

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40P1-77

DIST. 4 REGION

W.P. No. 66-67-03

CONT. No. 90-95

W. O. No.

STR. SITE No.

HWY. No. 403

LOCATION Brandford

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

DIST.	No. 4
CONT.	No.
WP.	No.66-67-03



Morrison Hershfield Limited
Consulting Engineers

1. CLASS OF CONCRETE

DECK	35 MPa
REMAINDER (UNLESS NOTED)	30 MPa

2. REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED.

BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.

3. CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100±25
ABUTMENTS AND WINGWALLS	
FRONT FACE	80±20
BACK FACE	70±20
PIERS	80±20
DECK SLAB	
TOP	70±20
BOTTOM AND SIDES	50±10
REMAINDER (UNLESS NOTED)	70±20

4. CONSTRUCTION NOTE

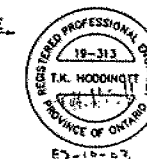
IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

- 01-190-1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION AND SOIL STRATA
3. FOUNDATION LAYOUT AND REINFORCEMENT
4. NORTH ABUTMENT
5. SOUTH ABUTMENT
6. WINGWALL LAYOUT AND REINFORCEMENT
7. PIER AND BEARING DETAILS
8. DECK LAYOUT AND SCREED ELEVATIONS
9. LONGITUDINAL CABLE LAYOUT
10. TRANSVERSE CABLE LAYOUT
11. DECK REINFORCEMENT
12. PRESTRESSING AND REINFORCING DETAILS - I
13. PRESTRESSING AND REINFORCING DETAILS - II
14. JOINT ANCHORAGE AND ARMOURING
15. BARRIER WALL
16. 6000 mm APRON
17. DETAILS OF CONCRETE SLOPE PAVING
18. STANDARD DETAILS
19. BRIDGE DATE AND SITE NUMBER DATA
20. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
21. ELECTRICAL EMBEDDED WORK
22. QUANTITIES SHEET - STRUCTURAL I
23. QUANTITIES SHEET - STRUCTURAL II

T/F TOP OF FOOTING
T/C TOP OF CONCRETE
T/P TOP OF PAVEMENT
W.P. WORKING POINT
C. CENTRE LINE

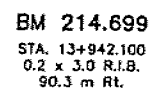
DD-3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS
OPSD 508.02 BRIDGE DECK WATERPROOFING

ISSUED
DEC 18 1989
MORRISON HERSHFIELD
LIMITED
DRAWING OFFICE



100 mm ON ORIGINAL DRAWING

REVISIONS					
	DATE	BY	DESCRIPTION		
	DESIGN T.H.	CHK. ATC CODE 0H8DC-83	LOAD CLASS AIDATE	SEPT./83	
	DRAWN T.H.	CHK. ATC SITE 01-190	STRUCT.	SCHEME	DWG. 1



N.T.S.

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 90-95



Ontario

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

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

for

Jerseyville Rd. Interchange Underpass
13.7 km West of Hwy. #2
W.P. 66-67-03, Site 1-190
Hwy. #403, District 4, Hamilton

INTRODUCTION

This report contains the results of the foundation investigation carried out for the proposed structure at the junction of the existing Jerseyville Rd. and New Hwy. #403, during the periods of 1976 03 15 - 16 and 1979 07 26 - 30. The fieldwork consisted of three sampled boreholes and two dynamic cone penetration tests. The borings were advanced by employing continuous flight auger machines, mounted either on a muskeg vehicle or on an all-terrain vehicle and equipped with 82 mm I.D. hollow stem augers.

SITE DESCRIPTION

The site is located at the future junction of the existing Jerseyville Rd. and proposed New Hwy. #403, in the Township of Brantford.

The surrounding terrain is relatively flat, cultivated agricultural land.

The site lies in the physiographic region known as the Haldimand Clay Plain.

This extensive plain consists of stratified clay, silts and sands deposited by glacial lakes Whittlesey and Warren.

SUBSURFACE CONDITIONS

General

Generally uniform subsoil conditions were found to exist across the site. The subsoil (apart from the existing Jerseyville Rd. roadway material) consists of a deep deposit (36 - 38 m) of stratified silty clay with trace of sand followed by dolomite type bedrock.

The boundary between the overburden and bedrock together with the field and laboratory tests results are shown on the Record of Borehole Sheets contained in the Appendix. The stratigraphical profile shown on Drawing No. 2 of the Contract Documents is based on this information. The drawing also shows the locations and elevations of the borings. A detailed description of the encountered subsurface conditions is given below.

Silty Clay Trace of Sand

This stratum was intersected in all borings and extends from immediately below the ground surface to the bedrock for a depth of 36 - 38 m. The material in the deposit is stratified and classified as silty clay with trace of sand. The stratification is rather random and ranges in thickness from 5 mm to about 150 mm. The plasticity of the individual layers varies from low to high. Occasional silt seams were also observed throughout the stratum. The Atterberg Limit test results for the overall deposit are plotted on the plasticity chart (Figure 1). The consistency of the stratum varies randomly from stiff to very stiff. The assessment is based on a number of field vane and laboratory unconfined and quick triaxial tests. The test results are plotted on Figure 2 and summarized below, together with other physical properties.

	Range
Natural Moisture Content (W) %	13 - 46
Liquid Limit (W _L) %	22 - 63
Plastic Limit (W _p) %	13 - 21
Undrained Shear Strength (c _u) %	7 - 14
Unconfined	39 - 96 kPa
Quick Triaxial	48 - 101 kPa
Field Vane	41 - over 100 kPa
Unit Weight (γ)	19.3 - 20.5 kN/m ³
Sensitivity (Based on Field Vane Tests)	2 - 5

Grain size distribution curves are presented in an envelope form on Figure 3 of the Appendix.

One consolidation test was performed on a sample obtained from this stratum. The tests indicate that the soil is overconsolidated with a preconsolidation pressure of 435 kPa.

For design purposes in terms of total stresses, an average undrained shear strength value of 60 kPa is recommended.

Silt

A loose to dense, approx. 2 to 2.4 m thick silt with traces of sand and clay zone was found to be sandwiched between the brown and grey portion of the silty clay deposit.

Bedrock

Bedrock was found at depths about 36.6 below ground (elevation 182±) which consists of moderately fractured, hard, light grey to white dolomite.

Groundwater Conditions

The following groundwater levels were observed at the boring locations:

- B.H. #1 - Elevation 214.8
- B.H. #2 - not observed
- B.H. #3 - Elevation 214.6

It is pointed out that the subsoil is relatively impermeable, therefore a considerable time is required for the water levels to stabilize.

For design and construction purposes, it should be assumed that the groundwater level at this site is probably at elevation 215 \pm . Seasonal changes may influence the groundwater levels.



P. Payer
P. Payer, P. Eng.
Sr. Foundation Engineer

M. Devata
M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1 (0.0 - 30.2 m) METRIC

W P 56-67-03 LOCATION Co-ords. N 4 871 255.0; E 250 314.0 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, BX-Core COMPILED BY PRK
DATUM Geodetic DATE 79 07 26/27 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	15 30 45					
218.7	Ground Level													
0.0	Silty clay Stratified						218							
217.3	Very stiff - brown		1	SS	21									
1.4	Silt		2	SS	17									
	Trace of sand and clay		3	SS	15		216							
215.3	Compact		4	SS	27									
3.4	Silty clay Stratified		5	SS	13									
	Trace of sand		6	SS	10		214							
	Occasional layers and seams of silt		7	SS	8									
			8	TW	PH		212						20.0	0 0 85 15
	Firm to very stiff		9	SS	10									
			10	TW	PH		210							
	Grey coloured		11	SS	11		208							
			12	TW	PH		206						19.5	
			13	SS	10									
			14	TW	PH		204							
							202							
							200							
			15	TW	PH		198						19.8	0 0 70 30
							196							
			16	TW	PH		194							
							192							
							190							
188.53			17	SS	19									

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1 Cont. (30.2 - 38.4 m)

METRIC

W P 66-67-03 LOCATION _____ ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, EX-Core COMPILED BY PRK
DATUM Geodetic DATE 79 07 26/27 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					
188.53																	
30.2	Silty clay <i>N</i>																
			18	SS	15												
182.13			19	SS	40/												
36.6	Bedrock moderately fractured																
180.33	Dolomite		20	RC EX	98% REC												
38.4	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2 (0.0 - 30.2 m)

METRIC

W P 66-67-03 LOCATION Co-ords. N 4 871 308.0; E 250 326.0 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
DATUM Geodetic DATE 79 07 30 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100	W _p	W	W _L		
219.4	Ground Level													
0.0	Silty clay Stratified Very stiff - brown		1	SS	20	Not Observed	218							0 0 88 12
217.7			2	SS	12									
1.7	Silt Trace of sand and clay Compact		3	SS	21		216							0 0 60 40
			4	SS	17									
215.3			5	SS	6									
4.1	Silty clay Stratified		6	SS	9		214							
	Traces of sand		7	TW	PH		212						19.5	0 0 45 55
	Occasional layers and seams of silt		8	SS	8		210							
	Firm to very stiff		9	TW	PH		208							
	Grey coloured		10	TW	PH		206							
			11	SS	14		204						19.5	0 0 90 10
			12	TW	PH		202							
			13	SS	7		200							
			14	TW	PH		198						20.0	
			15	TW	PH		196							
							194							
							192							
							190							
188.84														

OFFICE REPORT ON SOIL EXPLORATION

30.2 Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 Cont. (30.2 - 37.1 m)

METRIC

W P 66-67-03 LOCATION _____ ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
DATUM Geodetic DATE 79 07 30 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					
188.4																	
30.20	Silty clay		16	SS	18		188										
							186										
							184										
37.1	Probable Bedrock End of Borehole		17	SS	13-6	0.07 m - 45	180										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 (Formerly B.R. #5)
(W.P. 66-67-01)

METRIC

W P 66-67-03 LOCATION Co-ords. N 4 871 274.1; E 250 292.6 ORIGINATED BY MK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MK
DATUM Geodetic DATE 76 03 15/16 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	25 50 75 100 125					
218.50	Ground Level													
0.0	Silty clay						218							
217.5	Stratified													
1.3	Very stiff (Brown)													
	Silt		1	SS	4		216							
	Trace of sand and													
	clay													
	Loose to dense													
214.8			2	SS	32		214							
3.7	Silty clay													
	Stratified													
	Trace of sand		3	SS	10		212							
			4	TW	PH									
	Occasional layers and													
	seams of silt													
			5	SS	16		210							
	Firm to very stiff		6	TW	PH		208							
			7	SS	8									
	Grey coloured		8	TW	PH		206							
			9	SS	10		204							
			10	TW	PH		202							
			11	SS	7		200							
			12	TW	PH		198							
			13	SS	14		196							
			14	TW	PH		194							
188.3							192							
30.2							190							

OFFICE REPORT ON SOIL EXPLORATION

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 Cont. (Formerly B.H. #5)

METRIC

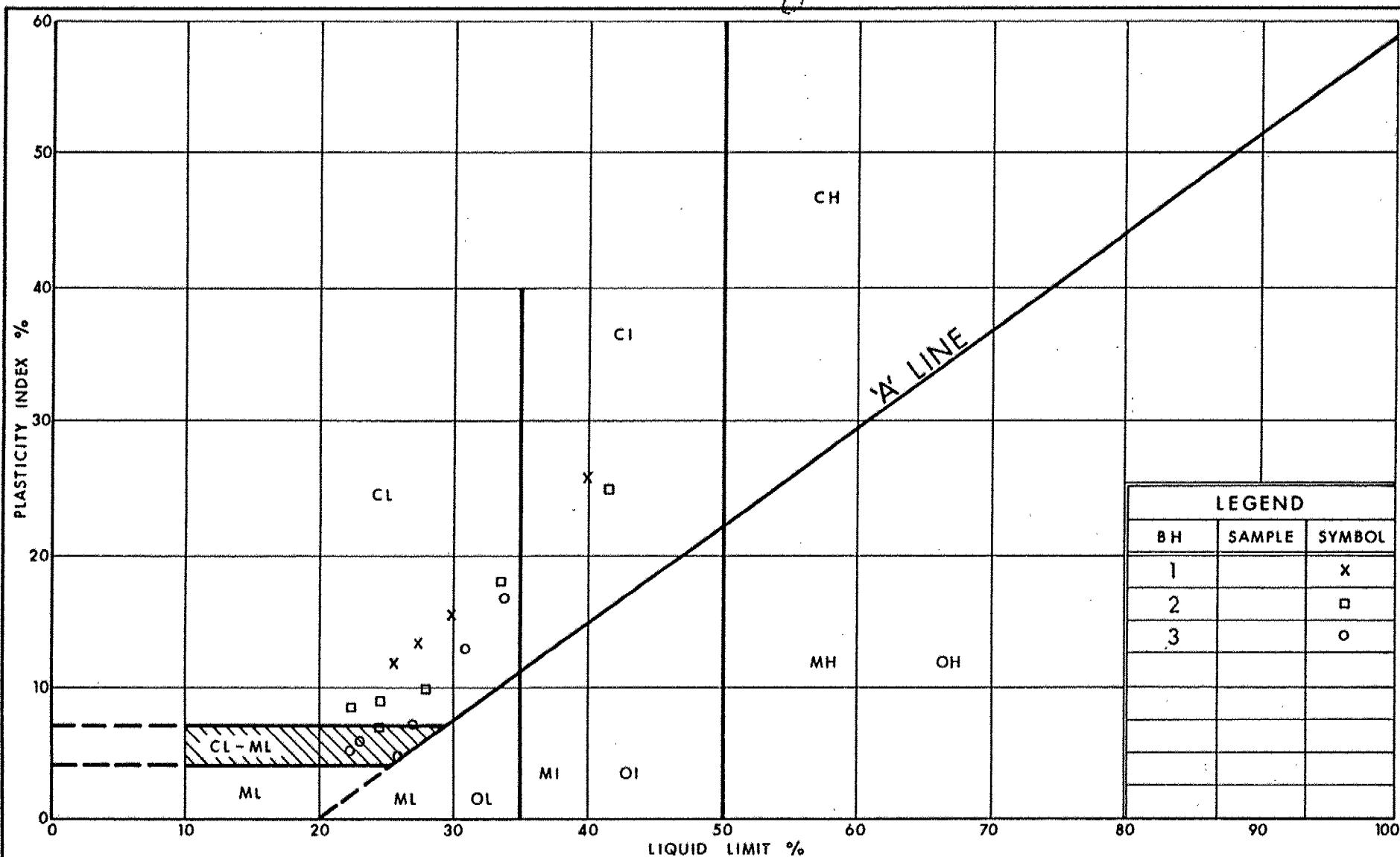
W P 66-67-03 LOCATION _____ ORIGINATED BY MK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY _____
DATUM Geodetic DATE 76 03 15/16 CHECKED BY _____

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 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					
188.30																	
30.20	Silty clay		15	SS	12		188										
							186										
			16	TW	PH		184									19.5	
							182										
181.5	Some sand and gravel		17	SS	38												
37.0	End of Borehole Probable Bedrock																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

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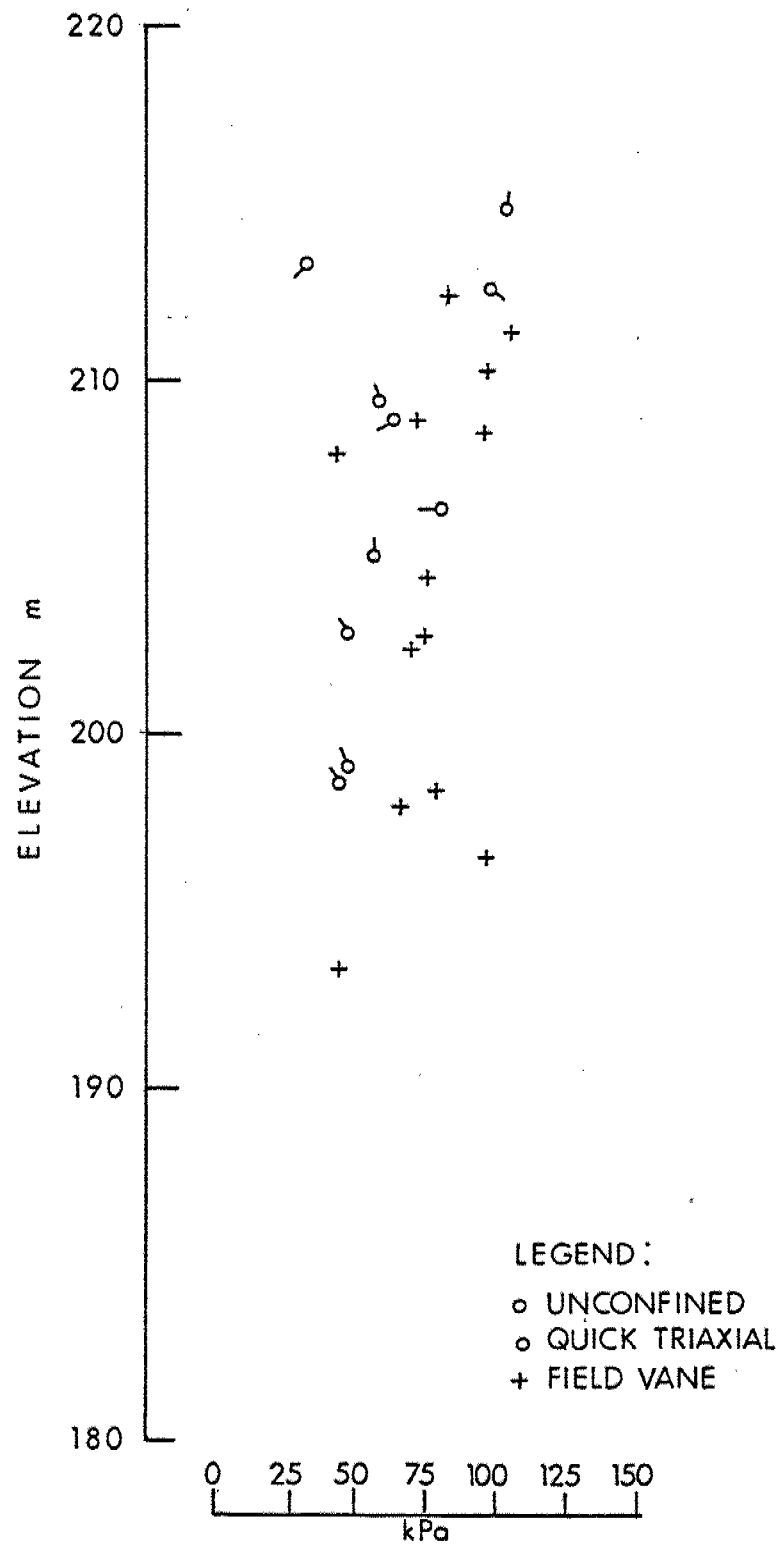
Ontario

ENGINEERING SERVICES BRANCH

PLASTICITY CHART
SILTY CLAY STRATIFIED
TRACE OF SAND

FIG No 1

W P 66-67-03



SHEAR STRENGTH VS ELEVATIONS

FIG 2

W.P. 66-67-03



**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION
SILTY CLAY.
STRATIFIED. TRACE OF SAND.

FIG No 3

W P 66-67-03 .

