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GEOCRES No. 40 I 14-112

DIST. 2 REGION

W.P. No. 52-84-02

CONT. No. 90-10

W. O. No.

STR. SITE No. 19-340

HWY. No. 2

LOCATION Dingman Creek

Bridge Replacement

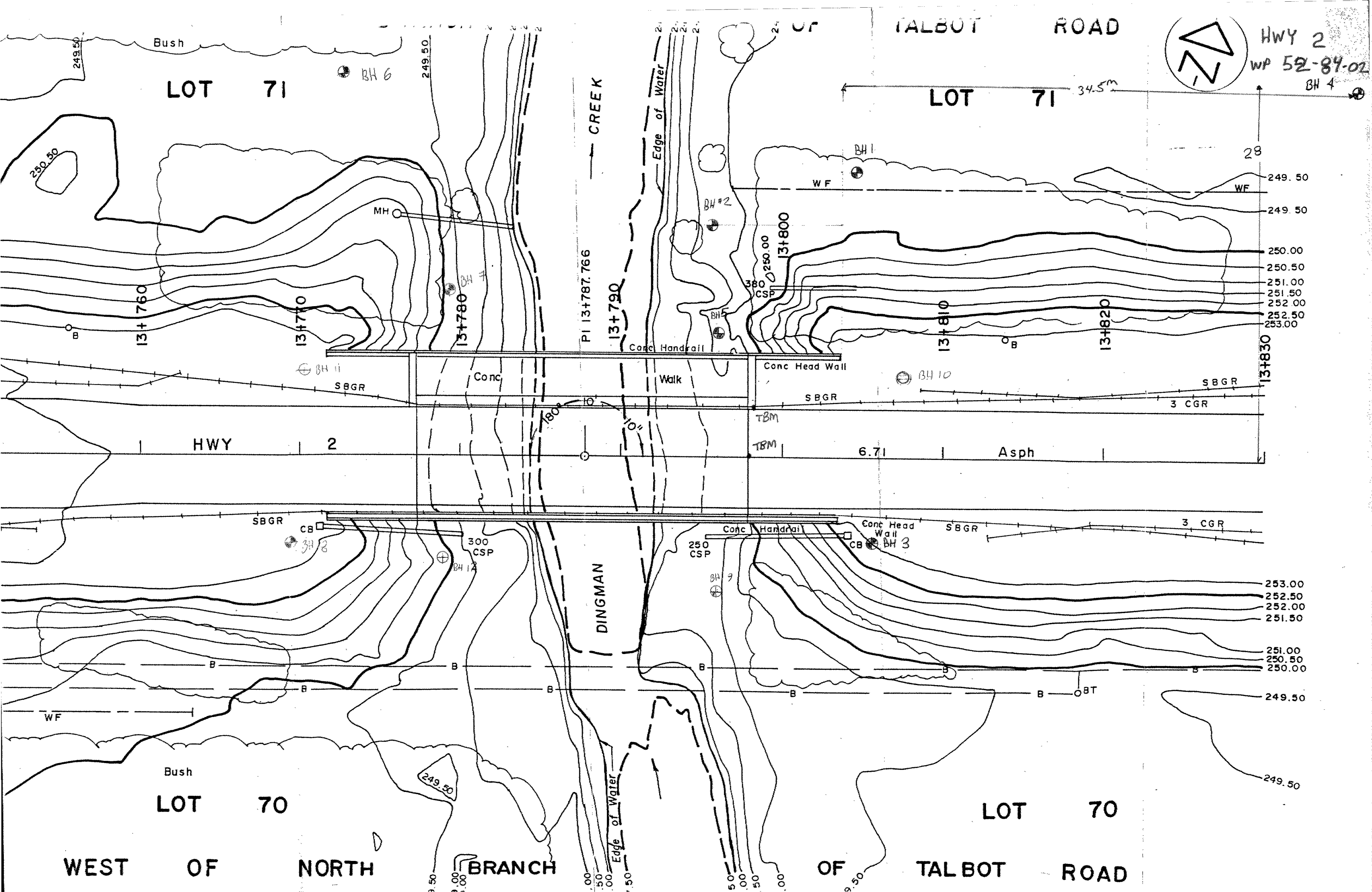
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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976



FOUNDATION INVESTIGATION REPORT

CONTRACT NO 90-10



Ministry of
Transportation and
Communications

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Note: For purposes of the contract, this report supercedes all other Foundation Reports prepared by, or for the Ministry in connection with the above-mentioned project.

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

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 = $\frac{w_L - w_p}{I_p}$	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						

For

Dingman Creek Structure Replacement

Hwy. 2, Westminster Township

WP 52-84-02, Site 19-340

District #2, London

INTRODUCTION

This report contains the results of a foundation investigation conducted at the abovementioned site during the period from 87-11-26 to 88-01-28. The fieldwork consisted of 8 sampled boreholes and 12 dynamic cone penetration tests. The borings were advanced by a skid-mounted diamond drill using BW and NW sized casings. Sampling was performed to a maximum depth of 17.0 m (E1. 236.1 m) and dynamic cone testing penetrated to a maximum depth of 10.3 m (E1. 242.7 m).

SITE DESCRIPTION

The intersection of Dingman Creek and Highway 2 is located west of Lambeth, approximately 0.5 km west of Highway 4. Terrain in the immediate vicinity of the proposed structure is flat, wet and marshy with light brush and tree cover. The creek channel in this area varies in width from 4.5 m to 9.5 m. The water level was variable during the investigation fluctuating from 0.6 m to overflowing. The creek rose over 1.0 m in depth within 24 hours during a period of heavy rainfall, the water spilling over the banks of the creek into the adjacent flood plain.

Dingman Creek is situated on a glacial spillway formed by a late stage of Lake Maumee. The spillway drains a broad valley floored with clay, silt, sand and gravel and this accounts for the variable nature of the subsurface material encountered during this investigation.

SUBSURFACE CONDITIONS

The surficial deposits vary from silty sand to silt to clayey silt and are generally underlain by sand and gravel. BH's 3 and 8 were advanced through the approach fills. The fill material also varies in composition from silty sand, sandy silt and clayey silt.

The boundaries of the different deposits together with the field and laboratory test results are shown on the Record of Borehole sheets found in the Appendix of this report. A stratigraphical profile is shown on Dwg. No. 2. A description of the different strata encountered is given below.

Silty Sand to Sandy Silt to Clayey Silt, Some Gravel, Trace Organics (Fill Material)

Boreholes 3 and 8 were advanced in the approaches of Highway 2 and contain 4.4 m of fill material. The deposit is variable in composition and largely non-cohesive. The N values obtained from field testing range from 2 to 10 reflecting a material that is very loose to loose. The natural moisture content obtained from laboratory testing varies from 11% to 23%.

Silt to Clayey Silt, with Sand, Trace Gravel, Trace Organics

A silt to clayey silt stratum was encountered as the surficial deposit in BH's 1 and 2 and beneath the approach fill in BH 3. It varies in thickness from 1.1 m to 2.3 m. The material is cohesive exhibiting low plasticity and a consistency of soft to stiff. The N values range from 3 to 10. The following physical properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	31-39
Liquid Limit (%)	30
Plastic Limit (%)	18-28

Organic Silt, Trace Sand

A thin stratum of organic silt was encountered as the surficial deposit in BH #4 which was advanced in the marshy floodplain adjacent to Dingman Creek. The deposit extends to a depth of 1.3 m. The material is soft with N values of 2. Its physical properties indicate that it is an organic material of medium plasticity. The following properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	50-67
Liquid Limit (%)	45-52
Plastic Limit (%)	28-41

Silty Sand to Sand, Varying Proportions of Gravel

A non-cohesive silty sand deposit was encountered in all of the boreholes ranging in thickness from 1.1 m to 4.4 m. It appears as the surficial deposit in BH's 5, 6, and 7 and beneath the fill material in BH 8 and contains traces of organic material at these locations. 'N' values vary from 3 to 47 reflecting a denseness of loose to dense. Laboratory testing yielded natural moisture contents ranging from 12% to 43%.

Silt to Clayey Silt Trace/Some Sand, Trace/Some Gravel

Beneath the non-cohesive stratum lies a silt to clayey silt deposit which was encountered in all but one borehole. Two of the borings were terminated in this layer. The material exhibits low plasticity and a consistency that varies from firm to hard. 'N' values obtained from field testing range from 4 to blows in excess of 120 per 30 cm. The following properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	12-30
Liquid Limit (%)	18-34
Plastic Limit (%)	12-17

Refer to Figure 1 for a Plasticity Chart of this material.

Sandy Silt Trace Gravel, Trace Clay

A stratum of sandy silt was encountered in BH's 3 and 6. It extends for 3.2 m below the silty sand to sand deposit in BH 3. Drilling was terminated 2.9 m into the deposit in BH 6. The N values range from 18 to blows in excess of

120 per 30 cm. The denseness of the sandy silt varies from compact to very dense.

