



**FOUNDATION INVESTIGATION REPORT**

**for**

**OJIBWAY CANYON-CULVERT C8 (MOWAT TOWNSHIP)  
HIGHWAY 69 FOUR-LANING  
FROM 3.5 KM NORTH OF HWY 522  
TO 10.7 KM NORTH OF HWY 522  
G.W.P. 5203-06-00 (PART OF G.W.P. 5378-02-00)  
SUDBURY AREA, ONTARIO**

***PHASE 3: STA. 13+100 TO 21+500 (TOWNSHIP OF MOWAT)***

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**FOUNDATION INVESTIGATION REPORT**  
for  
Ojibway Canyon-Culvert C8  
Highway 69 Four-Laning  
From 3.5 km North of Hwy 522  
To 10.7 km North of Hwy 522  
G.W.P. 5203-06-00 (Part of G.W.P. 5378-02-00)  
Sudbury Area, Ontario

*PHASE 3:   Sta. 13+100 to 21+500 (Township of Mowat)*

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**1.   INTRODUCTION**

This report summarizes the results of the foundation investigation carried out for culvert site C8 which is located within the Ojibway Canyon at Sta. 20+805 in the Township of Mowat. The installation of box culvert C8 is planned within the Phase 3 of the realignment and four-laning of the section of Highway 69 that extends from 3.5 km north of Highway 522 to 10.7 km north of Highway 522, District 54, Sudbury, Ontario. Peto MacCallum Ltd. (PML) conducted the foundation investigation for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

**2.   SITE DESCRIPTION AND GEOLOGY**

The Ojibway Canyon section of the realignment and four-laning of Highway 69 is located about 70 km south of Sudbury.

The study area is located in the Precambrian Laurentian peneplane. In general, the topography of the study area is irregular with shallow bedrock sections and deep swamp deposits. Pleistocene lacustrine/fluvial deposits and recent swamp sediments have been laid down in depressions and are probably associated with the Nipissing post-glacial stage of the Great Lakes. The ground cover comprises grasses and typical swamp vegetation, bushes and stands of trees. Locally, the bottom of the Ojibway Canyon is covered by swampy ground draining from west to east. The south and north walls of the canyon are nearly 10 to 14 m high and are steeply sloped at about 50 to 80° with the horizontal.



Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting. The bedrock outcrops at many locations throughout the project section.

The mineral soil cover is typically less than 1 m thick and may vary greatly over short distances. In swampy lands, the depth of soil cover may extend to depths exceeding 30 m.

### **3. INVESTIGATION PROCEDURES**

The field work for this study was carried out during February and March 2009 and included five sampled boreholes. Five boreholes designated C8-1 to C8-5 were drilled along the alignment of culvert C8 Highway 69 SBL and NBL. The alignment of the culvert was shifted after boreholes were drilled. Therefore, all boreholes shown on the Drawing C8 are offset from the centreline of the culvert. The boreholes were considered to be representative of the conditions at the relocated culvert location. The boreholes were drilled to depths of 1.2 to 5.2 m, elevations 182.3 to 187.3. Boreholes C8-1, C8-3 and C8-5 were extended by coring 3.1 and 3.2 m into bedrock to a total depth of 5.9 to 8.3 m elevations 179.2 to 182.1. The data was supplemented by data from subsurface investigations for the swamp crossing (borehole 315-6) and possible pier (borehole P1-SBL) during the same period.

The locations of the boreholes put down along the culvert site are shown on the attached Drawing C8.

The borehole locations were established in accordance with the MTO requirements indicated in the RFP and in general accordance with the requirements of the MTO Northeastern Region Pavement Design Practices and Guidelines (May 20, 1997). Callon Dietz Inc., Ontario Land Surveyors laid out the reference lines of the new highway in the field and these lines were used by PML to select the borehole locations. The ground surface elevations at the boreholes were provided by Callon Dietz Inc., Ontario Land Surveyors. The elevations in this report are expressed in metres.



The boreholes were advanced using continuous flight hollow and solid stem augers and NW washboring, powered by track-mounted D-50 drill rig. The equipment was supplied and operated by a specialist drilling contractor working under the full-time supervision of members of PML engineering staff. The culvert boreholes were taken into competent native soils or where bedrock was encountered, the bedrock were extended 3.1 and 3.2 m into bedrock using rotary diamond drilling methods.

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

In boreholes C8-1, C8-2 and C8-3, approximate 3.1 and 3.2 m lengths of rock cores were recovered using NQ rock coring equipment. A PML senior geologist examined and classified the recovered rock core samples. Detailed descriptions of the recovered rock core are provided in Table A.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole.

