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W.P. No. 135-94-01

CONT. No.

W. O. No.

STR. SITE No. 6-37

HWY. No. 2

LOCATION Hwy 2 & Ruscom River

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ontario

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FILE No. ______________ **DATE** ______________

REMARKS Pete A. Bifolchi

1) Talked to John Schefer on 95/08/31 regarding bore hole elevations.

ADM-G-24 91-02

Made from recovered materials   Fait de matériaux récupérés

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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP	135-94-01	DIST	32
HWY	2	STR SITE	6-37

Ruscom River Replacement Bridge

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GEOCRES 40J7-21 DATE JUN 05 1996

FOUNDATION INVESTIGATION REPORT

For

Ruscom River Replacement Bridge

W.P. 135-94-01; Site 6-37

Highway 2, District 32, Chatham

INTRODUCTION

This report contains the results of a foundation investigation carried out at the crossing of Highway 2 and Ruscom River. The fieldwork was carried out between 1995 07 24 and 1995 08 01, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to both of these holes.

Boreholes were advanced to a maximum depth of 36.1 m (El. 142.1) below the existing ground level using a 82 mm I.D. continuous flight hollow stem auger as well as BW casing.

SITE DESCRIPTION

The site under investigation is located at the crossing of Highway 2 and Ruscom River, approximately 7 km southeast of Belle River East Limits in theTownship of Rochester, County of Essex. The surrounding area is generally flat and cultivated farmland.

The river banks are almost vertical and about 3.5 m deep at this crossing. The width of the river along the centreline of Highway 2 is approximately 26 m and during peak flood, the depth of the water is expected to about 2.0 m at the deepest location.

The topography of the site is generally flat. Physiographically, the area is located in the region known as the "St. Clair Clay Plain". Adjoining the Lake St. Clair in Essex and Kent Counties are extensive clay plains covering several hundred square kilometres. Limestone bedrock underlies Essex County and the adjacent part of Kent County, while the remainder of the region is underlain by a black shale. The subsoil at this site is a clayey material deposited during the Wisconsin glacial stage of the Pleistocene Epoch. The bedrock underlying the clayey soil is a limestone of Devonian and Mississippian Age.

SUBSURFACE CONDITIONS

General

Generally uniform subsoil conditions were found to prevail over the project area. The underlying subsoil at this site consists of 0.8 m granular fill underlain by 28.7 m to 30.0 m very stiff to firm silty clay to clayey silt with occasional silty sand layers varying in thickness from a minimum of 0.8 m to a maximum of 1.7 m. The clayey deposit is underlain by 1.7 to 2.7 m very dense heterogeneous mixture of silt, sand and gravel (glacial till), which overlies the limestone bedrock of the Dundee Formation. For classification purposes, the soils encountered at this site can be divided into five different zones.

a) Silty Sand with Gravel (Granular Fill)
b) Silty Clay to Clayey Silt, Trace of Sand, Trace of Gravel
c) Silty Sand, Trace of Gravel
d) Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)
e) Limestone Bedrock

The subsurface conditions 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 section is shown on Drawing No. 1359401-A. This drawing also shows the location and elevation of the borings. Description of the strata encountered are given below.

Silty Sand, with Gravel (Granular Fill)

This fill which was placed to raise the finished grade of Highway 2 was encountered only in Borehole No. 1 and consists of compact silty sand with gravel. The thickness was observed to be about 0.8 m.

Silty Clay to Clayey Silt, Trace of Sand, Trace of Gravel

The granular fill is underlain by this silty clay to clayey silt with trace of sand and gravel. The thickness of this deposit varies from a 28.7 m to 30.0 m and extends to elevations 148.0 to 147.0. The natural moisture content varies from 19.5% to 27.5% with an average value of 23.5%. The Atterberg Limits determined for the representative samples of this deposit are shown on Figure 1. The in-situ vane shear strength of upper 5.0 m of this deposit (i.e. above El. 173.0) was observed to be in excess of 100 kPa, and below this depth, the Vane Shear Test results vary from a minimum of 38 kPa to a maximum of 69 kPa. The Standard Penetration Test results vary over a wide range (4 blows/0.3 m to 26 blows/0.3 m). Based on these test results, this deposit may be classified as very stiff to firm.

The bulk density from a undisturbed sample was observed to be in the order of 20.1 kN/m^3 and corresponding dry density being 16.2 kN/m^3. The results of the Consolidation Test carried out to determine the compressibility characteristics of this deposit are shown on Figures 2 and 3. The test results indicate that this deposit is slightly over consolidated with preconsolidation pressure of 130 kPa compared to effective overburden pressure of 100 kPa.

Silty Sand, Trace of Gravel

This silty sand layer is sandwiched in the silty clay to clayey silt deposit and encountered at various depths. The thickness of this layer varies from a minimum of 0.8 m to a maximum of 1.7 m. The results of the Gradation Test carried out on representative soil samples are shown on Figure 4. The test results indicate that this deposit is predominantly composed of sand (62% to 71%) and silt (29% to 38%). The Standard Penetration Test results indicate very loose to loose state of denseness.

Heterogeneous Mixture of Silt, Sand & Gravel (Glacial Till)

The upper boundary of this deposit was encountered between El. 148 and El. 147.0. The thickness of this glacial deposit varies from 1.7 m to 2.7 m and extends to elevation 145.3. Gradation Test was carried out only on one sample and the test result is shown on Figure 5. The Standard Penetration Test results (78 blows/0.3 m to over 100 blows/0.3 m) indicate very dense state of denseness.

Limestone Bedrock

The rock cores were obtained using BXL core barrel and the description of the bedrock is included in the Appendix of this report.

The bedrock was encountered at about elevation 145.3. Based on the RQD values measured from BX cores, the quality of the bedrock may be described as good to excellent (RQD-Values 72% to 100%). The bedrock at this site may be classified as slightly weathered to unweathered limestone of the Dundee Formation.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during the investigation and was observed between elevations 174.2 and 172.8. The water level in the river was observed at about elevation 175.3. Seasonal fluctuation of the groundwater level may be expected due to the influence of the river. The goundwater level at each borehole is as follows:

Borehole No.	Elevation	Remarks
1	174.2	
2	172.8	Not stabilized

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to replace the existing concrete bridge at the crossing of Highway 2 and Ruscom River. The following alternatives are under consideration for the replacement structure.

