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W.P. No. 202-87-00
(formerly 105-84-01/02)

CONT. No. 87-74

W. O. No.

STR. SITE No.

HWY. No. 401

LOCATION H.M.L. East of Yonge to
East of Bayview

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 87-74



Ontario

Ministry of
Transportation and
Communications

I N D E X

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NOTE: For purposes of the Contract this report supersedes all other reports prepared by or for the Ministry in connection with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT
for

High Mast Lighting
from East of Yonge Street
to East of Bayview Avenue
W.P. 202-87-00, Hwy. 401
District 6 - Toronto

3

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-noted site between 87 02 02 and 87 02 11. The fieldwork consisted of advancing one borehole at each of the 16 high mast light (HML) locations. The boreholes involved the sampling of the soil by means of the split spoon test, to depths ranging between 10.7 and 15.7 m below the shoulder pavement surface.

Boreholes are numbered BH 1 to BH 16, corresponding to the identifying number of the associated HML. The location of each borehole is shown in plan on Dwg. No. 2028700-A in the Appendix.

SITE DESCRIPTION

The site of the proposed 16 HML is located along Hwy.401 from approximately 450 m east of Yonge St. to approximately 700 m east of Bayview Ave. The site is located in the City of North York, Regional Municipality of York.

Outside the highway right-of-way, land use is primarily residential with some commercial development. Topography across the site is relatively flat.

Physiographically, the site lies within the region known as the South Slope (Ref: Chapman and Putnam, 'The Physiography of Southern Ontario', 3rd Ed., 1984). Specifically, the site is located in a till plain north of the past Lake Iroquois shoreline. The soil is a ground moraine which originated in the Pleistocene Age. Bedrock across the site consists of black and grey shale of the Georgian Bay Formation and is estimated to occur at 70 to 80 m below the ground surface. Boreholes in this investigation were not advanced to these depths.

SUBSURFACE CONDITIONS

The native deposits across the site are of glacial origin. Deposits of silty clay till, sand and silt till, fine sand, and silt are among the most predominant encountered within the investigation limits.

The boundaries between the various soil types, in-situ and laboratory test results, as well as groundwater levels are shown on the Record of Borehole Sheets in the Appendix.

Detailed descriptions of the various soil deposits are not given in this report. However, reference should be made to the appropriate Record of Borehole Sheet for subsurface conditions at each HML location.

Numerous laboratory tests were carried out on samples of soils from each borehole. These include Atterberg Limits, Grain Size Distribution and Moisture Content tests. The results are indicated on each Record of Borehole Sheet, and are summarized graphically in the Appendix.

For cross-reference to the Plasticity Charts, (Atterberg Limits results) the following should be used:

<u>Boreholes</u>	<u>Figure</u>
1	1
2	2
3	3
4	4
5	5
6	6
7,8	7
10,11	8
12,13,14	9
15,16	10

For typical Grain Size Distribution curves the following figures should be referenced.

<u>Borehole</u>	<u>Figure</u>	<u>Borehole</u>	<u>Figure</u>
1	11	9	19
2	12	10	20
3	13	11	21
4	14	12	22
5	15	13	23
6	16	14	24
7	17	15	25
8	18	16	26

The investigation revealed that the subsurface conditions across the site are not consistent, as both cohesive and cohesionless deposits are encountered throughout. In addition, it was noted that some of the cohesive deposits contain random zones and seams of cohesionless or slightly plastic material, some of which are water-bearing.

In zones where the soil is slightly plastic or non-cohesive, and below the groundwater level, it is likely that the sides of an unsupported augered hole will cave in, and seepage will occur. In situations where excavations (or augered holes) extend into cohesionless soils below the groundwater table, 'boiling' may be experienced at the base.

Groundwater levels were measured at the completion of each borehole. The measured levels are shown on each Record of Borehole Sheet. In view of the hard and very dense nature of glacial deposits, it is believed that the measured groundwater levels do not represent stabilized conditions and the actual levels may, in fact, be higher than those indicated on the Record of Borehole Sheets.

MISCELLANEOUS

The fieldwork for this investigation was carried out between 87 02 02 and 87 02 11 utilizing equipment owned and operated by Master Soil Investigation Ltd. and Archer Drilling Ltd. Two truck-mounted and one track-mounted auger machines were used in the investigation. The fieldwork was carried out under the supervision of G. Petruzzello and M. L. Pauly, M. Jolink, of the Foundation Design Section.

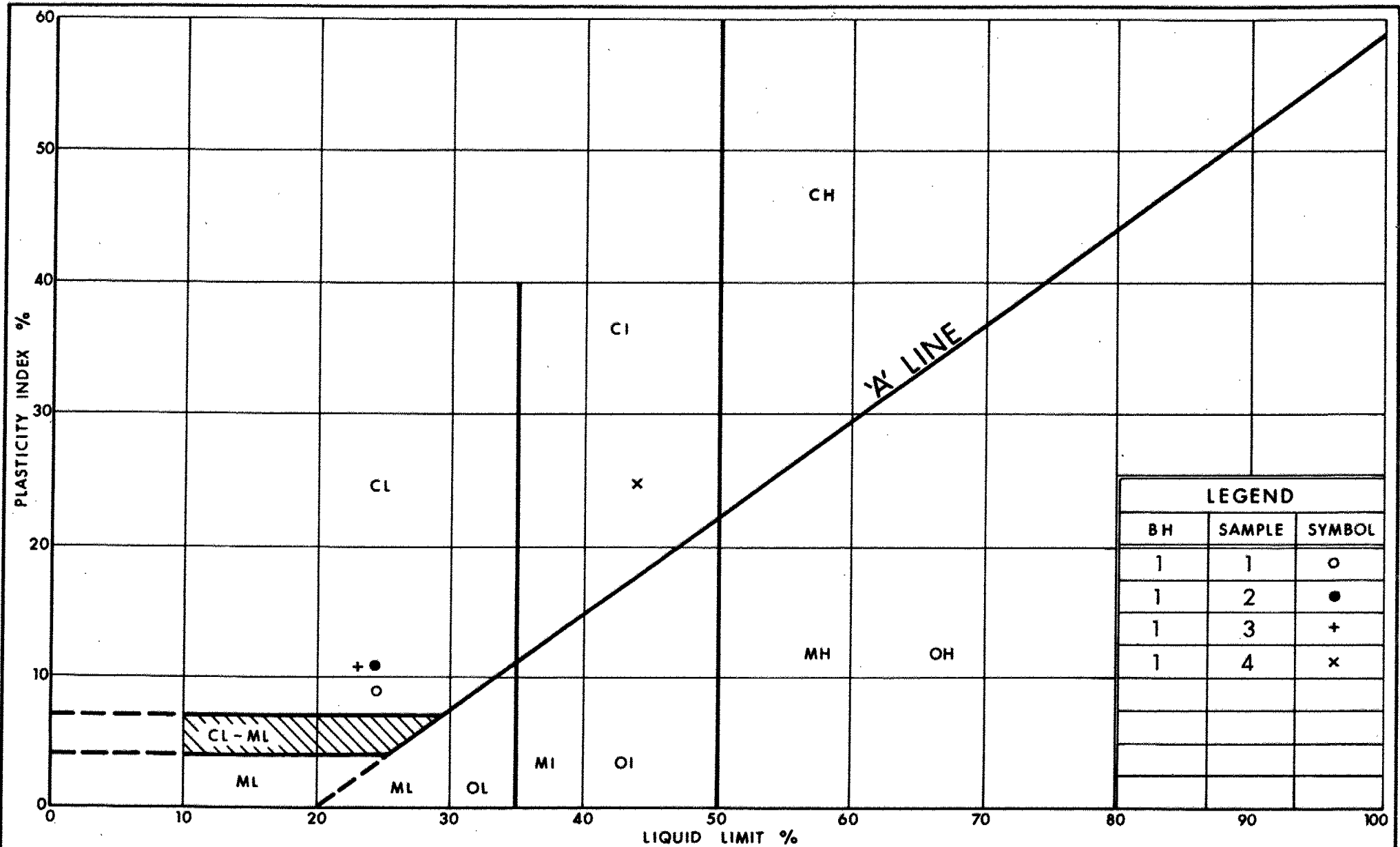
This report was written by L. Politano, Project Foundations Engineer, and was reviewed by M. Devata, Chief Foundations Engineer (East).



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APPENDIX



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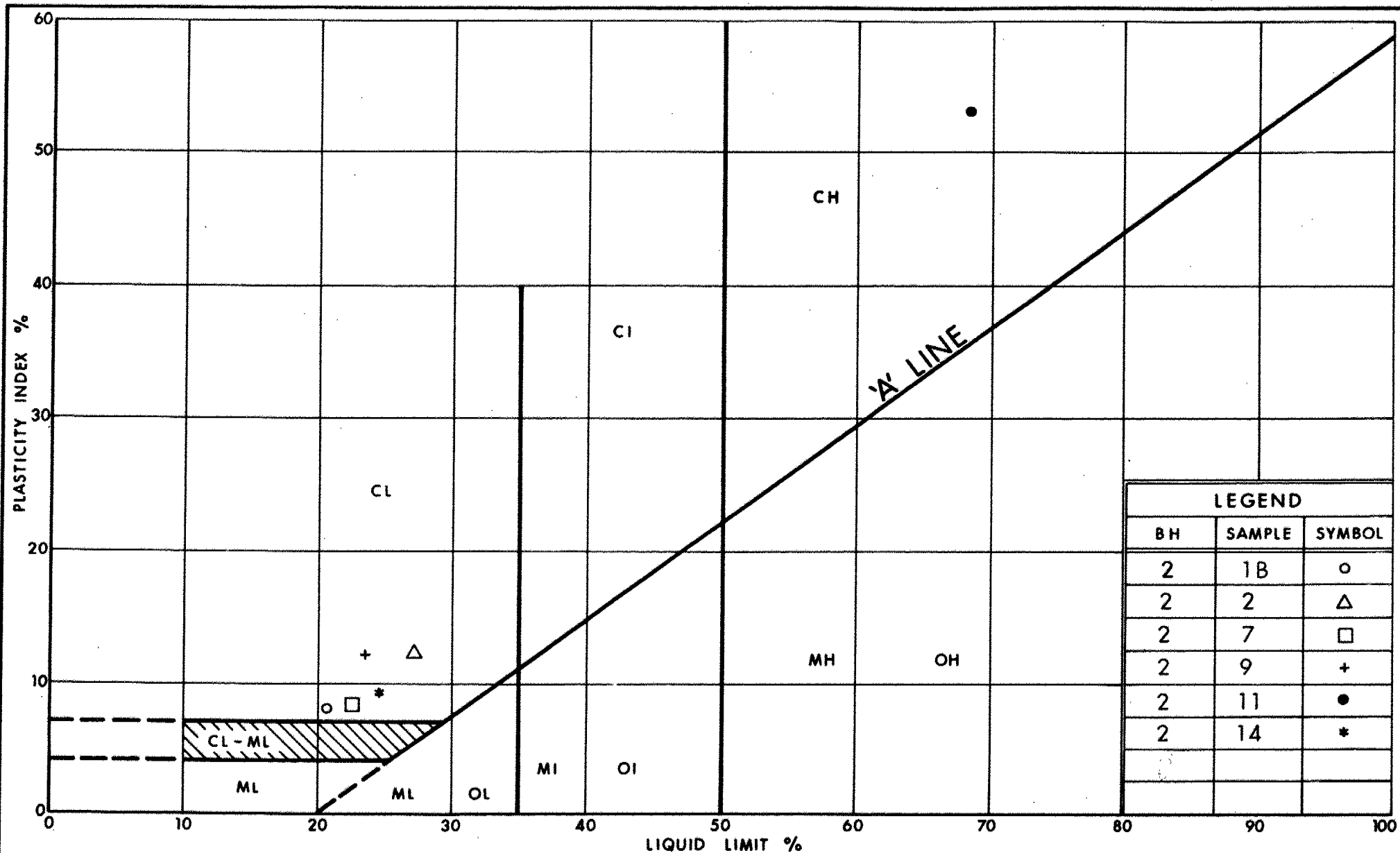
PLASTICITY CHART

FIG No 1

W P 202-87-00

BH-1

✓



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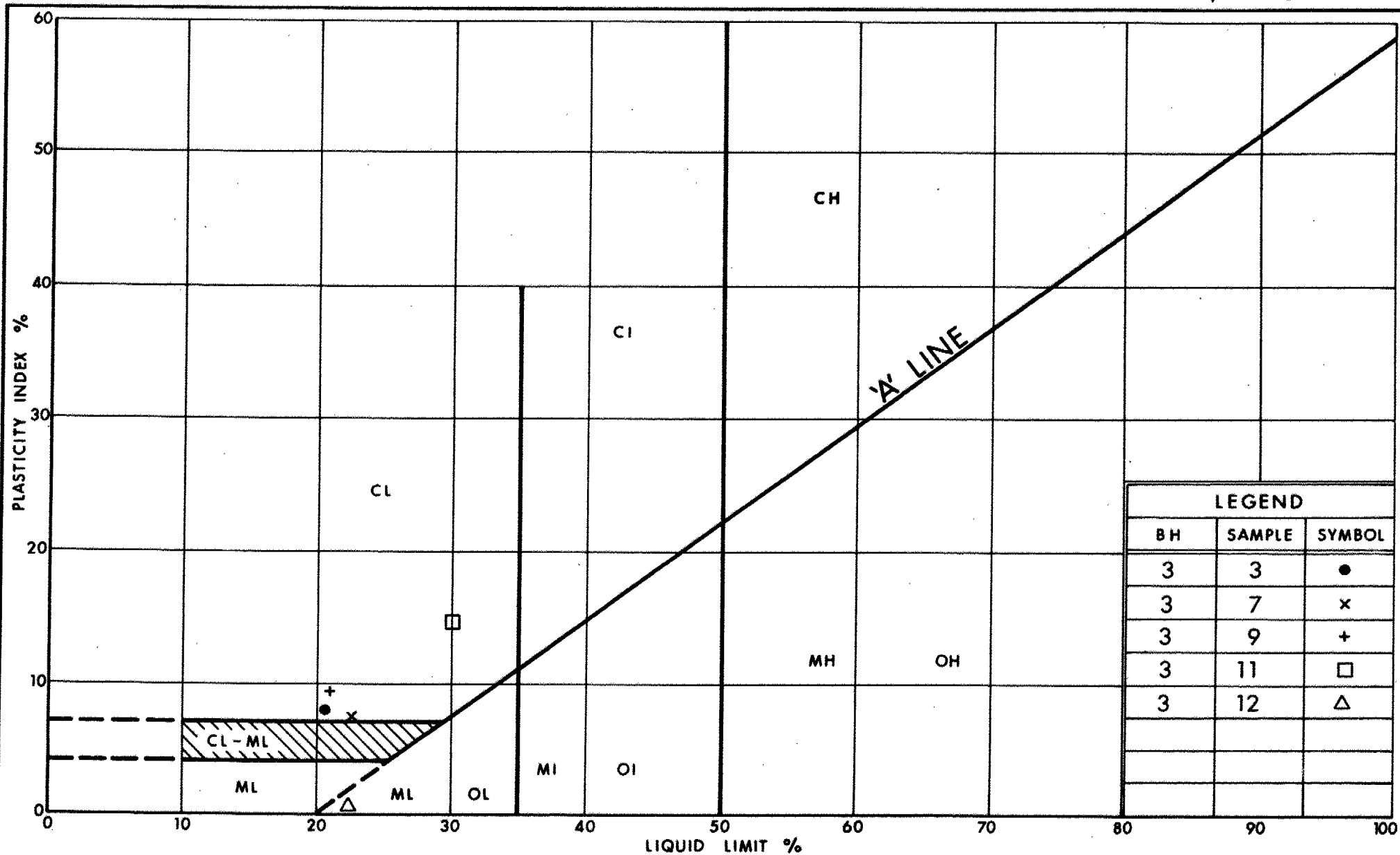
PLASTICITY CHART

FIG No 2

W P 202-87-00

BH-2

∞



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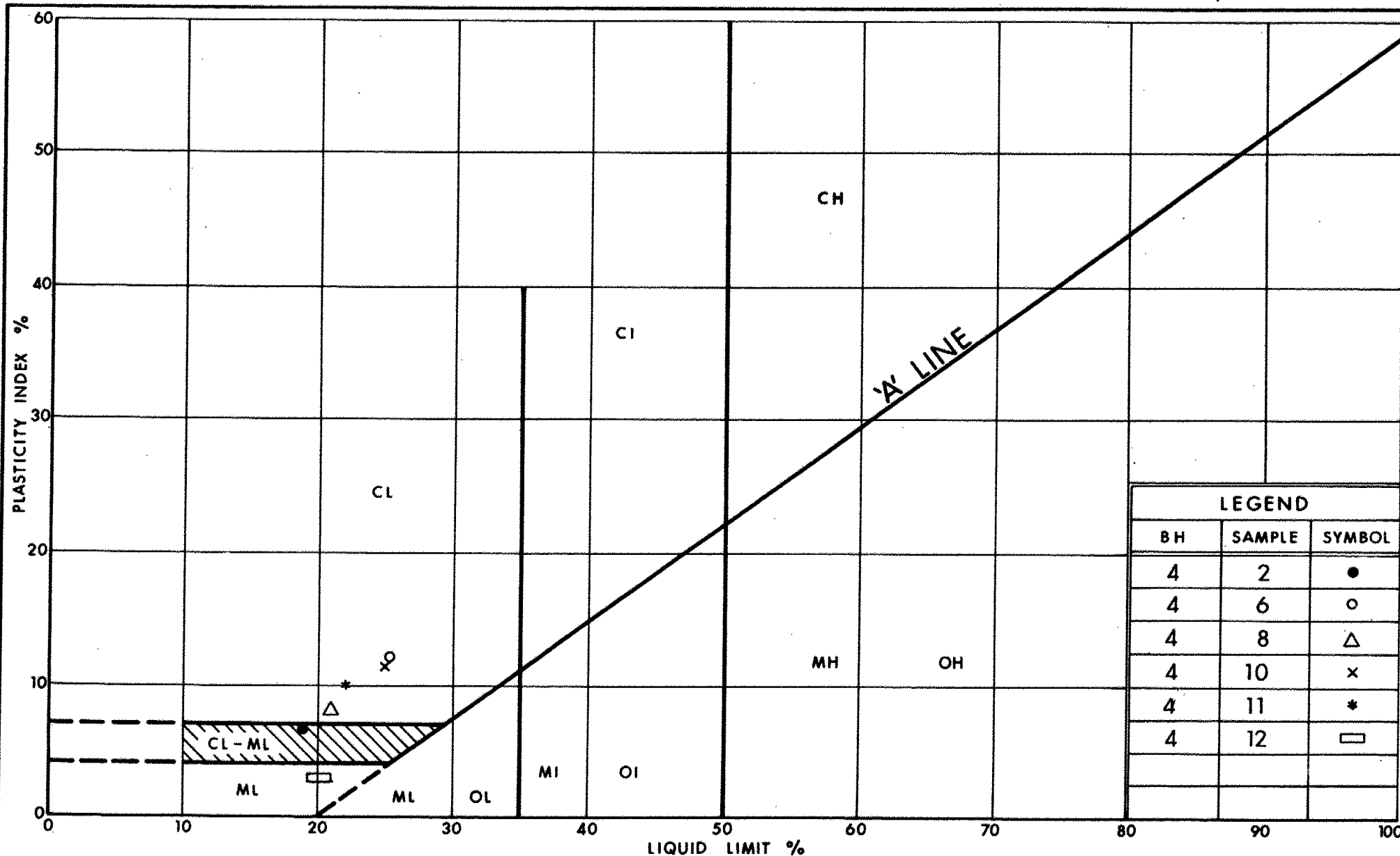
PLASTICITY CHART

FIG No 3

W P 202-87-00

BH-3

o



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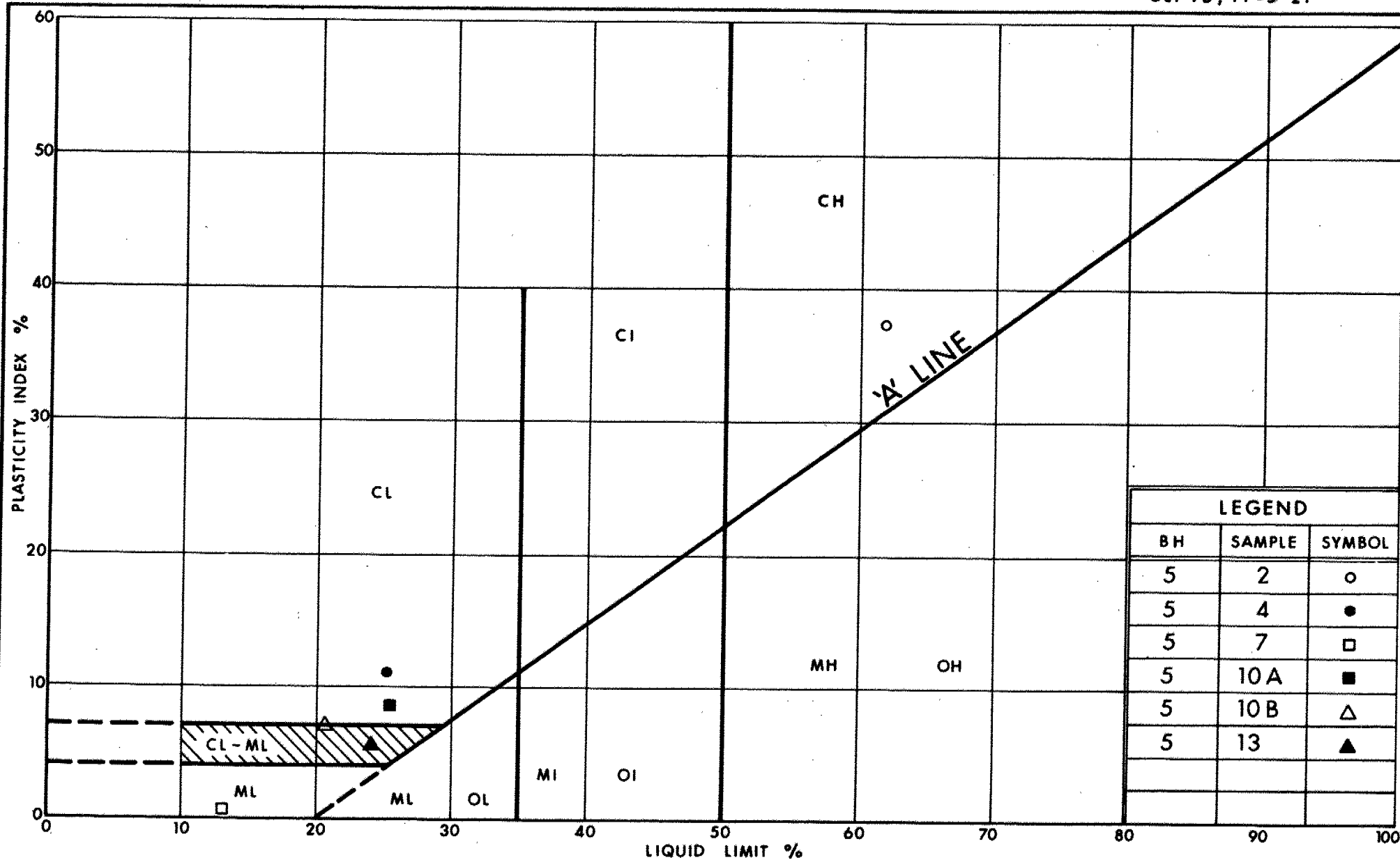
PLASTICITY CHART

FIG No 4

W P 202-87-00

BH - 4

0



LEGEND		
BH	SAMPLE	SYMBOL
5	2	○
5	4	●
5	7	□
5	10A	■
5	10B	△
5	13	▲



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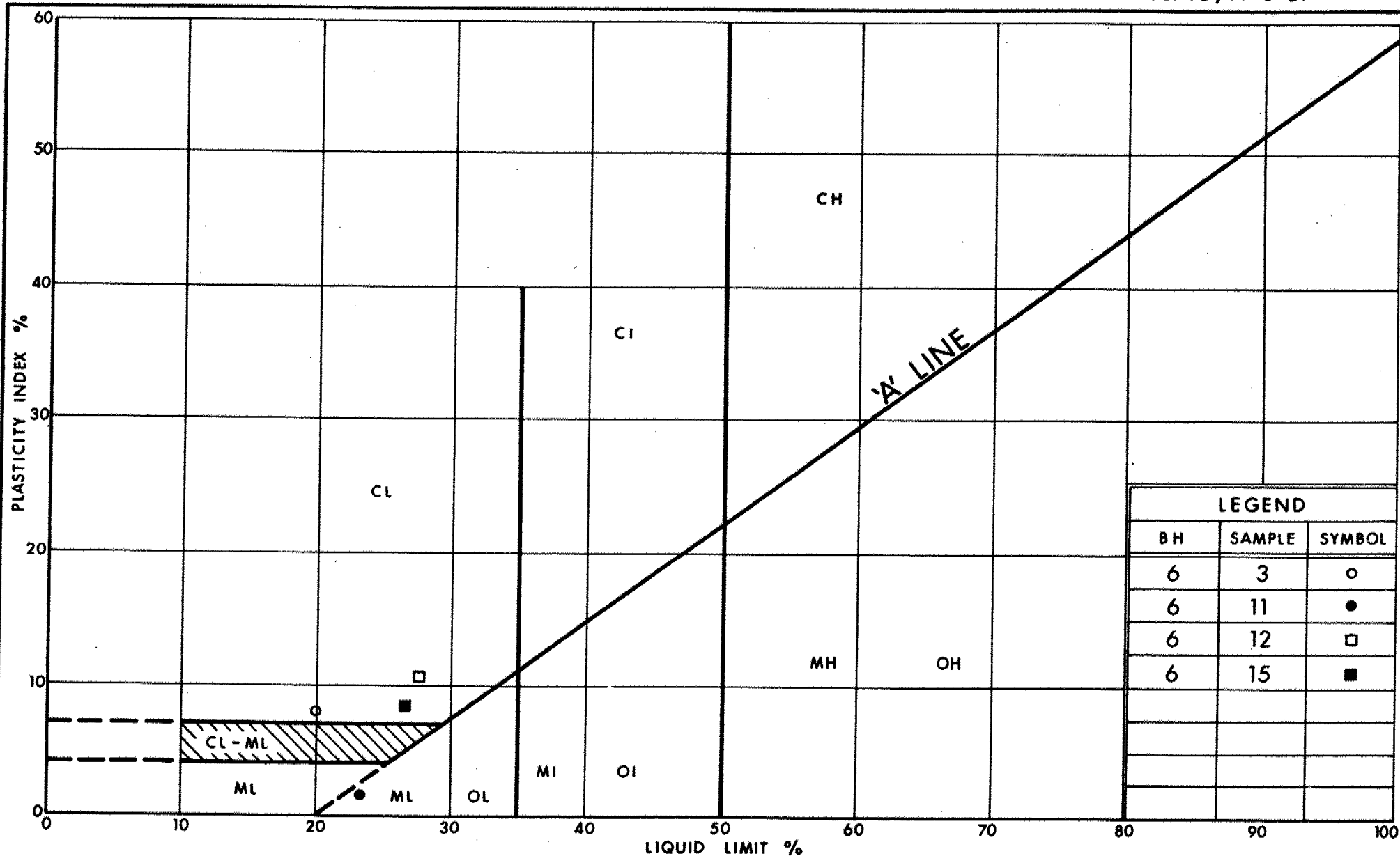
PLASTICITY CHART

FIG No 5

W P 202-87-00

BH-5

11



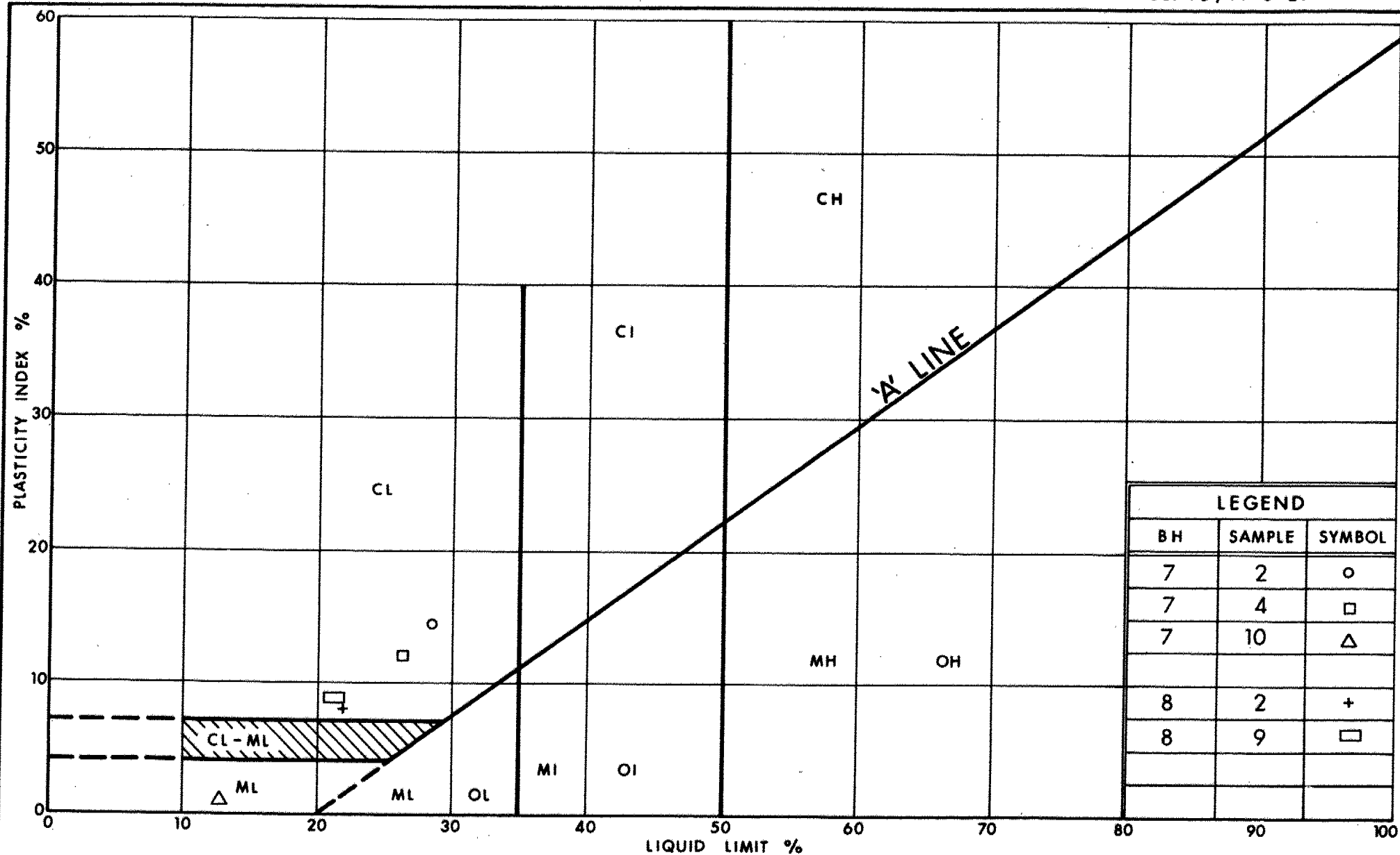
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PLASTICITY CHART

