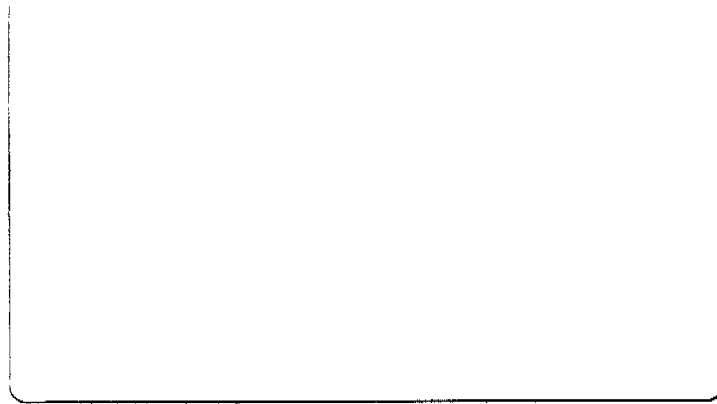


Geoc No 30 M15 -70

GO-ALERT



FINAL



Ministry of
Transportation and
Communications

Foundation Investigation
Henry Street Underpass
140 m South of Hwy 401
W.P. EGG-000-21
District 6, Whitby, Ontario

B.P.Walker Associates Ltd.

Consulting Geotechnical, Inspection and Testing Engineers

101 Amber Street, Suite 2, Markham, Ontario, L3R 3B2

(416)491-4075

April 30, 1984

Project No.:1743A-4/4

Ministry of Transportation & Communications
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

ATTENTION: Mr. M. Devata, P. Eng.

Foundation Investigation
Henry Street Underpass
140 m South of Hwy 401
W.P. EGG-000-21
District 6, Whitby, Ontario

Dear Sir:

INTRODUCTION

This report contains the results and recommendations of a foundation investigation carried out at the site of the above mentioned project during the period of August 24th to 26th, 1983 inclusive for the underpass and the retaining walls and during the period of April 2nd to April 5th for the extension of the north east retaining wall.

The boreholes ranged in depth from 12.4 m to 16.8 m below the existing ground surface.

SITE DESCRIPTION & GEOLOGY

The site is located about 140 m south of Hwy 401 in the Town of Whitby in Regional Municipality of Durham.

The area is located in the physiographical region known as the Iroquois Plain. In this area the subsoil is a mosaic of till plains, drumlins and areas of silty lacustrine deposits. The topography is flat to gently rolling.

SUBSURFACE CONDITIONS

Subsurface conditions at the site were found to be generally uniform. The original ground, under a thin layer of topsoil, is a glacial till composed of a heterogeneous mixture of silty clay and sand, trace gravel changing with depth to a granular heterogeneous mixture of sand with silt and clay. At borehole nine (9) location a deposit of silty clay with sand and gravel (reworked shale till) was encountered below the granular sand with silt and clay at an elevation of 77.7 m. The boundaries between the upper slightly cohesive glacial till and the lower non-cohesive portion of this deposit vary from a depth of 2.3 m to 5.0 m below the original ground level. The boundary of the glacial till stratum is at an elevation varying from 74.7 m to approximately 73.7 m, on shale bedrock encountered at borehole 1, 7, 8 and 9, but this was not proven by coring. The existing Henry Street embankment is composed of fill material which is borrowed parent material composed of cohesive glacial till.

A detailed description of the soil encountered in each borehole is given in the Record of Borehole sheets. The estimated stratigraphical profile and the sections shown on Drawing EGG-000-21-A and B are based upon this information. The location of the boreholes is also shown on the above drawing. From ground level downwards, the subsurface conditions are as follows:

Fill Material

Three boreholes, boreholes 2, 3 and 5, were carried out through the embankment of the existing Henry Street at the north and south of the site. The thickness of the fill material was found to be about 4.9 m. The fill material is comprised of a cohesive glacial till (heterogeneous mixture of silty clay, sand and gravel) and contains occasional traces of organics.

Standard Penetration Tests gave 'N' values in the range of 6-41 blows per 30 cm, indication that the fill material has a firm to hard consistency.

The results of grain size distribution testing performed on representative samples from the fill are shown on Figure 1.

Glacial Till (Heterogeneous mixture of silty clay and sand trace gravel changing with depth to a heterogeneous mixture of gravelly sand with silt and clay).

Under a thin layer of topsoil or immediately under the fill material is a deposit of glacial till. The deposit is composed of a cohesive heterogeneous mixture of silty clay and sand, trace gravel changing with depth to a heterogeneous mixture of gravelly sand with silt and clay. The boundaries between the upper slightly cohesive glacial till and the lower non-cohesive portions of this deposit vary from a depth of 2.3 m to 5.0 m below the existing ground level.

Silty Clay with Sand and Gravel (Reworked Shale Till)

Reworked shale till was encountered at borehole nine (9) only at an elevation of approximately 77.7 m. This deposit is composed of silty clay with sand and gravel and is grey in colour. Standard Penetration test gave 'N' values of over 100 blows per 30 cm indicating the consistency of the deposit to be hard.

The results of the Atterberg Limit Tests carried out on upper glacial till are shown on the Plasticity Chart on Figure 4. These results indicate that the matrix is inorganic and of low plasticity (CL- ML to ML Zone).

The results of grain size distribution testing performed on representative samples from the upper glacial till are shown in envelope form on figure 2. The results for the lower glacial till are shown in envelope form on figure 3 for boreholes 1, 2, 4 & 5 and on figures 5 & 6 for boreholes 7 & 8.

The result of grain size distribution test performed on reworked shale till is shown on figure 7.

The standard penetration tests gave 'N' values in the range of 20 to over 100 blows per 30 cm. Based on these 'N' values the consistency of the slightly cohesive upper stratum is estimated to be very stiff to hard, whereas the relative density of the lower non-cohesive portion of the glacial till is dense to very dense, generally in the very dense range. The low 'N' values at an elevation of approximately 78.0 m at boreholes 7 & 8 are probably due to loosening of the non-cohesive soil and do not represent the true density of the soil. A dynamic cone penetration test carried out in a borehole approximately 1.0 m from borehole 8, augered to 9.1 m, substantiates this point. The cone penetration results are shown on the borehole log.

The lower boundary of the glacial till was on possible shale encountered at depth varying from about 13.7 m to about 15.2 m below original ground but this was not proved by coring.

GROUND WATER

A piezometer was installed at borehole eight location in order to establish the stabilized water table. At other boreholes the ground water level conditions were observed by measuring in the open boreholes during and after completion of the foundation investigation. The stabilized water table at borehole eight (8) was at an elevation of 83.4 m. The ground water level at other boreholes was found to vary between elevations of 82.3 m to 86.6m.

DISCUSSION & RECOMMENDATION

A new structure is proposed for this site. It will consist of an underpass separating the existing Henry Street and the proposed GO-ALRT tracks. The top of GO-ALRT track elevation will be at about 84.4 m, about 4.8 m below the existing natural ground level. Retaining walls are proposed on both east and west sides of the underpass.

The founding elevation of the underpass and the retaining walls will be at an elevation of about 81.3 m. This will place the footings in the lower glacial till.

In view of the competence of the soils at the above founding elevation, foundations for the structure should be quite straightforward.

STRUCTURE FOUNDATIONS

We recommend that foundations consist of footings placed in competent natural glacial till. Footings placed at the above elevation may be designed using a factored bearing capacity at Ultimate Limit States (Q_f) of 1000 kPa.

For foundations designed as given above, the resulting settlement will be less than 12 mm. The loading required to produce detrimental settlement of the structure will be considerably more than the factored bearing capacity at Ultimate Limit States. The factored bearing capacity at Serviceability Limit States, will, therefore, not be the governing factor in the design of the above structure.

Backfill to the structures should consist of granular material in accordance with M.T.C. Standard, Special Provision #121, October 1983. Computation of the earth pressure should be in accordance with 6.6.1.2/ of the O.H.B.D.C. If granular 'A' backfill is to be used the following properties may be assumed for design:

$$\gamma = 22 \text{ kN/m}^3, \quad \phi = 35^\circ$$

If granular 'B' backfill is to be used a fairly wide range of values of γ and ϕ exists and unless the exact source of the material is known and tests are done predictions of both γ and ϕ may be subject to considerable error. In this case it will be necessary to compute earth pressure in accordance with 6.6.1.2.2 of the O.H.B.D.C. It should be noted that for earth pressure coefficients, since the foundation is non yielding, the "at rest" condition applies.

For a free draining material, the following equivalent fluid pressure may be assumed.

(a) At Ultimate Limit States

- | | |
|--------------------|------------|
| (i) Active State | 8.0 kPa/m |
| (ii) At Rest State | 10.0 kPa/m |

(b) At Serviceability Limit States

- | | |
|--------------------|-----------|
| (i) Active State | 6.5 kPa/m |
| (ii) At Rest State | 8.5 kPa/m |

Adequate permanent drainage should be provided for the backfill to ensure that water pressure does not build-up.

All footings should be placed below a depth of 1.2 m to avoid frost penetration.

For footings placed on the dense to very dense lower glacial till we recommend a coefficient of sliding resistance between concrete of the footing and natural till of 0.84. This value is based at an angle of shearing resistance of 40° .

CONSTRUCTION CONSIDERATIONS

The footings, placed at an elevation of 81.3 m or below, will be below the existing water level and it will be difficult to maintain the non-cohesive lower glacial till in an undisturbed state below the water table.

With the present water level it will be necessary to dewater the area prior to excavation for footings. It is our opinion that the amount of water will not be great and pumping from sumps, around the perimeter of the excavation, will be adequate.

Since the water level may vary, depending on the season of the year, we will recommend that the water level should be checked prior to starting the excavation to determine if the dewatering will be required.

The faces of temporary excavation in the fill material of the embankment and in the glacial till, about the water table, should safely stand at an angle of 45°. Tarpaulins should be placed on sand to prevent surface erosion during rainfall.

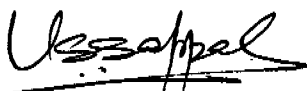
MISCELLANEOUS

The field work for the investigation was performed under the supervision of Mr. Mark McKinnon, Technician and David Oliver, Junior Engineer. The drilling equipment was operated by Master Soil Investigations Ltd., Weston, Ontario.

We are pleased to provide this service to you. If you have any questions concerning the contents of this report, please contact this office.

Yours very truly,

B.P. WALKER ASSOCIATES LTD.



U.S. Sappal, P. Eng.



B.P. Walker, Ph. D., P. Eng.



RECORD OF BOREHOLE No 1

METRIC

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 318.0; E 349 667.0 ORIGINATED BY MM
 DIST 6 HWY GO - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY USS
 DATUM GEODETIC DATE 83 - 8 - 24 CHECKED BY BPW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					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					
89.0	GROUND LEVEL																
0.0	Silty clay and sand, trace of gravel, (Upper Glacial Till) Low Plasticity Very Stiff to Hard		1	SS	20		88										5 47 36 12
			2	SS	59												
			3	SS	72		86										
			4	SS	115												
84.4																	
4.6	Gravelly Sand, trace of silt and clay (Lower Glacial Till) Very Dense Brown Grey		5	SS	132		84										27 61 12
			6	SS	61/8cm												
			7	SS	130/15cm		82										
			8	SS	50		80										
			9	SS	186		78										
			10	SS	134		76										
73.7							74										
15.3	Shale, weathered, grey																
72.2																	
16.8	End of Borehole						72										

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



RECORD OF BOREHOLE No 2

METRIC

W P EGG - 000 - 21

LOCATION Co-ords N 4 858 315.3: E 349 682.8

ORIGINATED BY MM

DIST 6

HWY 60 - A.L.R.T.

BOREHOLE TYPE SOLID STEM AUGER & CONE TEST

COMPILED BY USS

DATUM GEODETIC

DATE 83 - 8 - 25

CHECKED BY BPW

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					
93.6	GROUND LEVEL															
0.0	Silty clay and sand, trace of gravel (Fill) Low Plasticity Firm to Hard		1	SS	6											
			2	SS	41											
			3	SS	28											
			4	SS	25											
88.5			5	SS	11											
5.1	Silty clay and sand, trace of gravel (Upper Glacial Till) Low Plasticity Hard		6	SS	80											
	Brown		7	SS	110/15cm											
	Grey		8	SS	87/15cm											
82.8			9	SS	114/15cm											
10.8	Gravelly Sand, trace of silt and clay (Lower Glacial Till)		10	SS	100/12cm											
81.1	Very Dense															
12.5	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



METRIC

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 311.7; E 349 712.0 ORIGINATED BY MM
DIST 6 HWYGO - A.I.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST COMPILED BY USS
DATUM GEODETIC DATE 83 - 8 - 25 CHECKED BY RPW

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
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Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P EGG - 000 - 21

LOCATION Co-ords N 4 858 308.4; E 349 673.3

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST

COMPILED BY USS

DATUM GEODETIC

DATE 83 - 8 - 24

CHECKED BY BFW

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				
89.4	GROUND LEVEL															
0.0	Silty clay with sand trace of gravel (Upper Glacial Till) Low Plasticity Very stiff to hard		1	SS	23		88									
			2	SS	38											
			3	SS	80											
			4	SS	99/15 cm		86									
84.8	Brown															
4.6	Grey Gravelly Sand with trace of silt and clay (Lower Glacial Till) Non Plastic Very Dense		5	SS	115		84									
			6	SS	71/15 cm		82									
			7	SS	107											
			8	SS	96		80									
			9	SS	82/8 cm		78									
76.9			10	SS	120/15 cm											
12.5	End of Borehole						76									

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P EGG - 000 - 21

LOCATION Co-ords N 4 858 301.6; E 349 702.8

ORIGINATED BY MM

DIST 6 HWY 40 - A.T.R.T.

BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST

COMPILED BY USS

DATUM GEODETIC

DATE 83 - 8 - 24

CHECKED BY BPW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100					
93.2	GROUND LEVEL													
0.0	Silty Clay with sand, trace of gravel (Fill) Low Plasticity Firm to Very Stiff		1	SS	17		92						22.1	
			2	SS	20									8 26 31 35
			3	SS	20									
			4	SS	7		90							
88.3			5	SS	27									
4.9	Silty clay and sand, trace of gravel (Upper Glacial Till) Low Plasticity Hard		6	SS	74		88							17 42 29 12
84.6	Brown		7	SS	100	10cm	86							
8.6	Grey		8	SS	103	15cm	84							
	Gravelly Sand with silt and clay (Lower Glacial Till) Very Dense		9	SS	128	15cm	82							20 62 9 10
80.8			10	SS	152	15cm								
12.4	End of Borehole						80							

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P BGC - 000 - 21 LOCATION Co-ords N 4 858 300.7; E 349 715.6 ORIGINATED BY MM
 DIST 6 HWY GO - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST COMPILED BY USS
 DATUM GEODETIC DATE 83 - 8 - 26 CHECKED BY BPW

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					
89.2	GROUND LEVEL																
0.0	Silty clay and sand, some gravel (Upper Glacial Till) Low Plasticity Very stiff to hard		1	SS	29		88										
			2	SS	55												
			3	SS	88												
			4	SS	101	15cm	86										
84.7	Brown																
4.5	Grey		5	SS	99	15cm	84										
	Gravelly Sand, trace of silt and clay (Lower Glacial Till) Non Plastic Very Dense		6	SS	98	5cm											
			7	SS	110	13cm	82										
			8	SS	100	10cm	80										
			9	SS	131		78										
76.5			10	SS	38												
12.7	End of Borehole						76										

RECORD OF BOREHOLE No 7

METRIC

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 306.8; E 349 735.0 ORIGINATED BY D.O.
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger to 9.1m Wash Boring Below COMPILED BY U.S.S.
 DATUM Geodetic DATE 84-04-02 and 84-04-03 CHECKED BY U.S.S.

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			20	40	60	80	100					
89.3	Ground Level															
0.0	Silty Clay & Sand, Some Gravel (Upper Glacial Till)		1	SS	8											
87.0	Low Plasticity, Stiff to Hard		2	SS	51											
2.3			3	SS	102											
	Brown Grey Gravelly Sand, Trace Silt and Clay (Lower Glacial Till)		4	SS	100	23cm										
	Non Plastic Very Dense		5	SS	100	15cm										
			6	SS	79											
			7	SS	100	25cm										
			8	SS	111											
			9	SS	16											
			10	SS	170	23cm										
75.6			11	SS	105	15cm										
13.7	Shale - Weathered															
73.9			12	SS	110	15cm										
15.4	End of Borehole															
	On completion cave-in at 4.9m. W.L. at 2.7m.															

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 301.0; E 349 759.4 ORIGINATED BY D.O.
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger to 10.7m, Wash boring below COMPILED BY U.S.S.
 DATUM Geodetic DATE 84-02-02 and 84-04-05 CHECKED BY U.S.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										SHEAR STRENGTH			WATER CONTENT (%)		
																		○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			10 20 30		
89.1	Ground Level																GR SA SI CL						
0.0	Silty Clay & Sand, Some Gravel, (Upper Glacial Till)		1	SS	13		88																
86.8	Low Plasticity, Very Stiff		2	SS	23																		
2.3	Brown Grey Silty Sand, Trace Gravel and Clay, (Lower Glacial Till), Very Dense		3	SS	64		86																
			4	SS	100	13cm		84															
			5	SS	100	25cm	Bentonite Seal																
			6	SS	100	9cm		82															
			7	SS	100	10cm		80															
			8	SS	15		Piezometer	78															
			9	SS	170			76															
74.9				10	SS	112																	
14.2		Shale - Weathered					74																
73.6		11	SS	100	10cm																		
15.5	End of Borehole																						
Cone Penetration Tests																							
(M) Penetra- tion																							
Depth	ELEV.	Resistance																					
9.1	80.0	140/30cm																					
9.4	79.7	100/4cm																					
9.8	79.3	200/30cm																					
10.1	79.0	194/5cm																					
10.4	78.7	57/30cm																					
10.7	78.4	80/30cm																					
11.0	78.1	200/23cm																					
11.3	77.8	23/30cm																					
11.6	77.5	100/30cm																					
11.9	77.2	100/8cm																					

+3, x5: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W.P. EGG - 000 - 21 LOCATION Co-ords N 4 858 295.0; E 349 783.8

ORIGINATED BY D.O.

DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger

COMPILED BY U.S.S.

DATUM Geodetic DATE 84 - 04 - 04

CHECKED BY U.S.S.

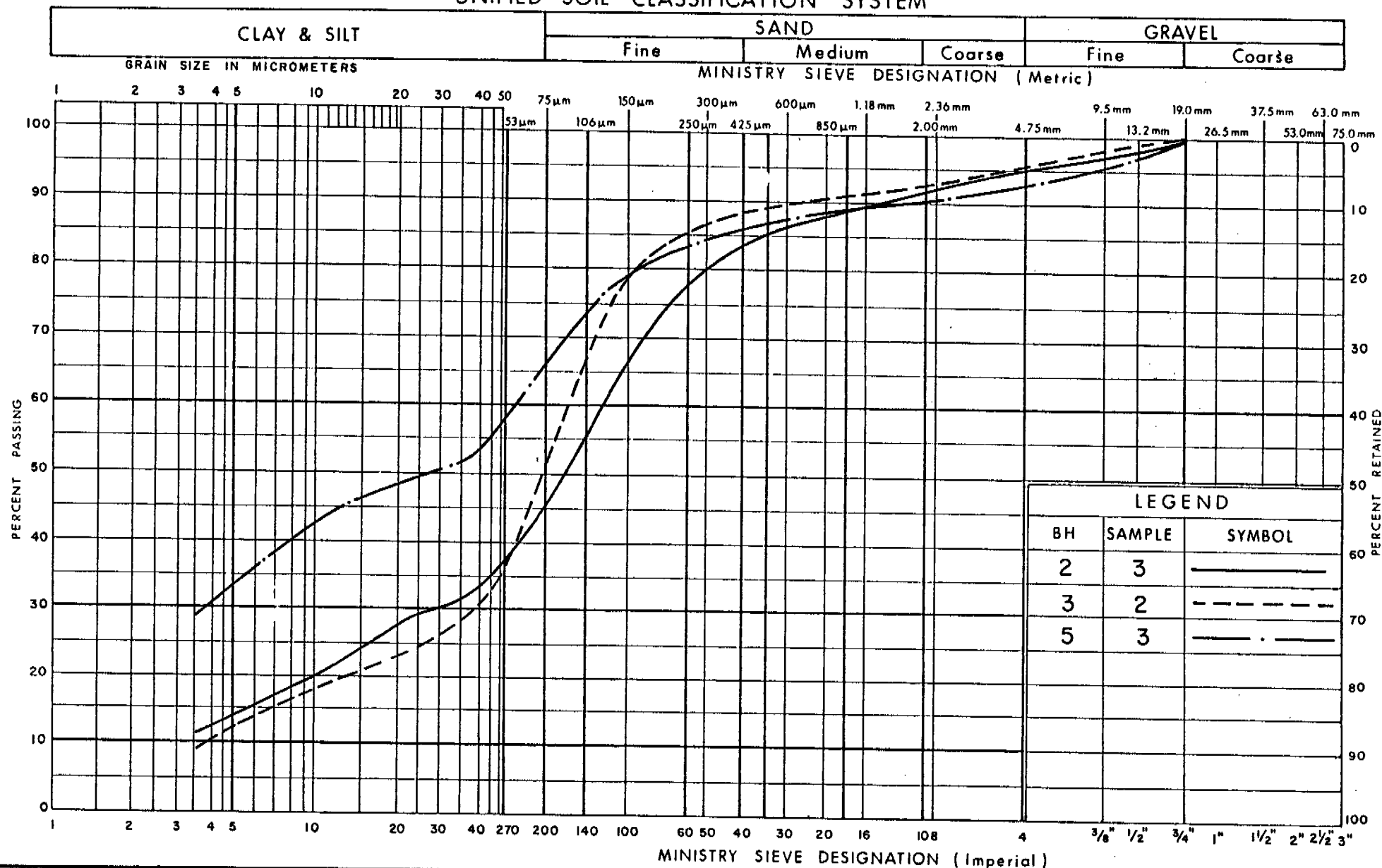
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
88.4	Ground Level																
0.0	Silty Clay & Sand, Some Gravel, (Upper Glacial Till), Low Plasticity, Very Stiff to Hard		1	SS	21	*	88										
			2	SS	38												
85.4			3	SS	41		86										
3.0	Brown Grey Silty Sand, Trace of Gravel and Clay (Lower Glacial Till) Very Dense		4	SS	51												
			5	SS	50/	3cm	84										
			6	SS	125	21cm	82										
			7	SS	100	13cm	80										
			8	SS	60/	3cm											
77.7			9	SS	100	13cm	78										
10.7	Silty Clay with Sand, Trace Gravel (Reworked Shale Till) Low Plasticity Hard		10	SS	160		76										
74.7			11	SS	100	5cm											
13.7	Shale - Weathered		12	SS	100	13cm	74										
73.0																	
15.4	End of Borehole																
	* W.L. not established																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to
Sensitivity

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

UNIFIED SOIL CLASSIFICATION SYSTEM



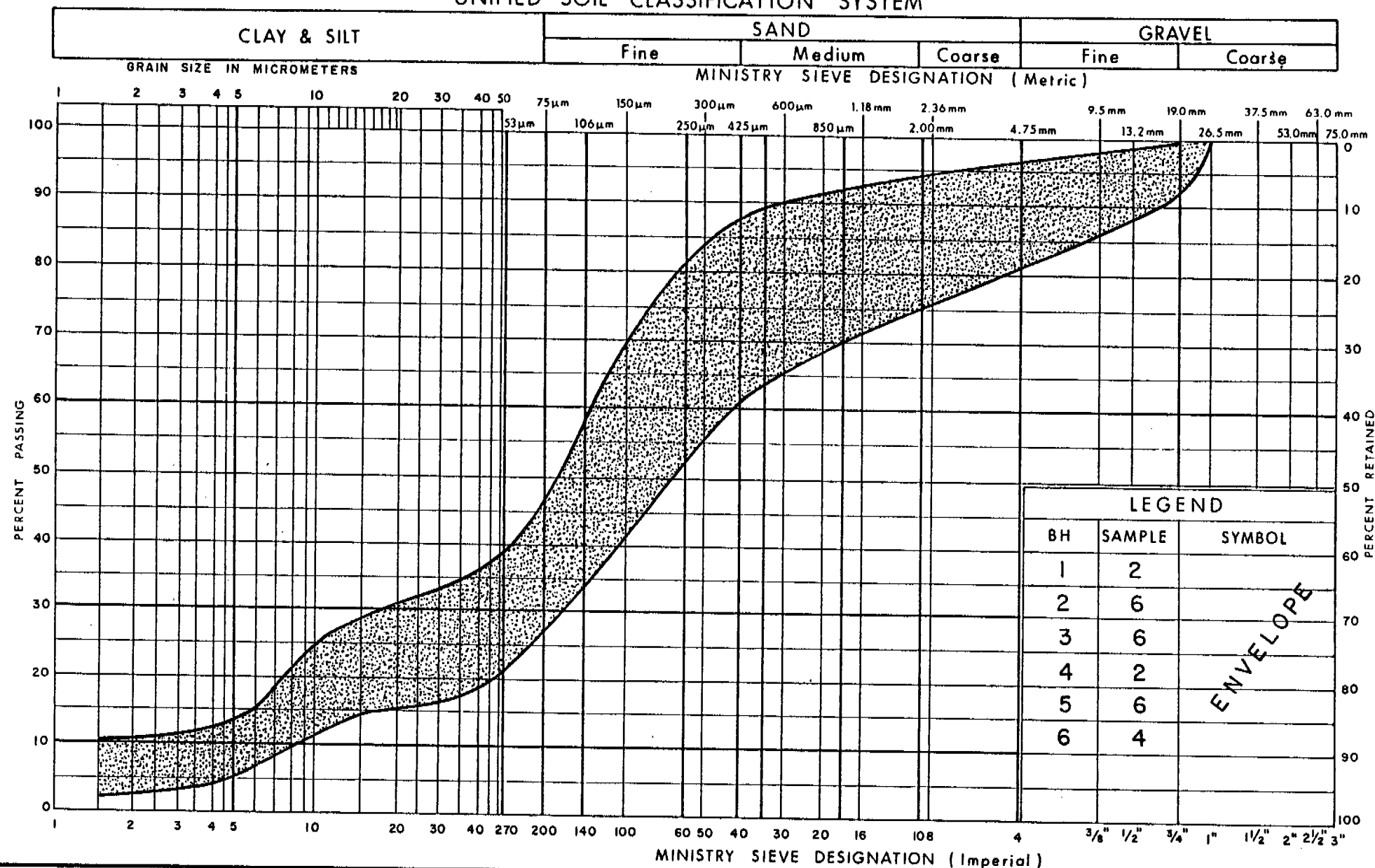
Ministry of
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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY AND SAND TRACE OF GRAVEL (Fill)

FIG No 1

WP EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

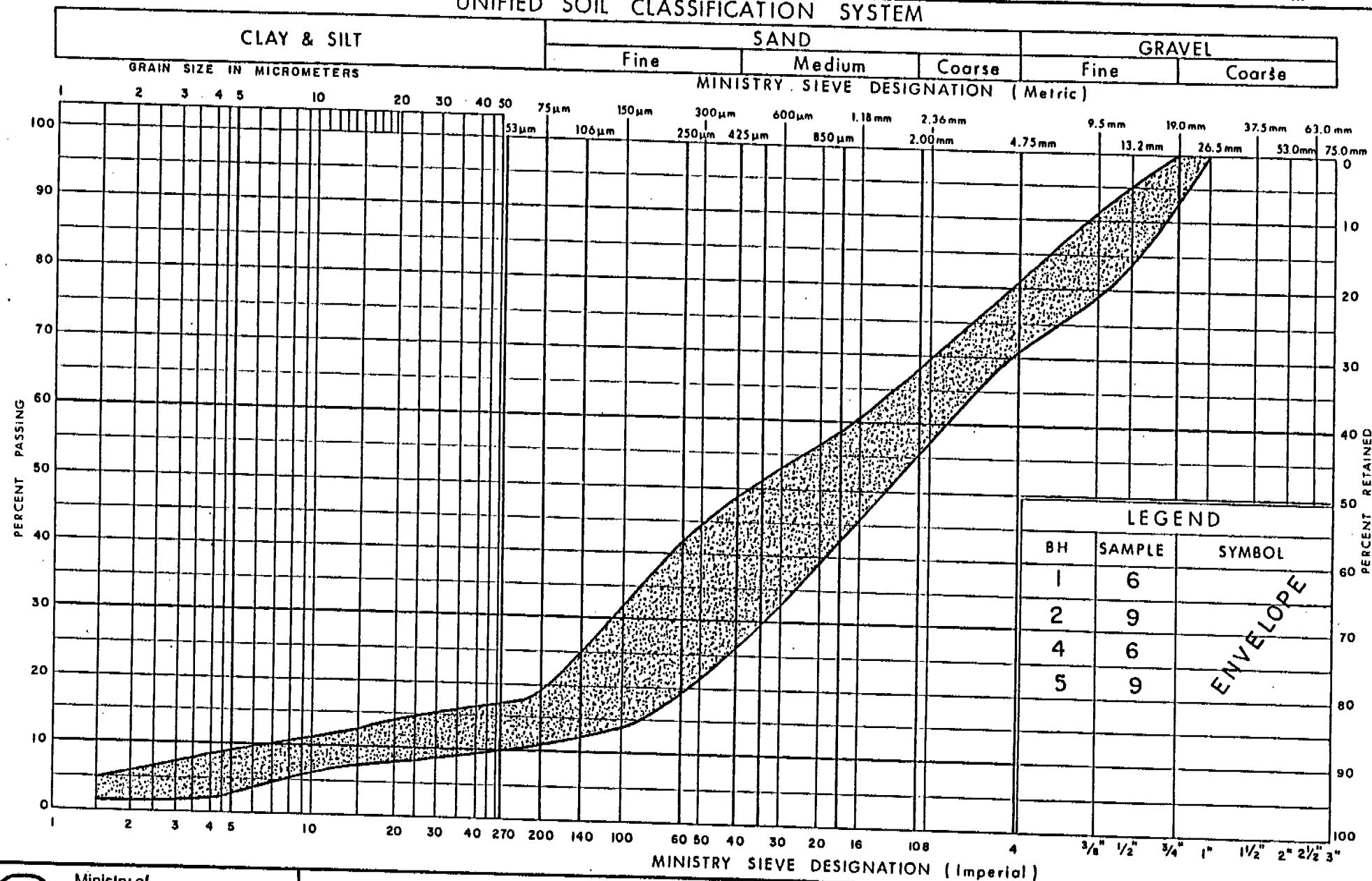
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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY AND SAND TRACE OF GRAVEL
 (Upper Glacial Till)

