

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 42#-12

DIST. 16 REGION

W.P. No. 150-86-02

CONT. No. 88-211

W. O. No.

STR. SITE No. 39W-006

HWY. No. ~~60~~ 11

LOCATION 60.8 km West of Hearst
at Skunk River

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

DIST. 16 HWY. 11
 CONT No
 WP No 150-86-02



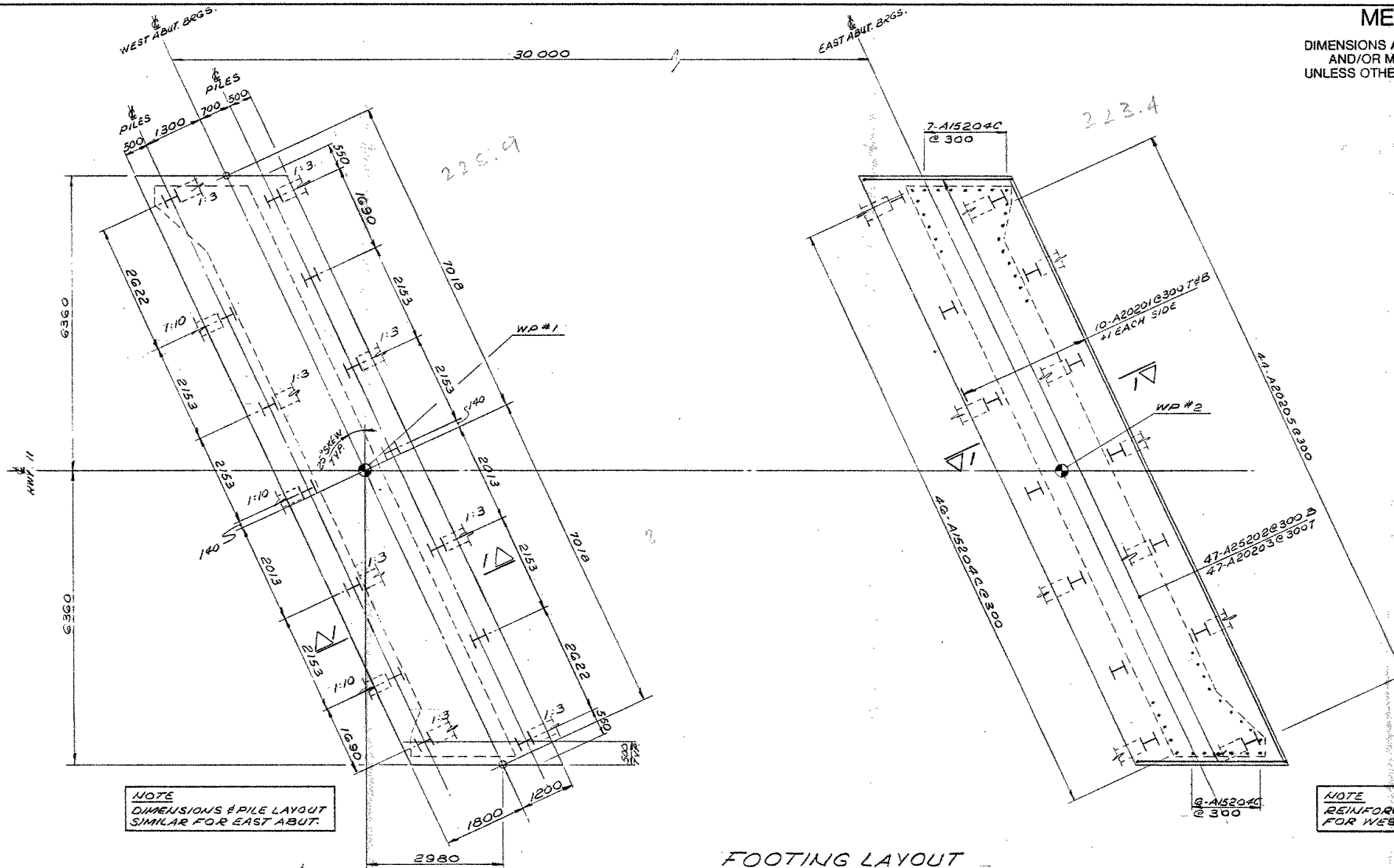
SKUNK RIVER BR.
 FOUNDATION LAYOUT

SHEET
 18

Fenco

FENCO ENGINEERS INC.

- NOTES:**
- PILES TO BE DRIVEN TO BED ROCK.
 - PILE SPACING IS MEASURED AT THE UNDERSIDE OF THE FOOTING.
 - ALL PILES SHALL BE HP 310x110 STEEL 'H' PILES.
 - PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW PILE CUT-OFF.
 - CAPACITY @ S.L.S. TYPE II = 1150 kN
 FACTORED CAPACITY @ U.L.S. = 1600 kN
 - ALL PILES TO BE FITTED WITH DRIVING SHOES. SEE STANDARD DD 3301.
 - THE PILE DRIVING HAMMER SHALL HAVE AN ACTUAL CAPACITY OF NOT LESS THAN 50,000 JOULES.



