



FOUNDATION INVESTIGATION REPORT

CONTRACT NO. GGE-312

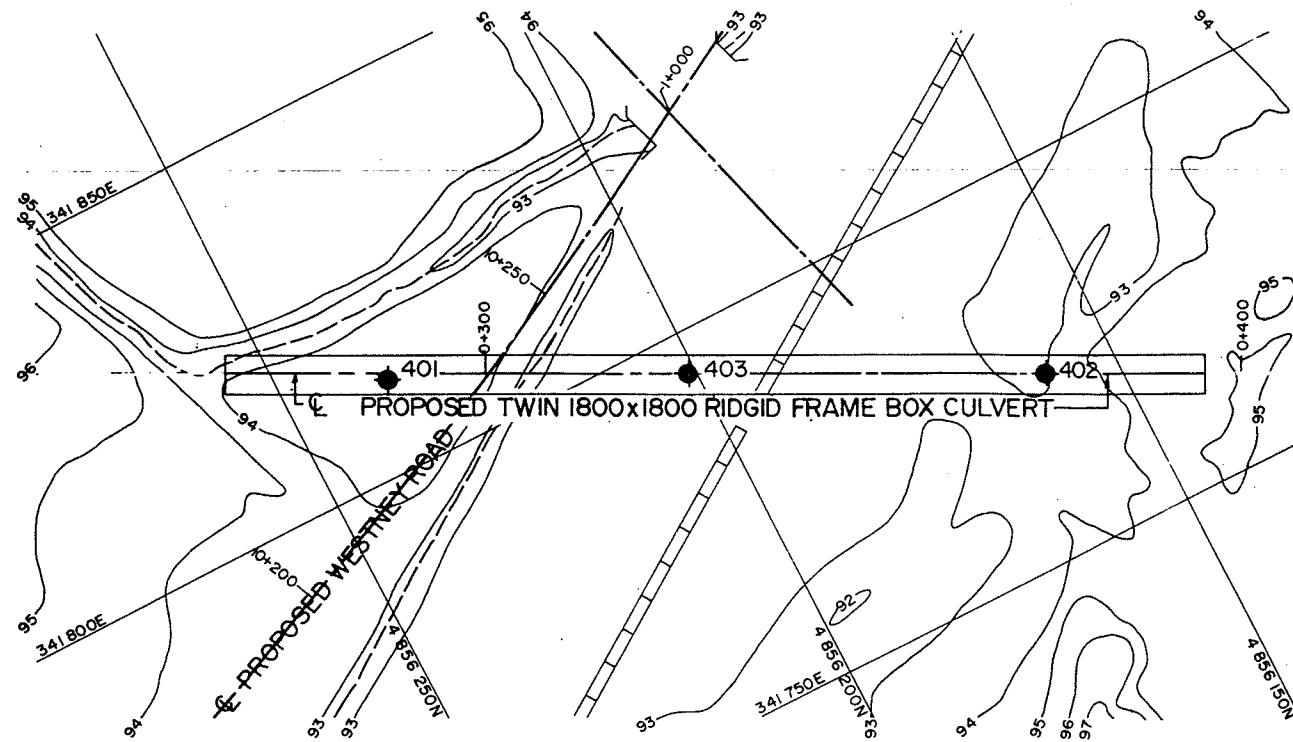


Ontario

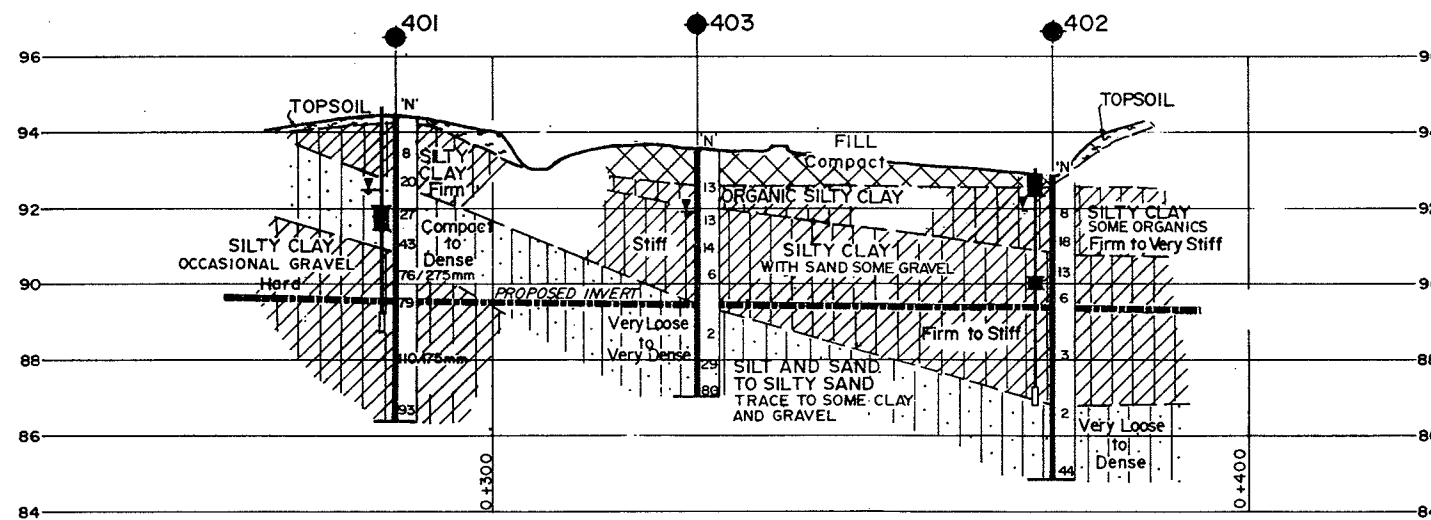
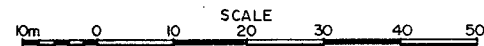
Ministry of
Transportation and
Communications

METRIC

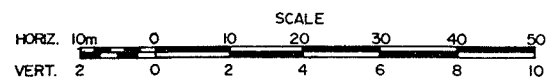
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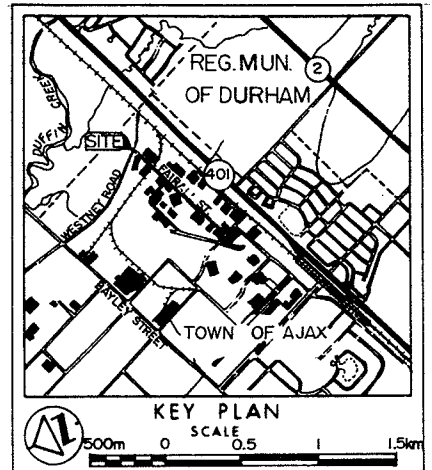
PLAN



PROFILE



Report recommends
1.2 m drainage blanket
in areas of frost
susceptible soil
ie in silt and sand



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 May-June, 1984
- Bentonite Seal
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
401	94.5	4,856,237	341,812
402	92.9	4,856,160	341,784
403	93.6	4,856,201	341,795

Geocres No 30M12-177

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: RWR

DESIGNED BY:

JUNE 6, 1984

CHK'D BY: ASP

APPROVED BY:

JUNE 22, 1984

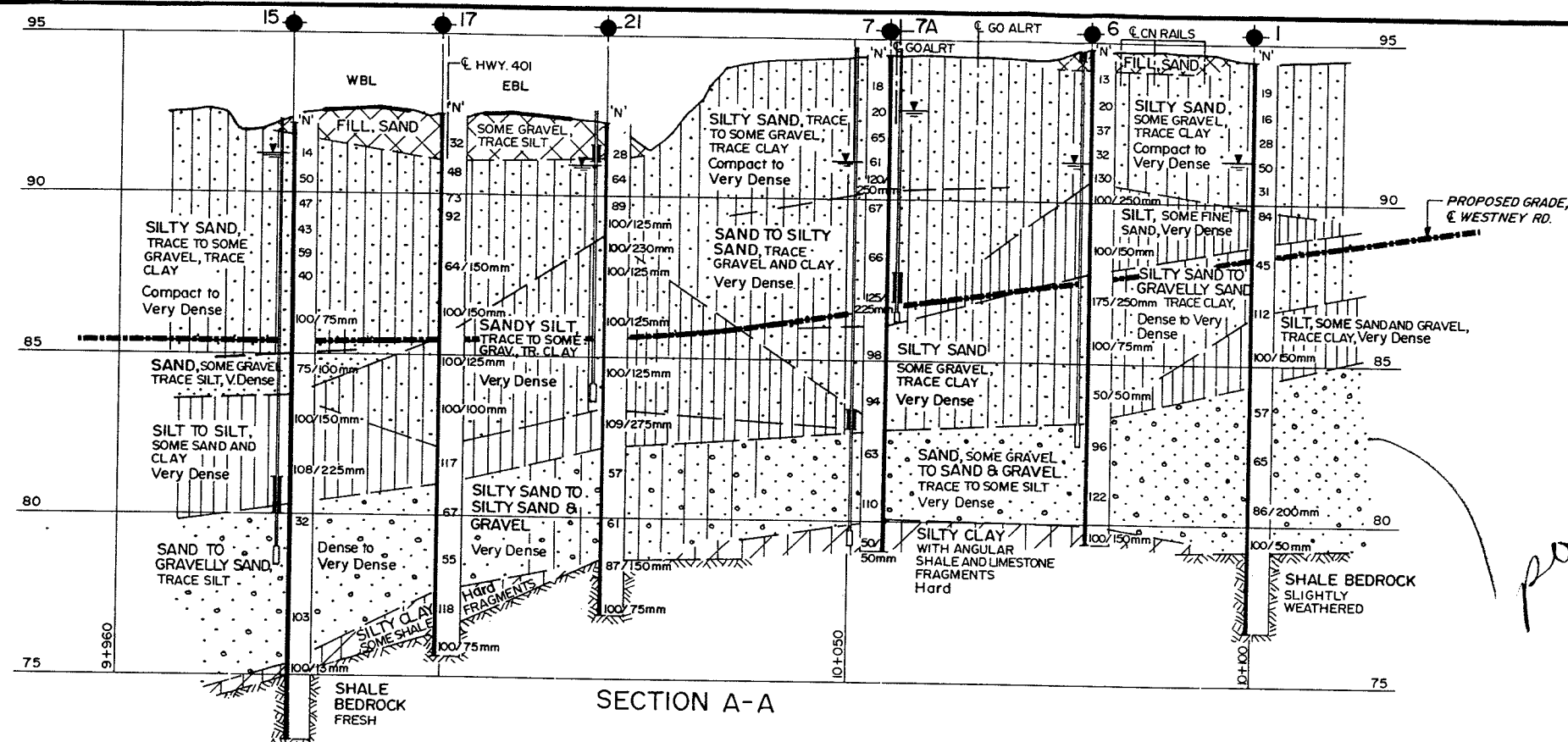
SCALE: 1:500 FULL SIZE ONLY

AS SHOWN



DURHAM REGION
WESTNEY ROAD CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

CONTRACT NO GGE 312	DWG NO S-070	REV	SHEET 63A
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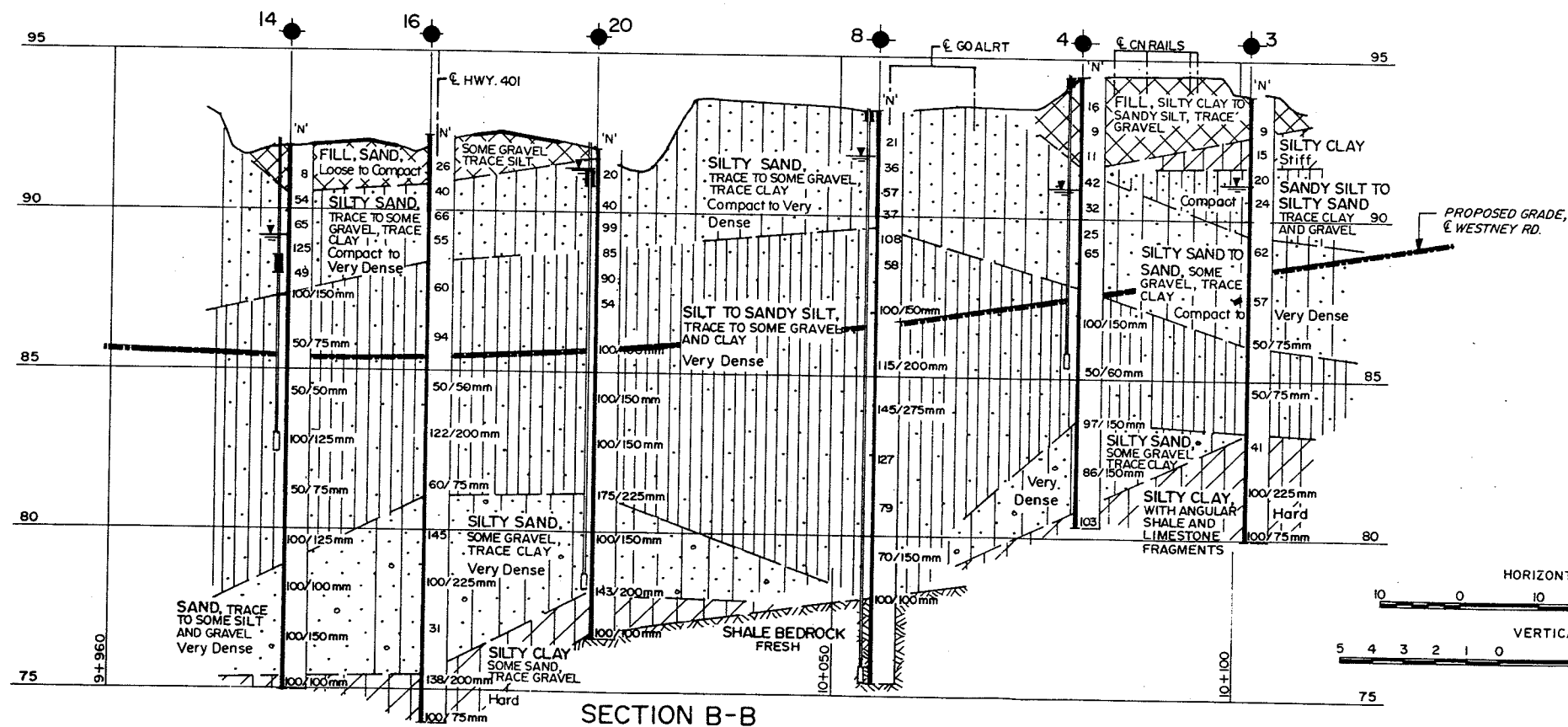


METRIC

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

SEE Dwg S-028
SHEET III

KEY PLAN
SCALE



LEGEND

-
- A vertical line represents a borehole. From top to bottom, the components are: a solid black circle (Bore Hole), a circle with a crosshair (Dynamic Cone Penetration Test (Cone)), a circle with a crosshair and a horizontal line through it (Bore Hole & Cone), the letter 'N' (Blows/0.3m (Std Pen Test, 475 J/blow)), the word 'CONE' (Blows/0.3m (60° Cone, 475 J/blow)), a detailed drawing of a sampler (WL at time of investigation, July - Aug. 1983), a solid black rectangle (Bentonite Seal), and a circle with a crosshair (Piezometer).
- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation, July - Aug. 1983
- Bentonite Seal
- Piezometer

No	ELEVATION
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SEE Dwg S-028
SHEET III




Geocres No 30M14-171

NOTE

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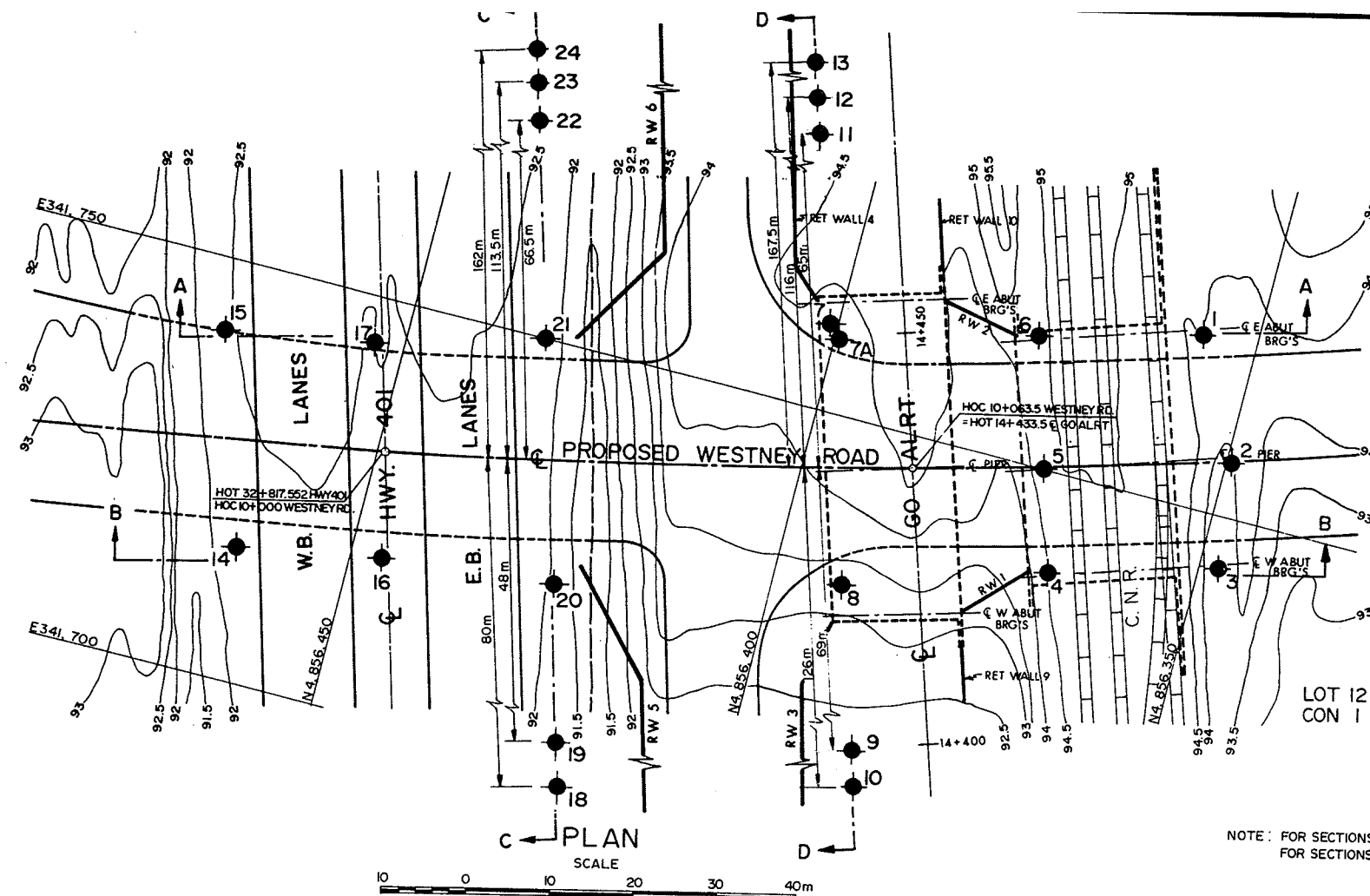
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

GO-ALRT REF B-2-GA-2

REFERENCE DRAWINGS				REVISIONS		DRAWN BY: MHW		DESIGNED BY:		 Golder Associates <small>CONSULTING GEOLOGICAL AND MINING ENGINEERS</small>		 GO-ALRT <small>Ministry of Transportation and Communications</small>  PROJECT MANAGER		GO-ALRT REF B-2-GA-2			
						CHK'D BY: HO		APPROVED BY: JRB						DURHAM REGION GO ALRT/WESTNEY RD STRUCTURE AND RETAINING WALLS SECTIONS AND SOIL STRATA			
						SCALE: FULL SIZE ONLY AS SHOWN								CONTRACT NO GGE 312		DWG NO S-029	

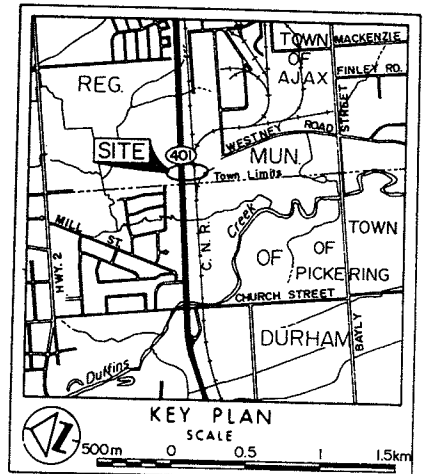
METRIC

ALL DIMENSIONS SHOWN ARE
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NOTED.



BOREHOLES BY MTC			
No	ELEVATION	STATION	OFFSET
101	90.0	14+220.2	6.0 m Lt
102	91.8	14+223.7	39.1 m Lt
103	92.9	14+287.7	36.4 m Lt
104	91.9	14+515.2	28.7 m Lt
105	92.6	14+570.0	26.4 m Lt
106	93.3	14+623.8	23.1 m Lt
107	94.2	14+652.7	10.7 m Lt
108	95.8	14+686.4	11.5 m Lt

SUBSOIL INFORMATION FOR
BOREHOLES LISTED ABOVE
REFER TO DWG No



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, July-Aug. 1983
- Ground Surface
- Bentonite Seal
- Standpipe

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	94.5	4,856,356	341,771
2	94.0	4,856,349	341,757
3	93.8	4,856,348	341,744
4	94.4	4,856,368	341,738
5	94.5	4,856,372	341,750
6	94.7	4,856,376	341,765
7	94.4	4,856,401	341,760
7A	94.4	4,856,400	341,759
8	93.3	4,856,392	341,730
9	90.9	4,856,375	341,682
10	93.5	4,856,357	341,623
11	91.9	4,856,418	341,805
12	92.3	4,856,430	341,843
13	93.6	4,856,449	341,902
14	92.0	4,856,463	341,716
15	92.2	4,856,471	341,741
16	92.3	4,856,446	341,720
17	92.5	4,856,454	341,744
18	91.4	4,856,406	341,658
19	91.7	4,856,416	341,689
20	91.9	4,856,425	341,732
21	92.2	4,856,434	341,750
22	92.6	4,856,449	341,799
23	92.9	4,856,459	341,835
24	93.4	4,856,476	341,890

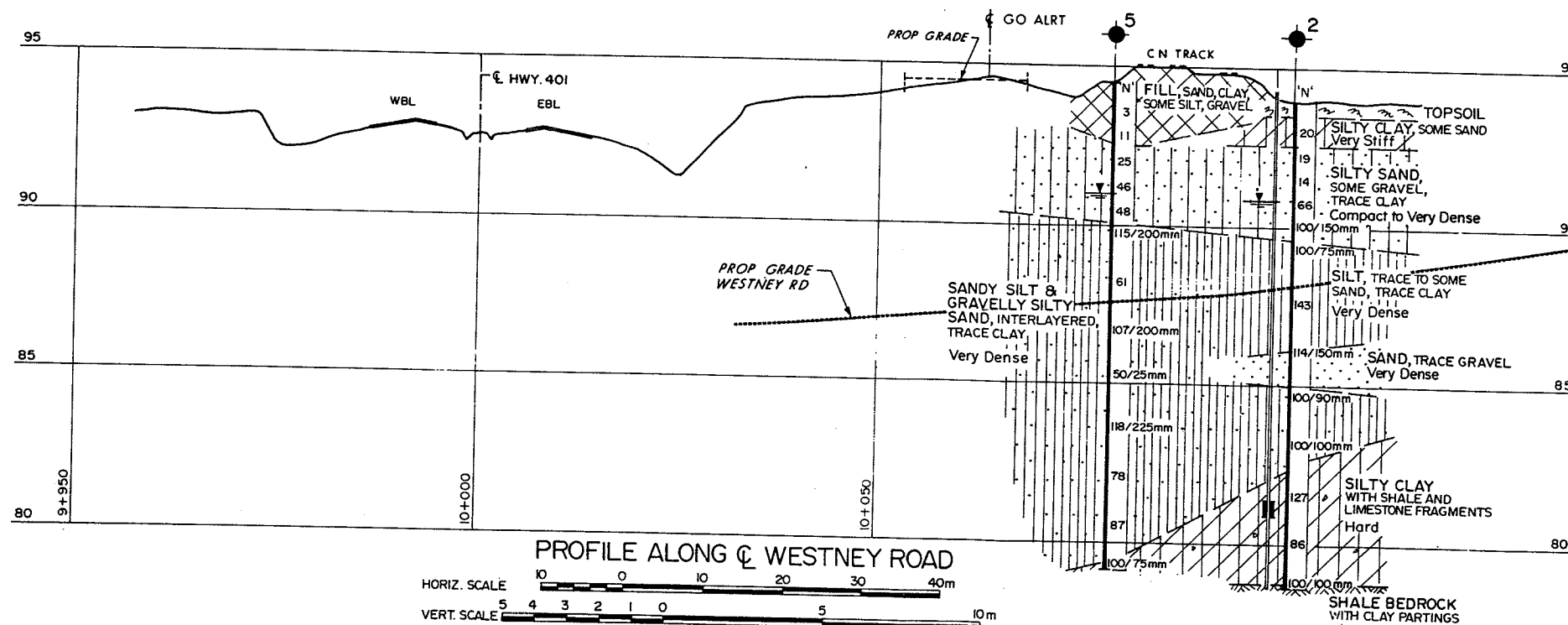
Geocres No 30M14-171

=NOTE=

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

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GO-ALRT REF B-2-GA-2



PROFILE ALONG CL WESTNEY ROAD

HORIZ. SCALE 0 10 20 30 40m
VERT. SCALE 5 4 3 2 1 0 5 10m

REFERENCE DRAWINGS

REVISIONS

DRAWN BY: EFO, MHW
DESIGNED BY:

CHK'D BY: HCO
APPROVED BY: JRB

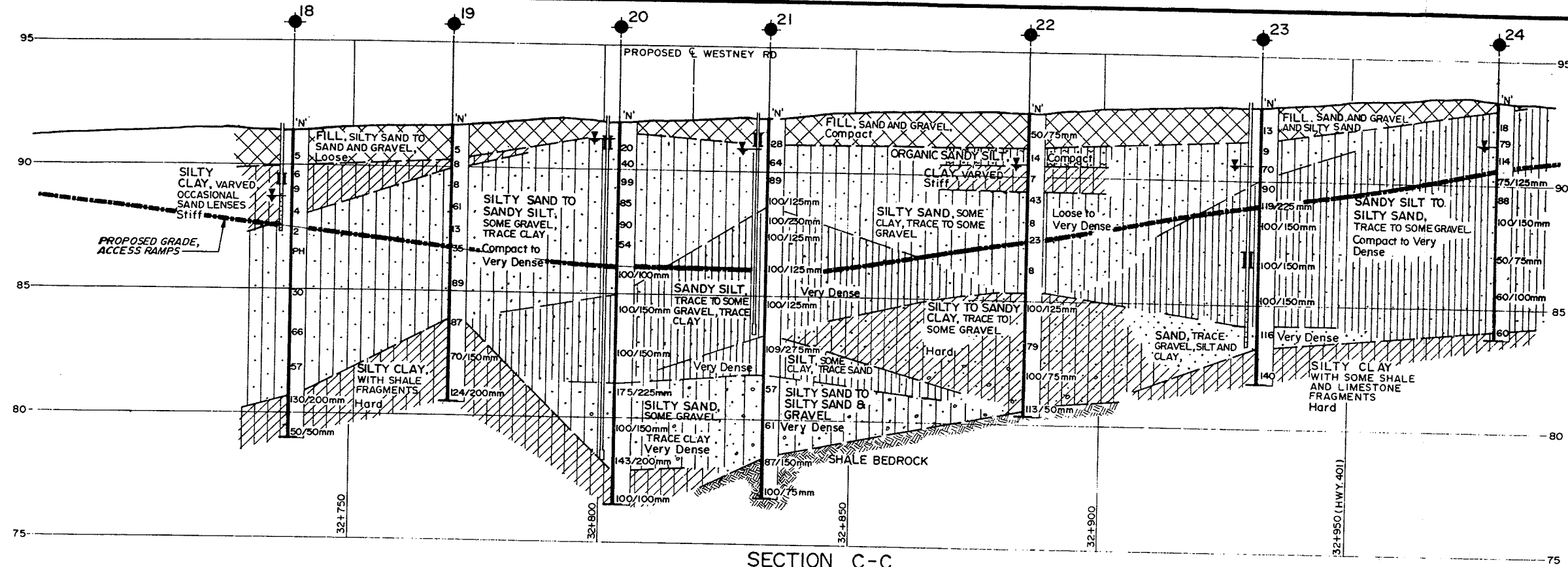
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AS SHOWN



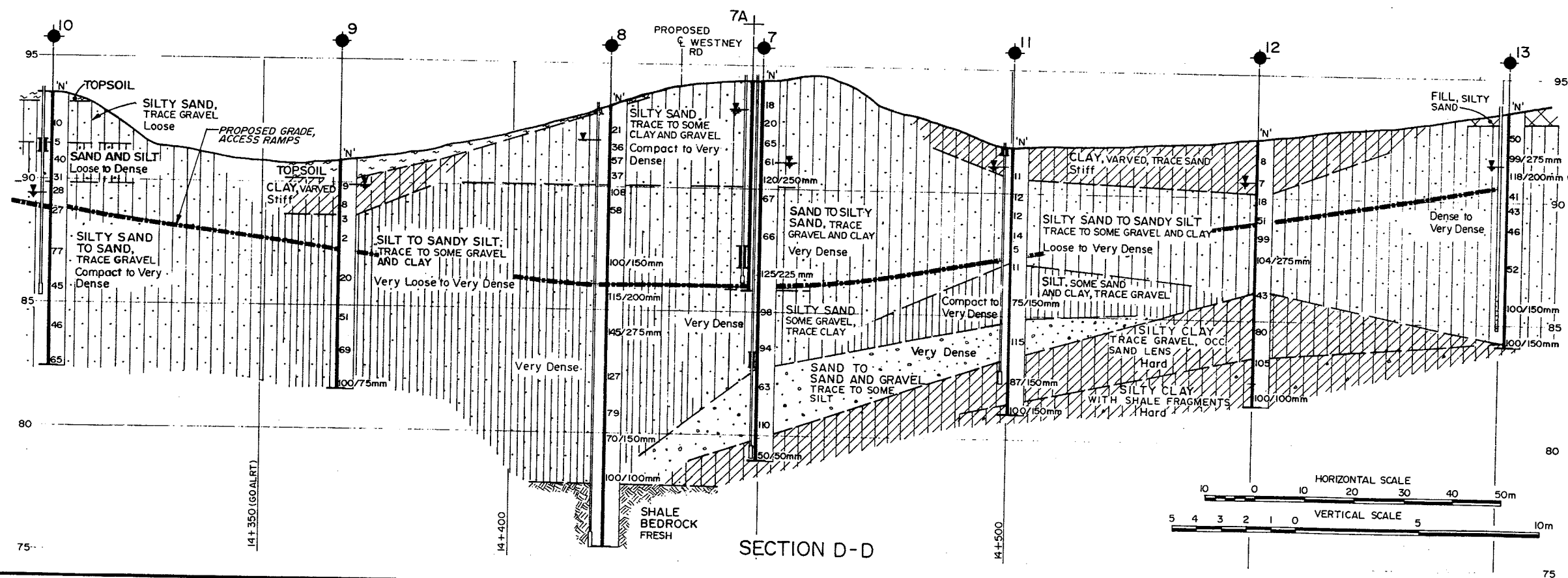
[Signature]
PROJECT MANAGER

DURHAM REGION
GO ALRT/WESTNEY RD STRUCTURE
AND RETAINING WALLS
BOREHOLE LOCATIONS AND SOIL STRATA

CONTRACT NO GGE 312 DWG NO S-028 REV SHEET III



SECTION C-C



SECTION D-D







METRIC

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

SEE Dwg S-028
SHEET III

KEY PLAN
SCALE

LEGEND

-  Bore Hole
 Dynamic Cone Penetration Test (Cone)
 Bore Hole & Cone
 N Blows/0.3m (Std Pen Test, 475 J/blow)
 CONE Blows/0.3m (60° Cone, 475 J/blow)
 WL at time of investigation July-
 Aug.1983
 Bentonite Seal
 Piezometer

SEE Dwg S-028
SHEET III




Geocres No 30M14-171

NOTE

=NOTE=
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GO-ALRT REF B-2-GA-2

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: EFO, MHW	DESIGNED BY:	 Golder Associates CONSULTING GEOTECHNICAL AND MINING ENGINEERS	 GO-ALRT Ministry of Transportation and Communications  PROJECT MANAGER	75 accordance with the conditions of Section 102-2 of Form 100 GO-ALRT REF B-2-GA-2			
				CHK'D BY: HCO	APPROVED BY: RJB			DURHAM REGION GO ALRT/WESTNEY RD STRUCTURE AND RETAINING WALLS SECTIONS AND SOIL STRATA	CONTRACT NO GGE 312	DWG NO S-030	REV 113
				SCALE: FULL SIZE ONLY AS SHOWN							

RECORD OF BOREHOLE No 101 METRIC

W P 470-711-611 LOCATION Co-ords. N 4 856 327; E 341 541 Sta. 14 + 220.2; O/S 6.0 m LT GO-ALRT

DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY DT

DATUM Geodetic DATE 84 02 21 COMPILED BY DT

CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER									
90.0	Ground Surface											
0.0												
	Sandy Silt		1 SS 8									
	trace gravel		2 SS 15									
	trace clay brown grey		3 SS 44									
	Loose to Very Dense		4 SS 109									
			5 SS 51									
84.5			6 SS 100/175 mm									
5.5			7 SS 153									
	Silty Clay											
	trace gravel grey		8 SS 100/125 mm									
	Hard											
	with shale fragments											
80.4			9 SS 118									
9.6	End of Borehole											

RECORD OF BOREHOLE No 102 METRIC

W P 470-711-611 LOCATION Co-ords. N 4 856 359; E 341 534 Sta. 14 + 223.7; O/S 39.1 m LT GO-ALRT

DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY DT

DATUM Geodetic DATE 84 02 21 COMPILED BY DT

CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER									
91.8	Ground Surface											
0.0												
	Silty Sand to Sandy Silt		1 SS 19									
	trace gravel Brown Grey		2 SS 30									
	trace clay		3 SS 100/100 mm									
			4 SS 77									
			5 SS 65									
	Compact to Very Dense		6 SS 91									
84.8			7 SS 100/100 mm									
7.0			8 SS 101									
	Silty Clay											
	trace gravel											
	Hard grey		9 SS 103/150 mm									
	with shale fragments											
80.7			10 SS 144/275 mm									
11.1	End of Borehole											

RECORD OF BOREHOLE No 103 METRIC

W P 470-711-611 LOCATION Co-ords. N 4 856 376; E 341 596 Sta. 14 + 287.7; O/S 36.4 m LT GO-ALRT

DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY DT

DATUM Geodetic DATE 84 02 21 - 22 COMPILED BY DT

CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER									
92.9	Ground Surface											
0.0												
	Silty Sand to Sandy Silt		1 SS 36									
	trace gravel		2 SS 43									
	trace clay		3 SS 43									
			4 SS 42									
			5 SS 40									
			6 SS 40									
	Compact to Very Dense		7 SS 16									
			8 SS 32									
			9 SS 47									
			10 SS 151									
80.3			11 SS 190/225 mm									
12.6	End of Borehole											

RECORD OF BOREHOLE No 104 METRIC

W P 470-711-611 LOCATION Co-ords. N 4 856 439; E 341 815 Sta. 14 + 515.2; O/S 28.7 m LT GO-ALRT

DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY DT

DATUM Geodetic DATE 84 02 22 COMPILED BY DT

CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER									
91.9	Ground Surface											
0.0												
	Silty Clay		1 SS 12									
	trace sand		2 SS 18									
			3 SS 11									
	Firm to Very Stiff		4 SS 5									
			5 TW PH									
86.1			6 SS 33									
5.8	Sand, some silt some clay Grey Dense											
84.6			7 SS 69									
7.3	Silty Clay some sand											
	Hard with shale fragments		8 SS 161/250 mm									
81.5			9 SS 100/125 mm									
81.0	Weathered Shale											
10.9	End of Borehole											

METRIC

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

SEE Dwg S-028
SHEET III

KEY PLAN
SCALE

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

Geocres No 30M14-171

=NOTE=

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GO-ALRT REF

REFERENCE DRAWINGS		REVISIONS		DRAWN BY:	DESIGNED BY:	GO-ALRT Ministry of Transportation and Communications <i>Project Manager</i> PROJECT MANAGER	DURHAM REGION GO ALRT/WESTNEY RD STRUCTURE AND RETAINING WALLS RECORD OF BOREHOLE SHEETS	
				CHK'D BY:	APPROVED BY:		CONTRACT NO GGE 312	DWG NO S-047
				SCALE: AS SHOWN	FULL SIZE ONLY		REV 113A	SHEET 113A

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

[illegible][illegible]

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

No	ELEVATION		



Geocres No

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GO-ALRT REF

REFERENCE DRAWINGS				REVISIONS		DRAWN BY:	DESIGNED BY:	  PROJECT MANAGER	GO-ALRT REF _____			
						CHK'D BY:	APPROVED BY:		DURHAM REGION			
									GO ALRT/WESTNEY RD STRUCTURE			
									AND RETAINING WALLS			
									RECORD OF BOREHOLE SHEETS			
						SCALE: FULL SIZE ONLY AS SHOWN			CONTRACT NO GGE 312	DWG NO S-048	REV	SHEET 113 E

INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations and Symbols
3-151	Foundation Investigation Report For; Westney Road/GO-ALRT Structure Westney Road/C.N.R. Structure and Associated Retaining Walls Drainage Structure No. 13 GO-ALRT and Miller Creek Pedestrian Tunnels, Westney Road Station Storm Sewer at Westney Road/GO-ALRT Crossing Extension to GO-ALRT Station 14+155 and Diversion Structure at Station 0+745 to 0+780 Storm Sewer - Westney Road Station 10+490 to 10+970 Twin Box Rigid Concrete Box Culvert Westney Road, Station 0+266 to 0+395

NOTE: For purposes of the contract, these reports supercedes all other foundation reports prepared by or for GO-ALRT in connection with the above-mentioned projects.

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_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 = $\frac{w_L - w_p}{w - w_p}$	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						

for
Westney Road/GO-ALRT Structure
Westney Road/C.N.R. Structure
and Associated Retaining Walls

INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out between 83 07 19 and 83 08 02. During this period, a total of 24 sampled boreholes were put down to depths of up to 18.4 m. A subsequent investigation was carried out between 84 02 21 and 84 02 24, by the MTC Foundation Design Section in which an additional 8 boreholes were advanced to depths of up to 12.6 m.