FIG No 6

W P 202-87-00

BH - 6



LEGEND		
BH	SAMPLE	SYMBOL
7	2	○
7	4	□
7	10	△
8	2	+
8	9	□



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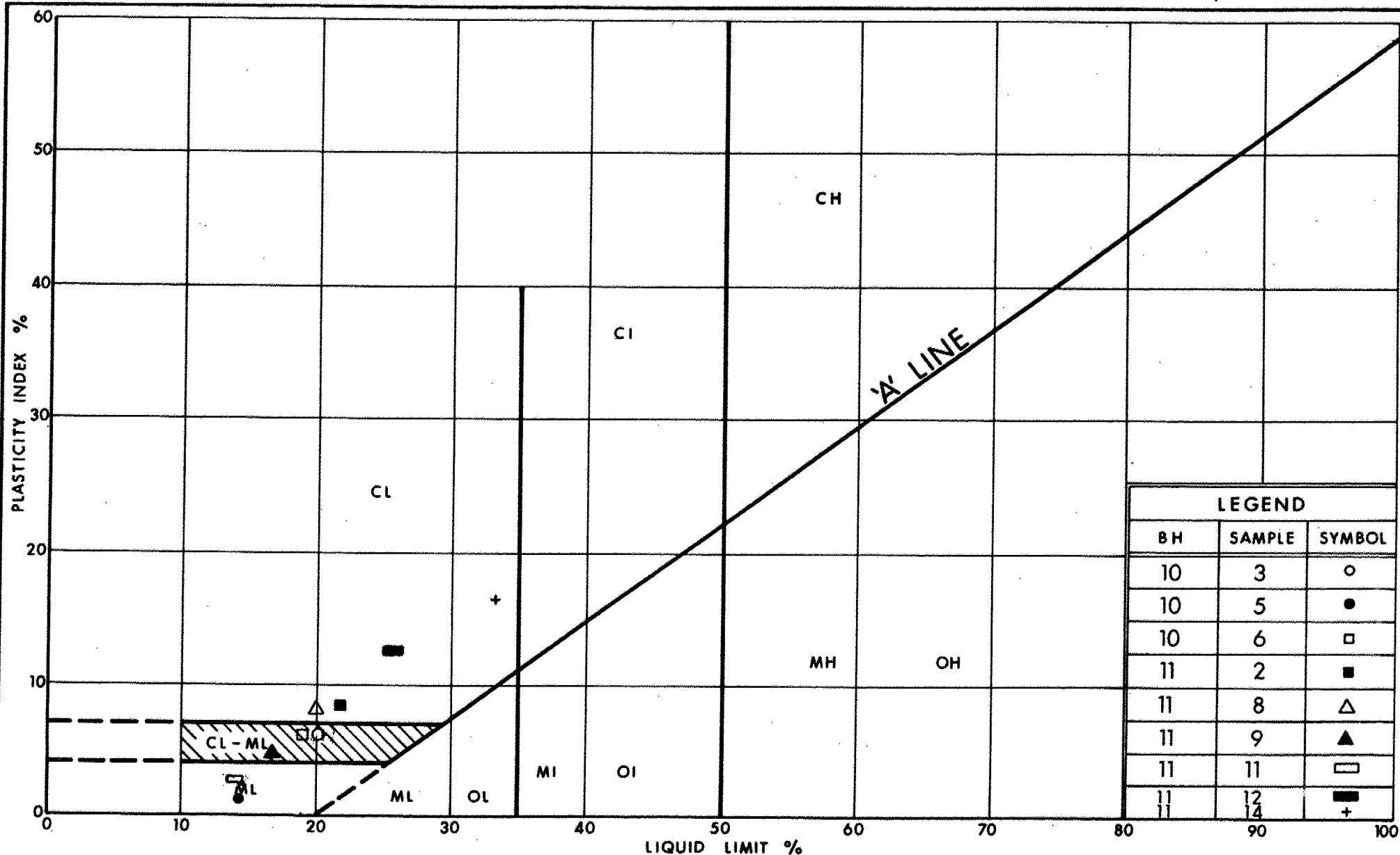
PLASTICITY CHART

FIG No 7

W P 202-87-00

BH-7, 8

13



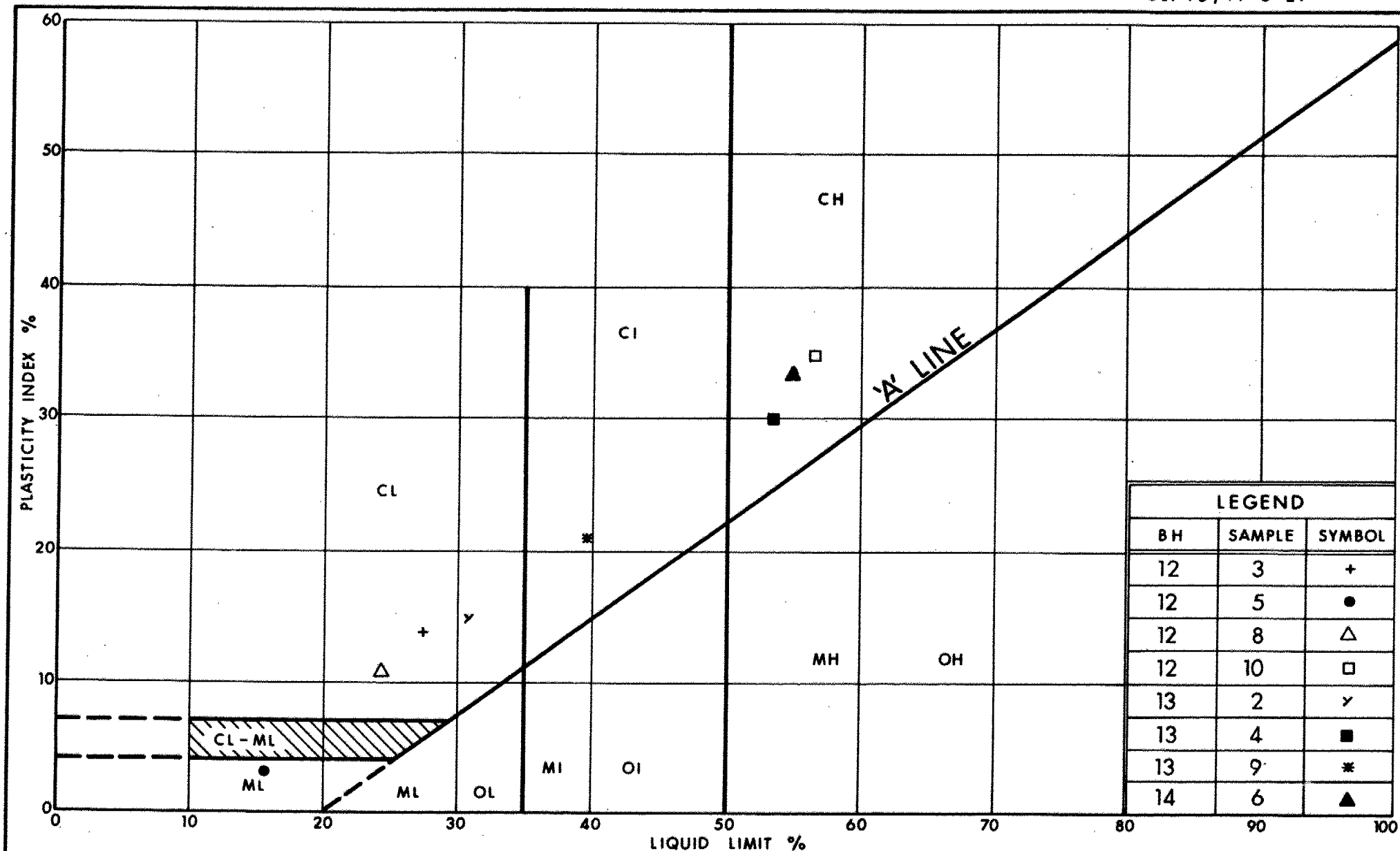
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PLASTICITY CHART

FIG No 8

W P 202-87-00

BH-10, 11



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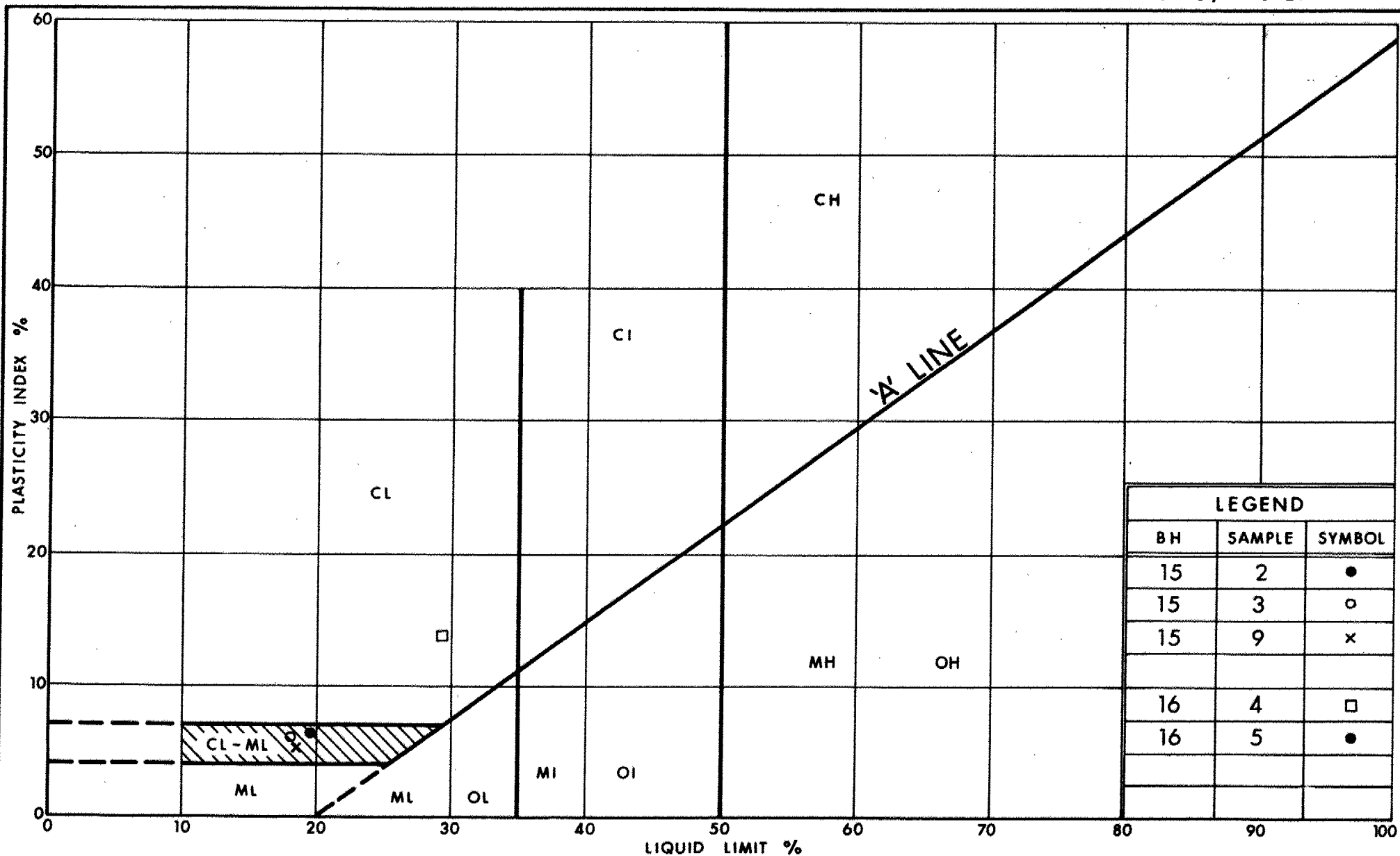
PLASTICITY CHART

FIG No 9

W P 202-87-00

BH - 12, 13, 14

5



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PLASTICITY CHART

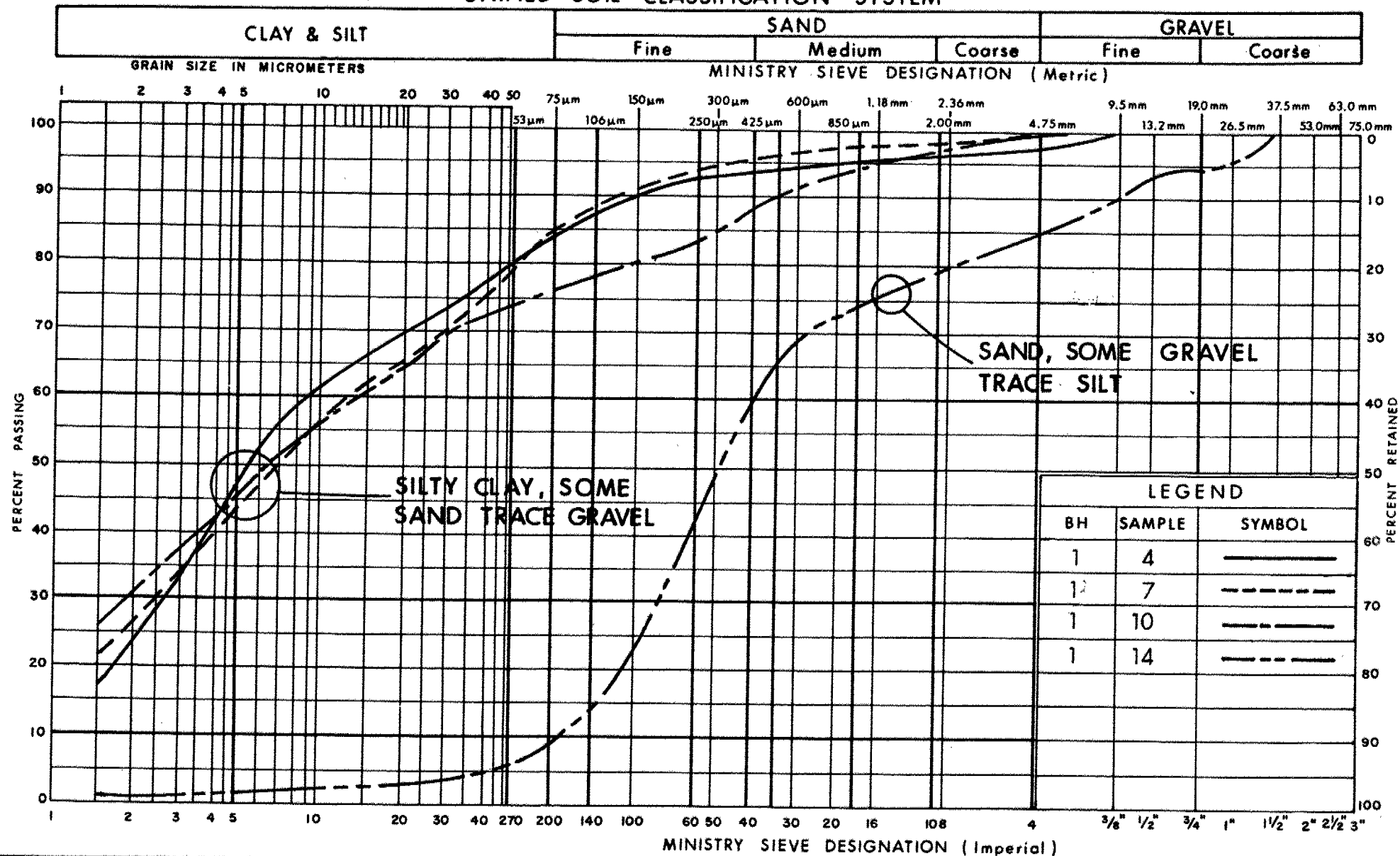
FIG No 10

W P 202-87-00

BH-15,16

16

UNIFIED SOIL CLASSIFICATION SYSTEM



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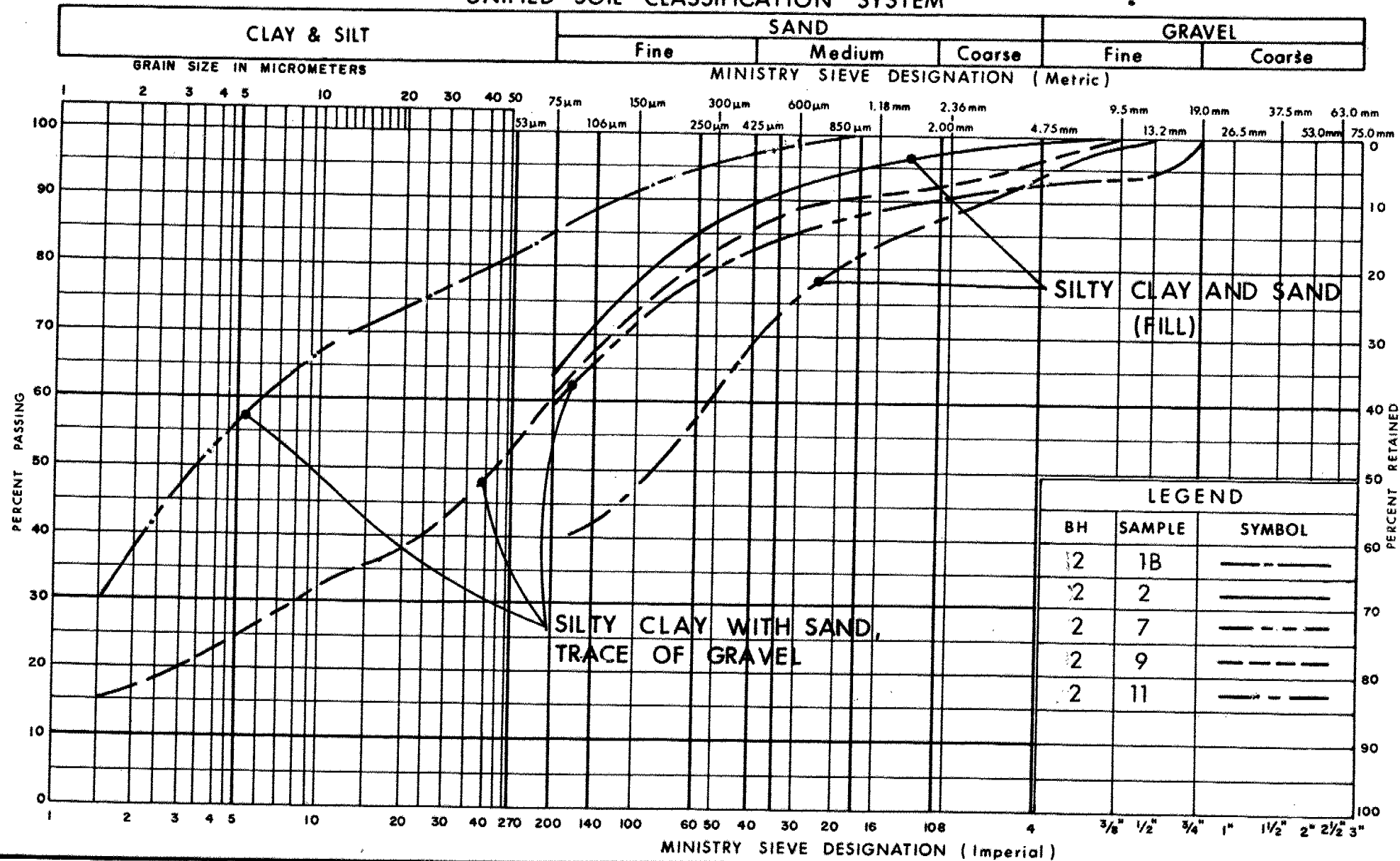
GRAIN SIZE DISTRIBUTION

FIG No 11

W P 202-87-00

BH-1

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

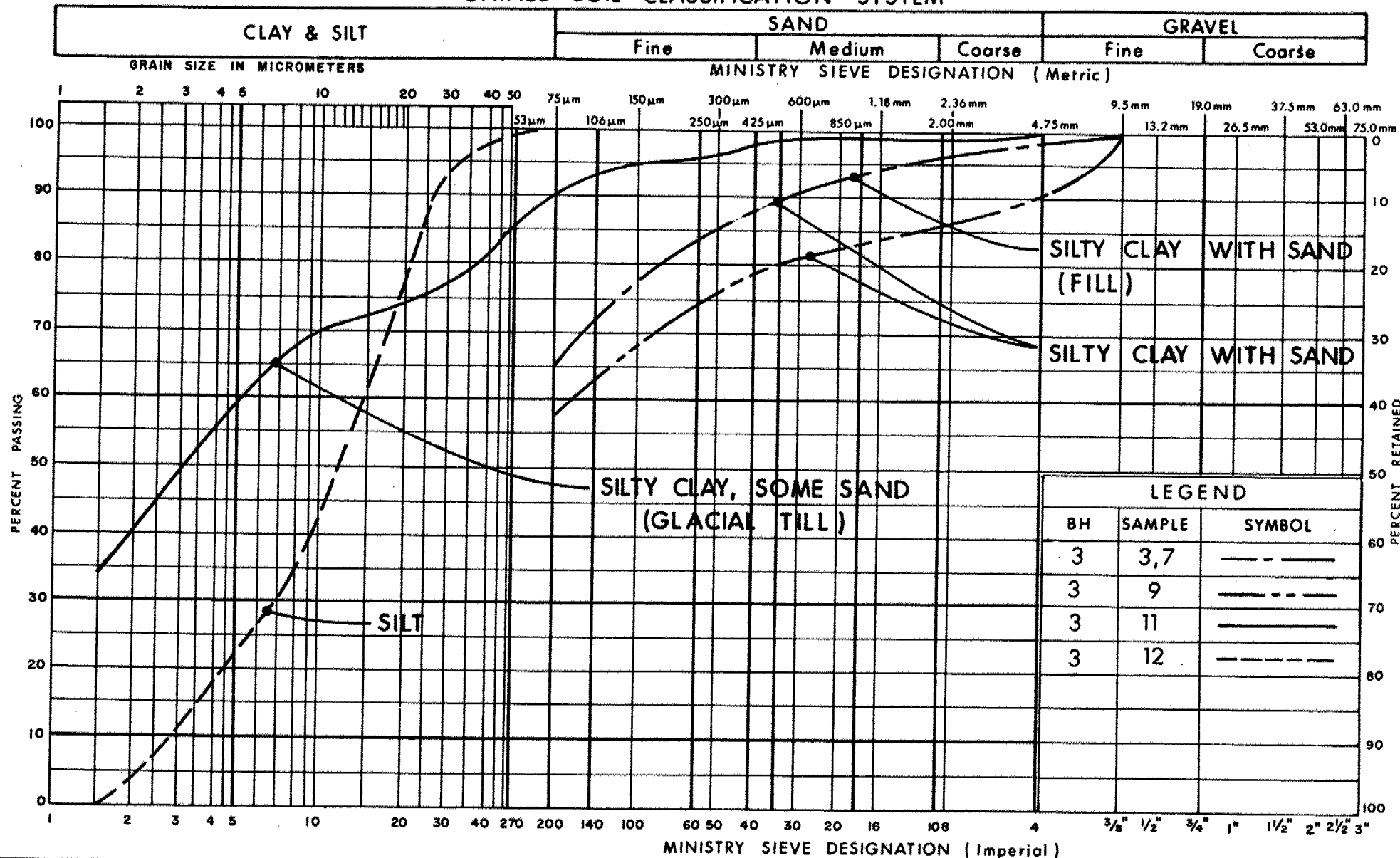
FIG No 12

W P 202-87-00

BH - 2

18

UNIFIED SOIL CLASSIFICATION SYSTEM



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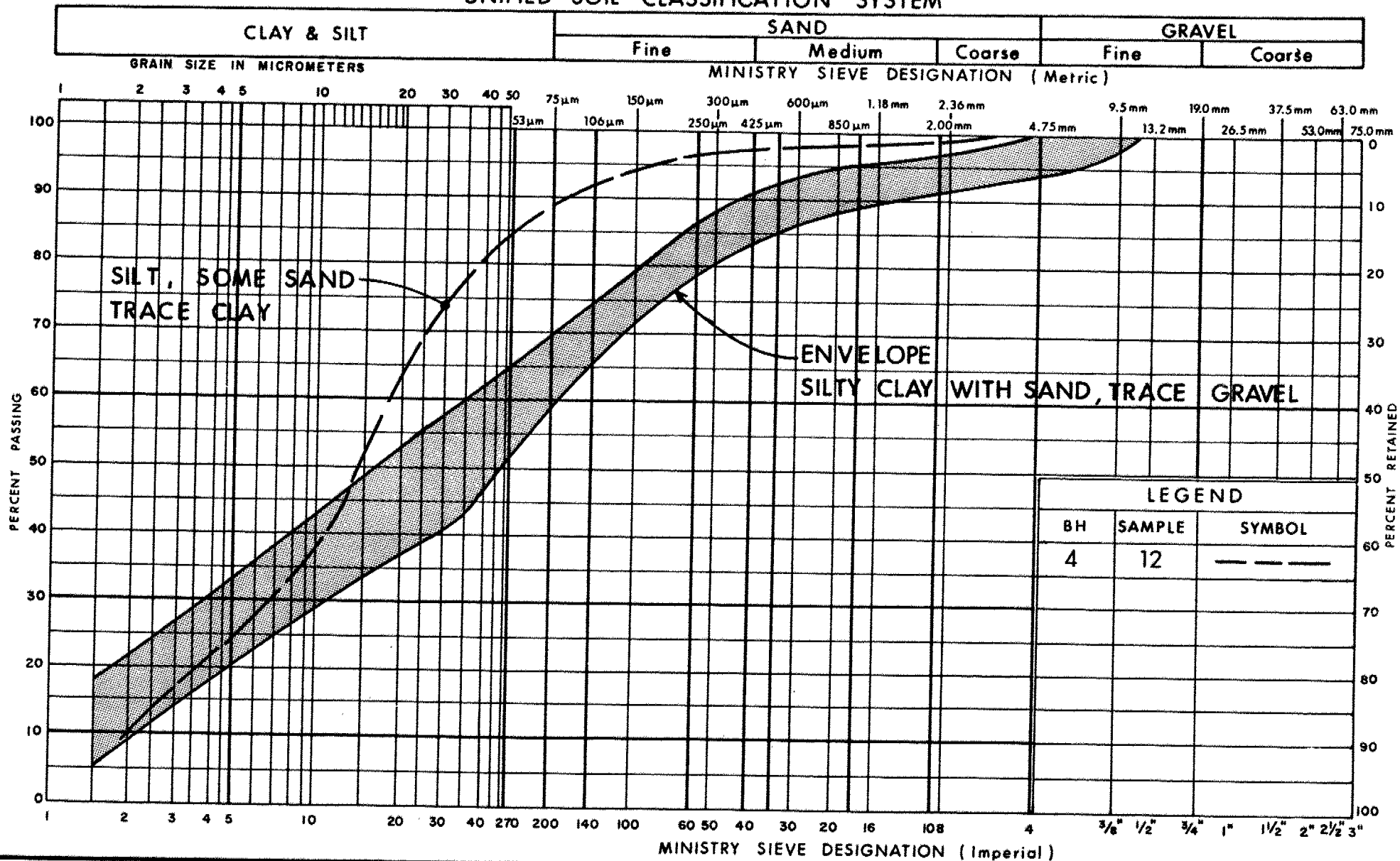
GRAIN SIZE DISTRIBUTION

FIG No13

W P 202-87-00

BH - 3

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

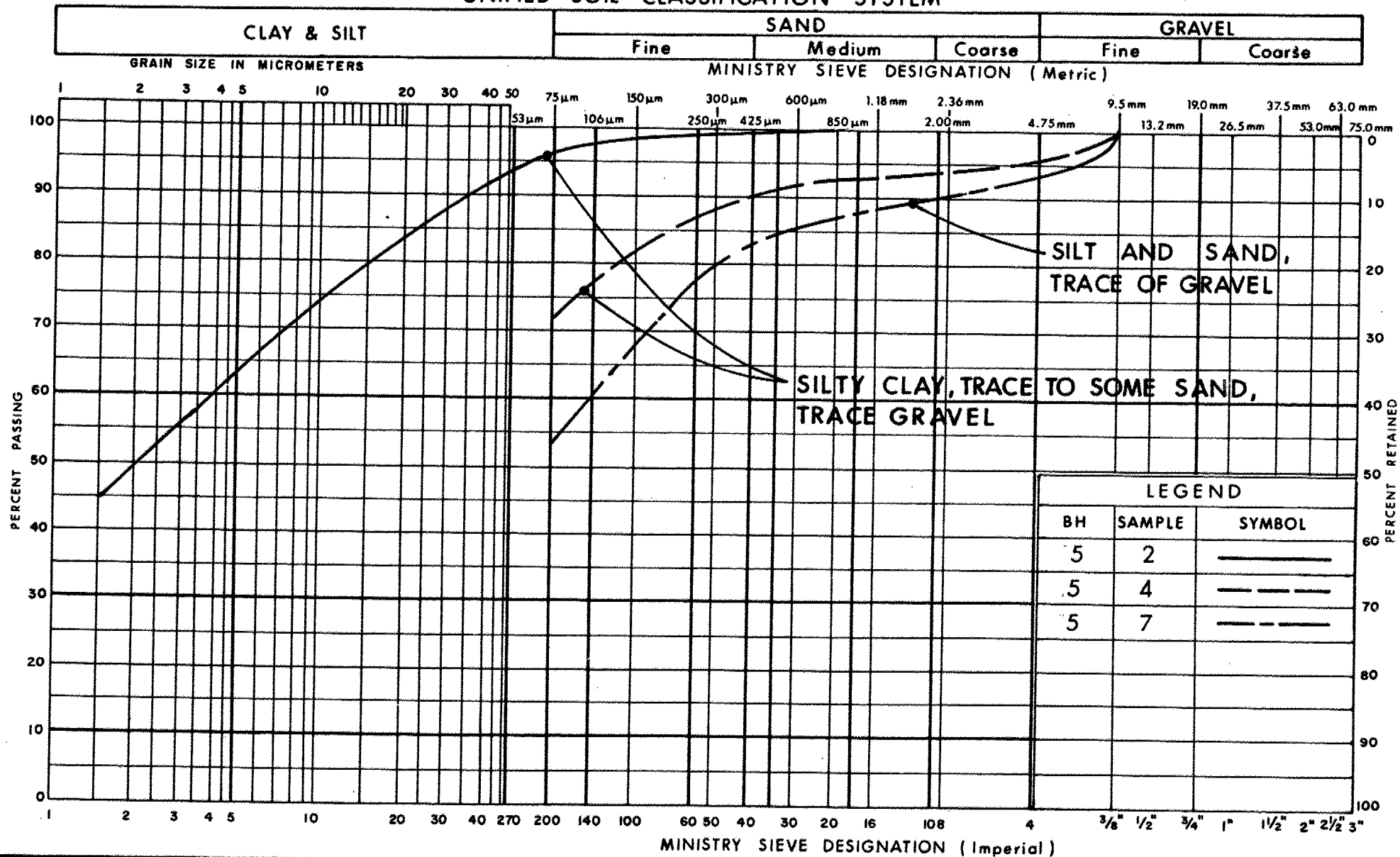
FIG No 14

W P 202-87-00

BH - 4

20

UNIFIED SOIL CLASSIFICATION SYSTEM



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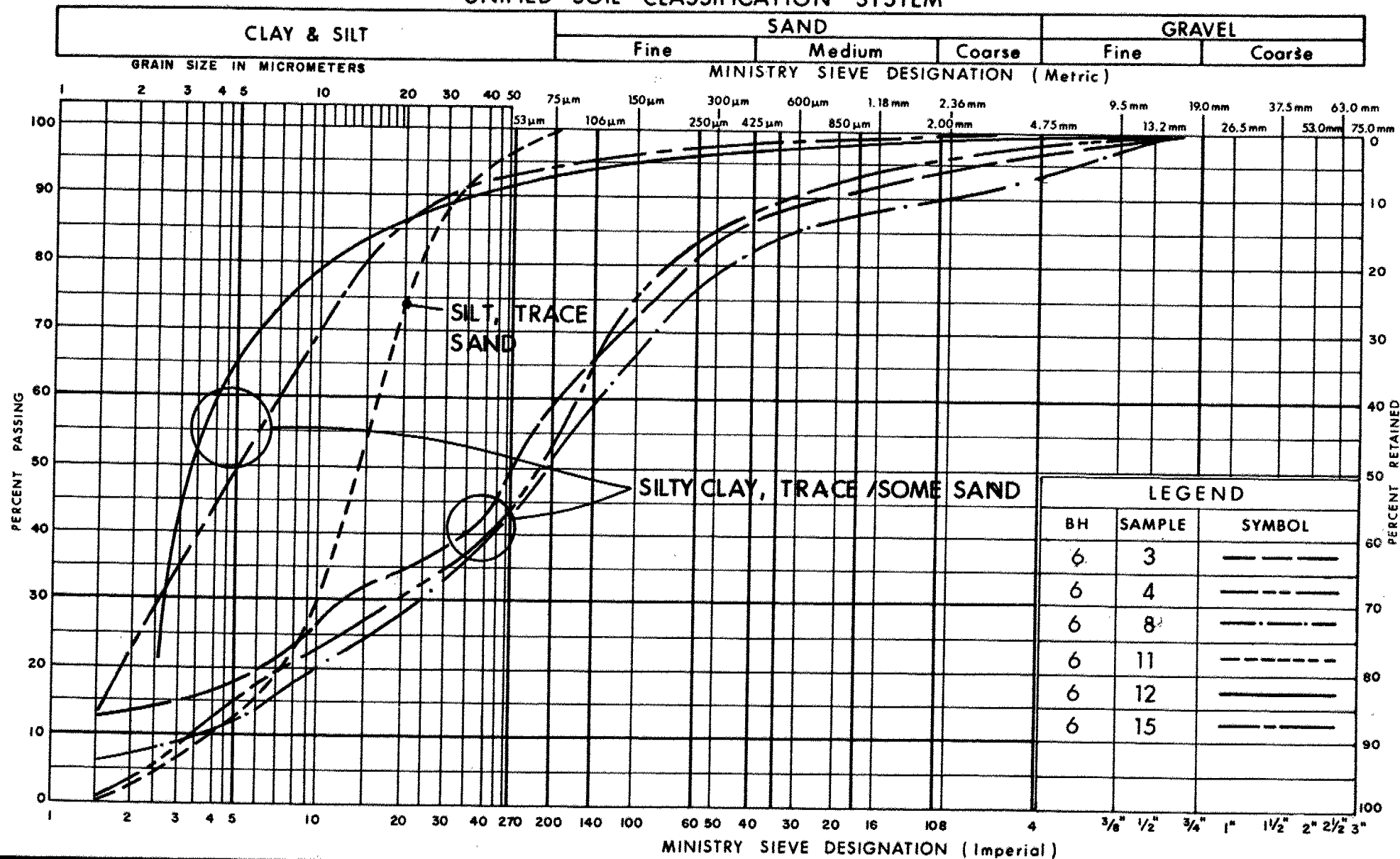
GRAIN SIZE DISTRIBUTION