Upon completion of drilling, all the boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO and MOE Reg. 903 guidelines for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The recovered samples were returned to our laboratory for detailed visual examination and classification. The laboratory testing programme consisted of moisture content determinations and grain size distribution analyses. Atterberg plasticity limits were not attempted on any sample since the soils were identified to be cohesionless (non-plastic) by visual and tactile examination. The laboratory testing program comprised the following tests:

- Natural moisture content determinations (14)
- Grain size analyses (6)



The results of the laboratory natural moisture content determination and grain size distribution analyses are shown on the Record of Borehole Sheets. The grain size distribution charts are presented on Figure C8-GS-1.

#### **4. SUMMARIZED SUBSURFACE CONDITIONS**

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

The borehole locations are shown on Drawing C8. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

##### **4.1 General**

The subsurface stratigraphy revealed in the boreholes generally comprised a surficial peat unit or snow/ice layer overlying a peat unit. The peat unit was underlain by cohesionless sand soils which in turn mantled probable bedrock or bedrock. Locally, the peat unit mantled bedrock. Bedrock/inferred bedrock was contacted at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). Groundwater was observed at 0.1 to 0.6 m depths (elevations 186.5 to 187.7) below the ground surface in all of the boreholes.

Reference should also be made to the boreholes conducted in swamp 315 (borehole 315-6) and for bridge pier of southbound lane of Highway 69 (borehole P1-SBL) that are within proximity of the culvert (borehole P1-SBL). The boreholes reveal consistent soil conditions with bedrock/inferred bedrock contacted at depths of 4.6 to 5.0 m (elevation 182.7 to 183.1) and observed groundwater level at 0.6 m depth (elevation 186.6 and 187.1) below the ground surface.



A description of the subsurface stratigraphy at each culvert location is summarised in the following subsections of the report.

#### **4.2 Snow/Ice**

A 400 and 700 mm thick snow/ice layer was contacted in boreholes C8-2 through C8-5.

#### **4.3 Peat**

The surficial peat unit contacted in borehole C8-1 and beneath the snow/ice layer in boreholes C8-2 through C8-5 were 200 to 500 mm thick and were penetrated at elevations 186.9 and 187.6.

A localized 0.3m thick organic clayey silt was encountered beneath the peat unit at 0.8 m depth (elevation 186.9) in borehole C8-4 and extended to 1.1 m depth (elevation 186.6).

#### **4.4 Sand**

Underlying the peat unit at 0.4 to 0.8 m depths (elevation 186.9 and 187.6) in boreholes C8-1, C8-3 and C8-5 and the organic clayey silt at 1.1 m depth (elevation 186.6) in borehole C8-4, a cohesionless sand deposit was contacted. The deposit was 2.4 and 4.6 m thick and extended to the probable bedrock or underlying bedrock at 2.8 and 5.2 m depths (elevations 182.3 and 185.2). The sand deposit contains some to with gravel trace to with silt trace clay, and cobbles and boulders. The relative density of the deposit was compact to dense. The N values typically ranged from 13 to 38 blows. Higher N values were recorded but reflect the presence of cobbles and boulders or interface of soil with bedrock. A single low N value of 4 was also recorded. The moisture content of the sand deposit ranged between 10 to 22%. The results of grain size distribution analyses conducted on representative samples of the sand deposit are presented in Figure C8-GS-1.



#### **4.5 Bedrock**

Bedrock was contacted in boreholes C8-1, C8-3 and C8-5 at depths of 2.8 to 5.2 m (elevations 182.3 to 185.2). Generally, the bedrock and probable bedrock surfaces encountered in the drilled boreholes for culvert, pier and swamp slope gently downward ( $3^{\circ}$ ) from west end of the culvert (borehole C8-1) to centreline median (borehole C8-3) then become relatively flat between borehole C8-3 to east end of the culvert (borehole C8-5).

The retrieved rock cores comprise dark green to black and grey gabbro and exhibited high strength. A detailed description of the rock cores retrieved from boreholes C8-1, C8-3 and C8-5 is given in the appended Table A.

The measured core recovery was in a range of 98 to 100%. The RQD determined from the rock cores was in a range of 70 to 100, thus indicating a fair to excellent quality rock. Locally, in borehole C8-3, the RQD determined from rock cores at upper zone, 4.9 to 7.6 m depths (elevations 182.8 to 180.1), was 15 and 29 % indicating a very poor to poor quality rock. This is due to presence of very close to close spaced cross joints in the rock.

