

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 97-21



Ontario

Ministry of
Transportation

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	Foundation Investigation Report for
3 - 22	Ottawa Street North Underpass W.P. 102-94-01, Site 33-231 Hwy 7, District 31, London

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

EXPLANATION OF TERMS USED IN REPORT

2

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
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^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

For

Ottawa Street North Underpass

W.P. 102-94-01; Site 33-231

Highway 7, District 31, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The fieldwork was carried out on 1994 07 28 and 29, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes. However, the boreholes for the existing structure were advanced in June 1965.

Boreholes were advanced to a maximum depth of 12.6 m (El. 306.1) below the existing highway shoulder level using a 82 mm I.D. continuous flight hollow stem auger.

SITE DESCRIPTION

The site under investigation is located approximately 1.3 km east of the present intersection of Hwy. 7 and Hwy. 8 in the Regional Municipality of Waterloo.

The topography of the area is generally undulating. The site is in a residential area of Kitchener and was modified to the present condition by cutting approximately 6.0 m below the present grade of Ottawa Street. The surface in this area is composed of sandy hills, some of these being ridges of sand till while others are kames and kame moraine with outwash sands occupying the intervening hollows. Physiographically the area is located in the Region known as the "Waterloo Hills".

SUBSURFACE CONDITIONS

Geologically the soils at this site are horizontally bedded outwash sands and silts overlying hard clayey silt. The underlying subsoil consists of 0.7 m to 1.9 m very stiff to hard clayey silt underlain by 1.1 m to 2.8 m dense to very dense sandy gravel with varying proportions of silt. This gravel deposit is underlain by 1.3 m to 5.9 m very dense silt to sandy silt with varying proportions of sand which overlies hard silty clay. However, in the area where abutments are located, the clayey silt layer is overlain by 2.7 m to 6.0 m dense to very dense silty sand to sand. For classification purposes, the soils encountered at this site can be divided into six different zones.

- a) Silty Sand to Sand (Fill)
- b) Silty Sand to Sand
- c) Clayey Silt
- d) Sandy Gravel, Trace of Silt
- e) Silt to Sandy Silt
- f) Silty Clay

The soils encountered during the course of the investigation, 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 and section at each abutment location are shown on Drawing No. 1029401-A.* This drawing also shows the location and elevation of the borings. Description of the strata encountered are given below.

A foundation investigation for the existing bridge was carried out in June, 1965. The record of Borehole Sheets from this investigation are also included in this report. However, the grade at borehole locations 101, 102, 103, 104, 105, 106, 107, & 108 has changed since the original investigation in 1965.

* Dwg. No. 2, Sheet 166-1, of the Contract Drawings.

Silty Sand to Sand (Fill)

This fill was encountered only in BH#7 near east abutment. The depth of fill at this location is approximately 3.2 m and extends to elevation 318.8. The Standard Penetration Test values vary from 1 blow/0.3 m to 3 blows/0.3 m indicating very loose state of denseness.

Silty Sand to Sand

This sandy deposit was encountered immediately below the existing ground level in boreholes located near the abutments (BH Nos. 101, 102, 103, 104 & 108). The thickness of this deposit varies from a minimum of 0.9 m to a maximum of 6.0 and extends to elevation 319.3 to 318.0. The Standard Penetration Test results in this deposit were observed to vary over a wide range (40 blows/0.3 m to over 95 blows/0.3 m) indicating dense to very dense state of denseness.

Clayey Silt

This clayey silt deposit was encountered immediately below the existing grade of Highway 7. However, at the abutment locations, this clayey deposit is overlain by silty sand to sand layer. The thickness of this deposit varies from 0.7 m to 1.7 m within the area where this strata was fully penetrated. The natural moisture content was observed to vary from 9.6% to 20.0% with an average value of 13.1%. The Atterberg Limit Test results are shown on Figure 1. The consistency of this stratum may be classified as very stiff to hard.

Sandy Gravel, Trace of Silt

The clayey silt deposit is underlain by this gravelly strata. The thickness of this strata varies from 1.1 m to 2.8 m and extends to elevation 315.8 to 314.5. The Standard Penetration Test results vary from 26 blows/0.3 m to 71 blows/0.3 m indicating compact to very dense state of denseness.

Silt to Sandy Silt

This silty deposit was encountered in all the boreholes advanced below El. 319.9 to El. 317.1. The thickness of this deposit varies from a minimum of 1.3 m to a maximum of 5.9 m and extends to elevation 313.9 to 308.6. The Grain Size Distribution Test results are shown on Figure 2 in an envelope form. The Gradation Test results indicate that this deposit is predominantly composed of silt (66% to 96%), with varying proportions of sand size particles (4% to 34%). The Standard Penetration Test results were observed to vary from 50 blows/0.3 m to over 100 blows/0.3 m indicating very dense state of denseness.

Silty Clay

This silty clay layer was encountered immediately below silt to sandy silt strata. The natural moisture content was observed to vary between 10.0% to 17.0% with an average value of 15.0%. The results of the Atterberg Limit Test carried out on representative soil samples are shown on Figure 3. The consistency of this stratum may be classified as hard (N-values 57 blows/0.3 m to over 100 blows/0.3 m). The full extent of this stratum was not proven below El. 306.1.

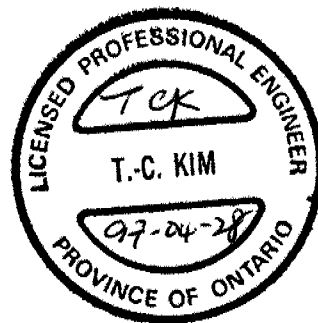
Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed between elevation 318.3 and 317.9. However, the borings for the existing structure indicate water level at higher elevations. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
1	318.3
2	317.9
101	320.3
102	320.0
107	319.7
108	319.9

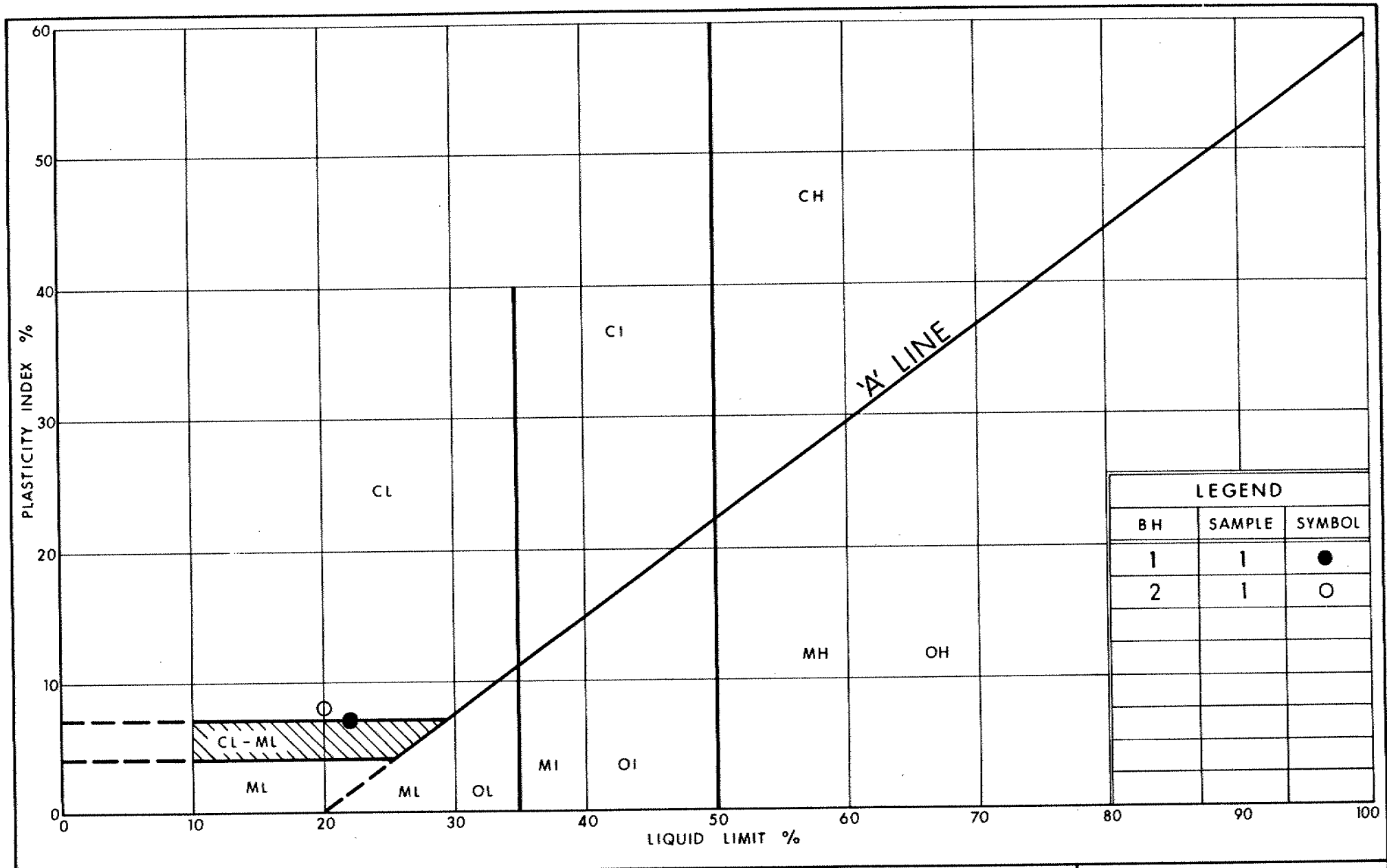
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Vasavathisan. The equipment used was owned and operated by Dominion Soil Investigation Inc. This report was prepared by M. Vasavithasan, Foundation Engineer and reviewed by T.C. Kim, Senior Foundation Engineer.