FIG No 15

W P 202-87-00

BH - 5

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Communications

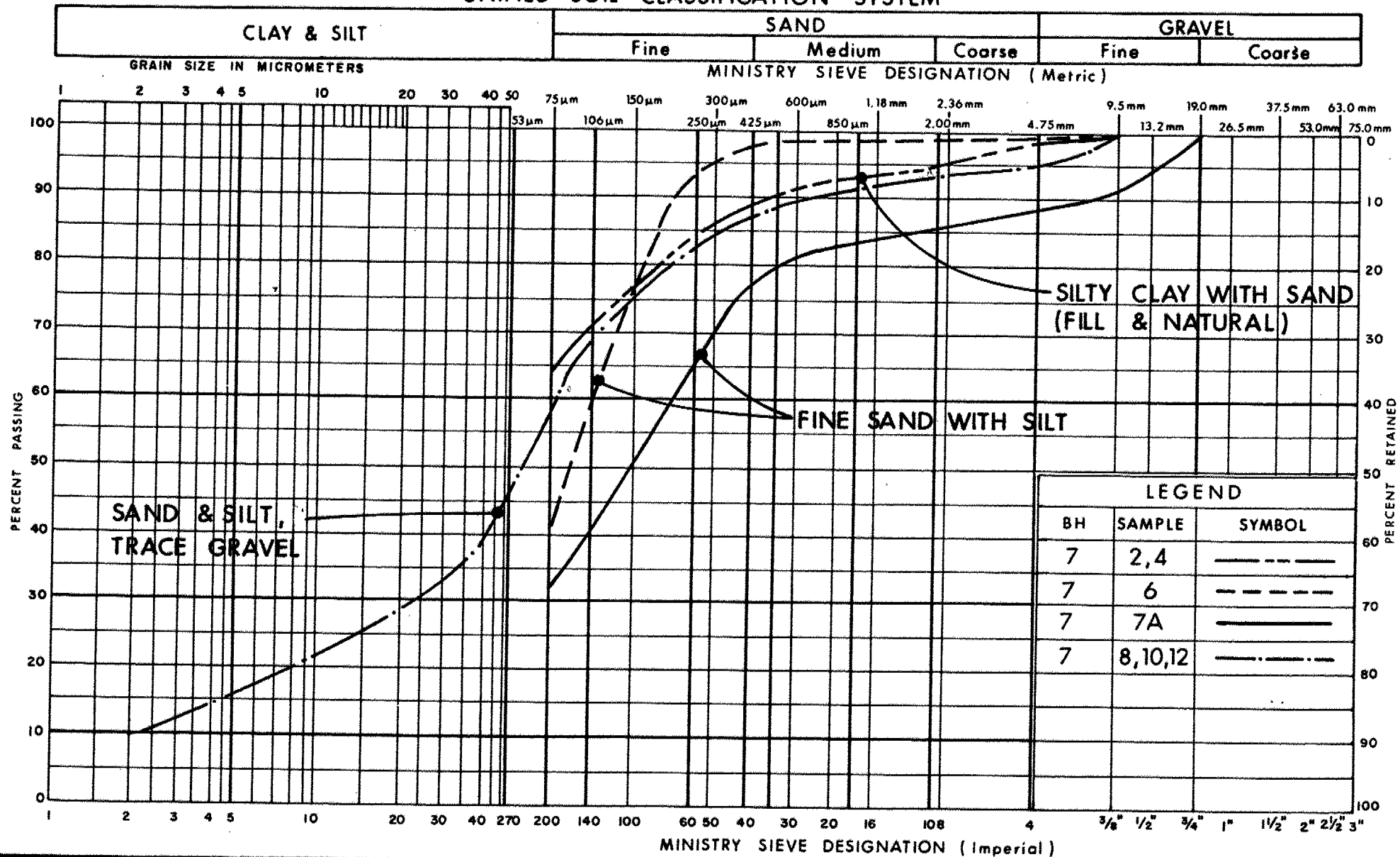
GRAIN SIZE DISTRIBUTION

FIG No 16

W P 202-87-00

BH -6

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

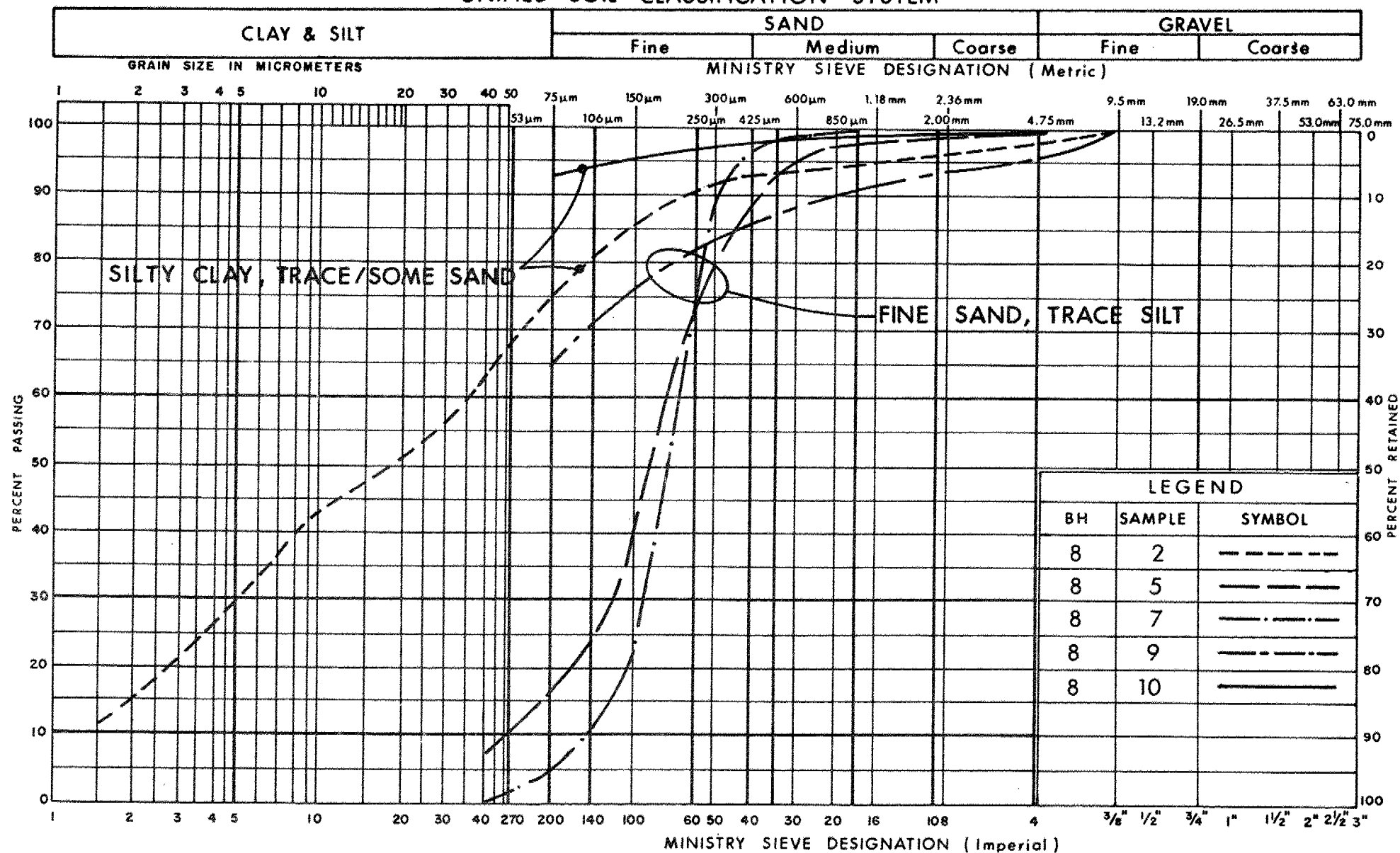
FIG No 17

W P 202-87-00

BH - 7

23

UNIFIED SOIL CLASSIFICATION SYSTEM



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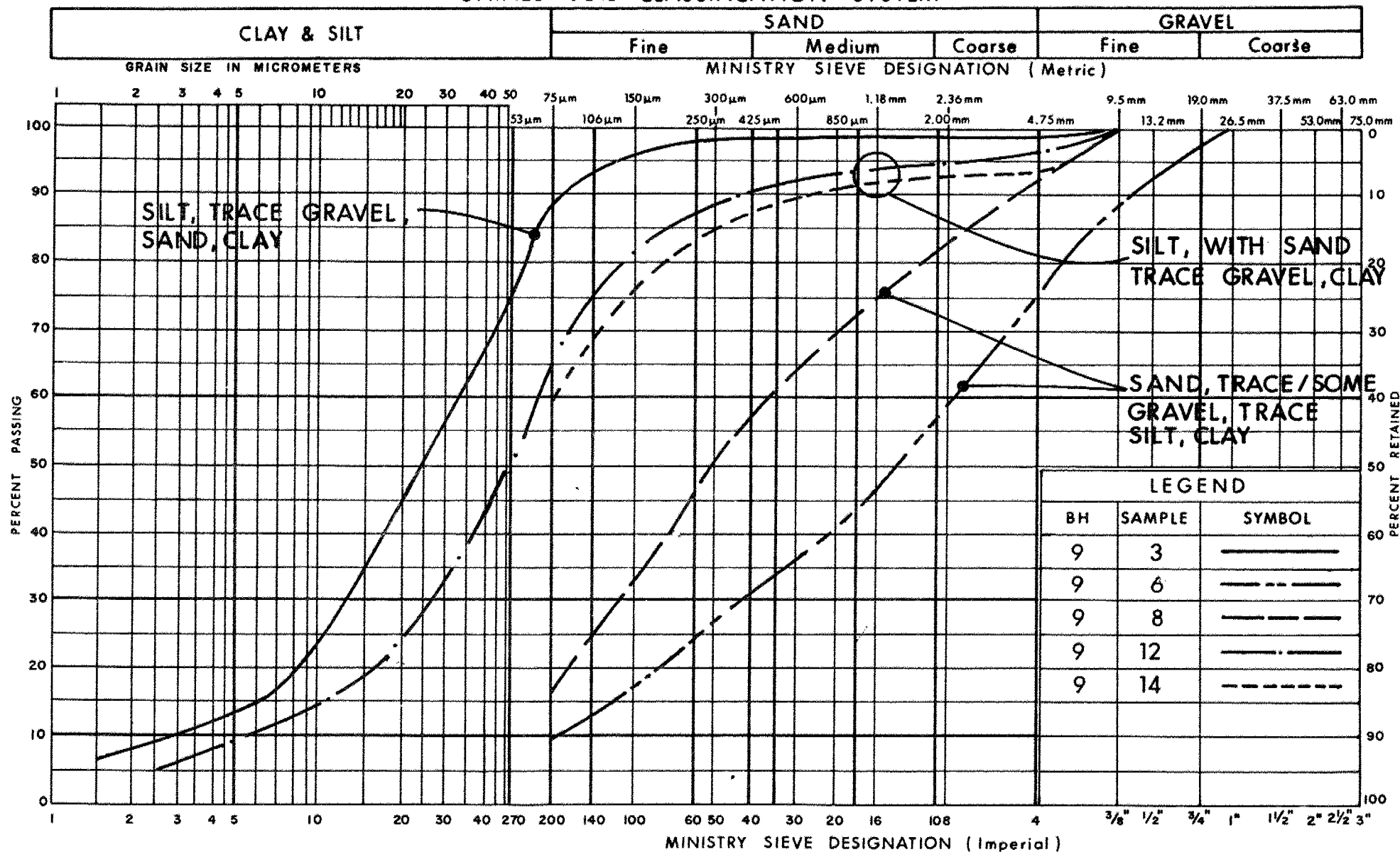
GRAIN SIZE DISTRIBUTION

FIG No 18

W P 202-87-00

BH-8

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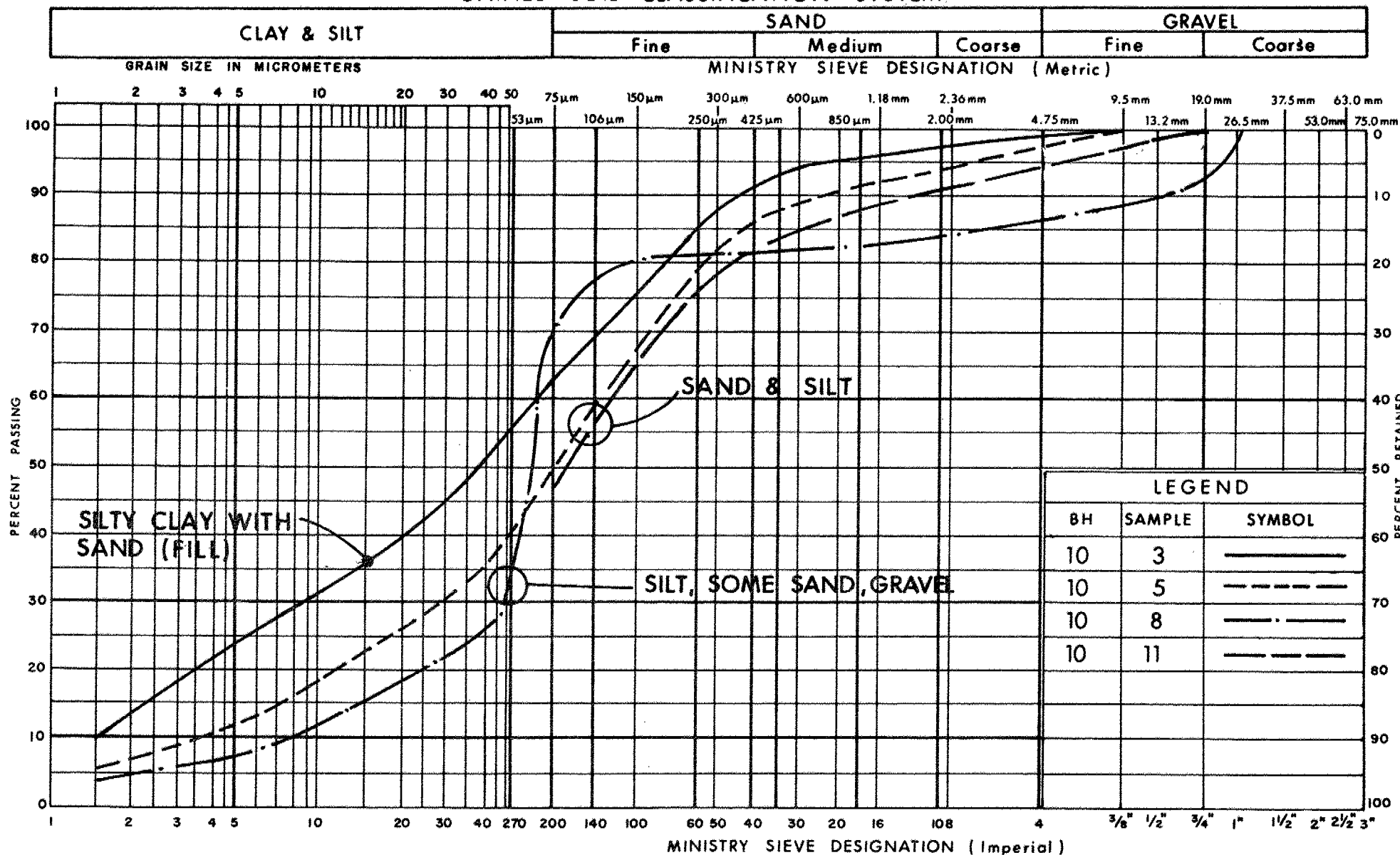
GRAIN SIZE DISTRIBUTION

FIG No 19

W P 202-87-00

BH - 9

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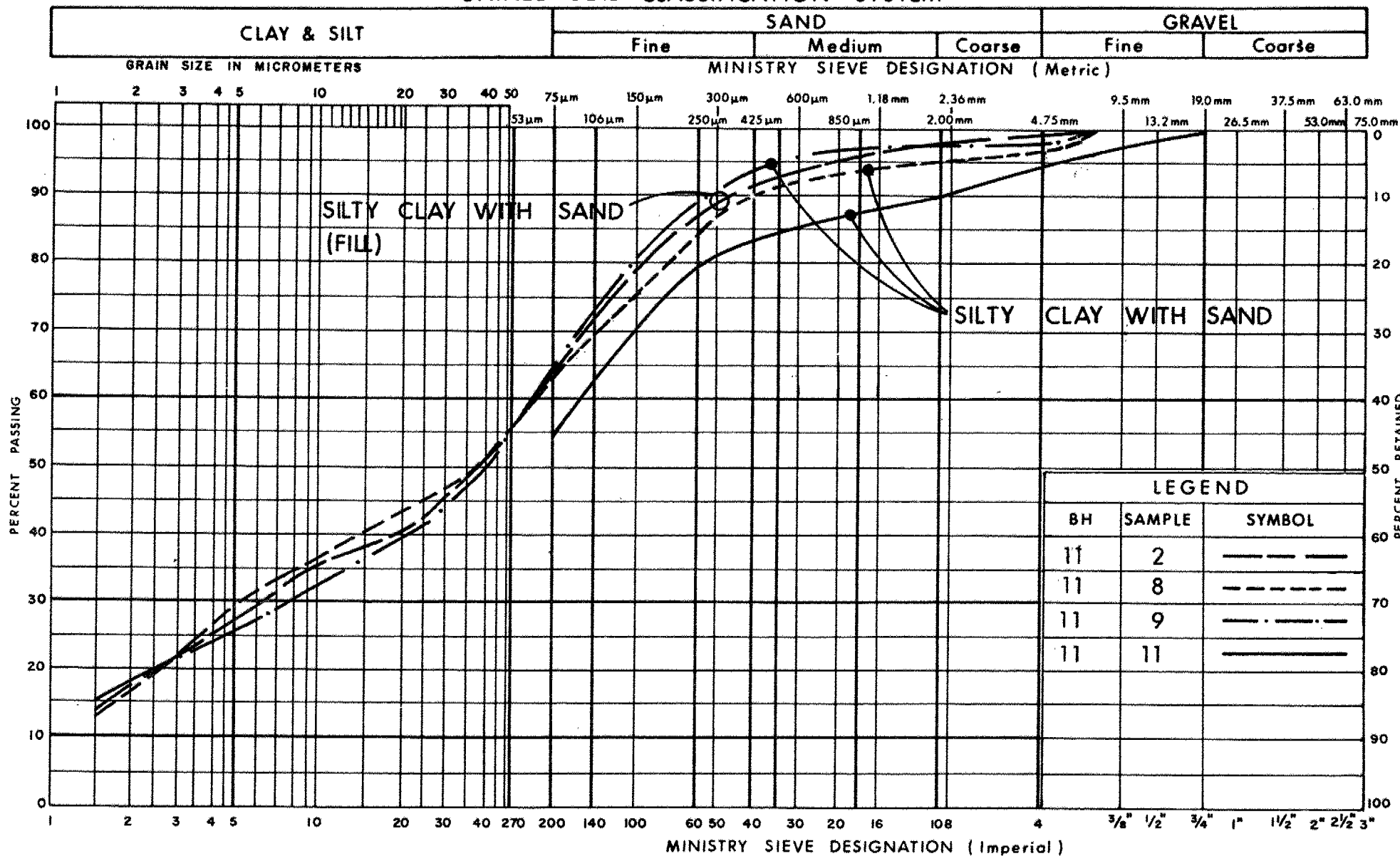
FIG No 20

W P 202-87-00

BH - 10

26

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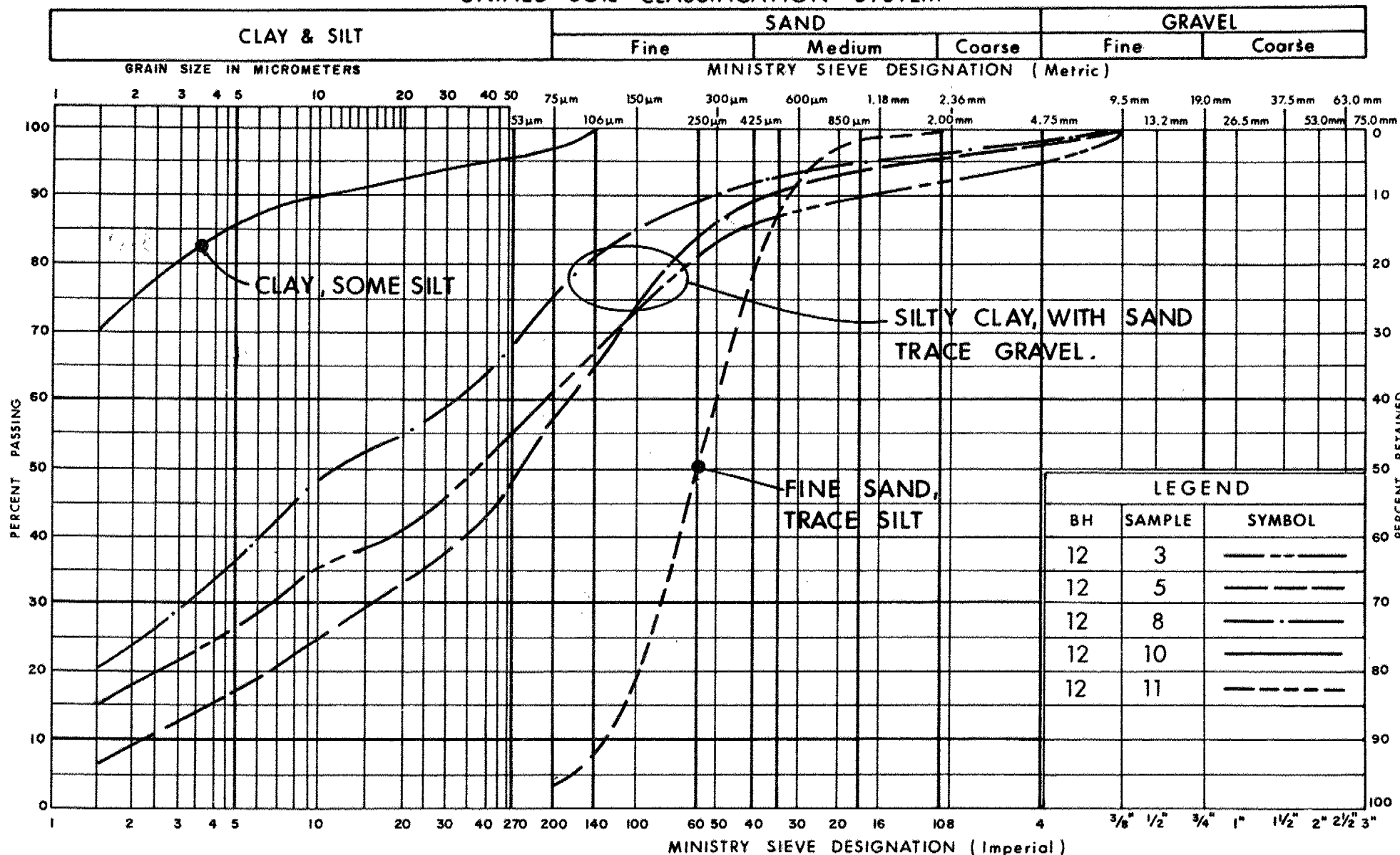
GRAIN SIZE DISTRIBUTION

FIG No 21

W P 202-87-00

BH-11

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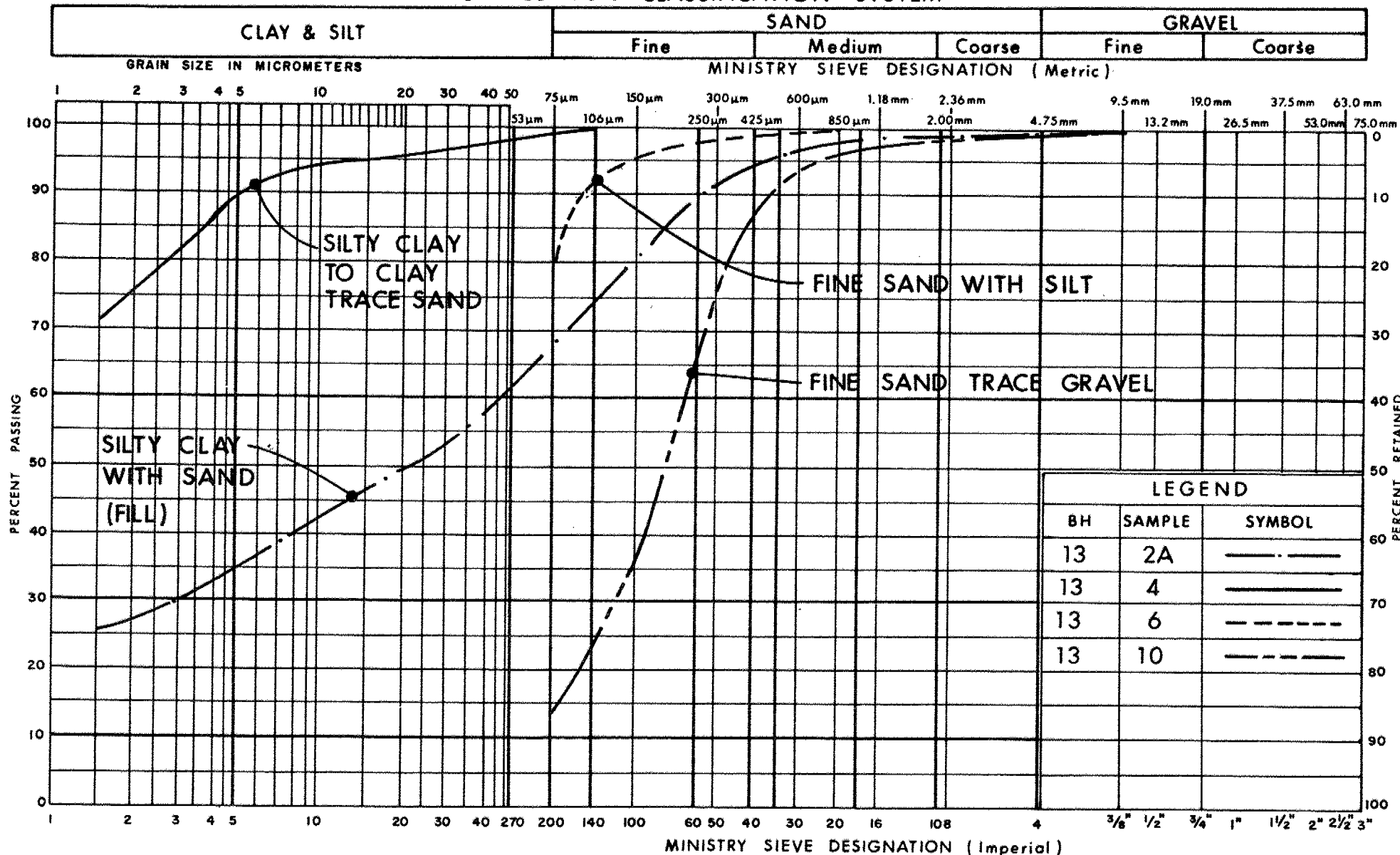
GRAIN SIZE DISTRIBUTION

FIG No 22

W P 202-87-00

BH - 12

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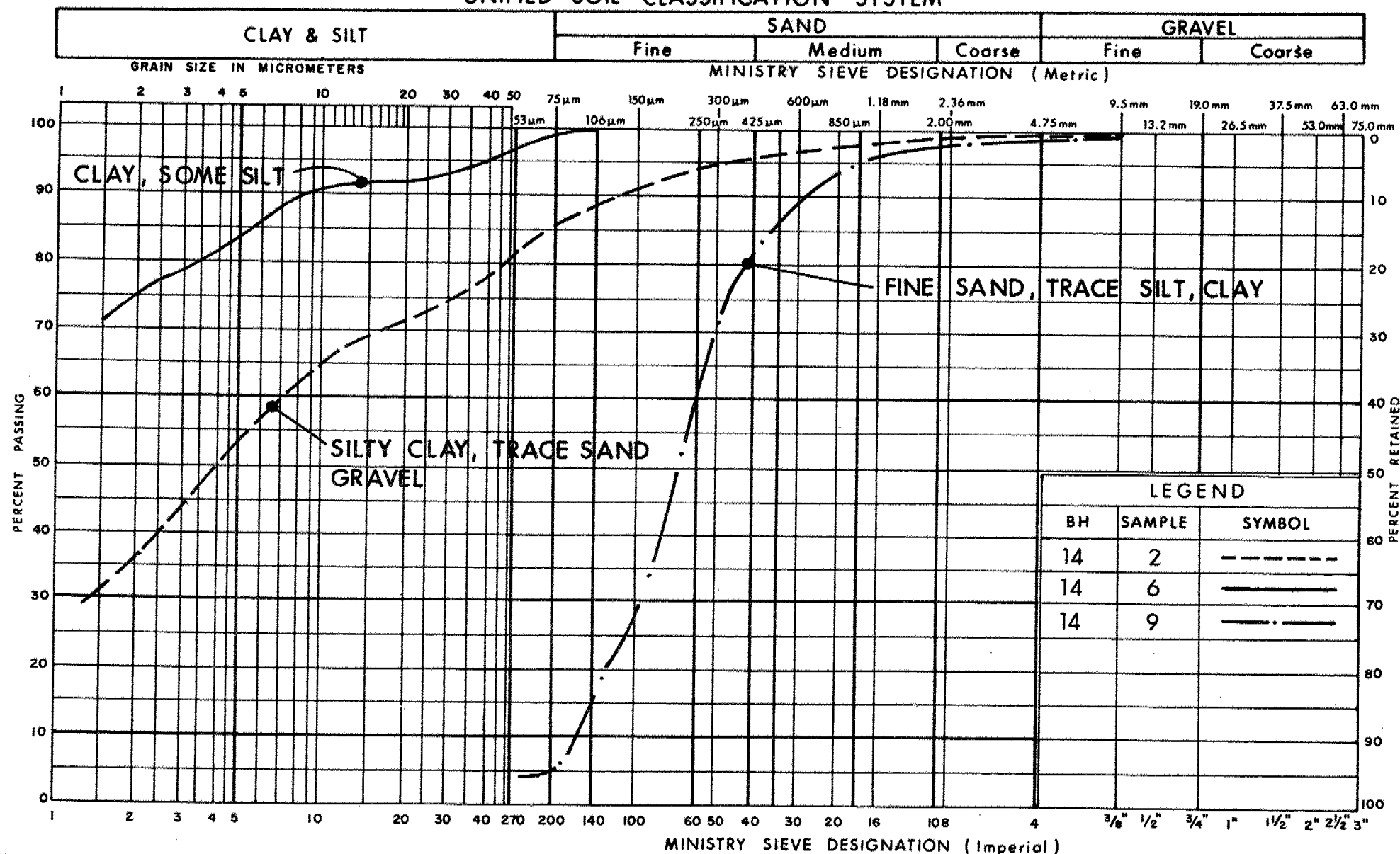
GRAIN SIZE DISTRIBUTION