FIG No 2

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM

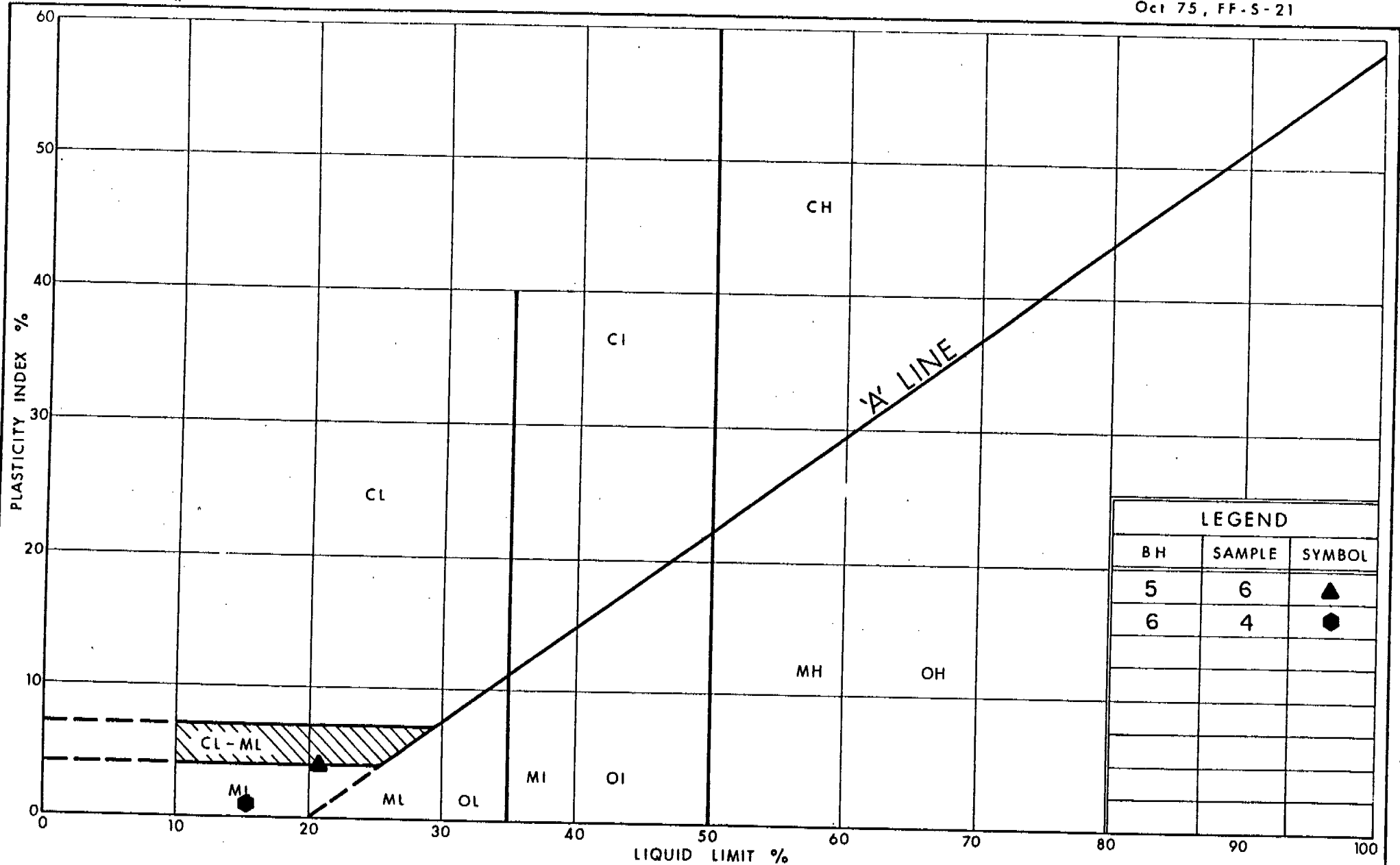


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GRAIN SIZE DISTRIBUTION
GRAVELLY SAND TRACE OF SILT AND CLAY
(Lower Glacial Till)

FIG No 3

WP EGG-000-21



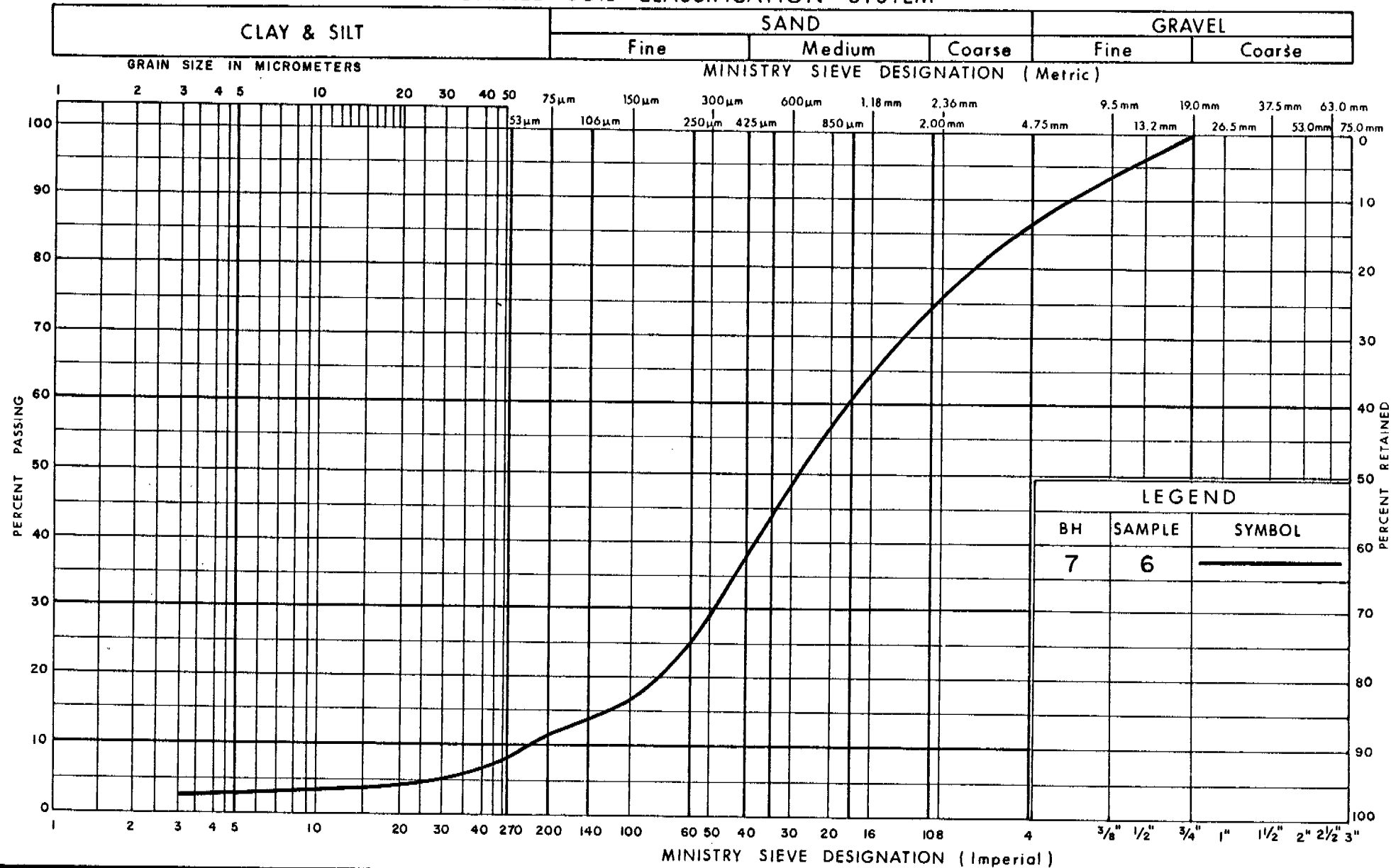
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PLASTICITY CHART SILTY CLAY AND SAND TRACE OF GRAVEL (Upper Glacial Till)

FIG No 4

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



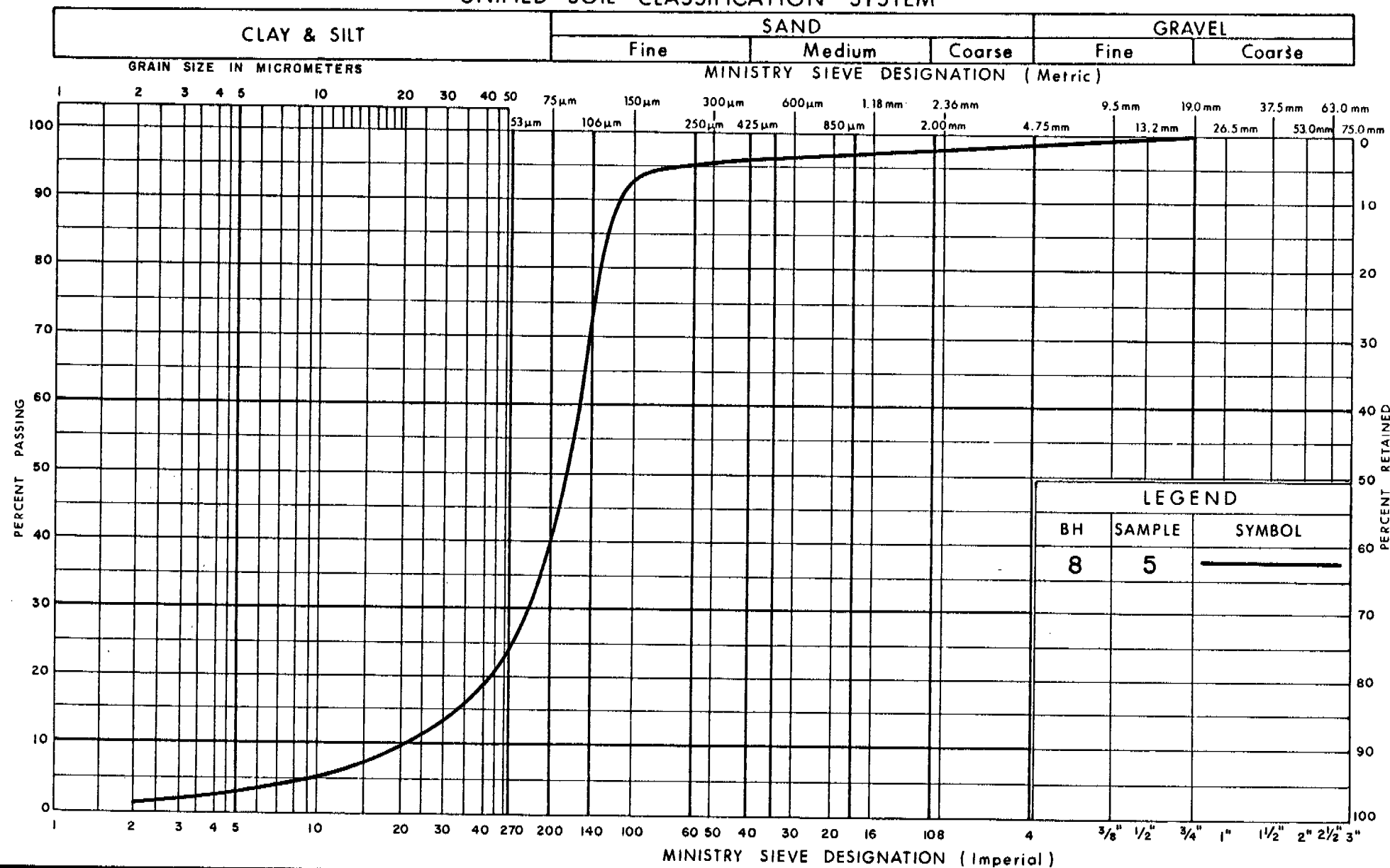
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, TRACE OF SILT AND CLAY
(Lower Glacial Till)

FIG No 5

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



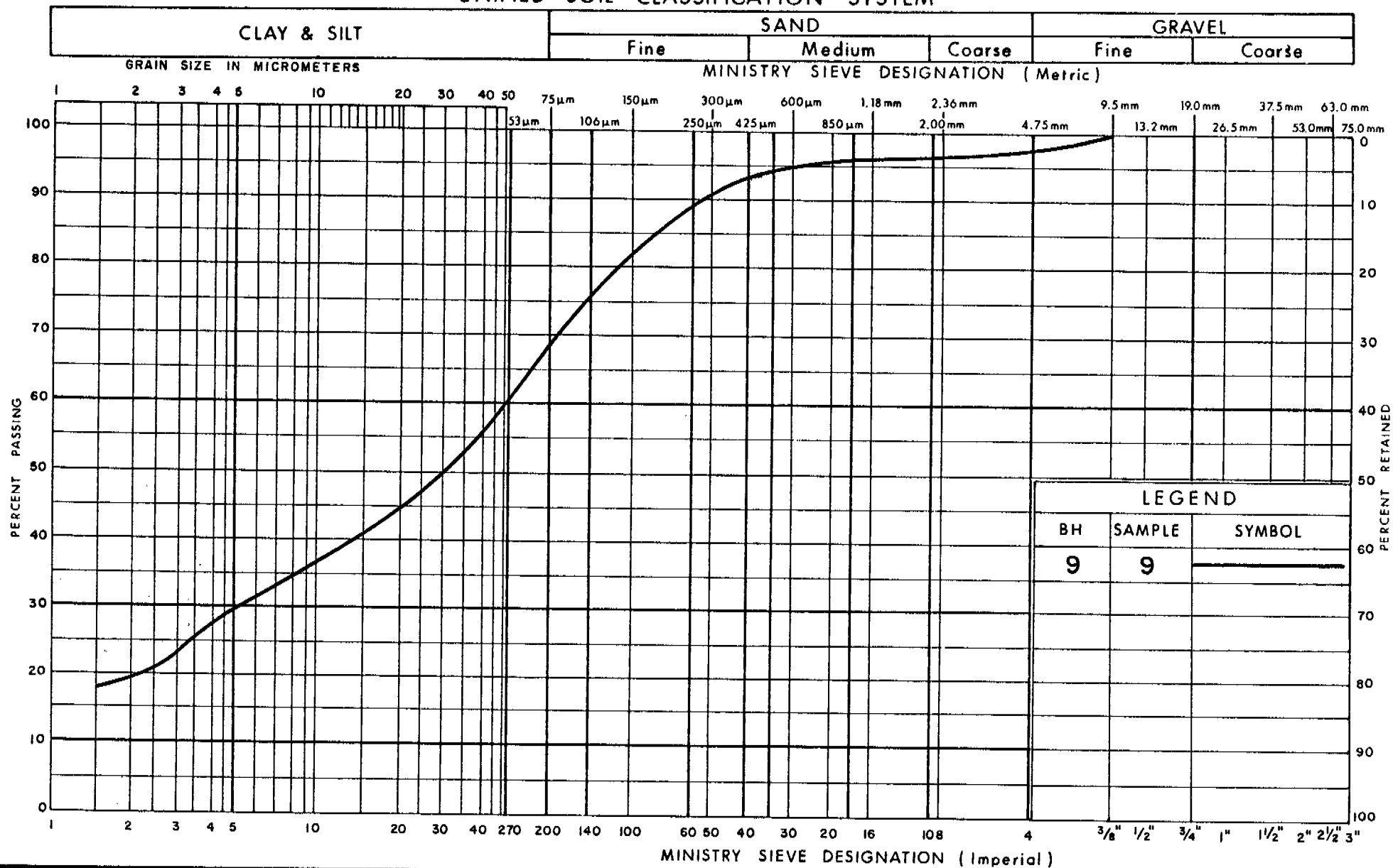
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND, TRACE OF GRAVEL AND CLAY
 (Lower Glacial Till)

FIG No 6

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH SAND, TRACE OF GRAVEL
 (Reworked Shale Till)

FIG No 7

W P EGG-000-21

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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

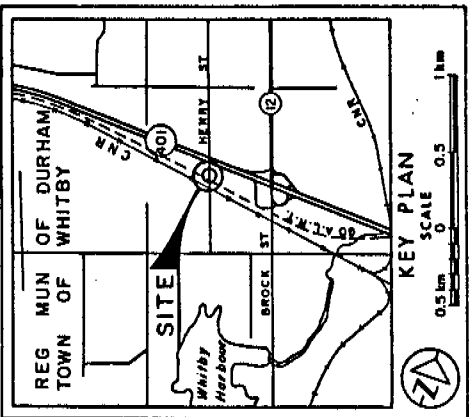
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

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
γ_{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

ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.



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 (40° Cone, 475 J/blow)
- W.L. at time of investigation Aug 1983 and April 1984

No	ELEVATION	CO-ORDINATES NORTH EAST
1	89.0	4858318.0 3496670.0
2	93.6	4858315.3 3496828.8
3	92.3	4858311.7 3497120.0
4	89.4	4858308.4 3496733.3
5	93.2	4858301.6 3497028.8
6	89.2	4858300.7 349715.6
7	89.3	4858306.8 3497350.0
8	89.1	4858301.0 349759.4
9	88.4	4858295.0 349783.8

Geocres No 30M15-70

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 included in accordance with the conditions of Section 102-2 of Form 100

90-ALRT REF PDI-601

HENRY STREET UNDERPASS

B.P. Walker Associates Ltd.
Ministry of Transportation and Communications

B.P. Walker Associates Ltd.

DESIGNED BY:
U.S.S.

APPROVED BY:
U.S.S.

SCALE:
FULL SIZE ONLY

AS NOTED

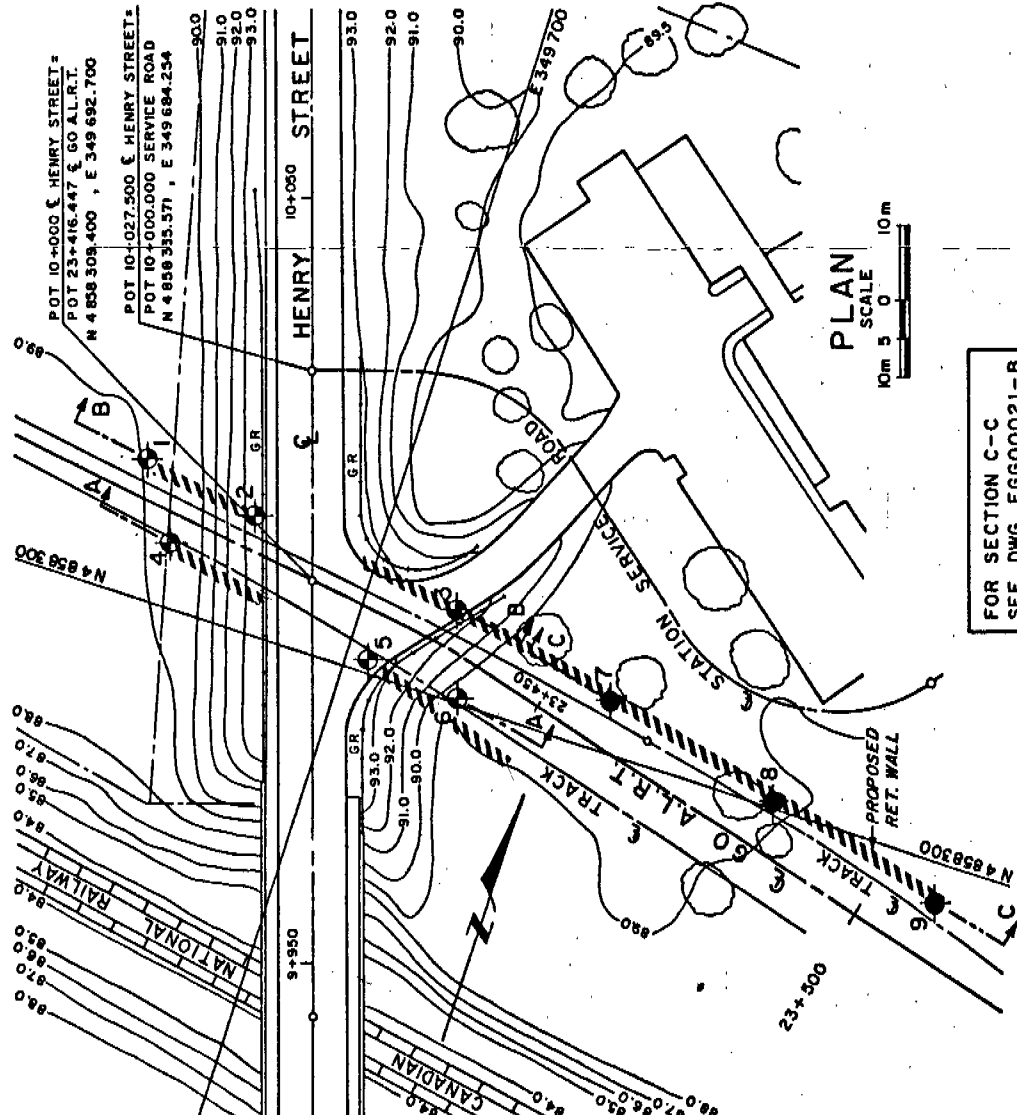
PROJECT MANAGER

CONTRACT NO
601

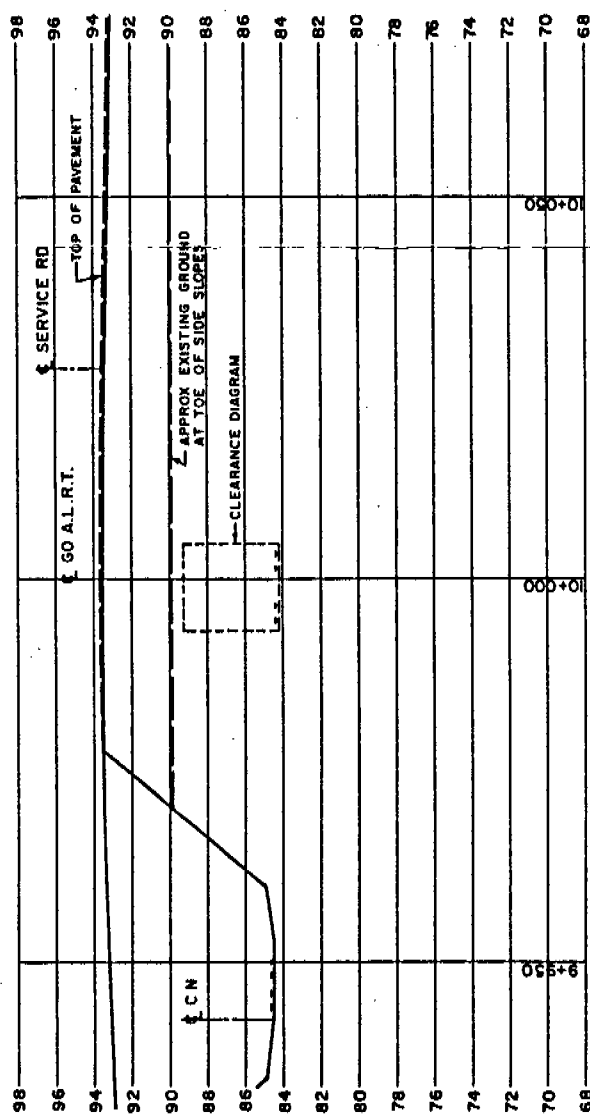
DWG NO
EGG00021-A

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SHEET

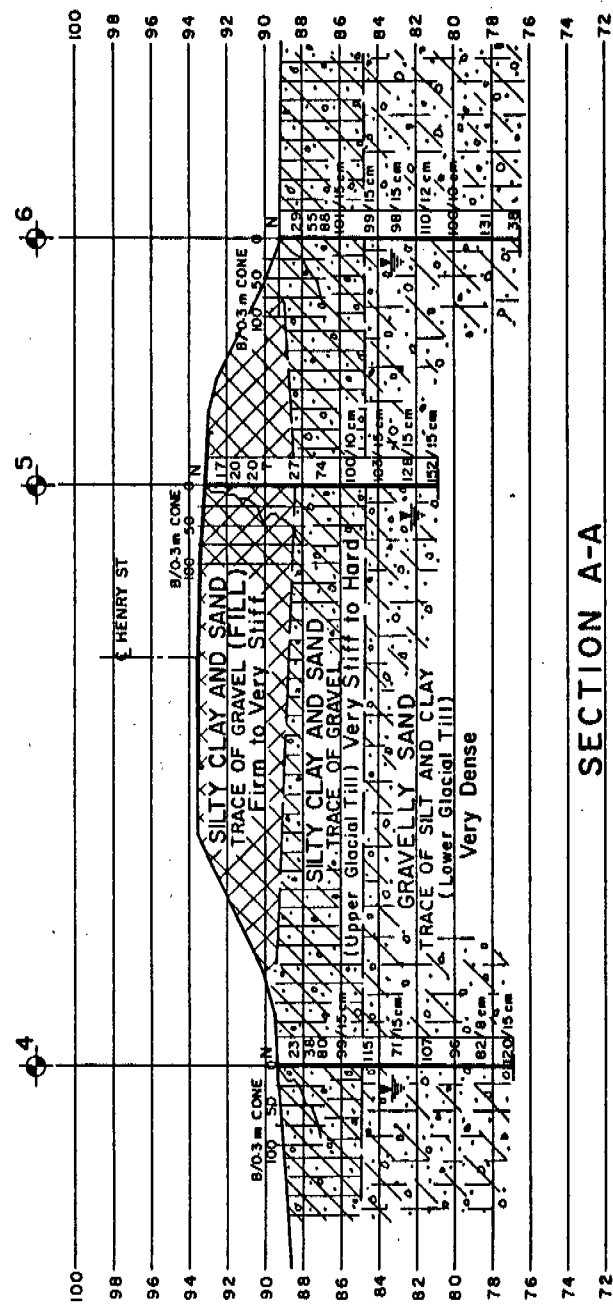


FOR SECTION C-C
SEE DWG EGG00021-B



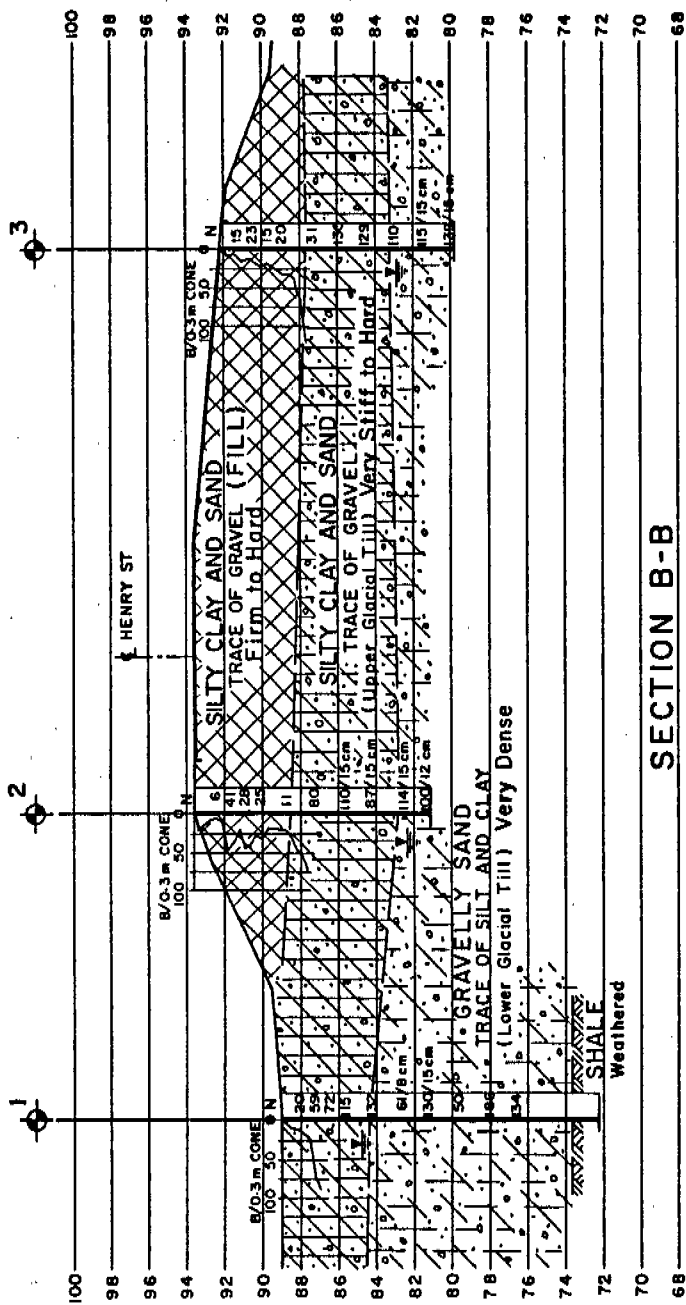
PROFILE HENRY ST

SCALE
HOR 10m 5 0 10m
VERT 4m 2 0 4m



SECTION A-A

SCALE
4m 2 0 4m



SECTION B-B

SCALE
4m 2 0 4m

REFERENCE DRAWINGS

REVISIONS

DRAWN BY:
D.T.

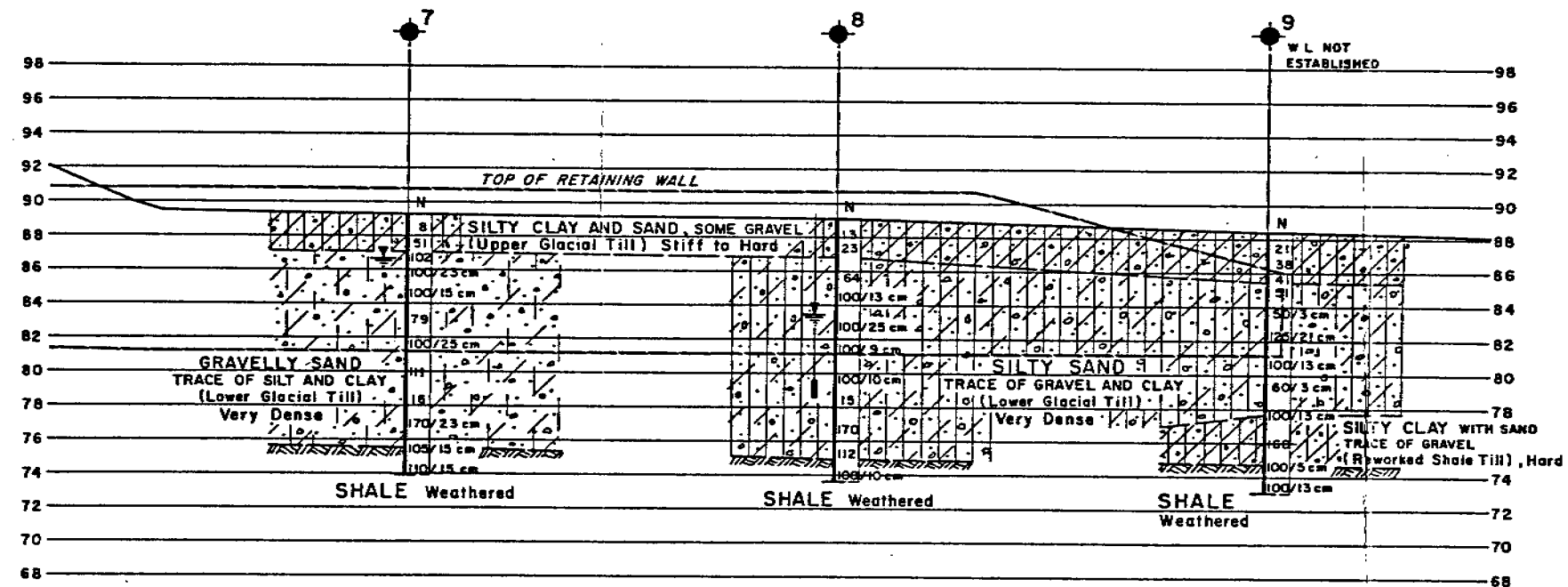
CHK'D BY:
U.S.S.