Sand, Varying Proportions of Gravel Trace/Some Silt, Trace Clay

Boreholes 1, 3, 5, 7, and 8 were terminated in a granular deposit that was encountered at each location at approximate El. 243.0. The material is very dense throughout with N values of 82 and greater. Laboratory testing yielded natural moisture contents ranging from 5% to 15%.

GROUNDWATER

The following groundwater elevations were recorded at each of the borehole locations:

<u>Borehole</u>	<u>Groundwater Elevation</u>
1	249.3 m
2	249.1 m
3	248.3 m
4	249.2 m
5	248.5 m
6	247.9 m
7	248.1 m
8	247.3 m

Groundwater levels in the immediate vicinity of the river are sensitive to seasonal variations and rapid fluctuations in the creek water level.



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Chief Foundation Engineer

A P P E N D I X

RECORD OF BOREHOLE No 1

METRIC

W P 52-84-02 LOCATION Sta. 13 + 804.4, O/S 17.5 m Lt. ORIGINATED BY DM
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY BB
 DATUM Geodetic DATE 87 11 26 CHECKED BY

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				
249.7	Ground Surface															
0.0	Clayey Silt With Sand		1	SS	3											7 42 (51)
	Trace Gravel		2	SS	10											7 42 (51)
	Trace Organics		3	SS	3											
	Soft to Stiff		4	SS	6											
247.4			5	SS	6		248									6 48 (46)
2.3	Sand and Gravel		6	SS	15											59 30 (11)
	Trace Silt		7	SS	13											
	Trace Clay		8	SS	26		246									44 43 (13)
	Compact		9	SS	17											
			10	SS	12											
244.5							244									
5.2	Clayey Silt															
	Some Sand		11	SS	56											11 23 34 32
243.0	Some Gravel															
	Hard															
6.7			12	SS	94	28 cm										41 48 9 2
	Gravelly Sand		13	SS	71	22 cm	242									
	to Sand															
	Traces of Silt		14	SS	110	28 cm	240									
	and Clay															
	Very Dense		15	SS	110	25 cm										8 75 13 4
237.1							238									
12.6	End of Borehole		16	SS	87											

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC

W P 52-84-02 LOCATION Sta. 13 + 795.5, O/S 14.4 m Lt. ORIGINATED BY DM
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY BB
 DATUM Geodetic DATE 87 11 27 to 87 11 30 CHECKED BY

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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
249.4	Ground Surface		1	SS	4								
0.0	Silt to Clayey Silt With Sand, Trace Gravel Trace Organics Soft to Firm		2	SS	7								
248.0			3	SS	5								
1.4	Silty Sand and Gravel Trace Clay Loose to Dense		4	SS	6								
			5	SS	16								
			6	SS	16								
			7	SS	12								
245.7			8	SS	47								
3.7	Silt to Clayey Silt Trace Sand Stiff to Very Stiff		9	SS	16								
			10	SS	12								
244.0			11	TW	PM/								
243.3			12	SS	24								
5.4	End of Borehole												
6.1	End of Cone Test												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 52-84-02 LOCATION Sta. 13 + 806, O/S S.3 m Rt. ORIGINATED BY ND
DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
DATUM Geodetic DATE 87 12 21 to 87 12 24 CHECKED BY ---

[illegible]

*3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 4

METRIC

W P 52-84-02 LOCATION Sta. 13 + 838, O/S 2.3 m Lt. ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88 01 15 to 88 01 18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
249.7	Ground Surface													
0.0	Organic Silt		1	SS	2									
	Trace Sand		2	SS	2									
248.4	Soft		3	SS	4									
1.3	Silty Sand		4	SS	7									
	Some Gravel		5	SS	7									
	Trace Clay		6	SS	5									
	Loose to Compact		7	SS	16									
246.0														
3.7	Silt to Clayey Silt		8	SS	13									
	Trace Sand													
	Trace Gravel		9	SS	20									
	Stiff to Hard													
243.9														
5.8	End of Borehole		10	SS	56									

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 52-84-02 LOCATION Sta. 13 + 796, O/S 7.7 m Lt. ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88 01 - 19 - 20 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
249.2	Ground Surface											
0.0	Silty Sand and Gravel Trace Clay Loose		1	CS								17 47 (36)
			2	SS	4							32 52 (16)
			3	SS	6							
			4	SS	10							
245.5			5	SS	8							
3.7	Silt to Clayey Silt Trace Sand Trace Gravel Firm to Stiff		6	SS	7							6 1 77 16
			7	SS	4							
243.0			8	SS	13							0 0 (100)
6.2			9	SS	77							
	Sand Some Gravel Trace to Some Silt Very Dense		10	SS	104	25 cm						
			11	SS	93	25 cm						
			12	SS	96							13 75 (12)
			13	SS	110							
236.6			14	SS	82							
12.6	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 6

METRIC

W P 52-84-02 LOCATION Sta. 13 + 772.8, Offset 23.8 m Lt. of C ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing, BW Casing COMPILED BY PM
 DATUM Geodetic DATE 88 01 21 to 88 01 25 CHECKED BY

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					
249.8	Ground Surface															GR SA SI CL
0.0	Silty Sand and Gravel Trace Clay Very Loose to Compact		2	SS	5											0 58 38 4
			3	SS	3											55 29 (16)
			4	SS	11											
			5	SS	17											
245.4			6	SS	21											
4.4	Silt to Clayey Silt Trace Gravel Trace to Some Sand Firm to Hard		7	SS	7											0 0 86 14
			8	SS	10											
			9	SS	38											
			10	SS	54											3 11 (86)
241.6			11	SS	89	25 cm										
8.2	Sandy Silt Trace Gravel Very Dense		12	SS	60	8 cm										6 10 (84)
238.7			13	SS	100	15 cm										
11.1	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 7

METRIC

W P 52-84-02 LOCATION Sta. 13 + 779.3, Offset 10.2 m Lt of C ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY PM
 DATUM Geodetic DATE 88 01 25 to 88 01 27 CHECKED BY

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	SHEAR STRENGTH kPo					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
249.8	Ground Surface													
0.0	Silty Sand Some Gravel Trace Organics		1	CS										
			2	SS	11									
247.7	Loose to Compact		3	SS	5									
2.1	Sand Trace Silt Trace Gravel		4	SS	6									
			5	SS	13									
245.5	Compact		6	SS	10									
4.3	Clayey Silt to Silty Clay Trace Sand		7	SS	12									
			8	SS	16									
			9	SS	80									
242.5	Trace Gravel Stiff to Hard		10	SS	100	23 cm								
			11	SS	60	5 cm								
7.3			12	SS	75	13 cm								
	Sand and Gravel Some Silt Very Dense		14	SS	65	5 cm								
			16	SS	65	13 cm								
237.3			17	SS	105	15 cm								
12.5	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

W P 52-84-02 LOCATION Sta. 13 + 769.4, Offset 5.5 m Rt. of C ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY PN
 DATUM Geodetic DATE 88 01 28 to 88 02 01 CHECKED BY

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
253.2	Ground Surface												
0.0	Zones of Silty Sand Sandy Silt Clayey Silt Trace Organics Some Gravel Loose (Fill)		1	CS									
			2	SS	5								
			3	SS	6								
			4	SS	6								
			5	SS	10								
248.8			6	SS	8								
4.4	Silty Sand, Trace to some Gravel, pockets of Organ. Loose		7	SS	6								
247.1			8	SS	5								
6.1			9	SS	28								
			10	SS	43								
	Silt to Clayey Silt Trace Sand Trace Gravel Stiff		11	SS	13								
243.1			12	SS	12								
10.1			13	SS	60								
	Sand Trace Gravel Trace Silt Very Dense		16	SS	70								
237.7			17	SS	70								
15.5	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 10

METRIC

W P 52-84-02 LOCATION Sta. 13 + 807.6 m, O/S 4.9 m Lt. of C ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Cone Test COMPILED BY PM
 DATUM Geodetic DATE 88 01 20 CHECKED BY ---

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	Wl	WATER CONTENT (%)		
253.2	Ground Surface													
0.0	Probable Silty Sand Fill													
248.6														
4.6	Probable Silty Sand to Clayey Silt													
243.3														
9.9	End of Cone Test													

OFFICE REPORT ON SOIL EXPLORATION

$\times 3, \times 5$: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11

METRIC

W P 52-84-02 LOCATION Sta. 13 + 770.4 m, O/S 5.2 m Lt. of E ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Cone Test COMPILED BY PM
 DATUM Geodetic DATE 88 01 20 CHECKED BY

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	45	60	80	100	W _p	W	W _L		
253.2	Ground Surface																
0.0	Probable Silty Sand to Sandy Silt Fill																
248.7	Probable Silty Sand to Clayey Silt																
4.5																	
242.9	End of Cone Test																
10.3																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 12