Tae C. Kim
Tae C. Kim, P. Eng.
Senior Foundation Engineer

APPENDIX



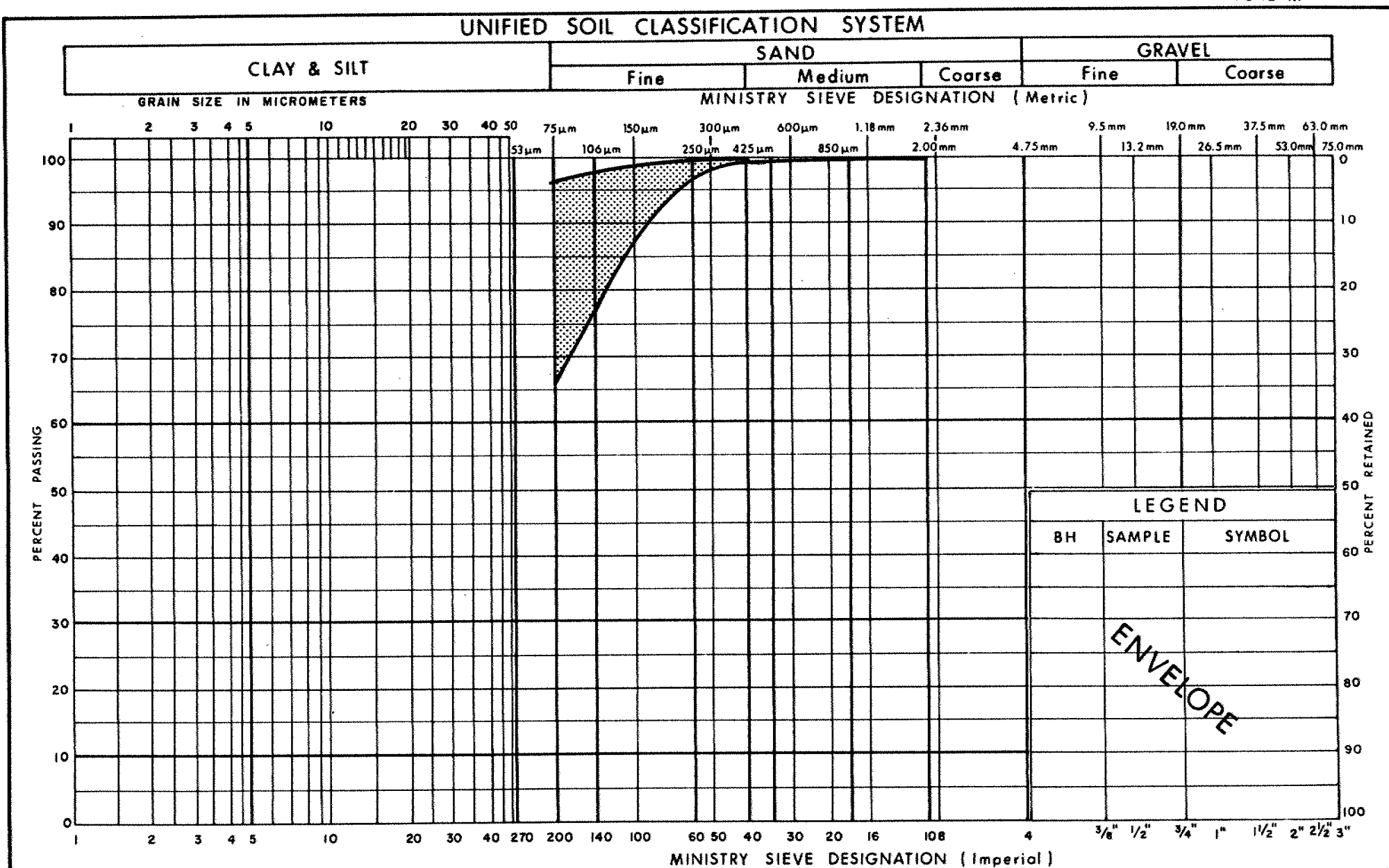
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PLASTICITY CHART CLAYEY SILT

FIG No 1

W P 102-94-01

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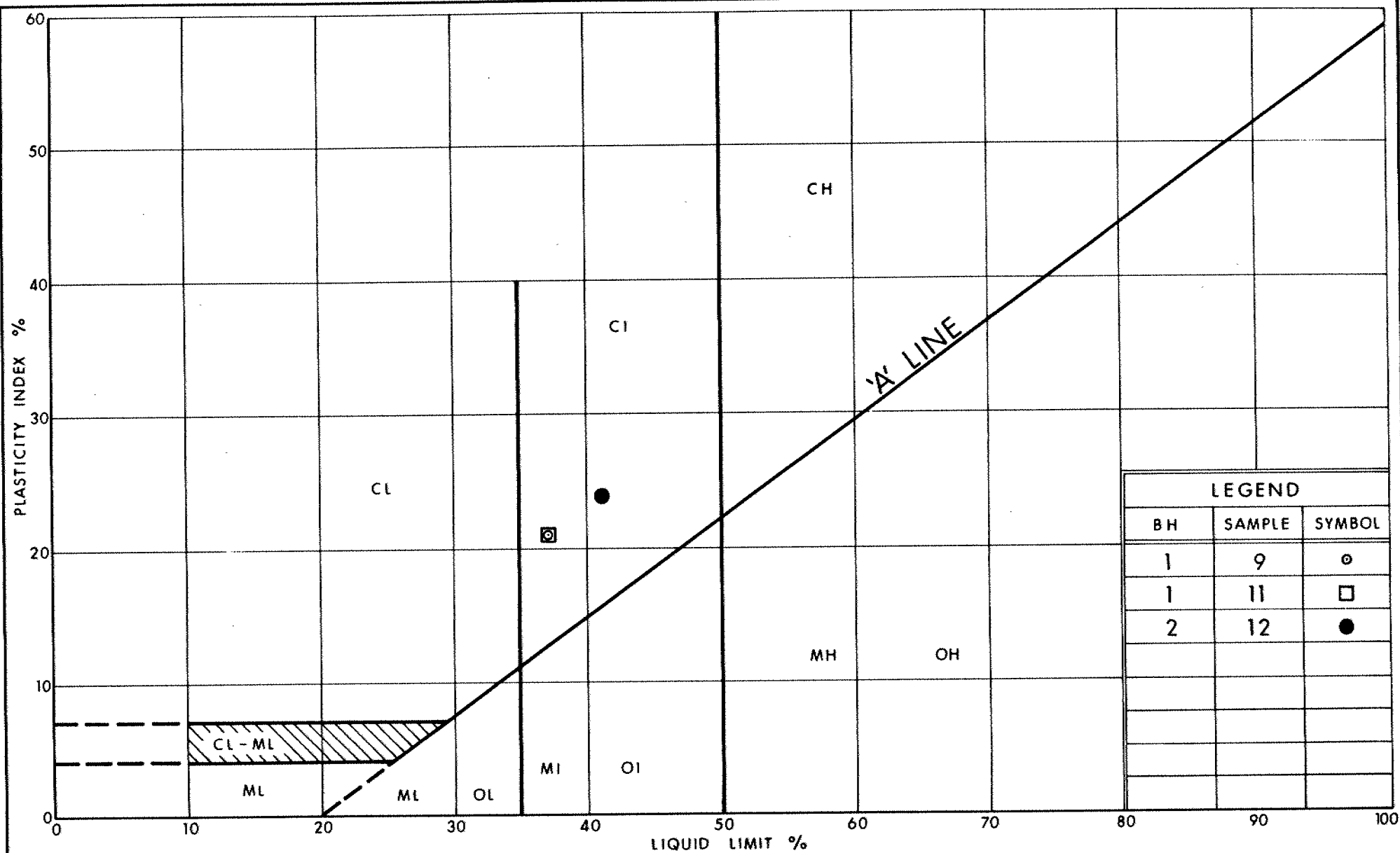
GRAIN SIZE DISTRIBUTION

SILT TO SANDY SILT

FIG No 2

W P 102 - 94 - 01

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LEGEND		
BH	SAMPLE	SYMBOL
1	9	○
1	11	□
2	12	●