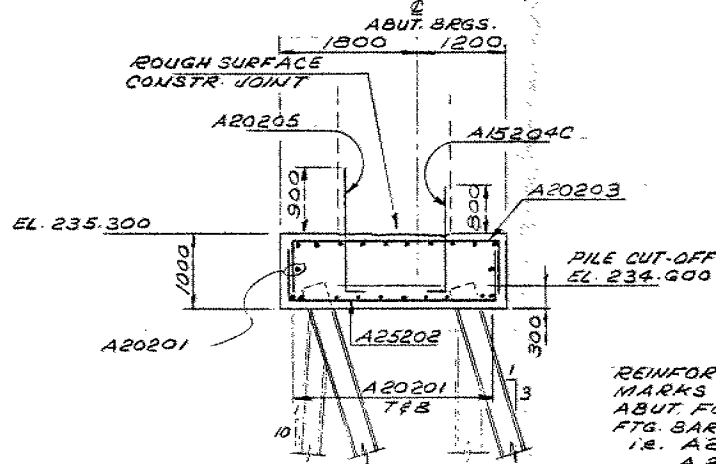
223.60
 9.10
 225.50

NOTE
 DIMENSIONS & PILE LAYOUT
 SIMILAR FOR EAST ABUT.

NOTE
 REINFORCEMENT SIMILAR
 FOR WEST ABUTMENT.

FOOTING LAYOUT

1:50



REINFORCING STEEL BAR
 MARKS ARE FOR EAST
 ABUT. FOOTING. WEST ABUT.
 FTG. BAR MARKS BEGIN @ 001
 I.E. A20001 WEST ABUT.
 A20201 EAST ABUT.

PILE DATA				
	LOCATION	NO	LENGTH	BATTER
WEST ABUT.	FRONT ROW	4	9600	3:1
	FRONT ROW	3	9100	NIL
	BACK ROW	4	9600	3:1
	BACK ROW	3	9100	10:1
EAST ABUT.	FRONT ROW	4	12200	3:1
	FRONT ROW	3	11600	NIL
	BACK ROW	4	12200	3:1
	BACK ROW	3	11600	10:1



DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE	BY
DESIGN	5/7/97	CHECK	4/1/97	LOADING	04/02/97
DRAWING	5/7/97	CHECK	5/7/97	SITE	35W-303-006
				DWG	4

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 150-86-⁰²~~01~~

DIST 16

HWY 11

STR SITE 39W-006

Skunk River Bridge

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FOUNDATION INVESTIGATION REPORT

For

Skunk River Bridge

W.P. 150-86-01, Highway 11, Site 39W-006

District 16, Cochrane

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above site during the period of 87 02 26 to 87 03 03. The fieldwork consisted of 5 sampled boreholes accompanied by dynamic cone penetration tests. A skid mounted drill attached to a trailer was employed for the duration of the job. The boreholes were advanced by hollow stem augers until bouldery material was encountered, after which a bi-cone and BX casing was utilized. BX size rock samples were cored in 3 of the 5 boreholes.

SITE DESCRIPTION

The site is located on Hwy. 11 at the Skunk River, approximately 61 km west of Hearst. An existing 9 span timber beam bridge crosses the 15 m wide river which flows through a fairly narrow and shallow valley. The surrounding terrain is relatively flat and densely covered with coniferous forest.

SUBSURFACE CONDITIONS

General

The overburden at this location consists of approximately 1-2 metres of organic silt or silty clay and organics with a trace of sand underlain by layers of silty sand and sandy silt.

On the south side of the highway the sand/silt material is underlain by a very dense heterogeneous mixture of silt, sand and gravel with occasional cobbles. Boulders were encountered within this till material at an elevation of approximately 226.0.

On the north side of the highway a silty clay of slight to medium plasticity underlies the sand/silt layer which is in turn underlain by a silty clay, trace of gravel with occasional cobbles and boulders.

Gneiss bedrock was encountered between El. 223.4 and 225.9.

The boundaries between the different strata, together with field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix. A stratigraphical profile along with the location and elevations of boreholes is shown on Dwg. No. 1508601-A.

Organic Silt/Silty Clay and Organics

This stratum was encountered in all the sampled boreholes just below ground level for a depth of about 1 to 2 m. The material consists largely of silt with varying degrees of clay, fine sand and organics as well as a trace of gravel. It is described as soft to firm with low to medium plasticity and a natural moisture content of between 23% and 59%.

Silty Sand and Sandy Silt

Silty sand and sandy silt with a trace of gravel and a trace of clay were found in various proportions below the organic silt/silty clay layer in all boreholes except BH 4. The material is described as compact to very dense and ranges between 1.2 m and 4.8 m in thickness. On the south side of the highway the first 0.8 m contained traces of organics. The natural moisture content of this material varied from 6% to 23%.

Silty Clay, trace of Sand, trace of Gravel

This cohesive deposit was only encountered on the north side (BH 2, 3 and 4) of the existing highway. In BH 2 the material was hard and contained some sand and occasional cobbles and boulders. It also exhibited slightly plastic properties and had a natural moisture content of 8%. The layer ranged between El. 223.4 and 228.6.