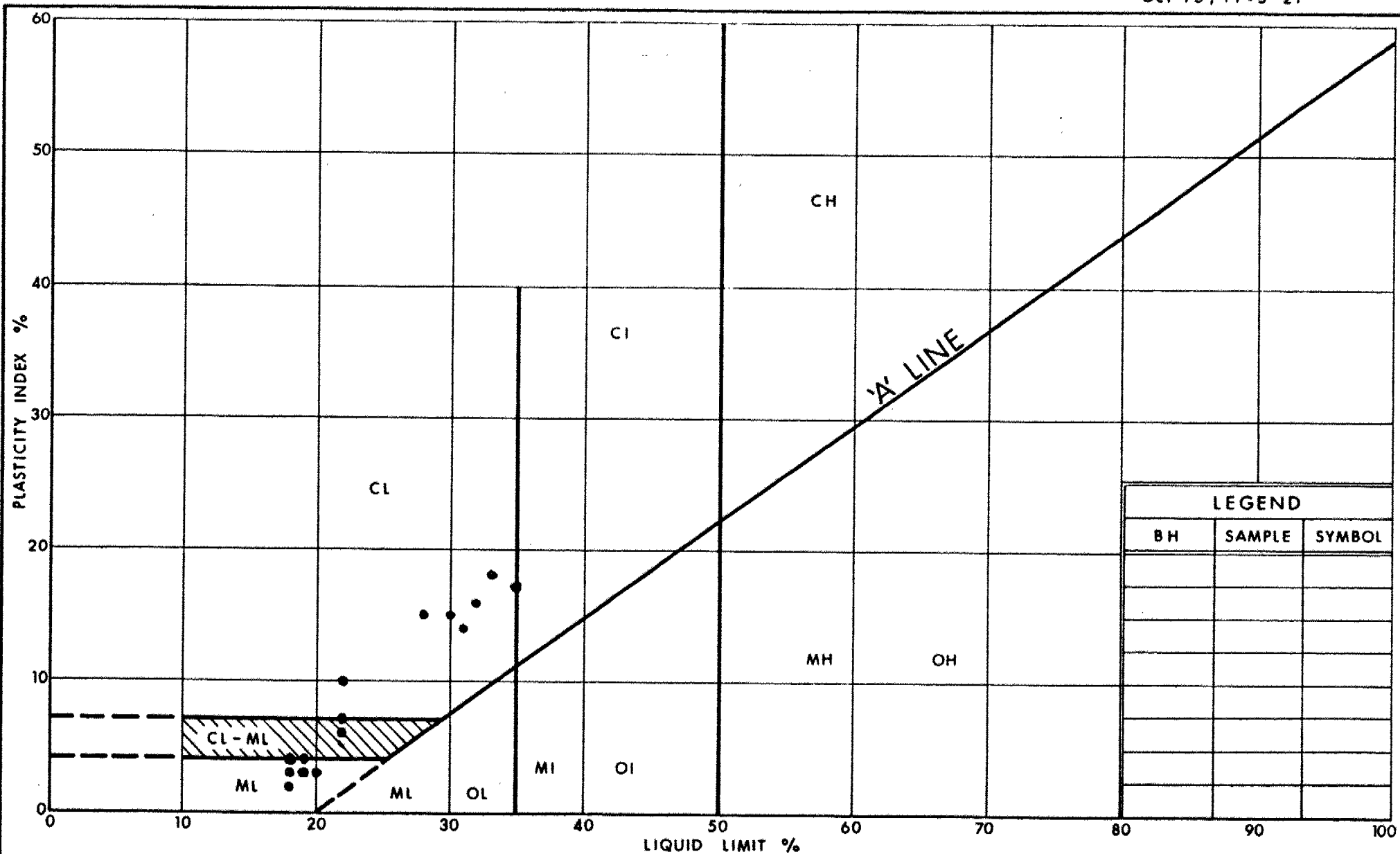
METRIC

W P 52-84-02 LOCATION Sta. 13 + 779, Offset 6.3 m Rt. of C ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Cone Test COMPILED BY PM
 DATUM Geodetic DATE 88 01 28 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
249.8	Ground Surface												
0.0	Probable Silty Sand To Clayey Silt												
242.8	End of Cone Test						29cm						
7.0													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (% STRAIN AT FAILURE



Ministry of
Transportation
Ontario

PLASTICITY CHART SILT to CLAYEY SILT Trace/Some Sand, Trace/Some Gravel

FIG No 1

W P 52 - 84 - 02

FOUNDATION INVESTIGATION FOR
For
Dingman Creek Structure
W.P. 68-85-02
SITE 19-341, Hwy. 4
DISTRICT 2, LONDON

Introduction

This report contains the results of a foundation investigation carried out at the abovementioned site during the period of 87 12 01 and 88 01 11. The fieldwork consisted of 7 sampled boreholes and nine dynamic cone penetration tests. The borings were advanced by NW casing using a diamond drill mounted on skids. Sampling was performed to a maximum depth of 30.5 m to elevation 219.8 m and the cone tests to a maximum depth of 8 m and to elevation 244.3 .

Site Description

The site is located 1 km south of Lambeth at the crossing of Hwy. 4 and Dingman Creek. The terrain in the immediate vicinity of the proposed structure is flat, wet and marshy with light brush cover and some willow trees. Dingman creek is situated on a glacial spillway formed by a late stage of Lake Maumee. The spillway drains a broad valley floored with clay, silt, and sand or gravel and this accounts for the variance of material encountered in this investigation.

Subsurface Conditions

General

The surficial deposit varied from silty sand to sandy silt with pockets of silt to silty clay and organic silt. The surficial deposits extended 2-4 m and were underlain by silty clay with layers of silt and traces of sand and gravel. BH #3 was sampled through the approach fill and contained sand, some gravel and some silt.

The boundaries of the different strata, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 2.A description of the different strata encountered is given below.

Silty sand to sandy silt, pockets of
silt to silty clay and organic silt

This stratum was encountered in all the sampled borings except BH #3 immediately below the original ground level and extended for 2 to 4 m. The material was predominantly non-cohesive with a denseness of very loose to compact. The composition varied between the boreholes with BH #2 containing sandy silt to silt overlain by a 1 m surficial layer of silty clay.

Sand, some gravel and some silt
(Fill Material)

A 4 m thick sand with trace to some gravel and some silt was encountered in BH #3. This is the approach fill of the existing structure and had a denseness of very loose to compact.

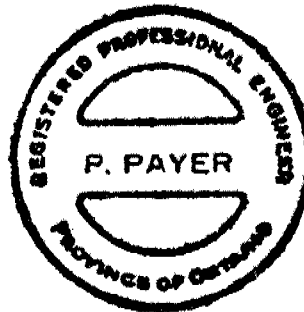
Silty clay

Silty clay extended from approximate elev. 246 m to elev. 219.8 m and contained some sand and gravel layers and traces of sand throughout the silty clay. The consistency was firm to hard. The lower boundary of this stratum was not determined as all the borings were terminated in this stratum. Physical properties of the material as determined from laboratory tests are as follows:

	<u>Range</u>
Natural Moisture Content (%)	7-24
Liquid Limit (%)	12-31
Plastic Limit (%)	8-16

Groundwater conditions

The groundwater level is 0.5 m below the ground level at approximate elevation 249.9 m at the time of the field investigation. The groundwater level is subject to rapid variations due to surface runoff. The creek water level fluctuated over 1.0 m height in 24 hours during the investigation.



P. Payer, P. Eng.

Senior Foundation Engineer

M. Devata, P.Eng.

Chief Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 68-85-02 LOCATION Sta. 17 + 6631.1, O/S 26.1 m Lt. G Hwy. 4
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing
 DATUM Geodetic DATE 87 12 01
 ORIGINATED BY DM
 COMPILED BY BB
 CHECKED BY

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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
249.8	Ground Surface											
0.0	Silty Clay, Trace		1	SS	6							
248.8	Organics, Some Sand, Firm		2	SS	6							
1.0	Organic Silt With		3	SS	5							
248.0	Sand, Firm		4	SS	6							
1.8	Silty Clay		5	SS	16							
	With Layers of Silt		6	SS	10							
	Trace of Sand		7	SS	20							
	Stiff to Hard		8	SS	21							
			9	SS	24							
			10	SS	22							
			11	SS	25							
			12	SS	36							
			13	SS	30							
243.2			14	SS	31							
6.6	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 2

METRIC

W P 6R-85-02 LOCATION Sta. 17 + 689.5 O/S 26.1 m Lt. 4 Hwy. 4 ORIGINATED BY DM
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY BB
 DATUM Geodetic DATE 87 12 01 - 03 CHECKED BY

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					
250.3	Ground Surface													
0.0	Silty Clay, Some Sand,													
249.0	Trace Organics, Firm		1	SS	5									
1.3	Silty Sand, Trace													
248.3	Organics, Very Loose		2	SS	2									
2.0	Sandy Silt to Silt													
246.8	Trace Gravel, Occ. Silty		3	SS	5									
	Clay Layers, Loose													
	to Compact		4	SS	15									
3.5			5	SS	18									
	Silty Clay With		6	SS	16									
	Layers of Silt		7	SS	46									
	Trace Sand		8	SS	12									
	Stiff to Hard		9	Tw	PM									
			10	SS	35									
			11	SS	29									
			12	SS	40									
			13	SS	30									
			14	SS	31									
			15	SS	17									
			16	SS	43									
			17	SS	50									
225.5			18	SS	105									
24.8	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 68-85-02 LOCATION Sta. 17 + 667.3; O/S 6.5 m Lt. Q Hwy. 4 ORIGINATED BY DM
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY BB
 DATUM Geodetic DATE 87 12 4, 7, 8, 9 CHECKED BY