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PLASTICITY CHART SILTY CLAY

FIG No 3

W P 102-94-01

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 075.5; E 226 997.6 ORIGINATED BY M V
 DIST 31 HWY 7 BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 94 07 28 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	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	20 40 60 80 100	20 40 60 80 100		
319.4	Ground Surface												
0.0	Topsoil		1	SS	21		318						
317.0	SANDY SILT, Occasional Clayey Silt Layers, Compact to Dense		2	SS	38								
2.4	SANDY GRAVEL, Trace of Silt, Compact to Dense		3	SS	28		316						
315.0			4	SS	41								
			5	SS	29								
4.4	SILT TO SANDY SILT, Very Dense		6	SS	105		314						
			7	SS	82								
			8	SS	137								
311.8			9	SS	85		312						
7.8	SILTY CLAY, Occasional Sandy Silt Layers, Hard		10	SS	112		310						
			11	SS	99								
306.8			12	SS	128		308						
12.6	End of Borehole												

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 B12 081.3; E 227 082.3 ORIGINATED BY M V
DIST 31 HWY 7 BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETTIC DATE 94.07.29 CHECKED BY T C K

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					
318.7	Ground Surface													
0.0	Topsoil													
316.8	CLAYEY SILT, Occasional Silt Layers, Stiff to Very Stiff		1	SS	13		318							
1.9	SANDY GRAVEL, Trace of Silt, Dense		2	SS	29		316							
			3	SS	34									
314.5			4	SS	36									
4.2			5	SS	45									
			6	SS	50									
			7	SS	64									
	Some Gravel		8	SS	71									
	SILT TO SANDY SILT, Occasional Clayey Silt and Sand Seams, Very Dense		9	SS	123	/23cm								0 14 (88)
308.6			10	SS	121									15 30 (55)
10.1	SILTY CLAY, Occasional Gravel, Hard		11	SS	71									
308.1			12	SS	57									
12.6	End of Borehole													

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 053.9; E 227 001.3 ORIGINATED BY VTS&CFF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M.V.
DATUM GEODETIC DATE 85 06 18 CHECKED BY T.C.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m ³	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		
326.7	Ground Surface																
0.0	Topsoil and Fill																
0.8	Compact		1	SS	20												
			2	SS	60												
			3	SS	40												
			4	SS	48												
	SILTY SAND TO SAND, Dense to Very Dense		5	SS	44												
			6	SS	45												
			7	SS	73												
			8	SS	54												
318.0																	
8.7 317.1	CLAYEY SILT, Hard		9	SS	44												
9.6	End of Borehole																
	<p>* Note: Formerly BH # 1 of W. P. 631 - 84</p> <p>Grade has Changed Since the Investigation in June 1965</p>																

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 069.6; E 226 991.7 ORIGINATED BY VTS&CFE
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETTIC DATE 65 06 11 CHECKED BY T C K

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
326.7	Ground Surface												
0.0	Topsoil and Fill												
0.5	SILTY SAND TO SANDY SILT, Occasional Silt Seams, Dense to Very Dense		1	SS	28								
			2	SS	34								
			3	SS	57								
323.2			4	SS	152								
3.5	SAND, Some Gravel, Dense to Very Dense		5	SS	75								
			6	SS	40								
			7	SS	95								
318.8			8	SS	42								
7.9	CLAYEY SILT, Hard												
317.1	9	SS	112										
9.6	End of Borehole												
	<p>Note: Formerly BH # 2 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>												

RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 065.1; E 227 023.9 ORIGINATED BY VTS&GFF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M.V.
DATUM GEODETIC DATE 65 06 21 & 22 CHECKED BY T.C.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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	W _p	W	W _L		
326.7	Ground Surface													
0.0	SILTY SAND (Fill) ----- Topsoil		1	SS	22		326							
325.3			2	SS	31									
1.4			3	SS	34									
			4	SS	28									
			5	SS	48									
	SILTY SAND TO SAND, Occasional Silt Layers, Dense to Very Dense		6	SS	35									
			7	SS	50									
318.8			8	SS	95									
7.9	CLAYEY SILT, Hard		9	SS	79									
317.4			10	SS	71									
9.3	SANDY GRAVEL, Trace of Silt, Very Dense		11	SS	124	/23cm								
314.6			12	SS	150	/23cm								
12.1	SILT, Occasional Clayey Silt Layers, Very Dense		13	SS	90	/20cm								
313.3														
13.4	SILTY CLAY, Occasional Sand and Silt Layers, Hard													
311.3														
15.4	End of Borehole													
	<p>* Note: Formerly BH # 3 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>													

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 077.0; E 227 007.0 ORIGINATED BY VTS&CFF
 DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
 DATUM GEODETTIC DATE 65 06 10 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT		UNIT WEIGHT γ kN/m ³	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	W _p	W		
326.7	Ground Surface												
0.0	Topsoli and Fill												
0.5			1	SS	18		326						
	Some Gravel		2	SS	22								
			3	SS	30		324						
			4	SS	53								
	SILTY SAND TO SAND, Occasional Silt Layers, Compact to Very Dense		5	SS	50		322						
			6	SS	52								
			7	SS	67		320						
319.1													
7.6	CLAYEY SILT, Hard		8	SS	115		318						
8.3													
	SANDY GRAVEL, Trace of Silt, Very Dense		9	SS	80		316						
315.7			10	SS	86								
11.0	SILT, Occasional Sand Layers, Very Dense						314						
313.6													
13.1	SILTY CLAY, Occasional Sandy Silt and Silt Layers, Hard		12	SS	145	/25cm	312						
311.0			13	SS	162								
15.7	End of Borehole												
	* Note: Formerly BH # 4 of W. P. 631 - 64 Grade has Changed Since the Investigation in June 1965												

RECORD OF BOREHOLE No 105

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 080.5; E 227 053.8 ORIGINATED BY VTS&CFF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M.V.
DATUM GEODETTIC DATE 85 06 22-23 CHECKED BY T.C.K.

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					
326.4	Ground Surface													
0.0	SILTY SAND, Loose, (Fill)	⊗	1	SS	5		326							
325.3			2	SS	17		324							
1.1			3	SS	20		322							
	SAND, Trace of Gravel, Compact to Dense		4	SS	27		320							
			5	SS	40		318							
			6	SS	86		316							
319.1			7	SS	45		314							
7.3	CLAYEY SILT, Hard	⊗	8	SS	88		312							
317.4			9	SS	40		310							
9.0	SANDY GRAVEL, Occasional Sand Layers, Dense	⊗	10	SS	101									
315.8			11	SS	126	/20cm								
10.6	SANDY SILT, Occasional Sand Layers, Very Dense	⊗	12	SS	187	/23cm								
313.9			13	SS	96	/20cm								
12.5	SILTY CLAY, Occasional Sand Layers, Hard	⊗												
309.1	End of Borehole													
17.3	<p>Note: Formerly BH # 5 of W. P. 631 - 84</p> <p>Grade has Changed Since the Investigation in June 1965</p>													

RECORD OF BOREHOLE No 106

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 091.6; E 227 041.0 ORIGINATED BY VTS&CE
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 65 06 12 CHECKED BY T C K

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					
326.1	Ground Surface																
0.0	Compact		1	SS	20												
			2	SS	30												
			3	SS	45												
	SILTY SAND TO SAND, Occasional Gravel, Dense to Very Dense		4	SS	60												
			5	SS	77												
			6	SS	98												
319.9			7	SS	30												
6.2	SILT, Occasional Clayey Silt and Sand Layers, Dense to Very Dense		8	SS	133												
316.6			9	SS	48												
9.5	SANDY GRAVEL, Trace of Silt, Dense		10	SS	97												
315.5			11	SS	175	/18cm											
10.6	SILTY CLAY, Occasional Sand and Silt Layers, Hard		12	SS	200	/17cm											
			13	SS	235	/22cm											
310.7																	
15.4	End of Borehole																
	* Note: Formerly BH # 6 of W. P. 631 - 54 Grade has Changed Since the Investigation in June 1965																

RECORD OF BOREHOLE No 107

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 087.0; E 227 087.8 ORIGINATED BY VTS&CF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 85 06 23 & 24 CHECKED BY T C K

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					
326.3	Asphalt Surface													
0.0	Asphalt													
			1	SS	18									
			2	SS	7									
			3	SS	4									
			4	SS	3									
			5	SS	3									
			6	SS	3									
			7	SS	3									
318.8			8	SS	1									
7.5			9	SS	20									
	CLAYEY SILT, Occasional Silty Sand Layers, Hard		10	SS	90									
315.2			11	SS	50									
11.1	End of Borehole													
	Note: Formerly BH # 7 of W. P. 631 - 84													
	Grade has Changed Since the Investigation in June 1965													

RECORD OF BOREHOLE No 108

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 099.4; E 227 055.7 ORIGINATED BY VTS&CF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETTIC DATE 85 06 24 CHECKED BY T C K

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
326.1	Asphalt Surface													
0.0	Asphalt													
324.4	SILTY SAND, Trace of Organics, Compact (Fill)		1	SS	26									
1.7			2	SS	24									
			3	SS	28									
			4	SS	29									
	SAND, Trace of Silt, Compact to Dense		5	SS	41									
			6	SS	39									
319.3			7	SS	26									
6.8	CLAYEY SILT, Occasional Silt Layers, Hard		8	SS	66									
316.5			9	SS	57									
9.8	End of Borehole													
	Note: Formerly BH # 8 of W. P. 631 - 84 Grade has Changed Since the Investigation in June 1965													

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 102-94-01 DIST 31
HWY 7 STR SITE 33-231

CONT 97-21

Ottawa Street North Underpass

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GEOCRES 40P8-113

DATE JAN 19 1996

FOUNDATION INVESTIGATION REPORT

For

Ottawa Street North Underpass

W.P. 102-94-01; Site 33-231

Highway 7, District 31, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The fieldwork was carried out on 1994 07 28 and 29, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes. However, the boreholes for the existing structure were advanced in June 1965.