1) A single span 28.0 m long structure consisting of steel girder with composite concrete deck and integral type abutments. The profile grade will be set approximately 600 mm higher than the existing grade, i.e. approximately at elevation 179.0 (Option 1).

2) Two span, each 16.0 m long rigid frame concrete structure with profile grade elevation 178.4 which is same as the existing grade (Option 2).

The new structure will be constructed along the same horizontal alignment as the existing bridge. The following alternatives are under consideration for the diversion of the traffic during construction.

1) A single lane Bailey Bridge detour located 12 m south of the existing structure.
2) A local detour west of the crossing of Highway 2 and Ruscom River.

The existing bridge is a single span cast-in-place reinforced concrete structure. The clear span between the face of the abutments is about 26.0 m. No major settlement problems or distresses have been identified in the structure or in the approaches. However, the reinforcement of the deck has been exposed and corroded at several location. In addition, voids have been created at the underside of the deck due to the spalling of concrete.

The existing bridge was built in 1929, however, information about the foundation or structural drawing is not available.

Structure Foundation

Considering the subsoil conditions at the site, it is recommended that the structure for both options be supported on HP 310 x 110 steel H-piles driven to bedrock which will be encountered at elevation 145.3.

The geotechnical capacity will not govern for the piles driven to competent bedrock and it may be designed assuming the factored structural capacity. Further, the pile shall be considered laterally supported below the existing ground level as well as the river bed.

The option 1 may require determination of contraflexture point and for this purpose, the following coefficient of horizontal subgrade reaction values are recommended.

Elevation	Subgrade Reaction (kN/m^3)
177.5 - 173.0	21,600
173.0 - 147.0	9,800
147.0 - 145.3	130,000

Considering the span of the integral abutments type structure (28 m) and the nature of the soil below the pile cut-off level, pre-augered holes with loose sand backfilling may not be required at the abutment locations.

Boulders were encountered below elevation 146.5. In view of this, the pile tips should be reinforced with driving shoes as per MTO Standard DD-3301.

Bailey Bridge Foundation

There is no detail available regarding the duration of the detour, however, if it is proposed to be temporary during the summer months, the foundation may be placed at about elevation 177.0 after removing all the spongy and soft area observed within the base width of the footing. The following bearing capacity values are recommended for the design of the bailey bridge supported on conventional timber crib or equivalent abutments founded at a level not higher than El. 177.0

Factored Bearing Capacity at U.L.S.	=	250 kPa
Bearing Capacity at S.L.S.	=	150 kPa

However, appropriate frost cover (1.2 m) shall be provided to the footings, should the foundation exist in the winter months.

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.

	Granular 'A'	Granular 'B'
Angle of Internal Friction	$\phi = 35^0$	$\phi = 30^0$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.2$

Approach Embankment

The proposed finished grade of the replacement bridge will be either identical to that of the existing or 600 mm higher. No major instability problems are anticipated for the approach embankment constructed with 2H:1V side slope. The fill should consist of well compacted acceptable material. The topsoil as well any spongy or soft area observed within the base width of the embankment should be removed before placing the fill.

Other Considerations

In view of the impervious nature of the subsurface conditions at this site, no major dewatering problems are anticipated at the abutment locations. Any minor seepage or surface run-off into the excavation may be readily handled by pumping from the sump. Care shall be excercised during construction to prevent any flow of water from the river into the excavation.

However, in the case of Option 2, the pile cap will have to be constructed below the river water level, and for this purpose, a dewatering scheme consisting of cofferdam will be required.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Vasavithasan, Foundation Engineer and P.A. Bifolchi, Engineering Student. The equipment used was owned and operated by London Soil Test Limited. This report was prepared by M. Vasavithasan, Foundation Engineer and reviewed by T.C. Kim, Senior Foundation Engineer.

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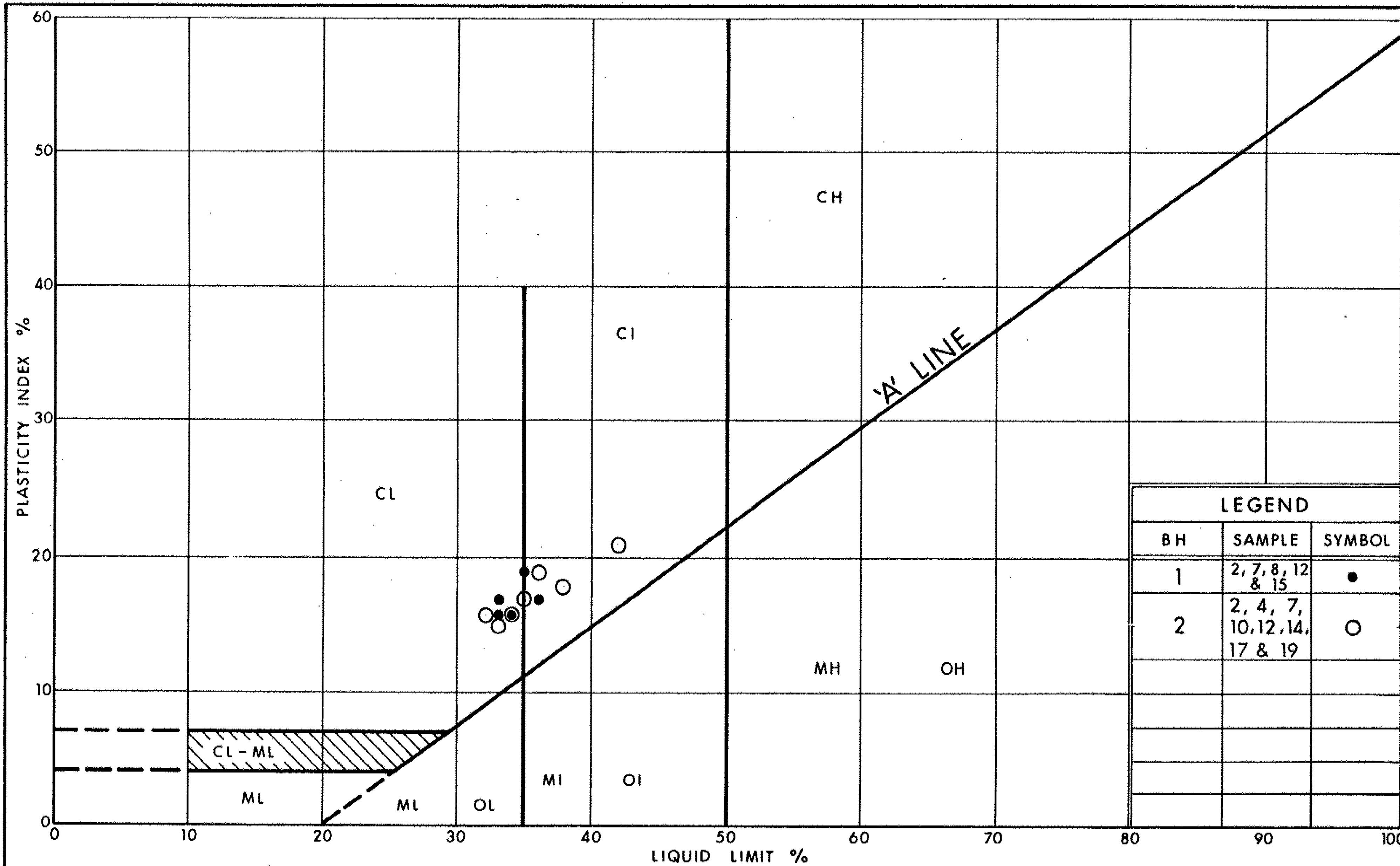
APPENDIX

