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GEOCRES No. 30M15-60

DIST. 7 REGION

W.P. No. 7-79-07

CONT. No. 85-39

W. O. No.

STR. SITE No. 21-431

HWY. No. 35/115

LOCATION Fifth line underpass

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 85-39



Ministry of
Transportation and
Communications

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NOTE: For the purposes of this Contract, these reports supersede all other foundation investigation reports prepared by or for the Ministry in connection with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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

FOUNDATION INVESTIGATION REPORT

FOR

Fifth Line Underpass
8.6 km North of Highway 401
W. P. 7-79-07, Site 21-431
Highway 35/115, District 7, Port Hope

The results of a foundation investigation program carried out at the above-mentioned structural site between 81 05 27 and 81 05 28 are presented in this report. A total of 4 sampled boreholes were advanced by means of continuous flight augers for depths varying from 9.5 to 13.9 metres below ground surface.

Site Description and Geology

The site is located on Highway 35/115 some 700 metres south of the existing Clarke 5th Line Concession Road (Station Street), in the Town of Newcastle, Regional Municipality of Durham.

The topography across the site is gently undulating with the predominate land use being for commercial mixed farming and grain crops.

Physiographically, the site is located on the South Slope Region which is characterized in this area by surficial fine sands and silt overlying highly calcareous sandy glacial tills.

Subsurface Conditions

Briefly, the site is underlain by a surficial deposit of silty sand to sandy silt encountered for a maximum depth of 5.2 metres. Underlying this surficial granular deposit and explored for a maximum thickness of 11 metres is a glacial till composed of a slightly plastic silt to silty clay of low plasticity with sand and a trace of gravel.

Bedrock was not encountered in any of the borings at the site.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized borehole water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on borehole data, are shown on Drawing No. 2 of the Contract Drawings for this project.

The various soil types encountered are briefly described in the following paragraphs.

Silty Sand to Sandy Silt

The site is underlain by a surficial glacio-fluvial deposit consisting of a silty sand to sandy silt with traces of clay and gravel. This deposit was encountered for depths ranging from 2.9 to 5.2 metres. Typical gradation curves plotted in envelope form are shown on Figure 1.

The denseness of this stratum based on interpretation of 'N' values indicates a range from loose to very dense, but generally very dense throughout.

Silt to Silty Clay (Glacial Till)

The predominant deposit underlying the site, and explored to a maximum depth of 13.9 metres is an overconsolidated glacial till deposit consisting of a slightly plastic silt to silty clay with to some sand and a trace of gravel. Occasional seams and layers of silty sand to sand were encountered throughout this relatively incompressible deposit.

The results of laboratory tests consisting of Atterberg Limit and water content testing are plotted on the plasticity chart, Figure 2 and summarized as follows:

	<u>Range</u>	<u>Average</u>
Water content (W)%	5-13	10
Liquid Limit (W_L)%	13-26	18
Plastic Limit (W_p)%	9-13	11
Plasticity Index (I_p)%	2-15	9

These results indicate the glacial till deposit to be an Inorganic slightly plastic silt to silty clay of low plasticity (ML-CL).

The consistency of this till deposit, as based on interpretation of Standard Penetration Test 'N' values and augering operations, is assessed as ranging from very stiff to hard but generally hard throughout.

Groundwater Conditions

Stabilized borehole water level readings as taken in two boreholes indicated groundwater levels varied from elevation 142.5 at the west abutment location to 144.5 at the east abutment location. This would indicate a gentle east to west gradient in the water levels across the site.

date: 85 02 06

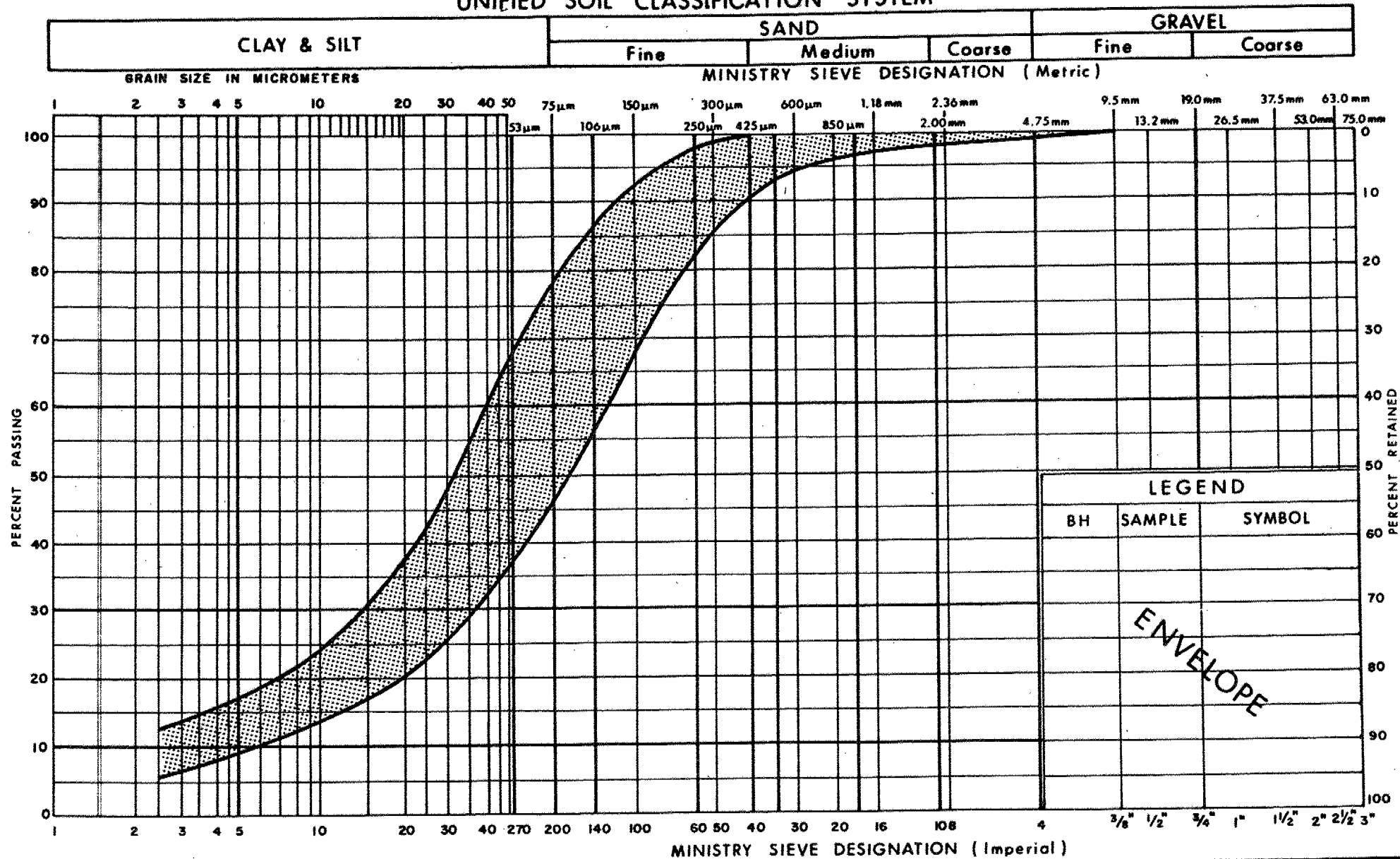


D. H. Dundas

D.H. Dundas, P. Eng.
Foundations Engineer
M.T.C. Foundation Design Sect.

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



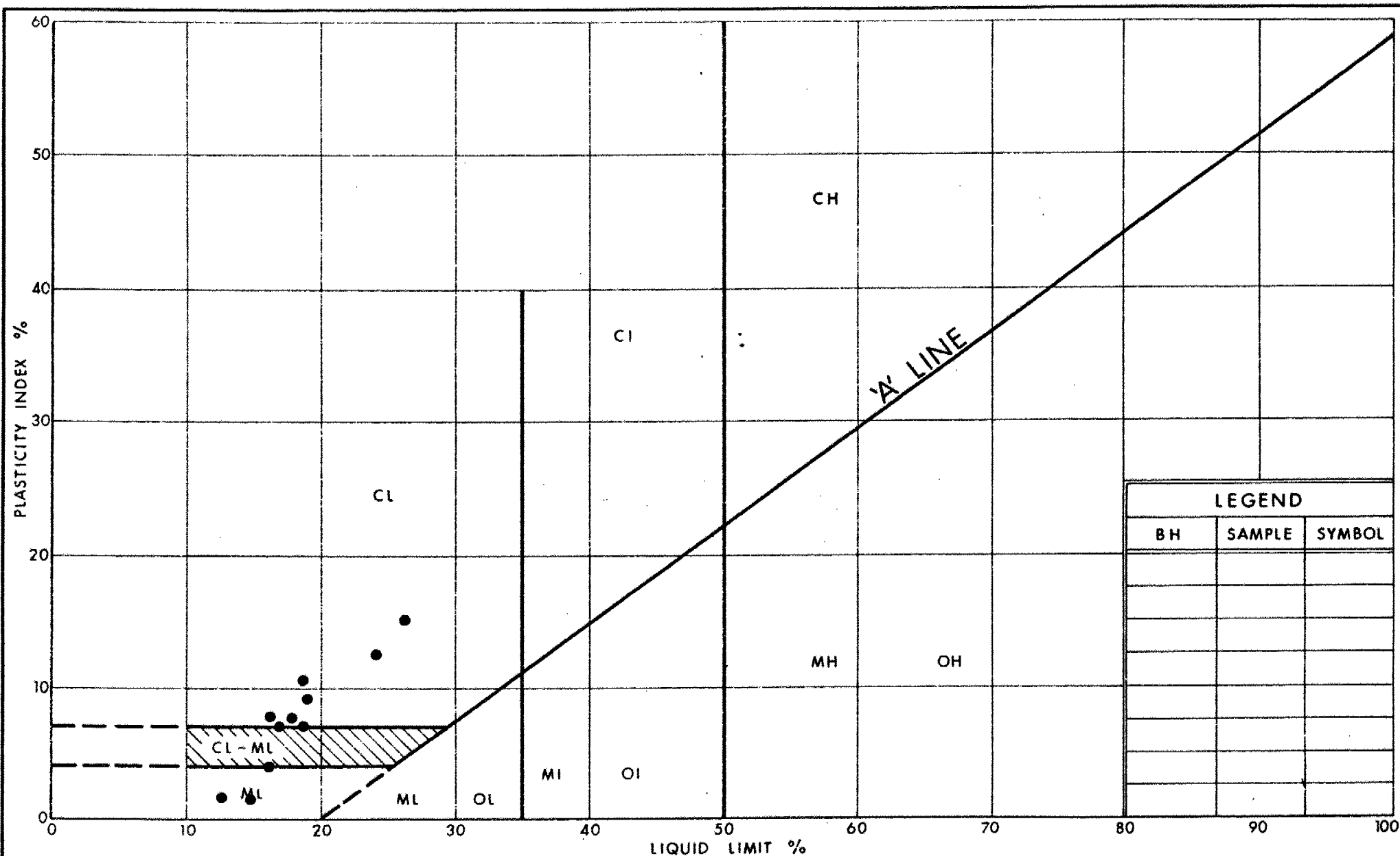
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GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT
TRACE OF CLAY & GRAVEL

FIG No 1

W P 7-79-07



RECORD OF BOREHOLE No 1

METRIC 9

W P 7-79-07 LOCATION Co-ords 4 870 089.8 N; 376 211.8 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 27 CHECKED BY J

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
147.8	Ground Surface													
0.0	Silty sand to sandy silt trace to some clay dense to very dense		1	SS	54		146							0 53 35 12
			2	SS	50									0 51 38 11
			3	SS	37									0 45 50 5
			4	SS	54									0 46 44 10
144.1	Silt to silty clay of low plasticity Some sand Trace of gravel (Glacial Till) Hard		5	SS	100/15	15 cm	144							0 37 52 11
3.7			6	SS	125									
			7	SS	100/12	12 cm	142							
			8	SS	85/12	12 cm	140							
138.3			9	SS	103/20	20 cm								
9.5	End of borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC 10