FOUNDATION INVESTIGATION REPORT

for

FAIRCHILD CREEK TWIN STRUCTURES

W.P. 66-67-05; Site 1-192

Hwy. #403, District #4 (Burlington)

INTRODUCTION

Foundation Investigation was carried out at the above mentioned site on March 18, 1976 and from January 24 to 29, 1979. A foundation investigation and design report was issued on April 12, 1979. Since that time, the location of the structures were moved some 60 m easterly on the same alignment. A review of the available subsurface information indicated that additional borings are required. The additional fieldwork was carried out from February 14 to 27, 1989. A total of eight sampled boreholes was drilled in the three different time periods using Auger Machines equipped with Hollow Stem Augers and BXL rock coring equipment.

SITE DESCRIPTION

The site is located on the proposed new alignment of Hwy. 403 approximately 60 metres west of Fairchild Creek in the Township of Brantford, Brant County.

The land at the site is generally gentle to moderately rolling and used for agricultural purposes.

The site lies in the physiographic region known as the Haldimand Clay Plain. This extensive plain consists of stratified clay, silts and sands deposited by glacial lakes Whittlesey and Warren. Streams have severely dissected the lake plain in some areas. Along these streams more recent surficial deposits of alluvium are present.

SUBSURFACE CONDITIONS

Generally, uniform subsurface conditions were found to exist across the site. The surficial deposit consists of up to 7 metres of silt containing some sand. Immediately below this deposit a stratum composed of alternating layers of clayey silt and silty clay exists. This stratum extends up to a depth of 16.3 metres below the ground surface. In some of the borings a .9 to 3.4 metre thick deposit of clayey silt was found over the dolostone bedrock. For a detailed description of the soil and rock types encountered in each borehole refer to the Record of Borehole Sheets. The estimated stratigraphical profile and sections are shown on Drawing No. 666705-A.* The following is a summary of the soil types encountered from ground level downwards.

Silt of Slight Plasticity

Immediately below the ground surface a 2.3 to 7.0 metre thick deposit of silt of slight plasticity containing traces to some fine sand was encountered. The upper portion of this deposit

* DWG NO 2 OF THE CONTRACT DWG'S

contains traces of clay and organics. Occasional silty clay to clayey silt layers were also observed.

Standard Penetration Tests carried out within this stratum yielded 'N' values ranging from 2 to 20 blows/0.3 metres. Therefore, the denseness can be described as ranging from very loose to compact.

The natural moisture content as determined by laboratory testing ranged from 19 to 23%. Figure 1 illustrates the grain size distribution for samples obtained from this stratum.

Alternating Layers of Clayey Silt and Silty Clay

Beneath the surficial silt deposit a stratum consisting of alternating layers of clayey silt and silty clay with occasional layers of silt and clay exists. Overall, the stratum ranged in thickness from 8.1 to 12.7 metres with the individual clayey silt and silty clay layers varying from 2 to 130 mm in thickness.

Field vanes carried out within this stratum yielded an undrained shear strength ranging from 30 to over 100 kPa with a sensitivity of 2 to 5. During examination and testing of the obtained samples it was noted that the consistency of the clayey silt layers is generally higher than the silty clay layers. Overall, the consistency of the stratum varied from firm to very stiff.

The natural moisture contents of the individual layers within the stratum were determined in the laboratory. For the clayey silt layers the moisture content ranged from 23 to 27% with an average of 25%. The moisture content of the silty clay portion of the stratum ranged between 31 and 41% with the average being 37%.

Four consolidation tests were performed on samples obtained from this stratum. The results are plotted on the void ratio versus pressure curves, Figures 2, 3, 4, 5. The tests generally indicate that the soil is overconsolidated with a preconsolidation pressure ranging from 375 to 536 kPa.

Clayey Silt

Underlying the layered stratum is a deposit of clayey silt containing occasional pockets of silt. This deposit was found to vary from .9 to 3.4 metres in thickness. The lower portion of the deposit immediately above the bedrock contains some sand and traces of gravel.

Field vanes carried out within this stratum yielded an undrained shear strength ranging from 60 to greater than 107 kPa, indicating a stiff to very stiff consistency.

BEDROCK

Dolostone type bedrock was encountered at the following levels:

BH # 3	EL. 181.7
BH #102	EL. 182.8
BH #104	EL. 182.2

The upper surface of the bedrock in BH #102 and BH #3 is moderately weathered or fractured.

GROUNDWATER CONDITIONS

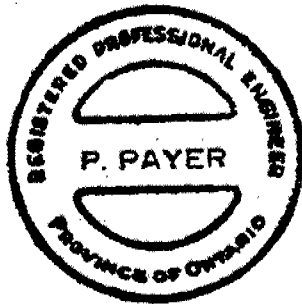
The following groundwater levels were observed in the open boreholes:

<u>Borehole No.</u>	<u>Elevation</u>
3	195.5 (March 1976)
20	197.3 (January 1979)
21	188.0 (January 1979)
23	185.8 (January 1979)
102	193.2 (February 1989)
103	191.6 (February 1989)
104	Not Observed
106	186.3 (February 1989)

MISCELLANEOUS

The fieldwork was carried out under the supervision of Mr. R. Van Veen, Mr. C. T. Johnson and Mr. L. Simolote.

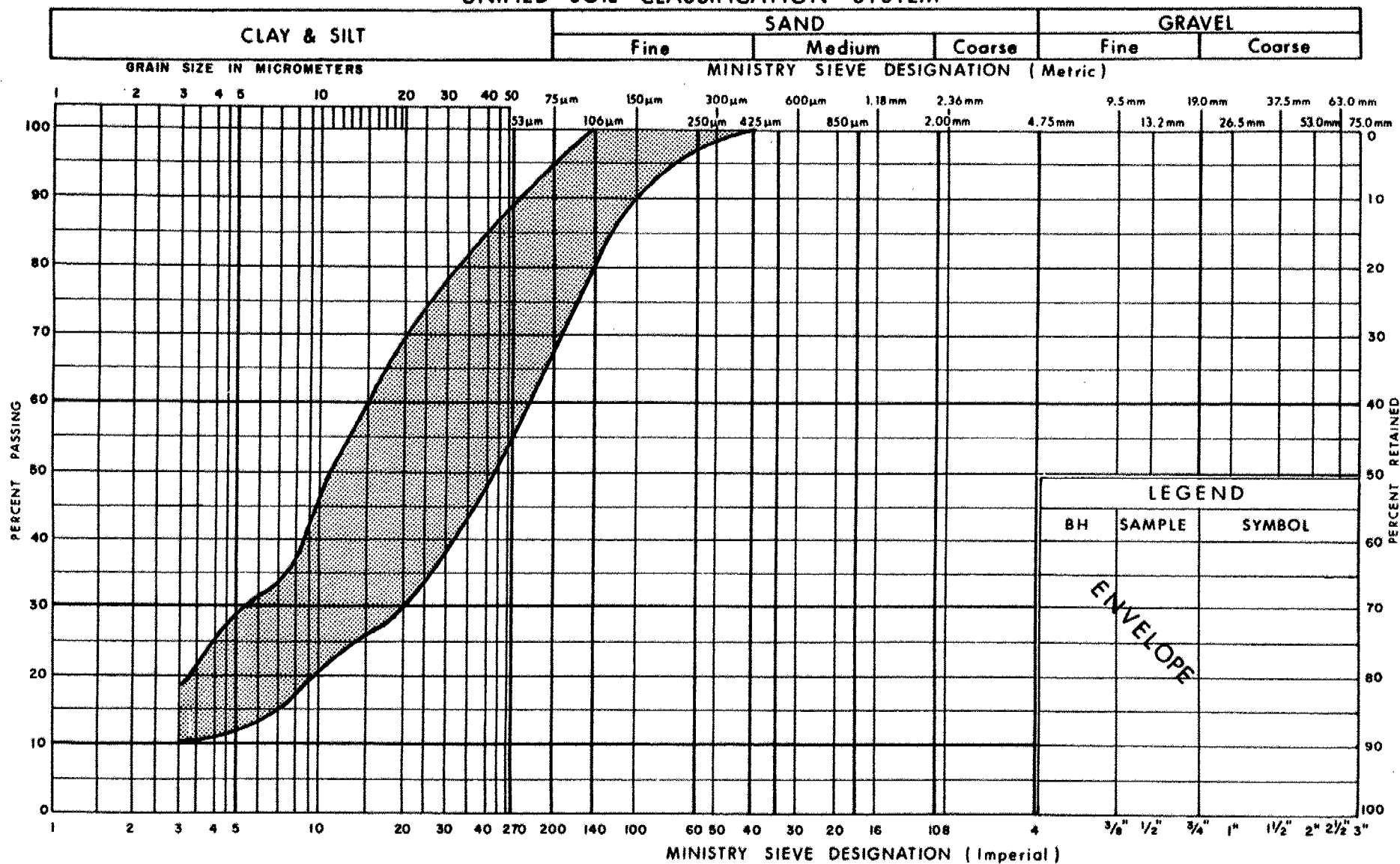
The original report was written by Mr. C. T. Johnson, Project Engineer and reviewed by Mr. K. G. Selby, Supervising Engineer in April 1979. The updated and revised report was written by Mr. P. Payer, and reviewed by Mr. M. Devata.



P. Payer
P. Payer, P. Eng.
Sr. Foundation Engineer

M. Devata
M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

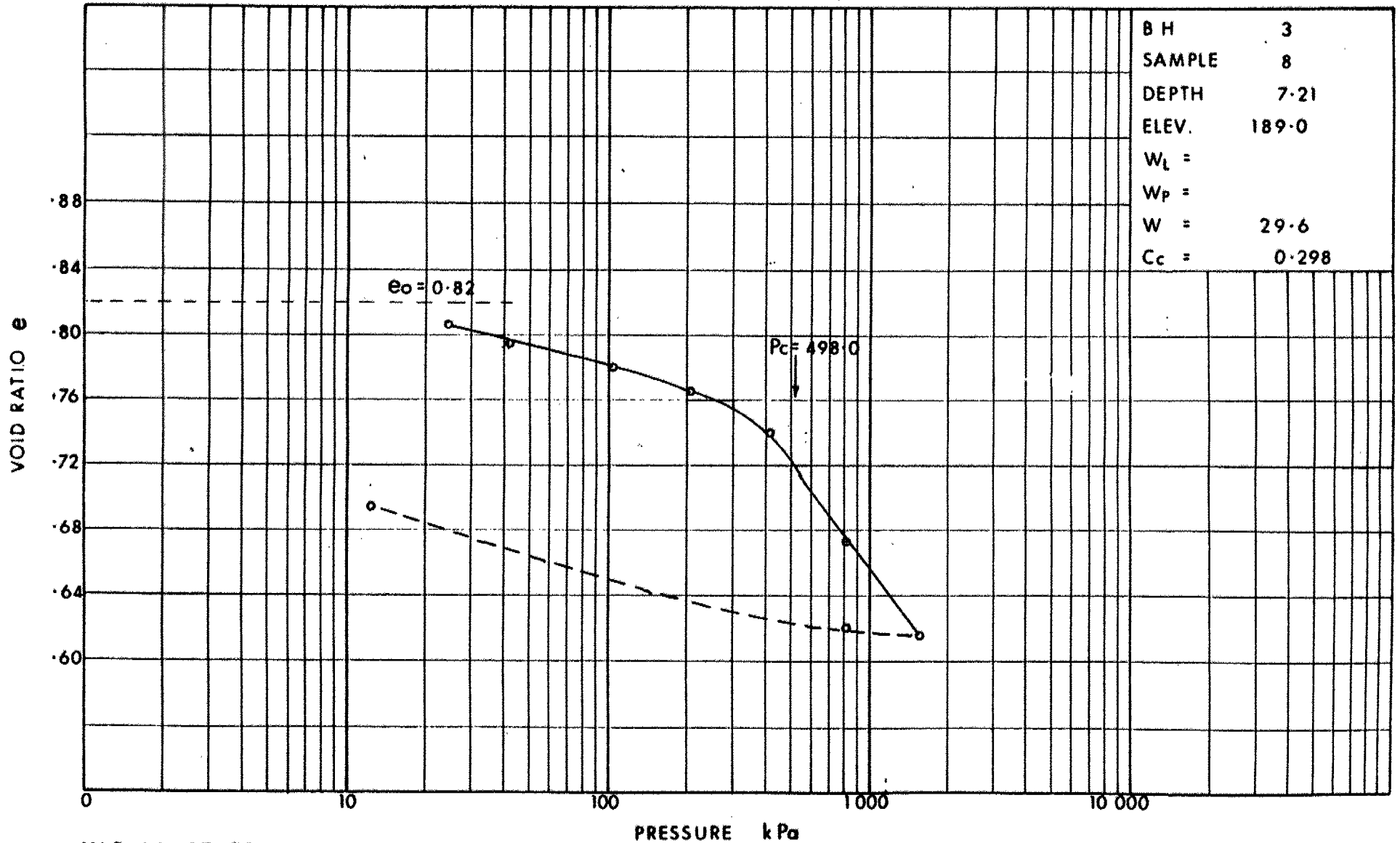
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT
SOME SAND