The locations of the boreholes in plan along with stratigraphic sections are included in the Contract Drawings, Drawing Nos. S-028 to S-030, and S-047 to S-048.

SITE DESCRIPTION

The site is located along Hwy. 401 between Church St. and Harwood Ave. in the Town of Ajax in the Regional Municipality of Durham (See Drawing No. S-028). At this location the C.N.R.'s main line runs parallel to Hwy. 401 some 100 m to the south. The top of the railway tracks are about 2.5 m higher than the level of the highway. The area south of the site is used for light industrial uses while north of Hwy. 401 open fields were present at the time of the investigation. The ground surface in the general area slopes westward to Duffins Creek which is located about 1 km west of the site.

SUBSURFACE CONDITIONS

Site Geology

The site is located in the physiographic region known as the Iroquois Plain¹ which typically exhibits level to gently undulating topography. The overburden soils consists of glacial drift with a thin surficial glacio-lacustrine deposit which was laid down after the end of the last glacial advance. Remnants of a raised shoreline formed within the glacial Lake Iroquois can be seen immediately to the southwest of the site. The glacial drift below the glacio-lacustrine

¹ Chapman, L.J. and Putnam, D.F., the Physiography of Southern Ontario, University of Toronto Press, Toronto, Ontario.

sediments is described by Caley² to consist of a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses. The bedrock consists of thin bedded grey to black calcareous, bituminous, micaceous shale of the Whitby Formation.

Soil Stratigraphy

Fill

Up to 2.9 m of fill was encountered in the boreholes. The fill in the boreholes put down along Hwy. 401 typically consists of brown sand to gravelly sand. Near the CNR railway tracks the fill consists of silty sand with some gravel and trace to some clay and contains traces of organic material. The fill is generally in a loose to compact state based on 'N'* values of 6 to 26.

Upper Silty Clay

In boreholes located in the low-lying areas of the site up to 2 m of glacio-lacustrine clay was encountered near the ground surface. The clay was found to be varved in most boreholes having alternating light and dark brown layers of 1 to 5 mm in thickness. The clay has a firm to stiff consistency (N values of 4 to 20). Occasional sand lenses were found in the clay at BH 18.

Typical grain size distribution curves of the clay are given on Fig. 1. The water content of the clay varies from 26 to 38%. The clay has an intermediate plasticity indices of 19 to 26%. The bulk unit weight of the clay was measured to be 18.8 kN/cu m in a sample from BH 18.

Silty Sand to Silt

The predominant soil deposit encountered in all boreholes is a generally unstructured heterogeneous material mainly composed of sand and silt with some proportion of clay and gravel sized particles contained within its matrix. Distinction between zones of the deposit has been made based on visual observation, grain size distribution and plasticity.

² Caley, J.F., Clark, T.H. and Owen, E.G., Groundwater Resources of Pickering Township, Ontario County, Ontario Dept. of Mines and Tech. Surveys, Water Supply Paper 285, 1974.

* 'N' values - Refer to Explanation of Terms

The deposit contains numerous pockets and seams of sand and silt. Pockets of sand with a trace of some silt were noted in BH 1, 2, 3, 7, 10 and 15. Some evidence of stratification was found in the samples taken within the sand and silt pockets. Grain size distribution curves for samples of the deposit are shown on Fig. 2 to 5.

The upper portion of the deposit is brown in colour. At depths of 3 to 4 m the colour changes to grey. Rust-stained fissures were found in the upper 3 to 4 m. Some of the gravel in the soil consists of dark grey shale particles and the proportion of shale increases with depth.

The soil is generally very dense and the 'N' values below 3 to 4 m depth are generally in excess of 40 and usually in excess of 100. At lesser depths the soil is less dense particularly in low-lying areas such as at BH 9. This suggests that the soil softens where exposed to groundwater at shallow depth. The 'N' values in the upper 3 to 4 m indicate the soil at shallow depth to be generally compact to dense (N values of 10 to 40 although very loose pockets were encountered in BH 9 and 104).

The silty sand to silt deposit has a low to zero plasticity. Liquid limits and plasticity indices of 10 to 18 and 2 to 7% respectively were measured on laboratory samples. The water content of laboratory samples of the soil was generally about 6 to 12% with silty zones having somewhat higher water content. The average bulk unit weight of the soil was measured to be 23.0 kN/cu m.

Sand and Gravel

Along the east side of Westney Road and in several nearby boreholes at a depth of about 12 m, sand and gravel with a trace to some silt underlies the silty sand to silt deposit. The sand and gravel appears to be continuous in the north-south direction along the line of sections A-A (Drawing No.S-029). Similar material was also encountered at the same stratigraphic horizon in BH 22 and 23 and it is possible that the sand and gravel extends to the north-east. The sand and gravel is dark grey in colour, and particles are generally subangular to subrounded in shape. The deposit varies from sand with some gravel to gravelly sand and apparently becomes coarser with depth. Grain size distribution curves of the material are shown on Fig. 6. 'N' values within the soil are consistently in excess of 50, indicative of its dense state.

In BH 7 a permeability test was undertaken in the piezometer. The water level in the piezometer could only be raised about 10 mm while pouring water into the piezometer at a rate of about 1 litre per minute. Based on this data the permeability (k) of the sand and gravel is in the order of 3×10^{-4} m/sec. Application of the Hazen formula to the gradation curves shown on Fig. 6 gives a range of k of 10^{-5} to 3×10^{-4} m/sec.

Lower Silty Clay

Immediately underlying the sand and gravel, or the silty sand to silt deposit where the sand and gravel is missing, silty clay was found at many borehole locations. The clay generally has a large proportion of angular shale and limestone fragments which increases with depth. The clay is dark grey in colour and with depth takes on the appearance of the underlying shale bedrock. The deposit is discontinuous across the site having a maximum thickness of 4.6 m at BH 12. In the upper 1 to 2 m at BH 11 and 12 the clay appeared to be thinly laminated and contained sandy lenses. A grain size distribution of this material is shown on Fig. 7.

The clay has a hard consistency as the 'N' values measured were generally in excess of 50. The soil has a low plasticity based on liquid limit and plasticity index of 26 and 12% respectively. The water content of the silty clay is typically about 10%. The bulk unit weight of the soil was measured to be between 20.5 and 24 kN/cu m.

Bedrock

Shale bedrock was inferred to be present below the above deposits at between elevations 75.0 and 81.5 in BH 1, 2, 8, 15, 17, 18, 20, 21, 22 and 104. The bedrock was cored in BH 1, 3 and 15 for depths of 2 to 3 m. The rock is grey to dark grey in colour and consists of calcareous to bituminous shale. The rock is moderately fractured to sound and is slightly weathered to fresh. Total core recoveries were in excess of 95% and improved with depth.

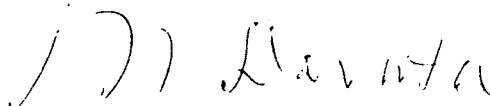
GROUNDWATER CONDITIONS

Groundwater was encountered in all boreholes during drilling. In some boreholes the groundwater flow in the sandy layers within the silty sand to silty deposit was sufficient to cause the borehole walls to collapse. Rapid

groundwater flow was experienced on penetrating the sand and gravel. Stabilized groundwater levels measured in the piezometers, stand-pipes, and open boreholes were between elevation 83.1 and 92.7 m with an average of 90.7 m.



B. E. Ruck
Project Foundations Engineer



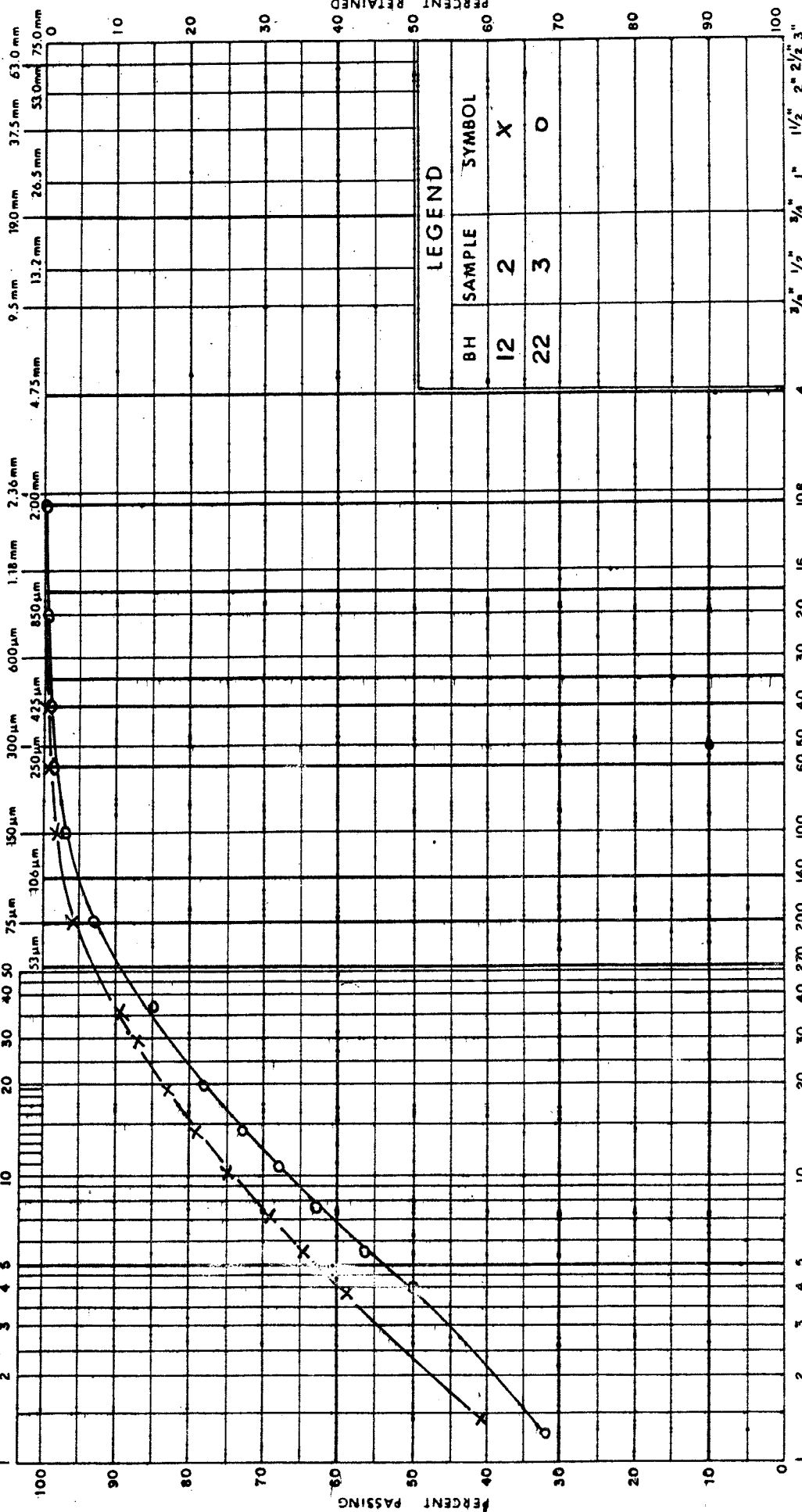
M. S. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
GRAIN SIZE IN MICROMETERS		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION (Metric)



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Communications



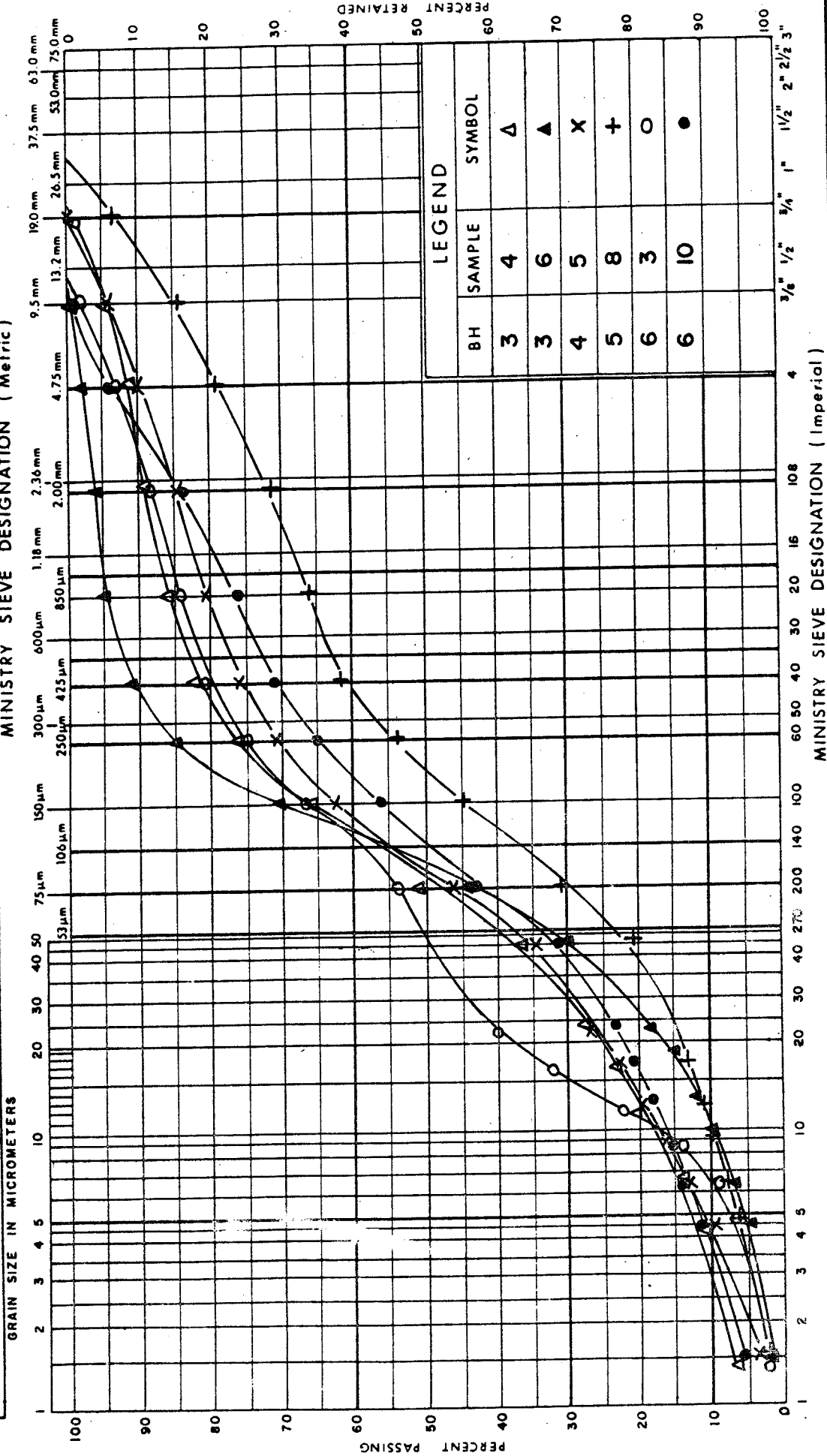
GRAIN SIZE DISTRIBUTION UPPER SILTY CLAY

FIG No I

W P 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	
MINISTRY SIEVE DESIGNATION (Metric)							



GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT

FIG No 2

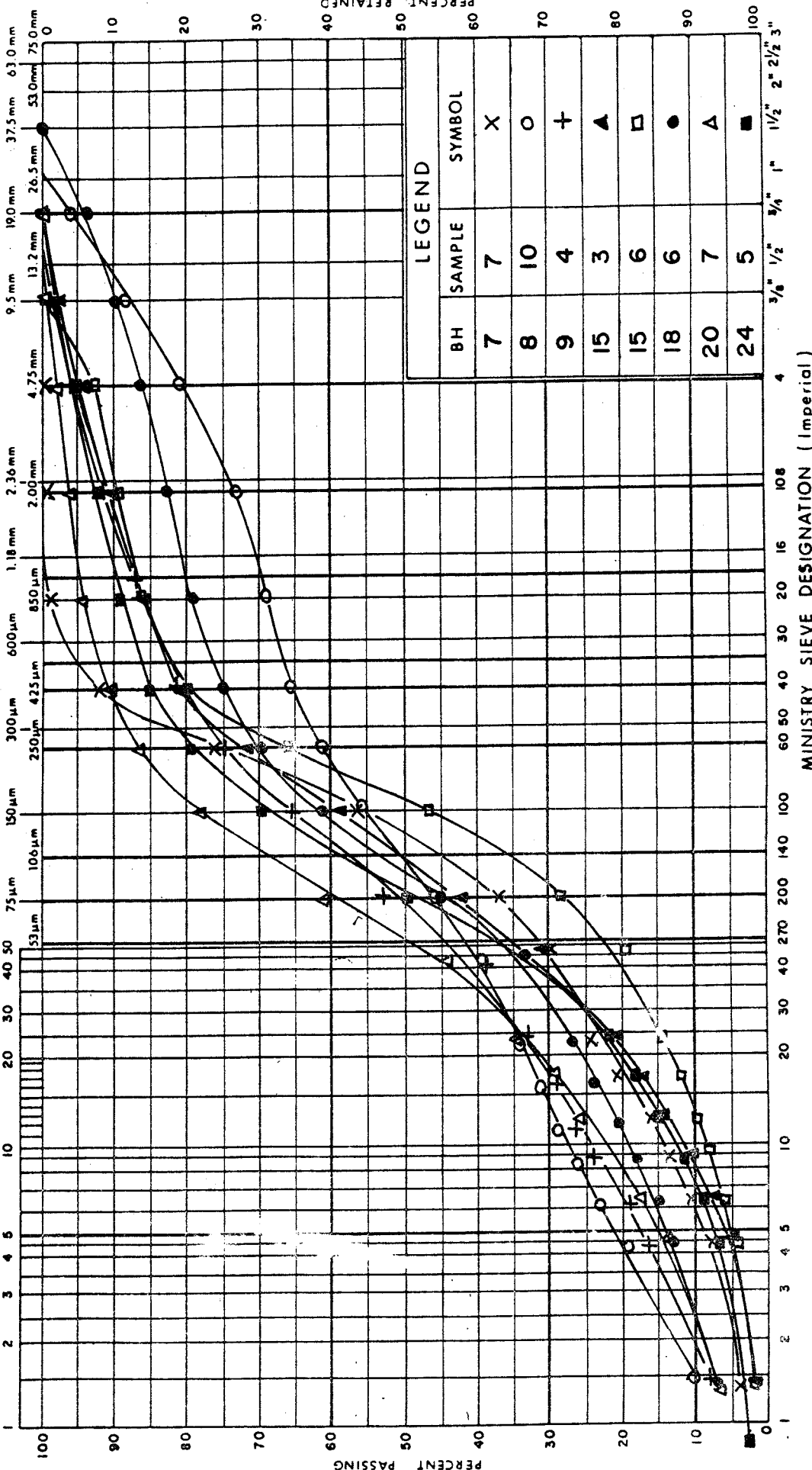
W P 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
Fine		Medium			Coarse	
Fine		Medium			Coarse	

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation and
Communications



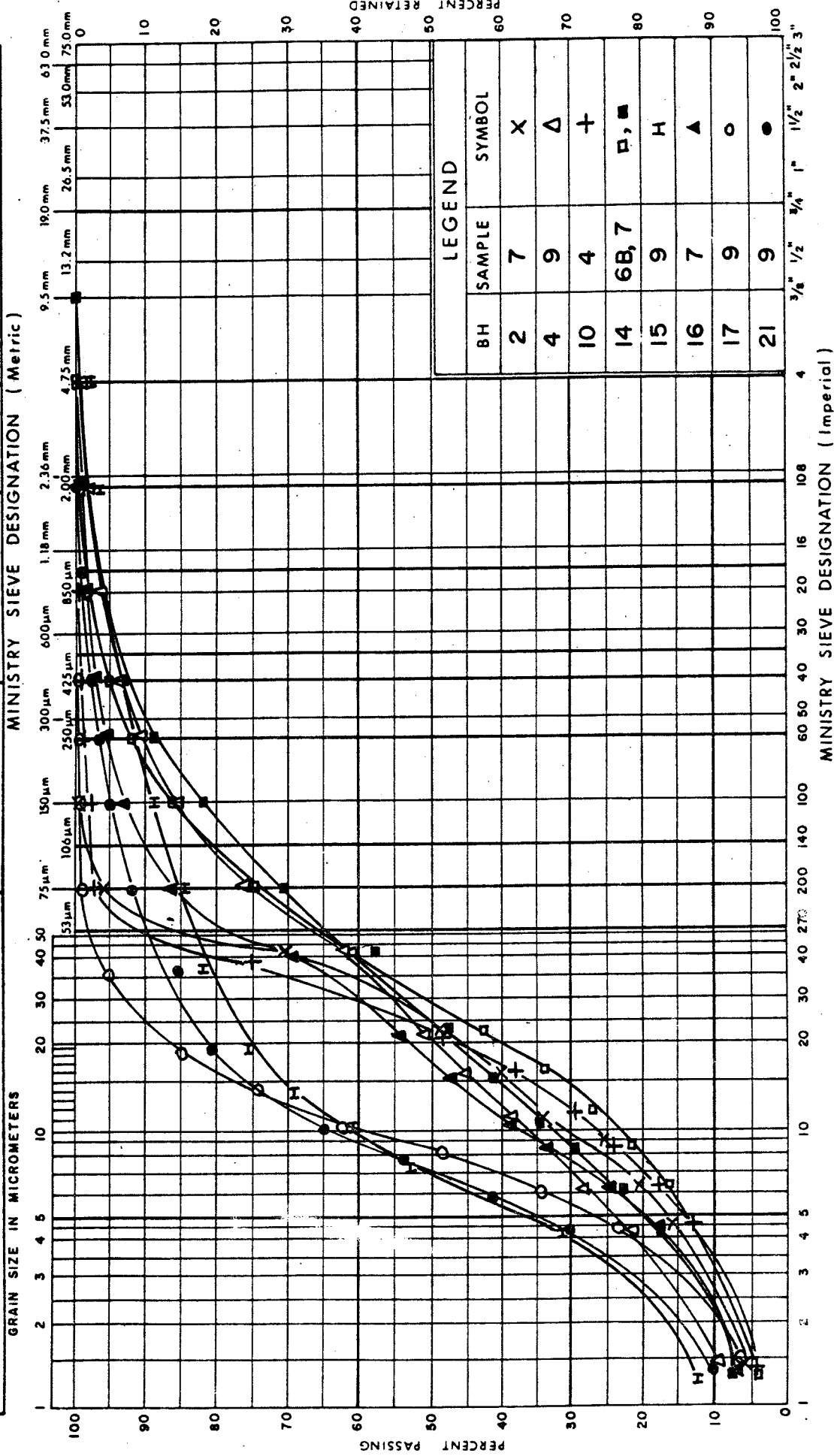
GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT

FIG No 3

W P 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

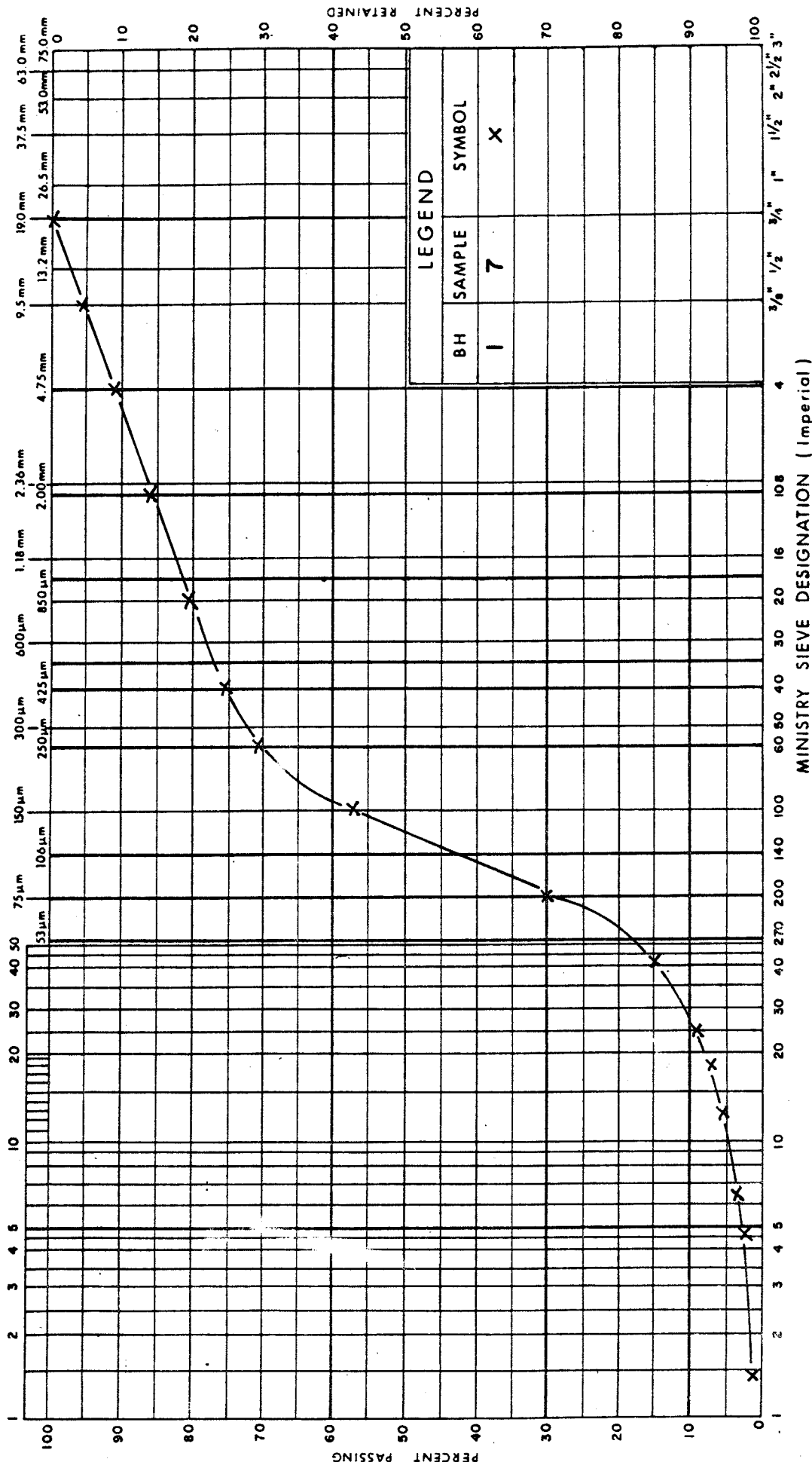


GRAIN SIZE DISTRIBUTION
SILT

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT			SAND			GRAVEL		
GRAIN SIZE IN MICROMETERS			Fine	Medium	Coarse	Fine	Coarse	

MINISTRY SIEVE DESIGNATION (Metric)



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Transportation and
Communications



GRAIN SIZE DISTRIBUTION

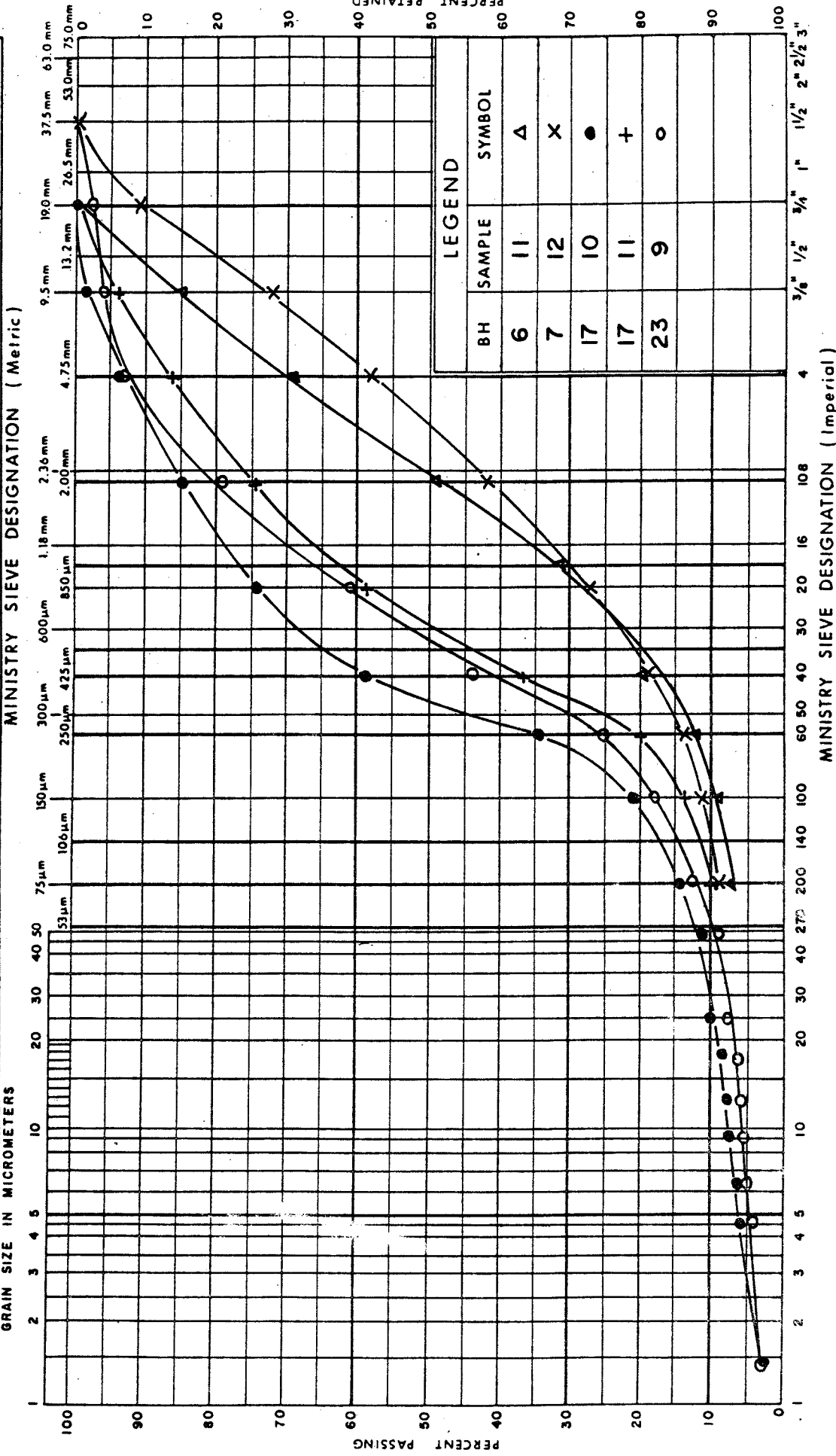
SAND

FIG No 5

W P 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse
		MINISTRY SIEVE DESIGNATION (Metric)				



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GRAIN SIZE DISTRIBUTION SAND AND GRAVEL

FIG No 6

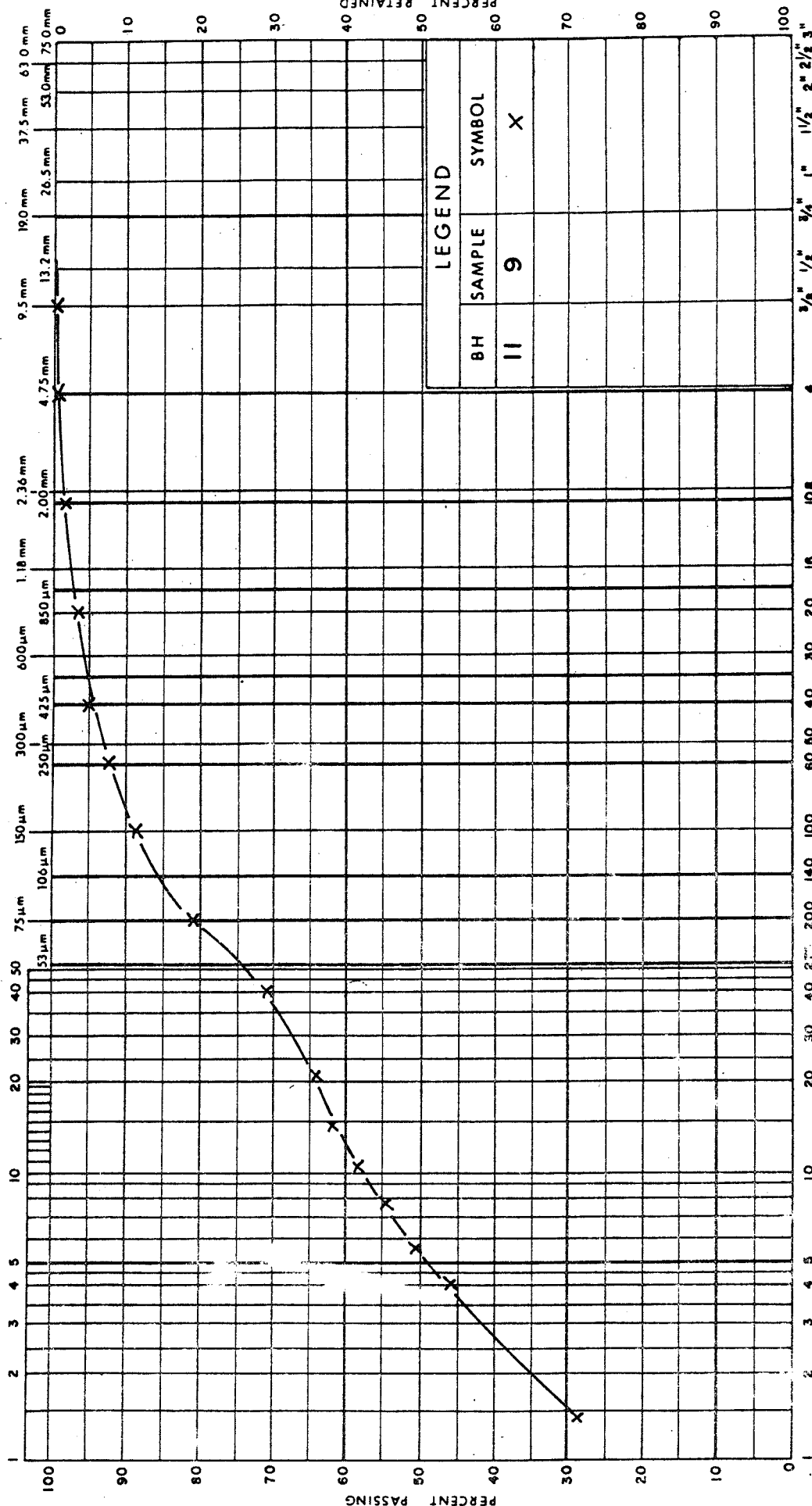
W P 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



LEGEND

BH	SAMPLE	SYMBOL
11	9	X

MINISTRY SIEVE DESIGNATION (Imperial)

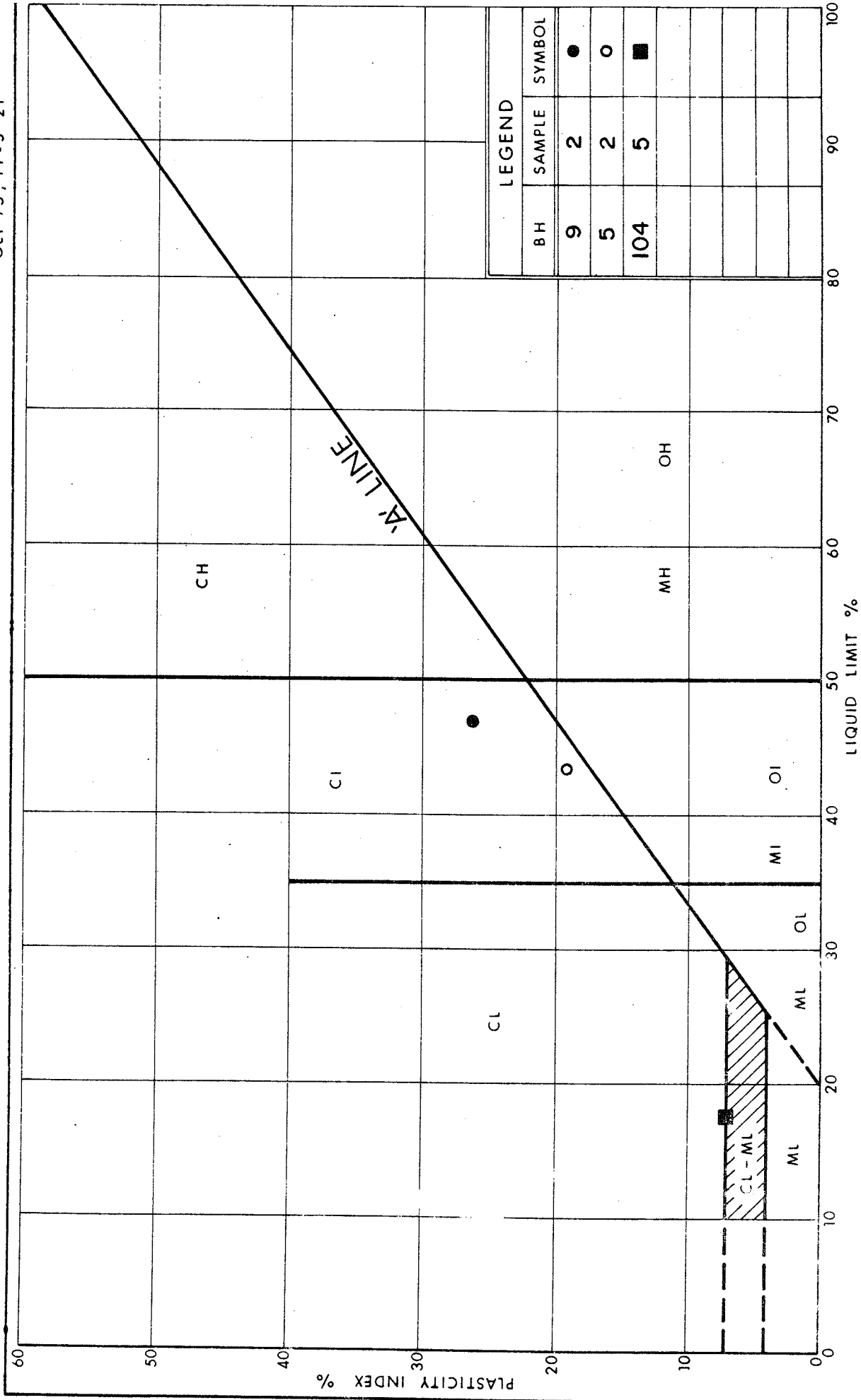
GRAIN SIZE DISTRIBUTION LOWER SILTY CLAY