SCALE:
FULL SIZE ONLY

AS NOTED

METRIC

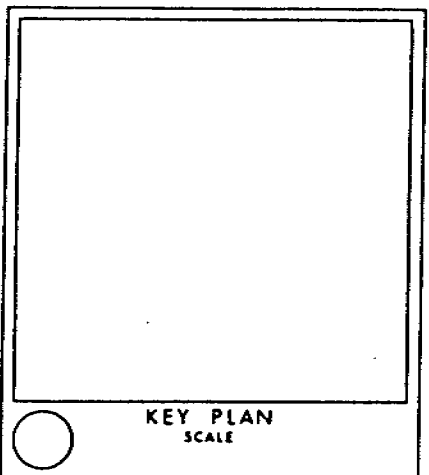
ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.



SECTION C-C

SCALE
10m 5 0 10m

FOR PLAN REFER TO
DWG No EGG00021-A



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 Apr 1984

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
7	89.3	4 858 306.8	349 735.0
8	89.1	4 858 301.0	349 759.4
9	88.4	4 858 295.0	349 783.8

Geocres No

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

GO-ALRT REF

REFERENCE DRAWINGS		REVISIONS		DRAWN BY:	DESIGNED BY:	B. P. Walker Associates Ltd.	 Ministry of Transportation and Communications	DURHAM REGION			
				D. T.	U.S.S.			HENRY STREET STRUCTURE			
				84 05 04	APPROVED BY:			RETAINING WALLS I			
				CHK'D BY:				CONTRACT NO	DWG NO	REV	SHEET
				U.S.S.				EGG00021-B			
				SCALE:	FULL SIZE ONLY			PROJECT MANAGER			



FOUNDATION INVESTIGATION REPORT

CONTRACT NO. GGE 330

SUPPLEMENT



Ontario

Ministry of
Transportation and
Communications

IndexPage

1	Index
2	Abbreviations and Symbols
3 - 38	Foundation Investigation Report for Proposed Sewers under Champlain Ave. West of Hopkins GO-ALRT Contract GGE-330

Note: For the purpose of this Contract, this report
supercedes all other foundation investigation
reports prepared by or for GO-ALRT in connection
with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

2

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	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:

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
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JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
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ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
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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						

1.0 INTRODUCTION

Dominion Soil Investigation Inc., Consulting Geotechnical Engineers, were retained by the Ontario Ministry of Transportation and Communications to conduct a geotechnical investigation for proposed sewers under Champlain Avenue, north of Highway 401 in Whitby, Ontario (GO-ALRT Project No. GGE-000-61).

The field work was carried out during the period of June 19 to June 23, 1984, and consisted of drilling eighteen boreholes to depths ranging from 4.1 to 9.8 m. The locations of the boreholes, along with subsurface profiles, are shown on Drawing Nos. GGE00061-E and F. The subsurface conditions encountered in the borings are presented on the Record of Borehole Sheets.

2.0 SUMMARIZED SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are given on the individual Record of Boreholes and conditions at each borehole location are also represented on the profiles presented on Drawing Nos. GGE00061-E and GGE00061-F. *

The subsurface conditions encountered in the boreholes can be summarized briefly as follows:

* These two drawings can be found in the Contract Drawing book and are identified as Sheet 36A and Sheet 36B.

.../...

Below some fill and, in some of the boreholes a layer of silty clay, the site is underlain by glacial deposits ranging from silty clay to silty sand till. Deposits and layers of sand were also encountered, especially in the areas covered by Boreholes 32, 33, 36 and 37.

The relevant index and engineering properties of the principal soil strata are briefly discussed in the following paragraphs.

2.1 Topsoil

A layer of topsoil, ranging in thickness between 0.08 and 0.6 m, was encountered at the ground surface in the majority of the boreholes. In addition, in some of the boreholes, topsoil layers or pockets were contacted within or below the fill.

2.2 Fill

The majority of the boreholes encountered fill extending to depths ranging between 0.3 and 3.3 m (Borehole 36) below the ground surface. In addition, material identified as probably fill was also encountered in several of the boreholes.

At several borehole locations the fill was comprised of basically non-cohesive, granular materials. Fill consisting of silty clay mixed with some sand and traces of organics was also found in many of the boreholes. In some of the boreholes the fill was also found to consist of sandy silt or silty sand with some gravel (derived from indigenous till materials). The

composition of the fill was thus found to be variable, not only from borehole to borehole, but in some cases also within the same borehole. Differences in the engineering properties such as permeability characteristics of the fill can, therefore, be expected even within short distances.

'N'-values recorded within these fill materials range from 3 to 56 blows/0.3 m, indicating that, in most cases, the fill has received some compaction.

2.3 Silty Clay

Silty clay was encountered in Boreholes 26, 27, 28, 37, 39 and 40 at depths ranging between 1.4 and 3.0 m below the ground surface and comprises the uppermost natural stratum below the fill. The thickness of the material ranges from 0.2 (Borehole 26) to 1.5 m (Borehole 40).

In some boreholes the silty clay has a layered, almost varved-like, structure whereas at other locations material with a blocky and probably sensitive structure was also noted.

Atterberg Limit tests performed on a sample from the silty clay deposit gave the following values:

Liquid Limit	50%	
Plastic Limit	22%	
Plasticity Index	28%	
Moisture Content	29 - 40%	(Average = 33%)

These values are characteristics of clays of medium-high plasticity.

Standard Penetration Resistances ('N'-values) recorded within the deposit are 7 to 15 blows/0.3 m. From these results, the consistency of the material is described as 'firm to very stiff'.

The silty clay is a practically impervious material.

2.4 Silty Clay Till

Silty clay till was encountered in the majority of the boreholes, drilled at the site, at depths ranging from approximately 0.3 m to 3.7 m below the ground surface, generally overlying the coarser sandy silt till deposits.

The grain size distribution of a typical sample from this deposit is shown on Figure 1, indicating approximately the following particle sizes:

Gravel	=	17%
Sand	=	27%
Silt	=	39%
Clay	=	17%

The following index properties were measured in the laboratory:

	<u>Range</u>	<u>Average</u>
Liquid Limit	21 - 32%	27%
Plastic Limit	11 - 15%	13%
Plasticity Index	8 - 21	14
Moisture Content	9 - 23%	16%

These values are characteristics of clay deposits of low to medium plasticity and the material can be expected to be practically impervious.

'N'-values recorded in this deposit generally range from 8 to more than 100 blows/0.3 m and field vane tests gave undrained shear strengths ranging from 132 to 180 kPa. From these values, the material is considered to be generally stiff to hard although 'N'-values less than 8 blows/0.3m also were recorded in some of the boreholes (e.g. Boreholes 28, 38, 39 and 40), indicating the presence of firm zones within the deposit.

2.5 Sandy Silt Till

The predominant soil stratum in many of the boreholes is sandy silt till. The material is an unsorted, non-homogeneous mixture of sand, silt, gravel and clay size particles. It is frequently interbedded with somewhat coarser silty sand till and finer silty clay till layers or zones, in addition to sand and occasional silt seams.

The grain size distribution of a sample from the deposit is shown on Figure 2, indicating the following composition:

Gravel	=	5%
Sand	=	50%
Silt	=	33%
Clay	=	12%

The material has a coarser texture than the silty clay till described in Section 2.4 and is basically a non-cohesive (granular) deposit. Owing to some cementation between the particles, however, it exhibits some apparent cohesion. In some instances where the clay content is somewhat greater, the material has a higher degree of cementation and cohesion.

The presence of some cobbles and boulders can be expected in the glacial till deposits.

The sandy silt till is considered to be moderately impervious with an estimated coefficient of permeability (k) of the order of 5×10^{-5} to 10^{-6} cm/sec. These values indicate moderate to small amounts of seepage through these materials. Heavier seepage can, however, be expected through the sand seams or layers present in the till. The measured moisture contents generally range from 7.5 to 10% with occasional lower values, but where the material is wet, higher moisture contents (up to 14%) were measured.

Penetration Resistances ('N'-values) recorded within the deposit are generally greater than 20 blows/0.3 m and in many instances, more than 50 blows/0.3 m, indicating a generally compact to very dense material. However, in some cases, 'N'-values were less than 20 blows/0.3 m and in two of the boreholes (i.e. Boreholes 25 and 30) less than 10 blows/0.3 m, indicating the presence of very loose to loose zones or layers.

2.6 Silty Sand Till

Silty sand till was generally found interbedded with the sandy silt till but was less frequently encountered. It has a somewhat coarser texture, is generally uncemented and can be expected to be more pervious.

.../...

In general, 'N'-values recorded within the silty sand till range from 30 to more than 100 blows/0.3 m, indicating a competent material except where 'N'-values between 2 and 10 blows were recorded (e.g. Boreholes 37 and 38).

2.7 Sand

Layers and deposits of sand were contacted at various borehole locations throughout the site. Frequent sand seams or lenses, in some cases water bearing, were generally found to be interbedded with the till deposits. In addition, relatively thicker sand layers were encountered in Boreholes 31, 36 and 37, while sand constitutes the predominant soil type at Boreholes 32 and 33.

In general, the grain size distribution of the sand is in the fine sand range with a trace to some silt size particles, as shown in Figures 3 and 4. Occasional coarser layers or zones, however, were also encountered (Figure 5).

Based on 'N'-values, which generally ranged upwards of 17 blows/0.3 m, the relative density of these deposits is described as compact to very dense with occasional loose zones (e.g. Borehole 37).

The sand deposits are expected to have a medium to high permeability. Below the water table considerable seepage could therefore be expected through these materials and they would also be unstable when excavated

below the water table. Furthermore, the silty fine sands will exhibit a tendency to dilate and could easily be disturbed when unloaded in the trenches.

A potential problem could arise if the base of the excavation in a relatively impervious stratum too closely approaches the upper surface of a more pervious sand layer which is under excess hydrostatic pressure. In such a case, the base of the excavation could be disturbed by bottom heave or piping. Under these conditions, the excess hydrostatic pressure in the sand, below the excavation level, will have to be relieved.

2.8 Silt

Occasional silt seams were encountered interbedded with the till deposits. In addition, at Borehole 40, a relatively thick sandy silt layer was encountered below 5.2 m.

The silt has a medium permeability. The silt and, in some cases, the silty fine sands and the relatively weaker and wet silty till could dilate upon excavation, especially in the presence of water. If the material below the invert level has a liverish, jelly-like appearance during trenching, the disturbed, dilated soil must be removed and if this is not feasible, it must be stabilized by a suitable method to prevent the dilatation of the soil.

.../...

2.9 Groundwater Conditions

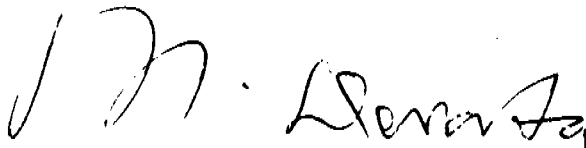
Groundwater conditions in the open boreholes were observed during the drilling and, where possible, periodically after their completion. In addition, sealed piezometers were installed in nine boreholes in order to monitor the water levels over a prolonged period of time.

The final water levels recorded in the open boreholes and in the sealed piezometers are given on the individual Record of Borehole sheets. The groundwater levels recorded at the time of the investigation range from 0.9 to 6.3 m below the ground surface but were generally 2 to 4 m below the ground surface.

Note: The preceding 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 who were under the technical supervision of the M.T.C. Foundation Design Section.



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APPENDIX

BH	SA	DEPTH	w	w _L	w _p	I _p	I _L	GRADATION				γ	γ _d	e	c	G ₃	E _f		GROUP SYMB.
								G	S	F	-2μ								
No.		per cent																	
24	3	2.5	19.3	29.0	14.0	15.0													
	4	3.3	10.4																
25	6		22.7	25.8	14.6	11.2													
28	4	3.4	21.9																
29	5	4.0	14.5	32.0	15.0	17.0													
30	3	2.5	14.1																
32	4	3.3	5.5					0	79	21									
	5	4.0	8.2																
	6	4.8	14.3																
	7	5.8	19.2																
	8	6.3	22.0					0	80	20	2								
33	4	3.3	4.0					0	96	4									
	6	4.8	3.3																

SUMMARY OF LABORATORY TESTS

TABLE I -

BH	SA	DEPTH	w	w _L	w _p	I _p	I _L	GRADATION				γ	γ _d	e	c	G _s	E _s	GROUP SYMB.	
No.	m	per cent						G	S	F	-2μ								%
								per cent											
33	7	5.8	2.0																
	8	6.3	14.7																
34	1	0.9	9.9																
	2	1.7	10.2																
	3	2.5	8.8					5	50	45	12								
	4	3.3	7.5																
	5	4.0	6.1																
	6	4.6	4.8																
36	5	4.0	12.5																
	6	4.8	13.5																
	7	5.6	11.0					19	73	8									
37	5	4.0	32.3	49.6	21.8	27.8													
38	4	3.3	17.4																
	5	4.0	16.8																
	6	4.8	9.2																
	7	5.6	9.6																

SUMMARY OF LABORATORY TESTS

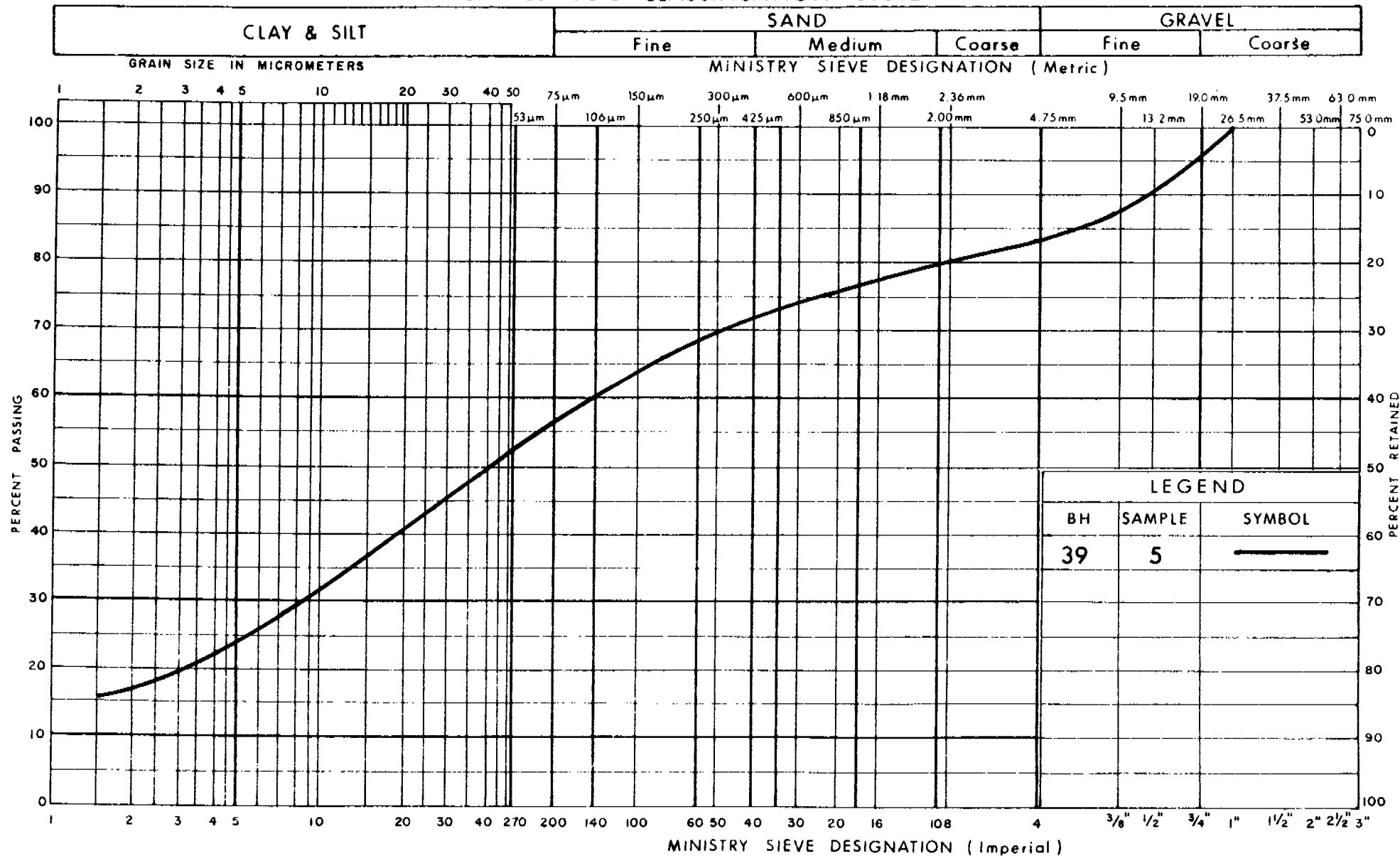
TABLE I -

BH	SA	DEPTH	w	w _L	w _p	I _p	I _L	GRADATION				γ	γ _d	e	c	G _s	E _s		GROUP SYMB.	
No.	m	per cent						G	S	F	-2μ									%
								per cent												
39	3	2.5	40.4																	
	4	3.3	17.9																	
	5	4.0	18.5	20.9	12.4	8.5		17	27	56	17									
	7	5.6	9.6																	
40	2	1.7	28.5																	
	3	2.5	30.3																	
	4	3.3	19.2	32.3	11.0	21.3														
	5	4.0	8.8	21.4	12.5	8.9														
	6	4.8	7.8																	
	7	5.6	15.5																	

SUMMARY OF LABORATORY TESTS

TABLE I -

UNIFIED SOIL CLASSIFICATION SYSTEM



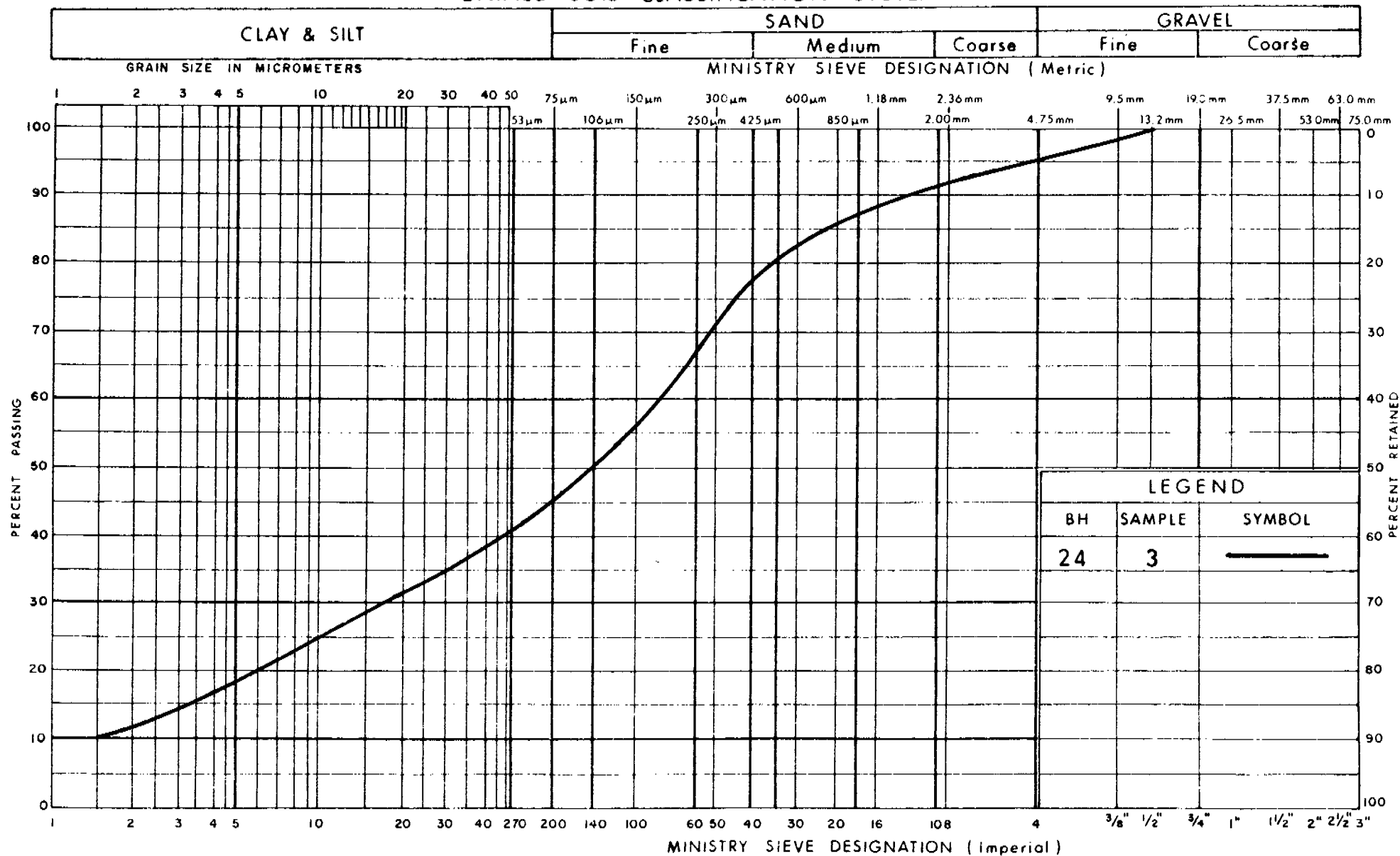
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Communications

GRAIN SIZE DISTRIBUTION SILTY CLAY TILL

FIG No 1

W P GGE000-61

UNIFIED SOIL CLASSIFICATION SYSTEM

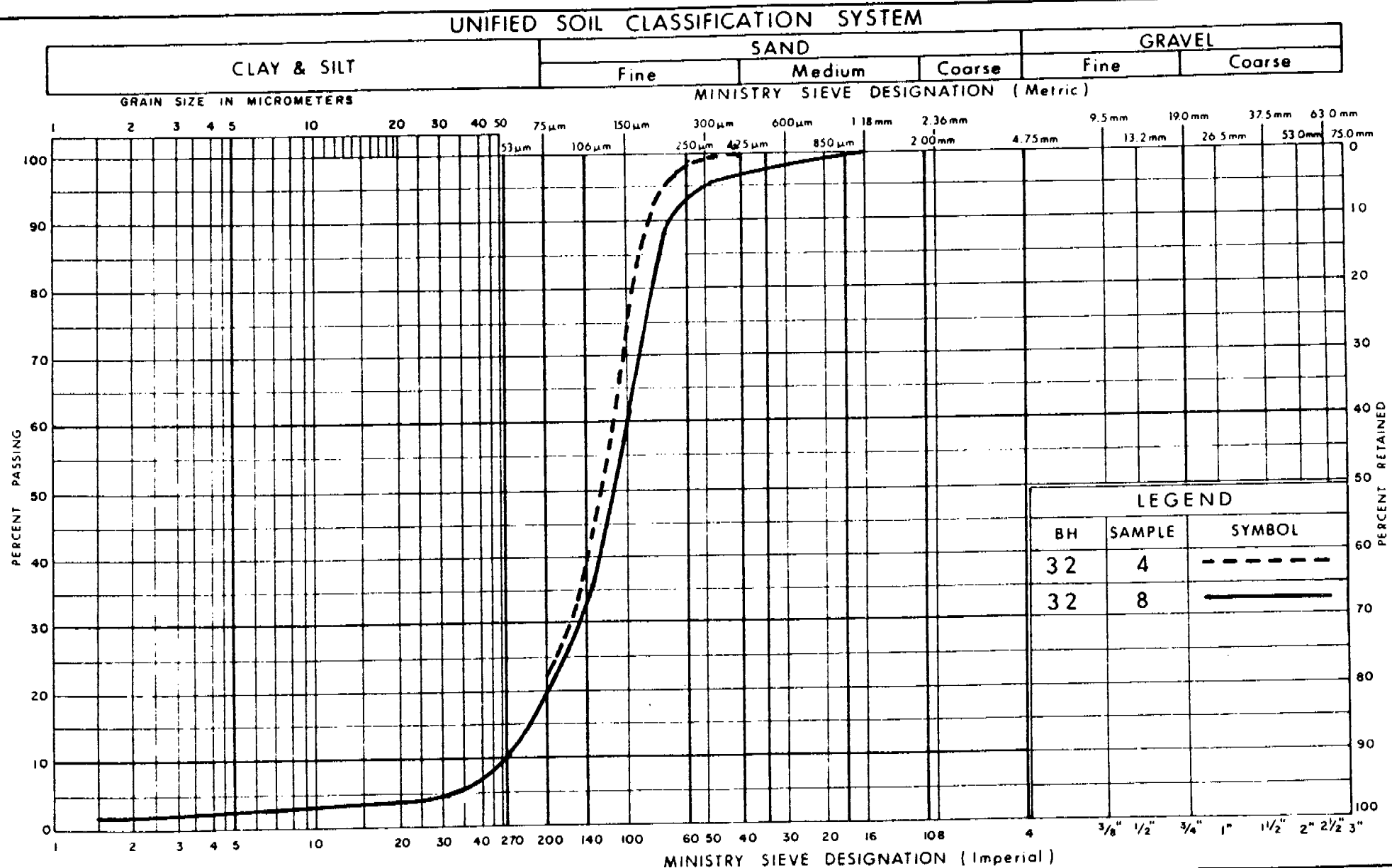


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Communications

GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No 2

W P GGE000 - 61



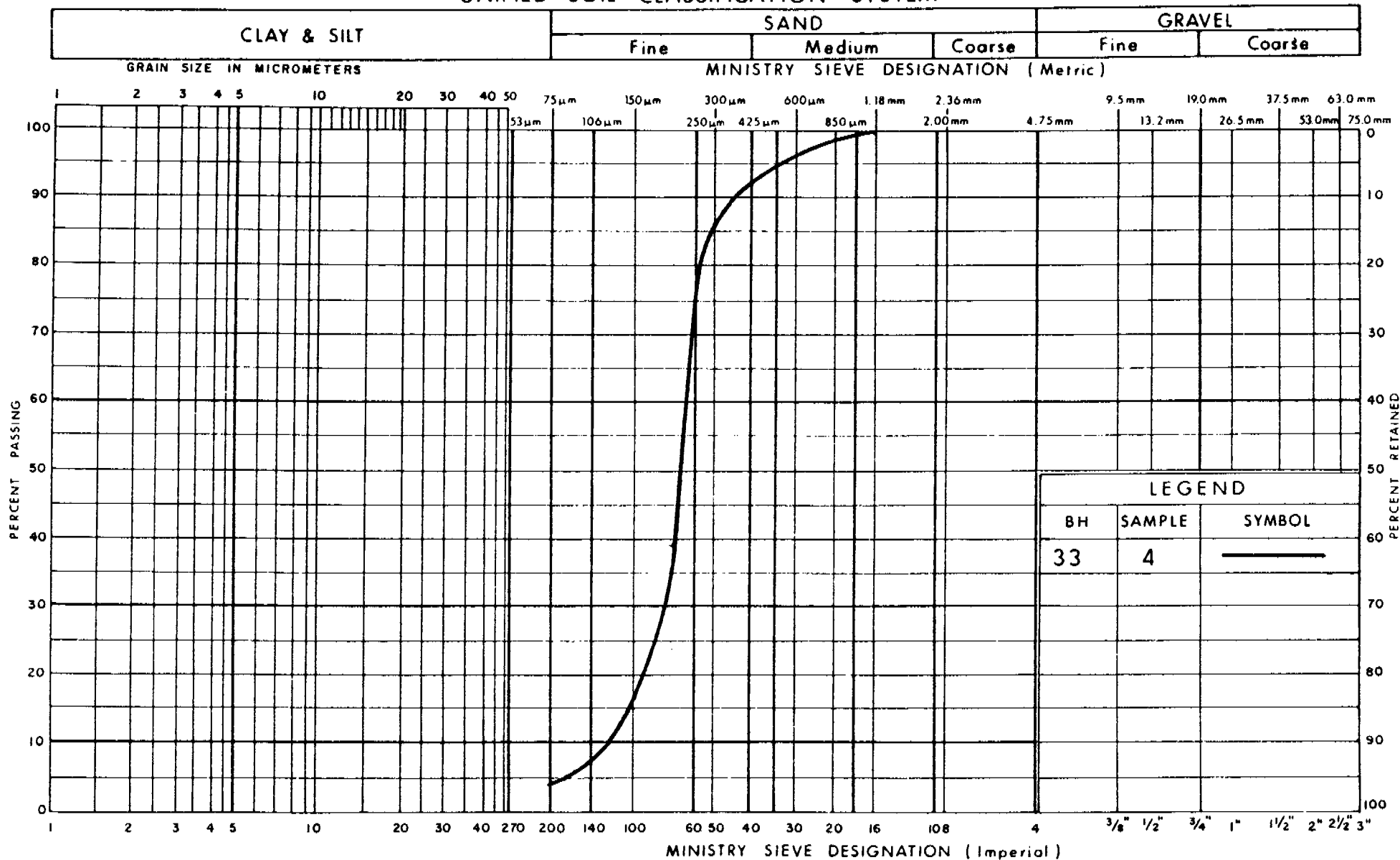
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Communications