#### **4.6 Groundwater**

Groundwater was observed in all boreholes at depths of 0.1 to 0.6 m (elevations 186.5 to 187.7) below the ground surface during and upon completion of drilling. During the investigation for the swamp 315 crossing and possible southbound lane pier at the same period of time in February and March 2009, the groundwater was observed at similar depth and elevation (0.6 m depth, elevation 186.6 and 187.1). The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.





## 5. MISCELLANEOUS

The field work was carried out under the supervision of Mr. F. Portela, and the direction of Mr. C.M.P. Nascimento, P.Eng., Senior Foundation Engineer. Walker Drilling Ltd. supplied the drilling equipment. The laboratory work was carried out in the PML laboratory in Toronto. This report was prepared by Mr. C.M.P. Nascimento, P.Eng. with the assistance of Mr. M.J. Narduzzi, BEng., and was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly

Peto MacCallum Ltd.



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



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

CN/BRG:mn-mi-nk



**TABLE A**  
**ROCK CORE DESCRIPTIONS**

LOCATION (BH)	CORE RECOVERY				CORE DESCRIPTION	
	RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
C8-1	5	2.8 – 3.1	100	73	2.8 – 5.9	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough planar with occasional horizontal slickensides, with some vertical fissures, tight to open to 1 mm, generally slightly altered with black silty infilling, occasional white scale, fair to excellent quality.
	6	3.1 – 4.3	100	70		
	7	4.3 – 5.9	100	99		
C8-3	7	4.9 – 6.0	98	15	4.9 – 8.1	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, very close to close spaced (moderate below 7.2 m) flat to dipping cross joints, rough planar with occasional horizontal slickensides, with numerous vertical fissures (some compound), tight to open (5 mm), generally slightly altered with black silty infilling, very poor to poor becoming excellent quality.
	8	6.0 – 7.6	100	29		
	9	7.6 – 8.1	100	100		
C8-5	7	5.2 – 6.3	100	100	5.2 - 8.3	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping (locally vertical) cross joints, rough planar, locally open (to 1 mm), tight to slightly altered with black silt infilling, occasional green scale on parting surface, good to excellent quality.
	8	6.3 – 7.2	100	85		
	9	7.2 – 8.3	100	95		