Ministry of
Transportation and
Communications



FIG No 7

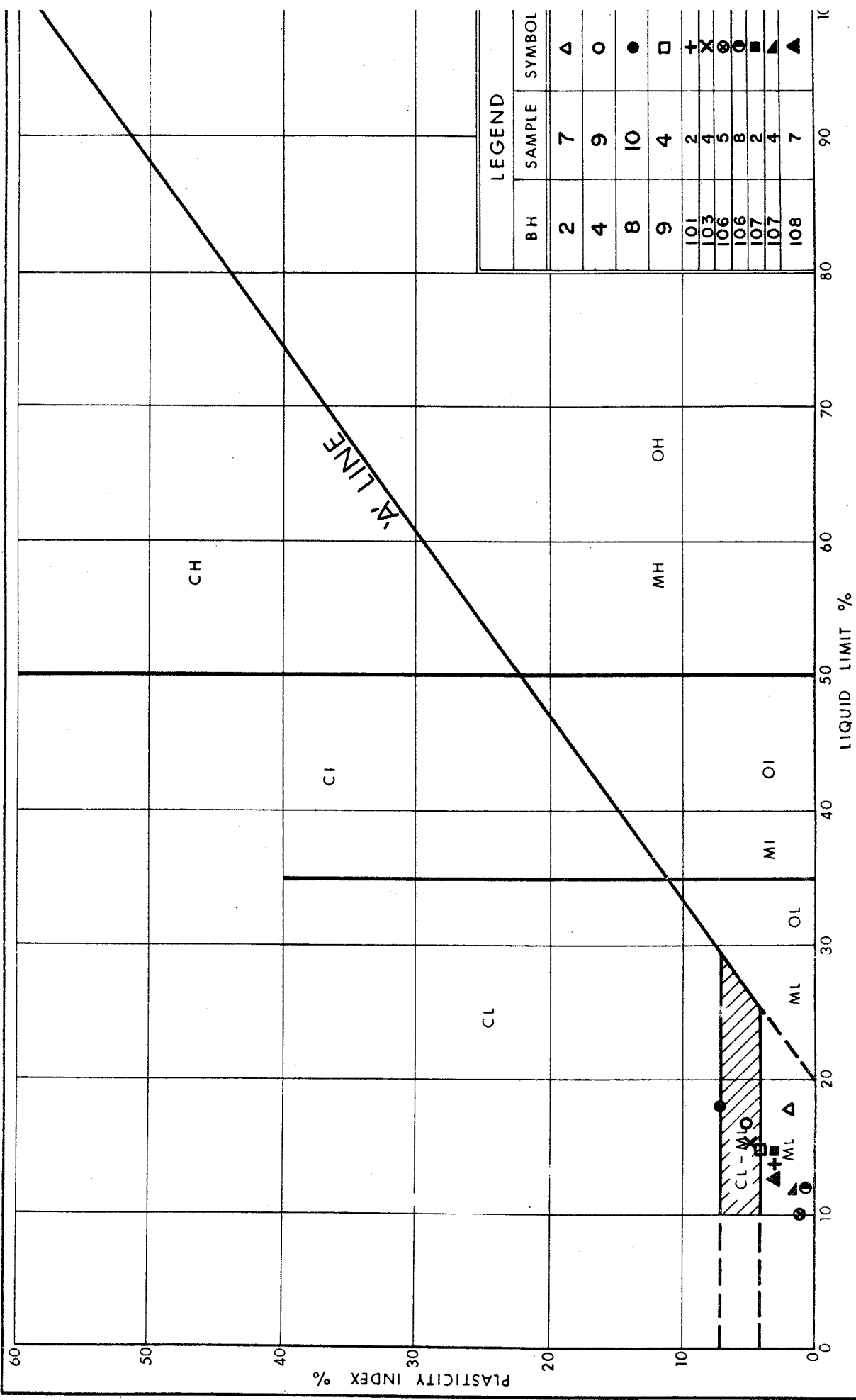
W P 470-711-611



PLASTICITY CHART
UPPER SILTY CLAY

FIG No 8

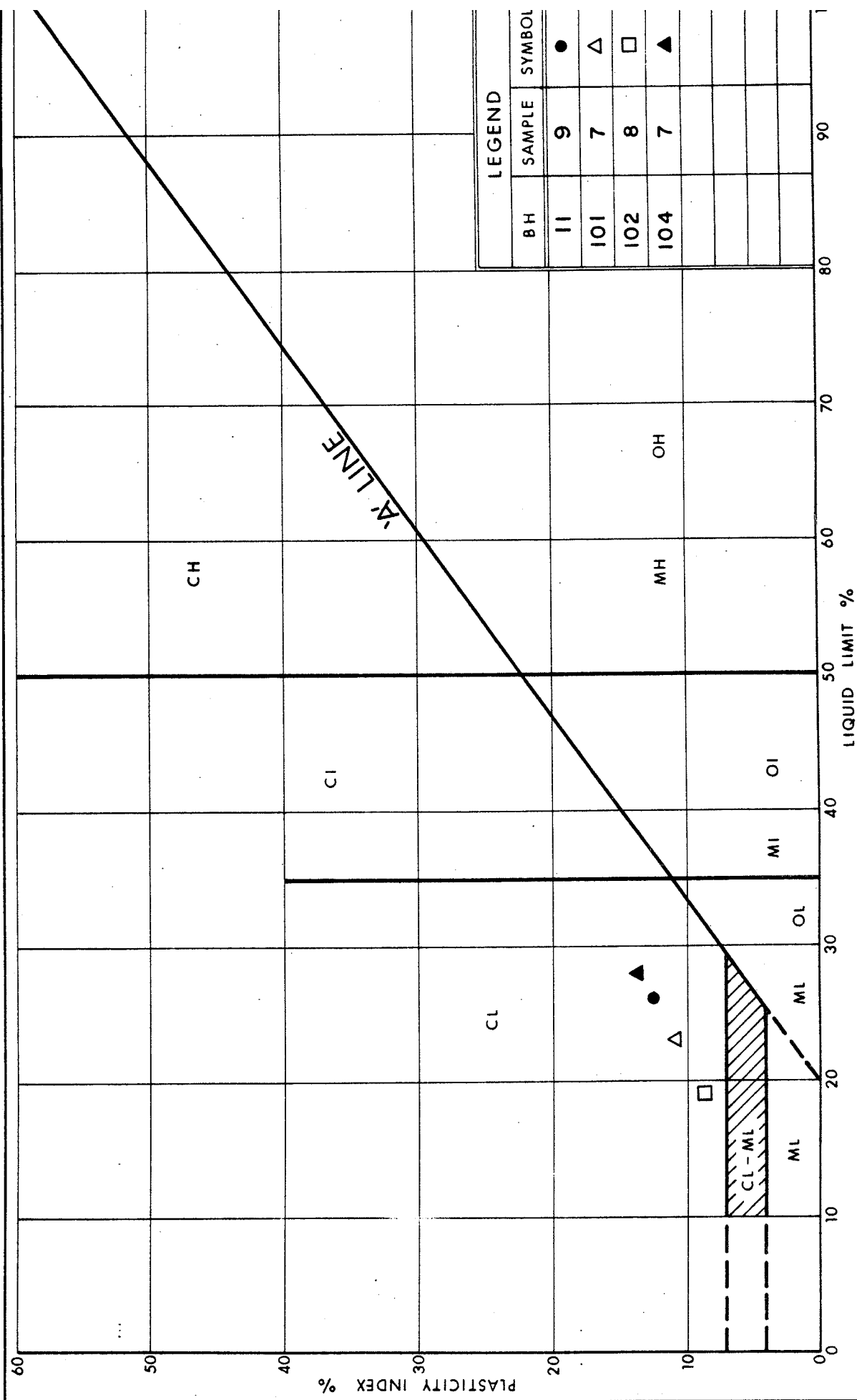
W P 470-711-611



PLASTICITY CHART SILTY SAND TO SANDY SILT

FIG No 9

W P 470-711-611



W P 170-711-611 LOCATION Co-ordinates N 4,856,356; E 341,771 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger, Solid Stem Auger COMPILED BY MHW
 DATUM Geodetic DATE July 19 and 20, 1983 CHECKED BY JRB

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					
94.5	Ground Surface																
0.0	Silty sand, some gravel, trace clay		1	SS	19												
	Compact to Dense		2	SS	16												
			3	SS	28												
	Brown becoming Grey at Elev. 90.6 m		4	SS	50												
89.9			5	SS	31												
4.6	Silt, some fine sand and gravel		6	SS	84												
88.7	Very Dense Grey																
5.8	Silty sand, trace clay and fine gravel changing to gravelly sand some silt		7	SS	45												
86.6	Dense to Very Dense Grey		8	SS	112												
7.9	Silt, some sand and gravel trace clay		9	SS	100/150 mm												
84.4	Very Dense Grey becoming dark grey at elev 85.2 m																
10.1	Sand some gravel and trace silt to silty sand and gravel		10	SS	57												
	Very Dense Dark Grey		11	SS	65												
			12	SS	86/200 mm												
79.3			13	SS	100/50 mm												
15.2	Shale bedrock, calcareous, moderately fractured to sound below elev. 78.8 m, fresh to slightly weathered, grey with occasional black shale beds		14	BQ RC	REC 100%												
76.7			15	BQ RC	REC 100%												
17.8	End of Borehole																

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

20

W P 470-711-611 LOCATION Co-ordinates N 4,856,349; E 341,757 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 19, 1983 CHECKED BY JRB

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					
94.0	Ground Surface													
0.0	Topsoil													
0.5	Silty clay some sand trace root fibres		1	SS	20									
92.6	Very stiff Brown													
1.4	Silty sand some gravel and trace clay		2	SS	19									
	Compact to Very Dense		3	SS	14									
	Brown		4	SS	66									
89.6			5	SS	1007 150									
4.4	Silt trace to some fine sand trace clay becoming gravelly at elev. 86.4		6	SS	1007 75 mm									
	Very Dense Grey		7	SS	143									0 4 88 8
86.2			8	SS	1147 150									
7.8	Sand trace gravel													
85.0	Very Dense Grey		9	SS	1007 90 mm									
9.0	Sandy silt with trace gravel and clay													
	Very Dense Dark Grey		10	SS	1007 100									
82.4														
11.6±	Silty clay with some gravel-sized shale fragments increasing in frequency with depth		11	SS	127									
	Hard Dark Grey		12	SS	86									
78.8			13	SS	1007 100 mm									
15.3	End of Borehole													
	Probably shale bedrock with clay partings dark grey													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

21

W P 470-711-611 LOCATION Co-ordinates N 4,856,348; E 341,744 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger, Wash Boring COMPILED BY MHW
DATUM Geodetic DATE July 20 and 21, 1983 CHECKED BY JRB

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				
93.8	Ground Surface															
0.0	Fill, silty clay with organic matl. throughout															
92.6	Stiff Black		1	SS	9											
1.2	Silty clay, varved		2	SS	15											
91.7	Stiff Brown		3	SS	20											
2.1	Sandy silt to silty sand, trace clay and gravel		4	SS	24											
89.5	Compact becoming Grey with depth															
4.3	Silty sand trace gravel and clay to sand, some gravel and silt		5	SS	62											
	Very Dense Grey		6	SS	57											
86.1			7	SS	50/75 mm											
7.7	Sandy silt with trace to some gravel		8	SS	50/75 mm											
	Very Dense Grey															
83.3			9	SS	41											
10.5	Silty clay with angular gravel-sized shale and limestone fragments increasing in frequency with depth, some sand, layered in upper portion		10	SS	100/225 mm											
79.9	Hard Grey		11	SS	100/75 mm											
13.9	End of Borehole															
	NOTE: Continuous grinding of augers experienced from elev. 83.9 m to 83.3 m															

OFFICE REPORT ON SOIL EXPLOR. N

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

RECORD OF BOREHOLE No 4

22

W P 470-711-611 LOCATION Co-ordinates N 4,856,368; E 341,738 ORIGINATED BY HCO
DIST 6 HWY CO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 20, 1983 CHECKED BY JRB

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						
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE					
							WATER CONTENT (%)		10 20 30					
94.4	Ground Surface													
0.0	Topsoil													
0.3	Fill - sandy silt trace clay and gravel, occasional organic material		1	SS	16									
			2	SS	9									
	Loose to Compact Brown		3	SS	11									
91.5			4	SS	42									
2.9	Silty sand, trace to some gravel and trace clay		5	SS	32									
	Compact to Very Dense Brown changing to Grey at ± elev. 89.4 m		6	SS	25									
			7	SS	65									
87.9														
6.5±	Silt some sand and clay trace gravel		8	SS	100/ 150									
	Very Dense Grey		9	SS	50/ 60 mm									
83.7			10	SS	97/ 150									
10.7	Silty sand, some gravel and trace to some clay													
	Very Dense Dark Grey		11	SS	86/ 150									
80.6			12	SS	103									
13.8														
14.1	End of Borehole													
	Silty clay some angular shale fragments Hard Dark Grey													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

23

W P 470-711-611 LOCATION Co-ordinates N 4,856,372; E 341,750 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY MHW
 DATUM Geodetic DATE July 20 and 21, 1983 CHECKED BY JRB

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 x LAB VANE								W _p W W _L					
94.5	Ground Surface														GR SA SI CL						
0.1	Topsoil																				
	Fill - sand, clay some silt, gravel trace cobbles and organic material		1	SS	3																
92.4			2	SS	11																
2.1	Silty sand some gravel trace clay		3	SS	25																
	Compact to Dense		4	SS	46																
90.1	Brown		5	SS	48																
4.4	Interlayered sandy silt with traces gravel and clay		6	SS	115/200 mm																
	Gravelly silty sand and silt with trace to some sand. Occasional seams of sand trace silt		7	SS	61																
			8	SS	107/200 mm																
			9	SS	50/25 mm																
			10	SS	118/225 mm																
			11	SS	78																
	Very Dense Dark Grey		12	SS	87																
79.3			13	SS	100/75 mm																
15.2	End of Borehole																				
15.3	Silty clay with shale and limestone fragments																				
	Hard Dark Grey																				

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

24

W P 470-711-611 LOCATION Co-ordinates N 4,856,376; E 341,765 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY MHW
DATUM Geodetic DATE July 21 and 22, 1983 CHECKED BY JRB

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				
94.7	Ground Surface															
0.0	Fill - silty sand trace organic matter															
94.1																
0.6	Silty sand some gravel trace clay. Silt content decreasing with depth, trace organic matter to elev. 93.7 m		1	SS	13											
			2	SS	20											
			3	SS	37											
			4	SS	32											
	Compact to Dense Brown		5	SS	130											
90.6			6	SS	100/250											
4.1	Silt some fine sand some stratification at depth		7	SS	100/150											
87.7	Very Dense Grey		8	SS	175/250											
7.0	Silty sand some gravel trace clay to gravelly sand some silt		9	SS	100/75											
	Very Dense Grey		10	SS	50/50											
83.1			11	SS	66											
	Sand and gravel trace to some silt occasional cobbles		12	SS	122											
	Very Dense Dark Grey		13	AS	-											
79.9			14	SS	100/											
14.8																
79.3																
15.4	End of Borehole				150											
	Silty clay with angular shale and limestone fragments															
	Hard Dark Grey															

+3, x5: Numbers refer to Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

25

W P 470-711-611 LOCATION Co-ordinates N 4,856,401; E 341,760 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 27 and 28, 1983 CHECKED BY JRB

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							
94.4	Ground Surface														
0.0	Topsoil														
0.1	Silty sand trace to some gravel trace clay occasional rust stained fissures		1	SS	18										
			2	SS	20										
	Compact to Very Dense Brown		3	SS	65										
			4	SS	61										
90.1			5	SS	120/ 250										
4.3	Sand trace to some silt trace gravel to silty sand trace gravel and clay		6	SS	67										
	Very Dense Grey		7	SS	66										1 62 32 5
			8	SS	125/ 225										
85.9															
8.5	Silty sand some gravel trace clay		9	SS	98										
	Very Dense Grey		10	SS	94										
82.7															
11.7	Sand and gravel some silt		11	SS	63										
	Very Dense Dark Grey		12	SS	110										42 48 (10)
79.9															
14.5	Silty clay with shale fragments		13	AS	-										
79.0	Hard Dark Grey		14	SS	507										
15.4	End of Borehole				50 mm										

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

W P	<u>470-711-611</u>	LOCATION	<u>Co-ordinates N 4,856,400; E 341,759</u>	ORIGINATED BY	<u>HCO</u>
DIST	<u>6 HWY GO-ALRT</u>	BOREHOLE TYPE	<u>Solid Stem Auger - Piezometer Installation</u>	COMPILED BY	<u>FFO</u>
DATUM	<u>Geodetic</u>	DATE	<u>July 29, 1983</u>	CHECKED BY	<u>JRB</u>

[illegible]

+³, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 8

27

W P 470-711-611 LOCATION Co-ordinates N 4,856,392; E 341,730 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow, Solid Stem Auger/BQ Rock Core COMPILED BY MHW
 DATUM Geodetic DATE July 21 and 22, 1983 CHECKED BY JRB

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					
93.3	Ground Surface															
0.1	Topsoil Silty sand trace to some clay and some gravel Compact to Very Dense Brown becoming Grey at elev. 91.8 m		1	SS	21	Water Level Elev. 91.9 m Aug. 5/83										
			2	SS	36											
			3	SS	57											
			4	SS	37											
89.6			5	SS	108											
3.7	Fine sandy silt trace clay and gravel Very Dense Grey		6	SS	58											
			7	SS	100/ 50 mm											
			8	SS	115/ 200 mm											
84.8			9	SS	145/ 275 mm											
8.5	Silt to sandy silt some gravel and clay Very Dense Grey to Dark Grey		10	SS	127											
			11	SS	79											
			12	SS	70/ 150 mm											
78.1			13	SS	100/ 100 mm											
15.2	Shale bedrock, grey calcareous lightly fractured, fresh		14	BQ RC	REC 93%											
			15	BQ RC	REC 100%											
75.4																
17.9	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

28

W P 470-711-611 LOCATION Co-ordinates N 4,856,375; E 341,682 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 22, 1983 CHECKED BY JRB

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
90.9	Ground Surface															
90.3	Topsoil															
0.6	Silty clay varved		1	SS	9											
	Stiff Brown		2	SS	8											
88.8	Silt to sandy silt		3	SS	3											
2.1	trace gravel some clay		4	SS	2											
	Very Loose to Very Dense															
	Grey		5	SS	20											
			6	SS	51											
			7	SS	69											
81.7			8	SS	100/75 mm											
9.2	End of Borehole															

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10

29

W P 470-711-611 LOCATION Co-ordinates N 4,856,357; E 341,623 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 26 and 27, 1983 CHECKED BY JRB

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					
93.5	Ground Surface													GR SA SI CL
0.0	Topsoil													
0.2	Silty sand trace gravel and organic matter		1	SS	10									
91.8	Loose Dark Brown		2	SS	5									
1.7	Interlayered sand and silt occasional rust staining		3	SS	40									
	Loose to Dense		4	SS	31									
89.8	Brown		5	SS	28									0 4 89 7
3.7	Interlayered silty sand trace gravel, silty fine sand and sand trace silt		6	SS	27									
	Compact to Very Dense		7	SS	77									
	Brown becoming Grey at elev. 90.6 m becoming Brown at 88.0 m and Grey at 86.2		8	SS	45									
			9	SS	46									
82.4			10	SS	65									
11.1	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 11

30

W P 470-711-611 LOCATION Co-ordinates N 4,856,418; E 341,805 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 22, 1983 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%)										
91.9	Ground Surface																
0.0	Silty clay trace sand, varved						Water Level										
90.7	Stiff Brown		1	SS	11		Elev. 91.2 m										
1.2	Silty sand some gravel trace to some clay		2	SS	12		Aug. 5/83										
	Compact to Loose		3	SS	12												
	Brown becoming Grey at Elev. 89.2		4	SS	14												
87.5			5	SS	5												
4.4	Silt some sand and clay traces gravel		6	SS	11												
	Compact to Very Dense Grey		7	SS	75/150												
84.7							85										
7.2	Sand and gravel trace to some silt		8	SS	115												
83.4	Very Dense, Dark Grey																
8.5	Silty clay some sand trace gravel		9	SS	87/150												
81.5	Hard Dark Grey																
10.4			10	SS	100/150												
10.8	End of Borehole						80										
	Silty clay with shale fragments																
	Hard Dark Grey																

+³, x⁵: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 12

31

W P 470-711-611 LOCATION Co-ordinates N 4,856,430; E 341,843 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE July 26, 1983 CHECKED BY JRB

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					
92.3	Ground Surface															
0.0	Topsoil															
0.3	Silty clay - varved to massive		1	SS	8											
90.2	Stiff Brown		2	SS	7											
2.1	Silty sand to sandy silt trace to some gravel trace clay		3	SS	18											
	Compact to Very Dense		4	SS	51											
			5	SS	99											
	Brown becoming Grey at about elev. 89.3 m		6	SS	104/275 mm											
86.1			7	SS	43											
6.2	Silty clay trace gravel occasional sand lenses, layered		8	SS	80											
	Hard Dark Grey															
83.5																
8.8	Silty clay with shale and limestone fragments increasing with depth		9	SS	105											
81.5	Hard Dark Grey		10	SS	106/											
10.8	End of Borehole				100 mm											

+3, x⁵: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13

32

W P 470-711-611 LOCATION Co-ordinates N 4,856,449; E 341,902 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 27, 1983 CHECKED BY JRB

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					
93.6	Ground Surface												
0.0	Fill - silty sand some gravel	X											
0.3	Silty sand trace to some gravel changing to sand some silt and gravel below elev. 90.7 m		1	SS	50								
			2	SS	99/275								
			3	SS	118/200								
	Dense to Very Dense		4	SS	41								
	Brown becoming Grey below elev. 90.7 m		5	SS	43								
			6	SS	46								
			7	SS	52								
			8	SS	100/150								
84.2			9	SS	100/150								
9.5	End of Borehole												
	Silty to sandy clay some gravel												
	Hard Dark Grey												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 14

33

W P 470-711-611 LOCATION Co-ordinates N 4,856,463; E 341,716 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 29, 1983 CHECKED BY JRB

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						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%)				
92.0	Ground Surface									10	20	30		GR SA SI CL
90.6	Fill - sand some gravel trace silt Loose Brown		1	SS	8					○				
1.4	Silty sand trace to some gravel changing to sand some silt and gravel. Silty fine sand lenses at depth		2	SS	54		90			○				
	Very Brown becoming Dense grey at elev. 88.7 m		3	SS	65		Water Level Elev. 89.2 m Aug 5/83			○				
87.3			4	SS	125					○				
4.7	Silt to sandy silt trace gravel and clay		5	SS	49					○				0 25 68 7
86.4	Very Dense Grey		6	SS	100/	150 mm				○				
5.6	Interlayered silt and silty sand trace gravel throughout		7	SS	50/	75 mm				○				1 28 61 10
	Very Dense Grey		8	SS	50/	50 mm	85			○				
			9	SS	100/	125 mm				○				
			10	SS	50/	75 mm				○				
			11	SS	100/	125 mm	80			○				
78.8														
13.2	Sand trace to some silt trace gravel		12	SS	100/	100 mm				○				
	Very Dense Grey		13	SS	100/	150 mm				○				
75.4														
16.6			14	SS	100/		75			○				
17.0	End of Borehole					100 mm								
	Silty clay with shale fragments													
	Hard Dark Grey													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 15

34

W P 470-711-611 LOCATION Co-ordinates N 4,856,471; E 341,749 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, Wash Boring, BQ Rock Core COMPILED BY EFO
DATUM Geodetic DATE July 28 and 29, August 2, 1983 CHECKED BY JRB

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					
92.2	Ground Surface																
0.0	Fill - sand trace																
0.3	gravel and silt																
	Silty sand trace to		1	SS	14												
	some gravel trace clay		2	SS	50												
	Compact to Very Dense		3	SS	47												
	Brown becoming		4	SS	43												
	Grey below elev.		5	SS	59												
	89.3 m		6	SS	40												
			7	SS	100/75 mm												
85.0																	
7.2	Sand some gravel trace		8	SS	75/100 mm												
83.7	Very Dense Grey																
8.5	Silt to silt some fine		9	SS	100/150 mm												
	sand and clay trace																
	gravel. Stratified at		10	SS	108/225 mm												
	depth																
	Very Dense Grey																
80.3																	
11.9	Sand some gravel trace		11	SS	32												
	silt to gravelly sand		12A	WS	-												
	trace silt		12B	CS	-												
	Dense to Very Dense		13	AS	-												
	Dark		14	WS	-												
	Grey		15	SS	103												
	Silty clay with shale																
	fragments																
75.2	Hard Dark Grey		16	SS	100/13 mm												
17.0																	
17.2	Shale bedrock, calcare-		17	BQ	REC												
	ous lightly to moder-			RC	97%												
	ately fractured, fresh,																
73.0	grey		18	BQ	REC												
				RC	100%												
19.2	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 16

35

W P 470-711-611 LOCATION Co-ordinates N 4,856,446; E 341,720 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 25, 1983 CHECKED BY JRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100		
92.3	Ground Surface												
0.0	Fill - sand trace to some silt trace gravel and organic material		1	SS	26								
90.8	Compact Brown		2	SS	40								
1.5	Silty sand trace to some gravel trace clay with rusty fissures		3	SS	66								
	Dense to Very Dense Brown to Grey		4	SS	55								
88.3													
4.0	Silt to sandy silt trace to some gravel and clay, occasional silty sand lenses		5	SS	60								
	Very Dense Grey		6	SS	94								
			7	SS	50/ 50 mm								
			8	SS	122/ 200 mm								
			9	SS	60/ 75 mm								
80.8													
11.5	Silty sand some gravel trace clay to gravelly silty sand traces clay		10	SS	145								
	Very Dense Grey		11	SS	100/ 225 mm								
			12	SS	31*								
75.4													
16.9	Silty to sandy clay trace to some gravel		13	SS	138/ 200 mm								
73.9	Hard Dark Grey		14	SS	100/ 75 mm								
18.4	End of Borehole												
	* Low N value likely due to disturbance during augering. Little sample recovered.												

+3, x⁵: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 17

36

W P 470-711-611 LOCATION Co-ordinates N 4,856,454; E 341,744 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MEW
DATUM Geodetic DATE July 25, 1983 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
92.5	Ground Surface													
0.0	Fill - sand trace silt (40 mm asphalt at sur- face) Dense Brown		1	SS	32									
1.1	Fill - silt sand trace organics		2	SS	48									
1.4	Silty sand trace to some gravel trace clay changing to gravelly sand with some silt occasional sand lense Dense to Very Dense Brown becoming Grey at elev. 89.9 m		3	SS	73		90							
			4	SS	92									
			5	SS	64/150									
85.5			6	SS	100/150									
7.0	Sandy silt trace clay and gravel Very Dense Grey		7	SS	100/125		85							
			8	SS	100/100									
82.1														
10.4	Silt trace fine sand and some clay		9	SS	117									0 1 89 10
80.9	Very Dense Light Grey													
11.6	Sand and gravel some silt Very Dense Dark Grey		10	SS	67		80							7 79 10 4
			11	SS	55									
77.6														14 76 (10)
14.9	Silty clay with shale fragments		12	AS	-									
76.3	Hard Dark Grey		13	SS	118									
16.2	Shale bedrock		14	AS	-									
75.6			15	SS	100/75		75							
16.9	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No 18

37

W P 470-711-611 LOCATION Co-ordinates N 4,856,406; E 341,658 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 27, 1983 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)					
91.4	Ground Surface														
0.2	Topsoil														
90.0	Fill, silty sand trace to some clay trace gravel, gasoline odour loose Brown		1	SS	5										
1.4	Silty clay, varved with occasional sand lenses		2	SS	6										
	Stiff Brown and Grey		3	SS	9										
88.0			4	SS	4										
3.4	Silty sand some gravel and clay		5	SS	2										
			6	TW	PH										
	Very loose becoming Dense to Very Dense below elevation 85.6 m Grey		7	SS	30										
			8	SS	66										
			9	SS	57										
81.0															
10.4	Silty clay with shale fragments increasing with depth and changing gradually to shale		10	SS	130/200 mm										
79.0	bedrock Hard Dark Grey		11	SS	30/50 mm										
12.4	End of Borehole														

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 19

38

W P 470-711-611 LOCATION Co-ordinates N 4,856,416; E 341,689 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 27, 1983 CHECKED BY JRB

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						
							○ UNCONFINED + FIELD VANE						
							● QUICK TRIAXIAL x LAB VANE						
91.7	Ground Surface												GR SA SI CL
0.0	Fill - sand trace silt and gravel, gasoline odour		1	SS	5								
90.3	Loose Brown												
1.4	Silty clay stiff varved		2	SS	8								
1.7	Silty sand some gravel trace clay, with sand and some silt trace gravel at about elev. 86.5 m to 86.0 m		3	SS	8								
			4	SS	61								
			5	SS	13								
			6	SS	35								
			7	SS	89								
84.4													
7.3	Silty clay with shale fragments increasing with depth		8	SS	87								
	Hard Dark Grey		9	SS	70/150 mm								
80.6			10	SS	124/200 mm								
11.1	End of Borehole												

γ=23.7
kN/m³

+³, x⁵: Numbers refer to Sensitivity

20
15
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 20

39

W P 470-711-611 LOCATION Co-ordinates N 4,856,425; E 341,732 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 26, 1983 CHECKED BY JRB

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					
91.9	Ground Surface																
0.0	Fill - sand and gravel	X															
0.3	Silty sand to sandy silt with trace gravel throughout, occasional silt and sand seams		1	SS	20												
			2	SS	40												
	Compact to Very Dense		3	SS	99												
	Brown becoming Grey below elev. 90.8 m		4	SS	85												
			5	SS	90												
			6	SS	54												
			7	SS	100/												
84.7					100												
7.2	Sandy silt trace gravel and clay		8	SS	100/												
	Very Dense				150												
	Light Dark Grey		9	SS	100/												
					150												
81.2																	
10.7	Silty sand some gravel trace clay, occasional sand seams		10	SS	175/												
	Very Dense				225												
	Grey		11	SS	100/												
					150												
77.9																	
14.0	Silty clay some sand trace gravel		12	SS	143/												
76.7	Hard Dark Grey				200												
15.3	End of Borehole				100												
	Shale Bedrock																

OFFICE REPORT ON SOIL EXPLOSION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 21

40

W P 470-711-611 LOCATION Co-ordinates N 4,856,434; E 341,750 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 26, 1983 CHECKED BY JRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
92.2	Ground Surface													
0.0	Fill, sand and gravel													
0.3	Fill - sand trace gravel and silt													
91.2			1	SS	28									
1.0	Compact Brown		2	SS	64									
	Silty sand, trace to some gravel, occasional horizontal layers of silt		3	SS	89									
88.7	Very Dense Brown		4	SS	100/125									
3.5	Sandy silt trace to some gravel trace clay		5	SS	100/230									
	Very Dense Grey		6	SS	100/125									
			7	SS	100/125									
			8	SS	100/125									
83.4														
8.8±	Silt, some clay trace sand		9	SS	109/275									
81.9	Very Dense Grey													
10.3	Silty sand to silty sand and gravel		10	SS	57									
	Very Dense Dark Grey		11	SS	61									
78.6														
13.6	Shale bedrock, fissile		12	SS	87/150									
	Dark Grey													
76.9			13	SS	100/75									
15.3	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 22

41

W P 470-711-611 LOCATION Co-ordinates N 4,856,449; E 341,799 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 26, 1983 CHECKED BY JRB

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 × LAB VANE						
92.6	Ground Surface							20 40 60 80 100							
91.2	Fill - sand and gravel trace silt and organic matter Compact Brown		1	SS	50/ 75 mm		Water Level Elev. 90.4 m July 29/83								
90.5	Organic sandy silt trace gravel and clay Compact Black		2	SS	14										
89.4	Silty clay trace sand varved		3	SS	7										
88.4	Stiff Brown and Grey		4A	SS	43										
87.4	Silty sand some clay and gravel		5	SS	8										
86.4	Loose to Dense		6	SS	23										
85.3	Brown becoming Grey below elev. 88.1 m		7	SS	8										
84.3	Silty to sandy clay trace to some gravel		8	AS	100/ 125 mm										
83.3	Hard Dark Grey		9	SS	79										
82.3			10	SS	100/ 75 mm										
81.3			11	AS	113/ 50 mm										
80.4	End of Borehole														
79.4	Shale bedrock - fissile highly weathered, black														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 23

42

W P 470-711-611 LOCATION Co-ordinates N 4,856,459; E 341,835 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 27, 1983 CHECKED BY JRB

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						
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE			10 20 30		
92.9	Ground Surface													
0.0	Fill - sand and gravel						Water Level							
0.3	Fill silty sand and gravel trace organics		1	SS	13		Elev.							
91.5	Compact Brown-Grey						90.6 m							
1.4	Silty sand trace to some gravel trace clay		2	SS	9		Aug 5/83							
	Brown		3	SS	70									
90.0	Loose to Very Dense						90							
2.9	Sandy silt to silty sand, trace gravel, occasional sandy pockets		4	SS	90									
			5	SS	119/225									
			6	SS	100/150									
	Very Dense Grey		7	SS	100/150									
			8	SS	100/150		85							
84.1														
8.8	Sand trace gravel silt and clay		9	SS	116									
83.2	Very Dense Dark Grey													7 80 10
9.7	Silty clay with some shale and limestone fragments													
81.8	Hard Grey		10	SS	140								γ=23.9 kN/m ³	
11.1	End of Borehole						80							

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 24

43

W P 470-711-611 LOCATION Co-ordinates N 4,856,476; E 341,890 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 27, 1983 CHECKED BY JRB

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT	NUMBER	TYPE	VALUES		20	40	60	80	100		
93.4	Ground Surface												
0.0	Fill - sand and gravel												
0.3	Sandy silt trace to some gravel occasional cobbles and sandy seams		1	SS	18								
	Compact to Very Dense		2	SS	79								
			3	SS	114								
	Brown becoming Grey at elev. 89.7 m		4	SS	75/ 125 mm								
			5	SS	88								
			6	SS	100/ 150 mm								
			7	SS	50/ 75 mm								
			8	SS	60/ 100 mm								
84.0			9A B	SS	60								
9.6	End of Borehole												
	Silty clay trace to some gravel and sand												
	Hard Dark Grey												

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 101

METRIC 44

W P 470-711-611 LOCATION Co-ords. N 4 856 327; E 341 541
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger
DATUM Geodetic DATE 84 02 21
ORIGINATED BY DT
COMPILED BY DT
CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
90.0	Ground Surface												
0.0	Sandy Silt trace gravel trace clay - brown grey Loose to Very Dense		1	SS	8								
			2	SS	15								
			3	SS	44								6 39 48 7
			4	SS	109								
			5	SS	51								
			6	SS	100/175 mm								14 3e 41 c
84.5													
5.5	Silty Clay trace gravel Hard grey with shale fragments		7	SS	153								
			8	SS	100/125 mm								
80.4													
9.6	End of Borehole		9	SS	118								

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No 102

METRIC

45

W P 470-711-611 LOCATION Co-ords. N 4 856 359; E 341 534
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger
DATUM Geodetic DATE 84 02 21

ORIGINATED BY DT
COMPILED BY DT
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40	60	80	100					
91.8	Ground Surface																GR SA SI CL
0.0	Silty Sand to Sandy Silt trace gravel trace clay	Brown Grey	1	SS	19												6 49 40 5
			2	SS	30												6 34 55 5
			3	SS	100/	100 mm											9 40 45 6
			4	SS	77												3 40 50 7
			5	SS	65												
			6	SS	91												
	Compact to Very Dense		7	SS	100/	100 mm											
84.8																	
7.0	Silty Clay trace gravel		8	SS	101												
	Hard grey with shale fragments		9	SS	103/	150 mm											
80.7																	
			10	SS	144/	275 mm											
11.1	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 103

METRIC

46

W P 470-711-611

LOCATION

Co-ords. N 4 856 376; E 341 596

Sta. 14 + 287.7; O/S 36.4 m LT & GO-ALRT

ORIGINATED BY DT

DIST 6

HWY GO-ALRT

BOREHOLE TYPE

Hollow Stem Auger

COMPILED BY DT

DATUM Geodetic

DATE

84 02 21 - 22

CHECKED BY *GP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	Wp	W	WL			WATER CONTENT (%)
92.9	Ground Surface													
0.0	Silty Sand to Sandy Silt trace gravel trace clay Compact to Very Dense	Brown Grey	1	SS	36									
			2	SS	43									
			3	SS	43									
			4	SS	42									
			5	SS	40									
			6	SS	40									
			7	SS	16									
			8	SS	32									
			9	SS	47									
			10	SS	151									
80.3			11	SS	190/225 mm									
12.6	End of Borehole													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 104

METRIC

47

W P 470-711-611

LOCATION

Co-ords. N 4 856 439; E 341 815
Sta. 14 + 515.2; O/S 28.7 m LT & GO-ALRT

ORIGINATED BY DT

DIST 6 HWY GO-ALRT

BOREHOLE TYPE Hollow Stem Auger

COMPILED BY DT

DATUM Geodetic

DATE 84 02 22

CHECKED BY *JP*

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					
91.9	Ground Surface															
0.0																
	Silty Clay		1	SS	12											
	trace sand		2	SS	18											
			3	SS	11											
	Brown															
	Grey															
	Firm to		4	SS	5											
	Very Stiff		5	TW	PH											
86.1																
5.8	Sand, some silt		6	SS	33											
	some clay Grey															
84.6	Dense															
7.3			7	SS	69											
	Silty Clay															
	some sand															
	Hard with shale		8	SS	161	250 mm										
	fragments															
			9	SS	100	125 mm										
	Weathered Shale															
	End of Borehole															

+³, x⁵: Numbers refer to 20
Sensitivity 15-20.5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 105

METRIC

48

W P 470-711-611

LOCATION

Co-ords. N 4 856 454; E 341 868

Sta. 14 + 570.0; O/S 26.4 m LT & GO-ALRT

ORIGINATED BY DT

DIST 6

HWY GO-ALRT

BOREHOLE TYPE

Hollow Stem Auger

COMPILED BY DT

DATUM

Geodetic

DATE

84 02 23

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
92.6	Ground Surface													
0.0														
	brown		1	SS	10									
	Sandy Silt compact		2	SS	84									
	trace clay		3	SS	84									
	trace gravel		4	SS	100/	275 mm								
	Very Dense		5	SS	107/	100 mm								
	Grey		6	SS	110/	125 mm								
87.4														
5.2	Silty Clay		7	SS	105/	125 mm								
	trace sand													
	trace gravel													
	Grey													
	Hard		8	SS	100/	150 mm								
84.8														
7.8	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLOSION

RECORD OF BOREHOLE No 107

METRIC

49

W P 470-711-611 LOCATION Co-ords. N 4 856 468; E 341 951 ORIGINATED BY DT
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 02 24 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
94.2	Ground Surface																
0.0	Fill - Silty Clay with sand, trace gravel Brown Very Stiff		1	SS	20		94										
92.7			2	SS	51												
1.5	Sandy Silt to Silty Sand trace clay trace gravel Very Dense		3	SS	110/75 mm		92										
			4	SS	105/150 mm												
			5	SS	170/250 mm		90										
			6	SS	120/150 mm												
			7	SS	103/150 mm		88										
87.2																	
7.0	Silty Clay grey																
86.1	trace gravel Hard		8	SS	158												
8.1	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 108

METRIC 50

W P 470-711-611 LOCATION Co-ords. N 4 856 482; E 341 991
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY DT
DATUM Geodetic DATE 84 02 24 COMPILED BY DT
CHECKED BY *EP*

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					
95.8	Ground Surface													GR SA SI CL
0.0	Fill - Silty Clay with sand trace gravel Firm	Brown	1	SS	6									
94.3			2	SS	43									
1.5	Silty Sand to Sandy Silt trace to some gravel trace clay Dense to Very Dense	Brown Grey	3	SS	93									3 59 36 2
			4	SS	59									
			5	SS	177/	250 mm								18 39 38 5
			6	SS	110/	150 mm								
			7	SS	100/	75 mm								
88.8														
7.0	Silty Clay													
87.9	with sand Hard		8	SS	100/	125 mm								
7.9	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 106

METRIC

51

W P 470-711-611

LOCATION

Co-ords. N 4 856 472; E 341 925

Sta. 14 + 623.8 O/S 23.1 m LT & GO-ALRT

ORIGINATED BY DT

DIST 6 HWY GO-ALRT

BOREHOLE TYPE

Hollow Stem Auger

COMPILED BY DT

DATUM Geodetic

DATE

84 02 23

CHECKED BY *AP*

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					
93.3	Ground Surface																
0.0	Fill																
	Silty Clay, with sand, trace gravel		1	SS	7												
91.8	Firm																
1.5	Sandy Silt		2	SS	165/275 mm												
	trace gravel		3	SS	110/150 mm												
	trace clay		4	SS	83												
			5	SS	122												
			6	SS	166												
	Very Dense		7	SS	100/50 mm												
			8	SS	100/25 mm												
84.5																	
8.8	Silty Clay																
83.7	trace gravel		9	SS	107												
9.6	End of Borehole																

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

for

Drainage Structure No. 13,

GO-ALRT and Miller Creek

INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out between 83 11 03 and 83 11 08. During this period, a total of 5 sampled boreholes were advanced for depths ranging from 4.6 to 7.1 m. Bedrock was cored in 2 boreholes, and in order to determine the groundwater level, 3 piezometers were installed.