The material in BH 3, which had a firm to stiff consistency, was similar in grain size distribution to that in BH 2, however, it was encountered at a higher elevation and thus did not have any occasional cobbles or boulders. Its natural moisture content was 24% and Atterberg Limit tests indicated the material to be a silty clay of low plasticity (CL zone).

The cohesive material in BH 4 contained a good degree more silt than that in BH 2 and BH 3. It had a firm consistency and a natural moisture content of 8%.

Silty Clay with Sand, trace of Gravel

This cohesive material was encountered in BH 2 and BH 4 between El. 228.6 and El. 229.6. It had a hard consistency and contained occasional cobbles and boulders. Its natural moisture content was 8% and Atterberg Limit tests indicated the material to be a silty clay of low plasticity (CL zone).

Heterogeneous mixture of Silt, Sand and Gravel, trace of Clay

This till deposit was encountered in each borehole - with the exception of BH 2 - between El. 229.9 and El. 231.5. The material extended down to bedrock and varied in thickness between 3.2 m and 10.9 m. It had a natural moisture content between 7% and 11% and was classified as very dense based on the interpretation of Standard Penetration 'N' values (76 to over 120 blows per 0.3 m).

Cobbles and boulders were encountered within this till layer between EL. 226.0 and El. 228.0 down to bedrock. At that point diamond drill techniques had to be utilized in order to continue the borehole. The results of several rock cores taken to prove the cobbles and boulders indicated diameters ranging between 0.1 m to 0.4 m.

Results of several grain size distribution tests conducted on this till material are illustrated in Figure 3 of the Appendix. Based on this information, the stratum can be described as a heterogeneous mixture of silt, sand and gravel with a trace of clay.

Biolite Gneiss Bedrock

Bedrock was cored in 3 of the 5 boreholes. The following elevations indicate the location at which bedrock was encountered in the field.

	<u>Elevation of Bedrock</u>
BH 1	223.6
2	223.4
3	225.9

The rock samples from each borehole cored were analyzed by Mr. S. A. Senior, Geological Engineer from the Soils and Aggregates Section. Part of Mr. Senior's report entitled "Description of Rock Core", is included in the Appendix.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

Borehole #1	El. 235.3
#2	234.5
#3	234.9
#4	234.4
#5	234.7

No artesian water conditions were encountered.

It should be noted that the groundwater levels may be subjected to seasonal changes.

DISCUSSION AND RECOMMENDATIONS

General

The existing structure at the site is to be replaced by either a 30 m± single span bridge or a three span structure. The horizontal alignment, vertical alignment and width of the new bridge is to be the same as the old structure. Traffic is to be maintained on a bailey bridge detour located 15 m north of the present structure's centreline.

Structure Foundation

It is recommended that the footings be founded on end bearing steel 'H' piles driven to bedrock (El. 223.4 in the N.E. quadrant, El. 223.6 in the S.E. quadrant, El. 225.9 in the N.W. quadrant, not encountered in the S.W. quadrant upon termination of the borehole at El. 219.0). A safe design load up to 1150 kN per pile should be used for section HP 310x110. For the purposes of the O.H.B.D.C. the following values are recommended:

<u>Piles</u>	<u>HP 310x110</u>
Factored Capacity at U.L.S.	1600 kN
Capacity at S.L.S., Type II	1150 kN

The hammer used for driving piles should have a minimum energy of 50 000 J and pile shoes are recommended for all piles.

Concrete in the footings should be placed 'in the dry' and pile caps should have a minimum of 2.4 m of earth cover for frost protection.

The earth pressures should be computed as per subsection 6.6.1.2.2 of the Code. Granular 'A' and 'B' backfill should be in accordance with Special Provision No. 121 (dated October, 1983).

The following values are recommended for granular backfill:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m ³) γ	22.8	21.2

Approach Embankments

The bridge approach fills may be constructed at standard 2:1 slopes with no stability problems anticipated.

Where extra fill is required, the maximum particle size should be 75 mm in the locations where piles are to be driven.

Bailey Bridge Detour


The bailey bridge should be founded on timber cribs of 4 m width and 3 m length. The nature of the subsurface material requires that the crib bottom be excavated to an elevation of at least 235.3 on the east side of the river and 234.3 on the west side. The timber cribs should be backfilled with granular 'A'.


At the time this report was written, the profile grade of the proposed bailey bridge detour had not yet been determined. As a result, three different options are presented, one for each of three different profile grades. All of the options require that some of the existing organic surface material be excavated and backfilled with non-cohesive material. Two of the options also require the construction of berms, and where this is the case, Special Provision No. 120.17 (dated 86 07 07) should be adhered to.

Figures 1 and 2 should be referred to for an illustration of the work required for each of the three individual options.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of R. Kohlberger, Foundation Design Section. The equipment used was owned and operated by Dominion Soil Inv. This report was written by R. Kohlberger and reviewed by Mr. P. Payer and Mr. K. G. Selby.

