310-21. It is worth noting that cobbles were



encountered within the stratum in borehole 310-7. The results of grain size distribution analysis performed on a sample of the sand are presented in Figure 310-GS-7.

- Bedrock was inferred by refusal in all the test holes at depths of 1.9 to 19.5 m (elevation 175.2 to 193.9).
- During drilling, water was detected at depths of 0.0 to 0.6 m, locally 2.7 m (elevation 193.2 to 194.9). Upon completion of drilling, groundwater was measured in all the boreholes to be at depths of 0.0 to 2.7 m (elevation 193.2 to 195.2). The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.

A summary of the subsurface conditions is compiled in the attached Table A.

According to the vertical alignment received on June 18, 2009, the embankment height between Sta. 13+400 and 13+450 ranges from 1.5 to 3.0 m in the southbound lanes (SBL). The maximum fill height for the SBL section extended south of the project limits to Sta. 13+150 is envisaged to be 3.5 m. No grade raise is planned for the existing Highway 69 embankment to be rehabilitated and used for the new northbound lanes (NBL) within the swamp 310 limits.

The results of slope stability analyses for the existing subsurface conditions at this crossing indicate that a 3.5 m high embankment constructed with rockfill and having side slopes inclined no steeper than 1.25H:1V would be stable without removal of the cohesive soils. The safety factor of about 1.4 obtained for this configuration is regarded adequate for embankment slopes to be stable during construction.

It is noteworthy that all organic soils are to be stripped. It is considered feasible to construct the SBL embankment by any of the following methods to mitigate settlements:

- Without removal of compressible soils. The consolidation settlement of the clayey soils left in place is calculated to be in the order of 525 mm under a 3.5 m high embankment. About 90% of the consolidation settlement would be complete within 42 months. The settlement of rockfill under its self-weight is estimated to be 75 mm. Therefore the maximum total settlement of the embankment surface is some 600 mm. Taking account of the settlements that would occur during the first year after fill placement, the post-construction settlements are not expected to exceed 275 mm. If the clayey soils are preloaded for a period of 24 or 36 months, the remaining total settlement is assessed to be 150 or 80 mm respectively. It is noted that no surcharging is allowed in view of instability issues arising.
- Partial excavation to elevation 187 to remove very soft compressible soils (excavation depth not exceeding 8.5 m; the existing highway remaining stable). If no surcharge is applied, the consolidation settlement of the clayey soils below elevation 187 is calculated to be in the order of 340 mm under a 3.5 m high embankment. About 90% of the consolidation settlement would be complete within 19 months. The settlement of rockfill under its self-weight is estimated to be 170 mm. Therefore the maximum total settlement of the embankment surface is some 510 mm. Taking account of the settlements that would occur during the first year after fill placement, the post-construction settlements are not expected to exceed 160 mm. If the clayey soils are preloaded for a period of 24 or 36 months, the remaining total settlement is assessed to be 60 or 25 mm respectively. Application of 2 m surcharge for a period of 12 months eliminates the consolidation settlement resulting from the embankment loading and reduces post-construction settlements to



about 80 mm. These settlements decrease to some 30 mm after 24 months and 15 mm after 36 months of surcharging.

- Full excavation of compressible soils (excavation depth not exceeding 15 m). The maximum total settlement of the embankment surface due to self-compaction of rockfill is estimated to be 315 mm. Taking into account that about 50% of the total settlement occurs during the first year following fill placement and the remaining 50% at a progressively decreasing rate during the following 5 to 10 year period, the settlements after 12, 24 and 36 months are assessed to be 155, 75 and 35 mm respectively. Applying a 2 m surcharge would reduce these settlements to some 125, 60 and 30 mm. It must be noted that excavation at the centreline median should be limited to maximum 5 m depth or shallower competent ground. This limitation applies to a 5 m wide strip west of the median.

A summary of the maximum settlement of the embankment surface for the above treatment options is as follows:

Method of Swamp Treatment	Maximum Settlement of Embankment Surface, mm			
	Total	Remaining after Preloading / Surcharging for		
		12 months	24 months	36 months
Without removal of compressible soils	600	275	150	80
Partial excavation to elevation 187	510	160	60	25
Partial excavation to elevation 187 with 2 m surcharge	510	80	30	15
Full excavation of compressible soils	315	155	75	35
Full excavation of compressible soils with 2 m surcharge	315	125	60	30

Based on the results of preliminary analysis, it is considered that construction of the SBL embankment involving partial excavation of compressible soils to elevation 187 and surcharging is the preferred treatment option for swamp 310 between Sta. 13+190 and 13+425 (SBL). Full excavation of compressible soils is recommended for the shallower SBL sections at the limits of the crossing (Sta. 13+150 to 13+190 and Sta. 13+425 to 13+450). Installation of wick drains is not necessary at this crossing.

Excerpts from Tables 1, 3 to 6 to be incorporated in the final foundation design report are provided for review by MTO. All of the notes for each table were also included for completeness, although some of the notes apply only to other swamps.



We trust this is sufficient for your immediate purposes. The results of the investigation, discussion and recommended treatment for the crossing will be included in the Final Report after review by MTO.

Sincerely,  
Peto MacCallum Ltd.



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



Carlos Nascimento, P.Eng.  
Senior Project Engineer



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

Enclosure(s):

Table A – Summary of Subsoil Conditions  
Table B – List of Atterberg Limits and Moisture Content Results  
Figure 310-SS-1 – Shear Strength Profile  
Figures 310-PC-1 to 310-PC-5 – Plasticity Charts  
Figures 310-GS-1 to 310-GS-7 – Grain Size Distribution Charts  
Figures 310-C-1 and 310-C-2 – Laboratory Consolidation Test Results  
Explanation of Terms Used in Report  
Record of Borehole Sheets  
Drawings 310-1 to 310-3 – Borehole Locations and Soil Strata  
Tables 1, 3 to 6 (FDR)

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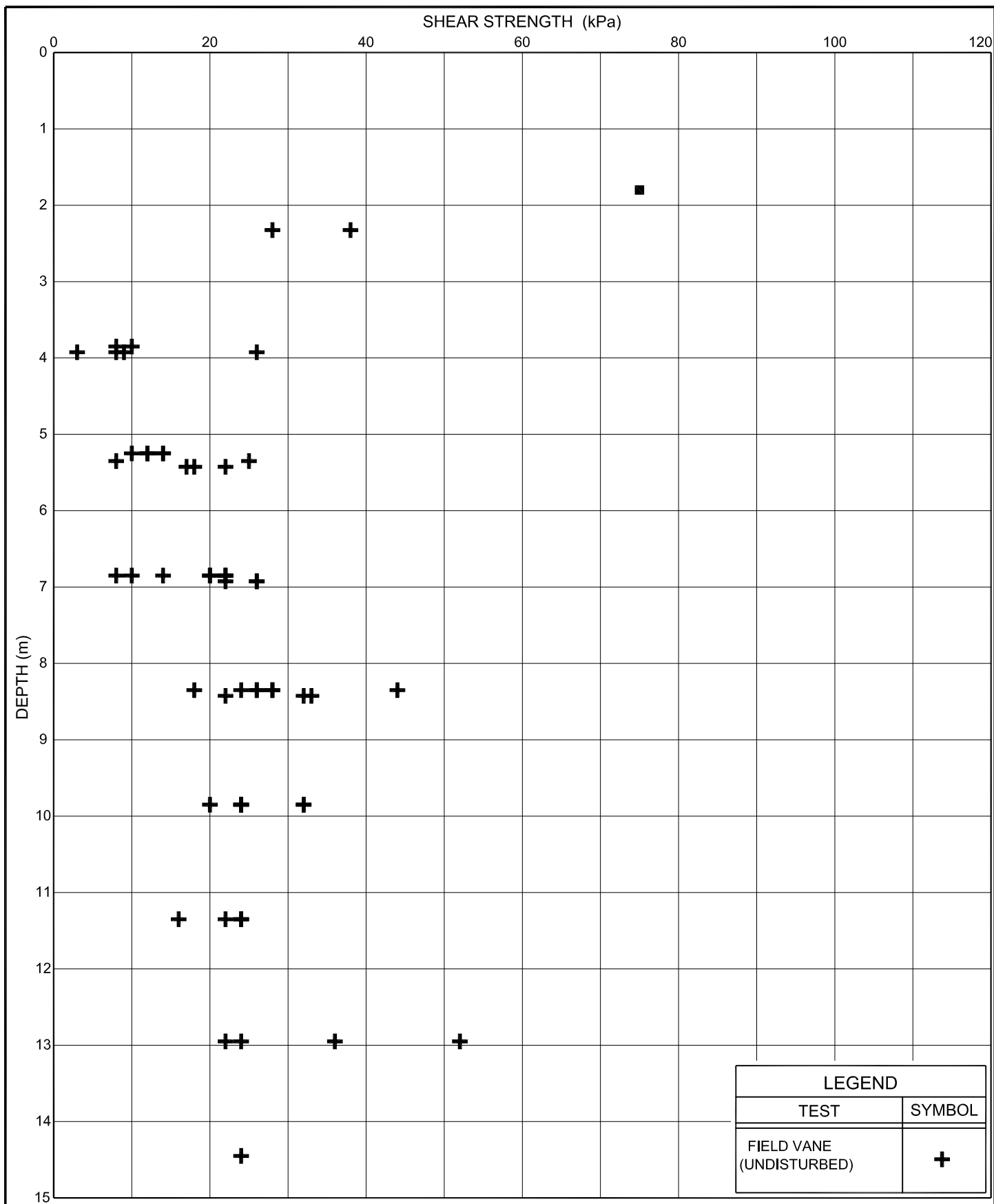
**TABLE A**  
**SUMMARY OF SUBSOIL CONDITIONS**

SWAMP NO.	LOCATION	NO. OF TEST HOLES	TOPSOIL/PEAT THICKNESS (m)	DEPTH TO BOTTOM OF CLAY (m)	DEPTH TO PROBABLE BEDROCK (m)	NOTES AND/OR SOIL PROFILE
<b>HIGHWAY 69 MAINLINE</b>						
310	Sta. 13+150 to 13+450 (SBL) Sta. 13+400 to 13+450 (NBL) Township of Mowat	27	0.2 – 4.8	3.2 – 15.0 (El. 179.4 – 192.7)	1.9 – 19.5 (El. 175.2 – 193.9)	Pavement and embankment fill encountered in 3 boreholes to depths of 1.8 to 4.3 m. Surficial fill unit present in 1 borehole to 1.4 m depth. Cobbles and boulders encountered in 6 boreholes. Peat present in most boreholes overlies cohesive clayey soils underlain by a localized deposit of cohesionless silt / silty sand / sand extending to bedrock.



**TABLE B**  
**LIST OF ATTERBERG LIMITS AND MOISTURE CONTENT RESULTS**

SWAMP No.	SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	LIQUID LIMIT (W <sub>L</sub> )	PLASTIC LIMIT (W <sub>p</sub> )	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
310	Clay	310-2	7	59	24	35	87
		310-21	5	70	25	45	118
		310-25	7	51	24	27	–
		310-27	4	62	24	38	79
	Silty Clay	310-4	6	43	21	22	75
		310-4	8	37	23	14	42
		310-20	4	45	23	22	–
		310-23	9	35	20	15	52
		310-26	8	36	20	16	54
		310-27	6	35	22	13	59
		310-5	6	31	20	11	43
		310-7	5	30	19	11	61
	Clayey Silt	310-13	3	35	20	15	43
		310-15	2	26	19	7	–
		310-18	7	32	21	11	–
		310-19	5	23	20	3	–
		310-21	10	25	18	7	33
		310-23	4	33	19	14	54
		310-18	8	25	20	5	–
		310-20	9	23	20	3	–
	Silt	310-21	12	21	19	2	25
		310-25	10	23	20	3	–