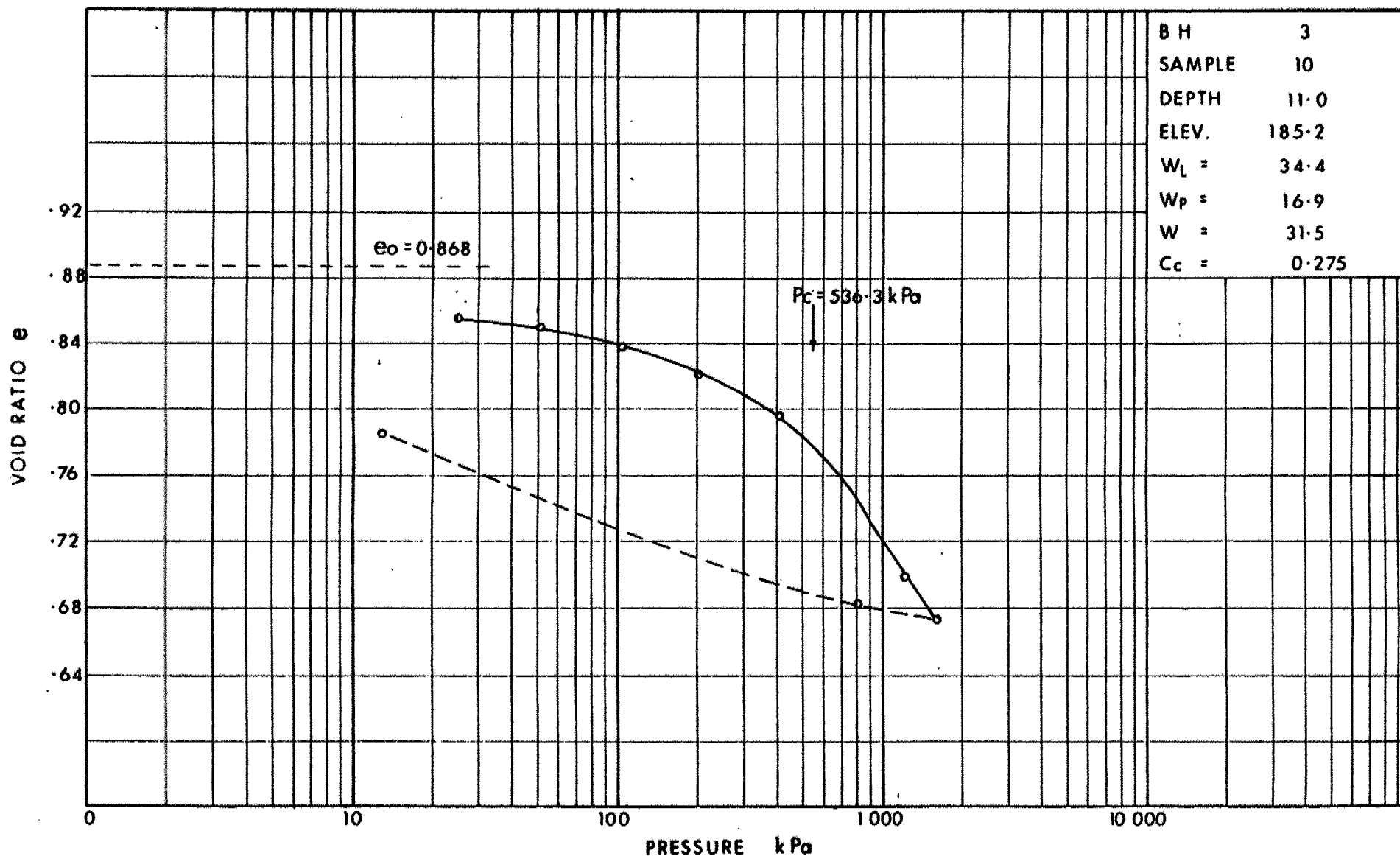
FIG No 1

W P 66-67-05

VOID RATIO - PRESSURE CURVE



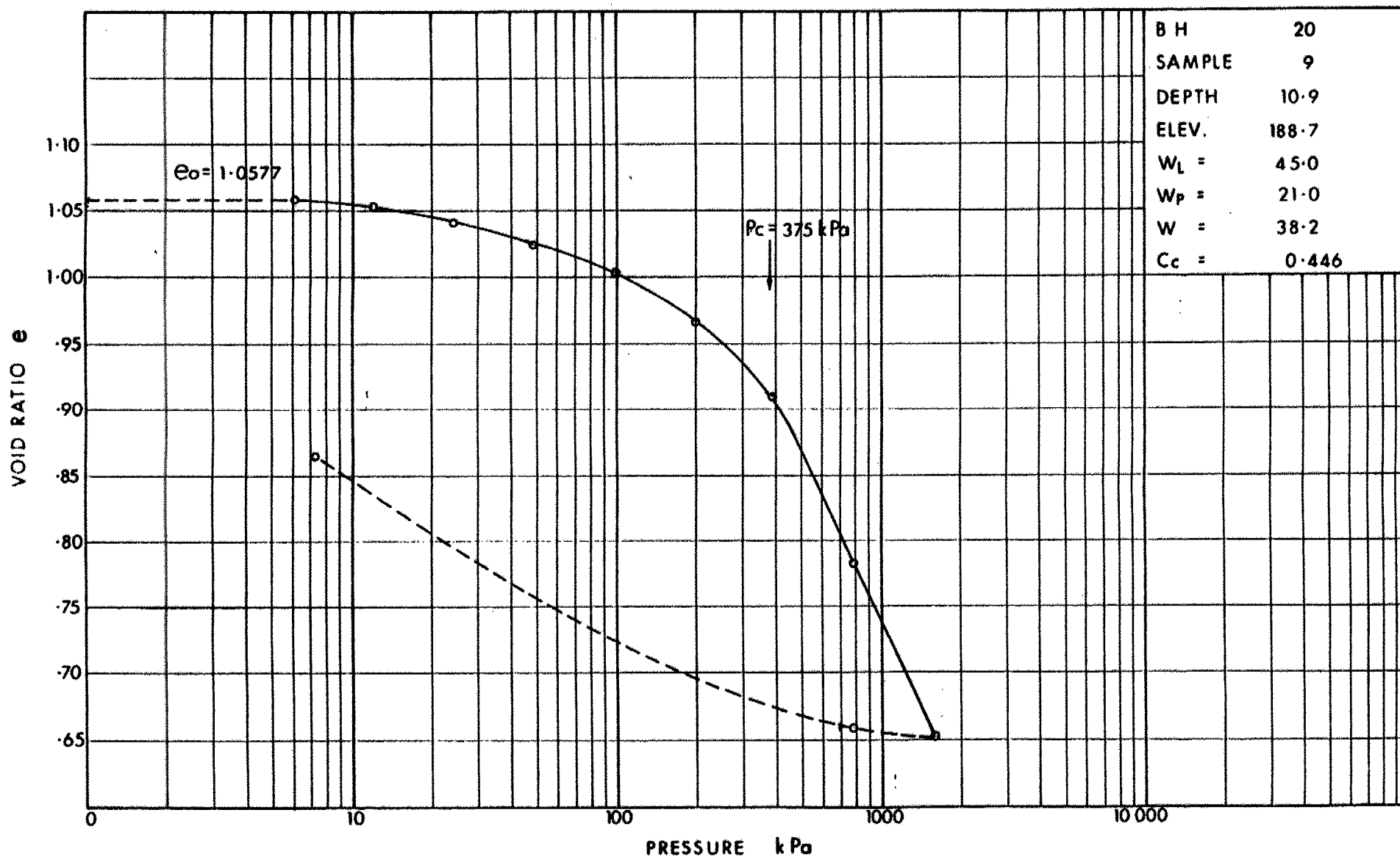
VOID RATIO - PRESSURE CURVE



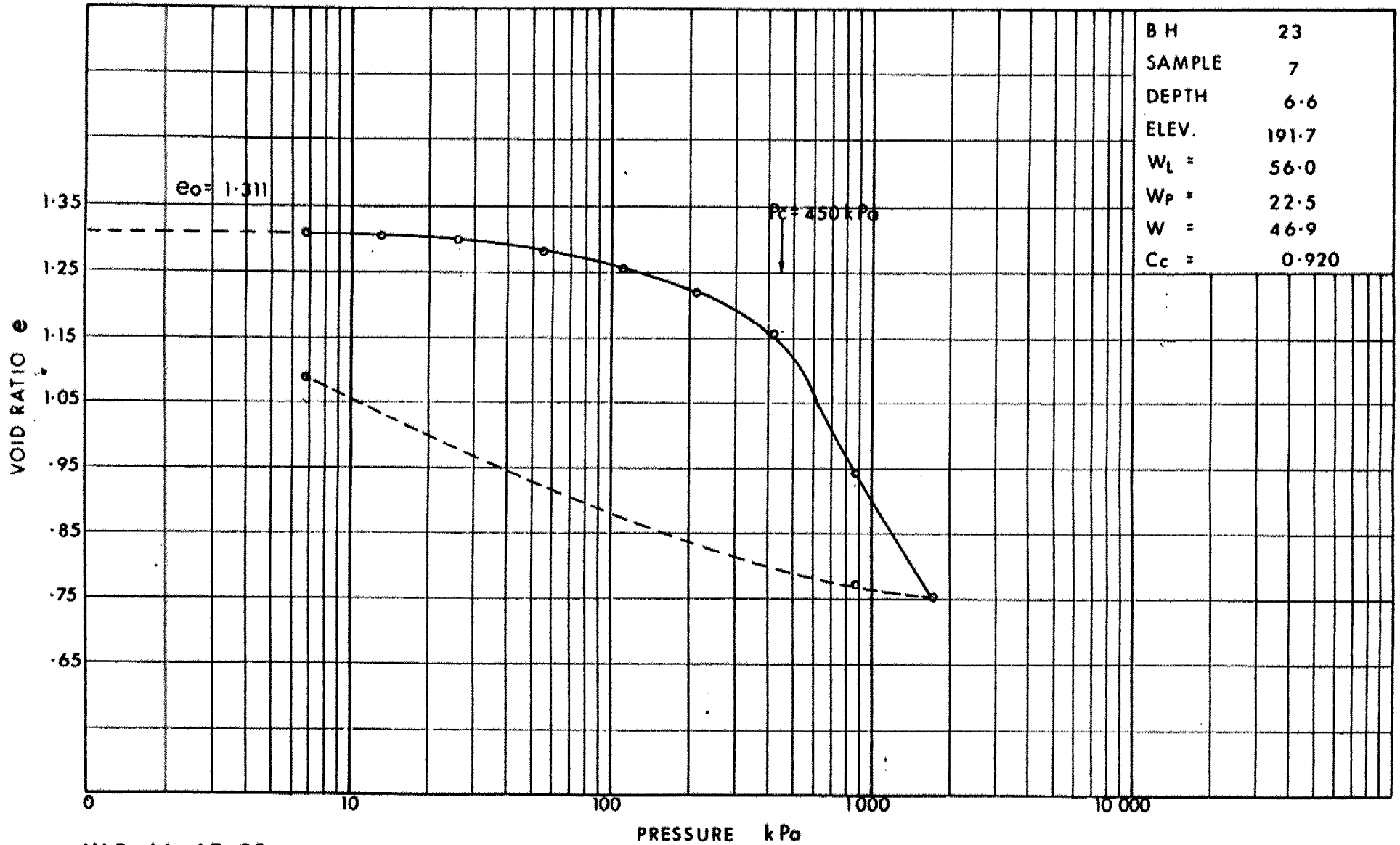
W P 66-67-05

FIG No 3

VOID RATIO - PRESSURE CURVE



VOID RATIO - PRESSURE CURVE



B H	23
SAMPLE	7
DEPTH	6.6
ELEV.	191.7
W_L	56.0
W_P	22.5
W	46.9
C_c	0.920

RECORD OF BOREHOLE No 3

METRIC

W P 66-67-05 LOCATION Coords. N 780 934.3; E 249 055.1 ORIGINATED BY BVV
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, Cone Test & BXL Rock Core COMPILED BY BVV
DATUM Geodetic DATE 1976 03 18 CHECKED BY *W.J.*

OFFICE REPORT ON SOIL EXPLORATION

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 25 50 75 100 125	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								
196.2	Ground Level											
0.0	Silt of Slight Plasticity, Some Very Fine Sand Trace of Clay and Organics (Wood Chips) Very Loose		1	SS	3						Org. 1.83%	0 9 79 12
			2	SS	2							
			3	SS	3							
			4	SS	4							
192.0	Alternating Layers of Clayey Silt And Silty Clay Occasional Seams of Silt Firm to Stiff		5	SS	4						Org. 1.38%	0 18 67 15
			6	SS	3							1 2 73 24
			7	TW	PH							
			8	TW	PH							
			9	SS	10							
			10	TW	PH							
			11	SS	5							
			12	SS	4							
182.6												
13.6	Clayey Silt, Some Sand & Gravel, Firm		13	SS	5							
181.7												
14.5	Dolostone Bedrock Moderately Fractured		14	RC BXL	Rec. 87%							24 12 26 28
180.2												
16.0	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 20										METRIC			
W P 66-67-05		LOCATION Coords. N 4 780 922.0; E 248 043.0				ORIGINATED BY CTJ							
DIST 4 HWY 403		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY CTJ							
DATUM Geodetic		DATE 1979 01 29				CHECKED BY <i>WJ</i>							
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			VALUES	20 40 60 80 100					
199.6	Ground Level												
0.0	Trace of Organics and Clay		1	SS	14								
197.3	Silt of Slight Plasticity, trace to Some Sand, Compact		2	SS	11								
2.3	Alternating Layers of Clayey Silt and Silty Clay		3	SS	6								
	Layers Vary in Thickness from 2 mm to 130 mm		4	SS	5								
	Brown Occasional Layers of Silt		5	TW	PH								
	Firm to Stiff		6	TW	PH								
			7	TW	PH								
			8	SS	5								
			9	TW	PH								
			10	SS	7								
185.4	Clayey Silt		11	TW	PH								
14.2	Occasional Pockets of Silt Grey		12	SS	8								
	Firm to Stiff		13	SS	25								
182.1	Traces of Gravel & Sand												
	Refusal to Augering												
17.5	End of Borehole Probable Bedrock												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 21

METRIC

W P 66-67-05 LOCATION Coords. N 4 780 943.3; E 248 072.0 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 1979 01 24 and 1979 01 25 CHECKED BY *CTJ*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100		W _p	W	W _L		
199.2	Ground Level												GR SA SI CL
0.0	Trace of Organics and Clay		1	SS	8	198							0 12 78 10
	Silt of Slight Plasticity		2	SS	7								0 14 77 9
	Some Fine Sand Loose		3	SS	5								0 29 60 11
195.2			4	SS	8	196							
4.0	Alternating Layers of Clayey Silt and Silty Clay		5	SS	5								0 0 78 22
	Brown Firm to Stiff		6	SS	5	194							
			7	SS	6								
			8	SS	7	192							
			9	SS	5	190							
189.1													
10.1	End of Borehole					188							
						186							
						184							
182.7													
16.5	End of Cone Test Probable Bedrock												50 blows/25 mm bouncing

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 23										METRIC			
W P 66-67-05		LOCATION Coords. N 4 780 942.5; E 249 022.0				ORIGINATED BY CTJ							
DIST 4 HWY 403		BOREHOLE TYPE Hollow Stem Auger				COMPILED BY CTJ							
DATUM Geodetic		DATE 1979 01 25				CHECKED BY <i>CTJ</i>							
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 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					
198.3	Ground Level												
0.0	Trace of Organics and Clay		1	SS	10							Org. 0.58%	0 4 83 13
	Silt		2	SS	8								
	of Slight Plasticity		3	SS	4								
	Trace to Some Fine		4	SS	6								
	Sand		5	SS	4								
194.0	Loose		6	SS	3								
	Medium and Fine Sand		7	TW	PH								
4.3	Alternating Layers of Clayey Silt and Silty Clay		8	SS	5								
	Layers Vary in Thickness From 5 mm to 70 mm		9	TW	PH								
	Brown		10	SS	9								
	Firm to Stiff		11	TW	PH								
	Occasional Layers of Clay		12	SS	15								
185.9	Clayey Silt		13	SS	20								
12.4	Occasional Small Silt Pockets												
	Gray												
	Stiff to Very Stiff												
182.5	Some Sand, Trace Gravel												
15.8	Refusal to Augering												
	End of Borehole												
	Probable Bedrock												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 101										METRIC			
W P <u>66-67-05</u>		LOCATION <u>Co-ords: N 4 780 946.1; E 249 060.5</u>				ORIGINATED BY <u>LNS</u>							
DIST <u>4</u> HWY <u>403</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test Only</u>				COMPILED BY <u>LNS</u>							
DATUM <u>Geodetic</u>		DATE <u>89 02 20</u>				CHECKED BY <u>DT</u>							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		WATER CONTENT (%)			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	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
196.5 0.0	Ground Level						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
						196	Frozen						
						194							
						192							
						190							
						188							
						186							
						184							
182.2													
14.3	End of Cone Test												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 102										METRIC			
W P 66-67-05		LOCATION Co-ords: N 4 780 947.5; E 249 087.3				ORIGINATED BY LNS							
DIST 4 HWY 403		BOREHOLE TYPE Cont. Flight Auger (H.S)				COMPILED BY PP							
DATUM Geodetic		DATE 89 02 17				CHECKED BY <input checked="" type="checkbox"/>							
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					
197.4	Ground Level												
0.0													
	Silt of Slight Plasticity Some Sand Occ. Clay Seams		1	SS	6								0 22 (78)
			2	SS	5								
			3	SS	4								
			4	SS	4								
193.0	Loose		5	SS	6								0 49 (51)
4.4			6	SS	5								
	Alternating Layers of Silty Clay and Clayey Silt Trace of Sand Occ. Silt and Clay Seams		7	SS	7								
			8	TW	PH								
			9	TW	PH								
	Firm to V. Stiff		10	TW	PH								
			11	SS	18								
			12	TW	PH								
184.0	Clayey Silt												
13.4	Some Sand & Gravel		13	SS	24								
182.8	V. Stiff												
14.6	Weathered Unweathered Dolostone Bedrock		14	RC EXL	Rec 92%								
181.2													
16.2	End of Borehole												RQD 70%