W P 7-79-07 LOCATION Co-ords 4 870 077.0 N; 376 197.6 E ORIGINATED BY Z M
DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
DATUM Geodetic DATE 81 05 27 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	10						20	30	
147.3	Ground Surface																			
0.0	Silty sand to sandy silt		1	SS	56	*	146						○			11 58 25 6				
	Trace of clay		2	SS	51		144							○		0 33 61 6				
	Trace of gravel																			
	Dense to very dense																			
142.6			3	SS	28		142							○		0 27 64 9				
4.7	Silty clay of low plasticity		4	SS	69		140							○						
	Some sand		5	SS	116	20 cm	140							○		41 15 27 17				
	Varying amounts of gravel		6	SS	100	12 cm														
	(Glacial Till)		7	SS	64	10 cm								○						
			8	SS	100	15 cm	138													
	Hard	9	SS	100	15 cm	136							○							
134.8		10	SS	85	12 cm															
12.5	End of borehole																			
	* Water level was not established																			

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC

11

W P 7-79-07 LOCATION Co-ords 4 870 088.5 N; 376 180.5 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 28 CHECKED BY [Signature]

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							
								SHEAR STRENGTH							
						○ UNCONFINED	+ FIELD VANE								
						● QUICK TRIAXIAL	x LAB VANE								
						WATER CONTENT (%)									

RECORD OF BOREHOLE No 4

METRIC

12

W P 7-79-07 LOCATION Co-ords 4 870 078.0 N; 376 166.8 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 28 CHECKED BY [Signature]

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					
149.3	Ground Surface																
0.0	Silty sand trace of clay		1	SS	6		148										
	Silty clay some sand		2	SS	16												0 12 64 24
	Loose to dense		3	SS	45												0 43 47 10
146.4			4	SS	24		146										0 1 44 55
2.9	Silt to silty clay of low plasticity with sand trace of gravel (Glacial Till)		5	SS	18												
			6	SS	19		144										
	sand trace silt		7	SS	50		142										0 90 (10)
			8	SS	58												
	Sand trace gravel		9	SS	101	23 cm	140										7 79 (14)
	occasional granular layers throughout		10	SS	105	23 cm	138										
	Very stiff to hard		11	SS	100	10 cm	136										
135.4			12	SS	100	15 cm											
13.9	End of borehole																

FOUNDATION INVESTIGATION REPORT

FOR

Regional Road 4 Overpass
W.P. 7-79-08; Site 21-432
Hwy. 35/115, District 7, Port Hope

1.0 INTRODUCTION

Dominion Soil Investigation Inc. was retained by the Ontario Ministry of Transportation & Communications to carry out a geotechnical investigation at the site of the proposed grade separation of Highway 35/115 and Durham Regional Road No. 4.

Authorization to carry out the project was contained in a Memorandum of Agreement dated the 1st. day of June 1981, and bearing the Highway Engineering Division Agreement No. 42-9081-58.

2.0 DESCRIPTION OF THE SITE AND GEOLOGY

The site is located on Highway 35/115 where it crosses Durham Region Road No. 4. It is located approximately 11 km north of Lake Ontario and about 2 km north of the old shoreline of post glacial Lake Iroquois. The terrain has a rolling topography with an overall slope towards the south.

Physiographically the site is located on the "South Slope" which connects the Oak Ridges Morain to the north with the Lake Iroquois plane to the south. Drainage is generally from north to south and the streams have cut steep valleys in the till. In addition, numerous gulleys have been cut by intermittent drainage and each of these gulleys and the valleys have a generally north to south orientation. Drainage to the area is provided by the Wilmot and Orono Creeks both following a southerly course.

The bedrock underlying the area is of Ordovician age and it consists of the Whitby formation which is a black fossiliferous shale with interbedded limestone beds. The surface of the bedrock in the area, however, lies some 70 m or more below the ground surface. The overburden consists of sediments of Pleistocene and Recent age. It is a variety of glacial and glacio-fluvial deposits. The unstratified and unsorted glacial deposits (till) are found in the form of ground and kame morains, and drumlins, whereas the glaciofluvial deposits occur as coarse grained outwash and ice contact sediments deposited by melt water flowing off the ice front into Lake Iroquois.

.../...

3.0 METHOD OF INVESTIGATION

The investigation in the field was carried out during the period of July 29 to August 6, 1981. During this period a total of six exploratory boreholes were drilled with a power auger machine equipped with continuous flight hollow stem augers. To a depth of 9.5 m the subsoil was sampled at 0.75 m intervals and at 1.5 m intervals below, using conventional 50 mm O.D. split spoon sampler. Standard Penetration tests were carried out during sampling.

Following completion of the boreholes, piezometers were installed in three boreholes and sealed into the various strata to permit monitoring of the groundwater level over a longer period of time. The location of the boreholes are shown on Drawing 77908-A,*and the location of the samples, the results of the Standard Penetration tests, and details of the piezometer installations, are shown on the Record of Boreholes presented as Enclosures 1 to 6 inclusive.

The field work was supervised throughout by a member of our engineering staff who located the borings in the field, directed the drilling and sampling operations, and logged the borings.

The elevations of the boreholes were determined by a survey crew of M.T.C. who were at the site when the field work was in progress. The elevations shown on the Record of Boreholes and the geological sections are referred to the geodetic datum.

.../...

* Note: The locations of the boreholes are shown on Drawing No. 2 of the Contract Drawings for this project.

Following field identification all the samples obtained from the boreholes were sealed in air tight jars and were returned to our laboratory for further detailed examination and testing.

The laboratory testing program consisted of sieve and hydrometer analysis, to determine the grain size distribution of the various strata, and the measurement of the natural moisture content of selected representative soil samples. The test results are plotted on the Record of Boreholes and are also presented in the form of Grain Size Distribution Curves on Figures 1 to 8 inclusive.

.../...

4.0 SUBSOIL CONDITIONS

The stratigraphy encountered in the boreholes are given in detail on the attached Record of Borehole sheets and are also graphically presented on the Sections of Drawing 77908-B.*

The subsurface conditions were explored at six locations: Boreholes 1 to 4 were drilled in the area of the proposed bridge structure, and Boreholes 5 and 6 were put down near the alignment of a proposed retaining wall to be located west of the bridge structure.

The borings indicate a complex stratigraphy which in very general terms can be described as consisting of some shallow surficial deposits, mostly fill, underlain by two glacial till sheets.

The above soil deposits and their properties are described briefly in the following paragraphs.

4.1 Surficial Deposits

The boreholes encountered a variety of shallow, surficial deposits ranging from asphalt and topsoil to fill and silty fine sand. The thickness of these deposits ranges between 0.45 and 2.1 m.

.../...

*Note: Stratigraphical profiles, based on the borehole data, are shown on Drawing No. 2-1 of the Contract Drawings for this project.

Fill was encountered in Boreholes 2, 3, 4 and 5, where it consists of sand or silty sand in a loose to compact state. Standard Penetration resistances, or 'N'-values ranged between 5 and 18 blows/0.3 m of penetration.

In Borehole No. 6, underlying 0.2 m of topsoil, the surficial deposit is a very dense, brown silty fine sand in which Standard Penetration resistances ranged between 57 and 107 blows/0.3 m.

4.2 Upper Till Sheet

Underlying the above described surficial deposits, the upper till sheet extends to between about El. 194 and 191 m. The till is a generally coarse textured mixture of sand and silt size particles with some gravel and occasional cobbles. The particles are held together by a weak cementing bond. Interbedded in the till are layers of noncemented, cohesionless, granular material consisting of gravelly sand to fine sand and silt. At the bridge structure site, that is in Boreholes 1, 2, 3 and 4, these cohesionless sand and silt deposits dominate, whereas in Boreholes 5 and 6 only minor layers of sand are present. Occasional thin silty clay (CL-ML) or gravel layers were also encountered in the upper till sheet.

Typical grading curves of the cemented portion of the till are shown on Figure 7, indicating that it consists of predominantly fine sand, silt

.../...

and clay size particles. The sand fraction ranges between 20 and 50%, and 5 to 20% of the particles is smaller than 2 micrometer (clay size).

The composition of the interbedded granular materials are depicted on Figures 1 to 6 inclusive. These figures show a great variety of material ranging from fine sand (Figure 1), gravelly sand (Figure 2), and fine to medium sand (Figure 3), to silty fine sand (Figures 4 and 5) and fine sand and silt (Figure 6).

The relative density of the deposit was inferred from the Standard Penetration test results which gave 'N'-values ranging between 13 and over 100 blows/0.3 m. From this, it is inferred that the till is compact to very dense. Generally, it was found that to a depth of about 3 to 4 m the till is compact to dense, whereas below the till is dense to very dense. Exception to this was found only in Boreholes 1 and 2, where occasional compact zones were found to a depth of 6.5 to 7.0 m below ground surface. The natural moisture content of this deposit was measured to range between 5 and 20% with most of the values around 15%.

The permeability of the till is estimated to range between wide limits. The coefficient of permeability can be estimated from the grading curves and the relationship established by Hazen between the coefficient of permeability and the effective grain size (D_{10}). From this, it is

.../...

estimated that the slightly cemented portion of the till has a coefficient of permeability (k) less than 5×10^{-5} cm/sec., and that the coefficient of permeability of the interbedded granular materials ranges between 5×10^{-5} and 10^{-2} cm/sec. It is expected that due to the layered nature of the till and the presence of occasional clayey silt seams the vertical permeability of the till will be smaller.

4.3 Lower Till Sheet

The surface of the lower till sheet was encountered between Elevations 194 m in Borehole No. 6, and 191.1 m in Borehole No. 3. This till has a medium to dark grey colour, it is strongly cemented, and consists of a well graded mixture of gravel to clay size particles with occasional cobbles. Typical grading curves of the till are shown on Figure 8 indicating that the material consists of about 10% gravel, 40% sand and 50% of soil fines (silt and clay). The natural moisture content of this deposit is between 5 and 7%. Standard Penetration resistances in this till ranged between 54 and over 100 blows/0.3 m, but were generally in excess of 80 blows/0.3 m indicating a very dense relative density. The permeability of this stratum is estimated to be less than 10^{-6} cm/sec.

5.0 GROUNDWATER CONDITIONS

The groundwater conditions in the boreholes were observed both during the drilling and after the boreholes were completed either in the uncased boreholes or in piezometers installed in Boreholes 1, 3 and 6. Water level readings and observations are recorded on the Record of Boreholes.