Oct 75, FF-S-21



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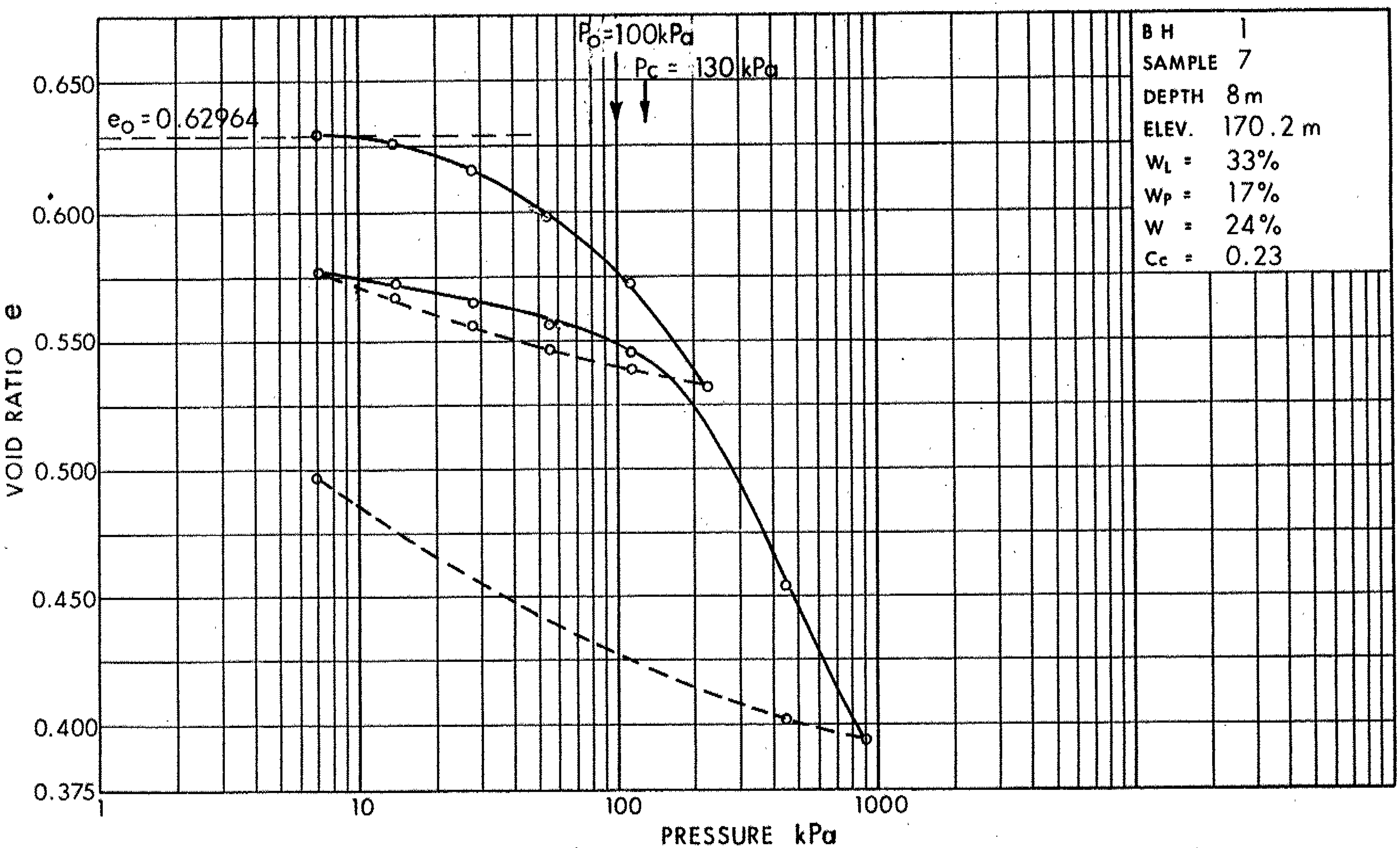
PLASTICITY CHART
SILTY CLAY TO CLAYEY SILT