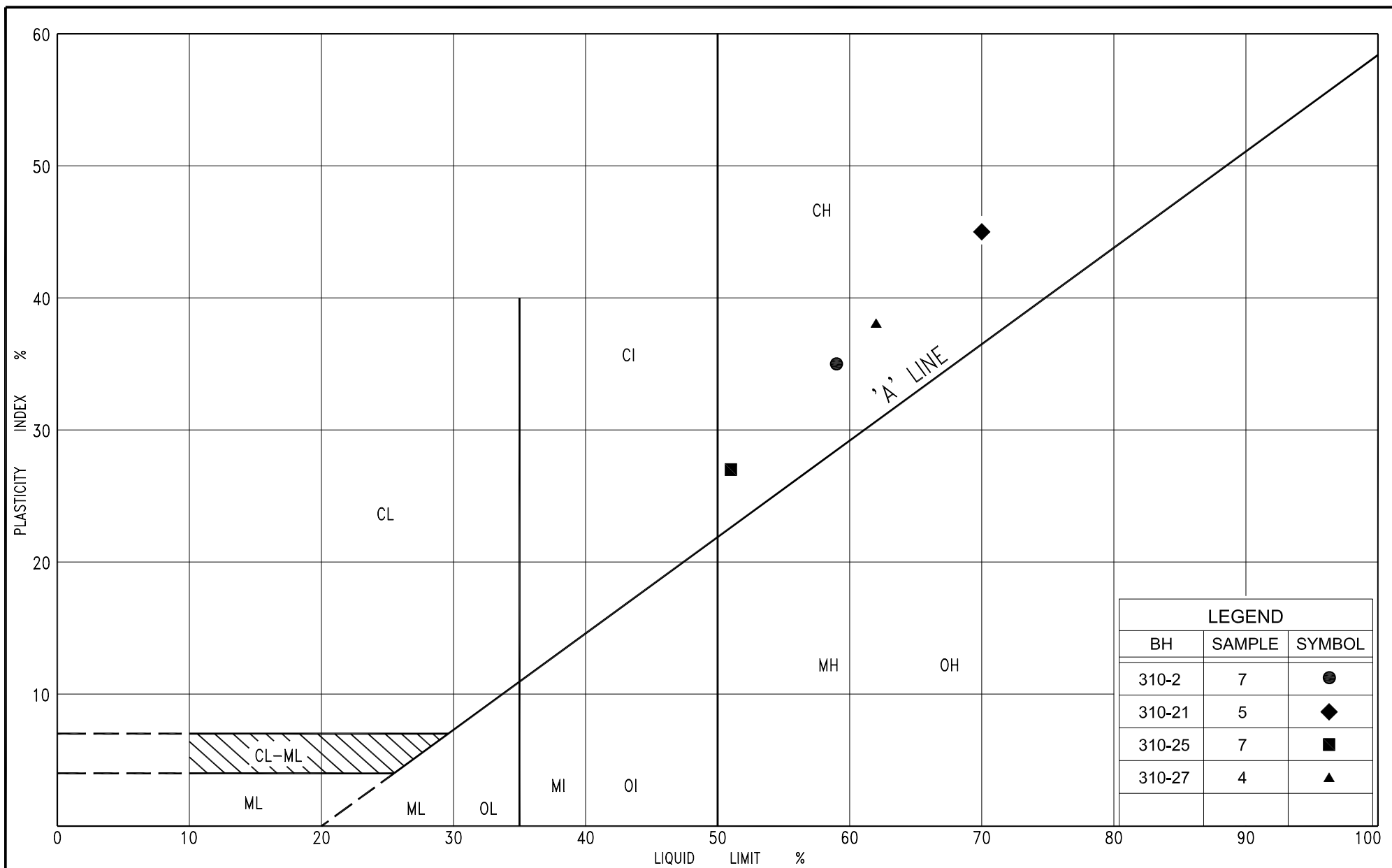


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## SHEAR STRENGTH SWAMP 310

FIG No.	310-SS-1
HWY	69
G.W.P. No.	5203-06-00





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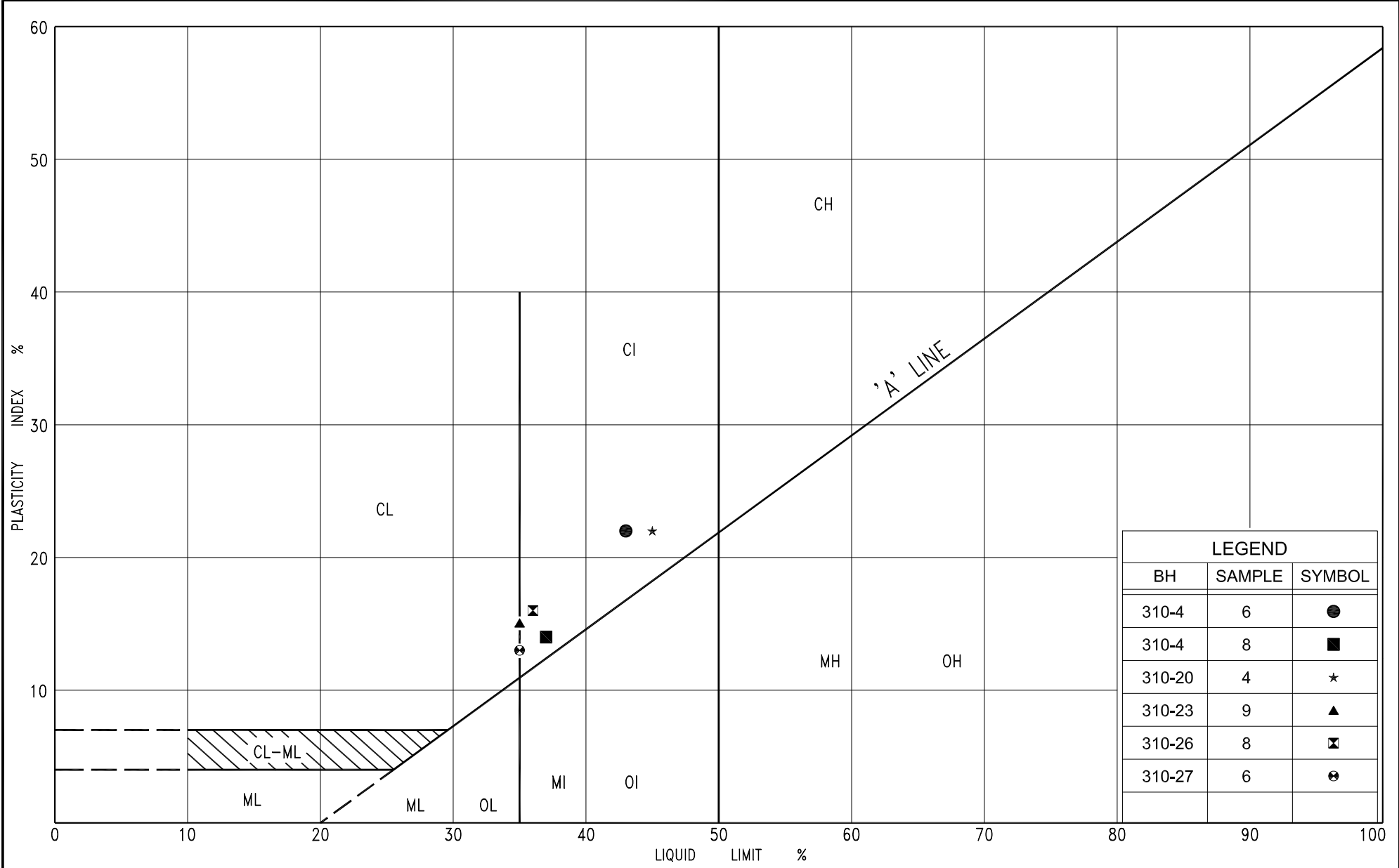
## PLASTICITY CHART