RQD = Rock Quality Designation

Originated: JFW  
 Compiled: FP  
 Checked: AS / CN

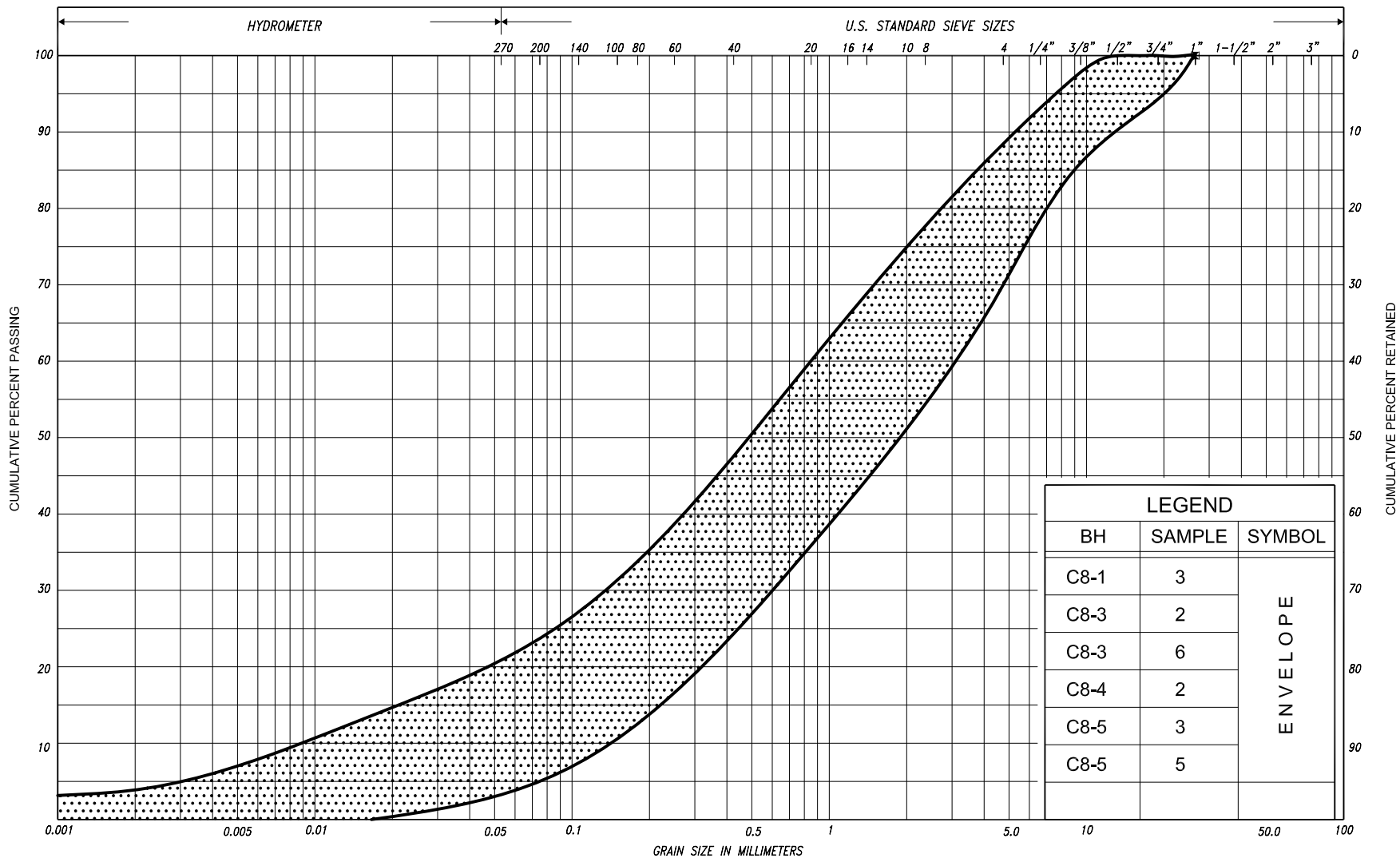


**TABLE A**  
**ROCK CORE DESCRIPTIONS**

LOCATION (BH)	CORE RECOVERY				CORE DESCRIPTION	
	RC	DEPTH (m)	REC (%)	RQD (%)	DEPTH (m)	DESCRIPTION
BRIDGE PIER - SBL Sta. 20+803, O/S 18.8 m LT CL	5	5.0 – 6.1	100	86	5.0 – 9.7	GABBRO: Dark green to black and grey, fine to medium crystalline, high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping cross joints, rough planar with occasional horizontal slickensides, with some vertical fissures, tight to open to 1 mm, generally slightly altered with black silty infilling, occasional white scale, good to excellent quality.
	6	6.1 – 7.6	95	91		
	7	7.6 – 9.1	100	88		
	8	9.1 – 9.7	96	85		

RQD = Rock Quality Designation

Originated: JFW  
 Compiled: FP  
 Checked: AS / CN



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

## GRAIN SIZE DISTRIBUTION

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

FIG No. C8-GS-1

HWY: 69

G.W.P. No. 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 (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	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**

Hwy 69 (New), Sta. 20+807.3, o/s 58m Lt CL Med.

ORIGINATED BY F.P.

COMPILED BY A.S.

CHECKED BY B.R.G.

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

**RECORD OF BOREHOLE No C8-2**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Coords: 5 096 738.2 N; 221 538.6 E  
Hwy 69 (New), Sta. 20+805.7, o/s 38.3m Lt CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
DATUM Geodetic DATE March 02, 2009 CHECKED BY B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
188.5 0.0	Top of Ice Snow and Ice							20	40	60	80	100	20	40	60	kN/m <sup>3</sup>	GR SA SI CL			
187.8 0.7	Peat, coarse fibrous		1	CS	-	▼*	▽*													
187.3 1.2	Dark brown																			
	End of borehole																			
	Refusal on probable boulders																			
	* 2009 03 02																			
	▽ Water level observed during drilling																			
	▼ Water level measured after drilling																			

**RECORD OF BOREHOLE No C8-3**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Coords: 5 096 739.8 N; 221 577.1 E  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Coring ORIGINATED BY F.P.  
DATUM Geodetic DATE February 26 and 28, 2009 COMPILED BY A.S.  
CHECKED BY B.R.G.