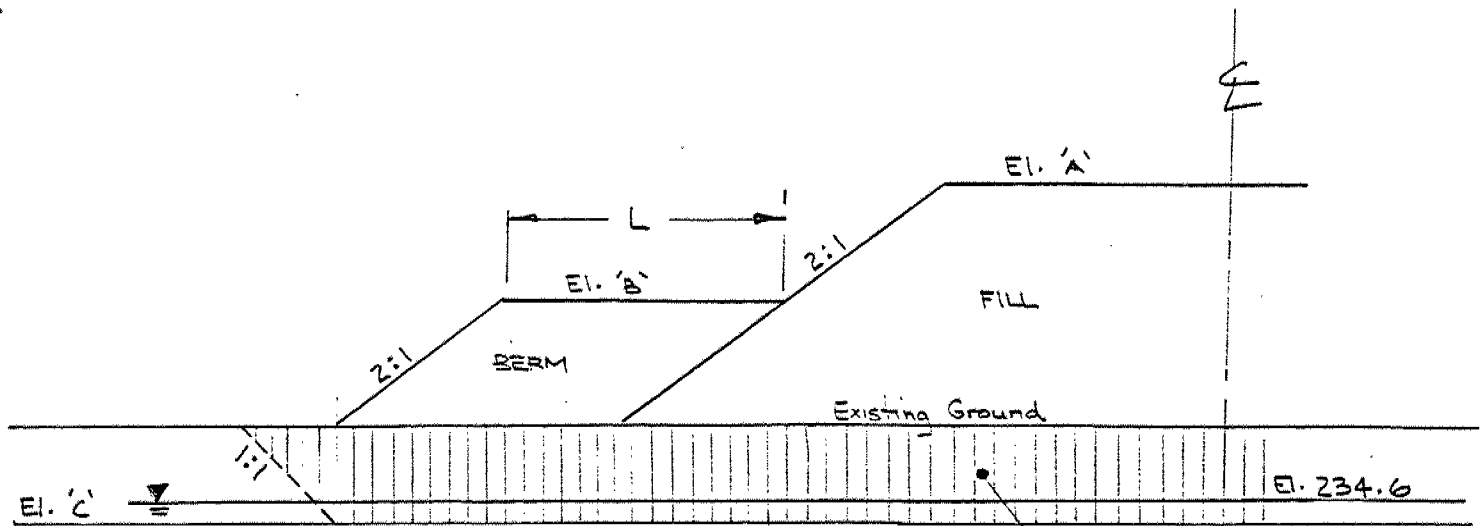

R. Kohlberger
For Trainee Engineer


K. G. Selby, P.Eng.
Chief Foundation Engineer (West)

APPENDIX

TRANSVERSE SECTION OF PROPOSED DETOUR

N.T.S.



EXCAVATE ORGANIC MATERIAL AND BACKFILL
WITH NON-COHESIVE MATERIAL

(Figure 1)

WEST SIDE

* El. 'A' \	L (m)	El. 'B'	El. 'C'
238.0	0	—	234.3
239.0	3.0	237.0	234.3
240.0	6.0	237.5	234.3