FIG No 23

W P 202-87-00

BH-13

UNIFIED SOIL CLASSIFICATION SYSTEM



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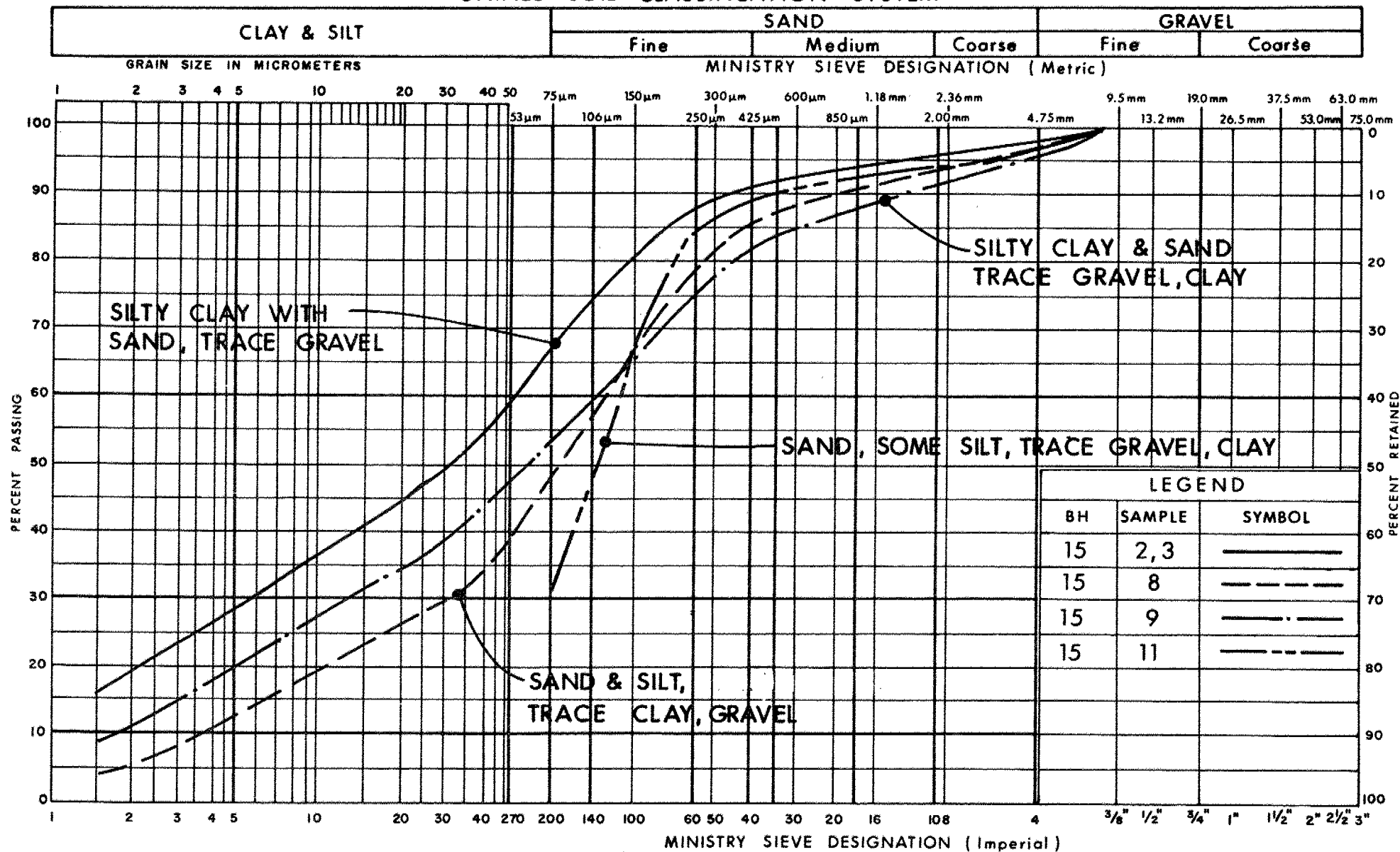
GRAIN SIZE DISTRIBUTION

FIG No 24

W P 202-87-00

BH-14

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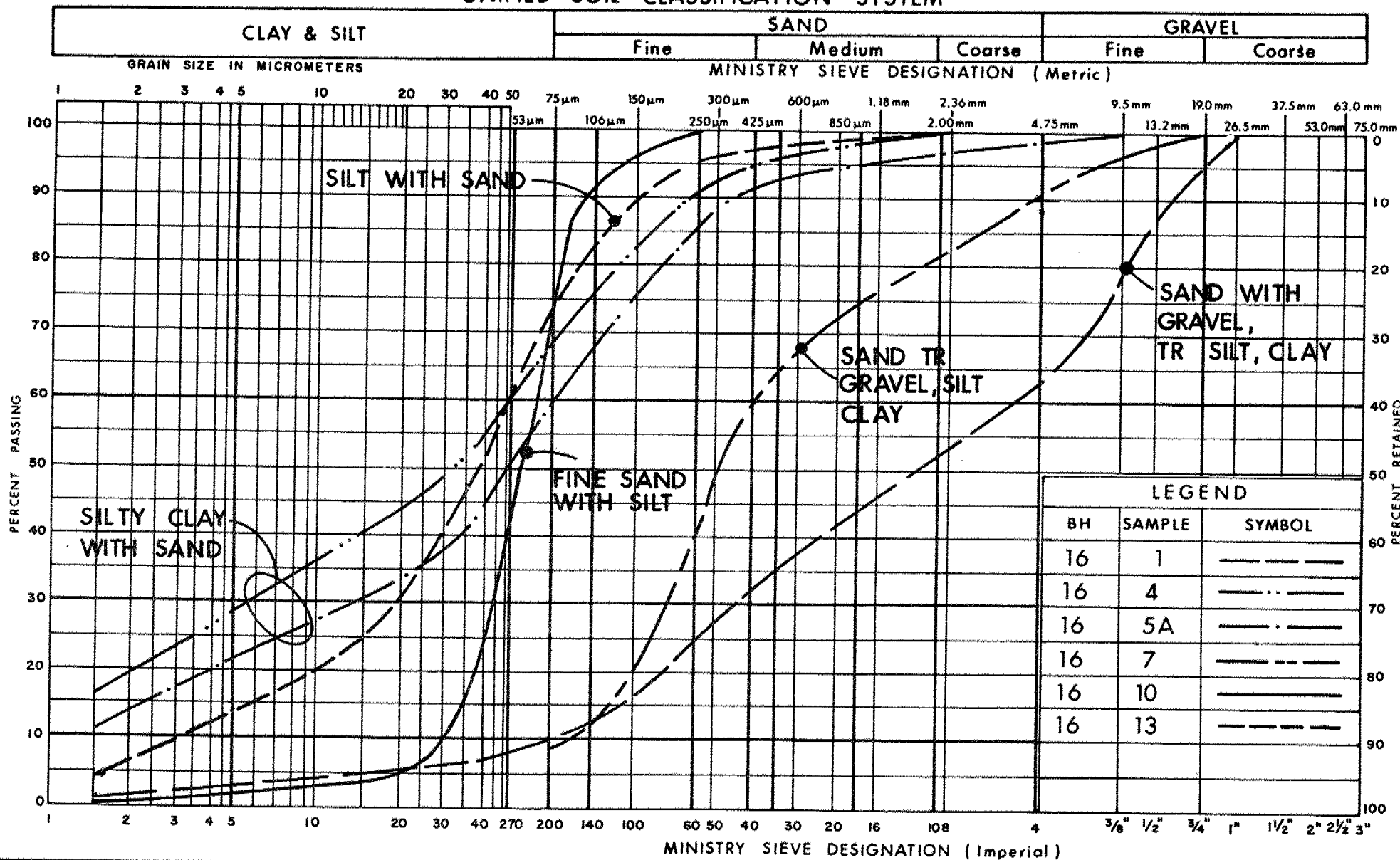
GRAIN SIZE DISTRIBUTION

FIG No 25

W P 202-87-00

BH - 15

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GRAIN SIZE DISTRIBUTION

FIG No 26

W P 202-87-00

BH-16

RECORD OF BOREHOLE No 1

METRIC

W P 202-87-00 LOCATION Sta. 21 + 933 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 11 CHECKED BY DT

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					
174.5	Shoulder Surface																
0.0	Ashpalt																
173.7	Sand some Gravel (Fill)						174										
0.8	Silty Clay some sand		1	SS	18												
172.4	trace gravel (Fill)		2	SS	28												
2.1			3	SS	27		172										
			4	SS	43												
	Silty Clay		5	SS	23												3 13 62 22
	some sand		6	SS	30		170										
	trace gravel		7	SS	42												2 13 59 26
			8	SS	55		168										
	Very Stiff to Hard		9	SS	40												
			10	SS	87		166										
			11	SS	144		164										1 23 46 30
162.9	Silty Clay of Intermediate Plasticity (CI)																
11.6	Silt, some sand		12	SS	42		162										0 20 (80)
161.1	Dense																
13.4	Sand, some gravel, trace silt		13	SS	38		160										
159.2	Very Dense		14	SS	79	**											15 76 8 1
15.3	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																
	** 'N' value may not be representative since sand came up to Elev. 160 before driving spoon																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 202-87-00 LOCATION Sta. 22 + 082, O/S 2.1 m Lt. ORIGINATED BY DL
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 11 CHECKED BY DT

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					
172.9	Shoulder Surface																
0.0	Asphalt																
172.0	Sand and Gravel (Fill)		1	SS	12		172										6 55 (39)
0.9	Silty Clay and Sand (Fill)		2	SS	23												1 36 (63)
			3	SS	21												
			4	SS	11		170										
			5	SS	12												
168.6	Silty Clay with Sand		6	SS	10												
4.3			7	SS	35		168										6 33 (61)
			8	SS	33												
			9	SS	15		166										5 34 45 16
	trace gravel																
	Fine Silty Sand		10	SS	25		164										
	With Occasional non-cohesive zones and random seams of fine sand		11	SS	41		162										0 13 50 37
	Hard		12	SS	113												
			13	SS	60/9 cm		160										
			14	SS	60/10 cm		158										
157.4	End of Borehole																
15.5	* Groundwater Level measured at completion of B.H. Level may not be stabilized																

RECORD OF BOREHOLE No 3

METRIC

W P 202-87-00 LOCATION Sta. 22 + 230 O/S 2.1 m Lt. ORIGINATED BY GP
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 1987 02 11 CHECKED BY DT

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					
171.2	Shoulder Surface																
0.0	Asphalt					*											GR SA SI CL
170.2	Sand with Gravel (Fill)		1	SS	14		170										
1.0	Silty Clay, with sand trace gravel (Fill)		2	SS	30												
168.3	Trace organic		3	SS	24												2 36 (62)
2.9	Firm		4	SS	8		168										
			5	SS	8												
			6	SS	29		166										2 35 (63)
			7	SS	25												
	Silty Clay some with sand trace gravel		8	SS	30		164										10 32 (58)
			9	SS	16												
	Very Stiff		10	SS	32		162										
			11	SS	36												0 15 45 40
			12	SS	125	20 cm	160										0 0 96 4
	Silt (slight cohesive)		13	SS	65		158										
			14	SS	102	25 cm	156										
155.5	Hard																
15.7	End of Borehole																
	* Borehole at completion. Groundwater level may not have been stabilized.																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 202-87-00 LOCATION Sta. 22 + 381 O/S 2.1 m Lt. ORIGINATED BY MLP
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 10 CHECKED BY D+

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					
169.6	Shoulder Surface																
0.0	Asphalt					*											
168.6	Sand and Gravel (Fill)																
1.0			1	SS	19		168										3 38 45 14
	Silty Clay with sand trace gravel		2	SS	7												
	Firm		3	SS	9												
	Silt		4	SS	7		166										
			5	SS	15												
	With occasional non-cohesive zones and thin seams of fine sand and silt		6	SS	18												3 35 43 19
			7	SS	29		164										
			8	SS	25												3 32 50 15
			9	SS	32		162										
	Very Stiff to Hard		10	SS	73		160										3 28 48 21
158.0			11	SS	110												1 34 55 10
11.6	Silt, some sand trace clay Very Dense		12	SS	78		158										0 11 79 10
155.8			13	SS	120	10 cm	156										
13.8	Silty Clay with sand																
153.9	Hard		14	SS	120		154										
15.7	End of Borehole																
	* Borehole dry at completion. Groundwater level may not be stabilized.																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 202-87-00 LOCATION Sta. 22 + 532 O/S 2.1 m Lt. ORIGINATED BY GP
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 1987 02 10 CHECKED BY *Dr*

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								
168.7	Shoulder Surface															
0.0	Asphalt					*										
167.7	Sand some Gravel(Fill)		1	SS	17		168									
1.0	Silty Clay trace/some sand trace gravel Very Stiff		2	SS	16											
			3	SS	18											
			4	SS	89											
	With slight to non-plastic zones and seams		5	SS	72											
			6	SS	59											
			7	SS	119	28 cm										
	Silt and Sand trace gravel Very Dense		8	SS	125	20 cm										
			9	SS	127											
	Hard		10	SS	74											
			11	SS	110	25 cm										
			12	SS	85											
	Fine Sand some silt Dense		13	SS	107	25 cm										
	154.6	End of Borehole														
14.1	* Borehole dry at completion of borehole. Groundwater level may not be stabilized															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W P 202-87-00 LOCATION Sta. 22 + 683 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 09 CHECKED BY DJT

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					
167.9	Shoulder Surface																
0.0	Asphalt																
167.0	Sand some Gravel (Fill)																
0.9	Silty Clay, trace		1	SS	23												
166.1	sand, gravel (Fill)		2	SS	23												
1.8	Silty Clay		3	SS	38												
	trace sand		4	SS	75												
	gravel		5	SS	52												
	Fine Silty Sand		6	SS	31												
	With zones of		7	SS	61												
	slightly plastic		8	SS	67												
	material and random		9	SS	140												
	thin seams of silt		10	SS	195												
161.2	Hard		11	SS	95												
6.7	Silt, trace sand																
	gravel																
	Very Dense																
157.8	Silty Clay		12	SS	146												
10.1	trace/some sand																
	trace gravel																
	Hard		13	SS	138												
	Fine Silty Sand																
	With zones of		14	SS	152												
	slightly plastic																
	material and occ.																
	random thin seams																
	of silt		15	SS	121												
152.2	End of Borehole																
15.7	* Groundwater Level not established																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 202-87-00 LOCATION Sta. 22 + 834 O/S 2.1 m Lt. ORIGINATED BY MJ
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY LP
 DATUM Geodetic DATE 87 02 10 CHECKED BY DT

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					
167.1	Shoulder Surface																
0.0	Asphalt																
165.7	Sand some gravel (Fill)		1	SS	21		166										
1.4	Silty Clay with sand (Fill)		2	SS	7												2 36 (62)
164.1			3	SS	7												
3.0	with organics		4	SS	4		164										0 43 (57)
162.8	Silty Clay and sand Firm																
4.3	Fine Sand with silt Compact		5	SS	11		162										0 62 (38)
160.8			6	SS	15												11 58 (31)
6.3			7	SS	52												
	Sand and Silt trace gravel clay		8	SS	40		160										4 39 47 10
	with occasional slightly cohesive zones		9	SS	168		158										
			10	SS	110		156										4 42 47 7
			11	SS	125/15 cm		154										
	Very Dense		12	SS	105/15 cm												4 44 43 9
151.9			13	SS	106/15 cm		152										
15.2	End of Borehole																
	* Borehole dry at completion. Groundwater level may not be stabilized																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P 202-87-00 LOCATION Sta. 22 + 985 O/S 2.1 m Lt. ORIGINATED BY GP
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 1987 02 09 CHECKED BY DT

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					
167.2	Shoulder Surface																
0.0	Asphalt																
166.1	Sand with gravel (Fill)		1	SS	20		166										1 23 58 18
1.1	Silty Clay trace to some sand trace gravel		2	SS	36												
164.2	Hard		3	SS	99												
2.9	Fine Sand trace silt clay		4	SS	97		164										0 83 (17)
			5	SS	85												
			6	SS	47		162										0 94 (6)
	Very Dense Compact		7	SS	46												
			8	SS	29												
			9	SS	9		160										
157.9			10	SS	110	25 cm	158										4 32 (64)
9.3	Silty Clay with sand trace gravel		11	SS	106	25 cm	156										
155.6	Hard		12	SS	127	20 cm	154										
11.6	Sand and Silt trace gravel		13	SS	100	15 cm											
153.2	Very Dense																
14.0	End of Borehole																
	* Groundwater Level measured at completion of B.H. Level may not be stabilized																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9

METRIC

W P 202-87-00 LOCATION Sta. 23 + 131 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 12 CHECKED BY DT

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
168.1	Shoulder Surface															GR SA SI CL
0.0	Asphalt					168										
166.8	Sand with Gravel (Fill)		1	SS	23											
1.3	Silt, some sand trace gravel clay Occ. plastic zones		2	SS	56											1 10 80 9
			3	SS	80											
			4	SS	57											
163.5	Very Dense		5	SS	39											
4.6			6	SS	60											25 65 (10)
	Sand, trace/some gravel, trace silt clay		7	SS	60											
161.1	Very Dense		8	SS	52											9 78 (13)
7.0			9	SS	108											
	Silt with sand trace gravel clay		10	SS	100											
			11	SS	180											
	Sand with silt Very Dense		12	SS	146											3 33 59 5
			13	SS	112/13											
	Very Dense		14	SS	63											6 35 (59)
152.7																
15.4	End of Borehole															
	* Groundwater level measured at completion of B.H. Level may not be stabilized.															
	** N value for SS#13 may not be represen- tative since sand came up to Elev.155 before driving spoon															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10

METRIC

W P 202-87-00 LOCATION Sta. 23 + 275 O/S 2.1 m Lt. ORIGINATED BY MLP
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 06 CHECKED BY DT

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					
169.8	Shoulder Surface																
0.0	Asphalt																
168.6	Sand with Gravel (Fill)		1	SS	33												
1.2	Silty Clay with sand trace organics (Fill)		2	SS	25												
167.1			3	SS	37												
2.7	Sand and Silt		4	SS	48												
165.5	Very Dense		5	SS	134												
4.3	Silty Clay with sand		6	SS	28												
164.6	Very Stiff																
5.2	Silt, some sand gravel		7	SS	59												
			8	SS	70												
			9	SS	130												
161.0	Very Dense																
8.8	Sand and silt with occasional slightly cohesive zones		10	SS	130	20 cm											
			11	SS	103												
157.2	Very Dense		12	SS	134	25 cm											
12.6	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 11

METRIC

W P 202-87-00 LOCATION Sta. 23 + 428 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 06 CHECKED BY DT

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	40	60	80	100					
174.0	Shoulder Surface																
0.0	Asphalt																
172.8	Sand and Gravel (Fill)		1	SS	29												
1.2	Silty Clay with sand trace gravel (Fill)		2	SS	29		172										1 35 48 16
			3	SS	8												
			4	SS	7												
169.4			5	SS	7		170										
4.6	Trace org		6	SS	10												
	Stiff		7	SS	15		168										4 33 47 16
			8	SS	29												
	Silty Clay with sand trace gravel		9	SS	100		166										2 33 47 18
			10	SS	33		164										
	With dense zone of slightly plastic silt (CL-ML material between Elev. 164.5 and 162.5		11	SS	35												6 39 (55)
	Hard		12	SS	103		162										
			13	SS	58		160										
159.1			14	SS	63												
14.9	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																

RECORD OF BOREHOLE No 12

METRIC

W P 202-87-00 LOCATION Sta. 23 + 705 O/S 2.1 m Lt. ORIGINATED BY MJ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 05 CHECKED BY DT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					10 20 30				
176.0	Shoulder Surface																
0.0	Asphalt																
174.7	Sand some gravel (Fill)		1	SS	30												
1.3	Trace org.		2	SS	18												
	Silty Clay with sand trace gravel		3	SS	18		174									6 33 43 18	
			4	SS	6												
	With loose zone of plastic silt and sand between Elev. 172 and 173		5	SS	20		172									1 42 47 10	
			6	SS	34												
			7	SS	70		170									2 24 49 25	
	Occ. random thin seams of sand		8	SS	47												
167.5	Very Stiff to Hard		9	SS	49		168										
8.5	Clay (CH) some silt		10	SS	32												
165.9	Hard						166									0 3 22 75	
10.1	Fine sand, trace silt																
164.9	Very Dense		11	SS	156	**										0 96 (4)	
11.1	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																
	** Sand came up augers to Elev. 166																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 13

METRIC

W P 202-87-00 LOCATION Sta. 23 + 855 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 05 CHECKED BY DA

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					
174.3	Shoulder Surface																
0.0	Asphalt						174										
173.4	Sand and Gravel (Fill)		1	SS	16												
0.9	Silty Clay with sand		2	SS	14												0 32 40 28
172.5	(Fill)																
1.8	Trace organics		3	SS	25		172										
	Silty Clay (CI) to		4	SS	40												0 2 23 75
	clay (CH) trace sand		5	SS	39												
	with occ. thin seams		6	SS	27		170										0 22 (78)
	of fine sand		7	SS	19												
	Fine Sand with silt		8	SS	22		168										
	Silt some sand		9	SS	70												0 2 (98)
	Very Stiff						166										
	to Hard																
165.5			10	SS	99		164										1 84 (15)
8.8	Fine Sand, trace																
	gravel, silt, clay																
163.6	Very Dense																
10.7	End of Borehole																
	* Groundwater level																
	measured at																
	completion of B.H.																
	Level may not be																
	stabilized																
	** At Elev. 163.6 B.H.																
	silted up to																
	Elev. 167±.																
	Borehole terminated																

RECORD OF BOREHOLE No 14

METRIC

W P 202-87-00 LOCATION Sta. 23 + 992 O/S 2.1 m Lt. ORIGINATED BY MJ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 04 CHECKED BY DA

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		
172.4	Shoulder Surface													
0.0	Asphalt													
171.5	Sand with gravel (Fill)		1	SS	19		172							
0.9	Silty clay, trace sand, gravel		2	SS	38									2 11 51 36
	Hard		3	SS	43		170							
169.5	Fine sand with silt trace clay		4	SS	38									
2.9	Compact to Dense		5	SS	26									
168.0	Clay some silt (CH)		6	SS	33		168							0 1 25 74
4.4	Hard		7	SS	162									
166.9	Fine sand trace silt clay		8	SS	100		166							0 96 (4)
5.5	Very Dense		9	SS	95									
	Fine to Medium Sand		10	SS	68		164							
161.7	trace gravel						162							
10.7	End of Borehole													
	* Groundwater level measured at completion of borehole. Level may not be stabilized													

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 15

METRIC

W P 202-87-00 LOCATION Sta. 24 + 128 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 03 CHECKED BY DT

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					
170.3	Shoulder Surface																
0.0	Asphalt						170										
169.1	Sand some silt gravel (Fill)		1	SS	26												
1.2	Silty Clay with sand		2	SS	38												2 30 48 20
167.4	trace gravel Very Stiff		3	SS	22		168										2 31 47 20
2.9	Sand and silt trace clay gravel (slightly cohesive)		4	SS	53												
			5	SS	149												
			6	SS	143		166										
	Very Dense		7	SS	85												
			8	SS	49		164										3 48 43 6
163.3																	
7.0	Silty clay and sand trace gravel		9	SS	95												5 43 41 11
161.8	Hard						162										
8.5	Sand some silt trace gravel		10	SS	72												
	clay		11	SS	107		160										6 67 (27)
158.1	Very Dense		12	SS	30	**											
12.2	End of Borehole																
	* Groundwater level measured at completion of borehole. Level may not be stabilized.																
	** Sample disturbed; 'N' value not representative; Sand boiling																

+³, x⁵: Numbers refer to
Sensitivity

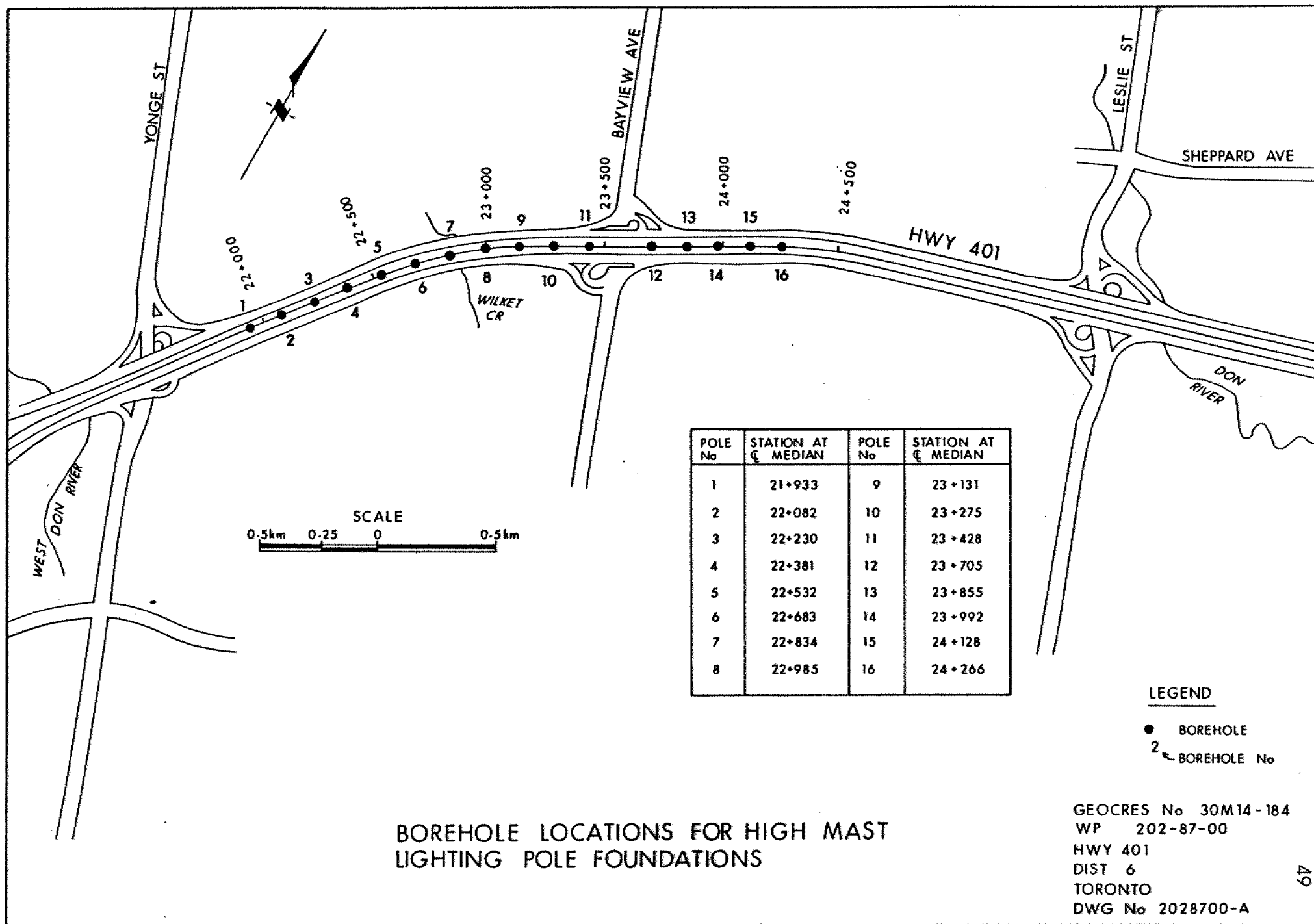
20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 16

METRIC

W P 202-87-00 LOCATION Sta. 24 + 266 O/S 2.1 m Lt. ORIGINATED BY MJ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
 DATUM Geodetic DATE 87 02 02 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
168.3	Shoulder Surface													
0.0	Asphalt													
	Sand with gravel trace silt, clay (Fill)		1	SS	43		168							
			2	SS	13									38 51 10 1
165.8			3	SS	17		166							
2.5	Silty Clay with sand		4	SS	15									0 34 49 17
164.3	Very Stiff		5	SS	22									1 41 44 14
4.0			6	SS	44		164							
	Sand trace gravel silt, clay (well graded)		7	SS	50									10 82 (8)
	Dense		8	SS	52		162							
161.3														
7.0			9	SS	61		160							
	Fine Sand with silt													
	silt content increasing gradually with depth		10	SS	17									0 33 66 1
	Compact to Very Dense		11	SS	62		158							
156.1														
12.2			12	SS	40		156							
	Silt with sand													
	Very Dense		13	SS	52									1 26 68 5
153.4			14	SS	75		154							
14.9	End of Borehole													
	* Groundwater level measured at completion of borehole May not represent stabilized level													





Ministry of
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CONT. 87-74

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 202-87-00

DIST 6

HWY 401

STR SITE -

High Mast Lighting from
East of Yonge St. to
East of Bayview Ave.

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FOUNDATION INVESTIGATION REPORT
for
High Mast Lighting
from East of Yonge Street
to East of Bayview Avenue
W.P. 202-87-00 Hwy. 401
District 6 - Toronto

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the above-noted site between 87 02 02 and 87 02 11. The fieldwork consisted of advancing one borehole at each of the 16 high mast light (HML) locations. The boreholes involved the sampling of the soil by means of the split spoon test, to depths ranging between 10.7 and 15.7 m below the shoulder pavement surface.

Boreholes are numbered BH 1 to BH 16, corresponding to the identifying number of the associated HML. The location of each borehole is shown in plan on Dwg. No. 2028700-A in the Appendix.

SITE DESCRIPTION

The site of the proposed 16 HML is located along Hwy.401 from approximately 450 m east of Yonge St. to approximately 700 m east of Bayview Ave. The site is located in the City of North York, Regional Municipality of York.

Outside the highway right-of-way, land use is primarily residential with some commercial development. Topography across the site is relatively flat.

Physiographically, the site lies within the region known as the South Slope (Ref: Chapman and Putnam, 'The Physiography of Southern Ontario', 3rd Ed., 1984). Specifically, the site is located in a till plain north of the past Lake Iroquois shoreline. The soil is a ground moraine which originated in the Pleistocene Age. Bedrock across the site consists of black and grey shale of the Georgian Bay Formation and is estimated to occur at 70 to 80 m below the ground surface. Boreholes in this investigation were not advanced to these depths.

SUBSURFACE CONDITIONS

The native deposits across the site are of glacial origin. Deposits of silty clay till, sand and silt till, fine sand, and silt are among the most predominant encountered within the investigation limits.

The boundaries between the various soil types, in-situ and laboratory test results, as well as groundwater levels are shown on the Record of Borehole Sheets in the Appendix.

Detailed descriptions of the various soil deposits are not given in this report. However, reference should be made to the appropriate Record of Borehole Sheet for subsurface conditions at each HML location.