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				
252.9	Ground Surface															
0.0	Sand Some Silt Trace/Some Gravel Very Loose to Compact (Fill Material)		1	SS	20		252									23 64 (13)
			2	SS	6											
			3	SS	5											
249.2			4	SS	3		250									7 43 (56)
3.7	Silt Trace Sand Trace/Some Gravel Trace Organics Very Loose to Compact		5	SS	2											
			6	SS	13		248									
247.0			7	SS	11											24 13 (63)
5.9			8	SS	11											0 2 (98)
			9	SS	20		246									0 4 (96)
			10	SS	60											
			11	SS	9		244									
	Silty Clay With Layers of Silt		12	SS	64		242									0 7 (93)
			13	SS	18											0 1 (95)
	Trace of Sand		14	SS	30		240									
	Stiff to Hard		15	SS	34		238									
			16	SS	18		236									
							234									
	Sand Layers Trace Gravel Hard		17	SS	45		232									8 35 (57)
			18	SS	34		230									
							228									
225.9			19	SS	N/A		226									
27.0	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 4

METRIC

W.P. 68-85-02 LOCATION Sta. 17 + 660 O/S 10.0 m Rt. 4 Hwy. 4 ORIGINATED BY DM
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY BB
 DATUM Geodetic DATE 87 12 10 - 11 CHECKED BY

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 (%)				
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
250.3	Ground Surface														GR SA SI CL					
0.0	Silty Clay, Trace Sand, Trace Gravel, Trace Organics Stiff		1	SS	8		250													
248.9			2	SS	23		248							12 33 (55)						
1.4	Silt to Organic Silt With layers of Sand & Gravel, Compact		3	SS	26		246							0 8 (92)						
247.4			4	SS	21		244							0 2 (98)						
2.9	Silty Clay with Layers of Silt Trace of Sand Stiff to Hard		5	SS	10		242							0 1 (99)						
			6	SS	11		240							0 2 (98)						
			7	SS	47		238													
			8	SS	43		236													
			9	SS	13		234													
			10	SS	17		232													
			11	SS	27		230													
			12	SS	46		228													
			13	SS	17		226													
			14	SS	15		224													
			15	SS	21		222													
			16	SS	29															
			17	SS	25															
			18	SS	42															
			19	SS	64/8 cm															
219.8																				
30.5		End of Borehole																		

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 68-85-02 LOCATION Sta. 17 + 638.6 O/S 15.5 m Lt. 4 Hwy 4 ORIGINATED BY MD
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY
 DATUM Geodetic DATE 87 12 16 - 18 CHECKED BY

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
							20 40 60 80 100	20 40 60 80 100	20 40 60					
250.3	Ground Surface		1	SS	5									
0.0	Silt to Silty Clay Some/With Sand Trace Gravel, Trace Organics, Firm		2	SS	4								0 35 (65)	
248.2			3	SS	6								2 49 (49)	
2.1	Silty Sand to Sandy Silt, Trace Gravel, Occ. Silty Clay Layers, Very Loose to Compact		4	SS	3								7 70 (23)	
246.6			5	SS	27								4 35 (61)	
3.7			6	SS	11									
			7	SS	31									
			8	SS	35								0 7 (93)	
			9	SS	72									
			10	SS	15									
			11	SS	22									
			12	SS	19									
			13	SS	19								0 0 (100)	
			14	SS	19									
			15	SS	17									
			16	SS	18								0 0 (100)	
			17	SS	57								17 17 (66)	
			18	SS	29									
225.5			19	SS	64									
24.8	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 6

METRIC

W.P. 68-R5-02 LOCATION Sta. 17 + 642 O/S 28.5 m Lt. 4 Hwy 4 ORIGINATED BY MD
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88 01 05 - 06 CHECKED BY

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					
249.0	Ground Surface												
0.0	Sandy Silt to Silty Sand , Trace Organics Very Loose to Compact		1	SS	3							0 42 (58)	
			2	SS	4								1 69 (30)
247.3			3	SS	12								0 6 (94)
2.6			4	SS	21								0 6 (94)
	Silty Clay With Layers of Silt Trace of Sand Very Stiff to Hard		5	SS	17								
			6	SS	16								
			7	SS	19								
			8	SS	51								0 8 (92)
			9	SS	47								
			10	SS	18								0 0 (100)
			11	SS	20								
			12	SS	21								0 0 (100)
			13	SS	37								0 1 (99)
			14	SS	25								0 0 (100)
			15	SS	37								
			16	SS	25								
			17	SS	52								
228.1			18	SS	39								
21.8	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 7

METRIC

W.P. 68-85-02 LOCATION Sta. 17 + 640.5 O/S 11.3 m Rt. 6 Hwy. 4 ORIGINATED BY MD
 DIST 2 HWY 4 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88.01.07 - 08 CHECKED BY

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 (%)		
								SHEAR STRENGTH kPa							20	40	60			

249.8	Ground Surface													GR SA SI CL
0.0	Silty Sand to Sandy Silt Occ. Silty Clay Layers Loose		1	SS	4									0 34 (65)
			2	SS	4									4 39 (57)
			3	SS	5									
246.1			4	SS	7									19 35 (46)
3.7			5	SS	23									0 3 (97)
	Silty Clay, With Layers of Silt Trace Sand		6	SS	21									0 2 (98)
			7	SS	34									0 2 (98)
			8	SS	7									
			9	SS	18									0 3 (97)
			10	SS	11									
			11	SS	24									
			12	SS	26									0 0 (100)
			13	SS	43									0 0 (100)
	Firm to Hard		14	SS	19									
			15	SS	25									
	Layers of Sand and Gravel		16	SS	65									5 50 (45) 23 29 (48)
	Hard													
228.0			17	SS	35									
21.8	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 8

METRIC

W P 68-85-01 LOCATION Sta. 17 + 630 O/S 13.5 m Rt. 6 Hwy. 4 ORIGINATED BY MD
 DIST 2 HWY 4 BOREHOLE TYPE Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 88 01 11 CHECKED BY SMH

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
250.3	Ground Surface													
0.0	Probable Silty Sand to Sandy Silt						250							
	Probable Silty Clay						248							
244.8							246							
5.5	End of Cone Test													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 9

METRIC

W.P. 68-85-02 LOCATION Sta. 17 + 661.7 O/S 11.2 m Lt. 6 Hwy. 4
 DIST 2 HWY 4 BOREHOLE TYPE Cone Test
 DATUM Geodetic DATE 88 01 11
 ORIGINATED BY MD
 COMPILED BY SMH
 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
250.3	Ground Surface												
250	Probably Silty Clay with Layers of Silt							Frozen					
248													
246													
245.2	End of Cone Test							23 cm					
5.1													

+3, x5: Numbers refer to Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT FOR BORERATION

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 52-84-02

DIST 2

HWY 2

STR SITE 19-340

Dingman Creek Structure Replacement

DISTRIBUTION

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M. MacLean (Cover Only)
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FOUNDATION INVESTIGATION REPORT
For
Dingman Creek Structure Replacement
Hwy. 2, Westminster Township
WP 52-84-02, Site 19-340
District #2, London

INTRODUCTION

This report contains the results of a foundation investigation conducted at the abovementioned site during the period from 87-11-26 to 88-01-28. The fieldwork consisted of 8 sampled boreholes and 12 dynamic cone penetration tests. The borings were advanced by a skid-mounted diamond drill using BW and NW sized casings. Sampling was performed to a maximum depth of 17.0 m (El. 236.1 m) and dynamic cone testing penetrated to a maximum depth of 10.3 m (El. 242.7 m).

In addition to the results of the field investigation, this report contains recommendations for the design and construction of the proposed structure foundations and the proposed detour structure foundations.

SITE DESCRIPTION

The intersection of Dingman Creek and Highway 2 is located west of Lambeth, approximately 0.5 km west of Highway 4. Terrain in the immediate vicinity of the proposed structure is flat, wet and marshy with light brush and tree cover. The creek channel in this area varies in width from 4.5 m to 9.5 m. The water level was variable during the investigation fluctuating from 0.6 m to overflowing. The creek rose over 1.0 m in depth within 24 hours during a period of heavy rainfall, the water spilling over the banks of the creek into the adjacent flood plain.

Dingman Creek is situated on a glacial spillway formed by a late stage of Lake Maumee. The spillway drains a broad valley floored with clay, silt, sand and gravel and this accounts for the variable nature of the subsurface material encountered during this investigation.

SUBSURFACE CONDITIONS

The surficial deposits vary from silty sand to silt to clayey silt and are generally underlain by sand and gravel. BH's 3 and 8 were advanced through the approach fills. The fill material also varies in composition from silty sand, sandy silt and clayey silt.