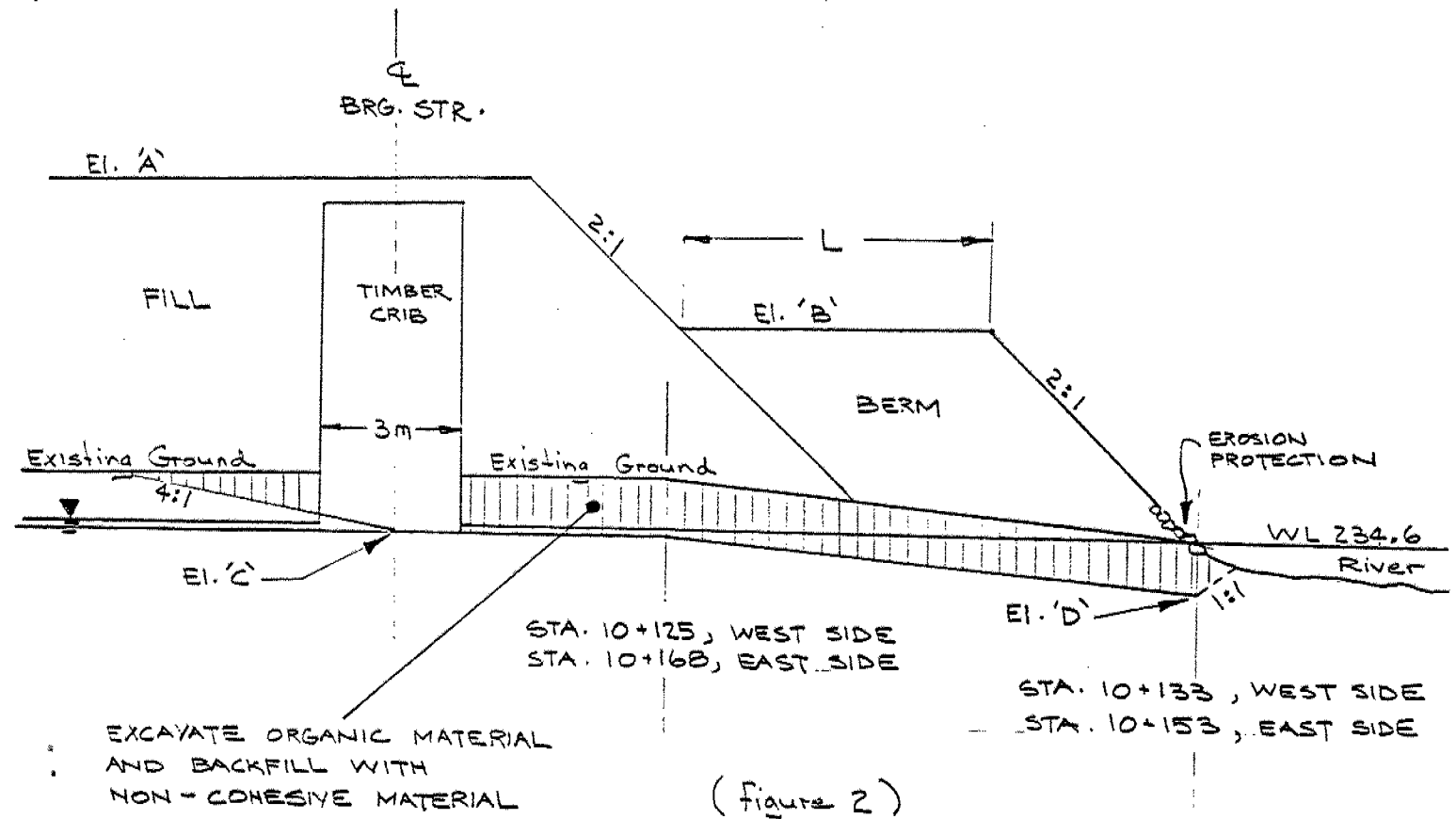
EAST SIDE

* El. 'A' \	L (m)	El. 'B'	El. 'C'
238.0	0	—	235.3
239.0	0	—	235.3
240.0	0	—	235.3

* El. 'A' DENOTES PROFILE GRADE OF PROPOSED DETOUR

LONGITUDINAL SECTION OF PROPOSED DETOUR

N.T.S.



WEST SIDE

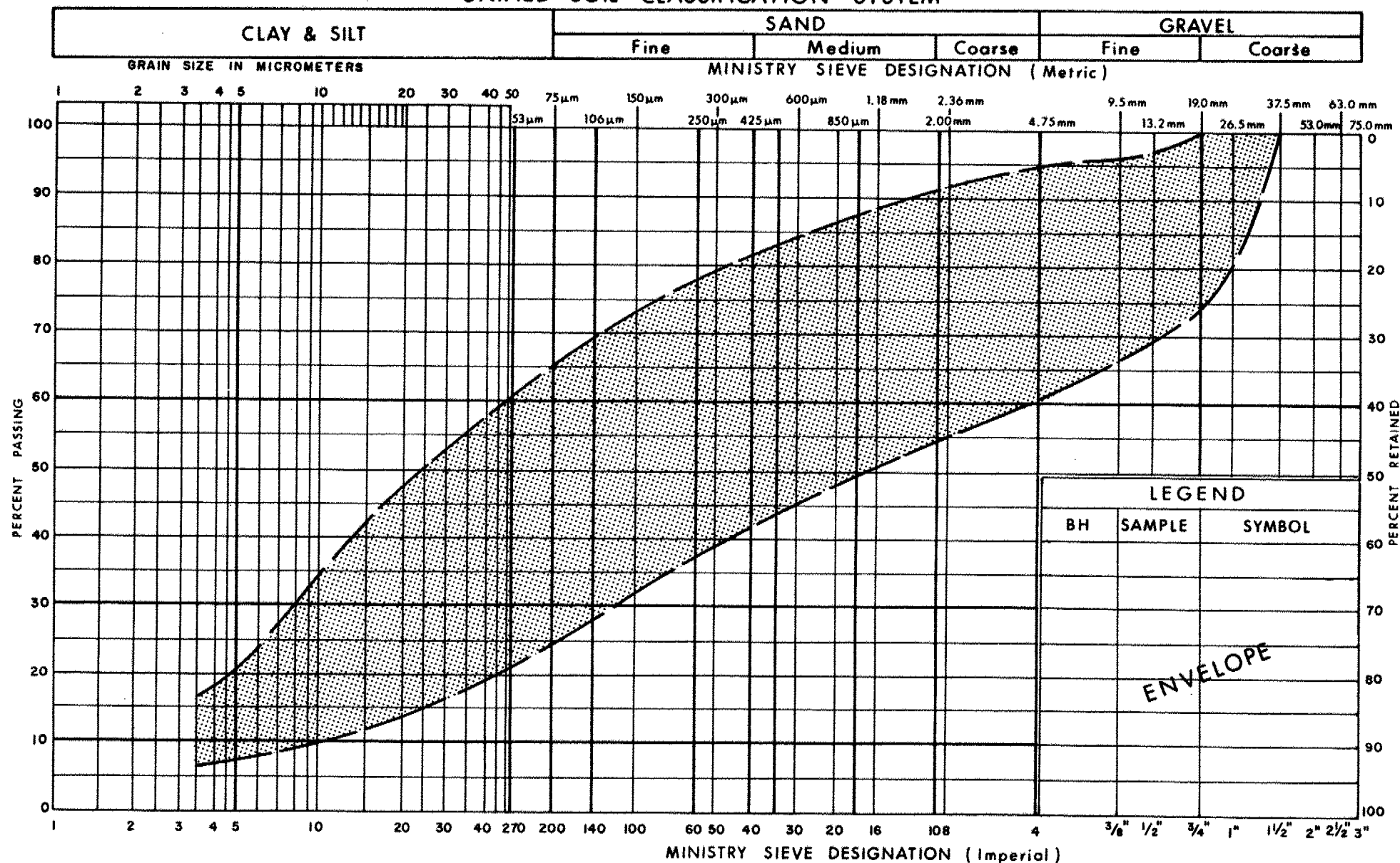
* El. 'A' \ L (m)	El. 'B'	El. 'C'	El. 'D'
238.0	0	—	234.3
239.0	3.1	237.0	233.5
240.0	6.3	237.5	233.5