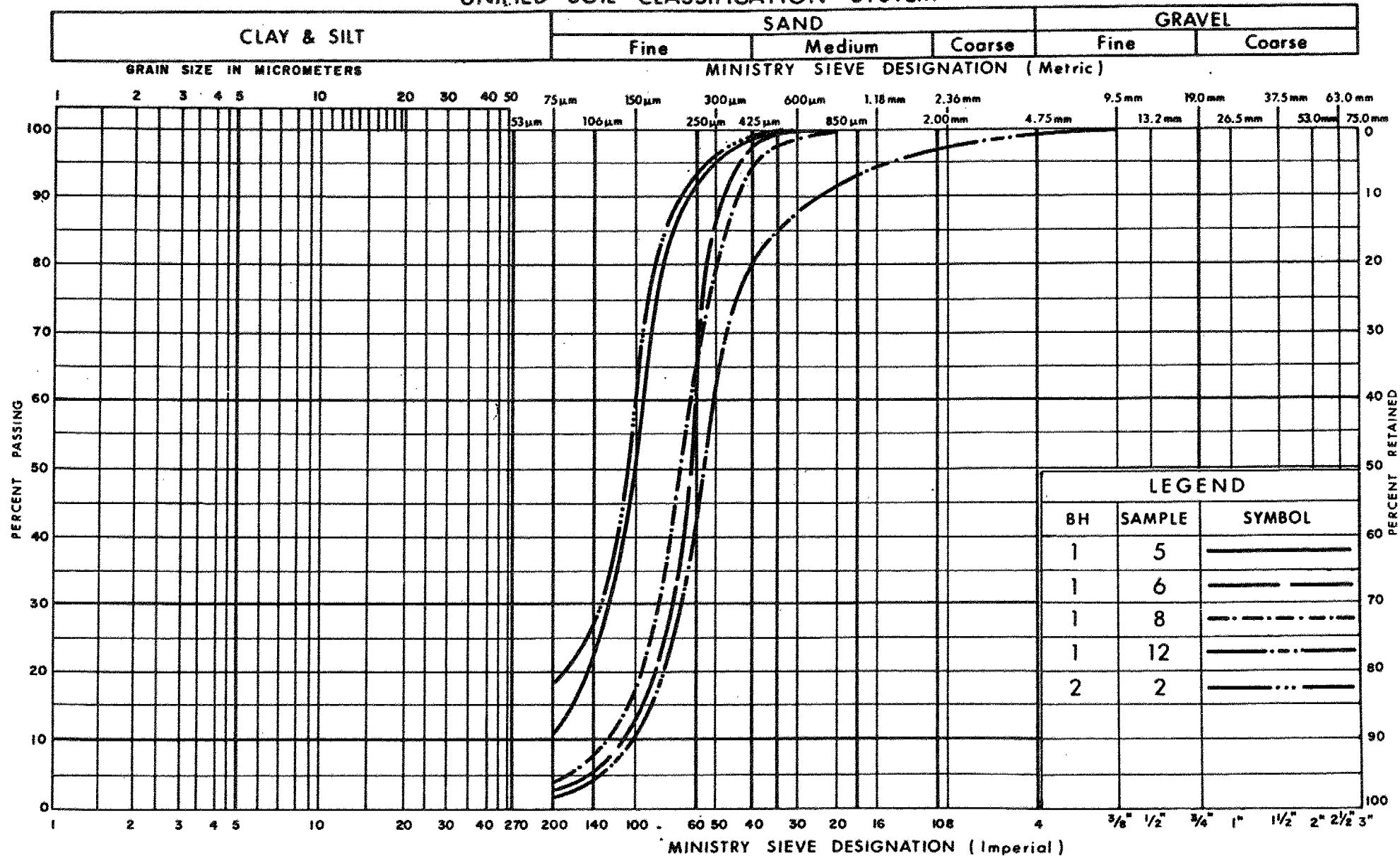
The final recorded water levels range between Elevation 199.5 and 198 m. These recorded water levels agree well with the inferred groundwater contours given in the Ministry of Environment Water Resources Report No. 9A (1977). This report also indicates that the direction of groundwater flow in the area is from northeast to southwest with an average gradient of 45 m in 1 km.

NOTE: The preceding report is a copy of the factual information from the Foundation Investigation Report prepared by Dominion Soil Investigation Inc., the consulting geotechnical engineers for this project, under the technical supervision of the M.T.C. Foundation Design Section.

D.H. Dundas
D.H. Dundas, P. Eng.
Foundations Engineer
M.T.C. Foundation Design Section

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



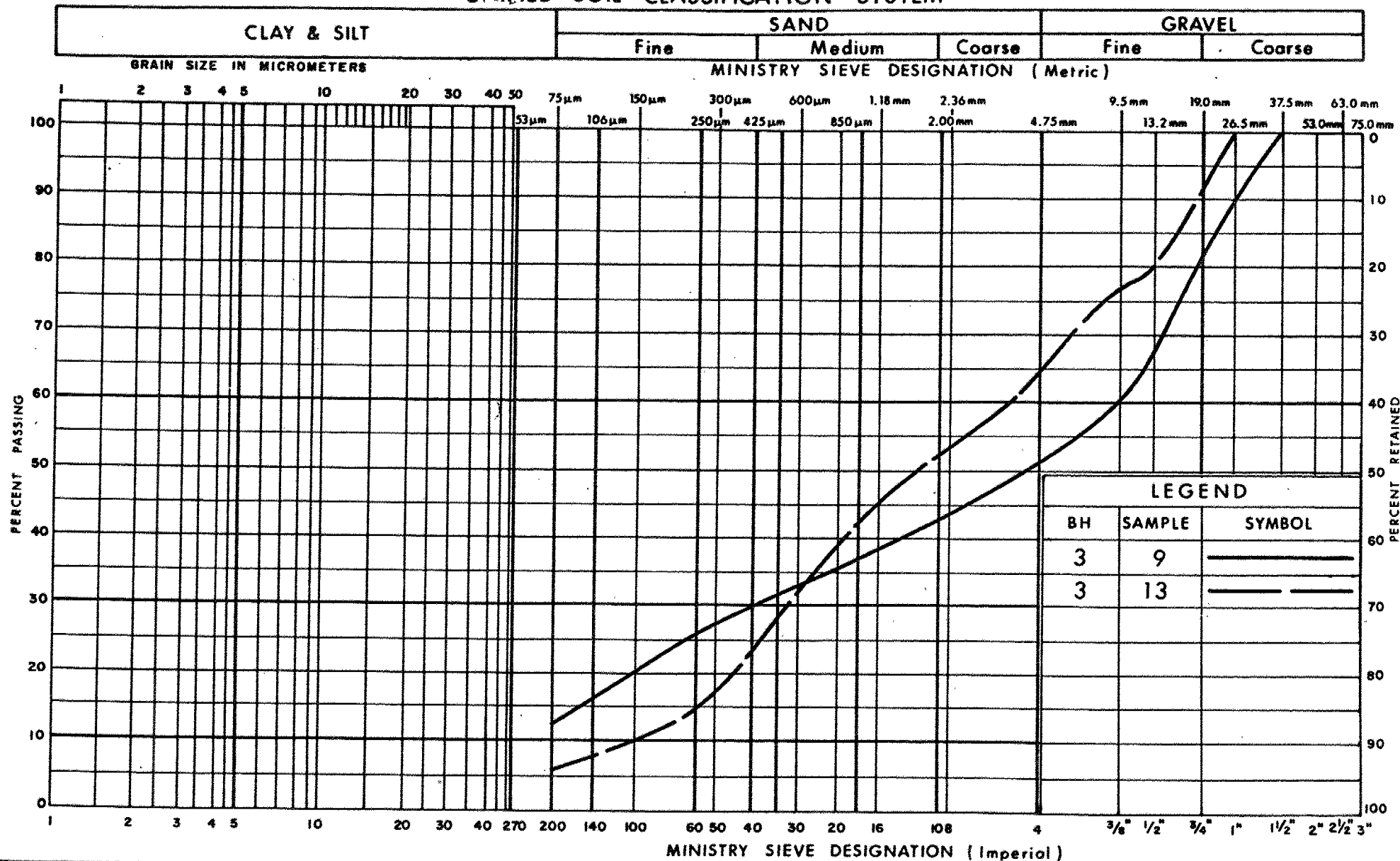
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GRAIN SIZE DISTRIBUTION
FINE SAND, SOME SILT

FIG No 1

W P 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



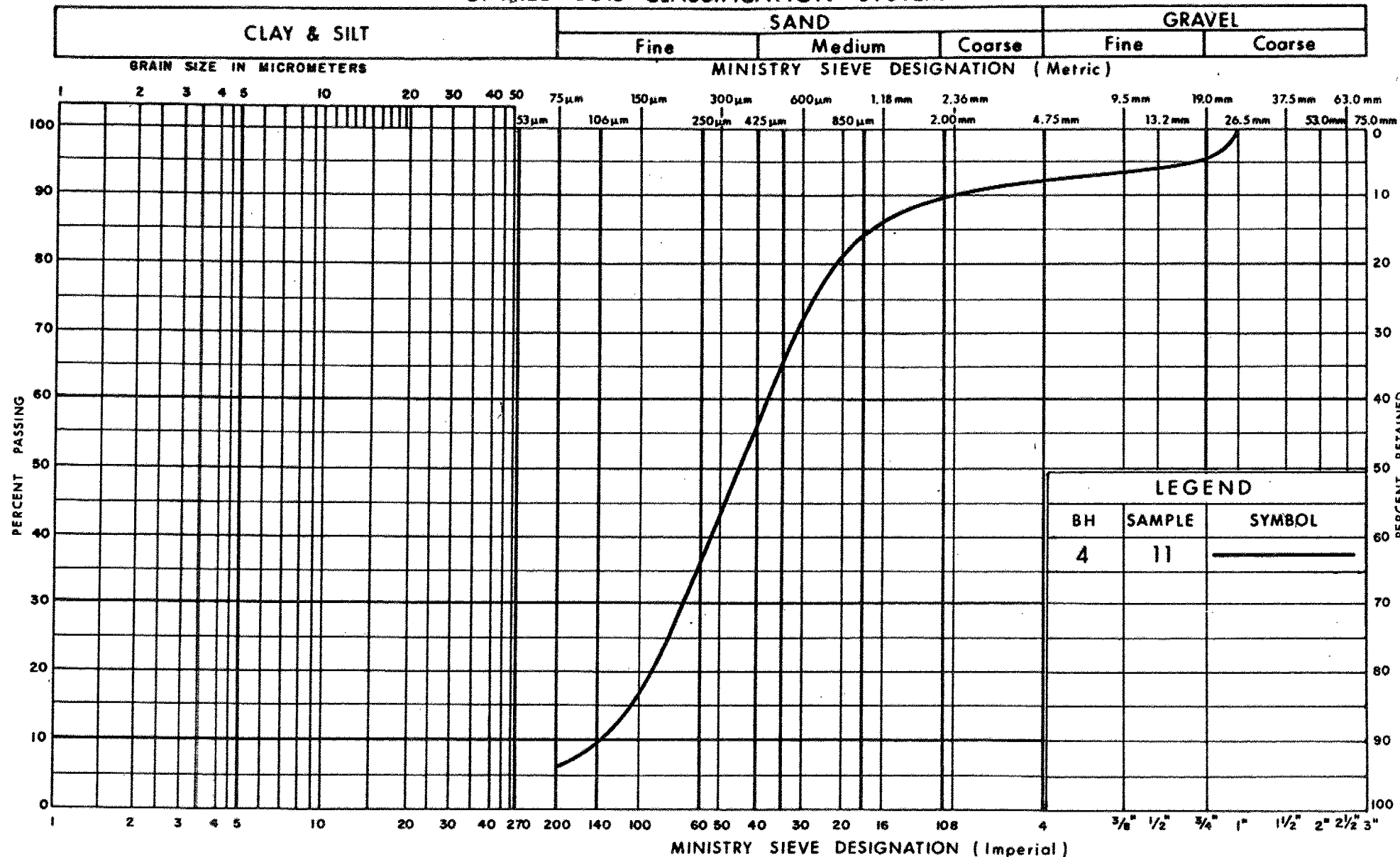
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GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, SOME SILT