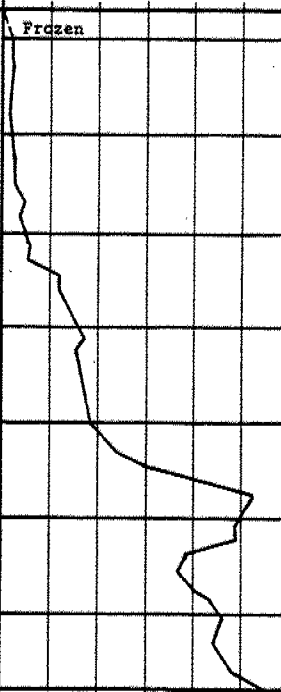
OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 103										METRIC					
W P 66-67-05		LOCATION Co-ords: N 4 780 937.0; E 250 011.6						ORIGINATED BY LNS							
DIST 4 HWY 403		BOREHOLE TYPE Cont. Flight Augers (H.S.)						COMPILED BY PP							
DATUM Geodetic		DATE 89 02 16						CHECKED BY <u>PK</u>							
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
197.4	Ground Level														
0.0	Silt of Slight Plasticity Some Sand		1	SS	6										
			2	SS	5										
	Occ. Clayey		3	SS	4										
	Silt Layers		4	TW	PH										
			5	SS	4										
	Loose		6	SS	7										
190.4															
7.0			7	TW	PH										
	Alternating Layers of Silty Clay and Clayey Silt Trace of Sand Occ. Clay and Silt Seams		8	SS	8										
			9	SS	10										
			10	SS	23										
			11	TW	PH										
	Firm to V. Stiff														
181.9															
5.5	End of Borehole														
	Probable Bedrock														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 104										METRIC						
W P 66-67-05		LOCATION Co-ords: N 4 780 923.5; E 249 082.5				ORIGINATED BY LNS										
DIST 4 HWY 403		BOREHOLE TYPE Cont. Flight Auger (H.S.)				COMPILED BY PP										
DATUM Geodetic		DATE 89 02 14-15				CHECKED BY <i>PK</i>										
ELEV DEPTH	SOIL PROFILE DESCRIPTION	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 (%)
			NUMBER	TYPE			'N' VALUES	20	40	60	80					
197.4	Ground Level						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) 10 20 30				
0.0	Silt of Slight Plasticity Some Sand Occ. Organic Silty Clay Layers Loose		1	SS	7											0 15 (85)
			2	SS	5											
			3	SS	5											
			4	TW	PH											
			5	SS	9											
190.7																
6.7	Alternating Layers of Silty Clay and Clayey Silt Trace of Sand Occ. Clay and Silt Seams Firm to Stiff		6	TW	PH											15.1
			7	SS	8											
			8	SS	10											
			9	TW	PH											
			10	SS	12											
182.2																
15.2	Dolostone Sound Bedrock		11	RC BXL	Rec 100%											18.4
180.7																
16.7	End of Borehole *Groundwater Level not Observed															0 0 (100)

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 105										METRIC			
W P <u>66-67-05</u>		LOCATION <u>Co-ords: N 4 780 922.5; E 249 055.0</u>				ORIGINATED BY <u>LNS</u>							
DIST <u>4</u> HWY <u>403</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test Only</u>				COMPILED BY <u>LNS</u>							
DATUM <u>Geodetic</u>		DATE <u>89 02 24</u>				CHECKED BY <u>DT</u>							
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					
196.5	Ground Level						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
0.0							Frozen						
													
182.5													
14.0	End of Cone Test												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 106

METRIC

W P 66-67-05

LOCATION Co-ords: N 4 780 915.5; E 249 008.0

ORIGINATED BY LNS

DIST 4 HWY 403

BOREHOLE TYPE Cont. Flight Auger (H.S.)

COMPILED BY LNS

DATUM Geodetic

DATE 89 02 27

CHECKED BY STK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div>20 40 60 80 100</div>	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								

198.5	Ground Level						198	Frozen					
0.0	Silt of Slight Plasticity Some Sand Occ. Clayey Silt Zones Compact		1	SS	16								0 18 (82)
			2	SS	16								
			3	SS	20								
194.8			4	SS	14								
3.7	Alternating Layers of Clayey Silt and Silty Clay Trace of Sand Occ. Clay and Silt Seams Firm to V. Stiff		5	SS	5								
			6	SS	6								
			7	TW	PH							19.5	0 1 (99)
			8	SS	4								
			9	TW	PH							18.9	0 1 (99)
			10	SS	9								
			11	TW	PH							19.8	
			12	SS	9								
			13	TW	PH								
182.2													
16.3	Refusal to Auger End of Borehole										120 Blows/150 mm		

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

FOUNDATION INVESTIGATION REPORT

for

Johnson Road Underpass

W.P. 66-67-06, Site 1-193

Hwy. 403, District 4 (Burlington)INTRODUCTION

This report contains the results of a foundation investigation carried out for the proposed structure at the junction of the existing Johnson Road and New Hwy. 403, during the periods of 76 03 05-11 and 79 07 23-24. The fieldwork consisted of three sampled boreholes and two dynamic cone penetration tests. The borings were advanced by employing continuous flight auger machines, mounted either on a muskeg vehicle or on an allterrain vehicle and equipped with 82 mm I.D. hollow stem augers.

SITE DESCRIPTION

The structure site is located at the future junction of the existing Johnson Road and proposed New Hwy. 403, in the Township of Brantford.

The surrounding terrain is relatively flat, cultivated agricultural land.

SUBSURFACE CONDITIONS

General

Generally uniform subsoil conditions were found to exist across the site. The subsoil (apart from the existing roadway material) consists of a deep deposit (24 - 26 m) of stratified silty clay with trace of sand followed by dolomite type bedrock.

The boundary between the overburden and bedrock, together with the obtained field and laboratory tests results are shown on the Record of Borehole Sheets contained in the Appendix. The stratigraphical profile shown on Drawing No. 666706-A* is based on this information. The drawing also shows the locations and elevations of the borings. A detailed description of the encountered subsurface conditions is given below.

Silty Clay Trace of Sand

This stratum was intersected in all borings and extends from immediately below the ground surface to the bedrock for a depth about 24 - 26 m. The material in the deposit is stratified and classified as silty clay with trace of sand. The stratification is rather random and ranges in thickness from 5 mm to about 100 mm. The plasticity of the individual layers varies from low to high. Occasional silt seams were also observed throughout the stratum. The Atterberg Limit test results for the overall deposit are plotted on the

* DWG NO 2 OF THE CONTRACT DWG'S

plasticity chart (Figure 1). The consistency of the stratum varies randomly from firm to very stiff. This assessment is based on a number of field vane and laboratory unconfined and quick triaxial tests, the results of which as plotted on Figure 2 and summarized below, together with other physical properties determined from field and laboratory tests.

	<u>Range</u>
Natural Moisture Content (W)	14 - 47%
Liquid Limit (W_L)	15 - 66%
Plastic Limit (W_P)	12 - 25%
Undrained Shear Strength (c_u)	
Unconfined	45 - 95 kPa
Quick Triaxial	45 - 58 kPa
Field Vane	55 - over 100 kPa
Unit Weight (γ)	18.4 - 22.9 kN/m ³
Sensitivity (Based on field vane tests)	2 - 5

Grain size distribution curves are presented in an envelope form on Figure 3 of the Appendix.

Two consolidation tests were performed on samples obtained from this stratum. The test results are plotted on the void ratio versus pressure curves (Figure 4) in the Appendix. The tests indicate that the soil is overconsolidated with a preconsolidation pressure ranging from 550 to 620 kPa.

For design purposes in terms of total stresses an average undrained shear strength value of 65 kPa is recommended.

Bedrock

Bedrock was found at depths about 24 - 26 m below ground level (elevation 185 - 186) which consists of moderately fractured, hard, light grey to white dolomite.

Groundwater Conditions

The following groundwater levels were observed the boring locations:

B.H. #1 - Elevation 208.8

B.H. #2 - Elevation 209.1

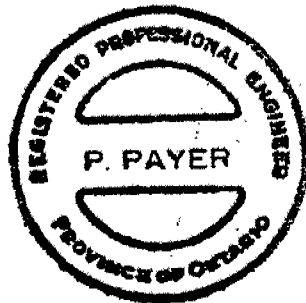
B.H. #3 - Elevation 207.5

It is pointed out that the subsoil is relatively impermeable therefore, a considerable time is required for the water levels to stabilize.

For design and construction purposes, it should be assumed that the groundwater level at this site is probably at elevation 208.5±. Seasonal changes may also influence the groundwater level.

MISCELLANEOUS

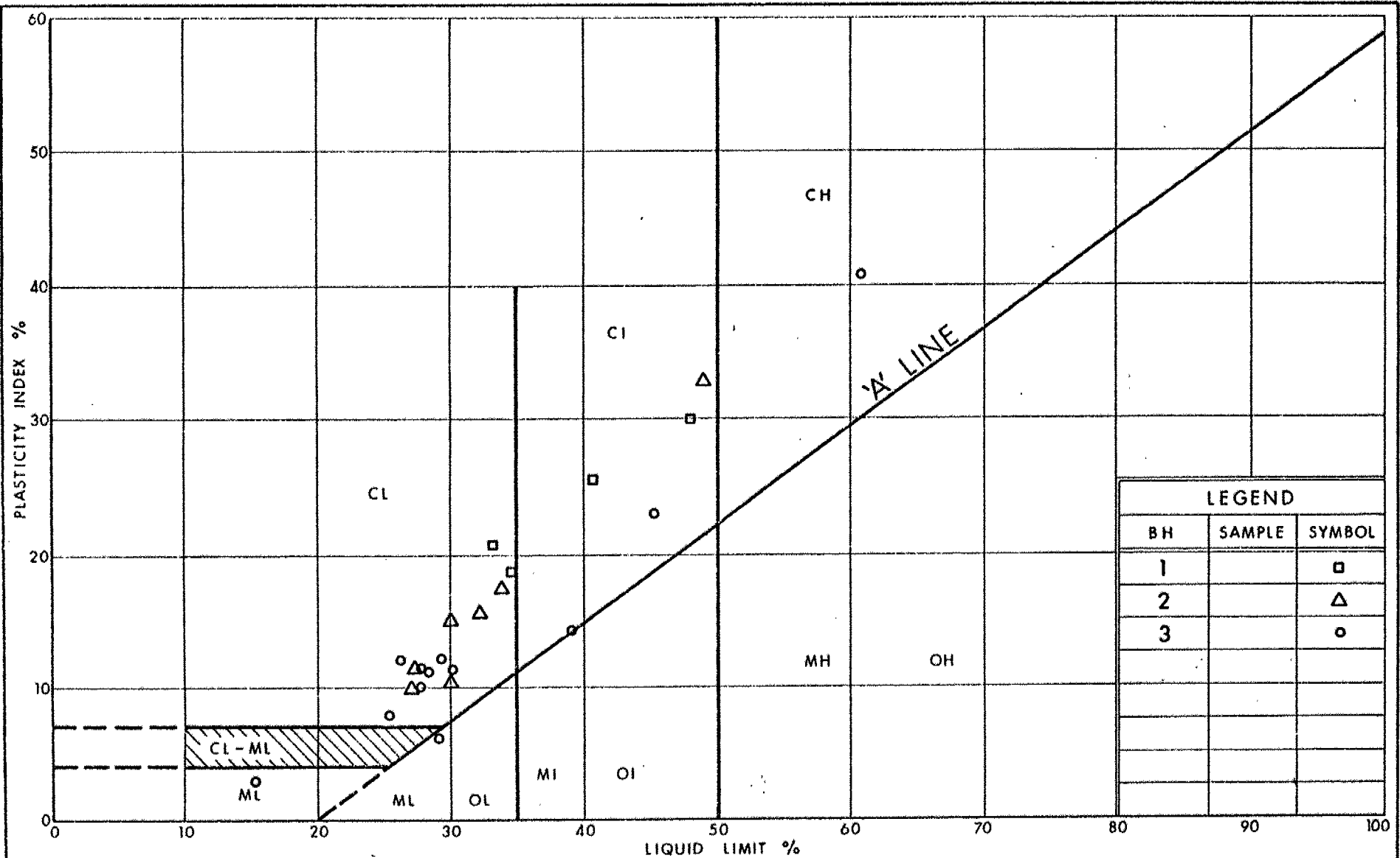
The fieldwork for this project was supervised by Mr. R. Van Veen, Project Engineer and Mr. P.R. Korpel, Trainee Engineer. The equipment used, was owned and operated by Atcost Soil Drilling Inc., and Dominion Soil Investigation Ltd. The original report was written by Mr. P. Payer, Foundations Engineer and reviewed by Mr. K.G. Selby, Senior Foundation Engineer.



P. Payer
P. Payer, P. Eng.
Sr. Foundation Engineer

M. Devata
M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX



Ministry of
Transportation

PLASTICITY CHART
SILTY CLAY STRATIFIED, TRACE OF SAND
OCC LAYERS AND SEAMS OF SILT

FIG No 1

W P 66-67-06

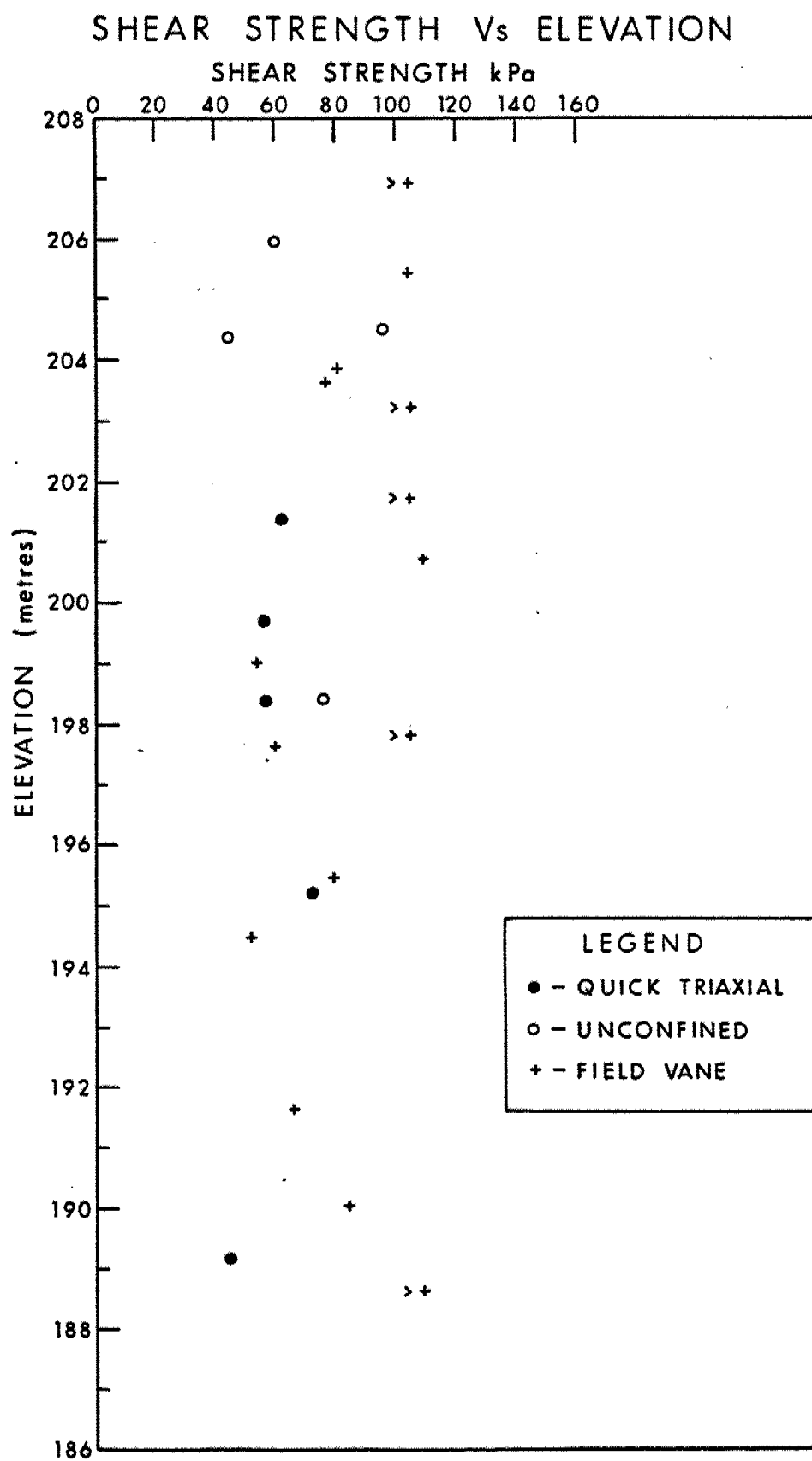
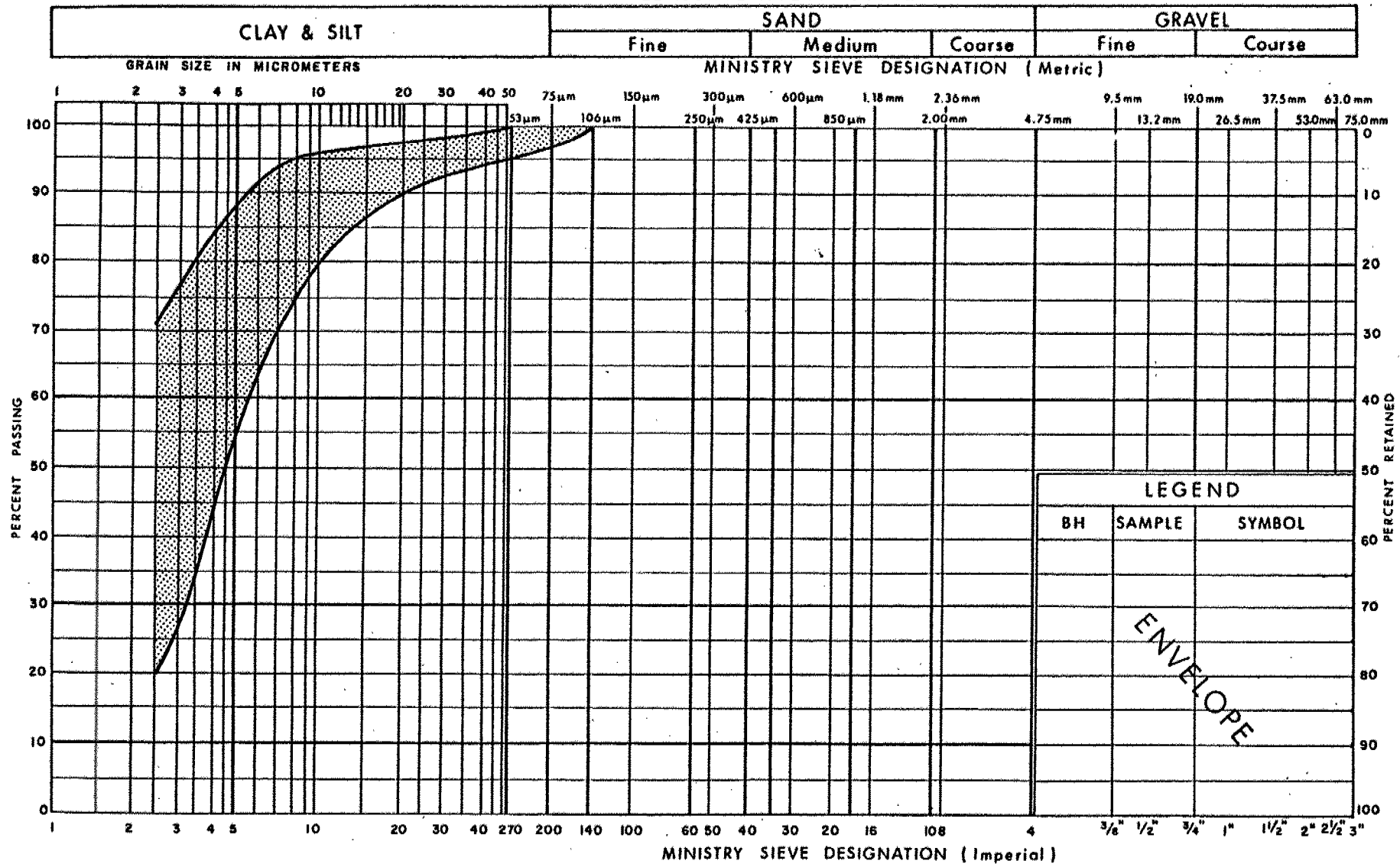