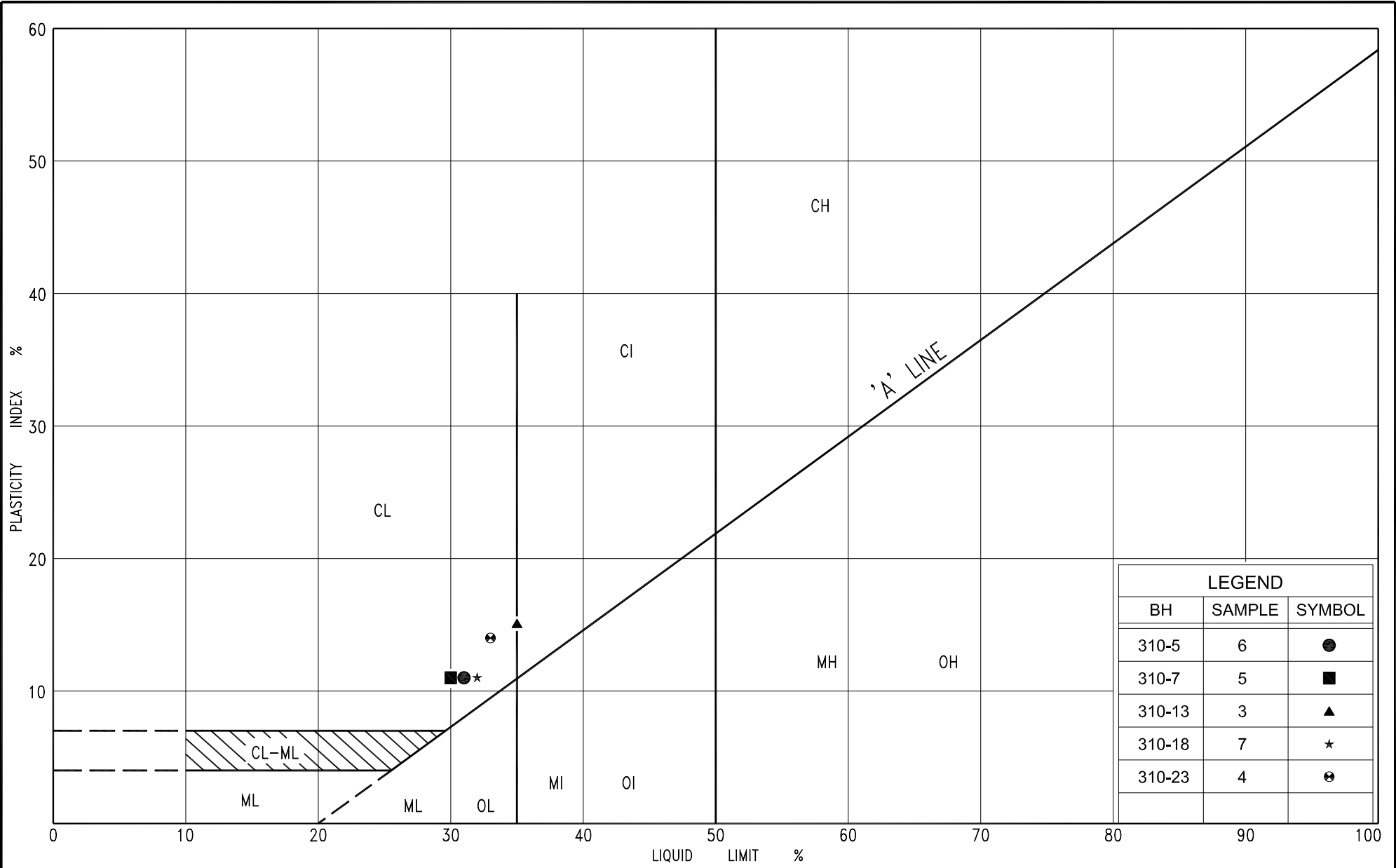
CLAY, trace sand

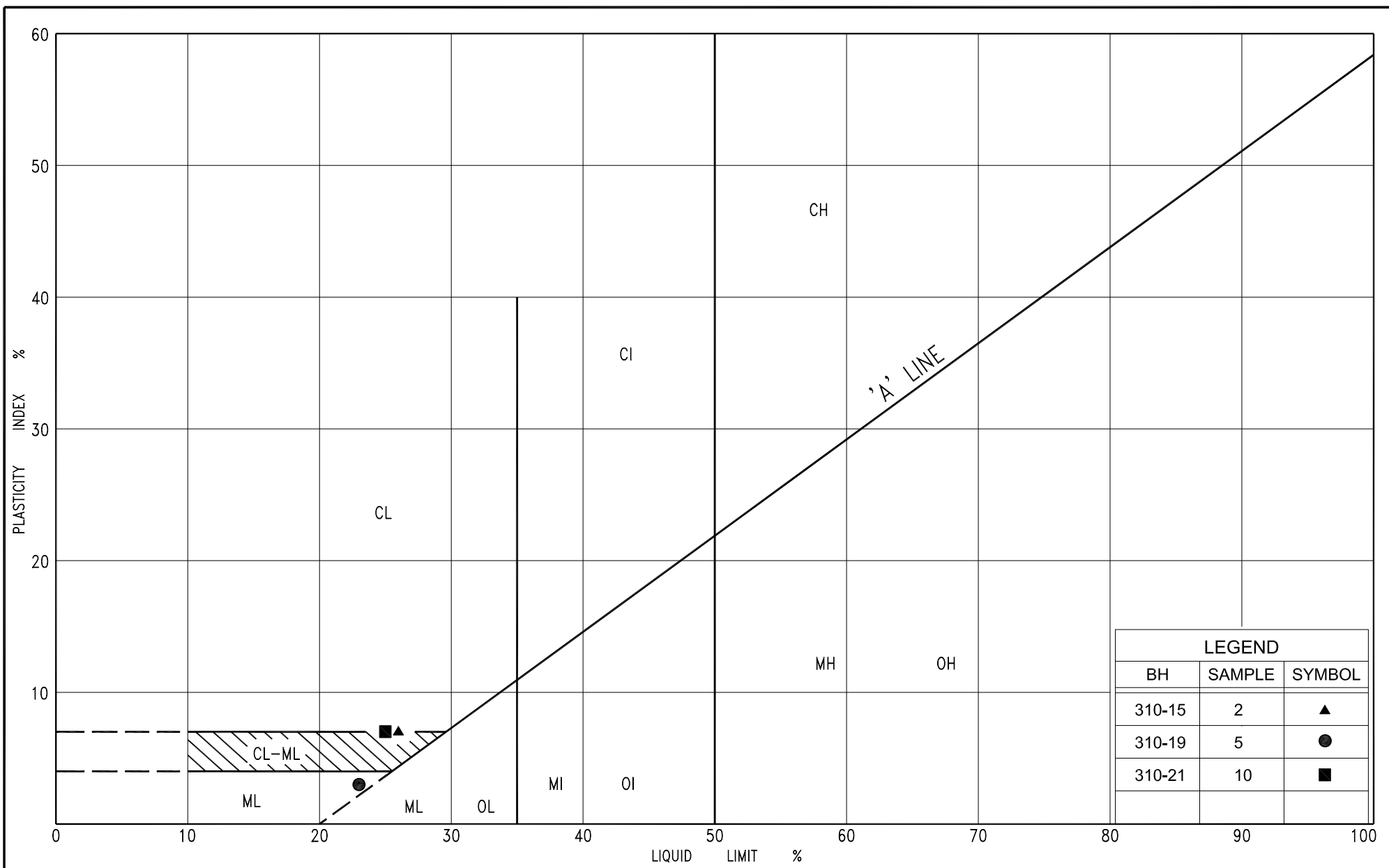
FIG No. 310-PC-1

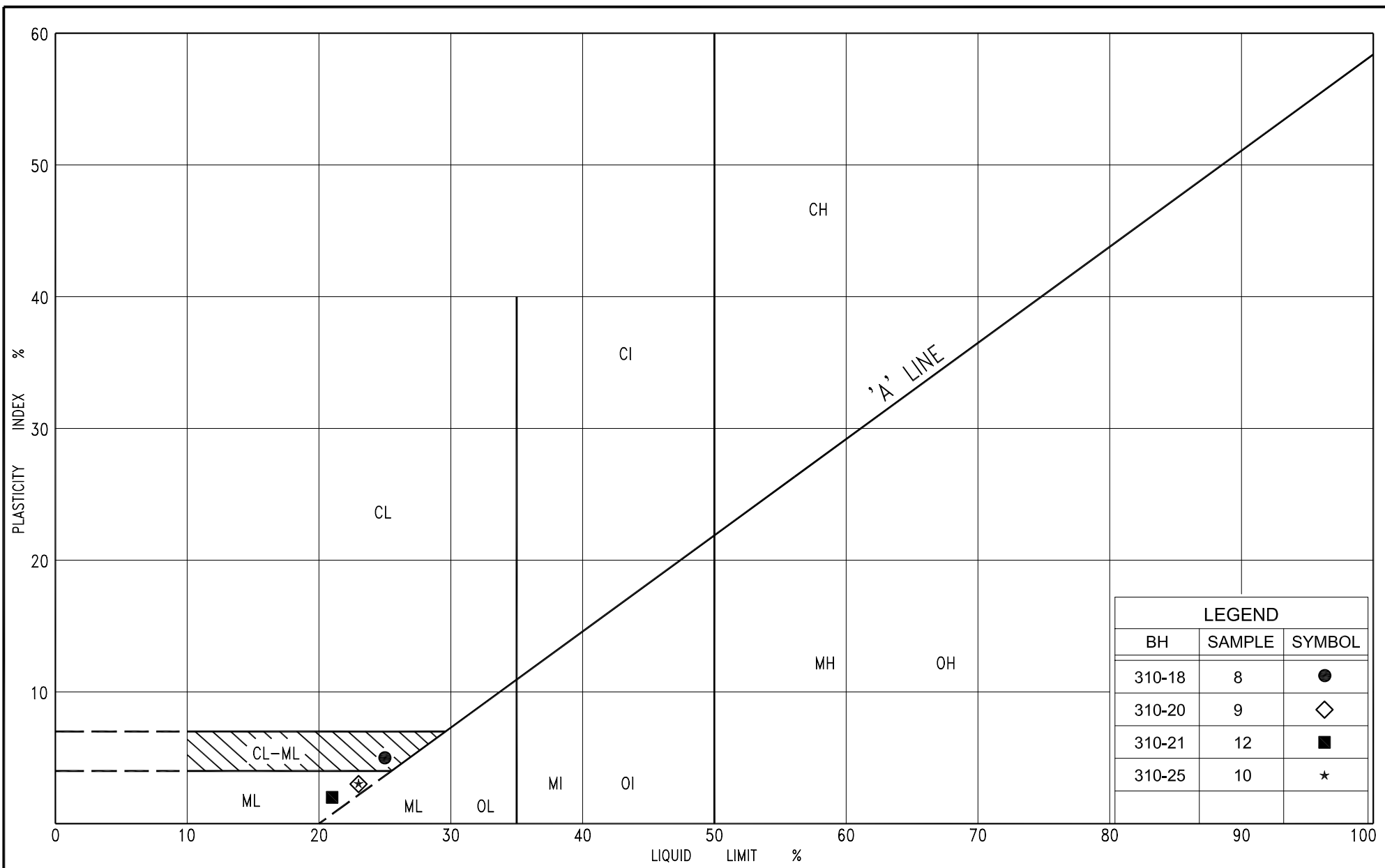
HWY: 69

G.W.P. No. 5203-06-00









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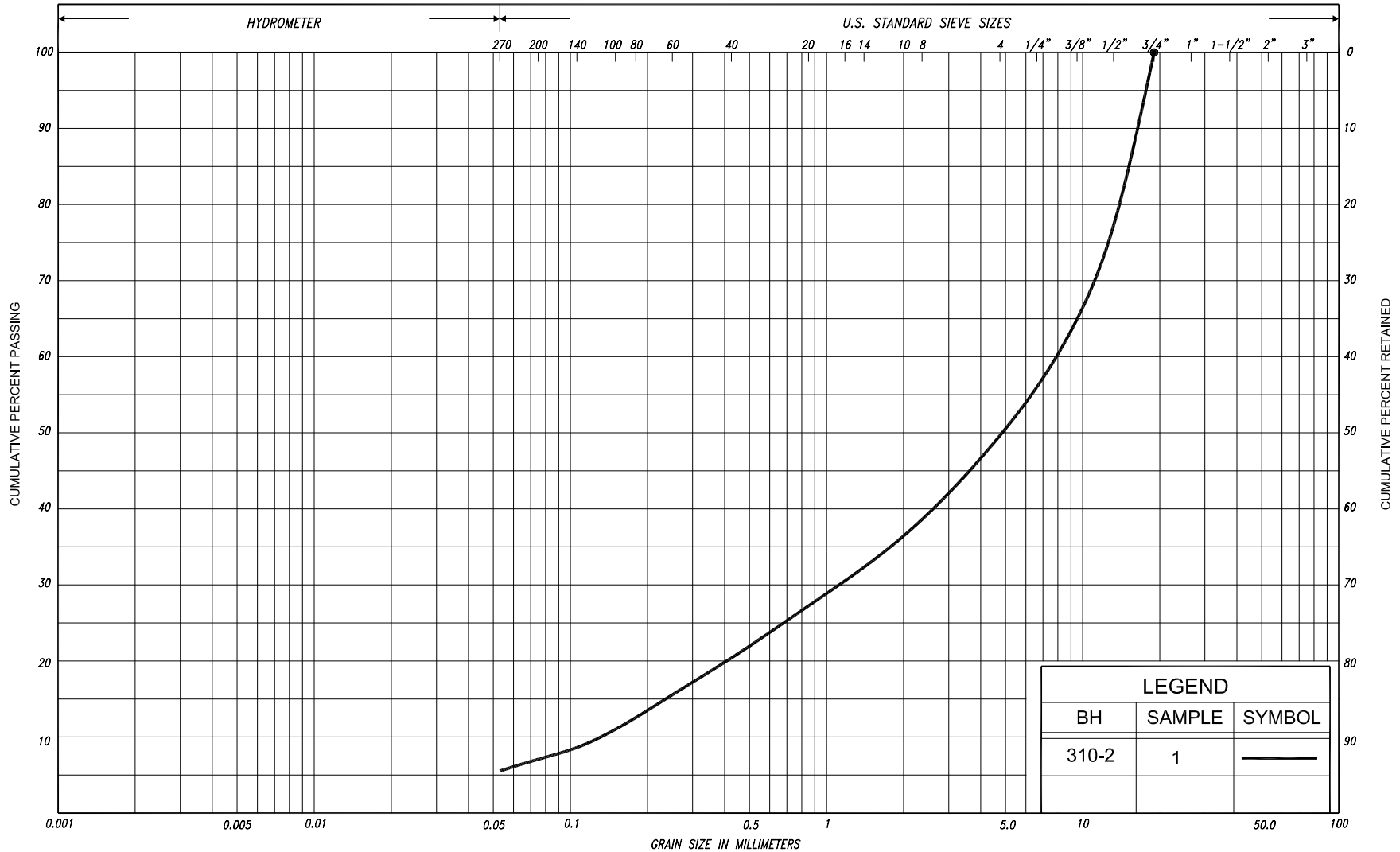
## PLASTICITY CHART

SILT, trace sand

FIG No. 310-PC-5

HWY: 69

G.W.P. No. 5203-06-00

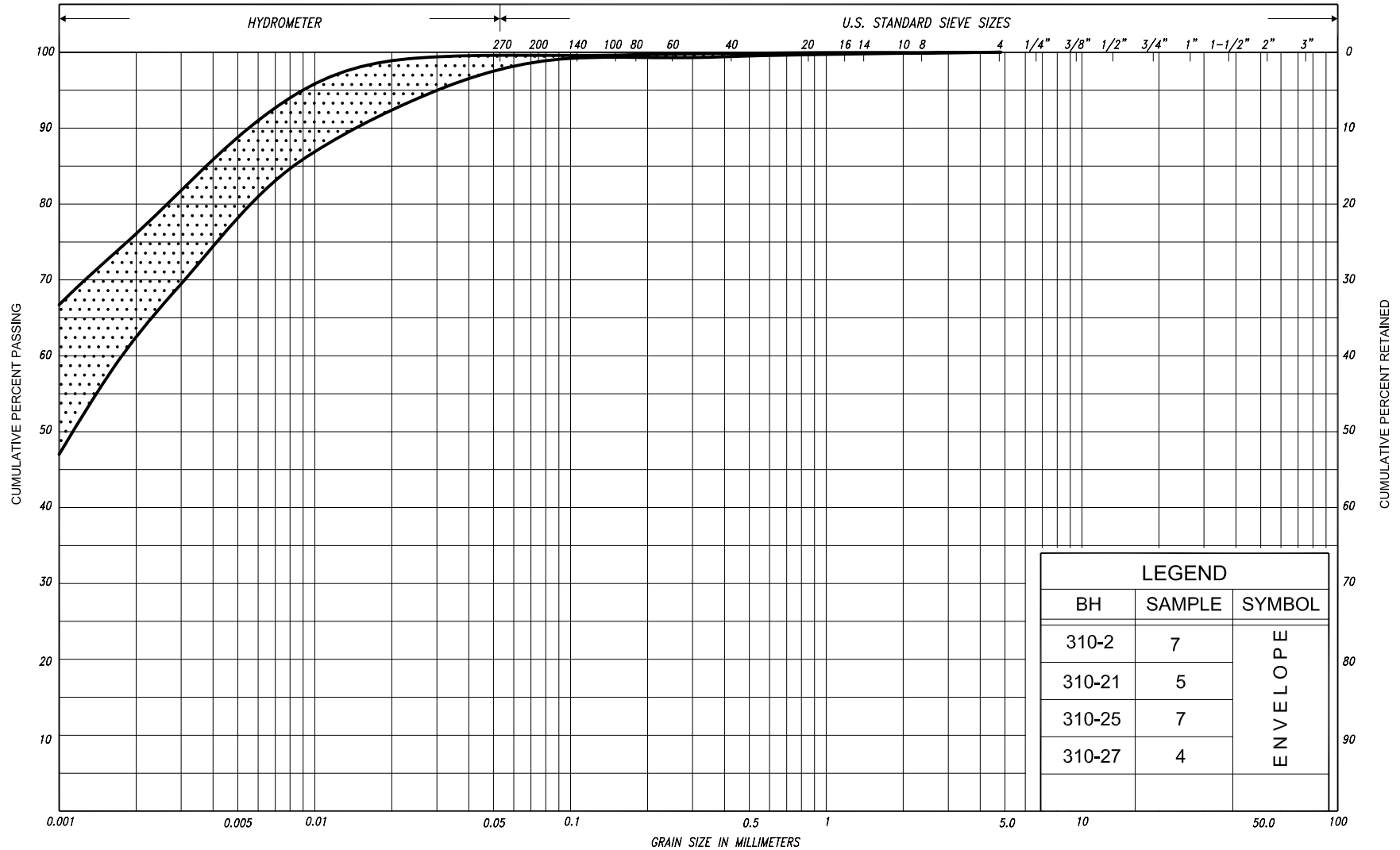


SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL				COBBLES	UNIFIED		
					SAND													
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL				COBBLES	M.I.T.
	SILT					SAND							GRAVEL					
CLAY		SILT			V. FINE	FINE	MED.	COARSE		GRAVEL								U.S. BUREAU
					SAND													

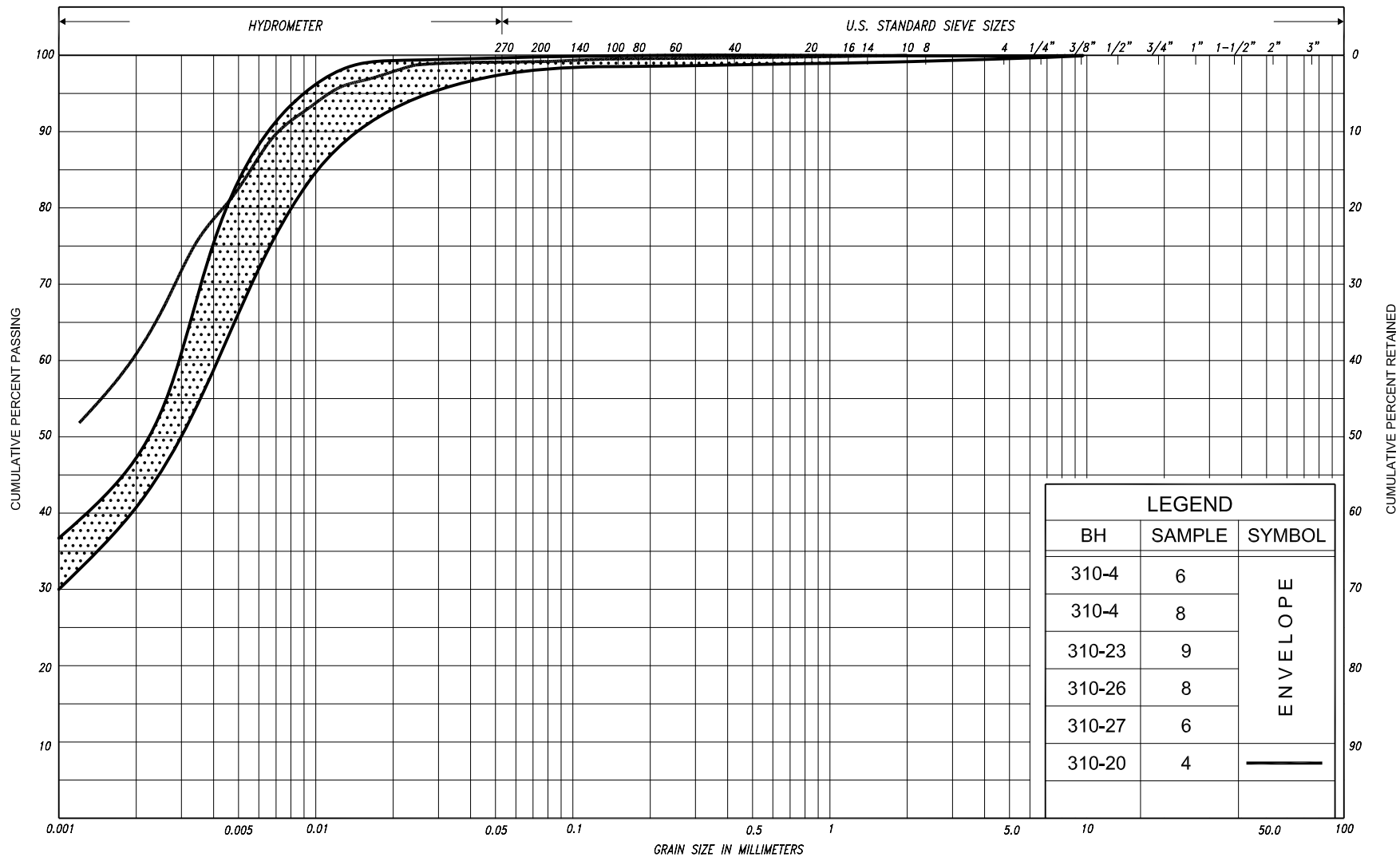
## GRAIN SIZE DISTRIBUTION

### SAND and GRAVEL, trace silt (FILL)

FIG No. 310-GS-1  
 HWY: 69  
 G.W.P. No. 5203-06-00

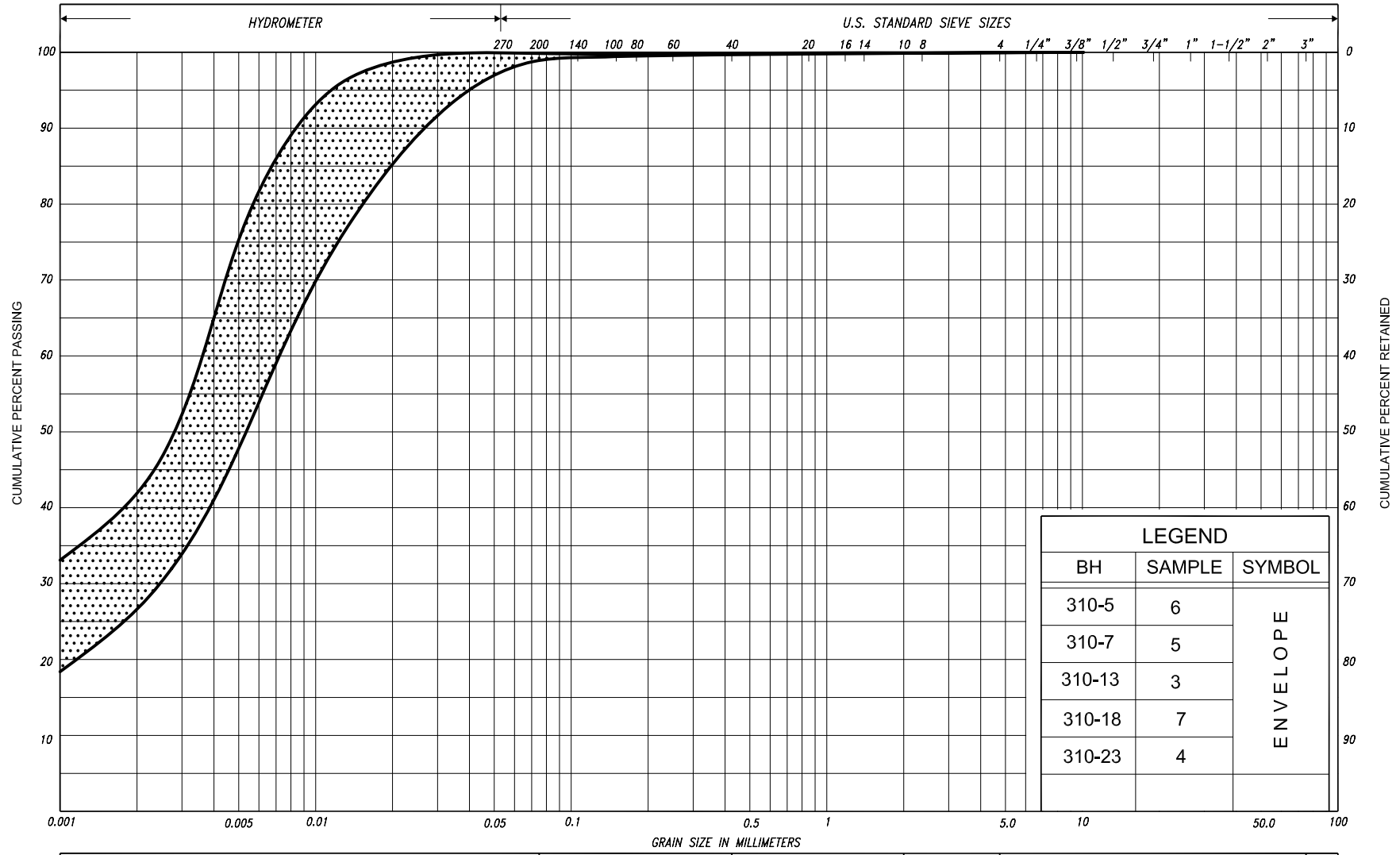


SILT & CLAY					FINE		MEDIUM		COARSE		GRAVEL				COBBLES	UNIFIED		
					SAND													
CLAY	FINE		MEDIUM		COARSE		FINE		MEDIUM		COARSE		GRAVEL				COBBLES	M.I.T.
	SILT																	
CLAY			SILT			V. FINE	FINE	MED.	COARSE		GRAVEL						U.S. BUREAU	
						SAND												