FIG No 2

W P 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



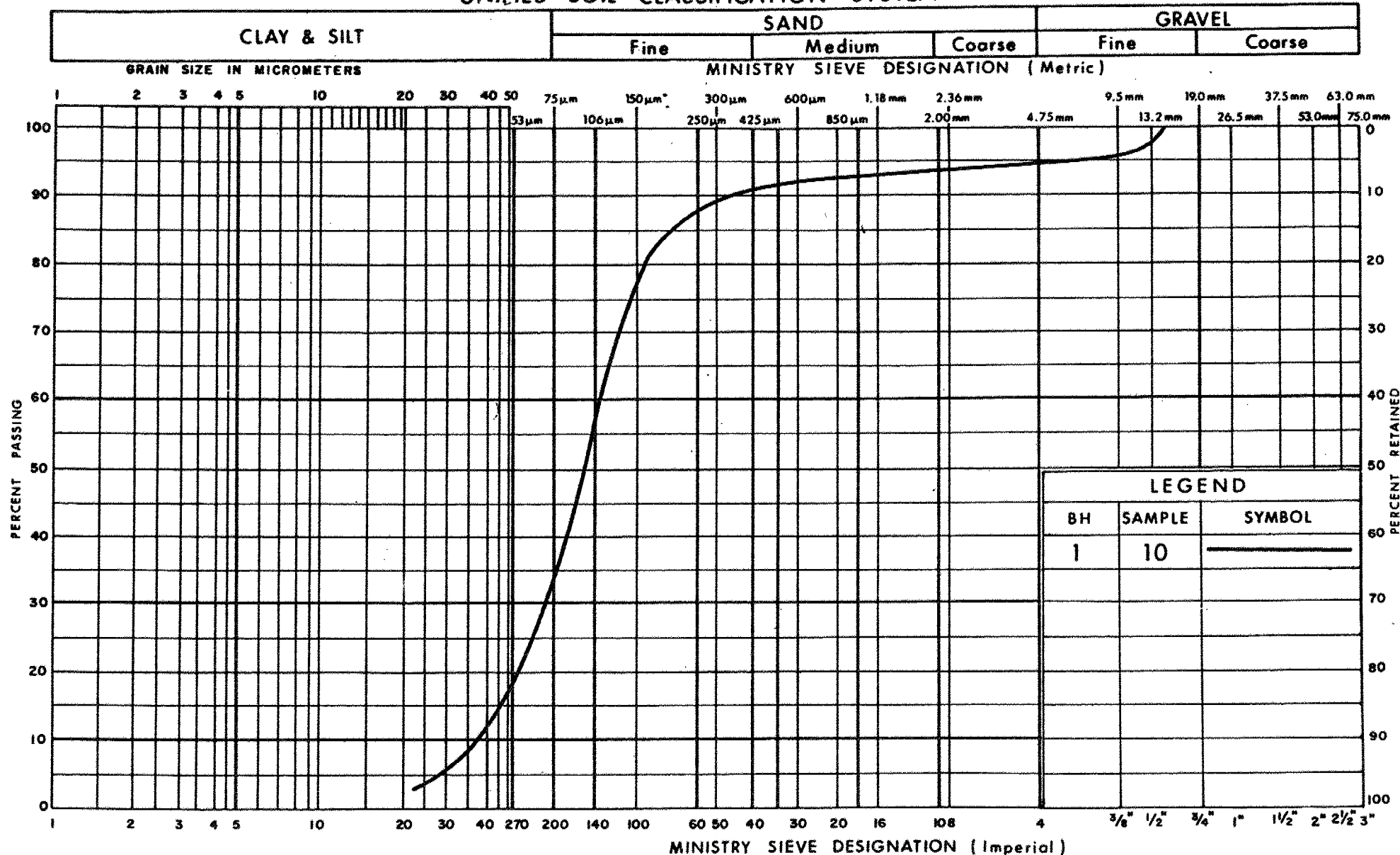
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FINE TO MEDIUM SAND, TRACE OF GRAVEL & SILT

FIG No 3

W P 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



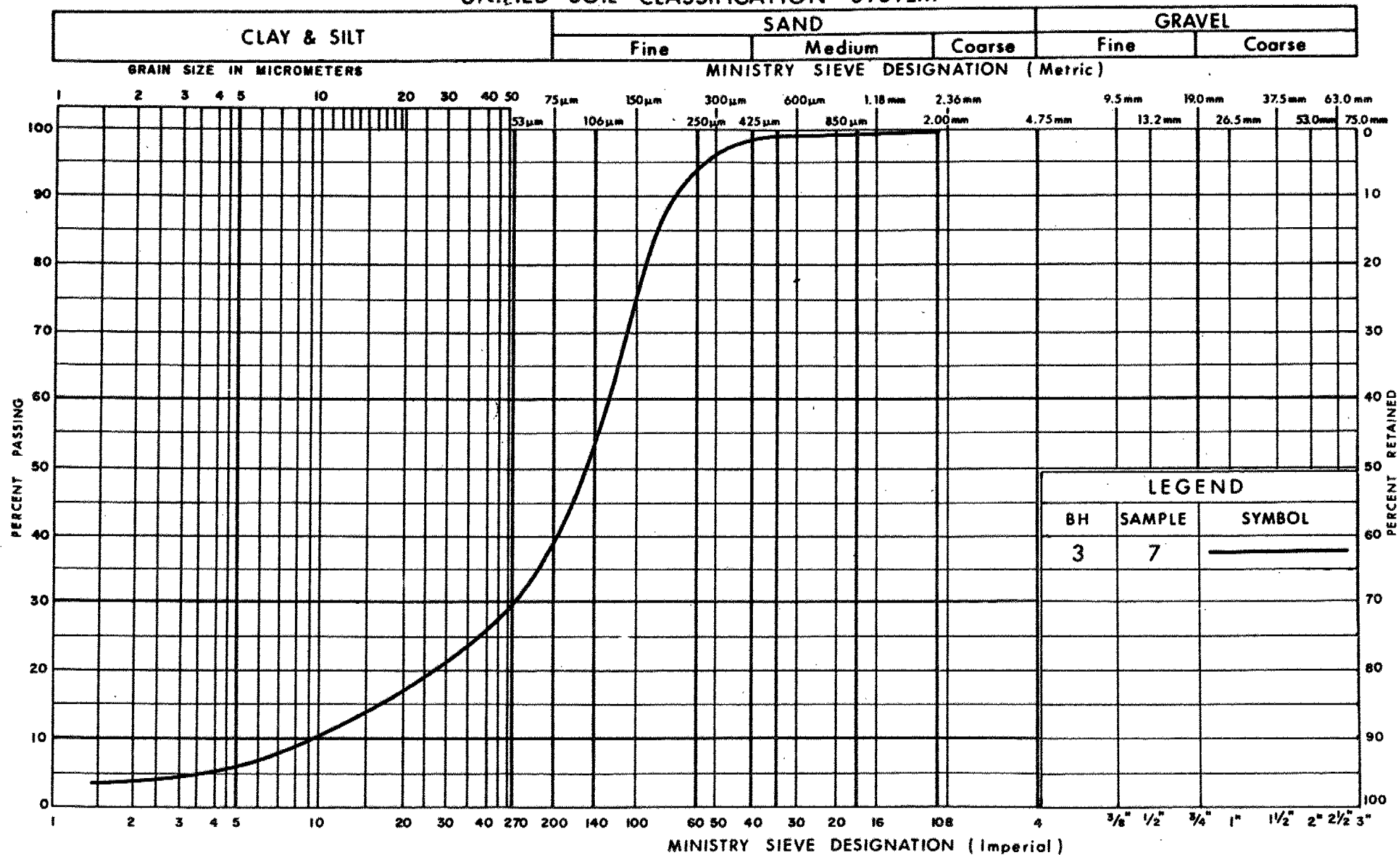
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GRAIN SIZE DISTRIBUTION
SILTY FINE SAND, TRACE OF GRAVEL

FIG No 4

W P 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



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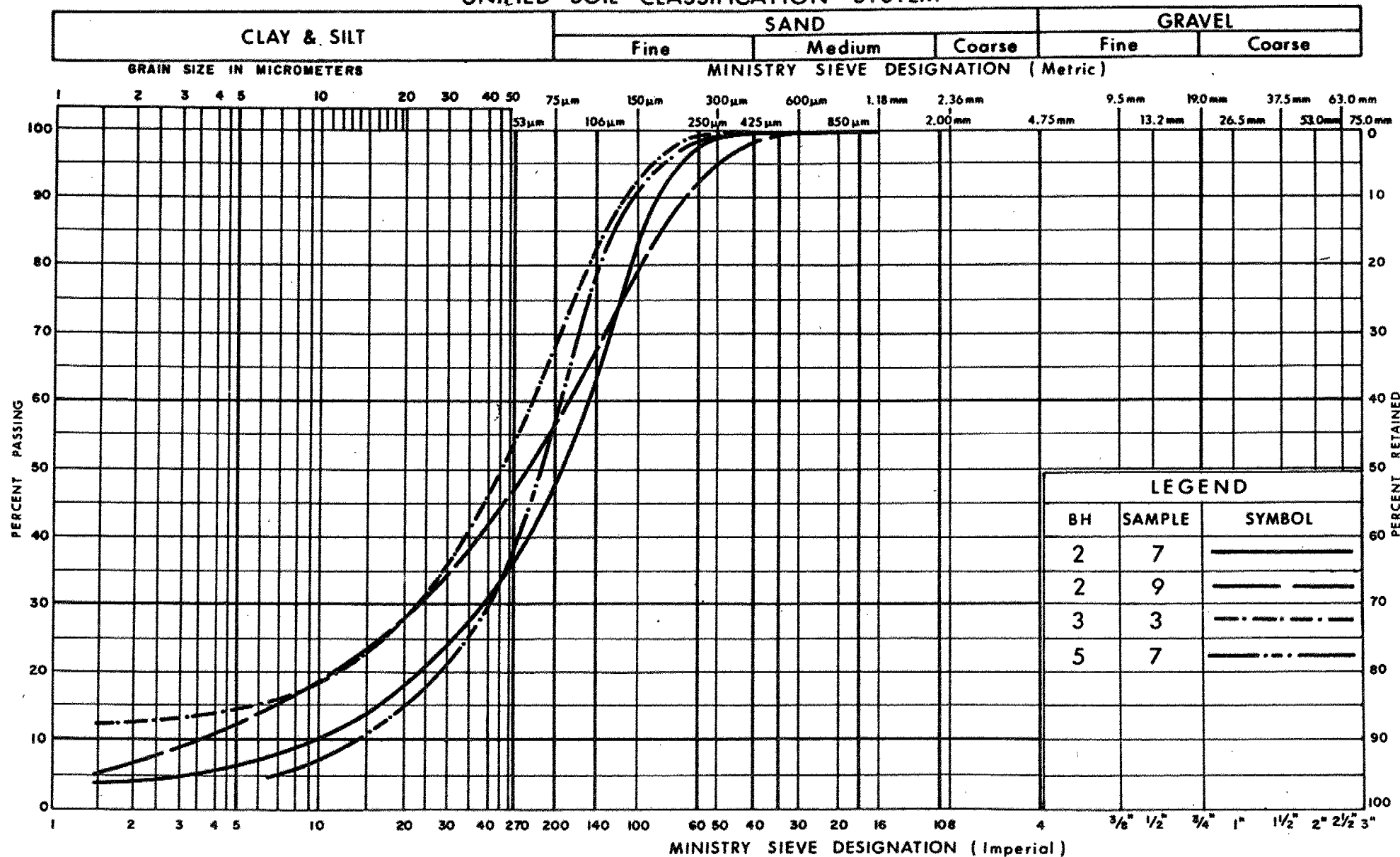
GRAIN SIZE DISTRIBUTION

SILTY FINE SAND

FIG No 5

W P 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



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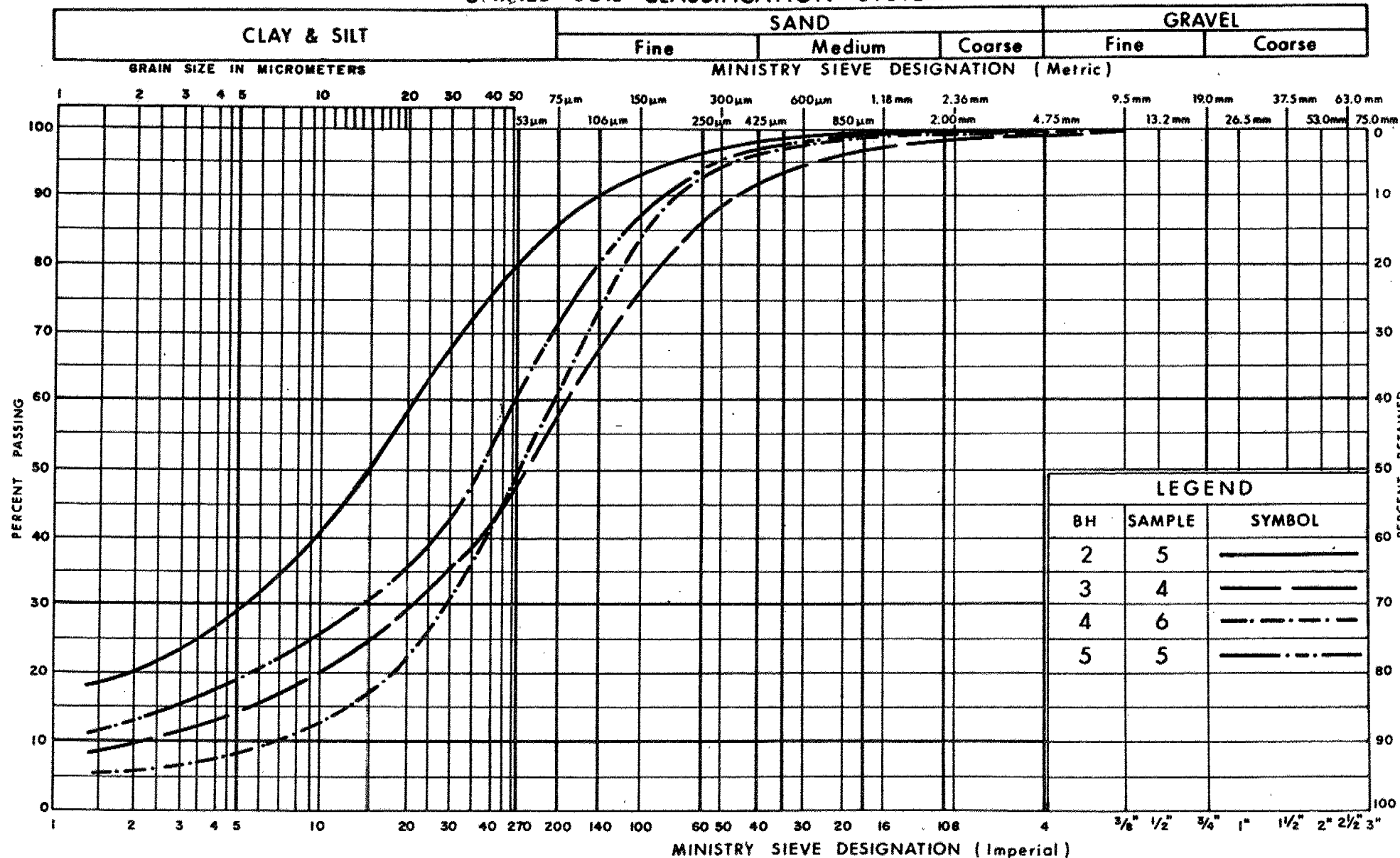
GRAIN SIZE DISTRIBUTION