Boreholes were advanced to a maximum depth of 12.6 m (El. 306.1) below the existing highway shoulder level using a 82 mm I.D. continuous flight hollow stem auger.

SITE DESCRIPTION

The site under investigation is located approximately 1.3 km east of the present intersection of Hwy. 7 and Hwy. 8 in the Regional Municipality of Waterloo.

The topography of the area is generally undulating. The site is in a residential area of Kitchener and was modified to the present condition by cutting approximately 6.0 m below the present grade of Ottawa Street. The surface in this area is composed of sandy hills, some of these being ridges of sand till while others are kames and kame moraine with outwash sands occupying the intervening hollows. Physiographically the area is located in the Region known as the "Waterloo Hills".

SUBSURFACE CONDITIONS

Geologically the soils at this site are horizontally bedded outwash sands and silts overlying hard clayey silt. The underlying subsoil consists of 0.7 m to 1.9 m very stiff to hard clayey silt underlain by 1.1 m to 2.8 m dense to very dense sandy gravel with varying proportions of silt. This gravel deposit is underlain by 1.3 m to 5.9 m very dense silt to sandy silt with varying proportions of sand which overlies hard silty clay. However, in the area where abutments are located, the clayey silt layer is overlain by 2.7 m to 6.0 m dense to very dense silty sand to sand. For classification purposes, the soils encountered at this site can be divided into six different zones.

- a) Silty Sand to Sand (Fill)
- b) Silty Sand to Sand
- c) Clayey Silt
- d) Sandy Gravel, Trace of Silt
- e) Silt to Sandy Silt
- f) Silty Clay

The soils encountered during the course of the investigation, 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 and section at each abutment location are shown on Drawing No. 1029401-A. This drawing also shows the location and elevation of the borings. Description of the strata encountered are given below.

A foundation investigation for the existing bridge was carried out in June, 1965. The record of Borehole Sheets from this investigation are also included in this report. However, the grade at borehole locations 101, 102, 103, 104, 105, 106, 107, & 108 has changed since the original investigation in 1965.

Silty Sand to Sand (Fill)

This fill was encountered only in BH#7 near east abutment. The depth of fill at this location is approximately 3.2 m and extends to elevation 318.8. The Standard Penetration Test values vary from 1 blow/0.3 m to 3 blows/0.3 m indicating very loose state of denseness.

Silty Sand to Sand

This sandy deposit was encountered immediately below the existing ground level in boreholes located near the abutments (BH Nos. 101, 102, 103, 104 & 108). The thickness of this deposit varies from a minimum of 0.9 m to a maximum of 6.0 and extends to elevation 319.3 to 318.0. The Standard Penetration Test results in this deposit were observed to vary over a wide range (40 blows/0.3 m to over 95 blows/0.3 m) indicating dense to very dense state of denseness.

Clayey Silt

This clayey silt deposit was encountered immediately below the existing grade of Highway 7. However, at the abutment locations, this clayey deposit is overlain by silty sand to sand layer. The thickness of this deposit varies from 0.7 m to 1.7 m within the area where this strata was fully penetrated. The natural moisture content was observed to vary from 9.6% to 20.0% with an average value of 13.1%. The Atterberg Limit Test results are shown on Figure 1. The consistency of this stratum may be classified as very stiff to hard.

Sandy Gravel, Trace of Silt

The clayey silt deposit is underlain by this gravelly strata. The thickness of this strata varies from 1.1 m to 2.8 m and extends to elevation 315.8 to 314.5. The Standard Penetration Test results vary from 26 blows/0.3 m to 71 blows/0.3 m indicating compact to very dense state of denseness.

Silt to Sandy Silt

This silty deposit was encountered in all the boreholes advanced below El. 319.9 to El. 317.1. The thickness of this deposit varies from a minimum of 1.3 m to a maximum of 5.9 m and extends to elevation 313.9 to 308.6. The Grain Size Distribution Test results are shown on Figure 2 in an envelope form. The Gradation Test results indicate that this deposit is predominantly composed of silt (66% to 96%), with varying proportions of sand size particles (4% to 34%). The Standard Penetration Test results were observed to vary from 50 blows/0.3 m to over 100 blows/0.3 m indicating very dense state of denseness.

Silty Clay

This silty clay layer was encountered immediately below silt to sandy silt strata. The natural moisture content was observed to vary between 10.0% to 17.0% with an average value of 15.0%. The results of the Atterberg Limit Test carried out on representative soil samples are shown on Figure 3. The consistency of this stratum may be classified as hard (N-values 57 blows/0.3 m to over 100 blows/0.3 m). The full extent of this stratum was not proven below El. 306.1.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed between elevation 318.3 and 317.9. However, the borings for the existing structure indicate water level at higher elevations. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
1	318.3
2	317.9
101	320.3
102	320.0
107	319.7
108	319.9

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to replace the existing bridge at the crossing of Highway 7 and Ottawa Street to accommodate the widening of Highway 7 to six lanes. The new structure will be constructed along the same alignment as the existing bridge. The profile grade of Ottawa Street at the east abutment will be set at about El. 326.7 and at west abutment, it will be set at El. 327.2. The replacement bridge will be a two span concrete structure with a pier column along the Hwy. 7 median. Each span will be approximately 36.0 m and the location of the abutments and pier is as follows:

<u>Structure</u>	<u>Location</u>
West Abutment	Sta. 9 + 964
Pier	Sta. 10 + 000
East Abutment	Sta. 10 + 036

The existing bridge is a four span structure with 19.5 m end spans and approximately 21.6 m centre span. The Structural Drawing No. D-5805-3 dated October 1966 indicates that the west abutment and piers of the existing bridge are supported on shallow foundation. The founding level of the spread footings are as follows:

<u>Structure</u>	<u>Footing Elevation</u>
West Abutment	322.2
West Pier	318.1
East Pier	317.8

However, the east abutment is supported on 324 mm O.D. and 7 mm thick pipe piles driven to El. 317.3. The pipe piles filled with concrete were designed to carry a load of 450 kN (45 tons). In order to facilitate the construction of the existing underpass, the ground level was lowered by approximately 6.0 m below the present grade (El. 326.3) of Ottawa Street.

The approach embankments as well as the bridge deck appear in very good condition. However, spalling of concrete have been noticed at few locations.

Structure Foundations

Considering the subsoil conditions at this site, it is recommended that the abutments and centre pier be supported on spread footings. The spread footings for the west abutment may be placed at about elevation 322.0, and designed assuming the following bearing pressures.

Factored Bearing Capacity at U.L.S.	=	850 kPa
Bearing Capacity at S.L.S.	=	350 kPa

The foundation for the east abutment and centre pier may be placed at about El. 317.0, and for the design of the footing, the following bearing capacity values are recommended.

Factored Bearing Capacity at U.L.S.	=	900 kPa
Bearing Capacity at S.L.S.	=	350 kPa

The allowable bearing pressures (S.L.S.) recommended above are based on the assumption that the footing will not be less than 1.5 m wide and will not be placed at a level higher than the elevations indicated above. The total settlement for these bearing pressures is not expected to exceed 25 mm.

Lateral Earth Pressure

Earth pressure should be computed as per Section 6.7.4.5 of the O.H.B.D.C., and the coefficient of earth pressure at rest shall be used for rigid and unyielding walls. The Granular 'A' or 'B' backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction	$\phi = 35^{\circ}$	$\phi = 30^{\circ}$
Unit Weight (kN/m ³)	$\gamma = 22.8$	$\gamma = 21.2$

The sliding resistance may be estimated assuming an unfactored coefficient of friction value of $\tan 30$ for footing placed on granular material.

Approach Embankments

The profile grade of Ottawa Street at the intersection is expected to vary between El. 327.2 and El. 326.7. Considering the subsoil conditions at this site, no major stability problems are anticipated for the approach embankments constructed with 2 horizontal to 1 vertical side slope.

The fill should consist of well compacted acceptable material. The topsoil as well as any spongy or soft area observed within the base width of the embankment should be removed before placing the fill.

Other Considerations

The spread footings should have a minimum of 1.5 m earth cover to protect against frost penetration.

Considering the groundwater level, dewatering will be necessary during the construction of the pier as well as east abutment footings. This may be handled by pumping from the sump.

Dewatering scheme as suggested or an equivalent alternate scheme should be submitted by the Contractor three weeks in advance to the Pavements and Foundations Section for approval.

However, the Contractor is responsible for dewatering the excavation area effectively and for this purpose, an item should be included in the contract by Non-Standard Special Provision.

We understand that the Ottawa Street will not be opened for traffic during construction and for this reason no recommendation is provided for the design of roadway protection. The excavation may be carried out with 2H:1V forward slope..