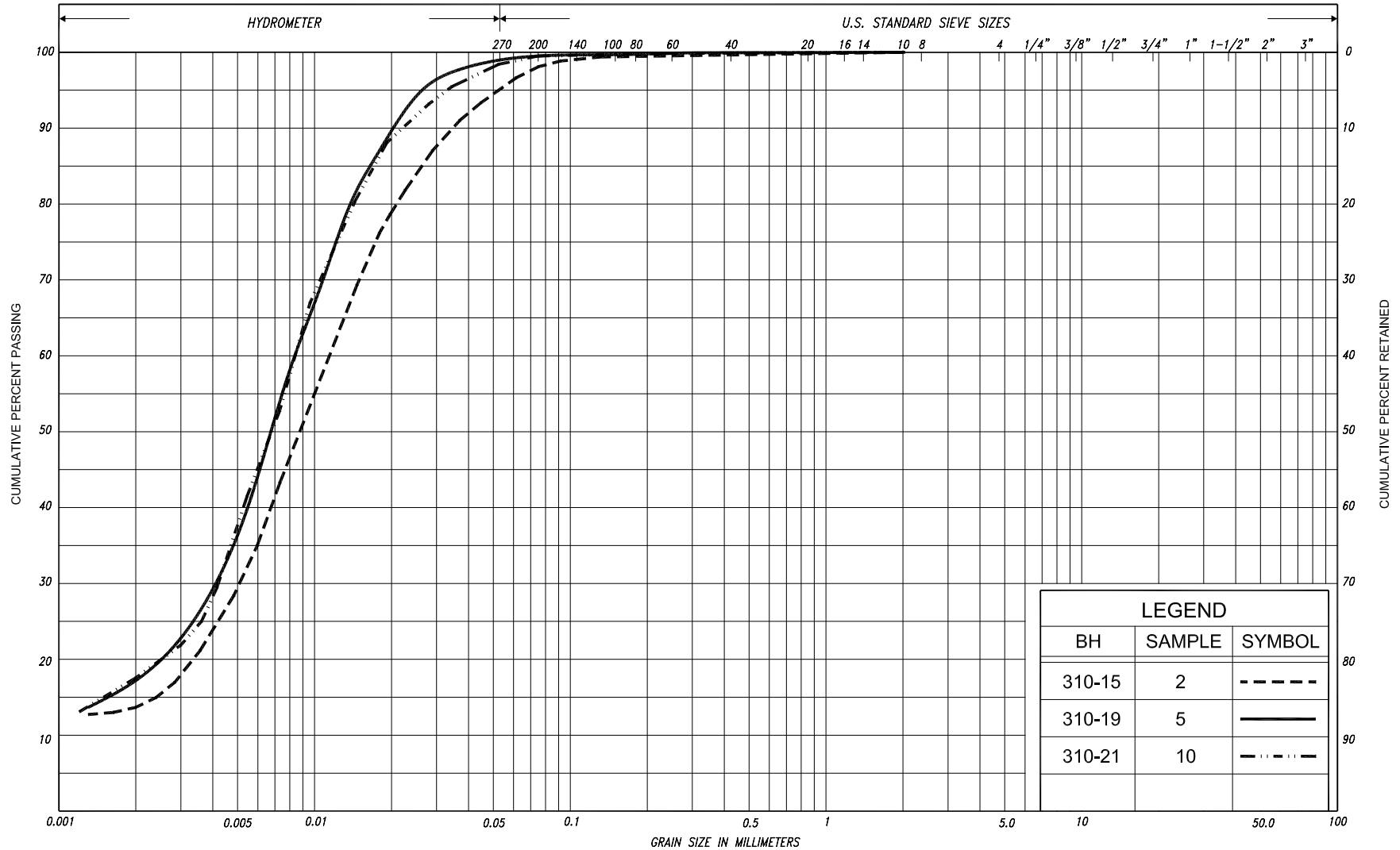
SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED		
					SAND											
CLAY	FINE		MEDIUM	COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.	
	SILT															
CLAY		SILT			V. FINE	FINE	MED.	COARSE	GRAVEL							U.S. BUREAU
					SAND											



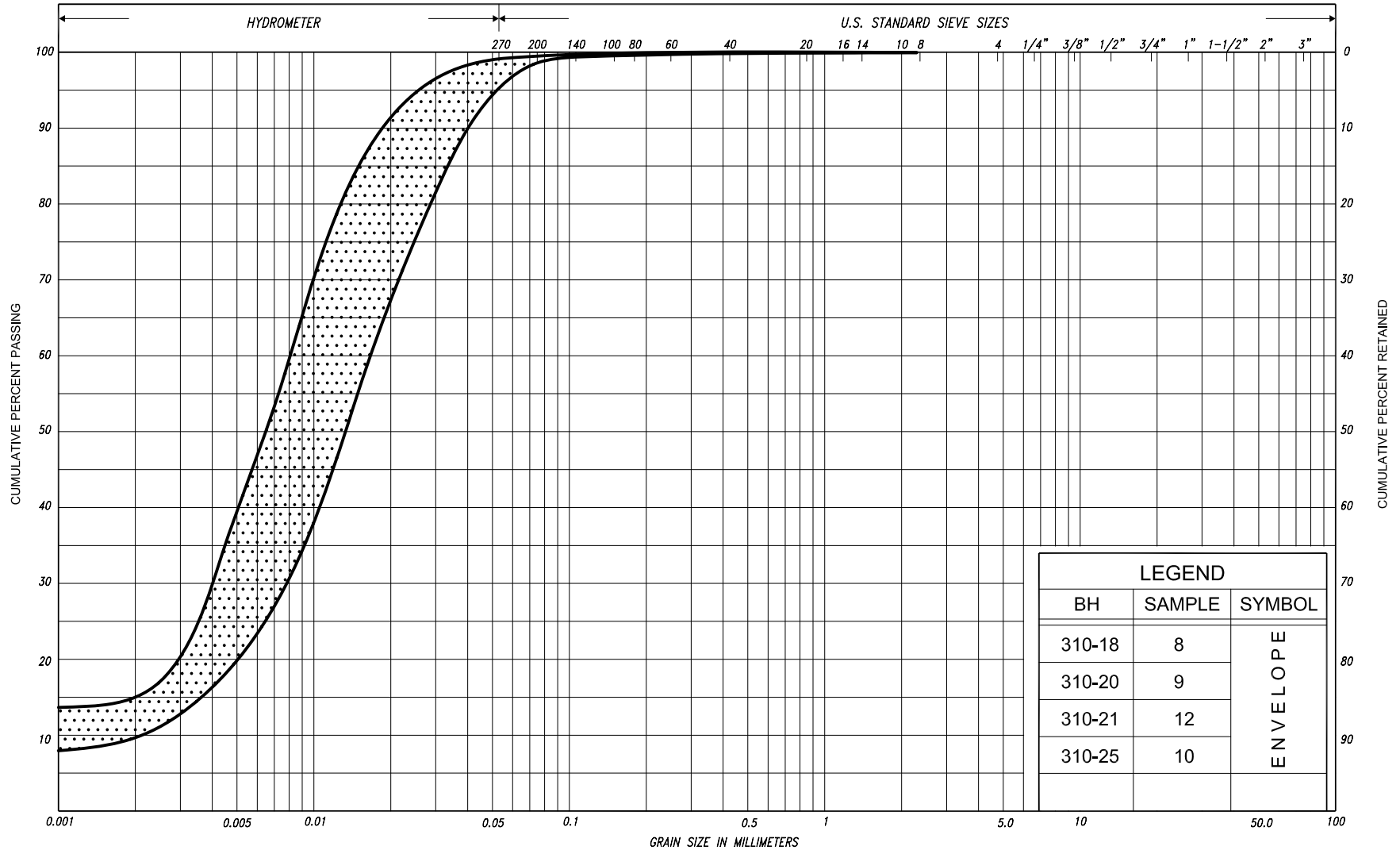


LEGEND		
BH	SAMPLE	SYMBOL
310-5	6	ENVELOPE
310-7	5	
310-13	3	
310-18	7	
310-23	4	

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



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



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

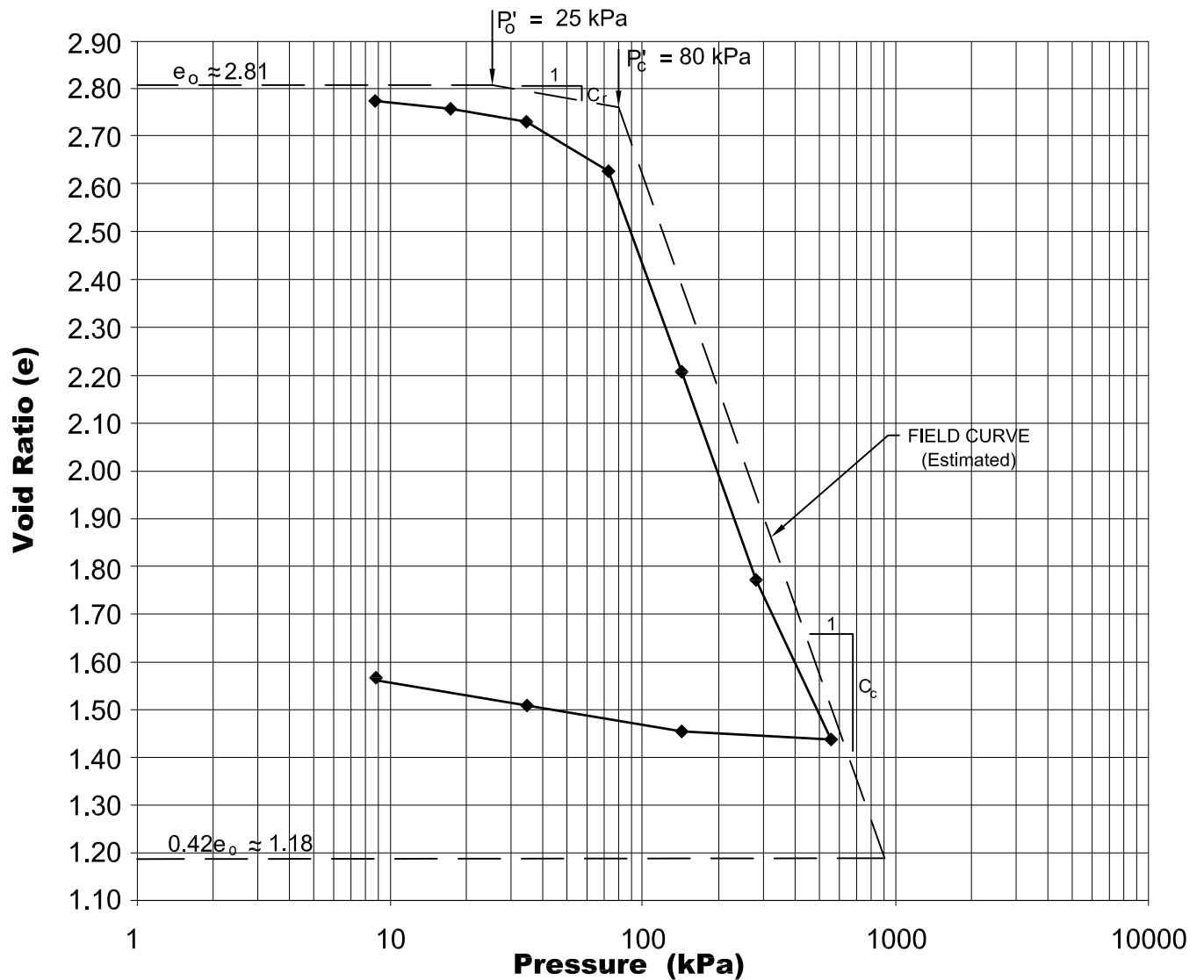


Laboratory Consolidation Test Results

Highway 69  
From 3.1 km north of Highway 522 to 10.7 km north of Highway 522  
District 54, Ontario

Swamp 310, Borehole 310-21, Sample 5  
Station 13+275, 54.0 m Lt.  $\varnothing$  Median, Depth 6.1 - 6.7 m

**Void Ratio versus Log of Pressure**



SOIL TYPE: CLAY, trace sand

$e_0 \approx 2.81$

$W_0 = 101\%$

$\gamma = 14.4 \text{ kN/m}^3$

$P'_0 = 25 \text{ kPa}$

$P'_c = 80 \text{ kPa}$

$C_c = 1.49$

$C_r = 0.09$

$W_L = 70$

$W_P = 25$

$PI = 45$

FIGURE No: 310-C-1

HIGHWAY: 69

TOWNSHIP: MOWAT

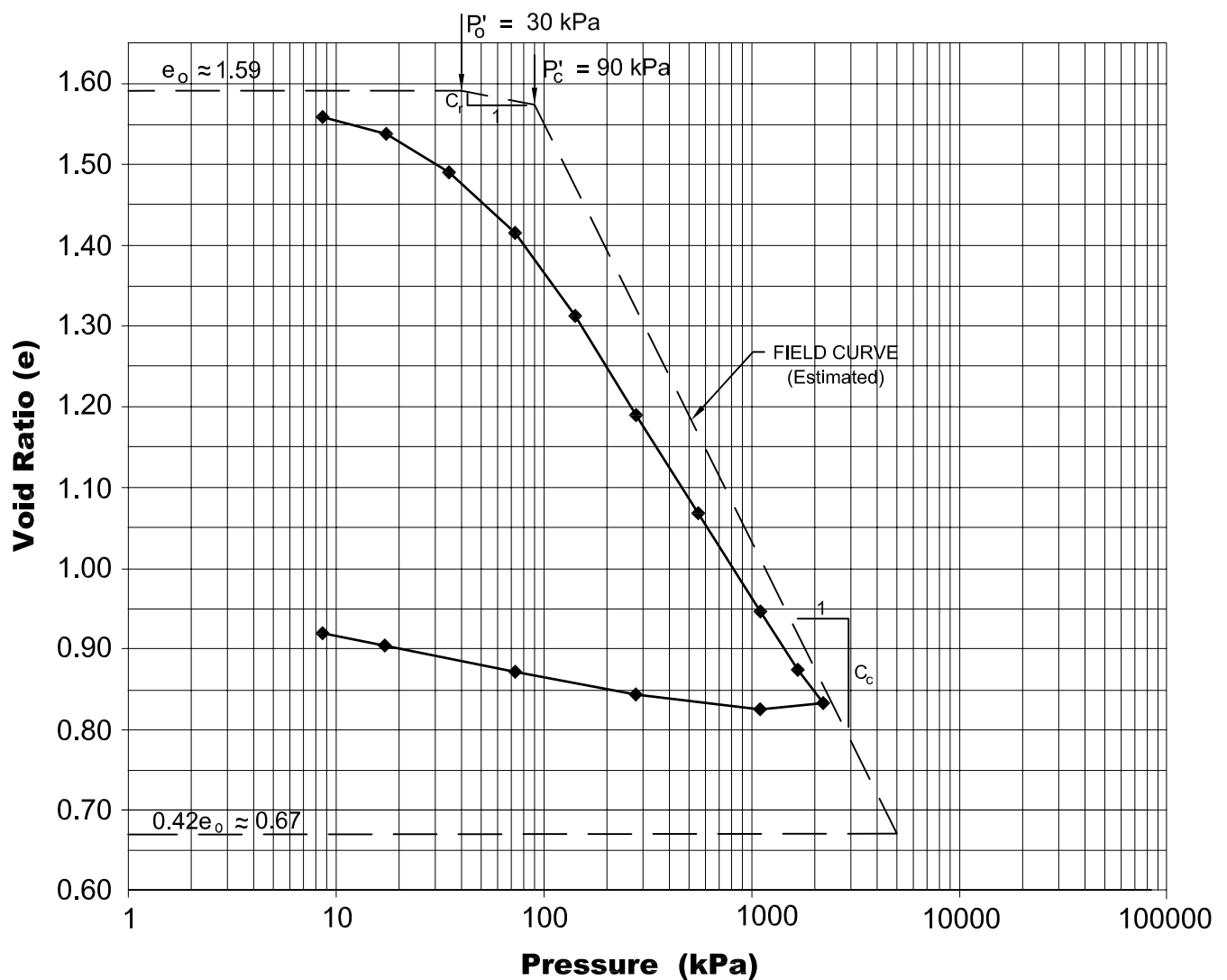
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Laboratory Consolidation Test Results