FINE SAND AND SILT

FIG No 6

WP 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



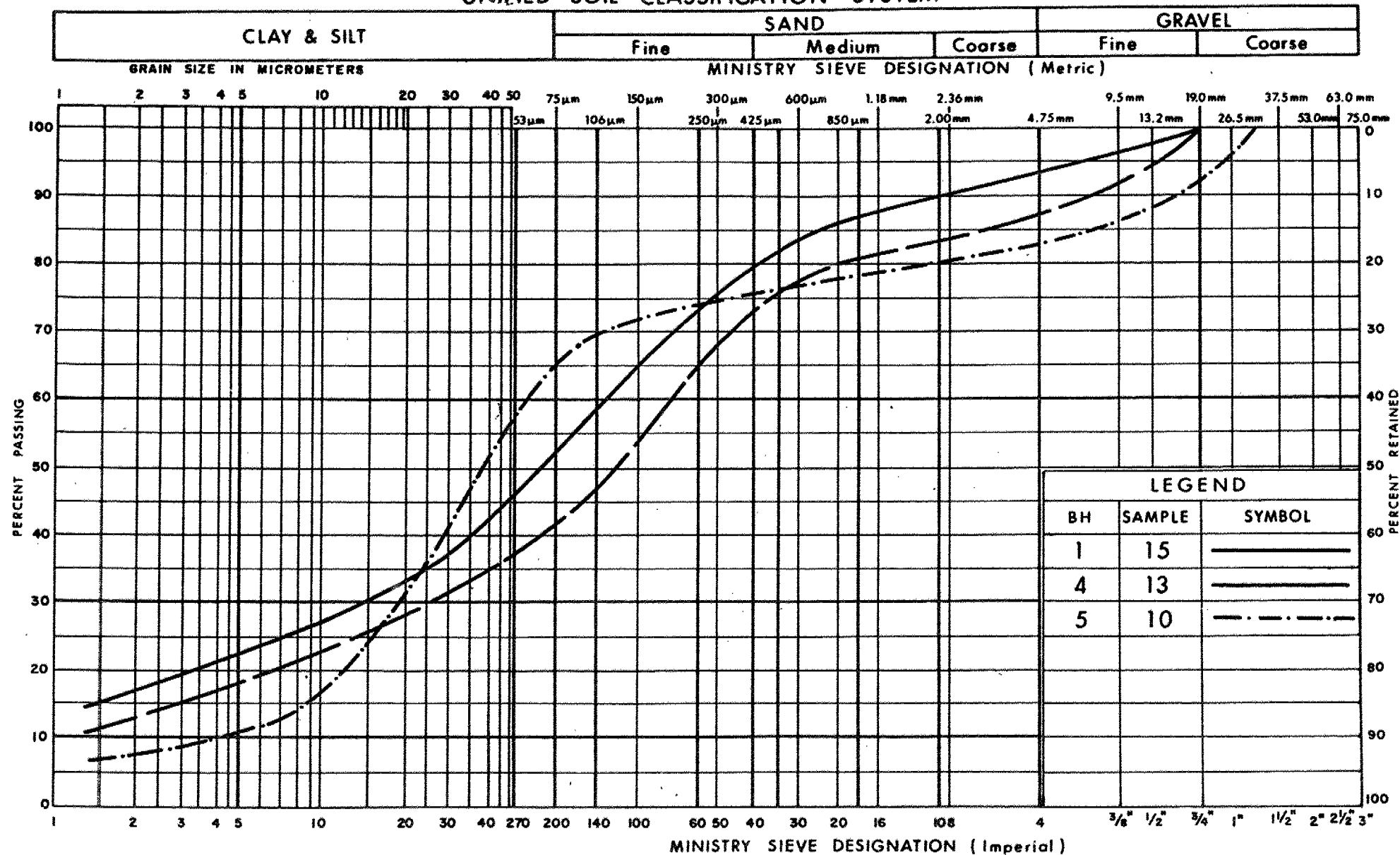
Ministry of
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GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE TO SOME CLAY
(Glacial Till)

FIG No 7

WP 7-79-08

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of
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Communications

GRAIN SIZE DISTRIBUTION
SANDY SILT, SOME GRAVEL AND CLAY
(Glacial Till)

FIG No 8

W P 7-79-08



RECORD OF BOREHOLE No 1

METRIC

31

W P 7-79-08 LOCATION Co-Ords N 4 872 706.3 ; E 376 122.0 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 08/04 to 05/81 COMPILED BY S.C.
DATUM Geodetic DATE AUGERING, 114 mm DIA. CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH								
203.8	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	10 20 30			
0.0	0.45 m TOPSOIL compact brown SANDY SILT, embedded gravel (Glacial Till)		1	SS	12											
201.2			2	SS	21											
2.6	compact to very dense brown SAND		3	SS	30											
			4	SS	52											
			5	SS	40											
			6	SS	28											
			7	SS	42											
	traces to some silt		8	SS	25											
	fine		9	SS	50/0	15m										
	gravelly		10	SS	82											
	silty		11	SS	100											
	fine to medium		12	SS	68											
192.7	gravelly		13	SS	100/0	0.15m										
11.1	very dense grey SANDY SILT (Glacial Till) cemented		14	SS	100/0	0.07m										
			15	SS	100/0	0.15m										
188.4			16	SS	75/0	0.15m										
15.4	END OF BOREHOLE															

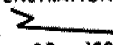
















+3, x5: Numbers refer to
Sensitivity20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2

METRIC 32

W P 7-79-08 LOCATION Co-Ords N 4872 726.6 : E 376 128.2 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 08/06/81 COMPILED BY S.C.
DATUM Geodetic DATE AUGERING, 114 mm. DIA. 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					
204.5	GROUND SURFACE																
0.0	loose brown SILTY SAND FILL		1	SS	7		204										
202.4			2	SS	5												
2.1	compact to very dense layers of fine SAND, SILT and occasional thin SILTY CLAY		3	SS	24		202										
			4	SS	37												
			5	SS	15												
			6	SS	22		200										0 15 67 18
	cobbles		7	SS	84												0 53 43 4
			8	SS	26		198										0 43 51 6
197.0			9	SS	17												
7.5	dense to very dense SAND fine to medium some silt trace of gravel		10	SS	43		196										0 83 17 0
	gravelly		11	SS	60/0	15m											
			12	SS	43		194										
193.5			13	SS	51												
11.0	very dense grey SANDY SILT some embedded gravel (Glacial Till)		14	SS	80/0	15m	192										
			15	SS	85/0	15m	190										
189.1			16	SS	100/0	12m											
15.4	END OF BOREHOLE																

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 3

METRIC

33

W P 7-79-08 LOCATION Co-0rds N 4 872 715.6 ; E 376 091.5 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 07-30 to 31-81 COMPILED BY S.C.
DATUM Geodetic DATE AUGERING, 114 mm. DIA. CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										WATER CONTENT (%)		
								SHEAR STRENGTH										10 20 30		
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE														
204.1	GROUND SURFACE						204													
9.0	76 mm Asphalt																			
203.2	SAND FILL																			
0.9	brown SANDY SILT		1	SS	15															
			2	SS	17															
	non cemented		3	SS	23		202									0 30 58 12				
	(Glacial Till)		4	SS	14											0 40 52 8				
	compact dense		5	SS	33		200													
199.5			6	SS	42															
4.6	dense brownish-grey SILTY FINE SAND		7	SS	38											0 64 32 4				
197.2			8	SS	45		198													
6.9	very dense, grey cemented GRAVELLY SAND some cobbles, (Glacial Till)		9	SS	52											48 40 12 0				
			10	SS	58															
195.3			11	SS	90		196													
8.8	dense to very dense		12	SS	42															
	GRAVELLY SAND trace silt, some cobbles		13	SS	64		194									36 57 7 0				
							192													
191.1							190													
13.0	very dense grey SANDY SILT some embedded gravel (Glacial Till)		14	SS	112															
188.6			15	SS	100	0.15m														
15.5	END OF BOREHOLE																			



RECORD OF BOREHOLE No 4

METRIC 34

W P 7-79-08 LOCATION Co-Ords N 4 872 700.8 ; E 376 081.2 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 08-04-81 COMPILED BY S.C.
DATUM Geodetic DATE AUGERING, 114 mm. DIA. CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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								
								SHEAR STRENGTH								
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								Wp — W — Wl		WATER CONTENT (%) 10 20 30						
203.6	GROUND SURFACE															
0.0	0.11 m Asphalt															
202.7	SAND FILL															
0.9	dense SANDY SILT		1	SS	60											
202.1	(Glacial Till)															
1.5	compact brown layers of FINE SAND, SILT and		2	SS	13											
			3	SS	28											
			4	SS	14											
199.8	SILTY CLAY															
3.8	dense to very dense light brown SANDY SILT trace of gravel slightly cemented (Glacial Till)		5	SS	48											
	wet, dilatant		6	SS	37											
			7	SS	52											
			8	SS	72											
			9	SS	50											
195.7			10	SS	53											
7.9	very dense brown SAND fine to coarse, trace gravel & silt, wet		11	SS	104											
			12	SS	62											
193.1																
10.5	very dense grey SILTY SAND to SANDY SILT some gravel cemented (Glacial Till)		13	SS	100/0.7m											
			14	SS	95/0.15m											
			15	SS	69											
188.1			16	SS	50/0.7m											
15.5	END OF BOREHOLE															



RECORD OF BOREHOLE No 5

METRIC 35

W P 7-79-08 LOCATION Co-Ords N 4 872 707.5 ; E 376 058.8 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 07-30-81 COMPILED BY S.C.
DATUM Geodetic DATE AUGERING, 114 mm. DIA. 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								
								SHEAR STRENGTH				10 20 30				
203.6	GROUND SURFACE															
0.0	54 mm Asphalt compact SAND FILL		1	AS	-											
202.2			2	SS	18											
1.4			3	SS	22		202									
	compact dense brown		4	SS	25											
			5	SS	31											
			6	SS	38		200									0 33 56 11
	very dense greyish brown grey		7	SS	64											0 53 45 2
			8	SS	59		198									
	SANDY SILT to SILTY SAND trace of gravel (Glacial Till)		9	SS	77											
	moderately cemented layers of fine sand, and silty clay occasional cobbles.		10	SS	83		196									18 15 60 7
			11	SS	105											
			12	SS	122		194									
			13	SS	56											
191.4							192									
12.2	very dense grey SANDY SILT some embedded gravel (Glacial Till)		14	SS	85		190									
			15	SS	82											
188.1			16	SS	80/0	15m										
15.5	END OF BOREHOLE															