GRAIN SIZE DISTRIBUTION
FINE SAND, some Silt

FIG No 3

W P GGE 000-61

UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

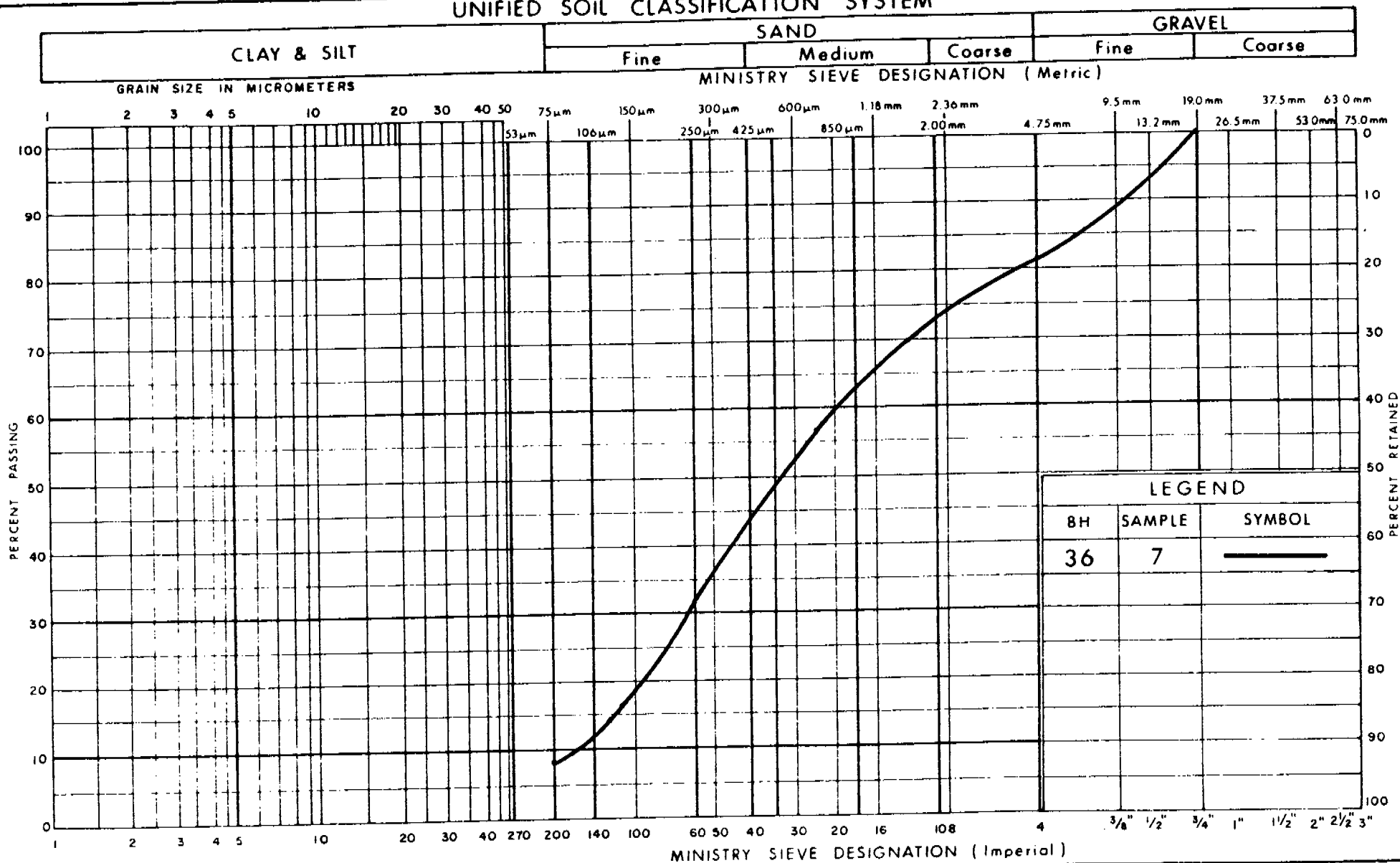
GRAIN SIZE DISTRIBUTION

FINE SAND

FIG No 4

W P GGE000-61

UNIFIED SOIL CLASSIFICATION SYSTEM

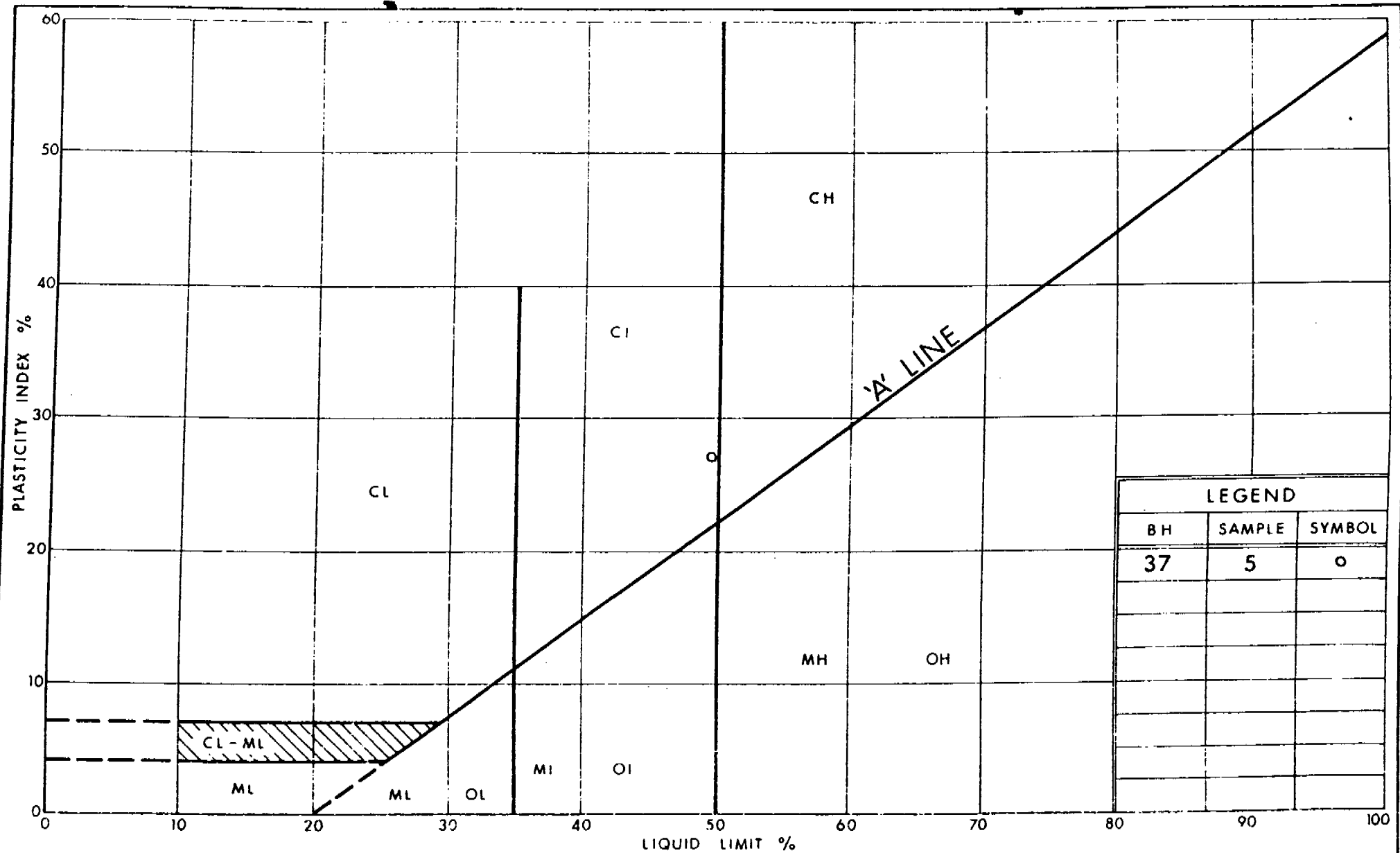


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Communications

GRAIN SIZE DISTRIBUTION
SAND, with some gravel & traces of silt.

FIG No 5

W P GGE000-61

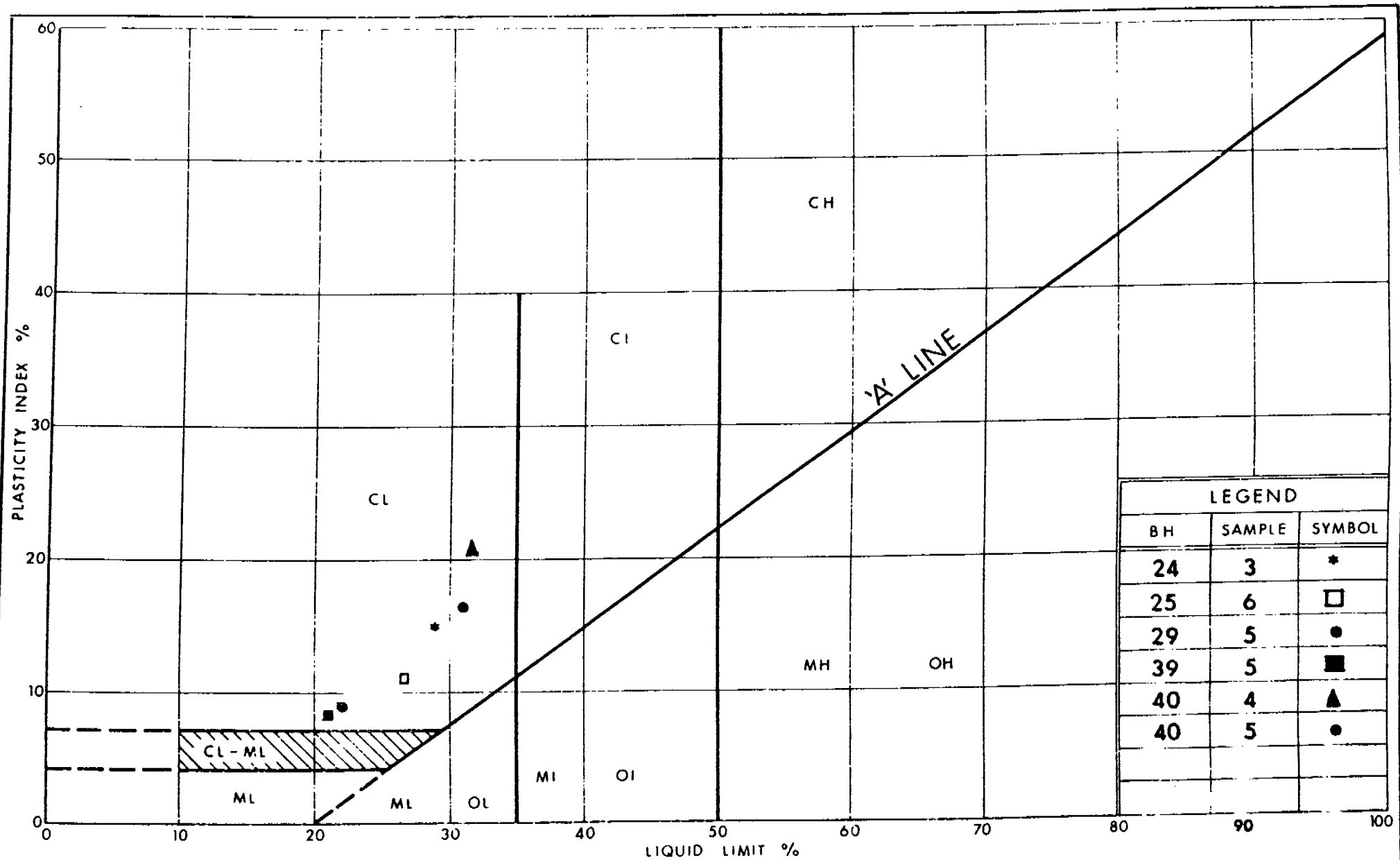


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PLASTICITY CHART SILTY CLAY

FIG No. 6

W P GGE000-61



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PLASTICITY CHART SILTY CLAY TILL

FIG No. 7

W P G G E 000 - 61

RECORD OF BOREHOLE No 23 & 24

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,595N; 351,771E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

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				
92.2	Ground Level							(23)								
0.0	0.08 m Topsoil 0.2 m Fill - gravelly sand. hard		1	SS	44	SEAL	92									
	Silty clay till, occasional sand seams. Brown		2	SS	82	SEAL	91									
89.5			3	SS	100/0.28 m		90									
2.7	Silty sand till with sandy silt till layers greyish and silty sand brown seams, v.dense. grey		4	SS	64/0.15 m	PIEZOMETER	89									
88.1			5	SS	75/0.15 m											
4.1	END OF BOREHOLE							CO-ORDS. 4,858,550N; 351,767E HOLLOW STEM AUGER								
91.3	Ground Level							(24)								
0.0	0.15 m Topsoil Fill - Silty sand with traces of gravel. Brown		1	SS	29		91									
89.9			2	SS	11		90									
1.4	Fill - Silty clay mixed with topsoil. Dark brown/black.		3	SS	14		89									
89.2			4	SS	20		88									
2.1	Silty clay till. Stiff to v.stiff. Brown		5	SS	44		87									
87.6			6	SS	65/0.15 m											
3.7	Silty sand till with dense sandy silt v.dense till layers and occ. silty sand seams.		7	SS	33/0.05 m		86									
85.8																
5.5	END OF BOREHOLE															

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 25

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,543N; 351,743E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

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 (%)		
								20 40 60 80 100										20 40 60		
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE														
91.1	Ground Level																			
0.0	0.15 m Topsoil Silty sand, traces of gravel, brown, moist (probably fill).		1	SS	9	SEAL	91													
89.6							90													
1.5	Sandy silt till. Compact, brown		2	SS	21		89													
88.5			3	SS	15															
2.6	Silty clay till. Brown		4	SS	18	SEAL	88													
			5	SS	23		87													
	v. stiff stiff		6	SS	9		86													
85.9	Occasional weak clay seams.																			
5.2	Some clay.		7	SS	4		85													
	Sandy silt till. V. loose, grey.		8	SS	5															
84.4																				
6.7	END OF BOREHOLE																			

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 26

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,531N; 351,714E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

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				
90.8	Ground Level															
0.0	0.15 m Topsoil															
89.9	Fill - Silty sand, traces of gravel, brown.															
0.9	fine sand		1	SS	32		90									
	Fill - Sandy silt, traces of gravel, brown.															
			2	SS	23		89									
88.5																
2.3	Silty clay, brown.															
88.3			3	SS	11											
2.5	Silty clay till. Brown						88									
			4	SS	21											
	stiff															
	stiff						87									
	Occasional sand pockets		5	SS	15											
86.5																
4.3	END OF BOREHOLE															

Sampler wet
@ 4 m.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 27 & 28

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,523N; 351,683E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

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					
							SHEAR STRENGTH							
							○ UNCONFINED + FIELD VANE							
							● QUICK TRIAXIAL x LAB VANE							
							100 200							
90.7	Ground Level						(27)							
0.0	0.2 m Topsoil													
89.8	Fill - Silty sand, traces of gravel, brown.					SEAL	90							
0.9	Fill - Mixture of silt, sand & clay, so. organic pockets, brown/grey/black.		1	SS	20									
89.2	Fill - Sandy silt, some clay, traces of gravel. Brown		2	SS	23		89							
1.5	Silty clay(probably fill).		3	SS	11	SEAL	88							
2.1	Silty clay.		4	SS	15									
88.2	Stiff to v.stiff, brown.						87							
2.5	Silty clay till. V.stiff, brown.		5	SS	54									
87.3	Sandy silt till with silty sand till layers, v.dense.		6	SS	75/	0.15m	86							
3.4	Brown													
86.9	END OF BOREHOLE						CO-ORDS. 4,858,512N; 351,646E HOLLOW STEM AUGER							
3.8							(28)							
85.8	Ground Level													
4.9	0.25 m Topsoil													
90.4	Fill - Silty sand, trace gravel. Brown		1	SS	11		90							
0.0	Fill - Sandy silt, traces of organics. Brown		2	SS	19		89							
89.1	Fill - Silty clay.		3	SS	12		88							
1.3	Silty clay, stiff brown.		4	SS	7		87							
88.3	firm to stiff		5	SS	22		86							
2.1	Silty clay till.		6	SS	8									
87.8	stiff to firm - sandy													
2.6														
87.1														
3.3														
85.2	END OF BOREHOLE													
5.2														

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 29

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,498N; 351,587E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

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				
90.5	Ground Level															
0.0	0.25 m Topsoil					SEAL	90									
	Fill - Silty sand and sandy silt, traces of gravel. Brown		1	SS	33											
			2	SS	20		89									
88.4																
2.1	Fill - Sandy silt and clay, wet.		3	SS	3		88									
87.5						SEAL										
3.0	Silty clay till; organic stained (probably fill).		4	SS	7		87									
86.8																
3.7	Silty clay till. Stiff, brown.		5	SS	10		86									
86.1																
4.4	Sandy silt till. Compact, brown.		6	SS	24		85									
84.7	Silty sand till layers. Grey, dense.		7	SS	33											
5.8	END OF BOREHOLE															

+³, x⁵ : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 30										METRIC				
W P <u>GGE 000-61</u>		LOCATION <u>CO-ORDS. 4,858,488N; 351,547E</u>		ORIGINATED BY <u>R.M.</u>										
DIST <u>6</u> HWY <u>401</u>		BOREHOLE TYPE <u>HOLLOW STEM AUGER</u>		COMPILED BY <u>F.L.</u>										
DATUM <u>GEODETIC</u>		DATE <u>1984.06.20</u>		CHECKED BY <u>Z.S.O.</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	40					
90.8	Ground Level													
0.0	0.15 m Topsoil													
	Fill - Sandy silt, some gravel. Brown		1	SS	56									
89.3														
1.5	Fill - Silty clay, organic, some sand pockets, dk.grey/black		2	SS	9									
88.6														
2.2			3	SS	9									
	loose													
	compact		4	SS	28									
	v.dense													
	brown grey		5	SS	100/	0.28m								
	Sandy silt till, some clay content, occasional silt seams.		6	SS	50/	0.07m								
85.4														
			7	SS	50/	0.02m								
5.4	END OF BOREHOLE													

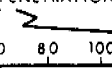




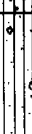
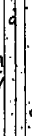
OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 31

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858.475N; 351.520E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

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		
90.7														
0.0	0.6 m Topsoil					SEAL								
	Silty fine sand, compact, brown, moist (possible fill).		1	SS	20		90							
89.2														
1.5	Silty fine sand.		2	SS	17		89							
88.6	Compact, brown, wet.													
2.1														
			3	SS	34	SEAL	88							
			4	SS	33		87							
	dense --- brown v.dense grey													
			5	SS	95									
	Sandy silt till, some clay content, occasional thin sand seams.													
			6	SS	60/	0.15m	86							
			7	SS	120		85							
84.6														
6.1	END OF BOREHOLE													

+3, x5 : Numbers refer to
Sensitivity



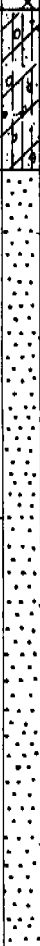
20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 32

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,473N; 351,481E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.20-21 CHECKED BY Z.S.O.

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 (%)				
91.6	Ground Level							20	40	60	80	100	20 40 60				
0.0	0.45 m Topsoil Fill - Silty clay mixed with some topsoil.					SEAL	91										
90.3			1	SS	17												
1.3	Silty clay till. Stiff to v.stiff, brown.		2	SS	17		90										
89.1			3	SS	45	SEAL	89										
2.5	dense damp v.dense		4	SS	83		88										0 79 21
	Fine sand with traces of silt, occ. thin silty fine sand seams. Brown		5	SS	82	PIEZOMETER	87										
			6	SS	100		86										
	moist wet		7	SS	60		85										Sampler wet @ 4.8 m.
	Some silt.		8	SS	58		84										
			9	SS	100	0.25m											0 80 18 2
			10	SS	70	0.15m											June 20... Augers left @ 8.4m over- night. Soil backed-up in the augers by 1.5 m.
83.2																	
8.4	END OF BOREHOLE																

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 33

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,460N; 351,455E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

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					
92.7	Ground Level																
0.0	0.3 m Topsoil																
92.0	Fill - Sandy silt some gravel.																
0.7	Fill - Silty clay traces of organics.		1	SS	12												
91.3	Brown																
1.4	Fill - Silty clay some sand, traces of or- ganics.		2	SS	5												
	Brown																
90.2			3	SS	9												
2.5	loose																
	compact		4	SS	32												
	dense																
	v.dense		5	SS	88												
	Fine sand, with traces of silt, occ. gravel.		6	SS	55/	0.15 m											
			7	SS	98/	0.25 m											
	damp																
	moist		8	SS	90/												
						0.28 m											
	wet		9	SS	90												
			10	SS	72												
84.6																	
8.1	END OF BOREHOLE																

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 34

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,461N; 351,423E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

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										WATER CONTENT (%) 20 40 60		
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
91.7																				
0.0	0.15 m Topsoil																			
91.1	Sandy silt, tr. gravel Brown.																			
0.6																				
	higher sand content		1	SS	56		91					○								
			2	SS	75		90					○								
	-----		3	SS	70		89					○				5 50 33 12				
	Sandy silt till, v.dense.		4	SS	65		88					○								
			5	SS	60		87					○								
	brown grey		6	SS	50	0.07 m	86					○				Hard augering below 4 m.				
			7	SS	50	0.10 m	85													
			8	SS	70	0.10 m										Sample 8: No recovery.				
84.0			9	SS	75	0.07 m														
7.7	END OF BOREHOLE																			

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 35

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,448N; 351,395E ORIGINATED BY S.D.
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.23 CHECKED BY Z.S.O.

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		
91.9	Ground Level																			
0.0	0.3 m Topsoil																			
	compact v. dense		1	SS	29	SEAL														
			2	SS	84															
	Sandy silt till.		3	SS	65	PIEZOMETER														
			4	SS	90	0.23m														
	boulder		5	SS	100	0.10m														
			6	SS	60	0.12m														
	brown grey		7	SS	100	0.12m														
			8	SS	50	0.07m														
84.9																				
7.0	END OF BOREHOLE																			



RECORD OF BOREHOLE No 36

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,447N; 351,345E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

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					
89.9	Ground Level																
0.0	0.15 m Topsoil Fill - Silty sand with traces of gravel. Occasional sandy silt and organic lenses, brown.		1	SS	30		89										AS = Auger Sample
88.5																	
1.4	Fill - Silty clay with traces of sand and gravel, occ. organic lenses, brown.		2	SS	15		88										
			3	SS	20												
86.9							87										
3.0	Fill - Silty sand.		4	SS	25												
86.6																	
3.3	Silty sand till. Sand, some gravel, traces of silt. compact dense moist wet		5	SS	30		86						o				
			6	SS	35		85						o				
			7	SS	38		84						o				19 73 8
			8	SS	70												
83.4																	
6.5	Sandy silt till. V.dense, grey.						83										
82.3			9	AS	-												
7.6	END OF BOREHOLE																

RECORD OF BOREHOLE No 37

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,440N; 351,295E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

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				
87.8	Ground Level															
0.0	0.15 m Topsoil					SEAL										
	Fill - Silty sand															
	traces of silt, clay															
	and organic pockets.															
	Brown		1	SS	34											
86.4	cobble															
1.4	Fill - Silty clay,															
	some sand, gravel and															
	organic pockets.															
	Brown		2	SS	11											
			3	SS	15											
84.8						SEAL										
3.0	organic															
	stained		4	SS	12											
	Silty clay, stiff,															
	brown.		5	SS	12											
83.4																
4.4	Sandy silt															
	till.		6	SS	26											
	Compact															
		moist														
		brown														
		grey														
		wet														
	traces of clay															
	frequent															
	silty sand		8	SS	26											
	till layers															
	Some thin silty sand,															
	silt and silty clay															
	seams.		9	SS	16											
80.3																
7.5	Silty sand, some gravel															
	with silty sand till		10	SS	10											
	layers.															
	Loose, grey, wet.		11	SS	6											
			12	SS	6											
78.0																
9.8	END OF BOREHOLE															

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Sample 10:
No recovery

RECORD OF BOREHOLE No 38

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,432N; 351,248E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

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					
85.9	Ground Level																
0.0	0.2 m Topsoil Fill - Silty sand with some sandy silt and silty clay pockets, traces of gravel and organic soil, brown.		1	SS	22		85										
			2	SS	34		84										
83.8																	
2.1	Fill - Silty clay some organic seams. Brown		3	SS	11		83										
82.7			4	SS	7												
3.2	Silty clay till, some sandy silt till seams. Firm to v.stiff, brown		5	SS	16		82										
81.5			6	SS	2		81										
4.4	Some clay content. Silty sand till with sandy silt till layers. Grey	wet v.loose compact wet v.dense	7	SS	30		80										
	more silty		8	SS	78/	0.28 m											
78.7			9	SS	60/	0.15 m	79										
7.2	END OF BOREHOLE																

RECORD OF BOREHOLE No 39

METRIC

W P GGF 000-61 LOCATION CO-ORDS. 4,858,428N; 351,205E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

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					
84.2	Ground Level																
0.0	0.3 m Topsoil					SEAL	84										
	Fill - Fine sand some silt; some silty clay and silt lenses. Brown		1	SS	12												
82.8							83										
1.4	Fill - Sandy silt. Brown		2	SS	10												
82.2																	
2.0	Silty clay. Firm to stiff, brown.		3	SS	7		82										
81.3						SEAL											
2.9	Silty clay till with sandy silt till and occasional fine sand and clay seams.		4	SS	9		81										
			5	SS	6												
							80										
			6	SS	8												
			7	SS	33		79										
			8	SS	13		78										
77.2			9	SS	34												
7.0	END OF BOREHOLE																

RECORD OF BOREHOLE No 40

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,424N; 351,168E ORIGINATED BY R.M.
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

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					
83.3	Ground Level																
0.0	0.3 m Topsoil						83										
	Fill - Silty sand and silty clay, traces of organic pockets, brown		1	SS	22												
81.9							82										
1.4	Silty clay, firm to stiff, brown.		2	SS	7									o			
	layered structure		3	SS	12		81							o			
80.4							80										
2.9	Silty clay till, occasional fine sand and clay seams. Firm to stiff. brown grey		4	SS	7												
			5	SS	9												
78.9							79										
4.4	Sandy silt till, some clay, compact, grey, wet.		6	SS	15									o			
78.1							78										
5.2	Sandy silt, trace of clay, some gravel. Dark grey/black loose compact to v.dense coarser		7	SS	8									o			
76.8			8	SS	68		77										
6.5	Sandy silt till, v.dense, grey.																
76.3			9	SS	100/	0.12m											
7.0	END OF BOREHOLE																

GEOCRES No. 30M15-70DIST. 6 REGION W.P. No. CONT. No. GGE-330W. O. No. STR. SITE No. HWY. No. 401LOCATION Go-ALRT & Hwy 401
CROSSING=====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



FOUNDATION INVESTIGATION REPORT

CONTRACT NO. GGE 330



Ontario

Ministry of
Transportation and
Communications

C O N T E N T S

- A. Foundation Investigation Report for: GO-ALRT/HIGHWAY 401 CROSSING
- B. Foundation Investigation Report for: HENRY STREET
UNDERPASS AND RETAINING STRUCTURE, GO-ALRT
and W.P.C.P ACCESS STRUCTURE, GO-ALRT

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations and Symbols
3 - 24	Foundation Investigation Report For: GO-ALRT, Hwy. 401 Crossing Contract No. GGE-330

NOTE: For purposes of the contract, this report supersedes all other foundation reports prepared by or for GO-ALRT 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 (R Q D), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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

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

3

for

GO-ALRT, Hwy. 401 Crossing

Contract No. GGE-330INTRODUCTION

Golder Associates were retained by the Ministry of Transportation and Communications on behalf of GO-ALRT to carry out a subsurface investigation at the site of the proposed GO-ALRT overpass structure over Hwy. 401 in Whitby at Pringle Creek some 400 m east of Brock Street.

This report, prepared by Golder Associates under the technical supervision of the Ministry's Foundation Design Section, summarizes the factual information obtained from the foundation investigation.

The investigation consisted of 8 boreholes which were put down between August 22 and 26, 1983. In addition, bedrock was proven in two boreholes.

SITE DESCRIPTION AND GEOLOGY

The project site is located on Hwy. 401 at the crossing of Pringle Creek approximately 400 m east of Brock Street. The area immediately east of Pringle Creek and north of Hwy. 401 is low and swampy. Pringle Creek is directed under the Hwy. 401 embankment through a concrete culvert. South of the highway, where the creek meanders to the west, the creek banks range in height from 1 to 3.5 m at slopes of up to 50 degrees. Where the banks have been undercut, sloughing of the overburden has occurred. Sanitary landfill is exposed in the west bank of the creek at the GO-ALRT crossing (Station 14+614) and the fill extends about 5 and 35 m north and south, respectively, of the route centreline.

Based on available geological information, the site is located within the Iroquois Plain, an area which resulted from inundation by Lake Iroquois during the last glaciation. The general area is underlain by glacial till and shale bedrock (Whitby Formation). The rivers and creeks in the area probably originated as glacial outwash streams discharging into the present Lake Ontario basin during a low lake stage. Deep valleys were eroded in the glacial till which were subsequently infilled with alluvium.

At various locations a soft to firm deposit is encountered in the area. This material has the composition of a till and is possibly a till which has softened while exposed to the waters of Lake Iroquois. Varved clays, occasionally encountered overlying the deposit, would have been laid down during this time.

SUBSURFACE CONDITIONS

The detailed stratigraphy encountered in each of the boreholes put down during this investigation is given on the attached Record of Borehole Sheets in the Appendix. It should be noted that the stratigraphic boundaries indicated are not intended to define exact planes of geologic change but represent transitions from one soil type to another. Subsurface conditions have been established at the borehole locations only and will vary between the boreholes, particularly with regards to the interface of the till and completely weathered shale. The locations of the boreholes are shown on Dwg. No. S-002 in the contract drawings. The results of laboratory testing carried out on representative samples are given on the Record of Borehole Sheets and on Fig.1 to 8 inclusive.

In general, the site is underlain by sands which are underlain by clays and silty clays north of Hwy. 401 and by silty sand till south of the highway. Shale bedrock underlies the silty clay and tills.

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

Sand Fill

BH #4, put down through the existing Hwy.401 embankment encountered about 2.9 m of fill material grading from sand to silty sand with some gravel (Fig.1). The lower 0.5 m of the fill contains pockets of organic silt which probably is derived from the original native soil. The fill materials have a compact to dense relative density with 'N' values from 12 to 45 blows per 0.3 m.

Sand

In BH #1 and #2, 0.8 to 1.2 m of sand with a trace of silt was encountered at ground surface. Underlying the fill in BH #4 and at ground surface in BH #5, #6 and #7, about 1.2 to 4.0 m of a sand material was encountered. This deposit grades (from east to west) from a grey gravelly sand with some silt (Fig.2) to sand with a trace of silt. 'N' values ranged from 18 to greater than 100 blows per 0.3m (the higher values obtained in the gravelly sands) indicating a compact to very dense relative density. The water content of samples obtained from this deposit ranged from 7 to 10%.

Silty Clay, Interlayered Silts and Clays

About 1.7 m of silty clay (Fig.3) was encountered underlying the sand in BH #2. The silty clay in turn is underlain by 0.5m of interlayered silts and clays. One metre of the interlayered material was encountered directly under the sand in BH #1. The silts and clays have a stiff to very stiff consistency with water contents measured in the laboratory ranging from 25 to 35%. One Atterberg Limits test performed on the unstratified silty clay gave a liquid limit of 44% and a plasticity index of 23% indicating a clay of intermediate plasticity (Fig.4).

Organic Silt

In BH #3, about 2.1 m of interlayered organic silt and silty sand containing numerous shell fragments was encountered at ground surface. 'N' values obtained within this deposit decreased with depth from 14 to 3 blows per 0.3 m indicating a compact to very loose relative density. The water content of one sample of the organic silt was 31%.

Lower Silty Clay

The organic material in BH #3 and the interlayered silts and clays in BH #1 and #2, are underlain by about 2.2 to 3.0m of a deposit which changes with depth from a clay with some silt (Fig.3) to a silty clay with some sand and a trace of gravel (Fig.5).