Fig 2

WP 66-67-06

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY STRATIFIED, TRACE OF SAND
OCC LAYERS AND SEAMS OF SILT

FIG No 3

WP 66-67-06

VOID RATIO-PRESSURE CURVES

47

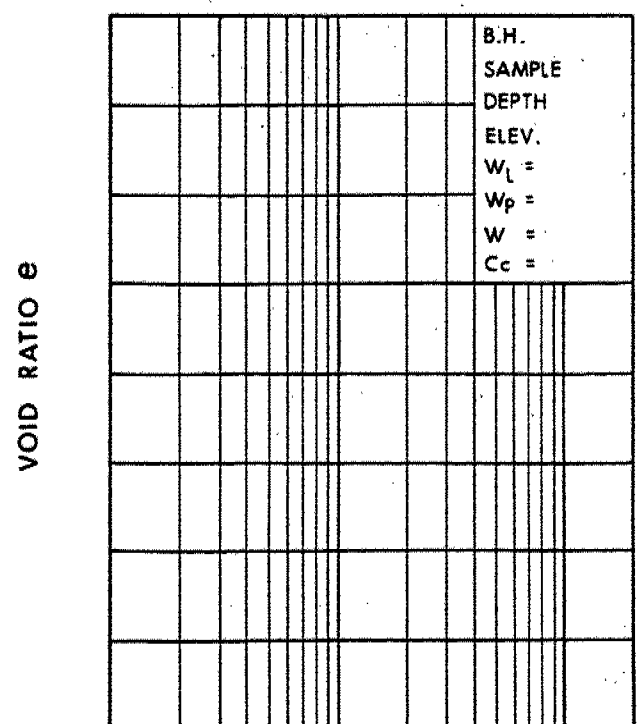
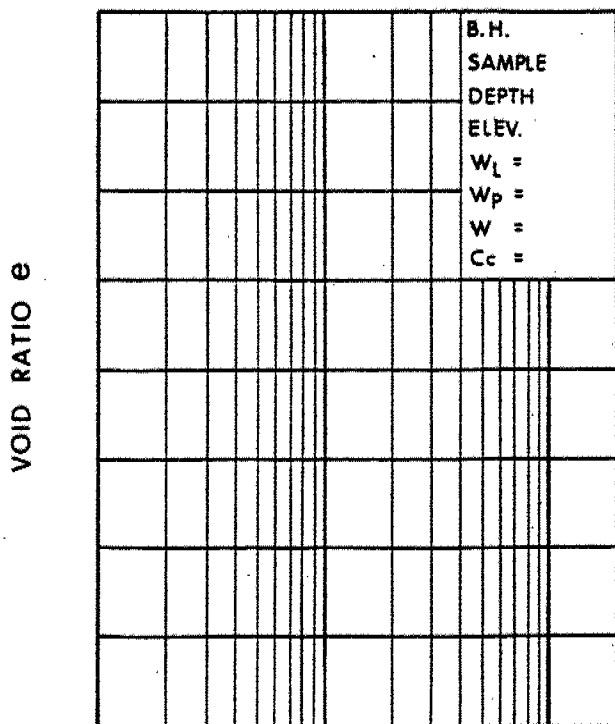
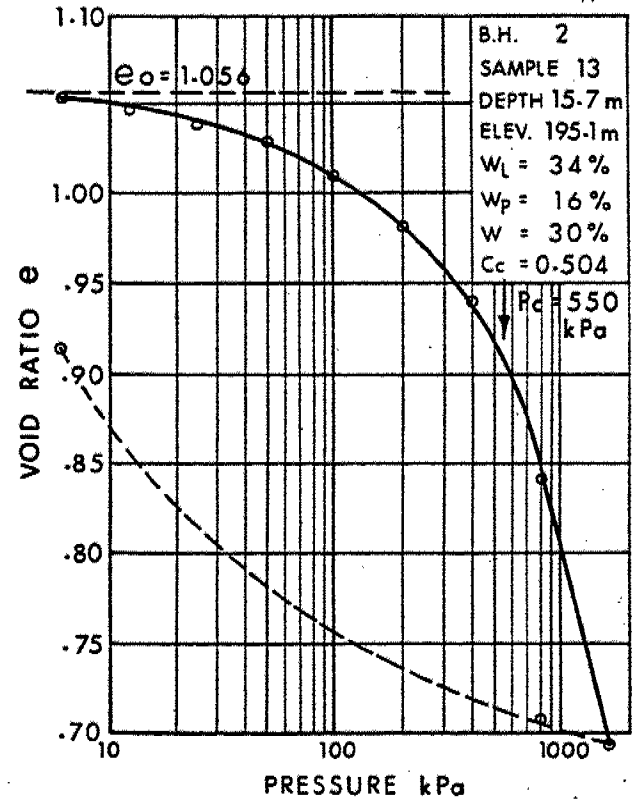
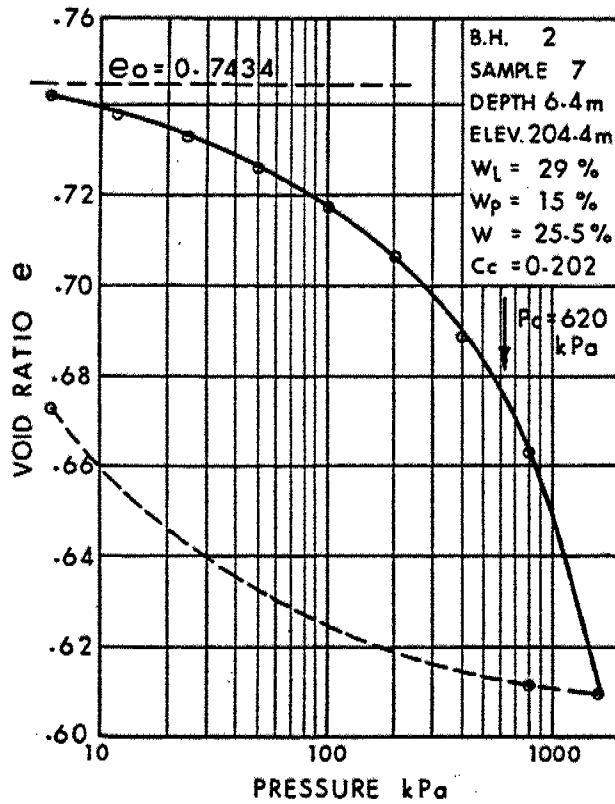


FIG. 4

WP 66-67-06

RECORD OF BOREHOLE No 1										METRIC	
W P 66-67-06		LOCATION N 4 780 951.0; E 248 672.0				ORIGINATED BY PRK					
DIST 4 HWY 403		BOREHOLE TYPE Hollow Stem Auger and Cone Test				COMPILED BY PRK					
DATUM Geodetic		DATE 1979 07 23				CHECKED BY <i>CP</i>					
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 (%) 15 30 45	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
210.6	Ground Level										
0.0	Silty clay Stratified		1	SS	14		210				
	Trace of sand		2	SS	11		208				
			3	SS	10		206				
			4	SS	20		204				
	Brown		5	SS	21		202				
	Grey		6	SS	6		200				
	Occasional layers and seams of silt		7	SS	8		198				
	Firm to stiff		8	TW	PH						
			9	SS	11						
			10	SS	5						
			11	TW	PH						
197.9			12	SS	11						
12.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 66-67-06 LOCATION Co-ords. N 4 780 898.8; E 248 671.5 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and BXL Rock Core COMPILED BY PRK
DATUM Geodetic DATE 1979 07 24 CHECKED BY JP

[illegible]

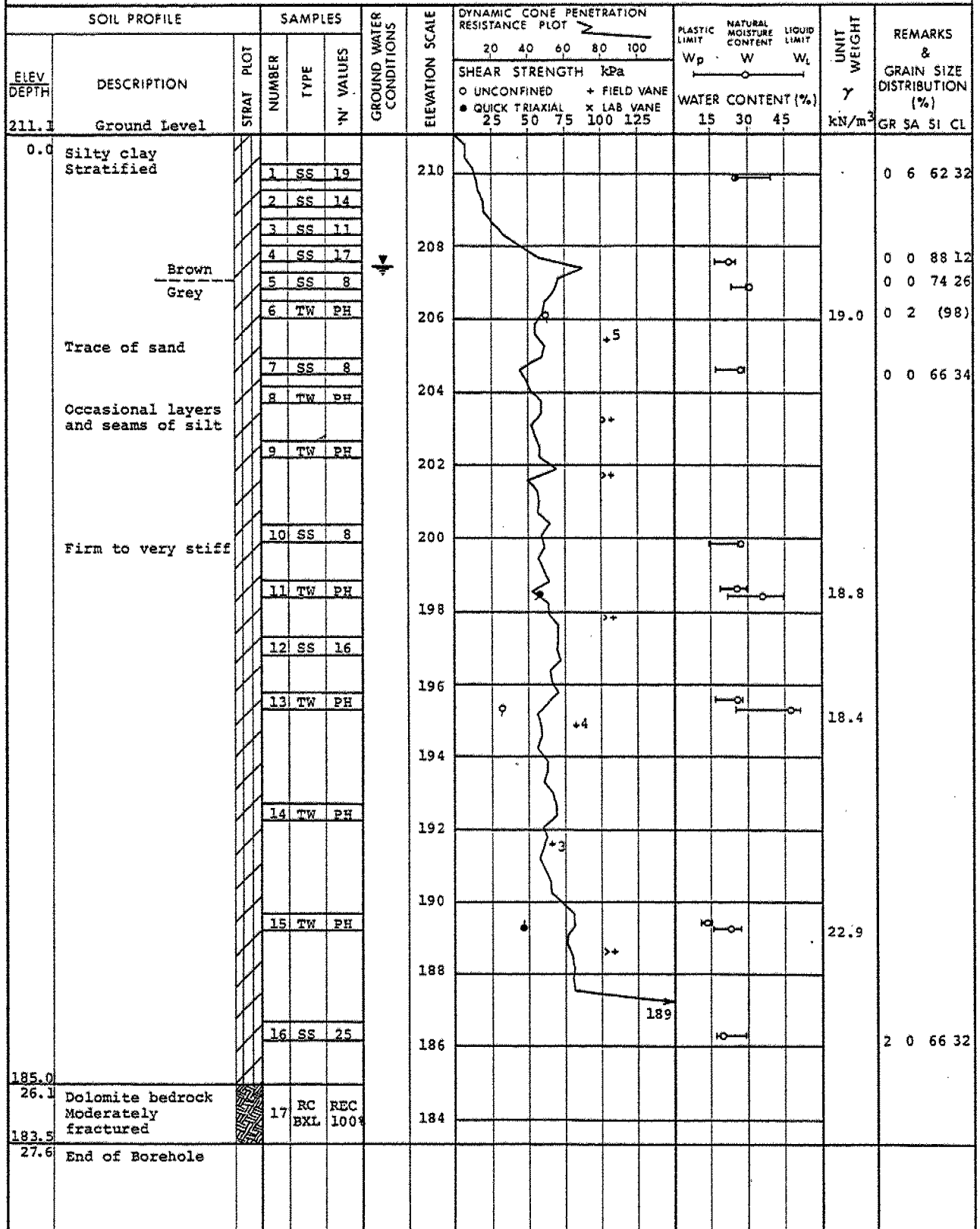
+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

10

RECORD OF BOREHOLE No 3 (Formerly B.H.#2 METRIC

W.P. 66-67-06 LOCATION Co-ords. N 4780 933.2; E 248 671.6 ORIGINATED BY BVV
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, EX Core and Cone Test COMPILED BY PRK
 DATUM Geodetic DATE 1976 03 05 - 11 CHECKED BY [Signature]



OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
for
Garden Ave. Interchange Underpass
W.P. 66-67-07, Site 1-194
Hwy. 403, District 4, Burlington

INTRODUCTION

This report contains the results of a foundation investigation carried out for the proposed structure at the junction of the existing Garden Ave. and New Hwy. 403, during the periods of 1976 03 11 - 15 and 1979 07 18 - 19. The fieldwork consisted of three sampled boreholes and two dynamic cone penetration tests. The borings were advanced by employing continuous flight auger machines, mounted either on a muskeg vehicle or on an all-terrain vehicle and equipped with 82 mm I.D. hollow stem augers.

SITE DESCRIPTION

The structure site is located at the future junction of the existing Garden Ave. and proposed New Hwy. 403, in the Township of Brantford.

The surrounding terrain is relatively flat, cultivated agricultural land.

SUBSURFACE CONDITIONS

General

Generally uniform subsoil conditions were found to exist across the site. The subsoil (apart from the existing Garden Ave. roadway material) consists of a deep deposit (30 - 31 m) of stratified silty clay with trace of sand followed by dolomite type bedrock.

The boundary between the overburden and bedrock, together with the obtained field and laboratory tests results are shown on the Record of Borehole Sheets contained in the Appendix. The stratigraphical profile shown on Drawing No. 666707-A^{*} is based on this information. The drawing also shows the locations and elevations of the borings. A detailed description of the encountered subsurface conditions is given below.

Silty Clay Trace of Sand

This stratum was intersected in all borings and extends from immediately below the ground surface to the bedrock for a depth about 30 - 31 m. The material in the deposit is stratified and classified as silty clay with trace of sand. The stratification is rather random and ranges in thickness from 5 mm to about 100 mm. The plasticity of the individual layers varies from low to high. Occasional silt seams were also observed throughout the stratum. The Atterberg Limit test results for the overall deposit are plotted on the plasticity chart (Figure 1). The

* DWG NO 2 OF THE CONTRACT DWG'S

consistency of the stratum varies randomly from stiff to very stiff. This assessment is based on a number of field vane and laboratory unconfined and quick triaxial tests, the results of which are plotted on Figure 2 and summarized below, together with other physical properties determined from field and laboratory tests.