The boundaries of the different deposits together with the field and laboratory test results are shown on the Record of Borehole sheets found in the Appendix of this report. A stratigraphical profile is shown on Dwg. No. 528402-A. A description of the different strata encountered is given below.

Silty Sand to Sandy Silt to Clayey Silt, Some Gravel, Trace Organics (Fill Material)

Boreholes 3 and 8 were advanced in the approaches of Highway 2 and contain 4.4 m of fill material. The deposit is variable in composition and largely non-cohesive. The N values obtained from field testing range from 2 to 10 reflecting a material that is very loose to loose. The natural moisture content obtained from laboratory testing varies from 11% to 23%.

Silt to Clayey Silt, with Sand, Trace Gravel, Trace Organics

A silt to clayey silt stratum was encountered as the surficial deposit in BH's 1 and 2 and beneath the approach fill in BH 3. It varies in thickness from 1.1 m to 2.3 m. The material is cohesive exhibiting low plasticity and a consistency of soft to stiff. The N values range from 3 to 10. The following physical properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	31-39
Liquid Limit (%)	30
Plastic Limit (%)	18-28

Organic Silt, Trace Sand

A thin stratum of organic silt was encountered as the surficial deposit in BH #4 which was advanced in the marshy floodplain adjacent to Dingman Creek. The deposit extends to a depth of 1.3 m. The material is soft with N values of 2. Its physical properties indicate that it is an organic material of medium plasticity. The following properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	50-67
Liquid Limit (%)	45-52
Plastic Limit (%)	28-41

Silty Sand to Sand, Varying Proportions of Gravel

A non-cohesive silty sand deposit was encountered in all of the boreholes ranging in thickness from 1.1 m to 4.4 m. It appears as the surficial deposit in BH's 5, 6, and 7 and beneath the fill material in BH 8 and contains traces of organic material at these locations. 'N' values vary from 3 to 47 reflecting a denseness of loose to dense. Laboratory testing yielded natural moisture contents ranging from 12% to 43%.

Silt to Clayey Silt Trace/Some Sand, Trace/Some Gravel

Beneath the non-cohesive stratum lies a silt to clayey silt deposit which was encountered in all but one borehole. Two of the borings were terminated in this layer. The material exhibits low plasticity and a consistency that varies from firm to hard. 'N' values obtained from field testing range from 4 to blows in excess of 120 per 30 cm. The following properties were obtained from laboratory testing:

	<u>Range</u>
Natural Moisture Content (%)	12-30
Liquid Limit (%)	18-34
Plastic Limit (%)	12-17

Refer to Figure 1 for a Plasticity Chart of this material.

Sandy Silt Trace Gravel, Trace Clay

A stratum of sandy silt was encountered in BH's 3 and 6. It extends for 3.2 m below the silty sand to sand deposit in BH 3. Drilling was terminated 2.9 m into the deposit in BH 6. The N values range from 18 to blows in excess of 120 per 30 cm. The denseness of the sandy silt varies from compact to very dense.

Sand, Varying Proportions of Gravel Trace/Some Silt, Trace Clay

Boreholes 1, 3, 5, 7, and 8 were terminated in a granular deposit that was encountered at each location at approximate El. 243.0. The material is very dense throughout with N values of 82 and greater. Laboratory testing yielded natural moisture contents ranging from 5% to 15%.

GROUNDWATER

The following groundwater elevations were recorded at each of the borehole locations:

<u>Borehole</u>	<u>Groundwater Elevation</u>
1	249.3 m
2	249.1 m
3	248.3 m
4	249.2 m
5	248.5 m
6	247.9 m
7	248.1 m
8	247.3 m

Groundwater levels in the immediate vicinity of the river are sensitive to seasonal variations and rapid fluctuations in the creek water level.

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing 19.2 m± single-span concrete bow-string arch bridge with one of the following two alternatives:

1. A single-span concrete rigid frame bridge with a span length of 20.0 m± and a height of 7.5 m±.
2. A three-span beam type structure with span lengths 11.0 m - 19.0 m - 11.0 m.

In addition to the replacement, a temporary detour is proposed approximately 22.0 m downstream of the existing structure. The deck level of the bailey bridge is set at El. 252.1 m.

Replacement Structure Foundations

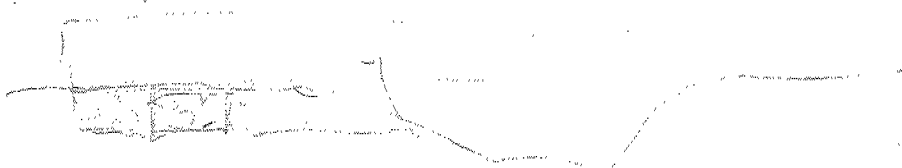
From the encountered subsurface conditions, it is recommended that the new structure be supported on steel 'H' piles driven to El. 240 m. At this depth it is estimated that a design load of 670 kN will be achieved for HP 310 x 110 piles. Pile driving should proceed in accordance with Standards SS-103-10/11. For purposes of the O.H.B.D.C. the following design values are recommended for HP 310 x 110 piles:

Factored Capacity at U.L.S. 1300 kN

Capacity at S.L.S. Type II 670 kN

Proposed Detour Structure

The abutments for the single-span bailey bridge detour structure may be supported on timber mats placed on granular pads. All topsoil and soft or loose material should be subexcavated for placement of the granular pads. The granular pads should consist of well compacted Granular 'A' for a minimum thickness of 1.0 m, to the required level at which the timber mats will be placed. The granular pads should be a minimum of 1.0 m larger all around



than the bearing area. The recommended design load for the timber mat is 100 kPa. For purposes of the O.H.B.D.C. the following design values are recommended:

Factored Bearing Capacity at U.L.S. 150 kPa
Bearing Capacity at S.L.S. Type II 100 kPa

In this case, a coefficient of friction equal to $\tan 30^\circ$ may be assumed for computing resistance to sliding between the underside of the timber mat and the well compacted granular pad.

Lateral earth pressures should be computed as per Section 6.6.1.2 of the O.H.B.D.C. A yielding foundation condition may be assumed. Backfill to the structures should be Granular 'A' or Granular 'B' for which the following properties may be assumed:

Granular 'A'	$\gamma = 22.8 \text{ kN/m}^3$	$\phi = 35^\circ$	$K_A = 0.271$
Granular 'B'	$\gamma = 21.3 \text{ kN/m}^3$	$\phi = 30^\circ$	$K_A = 0.333$

Approaches

Topsoil and soft or loose material should be removed prior to placing any fill. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches at locations through which piles have to be driven, and it is recommended that this portion of the fill contain grain sizes no larger than 75 mm in diameter.

Embankments should be constructed with forward and side slopes not steeper than 2 horizontal to 1 vertical.

Rip Rap

The slopes must be protected from scour with rip rap. The rip rap should be placed according to the hydrological requirements with the minimum slope

protection required extending from 0.3 m above the high water level to 2.0 m beyond the toe of slope in the flood plain and creek.

Dewatering

Concrete should be placed in the "dry". Excavation carried out below the creek or ground water level will require a dewatering scheme. The upper subsoil layers contain silty clay, sand and silt layers in random occurrence. The silt layers are subject to boiling due to unbalanced hydrostatic head. The most suitable dewatering scheme would be construction of a sheet pile coffer dam, with the sheet piles driven to a suitable depth depending on the locations of the footing or pile caps.

Frost Protection

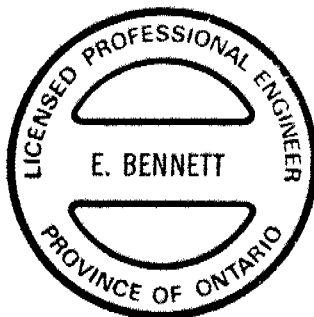
All footings and/or pile caps require a minimum of 1.2 m of earth cover for frost protection.

Settlements

Settlements will occur due to consolidation of the cohesive soil in the original ground due to the weight of the new approach embankments. This settlement is not anticipated to be significant and after completion should not exceed 25 mm over a long period of time.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Morch, Student Engineer, and S. Holmes and M. Dettweiler, Foundation Design Section. The equipment used was owned and operated by Master Soil Investigation Ltd. The report was prepared by Mr. S. Holmes and Mrs. B. Bennett. It was reviewed by Mr. P. Payer and Mr. K.G. Selby.