The grain size distribution curves for the silty clay and sand (Fig.5) in the lower portion of this deposit, resembles that of a till and it is considered that this material is indeed a till which has subsequently softened to its present consistency. In situ vane tests gave undrained shear strength values (C_u) ranging from 15 to 40 kPa with an average of about 28 kPa in the upper 1.0 to 1.5 m. The lower portion of this deposit has an average C_u value of about 18 kPa. The sensitivity of the silty clay ranged from 2 to 8. The water content of samples of the silty clay ranged from 17 to 41%, generally decreasing with depth. Atterberg Limits tests gave liquid limits of 16 to 29% (Fig.6) with corresponding plasticity indices of 5 to 14%, indicating a clay to a silt of low plasticity. In two of the samples tested the moisture content was in excess of the liquid limit and this is probably associated with the higher end of the sensitivity range measured. Two consolidation tests carried out on samples of this material gave coefficient of consolidation values (C_c) of 0.104 and 0.244 (Fig.7). Preconsolidation pressures of about 40 kPa in excess of the overburden pressure were estimated from the consolidation test results indicating that the clay is lightly overconsolidated.

Silty Sand (Till)

In BH #3, about 1.3 m of dark brown till consisting of silty sand and gravel with a trace of clay (Fig.8) was encountered underlying the silty clay. The till has a dense relative density as indicated by an 'N' value of 35 blows per 0.3 m. The water content of a sample of the till was 8%.

The sand and silty sand in BH #5, #6, #7 and #8 are underlain by about 1.0 to 1.8 m of a grey till material composed of silty sand with some clay and a trace of gravel (Fig.8). The till is in a compact to very dense state of packing with 'N' values of 22 to greater than 100 blows per 0.3 m. Water contents of samples of the till ranged from 7 to 10%.

Sanitary Landfill

BH #8 was put down at the top of the west bank of Pringle Creek at the centreline of the proposed GO-ALRT crossing to determine the depth of the sanitary landfill which is exposed in the creek bank. About 3.8 m of fill was encountered at ground surface and consisted of deleterious material, metal, plastic and silty sand. 'N' values generally ranged from 12 to 21 blows per 0.3 m with one value greater than 76 blows per 0.3 m. It is considered the higher value was the result of attempts to drive the spoon into wood or metal and that the fill is in a compact state of packing.

Completely Weathered Shale

About 1.5 to 2.7 m of silt with clay and sand and interlayers of shale was found underlying the till where encountered, and the lower silty clay in BH #1 and #2. This material is considered to be a shale which has completely weathered to a residual soil and is comprised of seams and layers up to 30 mm thick of fissile shale within a silt material containing sand and clay. The deposit has a structure similar to a till and has resulted from water percolation through fractures in the bedrock and breakdown of the shale into a soil. 'N' values obtained in the completely weathered shale ranged from 40 blows per 0.3 m to 100 blows for zero penetration.

Bedrock

Highly to moderately weathered shale bedrock was encountered in all boreholes at elevations from 71.6 to 75.0 m. The boreholes were extended at least a further 1.3 m by augering and/or BX rock coring. The shale occasionally gave off a strong petroliferous smell indicating the presence of hydrocarbons.

The bedrock was cored in BH #3 and #5 for 2.5 and 6 m, respectively. The core obtained was highly fractured (RQD values of 0 to 33%); however, it is considered that the majority of the fractures are mechanical breaks as a result of coring operations.

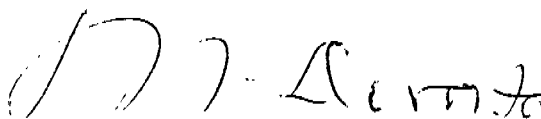
Groundwater Conditions

Following completion of BH #2 to #5, inclusive, and BH #7, piezometers were sealed within the various strata encountered to allow monitoring of the groundwater level across the site. The details of the piezometer installations are given on the Record of Borehole Sheets.

The water levels were monitored throughout the drilling operations and on Sept. 5 and 15, 1983. The stabilized groundwater level across the site generally ranged from 77.8 to 78.3 m, sloping gradually to the water level in the creek.



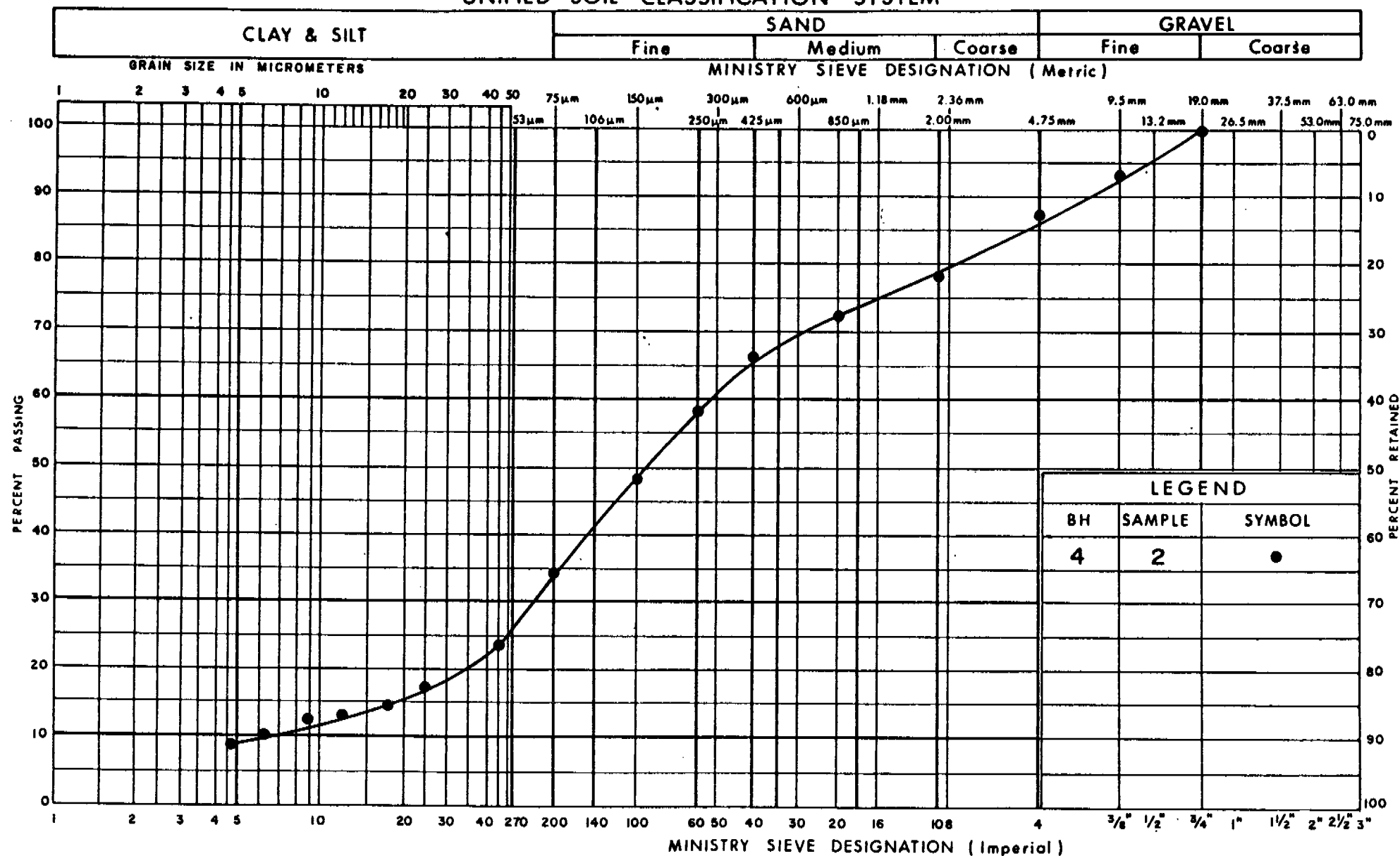
L. Politano
Project Foundations Engineer



M. Devata, P.Eng.
Chief Foundations Engineer (East)

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

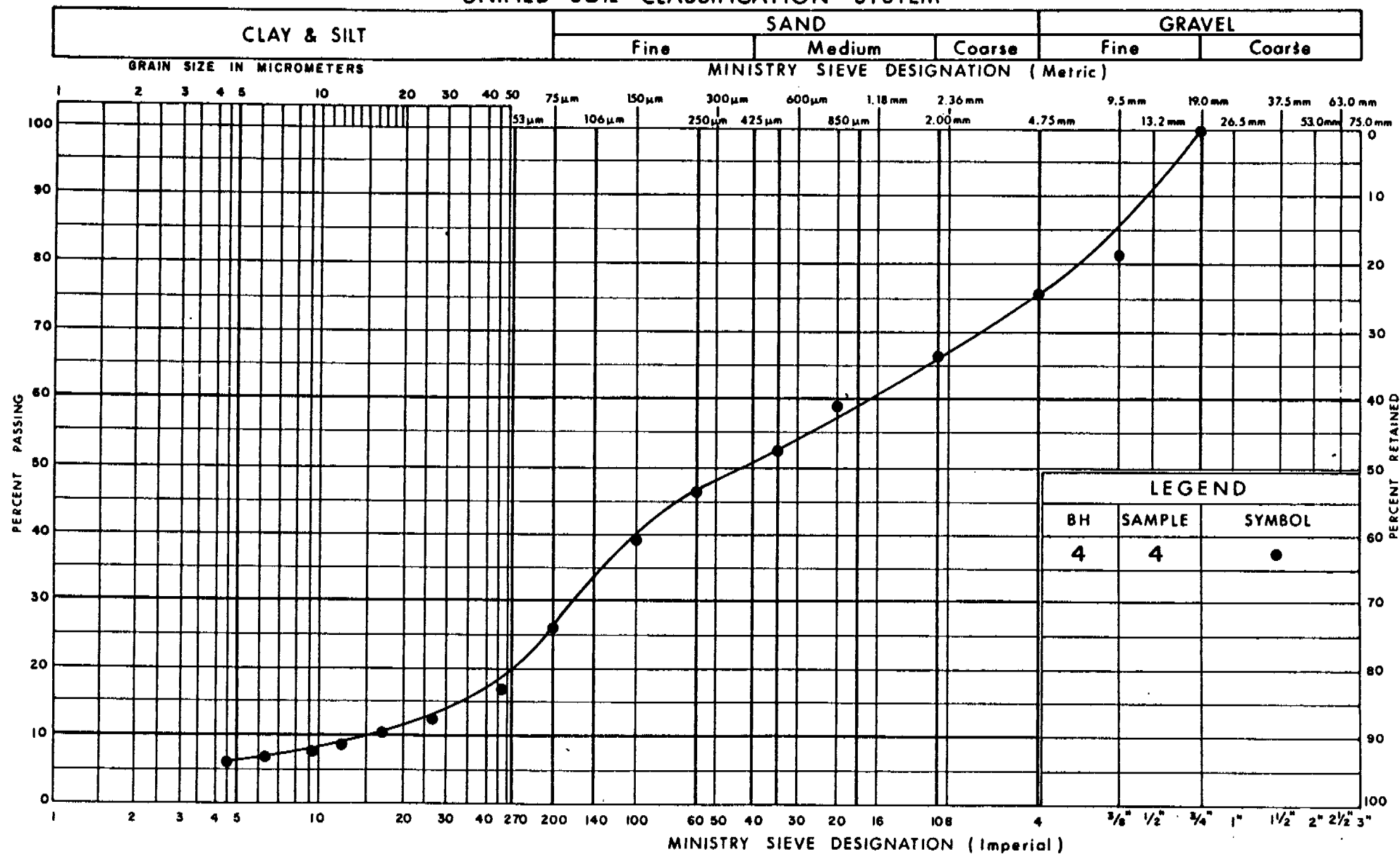
 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
SILTY SAND FILL

FIG No 1

W P EGG-000-23

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

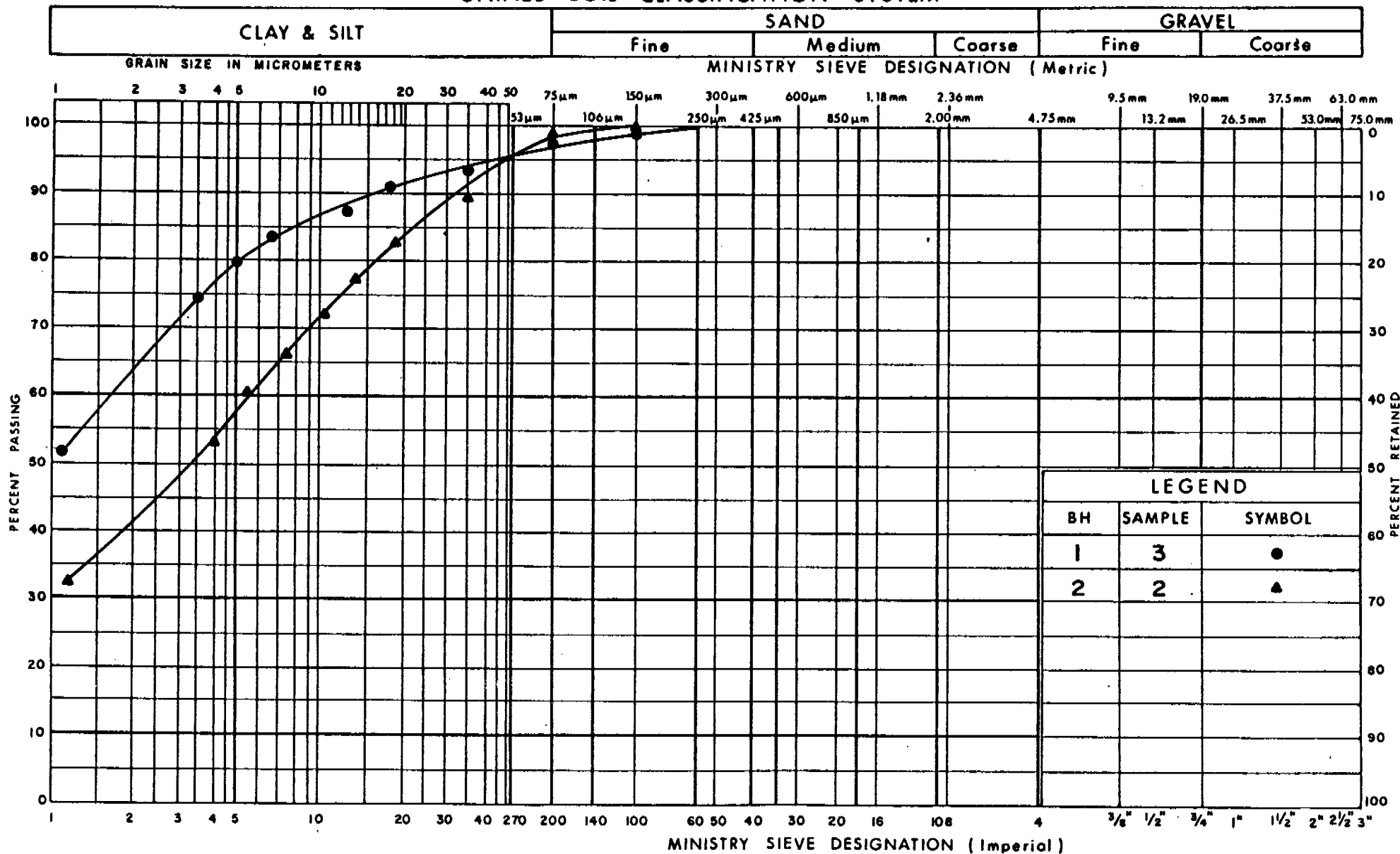
 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
GRAVELLY SAND

FIG No 2

W P EGG-000-23

UNIFIED SOIL CLASSIFICATION SYSTEM



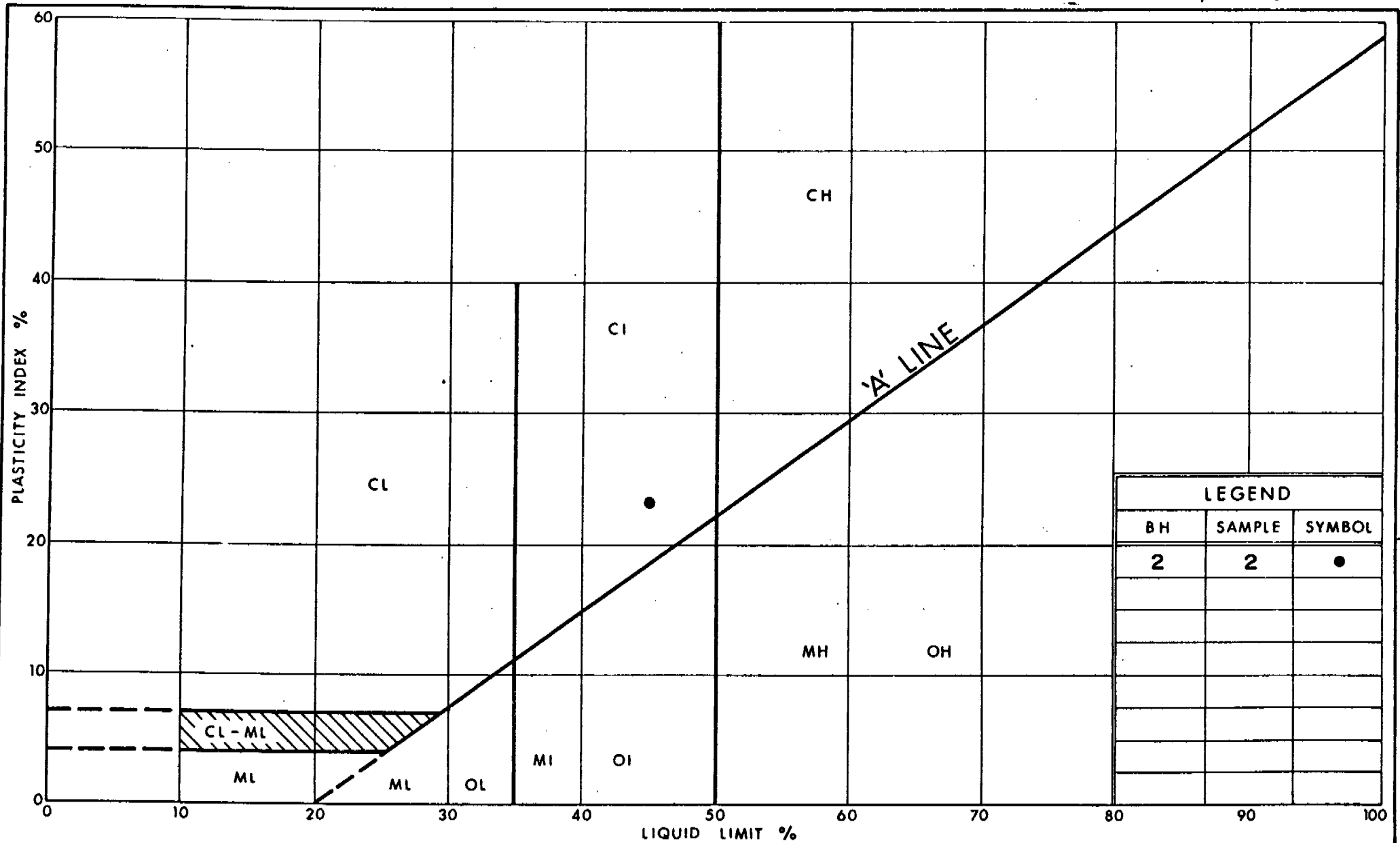
Ontario

 Ministry of
Transportation and
Communications

 GRAIN SIZE DISTRIBUTION
SILTY CLAY

FIG No 3

W P EGG-000-23

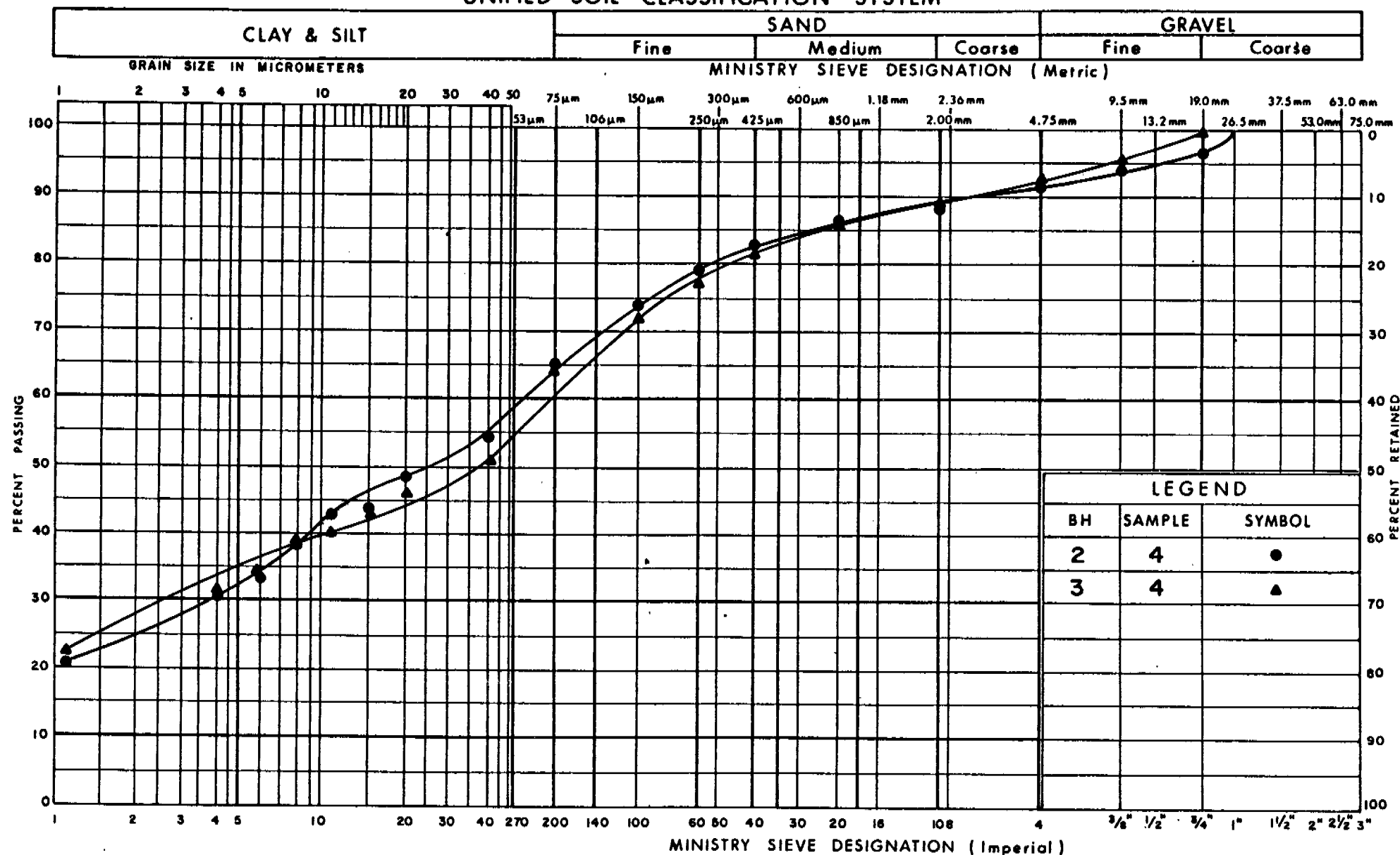


Ministry of
Transportation and
Communications

PLASTICITY CHART SILTY CLAY

FIG No 4
W P EGG-000-23

UNIFIED SOIL CLASSIFICATION SYSTEM



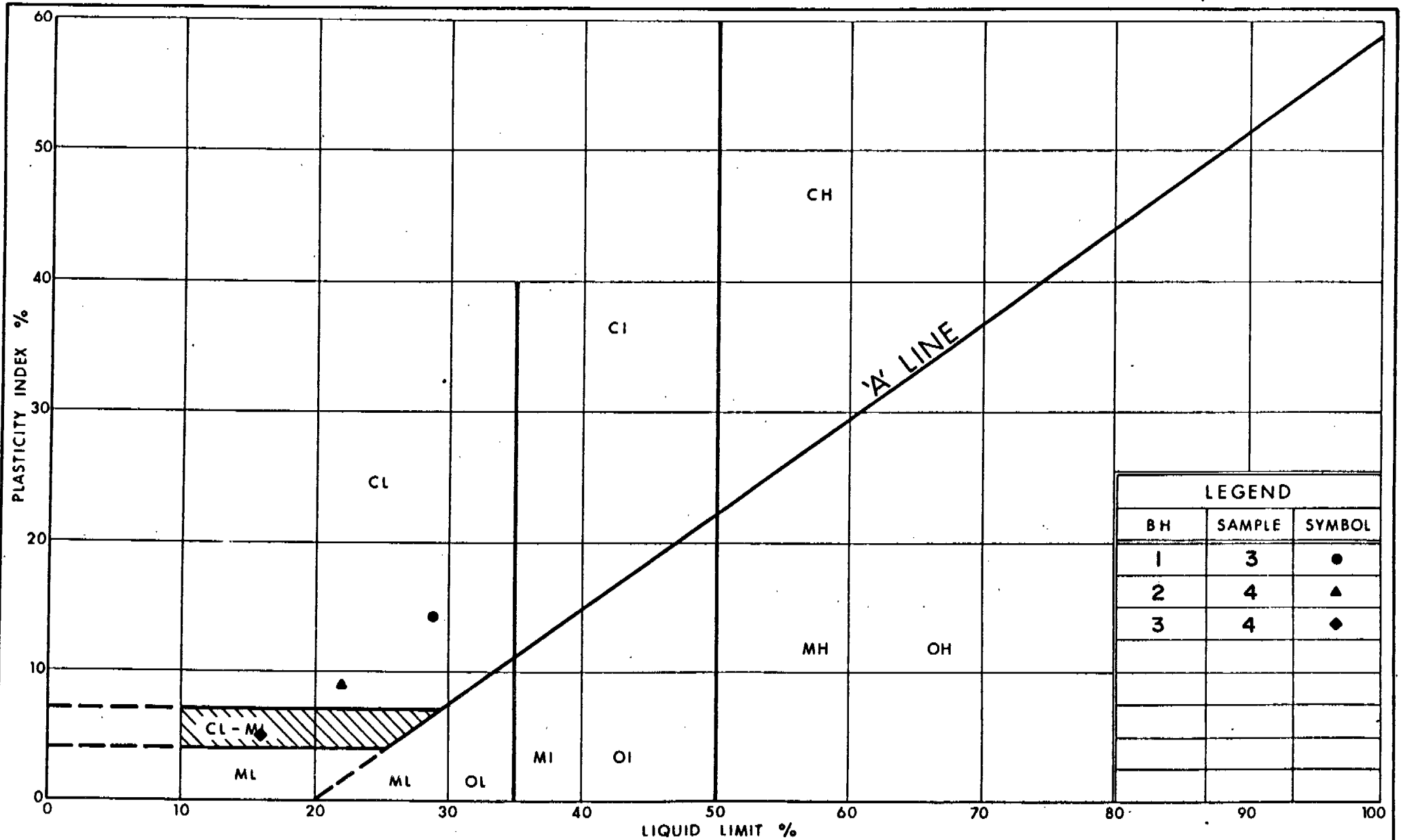
GRAIN SIZE DISTRIBUTION
SILTY CLAY SOME SAND

FIG No 5
W P EGG-000-23



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Transportation and
Communications
Ontario