REGIONAL GEOLOGY

The site is located in the physiographic region known as the Iroquios plain, an area whose geomorphology was influenced by Lake Iroquois during the last glaciation. The overburden in the area generally consists of glacial till with discontinuous surficial deposits of glaciolacustrine silts and clays. These lacustrine sediments were deposited in the glacial Lake Iroquois which occupied the Lake Ontario basin at the end of the last ice age. The underlying glacial till consists of a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses. The bedrock is a thinly bedded grey to black calcareous, bituminous, micaceous shale of the Whitby formation.

It should be noted that the stratigraphic boundaries indicated are not intended to define exact planes of geological change but represent transitions from one soil type to another. Subsurface conditions are only established at the borehole locations, and will vary between boreholes.

SITE DESCRIPTION

The site is located north and south of Hwy. 401 at the crossing of Miller Creek. North of Hwy. 401 the creek banks range in height from 1 to 6 m at slopes of up to 40°. The creek is directed under the highway embankment through a 6.1 by 2.4 m concrete culvert and a 4.3 m diameter steel culvert. South of the highway the creek banks over the bottom 3 to 4 m are faced with rip-rap and formed at slopes of 15 to 20°. The creek is directed under a CNR embankment located about 55 m south of the highway, by three steel culverts (diameters 1.5, 3.4 and 4.3 m). A 1.2 m diameter sanitary sewer crosses beneath the existing creek bed about 35 m south of the highway.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The detailed soil stratigraphy encountered in each boring, together with the results of laboratory tests carried out on representative samples, are given on the Record of Borehole Sheets and on Fig. 1 to 3 inclusive. The borehole locations, and inferred profile and a section are shown on Drawing No. S-064.

A silty sand fill was located in places, especially on the west bank south of the highway in BH A5. The native soil consisted of a silty clay till and was found immediately below ground surface or underlying the fill, where present. The till is underlain by shale bedrock at relatively shallow depths.

The following is a detailed description of the subsoils encountered:

Fill and Topsoil

In BH A1 located on the east bank of Miller Creek north of Hwy. 401, a 2.3 m thick layer of dark brown silty sand and gravel fill was encountered immediately below ground surface. The fill has a loose to compact relative density as indicated by 'N'* values of 7 and 14. The water content of a sample of the material was 20%.

In BH A2 and A5, 0.6 and 4.6 m, respectively, of silty sand fill was found below ground surface. The material is dark brown and contains traces of clay and gravel. Occasional pieces of decayed wood and organic matter was found in the deposit. The material has a loose to compact relative density as indicated by 'N' values of 7 to 13.

The water content of samples of the silty sand fill ranged from 11 to 19%. The grain size distribution curves of samples of the fill from BH A1 and A5 are shown on Fig. 1.

A 0.7 m thick layer of organic topsoil was found underlying the silty sand fill.

*'N' values - Refer to Explanation of Terms

Silty Clay Till

Below the ground surface in BH A3 and A4 is a grey and brown mottled, changing to grey with depth, silty clay deposit. The material also contains some sand and traces of gravel, and is inferred to be a till. The thickness of the deposit was found to be 1.1 and 3.4 m in BH A4 and A3 respectively. Atterberg limit tests give liquid limits of 18 and 22% and plasticity indices of 6 and 9%, indicating a clay of low plasticity (CL) according to the Unified Soil Classification System (Fig. 3). The consistency of the deposit ranges from stiff ('N' values of 9 to 20) to hard ('N' values in excess of 70) near the bottom of the stratum. Water contents of typical samples ranged from 8 to 12%. Typical grain size distribution curves are shown on Fig. 2.

Bedrock

Shale bedrock was encountered in all boreholes at elevations between 80.1 and 81.3 m. The boreholes were extended at least 1.4 m into the bedrock by augering, while in BH A2 and A4 the rock was cored in BX size for depths of 3.2 and 4.0 m respectively.

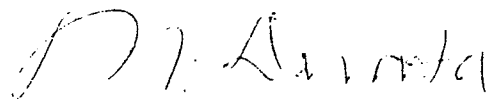
The shale bedrock is dark grey in colour, and is generally thinly bedded with occasional thin clay seams. The RQD* in the completely to highly weathered zone above approximate elevation 78 m is very poor, while in the underlying moderately to faintly weathered zone the RQD was noted to be poor to fair.

GROUNDWATER CONDITIONS

Groundwater was encountered in all boreholes during the drilling operation. Piezometers were sealed within the various strata encountered in BH A1, A3 and A4. The water levels were monitored throughout the drilling operation and periodically until 83 11 30. The stabilized groundwater level across the site ranges from elevation 82.0 m in BH A4, to elevation 82.4 m in BH A1.



B. E. Ruck
Project Foundations Engineer



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

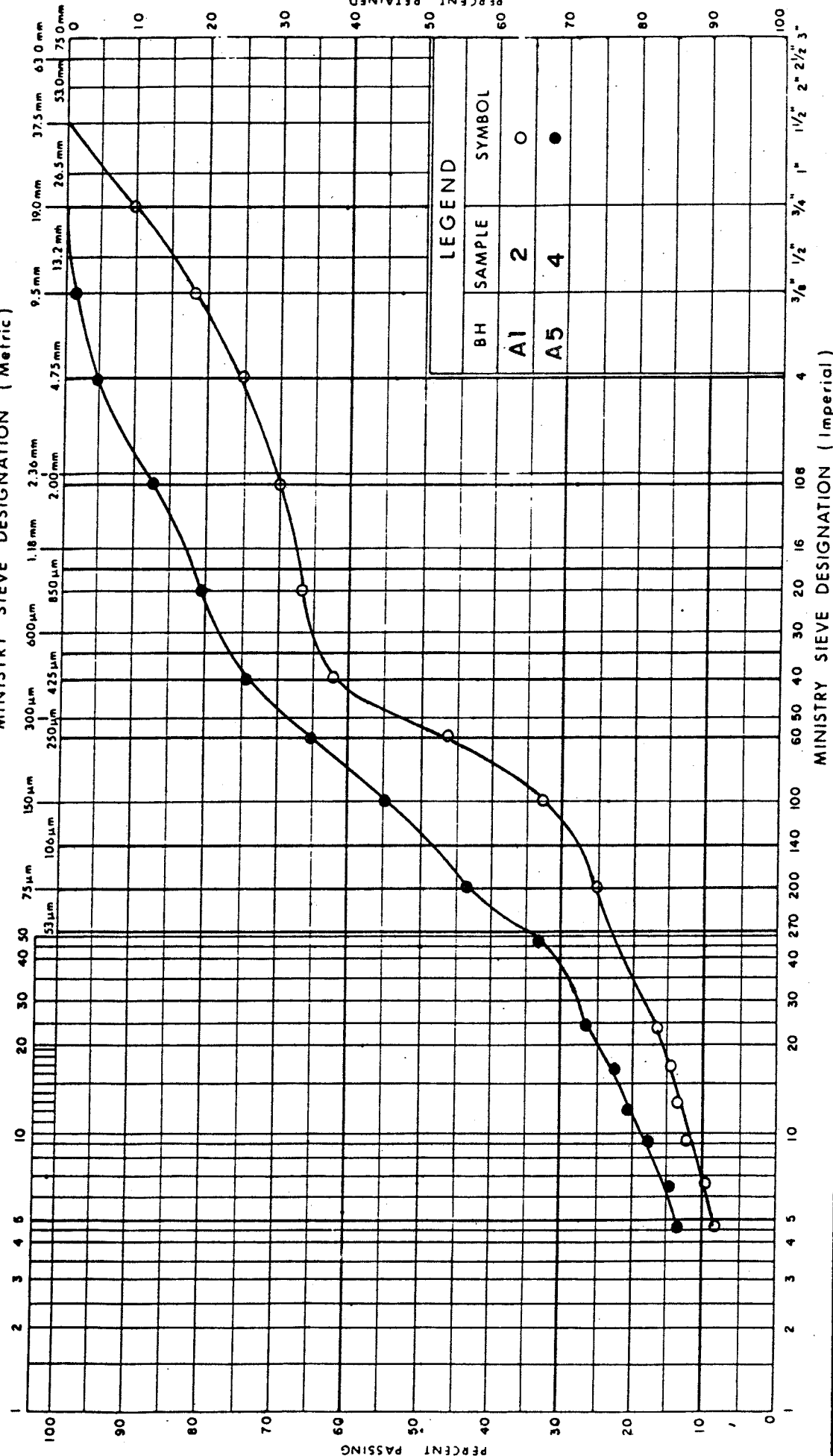
*RQD - Rock Quality Designation - Refer to Explanation of Terms

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse
MINISTRY SIEVE DESIGNATION (Metric)						

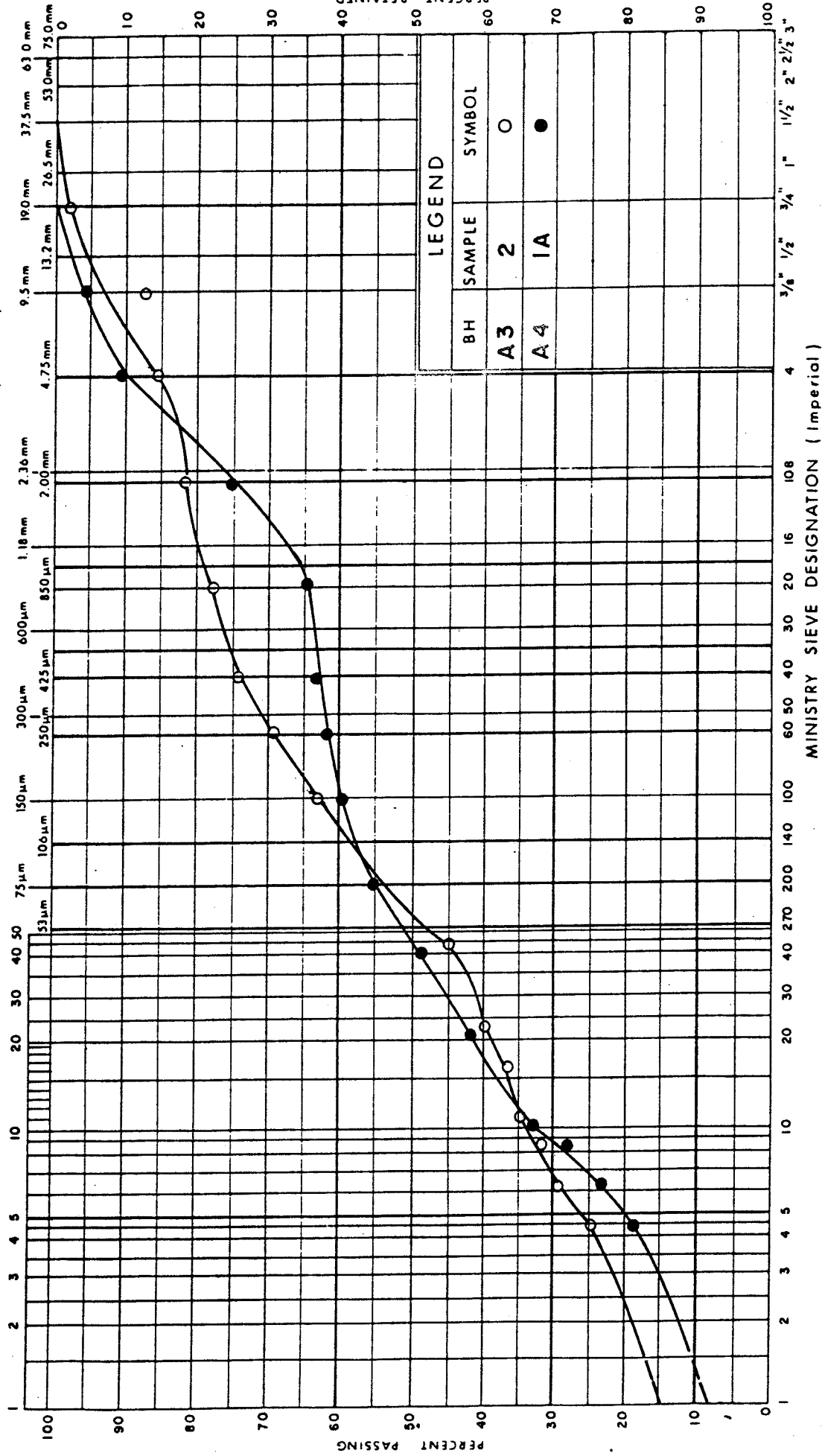
GRAIN SIZE IN MICROMETERS



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse
MINISTRY SIEVE DESIGNATION (Metric)						

GRAIN SIZE IN MICROMETERS

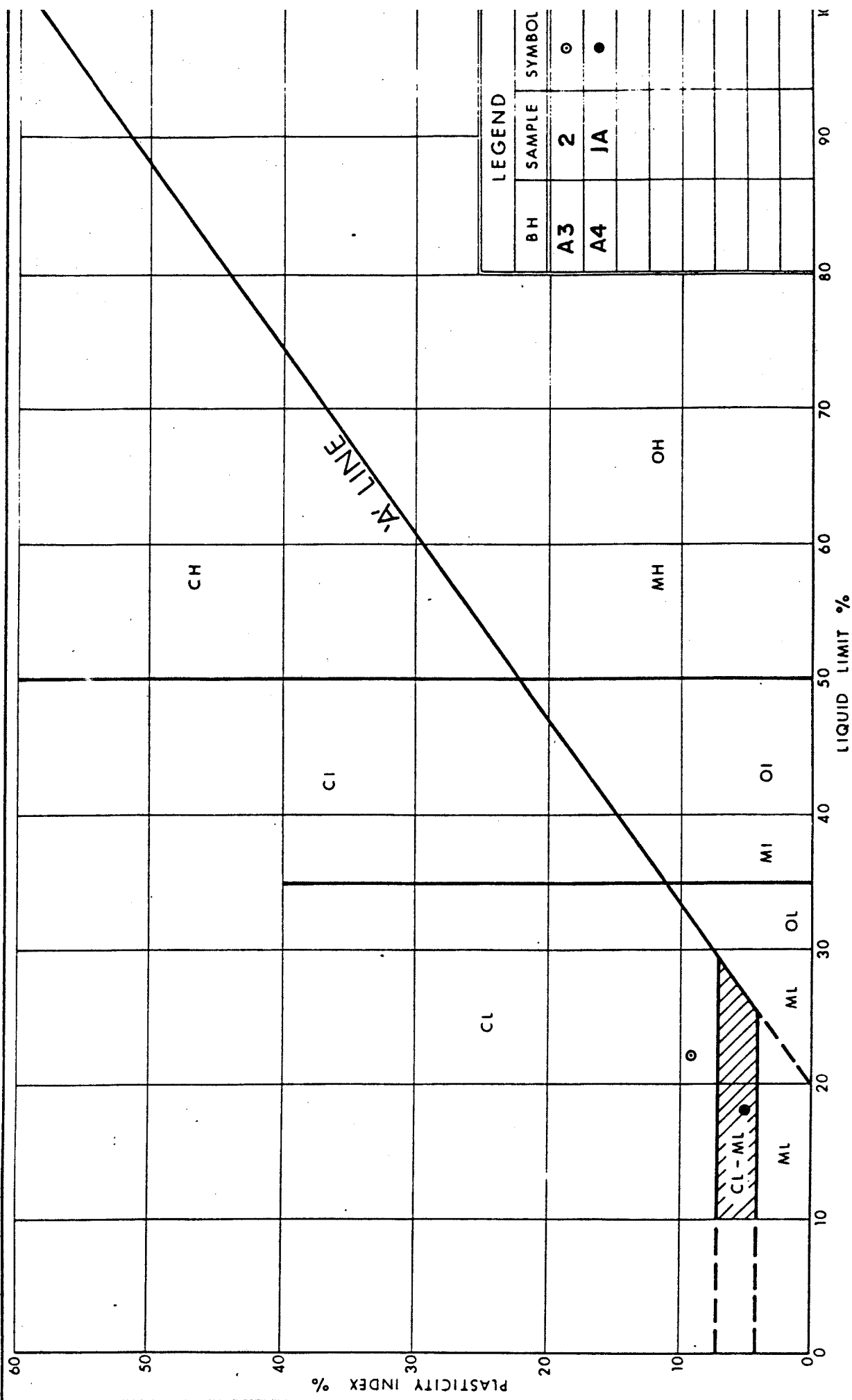


Ministry of
Transportation and
Communications



GRAIN SIZE DISTRIBUTION
SILTY CLAY SOME SAND (TILL)
(SITE 'A')

FIG No 2
W P EGG -000 - 40



LEGEND		
BH	SAMPLE	SYMBOL
A3	2	○
A4	1A	●

PLASTICITY CHART
SILTY CLAY, SOME SAND (TILL)
(SITE 'A')

FIG No 3

W P EGG-000-40

RECORD OF BOREHOLE No A1

METRIC

59

W P EGG-000-40 LOCATION Co-ordinates N 4,856,403; E 341,376 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY RWR
 DATUM Geodetic DATE November 3, 1983 CHECKED BY PC

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					
83.0	GROUND SURFACE															
0.0	Fill-Silty sand and gravel, occasional organics		1	SS	7											
80.7	Loose to compact Dark brown		2	SS	14											
2.3	Shale Bedrock, completely to highly weathered, thinly bedded		3	SS	83											
			4	SS	87											
78.4	Dark grey		5	SS	100											
4.6	END OF BOREHOLE															

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. A 2

METRIC 60

W P EGG-000-40 LOCATION Co-ordinates N 4,856,395; E 341,366 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BQ Rock Core COMPILED BY RWR
 DATUM Geodetic DATE November 3, 1983 CHECKED BY PC

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					
81.9	GROUND SURFACE													
0.0	Silty sand													
81.3	Dark brown													
0.6	Shale Bedrock, completely to highly weathered, thinly bedded.		1	SS	40									
			2	SS	111									
78.8			2	SS	100									
3.1	Faintly weathered, poor to fair RQD, occasional thin clay seams, thinly bedded.		4	BQ RC	REC 93%									
			5	BQ RC	REC 91%									
75.6	Dark grey													
6.3	END OF BOREHOLE													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No. A3

METRIC

61

W P EGG-000-40 LOCATION Co-ordinates N 4,856,286; E 341,399 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY RWR
 DATUM Geodetic DATE November 7, 1983 CHECKED BY PC

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	20					
83.5	GROUND SURFACE												
0.0	Till-Silty clay, some sand, trace to some gravel		1	SS	10								
	Grey and brown mottled		2	SS	20								
	Stiff to hard		3	SS	9								
80.1	Grey		4	SS	112								
3.4	Shale Bedrock, highly weathered, thinly bedded.		5	SS	100/75mm								
78.7	Dark grey												
4.8	END OF BOREHOLE												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity
 20
 15
 10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No.A4

METRIC

62

W P EGG-000-40 LOCATION Co-ordinates N 4,856,301; E 341,384 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger, BQ Rock Core COMPILED BY RWR
 DATUM Geodetic DATE November 7, 1983 CHECKED BY PC

SOIL PROFILE			SAMPLES			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					
81.5	GROUND SURFACE																
0.0	Till-Silty clay, some sand, trace gravel																
80.4	Hard Grey		1	SS	71											10 35 35 20	
1.1	Shale Bedrock, highly to moderately weathered, thin bedded, occasional thin clay seams		2	SS	100 / 75mm												
	Very poor RQD		3	BQ RC	REC 80%												
	Poor RQD		4	BQ RC	REC 94%												
			5	BQ RC	REC 98%												
74.4	Dark grey																
7.1	END OF BOREHOLE																
<p>* Note: Water from top of piezometer tube at 0.5m above ground level (elev. 82.0m) on Nov.30, 1983.</p>																	

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No. A 5

METRIC

63

W P EGG-000-40 LOCATION Co-ordinates N 4,856,279; E 341,372 ORIGINATED BY KES
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY RWR
 DATUM Geodetic DATE November 8, 1983 CHECKED BY PC

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					
85.8	GROUND SURFACE																
0.0	Fill-Silty sand, some clay, trace of gravel and organics, occasional pieces of wood.		1	SS	10		84										
			2	SS	9												
			3	SS	11												
			4	SS	7												
81.2	Loose to compact Dark brown		5	SS	13		82										
4.6	Topsoil		6	SS	8												
80.5			7	SS	100/75mm												
5.3	Shale Bedrock, highly weathered, thinly bed- ded.		8	SS	100/75mm		80										
78.9	Dark grey																
6.9	END OF BOREHOLE						78										

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT
for
Pedestrian Tunnels, Westney Rd. Station

INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out between 83 11 04 and 83 11 10. During this period a total of five sampled boreholes were advanced ranging in depth from 4.8 m to 8.0 m. Two piezometers were installed so that groundwater levels could be monitored.

REGIONAL GEOLOGY

The site is located in the physiographic region known as the Iroquois plain, an area whose geomorphology was influenced by Lake Iroquois during the last glaciation. The overburden in the area generally consists of glacial till with discontinuous surficial deposits of glaciolacustrine silts and clays. These lacustrine sediments were deposited in the glacial Lake Iroquois which occupied the Lake Ontario basin at the end of the last ice age. The underlying glacial till consists of a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses. The bedrock is a thinly bedded grey to black calcareous, bituminous, micaceous shale of the Whitby formation.

It should be noted that the stratigraphic boundaries indicated are not intended to define exact planes of geological change but represent transitions from one soil type to another. Subsurface conditions are only established at the borehole locations, and will vary between boreholes.

SITE DESCRIPTION

The site is located south of Hwy. 401 and about 200 m west of the proposed Westney Road Extension (refer to Drawing No. AA842-310.3-2.7. Two CNR main lines, a service track and a siding traverse the site in an east-west direction. The ground between the highway and the tracks is plateau-like, with gentle slopes leading to lower ground to the north, east and west. A 6 to 7 m high knoll is located south of the tracks, with a north-facing cut slope formed at about 35°.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The detailed soil stratigraphy encountered in each borehole together with results of laboratory tests carried out on representative samples, are given on the Record of Borehole Sheets and on Fig. 1 to 4 inclusive. The borehole locations, a centreline profile and two sections are shown on Drawing No. AA842-310.3-2.7.

The natural deposit at the site is a very dense sandy silt till which is overlain by a silty clay deposit at the locations of BH E4 and E5. Fill of variable composition was found overlying the natural deposits in BH E2, E3 and E5.

Fill

A greyish brown silty clay fill was encountered below the ground surface in BH E3. The fill is 2.7m thick at this location and contains some sand and traces of gravel.

The consistency of the material is inferred to be very stiff to hard as 'N' values obtained range from 21 to over 100. Atterberg Limits testing (Fig. 4) have established that the material is a clay of low plasticity (CL).

The water content of the fill was 11%. A grain size distribution curve for the material is shown on Fig. 1.

A brown silty sand fill with traces of clay and organic matter, was encountered in BH E-5. The layer is 1.4 m thick and has a loose relative density as indicated by an 'N' value of 9.

A 1.1 m thick layer of loose coal pieces was encountered at the surface in BH E2.

Silty Clay

A greyish brown silty clay deposit was encountered below 0.2 m of topsoil in BH E4 and underlying the silty sand fill in BH E5. The thickness of this deposit is 2 m in both boreholes, and it can be inferred to have a soft to hard consistency as 'N' values obtained in the deposit range from 3 to 52. Atterberg Limits testing have been established that the material is a clay of low plasticity (CL).

The water content of the deposit varies from 14% in the lower, hard portion to 30% near the ground surface. The grain size distribution curve of a sample from BH E4 is shown on Fig. 2.

Sandy Silt Till

A greyish brown sandy silt till deposit was encountered in all boreholes. The till was found under 0.1 m of topsoil in BH E1, under the fill in BH E2 and E3, and under the silty clay in BH E4 and E5. The deposit was found to extend to the maximum depth investigated. The material contains varying amounts of clay and gravel, with occasional interlayered sand and silt seams. In general, the deposit can be inferred to have a dense to very dense relative density, as indicated by 'N' values in excess of 50. Near the top of the stratum in BH E3 and E4 the till has a loose to compact relative density with 'N' values of 4 to 23.

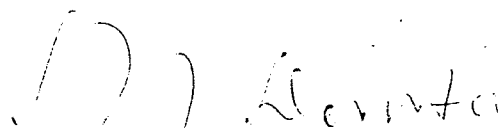
Water contents of samples of the till ranged from 8 to 10%, and were generally about 15%. The grain size distribution curves of typical till samples are shown on Fig. 3.

GROUNDWATER CONDITIONS

Two piezometers sealed into the till deposit at BH E2 and E4 indicate water levels at elevations 90.8 and 90.4 m, respectively. A water table may be perched in the fill above the silty clay stratum at the location of the proposed east tunnel (at BH E4 and E5).

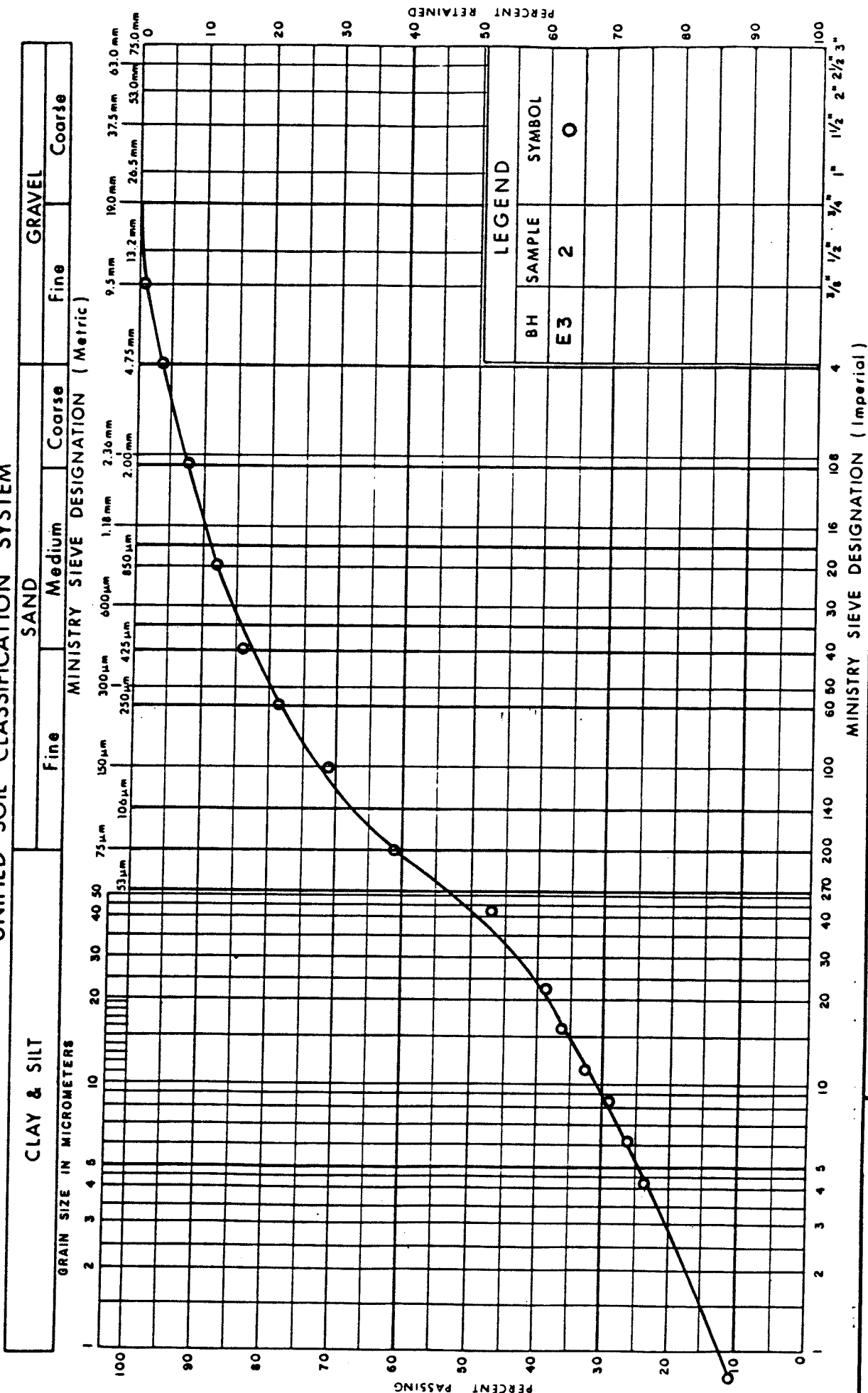


B. E. Ruck
Project Foundations Engineer



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

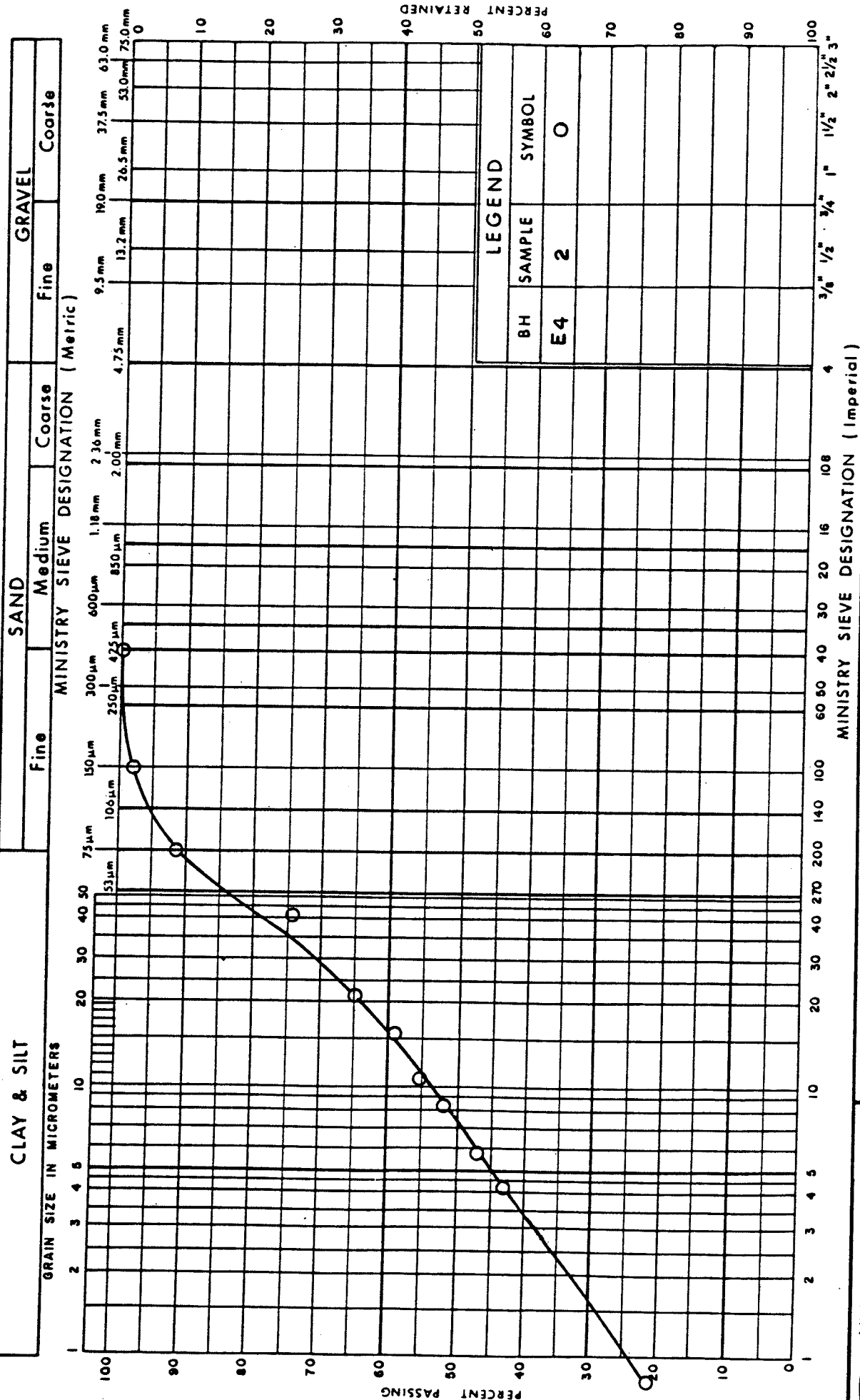
APPENDIX

Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY (FILL)
(SITE 'E')

FIG No. 1

W P EGG - 000 - 40

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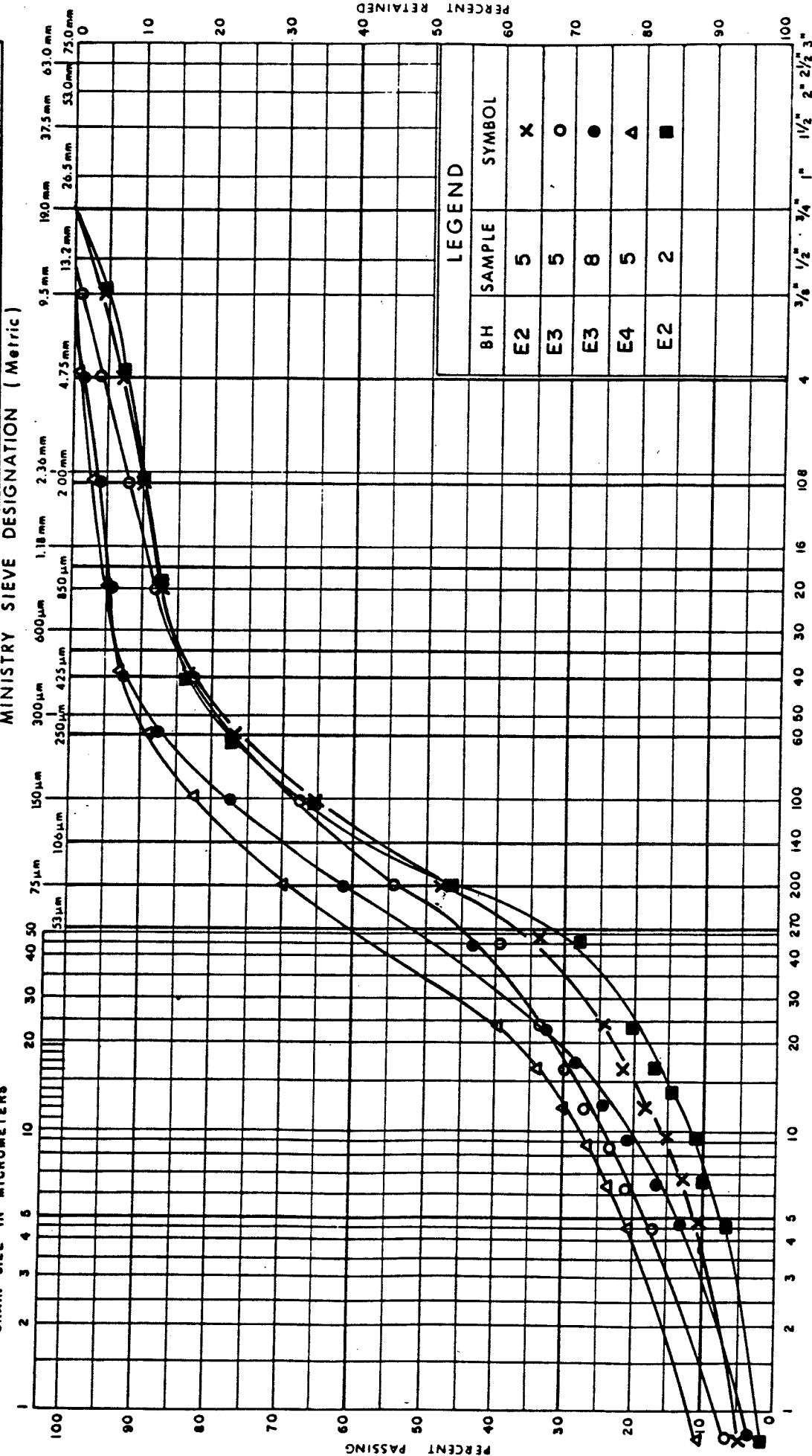
GRAIN SIZE DISTRIBUTION
SILTY CLAY
(SITE 'F')

FIG No - 2

W P EGG - 000-40

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT			SAND			GRAVEL		
GRAIN SIZE IN MICROMETERS			Fine	Medium	Coarse	Fine	Coarse	
MINISTRY SIEVE DESIGNATION (Metric)			MINISTRY SIEVE DESIGNATION (Imperial)					



Ministry of
Transportation and
Communications

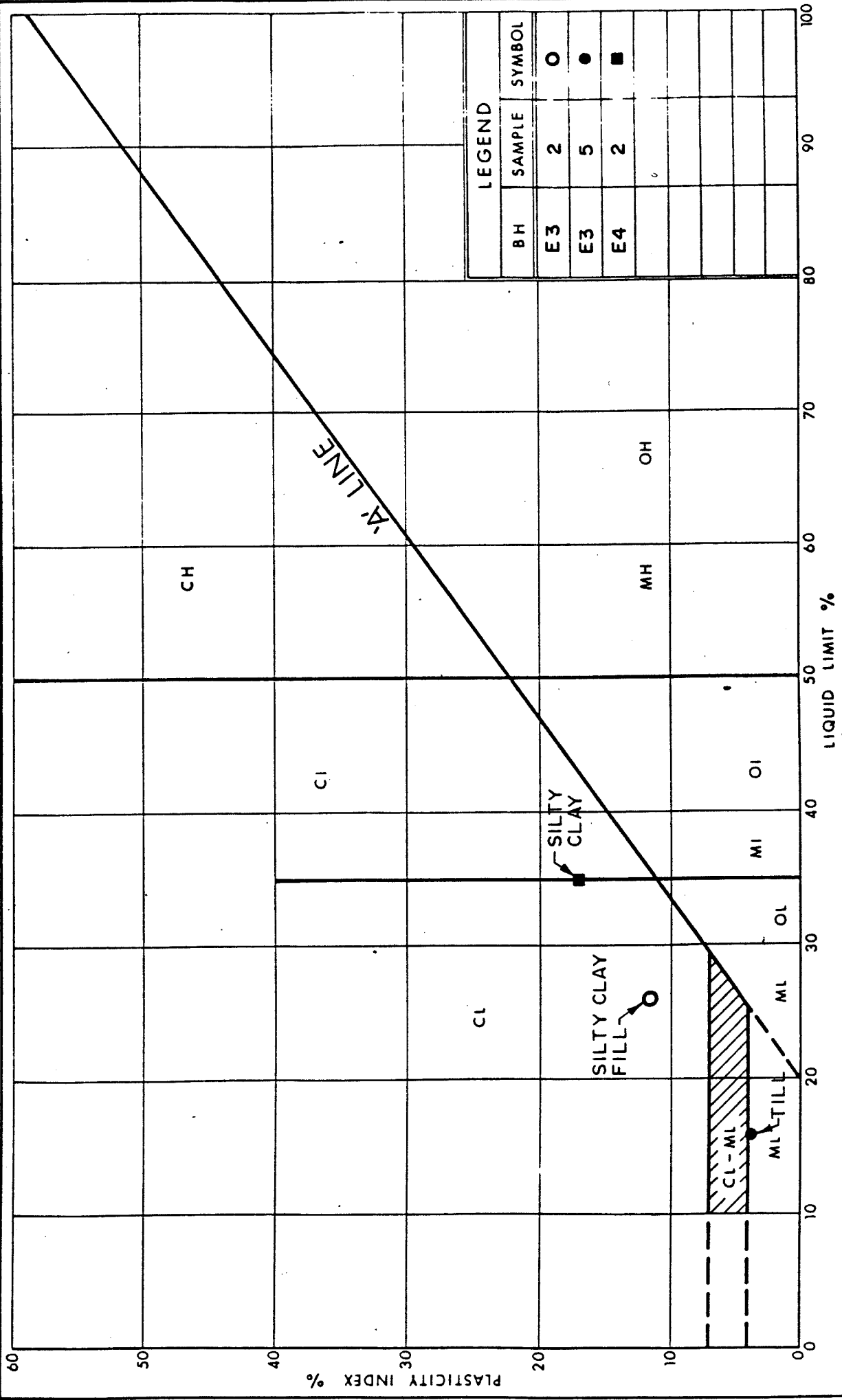


GRAIN SIZE DISTRIBUTION SANDY SILT (TILL)

FIG No - 3

W P EGG-000-40

70



METRIC 72

W P EGG-000-40 LOCATION Co-ordinates N 4,856,335; E 341,559 ORIGINATED BY PC
DIST 6 HWY GQ-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE November 4, 1983 CHECKED BY PC

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						
93.1	GROUND SURFACE															
0.1	Topsoil		1	SS	59	*	92									
	Till - Sandy silt, some clay and gravel occa- sional silt partings.		2	SS	84											
			3	SS	70		90									
			4	SS	100/250mm											
88.3	Very dense Greyish brown															
4.8	END OF BOREHOLE						88									
☆ <u>Note:</u> Open hole dry on Nov. 4, 1933.																