The base of the excavation for the footings shall be covered with 150 mm thick lean concrete pad upon exposure to avoid any deterioration of the founding soil.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Vasavathisan. The equipment used was owned and operated by Dominion Soil Investigation Inc. This report was prepared by M. Vasavithasan, Foundation Engineer and reviewed by T.C. Kim, Senior Foundation Engineer.

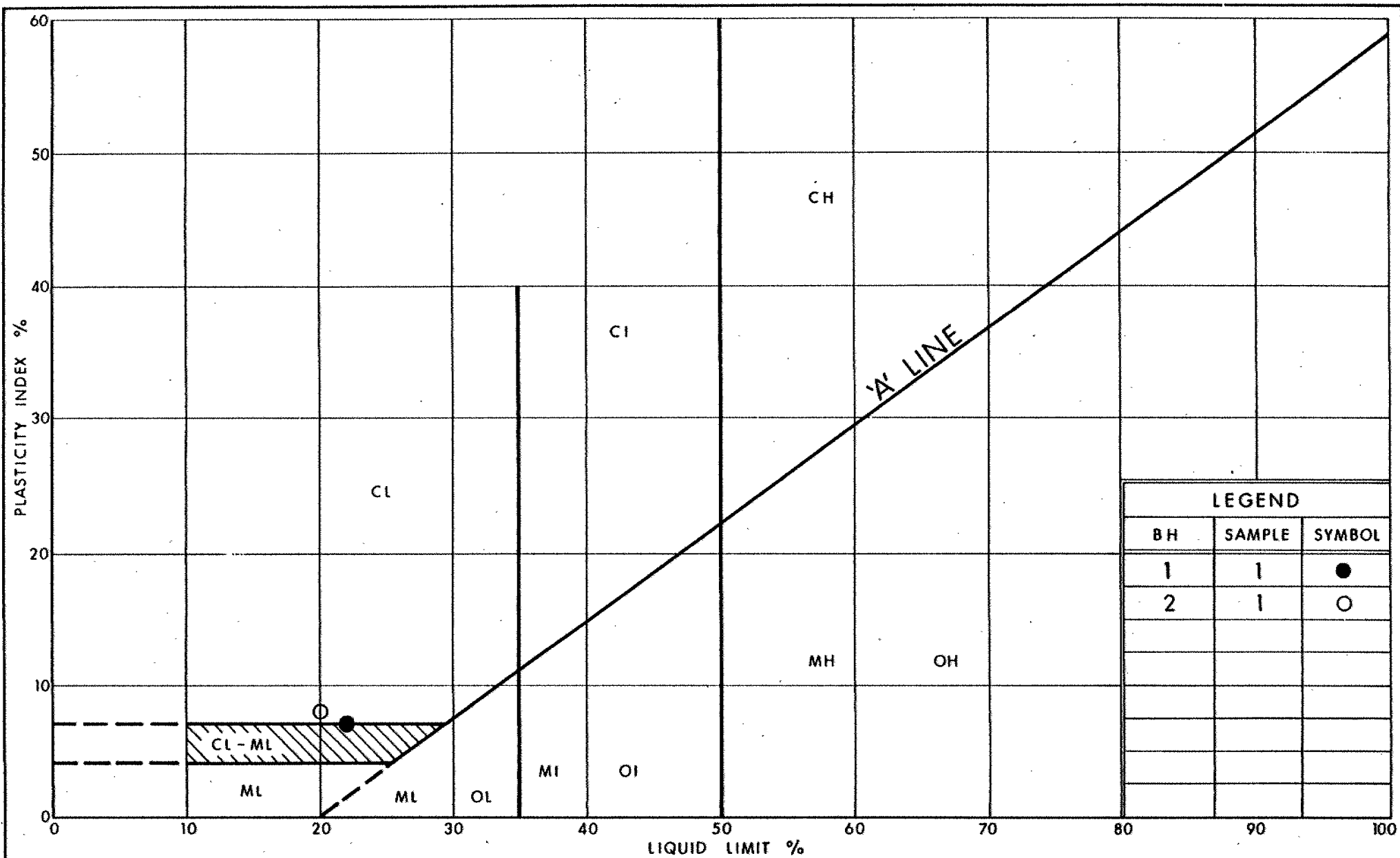


M. Vasavithasan, P. Eng.
Foundation Engineer



T.C. Kim, P. Eng.
Sr. Foundation Engineer

APPENDIX



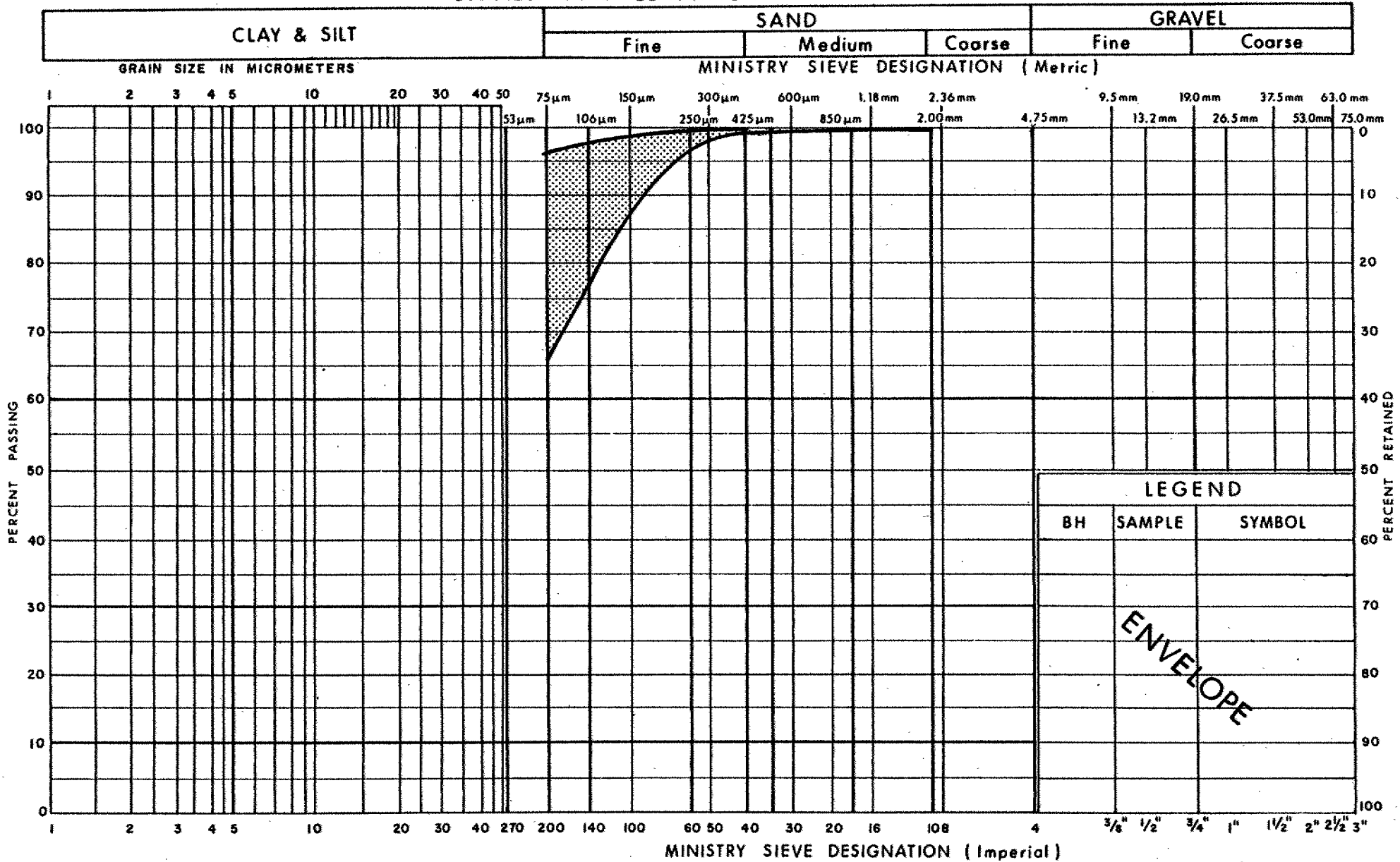
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Ontario