PLASTICITY CHART SILTY CLAY TO SILTY CLAY, SOME SAND

FIG No 6
W P EGG-000-23

VOID RATIO - PRESSURE CURVES

15

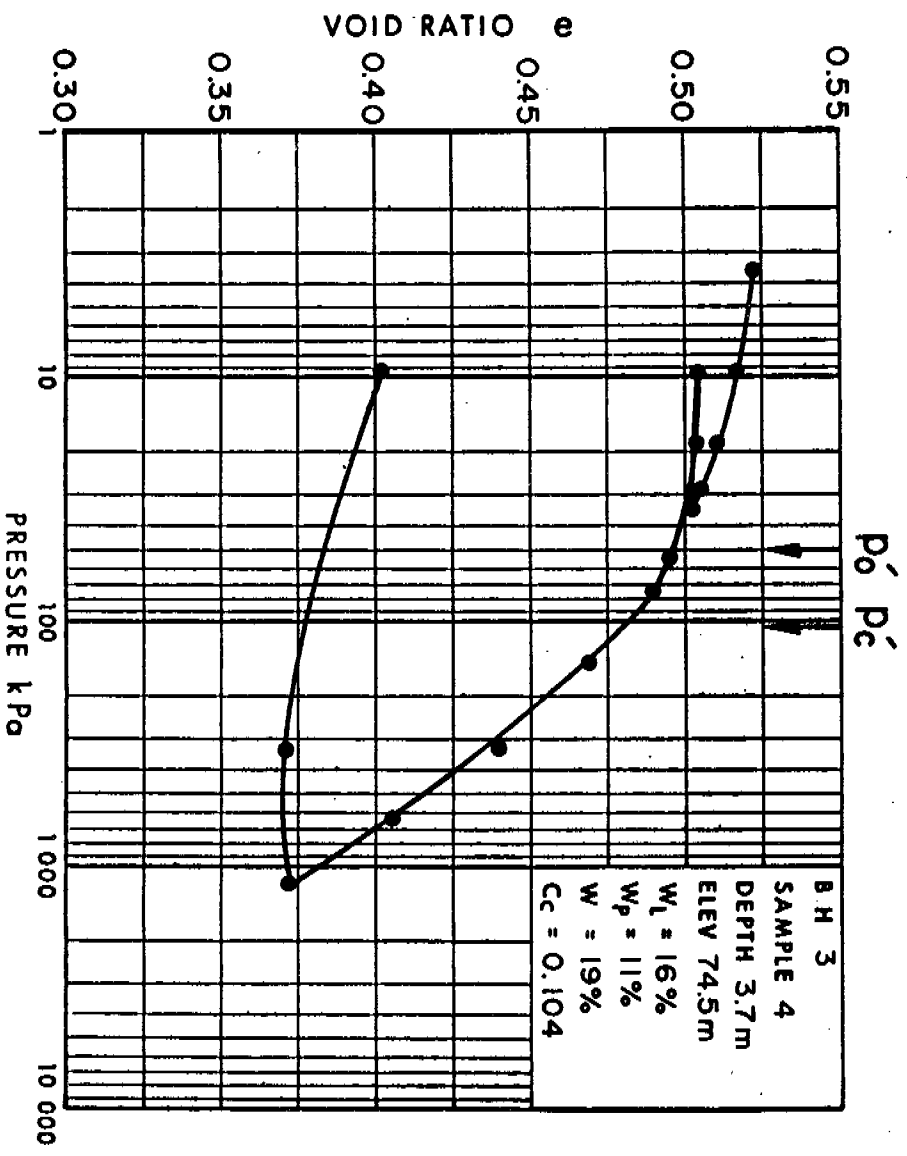
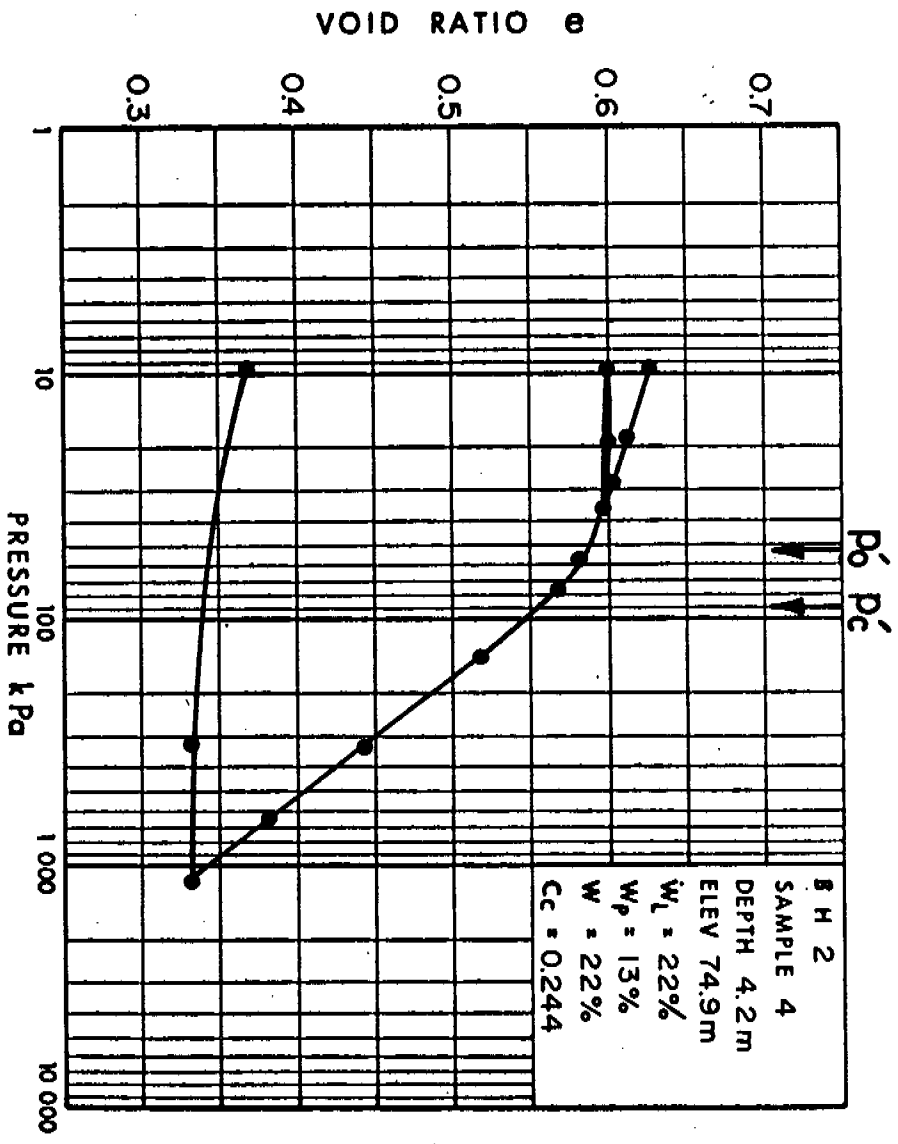
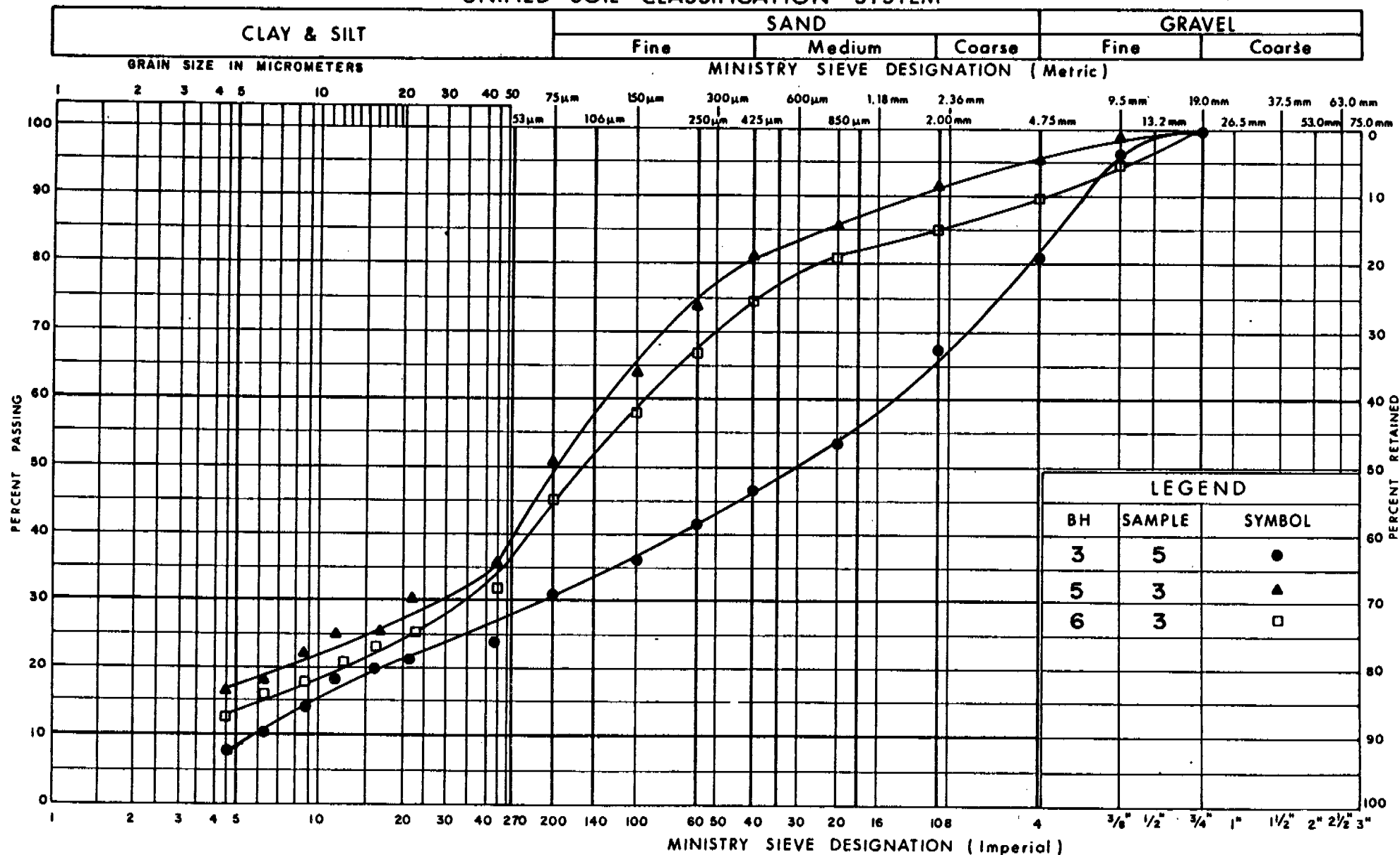


FIG No. 7

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SILTY SAND TILL

FIG No 8

W P EGG-000-23



Ministry of
Transportation and
Communications

RECORD OF BOREHOLE No 1

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,386; E 351,088 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
DATUM Geodetic DATE August 22, 1983 CHECKED BY ASP

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					
80.86	Ground Surface																GR SA SI CL
0.00	Sand, trace silt																
79.70	Compact Brown		1	S.S.	14		80										
1.16	Interlayered silt and silty clay		2	S.S.	23		elev. 79.15 m,										
78.73	Very stiff Grey/Brown		3	S.S.	2		Aug. 25, 1983										
2.13	Clay, some silt, trace sand grading to silty clay some sand, trace gravel		4	S.S.	1		78										0 2 18 80
75.68	Soft to Firm Grey						76										
5.18	Silt with clay and sand and interlayers of shale. Completely weathered shale.		5	S.S.	40												
	Dense to Dark		6	S.S.	80		74										
72.94	Very Dense Grey/Brown		7	S.S.	>100												
7.92	Shale Bedrock, highly to moderately weathered, petroliferous		8	S.S.	100		72										
71.66																	
9.20	Dark Brown				5mm		70										
	End of Borehole																

RECORD OF BOREHOLE No 2

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,386; E 351,067 ORIGINATED BY MH
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
DATUM Geodetic DATE August 22, 1983 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
80.03	Ground Surface													
0.00	Sand, trace silt													
79.27	Brown													
0.76	Silty Clay, trace sand		1	S.S.	11									
77.90	Stiff to Hard Grey/Brown		2	S.S.	32									
77.32	Interlayered Silt and Silty Clay Stiff		3	S.S.	9									
2.71	Silty Clay some Sand trace gravel		4	T.O.	PH									
74.85	Soft to Firm Grey													
5.18	Silt with clay and sand and interlayers of shale Completely weathered shale.		5	S.S.	44									
			6	S.S.	62									
72.72	Dense to Dark Very Dense Grey/Brown													
7.31	Shale Bedrock, highly to moderately weathered.		7	S.S.	20/0 mm									
70.89	Dark Brown													
9.14	End of Borehole													

RECORD OF BOREHOLE No 3

Metric

W P	Proj. # EGG-000-23	LOCATION	Co-ordinates N 4,858,374; E 351,022	ORIGINATED BY	MH
DIST	6 HWY GO-ALRT	BOREHOLE TYPE	Solid Stem Auger, Bx Rock Core	COMPILED BY	EO
DATUM	Geodetic	DATE	August 23, 1983	CHECKED BY	ASP

[illegible]

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 4

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,346; E 350,956 ORIGINATED BY MH
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
 DATUM Geodetic DATE August 24, 1983 CHECKED BY ASP

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					
81.63	Ground Surface																
0.00	Fill - Sand, trace silt and gravel.																
90.48	Compact Brown		1	S.S.	18												
1.15	Fill - silty sand, some gravel, trace clay, or organic material at 2.4m depth.		2	S.S.	45												13 53 26 8
78.74	Compact to Dense Brown to Grey		3	S.S.	12												
2.89			4	S.S.	57												25 49 19 7
	Gravelly sand, some silt, trace clay. Possible Till.		5	S.S.	60												
			6	S.S.	20												
			7	S.S.	80												
74.77	Very Dense Grey		8	S.S.	104												
6.86	Silt with clay & sand & interlayers of shale. Completely weathered shale.		9	S.S.	50												
73.25	Very Dense Dark Brown		10	S.S.	100												
8.38	Shale Bedrock, moderately weathered, fissile																
71.27	Dark Brown																
10.36	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,320; E 350,909 ORIGINATED BY MH
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, Bx Rock Core COMPILED BY EO
 DATUM Geodetic DATE August 24, 1983 CHECKED BY ASP

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		
79.36	Ground Surface													
0.00	Silty sand and gravel, occ. cobble		1	S.S.	46		elev. 78.02m							
77.53	Dense Brown		2	S.S.	38		78 Sept. 15, 1983							
1.83	Till, Silty Sand, some clay, trace gravel		3	S.S.	47		elev. 77.81m							
76.47	Dense Gray		4	S.S.	84		Sept. 5, 1983							5 45 32 18
2.89	Silt with clay and sand and interlayers of shale Completely weathered shale.		5	S.S.	100									
74.94	Very Dense Dark Brown		6	S.S.	109									
4.42	Shale Bedrock, highly to moderately weath- ered, fissile, very poor to poor RQD.		7	S.S.	100									
			8	Bx	63%									
			9	RC	61%									
			10	Bx RC	REC. 92%									
			11	Bx RC	REC. 95%									
			12	Bx RC	REC. 97%									
67.69	Dark Brown													
11.67	End of Borehole													



RECORD OF BOREHOLE No 6

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,310: E 350,887 ORIGINATED BY MH
DIST 6 HWY GO ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
DATUM Geodetic DATE August 25, 1983 CHECKED BY ASP

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					
78.91	Ground Surface																
0.00	Silty Sand, trace gravel																
77.69	Compact Grey		1	S.S.	30		78										
1.22	Till, silty sand, some clay, trace gravel		2	S.S.	22												
			3	S.S.	34												
	Compact to Brown to Very Dense Grey		4	S.S.	114		76										
74.95			5	S.S.	83												
3.96	Shale Bedrock, highly to moderately weath- ered, fissile.		6	S.S.	100 15mm		74										
			7	S.S.	30 0mm												
71.29	Dark Brown		8	S.S.	30 0mm		72										
7.62	End of Borehole						70										

RECORD OF BOREHOLE No 7

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,298; E 350,880 ORIGINATED BY MH
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
DATUM Geodetic DATE August 26, 1983 CHECKED BY ASP

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			20	40	60	80	100					
77.45	Ground Surface															
0.00	Sand, trace silt															
76.08	Compact Grey		1	S.S.	18											
1.37	Fill, silty sand, trace gravel and clay		2	S.S.	80											
75.01	Very Dense Brown/Grey		3	S.S.	120											
2.44	Shale Bedrock, highly to moderately weathered completely weathered from 4.6 to 5.8 m depth petroliferous.		4	S.S.	28mm											
			5	S.S.	30mm											
			6	S.S.	2mm											
			7	S.S.	2mm											
			8	S.S.	0mm											
63.31	Dark Brown		9	A.S.												
9.14	End of Borehole															

RECORD OF BOREHOLE No 8

Metric

W P Proj. #EGG-000-23 LOCATION Co-ordinates N 4,858,285; E 350,854 ORIGINATED BY MH
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EO
 DATUM Geodetic DATE August 26, 1983 CHECKED BY ASP

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					
79.75	Ground Surface																
0.00	Fill, silty sand, wood plastic, metal, organ- ic material		1	S.S.	15												
			2	S.S.	75												
			3	S.S.	12												
75.94	Compact to Very Dense		4	S.S.	21												
3.81	Fill, silty sand, some clay trace gravel.		5	S.S.	62												
			6	S.S.	115												
73.71	Very Dense Grey		7	S.S.	130												
6.04	Shale Bedrock, highly to moderately weathered		8	S.S.	135												
			9	S.S.	50												
70.61	Dark Brown		10	S.S.	50												
9.14	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

INDEX

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2	Abbreviations & Symbols
3 - 46	Foundation Investigation Reports for Henry Street Underpass & Retaining Structure GO-ALRT W.P.C.P. Access Structure GO-ALRT

Note: For purposes of the contract these reports supercede all other Foundation Reports prepared by or for GO-ALRT in connection with the above-mentioned projects.

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

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

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
Henry Street Underpass
GO-ALRT Contract GGE-330

Introduction

This report contains the results of a foundation investigation carried out at the site of the above-mentioned project during the period of August 24th to 26th, 1983 inclusive for the underpass and the retaining walls and during the period of April 2nd to April 5th, 1984 for the extension of the north east retaining wall. This report was prepared by B.P. Walker Associates Limited, Consulting Geotechnical Engineers under the technical direction of the Foundation Design Section of the Ministry of Transportation and Communications.

The boreholes ranged in depth from 12.4 m to 16.8 m below the existing ground surface.

Site Description and Geology

The site is located about 140 m south of Highway 401 in the Town of Whitby in the Regional Municipality of Durham.

The area is located in the physiographical region known as the Iroquois Plain. In this area the subsoil is a mosaic of till plains, drumlins and areas of silty lacustrine deposits. The topography is flat to gently rolling.

Subsurface Conditions

Subsurface conditions at the site were found to be generally uniform. The original ground, under a thin layer of topsoil, is a glacial till composed of a heterogeneous mixture of silty clay and sand, trace gravel changing with depth to a granular heterogeneous mixture of sand with silt and clay. At borehole nine (9) location a deposit of silty clay with sand and gravel (reworked shale till) was encountered below the granular sand with silt and clay at an elevation of 77.7 m. The boundaries between the upper slightly cohesive glacial till and the lower non-cohesive portion of this deposit vary from a depth of 2.3 m to 5.0 m below the original ground level.

The boundary of the glacial till stratum is at an elevation varying from 74.7 m to approximately 73.7 m, on shale bedrock encountered at borehole 1, 7, 8 and 9, but this was not proven by coring. The existing Henry Street embankment is composed of fill material which is borrowed parent material composed of cohesive glacial till.

A detailed description of the soil encountered in each borehole is given in the Record of Borehole Sheets in the Appendix. The estimated stratigraphical profile and the sections shown on Sheets 59 and 59A in the Contract Drawings are based upon this information. The location of the boreholes is also shown on Sheet 59. From ground level downwards, the subsurface conditions are as follows:

Fill Material

Three boreholes, boreholes 2, 3 and 5, were carried out through the embankment of the existing Henry Street at the north and south of the site. The thickness of the fill material was found to be about 4.9 m. The fill material is comprised of a cohesive glacial till (heterogeneous mixture of silty clay, sand and gravel) and contains occasional traces of organics.

Standard Penetration Tests gave 'N' values in the range of 6-41 blows per 30 cm, indication that the fill material has a firm to hard consistency.

The results of grain size distribution testing performed on representative samples from the fill are shown on Figure 1.

Glacial Till (Heterogeneous Mixture of silty clay and sand trace gravel changing with depth to a heterogeneous mixture of gravelly sand with silt and clay).

Under a thin layer of topsoil or immediately under the fill material is a deposit of glacial till. The deposit is composed of a cohesive heterogeneous mixture of silty clay and sand, trace gravel changing with depth to a heterogeneous mixture of gravelly sand with silt and clay. The boundaries between the upper slightly cohesive glacial till and the lower non-cohesive portions of this deposit vary from a depth of 2.3 m to 5.0 m below the existing ground level.

Silty Clay with Sand and Gravel (Reworked Shale Till)

Reworked shale till was encountered at borehole nine (9) only at an elevation of approximately 77.7 m. This deposit is composed of silty clay with sand and gravel and is grey in colour. Standard Penetration test gave 'N' values of over 100 blows per 30 cm indicating the consistency of the deposit to be hard.

The results of the Atterberg Limit Tests carried out on upper glacial till are shown on the Plasticity Chart on Figure 4. These results indicate that the matrix is inorganic and of low plasticity (CL - ML to ML Zone).

The results of grain size distribution testing performed on representative samples from the upper glacial till are shown in envelope form on Figure 2. The results for the lower glacial till are shown in envelope form on Figure 3 for boreholes 1, 2, 4 & 5 and on Figures 5 & 6 for boreholes 7 & 8.

The result of grain size distribution test performed on reworked shale till is shown on Figure 7.

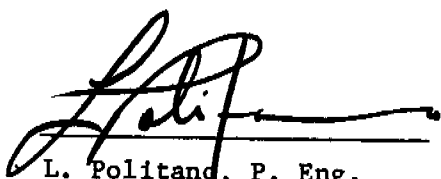
The standard penetration tests gave 'N' values in the range of 20 to over 100 blows per 30 cm. Based on these 'N' values the consistency of the slightly cohesive upper stratum is estimated to be very stiff to hard, whereas the relative density of the lower non-cohesive portion of the glacial till is dense to very dense, generally in the very dense range. The low 'N' values at an elevation of approximately 78.0 m at boreholes 7 & 8 are probably due to loosening of the non-cohesive soil and do not represent the true density of the soil. A dynamic cone penetration test carried out in a borehole approximately 1.0 m from borehole 8, augered to 9.1 m, substantiates this point. The cone penetration results are shown on the borehole log.

The lower boundary of the glacial till was on possible shale encountered at depth varying from about 13.7 m to about 15.2 m below original ground but this was not proved by coring.

Groundwater

A piezometer was installed at borehole eight location in order to establish the stabilized water table. At other boreholes the groundwater level conditions were observed by measuring in the open boreholes during and after completion of the foundation investigation. The stabilized water table at borehole eight (8) was at an elevation of 83.4 m. The groundwater level at other boreholes was found to vary between elevations of 82.3 m to 86.6 m.

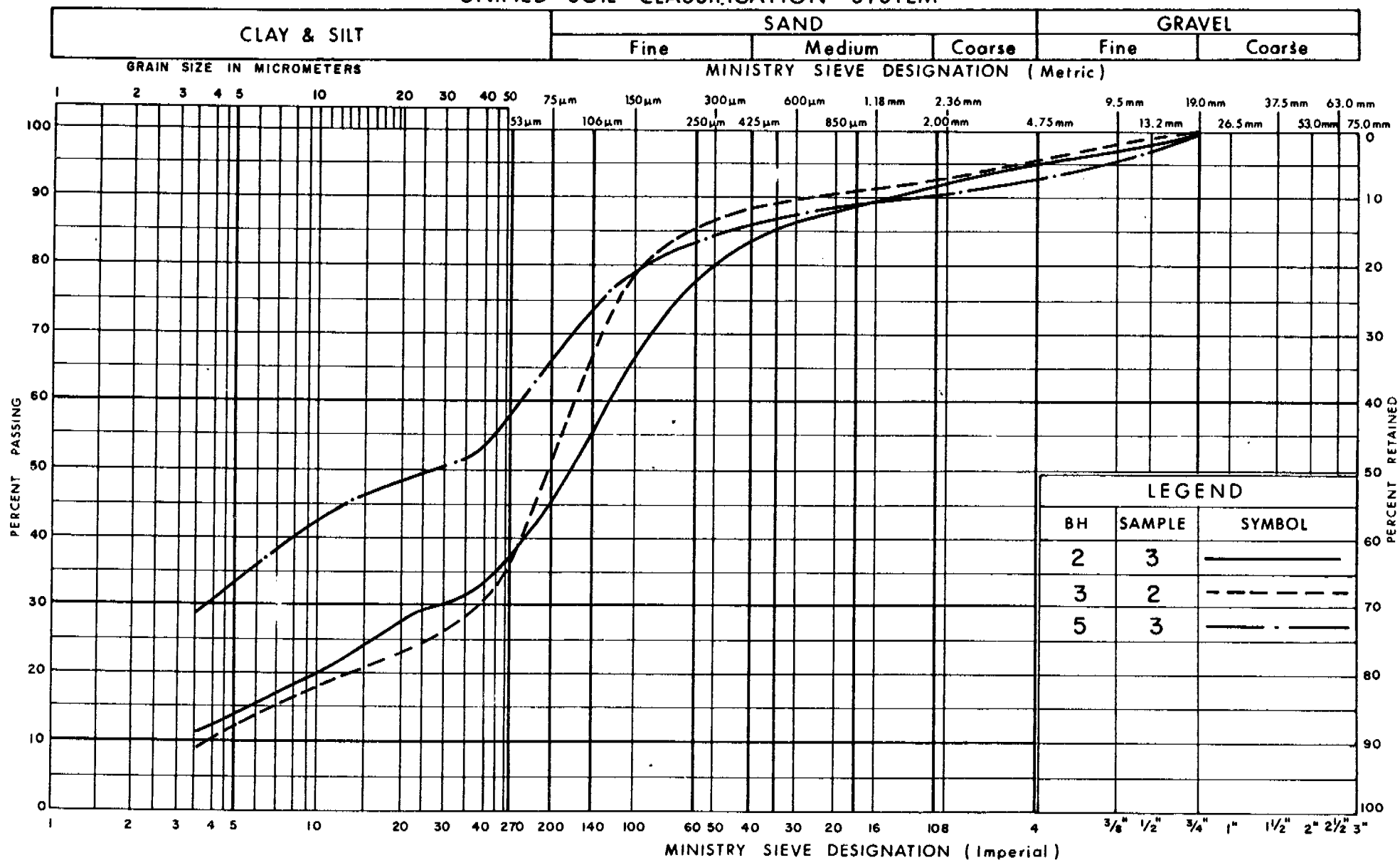
NOTE: The preceding Foundation Investigation Report is a copy of the factual information prepared by B.P.Walker Associates Ltd., the geotechnical consulting engineers for this project.

A handwritten signature in black ink, appearing to read 'L. Politano', written over a horizontal line.

L. Politano, P. Eng.
Project Foundations Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



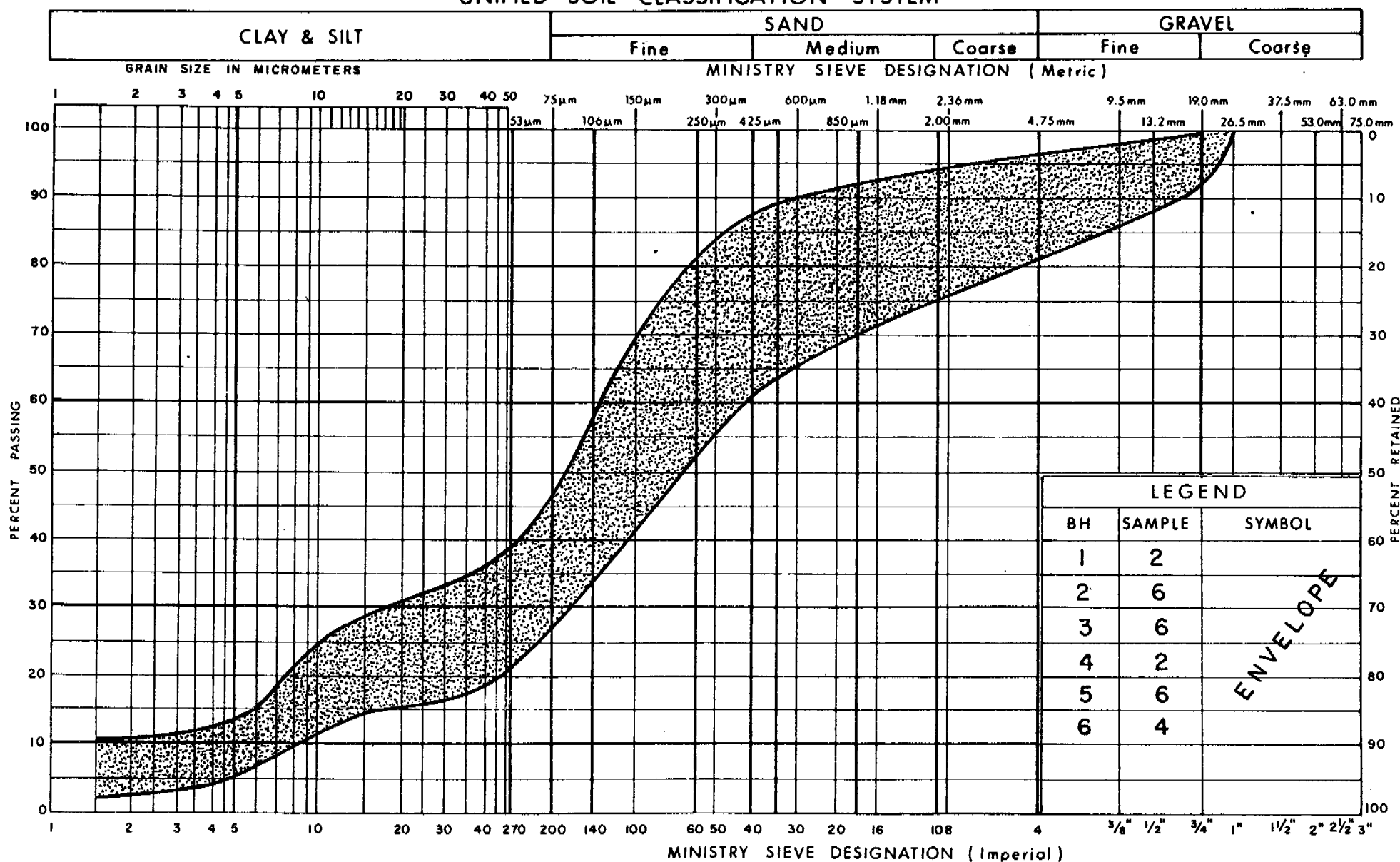
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GRAIN SIZE DISTRIBUTION
SILTY CLAY AND SAND TRACE OF GRAVEL (Fill)

FIG No 1

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
SILTY CLAY AND SAND TRACE OF GRAVEL
(Upper Glacial Till)

FIG No 2

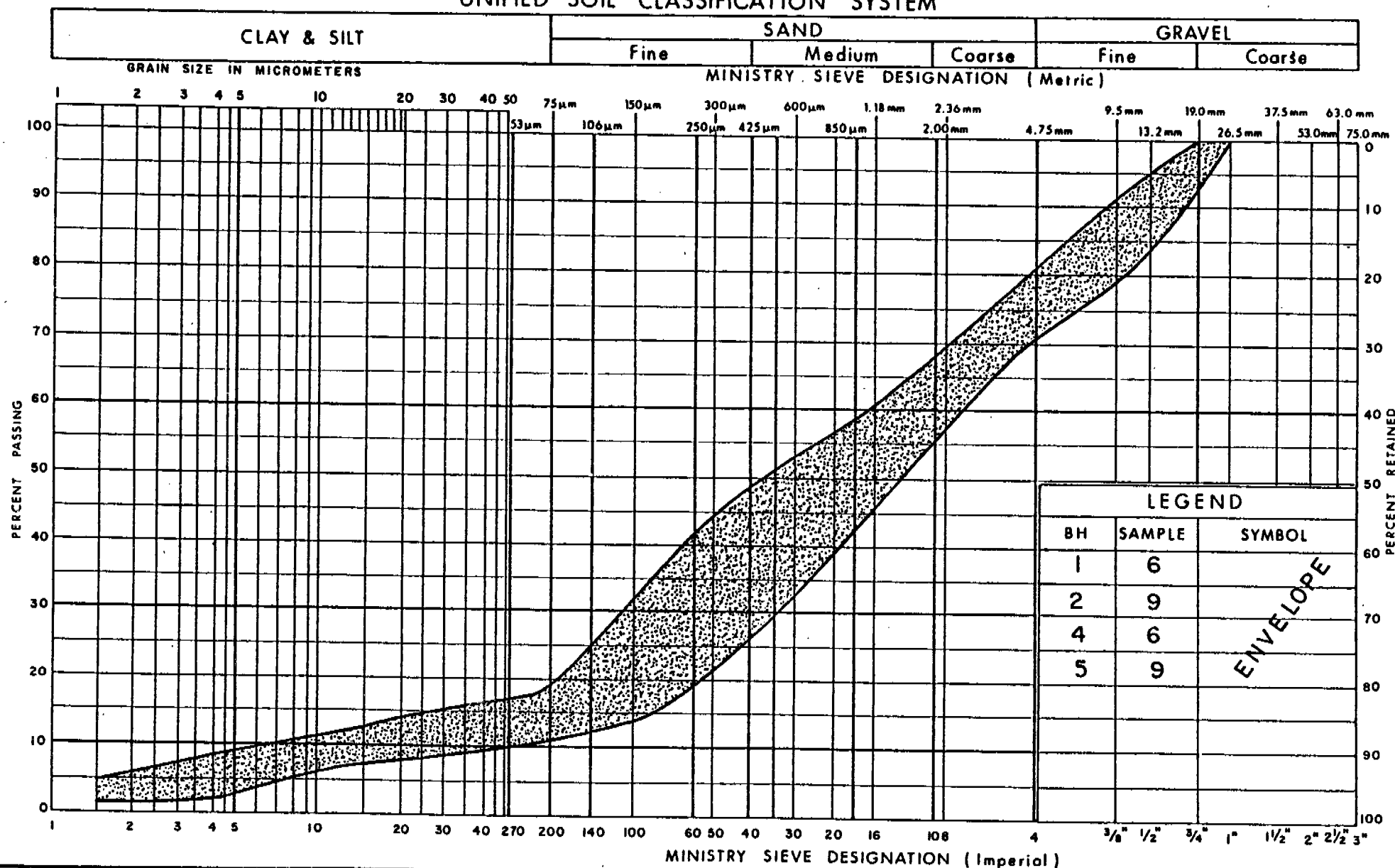
W P EGG-000-21



Ontario

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Transportation and
Communications