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												
187.7	Top of Snow							20	40	60	80	100								
0.0	Snow and ice																			
187.3																				
0.4	Peat, coarse fibrous																			
186.9	Dark brown      Wet		1	SS	20/5cm	▼*	187													
0.8	Sand, with gravel some silt, trace clay cobbles and boulders																			
	Loose to      Grey      Wet compact		2	SS	15		186							○				30 52 15 3		
			3	SS	4		185							○						
			4	SS	16		184							○						
			5	SS	24															
182.8	with silt, some gravel		6	SS	12/17cm		183							○				15 61 20 4		
4.9	Gabbro bedrock																			
	Slightly weathered to unweathered		7	RC NQ	REC 98%		182											RQD 15%		
	Hight strength																			
	Very poor to poor becoming excellent quality		8	RC NQ	REC 100%		181											RQD 29%		
			9	RC NQ	REC 100%		180											RQD 100%		
179.6	End of borehole																			
8.1																				
	Samples 1 & 6: Sampler bouncing																			
	*      2009   02   28																			
	▽      Water level observed during drilling																			
	▼      Water level measured after drilling																			
	C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers																			



**METRIC**

Hwy 69 (New), Sta. 20+799.5, o/s 38.4m Rt CL Med.

ORIGINATED BY F.P.

COMPILED BY A.S.

CHECKED BY B.R.G.

(%) STRAIN AT FAILURE

**METRIC**

Hwy 69 (New), Sta. 20+798, o/s 58m Rt CL Med.

ORIGINATED BY F.P.





COMPILED BY A.S.

CHECKED BY B.R.G.

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

**RECORD OF BOREHOLE No P1-SBL 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Coords: 5 096 737.8 N; 221 558.4 E  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and NQ Diamond Coring ORIGINATED BY F.P.  
 DATUM Geodetic DATE February 18 and 24, 2009 COMPILED BY A.S.  
 CHECKED BY B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  $w_p$	NATURAL MOISTURE CONTENT  $w$	LIQUID LIMIT  $w_L$	UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								$\circ$ UNCONFINED	$\bullet$ QUICK TRIAXIAL	$+$ FIELD VANE	$\times$ LAB VANE									
187.7	Ground Surface							20	40	60	80	100								
0.0	Peat, coarse fibrous		1	CS	-	 *	 *													
187.4	Dark brown		2	SS	10/8cm												5 55 34 6			
0.3	Sand, with silt trace clay, trace gravel cobbles and boulders																			
	Compact Brown Moist		3	CS	-															
			4	CS	-															
182.7	Gabbro bedrock																			
5.0	Slightly weathered to unweathered		5	RC NQ	REC 100%												RQD 86%			
	High strength		6	RC NQ	REC 95%												RQD 91%			
	Good to excellent quality		7	RC NQ	REC 100%												RQD 88%			
			8	RC NQ	REC 96%												RQD 85%			
178.0	End of borehole																			
9.7	Sample 2: Sampler bouncing on cobbles and boulders, Numerous cobbles and boulders detected during drilling																			
	* 2009 02 24																			
	 Water level observed during drilling																			
	 Water level measured after drilling																			
	C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers																			

## 1 of 1

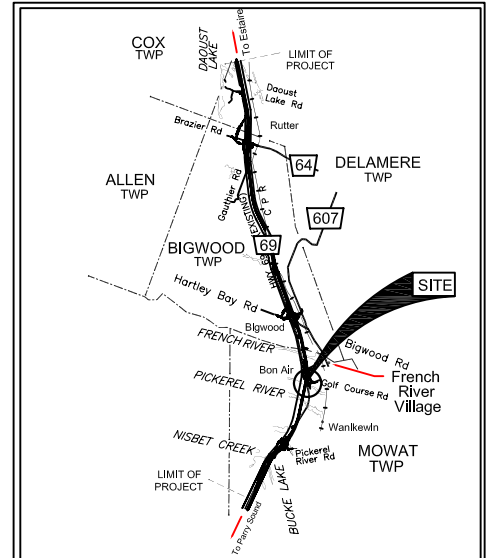
METRIC

## Foundation Design

SOIL PROFILE											
ELEV DEPTH	DESCRIPTION	STRAT PLOT	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 (%)
			NUMBER			TYPE	"N" VALUES	20    40    60    80    100	w <sub>p</sub>		w
187.7 0.0	Top of Ice Snow and ice	[Strat Plot]									
187.2 0.5	Peat, coarse fibrous	[Strat Plot]									
186.8 0.9	Dark brown Sand, some gravel cobbles and boulders Compact Grey Wet	[Strat Plot]	1	SS	12/15cm						24 60 13 3
		[Strat Plot]									
		[Strat Plot]	2	SS	26						
		[Strat Plot]									
183.1 4.6	End of borehole Refusal on probable bedrock Sample 1: Sampler bouncing * 2009 03 01 ∇ Water level observed during drilling ▼ Water level measured after drilling	[Strat Plot]									