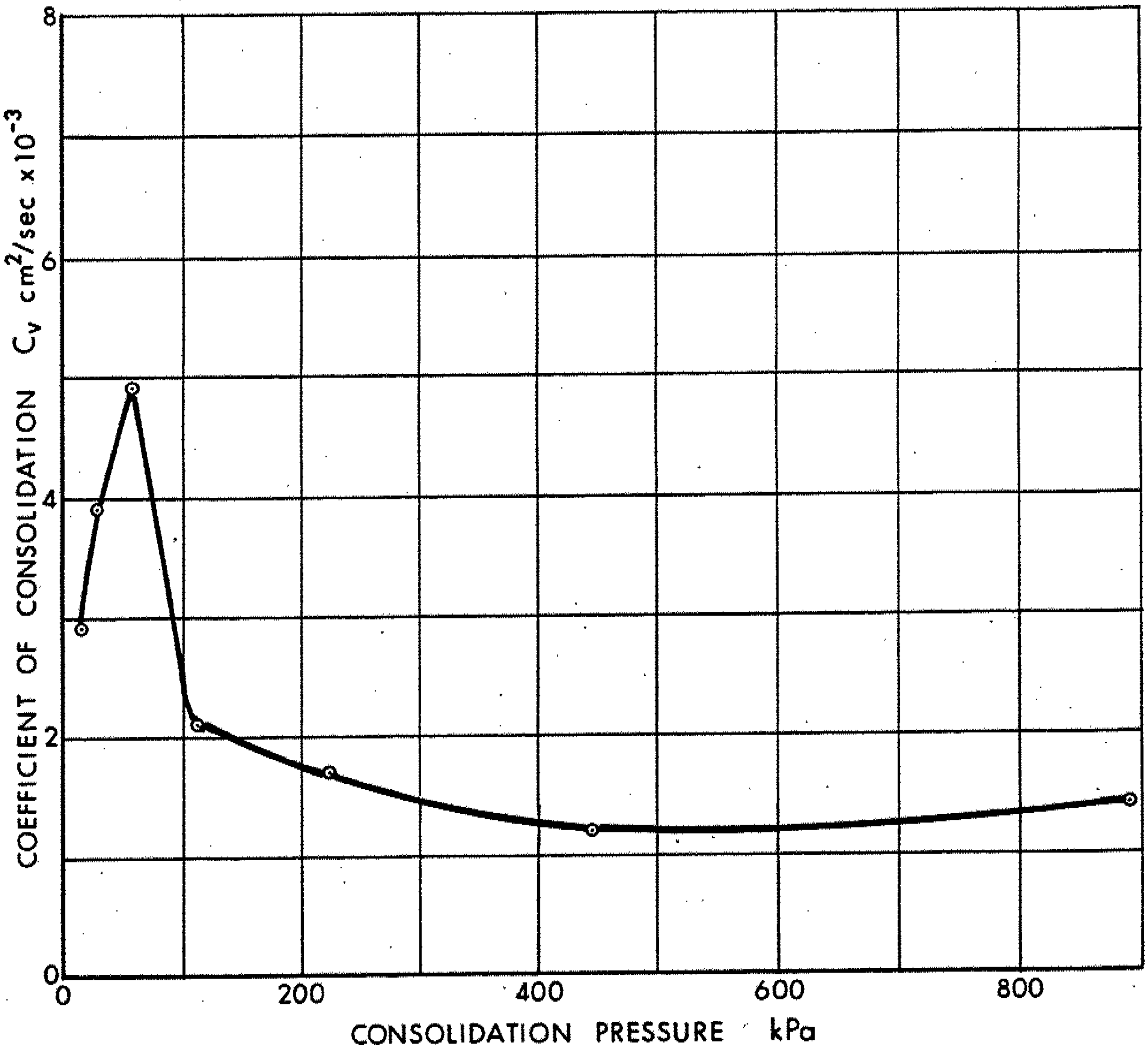
FIG No 1
W P 135 - 94 - 01

VOID RATIO - PRESSURE CURVE



WP 135-94-01

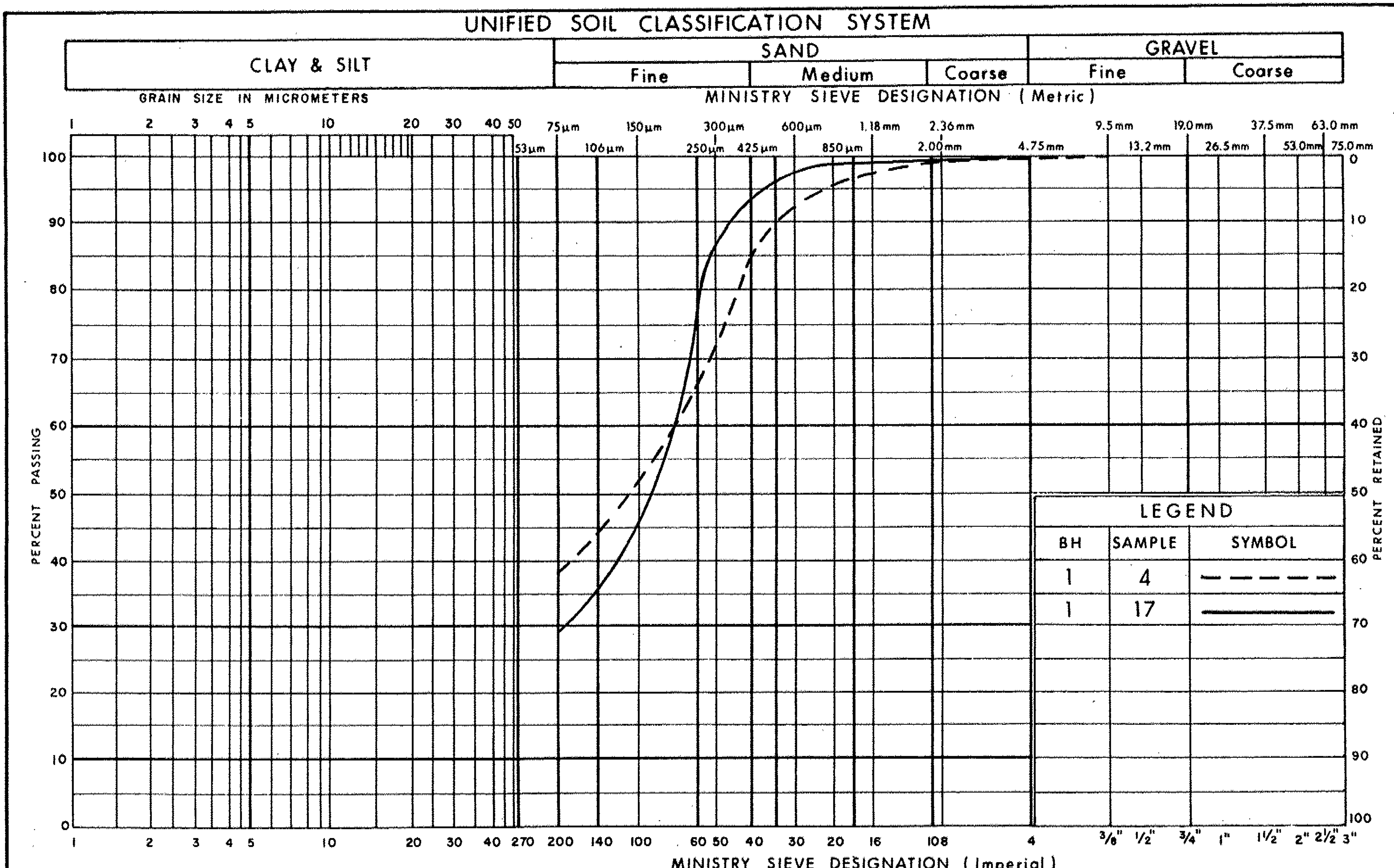
FIG No 2



COEFFICIENT OF CONSOLIDATION
Vs
CONSOLIDATION PRESSURE

FIG 3
WP 135-94-01

78 12 M



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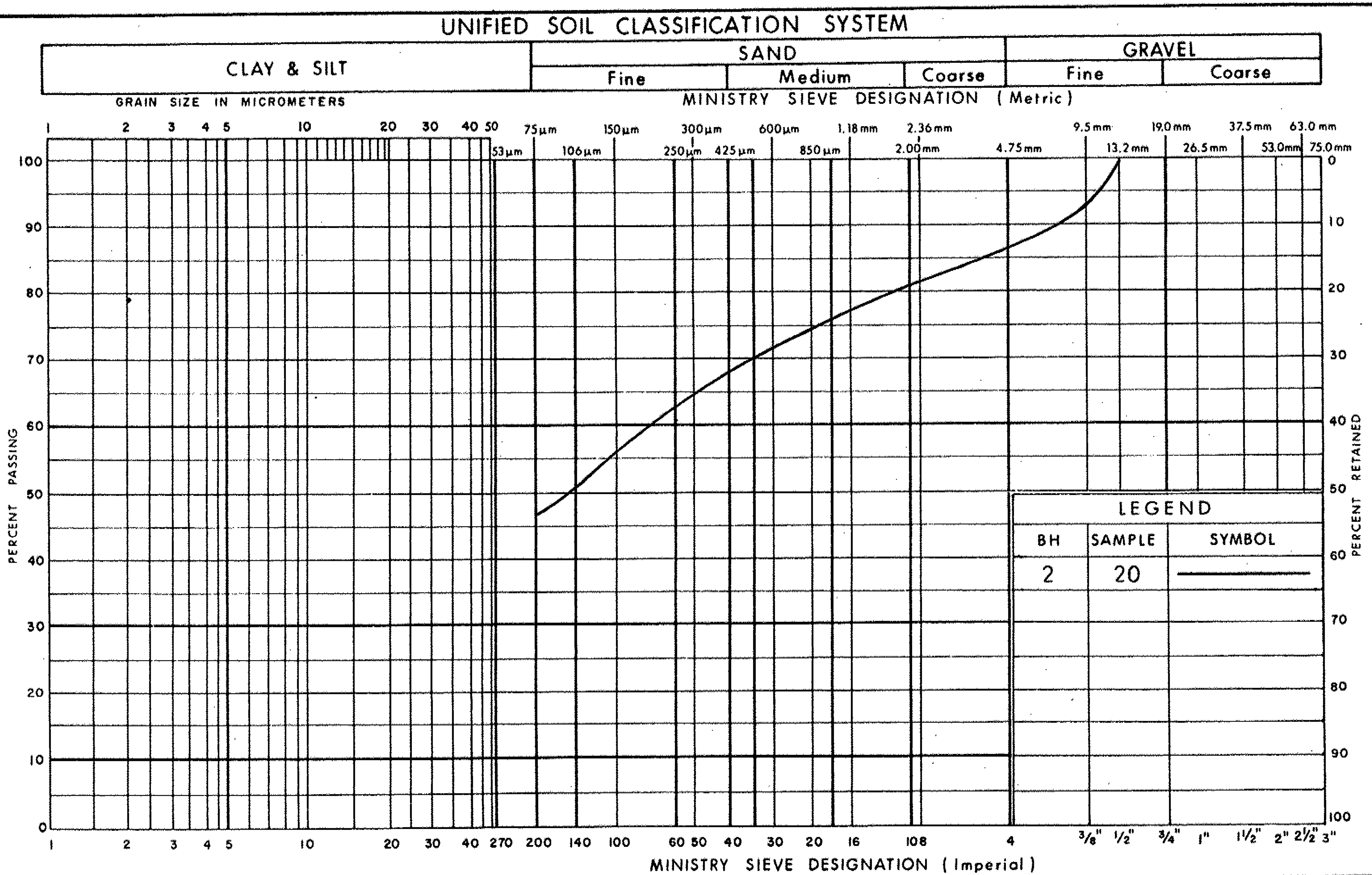
GRAIN SIZE DISTRIBUTION
SILTY SAND

FIG No 4
W P 135-94-01

78 12 M



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GRAIN SIZE DISTRIBUTION