+3, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No.E2

METRIC

73

W P EGG-000-40 LOCATION Co-ordinates N 4,856,323; E 341,565 ORIGINATED BY PC
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM Geodetic DATE November 4, 1983 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
93.8	GROUND SURFACE													
0.0	Fill-Pieces of coal													
92.7	Loose Black		1	SS	6		92							7 47 38 8
1.1			2	SS	40									
	Greyish brown		3	SS	79		elev. 90.8m Nov. 30, 1983							
	Till-Sandy silt, some clay, trace gravel.		4	SS	100/100mm		90							
			5	SS	100/180mm		88							7 47 34 12
86.2	Very dense Grey		6	SS	50/25mm		86							
7.6	END OF BOREHOLE													

+³, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No.E3

METRIC 74

W P EGG-000-40 LOCATION Co-ordinates N 4,856,294; E 341,567 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE November 10, 1983 CHECKED BY PC

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					
93.8	GROUND SURFACE																
0.0	Fill-Silty clay, some sand, trace gravel, occasional rootlets.		1	SS	100/25mm												
			2	SS	22		92										4 35 36 25
91.1	Very stiff		3	SS	21												
2.7	Till - Sandy silt, some clay, trace gravel, increasing silt content with depth, occasional sand partings.		4	SS	4												
			5	SS	17		90										4 41 36 19
			6	SS	58												
			7	SS	54												
			8	SS	85		88										
	Loose to very dense																
85.8			9	SS	73		86										2 37 47 14
8.0	END OF BOREHOLE																
							84										

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No.E4

METRIC 75

W P EGG-000-40 LOCATION Co-ordinates N 4,856,345; E 341,639 ORIGINATED BY PC
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE November 4, 1983 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
92.8	GROUND SURFACE												
0.2	Topsoil												
	Silty clay, trace to some sand, occasional sand partings. Greyish Soft to stiff brown		1	SS	3		92						0 10 45 45
90.7			2	SS	11								
2.1	Till - Sandy silt, some clay, occasional inter- layered fine and coarse sand seams.		3	SS	23								
			4	SS	32								
			5	SS	70								
			6	SS	60								
86.3	Compact to very dense Grey		7	SS	100								2 27 49 22
6.5	END OF BOREHOLE						86						

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No.E5

METRIC

76

W P EGG-000-40 LOCATION Co-ordinates N 4,856,319; E 341,653 ORIGINATED BY KES
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE November 10, 1983 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
93.7	GROUND SURFACE										
0.0	Fill-Silty sand, trace of clay and organics		1	SS	9						
92.3	Loose Brown		2	SS	27						
1.4	Silty clay, trace to some sand.		3	SS	49						
90.3	Very stiff Greyish to hard brown		4	SS	52						
3.4	Till - Sandy silt, some clay, occasional silt partings.		5	SS	71						
87.2	Dense to very dense Greyish brown		6	SS	47						
6.5	END OF BOREHOLE										

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

OFFICE REPORT ON SOIL EXPLORATION

For
Storm Sewer at Westney Road/GO-ALRT Crossing
Extension to GO-ALRT Station 14+155, and Diversion
Structure at Station 0+745 to 0+780

INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out between 83 07 19 to 83 07 29 and 84 05 29 to 84 05 31. During this period a total of 11 sampled boreholes were put down to depths of up to 17.8 m. Bedrock was cored in one borehole, and in order to monitor groundwater conditions, a total of seven piezometers were installed.

An additional eleven borehole logs and nine figures are presented in Appendix 1 for subsurface information only. These additional boreholes were advanced during the period between 84 03 08 to 84 03 13 on an alignment approximately 30 m north of the subject storm sewer.

REGIONAL GEOLOGY

The sites are located in the physiographic region known as the Iroquois Plain¹ which resulted from inundation by Lake Iroquois during the last glaciation. The general area is underlain by glacial drift with thin surficial glaciolacustrine deposits of the Pleistocene Era underlain by glacial till and shale bedrock. The glacial drift is described by Caley² as a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses.

SITE DESCRIPTION

The site is located south of the CN Rail tracks between approximately Miller Creek to the west and the proposed Westney Rd. extension to the east; GO-ALRT Sta. 14+155 to 14+450, respectively. At the Westney Rd. extension the site extends to the north of the CN Rail tracks.

¹ Chapman, L.J. and Putnam, D. F. "The Physiography of Southern Ontario". University of Toronto Press, Toronto, Ontario, 1966.

² Caley J.F. Clark, T.H. and Owen, E.B. "Groundwater Resources of Pickering Township, Ontario County", Ontario Dept. of Mines and Tech. Surveys, Water Supply Paper 285, 1947.

The topography at the site is level to sloping down to the west towards Miller Creek. A ridge, some 7 m high is located between about 100 and 190 m west along the proposed sewer alignment of the Westney Rd. extension. A swampy depression is located immediately to the north of the sewer alignment at about GO-ALRT Sta. 14+350 to 14+375.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The detailed stratigraphy encountered in each of the boreholes put down during this investigation together with the results of the laboratory testing carried out on representative samples are given on the Record of Borehole sheets and on Fig. 1 to 5 and C1 to C3, inclusive. The locations of the boreholes with inferred profile and stratigraphic sections are shown on Drawing Nos. S-068 and S-069. It should be noted that the stratigraphic boundaries indicated on the Record of Borehole sheets and on the stratigraphic sections are inferred from non-continuous sampling and represent a transition between soil types rather than an exact plane of geologic change. Conditions will vary between boreholes.

In general, the site is underlain by silty clay which in turn is underlain by a heterogeneous deposit consisting mainly of silty sand to silt. Two zones of a softer deposit consisting of silty clay with sand and gravel were encountered directly under the silty clay. Shale bedrock was encountered at varying elevations across the site. The following is a detailed description of the sub-soils encountered:

Fill and Topsoil

In BH 203, 1.4 m of fill consisting of silty sand and a trace of gravel was encountered. The fill is generally in a loose state of packing with one measured 'N'* value of 8 blows/0.3 m. The fill is underlain by 0.4 m of organic sandy silt. In BH 201, 202, 206 and 301 up to 1.1 m of topsoil was encountered.

* 'N' Values - Standard Penetration Resistance
Refer to Explanation of Terms Used in Report

Silty Clay

In all boreholes, except numbers 204 and 301, 1.1. to 2.0 m of silty clay was encountered at ground surface or underlying the topsoil and/or fill. The clay was generally brown in colour and at some locations was varved with alternating brown and grey seams. Insitu vane tests carried out within this deposit in BH 202 indicated an undrained shear strength (C_u) value of 65 kPa indicating a stiff consistency. The water content of samples of the clay ranged from 13 to 27%. A liquid limit and plasticity index of 46 and 22%, respectively, indicate the material to be a clay of intermediate plasticity (see Fig. 1). In BH 204, a layer of silty clay was encountered at about elevation 88 to 89 m with similar gradation (Fig. 2) as the varved silty clay encountered at ground surface elsewhere. This clay has a hard consistency with one 'N' value of greater than 100 blows/0.3 m.

Silty Clay With Sand

Underlying the silty clay in BH 202, 203, and 206 and underlying the topsoil in BH 301 about 1.1 to 4.1 m of silty clay with sand and gravel was encountered. Grain size distribution curves for samples of this deposit are shown on Fig. 3 and C1. Insitu vane tests indicated a soft to stiff consistency with C_u values ranging from 18 to 78 kPa. Based on 'N' values ranging from 3 to 14 blows/0.3 m, the deposit is considered to contain zones of a very stiff consistency. The sensitivity of the clay ranged from 1 to 4. The water content of samples of the silty clay ranged from 11 to 20%. Atterberg Limits tests gave liquid limits of 16 to 20% with corresponding plasticity indices of 4 to 9%, indicating the fines portion to be a clay to a silt of low plasticity (Fig. 4).

Alluvium

In BH 301, about 1.8 m of a deposit consisting of interlayered silty sand, sandy silt and sand and gravel was encountered below the silty clay deposit. It is considered that this material is a recent flood plain deposit/alluvium. The water content of a sample of the silty fine sand was 10%. The deposit is in a compact state of packing as indicated by 'N' values of 21 to 22 blows/0.3 m.

Silty Sand to Silt

In BH 201 to 205, a deposit ranging in composition from silty sand to silt with varying proportions of clay and gravel was encountered underlying the fill

or silty clay or at ground surface as in BH 204. Grain size distribution curves for samples of the deposit are shown on Fig. 5, C2, and C3. Some stratification was noted occasionally within samples. The materials are generally grey in colour with occasional brown zones where the deposit was encountered close to ground surface.

'N' values within the deposit were generally greater than 30 blows/0.3 m indicating a dense to very dense state of packing. A compact zone with an 'N' value of 18, was encountered directly underlying the silty clay in BH 203. The upper 1.5 m of the deposit in BH 204 has a compact relatively density as indicated by an 'N' value of 18 blows/0.3 m. The water content of samples of this deposit ranged from 3 to 19% with an average value of 11%.

Lower Silty Clays

In BH 201, 202, 204 and 205, about 0.9 to 3.1 m of dark brown silty clay with occasional gravel was encountered underlying the silty sand deposits. 'N' values were generally greater than 100 blows/0.3m indicating a hard consistency. The water contents of samples of this clay ranged from 15 to 20%. Atterberg Limits tests gave liquid limits of 42 to 53% with corresponding plasticity indices of 20 to 25%, indicating a clay of intermediate to high plasticity (Fig. 1).

In all boreholes, a deposit consisting of silty clay with numerous shale fragments was encountered. And all boreholes except numbers 205 and 301 were terminated in this deposit. 'N' values were generally much greater than 100 blows/0.3 m indicating a hard consistency. In BH 301, 'N' values of 29 to 33 blows/0.3 m were obtained in the upper 1 m of this deposit indicating a very stiff consistency. One water content of a sample of this clay was 9%.

Bedrock

Shale bedrock was encountered in BH 205 and 301. The bedrock was generally highly to moderately weathered and displayed a fissile texture. The elevation of the bedrock as determined by the previous investigations is variable across the site and ranges from elevation 77.0 to 81.5 m.

GROUNDWATER CONDITIONS

Groundwater was encountered in all boreholes during the drilling operations. Collapse of the borehole walls within the silty sand to silt deposit and caving to within 2 to 6 m of ground surface occurred in all boreholes except number 201. It is considered probable that the collapse was due to groundwater flow within the sandier zones of the deposit.

The water levels measured in the piezometers and standpipes installed during the investigations indicate a groundwater level at about elevation 91.3 to 91.9m between GO-ALRT sta. 14+250 and 14+450. To the west of sta. 14+250 where the ground surface slopes down towards Miller Creek, the groundwater level was about 0.2 m below ground surface elevation. The water levels in the piezometers in BH 203 and 204 were at a much lower elevation (83.1 to 88.1 m) at the time of measuring. It is anticipated that not enough time had elapsed to allow stabilization of the groundwater level. It is recommended that these readings are discounted and the water table is assumed to be at about elevation 91 m for design.

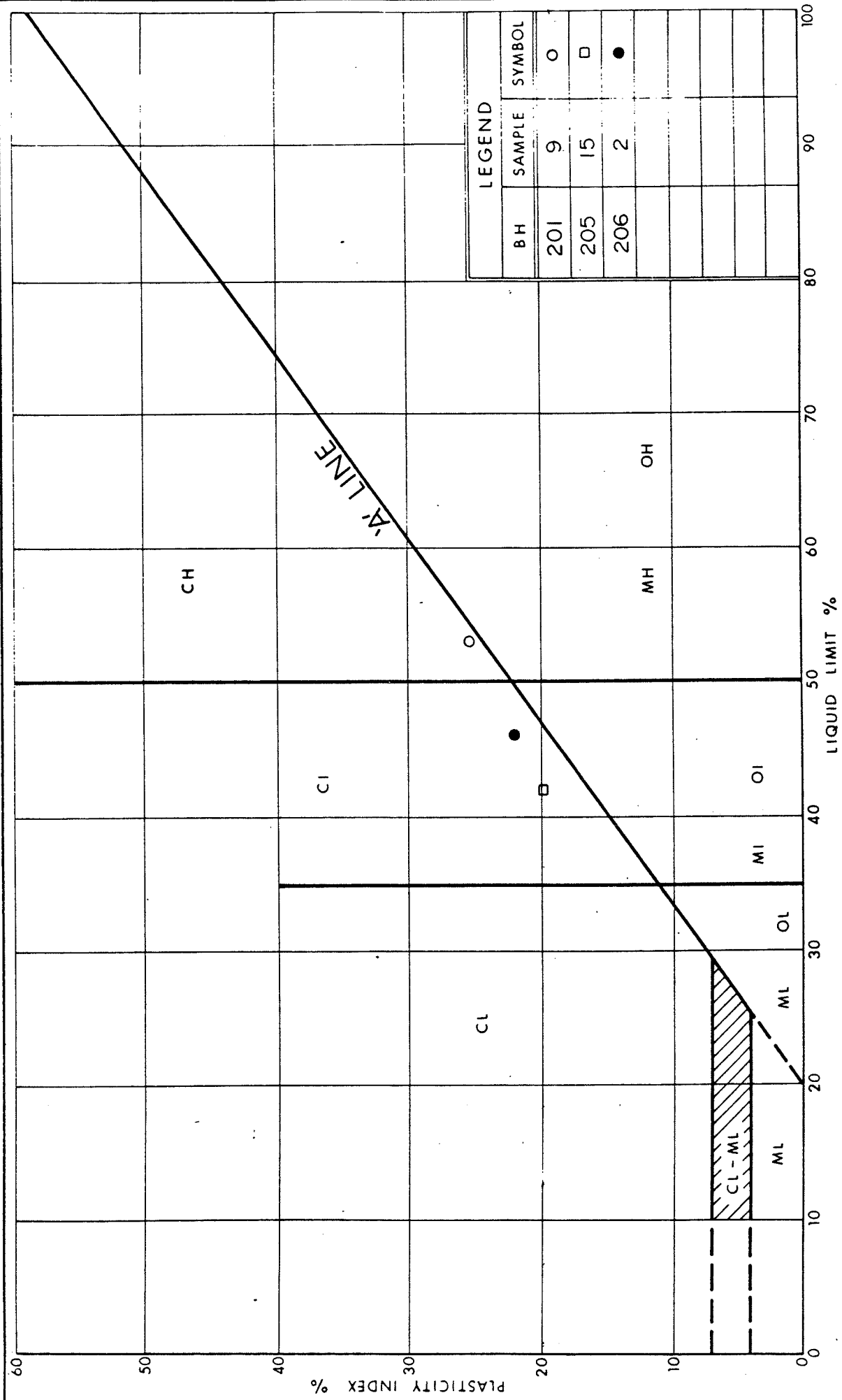


B.E. Ruck
Project Foundations Engineer



M.S. Devata
Chief Foundations Engineer (East)

APPENDIX



PLASTICITY CHART SILTY CLAY

FIG No I

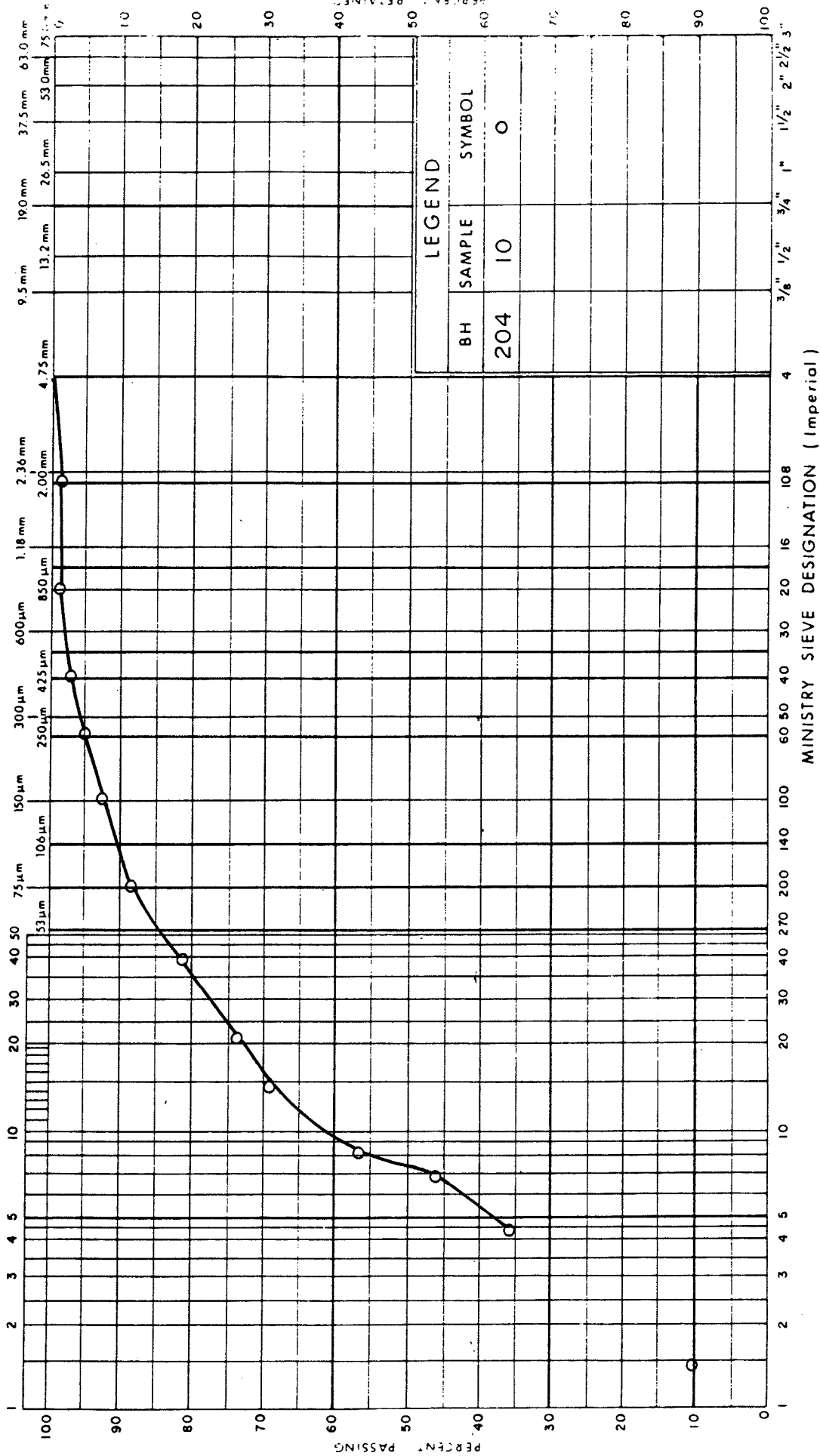
W P GGE-000-60

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
		Fine	Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



LEGEND

BH	SAMPLE	SYMBOL
204	10	O

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GRAIN SIZE DISTRIBUTION SILTY CLAY

FIG No 2

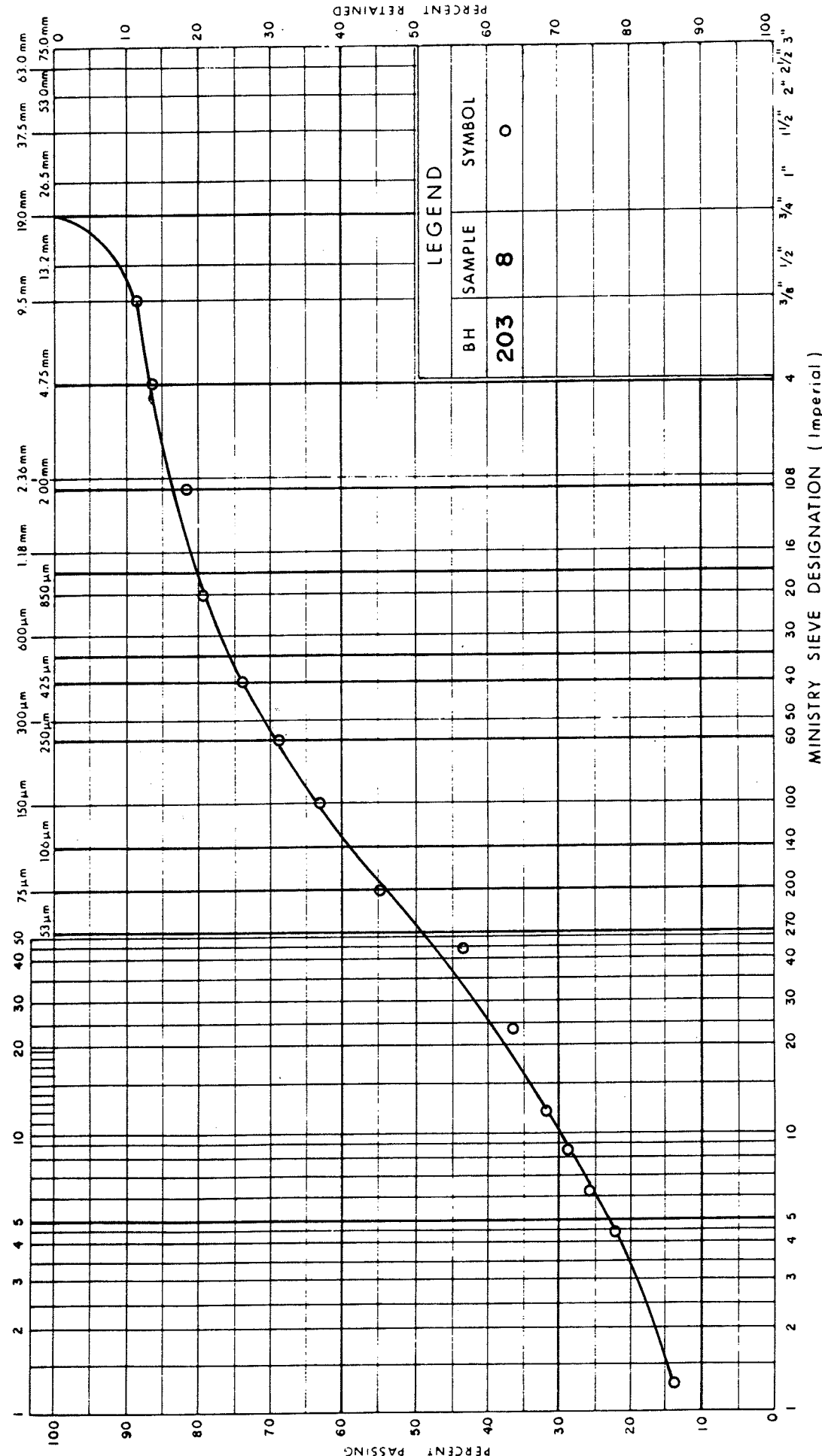
W P GGE-000-60

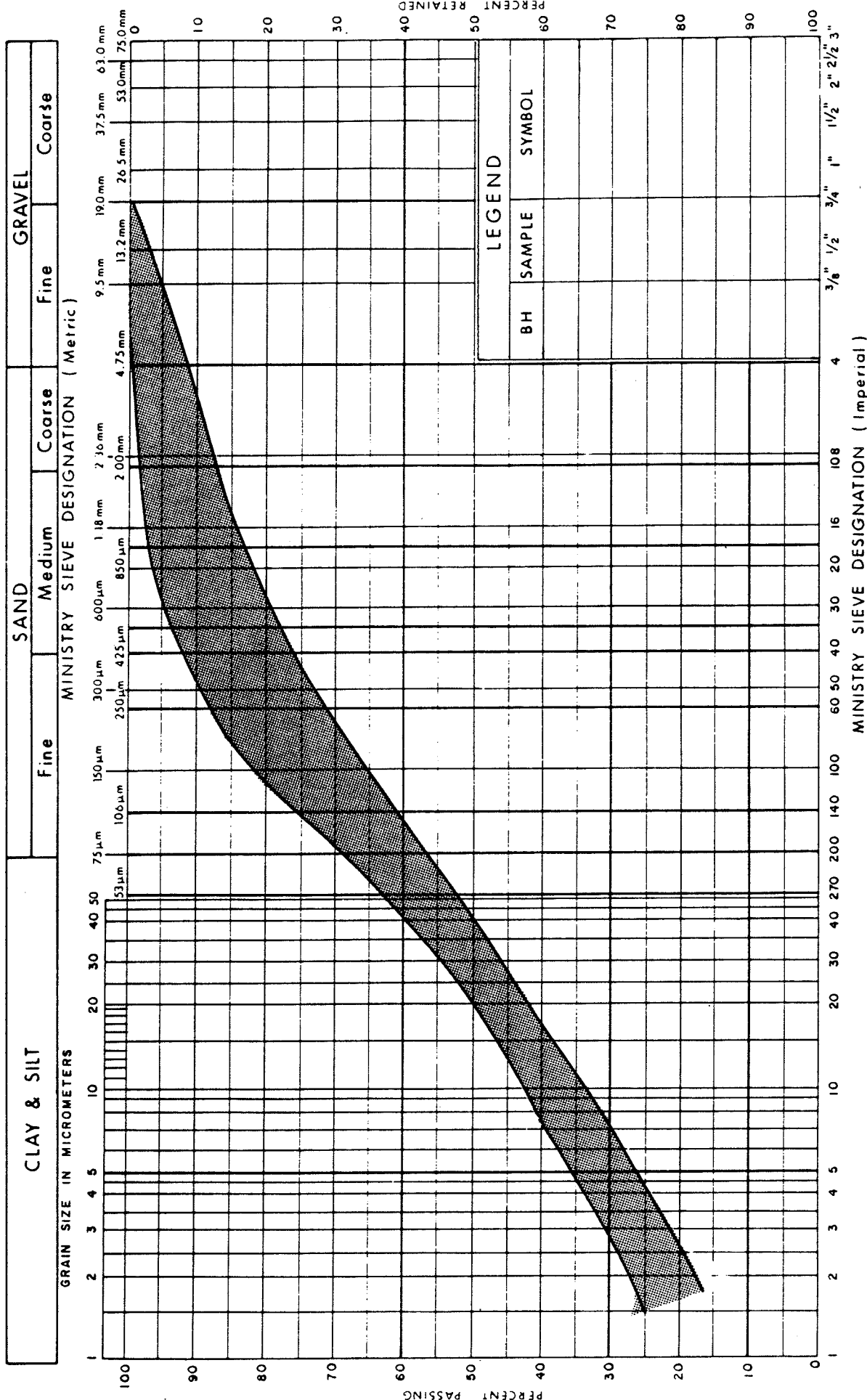
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



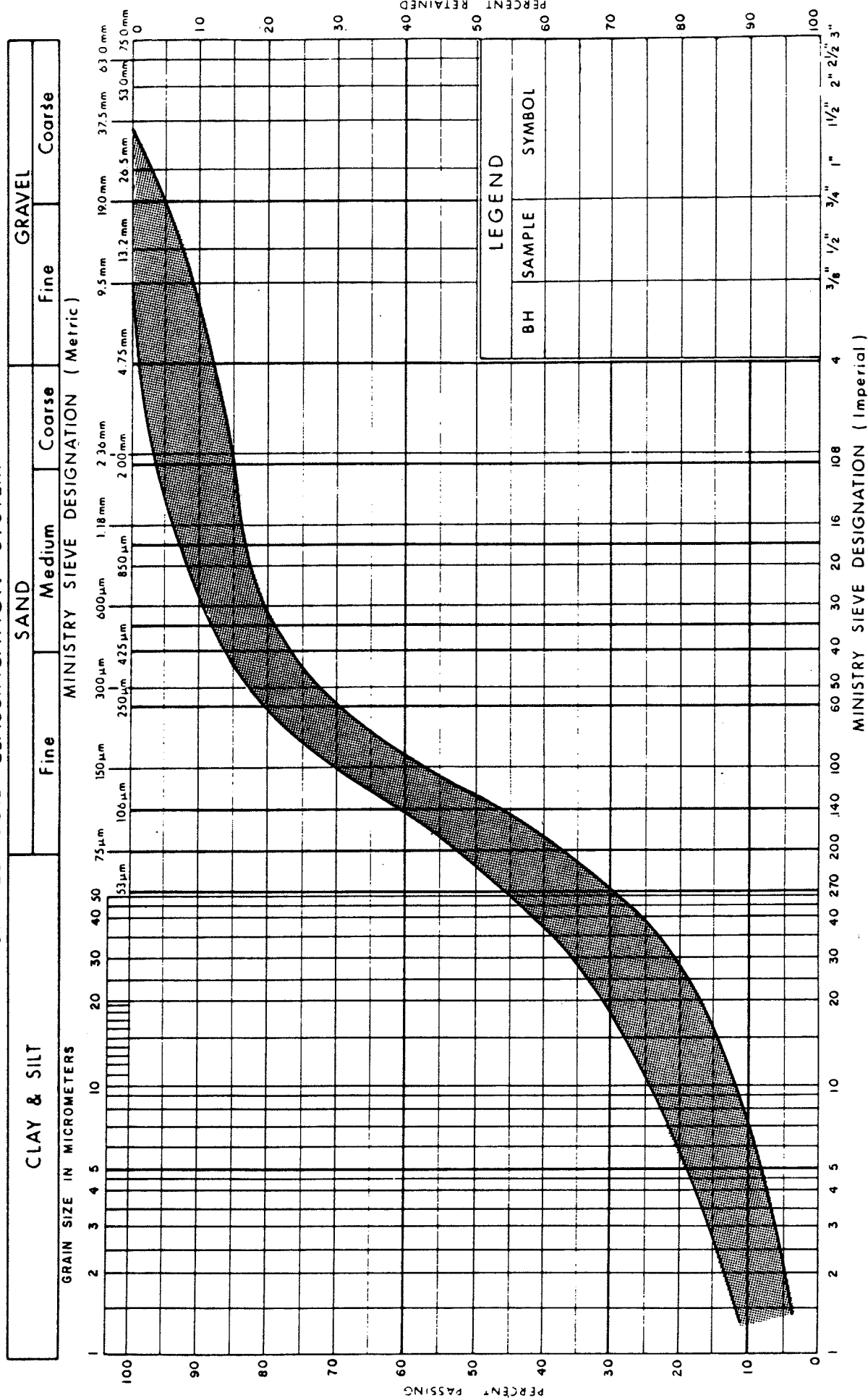
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GRAIN SIZE DISTRIBUTION