B. Bennett

B. Bennett, P.Eng
Jr. Foundation Engineer

for. K.G. Selby

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

A P P E N D I X

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
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

MECHANICAL PROPERTIES OF SOIL

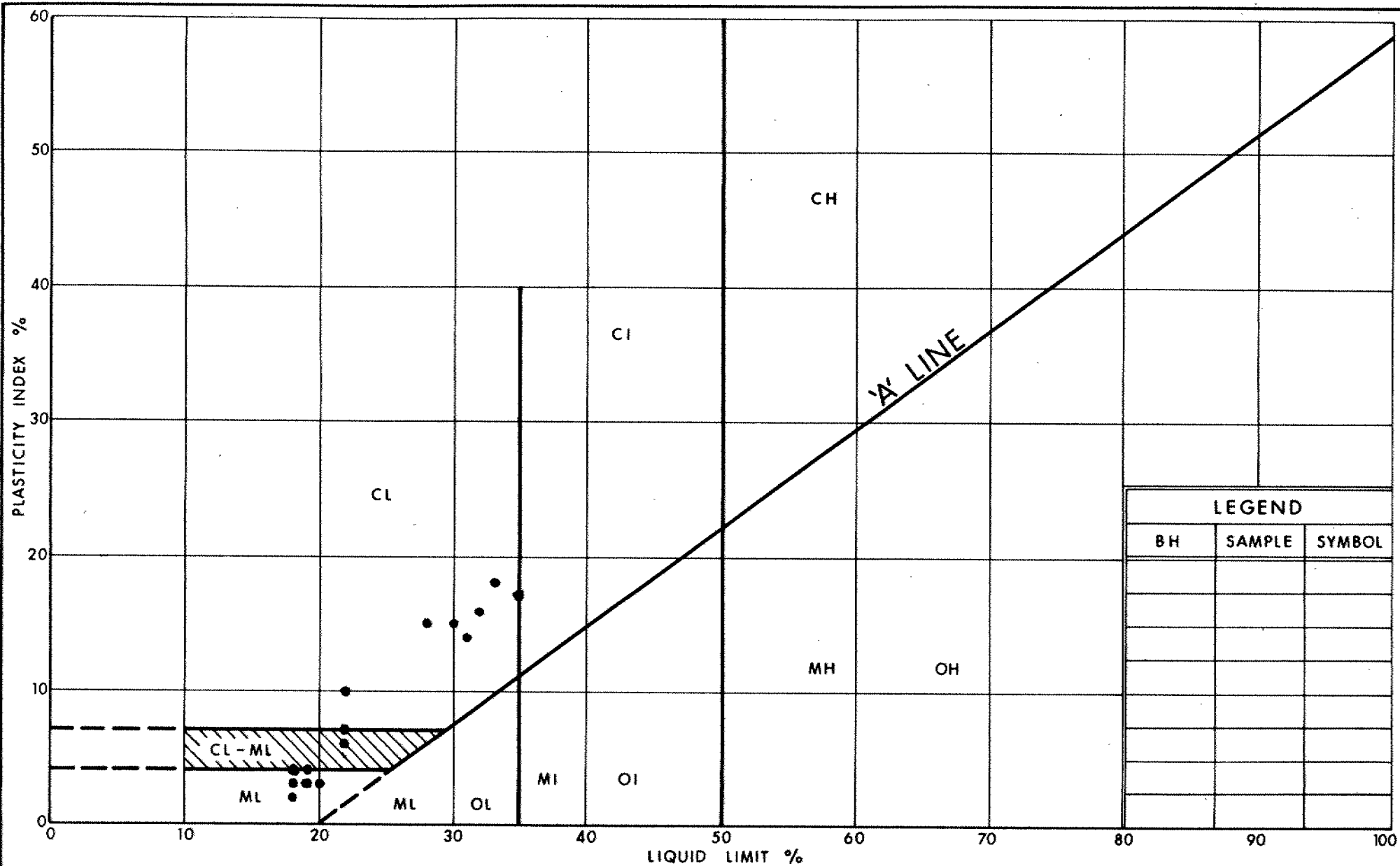
m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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
P	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 ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						



Ministry of
Transportation

Ontario

PLASTICITY CHART

SILT to CLAYEY SILT

Trace/Some Sand, Trace/Some Gravel

FIG No 1

W P 52 - 84 - 02



Ministry of
Infrastructure

RECORD OF BOREHOLE No. 1

METRIC

W P 52-84-02 LOCATION Sta. 13 + 804.4, O/S 17.5 m Lt. ORIGINATED BY DM
DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY BB
DATUM Geodetic DATE 87 11 26 CHECKED BY LT

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE	N VALUES			20	40	60	80	100					
249.7	Ground Surface																
0.0	Clayey Silt With Sand		1	SS	3												7 42 (51)
	Trace Gravel		2	SS	10												7 42 (51)
	Trace Organics		3	SS	3												
247.4	Soft to Stiff		4	SS	6												
			5	SS	6												
2.3	Sand and Gravel		6	SS	15												6 48 (46)
	Trace Silt		7	SS	13												59 30 (11)
	Trace Clay		8	SS	26												
	Compact		9	SS	17												44 43 (13)
			10	SS	12												
244.5	Clayey Silt																
5.2	Some Sand																
	Some Gravel																
243.0	Hard		11	SS	56												
6.7	Gravelly Sand to Sand		12	SS	94	28 cm											11 23 34 32
	Traces of Silt and Clay		13	SS	71	22 cm											41 48 9 2
	Very Dense																
			14	SS	110	28 cm											
			15	SS	110	25 cm											8 75 13 4
237.1																	
			16	SS	87												
12.6	End of Borehole																

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

METRIC

W P 52-84-02 LOCATION Sta. 13 + 795.5, O/S 14.4 m Lt. ORIGINATED BY DM
DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing COMPILED BY BB
DATUM Geodetic DATE 87 11 27 to 87 11 30 CHECKED BY

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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
249.4	Ground Surface										
0.0	Silt to Clayey Silt With Sand, Trace Gravel		1	SS	4						
	Trace Organics		2	SS	7						
248.0	Soft to Firm		3	SS	5						
1.4	Silty Sand and Gravel		4	SS	6						
	Trace Clay		5	SS	16						
	Loose to Dense		6	SS	16						
245.7			7	SS	12						
			8	SS	47						
3.7	Silt to Clayey Silt		9	SS	16						
	Trace Sand		10	SS	12						
244.0	Stiff to Very Stiff		11	TW	PM/						
			12	SS	24						
5.4	End of Borehole										
243.3											
6.1	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 52-84-02 LOCATION Sta. 13 + 806, O/S 5.3 m Rt. ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 87 12 21 to 87 12 24 CHECKED BY

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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
253.1	Ground Surface		1	SS	2							
0.0	Silty Sand Some Gravel Trace Clay Trace Organics Zones of Clayey Silt Very Loose to Loose (Fill)		2	SS	3							11 13 52 24
			3	SS	5							16 58 16 10
			4	SS	7							
			5	SS	4							
248.7			6	SS	6							
4.4	Clayey Silt with Sand Trace Gravel Trace Organics, Firm		7	SS	7							
247.8			8	SS	31							
5.3	Silty Sand and Gravel Compact		9	SS	17							
246.2			10	SS	18							
6.9	Sandy Silt Trace Clay Trace Gravel Compact		11	SS	19							
			12	SS	53							
243.0	Very Dense		13	SS	90	15 cm						
10.1	Sand Trace Gravel Trace Silt Very Dense		17	SS	40	8 cm						
235.1	End of Borehole											
17.0												

RECORD OF BOREHOLE No 4

METRIC

W P 52-84-02 LOCATION Sta. 13 + 838, O/S 2.3 m Lt. ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88 01 15 to 88 01 18 CHECKED BY

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			20 40 60 80 100		W _p	W	W _L		
249.7	Ground Surface													GR SA SI CL
0.0	Organic Silt		1	SS	2									0 14 73 13
	Trace Sand		2	SS	2									0 20 (80)
248.4	Soft		3	SS	4									0 48 (52)
1.3	Silty Sand		4	SS	7		248							0 42 (58)
	Some Gravel		5	SS	7									28 54 (18)
	Trace Clay		6	SS	5									
	Loose to Compact		7	SS	16									
246.0	Silt to Clayey Silt		8	SS	13		246							4 4 (92)
3.7	Trace Sand		9	SS	20									
	Trace Gravel													
243.9	Stiff to Hard		10	SS	56		244							4 10 (86)
5.8	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 52-84-02 LOCATION Sta. 13 + 796, O/S 7.7 m Lt. ORIGINATED BY MD
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing COMPILED BY SMH
 DATUM Geodetic DATE 88 01 - 19 - 20 CHECKED BY MD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
249.2	Ground Surface													
0.0	Silty Sand and Gravel Trace Clay Loose		1	CS										
			2	SS	4									17 47 (36)
			3	SS	6									32 52 (16)
			4	SS	10									
			5	SS	8									
245.5			6	SS	7									
3.7	Silt to Clayey Silt Trace Sand Trace Gravel		7	SS	4									6 1 77 16
			8	SS	13									
243.0	Firm to Stiff		9	SS	77									0 0 (100)
6.2			10	SS	104	25 cm								
	Sand Some Gravel Trace to Some Silt Very Dense		11	SS	93	25 cm								
			12	SS	96									
			13	SS	110									
														13 75 (12)
236.6			14	SS	82									
12.6	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 x 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 6

METRIC

W P 52-84-02 LOCATION Sta. 13 + 772.8, Offset 23.8 m Lt. of C
DIST 2 HWY 2 BOREHOLE TYPE Washbore, NW Casing, BW Casing
DATUM Geodetic DATE 88 01 21 to 88 01 25
ORIGINATED BY MD
COMPILED BY PM
CHECKED BY