PLASTICITY CHART CLAYEY SILT

FIG No 1

W P 102-94-01

UNIFIED SOIL CLASSIFICATION SYSTEM



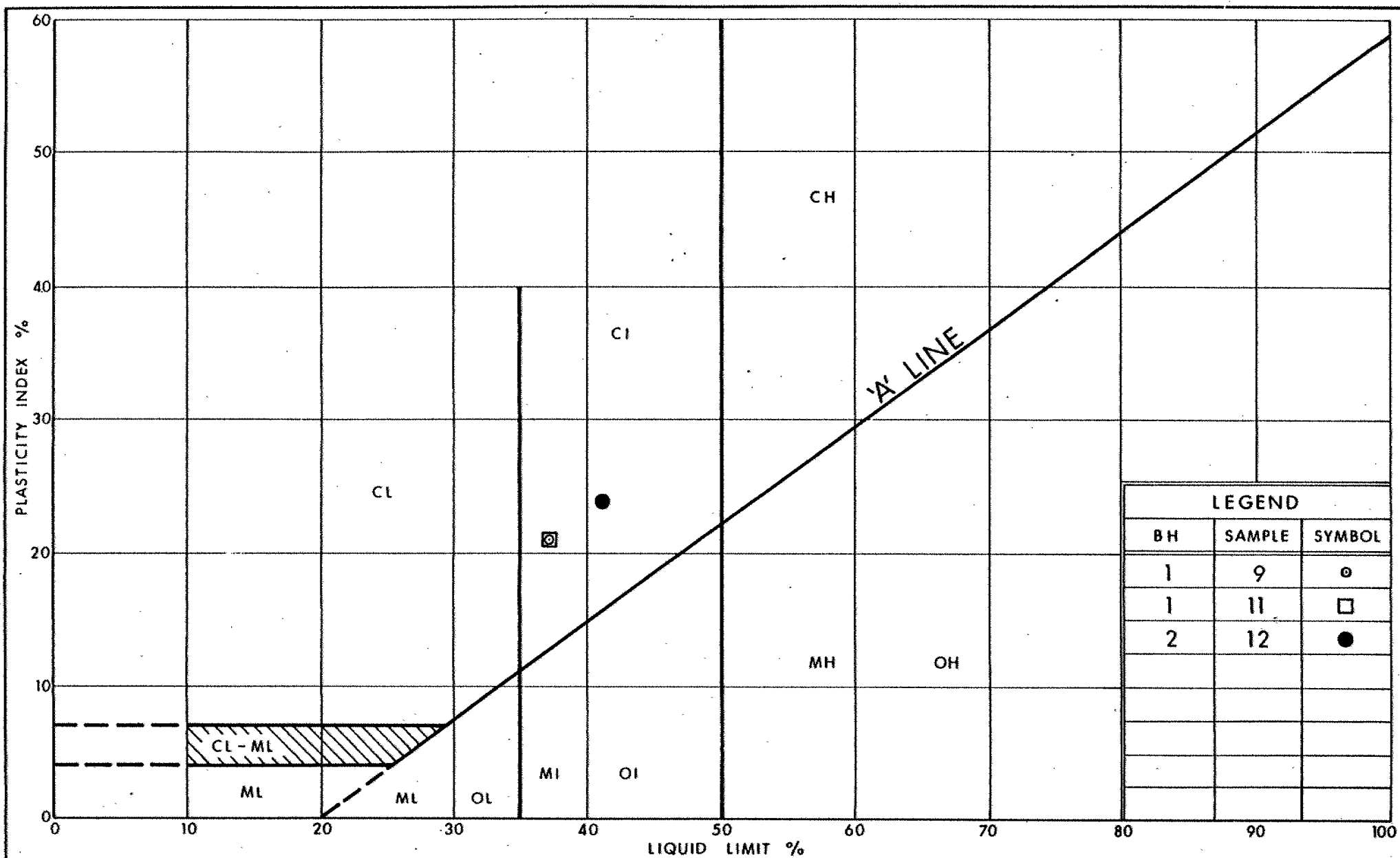
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Transportation

GRAIN SIZE DISTRIBUTION

SILTY TO SANDY SILT

FIG No 2

W P 102 - 94 - 01



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PLASTICITY CHART SILTY CLAY

FIG No 3

W P 102-94-01

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 075.5; E 226 997.6 ORIGINATED BY M.V.
DIST 31 HWY 7 BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST COMPILED BY M.V.
DATUM GEODETIC DATE 94 07 28 CHECKED BY T.C.K.

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	7
								SHEAR STRENGTH kPa							WATER CONTENT (%)						
						○ UNCONFINED + FIELD VANE															
						● QUICK TRIAXIAL × LAB VANE															
						20 40 60 80 100						20 40 60									
319.4	Ground Surface																				
0.0	Topsoil																				
	Clayey Silt		1	SS	21																
	SANDY SILT, Occasional Clayey Silt Layers, Compact to Dense		2	SS	38																
317.0			3	SS	28																
2.4	SANDY GRAVEL, Trace of Silt, Compact to Dense		4	SS	41																
315.0			5	SS	29																
4.4			6	SS	105																
	SILT TO SANDY SILT, Very Dense		7	SS	82																
			8	SS	137																
311.8			9	SS	65																
7.8			10	SS	112																
	Sandy Silt																				
	SILTY CLAY, Occasional Sandy Silt Layers, Hard		11	SS	99																
308.8			12	SS	128																
12.6	End of Borehole																				

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 081.3; E 227 082.3
 DIST 31 HWY 7 BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST
 DATUM GEODETIC DATE 94 07 29
 ORIGINATED BY M V
 COMPILED BY M V
 CHECKED BY T C K

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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
318.7	Ground Surface													
0.0	Topsoil													
316.8	CLAYEY SILT, Occasional Silt Layers, Stiff to Very Stiff		1	SS	13									
1.9			2	SS	29									
	SANDY GRAVEL, Trace of Silt, Dense		3	SS	34									
			4	SS	36									
314.5			5	SS	45									
4.2			6	SS	50									
			7	SS	84									
	Some Gravel		8	SS	71									
	SILT TO SANDY SILT, Occasional Clayey Silt and Sand Seams, Very Dense		9	SS	123	/23cm								
			10	SS	121									
308.6														
10.1	SILTY CLAY, Occasional Gravel, Hard		11	SS	71									
308.1														
12.6	End of Borehole		12	SS	57									

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CD - ORDS: N 4 812 053.9; E 227 001.3 ORIGINATED BY VTS&CFF
 DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M.V.
 DATUM GEODETIC DATE 65 06 18 CHECKED BY T.C.K.

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE			'N' VALUES	20						40	60
326.7	Ground Surface														
0.0	Topsoil and Fill	⊗													
0.6	Compact	⊗	1	SS	20										
		⊗	2	SS	60										
		⊗	3	SS	40										
		⊗	4	SS	48										
		⊗	5	SS	44										
		⊗	6	SS	45										
		⊗	7	SS	73										
		⊗	8	SS	54										
318.0															
8.7	CLAYEY SILT,	⊗													
317.1	Hard	⊗	9	SS	44										
9.6	End of Borehole														
<p>Note: Formerly BH # 1 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>															

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 069.6; E 226 991.7 ORIGINATED BY VTS&CFE
 DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 65 06 11 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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	W _P W W _L	20 40 60			
326.7	Ground Surface													
0.0	Topsoil and Fill													
0.5	SILTY SAND TO SANDY SILT, Occasional Silt Seams, Dense to Very Dense		1	SS	28									
			2	SS	34									
			3	SS	57									
323.2			4	SS	152									
3.5	SAND, Some Gravel, Dense to Very Dense		5	SS	75									
			6	SS	40									
			7	SS	95									
318.8	CLAYEY SILT, Hard		8	SS	42									
7.9			9	SS	112									
317.1														
9.6	End of Borehole													
<p>* Note: Formerly BH # 2 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>														

RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 065.1; E 227 023.9 ORIGINATED BY VTS&CF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 65 06 21 & 22 CHECKED BY T C K

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					
326.7	Ground Surface																
0.0																	
325.3	SILTY SAND (FIH)	Topsoil	1	SS	22		326										
1.4			2	SS	31												
			3	SS	34		324										
			4	SS	28												
	SILTY SAND TO SAND, Occasional Silt Layers, Dense to Very Dense		5	SS	48												
			6	SS	35		322										
			7	SS	50		320										
318.8			8	SS	95												
7.9	CLAYEY SILT, Hard		9	SS	79		318										
317.4			10	SS	71												
9.3	SANDY GRAVEL, Trace of Silt, Very Dense		11	SS	124	/23cm	316										
314.6			12	SS	150	/23cm	314										
12.1	SILT, Occasional Clayey Silt Layers, Very Dense		13	SS	90	/20cm	312										
313.3																	
13.4	SILTY CLAY, Occasional Sand and Silt Layers, Hard																
311.3																	
15.4	End of Borehole																
	Note: Formerly BH # 3 of W. P. 631 - 84 Grade has Changed Since the Investigation in June 1965																

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 077.0; E 227 007.0 ORIGINATED BY VTS&CFE
 DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M.V.
 DATUM GEODETTIC DATE 65 06 10 CHECKED BY T.C.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	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	W _p	W	W _L		
326.7	Ground Surface													
0.0	Topsail and Fill													
0.5			1	SS	18									
	Some Gravel		2	SS	22									
			3	SS	30									
			4	SS	53									
			5	SS	50									
	SILTY SAND TO SAND, Occasional Silt Layers, Compact to Very Dense		6	SS	52									
			7	SS	67									
319.1														
7.6	CLAYEY SILT, Hard		8	SS	115									
8.3														
	SANDY GRAVEL, Trace of Silt, Very Dense		9	SS	60									
315.7														
11.0	SILT, Occasional Sand Layers, Very Dense		10	SS	86									
313.6														
13.1	SILTY CLAY, Occasional Sandy Silt and Silt Layers, Hard		11	SS	140									
			12	SS	145									
311.0														
			13	SS	162									
15.7	End of Borehole													
	Note: Formerly BH # 4 of W. P. 631 - 64 Grade has Changed Since the Investigation in June 1965													