Highway 69  
From 3.1 km north of Highway 522 to 10.7 km north of Highway 522  
District 54, Ontario

Swamp 310, Borehole 310-27, Sample 6  
Station 13+375, 53.5 m Lt.  $\varnothing$  Median, Depth 7.6 - 8.2 m

**Void Ratio versus Log of Pressure**



SOIL TYPE: SILTY CLAY, trace sand

$e_o \approx 1.59$

$W_o = 58\%$

$\gamma = 16.7 \text{ kN/m}^3$

$P'_o = 30 \text{ kPa}$

$P'_c = 90 \text{ kPa}$

$C_c = 0.51$

$C_r = 0.05$

$W_L = 35$

$W_P = 22$

$PI = 13$

FIGURE No: 310-C-2

HIGHWAY: 69

TOWNSHIP: MOWAT

G.W.P. 5203-06-00

## 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  $\bar{N}$ .

**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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

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

### PHYSICAL PROPERTIES OF SOIL

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

**METRIC**[illegible]



**RECORD OF BOREHOLE No 310-2**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+400, o/s 13.3m Rt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE October 13, 2006 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub>	w	w <sub>L</sub>					
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE								
196.1	Ground Surface						20	40	60	80	100									
0.0	Sand and gravel, trace silt		1	SS	16	*														
	Compact     Dark     Wet brown																			

**RECORD OF PENETRATION TEST No 310-3**

1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 52.5m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						× LAB VANE		
195.0 0.0	Ground Surface Probable peat														GR SA SI CL			
	Probable silty clay Very soft to soft														0.5m frozen			
186.3 8.7	End of dynamic cone penetration test Refusal on probable bedrock																	

**RECORD OF BOREHOLE No 310-4**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 26.5m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			*GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE							
195.0	Ground Surface						20	40	60	80	100	WATER CONTENT (%)					
0.0	Peat, coarse fibrous Dark brown fine fibrous		1	CS	-	▽*											0.5m frozen
			2	SS	WH**										626	Org. 56.3%	
			3	SS	WH										988		
	amorphous layers of organic silty clay		4	SS	WH										184		
191.9																	
3.1	Silty clay, organics layers of organic silty clay, seashells to 4.5m Very soft Grey Wet to firm		5	SS	WH										94		
				FV													
	trace sand varved		6	SS	WH												1 1 51 47
				FV													
			7	SS	WH												
				FV													
			8	SS	WH												0 1 54 45
				FV													
	cobbles		9	SS	10/5cm												
185.4																	
9.6	End of borehole Refusal on probable bedrock																
	Sample 9: sampler bouncing																
	* 2007 03 05																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																
	WH** Denotes penetration due to weight of hammer and rods																

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF PENETRATION TEST No 310-6**

1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 32.5m Rt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE October 14, 2006 CHECKED BY C.N.













SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		w <sub>p</sub>	w	w <sub>L</sub>		
195.5 0.0	Ground Surface Probable fill  Loose   Probable clayey silt  Soft to firm	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></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**RECORD OF BOREHOLE No 310-7**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+425, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			*GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)					
195.0	Ground Surface							20	40	60	80	100						
0.0	Peat, coarse fibrous Dark brown		1	CS	-	 *												0.5m frozen
			2	SS	WH**		194											944
	amorphous layers of organic silty clay		3	SS	WH		193											89
192.4			4	SS	WH													
2.6	Clayey silt organics to 3.1m					192												
	Very soft Grey Wet to soft varved		5	SS	WH													0 0 68 32
				FV		191	 <sup>2</sup>											
			6	SS	1	190												
				FV			 <sup>3</sup>											
189.2																		
5.8	Sand trace to some silt trace gravel, cobbles		7	SS	10/7cm	189												2 87 (11)
188.4	Compact Grey Wet																	
6.6	End of borehole Refusal on probable bedrock																	
	Sample 7: sampler bouncing  * 2007 03 04   Water level observed during drilling   Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods																	

**RECORD OF BOREHOLE No 310-8**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+425, o/s 24.5m Rt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE October 14, 2006 CHECKED BY C.N.

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES	SHEAR STRENGTH kPa												
						○ UNCONFINED			+	FIELD VANE								
196.3	Ground Surface						○	+										
0.0	Topsoil		1	SS	13	* ▼	20	40	60	80	100	20	40	60				
	Sand, with silt																	
	Compact Brown Dry to dense		2	SS	35													
	cobbles and boulders		3	SS	18/15cm													
	Wet inclusions of peat, wood (FILL)		4	SS	7													
193.4	Silt																	
2.9	Loose Grey Wet		5	SS	8													
192.5	End of borehole																	
3.8	Refusal on probable bedrock																	
	Sample 3: Sampler bouncing																	
	* 2006 10 14																	
	▼ Water level measured after drilling																	

**RECORD OF BOREHOLE No 310-9**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 52.5m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	● QUICK TRIAXIAL	✦ FIELD VANE	✕ LAB VANE						WATER CONTENT (%)
195.0	Top of Ice/snow						20	40	60	80	100	20	40	60	kN/m <sup>3</sup>	GR SA SI CL	
0.0 194.7	Ice/Snow		1	CS	-	▽*											
0.3	Peat, coarse fibrous Dark brown fine fibrous		2	SS	WH**										166	Org. 9.5%	
193.5	Silty clay organics to 3.0m varved		3	SS	2												
1.5	Firm Grey Moist to wet			FV													
	layers of silt		4	SS	2												
			5	TW	PH												
190.1 4.9	layers of sandy silt trace gravel, cobbles		6	SS	10/10cm												
	End of borehole																
	Refusal on probable bedrock																
	Sample 6: Sampler bouncing																
	* 2007 03 05																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																
	WH** Denotes penetration due to weight of hammer and rods																



**RECORD OF PENETRATION TEST No 310-10**

1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 26.5m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							
195.0 0.0	Ground Surface  Probable peat														
	Probable silty clay  Very soft to soft														
190.0 5.0	End of dynamic cone penetration test  Refusal on probable bedrock														

**RECORD OF PENETRATION TEST No 310-11**

1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 6.5m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
195.0 0.0	Ground Surface Probable peat																
	Probable silty clay Very soft to soft																
191.2 3.8	End of dynamic cone penetration test Refusal on probable bedrock																

**RECORD OF BOREHOLE No 310-12**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 32.5m Rt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE October 14, 2006 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w <sub>p</sub> w w <sub>L</sub>				
195.8	Ground Surface						20	40	60	80	100					GR SA SI CL	
0.0	Topsoil Dark brown		1	SS	3	* ▼											
	Sand, trace silt																
	Loose Brown Dry																
194.4	with silt (FILL) Wet		2	SS	4												
1.4																	
194.2	Topsoil																
1.6	Sand, trace silt		3	SS	12/23cm												
193.9	Compact Brown Wet																
1.9	End of borehole																
	Refusal on probable bedrock																
	Sample 3: Sampler bouncing																
	* 2006 10 14																
	▼ Water level measured after drilling																

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 310-15**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+150, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 10, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED      + FIELD VANE									
								● QUICK TRIAXIAL    × LAB VANE									
					WATER CONTENT (%)												
195.9	Ground Surface							20	40	60	80	100					
0.0 195.6 0.3	Peat, coarse fibrous Dark brown		1	SS	3												
	Organic silt clayey silt layers																
194.7 1.2	Very loose Grey      Moist to loose						195										
	Clayey silt, trace sand silt layers																
	Stiff      Mottled Moist grey/brown		2	SS	10		194										0   2   84   14
	_____																
	layers of sand																
	_____																
192.7 3.2	trace gravel		3	SS	10/15cm		193										
	Grey      Wet																
	End of borehole																
	Refusal on probable bedrock																
	Sample 3: Sampler bouncing																
													</				

1 of 1 **METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 310-17**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+187.5, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Power Auger COMPILED BY G.D.  
 DATUM Geodetic DATE February 17, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE				
193.9	Ground Surface					▼											
0.0	Peat, coarse fibrous Dark brown					▽*											
	fine fibrous																
	amorphous organic silt layers																
191.5	Silty clay, trace sand																
2.4	Grey Wet																
	sand layers																
186.4	End of borehole																
7.5	Refusal on probable bedrock																
	* 2009 02 17																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																



**RECORD OF BOREHOLE No 310-18**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+200, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE February 11, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	W <sub>P</sub>	W	W <sub>L</sub>				
194.3	Ground Surface					▼											
0.0	Peat, coarse fibrous Dark brown		1	SS	WH**												
	fine fibrous																
			2	SS	WH												
	amorphous																
191.9	Silty clay, trace sand																
2.4	Very soft Grey Wet		3	SS	WR***												
				FV													
	varved																
	Soft		4	SS	WH												
				FV													
188.5	Clayey silt, trace sand																
5.8	Soft Grey Wet		5	SS	WH												
				FV													
	cobbles																
	Firm		6	SS	7												
				FV													
			7	SS	WH											0 1 60 39	
				FV													
184.1	Silt, trace sand																
10.2	clayey silt layers																
	Very loose Grey Wet		8	SS	WH											0 2 83 15	
	to compact																
181.8	End of borehole		9	SS	20/15cm												
12.5	Refusal on probable bedrock															WH** Penetration due to the weight of rods and hammer	
	Sample 9: Sampler bouncing															WR*** Penetration due to the weight of rods only	
	* 2009 02 11																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																

**RECORD OF BOREHOLE No 310-19**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+219, o/s 24.0m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE February 10, 2009 CHECKED BY C.N.












SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	✕ LAB VANE	✚ FIELD VANE									
194.4	Ground Surface							20	40	60	80	100								
0.0	Peat, coarse fibrous Dark brown		1	SS	WH**		194													
	fine fibrous/ amorphous						193													
			2	SS	WH															
192.0	Organic silt						192													
2.4	Very loose Grey Wet																			
			3	SS	WH		191													
190.9	Silty clay, trace sand			FV																
3.5	Very soft Grey Wet to soft						190													
			4	SS	WR***															
				FV			189													
188.5	Clayey silt, trace sand silt layers						188													
5.9	Soft to Grey Wet firm		5	SS	1												0 1 82 17			
				FV																
							187													
			6	SS	20/10cm															
186.5	End of borehole																			
7.9	Refusal on probable bedrock																			
	Sample 6: Sampler bouncing																			
	* 2009 02 10																			
	▽ Water level observed during drilling																			
	▼ Water level measured after drilling																			
	WH** Penetration due to the weight of rods and hammer																			
	WR*** Penetration due to the weight of rods only																			

**RECORD OF BOREHOLE No 310-20**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+250, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE February 09 & 10, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa										WATER CONTENT (%)		
							○ UNCONFINED	● QUICK TRIAXIAL	+ FIELD VANE	× LAB VANE									
194.4	Ground Surface						20	40	60	80	100								
0.0	Peat, coarse fibrous Dark brown		1	SS	WH**														
	fine fibrous/ amorphous																		
			2	SS	WH														
	amorphous layers of organic silt																		
			3	SS	WH														
190.3																			
4.1	Silty clay, trace sand																		
	Very soft Grey Wet		4	SS	WR***														
				FV															
	varved																		
	Soft to firm		5	SS	WH														
				FV															
			6	SS	1														
				FV															
			7	TW	PM														
				FV															
			8	SS	WH														
				FV															
182.5																			
11.9	Silt, trace sand layers of clayey silt																		
	Very loose Grey Wet to compact		9	SS	WH														
			10	SS	15/23cm														
180.1	sand layers																		
14.3	End of borehole																		
	Refusal on probable bedrock Cont'd																		

**METRIC**

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
179.4											

[illegible]

**RECORD OF BOREHOLE No 310-21**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+275, o/s 54.0m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 09, 2009 CHECKED BY C.N.