RECORD OF BOREHOLE No 6

METRIC

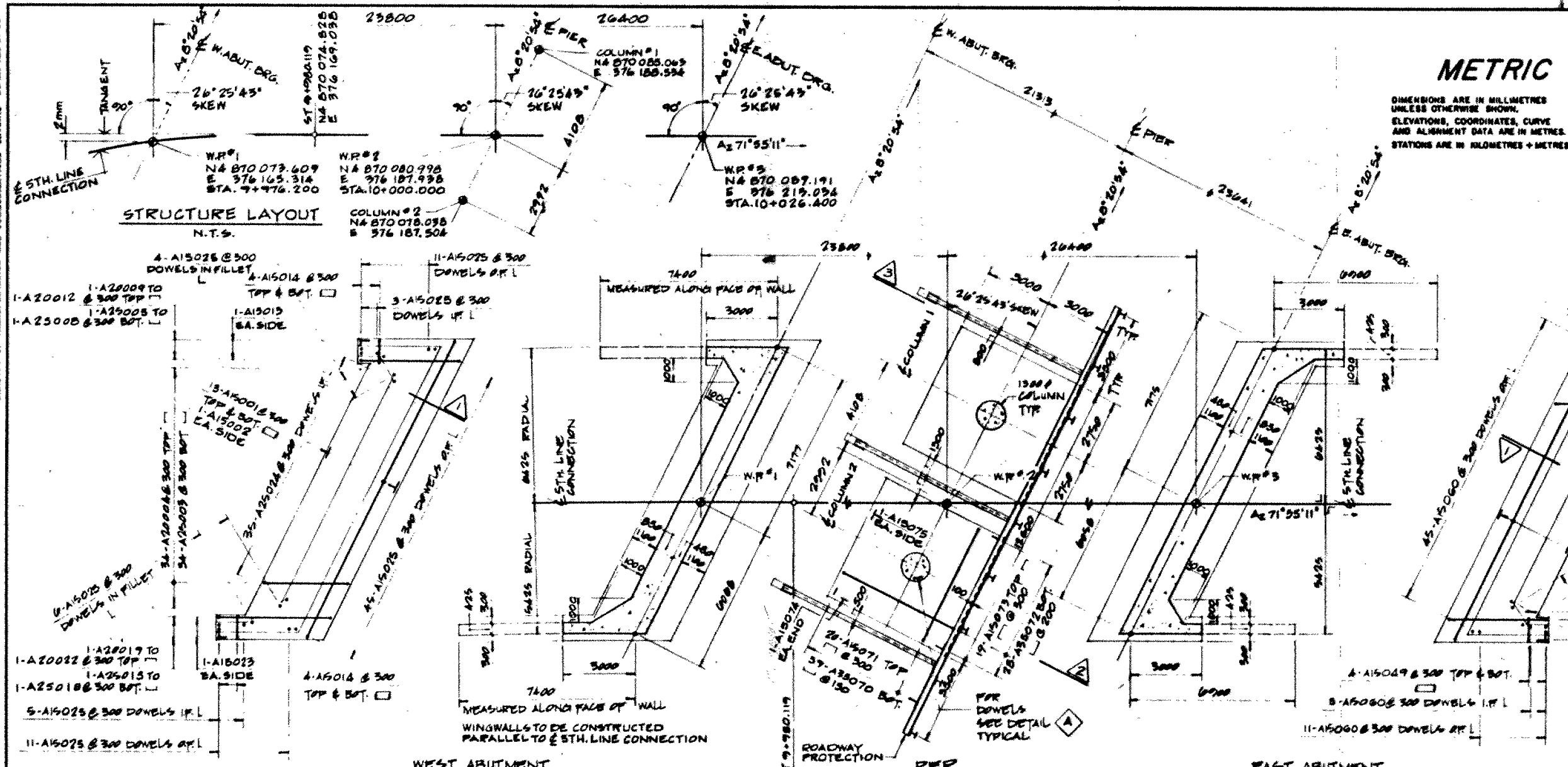
36

W P 7-79-08 LOCATION Co-Ords N 4 872 698.5 ; E 375 998.3 ORIGINATED BY S.C.
DIST 7 HWY 35/115 BOREHOLE TYPE 07-29-81 COMPILED BY S.C.
DATUM GEODETIC DATE AUGERING, 114 mm. DIA. CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
								20 40 60 80 100									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)					
201.6	GROUND SURFACE																
0.0	0.2 m TOPSOIL		1	AS	-												
	very dense		2	SS	57												
	brown																
199.5	SILTY FINE SAND		3	SS	107		200										
2.1	very dense		4	SS	60												
	SILTY SAND		5	SS	105												
	embedded gravel		6	SS	65/0	15m	198										
	(Glacial Till)		7	SS	105												
	brownish		8	SS	115/0	15m	196										
	grey		9	SS	90/0	15m											
	grey																
194.0	occasional cobbles		10	SS	80/0	15m	194										
7.6	very dense		11	SS	164		192										
	grey																
	SANDY SILT		12	SS	125		190										
	some embedded gravel		13	SS	119		188										
	occasional cobbles, (Glacial Till)		14	SS	69												
	cemented																
185.9			15	SS	54		186										
15.7	END OF BOREHOLE																

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

ALL DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES



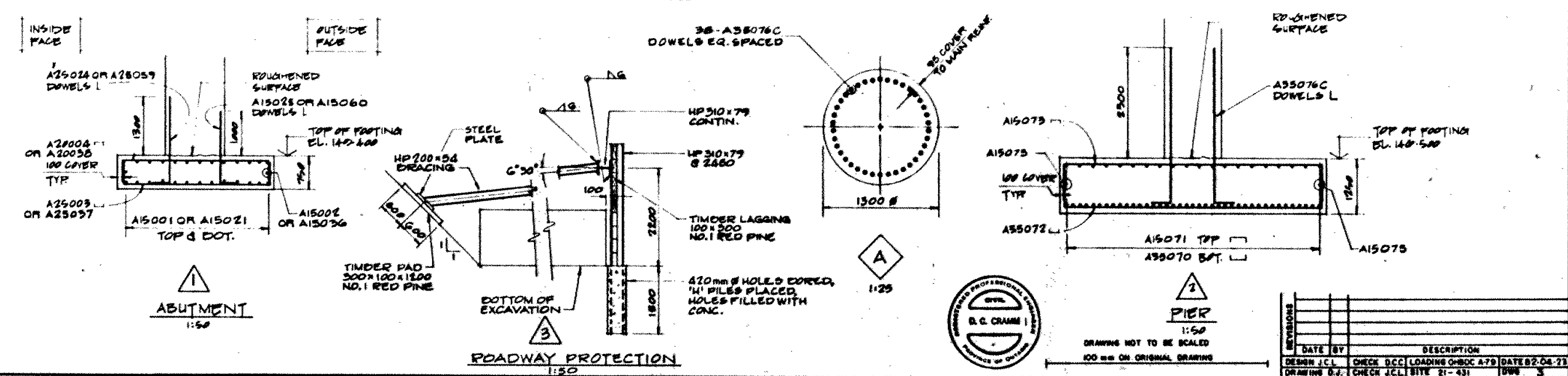
CONT No
WP No 7-79-07

5th. LINE UNDERPASS
AT HIGHWAY 35/115

FOUNDATION LAYOUT & REINFORCING

PARKER CONSULTANTS
Consulting Professional Engineers
Hamilton - London - Ottawa - Jarvis

SHEET



MAY 19 1982



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 7-79-07 DIST 7
HWY 35/115 STR SITE 21-431

Fifth Line Underpass
8.6 km North of Highway 401

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FOUNDATION INVESTIGATION REPORT

FOR

Fifth Line Underpass
8.6 km North of Highway 401
W. P. 7-79-07, Site 21-431
Highway 35/115, District 7, Port Hope

The results of a foundation investigation program carried out at the above-mentioned structural site between 81 05 27 and 81 05 28 are presented in this report. A total of 4 sampled boreholes were advanced by means of continuous flight augers for depths varying from 9.5 to 13.9 metres below ground surface.

Site Description and Geology

The site is located on Highway 35/115 some 700 metres south of the existing Clarke 5th Line Concession Road (Station Street), in the Town of Newcastle, Regional Municipality of Durham.

The topography across the site is gently undulating with the predominate land use being for commercial mixed farming and grain crops.

Physiographically, the site is located on the South Slope Region which is characterized in this area by surficial fine sands and silt overlying highly calcareous sandy glacial tills.

Subsurface Conditions

Briefly, the site is underlain by a surficial deposit of silty sand to sandy silt encountered for a maximum depth of 5.2 metres. Underlying this surficial granular deposit and explored for a maximum thickness of 11 metres is a glacial till composed of a slightly plastic silt to silty clay of low plasticity with sand and a trace of gravel.

Bedrock was not encountered in any of the borings at the site.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized borehole water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on borehole data, are shown on Drawing No. 77907-A.

The various soil types encountered are briefly described in the following paragraphs.

Silty Sand to Sandy Silt

The site is underlain by a surficial glacio-fluvial deposit consisting of a silty sand to sandy silt with traces of clay and gravel. This deposit was encountered for depths ranging from 2.9 to 5.2 metres. Typical gradation curves plotted in envelope form are shown on Figure 1.

The denseness of this stratum based on interpretation of 'N' values indicates a range from loose to very dense, but generally very dense throughout.

Silt to Silty Clay (Glacial Till)

The predominant deposit underlying the site, and explored to a maximum depth of 13.9 metres is an overconsolidated glacial till deposit consisting of a slightly plastic silt to silty clay with to some sand and a trace of gravel. Occasional seams and layers of silty sand to sand were encountered throughout this relatively incompressible deposit.

The results of laboratory tests consisting of Atterberg Limit and water content testing are plotted on the plasticity chart, Figure 2 and summarized as follows:

	<u>Range</u>	<u>Average</u>
Water content (W)%	5-13	10
Liquid Limit (W_L)%	13-26	18
Plastic Limit (W_p)%	9-13	11
Plasticity Index (I_p)%	2-15	9

These results indicate the glacial till deposit to be an inorganic slightly plastic silt to silty clay of low plasticity (ML-CL).

The consistency of this till deposit, as based on interpretation of Standard Penetration Test 'N' values and augering operations, is assessed as ranging from very stiff to hard but generally hard throughout.

Groundwater Conditions

Stabilized borehole water level readings as taken in two boreholes indicated groundwater levels varied from elevation 142.5 at the west abutment location to 144.5 at the east abutment location. This would indicate a gentle east to west gradient in the water levels across the site.

Discussion and Recommendations

Proposed widening of Highway 35/115 will require a 2 span underpass structure to carry the Fifth Line Concession Road over the Highway. A suggested profile grade for the Concession Road of elevation 154.6 will necessitate fill heights in order of 7 metres since no grade changes for Highway 35/115 are contemplated. Recommendations pertaining to the foundations of the new structure and the related earthworks are summarized as follows.

Perched abutments can be founded on spread footings located on a well compacted Granular 'A' core within the approach fills. Excavations for the core should be carried down to elevation 147 for both abutment locations to insure removal of all loose surficial material.

For footings founded on a well compacted Granular 'A' core, constructed to M. T. C. standards, an allowable capacity at the S. L. S. Type II of 280 kPa and a factored capacity at the U. L. S. of 430 kPa may be used.

Pier elements can be founded on spread footings located at or below elevation 145.5 for a design capacity at the S. L. S. Type II of 280 kPa and a factored capacity at the U. L. S. of 430 kPa.

Earth pressures against the abutment wall should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. Manual.

Resistance to sliding of the abutment footings can be calculated using a coefficient of friction of 0.6 between the underside of the concrete foundation and the Granular 'A' core.

The underside of all footing elements should be provided with a minimum 1.5 metres of earth cover for frost protection purposes.

No dewatering problems are anticipated since excavation will be carried out above the prevailing water table. Localized seepage can be controlled by perimeter ditches and pumping from corner sumps.