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	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
249.8	Ground Surface									
0.0										
	Silty Sand and Gravel		2	SS						
	Trace Clay		3	SS						
	Very Loose to Compact		4	SS						
			5	SS						
245.4			6	SS						
4.4	Silt to Clayey Silt		7	SS						
	Trace Gravel		8	SS						
	Trace to Some Sand		9	SS						
	Firm to Hard		10	SS						
241.6			11	SS						
8.2	Sandy Silt		12	SS						
	Trace Gravel									
	Very Dense									
238.7			13	SS						
11.1	End of Borehole									

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

METRIC

W P 52-84-02 LOCATION Sta. 13 + 779.3, Offset 10.2 m Lt of C
 DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing ORIGINATED BY MD
 DATUM Geodetic DATE 88 01 25 to 88 01 27 COMPILED BY PM
 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100		W _p	W	W _L		
249.8	Ground Surface												
0.0	Silty Sand Some Gravel Trace Organics		1	CS									
			2	SS	11								
247.7	Loose to Compact		3	SS	5								
2.1	Sand Trace Silt Trace Gravel Compact		4	SS	6								
			5	SS	13								
245.5	Compact		6	SS	10								
4.3	Clayey Silt to Silty Clay Trace Sand Trace Gravel Stiff to Hard		7	SS	12								
			8	SS	16								
			9	SS	80								
242.5			10	SS	100	23 cm							
			11	SS	60	5 cm							
7.3			12	SS	75	13 cm							
	Sand and Gravel Some Silt Very Dense		14	SS	65	5 cm							
			16	SS	65	13 cm							
237.3			17	SS	105	15 cm							
12.5	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 8

METRIC

W P 52-84-02 LOCATION Sta. 13 + 769.4, Offset 5.5 m Rt. of C
DIST 2 HWY 2 BOREHOLE TYPE Washbore, BW Casing ORIGINATED BY MD
DATUM Geodetic DATE 88 01 28 to 88 02 01 COMPILED BY PM
CHECKED BY

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L					
253.2	Ground Surface													
0.0	Zones of Silty Sand Sandy Silt Clayey Silt Trace Organics Some Gravel Loose (Fill)		1	CS			252	Frozen Ground						
			2	SS	5									
			3	SS	6									
			4	SS	6									
			5	SS	10		250							
248.8			6	SS	8									18 21 45 16
4.4	Silty Sand, Trace to some Gravel, pockets of Organ. Loose		7	SS	6		248							
247.1			8	SS	5									
6.1		Hard	9	SS	28		246							0 5 (95)
	Silt to Clayey Silt Trace Sand Trace Gravel Stiff		10	SS	43									
			11	SS	13		244							
243.1			12	SS	12									
10.1			13	SS	60	13 cm	242	8 cm						
	Sand Trace Gravel Trace Silt Very Dense		16	SS	70	13 cm	240							
237.7			17	SS	70	10 cm	238							1 92 (7)
15.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 9

METRIC

W P 52-84-02 LOCATION Sta. 13 + 796 m, O/S 8.3 Rt. of C
DIST 2 HWY 2 BOREHOLE TYPE Cone Test ORIGINATED BY MD
DATUM Geodetic DATE 88 01 20 COMPILED BY PM
CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
249.1	Ground Surface									
0.0										
	Probable Silty Sand to Clayey Silt									
248										
246										
244										
243.1	End of Cone Test						25 cm			
6.0										

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 10

METRIC

W P 52-84-02 LOCATION Sta. 13 + 807.6 m, O/S 4.9 m Lt. of C
DIST 2 HWY 2 BOREHOLE TYPE Cone Test
DATUM Geodetic DATE 88 01 20

ORIGINATED BY MD

COMPILED BY PM

CHECKED BY

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	PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
253.2	Ground Surface										
0.0	Probable Silty Sand Fill										
248.6	4.6										
	Probable Silty Sand to Clayey Silt										
243.3	9.9										
	End of Cone Test										

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11

METRIC

W P 52-84-02 LOCATION Sta. 13 + 770.4 m, O/S 5.2 m Lt. of E
 DIST 2 HWY 2 BOREHOLE TYPE Cone Test
 DATUM Geodetic DATE 88 01 20
 ORIGINATED BY MD
 COMPILED BY PM
 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
253.2	Ground Surface										
0.0											
	Probable Silty Sand to Sandy Silt Fill										
248.7											
4.5											
	Probable Silty Sand to Clayey Silt										
242.9											
10.3	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

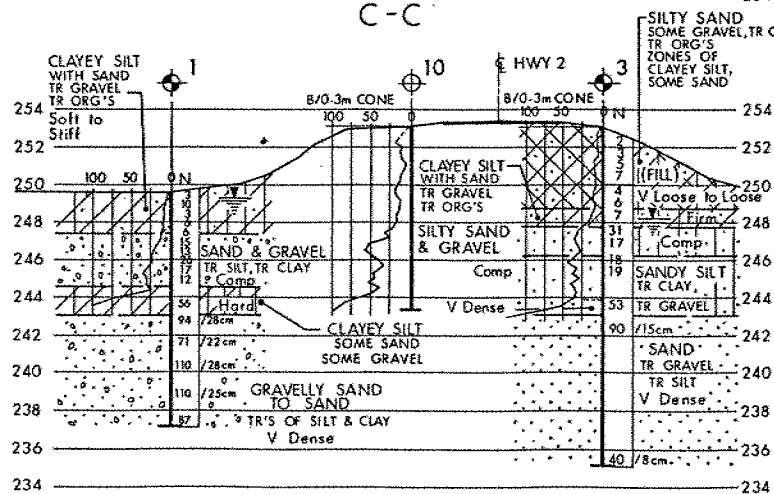
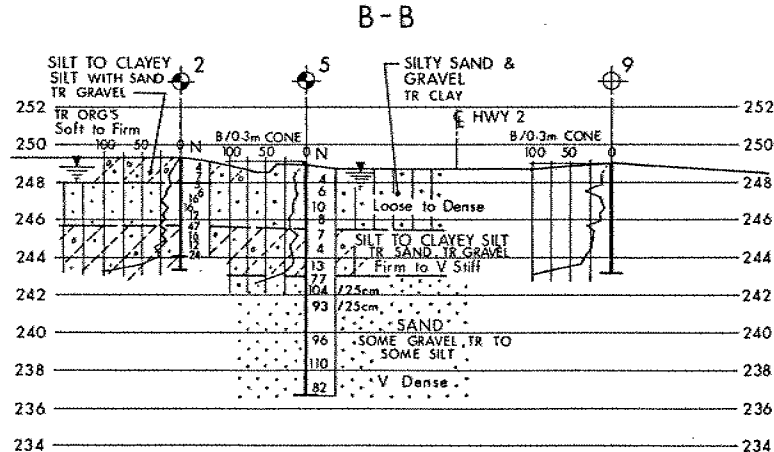
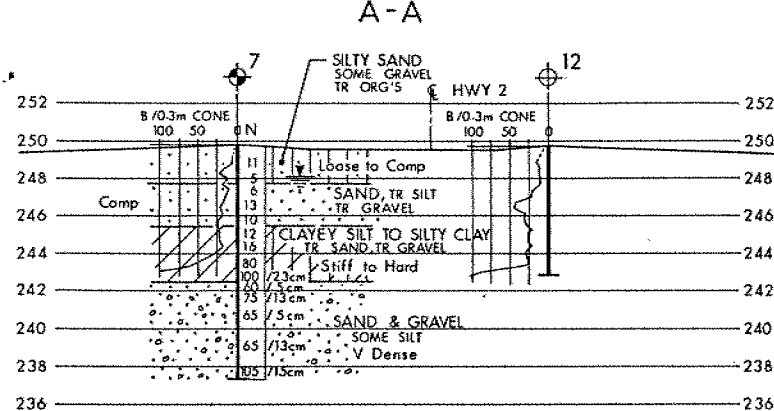
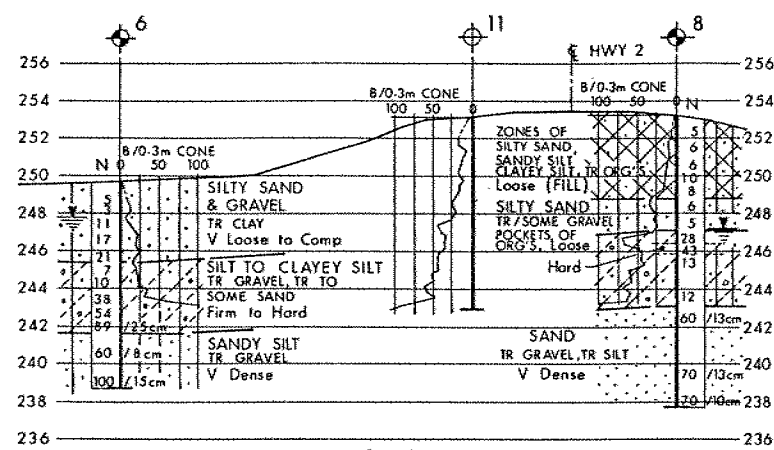