ENVELOPE: SILTY CLAY WITH SAND

FIG No C-1

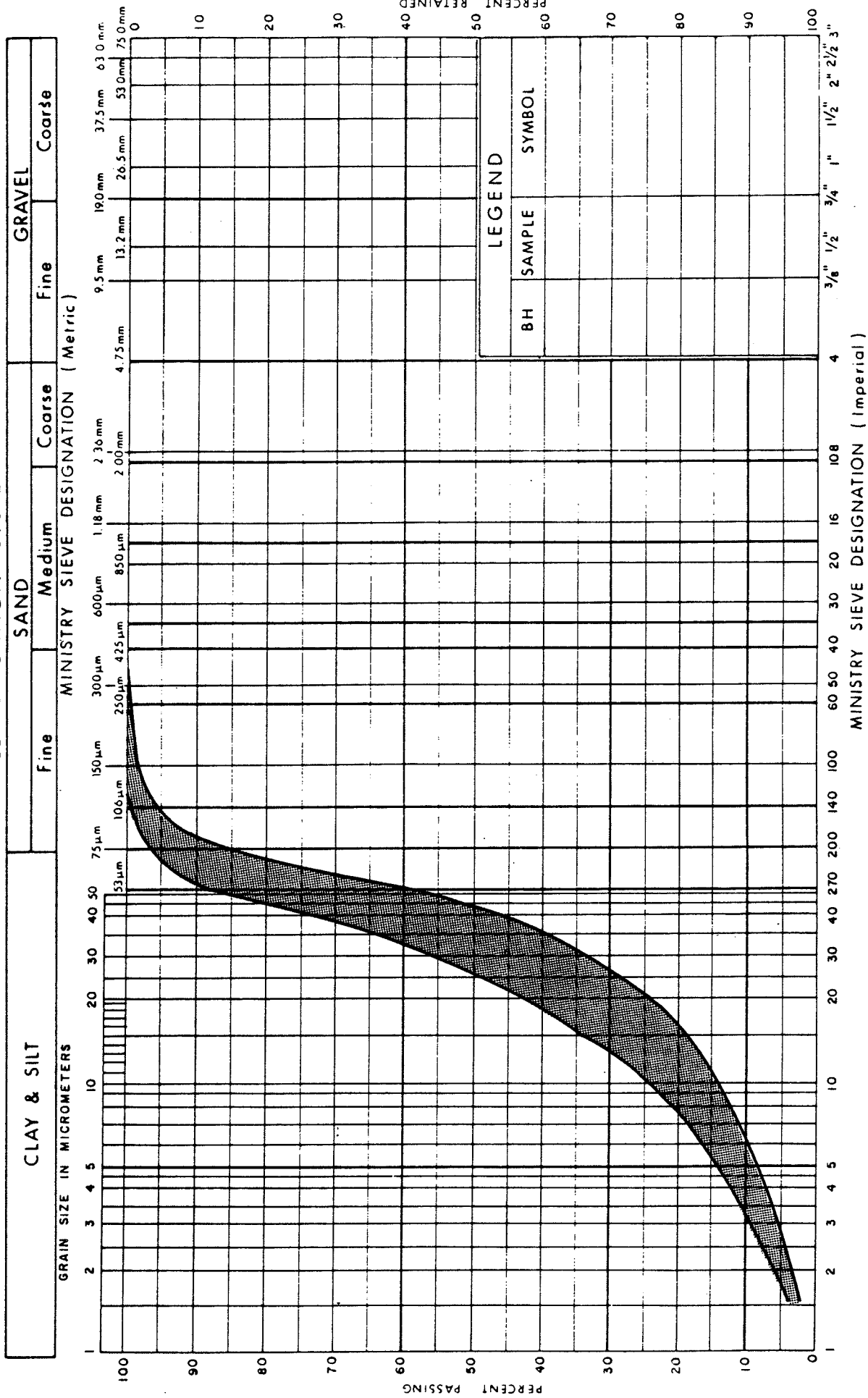
WP GGE-000-60

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GRAIN SIZE DISTRIBUTION

FIG No C-2

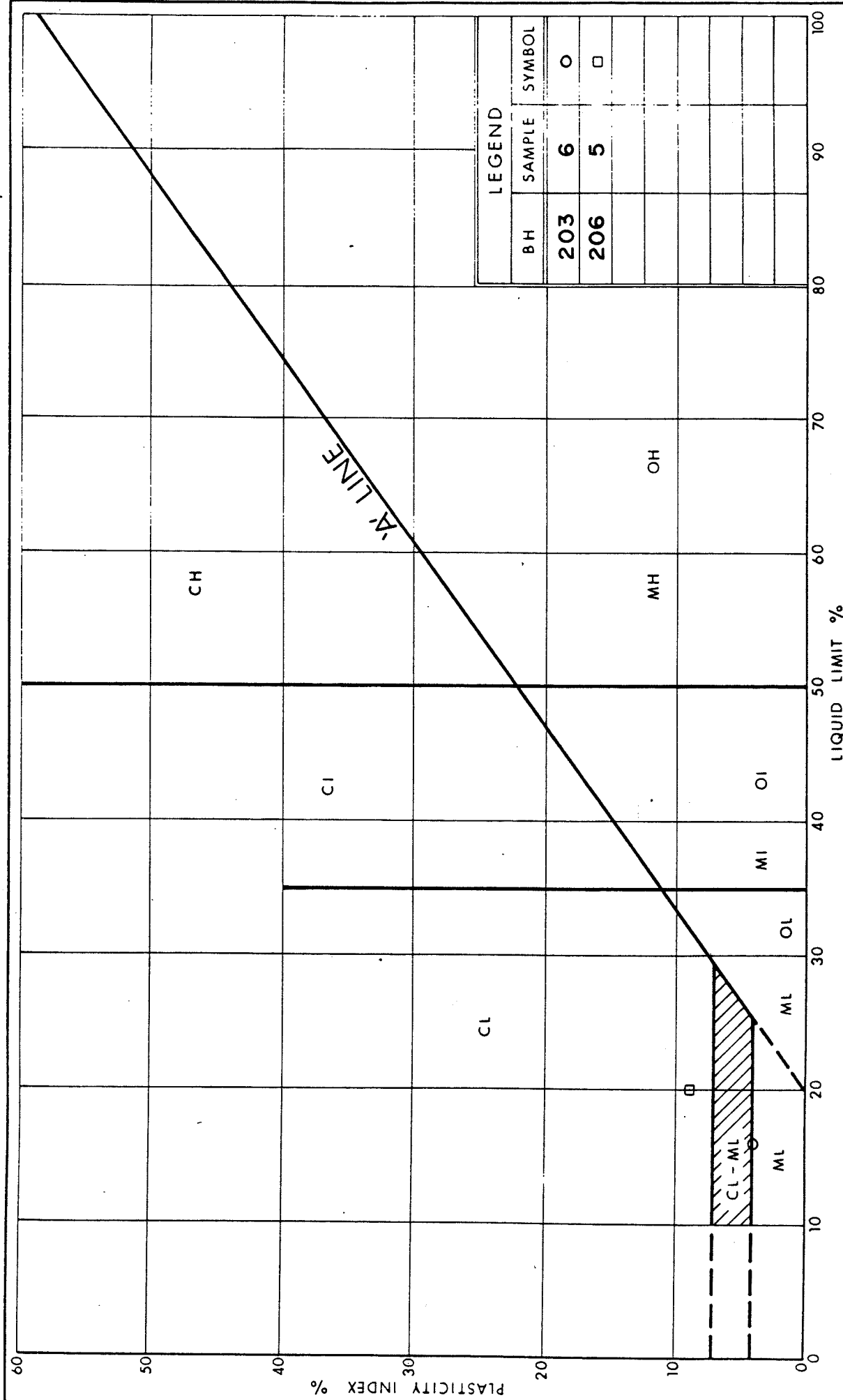
W P GGE-000-60

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GRAIN SIZE DISTRIBUTION

FIG No C-3

W P GGE-000-60



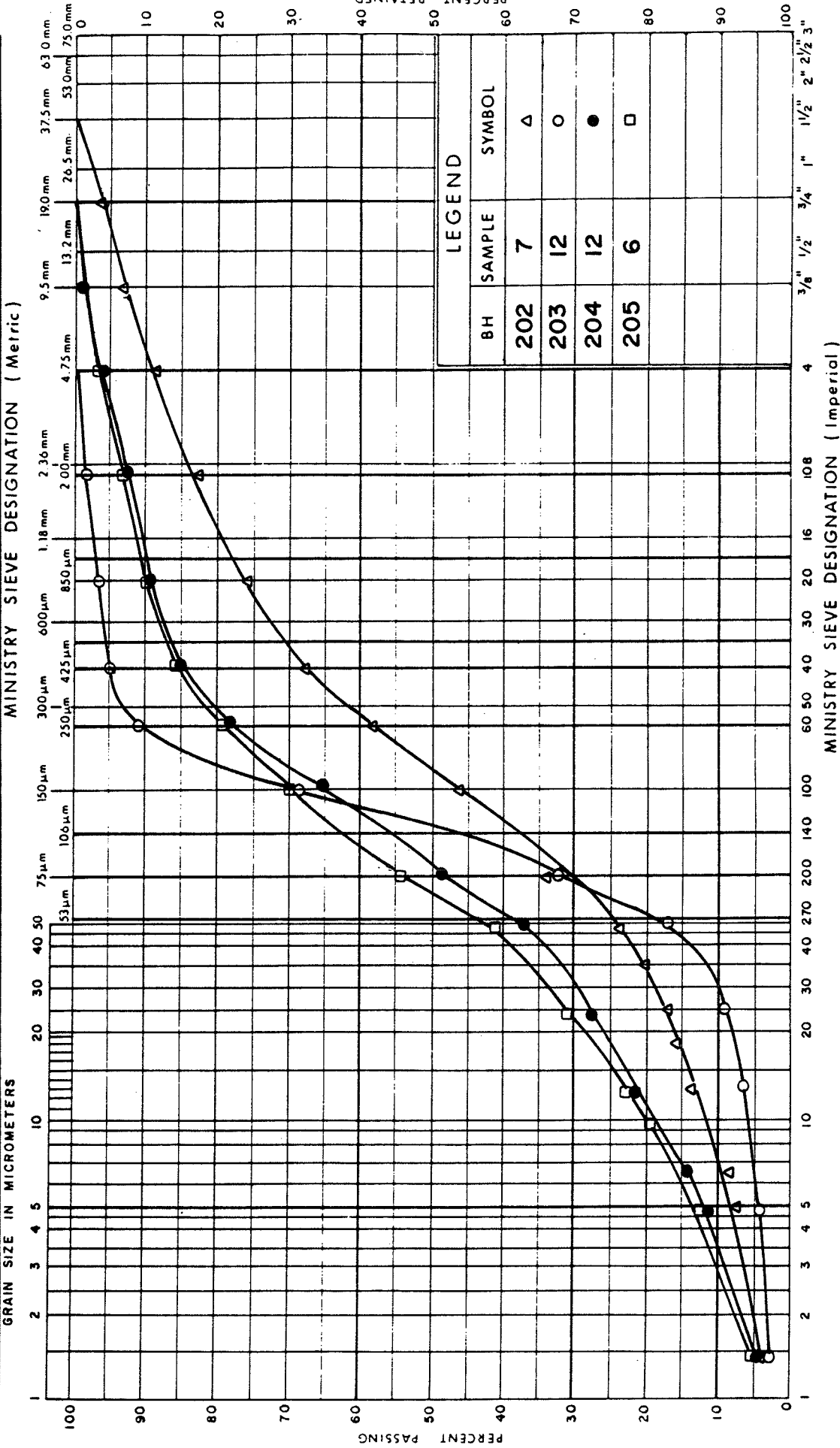
PLASTICITY CHART
SILTY CLAY WITH SAND

FIG No 4

W P GGE-000-60

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	
		MINISTRY SIEVE DESIGNATION (Metric)					



GRAIN SIZE DISTRIBUTION

SILTY SAND TO SILT, SOME SAND

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Communications



FIG No 5

W P GGE-000-60

RECORD OF BOREHOLE No 201

METRIC 91

W P GGE-000-60 LOCATION Co-ord. N 4,856,319 E 341,766 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY MHW
 DATUM Geodetic DATE May 29-30, 1984 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							
								SHEAR STRENGTH							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
							WATER CONTENT (%)			10 20 30					
93.5	GROUND SURFACE														
0.2	Topsoil														
92.1	Silty Clay, trace to some sand; varved. Stiff Grey & Brown		1	SS	14										
1.4	Silty Sand, trace clay and gravel with occ. sand, some silt seams and fine sandy silt layers.		2	SS	34										
			3	SS	62										
			4	SS	44										
			5	SS	38										
			6	SS	92										
86.5	Dense to Very Dense Brown to Grey		7	SS	100/ 150mm										
7.0	Silty Clay, occ. gravel with occ. sandy silt partings.		8	SS	100/ 150mm										
			9	SS	98										
83.4	Hard Dark brown														
10.1	Silty Clay with shale fragments; percentage increasing with depth.		10	SS	136/ 225mm										
81.1	Hard Brown/Grey		11	SS	85/ 65 mm										
12.4	END OF BOREHOLE														
							Water Level in Piezo-meter at Elev. 91.4m on June 4, 1984.								

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 202

METRIC

92

W P GGE-000-60 LOCATION Co-ord. N 4,856,313 E 341,732 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY MHW
DATUM Geodetic DATE May 29, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100				W _p	W	W _L		
92.3	GROUND SURFACE							SHEAR STRENGTH kPa				WATER CONTENT (%)				GR SA SI CL
0.2	Topsoil.						92	○ UNCONFINED + FIELD VANE								
90.5	Silty Clay, trace sand; varved. Firm to Stiff Brown and Grey		1	SS	8			● QUICK TRIAXIAL x LAB VANE								
1.8	Silty clay with sand, some gravel.		2	SS	12		90									
88.2	Soft to Very Stiff Mottled brown		3	SS	13											
4.1	Silty Sand, trace to some gravel, trace clay.		4	SS	4		88									
83.0	Very Dense Grey		5	SS	65		86									
9.3	Silty Clay, occ. gravel		6	SS	84		84									
81.9	Hard Dark Brown		7	SS	81		82									
10.4	Silty Clay with shale fragments, trace sand.		8	SS	76		80									
79.8	Hard Brown/Grey		9	SS	101/ 250mm		78									
12.6	END OF BOREHOLE		10	SS	104/ 250mm											
	Shale Bedrock, com- pletely weathered. Dark Brown		11	SS	110/ 250mm											

+3, x5: Numbers refer to
Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 203

METRIC 93

W P GGE-000-60 LOCATION Co-ord. N 4,856,300 E 341,678 ORIGINATED BY BL
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY MHW
DATUM Geodetic DATE May 29, 1984 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					
92.3	GROUND SURFACE													
0.0	Fill - silty sand, trace gravel.													
90.9	Loose Brown		1	SS	8									
90.5	Organic Sandy Silt.		2	SS	3									
1.8	Silty Clay, trace sand.		3	SS	5									
89.4	Soft Brown		4	SS	9									
2.9	Silty Clay with sand, some gravel, occ. silty sand, some clay and gravel layers.		5	SS	11									
			6	SS	3									
	Soft to Firm Grey		7	TW										
85.3			8	SS	11									
7.0			9	SS	7									
	Layered Silty Sand, Sand and Silt trace clay, occ. to trace gravel.		10	SS	18									
			11	SS	91									
			12	SS	122									
			13	SS	109									
			14	SS	96									
79.8	Loose to Very Dense Grey		15	SS	107									
12.5	Silty Sand, trace to some gravel.		16	SS	133									
77.8	Very Dense Grey													
14.5	Silty Clay and Shale Fragments													
77.0	Very Dense Grey		17	SS										
15.3	END OF BOREHOLE													

Water level in piezo-meter at Elev. 88.1m on June 1, 1984.

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 204

METRIC

94

W P GGE-000-60 LOCATION Co-ord. N 4,856,278 E 341,622 ORIGINATED BY BL
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
99.5	GROUND SURFACE													
0.0	Interlayered Silty Sand, occ. gravel, Sandy Silt, Sand and Gravel, and Sand with trace silt.		1	SS	18									
			2	SS	56									
			3	SS	91									
			4	SS	88									
95.1	Compact to Very Dense Brown		5	SS	62									
4.4	Silt, trace sand.		6	SS	72									
93.9	Very Dense Brown													
5.6	Silty Fine Sand, occ. gravel with occ. sandy silt and sand seams.		7	SS	48									
			8	SS	40									
			9	SS	74									
89.4	Dense to Very Dense Brown to Grey													
10.1	Silty Clay, trace sand.		10	SS	154/250mm									
88.1	Hard Grey													
11.4	Silty Fine Sand, trace gravel to Sand and Silt, some clay, trace gravel.		11	SS	96/125mm									
			12	SS	101/150mm									
84.1	Very Dense Grey		13	SS	60/150mm									
15.4	Silty Clay, occ. gravel		14	SS	81/150mm									
83.0	Hard Dark Brown													
16.5	Silty Clay with shale fragments, trace sand.		15	SS	81									
81.0	Hard Dark Grey		16	SS	85/100mm									
18.5	END OF BOREHOLE													

Water level in piezo-meter at Elev. 83.1m on June 4, 1984

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 205

METRIC

95

W P GGE-000-60 LOCATION Co-ord. N 4,856,263 E 341,575 ORIGINATED BY BL
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow and Solid Stem Augers COMPILED BY MHW
 DATUM Geodetic DATE May 29-30, 1984 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				
90.8	GROUND SURFACE															
0.0	Silty Clay, some sand, trace gravel.															
89.4	Stiff Brown		1	SS	13											
1.4	Layered Silty Sand Sand and Silt and Silt, trace to some clay, occ. to trace gravel.		2	SS	31											
			3	SS	53											
			4	SS	56											
			5	SS	40											
85.6	Dense to Very Dense Brown to Grey		6	SS	153											
5.2	Silty Sand, some gravel, trace clay. Occ. bould- ers.		7	SS	100/ 75 mm											
83.8	Very Dense Grey															
7.0	Silty Clay, occ. grav- el.															
82.9	Hard Dark Brown		8	SS	108											
7.9	Silty Clay with shale fragments.		9	SS	136											
			10	SS	166											
80.7	Hard Brown/Grey															
10.1	Shale Bedrock, highly to moderately weathered		11	SS	121/ 100 mm											
78.5	Grey		12	SS	100/ 75 mm											
12.3	END OF BOREHOLE															
<p>NOTE: Hollow Stem refusal was met at 5.3 m depth due to boulder. Borehole moved 1 m south. Auger refusal met at 6.1 m depth on boulder. Borehole moved 2 m west. Auger refusal at 5.5 m depth. Borehole extended with solid stem augers.</p>																
<p>Hole caved to Elev. 86.5 m. Water level in borehole at Elev. 89.9 m on June 4, 1984</p>																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 206

METRIC

96

W P GGE-000-60 LOCATION Co-ord. N 4,856,249 E 341,543 ORIGINATED BY BL
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
87.1	GROUND SURFACE																
86.7	Topsoil.																
0.4	Silty clay, trace sand, occ. sand parting.		1	SS	12												
	Stiff to Mottled to Varved		2	SS	26												
84.7	Very Stiff Brown		3	SS	12												
2.4	Silty Clay with sand, trace to some gravel.		4	SS	14												
	Soft to Mottled Brown to Grey		5	SS	5												
81.0	Stiff																
80.6			6	SS	43												
6.5	END OF BOREHOLE																
	Silty Clay with Shale Fragments. Hard Grey																

Water level in open Borehole at Elev. 85.0m on May 31, 1984.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 301

METRIC 97

W P GGE-000-60 LOCATION Co-ord. N 4,856,232 E 341,499 ORIGINATED BY BL
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)					
85.1	GROUND SURFACE																
0.0	Topsoil - silty sand.																
84.0	Compact Brown		1	SS	10												
1.1	Silty clay, some sand and gravel.		2	SS	17												
82.9	Very Stiff Brown																
2.2	Interlayered Silty Fine Sand, Sand and Gravel, Sandy Silt.		3	SS	21												
			4	SS	22												
80.9	Compact Grey		5	SS	33												
4.2	Silty Clay with shale fragments.		6	SS	29												
79.2	Hard Brown/Grey		7	SS	61												
78.9			8	SS													
6.2	END OF BOREHOLE																
	Shale Bedrock, highly weathered.																

Water level in Piezo-meter at Elev. 84.8, June 1, 1984

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1

98

W P 470-711-611 LOCATION Co-ordinates N 4,856,356; E 341,771 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger, Solid Stem Auger COMPILED BY MHW
DATUM Geodetic DATE July 19 and 20, 1983 CHECKED BY JRB

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				
94.5	Ground Surface														
0.0	Silty sand, some gravel, trace clay Compact to Dense Brown becoming Grey at Elev. 90.6 m		1	SS	19	Water Level in Open Hole at Elev. 91.3 m Aug 2/83								γ = 22.4 kN/m ³	9 61 28 2
			2	SS	16										
			3	SS	28										
			4	SS	50										
			5	SS	31										
89.9						90									
4.6	Silt, some fine sand and gravel Very Dense Grey		6	SS	84										
88.7															
5.8	Silty sand, trace clay and fine gravel changing to gravelly sand some silt Dense to Very Dense Grey		7	SS	45										
86.6			8	SS	112										
7.9	Silt, some sand and gravel trace clay Very Dense Grey becoming dark Grey at elev 85.2 m		9	SS	100/ 150 mm										
84.4						85									
10.1	Sand some gravel and trace silt to silty sand and gravel Very Dense Dark Grey		10	SS	57										
			11	SS	65										
			12	SS	88/ 200 mm										
			13	SS	100/ 50 mm	80									
79.3			14	BQ RC	REC 100%										
15.2	Shale bedrock, calcare- ous, moderately frac- tured to sound below elev. 78.8 m, fresh to slightly weathered, grey with occasional black shale beds		15	BQ RC	REC 100%										
76.7															
17.8	End of Borehole					75									

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

99

W P 470-711-611 LOCATION Co-ordinates N 4,856,348; E 341,744
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger, Wash Boring
DATUM Geodetic DATE July 20 and 21, 1983
ORIGINATED BY HCO
COMPILED BY MHW
CHECKED BY JRB

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					
93.8	Ground Surface															
0.0	Fill, silty clay with organic matl. throughout															
92.6	Stiff Black		1	SS	9											
1.2	Silty clay, varved		2	SS	15											
91.7	Stiff Brown		3	SS	20											
2.1	Sandy silt to silty sand, trace clay and gravel		4	SS	24											
89.5	Compact becoming Grey with depth															
4.3	Silty sand trace gravel and clay to sand, some gravel and silt		5	SS	62											
	Very Dense Grey		6	SS	57											
86.1			7	SS	50/75 mm											
7.7	Sandy silt with trace to some gravel		8	SS	50/75 mm											
	Very Dense Grey															
83.3			9	SS	41											
10.5	Silty clay with angular gravel-sized shale and limestone fragments increasing in frequency with depth, some sand, layered in upper portion		10	SS	100/225 mm											
79.9	Hard Grey															
13.9	End of Borehole															
	NOTE: Continuous grinding of augers experienced from elev. 83.9 m to 83.3 m															

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

100

W P 470-711-611

LOCATION Co-ordinates N 4,856,376; E 341,765

ORIGINATED BY HCO

DIST 6 HWY GO-ALRT

BOREHOLE TYPE Solid Stem Augers

COMPILED BY MHW

DATUM Geodetic

DATE July 21 and 22, 1983

CHECKED BY JRB

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
94.7	Ground Surface															GR SA SI CL
0.0	Fill - silty sand trace															
94.1	organic matter															
0.6	Silty sand some gravel		1	SS	13											
	trace clay. Silt con-		2	SS	20											
	tent decreasing with		3	SS	37											
	depth, trace organic		4	SS	32											
	matter to elev. 93.7 m		5 _A	SS	130											
	Compact to Dense		5 _B	SS	130											
90.6	Brown		6	SS	100/ 250											
4.1	Silt some fine sand		7	SS	100/ 150											
	some stratification at															
	depth															
	Very Dense Grey															
87.7																
7.0	Silty sand some gravel		8	SS	175/ 250											
	trace clay to gravelly		9	SS	100/ 75 mm											
	sand some silt															
	Very Dense Grey															
			10	SS	50/ 50 mm											
83.1																
11.6	Sand and gravel trace		11	SS	96											
	to some silt occasional															
	cobbles															
	Very Dense Dark		12	SS	122											
	Grey															
79.9																
14.8			13	AS	-											
79.3			14	SS	100/ 150 mm											
15.4	End of Borehole															
	Silty clay with angular															
	shale and limestone															
	fragments															
	Hard Dark															
	Grey															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 7

101

W P 470-711-611 LOCATION Co-ordinates N 4,856,401; E 341,760 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM Geodetic DATE July 27 and 28, 1983 CHECKED BY JRB

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					
94.4	Ground Surface																
0.0	Topsoil																
0.1	Silty sand trace to some gravel trace clay occasional rust stained fissures		1	SS	18												
			2	SS	20												
	Compact to Very Dense Brown		3	SS	65												
			4	SS	61												
90.1			5	SS	120/												
4.3	Sand trace to some silt trace gravel to silty sand trace gravel and clay		6	SS	67												
	Very Dense Grey		7	SS	66												
			8	SS	125/												
85.9					225												
8.5	Silty sand some gravel trace clay		9	SS	98												
	Very Dense Grey		10	SS	94												
82.7																	
11.7	Sand and gravel some silt		11	SS	63												
	Very Dense Dark Grey		12	SS	110												
79.9																	
14.5	Silty clay with shale fragments		13	AS	-												
79.0	Hard Dark Grey		14	SS	507												
15.4	End of Borehole				50 mm												

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7A

102

W P 470-711-611 LOCATION Co-ordinates N 4,856,400; E 341,759 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger - Piezometer Installation COMPILED BY FRD
DATUM Geodetic DATE July 29, 1983 CHECKED BY JRB

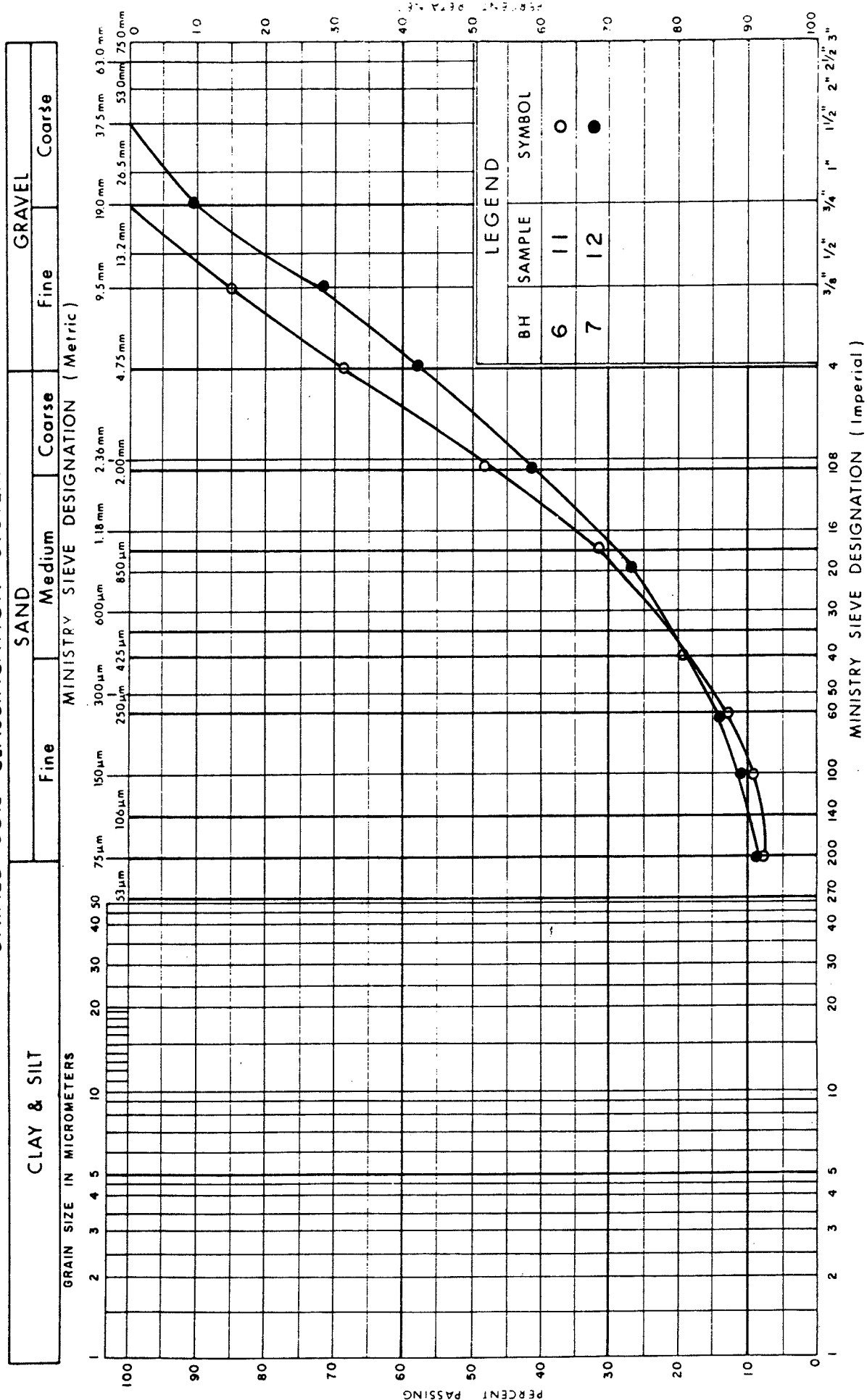
[illegible]

⁺³, ^{x5} : Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

APPENDIX 1

Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION SAND AND GRAVEL

FIG No B-1

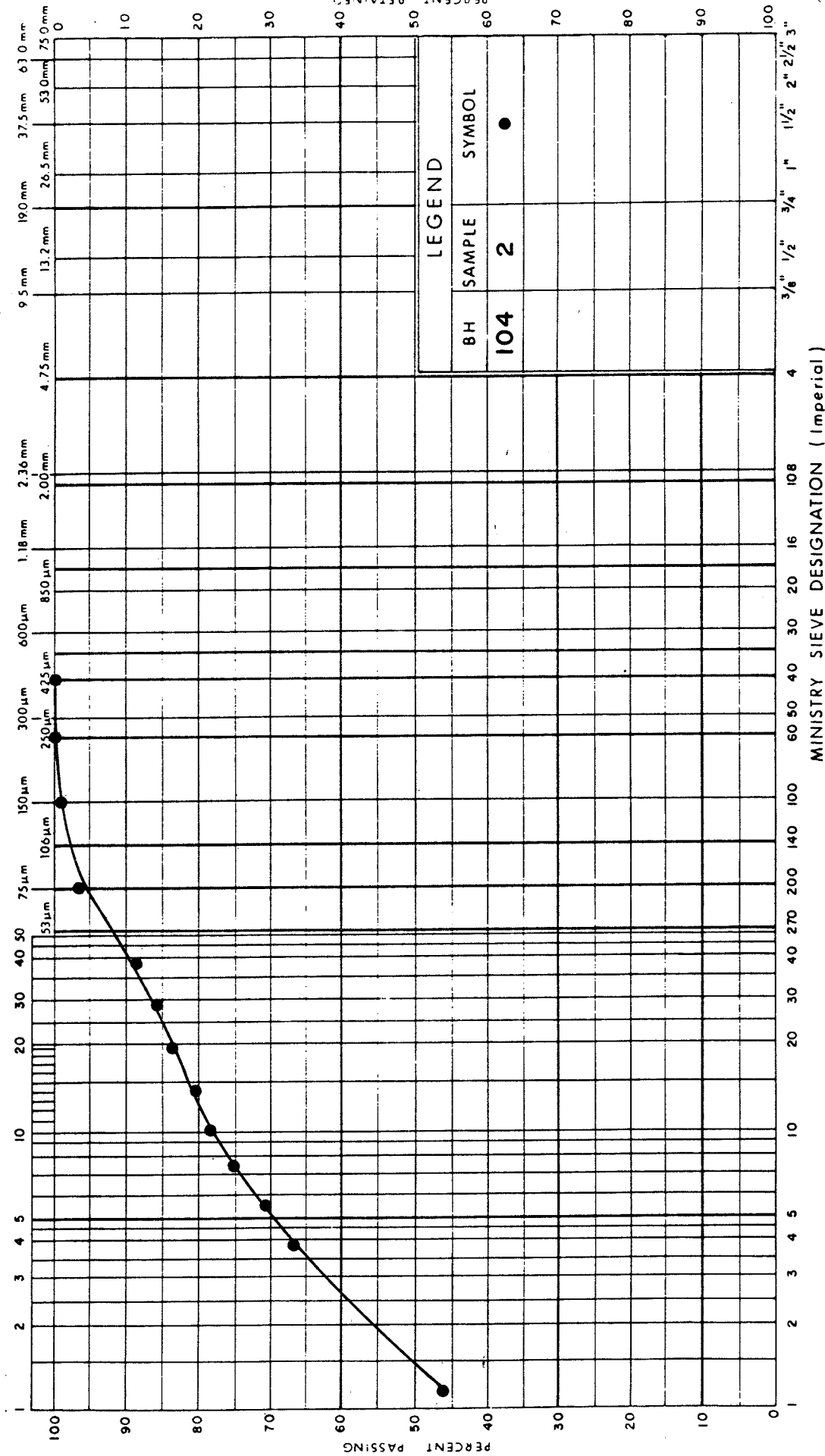
WP 470-711-611

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine		Medium	Coarse	Fine	Coarse

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



LEGEND

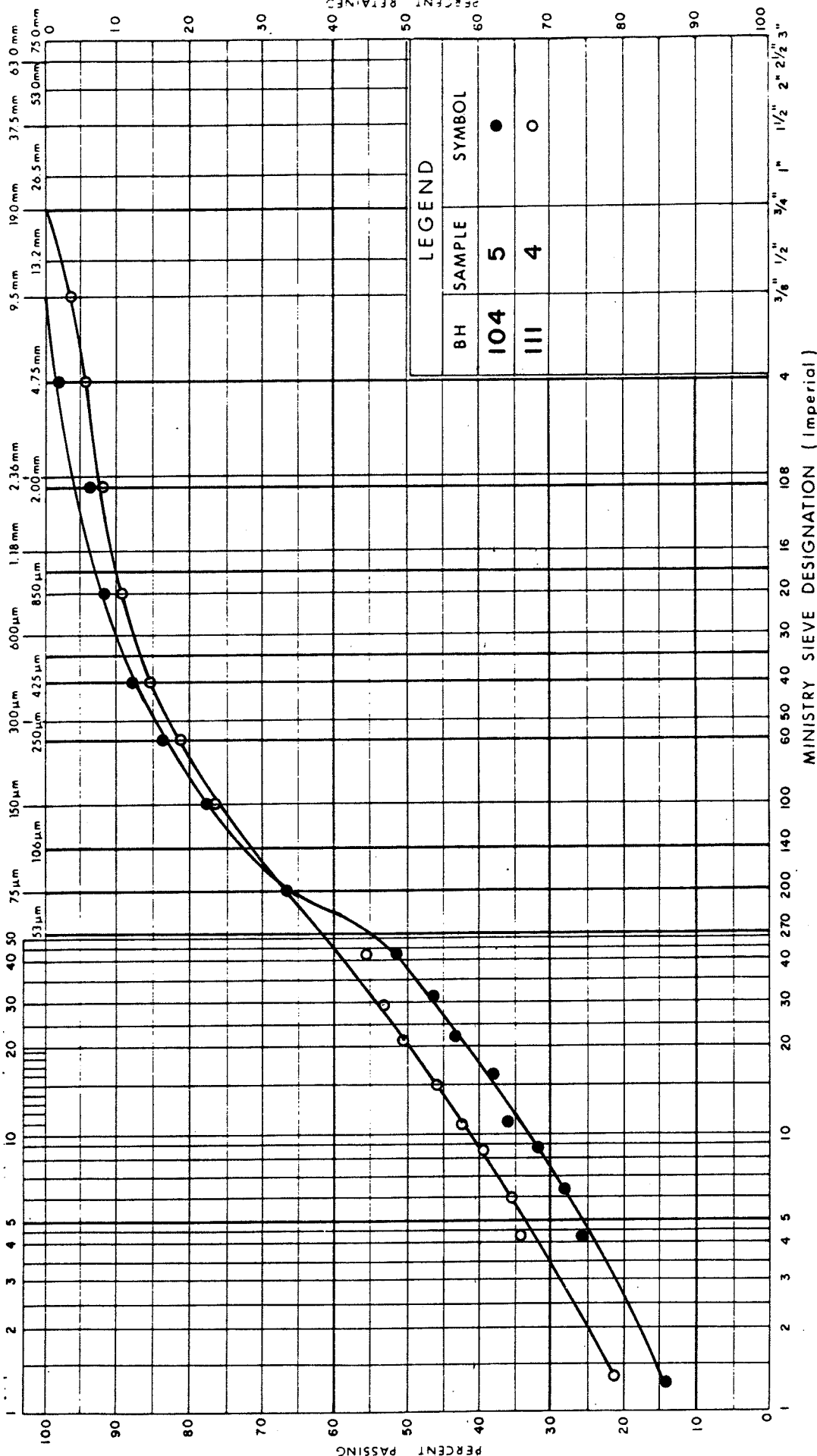
BH	SAMPLE	SYMBOL
104	2	●

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	Coarse

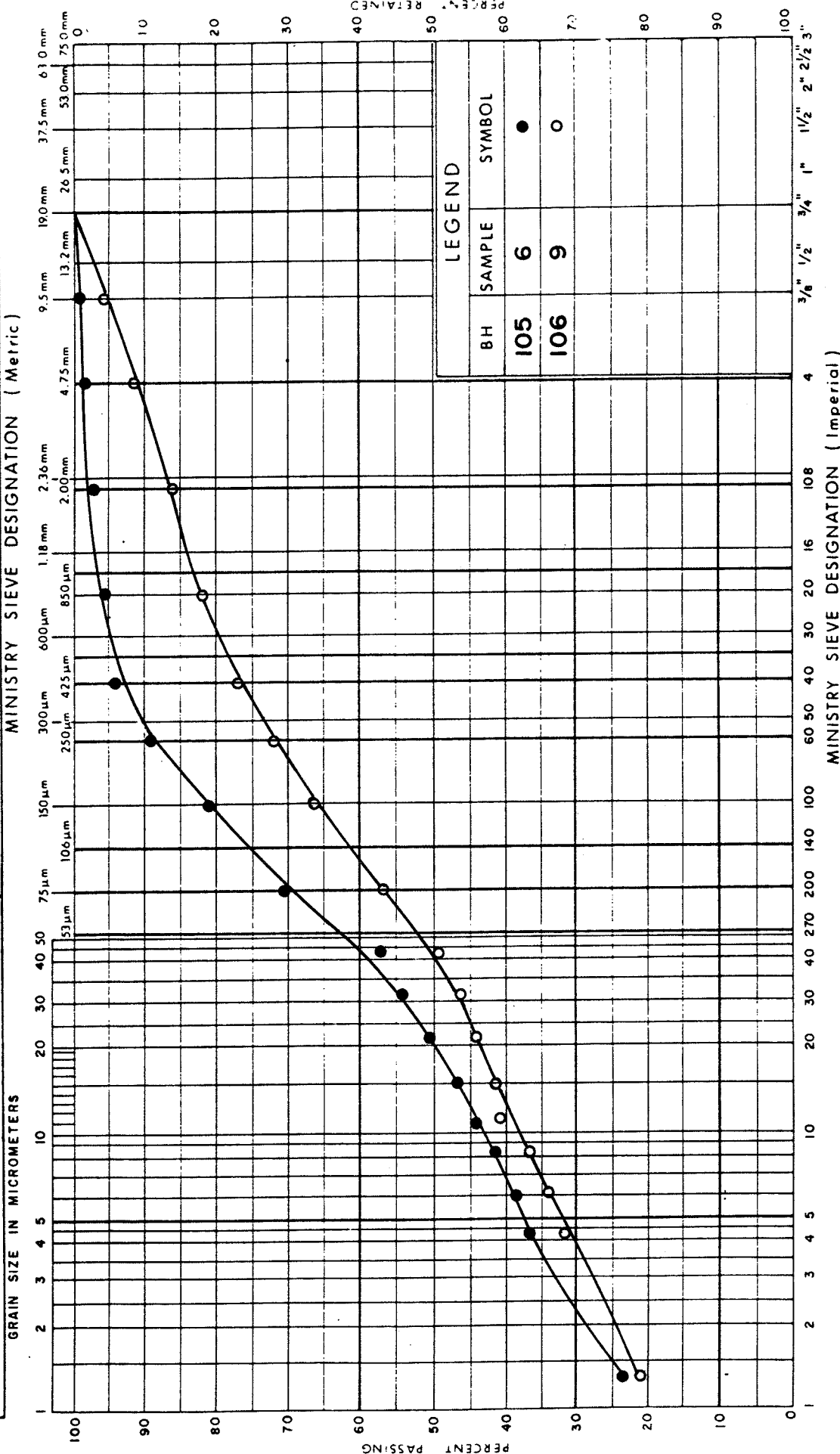
GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	
		MINISTRY SIEVE DESIGNATION (Metric)					