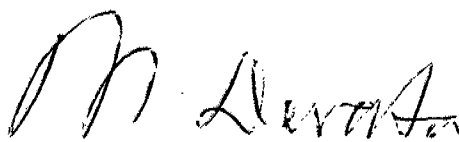
Embankment slopes constructed to a 2:1 geometry are not expected to undergo any stability or maintenance distress.

Miscellaneous

The fieldwork for this investigation was carried out under the supervision of Mr. Z. Mabraïdopoulos, Student Technician, utilizing equipment owned and operated by Master Soil Ltd., Toronto. The preliminary letter of foundation recommendations dated 81 07 16 and this report were written by Mr. T. J. Kazmierowski, Foundations Engineer and reviewed by Mr. M. Devata, Senior Foundations Engineer.




T. J. Kazmierowski, P. Eng.,
Foundations Engineer


M. Devata, P. Eng.,
Senior Foundations Engineer

A P P E N D I X

RECORD OF BOREHOLE No 1

METRIC

W P 7-79-07 LOCATION Co-ords 4 870 089.8 N; 376 211.8 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 27 CHECKED BY CP

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					
147.8	Ground Surface																GR SA SI CL
0.0	Silty sand to sandy silt trace to some clay dense to very dense		1	SS	54		146										0 53 35 12
			2	SS	50												0 51 38 11
			3	SS	37												0 45 50 5
144.1			4	SS	54												0 46 44 10
3.7	Silt to silty clay of low plasticity Some sand Trace of gravel (Glacial Till) Hard		5	SS	100/15	cm	144										0 37 52 11
			6	SS	125												
			7	SS	100/12	cm	142										
			8	SS	85/12	cm	140										
138.3			9	SS	103/20	cm											
9.5	End of borehole																

+3, x5 : Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No 2

METRIC

W P 7-79-07 LOCATION Co-ords 4 870 077.0 N; 376 197.6 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 27 CHECKED BY [Signature]

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					
147.3	Ground Surface																GR SA SI CL
0.0	Silty sand to sandy silt		1	SS	56	*	146										11 58 25 6
	Trace of clay		2	SS	51		144										0 33 61 6
142.6	Trace of gravel		3	SS	28		142										0 27 64 9
4.7	Dense to very dense		4	SS	69		140										41 15 27 17
	Silty clay of low plasticity		5	SS	116	20 cm	138										
	Some sand		6	SS	100	12 cm	136										
	Varying amounts of gravel		7	SS	64	10 cm											
	(Glacial Till)		8	SS	100	15 cm											
	Hard		9	SS	100	15 cm											
134.8	End of borehole		10	SS	85	12 cm											
12.5	* Water level was not established																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 7-79-07 LOCATION Co-ords 4 870 088.5 N; 376 180.5 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 28 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
147.7	Ground Surface							SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								WATER CONTENT (%)						
0.0	Silty sand to silt		1	SS	13		146							0 37 50 13
	Some sand		2	SS	57		144							12 65 17 6
	Trace of clay and gravel		3	SS	57									0 22 68 10
142.5	Compact to very dense		4	SS	84		142							0 21 65 14
5.2	Silt to silty clay of low plasticity with sand		5	SS	100/12 cm									
	Trace of gravel		6	SS	100/12 cm		140							
	(Glacial Till)		7	SS	100/15 cm									
	Hard		8	SS	100/12 cm		138							
			9	SS	100/8 cm									
135.4			10	SS	100/12 cm		136							
12.3	End of borehole													
	* Water level was not established													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

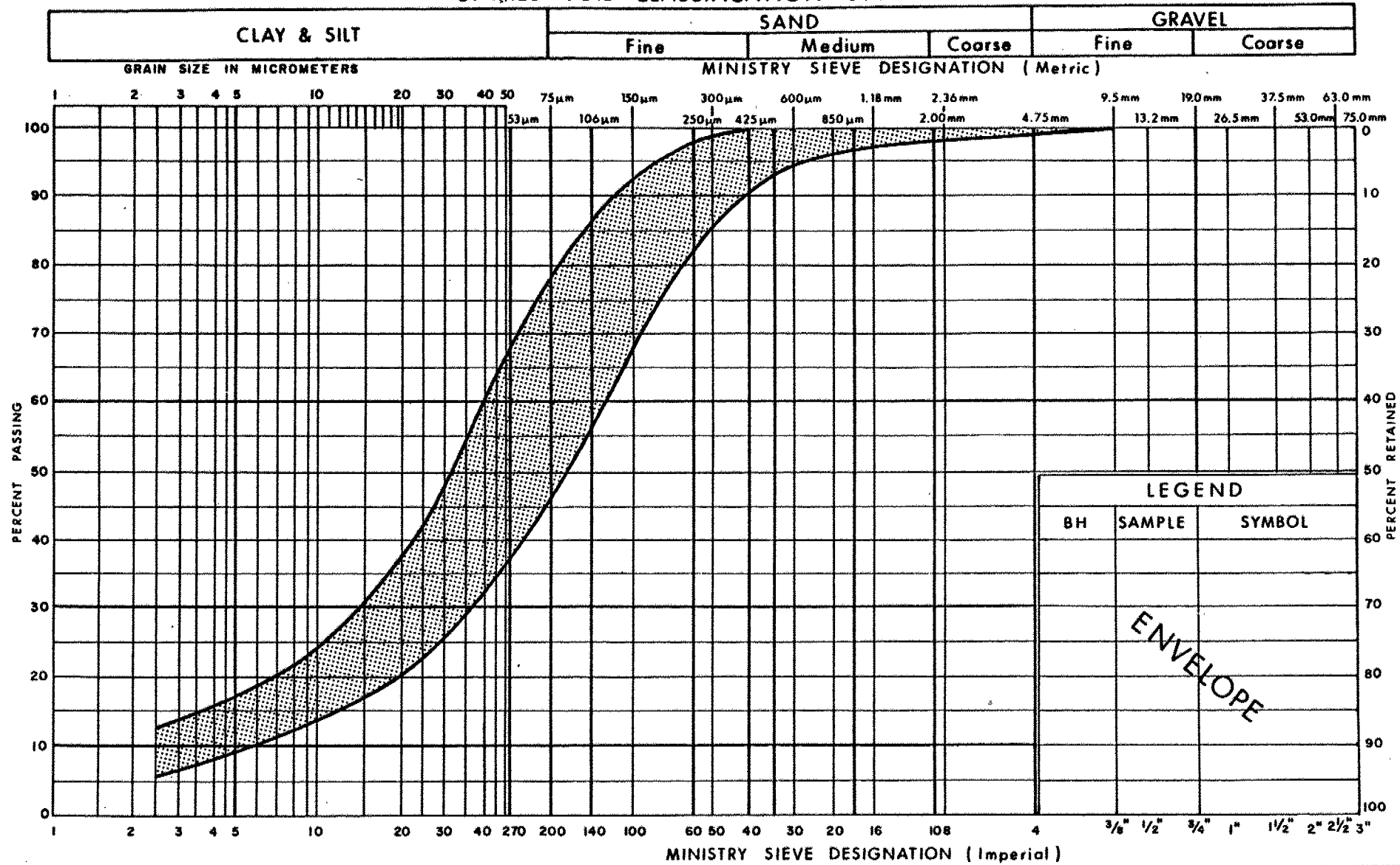
W P 7-79-07 LOCATION Co-ords 4 870 078.0 N; 376 166.8 E ORIGINATED BY Z M
 DIST 7 HWY 115/35 BOREHOLE TYPE Solid Stem Flight Augers COMPILED BY Z M
 DATUM Geodetic DATE 81 05 28 CHECKED BY [Signature]

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			SHEAR STRENGTH							
								20 40 60 80 100							
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL x LAB VANE							
149.3	Ground Surface														GR SA SI CL
0.0	Silty sand trace of clay		1	SS	6		148								0 12 64 24
	Silty clay some sand		2	SS	16										0 43 47 10
	Loose to dense		3	SS	45										0 1 44 55
146.4															
2.9	Silt to silty clay of low plasticity with sand trace of gravel (Glacial Till)		4	SS	24		146								
			5	SS	18										
			6	SS	19										
							144								
	sand trace silt		7	SS	50		142								0 90 (10)
			8	SS	58										
							140								7 79 (14)
	Sand trace gravel		9	SS	101/23 cm										
	occasional granular layers throughout		10	SS	105/23 cm		138								
	Very stiff to hard		11	SS	100/10 cm										
							136								
135.4			12	SS	100/15 cm										
13.9	End of borehole														

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

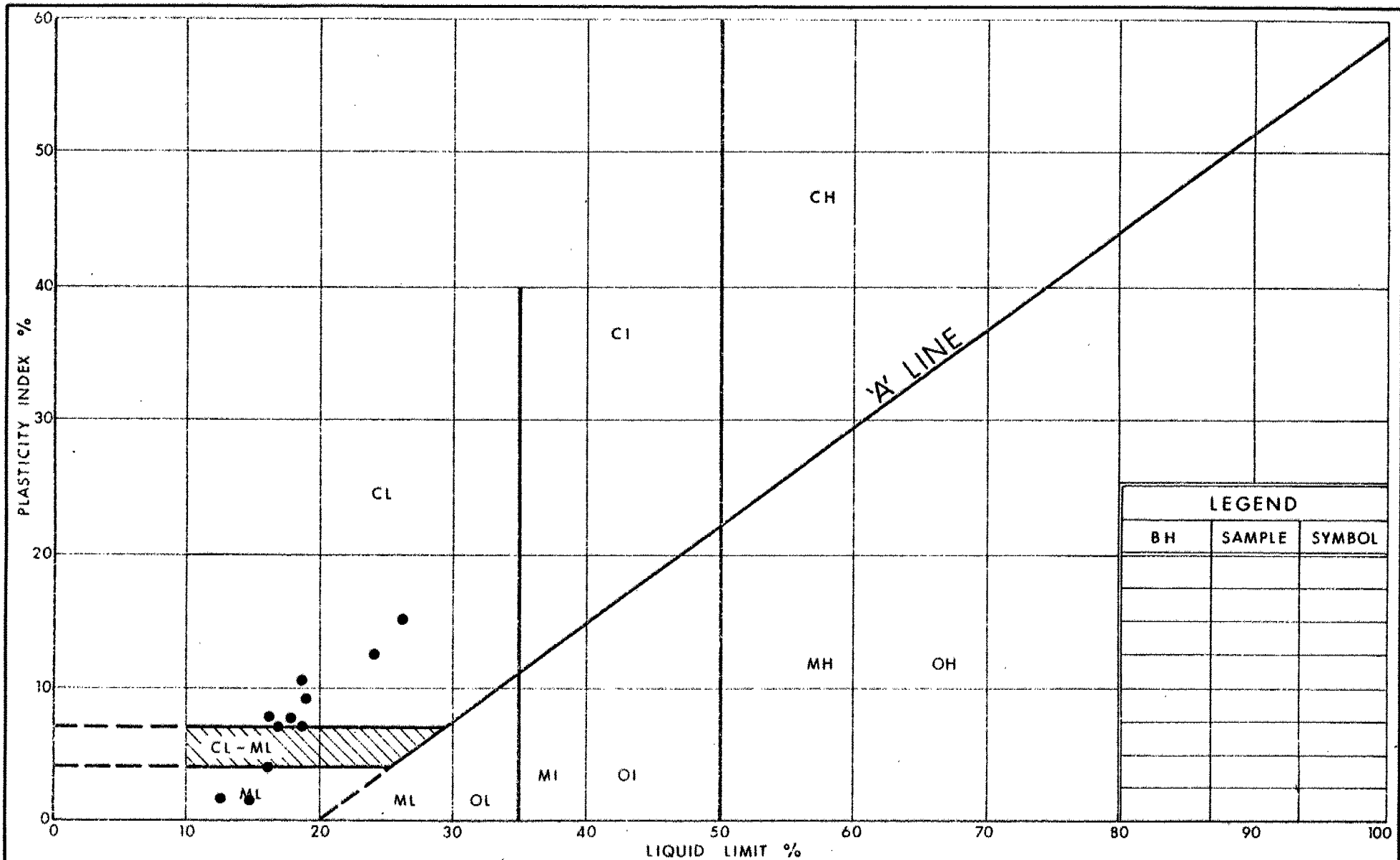


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT
TRACE OF CLAY & GRAVEL

FIG No 1

W P 7-79-07



Ministry of
Transportation and
Communications

PLASTICITY CHART
SILT TO SILTY CLAY OF LOW PLASTICITY
WITH TO SOME SAND, TRACE OF GRAVEL (Glacial Till)