SHEET



LEGEND

	Borehole
	Dynamic Cone Penetration Test (Cone)
	Borehole & Cone
N	Blows/0.3m (Std. Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
	W L at time of investigation Feb-Mar 2009
	Head
	ARTESIAN WATER
	Encountered
	PIEZOMETER

BH No	ELEVATION	CO-ORDS	
		NORTHING	EASTING
C8-1	188.0	N 5 096 737.5	E 221 518.9
C8-2	188.5	N 5 096 738.2	E 221 538.6
C8-3	187.7	N 5 096 739.8	E 221 577.1
C8-4	187.7	N 5 096 740.9	E 221 615.5
C8-5	187.5	N 5 096 741.7	E 221 635.2
P1-SBL	187.7	N 5 096 737.8	E 221 558.4
BH No	ELEVATION	STA	o/s CL MED
315-6	187.7	20+800	18.8m Rt.

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

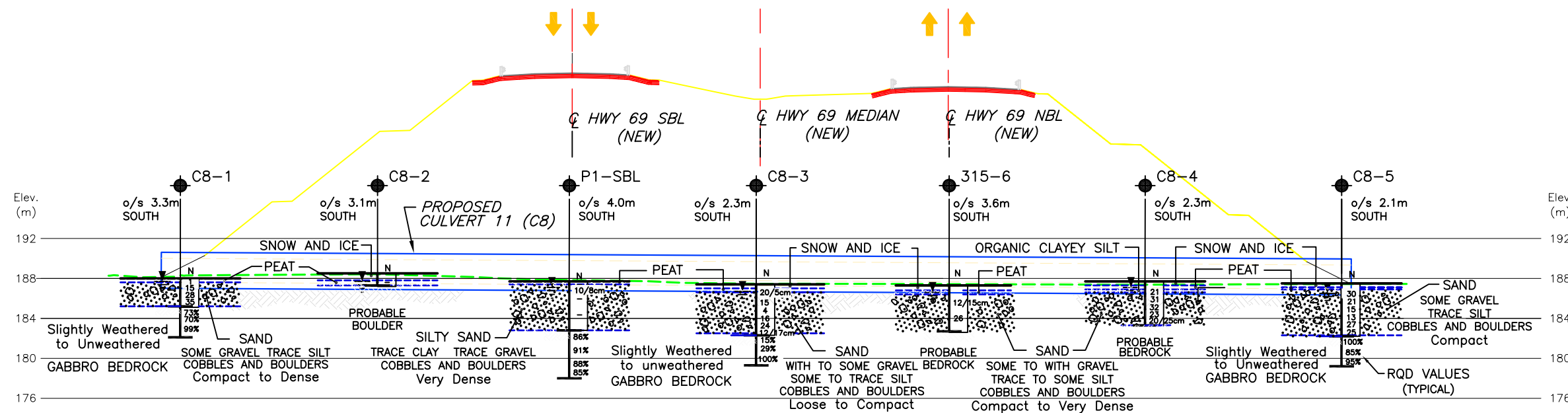
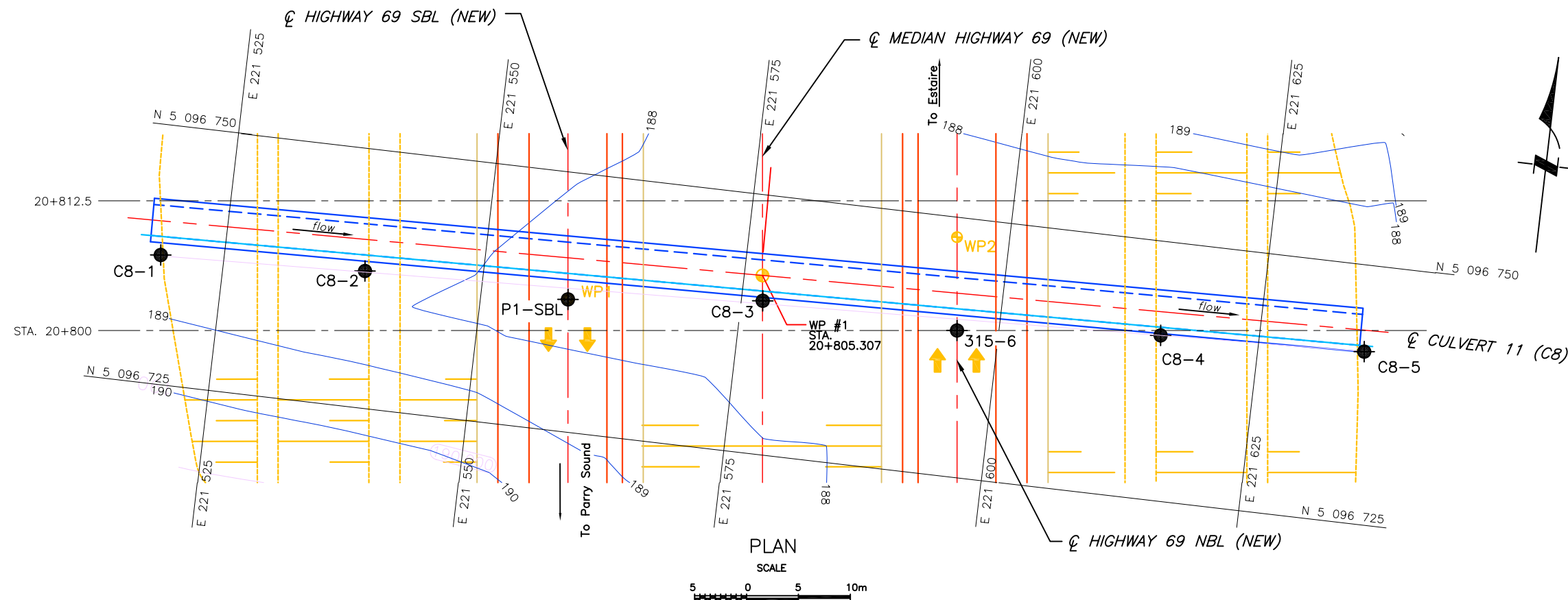
REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-250