HET MIXTURE OF

SILT, SAND & GRAVEL (Glacial Till)

FIG No 5

W P 135 -94-01

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RECORD OF BOREHOLE No 1

METRIC

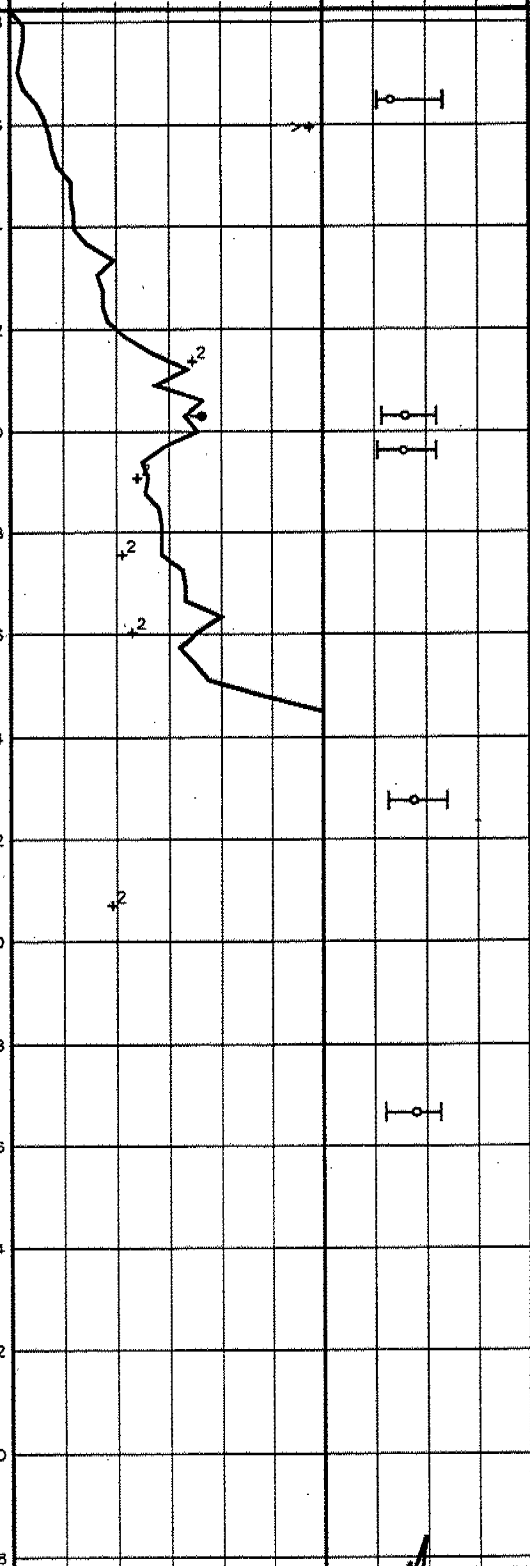
W.P. 135 - 94 - 01	LOCATION Sta 19+113.3, o/s 5.5 m Lt C/L Hwy 2		ORIGINATED BY M V&P B
DIST 32	HWY 2	BOREHOLE TYPE HOLLOW STEM AUGER, BW CASING & CONE TEST	COMPILED BY M V&P B
DATUM GEODETIC		DATE 1995 07 27 TO 1995 08 01	CHECKED BY T C K