Numerous laboratory tests were carried out on samples of soils from each borehole. These include Atterberg Limits, Grain Size Distribution and Moisture Content tests. The results are indicated on each Record of Borehole Sheet, and are summarized graphically in the Appendix.

For cross-reference to the Plasticity Charts, (Atterberg Limits results) the following should be used:

<u>Boreholes</u>	<u>Figure</u>
1	1
2	2
3	3
4	4
5	5
6	6
7,8	7
10,11	8
12,13,14	9
15,16	10

For typical Grain Size Distribution curves the following figures should be referenced.

<u>Borehole</u>	<u>Figure</u>	<u>Borehole</u>	<u>Figure</u>
1	11	9	19
2	12	10	20
3	13	11	21
4	14	12	22
5	15	13	23
6	16	14	24
7	17	15	25
8	18	16	26

The investigation revealed that the subsurface conditions across the site are not consistent, as both cohesive and cohesionless deposits are encountered throughout. In addition, it was noted that some of the cohesive deposits contain random zones and seams of cohesionless or slightly plastic material, some of which are water-bearing.

In zones where the soil is slightly plastic or non-cohesive, and below the groundwater level, it is likely that the sides of an unsupported augered hole will cave in, and seepage will occur. In situations where excavations (or augered holes) extend into cohesionless soils below the groundwater table, 'boiling' may be experienced at the base.

Groundwater levels were measured at the completion of each borehole. The measured levels are shown on each Record of Borehole Sheet. In view of the hard and very dense nature of glacial deposits, it is believed that the measured groundwater levels do not represent stabilized conditions and the actual levels may, in fact, be higher than those indicated on the Record of Borehole Sheets.

DISCUSSION AND RECOMMENDATIONS

A foundation investigation was carried out at the above-noted site in order to establish soil parameters for the design of the 16 HML foundations. The investigation consisted of advancing 1 borehole at each of the HML locations to a depth ranging between 10.7 and 15.7 m below the shoulder pavement surface.

TABLE 1 indicates the proposed location of each of the 30 m high HML along the Hwy. 401 centreline. The borings were advanced at an offset of 2.1 m left of centreline, on the W.B. core shoulder.

TABLE 1 - HML LOCATIONS

<u>HML#</u>	<u>Sta.</u>	<u>HML#</u>	<u>Sta.</u>
1	21+933	9	23+131
2	22+082	10	23+275
3	22+230	11	23+428
4	22+381	12	23+705
5	22+352	13	23+855
6	22+683	14	23+992
7	22+834	15	24+128
8	22+985	16	24+266

Dwg. No. 105840102-A in the Appendix indicates in plan, the proposed location of each HML.

Design Considerations

As per current MTC design guidelines, each HML pole will be supported on a single concrete caisson. For the design of the caisson, the Structural Office has adopted the method described by B. B. Broms in the following two papers.

Broms, B.B.

Lateral Resistance of Piles in Cohesive Soils,

Journal of the Soil Mechanics and Foundations Division, ASCE,

Vol. 90, No. SM2

Paper 3825, March 1964

and

Broms, B. B.

Lateral Resistance of Piles in Cohesionless Soils,

Journal of the Soil Mechanics and Foundation Division, ASCE,

Vol. 90, No. SM3

Paper 3909, May 1964

In the design of the HML foundations, the contribution of the surficial sand and gravel fill should be neglected from a lateral resistance viewpoint. In certain areas, silty clay fill was encountered under the sand and gravel. Under these circumstances, reduced unconfined compressive strength values have been recommended for the cohesive fill since fill material is, by nature, inconsistent in composition and compaction uniformity.

It should also be assumed that material in the zone of frost penetration does not provide any lateral resistance to the caisson loads. At this site, the depth of frost penetration through earth cover is approximately 1.2 m.

The soil parameters in TABLE 2 are recommended for the design of the HML foundations. The following notation has been adopted:

ϕ = apparent angle of friction for cohesionless soils

q_u = unconfined compressive strength in kPa ($q_u = 2c_u$) for cohesive soils

γ = bulk unit weight in kN/m³

TABLE 2 - Soil Parameters

Pole	Elev. (m) From ~ to	Type of Soil	Denseness or Consistency	ϕ	qu kPa	γ kN/m ³
1	174.5~173.7	Fill(Non-Coh.)	~	~	~	19.3
	173.7~172.4	Fill(Cohesive)	Well Compacted	~	100	20.5
	172.4~169.5	Cohesive	Very Stiff	~	240	20.4
	169.5~165.0	Cohesive	Hard	~	340	21.2
	165.0~163.0	Cohesive	Hard	~	500	21.2
	163.0~159.0	Non-Cohesive	Dense	36°	~	20.4
2	172.9~172.0	Fill(Non-Coh.)	~	~	~	19.3
	172.0~168.5	Fill(Cohesive)	Mod. Compacted	~	90	19.9
	168.5~164.5	Cohesive	Very Stiff	~	190	20.1
	164.5~163.5	Non-Cohesive	Compact	33°	~	20.1
	163.5~160.5	Cohesive	Hard	~	300	21.0
	160.5~157.5	Cohesive	Hard	~	500	21.2
3	171.2~170.2	Fill(Non-Coh.)	~	~	~	19.3
	170.2~168.0	Fill(Cohesive)	Well Compacted	~	150	19.9
	168.0~166.5	Cohesive	Firm	~	95	19.3
	166.5~164.5	Cohesive	Very Stiff	~	225	20.4
	164.5~162.0	Cohesive	Stiff	~	150	19.9
	162.0~159.0	Cohesive	Hard	~	270	20.7
	159.0~155.5	Cohesive	Hard	~	500	21.2
4	169.6~168.6	Fill(Non-Coh.)	~	~	~	19.3
	168.6~166.0	Cohesive	Firm	~	75	19.3
	166.0~164.0	Cohesive	Stiff	~	150	19.9
	164.0~161.0	Cohesive	Very Stiff	~	250	20.6
	161.0~158.0	Cohesive	Hard	~	500	21.2
	158.0~155.5	Non-Cohesive	Very Dense	43°	~	21.2
5	168.7~167.7	Fill(Non-Coh.)	~	~	~	19.3
	167.7~165.5	Cohesive	Very Stiff	~	160	19.9
	165.5~163.5	Cohesive	Hard	~	500	21.2
	163.5~161.0	Non-Cohesive	Very Dense	43°	~	21.2
	161.0~154.5	Cohesive	Hard	~	500	21.2
6	167.9~167.0	Fill(Non-Coh.)	~	~	~	19.3
	167.0~166.0	Fill(Cohesive)	Well Compacted	~	120	20.1
	166.0~163.0	Cohesive	Hard	~	320	21.1
	163.0~161.0	Cohesive	Hard	~	450	21.3
	161.0~158.0	Non-Cohesive	Very Dense	43°	~	21.2
	158.0~152.0	Cohesive	Hard	~	500	21.2
7	167.1~165.7	Fill(Non-Coh.)	~	~	~	19.3
	165.7~164.0	Fill(Cohesive)	Mod. Compacted	~	50	19.3
	164.0~162.5	Cohesive	Soft	~	40	19.3
	162.5~161.0	Non-Cohesive	Compact	30°	~	19.6
	161.0~158.0	Non-Cohesive	Very Dense	39°	~	21.2
	158.0~152.0	Non-cohesive	Very Dense	43°	~	21.2

TABLE 2 - Continued

Pole	Elev. (m) From ~ to	Type of Soil	Denseness or Consistency	ϕ	qu kPa	γ kN/m ³
8	167.2~166.0	Fill(Non-Coh.)	~	~	~	19.6
	166.0~164.3	Fill(Cohesive)	Well Compacted	~	150	20.1
	164.3~161.0	Non-Cohesive	Very Dense	39°	~	21.4
	161.0~158.0	Non-Cohesive	Compact	30°	~	19.6
	158.0~155.5	Cohesive	Hard	~	500	21.2
	155.5~153.0	Non-Cohesive	Very Dense	43°	~	21.2
9	168.1~166.8	Fill(Non-Coh.)	~	~	~	19.3
	166.8~153.0	Non-Cohesive	Very Dense	43°	~	21.2
10	169.8~168.6	Fill(Non-Coh.)	~	~	~	19.3
	168.6~167.0	Fill(Cohesive)	Well Compacted	~	150	20.5
	167.0~165.5	Non-Cohesive	Very Dense	39°	~	21.2
	165.5~164.5	Cohesive	Very Stiff	~	220	20.2
	164.5~157.0	Non-Cohesive	Very Dense	43°	~	21.2
11	174.0~172.8	Fill(Non-Coh.)	~	~	~	19.3
	172.8~169.5	Fill(Cohesive)	~	~	50	19.3
	169.5~168.0	Cohesive	Stiff	~	110	19.9
	168.0~162.0	Cohesive	Hard	~	270	20.7
	162.0~159.0	Cohesive	Hard	~	450	21.2
12	176.0~174.7	Fill(Non-Coh.)	~	~	~	19.3
	174.7~171.5	Cohesive	Very Stiff	~	150	19.9
	171.5~166.0	Cohesive	Hard	~	320	21.2
	166.0~165	Non-Cohesive	Very Dense	43°	~	21.2
13	174.3~173.4	Fill(Non-Coh.)	~	~	~	19.3
	173.4~172.5	Fill(Cohesive)	Mod. Compacted	~	90	19.6
	172.5~167.0	Cohesive	Very Stiff	~	230	20.6
	167.0~165.5	Cohesive	Hard	~	500	21.2
	165.5~163.5	Non-Cohesive	Very Dense	43°	~	21.2
14	172.4~171.5	Fill(Non-Coh.)	~	~	~	19.3
	171.5~169.5	Cohesive	Hard	~	300	21.2
	169.5~168.0	Non-Cohesive	Dense	34°	~	20.4
	168.0~167.0	Cohesive	Hard	~	270	20.7
	167.0~161.5	Non-Cohesive	Very Dense	40°	~	21.2
15	170.3~169.1	Fill(Non-Coh.)	~	~	~	19.3
	169.1~167.5	Cohesive	Very Stiff	~	200	20.2
	167.5~163.0	Non-Cohesive	Very Dense	43°	~	21.2
	163.0~161.5	Cohesive	Hard	~	500	21.2
	161.5~158.0	Non-Cohesive	Very Dense	39°	~	21.2
16	168.3~165.8	Fill(Non-Coh.)	~	~	~	19.3
	165.8~164.3	Cohesive	Very Stiff	~	150	20.0
	164.3~153.5	Non-Cohesive	Very Dense	39°	~	21.2

This Section should be contacted in the event that a caisson extending below the investigated depth is required.

Groundwater levels were measured in the open boreholes immediately upon the completion of each boring. In view of the very dense or hard nature of some of the soils, it is believed that the measured levels do not represent the stabilized conditions. For design purposes, it should be assumed that the groundwater level is found at 4.5 m below the pavement surface.

Construction Considerations

The investigation revealed that the subsurface conditions across the site are not consistent, as both cohesive and cohesionless deposits are encountered throughout. In addition, it was noted that some of the cohesive deposits contain zones and seams of cohesionless material, some of which are water-bearing.

In zones where the soil is slightly plastic or cohesionless, and below the groundwater level, it is possible that the sides of an unsupported augered hole will cave in. If caving, and as a result, disturbance occurs, the lateral resistance of the soil may be drastically reduced. Therefore, given the nature of the subsoils across the site, it is recommended that all caissons be constructed utilizing a temporary liner which could be withdrawn as the concrete is poured.

When fine-grained cohesionless soils are subjected to unbalanced hydrostatic pressures, 'boiling' will be experienced. Boiling (or quick) conditions result in complete loss of intergranular friction and the supporting capacity of the soil mass. It will therefore be necessary to prevent such conditions from developing.

Quick conditions could be controlled by balancing the hydrostatic pressures by using either slurry-drilling techniques or balancing the hydraulic head by means of water. The contractor should be informed of the potential of boiling and should be required to prevent the condition from occurring.

MISCELLANEOUS

The fieldwork for this investigation was carried out between 87 02 02 and 87 02 11 utilizing equipment owned and operated by Master Soil Investigation Ltd. and Archer Drilling Ltd. Two truck-mounted and one track-mounted auger machines were used in the investigation. The fieldwork was carried out under the supervision of G. Petruzzello and M. L. Pauly, M. Jolink, of the Foundation Design Section.

This report was written by L. Politano, Project Foundations Engineer, and was reviewed by M. Devata, Chief Foundations Engineer (East).

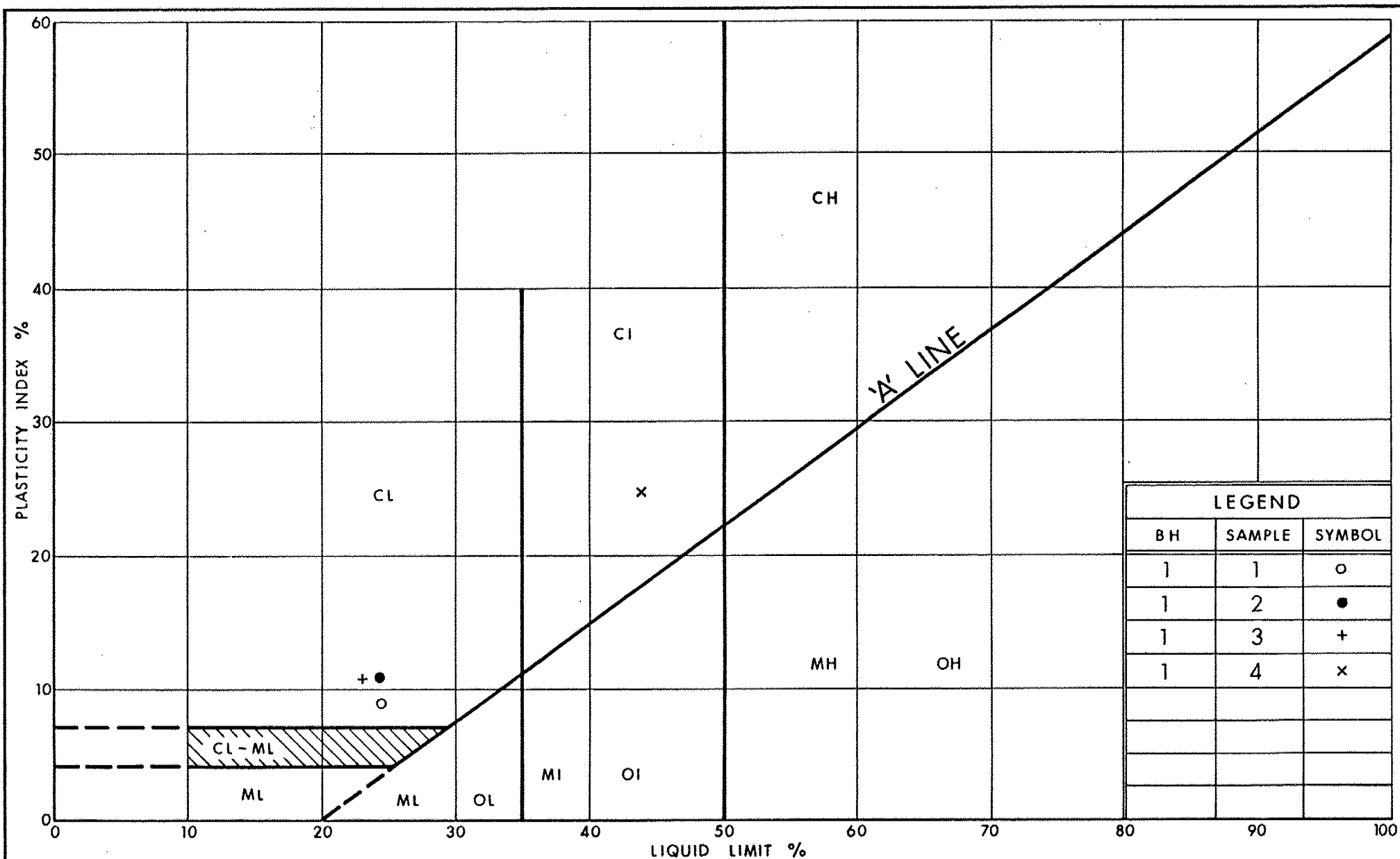


L. Politano, P. Eng.
Project Foundations Engineer

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

March, 1987.

APPENDIX



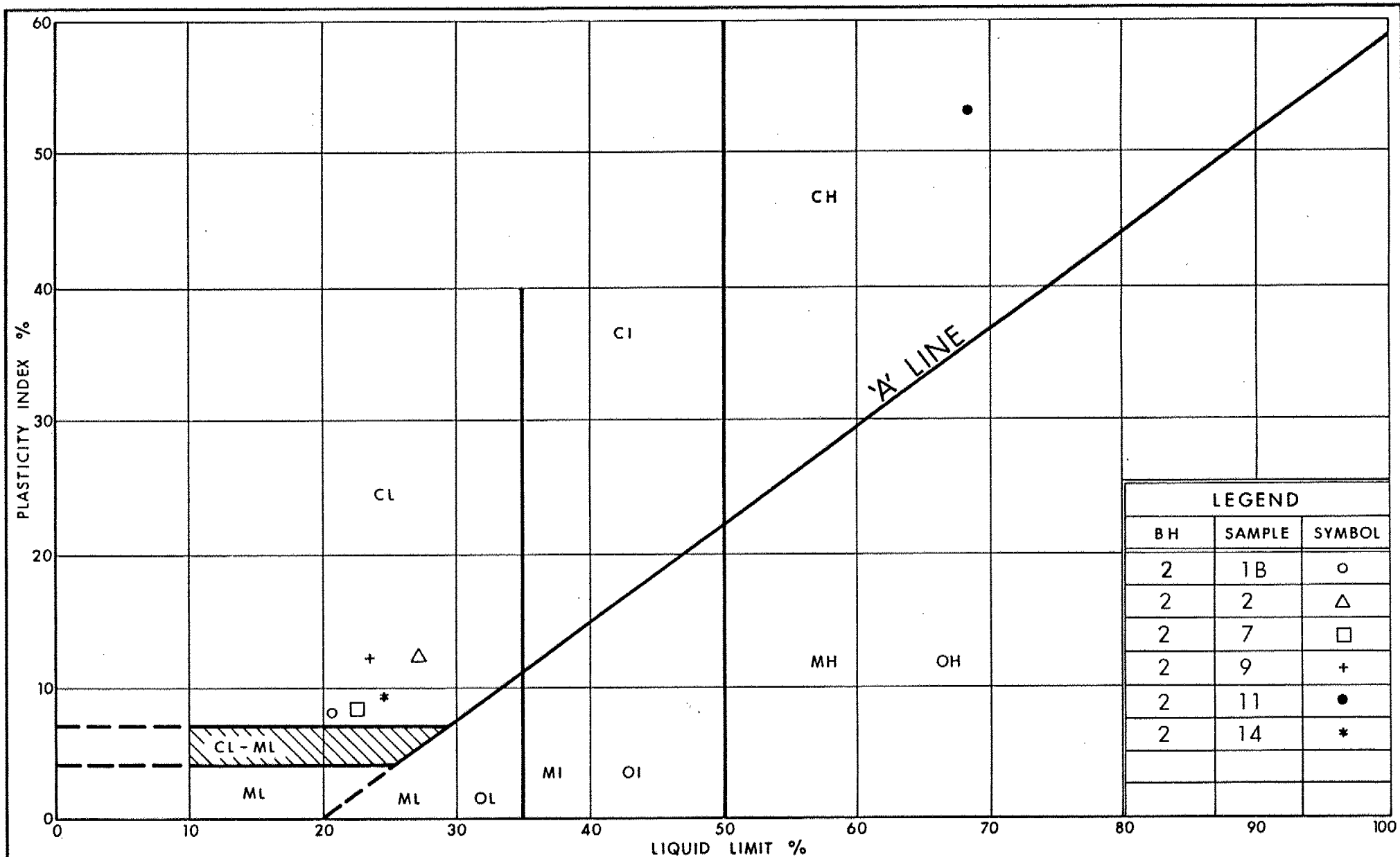
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PLASTICITY CHART

FIG No 1

W P 202-87-00

BH - 1



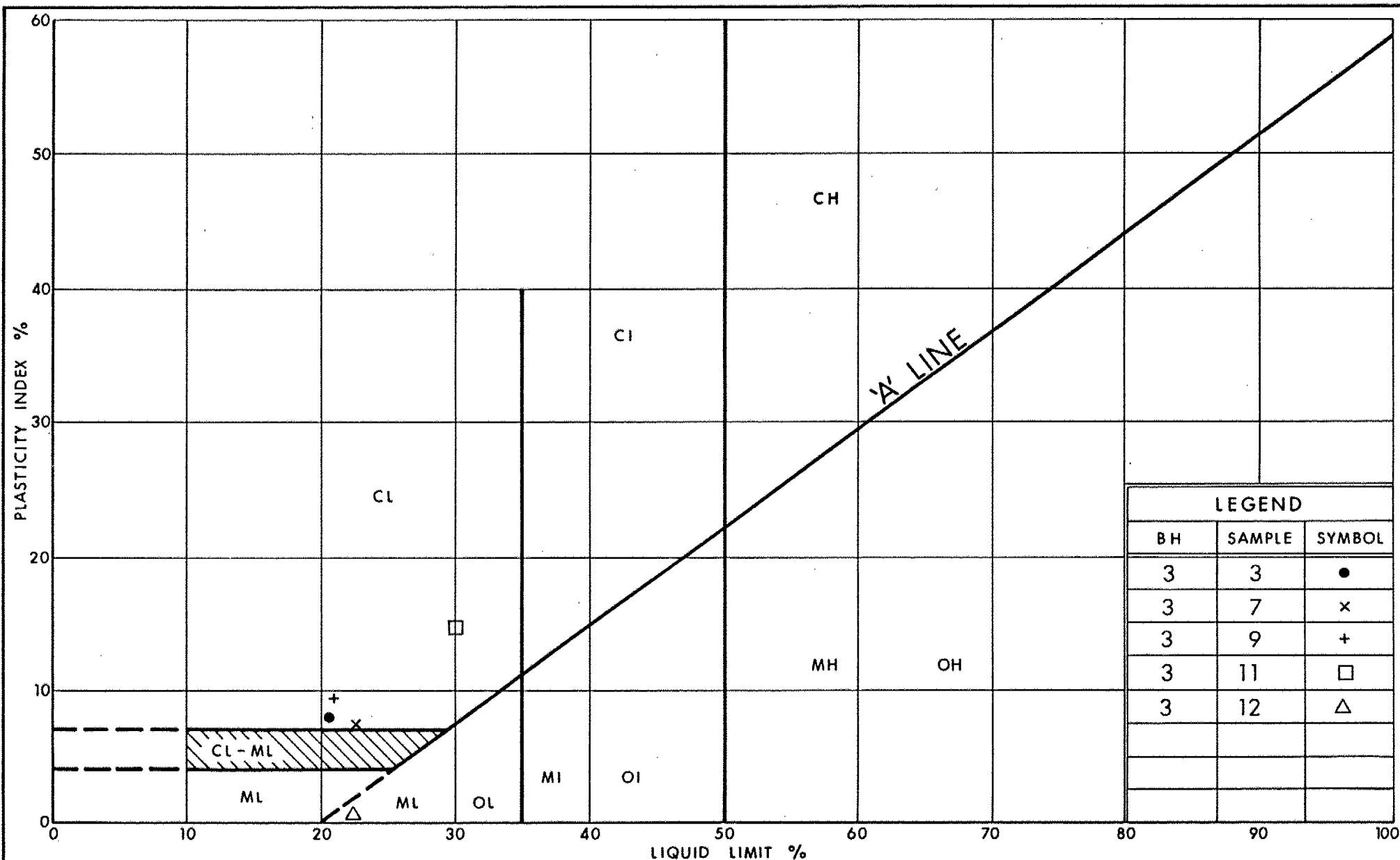
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PLASTICITY CHART

FIG No 2

W P 202-87-00

BH-2



LEGEND		
BH	SAMPLE	SYMBOL
3	3	●
3	7	×
3	9	+
3	11	□
3	12	△



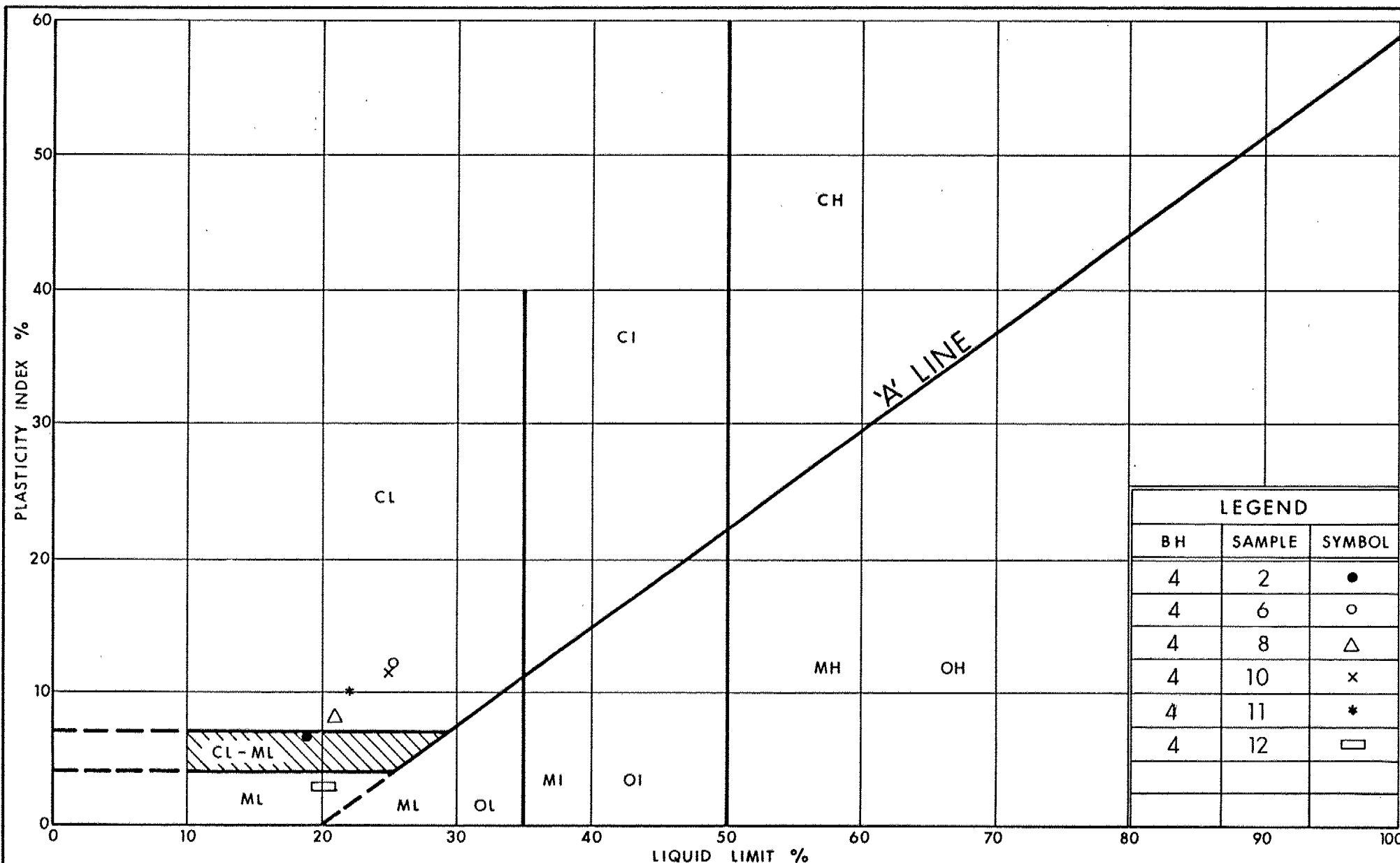
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PLASTICITY CHART

FIG No 3

W P 202-87-00

BH - 3



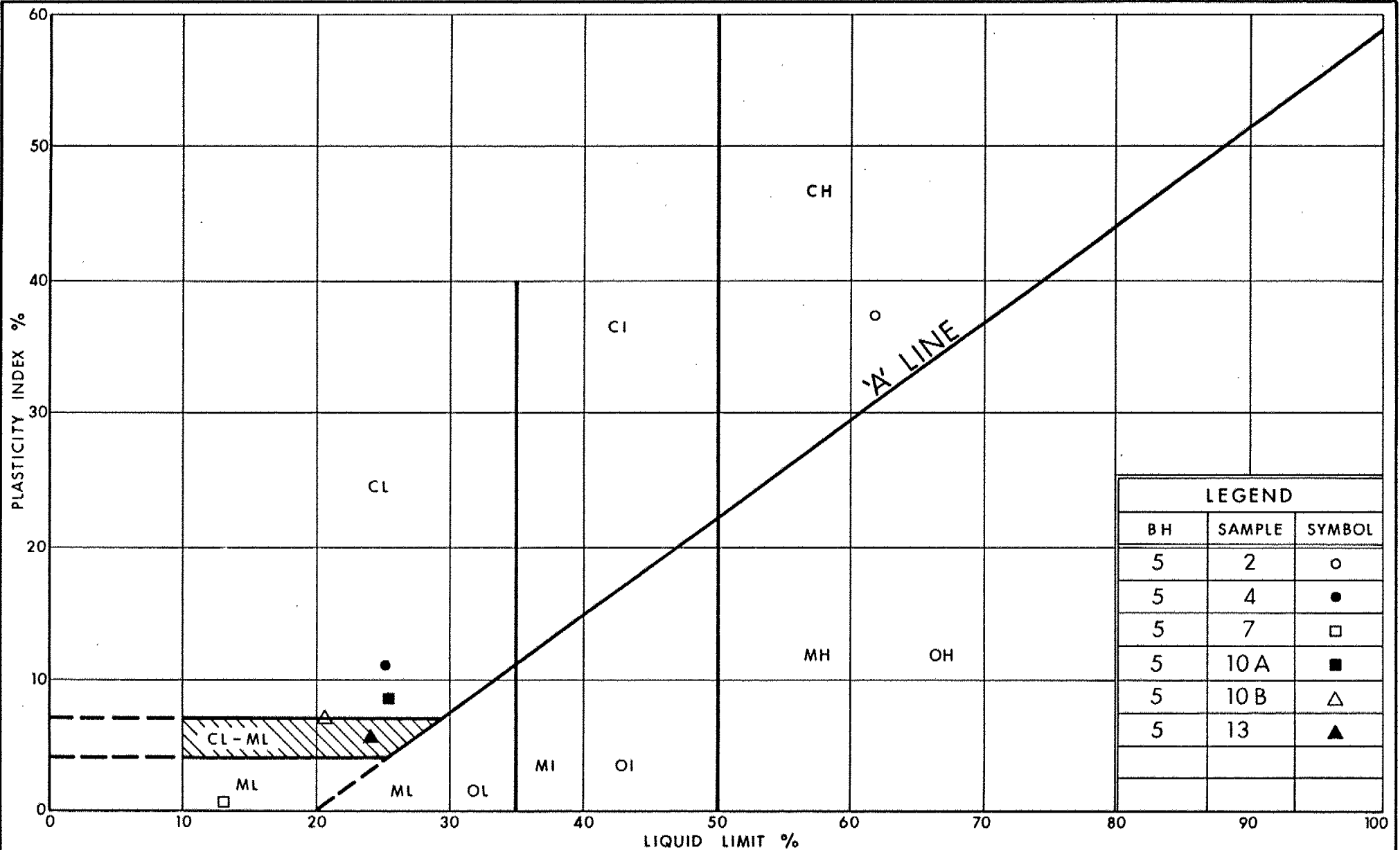
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PLASTICITY CHART