EAST SIDE

* El. 'A' \ L (m)	El. 'B'	El. 'C'	El. 'D'
238.0	0	—	235.3
239.0	0	—	233.5
240.0	0	—	233.5

* El. 'A' DENOTES PROFILE GRADE OF PROPOSED DETOUR

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION

HETEROGENEOUS MIXTURE OF SILT, SAND AND GRAVEL,
TRACE OF CLAY

FIG No 3

W P 150-86-01

DESCRIPTION OF ROCK CORE - W.P. 150-86-01

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR *	% RQD *	DEPTH (m)	DESCRIPTION
1	14.79-15.43	40	0	14.79-17.92	BIOTITE GNEISS, light green, mottled pink, fine grained, slightly weathered, closely spaced to very closely spaced fractures (up to 20 cm), very widely banded, slightly foliated; very closely spaced fractures below 16.78, sound bedrock not determined
	15.43-16.60	100	15		
	16.60-17.13	100	0		
	17.13-17.82	59	0		
2	12.66-14.18	-	-	12.66-14.64	BOULDER, material similar to bedrock; presence of foreign rock types (siltstone, limestone) differentiates boulder from in situ bedrock
	14.18-14.64	-	-		
	14.64-14.95	50	42	14.64-15.05	DIABASE,* medium to dark grey, black, medium grained, unweathered, closely spaced fractures
	14.95-15.05	100	0		
4	9.81-11.34	100	77	9.81-10.29	QUARTZ PEGMATITE, white, spotted black, green, very coarse grained, massive, unweathered, closely spaced fractures
	11.34-12.86	100	95	10.29-12.86	BIOTITE GNEISS, medium grey, medium grained, slightly unweathered, closely to moderately spaced fractures

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION



RECORD OF BOREHOLE No 1

METRIC

W P 150-86-01 LOCATION Sta. 10 + 175, 11.9 m Rt. of C
DIST 16 HWY 11 BOREHOLE TYPE H.S. Auger, BX Core and Dynamic Cone
DATUM Geodetic DATE 87 02 26 - 27
ORIGINATED BY RK
COMPILED BY RK
CHECKED BY PP

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
237.8	Ground Level													
0.0	Silty Sand, trace of gravel, trace of clay Dense		1	SS	30									GR SA SI CL
236.4	Organic silt some clay some sand Soft-Firm		2	SS	7									
234.9	Trace of Organics		3	SS	3									0 28 54 18
2.9	Trace of Organics		4	SS	6									2 20 64 14
	Sandy Silt trace of gravel, trace of clay Very Dense		5	SS	51									5 32 50 13
			6	SS	70									
			7	SS	65									
			8	SS	54									
230.4			9	SS	98/25 cm									
7.4	Silty Sand to Sandy Silt some gravel trace of clay occasional silty clay layer Very Dense		10	SS	92									20 44 34 2
			11	SS	122/28 cm									
			12	SS	80/10 cm									
	Occasional cobbles and boulders		13	RC-BX	20% REC									
			14	RC-BX	20% REC									
			15	RC-BX	20% REC									
			16	SS	100/13 cm									12 34 44 10
223.6														
14.2	Highly Weathered Gneiss Bedrock		17	RC BX	35% REC									RQD = 0 %
			18	RC BX	90% REC									RQD = 18 %
			19	RC BX	75% REC									RQD = 15 %
220.0			20	RC BX	55% REC									RQD = 11 %
17.8	End of Borehole													

+3, x5: Numbers refer to Sensitivity
20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