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
178.2	Hwy.2 Shoulder
0.0 / 177.4	SILTY SAND, With Gravel, Compact (Granular Fill)
0.8 – 173.7	SILTY CLAY TO CLAYEY SILT, With Sand, Trace of Gravel, Very Stiff to Stiff
4.5 – 172.0	SILTY SAND, Trace of Gravel, Very Loose to Loose
6.2 – 147.7	SILTY CLAY TO CLAYEY SILT, Trace of Sand, Trace of Gravel, Firm to Stiff (Silty Sand layer near sample 17)
30.5	Continued

SAMPLES

NUMBER	TYPE	'N' VALUES
1	SS	5
2	SS	7
3	SS	8
4	SS	3
5	SS	5
6	SS	6
7	TW	PH
8	SS	4
9	TW	PH
10	SS	5
11	SS	8
12	SS	12
13	SS	6
14	SS	9
15	SS	8
16	SS	11
17	SS	15



UNIT WEIGHT / REMARKS & GRAIN SIZE DISTRIBUTION (%)

Sample	Unit weight γ (kN/m³)	GR	SA	SI	CL
2		4	39	(57)	
4		0	62	(38)	
7	20.1	Pc = 130 kPa, Cc = 0.23, e = 0.63			
12		1	13	(86)	
17		0	71	(29)	

Continued

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

15-◇-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Continued

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 1

METRIC

W.P. 135 - 94 - 01 LOCATION Sta 19+113.3, o/s 5.5 m Lt C/L Hwy 2 ORIGINATED BY M V&P B

DIST 32 HWY 2 BOREHOLE TYPE HOLLOW STEM AUGER, BW CASING & CONE TEST COMPILED BY M V&P B

DATUM GEODETIC DATE 1995 07 27 TO 1995 08 01 CHECKED BY T C K

ELEV DEPTH	DESCRIPTION (SOIL PROFILE)	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L — WATER CONTENT (%) 15 30 45	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
147.7	Continued									
30.5	SILTY CLAY TO CLAYEY SILT, Trace of Sand and Gravel, Stiff	18	SS	15						
31.2	Het. Mix. of SILT, SAND & GRAVEL, Very Dense (Glacial Till) Boulders					146				
145.3 / 32.9	LIMESTONE BEDROCK, Slightly Weathered to Unweathered	19	RC BX	REC 100%		144				RQD 94%
		20	RC BX	REC 99%						RQD 99%
142.1 / 36.1	End of Borehole									

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

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC

W.P. 135 – 94 – 01
LOCATION Sta 19+152.3, o/s 10.1 m Rt C/L Hwy 2
ORIGINATED BY M V&P B

DIST 32 HWY 2
BOREHOLE TYPE HOLLOW STEM AUGER, BW CASING & CONE TEST
COMPILED BY M V&P B

DATUM GEODETIC
DATE 1995 07 24 TO 1995 07 26
CHECKED BY T C K

SOIL PROFILE

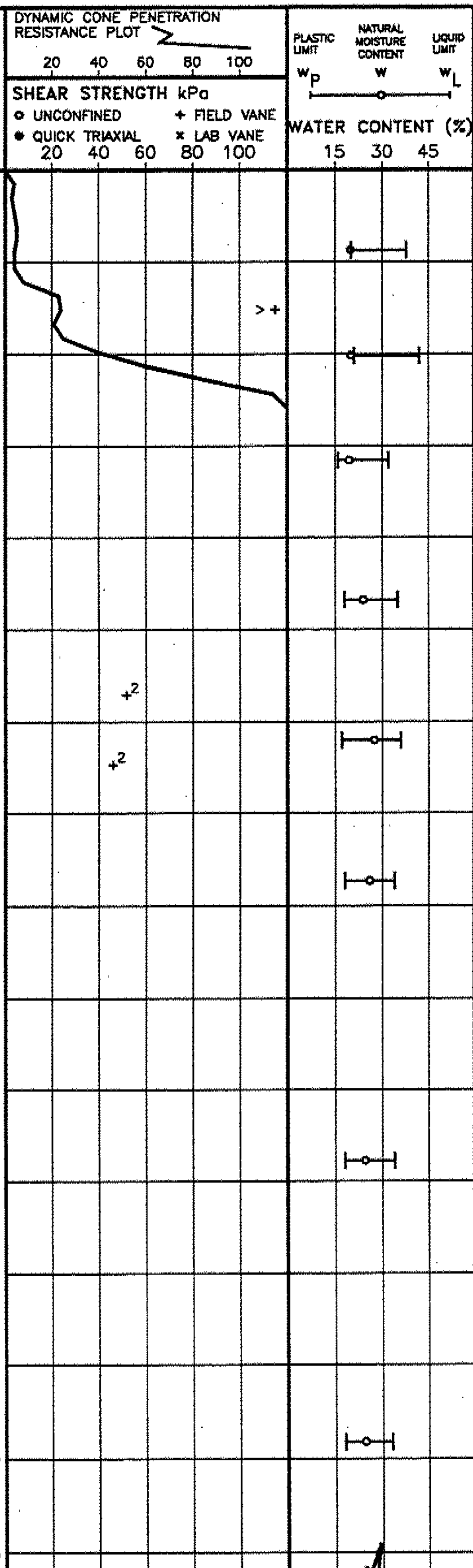
ELEV / DEPTH	DESCRIPTION
178.0	Ground Surface
0.0	Topsoil
	SILTY CLAY TO CLAYEY SILT, Trace of Sand, Trace of Gravel, Very Stiff to Stiff
	Silty Sand
148.0 / 30.0	(Glacial Till)
30.5	