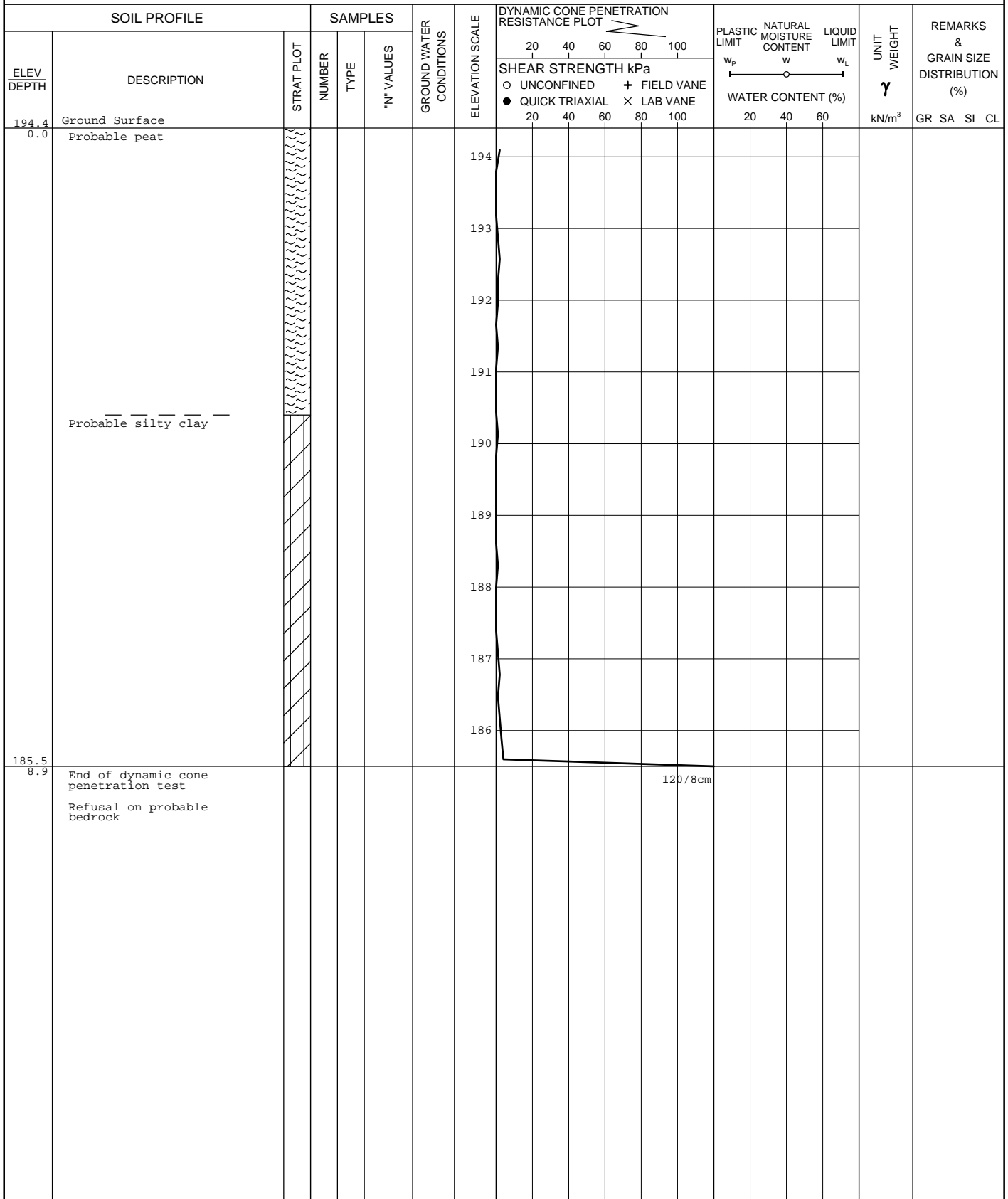
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W <sub>P</sub> W W <sub>L</sub>	WATER CONTENT (%)			GR SA SI CL								
194.7 0.0	Ground Surface Peat, coarse fibrous Dark brown		1	SS	WH**																
	fine fibrous																				
			2	SS	1										381						
	amorphous layers of organic silt																				
191.7 3.0	Clay, trace sand Very soft Grey Wet		3	SS	WH										99						
				4	SS	WH															
					FV																
	varved																				
	Soft to firm			5	TW	PM										118	14.4	0 1 26 73			
					FV																
				6	SS	WH										88					
					FV																
				7	SS	1															
					FV																
				8	SS	WH															
					FV																
182.7 12.0	Clayey silt, trace sand Soft to Grey Wet firm		9	SS	WH																
					FV																
	layers of silt																				
				10	SS	WH															
				FV																	
180.1 14.6																					
	Cont'd																				

**METRIC**

(%) STRAIN AT FAILURE

**RECORD OF PENETRATION TEST No 310-22** 1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+275, o/s 25.0m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE February 09, 2009 CHECKED BY C.N.



**RECORD OF BOREHOLE No 310-23**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+300, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 08, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa										WATER CONTENT (%)		
							○ UNCONFINED		+ FIELD VANE								● QUICK TRIAXIAL		
194.4	Ground Surface						20	40	60	80	100								
0.0	Peat, coarse fibrous Dark brown		1	SS	WH**	▼* ▼*													
	fine fibrous																		
			2	SS	WH									416					
	amorphous layers of organic silt																		
			3	SS	WH									118					
190.1																			
4.3	Silty clay layers of clayey silt		4	SS	WH														
	Very soft Grey Wet to firm			FV												0 0 58 42			
	varved																		
			5	TW	PM														
				FV															
			6	SS	WH														
				FV															
			7	SS	WH														
				FV															
			8	SS	WH														
				FV															
	trace sand																		
			9	SS	1											0 1 58 41			
				FV															
180.8																			
13.6	Clayey silt, trace sand silt layers		10	SS	WH														
	Soft to Grey Wet firm																		
179.4	Cont'd																		



**RECORD OF BOREHOLE No 310-23**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+300, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 08, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
179.4								20	40	60	80	100								
15.0	Silt, trace sand layers of clayey silt  Compact    Grey    Wet		11	SS	20/15cm		179													
178.1																				
16.3	End of borehole  Refusal on probable bedrock  																			

1 of 2 **METRIC**

G.W.P. 5203-06-00	LOCATION	Hwy 69(New), Sta. 13+325, o/s 54.0m Lt. CL Med.	ORIGINATED BY	F.P.
DIST 54 HWY 69	BOREHOLE TYPE	Dynamic Cone Penetration Test	COMPILED BY	G.D.
DATUM Geodetic	DATE	February 08, 2009	CHECKED BY	C.N.

[illegible]

**RECORD OF PENETRATION TEST No 310-24      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69(New), Sta. 13+325, o/s 54.0m Lt. CL Med.      ORIGINATED BY F.P.  
 DIST 54      HWY 69      BOREHOLE TYPE Dynamic Cone Penetration Test      COMPILED BY G.D.  
 DATUM Geodetic      DATE February 08, 2009      CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							
179.4 15.0	Probable silt	<div><div></div><div></div><div></div></div>					179	<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>							
178.8 15.6	End of dynamic cone penetration test  Refusal on probable bedrock							<div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div></div>							

**RECORD OF BOREHOLE No 310-25**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+325, o/s 25.0m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE February 07, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										W <sub>p</sub>	w	W <sub>L</sub>					
								○ UNCONFINED      + FIELD VANE													● QUICK TRIAXIAL      × LAB VANE				
								20   40   60   80   100													20   40   60				
194.4	Ground Surface																								
0.0	Peat, coarse fibrous Dark brown		1	CS	-																				
	fine fibrous																								
	amorphous layers of organic silt		2	SS	WH**																				
			3	SS	WH																				

**RECORD OF BOREHOLE No 310-25**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+325, o/s 25.0m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 07, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub> w                      w <sub>L</sub>							
								○ UNCONFINED                      + FIELD VANE ● QUICK TRIAXIAL                      × LAB VANE					WATER CONTENT (%)							
179.4								20	40	60	80	100		20	40	60				
	trace gravel sand layers		11	SS	7		179													
177.6	Loose to compact						178													
16.8	End of borehole Refusal on probable bedrock																			
	<div>*      2009   02   07</div> <div>▽      Water level observed during drilling</div> <div>▼      Water level measured after drilling</div> <div>WH**    Penetration due to the weight of rods and hammer</div> <div>WR***   Penetration due to the weight of rods only</div>																			

**RECORD OF BOREHOLE No 310-26**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+350, o/s 38.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 06, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × LAB VANE					W <sub>P</sub>	W	W <sub>L</sub>		WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
194.3	Ground Surface						20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						</

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 310-27**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+375, o/s 53.5m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE February 07, 2009 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
194.3	Ground Surface																
0.0	Peat, coarse fibrous Dark brown		1	SS	WH**	▽* ▽*	194										
	fine fibrous						193										
			2	SS	WH										234		
							192										
	amorphous layers of organic silt																
			3	SS	WH		191								116		
190.3																	
4.0	Clay, trace sand varved						190										
	Soft Grey Wet		4	SS	WH												0 1 23 76
				FV			189	+	2								
			5	TW	PM		188								110		
				FV				+	4								
187.0																	
7.3	Silty clay, trace sand clayey silt layers						187										
	Firm Grey Wet		6	TW	PM											16.7	0 1 52 47
				FV			186	+	4								
185.3																	
9.0	Silt, trace clay clayey silt layers						185										
	Very loose Grey Wet		7	SS	1												
	sand layers																
184.1																	
10.2	End of borehole																
	Refusal on probable bedrock																



# RECORD OF BOREHOLE No DCPGL3A-7 1 OF 1 METRIC

G.W.P. 5377-02-00 LOCATION Hwy 69-Grundy Lake 3A-Sta 16+275.25 LT, Co-ords: 5089356N 220737E ORIGINATED BY K. Crowe  
 DIST 54 HWY 69 BOREHOLE TYPE Tripod with Dynamic Cone Penetration Test COMPILED BY C. Roy  
 DATUM Geodetic DATE 2005.02.25 CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
195.5 0.0	Ice Surface probable peat											
191.2 4.3	possible CLAY											
187.6 7.9	End of Dynamic Cone Penetration Test											

3, x 3 Numbers refer to  
Sensitivity

3% STRAIN AT FAILURE

ONTARIO MOT. GRUNDY LAKE SWAMP GEJ. ONTARIO MOT. GDT. 05/08/26

RECORD OF BOREHOLE No DCPGL3A-8

1 OF 1

METRIC

G.W.P. 5377-02-00

LOCATION Hwy 69-Grundy Lake 3A - Sta 16+375 23 LT. Co-ords: 5089454N, 220758E

ORIGINATED BY K. Crowe

DIST 54 HWY 69

BOREHOLE TYPE Tripod with Dynamic Cone Penetration Test

COMPILED BY C. Roy

DATUM Geodetic

DATE 2005.02.25

CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC NATURAL LIMIT MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
195.5 0.0	Ice Surface probable peat											
188.6 7.0	Possible SAND											
187.6 7.9	End of Dynamic Cone Penetration Test											

ONTARIO MOT GRUNDY LAKE SWAMP GPJ ONTARIO MOT GOT 05/08/26

RECORD OF BOREHOLE No DCPGL3A-9

1 OF 1

METRIC

G.W.P. 5377-02-00

LOCATION

Hwy 69-Grundy Lake 3A-Sta 16+275 1B 5 RT, Co-ords: 5089347N, 220780E

ORIGINATED BY K. Crowe

DIST 54 HWY 69

BOREHOLE TYPE

Trnpoed with Dynamic Cone Penetration Test

COMPILED BY C. Roy

DATUM Geodetic

DATE

2005.02.15

CHECKED BY T. Crilly

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			TEST VALUES	20	40	60	80			100
159.5	Ice Surface													
0.0	probable peat													
152.8														
8.7	possible CLAY													
150.1														
9.4	possible SAND													
149.1														
10.4	End of Dynamic Cone Penetration Test													

+ 3, x 3

Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

ONTARIO MOT. GRUNDY LAKE SWAMP GPJ. ONTARIO MOT. GOT. 0508/26

195.5

RECORD OF BOREHOLE No DCPGL3A-10 1 OF 1 METRIC

G.W.P. 5377-02-00 LOCATION Hwy 69-Grundy Lake 3A-Sta 16+375 18.5 RT. Co-ords: 5089445N, 220801E ORIGINATED BY K. Crowe  
DIST 54 HWY 69 BOREHOLE TYPE Tripod with dynamic cone penetrometer COMPILED BY C. Roy  
DATUM Geodetic DATE 2005 02 25 CHECKED BY T. Cully

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
195.5 0.0	Ice Surface probable peat												
193.4 2.1	possible CLAY												
188.8 6.7	End of Dynamic Cone Penetration Test												

ONTARIO MOT GRUNDY LAKE SWAMP GPJ ONTARIO MOT GDT 05/06/26

# RECORD OF BOREHOLE No GL3A-16

1 OF 1

METRIC

G.W.P. 5377-02-00 LOCATION Hwy 69-Grundy Lake 3A-Sla 15+300 18.5 RT, Co-ords: 5088393N: 220760E  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Hollow Stem Auger  
 DATUM Geodetic DATE 2005 01 28  
 ORIGINATED BY K. Crowe  
 COMPILED BY C. Roy  
 CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
191.8	Ground Surface												
0.0	Peat, black, frozen												
190.3													
1.5	Clayey Silt, brown, moist, soft, trace oxidation, trace roots		1	SS	2								0 1 82 17
189.5													
2.3	End of Borehole Auger Refusal on Probable Bedrock												

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

ONTARIO MOT GRUNDY LAKE SWAMP GPJ ONTARIO MOT GDT 05/08/26

# RECORD OF BOREHOLE No GL3A-17

1 OF 1

METRIC

G.W.P. 5377-02-00

LOCATION

Hwy 69-Grundy Lake 3A-Sta 16+175 18 LT. Co-ords 5089258N, 220721E

ORIGINATED BY K. Crowe

DIST 54 HWY 69

BOREHOLE TYPE

Continuous Hollow Stem Auger

COMPILED BY C. Roy

DATUM Geodetic

DATE

2005 01 28

CHECKED BY T. Crilly

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 X LAB VANE 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT W <sub>p</sub> W W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES						
194.5	Water Surface										
0.0	Water										
193.9											
0.6	Peat, black, wet, fibrous										
193.5											
1.1	Clay, gray, wet, very soft										
			1	SS	WH						
			2	VANE							
			3	SS	WH						
			4	VANE							
189.4											
5.2	End of Borehole										
	Auger Refusal on Probable Bedrock										
	Groundwater encountered at surface at time of drilling										

3 X 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT GRUNDY LAKE SWAMP GPJ ONTARIO MOT GDT 05/08/28

RECORD OF BOREHOLE No GL3A-18

1 OF 1

METRIC

G.W.P. 5377-02-00

LOCATION

Hwy 69-Grundy Lake 3A-STA 16+175 18.5 RT. Co-ords. 5089250N 220757E

ORIGINATED BY K. Crowe

DIST 54

HWY 69

BOREHOLE TYPE

Continuous Hollow Stem Auger

COMPILED BY C. Roy

DATUM Geodetic

DATE

2005 01 28

CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
194.5	Water Surface													
0.0	Water													
193.5														
193.2	Peat, black, wet, some wood													
1.2	Clay, grey, wet to moist, very soft													
			1	SS	WH									
			2	VANE										
191.7														
2.7	End of Borehole													
	Refusal on Probable Bedrock													
	Groundwater encountered at surface at time of drilling													