RECORD OF BOREHOLE No 12

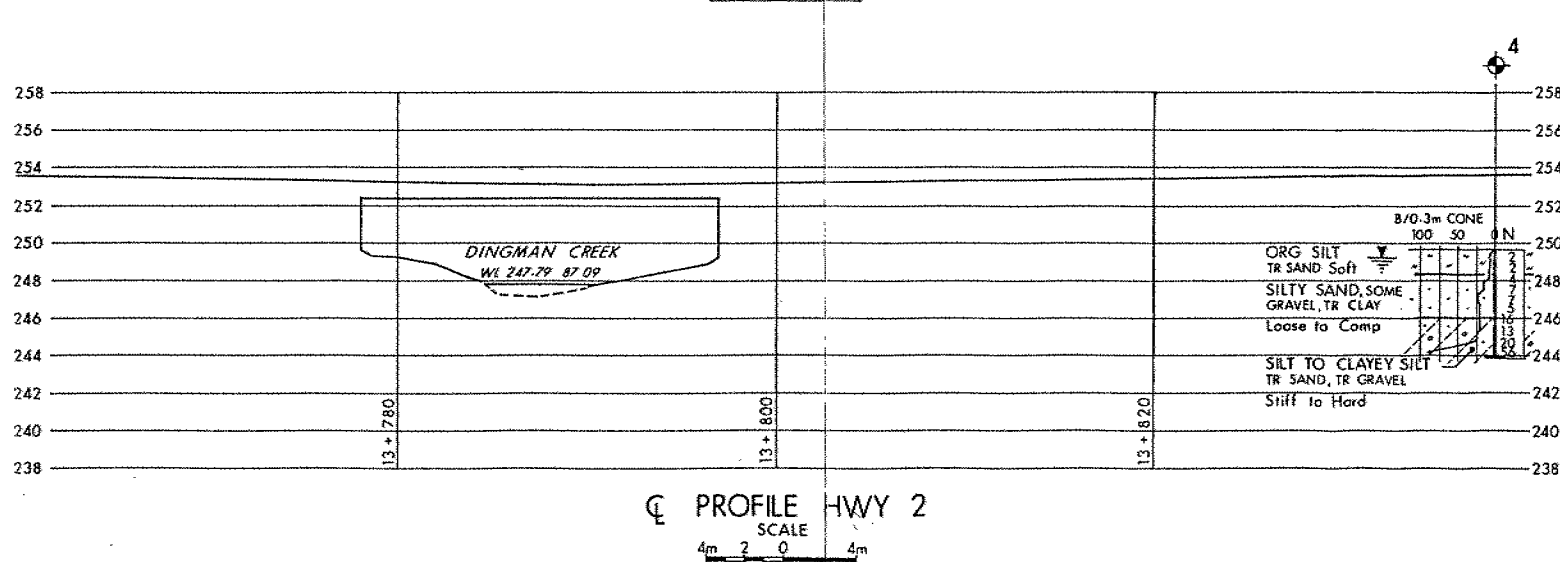
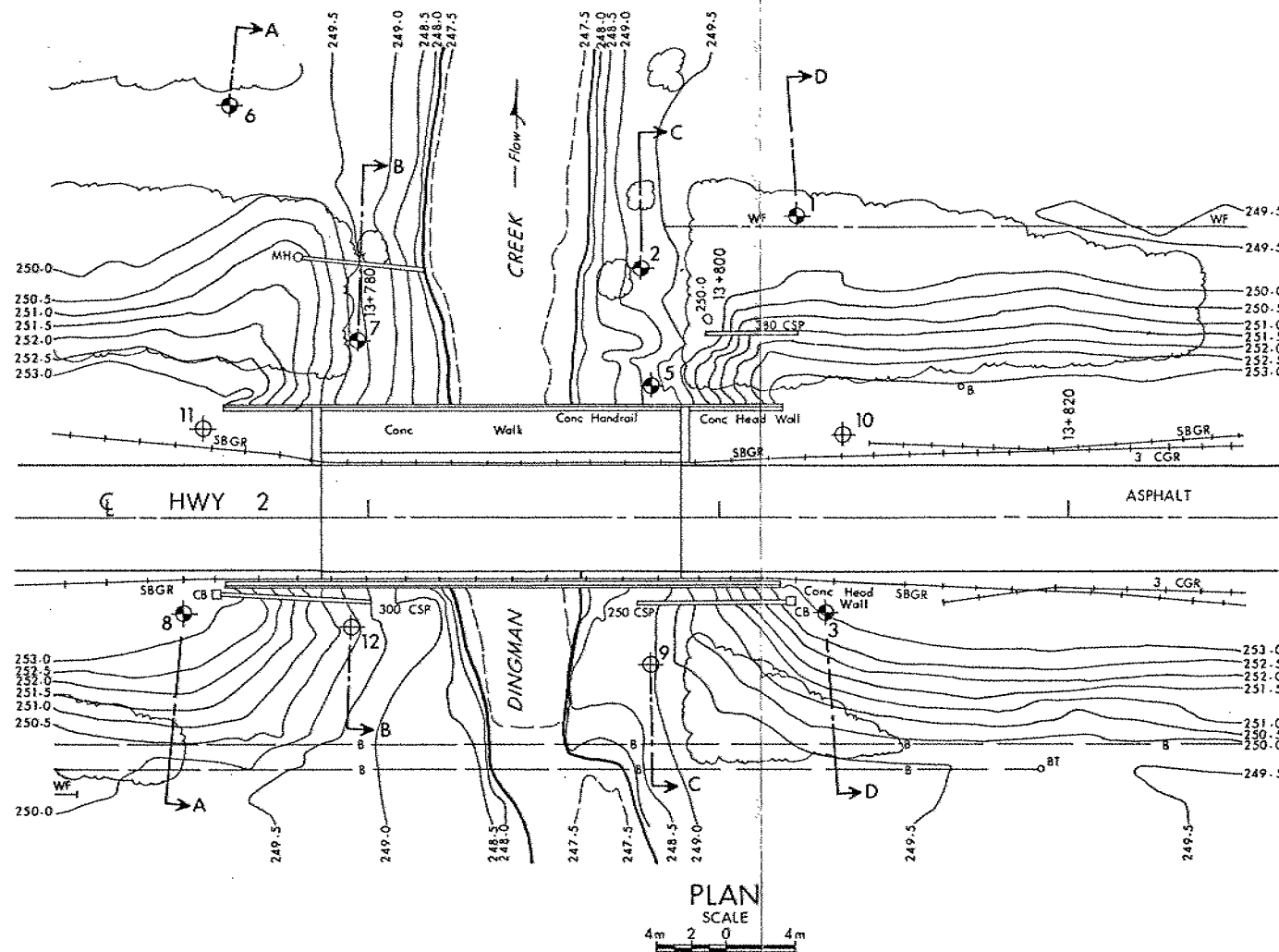
METRIC

W P 52-84-02 LOCATION Sta. 13 + 779, Offset 6.3 m. Rt. of C ORIGINATED BY MD
DIST 2 HWY 2 BOREHOLE TYPE Cone Test COMPILED BY PM
DATUM Geodetic DATE 88 01 28 CHECKED BY _____

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 Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
249.8 0.0	Ground Surface												
	Probable Silty Sand To Clayey Silt												
242.8 7.0	End of Cone Test												



SECTIONS
SCALE
4m 2 0 4m



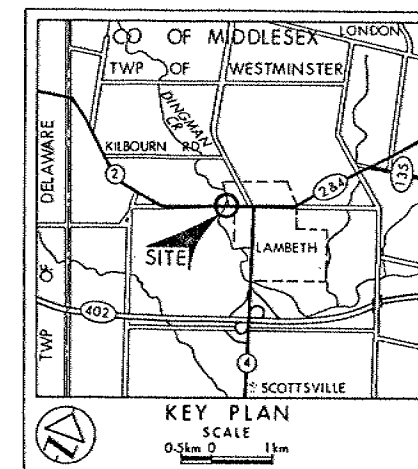
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 52-84-02

DINGMAN CREEK
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)
- W.L. at time of investigation
87 11 to 88 02

No	ELEVATION	STATION	OFFSET
1	249.7	13+804.4	17.5m Lt
2	249.4	13+795.5	14.4m Lt
3	253.1	13+806.0	5.3m Rt
4	249.7	13+838.0	23.0m Lt
5	249.2	13+796.0	7.7m Lt
6	249.8	13+772.8	23.8m Lt
7	249.8	13+779.3	10.2m Lt
8	253.2	13+769.4	5.5m Rt
9	249.1	13+796.0	8.3m Rt
10	253.2	13+807.6	4.9m Lt
11	253.2	13+770.4	5.2m Lt
12	249.8	13+779.0	6.3m 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 40114-112

HWY No 2	SUBM'D SMH	CHECKED	DATE 88 04 20	DIST 2
DRAWN DT	CHECKED	APPROVED		SITE 19-340
				DWG 528402-A