SAMPLES

NUMBER	TYPE	'N' VALUES
1	SS	9
2	SS	9
3	SS	5
4	SS	26
5	SS	25
6	SS	16
7	SS	17
8	SS	22
9	SS	16
10	SS	14
11	SS'	9
12	SS	10
13	SS	21
14	SS	17
15	SS	16
16	SS	18
17	SS	16
18	SS	21
19	SS	17

GROUND WATER CONDITIONS: water level symbol (*) at approx. elevation 172.7

ELEVATION SCALE: 176, 174, 172, 170, 168, 166, 164, 162, 160, 158, 156, 154, 152, 150, 148



UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

Elev.	GR	SA	SI	CL
~174	1	11	(88)	
~172	3	10	(87)	
~150	1	16	(83)	

Continued

Continued

+³, ×⁵ : Numbers refer to Sensitivity

15-◇-5 (%) STRAIN AT FAILURE (20 above, 10 below)

RECORD OF BOREHOLE No 2

 METRIC

W.P. 135 - 94 - 01	LOCATION Sta 19+152.3, o/s 10.1 m Rt C/L Hwy 2	ORIGINATED BY M V&P B
DIST 32 HWY 2	BOREHOLE TYPE HOLLOW STEM AUGER, BW CASING & CONE TEST	COMPILED BY M V&P B
DATUM GEODETIC	DATE 1995 07 24 TO 1995 07 26	CHECKED BY T C K

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
147.5	Continued						
30.5	Heterogeneous Mixture of SILT, SAND and GRAVEL, Very Dense (Glacial Till)	20	SS	78			13 41 (46)
145.3		21	SS	100/5cm		146	
32.7	LIMESTONE BEDROCK, Slightly Weathered to Unweathered	22	RC BX	REC 75%		144	RQD 72%
142.4		23	RC BX	REC 100%			RQD 100%
35.6	End of Borehole * Note: Water Level Not Stabilized						

Dynamic cone penetration resistance plot: 20 40 60 80 100. Shear strength kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100. Plastic limit w_P, natural moisture content w, liquid limit w_L; WATER CONTENT (%) 15 30 45. UNIT WEIGHT γ kN/m³.

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

15-◇-5 (20 above, 10 below) (%) STRAIN AT FAILURE

ROCK CORE DESCRIPTION
WP 135-94-01

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	1	32.92-34.49	100	94	32.92-36.07	**LIMESTONE** with stylolites and fossils (corals and crinoids), pale yellowish brown to medium light grey (matrix) to very light grey to white (fossils); fine to medium grained; medium strong to strong; unweathered to slightly weathered; fractures moderate to close spaced, flat to dipping, undulating, smooth to rough.
	2	34.49-36.07	99	99		
2	1	32.74-34.27	75	72	32.74-35.59	**LIMESTONE** with stylolites and fossils (corals and crinoids), pale yellowish brown to medium light grey (matrix) to very light grey to white (fossils); fine to medium grained; medium strong to strong; unweathered to slightly weathered; fractures moderate to close spaced, flat to dipping, undulating, smooth to rough.
	2	34.27-35.59	100	100		

***CR** = CORE RECOVERY
***RQD** = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%

Logged by: DAW, Soils and Aggregates Section

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 (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

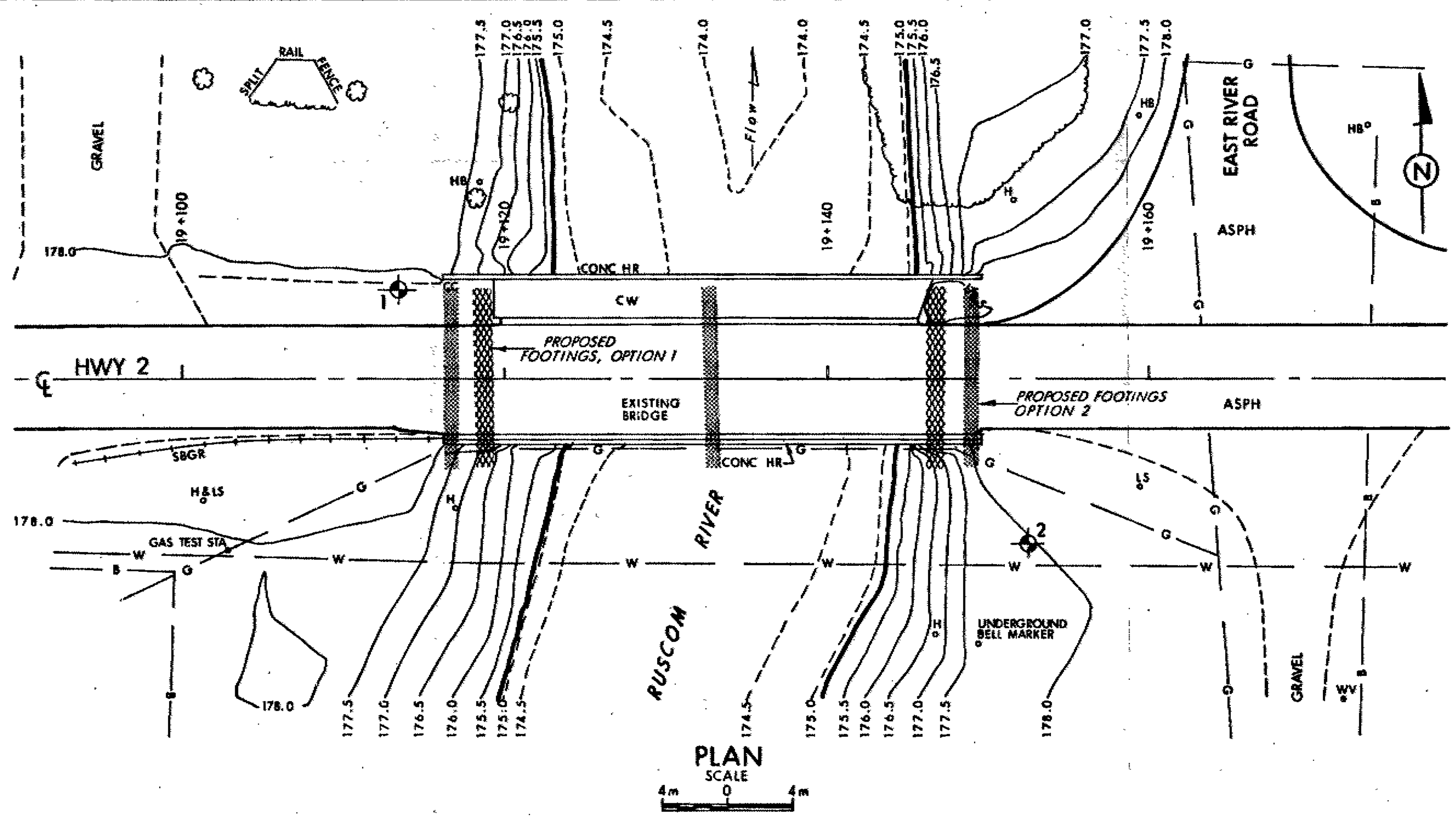
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