+ 3 x 3

Numbers refer to  
Sensitivity

○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No GL3A-19

1 OF 1

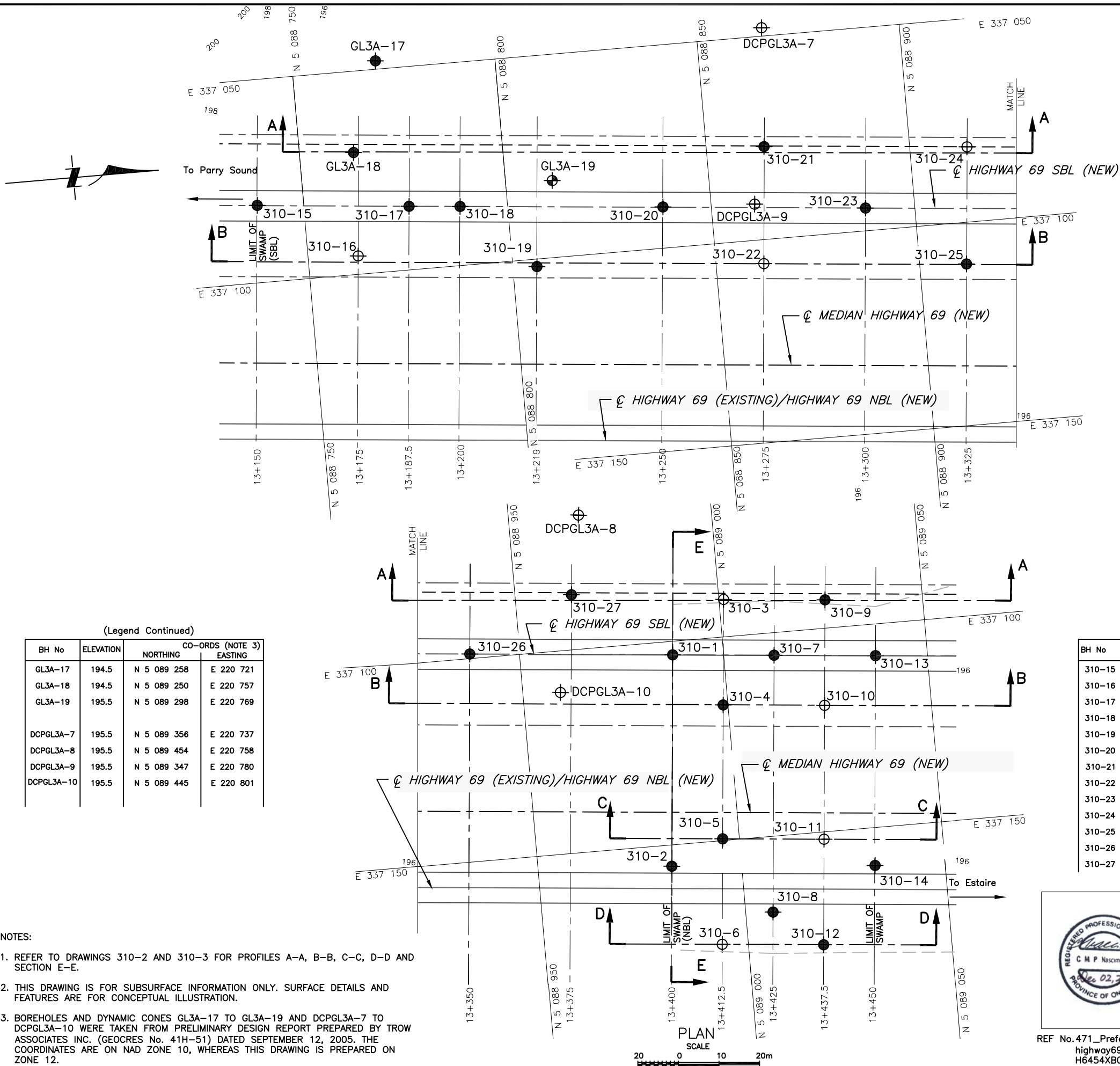
METRIC

G.W.P. 5377-02-00 LOCATION Hwy 69-Grundy Lake 3A-STA 16+225 18.5 RT, Co-ords 5089298N, 220769E  
 DIST 54 HWY 69 BOREHOLE TYPE Tripod with Dynamic Cone Penetration Test  
 DATUM Geodetic DATE 2005 02 25  
 ORIGINATED BY K. Crowe  
 COMPILED BY C. Roy  
 CHECKED BY T. Crilly

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT $\gamma$ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N-VALUES						
195.6	Water Surface										
0.6	Water										
195.0											
0.3	Peat, black, very wet, very soft, fibrous, trace clay seams		1	SS	WH						
			2	SS	1						
190.8											
4.7	Sand, brown, wet, very loose		3	SS	2						
188.4											
7.1	Clay, gray, very wet, firm, intermediate plasticity, some silt		4	SS	2						
185.9											
9.6	Dynamic Cone Penetration Test started probable clay										
182.5											
13.0	End of Dynamic Cone Penetration Test Groundwater encountered at surface at time of drilling										

ONTARIO MOT GRUNDY LAKE SWAMP GPJ, ONTARIO MOT, GDT 05/08/26





NOTES:

- REFER TO DRAWINGS 310-2 AND 310-3 FOR PROFILES A-A, B-B, C-C, D-D AND SECTION E-E.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- BOREHOLES AND DYNAMIC CONES GL3A-17 TO GL3A-19 AND DCPGL3A-7 TO DCPGL3A-10 WERE TAKEN FROM PRELIMINARY DESIGN REPORT PREPARED BY TROW ASSOCIATES INC. (GEOCREs No. 41H-51) DATED SEPTEMBER 12, 2005. THE COORDINATES ARE ON NAD ZONE 10, WHEREAS THIS DRAWING IS PREPARED ON ZONE 12.

(Legend Continued)

BH No	ELEVATION	CO-ORDS (NOTE 3)	
		NORTHING	EASTING
GL3A-17	194.5	N 5 089 258	E 220 721
GL3A-18	194.5	N 5 089 250	E 220 757
GL3A-19	195.5	N 5 089 298	E 220 769
DCPGL3A-7	195.5	N 5 089 356	E 220 737
DCPGL3A-8	195.5	N 5 089 454	E 220 758
DCPGL3A-9	195.5	N 5 089 347	E 220 780
DCPGL3A-10	195.5	N 5 089 445	E 220 801

(Legend Continued)

BH No	ELEVATION	STA	o/s CL MED
		MOWAT TWP	
310-15	195.9	13+150	38.8m Lt.
310-16	194.5	13+175	26.5m Lt.
310-17	193.9	13+187.5	38.8m Lt.
310-18	194.3	13+200	38.8m Lt.
310-19	194.4	13+219	24.0m Lt.
310-20	194.4	13+250	38.8m Lt.
310-21	194.7	13+275	54.0m Lt.
310-22	194.4	13+275	25.0m Lt.
310-23	194.4	13+300	38.8m Lt.
310-24	194.4	13+325	54.0m Lt.
310-25	194.4	13+325	25.0m Lt.
310-26	194.3	13+350	38.8m Lt.
310-27	194.3	13+375	53.5m Lt.

(Legend Continues)

BH No	ELEVATION	STA	o/s CL MED
		MOWAT TWP	
310-1	195.0	13+400	38.8m Lt.
310-2	196.1	13+400	13.3m Rt.
310-3	195.0	13+412.5	52.5m Lt.
310-4	195.0	13+412.5	26.5m Lt.
310-5	194.9	13+412.5	6.5m Rt.
310-6	195.5	13+412.5	32.5m Rt.
310-7	195.0	13+425	38.8m Lt.
310-8	196.3	13+425	24.5m Rt.
310-9	195.0	13+437.5	52.5m Lt.
310-10	195.0	13+437.5	26.5m Lt.
310-11	195.0	13+437.5	6.5m Rt.
310-12	195.8	13+437.5	32.5m Rt.
310-13	195.2	13+450	38.8m Lt.
310-14	196.4	13+450	12.9m Rt.

(Legend Continues)

- 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. 41H-75

HWY No	69	DIST	54
SUBM'D	NSB	CHECKED	GD
DRAWN	NA	CHECKED	CN
DATE	DEC. 02, 2009	DATE	DEC. 02, 2009
APPROVED	BRG	APPROVED	BRG
SITE	---	SITE	---
DWG	310-1	DWG	310-1

METRIC

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

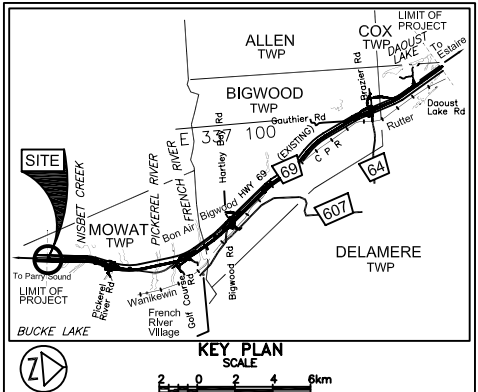
CONT No  
GWP No 5203-06-00

HIGHWAY 69  
HIGHWAY 69 FOUR-LANING  
SWAMP 310, STA. 13+150 TO 13+450 MOWAT TWP  
BOREHOLE LOCATIONS



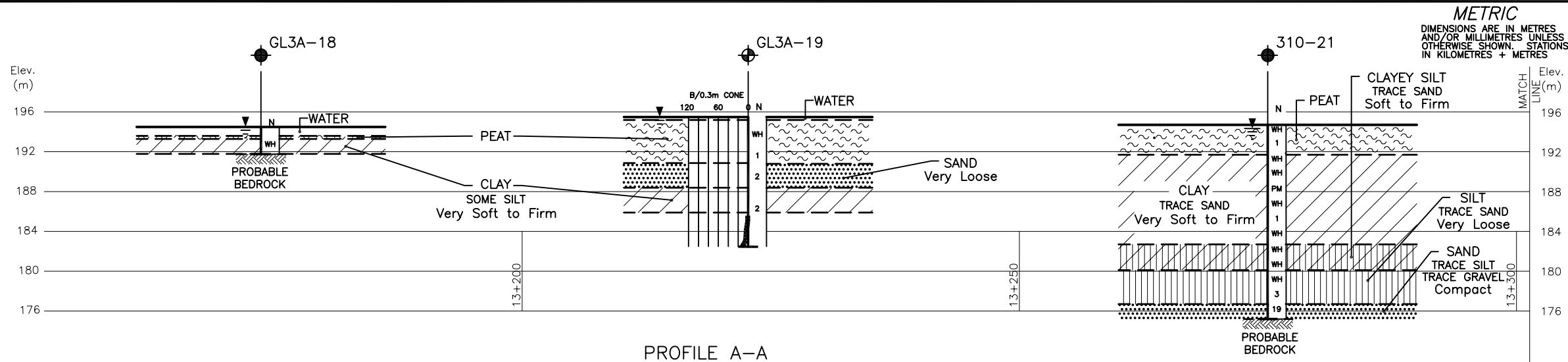
SHEET

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



LEGEND

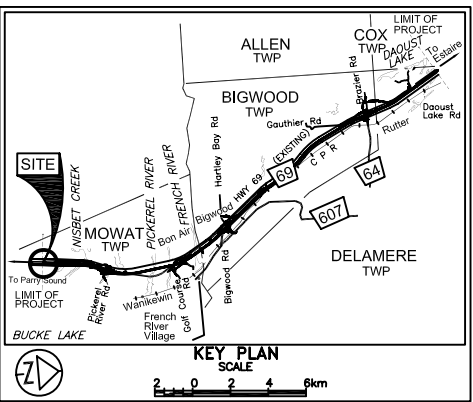
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60 Cone, 475 J/blow)
- WH Penetration due to weight of hammer and rods
- W L at time of investigation Oct 2006, Mar 2007 and Feb 2009
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER



**CONT No**  
**GWP No 5203-06-00**

**HIGHWAY 69**  
HIGHWAY 69 FOUR-LANING  
SWAMP 310, STA. 13+150 TO 13+450 MOWAT TWP

**SOIL STRATA**



**LEGEND**

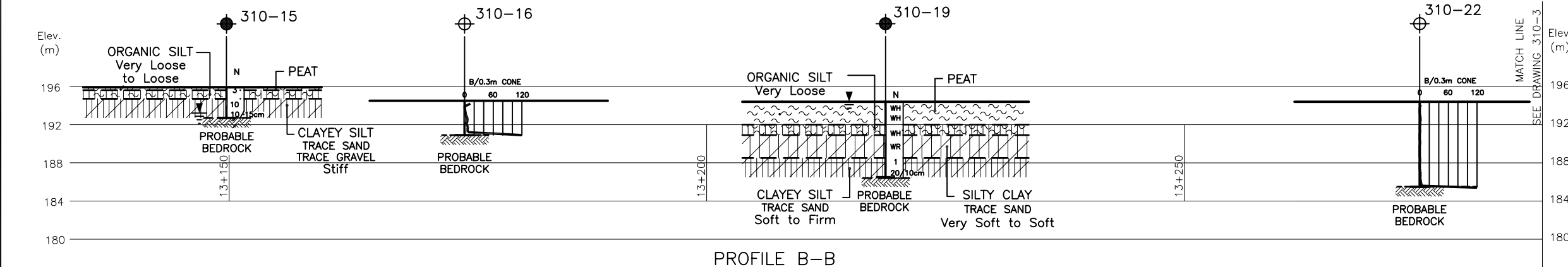
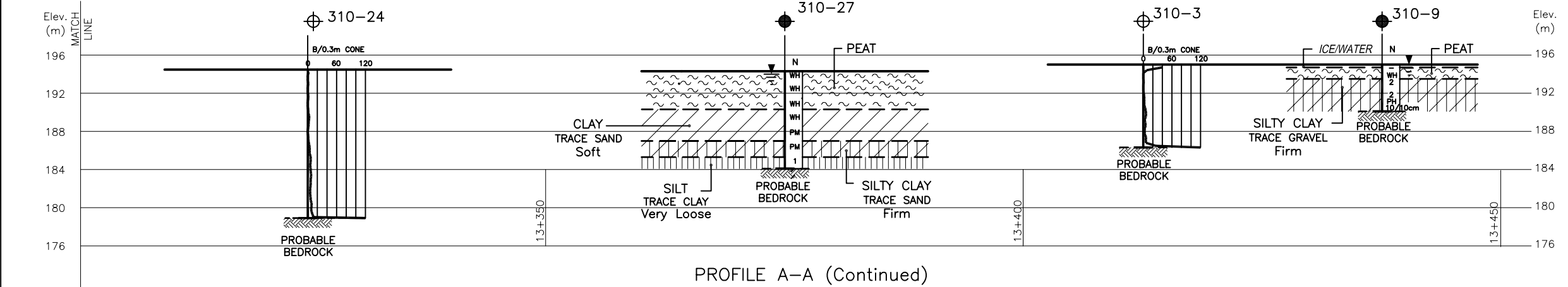
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60' Cone, 475 J/blow)
- WH Penetration due to weight of hammer and rods
- WR Penetration due to weight of rods only
- PM Thinwall Sample - Advanced Manually
- W L at time of investigation Oct 2006, Mar 2007 and Feb 2009
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	STA MOWAT TWP	o/s CL MED
SEE DRAWING 310-1 FOR DETAILS			

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

DATE	BY	DESCRIPTION

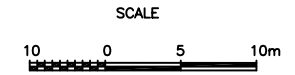
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SUBM'D NSB	CHECKED GD	DATE DEC. 02, 2009
DRAWN NA	CHECKED CN	APPROVED BRG
		SITE --
		DWG 310-2



**NOTES:**

1. REFER TO DRAWING 310-1 FOR BOREHOLE LOCATIONS PLAN AND DRAWING 310-3 FOR PROFILES B-B (Continued), C-C, D-D AND SECTION E-E.

THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.



REGISTERED PROFESSIONAL ENGINEER  
C. M. P. Nascimento  
DEC. 02, 2009  
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER  
B. R. GRAY  
DEC. 02, 2009  
PROVINCE OF ONTARIO

REF No. 471\_Preferred\_Plan\_PDR\_FINAL1.dwg;  
highway 69 basemapping\sept14\_2007\  
H6454xb02 contours zone 12.dwg;








CONT No  
GWP No 5203-06-00

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**HIGHWAY 69**  
HIGHWAY 69 FOUR-LANING  
SWAMP 310, STA. 13+150 TO 13+450 MOWAT TWP

**SOIL STRATA**

The map shows the project location (indicated by a circle and arrow) near the intersection of Highway 69 and Highway 64. The project is situated south of the Pickering River and French River, and west of the Highway 69 corridor. The map includes labels for various roads and landmarks, such as Nisbet Creek, Pickering River, French River, and the Highway 69 corridor. The map also shows the boundaries of the Municipality of the County of York and the Townships of Allen, Bigwood, Mowat, Delamere, and Buckle. A compass rose and a scale bar (0 to 6 km) are included.