GRAIN SIZE DISTRIBUTION

SILTY CLAY WITH SAND

Ministry of
Transportation and
Communications



FIG No 3

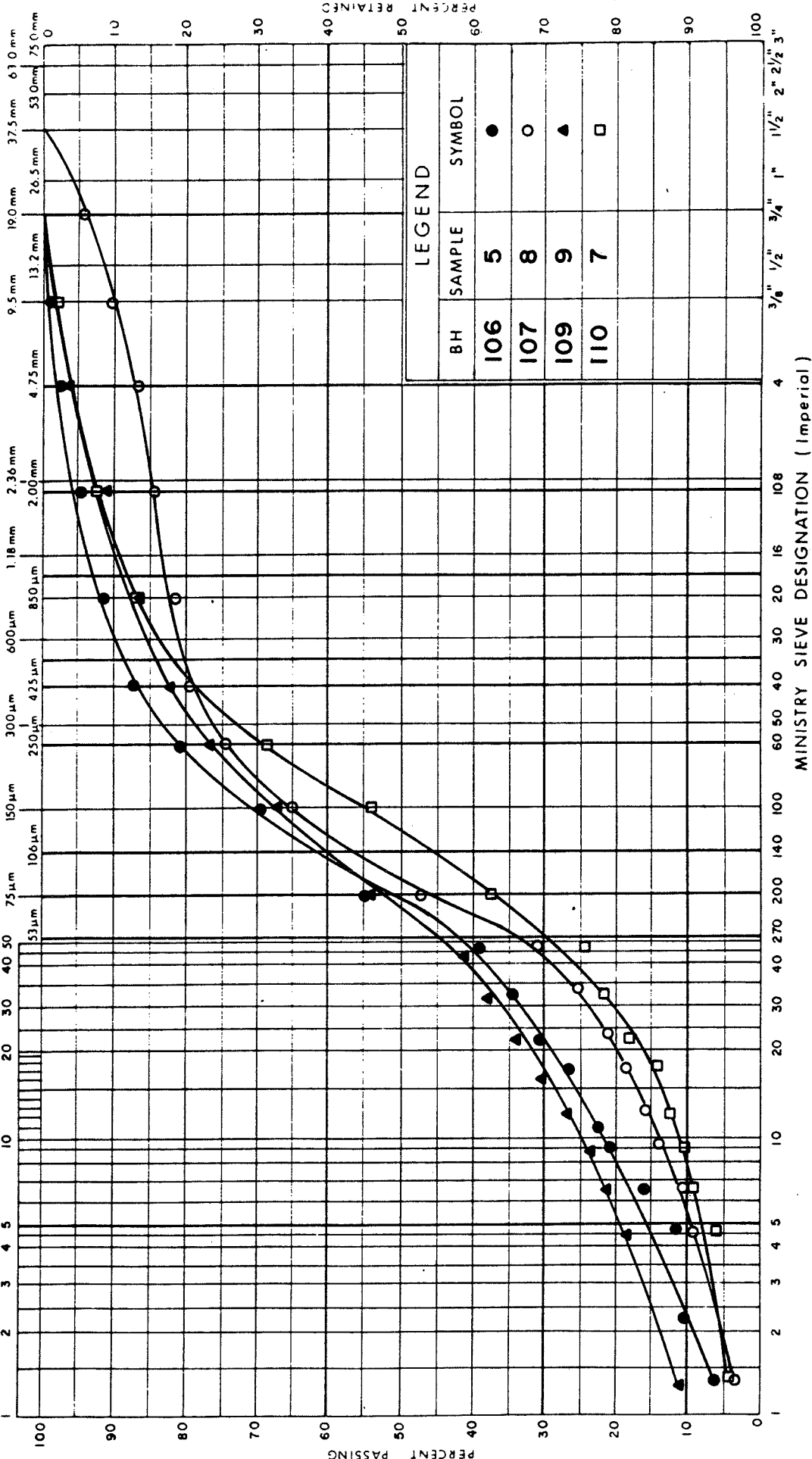
W P EGG-000-53

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



Ministry of
Transportation and
Communications



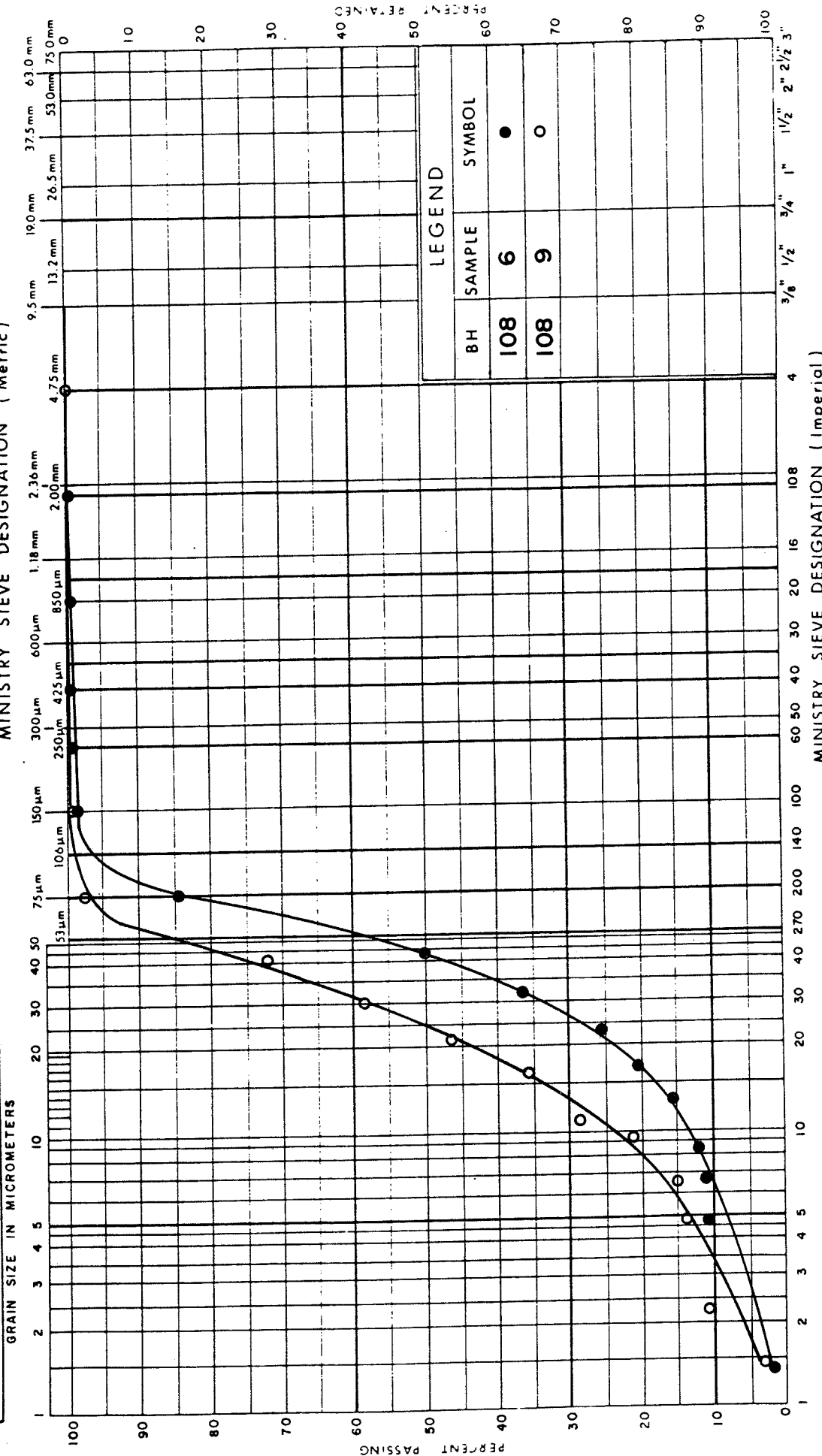
GRAIN SIZE DISTRIBUTION SILTY SAND TO SAND AND SILT

FIG No 4

W P EGG-000-53

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	
		MINISTRY SIEVE DESIGNATION (Metric)					



GRAIN SIZE DISTRIBUTION

SILT

FIG No 5

W P EGG-000-53

Ministry of
Transportation and
Communications

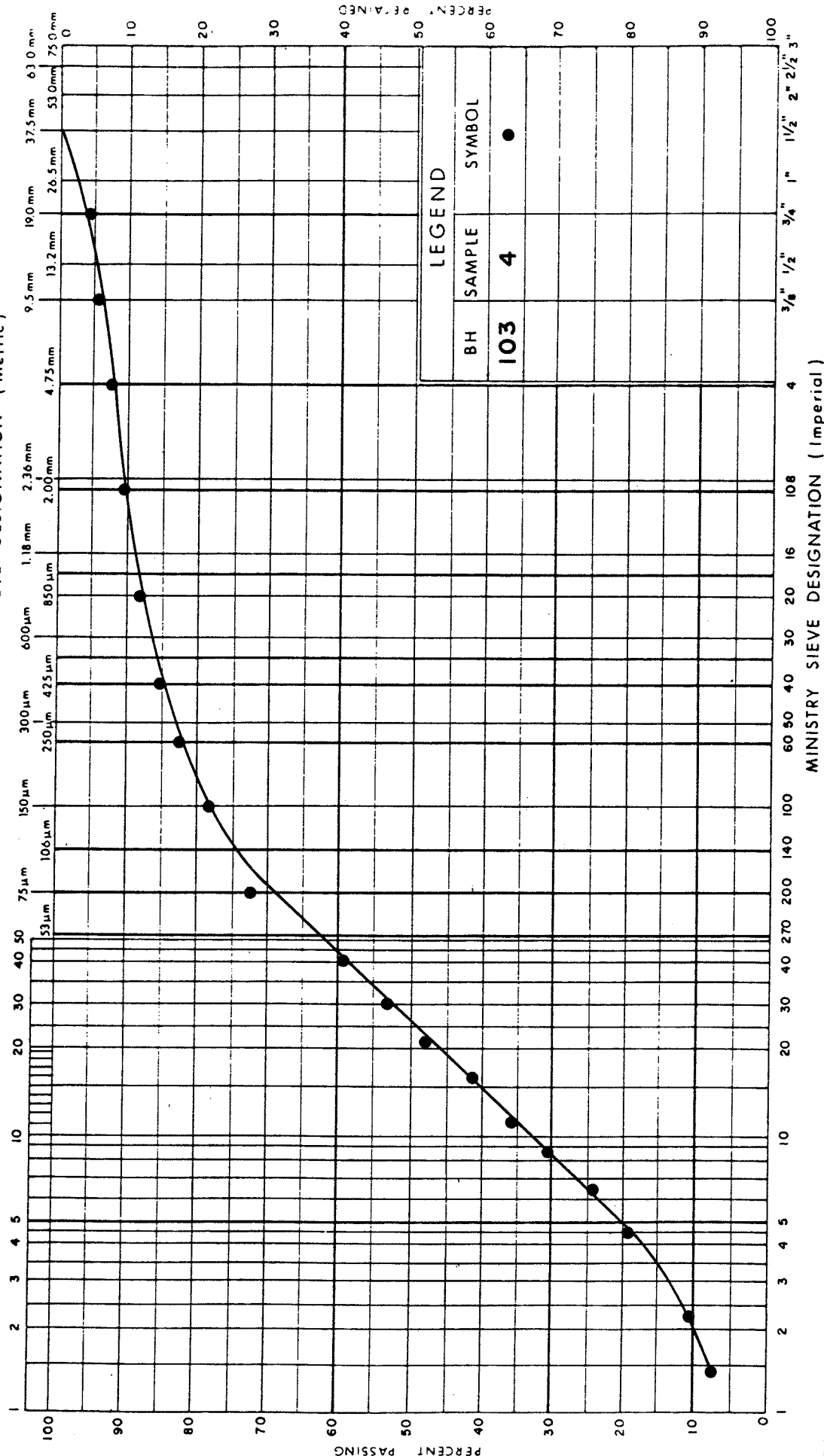


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

MINISTRY SIEVE DESIGNATION (Metric)

GRAIN SIZE IN MICROMETERS



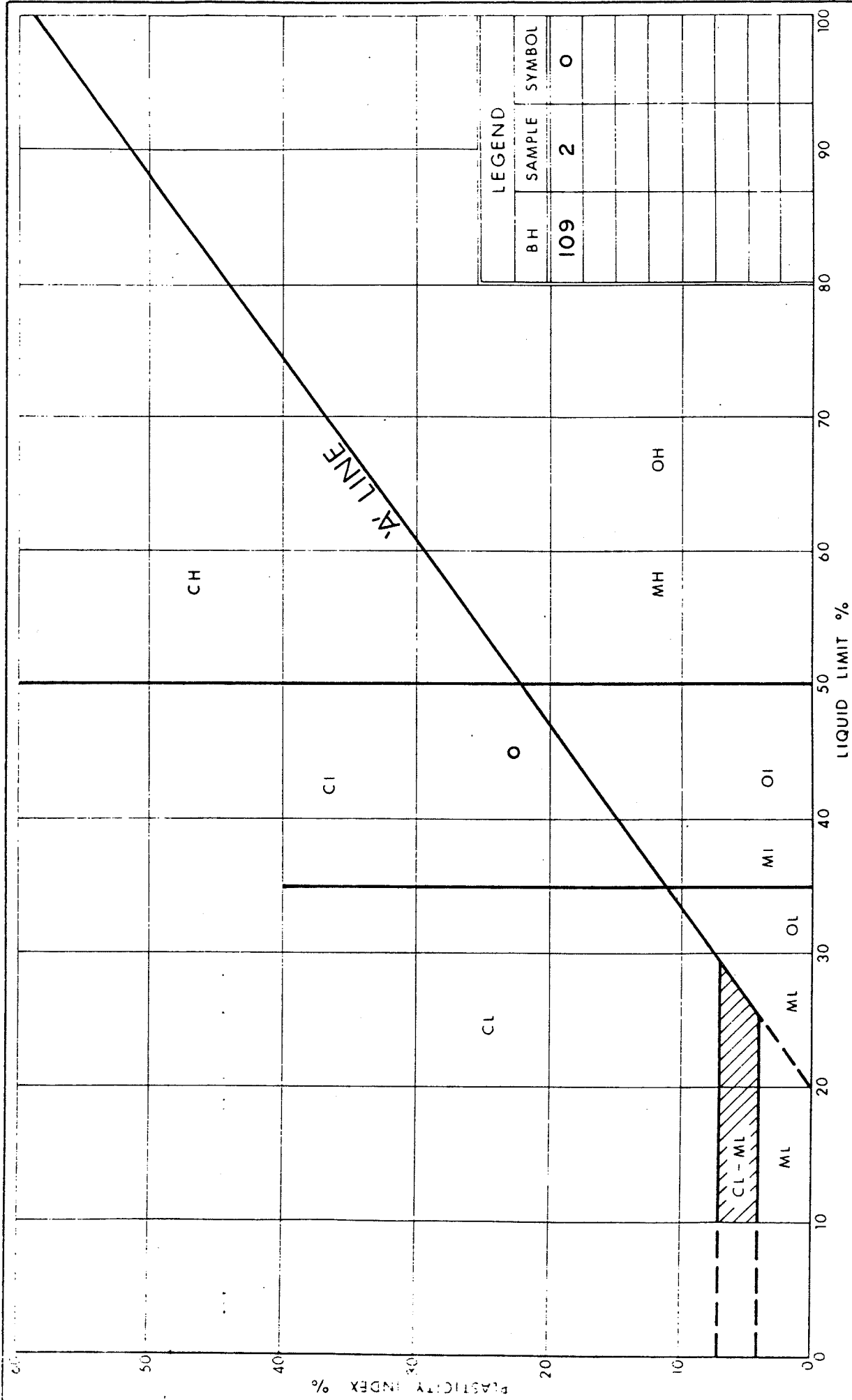
LEGEND

BH	SAMPLE	SYMBOL
103	4	●

Ministry of
Transportation and
Communications



FIG No 6
W P EGG-000-53



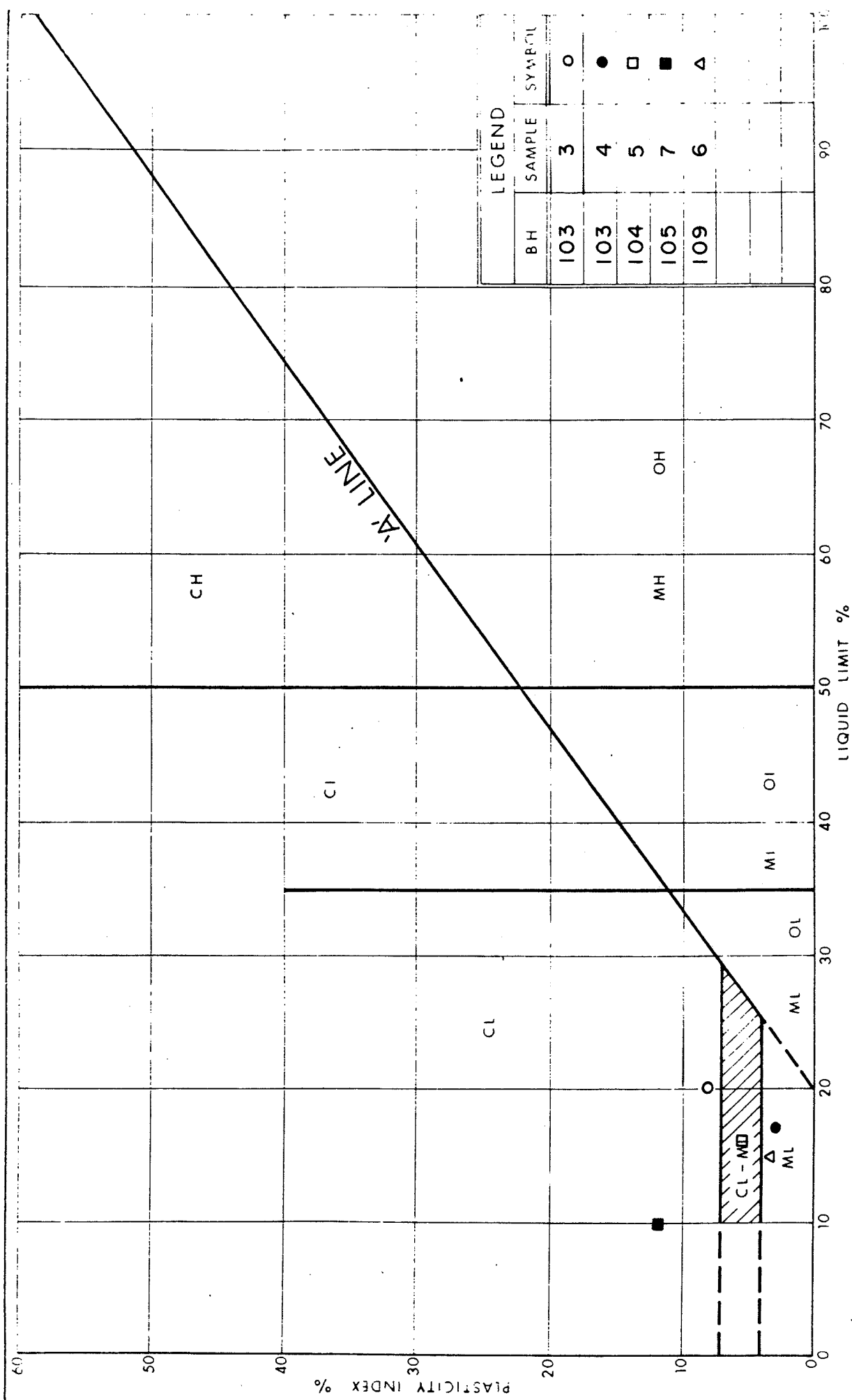
Ministry of
Transportation and
Communications

PLASTICITY CHART SILTY CLAY

FIG No 7

WP EGG-000-53

111



PLASTICITY CHART
SILTY CLAY WITH SAND

Ministry of
Transportation and
Communications



FIG No 8

W P EGG-000-53



RECORD OF BOREHOLE No 101

METRIC

113

W P GGE-000-60
(EGG-000-53)

LOCATION Co-ord. N 4,856,327 E 341,706

ORIGINATED BY HCO

DIST 6 HWY GO-ALRT

BOREHOLE TYPE Hollow Stem Auger

COMPILED BY EFO

DATUM GEODETIC

DATE March 13, 1984

CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
91.3	GROUND SURFACE												
91.2	TOPSOIL												
0.6	Varved Silty Clay, trace sand, occ. gravel.		1	SS	11								
90.0	Very Stiff Grey and Brown		2	SS	13								
1.8	Silty Clay, some sand and gravel to Silty Sand, some clay.		3	SS	7								
			4	SS	7								
	Firm to Stiff Brown to Grey												
86.9			5	SS	31								
4.9	Silty Sand to Sandy Silt, some gravel, trace to some clay.		6	SS	63								
			7	SS	63								
	Dense to Very Dense Grey		8	SS	90/150mm								
81.0			9	SS	100/150mm								
10.8	END OF BOREHOLE												

NOTE

THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 102

METRIC.

114

W P GGE-000-60
(EGG-000-53)

W P (EGG-000-53) LOCATION Co-ord. N 4,856,232 E 341,421

ORIGINATED BY HCO

DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger

COMPILED BY EFO

DATUM GEODETIC DATE March 13, 1984

CHECKED BY ASP

SOIL PROFILE						DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	W _p	W	W _L		
81.7	GROUND SURFACE											
0.0	Interlayered Silty Sand Sandy Silt and Organic Silt with occ. seams of silty clay. Gray/Brown Loose to Black		1	SS	8							
79.9			2	SS	55							
2.0	END OF BOREHOLE											
	Bedrock - highly weathered fissile shale Grey											

NOTE

THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵ : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 103

METRIC

115

W P GGE-000-60
(EGG-000-53)

LOCATION Co-ord. N 4,856,245 E 341,465

ORIGINATED BY HCO

DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger

COMPILED BY EFO

DATUM GEODETIC DATE March 12, 1984

CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
84.9	GROUND SURFACE										
84.3	Topsoil										
0.6	Silty Clay, occ. sand		1	SS	9						
83.5	seam. firm Brown										
1.4	Silty Clay with sand, some gravel, occ. silty clay and silt layers.		2	SS	14						
			3	SS	12						
81.5	Stiff Brown to Grey		4	SS	33						
3.4	Silty Clay, some sand trace gravel grading to Silty Clay with shale fragments.										
79.7	Very Stiff Grey to Dark Grey		5	SS	28						
5.2	Bedrock - highly weath- ered fissile shale.										
78.8	Grey		6	SS	150/						
6.1	END OF BOREHOLE				75mm						

Water level at elev. 84.6m on April 4, 1984

NOTE
THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 104

METRIC

116

W P GGE-000-60 LOCATION Co-ord. N 4,856,258 E 341,513 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM GEODETIC DATE March 12, 1994 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					
86.3	GROUND SURFACE													
0.0	Silty Clay with occ. sand seams, Varved		1	SS	13									
			2	SS	18									
83.6	Stiff to Very Stiff Brown		3	SS	5									
2.7	Silty Clay with sand, trace to some gravel.		4	SS	10									
			5	SS	3									
80.5	Firm Grey/Brown to Grey		6	SS	65									
5.8	Silty Sand, some grav- el, trace clay.													
78.6	Very Dense Grey		7	SS	100/100mm									
7.9	END OF BOREHOLE Bedrock - highly weathered shale. Dark Grey													

Water level at elev. 86.2m on April 4, 1984

NOTE
THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 105

METRIC

117

W P GGE-000-60
(EGG-000-53) LOCATION Co-ord. N 4,856,276 E 341,555 ORIGINATED BY HCO
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
DATUM GEODETIC DATE March 12, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)	GR SA SI CL			
89.2	GROUND SURFACE															
0.2	Topsoil															
	Sandy Silt, some grav- el, trace clay.		1	SS	19											
87.4	Compact Brown		2	SS	19											
1.8	Silty Sand, some grav- el, trace clay.		3	SS	13											
	Compact to Very Dense Grey		4	SS	65											
84.9																
4.3	Silty Clay with Sand, trace to some gravel grading to Sandy Silt, some clay at elev. 80.0 m.		5	SS	100/ 150mm											
			6	SS	93											
			7	SS	154											
			8	SS	118											
78.5	Hard Dark Grey															
10.7	Silty Clay with shale fragments, trace sand.		9	SS	150/ 50mm											
77.0	Hard Grey		10	AS	-											
12.2	Bedrock - highly to moderately weathered fissile shale.		11	SS	150/ 75mm											
75.5	Grey		12	SS	150/ 50mm											
13.7	END OF BOREHOLE															

Hole caved
to
elev.
85.5m

NOTE
THIS BOREHOLE IS
FOR SUBSURFACE
INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 106

METRIC 118

W P GGE-000-60 LOCATION Co-ord. N 4,856,290 E 341,587 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM GEODETIC DATE March 9, 1984 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					
92.8	GROUND SURFACE													
0.0	Silty Sand, trace clay occ. gravel.		1	SS	59									
			2	SS	91									
			3	SS	110									
89.6	Orange/ Brown to Grey Very Dense		4	SS	100/ 150mm									
3.2	Silt, trace sand to Sand and Silt, trace clay. Occ. gravel and boulders. Zones with fissile texture.		5	SS	50/ 75mm									
			6	SS	100/ 50mm									
85.8	Very Dense Grey		7	SS	100/ 114mm									
7.0	Silty Sand, some gravel, trace clay. Occ. boul- ders.		8	SS	100/ 125mm									
			9	SS	100/ 100mm									
82.8	Dark Brown/Grey Very Dense		10	SS	150/ 150mm									
10.0	Silty Clay with Sand, trace gravel.													
81.2	Very Dense Dark Brown													
11.6	Bedrock-highly weather- ed fissile shale. Grey													
80.5														
12.3	END OF BOREHOLE													

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

NOTE
THIS BOREHOLE IS
FOR SUBSURFACE
INFORMATION ONLY.

Water
level
at
elev.
91.1m
on
April
4,
1984

OFFICE REPORT ON SOIL EXPLORA. JN



RECORD OF BOREHOLE No 107

METRIC

119

W P GGE-000-60
(EGG-000-53)

LOCATION Co-ord. N 4,856,301 E 341,625

ORIGINATED BY ASP

DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger

COMPILED BY EFO

DATUM GEODETIC

DATE March 9, 1984

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
93.8	GROUND SURFACE													
0.0	Fill - Silty, Sand, trace gravel.													
93.0														
0.8	Silty Sand to Sandy Silt, trace clay, occ. gravel.		1	SS	38									
			2	SS	23									
			3	SS	28									
			4	SS	30									
	Compact to Dense Brown to Grey													
88.9			5	SS	20									
4.9	Silt, trace sand to Sand and Silt, trace clay, occ. to some gravel.													
			6	SS	108									
			7	SS	50									
	Very Dense Grey		8	SS	128									
83.7														
10.1	Silty Sand, trace gravel.		9	SS	100/150mm									
81.5	Very Dense Grey		10	SS	127/150mm									
12.3	Bedrock - completely to moderately weathered shale.													
80.1			11	SS	100/0mm									
13.7	END OF BOREHOLE													

Water level at elev. 91.3m on April 4, 1984

NOTE
THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 108

METRIC

120

W P GGE-000-60 LOCATION Co-ord. N 4,856,310 E 341,654 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM GEODETIC DATE March 8 and 9, 1984 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					
94.1	GROUND SURFACE															
	Fill - Silty Sand, trace gravel.		1	SS	11											
92.7	Compact Orange/Brown															
1.4	Silty clay, trace sand and gravel to Sandy Silt, some clay.		2	SS	24											
91.2	Very Stiff to Hard Brown		3	SS	31											
2.9	Layered Sandy Silt, Silty Sand and Silt, trace sand; trace clay, occ. to trace gravel. Occ. coarse sand seams.		4	SS	118/250mm											
			5	SS	55											
			6	SS	50											
	Dense to Layered Very Dense Brown and Grey		7	SS	39											- 16 74 10
85.6																
8.5	Silt, some clay, trace sand, occ. gravel.		8	SS	33											
			9	SS	54											- 3 83 14
	Dense to Very Dense Grey		10	SS	142											
81.6																
12.5	Silty Sand, trace to some gravel.		11	SS	100/100mm											
79.2	Very Dense Grey															
78.8			12	SS	150/											
15.3	END OF BOREHOLE				75mm											
	Bedrock - moderately weathered fissile shala Grey															

+³, x⁵: Numbers refer to Sensitivity

20
15
10

NOTE
THIS BOREHOLE IS
FOR SUBSURFACE
INFORMATION ONLY.

Water level
at
elev.
91.4m
on
April
4,
1984

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 109

METRIC

121

GGE-000-60
W P (EGG-000-53) LOCATION Co-ord. N 4,856,321 E 341,687 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Hollow Stem Auger COMPILED BY EFO
DATUM GEODETIC DATE March 8, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	Wp W Wl	10 20 30	GR SA SI CL		
91.4	GROUND SURFACE												
90.8	TOPSOIL												
0.6	Silty Clay, trace sand, occ. gravel and silt parting.		1	SS	5								
	Mottled to Varved Brown and Grey		2	SS	8								
	Firm to Very Stiff		3	SS	13								
88.0			4	SS	2								
3.4	Silty Clay with sand and gravel. Occ. zones and layers of silty clay, trace sand.		5	SS	1								
			6	SS	1								
			7	SS	3								
83.5	Soft to Firm Brown to Grey		8	SS	31								
7.9	Silty Sand, trace to some clay and gravel.		9	SS	53								
			10	SS	57								
			11	SS	49								
78.8	Dense to Very Dense Grey		12	SS	157								
12.6	END OF BOREHOLE												

Piez. plug-
ged at
elev.
84m.
Water
level
at
elev.
87.0m
on
April
4,
1984

NOTE
THIS BOREHOLE IS
FOR SUBSURFACE
INFORMATION ONLY.

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 110

METRIC 122

W P GGE-000-60 LOCATION Co-ord. N 4,856,331 E 341,726 ORIGINATED BY ASP
 (EGG-000-53)
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM GEODETIC DATE March 8, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE			VALUES	20 40 60 80 100	Wp W W _L	Wp W W _L	Wp W W _L		
92.4	GROUND SURFACE											
0.2	TOPSOIL											
	Silty Clay, trace to some sand and gravel.	1	SS	7								
90.3	Stiff to Mottled to Very Varved Gray and Brown	2	SS	10								
2.1	Silty Sand, some gravel, trace to some clay. Occ. zones of sandy silt.	3	SS	5								
		4	SS	5								
		5	SS	82								
85.4	Loose to Brown to Very Dense Gray	6	SS	118								
7.0	Silty Sand to Sand, some silt, trace to some clay and gravel.	7	SS	60								
		8	SS	100/50mm								
81.9	Very Dense Gray	9	SS	100/114mm								
10.5	Silty Clay with shale fragments.	10	SS	200/150mm								
80.2	Hard Gray/Brown	11	SS	150/150mm								
12.3	END OF BOREHOLE Bedrock - highly weathered shale. Gray/Brown											

Water level at elev. 91.9m on April 4, 1984

NOTE
THIS BOREHOLE IS FOR SUBSURFACE INFORMATION ONLY.

RECORD OF BOREHOLE No 111

METRIC 123

W P GGE-000-60 LOCATION Co-ord. N 4,856,322 E 341,690 ORIGINATED BY HCO
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Auger COMPILED BY EFO
 DATUM GEODETIC DATE March 13, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			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	20 40 60 80 100	W _p	W		
91.6	GROUND SURFACE												
0.0	Topsoil												
90.8													
0.8	Silty Clay, trace sand, occ. gravel.		1	SS	7								
			2	SS	9								
	Stiff Mottled to to Varved Very Grey and Stiff Brown		3	SS	3								
87.6													
4.0	Silty Clay with Sand, trace to some gravel.		4	SS	2								
			5	SS	5								
84.6	Firm Grey												
7.0	Silty Sand, some gravel, trace to some clay.		6	SS	48								
			7	SS	35								
80.5	Dense Grey		8	SS	34								
11.1	END OF BOREHOLE												

Water level in open hole at elev. 91.4m on March 13, 1984

NOTE
THIS BOREHOLE IS
FOR SUBSURFACE
INFORMATION ONLY.

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

OFFICE REPORT ON SOIL EXPLORATION

FOUNDATION INVESTIGATION REPORT

For

Storm Sewer - Westney Road

Station 10+490 to 10+970INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out between 84 05 30-31. During this period a total of 10 sampled boreholes were advanced to depths of up to 7.0 m. In order to monitor groundwater conditions, a total of 4 piezometers were installed.

REGIONAL GEOLOGY

The sites are located in the physiographic region known as the Iroquois Plain¹ which resulted from inundation by Lake Iroquois during the last glaciation. The general area is underlain by glacial drift with thin surficial glaciolacustrine deposits of the Pleistocene Era underlain by glacial till and shale bedrock. The glacial drift is described by Caley² as a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses.

SITE DESCRIPTION

The site extends for a distance of 480m between about 200m south of Fairall Rd. and 215 m north of Bayly St. W. (Sta. 10+590 and 10+970, respectively). The terrain is relatively level to gently sloping towards a small creek at Sta. 10+860. A swampy area exists to the west of the site between about Sta. 10+525 and 10+630 and appears to have been partially filled to the north of Sta. 10+525.

¹ Chapman, L.J. and Putnam, D. E. "The Physiography of Southern Ontario". University of Toronto Press, Toronto, Ontario, 1966.

² Caley J.F. Clark, T.H. and Owen, E.B. "Groundwater Resources of Pickering Township, Ontario County", Ontario Dept. of Mines and Tech. Surveys, Water Supply Paper 285, 1947.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The detailed stratigraphy encountered in each boring, together with the results of the laboratory tests carried out on representative samples, are given on the Record of Borehole sheets and on Fig. 7 to 11, inclusive. The borehole locations with an inferred profile and section are shown on Drawing No. S-005. It should be noted that the stratigraphic boundaries indicated on the Record of Borehole sheets and on the stratigraphic sections are inferred from non-continuous sampling and represent a transition between soil types rather than an exact plane of geologic change. Conditions will vary between boreholes.

In general, the site is underlain by up to 1.2 m of a material which ranges from silty clay with sand to silty sand with a trace to some organic material which in turn is underlain by up to 1.0 m of organic silt. The fill in the northern section and the organics along the remainder of the site are underlain by silty clay with varying percentages of sand and gravel which in turn is underlain by silty sand. The following is a detailed description of the subsoils encountered:

Topsoil, Fill and Organic Silt

All boreholes encountered about 0.2 m of topsoil at ground surface. The topsoil is underlain by 0.7 to 1.2 m of a material which consists of dark brown silty clay with sand, some organic material and trace gravel (Fig. 7) to silty sand with some clay. It is considered that this deposit is a fill material derived from the underlying soils. The water content of samples of the fill ranged from 11 to 19%. The silty clay fill generally has a firm consistency and the granular zones range from very loose to compact.

The fill materials are underlain in all boreholes except numbers 501 and 502, by about 0.1 to 1.0 m of organic silt to silty clay. The water content of a sample of the organic sandy silt was 21%.

Silty Clays

In BH 501, 502 and 505, about 0.9 to 1.0 m of mottled to varved brown silty clay with a trace of sand (Fig. 8) was encountered underlying the organic material. About 0.9 to 4.2 m of a deposit which generally consists of silty clay with sand and some gravel (Fig. 9), underlies the organic material and the silty clay

where encountered in all boreholes except number 505. In BH 506 to 510, inclusive, the deposit has interlayers of silty clay, silty sand with some clay and sandy silt. The 'N' values obtained in the silty clay deposits ranged from 2 to 14 blows per 0.3 m. Insitu vane tests indicated undrained shear strength (C_u) values of 44 to greater than 96 kPa. Based on these data it is considered that the deposit generally has a firm to very stiff consistency but contains occasional zones with very soft to soft consistency. Water contents of samples of the varved silty clay ranged from 24 to 41% while water contents of samples of the silty clay with sand were generally between 12 and 16%. An Atterberg Limits test on the varved silty clay gave liquid limit and plasticity index of 51 and 28%, respectively, indicating a clay of high plasticity (Fig. 10). A sample of the silty clay with sand had a liquid limit and plasticity index of 21 and 7, respectively, indicating the fines portion of the material to be a clay of low plasticity (Fig. 11).

Silty Sand and Silt

All boreholes except numbers 502 and 503 were terminated within a deposit which consists of silty sand with a trace to some clay and gravel and which underlies the silty clays. The upper approximately 0.75 to 2.5 m of this material is generally in a very loose to compact state of packing with 'N' values less than 10 blows/0.3 m. Below this zone the 'N' values increase significantly to greater than 30 blows/0.3 m indicating a dense to very dense state of packing. Water contents measured on samples of the silty sand ranged from 7 to 9%.


In BH 503 the silty sand was underlain by silt with a trace of sand which was penetrated for a depth of 0.6 m. The silt is in a very dense state of packing with one 'N' value of 68 blows/0.3 m.

GROUNDWATER CONDITIONS

The stabilized groundwater levels measured in the piezometers installed in the boreholes were about 1.2 to 1.7 m below ground surface (elevation 91.0 to 87.3 m).