	<u>Range</u>
Natural Moisture Content (w)	19 - 32%
Liquid Limit (w_L)	16 - 65%
Plastic Limit (w_p)	12 - 21%
Undrained Shear Strength (c_u)	
Unconfined	47 - 72 kPa
Quick Triaxial	61 - 70 kPa
Field Vane	50 - over 100 kPa
Unit Weight (γ)	19.3 - 20.5 kN/m ³
Sensitivity (Based on field vane tests)	2 - 5

Grain size distribution curves are presented in an envelope form on Figure 3 of the Appendix.

Two consolidation tests were performed on samples obtained from this stratum. The test results are plotted on the void ratio versus pressure curves (Figure 4) in the Appendix. The tests indicate that the soil is overconsolidated with a preconsolidation pressure ranging from 560 to 700 kPa.

For design purposes in terms of total stresses an average undrained shear strength value of 50 kPa is recommended.

Bedrock

Bedrock was found at a depth about 30 - 31 m below ground (Elevation 185 ±) which consists of moderately fractured, hard, light grey to white dolomite.

Groundwater Conditions

The following groundwater levels were observed the boring locations:

B.H. #1 - Elevation 213.7 (4 days after the completion of drilling)

B.H. #2 - Elevation 213.1 (3 days after the completion of drilling)

B.H. #3 - Elevation 211.6 (N.A.)

It is pointed out that the subsoil is relatively impermeable therefore, a considerable time is required for the water levels to stabilize. Measurements carried out immediately after the borings were completed, indicate that the groundwater levels were about 20 m below the ground surface.

For design and construction purposes, it should be assumed that the groundwater level at this site is probably at elevation 214±. Seasonal changes may also influence the groundwater levels.

MISCELLANEOUS

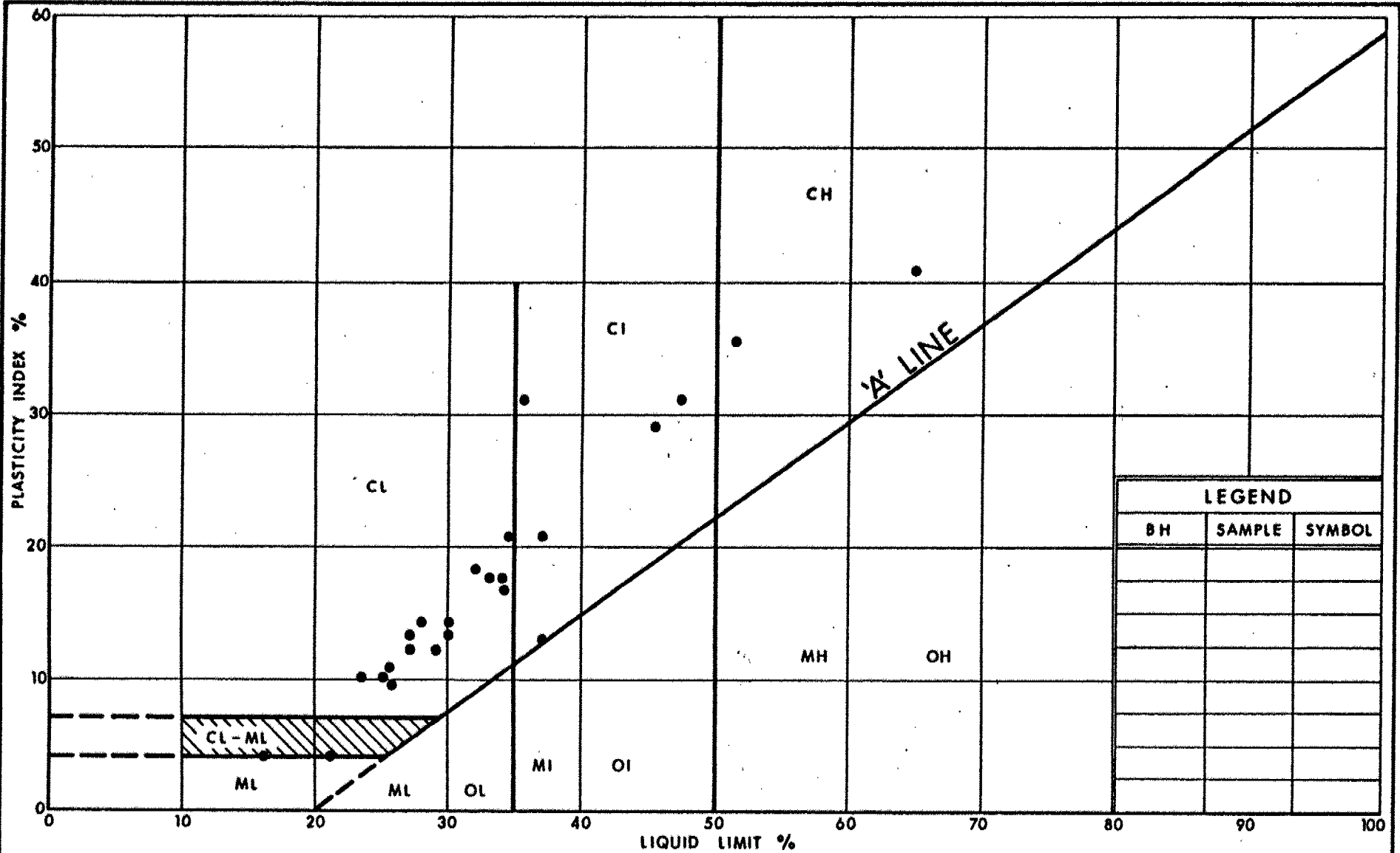
The fieldwork for this project was supervised by Mr. M. Kalapaca, Project Supervisor and Mr. P.R. Korpel, Trainee Engineer. The equipment used, was owned and operated by Atcost Soil Drilling Inc., and Dominion Soil Investigation Ltd. The original report was written by Mr. P. Payer, Foundations Engineer and reviewed by Mr. K.G. Selby, Senior Foundation Engineer.



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APPENDIX

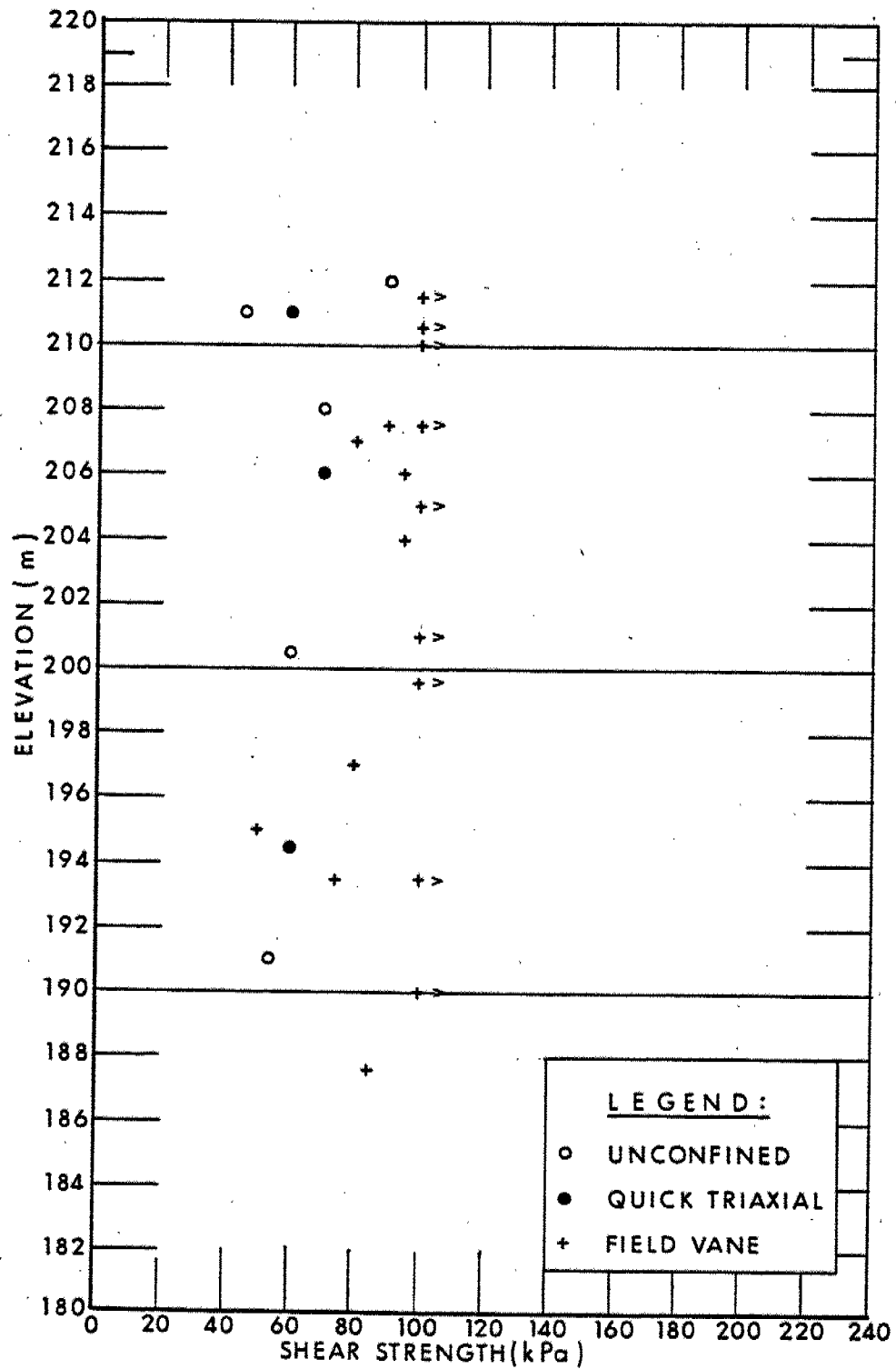


**Ministry of
Transportation**

PLASTICITY CHART
SILTY CLAY
(STRATIFIED)

FIG No 1

WP 66-67-07

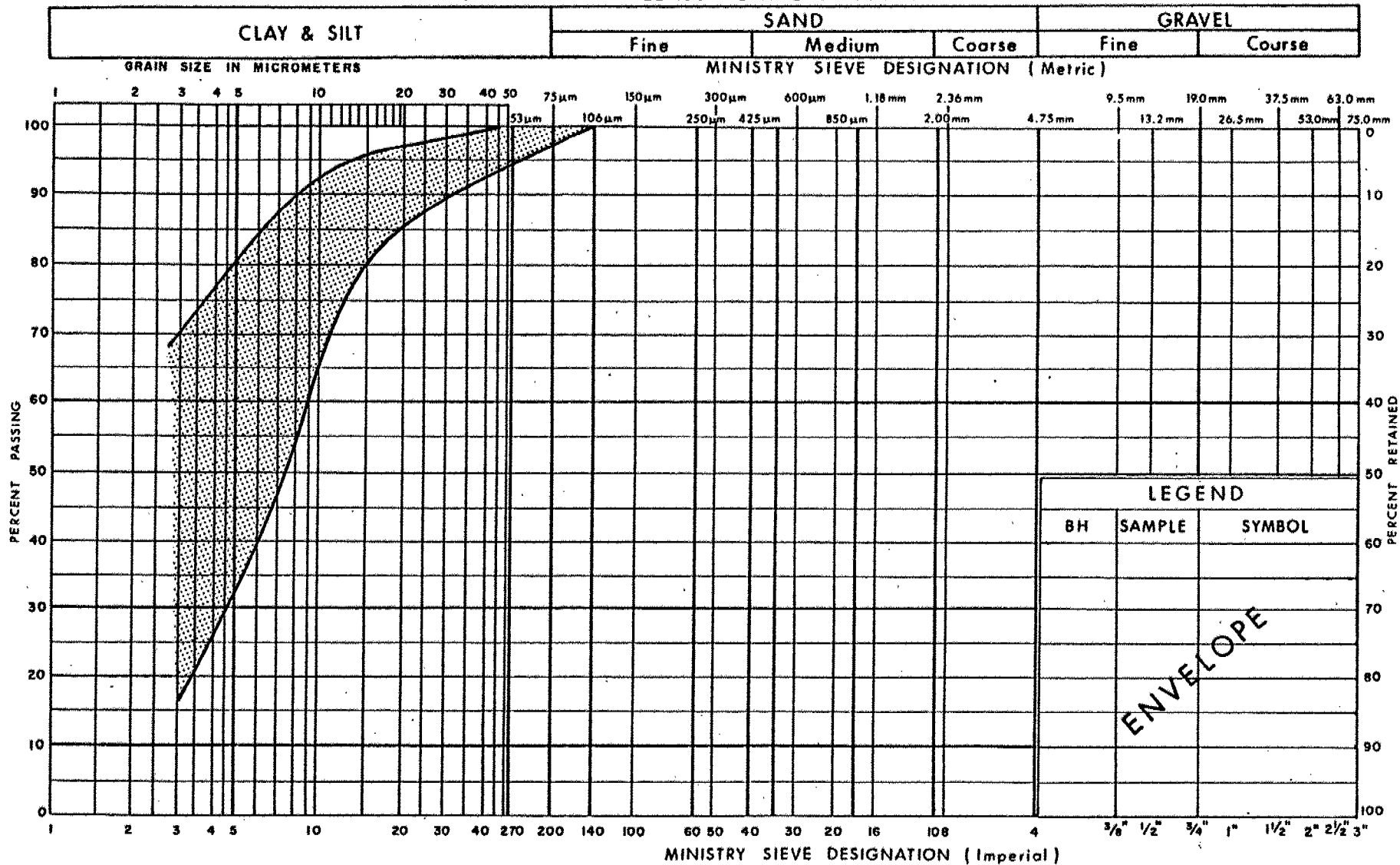


SHEAR STRENGTH vs ELEVATION

WP 66-67-07

FIG 2

UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

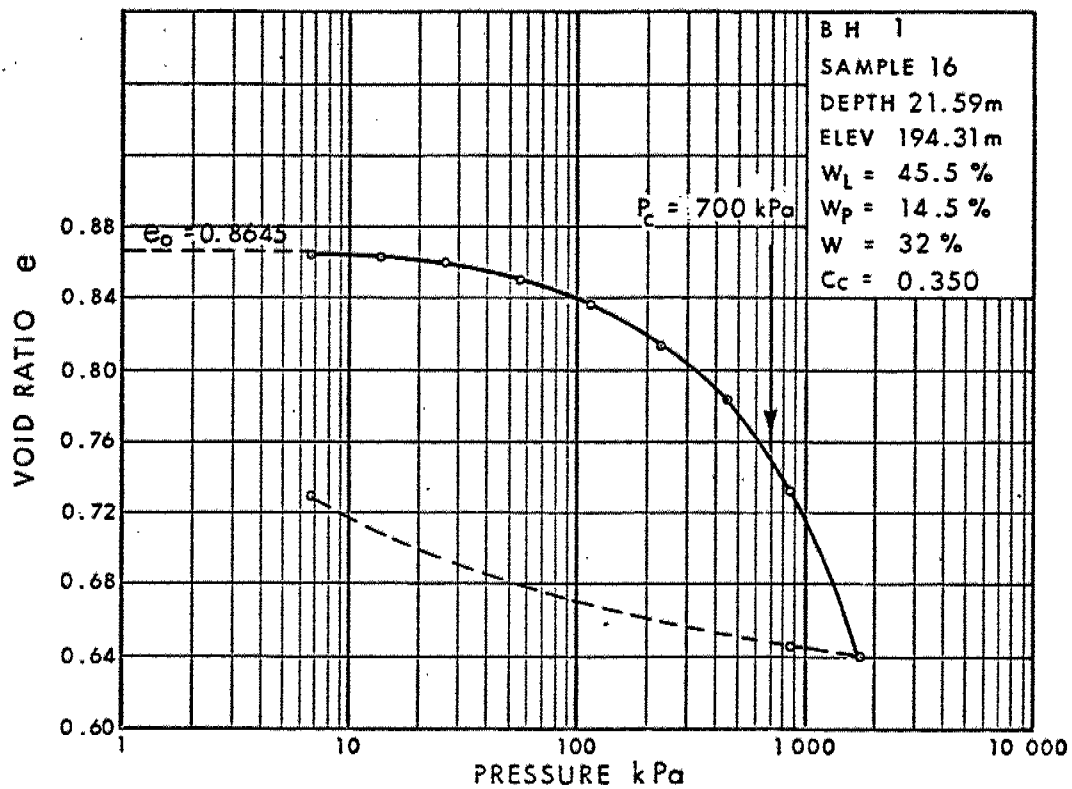
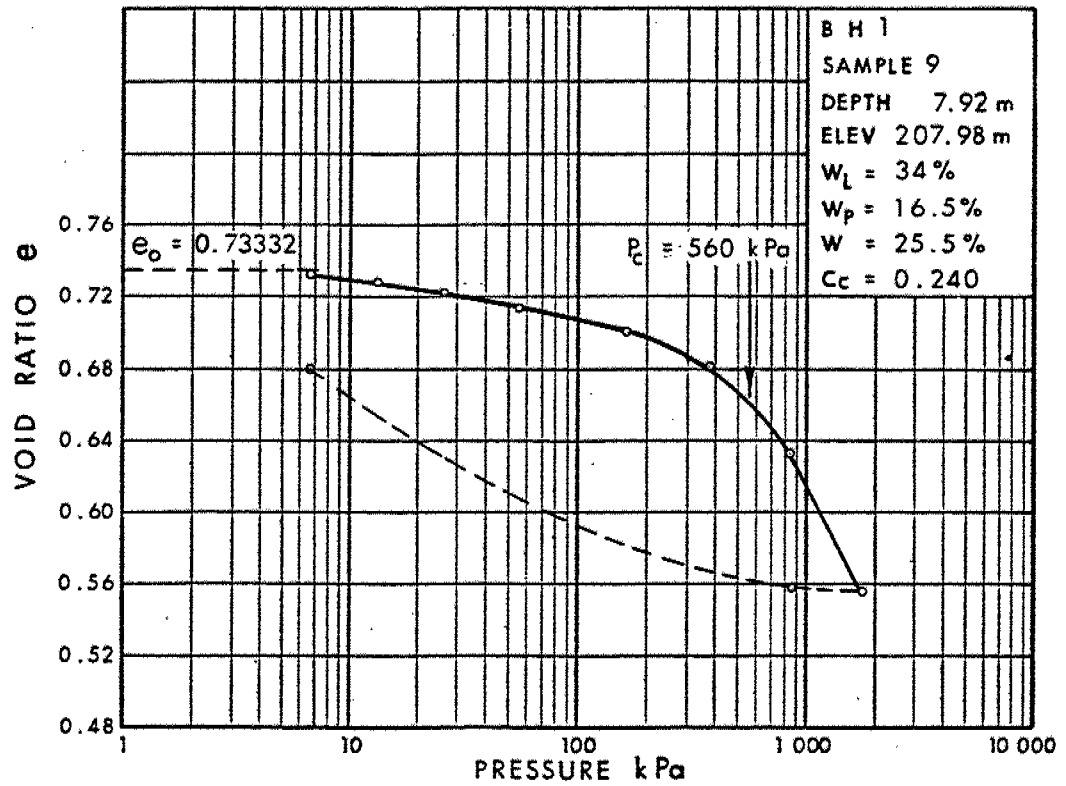
GRAIN SIZE DISTRIBUTION
SILTY CLAY
TRACE OF SAND
(STRATIFIED)