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)
WH	Penetration due to weight of hammer and rods
WR	Penetration due to weight of rods only
PM	Thinwall Sample – Advanced Manually
	W L at time of investigation Oct 2006, Mar 2007 and Feb 2009
	Head
	ARTESIAN WATER
	Encountered
	PIEZOMETER

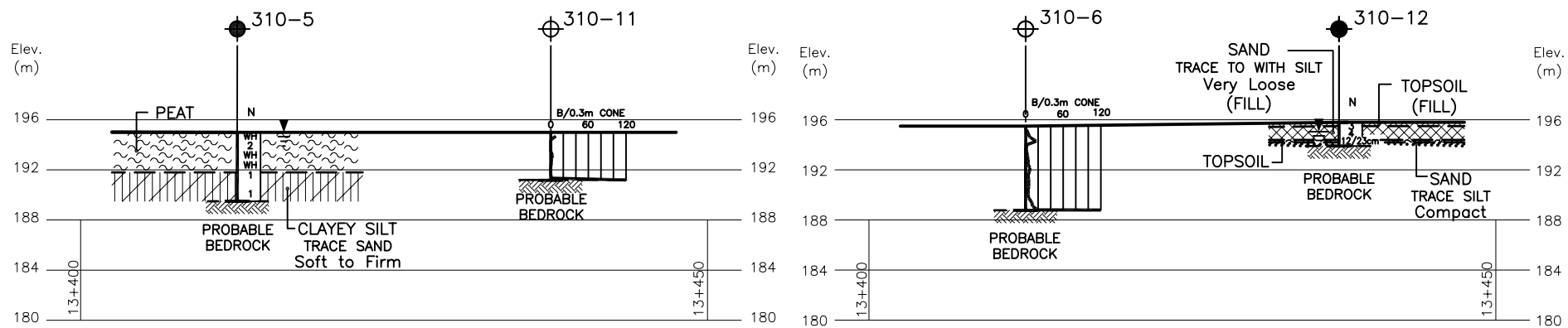
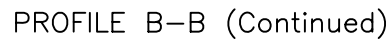
BH No	ELEVATION	STA MOWAT TWP	o/s CL MED
SEE DRAWING 310-1 FOR DETAILS			

- NOTE -

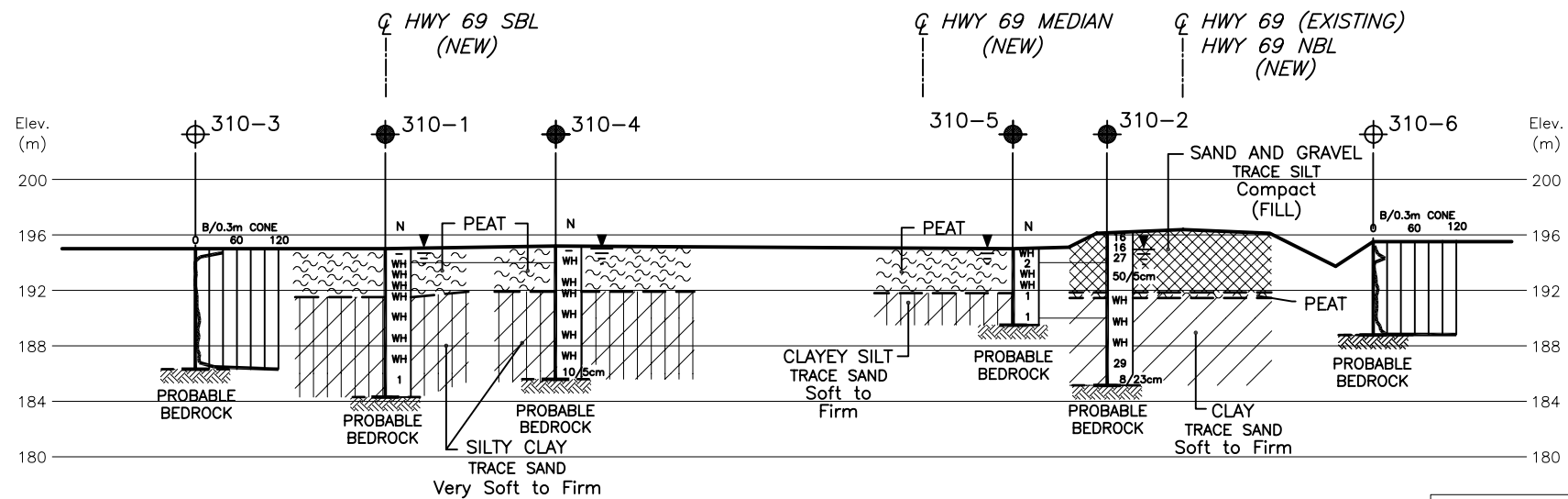
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

HWY No	69			DIST	54
SUBM'D	NSB	CHECKED	GD	DATE	DEC. 02, 2009
DRAWN	NA	CHECKED	CN	APPROVED	BRG
				DWG	310-3



PROFILE D-D



SECTION E-E

SCALE

10 0 5 10m



**TABLE 1**  
**SUMMARY OF SUBSOIL CONDITIONS AND RECOMMENDED TREATMENT**

PML SWAMP No.	LOCATION	ADDITIONAL FILL HEIGHT, m	DEPTH TO COMPETENT SOIL, m	SOIL BELOW EXCAVATION BASE	DEPTH TO PROBABLE BEDROCK, m	EXCAVATION PROCEDURE	RECOMMENDED TREATMENT
HIGHWAY 69 MAINLINE							
310	Sta. 13+400 to 13+450 (NBL)	~0.0 (NBL)	3.2 – 15.0	Very loose to compact silt / sand extending to bedrock	1.9 – 19.5 (El. 175.2 – 193.9)	Not required	NBL – Pavement rehabilitation
	Sta. 13+150 to 13+190 (SBL)	1.5 – 3.5 (SBL)				Earth excavation	SBL – Full excavation of compressible soils
	Sta. 13+425 to 13+450 (SBL)						SBL – Partial excavation to elevation 187 and preloading / surcharging
	Sta. 13+190 to 13+425 (SBL) Township of Mowat						

- NOTES:
1. Embankment fill height is based on profile prepared by MRC in April 2009 and received by PML on June 18, 2009.
  2. Depths to competent soil and probable bedrock are based on both borehole and dynamic cone penetration test data.
  3. Swamp excavation is expected where substantial thickness of peat and organic clay occurs. All peat and organic soils are to be removed from the swamp crossings.
  4. Recommendation of pavement rehabilitation assumes no centreline shift as well as adequacy of platform width.
  5. Recommended surcharge period and estimated settlement due to surcharging are given in Table 3.



**TABLE 3**  
**SETTLEMENT OF EMBANKMENT SURFACE**

SWAMP No.	RECOMMENDED TREATMENT OPTION	FILL HEIGHT (m)	TOTAL ROCKFILL SETTLEMENT (mm)	RECOMMENDED SURCHARGE PERIOD (months)	SETTLEMENT DUE TO SURCHARGE (mm)	REMAINING LONG-TERM SETTLEMENT (mm)
<b>HIGHWAY 69 MAINLINE</b>						
310				N/A		
Sta. 13+400 to 13+450 (NBL)	NBL – Pavement rehabilitation	~0.0	N/A			
Sta. 13+150 to 13+190 (SBL)	SBL – Full excavation of compressible soils	1.5 – 3.5	70 – 165	12	100	65
Sta. 13+425 to 13+450 (SBL)						
Sta. 13+190 to 13+425 (SBL)	SBL – Partial excavation to elevation 187 and preloading / surcharging		510 (see Note 3)	24 / 36	470 / 490	40 / 20
Township of Mowat						

- Notes:
1. Crossing 304 is located in rock cuts area.
  2. Includes rockfill settlement above and below grade / water table.
  3. Includes consolidation settlement of clayey subgrade soil left in place.
  4. Refer to Section 2.3.3 of the report for estimated rate of settlement.
  5. Recommended surcharge period is estimated to induce some 60% reduction in post-construction settlements.
  6. Settlement due to surcharging is based on a surcharge height of 2 m except at crossings 305 (NBL) and 306 (NBL).
  7. Surcharge period of 12 months is required for all embankment widening sections.



**TABLE 4**  
**SUMMARY OF DEPTH TO COMPETENT SOIL**

SWAMP No.	TEST HOLE No.	LOCATION OF EXCAVATION TO COMPETENT SOIL	COMPETENT SOIL AT	
			DEPTH (m)	ELEVATION
310	310-1	Sta. 13+400, o/s 38.8m Lt. CL median	10.7 (8.0)	184.3 (187.0)
	310-2 (*)	Sta. 13+400, o/s 13.3m Rt. CL median	11.0	185.1
	310-3	Sta. 13+412.5, o/s 52.5m Lt. CL median	8.7 (8.0)	186.3 (187.0)
	310-4	Sta. 13+412.5, o/s 26.5m Lt. CL median	9.6 (8.0)	185.4 (187.0)
	310-7	Sta. 13+425, o/s 38.8m Lt. CL median	5.8	189.2
	310-8 (*)	Sta. 13+425, o/s 24.5m Rt. CL median	2.9	193.4
	310-12	Sta. 13+437.5, o/s 32.5m Rt. CL median	1.6	194.2
	310-14 (*)	Sta. 13+450, o/s 12.9m Rt. CL median	4.1	192.3
	310-18	Sta. 13+200, o/s 38.8m Lt. CL median	10.2 (7.3)	184.1 (187.0)
	310-19	Sta. 13+219, o/s 24.0m Lt. CL median	7.9 (7.4)	186.5 (187.0)
	310-20	Sta. 13+250, o/s 38.8m Lt. CL median	11.9 (7.4)	182.5 (187.0)
	310-21	Sta. 13+275, o/s 54.0m Lt. CL median	14.6 (7.7)	180.1 (187.0)
	310-22	Sta. 13+275, o/s 25.0m Lt. CL median	8.9 (7.4)	185.5 (187.0)
	310-23	Sta. 13+300, o/s 38.8m Lt. CL median	15.0 (7.4)	179.4 (187.0)
	310-24	Sta. 13+325, o/s 54.0m Lt. CL median	15.0 (7.4)	179.4 (187.0)
	310-25	Sta. 13+325, o/s 25.0m Lt. CL median	13.4 (7.4)	181.0 (187.0)
	310-26	Sta. 13+350, o/s 38.8m Lt. CL median	14.0 (7.3)	180.3 (187.0 )
	310-27	Sta. 13+375, o/s 53.5m Lt. CL median	9.0	185.3



**TABLE 4**  
**SUMMARY OF DEPTH TO COMPETENT SOIL**

SWAMP No.	TEST HOLE No.	LOCATION OF EXCAVATION TO COMPETENT SOIL	COMPETENT SOIL AT	
			DEPTH (m)	ELEVATION
310	GL3A-19	(See Drawing 310-1 for location)	>13.0 (8.5)	<182.6 (187.0)
	DCPGL3A-7	(See Drawing 310-1 for location)	>7.9 (8.5)	<187.6 (187.0)
	DCPGL3A-8	(See Drawing 310-1 for location)	7.0	188.5
	DCPGL3A-9	(See Drawing 310-1 for location)	9.4 (8.5)	186.1 (187.0)
	DCPGL3A-10	(See Drawing 310-1 for location)	>6.7 (8.5)	<188.8 (187.0)

- NOTES:
1. Competent soil is either bedrock or probable bedrock for all other test hole locations.
  2. Swamp excavation is to primarily remove peat/topsoil and cohesive (clayey) soils.
  3. Allowance for additional 100 to 300 mm penetration of rockfill below the levels indicated should be made depending on the relative density of underlying soils.
  4. (\*) Under existing Hwy 69/New NBL pavement, cohesive soils need not be excavated for road grade raises less than 0.5 m.
  5. Depths/elevations in brackets correspond to base of excavation for recommended treatment.



**TABLE 5**  
**ADVANTAGES, DISADVANTAGES AND RELATIVE COSTS OF SWAMP TREATMENT ALTERNATIVES**

<b>PML SWAMP No.</b>	<b>TREATMENT TYPE</b>	<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>	<b>RELATIVE COSTS</b>	<b>RISKS/ CONSEQUENCES</b>	<b>RANK</b>
310 (SBL)	Full excavation (3.2 to 15.0 m)	<ul style="list-style-type: none"> <li>Minimises issues of stability and long-term settlement by removing all soft and compressible soils</li> <li>Facilitates future highway maintenance</li> </ul>	<ul style="list-style-type: none"> <li>Increased disposal of excavated soil</li> <li>Increased rockfill quantities</li> </ul>	<ul style="list-style-type: none"> <li>Increased costs for swamp excavation</li> <li>Increased costs for soil disposal</li> <li>Increased rockfill costs</li> </ul>	<ul style="list-style-type: none"> <li>Lesser risk than other options due to higher safety factor for stability</li> <li>Controlled long-term settlements</li> </ul>	<p>2</p> <p>3 (Sta. 13+190 to 13+425)</p>
	Partial excavation to elevation 187 and preloading/ surcharging	<ul style="list-style-type: none"> <li>Reduced disposal of excavated soil</li> <li>Reduced rockfill quantities</li> <li>Surcharging reduces post-construction settlements</li> </ul>	<ul style="list-style-type: none"> <li>Increased long-term settlements in relation to full excavation option</li> <li>Potentially requires more frequent highway maintenance to correct settlements</li> </ul>	<ul style="list-style-type: none"> <li>Cost savings in swamp excavation, rockfill quantities and disposal of excavated soil are offset by future maintenance costs</li> </ul>	<ul style="list-style-type: none"> <li>Adequate safety factor for stability</li> <li>Settlements of embankment rockfill and foundation soil</li> <li>Settlements due to secondary consolidation will occur</li> </ul>	<p>1 (Sta. 13+190 to 13+425)</p>
	Wick drains	<ul style="list-style-type: none"> <li>Reduced disposal of excavated soil</li> <li>Reduced rockfill quantities</li> <li>Increased rate of consolidation settlements in relation to preloading / surcharging option</li> </ul>	<ul style="list-style-type: none"> <li>Potentially requires more frequent highway maintenance to correct settlements</li> <li>Requires monitoring of settlements during construction and may induce construction schedule delays</li> </ul>	<ul style="list-style-type: none"> <li>Cost savings in rockfill quantities and disposal of excavated soil are offset by material, installation and future maintenance costs for depths less than 8 m</li> <li>No significant estimated cost savings for the use of wick drain in this section</li> </ul>	<ul style="list-style-type: none"> <li>Settlements of embankment rockfill and foundation soils</li> <li>Settlements due to secondary consolidation will occur</li> </ul>	<p>3</p> <p>2 (Sta. 13+190 to 13+425)</p>

- Notes:
- Crossing 304 is located in rock cuts area where swamp excavation is not required.
  - Swamp sections where road rehabilitation is planned were not discussed since no excavation/treatment is required. These include the NBL sections in swamps 307 to 310.
  - The following Alternative Swamp Treatment options were considered not applicable to most swamps and were excluded from the discussion in this Table:
    - Partial excavation and preloading / surcharging (recommended only for the SBL section in swamp 310)
    - Construction of a bridge to span the swamp/compressible soil (too costly)
    - Lengthening the construction schedule (not practical/acceptable)
    - Use of lightweight fill (too costly for current project)



**TABLE 6**  
**TEMPORARY BACKSLOPE INCLINATION FOR SWAMP EXCAVATION**

SWAMP NO.	TEMPORARY BACKSLOPE FOR SWAMP EXCAVATION (H:V)
310	Sta. 13+190 to 13+425 (SBL) – 2:1
	Other locations – 1:1

NOTE:

1. Recommended sideslopes for new embankment construction are 1.25H:1V for rockfill and 2H:1V for earth fill.