FIG No 4

W P 202-87-00

BH-4



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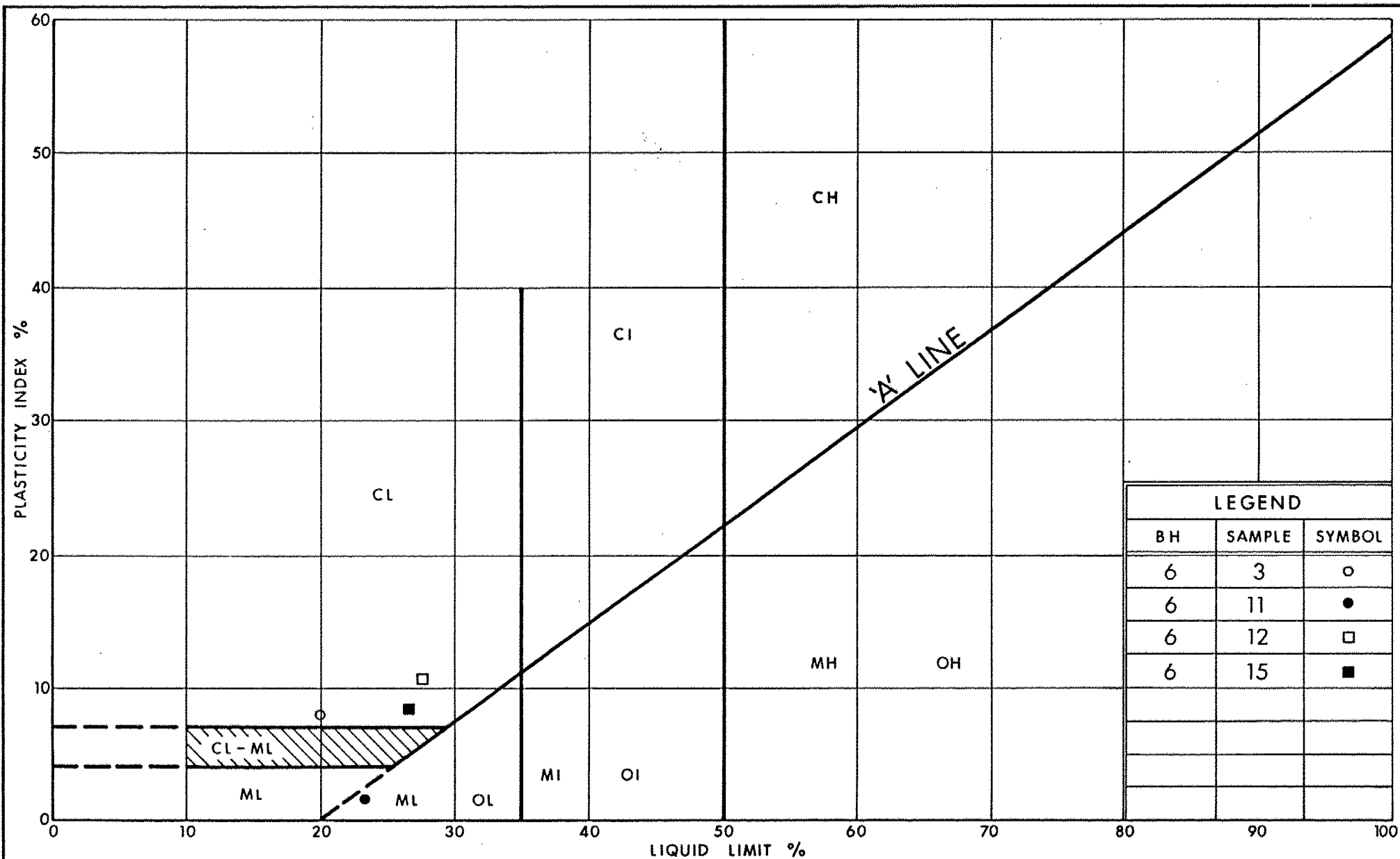
Ontario

PLASTICITY CHART

FIG No 5

W P 202-87-00

BH - 5



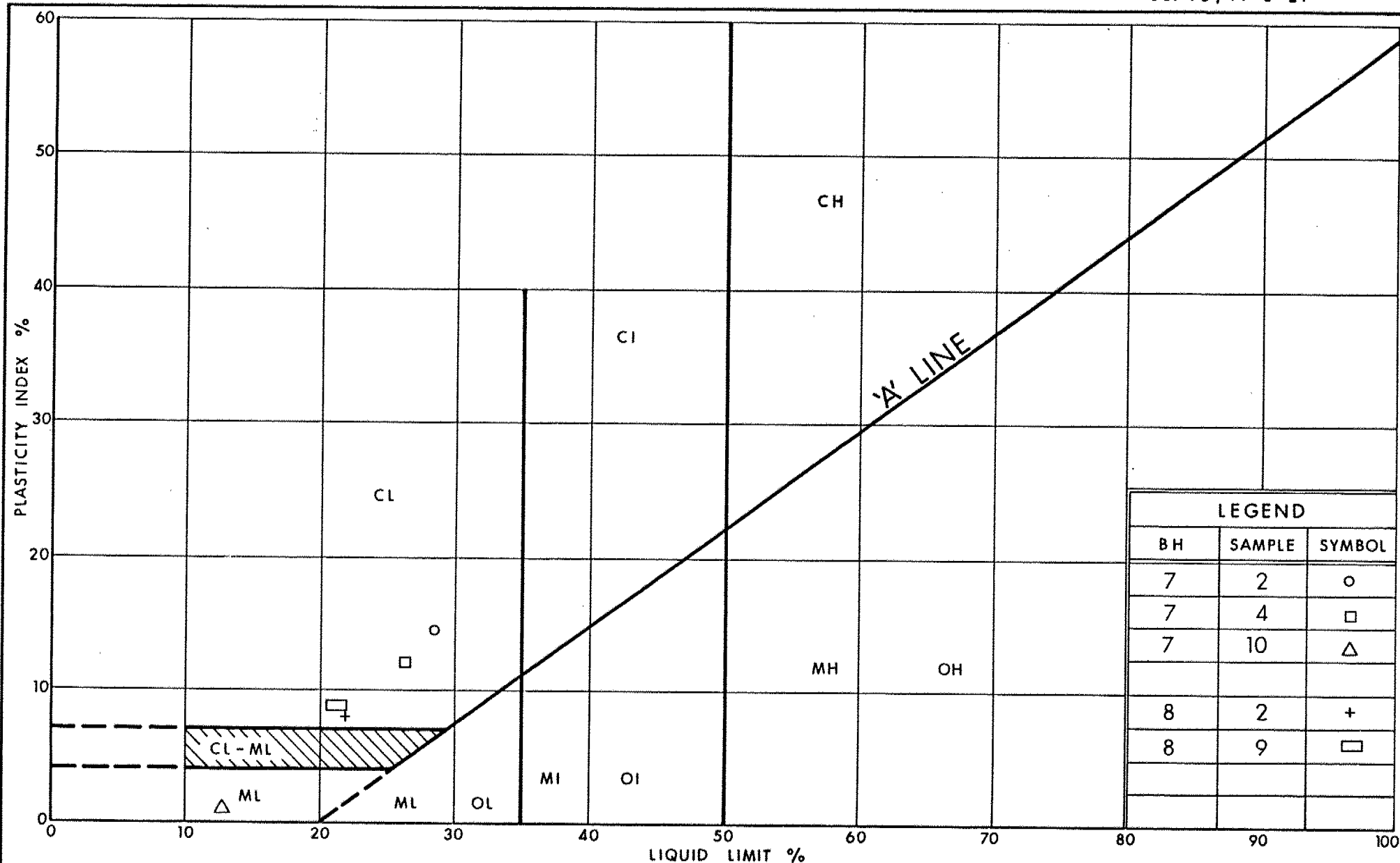
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PLASTICITY CHART

FIG No 6

W P 202-87-00

BH - 6



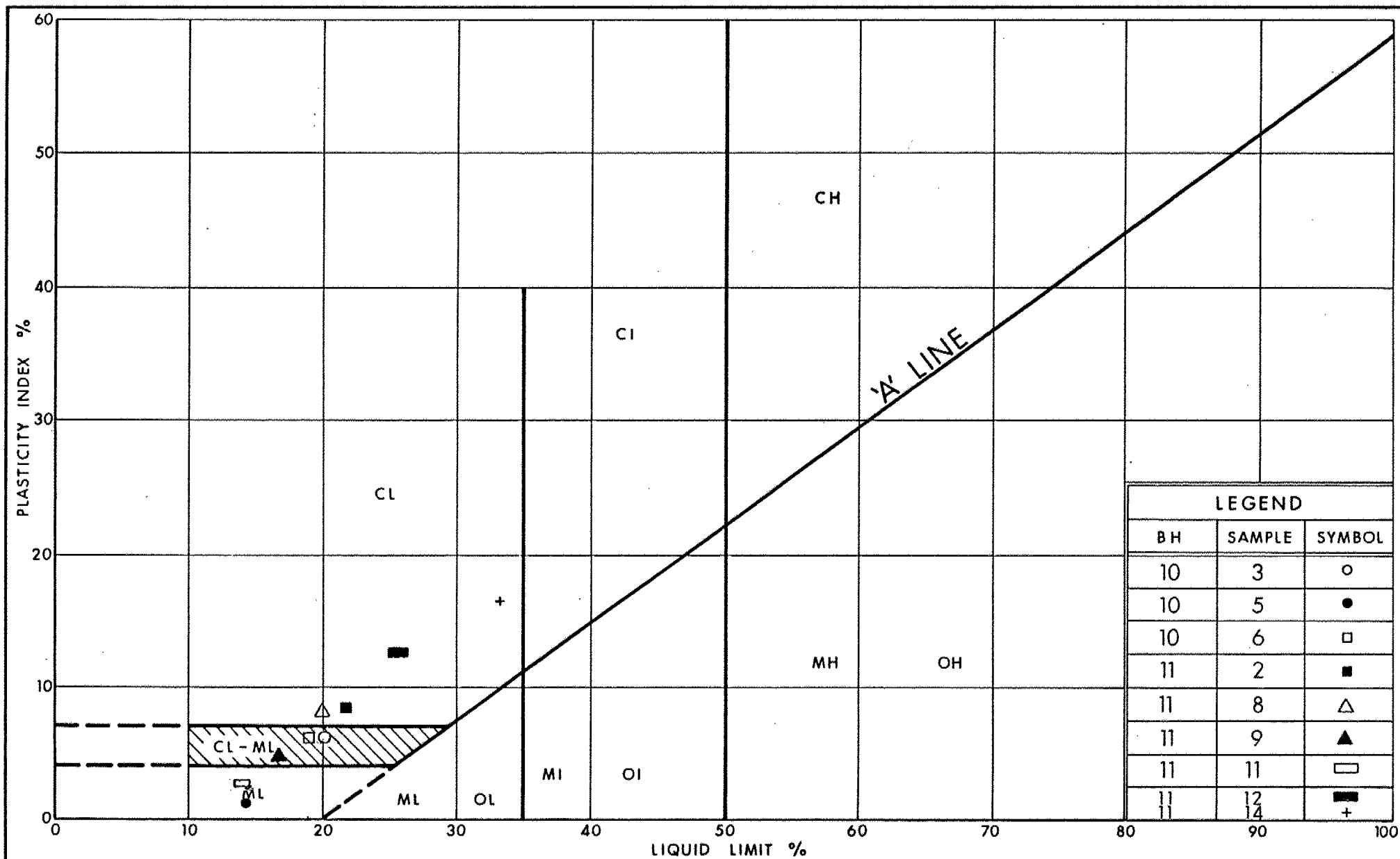
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PLASTICITY CHART

FIG No 7

W P 202-87-00

BH-7, 8



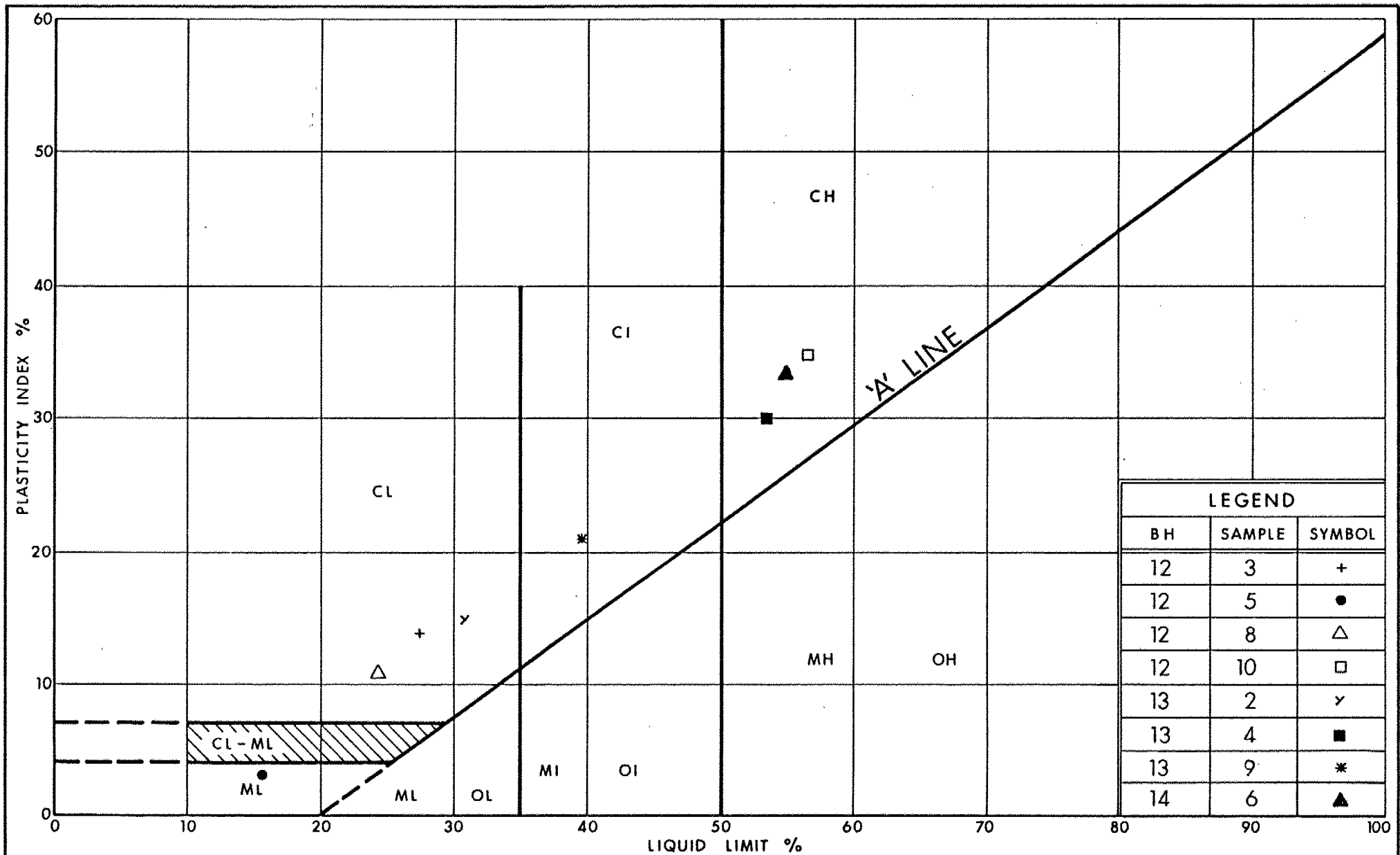
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PLASTICITY CHART

FIG No 8

W P 202-87-00

BH-10,11



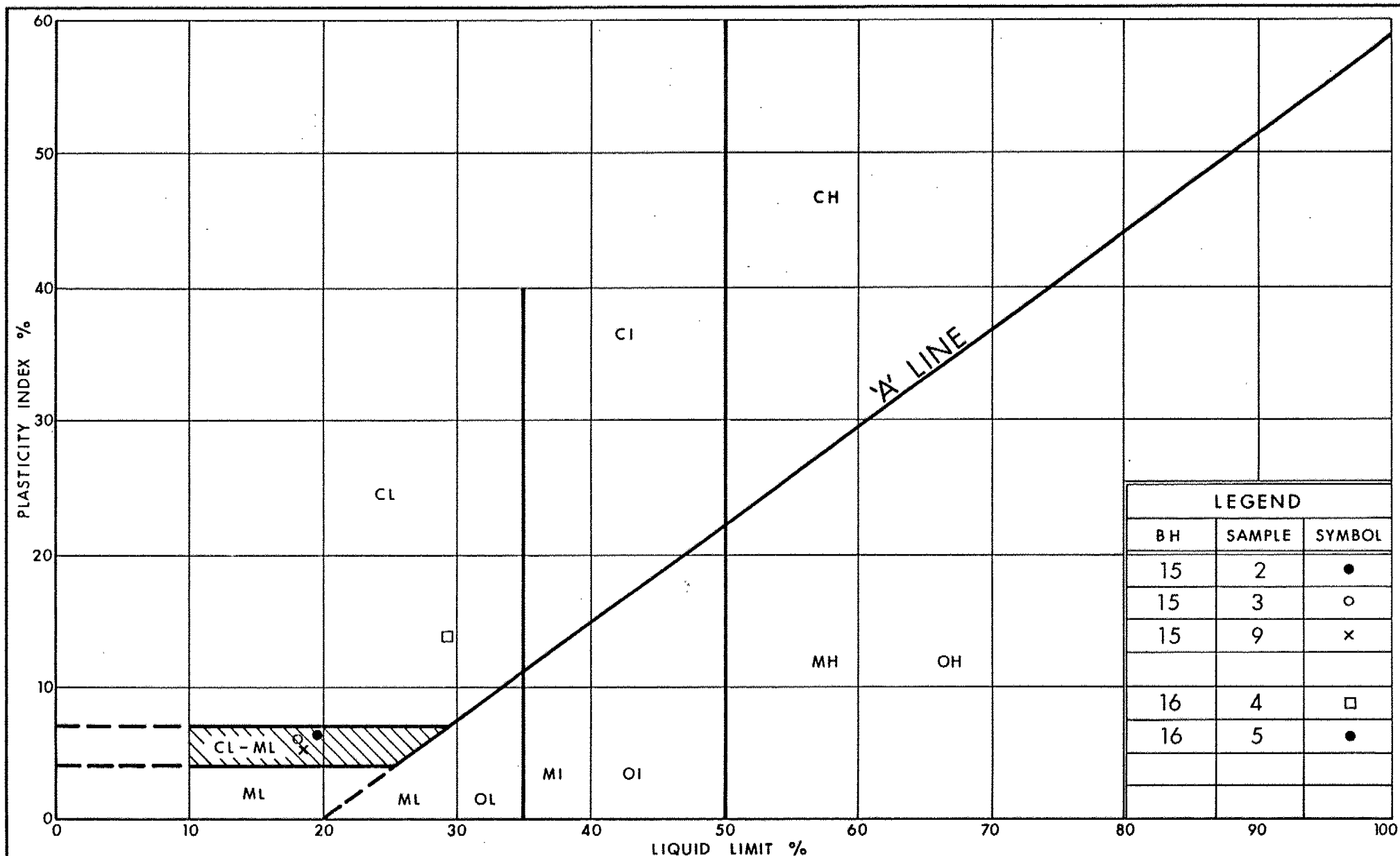
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PLASTICITY CHART

FIG No 9

W P 202-87-00

BH - 12,13,14



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Ontario

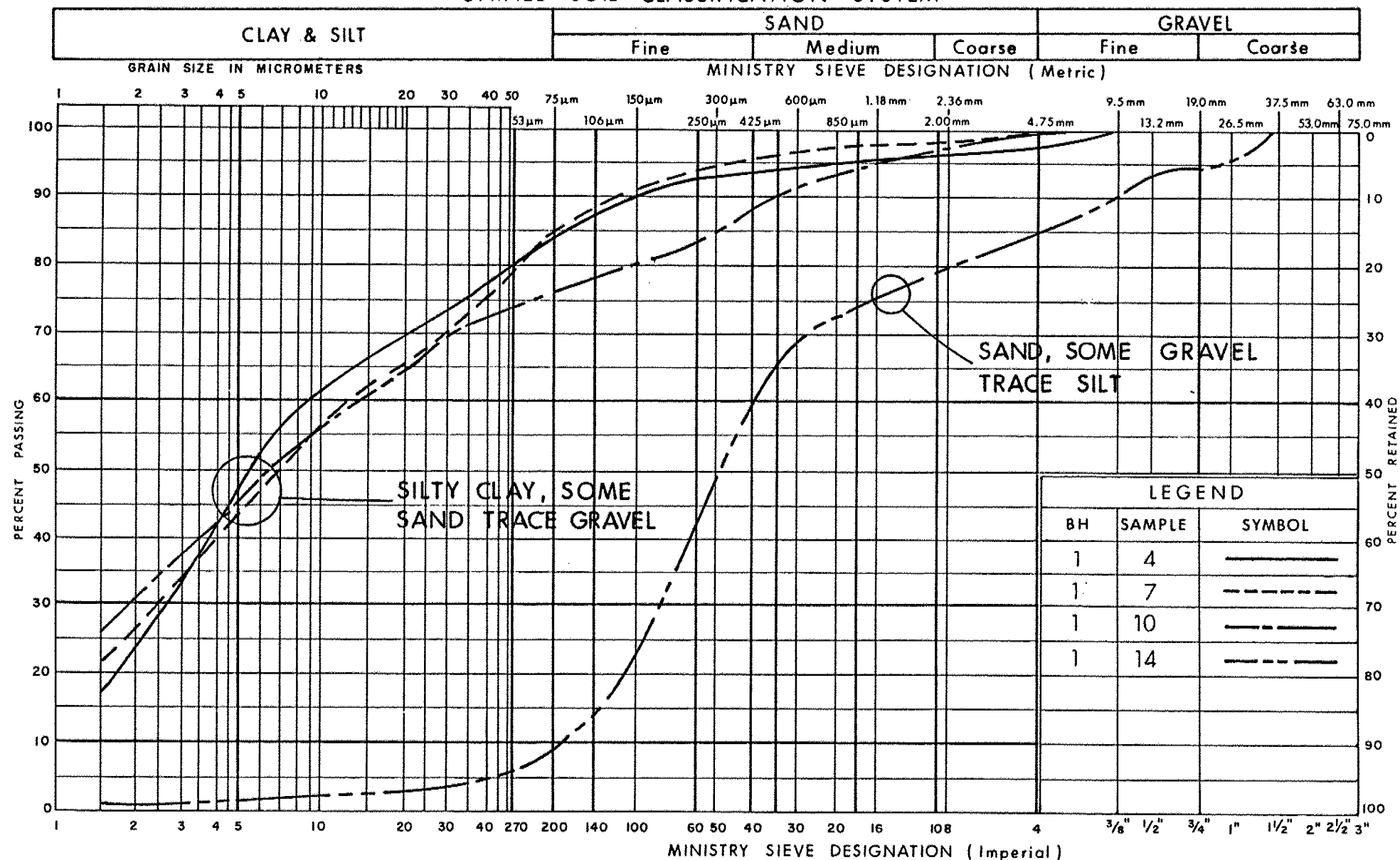
PLASTICITY CHART

FIG No 10

W P 202-87-00

BH- 15,16

UNIFIED SOIL CLASSIFICATION SYSTEM



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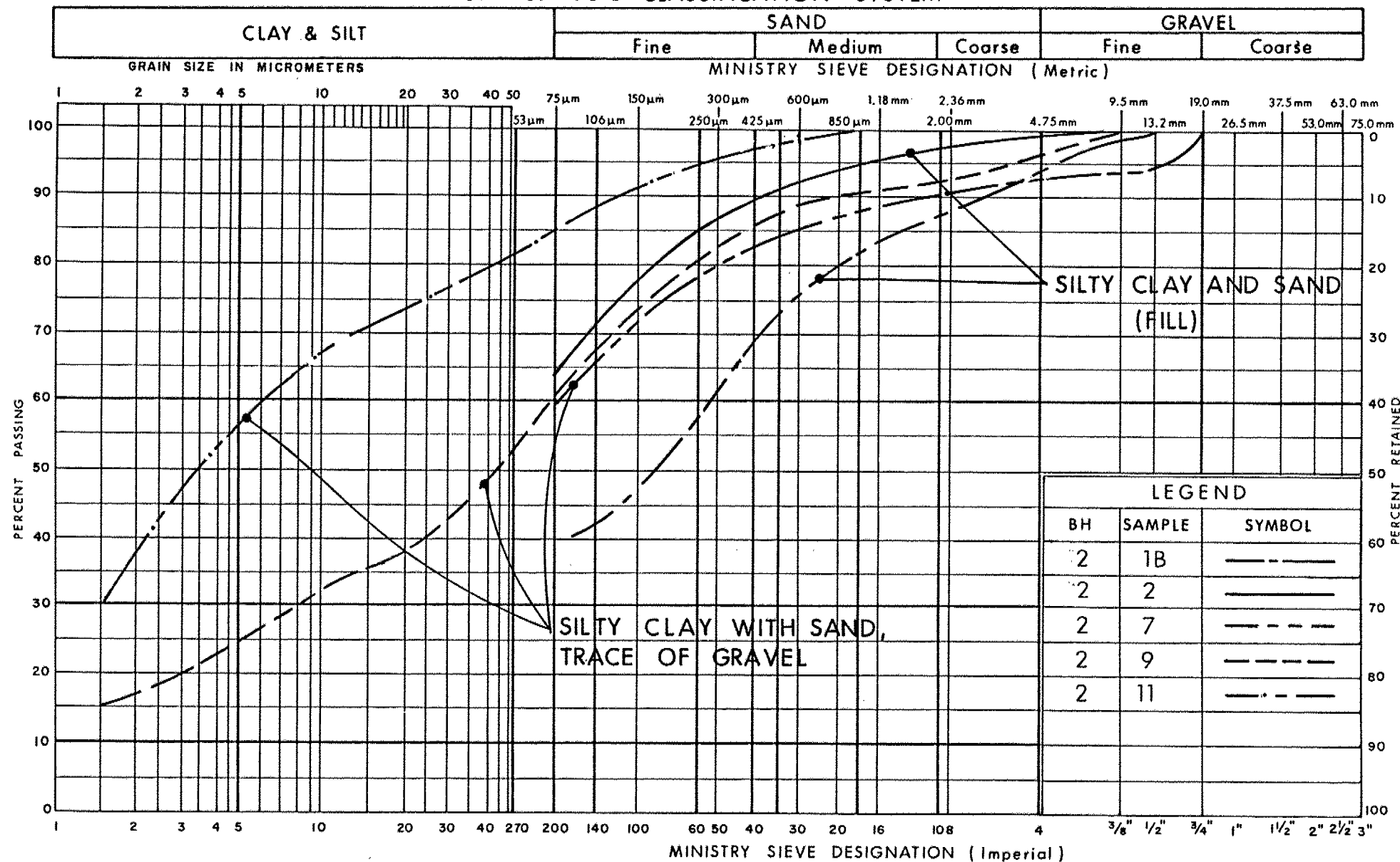
GRAIN SIZE DISTRIBUTION

FIG No 11

W P 202-87-00

BH-1

UNIFIED SOIL CLASSIFICATION SYSTEM



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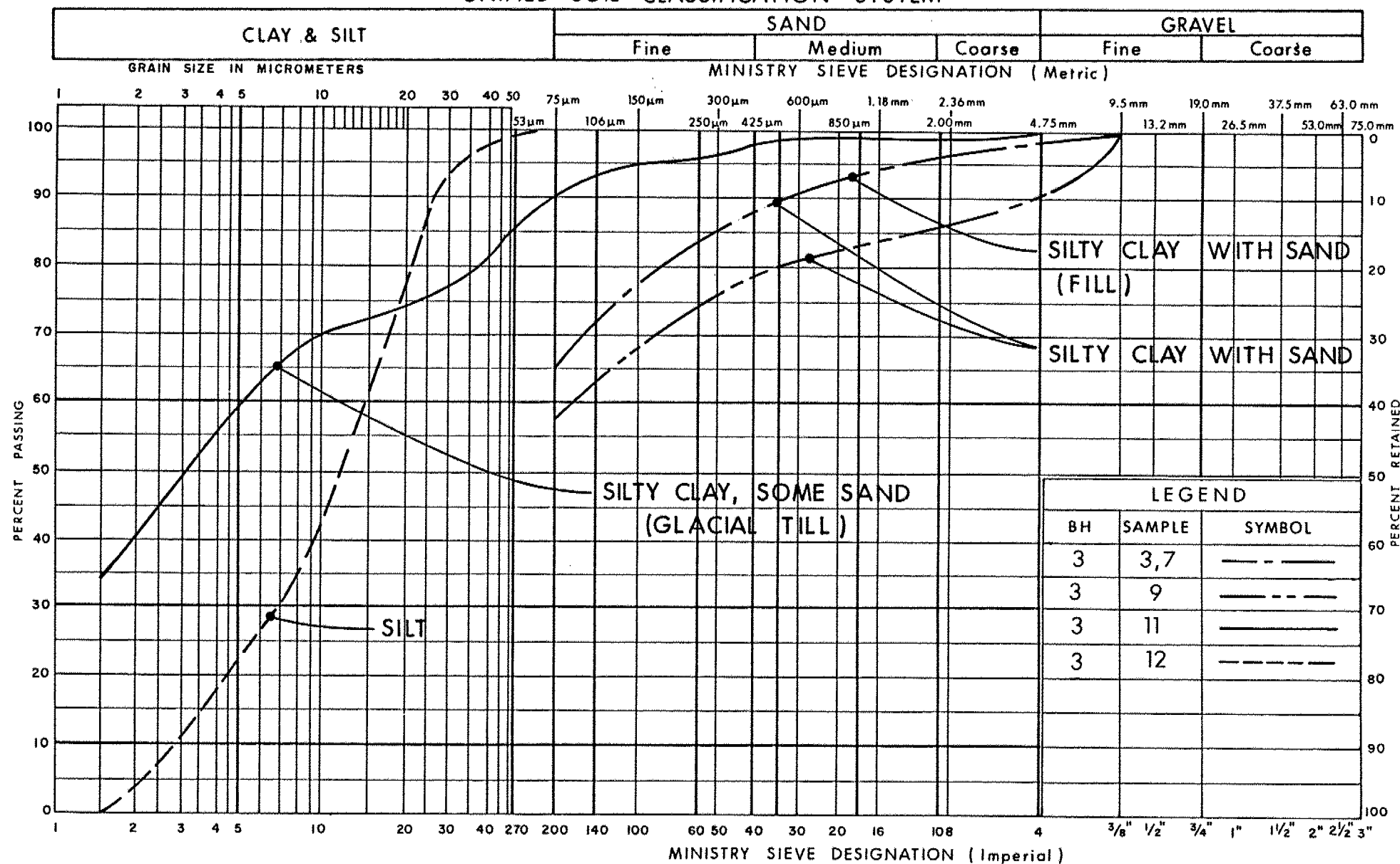
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FIG No 12