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
GRAVELLY SAND TRACE OF SILT AND CLAY
(Lower Glacial Till)

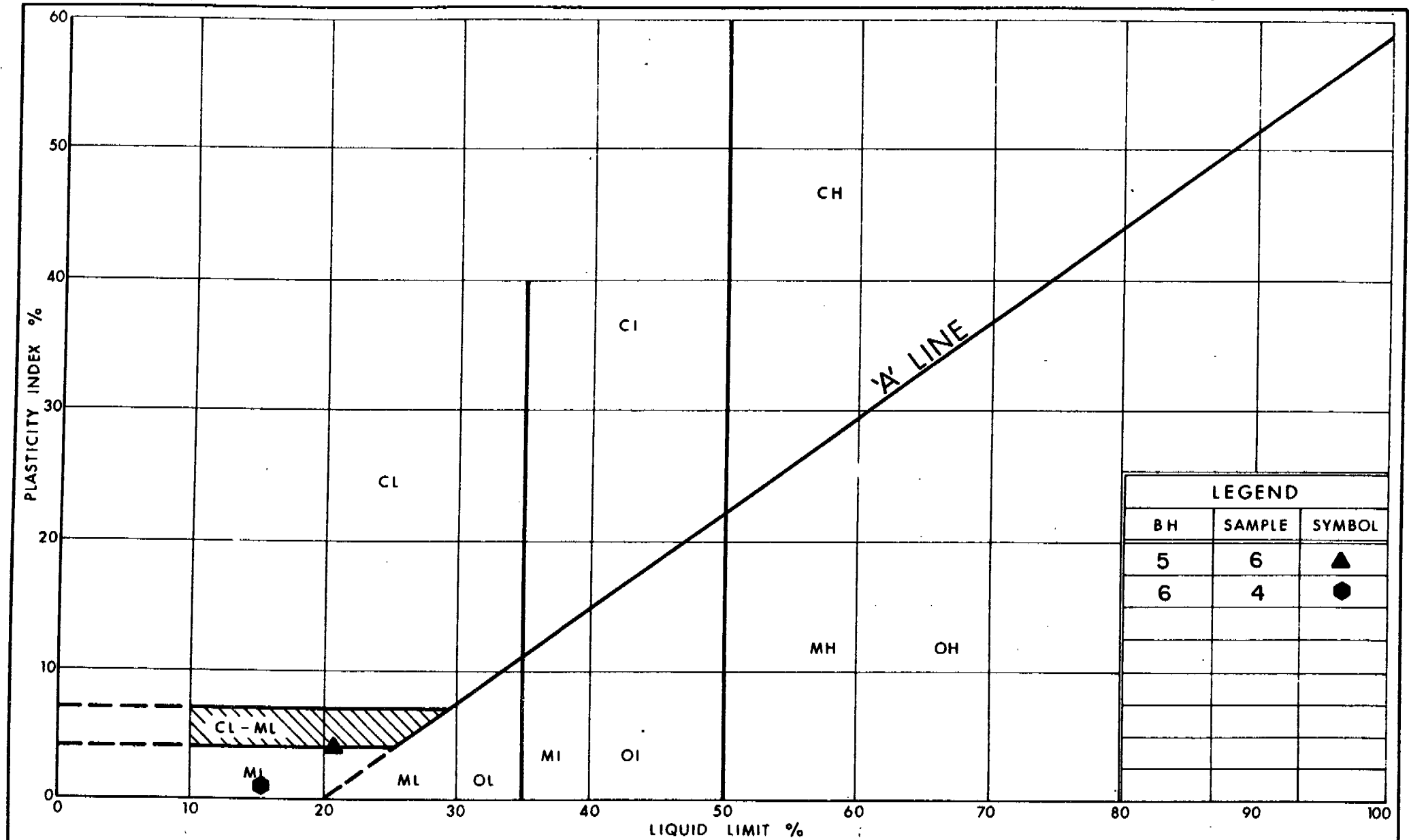
FIG No 3

WP EGG-000-21



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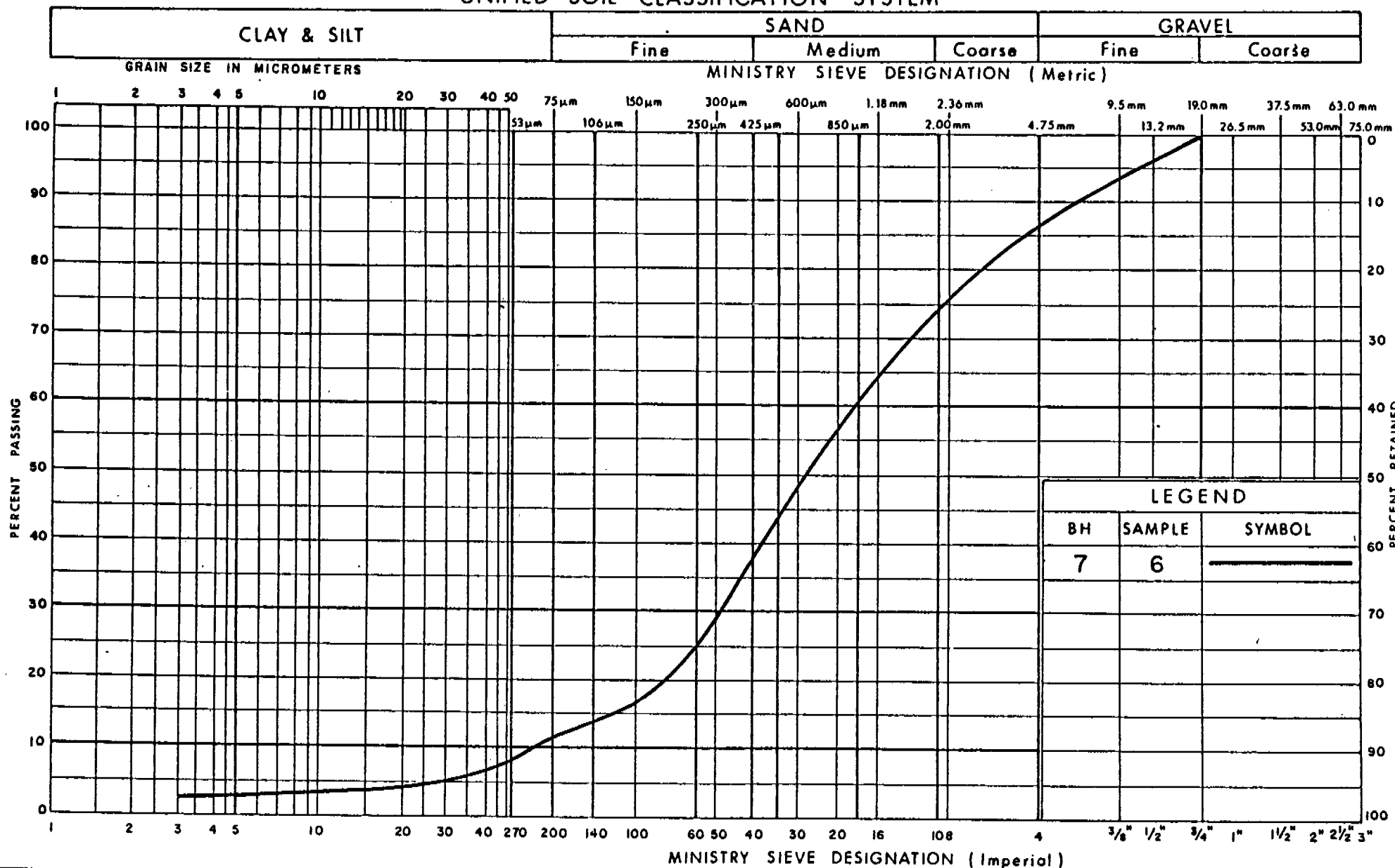
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Transportation and
Communications

PLASTICITY CHART SILTY CLAY AND SAND TRACE OF GRAVEL (Upper Glacial Till)

FIG No 4

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



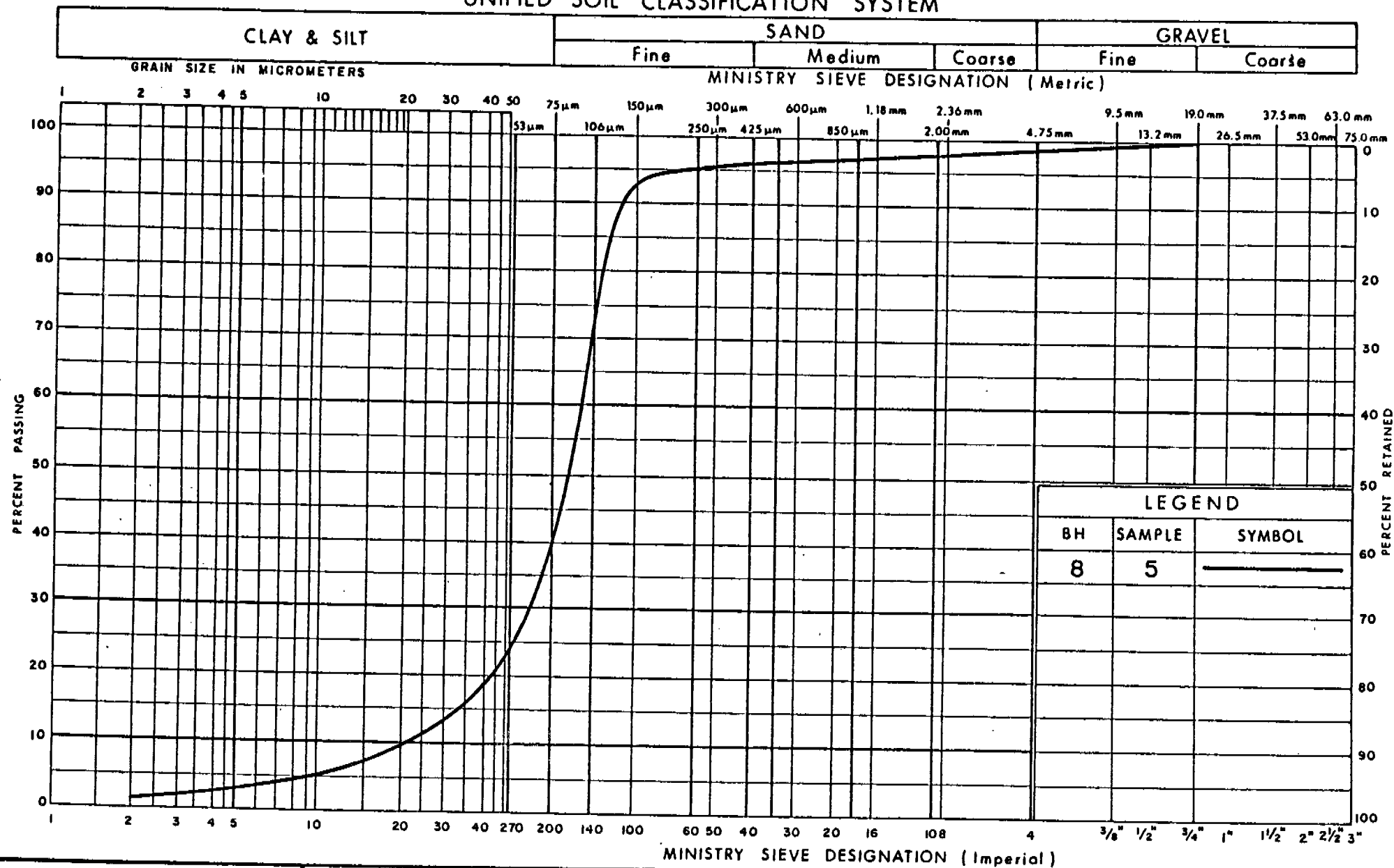
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Communications

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, TRACE OF SILT AND CLAY
(Lower Glacial Till)

FIG No 5

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



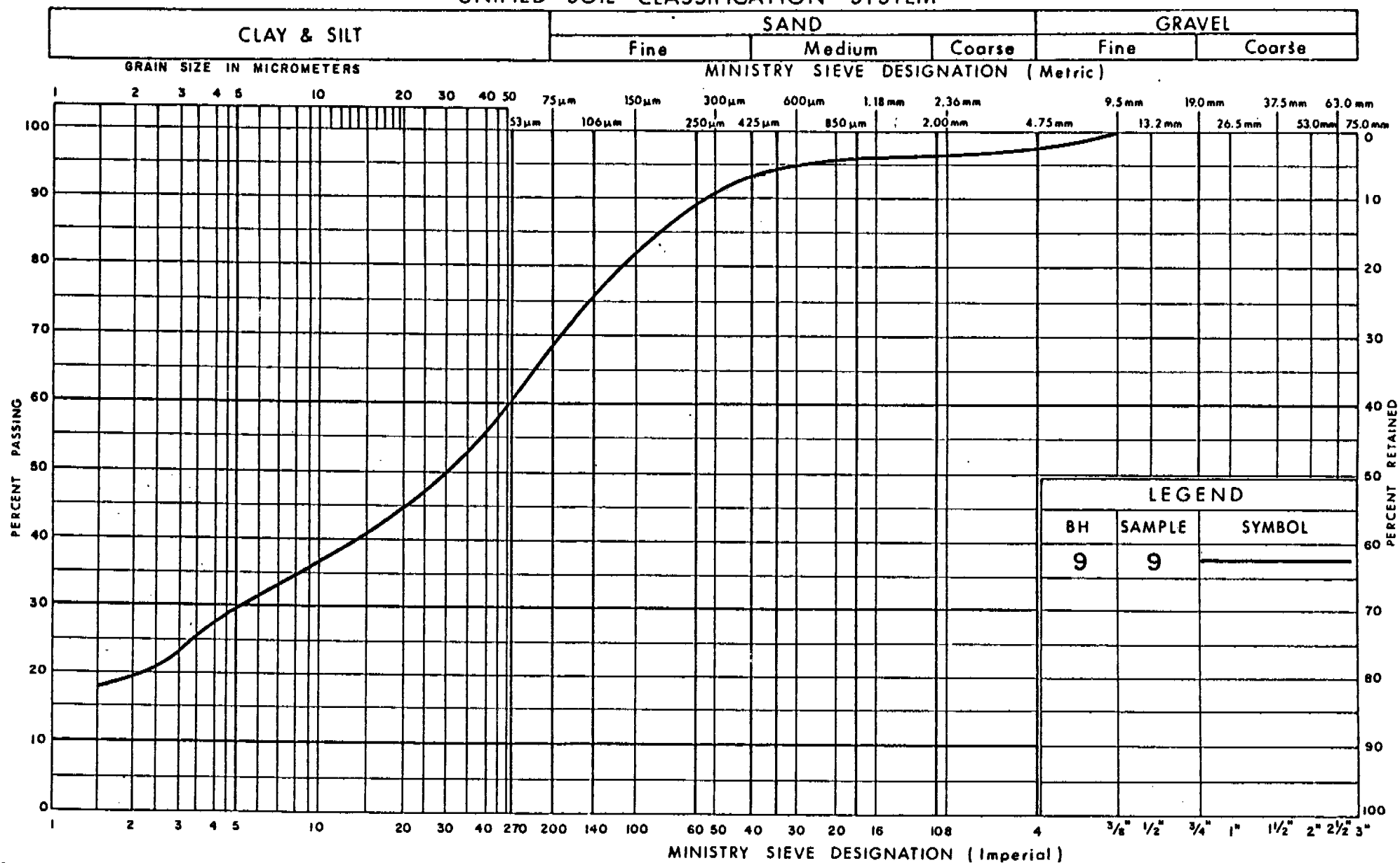
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GRAIN SIZE DISTRIBUTION
SILTY SAND, TRACE OF GRAVEL AND CLAY
(Lower Glacial Till)

FIG No 6

W P EGG-000-21

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH SAND, TRACE OF GRAVEL
(Reworked Shale Till)

FIG No 7

W P EGG-000-21



RECORD OF BOREHOLE No 1

METRIC

12

W P EGG - 000 - 21

LOCATION Co-ords N 4 858 318.0; E 349 667.0

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER & CONE TEST

COMPILED BY USS

DATUM GEODETIC

DATE 83 - 8 - 24

CHECKED BY BPW

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					
89.0	GROUND LEVEL																
0.0	Silty clay and sand, trace of gravel, (Upper Glacial Till) Low Plasticity Very Stiff to Hard		1	SS	20		88										5 47 36 12
			2	SS	59												
			3	SS	72		86										
			4	SS	115												
84.4																	
4.6	Gravelly Sand, trace of silt and clay (Lower Glacial Till) Very Dense Brown Grey		5	SS	132		84										27 61 12
			6	SS	61/8cm												
			7	SS	130/15cm		82										
			8	SS	50		80										
			9	SS	186		78										
			10	SS	134		76										
73.7							74										
15.3	Shale, weathered, grey																
72.2																	
16.8	End of Borehole						72										

+³, x⁵: Numbers refer to
Sensitivity

20
15 ± 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC

13

W P EGG - 000 - 21 LOCATION Co-ords N4 858 315.3; E 349 682.8 ORIGINATED BY MM
DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY USS
DATUM GEODETIC DATE 83 - 8 - 25 CHECKED BY BPW

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					
93.6	GROUND LEVEL																
0.0	Silty clay and sand, trace of gravel (Fill) Low Plasticity Firm to Hard		1	SS	6		92										5 50 30 15
			2	SS	41												
			3	SS	28												
			4	SS	25												
88.5			5	SS	11												
5.1	Silty clay and sand, trace of gravel (Upper Glacial Till) Low Plasticity Hard		6	SS	80		88										6 49 28 17
	Brown		7	SS	110/5cm		86										
	Grey		8	SS	87/15cm		84										
82.8			9	SS	114/5cm		82										19 63 12 6
10.8	Gravelly Sand, trace of silt and clay (Lower Glacial Till)		10	SS	100/12cm												
81.1	Very Dense																
12.5	End of Borehole						80										



RECORD OF BOREHOLE No 3

METRIC

14

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 311.7; E 349 712.0 ORIGINATED BY MM
DIST 6 HWY GO - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST COMPILED BY USS
DATUM CEODETIC DATE 83 - 8 - 25 CHECKED BY BPW

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	10 20 30					
92.3	GROUND LEVEL													
0.0	Silty clay and sand, trace of gravel (Fill) Low Plasticity Very Stiff		1	SS	15		92						21.3	5 42 40 13
			2	SS	23		90						18.7	
			3	SS	15									
			4	SS	20									
87.7							88							
4.6	Silty clay and sand, trace of clay (Upper Glacial Till) Low Plasticity Hard		5	SS	31									
			6	SS	130		86							15 56 22 7
			7	SS	129		84							
83.2	Brown													
9.1	Grey		8	SS	110		82							
	Gravelly Sand trace of silty and clay (Lower Glacial Till) Very Dense		9	SS	115/15cm									
79.8			10	SS	139/15cm		80							
12.5	End of Bore						78							



RECORD OF BOREHOLE No 4

METRIC

15

W P EGG - 000 - 21

LOCATION Co-ords N 4 858 308.4; E 349 673.3

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST

COMPILED BY USS

DATUM GEODETIC

DATE 83 - 8 - 24

CHECKED BY BPW

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					
89.4	GROUND LEVEL																
0.0	Silty clay with sand trace of gravel (Upper Glacial Till) Low Plasticity Very stiff to hard		1	SS	23		88										3 57 26 14
			2	SS	38												
			3	SS	80												
			4	SS	99/15cm		86										
84.8	Brown																
4.6	Grey Gravelly Sand with trace of silt and clay (Lower Glacial Till) Non Plastic Very Dense		5	SS	115		84										28 60 12
			6	SS	71/15cm												
			7	SS	107		82										
			8	SS	96		80										
			9	SS	82/8cm		78										
76.9																	
12.5	End of Borehole		10	SS	120/15cm		76										

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 301.6; E 349 702.8 ORIGINATED BY MM
DIST 6 HWY GO - A.I.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST COMPILED BY USS
DATUM GEODETIC DATE 83 - 8 - 24 CHECKED BY BPW

[illegible]

+3, x5; Numbers refer to Sensitivity

15 \pm 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

METRIC

17

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 300.7; E 349 715.6 ORIGINATED BY MM
DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE SOLID STEM AUGER AND CONE TEST COMPILED BY USS
DATUM GEODETIC DATE 83 - 8 - 26 CHECKED BY BPW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
89.2	GROUND LEVEL						20	40	60	80	100	10	20	30				
0.0	Silty clay and sand, some gravel (Upper Glacial Till) Low Plasticity Very stiff to hard		1	SS	29													
			2	SS	55													
			3	SS	88													
			4	SS	101	15cm												
84.7	Brown		5	SS	99	15cm												
4.5	Grey		6	SS	98	57cm												
	Gravelly Sand, trace of silt and clay (Lower Glacial Till) Non Plastic Very Dense		7	SS	110	13cm												
			8	SS	100	10cm												
			9	SS	131													
76.5			10	SS	38													
12.7	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

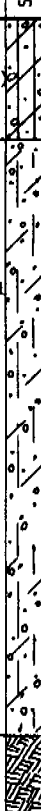


RECORD OF BOREHOLE No 7

METRIC

18

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 306.8; E 349 735.0 ORIGINATED BY D.O.
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger to 9.1m Wash Boring Below COMPILED BY U.S.S.
DATUM Geodetic DATE 84-04-02 and 84-04-03 CHECKED BY U.S.S.

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 ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
89.3	Ground Level							20 40 60 80 100							
0.0	Silty Clay & Sand, Some Gravel (Upper Glacial Till)		1	SS	8		88								
87.0	Low Plasticity, Stiff to Hard		2	SS	51										
2.3	<u>Brown</u> Grey Gravelly Sand, Trace Silt and Clay (Lower Glacial Till) Non Plastic Very Dense		3	SS	102	23cm	86								
			4	SS	100										
			5	SS	100	15cm	84								
			6	SS	79										
			7	SS	100	25cm	82								
			8	SS	111		80								
			9	SS	16		78								
			10	SS	170	23cm									
75.6		11	SS	105	15cm	76									
13.7	Shale - Weathered														
73.9		12	SS	110	15cm	74									
15.4	End of Borehole														
	On completion cave-in at 4.9m. W.L. at 2.7m.														



RECORD OF BOREHOLE No 8

METRIC

19

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 301.0; E 349 759.4 ORIGINATED BY D.O.
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger to 10.7m, Wash boring below COMPILED BY U.S.S.
DATUM Geodetic DATE 84-02-02 and 84-04-05 CHECKED BY U.S.S.

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 (%)		
								20 40 60 80 100										10 20 30		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE													
89.1	Ground Level																			
0.0	Silty Clay & Sand, Some Gravel, (Upper Glacial Till)		1	SS	13		88									2 65 30 3				
86.8	Low Plasticity, Very Stiff		2	SS	23															
2.3	BROWN Grey Silty Sand, Trace Gravel and Clay, (Lower Glacial Till), Very Dense		3	SS	64		86													
			4	SS	100	13cm		84												
			5	SS	100	25cm		82												
			6	SS	100	9cm		80												
			7	SS	100	10cm		78												
			8	ss	15			76												
			9	ss	170															
74.9				10	SS	112		74												
14.2			Shale - Weathered	11	SS	100	10cm													
73.6																				
15.5	End of Borehole																			
Cone Penetration Tests																				
(M) Penetration																				
Depth ELE. Resistance																				
9.1 80.0 140/30cm																				
9.4 79.7 100/4cm																				
9.8 79.3 200/30cm																				
10.1 79.0 194/5cm																				
10.4 78.7 57/30cm																				
10.7 78.4 80/30cm																				
11.0 78.1 200/23cm																				
11.3 77.8 23/30cm																				
11.6 77.5 100/30cm																				
11.9 77.2 100/8cm																				

RECORD OF BOREHOLE No 9

METRIC 20

W P EGG - 000 - 21 LOCATION Co-ords N 4 858 295.0; E 349 783.8 ORIGINATED BY D.O.
 DIST 6 HWY G0-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY U.S.S.
 DATUM Geodetic DATE 84 - 04 - 04 CHECKED BY U.S.S.

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					
88.4	Ground Level																
0.0	Silty Clay & Sand, Some Gravel, (Upper Glacial Till), Low Plasticity, Very Stiff to Hard		1	SS	21	*	88										
			2	SS	38		86										
85.4			3	SS	41												
3.0	Brown Grey Silty Sand, Trace of Gravel and Clay (Lower Glacial Till) Very Dense		4	SS	51												
			5	SS	50	3cm	84										
			6	SS	125	21cm	82										
			7	SS	100	13cm	80										
			8	SS	60	3cm											
77.7			9	SS	100	13cm	78										
10.7	Silty Clay with Sand, Trace Gravel (Reworked Shale Till) Low Plasticity Hard		10	SS	160		76										
74.7			11	SS	100	5cm											
13.7	Shale - Weathered		12	SS	100	13cm	74										
73.0																	
15.4	End of Borehole																
	* W.L. not established																

Foundation Investigation Report for
W.P.C.P. Access Structure
GO-ALRT Contract GGE-330

Introduction

This report contains the results of a foundation investigation carried out at the site of the above-mentioned project during the period of August 30th to September 6th, 1983 and during the period of December 15th and 16th, 1983. The investigation was carried out by B.P. Walker Associates Limited, Consulting Geotechnical Engineers under the technical direction of the Foundation Design Section of the Ministry of Transportation and Communications.

The fieldwork consisted of eighteen (18) sampled boreholes advanced by means of continuous flight auger machines, bombardier mounted CME 55 and CME 45, equipped with 10 cm O.D. solid stem auger. The boreholes ranged from 5.8 m to 12 m below the existing ground surface.

Site Description and Geology

The site is located south of Highway 401, between Highway 401 and Victoria Street, and west of Dunlop Drive, in the Town of Whitby in the Regional Municipality of Durham.

The area is located in the physiographical region known as the Iroquois Plain. In this area the subsoil is a mosaic of till plains, drumlins and areas of silty lacustrine deposits. The topography is flat to gently rolling.

Subsurface Conditions

Subsurface conditions at the site were found to be fairly uniform. With the exception of 1 borehole, borehole 11, fill was encountered at all boreholes varying in depth from 1.2 m to 3.8 m. The original ground is predominantly a glacial till composed of a mixture of sand and gravel with silt and traces of clay. The lower boundary of this deposit is on shale bedrock, proven by coring on borehole 102.

A detailed description of the soil encountered in each borehole is given in the Record of Borehole Sheets. The estimated stratigraphical profile and the sections shown on Sheets 77 & 77A are based upon this information. The location of the boreholes is shown on Sheet 77. From the ground level downwards, the subsurface conditions are as follows.

Fill Material

With the exception of borehole 11 fill was encountered at all borehole locations varying in depth from 1.2 m to 3.8 m. The composition of the fill varies considerably over the site from a silty clay with sand and trace of gravel, organics, paper and odd debris and clean silty sand with trace of gravel and sand.

Standard Penetration tests gave 'N' values in the range of 2 - 94 blows per 30 cm. The fill, in general, has a soft to firm consistency. The high 'N' values are due mainly to obstructions, thick layers of paper etc., in the fill and are not indicative of the consistency of the fill.

Varved Clay

A thin deposit of varved clay was encountered at boreholes 5, 6 and 14. The thickness of this deposit varies from 0.7 m to 1.0 m. The varved clay is comprised of a silty clay with sand and trace of gravel and is grey in colour. Standard Penetration test gave 'N' value in the range 7 - 9 indicating that the deposit has a firm consistency.

The results of Atterberg Limit tests are shown on the Plasticity chart on Figure 4. These results indicate that the matrix is inorganic and of low plasticity - CL zone.

The results of grain size distribution testing performed on representative samples from this deposit are shown on Figure 1.

Alluvium

A thin alluvial deposit comprising of sandy gravel with silt and trace of clay, varying in depth from 0.8 m to 1.0 m, was encountered at boreholes 10 and 12. This deposit is non-plastic and grey in colour.

The Standard Penetration tests gave 'N' value in the range 13 - 21 indicating that the deposit has a compact consistency.

Glacial Till

The predominant material on this site is a mixture of sand and gravel with silt and traces of clay. The relative proportions of the sand and gravel in the deposit vary considerably, ranging from silty sand with gravel traces of clay to gravelly sand with traces of silt and clay.

Standard Penetration Test gave 'N' values in the range of 7 to over 100 blows per 30 cm. Based on these 'N' values, the consistency of this non-cohesive deposit is loose to very dense, and generally in the very dense range.

The results of grain size testing performed on representative samples from the silty sand with gravel trace of clay and gravelly sand with trace of silt and clay are shown in an envelope form, on Figures 2 and 3 respectively.

Shale

Shale was encountered at most of the boreholes. The shale represents the bedrock and is black with a slight odour. The depth of weathering of the shale bedrock varies.

Shale bedrock was proved at borehole 102 by taking a BXL core for a depth of 1.5 m into the rock. The core recovery and the RQD of the core was 93% and 43% respectively indicating a poor quality shale bedrock.

Groundwater

The groundwater level conditions were observed by measuring in the open boreholes during and after completion of the foundation investigation. The groundwater level was found to vary between elevation of 76.6 m to 75.2 m with the exception of borehole 101, where the water level was at an elevation of 78.9m.

High water level reading at borehole 101 could be due to perched water in the fill. The fill may contain some perched water and the level of this perched water will vary with the seasons of the years.