1 OF 1

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
326.4	Ground Surface													
0.0	SILTY SAND, Loose, (Fill)	⊗												
325.3			1	SS	5									
1.1			2	SS	17									
			3	SS	20									
	SAND, Trace of Gravel, Compact to Dense		4	SS	27									
			5	SS	40									
			6	SS	86									
			7	SS	45									
319.1														
7.3	CLAYEY SILT, Hard	⊗	8	SS	86									
317.4														
9.0	SANDY GRAVEL, Occasional Sand Layers, Dense	⊗	9	SS	40									
315.8														
10.6	SANDY SILT, Occasional Sand Layers, Very Dense	⊗	10	SS	101									
313.9			11	SS	128	/20cm								
12.5														
	SILTY CLAY, Occasional Sand Layers, Hard	⊗	12	SS	167	/23cm								
309.1														
			13	SS	96	/20cm								
17.3	End of Borehole													
	<p>Note: Formerly BH # 5 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>													

RECORD OF BOREHOLE No 106

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 091.6; E 227 041.0 ORIGINATED BY VTS&CF
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 65 06 12 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	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	20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	20 40 60		
326.1	Ground Surface															
0.0	Compact		1	SS	20											
			2	SS	30											
			3	SS	45											
			4	SS	60											
			5	SS	77											
			6	SS	98											
319.9			7	SS	30											
6.2			8	SS	133											
316.6			9	SS	48											
9.5	SANDY GRAVEL, Trace of Silt, Dense		10	SS	97											
315.5			11	SS	175	/18cm										
10.6			12	SS	200	/17cm										
310.7			13	SS	235	/22cm										
15.4	End of Borehole															
	<p>Note: Formerly BH # 6 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>															

RECORD OF BOREHOLE No 107

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 087.0; E 227 087.8
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST
DATE GEODETIC DATE 65 06 23 & 24

ORIGINATED BY VTS&CF

COMPILED BY M V

CHECKED BY T C K

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
328.3	Asphalt Surface												
0.0	Asphalt		1	SS	19								
			2	SS	7								
			3	SS	4								
			4	SS	3								
			5	SS	3								
			6	SS	3								
			7	SS	3								
318.8			8	SS	1								
7.5	CLAYEY SILT, Occasional Silty Sand Layers, Hard		9	SS	20								
			10	SS	90								
			11	SS	50								
315.2													
11.1	End of Borehole Note: Formerly BH # 7 of W. P. 631 - 64 Grade has Changed Since the Investigation in June 1965												

RECORD OF BOREHOLE No 108

1 OF 1

METRIC

W.P. 102 - 94 - 01 LOCATION CO - ORDS: N 4 812 099.4: E 227 055.7 ORIGINATED BY VTS&CFE
DIST 31 HWY 7 BOREHOLE TYPE WASHBORING & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 65 06 24 CHECKED BY T C K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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	W _p	W	W _L		
326.1	Asphalt Surface													
0.0	Asphalt													
324.4	SILTY SAND, Trace of Organics, Compact (Fill)		1	SS	26									
1.7			2	SS	24									
			3	SS	26									
			4	SS	29									
	SAND, Trace of Silt, Compact to Dense		5	SS	41									
			6	SS	39									
319.3			7	SS	26									
6.8	CLAYEY SILT, Occasional Silt Layers, Hard		8	SS	66									
316.5			9	SS	57									
9.6	End of Borehole													
	<p>Note: Formerly BH # 8 of W. P. 631 - 64</p> <p>Grade has Changed Since the Investigation in June 1965</p>													

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

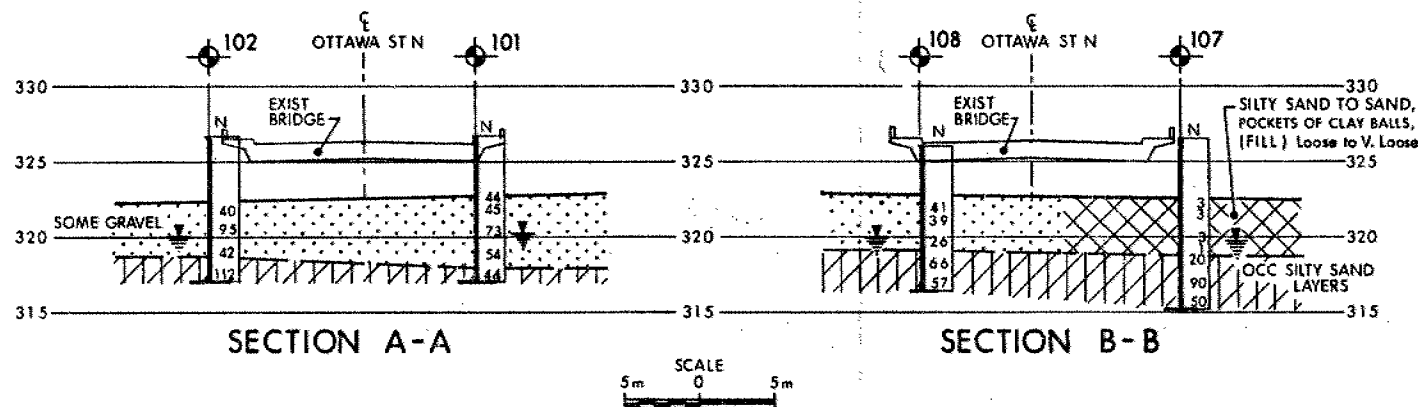
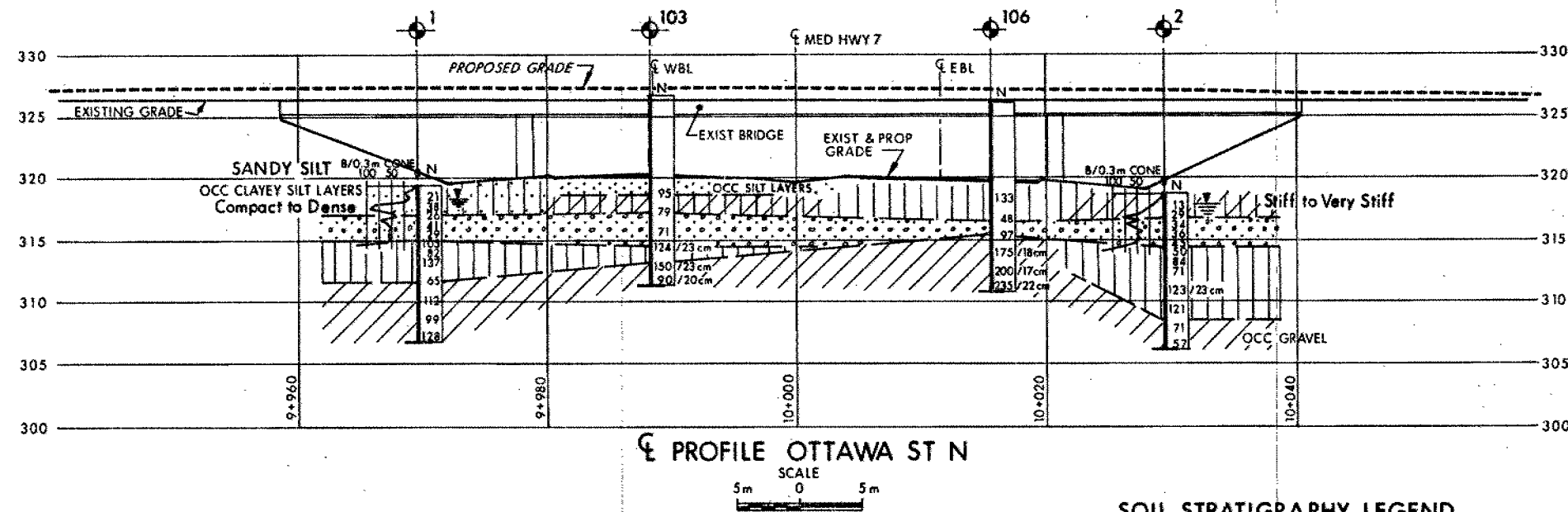
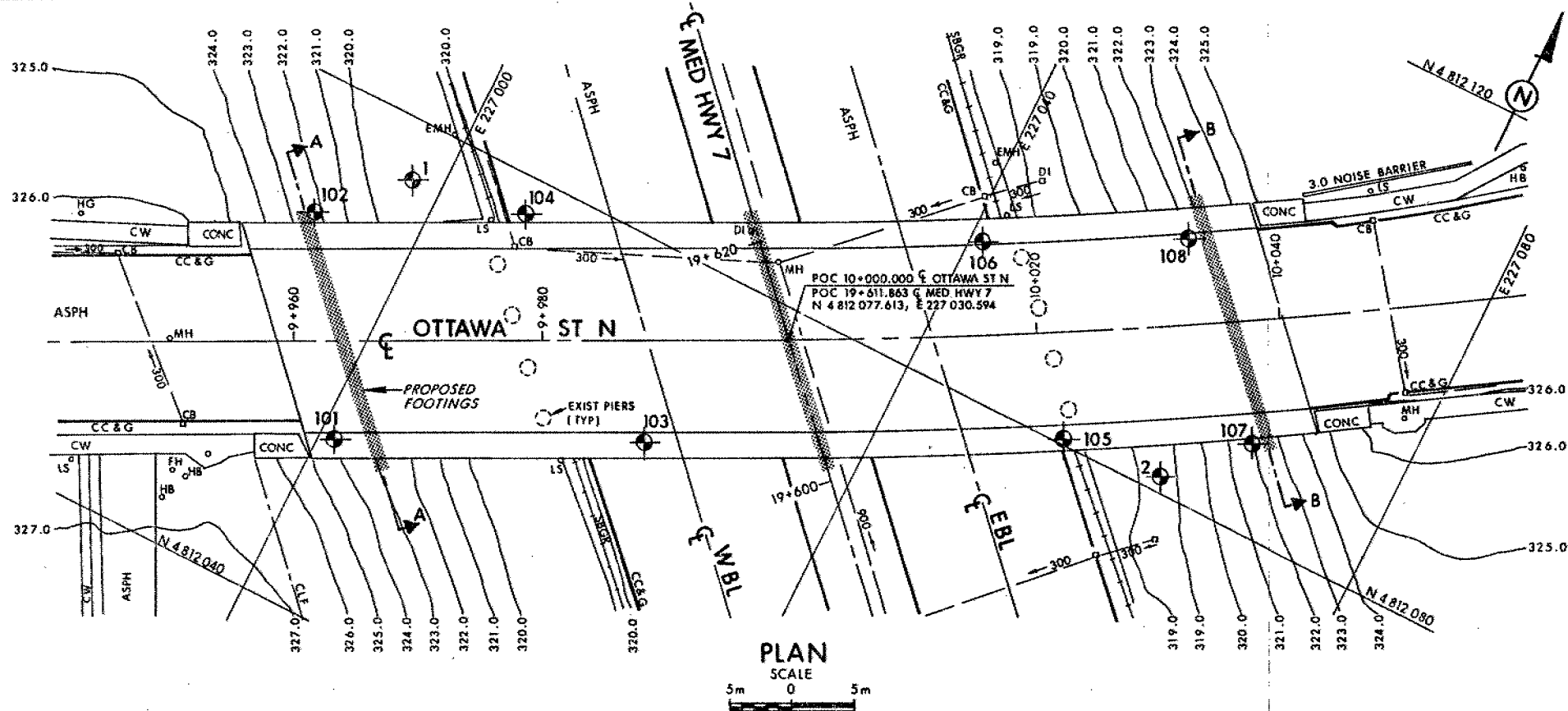
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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^3	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