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BH - 2

UNIFIED SOIL CLASSIFICATION SYSTEM



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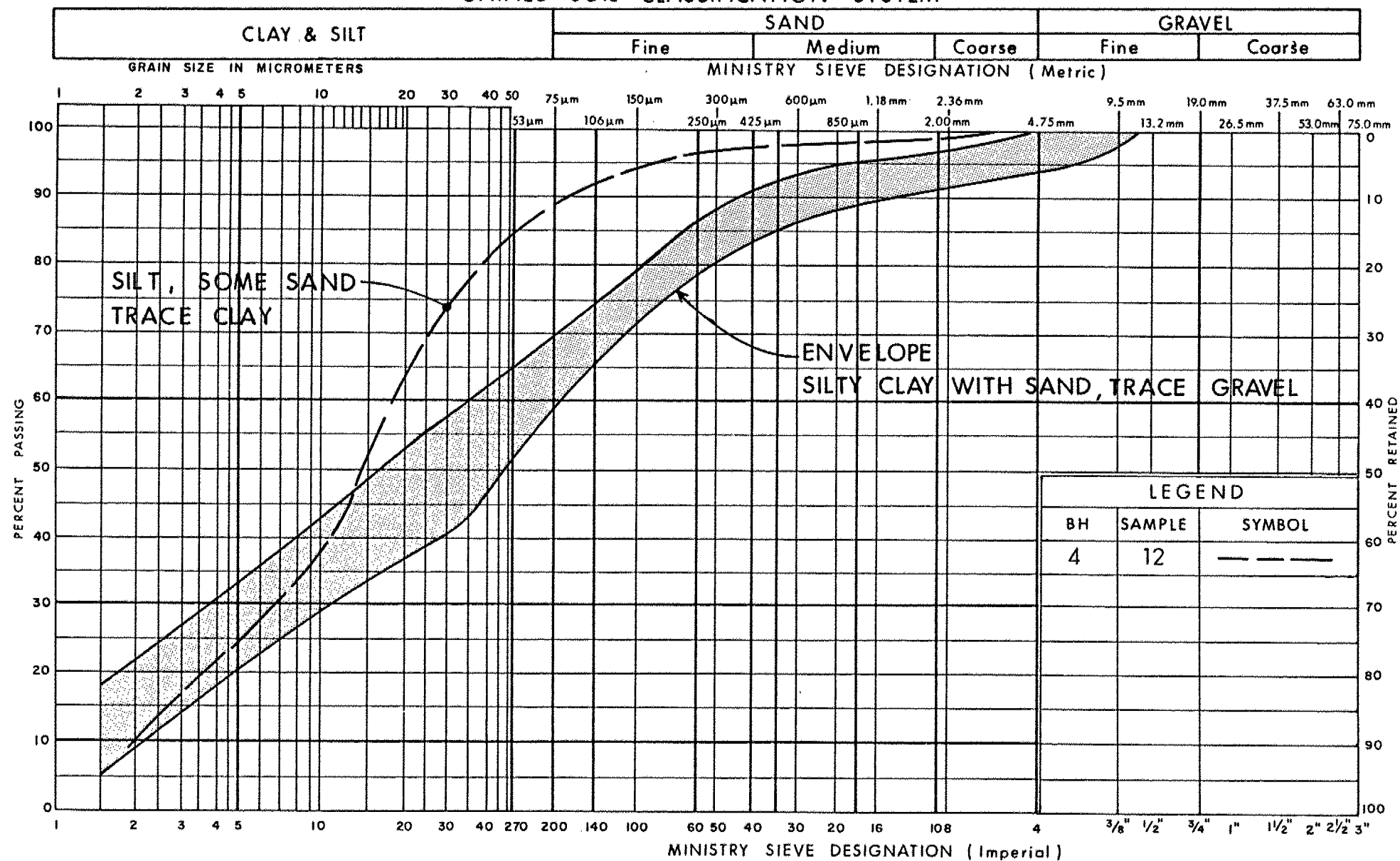
GRAIN SIZE DISTRIBUTION

FIG No13

W P 202-87-00

BH - 3

UNIFIED SOIL CLASSIFICATION SYSTEM



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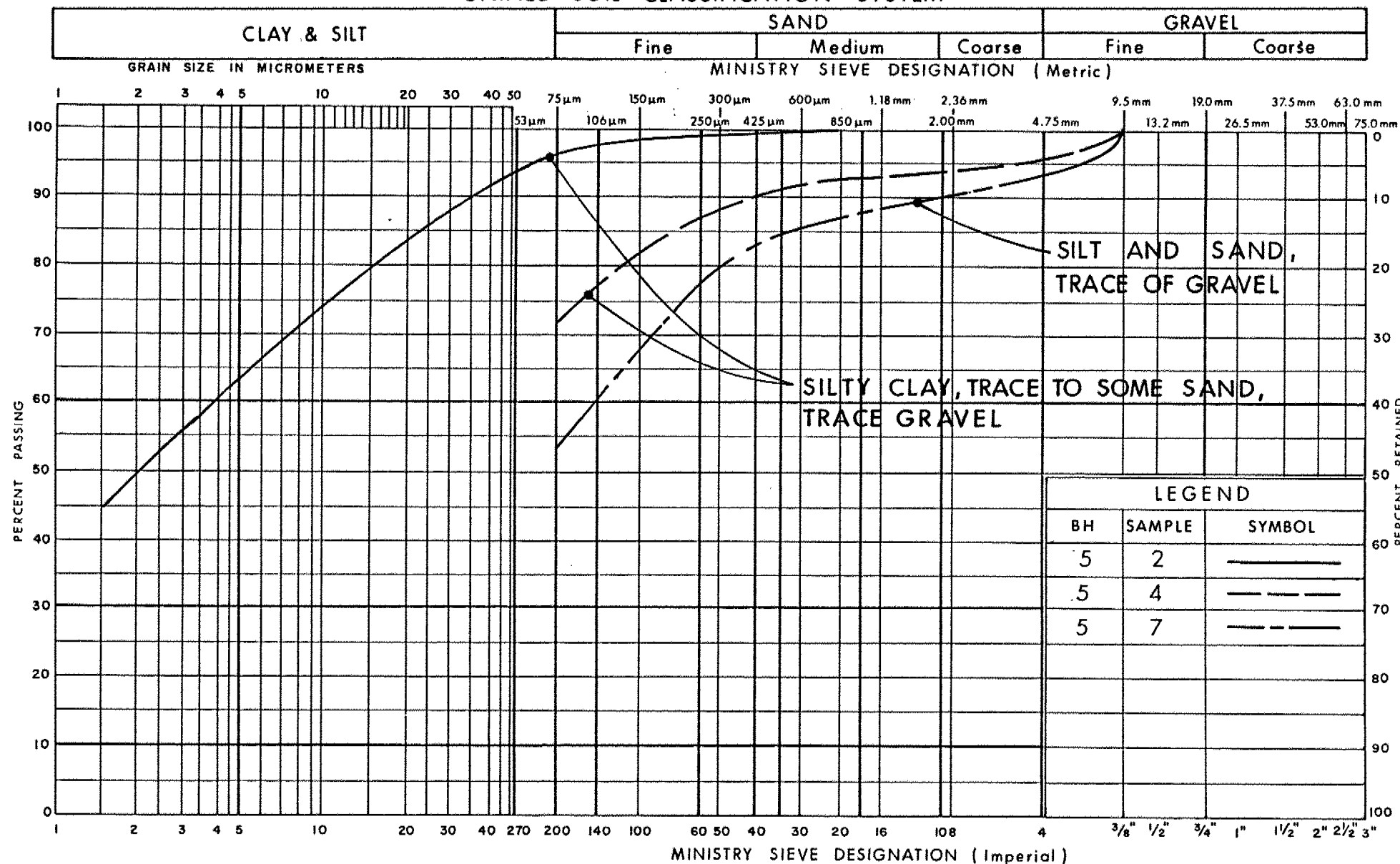
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FIG No 14

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BH - 4

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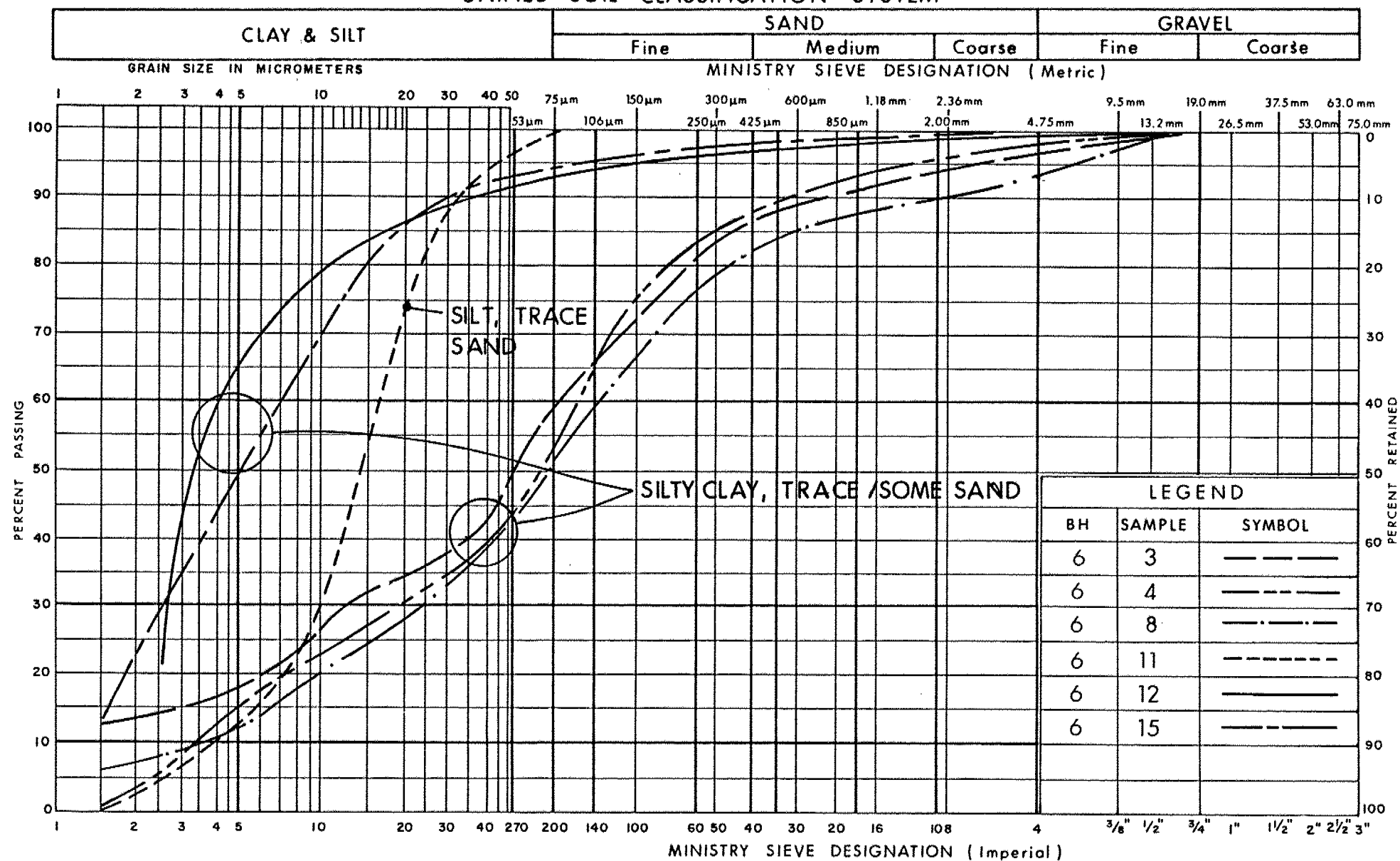
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FIG No 15

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BH - 5

UNIFIED SOIL CLASSIFICATION SYSTEM



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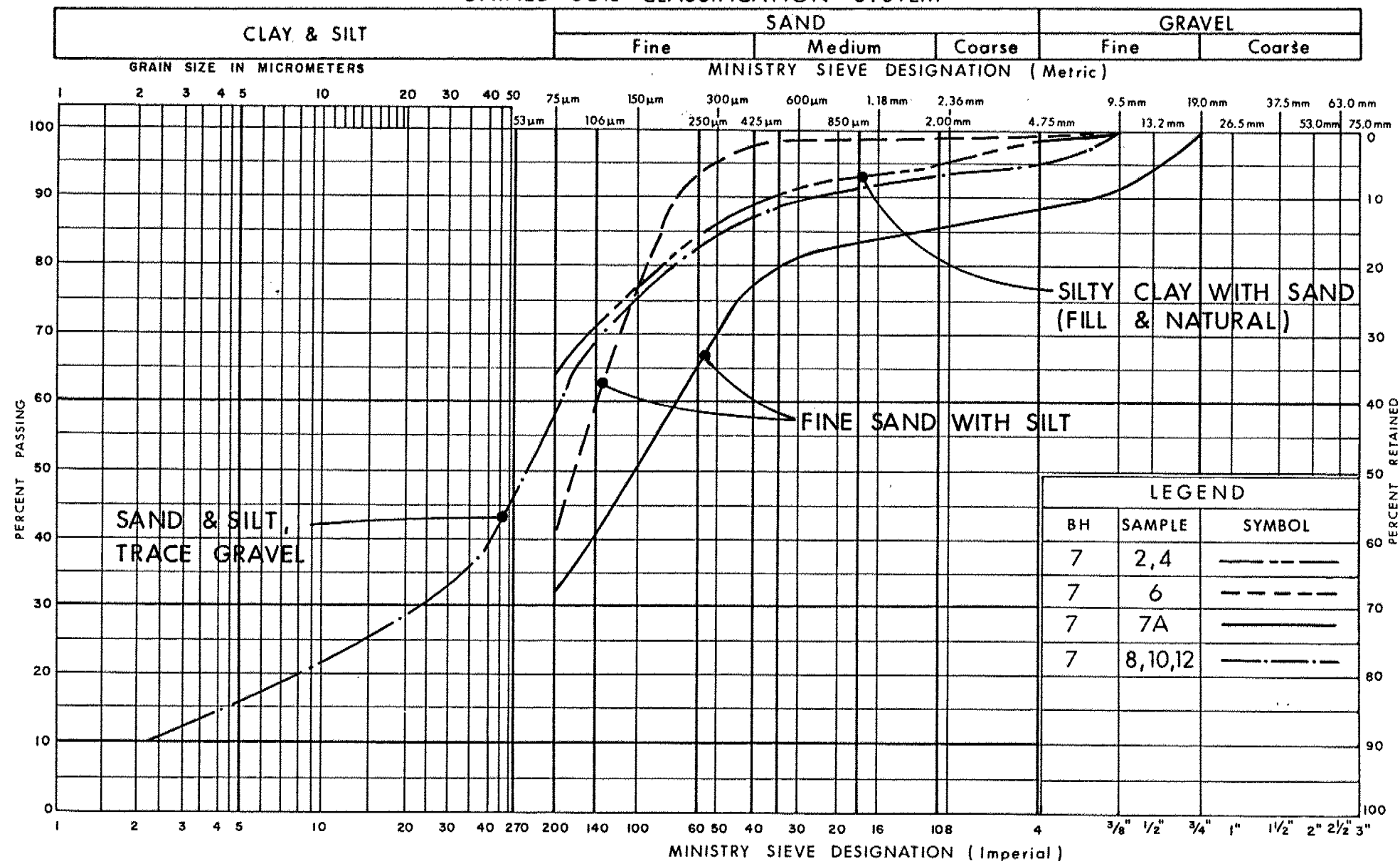
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FIG No 16

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BH - 6

UNIFIED SOIL CLASSIFICATION SYSTEM



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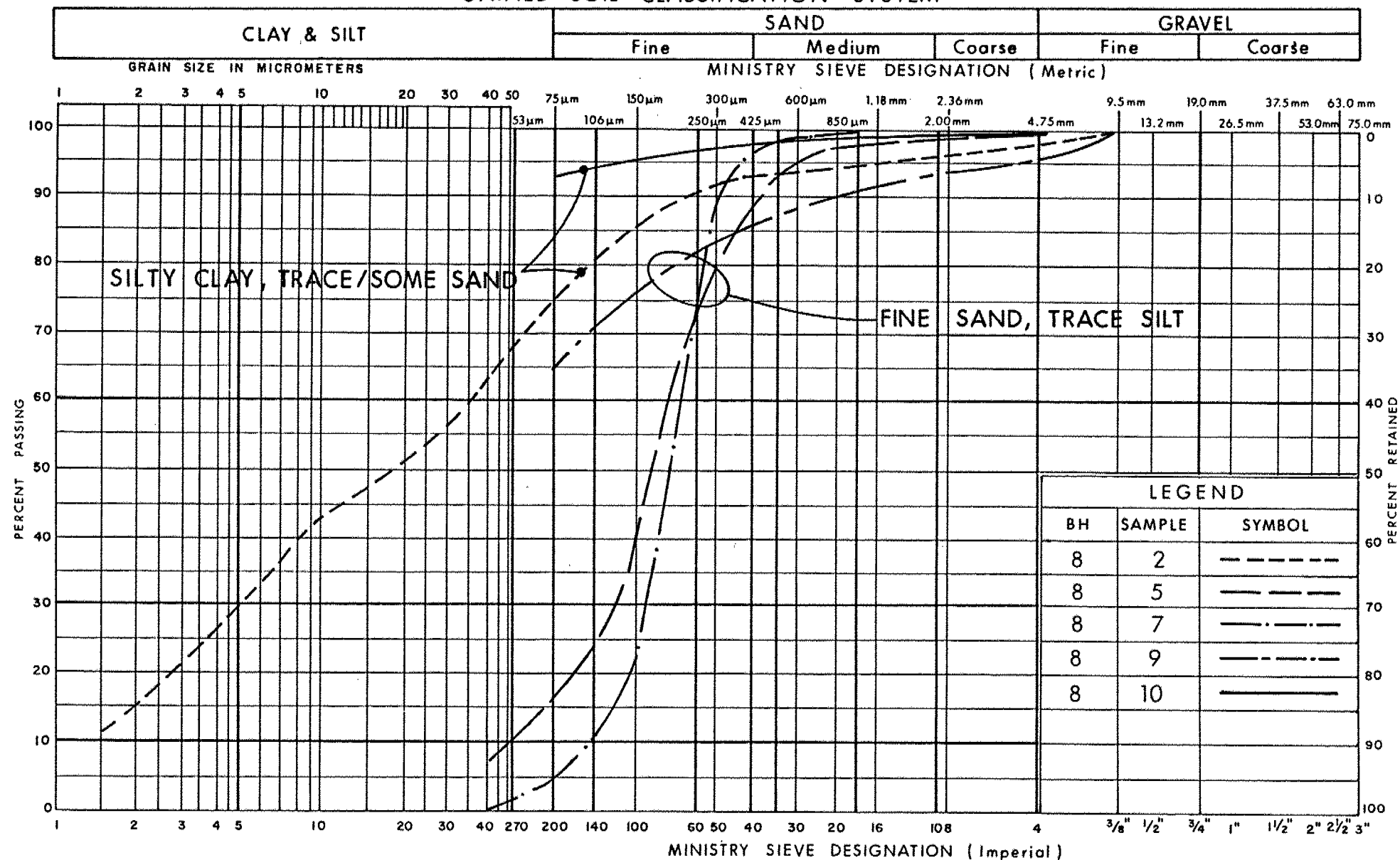
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FIG No 17

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BH - 7

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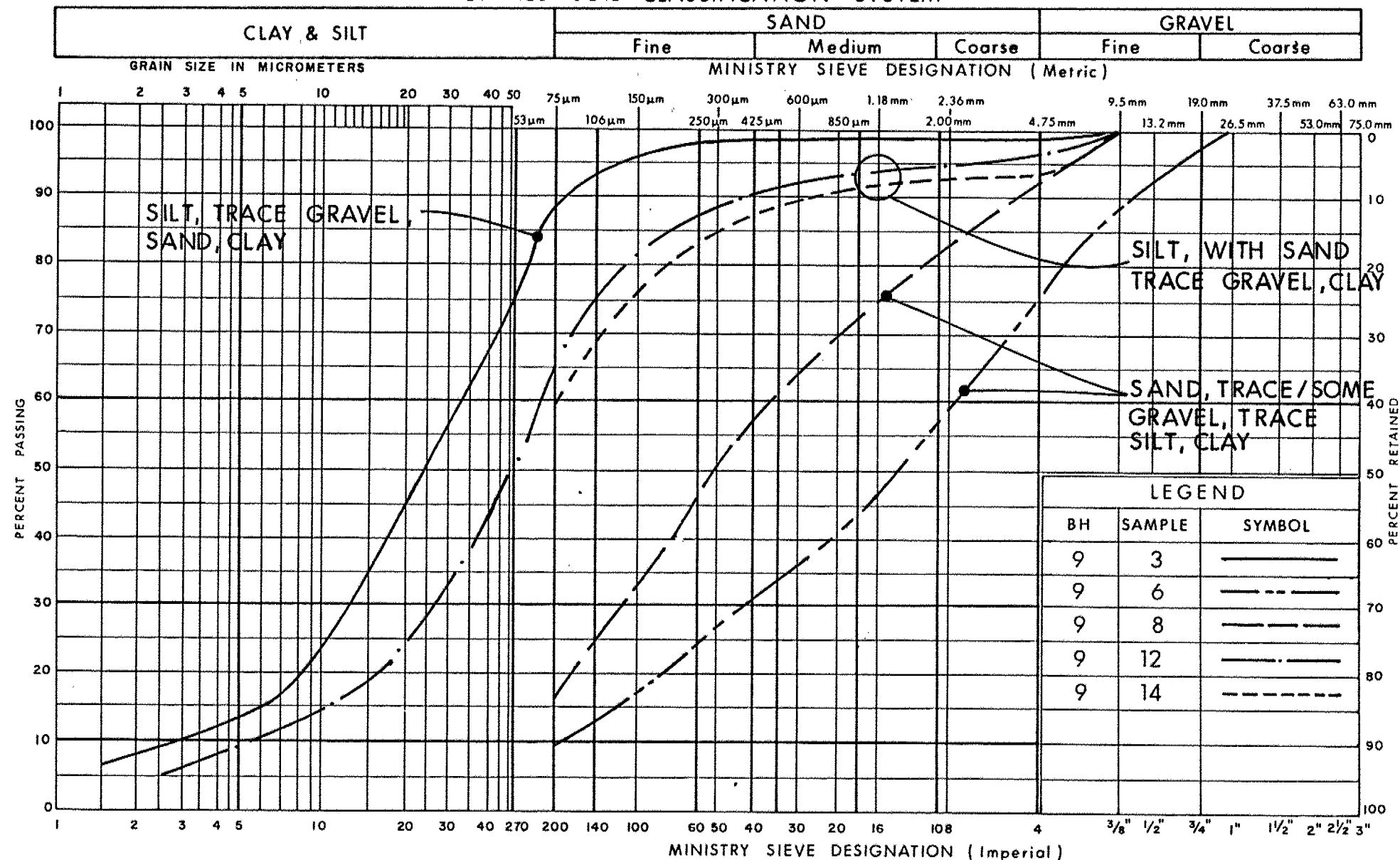
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FIG No 18

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BH-8

UNIFIED SOIL CLASSIFICATION SYSTEM



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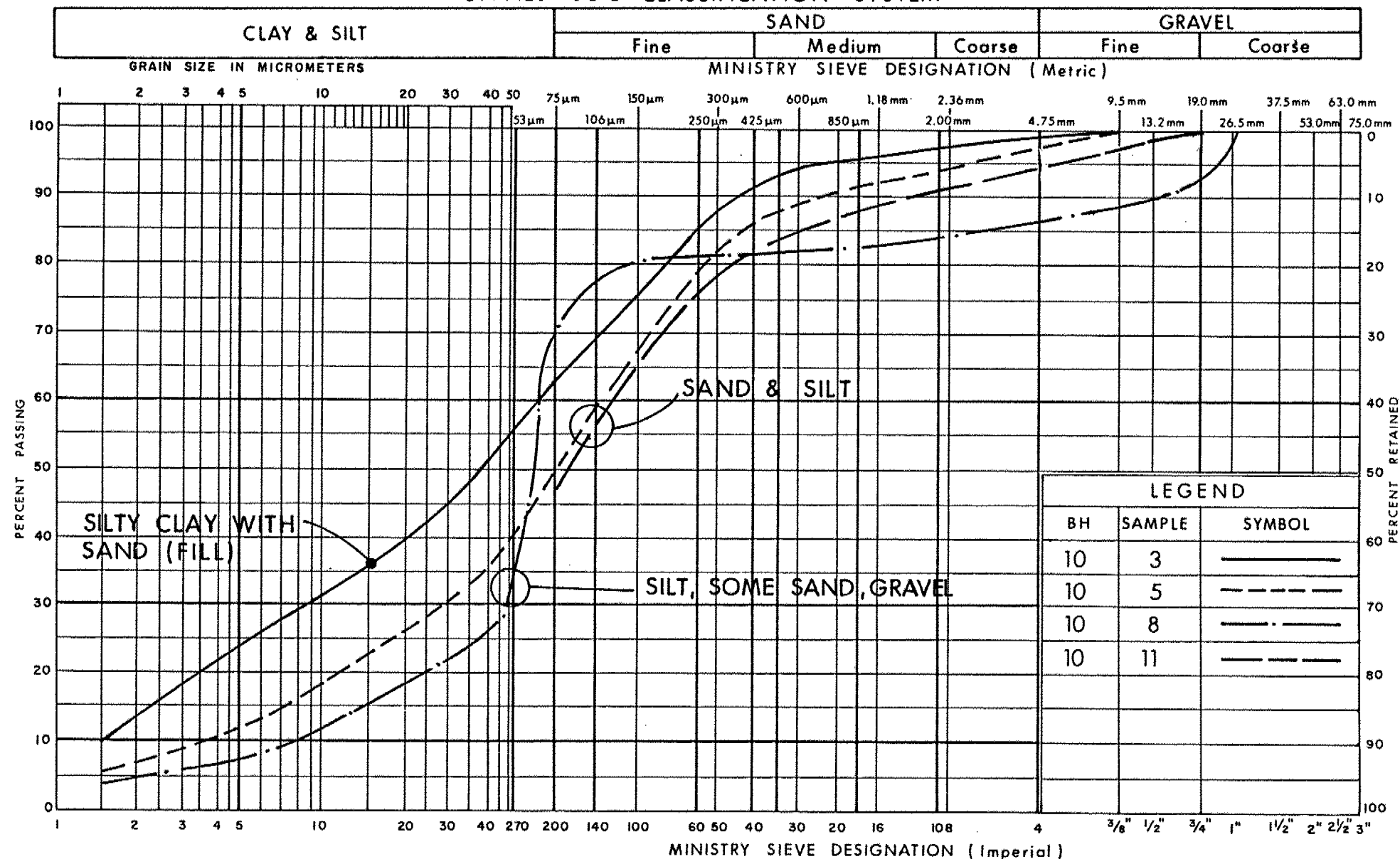
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FIG No 19

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BH - 9

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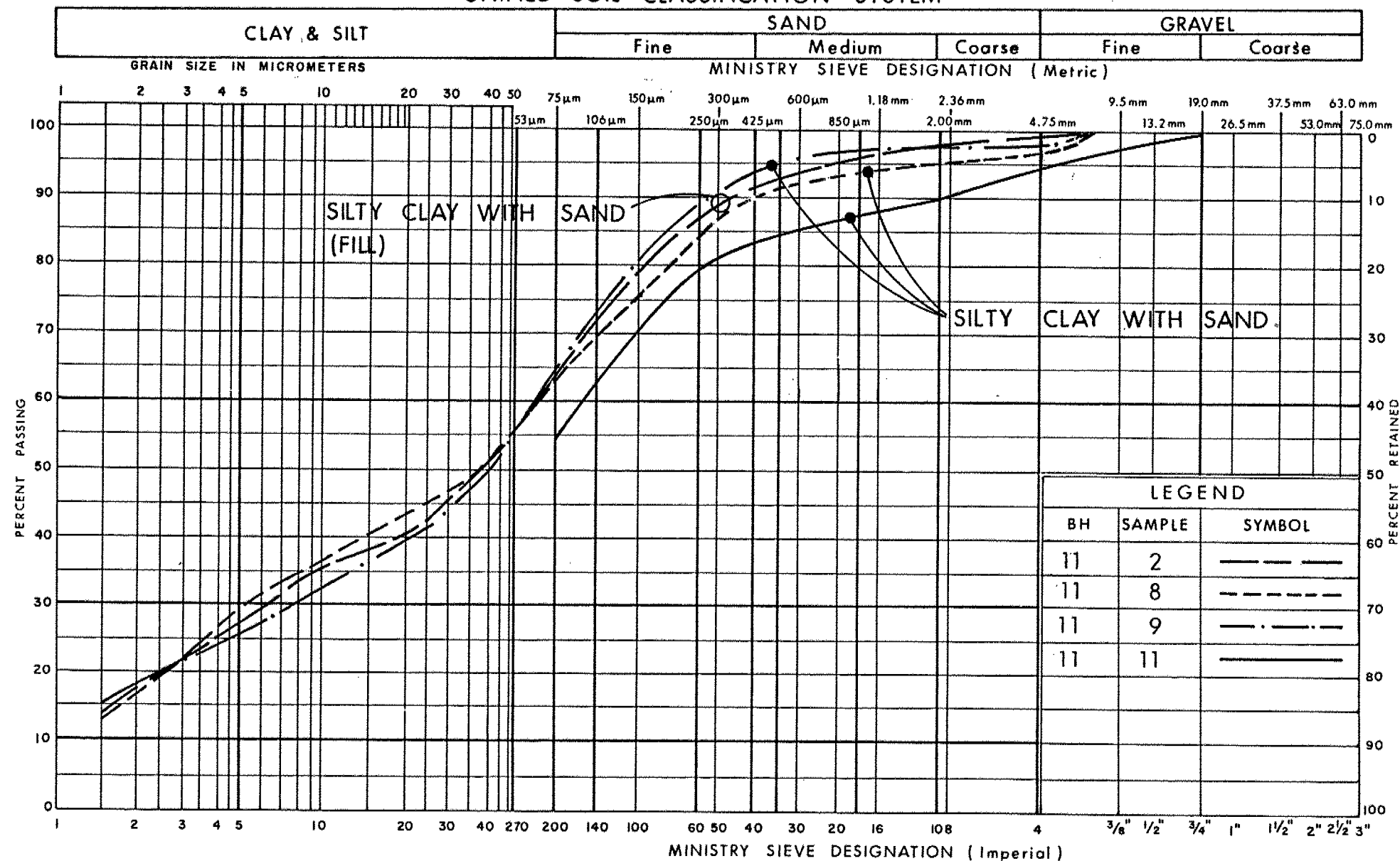
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FIG No 20

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BH - 10

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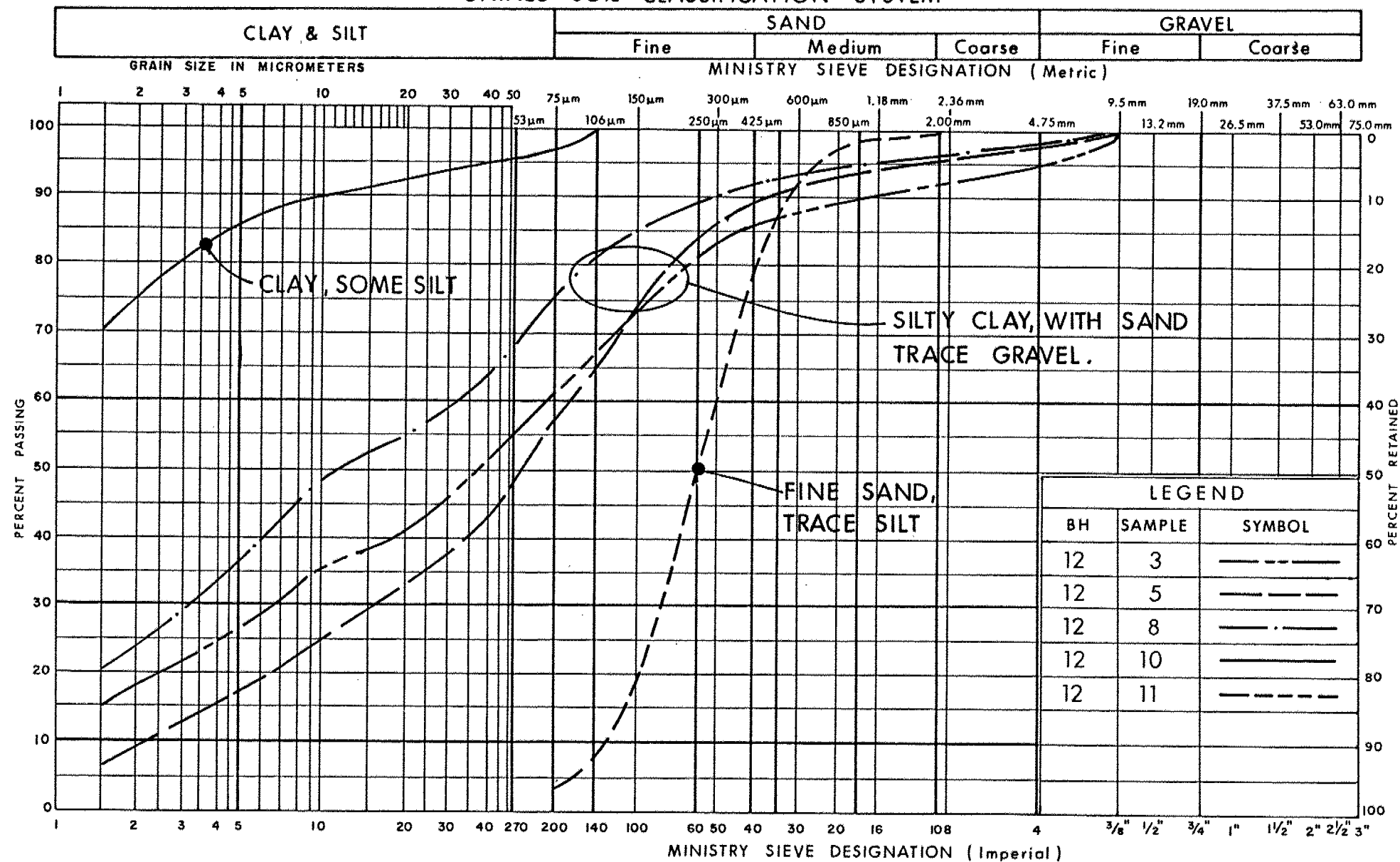
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FIG No 21