METRIC

W P 150-86-01 LOCATION Sta. 10 + 158, 12.8 m LT of C
DIST 16 HWY 11 BOREHOLE TYPE H.S. Auger, BX Core and Dynamic Cone
DATUM Geodetic DATE 87-02-27/28
ORIGINATED BY RK
COMPILED BY RK
CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
237.9	Ground Level													GR SA SI CL
0.0	Organic Silt, some gravel, some sand, trace clay Soft - Firm		1	SS	4									25 20 48 7
			2	SS	5									
			3	SS	5									
232.7			4	SS	18									13 73 13 1
3.2	Silty sand, some gravel, trace of clay Comp to Very Dense		5	SS	15									
			6	SS	76/	28cm								
			7	SS	33									22 50 25 3
			8	SS	94/	28cm								
228.6			9	SS	60/	15cm								
7.3	Silty clay with sand trace of gravel Occasional cobbles and boulders Hard		10	SS	60/	10cm								
			11	SS	106/	20cm								
			12	SS	118/	28cm								2 27 49 22
			13	SS	80/	13cm								
223.4			14	RC BX	77% REC									RQD = 77%
12.5	Slightly Weathered Gneiss Bedrock		15	RC BX	45% REC									RQD = 41%
220.9			16	RC BX	40% REC									RQD = 36%
15.0	End of Borehole		17	RC-BX	100% REC									RQD = 100%

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3

METRIC

W.P. 150-86-01 LOCATION Sta. 10 + 168. 15.8 m LT of C
DIST 16 HWY 11 BOREHOLE TYPE H.S Auger and Dynamic Cone
DATUM Geodetic DATE 87-03-01
ORIGINATED BY R.K.
COMPILED BY R.K.
CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
236.7	Ground Level													
0.0	Silty clay and organic trace of sand		1	SS	7		236							
235.3	Firm		2	SS	16									
1.4	Sand, trace of gravel, trace of silt, trace of clay		3	SS	12									
233.8	Compact		4	SS	14									
2.9	Silty clay, trace of sand		5	SS	60/	10cm								
232.7	Stiff		6	SS	31									
4.0	Poorly graded gravel with sand		7	SS	37									
231.5	Compact to Dense		8	SS	81/	25cm								
5.2	Heterogeneous mixture of Silty clay, sand and gravel		9	SS	60/									
	Occasional cobbles		10	SS	63	13cm								
228.3	Hard													
8.4	End of Borehole													
	Auger could not be advanced any further - probable boulders													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 150-86-01 LOCATION Sta. 10 + 124, 14.9 m LT of Q
DIST 16 HWY 11 BOREHOLE TYPE H.S. Auger, BX Core and Dynamic Cone
DATUM Geodetic DATE 87-03-01/02
ORIGINATED BY R.K.
COMPILED BY R.K.
CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							WATER CONTENT (%)	20 40 60			
								SHEAR STRENGTH kPa											
								○ UNCONFINED	+ FIELD VANE										
								● QUICK TRIAXIAL	x LAB VANE										
								20 40 60 80 100											
235.7	Ground Level													GR SA SI CL					
0.0	Silty clay and or- ganics, trace of sand. Firm		1	SS	15									0 11 71 18					
234.3			2	SS	9														
1.4	Silt to silty clay, trace of Sand		3	SS	7									0 8 85 7					
	Firm to Stiff		4	SS	5														
			5	TW	PM														
230.5			6	SS	14														
5.2	Silty Sand, trace of gravel Occ. cobble		7	SS	60	10cm													
229.6	Very Dense																		
6.1	Silty clay with sand, trace of gra- vel Hard		8	SS	67														
	Occasional cobbles and boulders		9	SS	58									13 34 42 11					
			10	SS	100	25cm													
225.9			11	RC-BX	70% REC														
9.8	Gneiss Bedrock Unweathered		12	RC BX	90% REC									RQD = 70%					
			13	RC BX	95% REC									RQD = 90%					
222.8																			
12.9	End of Borehole																		

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

METRIC

W P 150-86-02 LOCATION Sta. 10 + 141, 13.1 m RT of C ORIGINATED BY R.K.
DIST 16 HWY 11 BOREHOLE TYPE H.S. Auger, BX Core and Dynamic Cone COMPILED BY R.K.
DATUM Geodetic DATE 87-03-02/03 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
235.8	Ground Level															
0.0	Silty clay and organics with sand Firm		1	SS	7											1 31 57 11
234.5	Organic		2	SS	15											1 49 48 2
1.3	Sandy silt to silty sand, trace of clay Loose to Dense		3	SS	24											0 7 87 6
			4	SS	24											
			5	SS	6											
			6	SS	33											
229.9			7	SS	76											40 35 24 1
5.9	Heterogeneous mixture of gravel, sand and Silt, trace of clay Occasional cobbles Very Dense		8	SS	74/	28cm										
			9	SS	23											
			10	SS	110/	28cm										
			11	SS	89/	29cm										
	Occasional boulders		12	SS	112/	23cm										
223.9			13	RC-BX	60%	REC										
11.9	Gneiss Bedrock Highly Weathered															
219.0																
16.8	End of Borehole															

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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