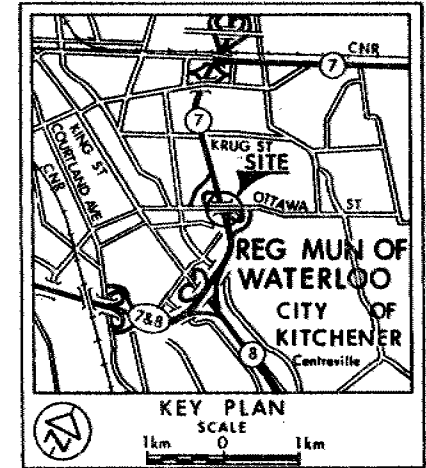


SOIL STRATIGRAPHY LEGEND

	SILTY SAND TO SAND Dense to Very Dense		SILT TO SANDY SILT OCC CLAYEY SILT LAYERS Dense to Very Dense
	CLAYEY SILT OCC SILT LAYERS Hard		SILTY CLAY OCC SAND & SILT LAYERS Hard
	SANDY GRAVEL TRACE OF SILT Compact to Very Dense		

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

CONT No
WP No 102-94-01
OTTAWA ST N
BORE HOLE LOCATIONS & SOIL STRATA



NOTES

- For Subsoil information of BH's 104 & 105, refer to Record of Borehole Sheets.
- Ground surface elevation for Boreholes 101 to 108 inclusive have changed since the previous investigation in June 1965.

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 1965 06 and 1994 07.

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	319.4	4812 075.5	226 997.6
2	318.7	4812 081.3	227 062.3
101	326.7	4812 053.9	227 001.3
102	326.7	4812 069.6	226 991.7
103	326.7	4812 065.1	227 023.9
104	326.7	4812 077.0	227 007.0
105	326.4	4812 080.5	227 053.8
106	326.1	4812 091.6	227 041.0
107	326.3	4812 087.0	227 067.8
108	326.1	4812 099.4	227 055.7

FORMERLY
WP 631-64
1965 06

NOTE

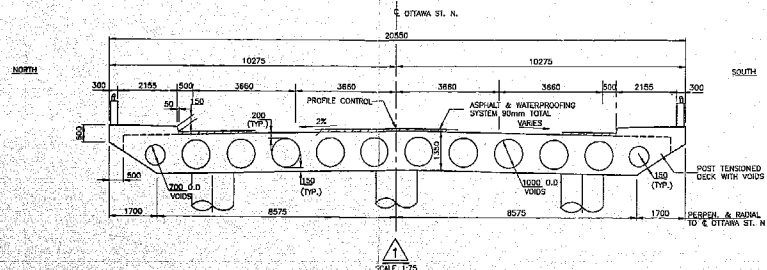
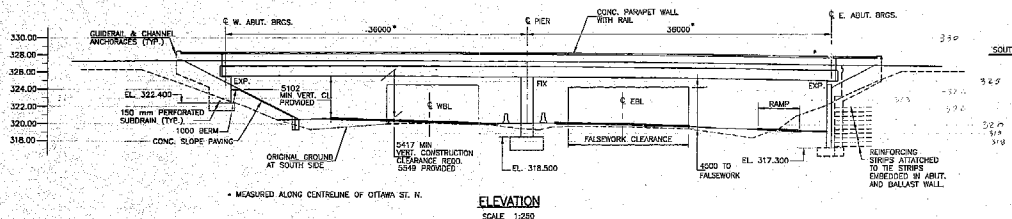
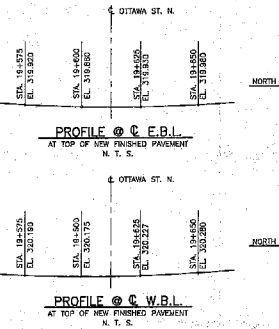
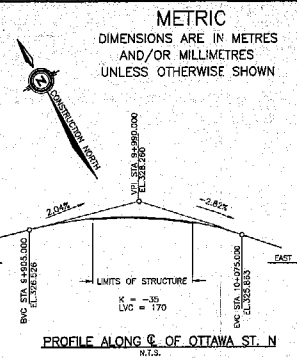
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.


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 GC 2.01 of OPS Gen. Cond.



DATE	BY	DESCRIPTION
1995 12 05	DATE	DATE
1995 12 05	CHECKED	CHECKED
1995 12 05	APPROVED	APPROVED
1995 12 05	DRAWN	DRAWN

Geocres No 40PB-113.
HWY No 7
SUBNO. MV
DIST 31
SITE 33-231
DWG 1029401-A



DIST 2 CONT No 97-21 WP No 102-94-01	
KITCHENER-WATERLOO EXPRESSWAY OTTAWA ST. N. UNDERPASS GENERAL ARRANGEMENT	SHEET 166-1

GENERAL NOTES

CLASS OF CONCRETE

PIER, DECK & COLUMNS-----	35 MPa
REMAINDER-----	30 MPa

CLEAR COVER TO REINFORCING STEEL

DECK :	TOP-----	70±20
	BOTTOM-----	50±10

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKED WITH PREFIX 'C' DENOTE COATED BAR.

CONSTRUCTION NOTES

THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESS FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESS ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BORCHOLE LOCATIONS & SOIL STRATA
3. FOUNDATION & FOOTING REINF.
4. FOOTING REINFORCEMENT
5. WEST ABUTMENT
6. EAST ABUTMENT
7. WEST MINORALLS
8. EAST MINORALLS
9. PIERS
10. BEARINGS
11. DECK DETAILS
12. LONGITUDINAL TENDONS I
13. LONGITUDINAL TENDONS II
14. TRANSVERSE TENDONS
15. DECK REINFORCEMENT I
16. DECK REINFORCEMENT II
17. DECK REINFORCEMENT III
18. DECK REINFORCEMENT IV
19. JOINT AND CRACKS AND AROUNDING
20. RAILING WITH SLAB
21. RAILING FOR BARRIER WALL
22. 5000 mm APPROACH SLAB
23. DETAILS OF CONCRETE SLOPE PAVING
24. DETAILS
25. ELECTRICAL EMBEDDED WORK
26. QUANTITIES - STRUCTURE I
27. QUANTITIES - STRUCTURE II

APPLICABLE STANDARD DRAWINGS

OPSD-4802.00 FALSEWORK CLEARANCES
OPSD-3501.00 MIN GRANULAR BACKFILL REQUIREMENTS

USED To Prepare our Plan

REVISIONS					DESCRIPTION		
	DESIGN	CHK	CODE	CHG	LOAD	CL	DATE
	AS	CHK	09H00C	91			JULY, 1995
	WP	CHK	33-231/2	STRUCT			
					SCHEME		LONG

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