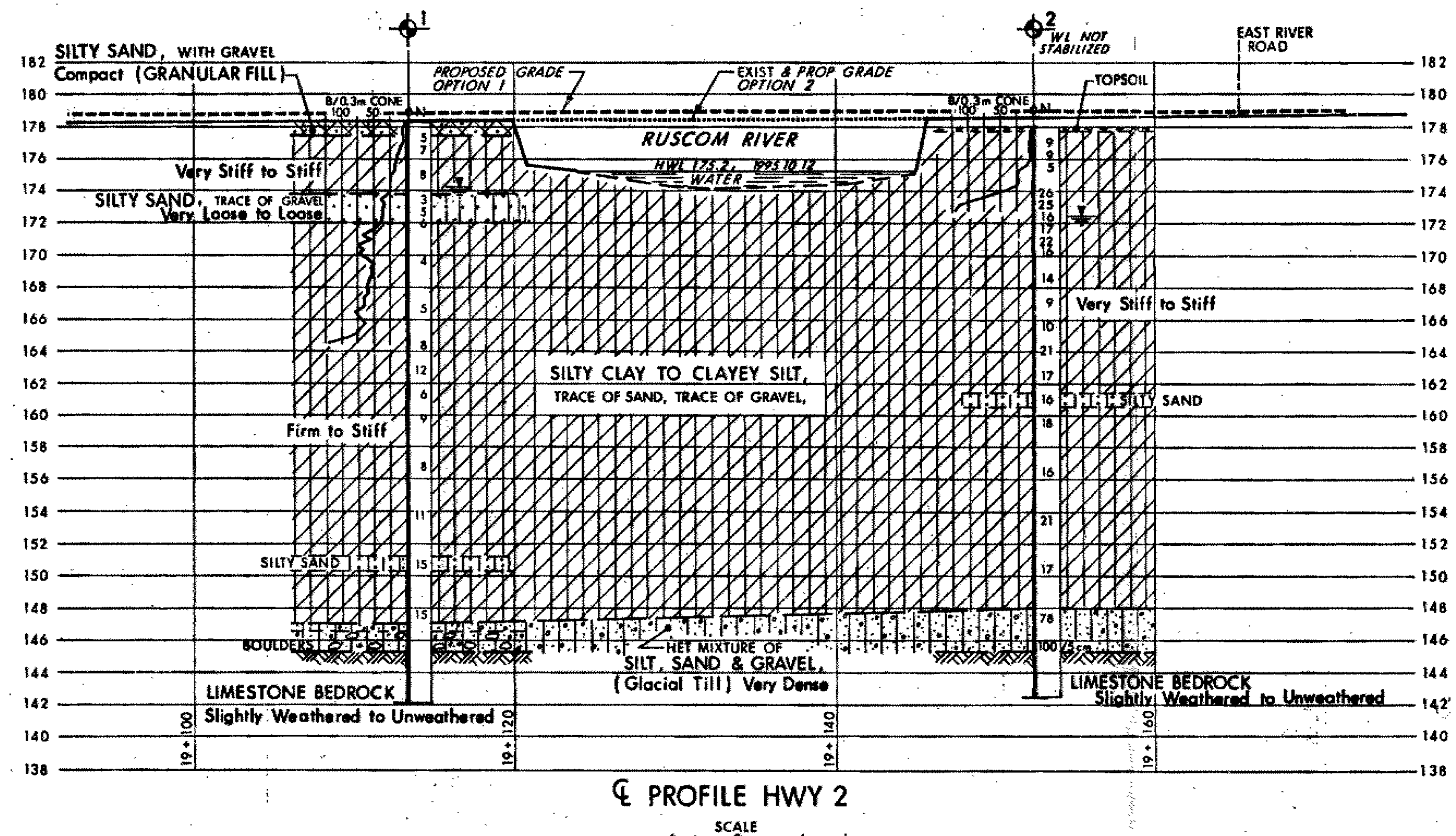
MECHANICAL PROPERTIES OF SOIL

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





REF No E-107-2-1, 1996 01

METRIC

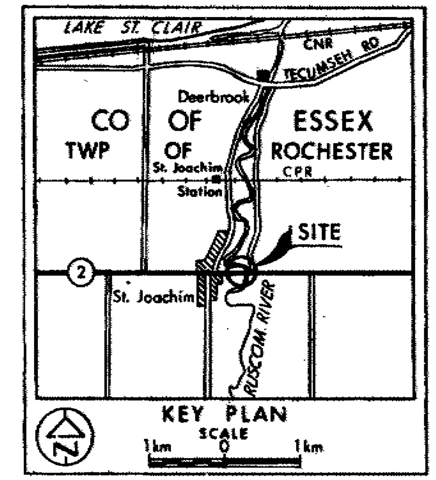
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 135-94-01

RUSCOM RIVER

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1995 07 and 08

No	ELEVATION	STATION	OFFSET
1	178.2	19+113.3	5.5m LT
2	178.0	19+152.3	10.1m RT

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

Geocres No 40J7-21

HWY No 2			DIST 32
SUBM'D MV	CHECKED	DATE 1996 04 23	SITE 6-37
DRAWN RS	CHECKED	APPROVED	DWG 1359401-A