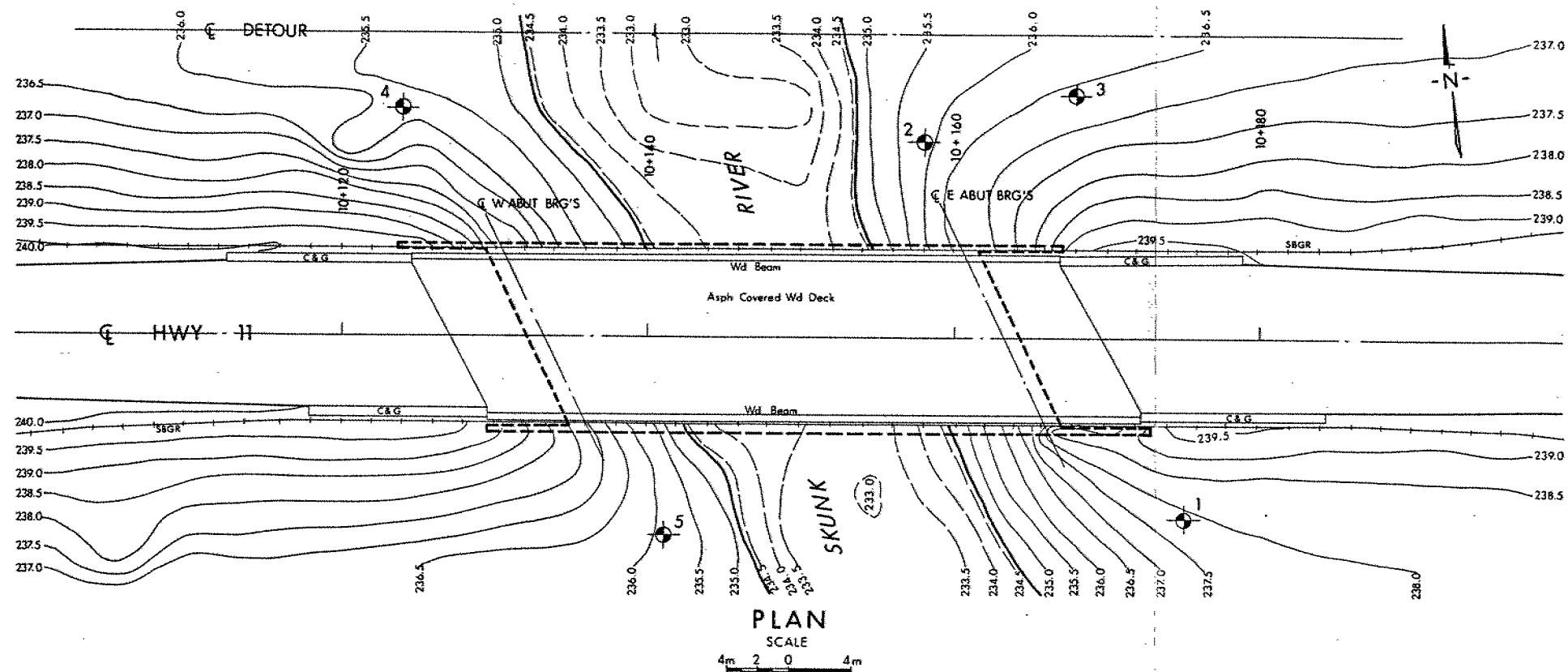
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



METRIC

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

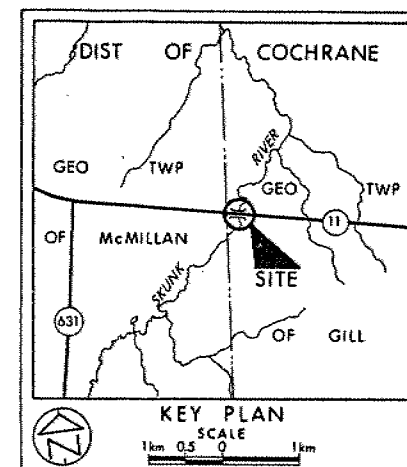
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WP No 150-86-02

SKUNK RIVER





BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- | | |
|---|--|
|  | Bore Hole |
|  | Dynamic Cone Penetration Test (Cone) |
|  | Bore Hole & Cone |
| N | Blows/0.3m [Std Pen Test, 475 J/blow] |
| CONE | Blows/0.3m (60° Cone, 475 J/blow) |
|  | WL at time of investigation 87 02 & 03 |

No	ELEVATION	STATION	OFFSET
1	237.8	10+175.0	11.9 m RT
2	235.9	10+158.0	12.8 m LT
3	236.7	10+168.0	15.8 m LT
4	235.7	10+124.0	14.9 m LT
5	235.8	10+141.0	13.1 m RT

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV				
	DATE	BY	DESCRIPTION	
Geocres No 42F-12				
HWY No 11			DIST 16	
SUBM'D	RK	CHECKED	DATE 1987 05 04	SITE 39W-309-006
DRAWN	SO	CHECKED	APPROVED	DWG 2