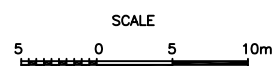
HWY No	69	DIST	Sudbury Area
SUBM'D	AS	CHECKED	AS
DRAWN	NA	CHECKED	CN
DATE	MAR. 4, 2010	APPROVED	BRG
SITE	--	DWG	C8-1



REF.: MRC DRAWINGS: 6454-300-001GA.DWG.dwg;  
H6454xb2 contours zone 10.dwg;  
H6454\_PHASE3\_XN01.dwg; H6454xb1 zone 10.dwg  
dated DECEMBER 07, 2009



PROFILE CULVERT 11 (C8) AT STATION 20+805



NOTES:

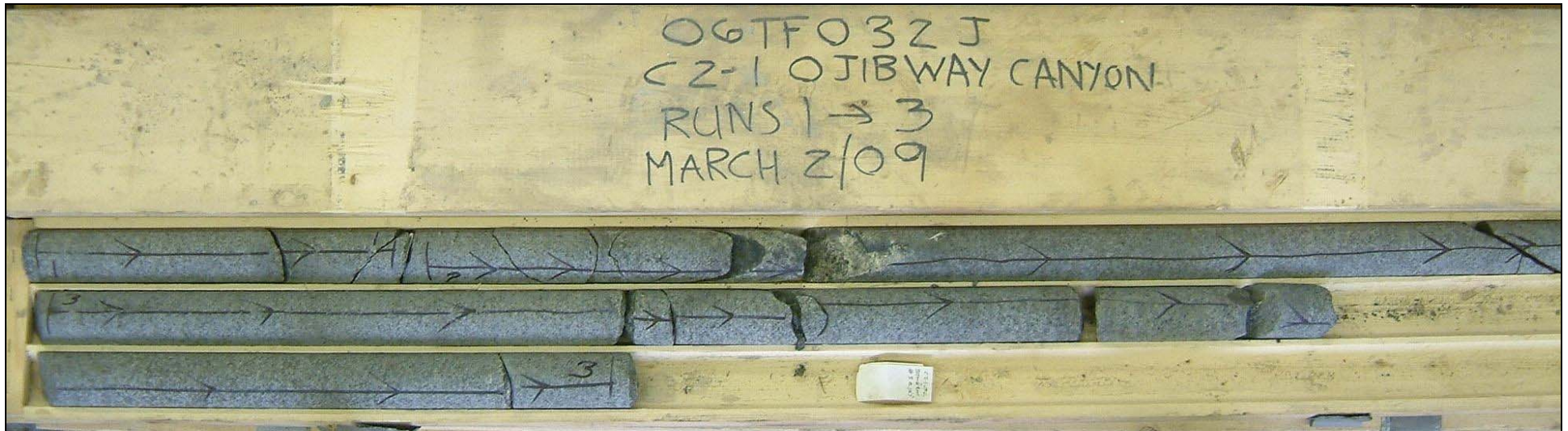
- DRAWING C8-1 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
- CULVERT C11 WAS DESIGNATED AS CULVERT C8 FOR THE INVESTIGATION.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