FIG No 2

W P 7-79-07

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 - 30	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

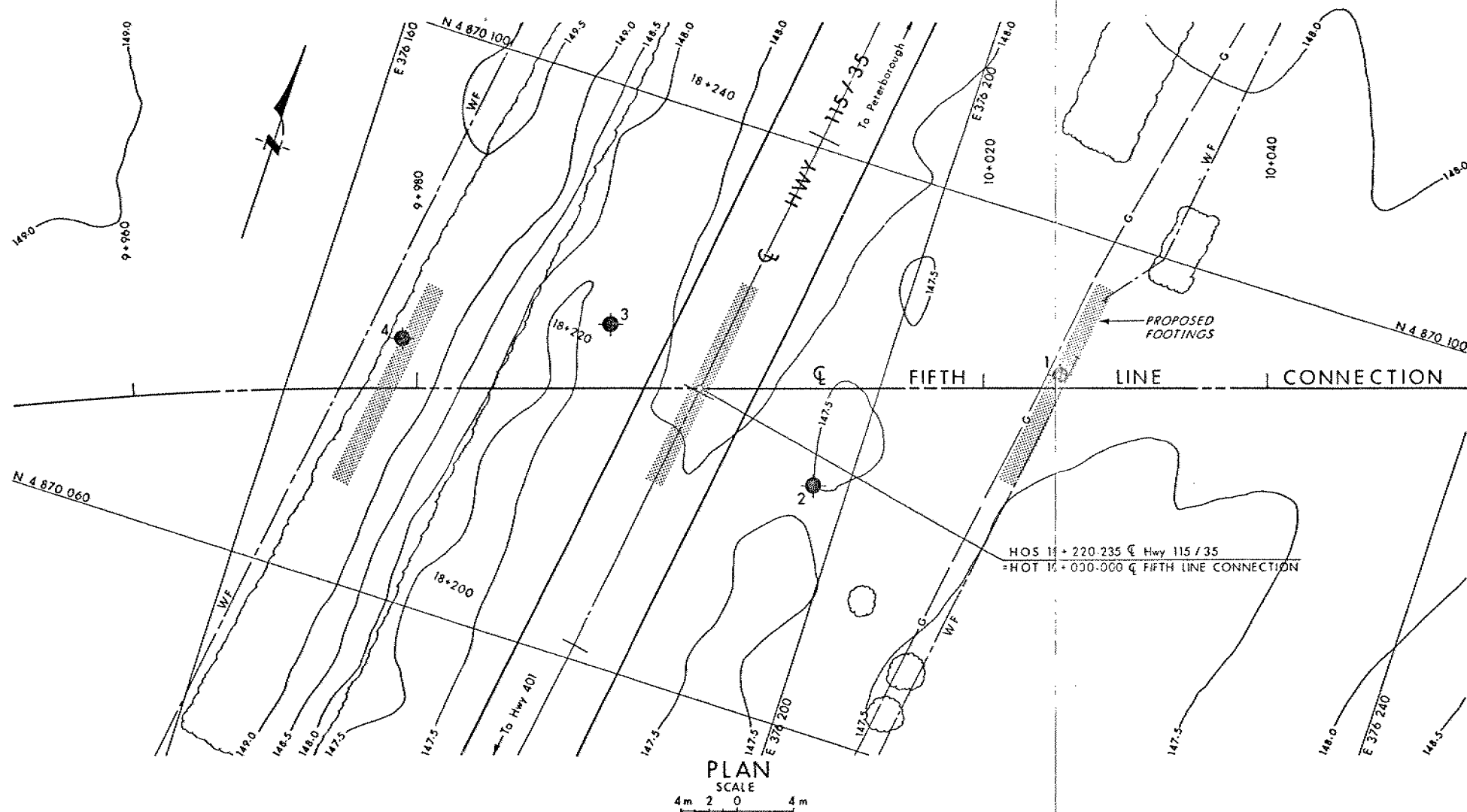
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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

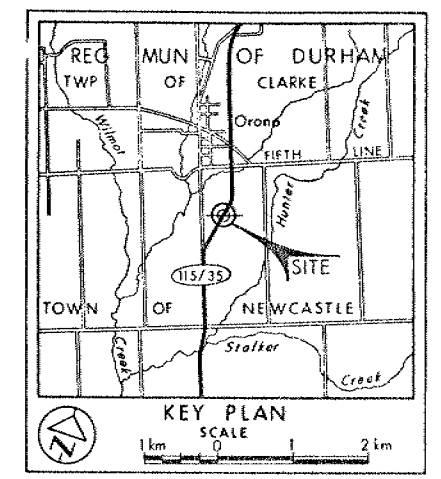


METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES UNLESS
 OTHERWISE SHOWN.
 STATIONS ARE IN
 KILOMETRES + METRES.

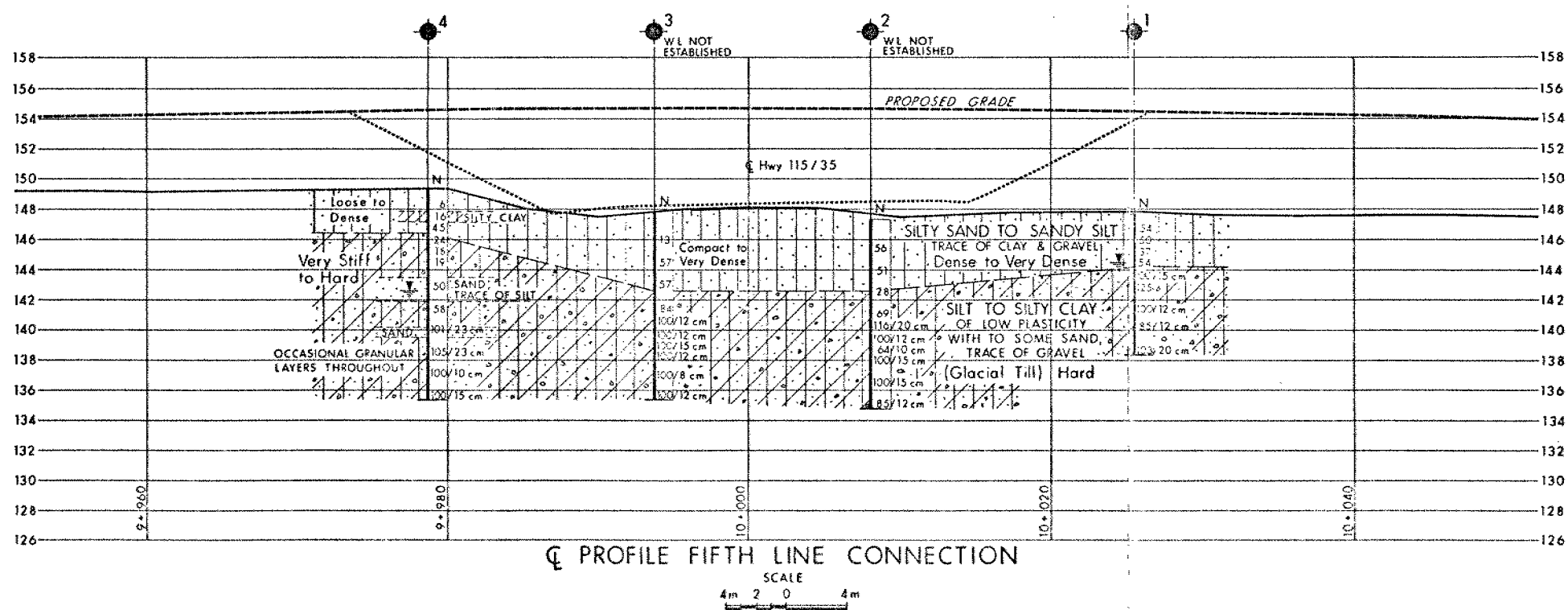
CONT No
 WP No 7-79-07
 FIFTH LINE UNDERPASS
 (8.6 km North of Hwy 401)
 BORE HOLE LOCATIONS & SOIL STRATA



SHEET



- LEGEND**
- Bore Hole
 - ⊕ Dynamic Cone Penetration Test (Cone)
 - ⊕ Bore Hole & Cone
 - N Blows/0.3m (Std Pen Test, 475 J/blow)
 - CONE Blows/0.3m (60° Cone, 475 J/blow)
 - W.L. at time of investigation 1981.05
 - W.L. Not Established in BH # 2 & 3



No	ELEVATION	CO ORDINATES NORTH	EAST
1	147.8	4870 089.8	376 211.8
2	147.3	4870 077.0	376 197.6
3	147.7	4870 088.5	376 180.5
4	149.3	4870 078.0	376 166.8

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

REVISIONS	
DATE	DESCRIPTION
Geocres No 30M15-60	
Hwy No 115/35	DIST 7
C. BARDIK	CHECKED DATE 1981.08.14 SITE 71-431
CRAWN	CHECKED DATE 1981.08.14 DWG 77907-A

memorandum



To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region

Date: 1981 07 16

From: Pavement & Foundation Design Section
Room 313, Central Building

Re: Proposed Fifth Line Underpass
Site 21-431, W.P. 7-79-07
Hwy. 35/115, District 7, Port Hope

This memo will summarize the subsurface conditions encountered during a foundation investigation program for the above mentioned structure and present design recommendations pertaining to the structure foundations and related earthworks. The complete report will be forwarded upon completion of laboratory testing and drafting requirements.

Subsurface Conditions

Briefly, the site is underlain by a surficial deposit of silty sand to sandy silt encountered for a maximum depth of 5.2 metres. The denseness of this stratum based on interpretation of 'N' values indicates a range from loose to very dense, but predominantly very dense. Underlying this surficial granular deposit and explored for a maximum thickness of 11 metres is a glacial till composed of a slightly plastic silt to silty clay of low plasticity with sand and a trace of gravel. Occasional seams and layers of sand were encountered throughout this deposit. A factual assessment of the consistency for this till material ranges from very stiff to hard, but generally hard throughout.

Stabilized water level readings taken in two boreholes indicated groundwater elevations varied from elevation 142.3 at the west abutment to elevation 144.1 at the east abutment location.

Discussion and Recommendations

Proposed widening of Hwy. 35/115 will require a 2 span underpass structure to carry the Fifth Line Concession Rd. over the highway. A suggested profile grade for the concession road of elev. 155.6, will necessitate fill heights in the order of 8 metres.

Recommendations pertaining to the foundations of the new structure and the related earthworks are summarized as follows.

Perched abutments can be founded on spread footings located on a well compacted Granular 'A' core within the approach fills. Excavations for the core should be carried down to elevation 147 for both abutment locations to insure removal of all loose surficial material.

cont'd..../2

For footings founded on a well compacted Granular 'A' core constructed to M.T.C. standards, an allowable capacity at the S.L.S. Type II of 280 kPa and a factored capacity at the U.L.S. of 430 kPa may be used.

Pier elements can be founded on spread footings located at or below elevation 145.5 for a design capacity at the S.L.S. Type II of 280 kPa and a factored capacity at the U.L.S. of 430 kPa.

Earth pressures against the abutment wall should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. Manual.


Resistance to sliding of the abutment footings can be calculated using a coefficient of friction of 0.6 between the underside of the concrete foundation and the Granular 'A' core.

The underside of all footing elements should be provided with a minimum 1.5 metres of earth cover for frost protection purposes.

No dewatering problems are anticipated since excavation will be carried out above the prevailing water table.

Embankment slopes constructed to a 2:1 geometry are not expected to undergo any stability or maintenance distress.

We trust the information provided in this memo is sufficient in scope for your immediate design requirements. Should further discussion be warranted, please feel free to contact this Section.


for: T.J. Kazmierowski
Foundations Engineer

TJK:ea

cc: R.D. Gunter
F. Norman
D.E. Thrasher
K. Bassi
B.J. Giroux
R. Hore