FIG No 3

W P 66-67-07

VOID RATIO - PRESSURE CURVES

60



WP 66-67-07

FIG No 4

RECORD OF BOREHOLE No 1

METRIC

W P 66-67-07 LOCATION Co-ords. N 4 780 907.5; E 246 767.7 ORIGINATED BY PRK
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY PRK
 DATUM Geodetic DATE 1979 07 18, 19 CHECKED BY RS

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			20 40 60 80 100	SHEAR STRENGTH kPa					
215.9	Ground Level												
0.0	Silty clay		1	SS	16								0 2 56 42
			2	SS	22								0 1 54 45
			3	SS	13								
			4	SS	6								
			5	SS	10								
			6	TW	PH							19.6	0 0 51 49
			7	SS	7								
			8	SS	6								
			9	TW	PH							19.6	0 0 70 30
			10	TW	PH								
			11	SS	6								
			12	SS	14								
			13	SS	6								
			14	TW	PH							19.5	0 0 93 7 0 0 40 60
			15	TW	PH								
			16	TW	PH							20.0	0 0 83 17 0 0 40 60
			17	SS	8								
189.1			18	SS	50/6mm Boulders								
29.8													
187.1													
28.8													
185.6													
30.3	Probable bedrock 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 66-67-07 LOCATION Co-ords. N 4 780 847.0; E 246 784.0 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
DATUM Geodetic DATE 1979 07 19, 20 CHECKED BY RS

[illegible]

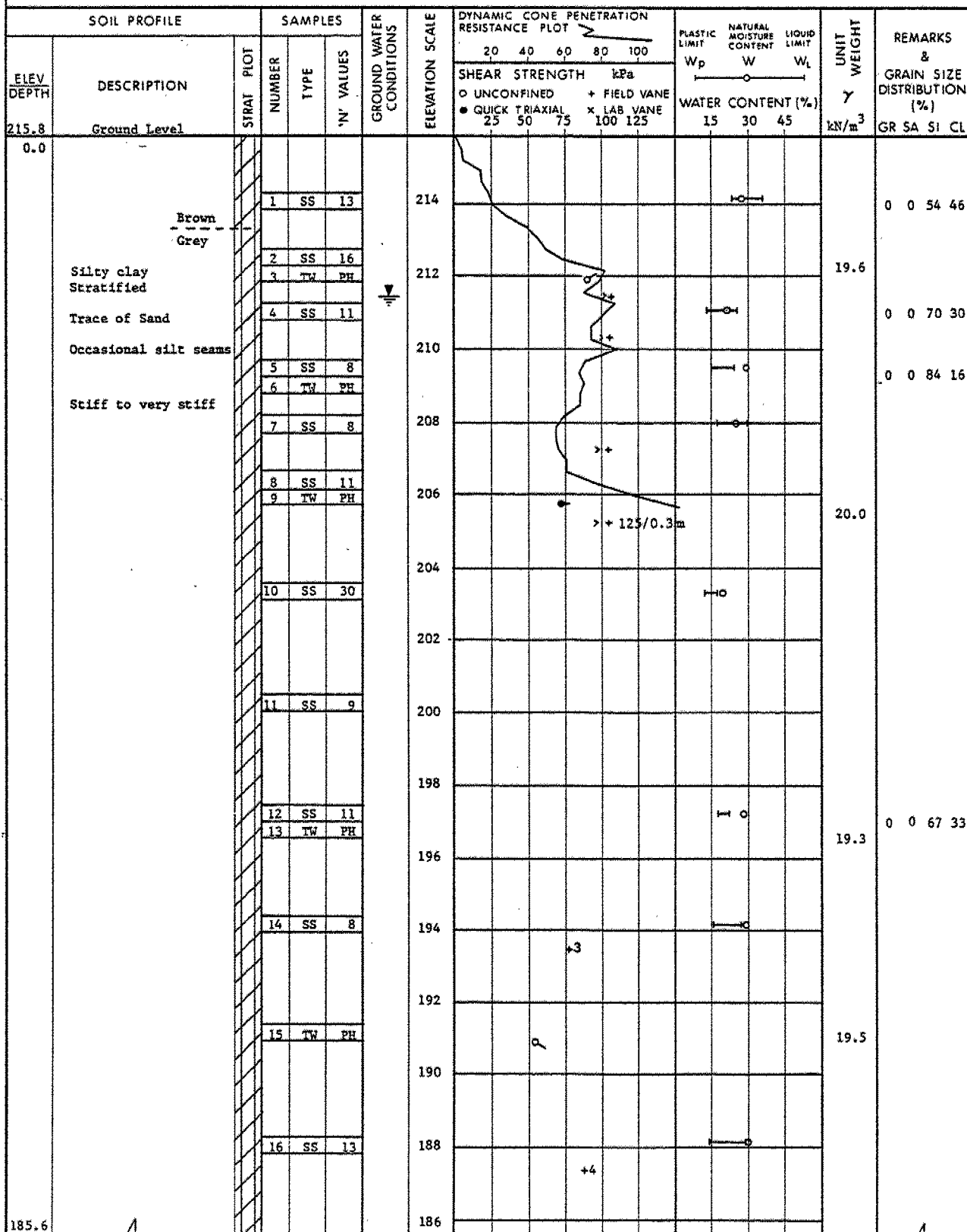
+3, x5: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3 (Formerly B.H.1 W.P.66-67-01) METRIC

W P 66-67-07 LOCATION Co-ords. N 4 780 877.0; E 246 793.5 ORIGINATED BY MK
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, BXL Core and Cone Test COMPILED BY PRK
 DATUM Geodetic DATE 1976 03 11 - 15 CHECKED BY RS



OFFICE REPORT ON SOIL EXPLORATION


Continued

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

RECORD OF BOREHOLE No 3 Continued

METRIC

W P 66-67-07 LOCATION Co-ords. N 4 780 876.0; E 246 793.5 ORIGINATED BY MK
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, EXL Core & Cone Test COMPILED BY PRK
 DATUM Geodetic DATE 1976 03 11 - 15 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA, SI, CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20	40	60	80	100	PLASTIC LIMIT W _p	W	LIQUID LIMIT W _L		
185.6																
30.2																
30.6	Moderately fractured dolomite bedrock		17	RC EXL	REC 98%	184										
			18	RC EXL	REC 98%											
182.1																
33.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications

FILE COPY

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

CONT 90-95
ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 66-67-03

DIST 4

HWY 403

STR SITE 1-190

Jerseyville Rd. Interchange Underpass
13.7 km West of Hwy. #2

DISTRIBUTION

G. C. E. Burkhardt (3)
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B. J. Giroux

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
T. J. Kovich)

Files

FOUNDATION INVESTIGATION REPORT

For

Jerseyville Rd. Interchange Underpass
13.7 km West of Hwy. #2
W.P. 66-67-03, Site 1-190
Hwy. #403, District #4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out for the proposed structure at the junction of the existing Jerseyville Rd. and New Hwy. #403, during the periods of 1976 03 15 - 16 and 1979 07 26 - 30. The fieldwork consisted of three sampled boreholes and two dynamic cone penetration tests. The borings were advanced by employing continuous flight auger machines, mounted either on a muskeg vehicle or on an all-terrain vehicle and equipped with 82 mm I.D. hollow stem augers.

SITE DESCRIPTION

The structure site is located at the future junction of the existing Jerseyville Rd. and proposed New Hwy. #403, in the Township of Brantford some 13.7 km west of Hwy. #2.

The surrounding terrain is relatively flat, cultivated agricultural land.

SUBSURFACE CONDITIONS

General

Generally uniform subsoil conditions were found to exist across the site. The subsoil (apart from the existing Jerseyville Rd. roadway material) consists of a deep deposit (36 - 38 m) of stratified silty clay with trace of sand followed by dolomite type bedrock.

The boundary between the overburden and bedrock, together with the obtained field and laboratory tests results are shown on

the Record of Borehole Sheets contained in the Appendix. The stratigraphical profile shown on Drawing No. 666703-A is based on this information. The drawing also shows the locations and elevations of the borings. A detailed description of the encountered subsurface conditions is given below.

Silty Clay Trace of Sand

This stratum was intersected in all borings and extends from immediately below the ground surface to the bedrock for a depth about 36 - 38 m. The material in the deposit is stratified and classified as silty clay with trace of sand. The stratification is rather random and ranges in thickness from 5 mm to about 150 mm. The plasticity of the individual layers varies from low to high. Occasional silt seams were also observed throughout the stratum. The Atterberg Limit test results for the overall deposit are plotted on the plasticity chart (Figure 1). The consistency of the stratum varies randomly from stiff to very stiff. The assessment is based on a number of field vane and laboratory unconfined and quick triaxial tests, the results of which are plotted on Figure 2 and summarized below, together with other physical properties determined from field and laboratory tests.

	<u>RANGE</u>
Natural Moisture Content (w)	13 - 46%
Liquid Limit (w_L)	22 - 63%
Plastic Limit (w_p)	13 - 21%
Undrained Shear Strength (c_u)	
Unconfined	39 - 96 kPa
Quick Triaxial	48 - 101 kPa
Field Vane	41 - over 100 kPa
Unit Weight (γ)	19.3 - 20.5 kN/m ³
Sensitivity (Based on Field Vane Tests)	2 - 5

Grain size distribution curves are presented in an envelope form on Figure 3 of the Appendix.

One consolidation test was performed on a sample obtained from this stratum. The tests indicate that the soil is overconsolidated with a preconsolidation pressure of 435 kPa.

For design purposes in terms of total stresses, an average undrained shear strength value of 60 kPa is recommended.

Silt

A loose to dense, approx. 2 to 2.4 m thick silt with traces of sand and clay zone was found to be sandwiched between the brown and grey portion of the silty clay deposit.

Bedrock

Bedrock was found at depth about 36.6 below ground (elevation 182 \pm) which consists of moderately fractured, hard, light grey to white dolomite.

Groundwater Conditions

The following groundwater levels were observed ^{at} the boring locations:

- B.H. # 1 - Elevation 214.8
- B.H. # 2 - not observed
- B.H. # 3 - Elevation 214.6

It is pointed out that the subsoil is relatively impermeable, therefore a considerable time is required for the water levels to stabilize.

For design and construction purposes, it should be assumed that the groundwater level at this site is probably at elevation 215 \pm . Seasonal changes may influence the groundwater levels.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a two span (25.5 m - 25.5 m) structure at the junction of future New Hwy. #403 and the existing Jerseyville Rd. As per present proposals, the profile grade of Hwy. #403 will be located at elevation 216.2 (H.O.T. 14 + 196.308 \varnothing median of Hwy. #403) with a gradient of 1.065% increase from west to east. The profile grade of Jerseyville Rd. will be raised by about 3.4 m to elevation 222.4 (H.O.T. 10+000.000 \varnothing Jerseyville Rd.). The average original ground level is at approx. elevation 219 \pm . The subsoil at this site was found to consist of a 36 - 38 m deep, firm to very stiff, stratified silty clay and followed by dolomite type bedrock.

Structure Foundation

The encountered subsurface conditions (relatively low bearing capacity value and settlement considerations) do not favour spread footing type foundations. Therefore, piled foundations are recommended. End-bearing piles driven to bedrock (elevation 182 \pm) appear to be the most practical solution. The type of pile selected (steel tube, steel 'H' or reinforced concrete) should be based on economic considerations. For steel tubes, 323.9 mm O.D. @ 49.73 kg/m or HP 310 x 110 steel 'H' piles with reinforced tips driven to bedrock, the maximum permissible load is 1100 kN. For concrete piles, the maximum load will be dependent on the manufacturers specification. If steel tube piles are selected, they can be driven successfully to bedrock without damage to the piles provided that the energy of the hammer used at the instant of contact with bedrock does not exceed 40 000 joules/blow. For this reason, the energy should be restricted accordingly for the last 2 m of driving. A suitable note should be provided on the design drawings in this matter.

Approach Embankments

To accommodate the proposed profile grades of New Hwy. #403 and Jerseyville Rd. up to 3 m deep cuts and up to 4 m high fills will be required respectively. No stability problems are anticipated for the approaches (cuts and fill) of this magnitude, constructed with 2:1 forward and side slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles have to be driven, and it is recommended that this portion of the fill contain no larger grain sizes than 50 mm. Settlement of the silty clay subsoil induced by the construction of approach fills is estimated to be in the range of 75 - 100 mm and will take place over a long term period. In order to minimize the effect of these settlements on the performance of the pavement, it is recommended that the approach embankments be built in advance of the final grading and paving for as long a period as possible.

Other Considerations

The pile caps should be located not less than 1.3 m below finished ground level so as to provide for frost protection.

No major dewatering problems are anticipated due to the relatively impermeable nature of the subsoil. Topsoil and/or soft surficial material should be removed in accordance with current M.T.C. practices.

The future abutments in part, will be located over the existing Jerseyville Rd. roadway. To avoid damages to the piles during driving, it is recommended that the entire roadbed (pavement and base coarse) be excavated to its full vertical and horizontal extent.

In order to estimate the earth pressures on the abutment walls, the following values are recommended.

Unit Weight of Granular Backfill: 21.2 kN/m^3
 Coefficient of Active Earth Pressure: $K_a = 0.35$
 Coefficient of Earth Pressure at Rest: $K_o = 0.5$

A suitable drainage system should be provided to relieve the build-up of excess hydrostatic pressure behind the abutment walls.

To provide a smooth transition between the structure and the approaches which will undergo settling for a long period of time, it is recommended that the structure be designed with approach slabs.

The exposed cut and fill slopes should be protected against erosion according to M.T.C. standards.

MISCELLANEOUS

The fieldwork for this project was carried out by Mr. M. Kalapaca and Mr. P. R. Karpol. This report was written by Mr. P. Payer, and reviewed by Mr. K. G. Selby. The equipments used were owned by Atcost Soil Drilling Inc., and Dominion Soil Investigation Inc.



P. Payer

P. Payer, P. Eng.
 Foundations Engineer.

K. G. Selby

K. G. Selby, P. Eng.
 Senior Foundations Engineer.

December, 1979.