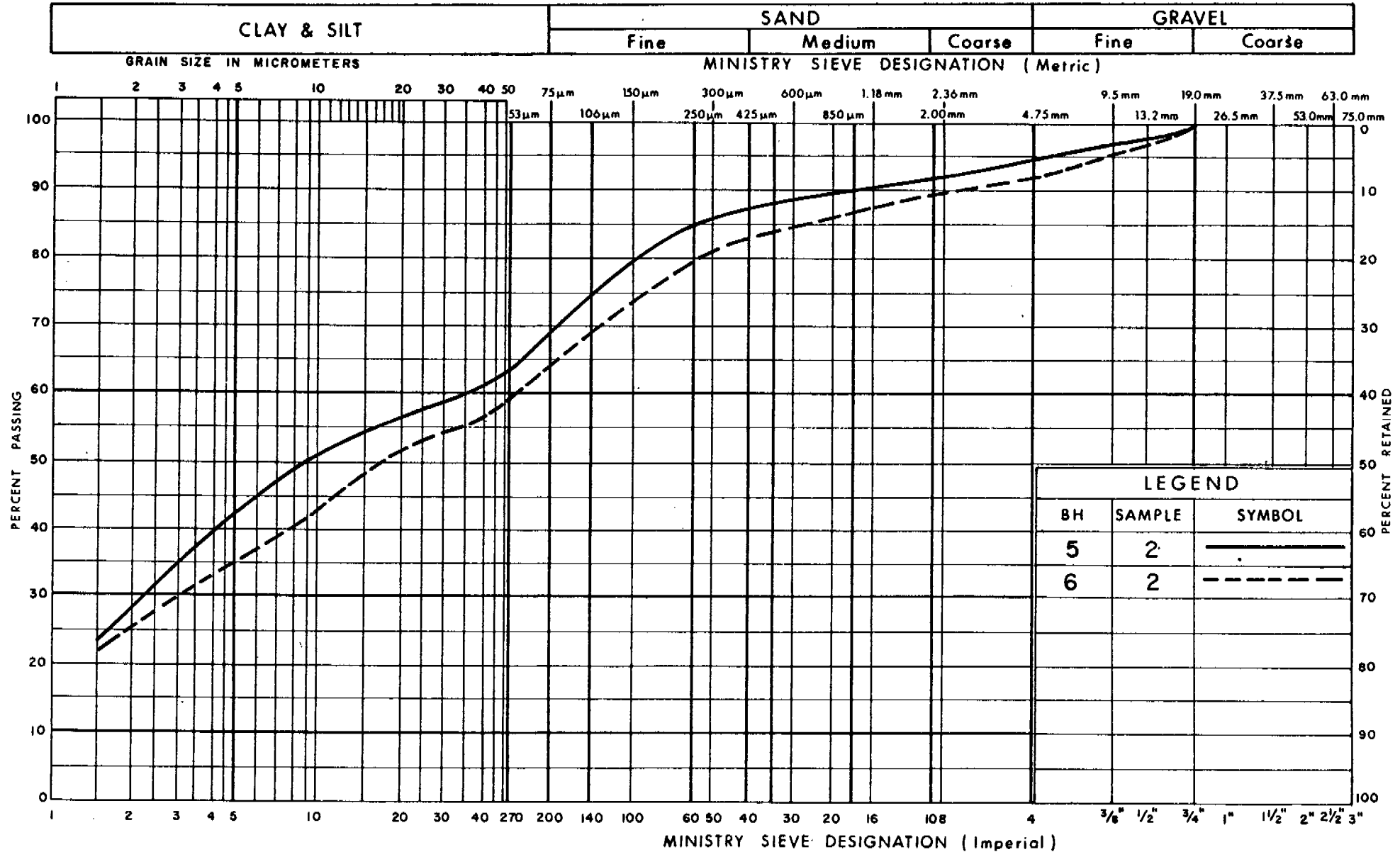
NOTE: The preceding Foundation Investigation Report is a copy of the factual information prepared by B.P.Walker Associates Ltd., the geotechnical consulting engineers for this project.

A handwritten signature in black ink, appearing to read 'L. Politano', is written over a horizontal line.

L. Politano, P. Eng.
Project Foundations Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND

BH	SAMPLE	SYMBOL
5	2	—
6	2	- - -

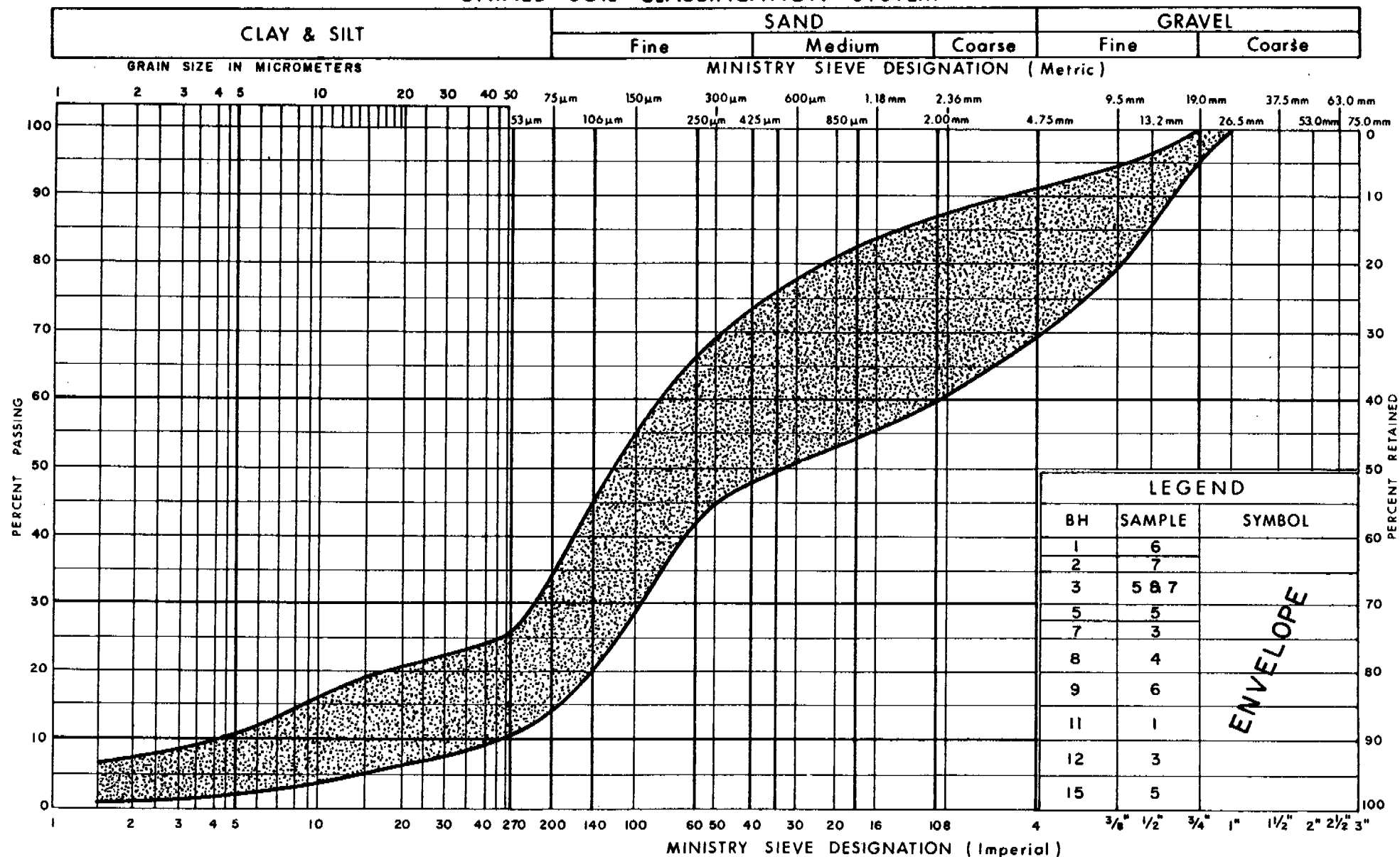


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH SAND TRACE OF GRAVEL
(VARVED CLAY)

FIG No 1
W P EGG-000-35

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

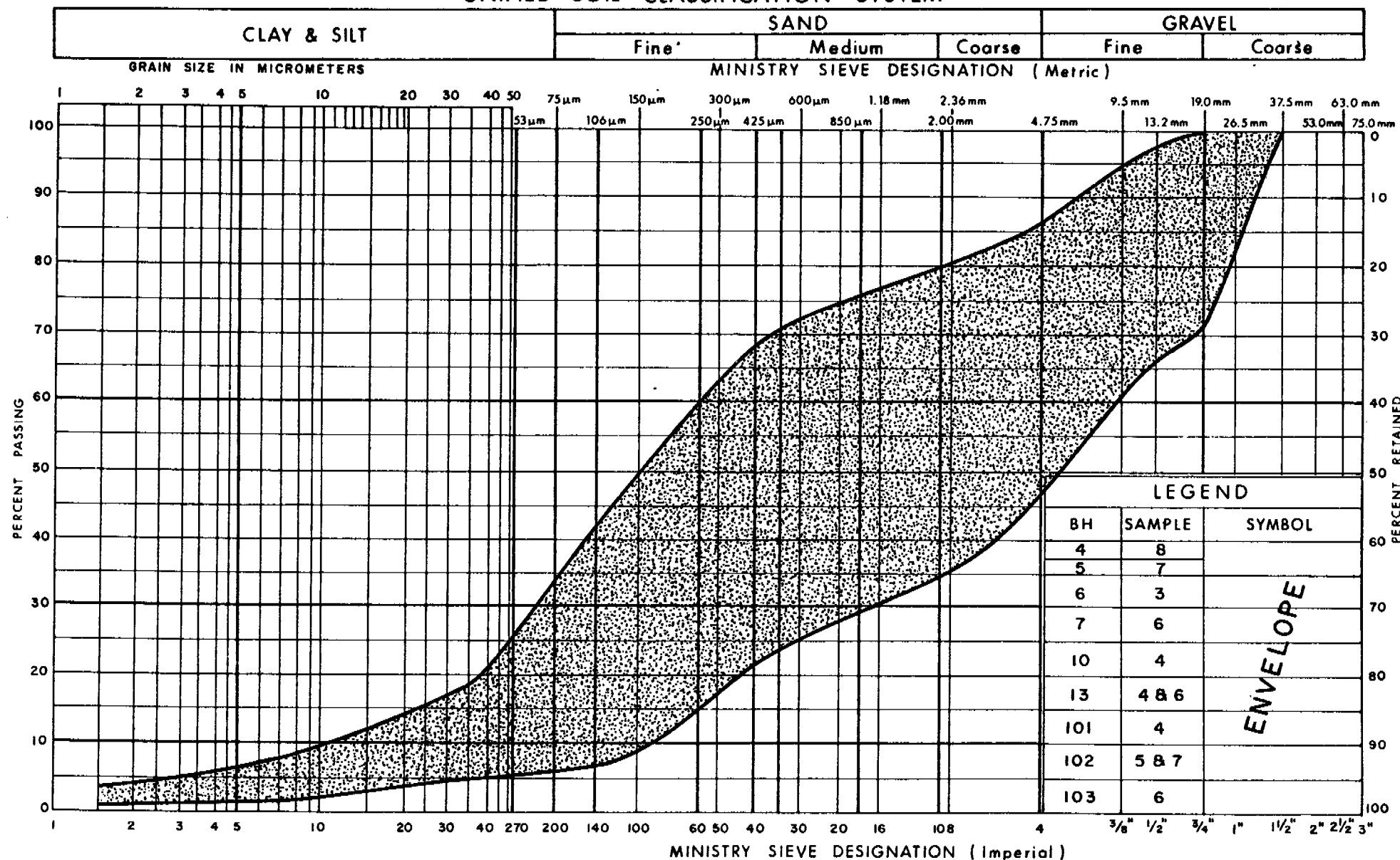
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND WITH GRAVEL TRACE OF CLAY
(Glacial Till)

FIG No 2

W P EGG-000-35

UNIFIED SOIL CLASSIFICATION SYSTEM

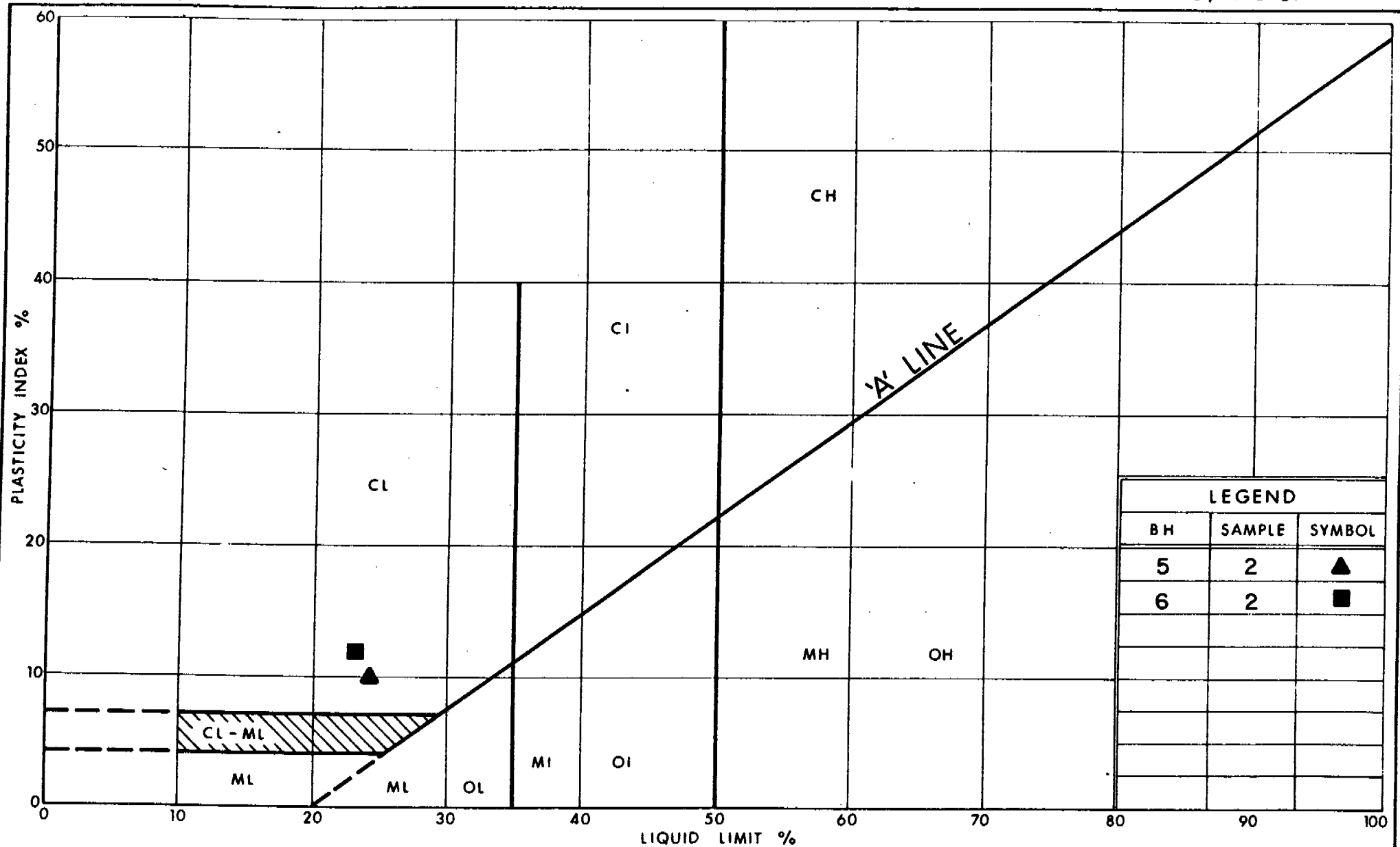


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Communications

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND TRACE OF SILT AND CLAY
(Glacial Till)

FIG No 3

W P EGG-000-35



Ministry of
Transportation and
Communications

Ontario

PLASTICITY CHART SILTY CLAY WITH SAND TRACE OF GRAVEL (VARVED CLAY)

FIG No 4

W P EGG-000-35



RECORD OF BOREHOLE No 1

METRIC

29

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4858 253.5 E 350 811.0 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 06 CHECKED BY BPW

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					
80.2	GROUND LEVEL																
0.0	Silty Clay with Sand, Trace of Gravel, Organics, Paper, Odd Debris, Slight Odour, Black (Fill)		1	SS	15		80										
			2	SS	15		79										
			3	SS	14		78										
			4	SS	21		77										
76.4	Gravelly Sand with Silt, Trace of Clay (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		5	SS	56		76										
			6	SS	63		75										
			7	SS	24		74										
			8	SS	200		73										
72.2	Shale, Weathered, Black, Slight Odour					12cm	72										
8.0																	
71.4	Refusal to Auger																
	End of Borehole																
	Water level on completion of borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC

30

W P BGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 242.0 E 350 788.0 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 01 CHECKED BY BPW

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					
80.8	GROUND LEVEL																
0.0	Silty Clay with Sand, Trace of Gravel, Cinders, Organics, Paper, Glass, Black (Fill), Firm to Very Stiff		1	SS	15		80						○				
			2	SS	10		79						○				
			3	SS	94		78						○				
			4	SS	10		77						○				
			5	SS	24		76						○				
76.6			6	SS	58		75						○				
4.2	Gravelly Sand with Silt, Trace of Clay, (Glacial Till), Non-Plastic, Very Dense, Grey		7	SS	151		74						○				
			8	SS	75		73						○				
			9	SS	190/25cm		72						○				
71.4			10	SS	100/1cm		71						○				
9.4	Shale, Weathered, Black, Slight Odour																
70.2																	
10.6	Refusal to Auger End of Borehole Water level on completion of borehole																

+3, x5 : Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 3

METRIC

31

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 227.8 E 350 754.5 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 01 CHECKED BY BPW

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	20						40	60	
80.9	GROUND LEVEL																			
0.0	Sandy Silt with Clay, Trace of Gravel, Compact, Brown (Fill)		1	SS	8		80							○						
			2	SS	8		79							○						
			3	SS	16		78							○						
77.5			4	SS	18		77							○						
3.4	Silty Sand with Gravel, Trace of Clay, (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		5	SS	26		77							○		13 55 22 10				
			6	SS	18		76							○						
							75													
			7	SS	48		75							○		19 58 21 2				
							74													
			8	SS	164		73							○						
							72													
71.4			9	SS	104/15cm		71							○						
9.5	Shale, Weathered, Black, Slight Odour																			
70.1			10	SS	140/12cm									○						
10.8	Refusal to Auger End of Borehole Water level on completion of borehole																			

+³, x⁵: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 4

METRIC 32

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 227.2 E 350 745.0

ORIGINATED BY MM

DIST 6 HWYGO -A.L.R.T. BOREHOLE TYPE Solid Auger

COMPILED BY USS

DATUM Geodetic DATE 83 08 31 & 09 01

CHECKED BY BPW

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	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	20	40	60			
81.1	GROUND LEVEL																
0.0	Silty Clay with Sand, Trace of Gravel, Organics, Stiff to Very Stiff Brown (Fill)						81										
			1	SS	23		80						○				
			2	SS	23		79						○				
			3	SS	36								○				
78.0																	
3.1	Silty Sand with Gravel, Trace of Clay, (Glacial Till), Non-Plastic, Compact, Grey		4	SS	16		78						○				
							77										
			5	SS	18								○				
75.9																	
5.2	Gravelly Sand, Trace of Silt and Clay (Glacial Till), Non-Plastic, Very Dense, Grey						76										
			6	SS	170/25cm		75						○				
							74										
			7	SS	91/15cm		73						○				
							72										
			8	SS	133							○					
70.9																	
10.2	Shale, Weathered, Black, Slight Odour						71										
70.1			9	SS	200/12cm								○				
11.0	Refusal to Auger End of Borehole Water level on completion of borehole																

+³, x⁵ : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 5

METRIC 33

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 223.5 E 350 736.6 ORIGINATED BY MM
DIST 6 HWY GO - A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 08 30 CHECKED BY BPW

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					
79.0	GROUND LEVEL																
0.0	Silty Clay with Sand, Trace of Gravel, Stiff to Very Stiff, Brown (Fill)		1	SS	27		78										
77.5																	
1.5	Silty Clay with Sand, Trace of Gravel, Low Plasticity, (Varved Clay), Firm, Grey		2	SS	8		77										6 24 27 43
76.7																	
2.3	Silty Sand with Gravel, Trace of Clay (Glacial Till), Non-Plastic, Dense to Very Dense Grey		3	SS	33		76										
			4	SS	64		75										
			5	SS	158	22cm	74										20 50 22 8
			6	SS	100	12cm	73										
							72										
							71										52 37 (11)
69.9	Shale		7	SS	193		70										
9.1	End of Borehole		8	SS	200	3cm											
	Water level on completion of borehole																



RECORD OF BOREHOLE No. 6

METRIC

34

W P BGG - 000 - 35

LOCATION CO-ORDS. N. 4 858 219.0 E 350 724.4

ORIGINATED BY MM

DIST 6 HWY GO-A.L.R.T.

BOREHOLE TYPE Solid Auger

COMPILED BY USS

DATUM Geodetic

DATE 83 08 30

CHECKED BY BPW

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					
78.7	GROUND LEVEL																
0.0	Silty Sand, Trace of Gravel and Clay, Organics, Loose, Brown (Fill)						78										
77.7																	
1.0	Silty Clay with Sand and Trace of Gravel, (Varved Clay), Low Plasticity, Firm, Grey		1	SS	6		77										8 29 26 37
76.7			2	SS	9												
2.0	Sandy Gravel with Silt, Trace of Clay, (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		3	SS	10		76										43 35 16 6
			4	SS	23												
							75										
			5	SS	230		74										
							73										
			6	SS	127												
							72										
			7	SS	118		71										
							70										
69.5			8	SS	100, 3cm												
9.2	End of Borehole Water level on completion of borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

METRIC 35

W P EGG - 000 - 35 LOCATION CO-ORDS. N 4 858 216.5 E 350 717.3 ORIGINATED BY MM
DIST 6 HWY 60-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 08 31 CHECKED BY BPW

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					
78.6	GROUND LEVEL																
0.0	Silty Sand, Trace of Gravel, Clinders, Brick Fragments, Compact, Brown/Black (Fill)		1	SS	12		78						○				
	Topsoil		2	SS	7		77							○			
76.2																	
2.4	Silty Sand with Gravel and Clay, (Glacial Till), Non-Plastic, Compact to Very Dense		3	SS	9		76						○				13 48 24 15
			4	SS	24		75						○				
74.1							74										
4.5	Gravelly Sand with Silt, Trace of Clay, (Glacial Till), Non-Plastic, Very Dense, Grey		5	SS	61		73						○				
			6	SS	128		72						○				31 49 14 6
							71										
			7	SS	69		70						○				
69.5																	
			8	SS	100/3cm								○				
9.1	Refusal to Auger End of Borehole on Probable Bedrock Water level on completion of borehole																

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

RECORD OF BOREHOLE No 8

METRIC

36

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 217.0 E 350 708.2 ORIGINATED BY MM
 DIST 6 HWY 60-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
 DATUM Geodetic DATE 83 08 31 CHECKED BY BPW

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
78.3	GROUND LEVEL																GR SA SI CL
0.0	Silty Clay, Trace of Gravel, Organics (Fill), Firm to Stiff, Brown		1	SS	19		78										
			2	SS	13		77										
			3	SS	9		76										
75.6			4	SS	10		75										5 50 40 5
2.7	Silty Sand, Trace of Gravel and Clay (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		5	SS	65		74										
			6	SS	64		73										
			7	SS	72		72										
							71										
							70										
69.2	Weathered Shale, Black, Slight Odour		8	SS	100	3cm											
9.1	End of Borehole																
	Water level on completion of borehole																



RECORD OF BOREHOLE No 9

METRIC

37

W P BGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 186.8 E 350 699.6

ORIGINATED BY MM

DIST 6 HWYGO-A.L.R.T. BOREHOLE TYPE Solid Auger

COMPILED BY USS

DATUM Geodetic DATE 83 09 01

CHECKED BY BPW

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					
79.1	GROUND LEVEL																
0.0	Silty Clay with Sand, Trace of Gravel, Organics, Pieces of Wood, (Fill), Firm, Brown/Grey		1	SS	10												
			2	SS	5												
			3	SS	8												
			4	SS	7												
75.3																	
3.8	Silty Sand with Gravel, Trace of Clay (Glacial Till), Non-Plastic, Very Dense, Grey		5	SS	61												
72.6			6	SS	101												
6.5	End of Borehole																
	Water Level on completion of borehole																



RECORD OF BOREHOLE No 10

METRIC

38

W P EGG - 000 - 35 LOCATION CO-ORDS N. 4 858 212.5 E 350 692.2 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 02 CHECKED BY BPW

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					
77.4	GROUND LEVEL																
0.0	Silty Sand, Trace of Gravel and Clay, Organics (Fill), Loose, Brown		1	SS	5		77						○				
76.0							76						○				
1.4	Sandy Gravel with Silt, Trace of Clay, Compact, Grey (Alluvium)		2	SS	21								○				
							75						○				
74.7			3	SS	13								○				
2.7	Gravelly Sand, Trace of Silt and Clay (Glacial Till), Non-Plastic, Very Dense, Grey		4	SS	120		74						○				28 59 10 3
							73						○				
			5	SS	144								○				
							72										
			6	SS	125		71						○				
							70										
69.7																	
7.7	Shale, Weathered		7	SS	100/1cm								○				
69.3	Black, Slight Odour																
8.1	Refusal to Auger End of Borehole Water level on completion of borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 11

METRIC

39

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 212.3 E 350 695.6 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 06 CHECKED BY BPW

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					
76.0	GROUND LEVEL																
0.0	Silty Sand, Trace of Gravel and Clay, (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		1	SS	19											8 75 11 6	
			2	SS	47												
			3	SS	55												
			4	SS	170	27cm											
			5	SS	165	25cm											
5.1	Shale, Weathered, Black, Slight Odour																
70.2	Refusal to Auger																
5.8	End of Borehole																
	Water level on completion of borehole																



RECORD OF BOREHOLE No 12

METRIC

40

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 240.5 E 350 700.5 ORIGINATED BY MM
DIST 6 HWYGO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 06 CHECKED BY BPW

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					
77.4	GROUND LEVEL																
0.0	Silty Sand, Trace of Gravel and Clay (Fill), Loose, Brown		1	SS	6		77										
76.2																	
1.2	Sandy Gravel with Silt, Trace of Clay, Compact, Grey, (Alluvium)		2	SS	16		76										
75.5																	
1.9	Silty Sand, Trace of Clay and Gravel (Glacial Till), Non-Plastic, Dense to Very Dense, Grey		3	SS	38		75										
			4	SS	58		74										
			5	SS	53		73										
							72										
71.3																	
6.1	Shale, Weathered, Black, Slight Odour		6	SS	125												
71.0																	
6.4	Refusal to Auger																
	End of Borehole																
	Water level on completion of borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 13

METRIC

41

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 221.0 E 350 674.2 ORIGINATED BY MM
DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
DATUM Geodetic DATE 83 09 02 CHECKED BY BPW

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									

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14

METRIC

42

W P EGG - 000 - 35 LOCATION CO-ORDS. N 4 858 201.2 E 350 593.6 ORIGINATED BY MM
 DIST 6 HWY GO-A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
 DATUM Geodetic DATE 83 09 02 CHECKED BY BPW

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					
78.5	GROUND LEVEL																
0.0	Silty Clay with Trace of Gravel and Sand, Organics (Fill), Soft to Firm, Grey/Black		1	SS	6		78										
			2	SS	17		77										
			3	SS	9		76										
			4	SS	8		75										
74.8			5	SS	7		74										
3.7	Silty Clay with Sand, Trace of Gravel (Varved Clay), Medium Plasticity, Firm, Grey		6	SS	38		73										
73.9			7	SS	150		72										
4.6	Silty Sand with Gravel, Trace of Clay (Glacial Till), Non-Plastic, Dense to Very Dense, Grey		8	SS	200/3cm		71										
							70										
69.9																	
69.8	Shale, weathered, black																
8.7	Refusal to Auger End of Borehole Water level on completion of borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15

METRIC

43

W P EGG - 000 - 35 LOCATION CO-ORDS. N. 4 858 197.7 E 350 561.8 ORIGINATED BY MM
 DIST 6 HWYGO - A.L.R.T. BOREHOLE TYPE Solid Auger COMPILED BY USS
 DATUM Geodetic DATE 83 09 02 CHECKED BY BPW

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			20	40	60	80	100					
78.4	GROUND LEVEL															
0.0	Silty Clay, Trace of Gravel and Sand (Fill), Soft to Firm, Brown/Grey		1	SS	12											
			2	SS	3											
			3	SS	2											
			4	SS	6											
74.5																
3.9	Silty Sand with Gravel, Trace of Clay (Glacial Till), Non-Plastic, Compact to Very Dense, Grey		5	SS	21											
			6	SS	39											
			7	SS	153/27cm											
70.7																
7.7	End of Borehole Water level on completion of borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 101

METRIC

44

W P EGG - 000 - 35

LOCATION CO-ORDS. N. 4 858 220.5; E. 350 747.2

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T. BOREHOLE TYPE Solid Auger

COMPILED BY USS

DATUM Geodetic

DATE 83 12 15

CHECKED BY BPW

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	VALUES		20	40	60	80	100					
79.8	GROUND LEVEL															
0.0	Silty Sand with Gravel, Trace of Clay, Asphalt, Some Organics, Brown/Black, (Fill)		1	SS	83							o				
77.8			2	SS	32							o				
2.0	Silty Sand with Gravel and Clay, (Glacial Till) Brown/Grey, Dense		3	SS	41							o				
77.1			4	SS	22							o				
2.7	Gravelly Sand with Trace of Silt and Clay (Glacial Till) Non-Plastic, Dense to Very Dense Grey		5	SS	60/	8cm						o				
			6	SS	103/	15cm						o				
			7	SS	73/	15cm						o				
			8	SS	100/	8cm						o				
70.7			9	SS	100/	10cm						o				
69.6																
10.2	Refusal to Auger End of Borehole Water level on completion of borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 102

METRIC

45

W P EGG - 000 - 35

LOCATION CO - ORDS. N. 4 858 209.3: E. 350 724.5

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T.

BOREHOLE TYPE Solid Auger to 10.5m. Wash boring 10.5m to 12.02m

COMPILED BY USS

DATUM Geodetic

DATE 83 12 16

CHECKED BY BPW

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					
79.0	GROUND LEVEL																
0.0	Silty Clay with Sand and Gravel, Organics Black (Fill) Firm to Stiff		1	SS	15		78										
			2	SS	13		77										
			3	SS	8		76										
75.8			4	SS	7		75										
3.2	Gravelly Sand with Trace of Silt and Clay (Glacial Till) Non-Plastic Loose to Very Dense Grey		5	SS	73/	15cm	74										46 34 11 9
			6	SS	53		73										
			7	SS	69/	15cm	72										45 49 (6)
70.8							71										
8.2	Shale, Weathered, black		8	SS	75/	13cm	70										
							69										
68.5							68										
10.5	Shale, Sound, Black		9	RC BXL	Rec 93%												R.Q.D. 43%
67.0																	
12.0	End of Borehole																
	Water level on completion of solid stem augering																

+³, x⁵: Numbers refer to
Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 103

METRIC

46

W P EGG - 000 - 35

LOCATION CO - ORDS. N. 4 858 197.3; E. 350 701.2

ORIGINATED BY MM

DIST 6 HWY 60 - A.L.R.T.

BOREHOLE TYPE Solid Auger

COMPILED BY USS

DATUM Geodetic

DATE 83 12 15

CHECKED BY BPW

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					
79.0	GROUND LEVEL																
0.0	Silty Clay, Sand and Gravel, Organics, Pieces of Wood, Occasional Sand Layers (Fill) Brown/Grey Stiff		1	SS	7		78										
			2	SS	7		77										
			3	SS	10		76										
75.5			4	SS	13		75										
3.5	Gravelly Sand with Silt, Trace of Clay, (Glacial Till) Non-Plastic Very Dense		5	SS	72/	15cm	74										
			6	SS	83/	15cm	73										
							72										
71.4							71										
7.6	Shale, Weathered, Black		7	SS	107/	15cm											
70.8																	
8.2	Refusal to Auger																
	End of Borehole																
	Water level on completion of borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10