B.E. Ruck
Project Foundations Engineer



M.S. Devata
Chief Foundations Engineer (East)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

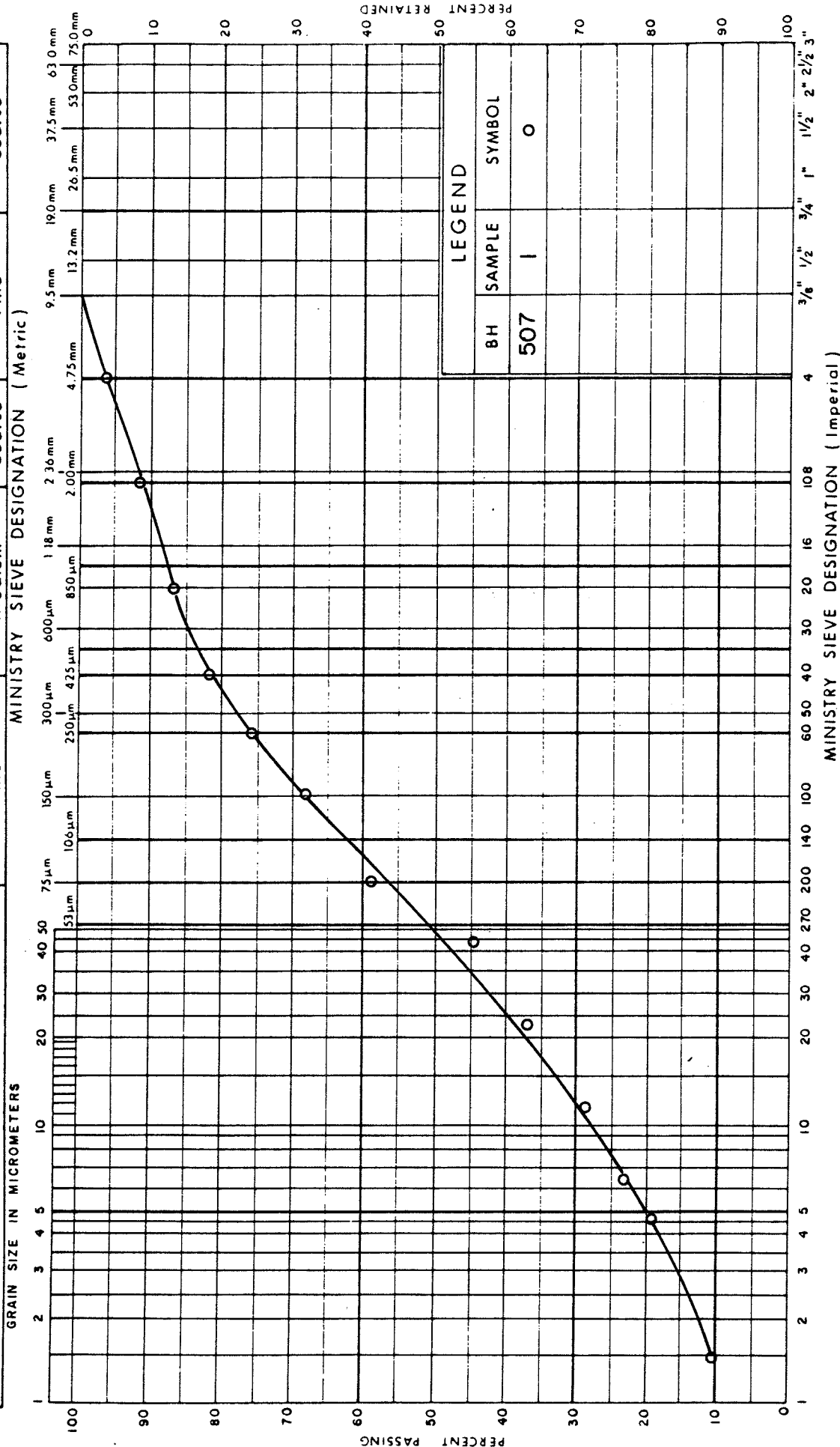


FIG No 7

W P GGE-000-60

GRAIN SIZE DISTRIBUTION

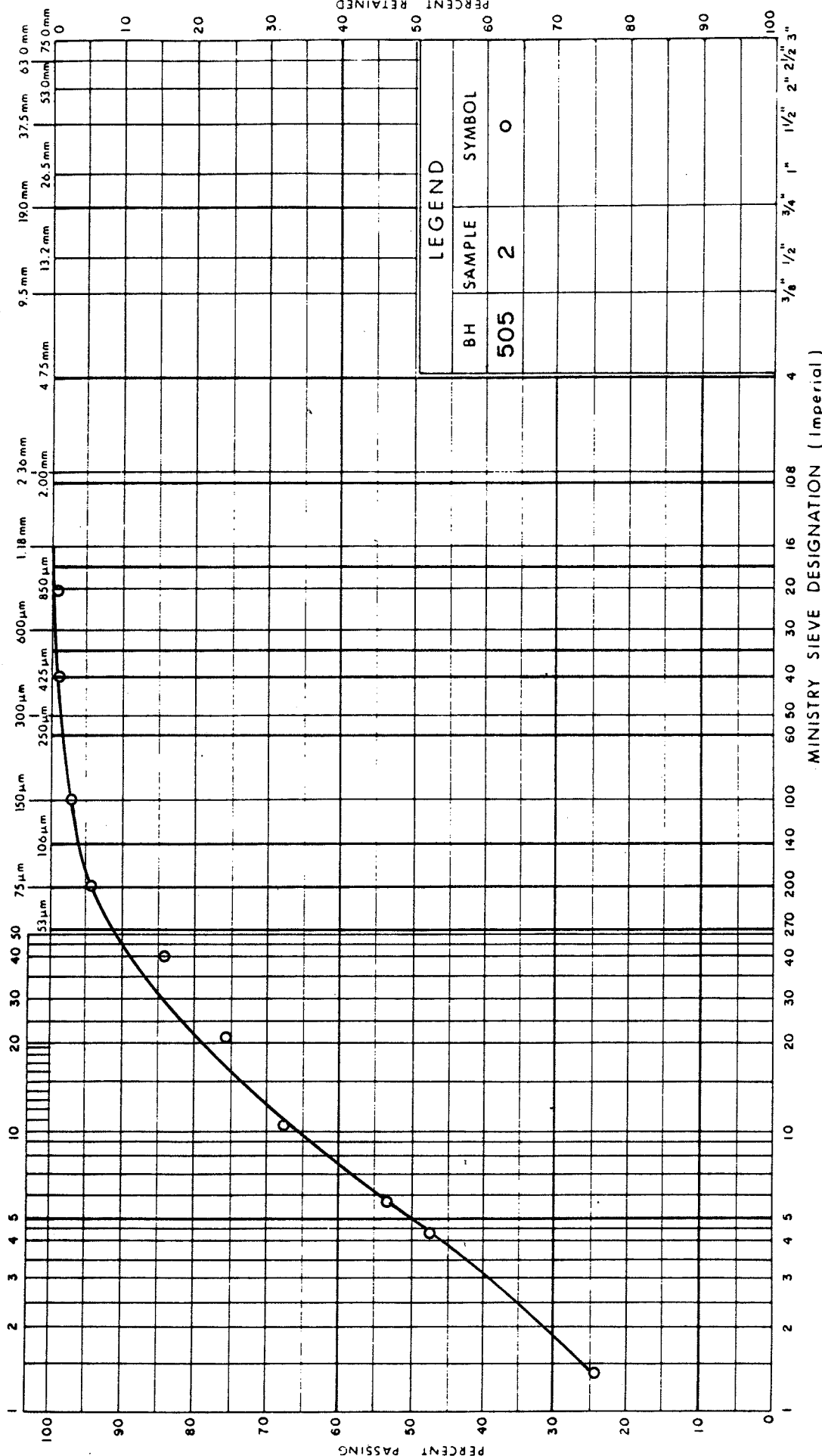
FILL - SILTY CLAY WITH SAND

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation and
Communications



GRAIN SIZE DISTRIBUTION
VARVED SILTY CLAY

FIG No 8

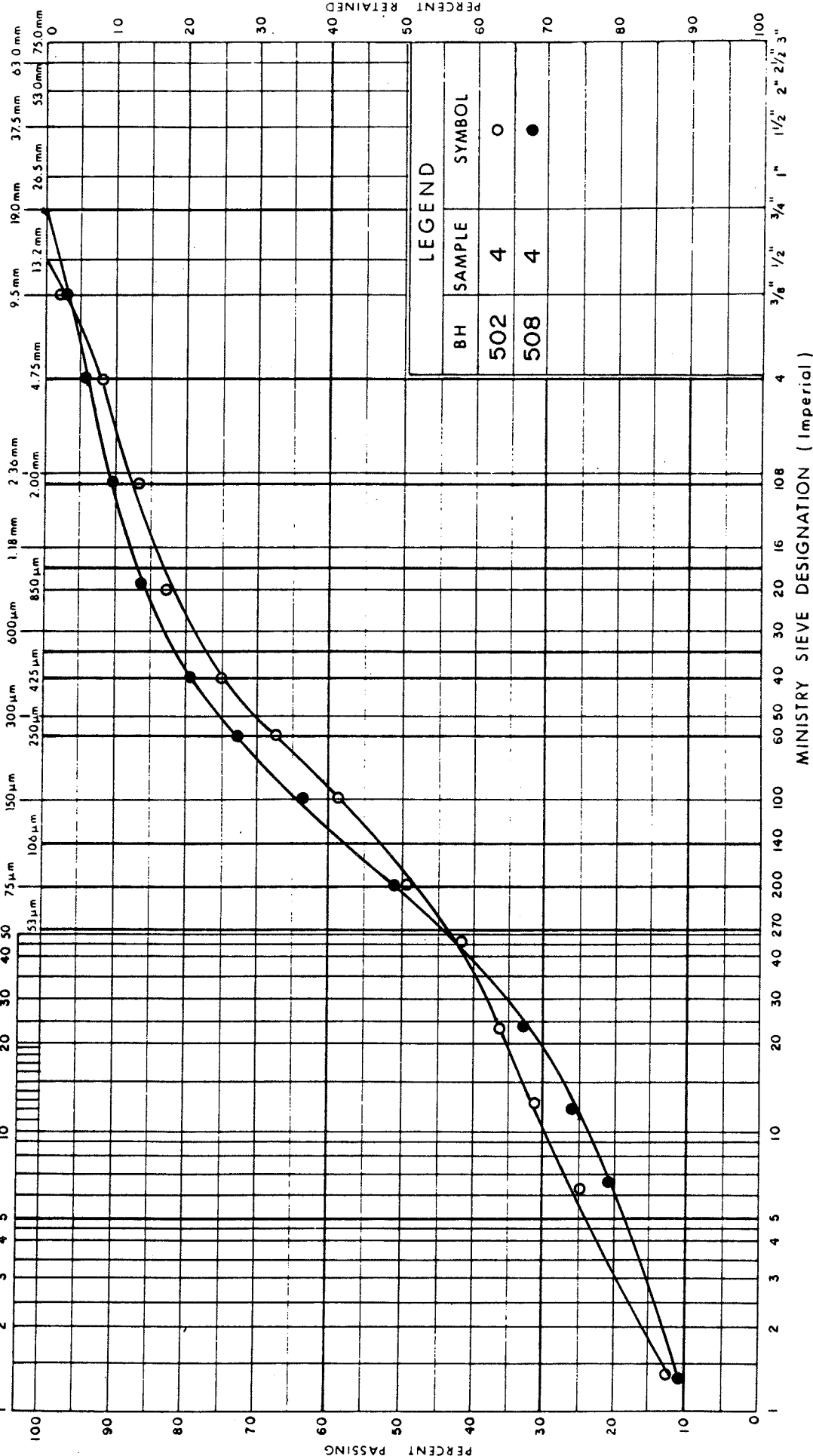
W P GGE-000-60

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of
Transportation and
Communications



GRAIN SIZE DISTRIBUTION SILTY CLAY WITH SAND

FIG No 9

W P GGE-000-60

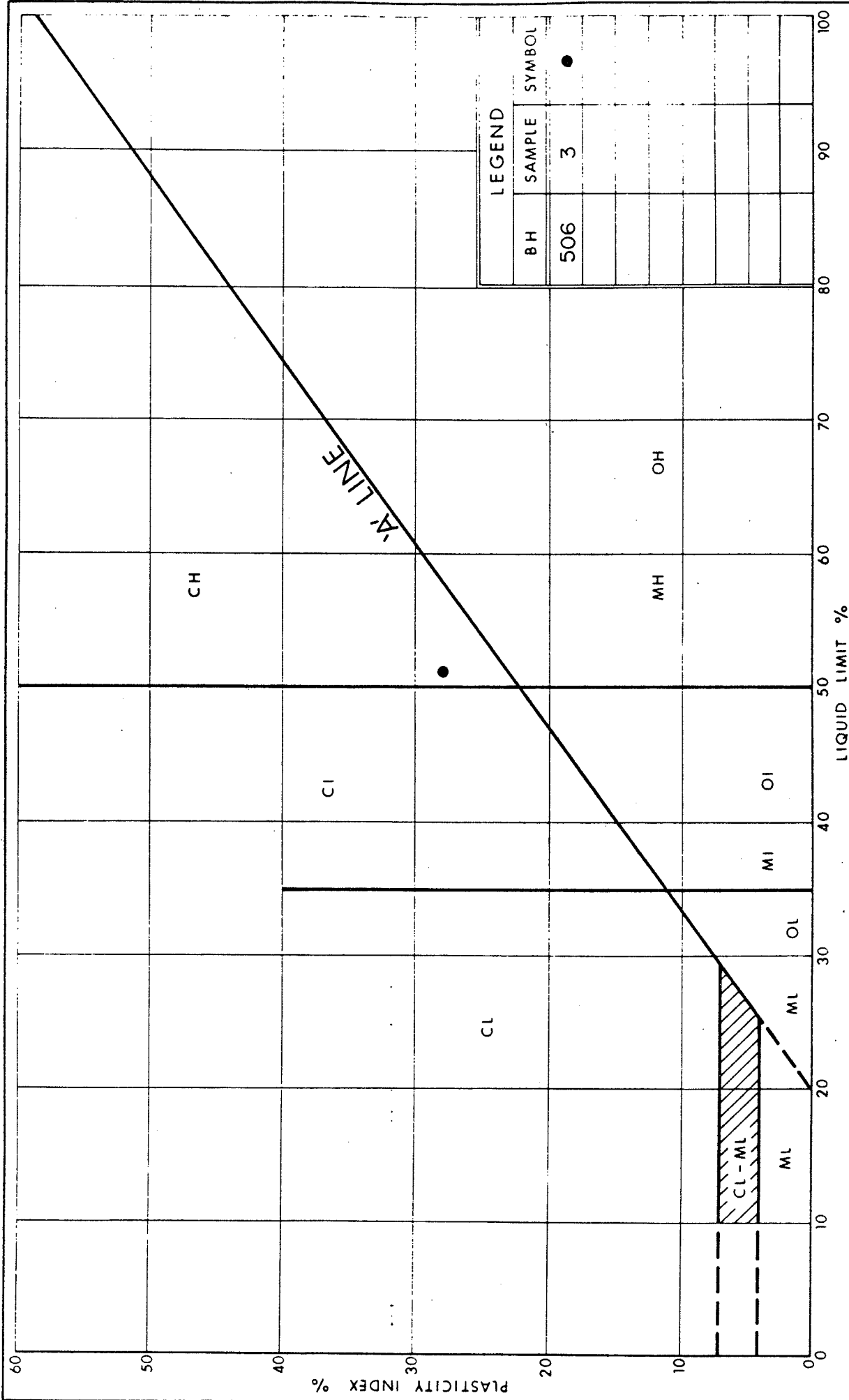


FIG No 10

W P GGE-000-60

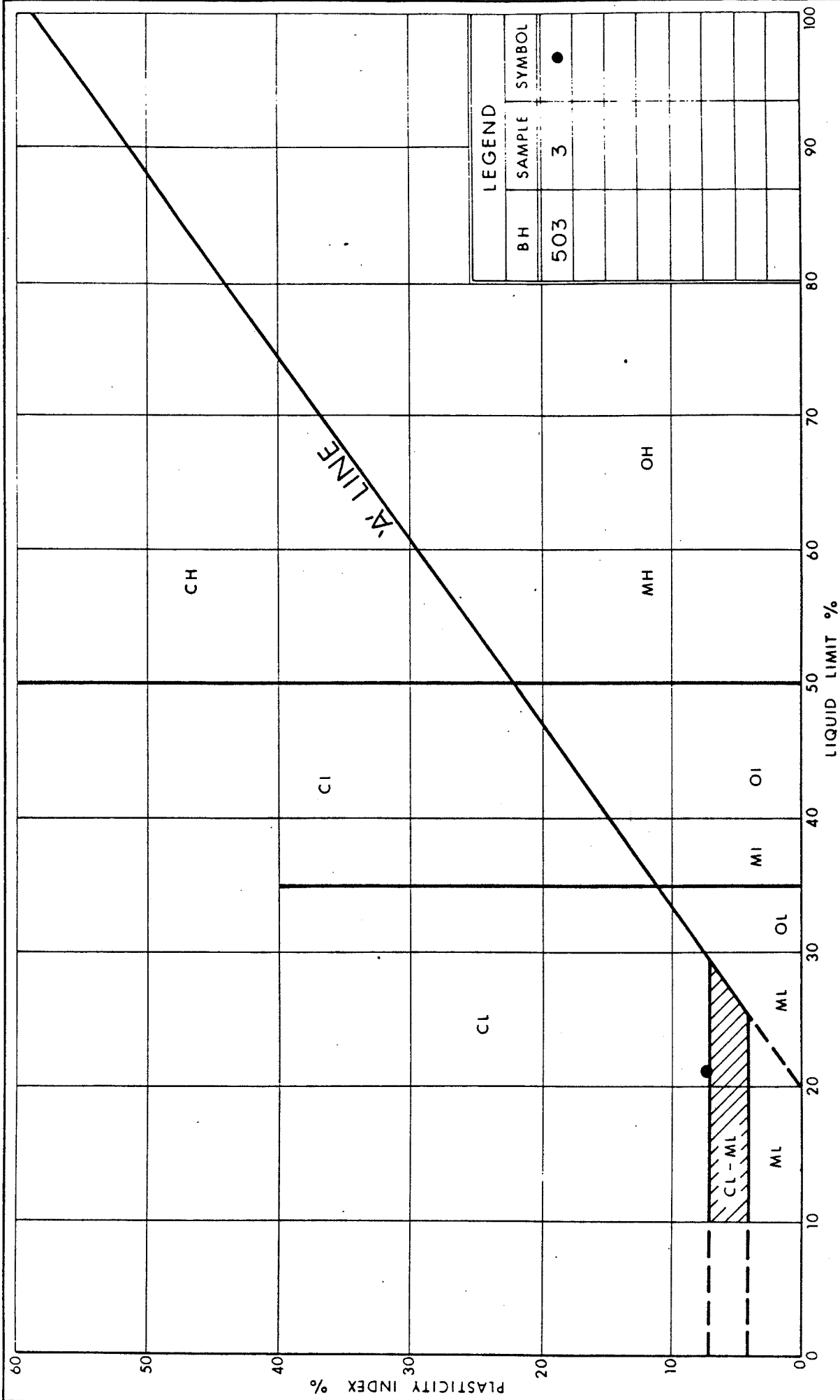


FIG No II

W P GGE-000-60

132

Ministry of
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Communications



W P GGE-000-60 LOCATION Co-ord. N 4,856,006 E 341,935 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY MHW
DATUM Geodetic DATE May 30, 1984 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					
92.7	Topsoil. GROUND SURFACE												
0.2	Fill - Silty Clay with sand, some organics.												
91.6	Firm Dark Brown		1	SS	9								
1.1	Silty Clay, trace sand and gravel; varved.												
90.6	Firm Brown		2	SS	10								
2.1	Silty Clay with sand, some gravel.		3	SS	10								
89.3	Firm Brown		4	SS	7								
3.4	Silty Sand, trace to some clay and gravel.		5	SS	5								
87.7	Loose to Dense Grey/Brown		6	SS	38								
5.0	END OF BOREHOLE												

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 502

METRIC

134

W P GGE-000-60 LOCATION Co-ord. N 4,855,979 E 341,957 ORIGINATED BY ASP
DIST 6 HWY GO²ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 30, 1984 CHECKED BY ASP

[illegible]

+3, x⁵: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 503

METRIC

135

W P GGE-000-60 LOCATION Co-ord. N 4,855,943 E 341,981 ORIGINATED BY BL
DIST 6 HWY GO-AIRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 30, 1984 CHECKED BY ASP

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 504

METRIC

136

W P GGE-000-60 LOCATION Co-ord. N 4,855,905 E 342,008 ORIGINATED BY BL
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 30, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W _p	W	W _L	WATER CONTENT (%)					
91.6	Topsoil.																
	GROUND SURFACE																
90.4	Fill - silty sand, some clay.		1	SS	12												
89.8	Compact Brown Organic Sandy Silt.		2	SS	7												
89.8	Loose Dark Brown		3	SS	5												
88.0	Silty Clay with sand, some gravel.		4	SS*	7												
88.0	Firm Mottled Brown and Grey		5	SS	8												
86.6	Silty Sand, trace to some clay and gravel. Loose to Dense Brown/Grey		6	SS	46												
5.0	END OF BOREHOLE																

Water level in piezometer at elev. 90.3 m on June 4, 1984

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 505

METRIC

137

W P GGE-000-60 LOCATION Co-ord. N 4,855,871 E 342,030 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 30, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	Wp W WL	Wp W WL			
91.5	Topsoil.												
	GROUND SURFACE												
0.2	Fill - silty clay												
90.7	Organic Silt		1	SS	14								
90.4	Silty Clay, trace sand: varved.		2	SS	20								
89.4	Very Stiff Brown		3	SS	15								
2.1	Silty Sand, some clay and gravel with occ. seams of varved silty clay and sandy silt.		4	SS	5								
	Loose to Very Dense		5	SS	4								
86.5	Brown to Brown/Grey		6	SS	62								
5.0	END OF BOREHOLE												

Water level in open borehole at elev. 89.4 m on May 30, 1984

+3, x5: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 506

METRIC 138

W P GGE-000-60 LOCATION Co-ord. N 4,855,838 E 342,049 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
91.2	Topsoil.																
	GROUND SURFACE																
0.2	Fill - Silty Clay, some sand and organics.		1	SS	10												
89.6	Firm Organic Silt		2	SS	5												
1.7	Interlayered Silty Clay, trace sand and Silty Clay with sand, some gravel.		3	SS	7												
			4	SS	7												
	Firm to Very Stiff		5	SS	6												
86.3	Brown and Grey		6	SS	6												
4.9	Silty Sand, trace to some clay and gravel. Loose to Very Dense																
84.7	Grey		7	SS	71												
6.5	END OF BOREHOLE																

Water level in open borehole at elev. 88.5 m on May 31, 1984

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 507

METRIC

139

W P GGE-000-60 LOCATION Co-ord. N 4,855,803 E 342,068 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			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	W _p	W	W _L		
90.6	Topsoil.													
	GROUND SURFACE													
0.2	Fill - Silty clay with sand, some organics.		1	SS	10									
89.4	Organic Silt													
1.4	Interlayered Silty Clay with sand, some gravel and varved Silty Clay, trace sand.		2	SS	7									
			3	SS	13									
			4	SS	4									
85.7	Firm to Stiff Brown to Grey		5	SS	6									
4.9	Silty Sand, trace to some clay and gravel.													
84.2	Loose to Very Dense Brown/grey		6	SS	32/150mm									
6.4	END OF BOREHOLE													

Water level in piezometer at elev. 88.9 m on June 4, 1984

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 508

METRIC 140

W P GGE-000-60 LOCATION Co-ord. N 4,855,768 E 342,087 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W _p	W	W _L			
90.1	Topsoil.													
0.1	GROUND SURFACE													
0.2	Fill - Silty Clay with sand.		1	SS	16									
88.7	Stiff Brown		2	SS	9									
1.4	Organic Sandy Silt to Silty Clay.		3	SS	5									
87.7	Firm Dark Grey		4	SS	6									
2.4	Interlayered Silty Clay Silty Clay with sand, some gravel and Silty Sand, some clay.		5	SS	8									
85.2	Firm Brown		6	SS	8									
4.9	Silty Sand, trace to some clay, trace gravel.		7	SS	2									
83.1	Very loose to Compact Grey		8	SS	28									
7.0	END OF BOREHOLE													

Water level in open borehole at Elev. 88.6m on May 31, 1984

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 509

METRIC

141

W P GGE-000-60 LOCATION Co-ord. N 4,855,725 E 342,103 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W _p	W		
89.3	Topsoil.															
89.3	GROUND SURFACE															
0.2	Fill - Silty clay, trace sand, some organics. Firm Brown		1	SS	10											
87.8	Organic Silty Clay.		2	SS	11											
1.7	Silty Clay with sand, some gravel. Occ. layers and lenses of silty clay, sandy silt and silty sand.		3	SS	14											
			4	SS	9											
			5	SS	2											
83.4	Very soft to stiff															
82.8	Brown to Grey		6	SS	57											
6.5	END OF BOREHOLE															
	Silty Sand, trace clay and gravel. Very Dense Grey															

Water level in open borehole at Elev. 87.5m on May 31, 1984

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 510

METRIC 142

W P GGE-000-60 LOCATION Co-ord. N 4,855,687 E 342,114 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W _p	W	W _L		
88.5	Topsoil. GROUND SURFACE												
0.2	Fill - silty clay with sand, some organics.		1	SS	4								
86.8	Soft Brown		2	SS	11								
86.4	Organic Silty Clay.		3	SS	11								
2.1	Silty Clay with sand, trace to some gravel.		4	SS	6								
84.4	Soft to Firm Brown and Grey		5	SS	5								
4.1	Silty Sand, trace to some clay and gravel with occ. fine sand and fine sandy silt seams.		6	SS	11								
81.5	Loose to Compact Grey		7	SS	29								
7.0	END OF BOREHOLE												

Water Level in piezometer at Elev. 87.3m on June 4, 1984

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

For

Twin Box Rigid Concrete Box Culvert

Westney Road, Station 0+266 to 0+395INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers carried out a foundation investigation at the above-noted site under the technical supervision of the MTC Foundation Design Section, for GO-ALRT.

The fieldwork for this investigation was carried out on 84 05 31 and consisted of 3 sampled boreholes advanced to depths of up to 8.0 m. Two piezometers were installed so that the groundwater levels could be measured.

REGIONAL GEOLOGY

The sites are located in the physiographic region known as the Iroquois Plain¹ which resulted from inundation by Lake Iroquois during the last glaciation. The general area is underlain by glacial drift with thin surficial glaciolacustrine deposits of the Pleistocene Era underlain by glacial till and shale bedrock. The glacial drift is described by Caley² as a heterogeneous mixture of gravel, sand, silt and clay with numerous sand and gravel lenses.

SITE DESCRIPTION

The site is located about 40 m south of the intersection of Westney Rd. South and Fairall Rd. at about Westney Rd. Sta. 10+230. The site is at present partially occupied by three CN Rail buildings, a parking area and a railway spur. A small creek is located at about Sta. 0+260 and a swampy depression extends across the alignment between about Sta. 0+370 and 0+380.

¹ Chapman, L.J. and Putnam, D.F. "The Physiography of Southern Ontario". University of Toronto Press, Toronto, Ontario, 1966.

² Caley J.F. Clark, T.H. and Owen, E.B. "Groundwater Resources of Pickering Township, Ontario County", Ontario Dept. of Mines and Tech. Surveys, Water Supply Paper 285, 1947.

SUBSURFACE CONDITIONS

Soil Stratigraphy

The detailed soil stratigraphy encountered in each boring, together with the results of laboratory tests carried out on representative samples, are given on the Record of Borehole sheets and on Fig. 12 and 13. The borehole locations, together with an inferred profile and section, are shown on Drawing No. S-070. It should be noted that the stratigraphic boundaries indicated on the Record of Borehole sheets and on the stratigraphic section are inferred from non-continuous sampling and represent a transition between soil types rather than an exact plane of geologic change. Conditions will vary between boreholes.

The surficial deposits overlying the site consist up to 6.1 m of silty clay with varying percentages of sand and gravel which in turn is underlain by silty sand. In the eastern portion of the site, the silty sand deposit is about 1.8 m thick and is underlain by silty clay. The following is a detailed description of the subsoils encountered:

Fill and Topsoil

In BH 401 and 402 about 0.3 m of topsoil was encountered at ground surface. In BH 403, about 1.1 m of fill consisting of silty sand with some gravel was encountered. The fill is in a compact state of packing as indicated by one 'N' value of 13 blows/0.3 m.

Silty Clay

In all boreholes, the fill and/or topsoil is underlain by 0.6 to 1.8 m of mottled and occasionally varved brown silty clay with trace sand. In BH 402 and 403, this deposit contained some organic material. Based on 'N' value of 8 to 18 blows/0.3 m, the silty clay is considered to have a firm to stiff clay ranged from 20 to 26%.

In BH 403, the lower 2.6 m of this deposit is interlayered with silty clay with sand and some gravel. Insitu vane tests carried out in this deposit indicated undrained shear strength (Cu) values of 90 to greater than 96 kPa. It is considered that the deposit has a stiff consistency and that the larger Cu values are influenced by gravelly layers.

Silty Clay With Sand

In BH 402, the silty clay is underlain by about 4.0 m of silty clay with sand and some gravel and containing occasional zones of silty sand with gravel and some clay. The deposit is considered to have a firm to stiff consistency with C_u values of 49 to 92 kPa as determined by insitu vane tests. Sensitivity values of 5 to 7 were obtained during these tests. Water contents of samples of this material ranged from 11 to 20% and one Atterberg Limits test gave a liquid limit and plasticity index of 21 and 9%, respectively (Fig. 12). The natural moisture content of this material is close to the liquid limit, reflecting the sensitivity of the material.

Silty Sand

In all boreholes the silty clays are underlain by grey silty sand to silt and sand with a trace to some clay and gravel (Fig. 13). BH 402 and 403 were terminated in this deposit. In these two boreholes the upper approximately 0.7 m of this deposit is in a very loose state of packing with 'N' values of 27 to 80 blows/0.3 m. Water contents of samples of this deposit ranged from 8 to 10%.

Lower Silty Clay

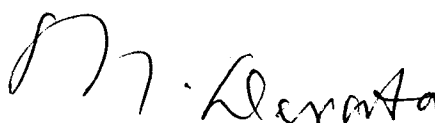
BH 401 was terminated in a deposit consisting of dark brown silty clay with occasional gravel and containing silt and fine sand partings. The clay has a hard consistency with 'N' values generally greater than 80 blows/0.3 m. Water contents of samples of this clay ranged from 7 to 12%.

GROUNDWATER CONDITIONS

The stabilized groundwater levels measured in the piezometers were at about elevation 92.0 to 92.5 m (about 0.9 to 2.0 m below ground surface).

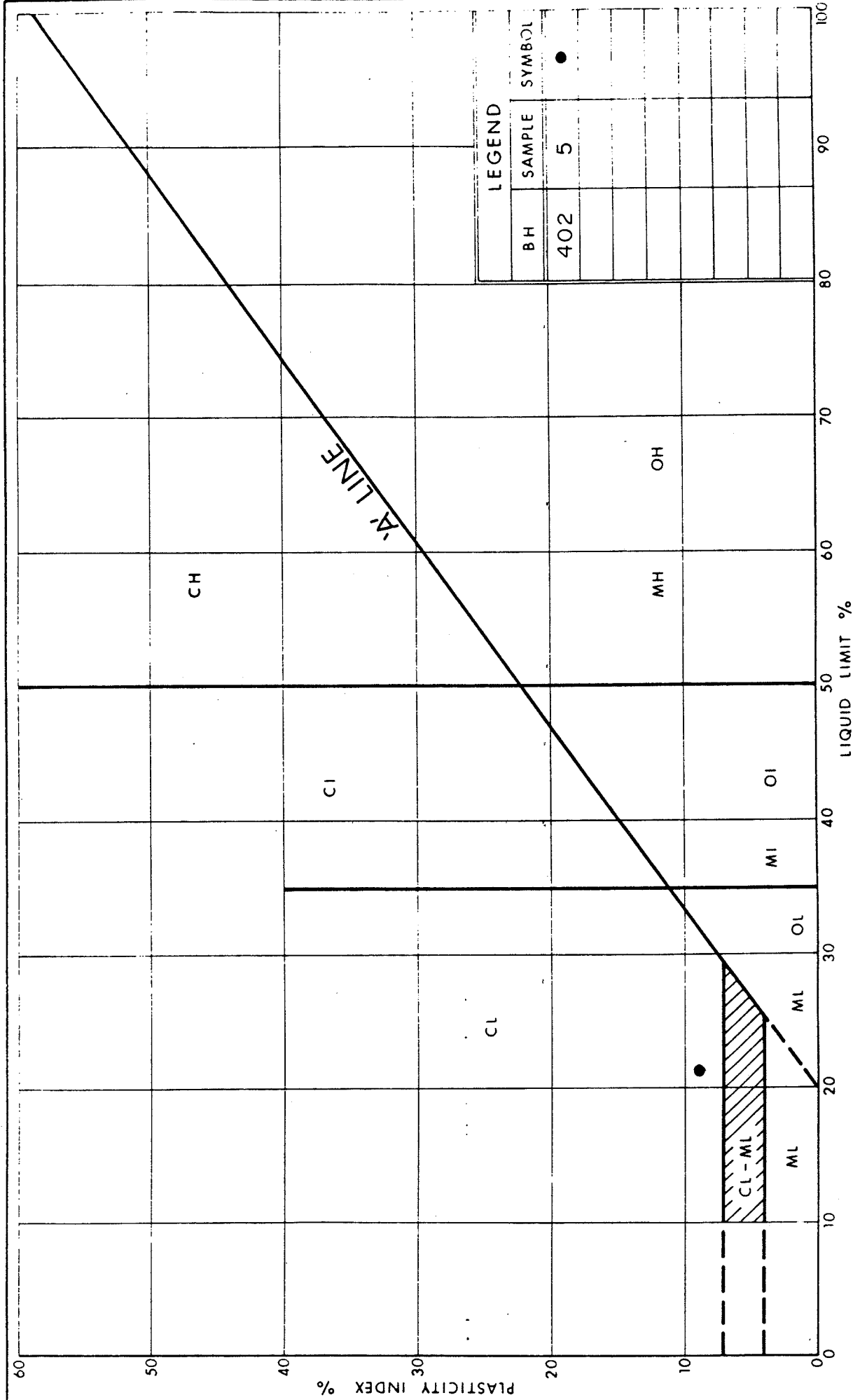


B.E. Ruck
Project Foundations Engineer



M.S. Devata
Chief Foundations Engineer (East)

APPENDIX



PLASTICITY CHART SILTY CLAY WITH SAND

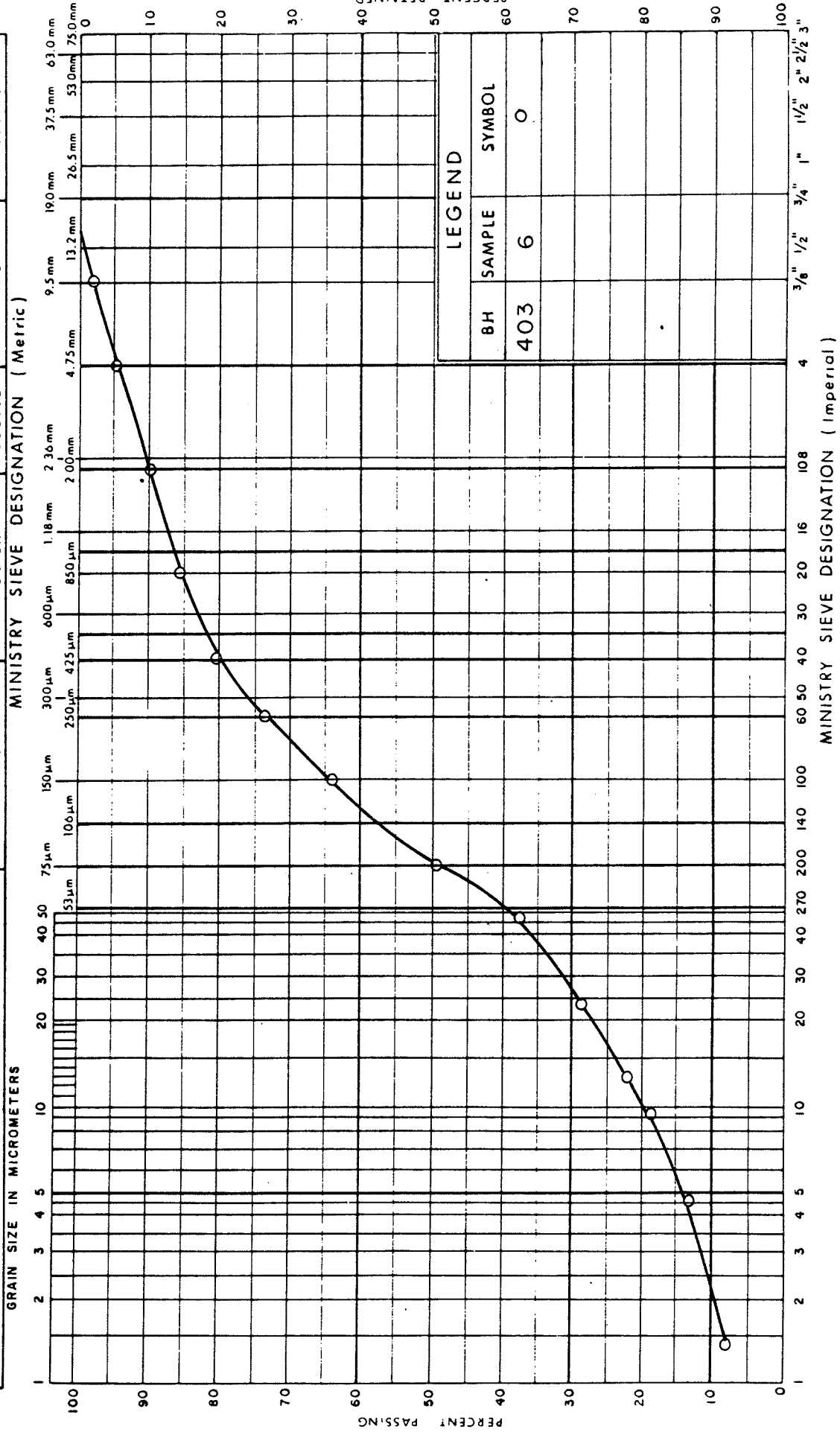
FIG No 12

W P GGE-000-60

147

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine		Medium	Coarse	Fine	Coarse
MINISTRY SIEVE DESIGNATION (Metric)							



GRAIN SIZE DISTRIBUTION SILT AND SAND

Ministry of
Transportation and
Communications



FIG No 13

W P GGE-000-60



RECORD OF BOREHOLE No 401

METRIC

149

W P GGE-000-60 LOCATION Co-ord. N 4,856,237 E 341,812 ORIGINATED BY ASP
DIST 6 HWY GO-ALRT BOREHOLE TYPE SOLID Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 31, 1984 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	SHEAR STRENGTH					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
94.5	GROUND SURFACE													
0.2	Topsoil.													
92.7	Silty Clay, trace to some sand and gravel. Firm Brown		1	SS	8									
1.8	Silty Sand, trace to some clay, trace gravel. Compact to Brown Dense to Grey		2	SS	20									
90.9			3	SS	27									
3.6			4	SS	43									
	Silty Clay, occ. gravel to silty clay, some sand and gravel. Silt and sand partings to 6.7 m depth. Occ. shale fragments.		5	SS	76/ 275 mm									
			6	SS	79									
			7	SS	110/ 175 mm									
86.5	Hard Dark Brown		8	SS	93									
8.0	END OF BOREHOLE													

Water Level
in piezo-
meter at
Elev. 92.5m
on June 4,
1984.

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 402

METRIC 150

W P GGE-000-60 LOCATION Co-ord. N 4,856,160 E 341,784 ORIGINATED BY BL
DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
DATUM Geodetic DATE May 31, 1984 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W _p W W _L	WATER CONTENT (%)			
92.9	GROUND SURFACE													
0.3	Topsoil.													
	Silty Clay, trace sand, occ. gravel, some organic material.		1	SS	8									
90.8	Firm to Very Stiff Brown		2	SS	18									
2.1	Silty Clay with sand, some gravel; occ. zones of silty sand and gravel with some clay.		3	SS	13									
			4	SS	6									
			5	SS	3									
86.8	Firm to Stiff Mottled Grey and Brown													
6.1	Silty Sand, trace to some clay and gravel.		6	SS	2									
	Very loose to Dense Grey													
84.9			7	SS	44									
8.0	END OF BOREHOLE													

Water level in piezo-meter at Elev. 92.0m on June 4, 1984.

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

RECORD OF BOREHOLE No 403

METRIC 151

W P GGE-000-60 LOCATION Co-ord. N 4,856,201 E 341,795 ORIGINATED BY ASP
 DIST 6 HWY GO-ALRT BOREHOLE TYPE Solid Stem Augers COMPILED BY EFO
 DATUM Geodetic DATE May 31, 1984 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					
93.6	GROUND SURFACE												
0.0	Fill-silty sand, some gravel. Compact Brown		1	SS	13								
92.5	Organic Silty Clay.		2	SS	13								
91.9	Silty Clay, trace sand, occ. gravel with layers of silty clay with sand some gravel. Mottled Brown and Grey		3	SS	14								
1.7	Stiff		4	SS	6								
89.3	Silt and Sand to Silty Sand, trace to some clay and gravel. Very Loose to Brown/grey		5	SS	2								
4.3	Very Dense		6	SS	29								
87.1	END OF BOREHOLE		7	SS	80								
6.5													

Water level in open borehole at elev. 91.9 m on May 31, 1984.

5
+
+
>96 kPa

6 44 36 14

OFFICE REPORT ON SOIL EXPLORATION