APPENDIX

RECORD OF BOREHOLE No 1 (0.0 - 30.2 m)

METRIC

W P 66-67-03 LOCATION Co-ords. N 4 871 255.0; E 250 314.0 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, BX-Core COMPILED BY PRK
DATUM Geodetic DATE 79 07 26/27 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 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	SHEAR STRENGTH kPa					
218.7	Ground Level													
0.0	Silty clay						218							
217.3	Stratified		1	SS	21									
	Very stiff - brown													
1.4	Silt		2	SS	17									
	Trace of sand and		3	SS	15									
	clay													
215.3	Compact		4	SS	27		216							
			5	SS	13									
3.4	Silty clay		6	SS	10		214							
	Stratified		7	SS	8									
	Trace of sand		8	TW	PH		212							
	Occasional layers and		9	SS	10									
	seams of silt													
	Firm to very stiff		10	TW	PH		208							
			11	SS	11									
	Grey coloured		12	TW	PH		206							
			13	SS	10									
			14	TW	PH		204							
							202							
							200							
			15	TW	PH		198							
							196							
			16	TW	PH		194							
							192							
							190							
188.53			17	SS	19									

Continued



+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1 Cont. (30.2 - 38.4 m)

METRIC

W P 66-67-03 LOCATION _____ ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, BX-Core COMPILED BY PRK
DATUM Geodetic DATE 79 07 26/27 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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
188.53	Silty clay <i>N</i>						188										
30.2							186										
			18	SS	15		184										0 0 78 22
182.13			19	SS	40/	0.0 m	Bounding										
36.6	Bedrock moderately fractured Dolomite		20	RC BX	98% REC		182										
180.33																	
38.4	End of Borehole						180										

RECORD OF BOREHOLE No 2 (0.0 - 30.2 m)

METRIC

W P 66-67-03 LOCATION Co-ords. N 4 871 308.0; E 250 326.0 ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
DATUM Geodetic DATE 79.07.30 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 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
219.4	Ground Level																
0.0	Silty clay Stratified Very stiff - brown		1	SS	20	Not Observed	218										0 0 88 12
217.7			2	SS	12												
1.7	Silt Trace of sand and clay Compact		3	SS	21		216										0 0 60 40
			4	SS	17												
215.3			5	SS	6												
			6	SS	9		214										
4.1	Silty clay Stratified		7	TW	PH		212									19.5	0 0 45 55
	Traces of sand		8	SS	8		210										
	Occasional layers and seams of silt		9	TW	PH		208										
	Firm to very stiff		10	TW	PH		206										
	Grey coloured		11	SS	14		204										
			12	TW	PH		202										
			13	SS	7		200										
			14	TW	PH		198										
			15	TW	PH		196										
							194										
							192										
							190										
188.84																	

30.2 Continued





+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 Cont. (30.2 - 37.1 m)

METRIC

W P 66-67-03 LOCATION _____ ORIGINATED BY PRK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY PRK
DATUM Geodetic DATE 79 07 30 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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE											
188.4	 Silty clay		16	SS	18															
30.20																				
37.1	Probable Bedrock End of Borehole		17	SS	13-6	/ .07 m - 45	0.0 m	180												
						Bouncing														

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 (Formerly B.R. #5)
(W.P. 66-67-01)

METRIC

W P 66-67-03 LOCATION Co-ords. N 4 871 274.1; E 250 292.6 ORIGINATED BY MK
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MK
DATUM Geodetic DATE 76 03 15/16 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 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					
218.50	Ground Level																
0.0	Silty clay Stratified						218										
217.5	Very stiff (Brown)																
1.3	Silt Trace of sand and clay Loose to dense		1	SS	4		216										
214.8			2	SS	32												0 1 91 8
3.7	Silty clay Stratified		3	SS	10		214										
	Trace of sand		4	TW	PH											18.8	
	Occasional layers and seams of silt		5	SS	16		212										
			6	TW	PH		210										
	Firm to very stiff		7	SS	8		208										
			8	TW	PH		206										
	Grey coloured		9	SS	10		204										
			10	TW	PH		202										19.5
			11	SS	7		200										
			12	TW	PH		198										
			13	SS	14		196										
			14	TW	PH		194										
							192										
							190										19.3
188.3																	

30.2

Continued

+3, x5: Numbers refer to
Sensitivity

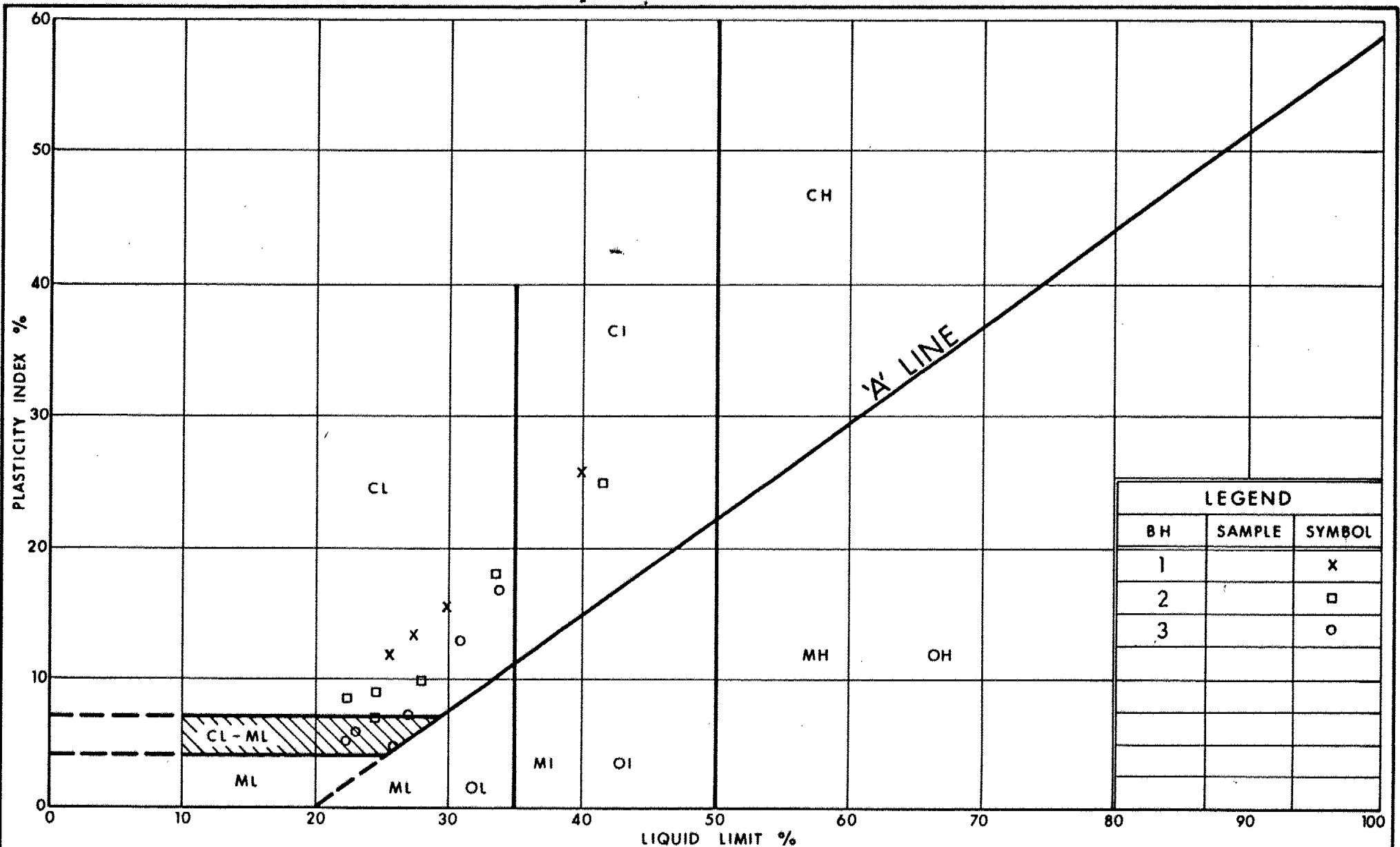
20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 Cont. (Formerly B.H. #5)

METRIC

W P 66-67-03 LOCATION _____ ORIGINATED BY MK
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY _____
 DATUM Geodetic DATE 76 03 15/16 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 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		
188.30																
30.20	Silty clay		15	SS	12	188										
						186										
			16	TW	PH	184										
						182										
181.5	Some sand and gravel		17	SS	38											
37.0	End of Borehole Probable Bedrock															



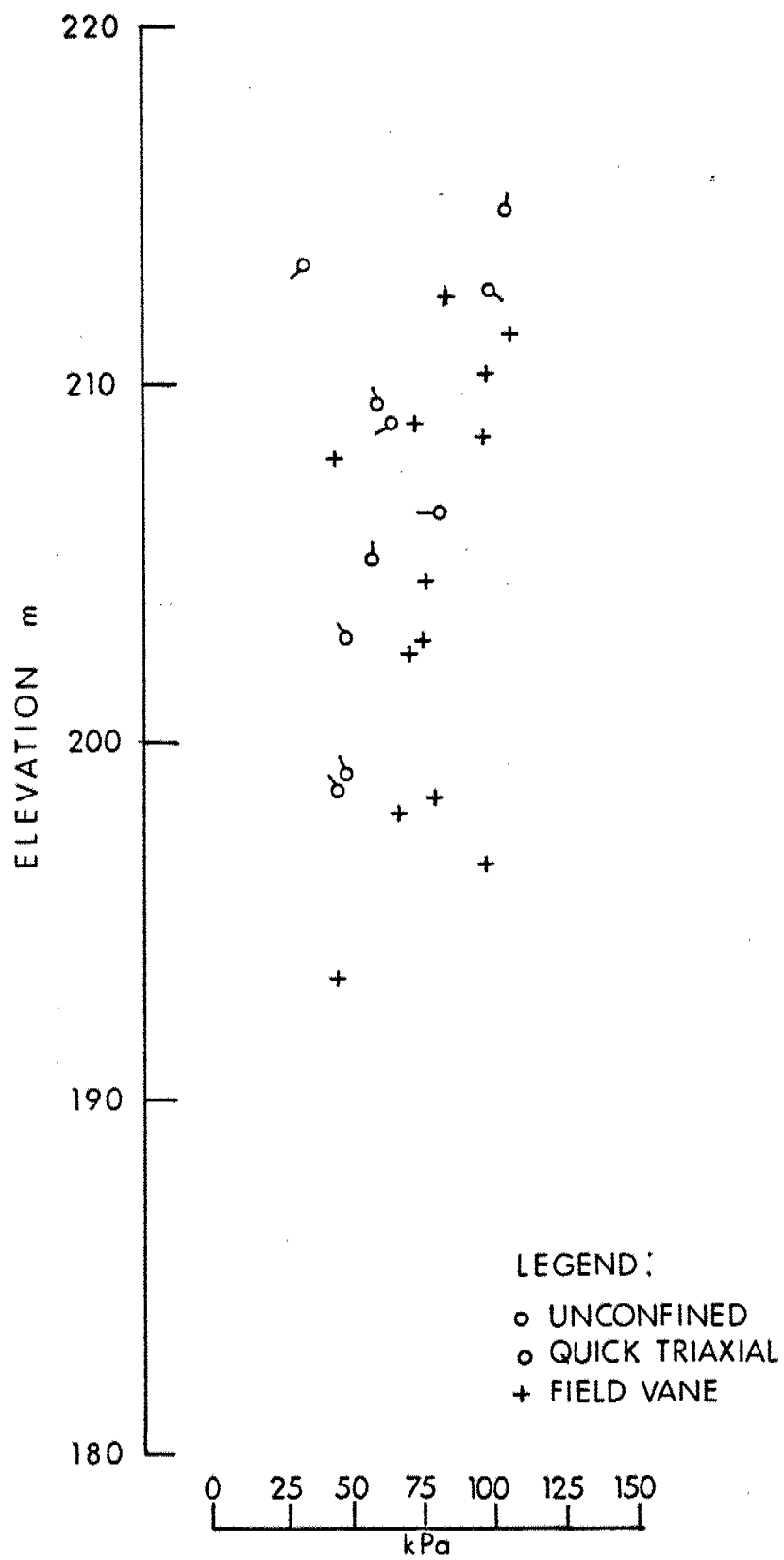
Ministry of
Transportation and
Communications

Ontario
ENGINEERING SERVICES BRANCH

PLASTICITY CHART SILTY CLAY STRATIFIED TRACE OF SAND

FIG No 1

W P 66-67-03



SHEAR STRENGTH VS ELEVATIONS

FIG 2

W.P. 66-67-03

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 / 0.3 m)	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

STRESS AND STRAIN

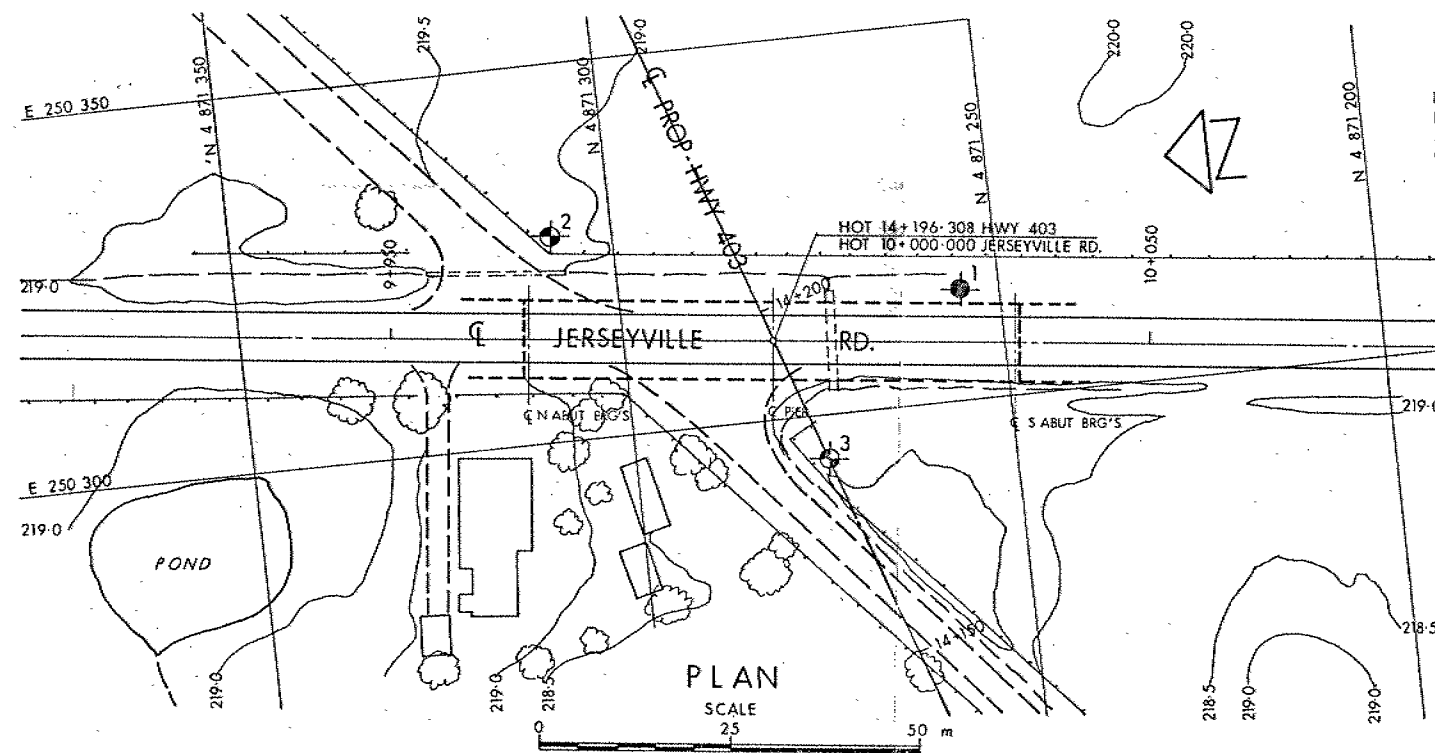
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

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 = $\frac{c_u}{\tau_r}$

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						



METRIC

NOTE:
DIMENSIONS ARE IN METERS
AND/OR MILLIMETERS UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

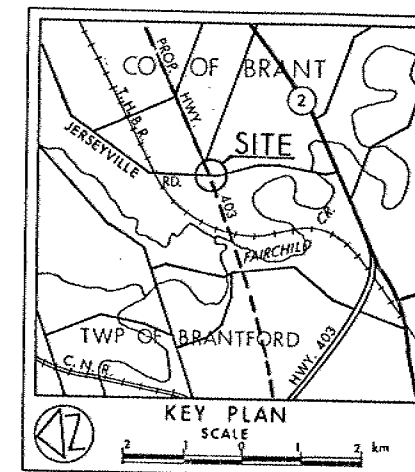
CONT No
WP No 66-67-03

HWY 403 & JERSEYVILLE RD.
UNDERPASS





BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

-  Bore Hole
 Dynamic Cone Penetration Test (Cone)
 Bore Hole & Cone
 N Blows/0.3m {Std Pen Test, 475 J/blow}
 CONE Blows/0.3m {60° Cone, 475 J/blow}
 WL at time of investigation
 BH No 1 79 07 26/27
 BH No 3 76 03 15/16
 NO WL Established BH No 2

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	218.7	4 871 255.0	250 314.0
2	219.0	4 871 308.0	250 326.6
3	218.5	4 871 274.1	250 292.6

NOTE

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

[illegible]

Geocres No 40PI-77

HWY No 403		DIST 4
SUBM'D P. P. CHECKED	DATE 79 12 14	SITE 1-190
DRAWN L. J. CHECKED	APPROVED	DWG 2