## **APPENDIX A**

### ROCK CORE PHOTOGRAPHS



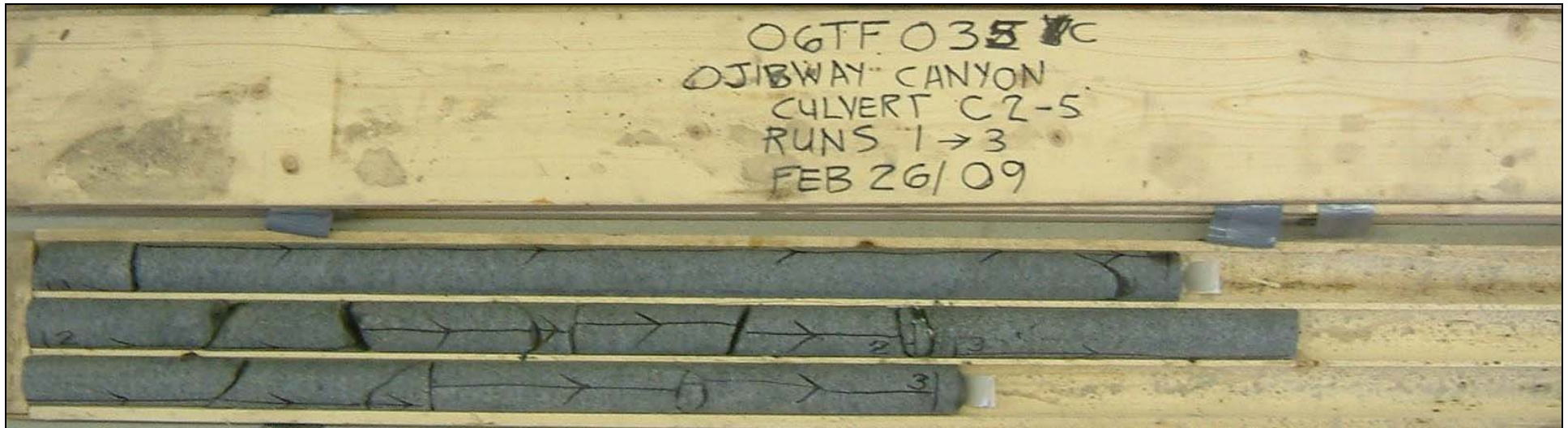


**Photograph 1:** Culvert C8, borehole C8-1, RC-5 to RC-7.

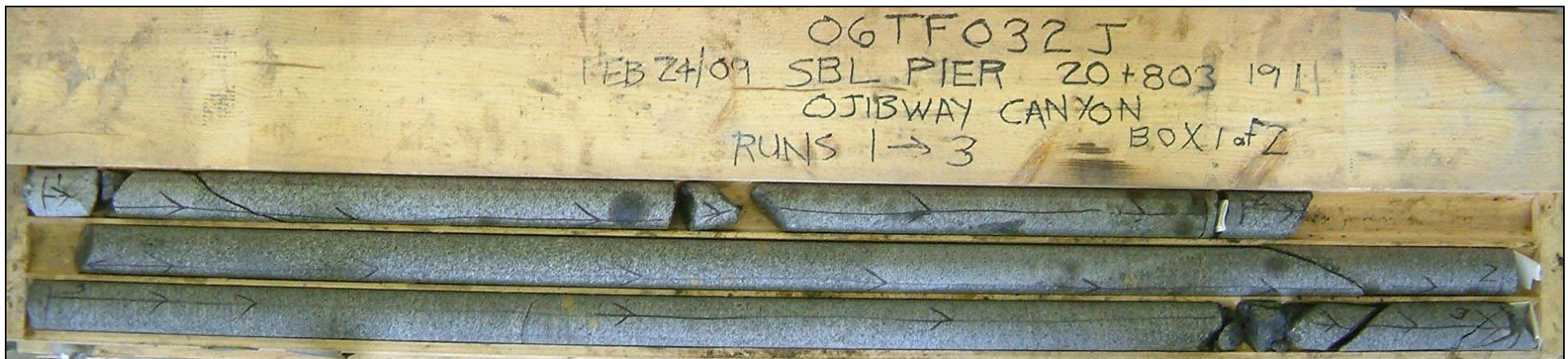


**Photograph 2:** Culvert C8, borehole C8-3, RC-7 to RC-9.





**Photograph 3:** Culvert C8, borehole C8-5, RC-7 to RC-9



**Photograph 4:** Bridge Pier 1 at station 20+803 (SBL), borehole P1-SBL, samples RC-5 to RC-8.