W P 202-87-00

BH-11

UNIFIED SOIL CLASSIFICATION SYSTEM



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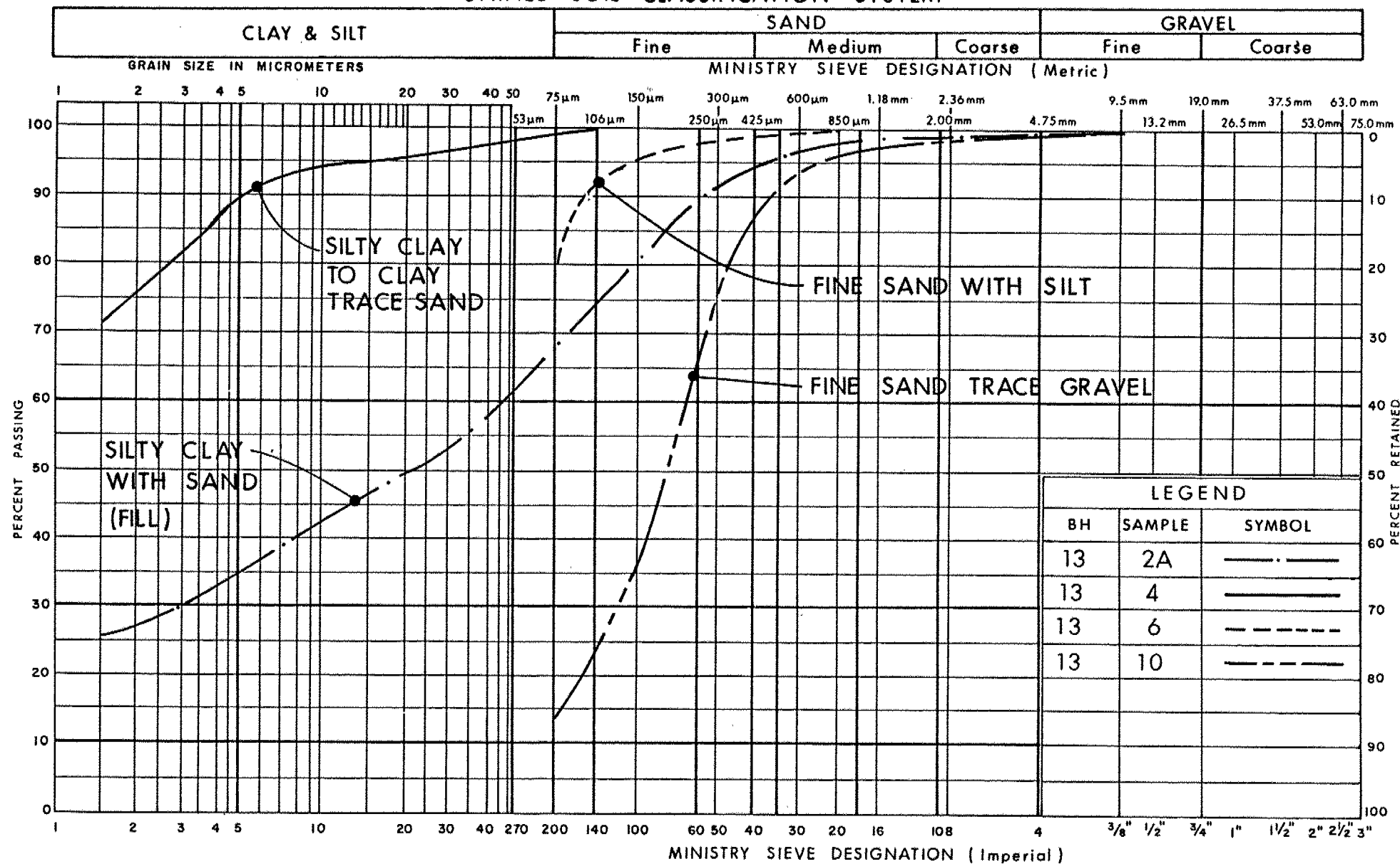
GRAIN SIZE DISTRIBUTION

FIG No 22

W P 202-87-00

BH - 12

UNIFIED SOIL CLASSIFICATION SYSTEM



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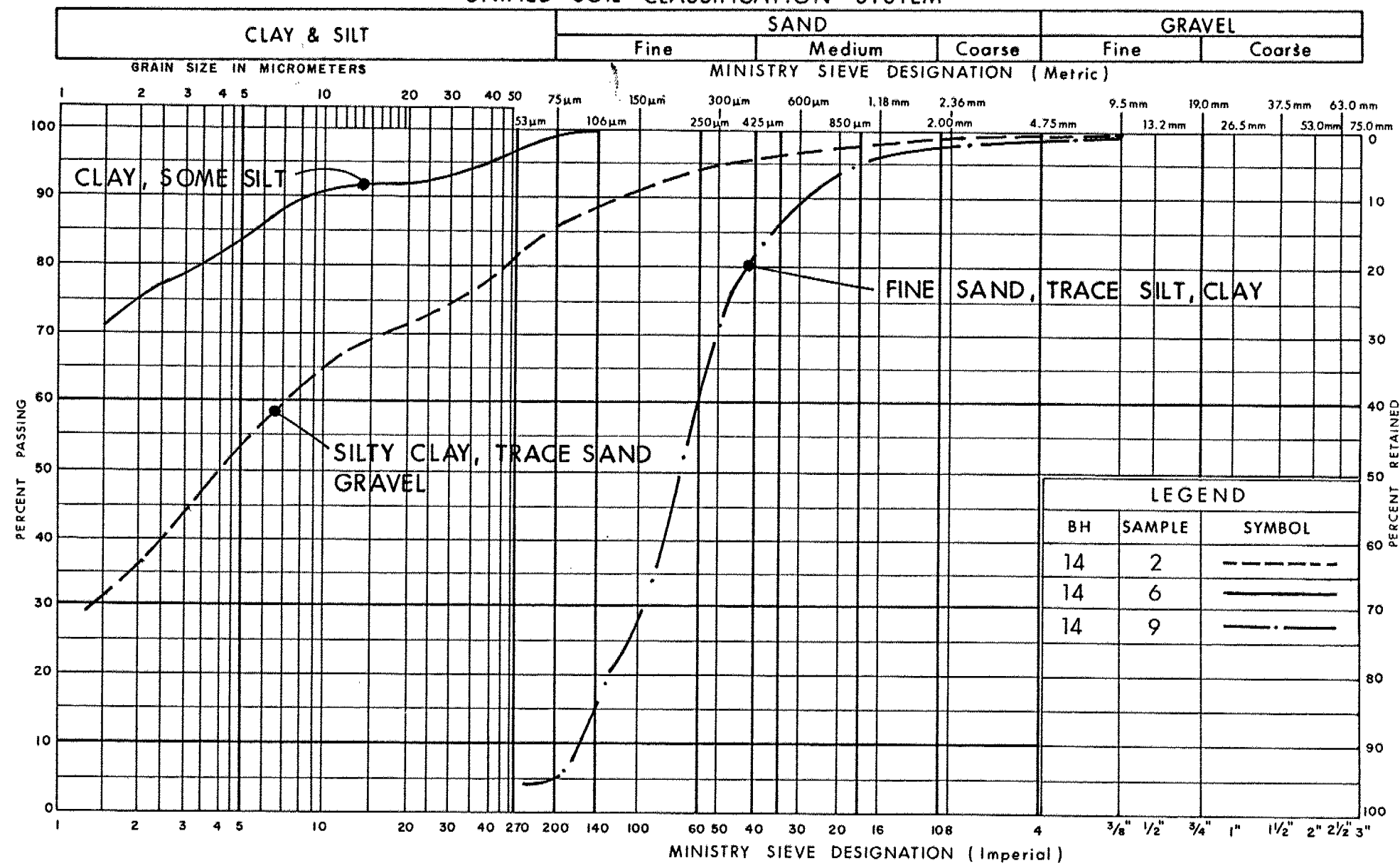
GRAIN SIZE DISTRIBUTION

FIG No 23

W P 202-87-00

BH-13

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation and
Communications

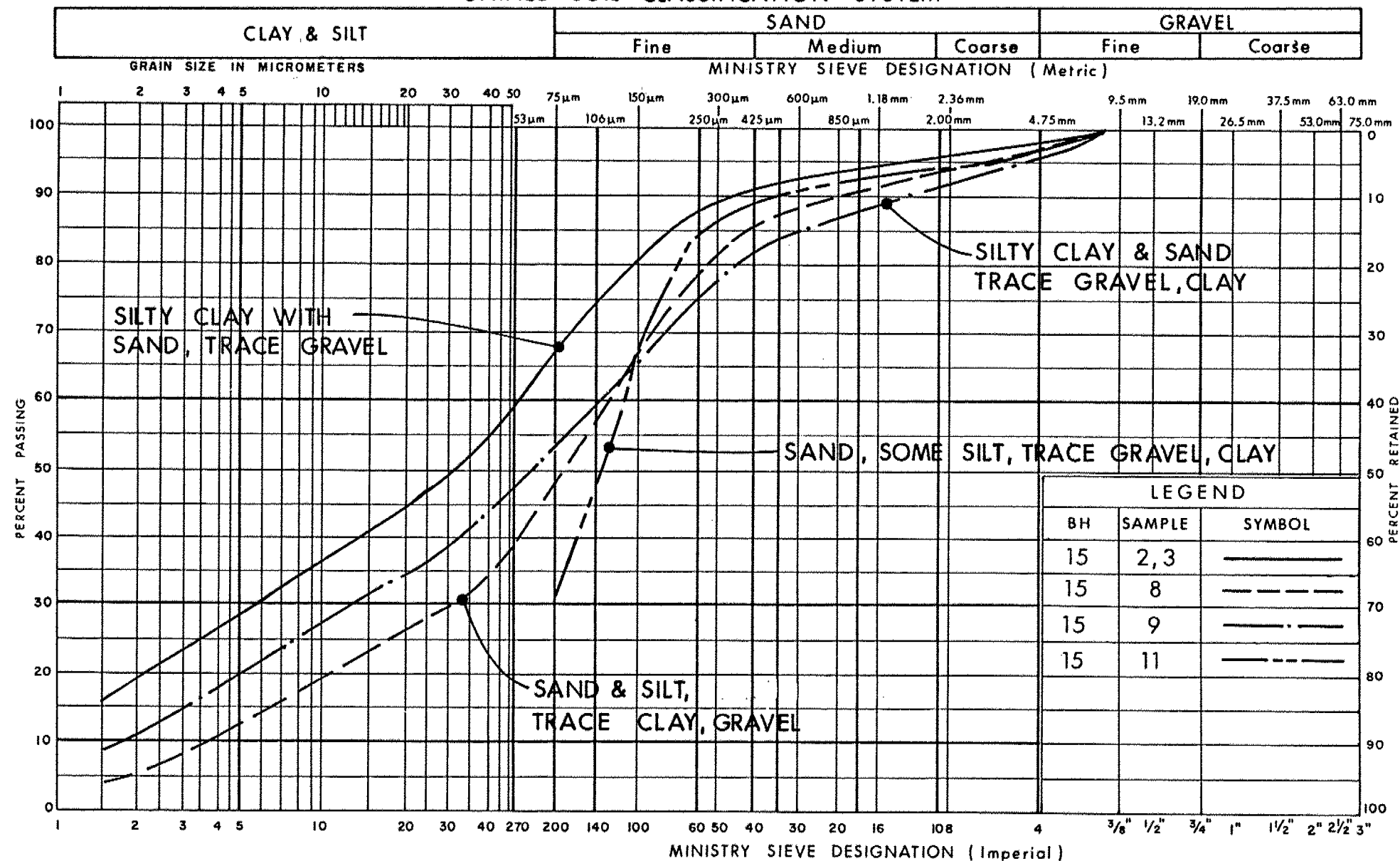
GRAIN SIZE DISTRIBUTION

FIG No 24

W P 202-87-00

BH-14

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation and
Communications

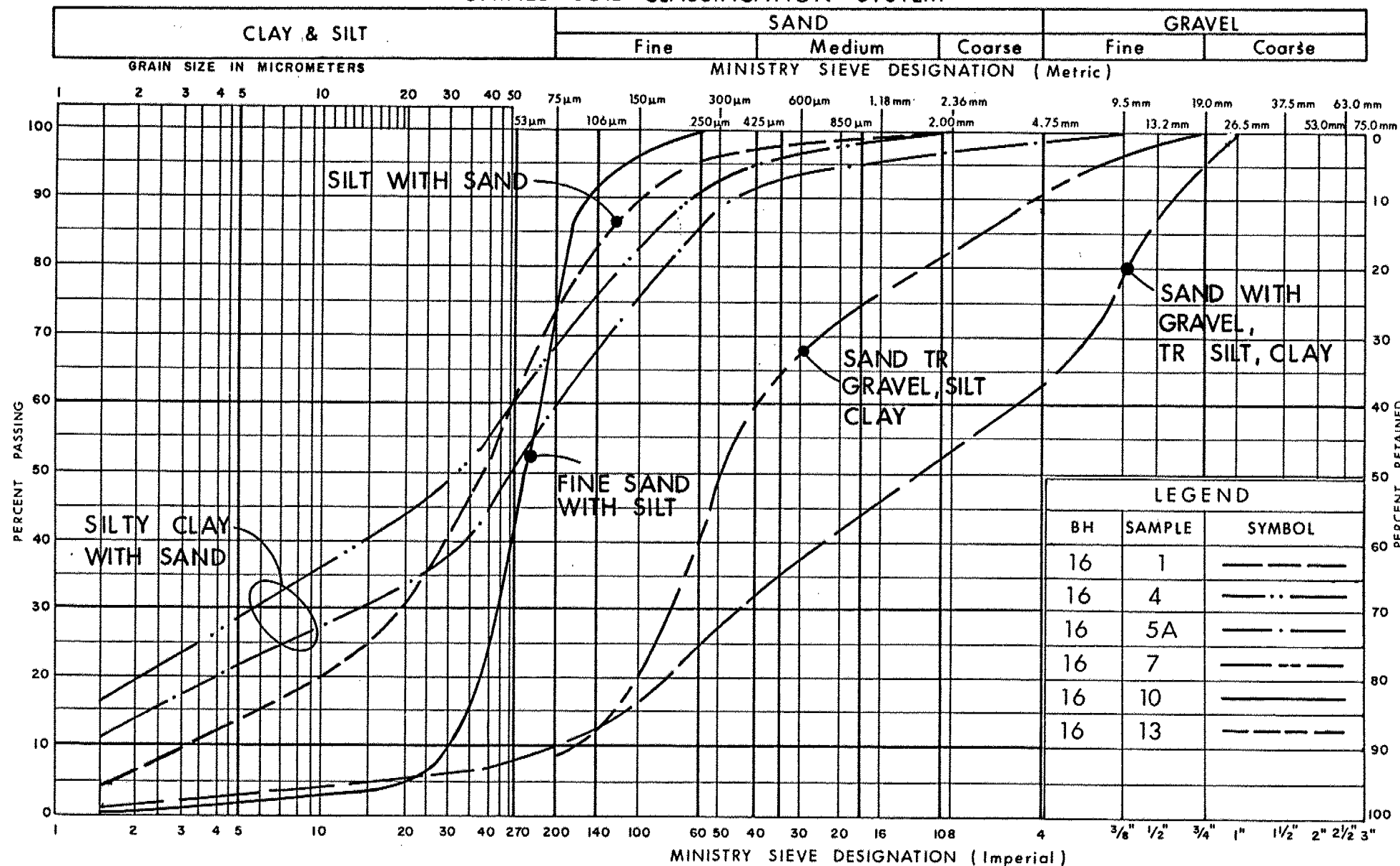
GRAIN SIZE DISTRIBUTION

FIG No 25

W P 202-87-00

BH - 15

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications

GRAIN SIZE DISTRIBUTION

FIG No 26

W P 202-87-00

BH -16



RECORD OF BOREHOLE No 1

METRIC

W P 202-87-00 LOCATION Sta. 21 + 933 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 11 CHECKED BY DT

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					
174.5	Shoulder Surface																
0.0	Ashpalt						174										
173.7	Sand some Gravel (Fill)																
0.8	Silty Clay some sand		1	SS	18												
172.4	trace gravel (Fill)		2	SS	28												
2.1			3	SS	27		172										
			4	SS	43												
	Silty Clay		5	SS	23												
	some sand		6	SS	30		170										
	trace gravel		7	SS	42												
			8	SS	55												
	Very Stiff to Hard		9	SS	40		168										
			10	SS	87		166										
			11	SS	144		164										
162.9	Silty Clay of Intermediate Plasticity (CD)																
11.6	Silt, some sand		12	SS	42		162										
161.1	Dense																
13.4	Sand, some gravel, trace silt		13	SS	38		160										
159.2	Very Dense		14	SS	79	**											
15.3	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																
	** 'N' value may not be representative since sand came up to Elev. 160 before driving spoon																



RECORD OF BOREHOLE No 2

METRIC

W P 202-87-00 LOCATION Sta. 22 + 082, O/S 2.1 m Lt. ORIGINATED BY DL
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 11 CHECKED BY DT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100								WATER CONTENT (%)	10 20 30	GR SA SI CL
								SHEAR STRENGTH										
172.9	Shoulder Surface																	
0.0	Asphalt																	
172.0	Sand and Gravel (Fill)		1	SS	12		172							6 55 (39)				
0.9	Silty Clay and Sand (Fill)		2	SS	23									1 36 (63)				
			3	SS	21		170											
			4	SS	11													
168.6			5	SS	12													
4.3	Silty Clay with Sand trace gravel		6	SS	10		168							6 33 (61)				
			7	SS	35													
			8	SS	33		166											
			9	SS	15									5 34 45 16				
	Fine Silty Sand		10	SS	25		164											
	With Occasional non-cohesive zones and random seams of fine sand		11	SS	41		162							0 13 50 37				
			12	SS	113		160											
			13	SS	60/9 cm		158											
157.4	Hard																	
15.5	End of Borehole		14	SS	60/10 cm													
	* Groundwater Level measured at completion of B.H. Level may not be stabilized																	



RECORD OF BOREHOLE No 3

METRIC

W P 202-87-00 LOCATION Sta. 22 + 230 O/S 2.1 m Lt. ORIGINATED BY GP
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 1987 02 11 CHECKED BY DT

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		
171.2	Shoulder Surface													
0.0	Asphalt					*								
170.2	Sand with Gravel (Fill)		1	SS	14		170							
1.0	Silty Clay, with sand trace gravel (Fill)		2	SS	30									
168.3	Trace organic		3	SS	24									2 36 (62)
2.9	Firm		4	SS	8		168							
			5	SS	8									
			6	SS	29		166							2 35 (63)
			7	SS	25									
	Silty Clay some/with sand trace gravel		8	SS	30		164							
			9	SS	16									10 32 (58)
			10	SS	32		162							
	Very Stiff		11	SS	36		160							0 15 45 40
			12	SS	125	20 cm	158							0 0 96 4
	Silt (slight. cohesive)		13	SS	65									
155.5	Hard		14	SS	102	25 cm	156							
15.7	End of Borehole													
	* Borehole at completion. Groundwater level may not have been stabilized.													

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 4

METRIC

W P 202-87-00 LOCATION Sta. 22 + 381 O/S 2.1 m Lt. ORIGINATED BY MLP
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 10 CHECKED BY DT

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					
169.6	Shoulder Surface																
0.0	Asphalt					*											
168.6	Sand and Gravel (Fill)																
1.0	Silty Clay with sand trace gravel		1	SS	19		168										3 38 45 14
			2	SS	7												
	Firm		3	SS	9												
	Silt		4	SS	7		166										
			5	SS	15												
	With occasional non-cohesive zones and thin seams of fine sand and silt		6	SS	18												3 35 43 19
			7	SS	29		164										
			8	SS	25												3 32 50 15
			9	SS	32		162										
	Very Stiff to Hard		10	SS	73		160										3 28 48 21
			11	SS	110												1 34 55 10
158.0							158										
11.6	Silt, some sand trace clay Very Dense		12	SS	78												0 11 79 10
155.8			13	SS	120	10 cm	156										
13.8	Silty Clay with sand																
153.9	Hard		14	SS	120		154										
15.7	End of Borehole																
	* Borehole dry at completion. Groundwater level may not be stabilized.																



RECORD OF BOREHOLE No 5

METRIC

W P 202-87-00 LOCATION Sta. 22 + 532 O/S 2.1 m Lt. ORIGINATED BY GP
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 1987 02 10 CHECKED BY ST

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					
168.7	Shoulder Surface							○ UNCONFINED + FIELD VANE						
0.0	Asphalt					*		● QUICK TRIAXIAL x LAB VANE						
167.7	Sand some Gravel(Fill)		1	SS	17		168							
1.0	Silty Clay trace/some sand trace gravel Very Stiff		2	SS	16									
			3	SS	18		166							
	With slight to non-plastic zones and seams		4	SS	89									
			5	SS	72		164							
			6	SS	59									
	Silt and Sand trace gravel Very Dense		7	SS	119	28 cm	162							
			8	SS	125	20 cm								
			9	SS	127		160							
	Hard		10	SS	74		158							
	Fine Sand some silt Dense		11	SS	110	25 cm	156							
			12	SS	85									
154.6	End of Borehole		13	SS	107	25 cm								
14.1	* Borehole dry at completion of borehole. Groundwater level may not be stabilized													



RECORD OF BOREHOLE No 6

METRIC

W P 202-87-00 LOCATION Sta. 22 + 683 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 09 CHECKED BY DT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
167.9	Shoulder Surface													
0.0	Asphalt													
167.0	Sand someGravel (Fill)		1	SS	23									
0.9	Silty Clay, trace		2	SS	23									
166.1	sand, gravel (Fill)		3	SS	38									
1.8	Silty Clay trace sand gravel		4	SS	75									
	Fine Silty Sand		5	SS	52									
	With zones of slightly plastic material and random thin seams of silt		6	SS	31									
	Hard		7	SS	61									
161.2			8	SS	67									
6.7	Silt, trace sand gravel		9	SS	140									
	Very Dense		10	SS	195									
157.8			11	SS	95									
10.1	Silty Clay trace/some sand trace gravel		12	SS	146									
	Hard		13	SS	138									
	Fine Silty Sand		14	SS	152	23 cm								
	With zones of slightly plastic material and occ. random thin seams of silt		15	SS	121									
152.2	End of Borehole													
15.7	* Groundwater Level not established													



RECORD OF BOREHOLE No 7

METRIC

W P 202-87-00 LOCATION Sta. 22 + 834 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY LP
DATUM Geodetic DATE 87 02 10 CHECKED BY DT

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 40 60 80 100	SHEAR STRENGTH							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE								

167.1	Shoulder Surface														
0.0	Asphalt														
165.7	Sand some gravel (Fill)		1	SS	21		166								
1.4	Silty Clay with sand (Fill)		2	SS	7										2 36 (62)
164.1	with organics		3	SS	7										
3.0	Silty Clay and sand Firm		4	SS	4		164								0 43 (57)
162.8															
4.3	Fine Sand with silt Compact		5	SS	11		162								0 62 (38)
160.8			6	SS	15										11 58 (31)
6.3			7	SS	52										
	Sand and Silt trace gravel clay		8	SS	40		160								4 39 47 10
	with occasional slightly cohesive zones		9	SS	168		158								
			10	SS	110		156								4 42 47 7
			11	SS	125	15 cm	154								
	Very Dense		12	SS	105	15 cm									4 44 43 9
151.9			13	SS	106	15 cm	152								
15.2	End of Borehole														
	* Borehole dry at completion. Groundwater level may not be stabilized														



RECORD OF BOREHOLE No 8

METRIC

W P 202-87-00 LOCATION Sta. 22 + 985 O/S 2.1 m Lt. ORIGINATED BY GP
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
 DATUM Geodetic DATE 1987 02 09 CHECKED BY DT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH							PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%)										
							10 20 30										
167.2	Shoulder Surface																
0.0	Asphalt																
166.1	Sand with gravel (Fill)		1	SS	20												
1.1	Silty Clay trace to some sand trace gravel		2	SS	36		166							1 23 58 18			
164.2	Hard		3	SS	99												
2.9	Fine Sand trace silt clay		4	SS	97		164							0 83 (17)			
			5	SS	85												
			6	SS	47		162							0 94 (6)			
	Very Dense Compact		7	SS	46												
			8	SS	29												
			9	SS	9		160										
157.9			10	SS	110	25 cm	158							4 32 (64)			
9.3	Silty Clay with sand trace gravel		11	SS	106	25 cm	156										
155.6	Hard		12	SS	127	20 cm	154										
11.6	Sand and Silt trace gravel		13	SS	100	15 cm											
153.2	Very Dense																
14.0	End of Borehole																
	* Groundwater Level measured at completion of B.H. Level may not be stabilized																



RECORD OF BOREHOLE No 9

METRIC

W P 202-87-00 LOCATION Sta. 23 + 131 O/S 2.1 m Lt.

ORIGINATED BY MJ

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers

COMPILED BY LP

DATUM Geodetic DATE 87 02 12

CHECKED BY DT

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									
								SHEAR STRENGTH									
○ UNCONFINED + FIELD VANE								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT									
● QUICK TRIAXIAL x LAB VANE								Wp W WL									
								WATER CONTENT (%)									
					10 20 30												
168.1	Shoulder Surface													GR SA SI CL			
0.0	Asphalt						168										
166.8	Sand with Gravel (Fill)		1	SS	23												
1.3	Silt, some sand trace gravel clay Occ. plastic zones Very Dense		2	SS	56		166							1 10 80 9			
			3	SS	80												
			4	SS	57												
163.5	Very Dense		5	SS	39		164										
4.6	Sand, trace/some gravel, trace silt clay Very Dense		6	SS	60									25 65 (10)			
			7	SS	60												
161.1			8	SS	52		162							9 78 (13)			
7.0	Silt with sand trace gravel clay		9	SS	108		160										
			10	SS	100												
							158										
	Sand with silt Very Dense		11	SS	180												
			12	SS	146		156							3 33 59 5			
	Very Dense		13	SS	112	**	154										
						13 cm											
152.7			14	SS	63									6 35 (59)			
15.4	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized.																
	** N value for SS#13 may not be represen- tative since sand came up to Elev.155 before driving spoon																



RECORD OF BOREHOLE No 10

METRIC

W P 202-87-00 LOCATION Sta. 23 + 275 O/S 2.1 m Lt. ORIGINATED BY MLP
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 06 CHECKED BY DT

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								



RECORD OF BOREHOLE No 11

METRIC

W P 202-87-00 LOCATION Sta. 23 + 428 O/S 2.1 m Lt.

ORIGINATED BY MJ

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers

COMPILED BY LP

DATUM Geodetic DATE 87 02 06

CHECKED BY DT

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	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
174.0	Shoulder Surface												
0.0	Asphalt												
172.8	Sand and Gravel (Fill)		1	SS	29								
1.2	Silty Clay with sand trace gravel (Fill)		2	SS	29		172						1 35 48 16
			3	SS	8								
			4	SS	7								
			5	SS	7		170						
169.4	Trace org		6	SS	10								
4.6	Stiff		7	SS	15		168						4 33 47 16
			8	SS	29								
	Silty Clay with sand trace gravel		9	SS	100		166						2 33 47 18
	With dense zone of slightly plastic silt (CL-ML material) between Elev. 164.5 and 162.5		10	SS	33		164						
			11	SS	35								6 39 (55)
	Hard		12	SS	103		162						
			13	SS	58								
159.1			14	SS	63		160						
14.9	End of Borehole												
	* Groundwater level measured at completion of B.H. Level may not be stabilized												



RECORD OF BOREHOLE No 12

METRIC

W P 202-87-00 LOCATION Sta. 23 + 705 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 05 CHECKED BY DT

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L
								SHEAR STRENGTH									
176.0	Shoulder Surface																
0.0	Asphalt																
174.7	Sand some gravel (Fill)		1	SS	30												
1.3	Trace org.		2	SS	18												
	Silty Clay with sand trace gravel		3	SS	18		174								6 33 43 18		
			4	SS	6												
	With loose zone of plastic silt and sand between Elev. 172 and 173		5	SS	20		172								1 42 47 10		
			6	SS	34												
			7	SS	70		170								2 24 49 25		
	Occ. random thin seams of sand		8	SS	47												
167.5	Very Stiff to Hard		9	SS	49		168										
8.5	Clay (CH) some silt		10	SS	32												
165.9	Hard						166							WL= 56.5%	0 3 22 75		
10.1	Fine sand, trace silt																
164.9	Very Dense		11	SS	156	**									0 96 (4)		
11.1	End of Borehole																
	* Groundwater level measured at completion of B.H. Level may not be stabilized																
	** Sand came up augers to Elev. 166																



RECORD OF BOREHOLE No 13

METRIC

W P 202-87-00 LOCATION Sta. 23 + 855 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 05 CHECKED BY DA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
174.3	Shoulder Surface													
0.0	Asphalt													
173.4	Sand and Gravel (Fill)						174							
0.9	Silty Clay with sand (Fill)		1	SS	16									
172.5	Trace organics		2	SS	14									
1.8	Silty Clay (CI) to clay (CH) trace sand with occ. thin seams of fine sand		3	SS	25		172						0 32 40 28	
			4	SS	40									
			5	SS	39									
	Fine Sand with silt		6	SS	27		170						0 2 23 75	
	Silt some sand		7	SS	19									
			8	SS	22		168						0 22 (78)	
	Very Stiff to Hard		9	SS	70									
165.5							166						0 2 (98)	
8.8	Fine Sand, trace gravel, silt, clay		10	SS	99								1 84 (15)	
163.6	Very Dense						164							
10.7	End of Borehole													
	* Groundwater level measured at completion of B.H. Level may not be stabilized													
	** At Elev. 163.6 B.H. silted up to Elev. 167±. Borehole terminated													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 14

METRIC

W P 202-87-00 LOCATION Sta. 23 + 992 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 04 CHECKED BY DA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH			PLASTIC LIMIT W _p			NATURAL MOISTURE CONTENT W
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			WATER CONTENT (%) 10 20 30				
172.4	Shoulder Surface														
0.0	Asphalt														
171.5	Sand with gravel (Fill)						172								
0.9	Silty clay, trace sand, gravel		1	SS	19										2 11 51 36
	Hard		2	SS	38										
169.5			3	SS	43		170								
2.9	Fine sand with silt trace clay		4	SS	38										
168.0	Compact to Dense		5	SS	26										
4.4	Clay some silt (CH)		6	SS	33		168								0 1 25 74
166.9	Hard		7	SS	162										
5.5	Fine sand trace silt clay		8	SS	100		166								
	Very Dense		9	SS	95										0 96 (4)
	Fine to Medium Sand		10	SS	68		164								
161.7	trace gravel						162								
10.7	End of Borehole														
	* Groundwater level measured at completion of borehole. Level may not be stabilized														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 15

METRIC

W P 202-87-00 LOCATION Sta. 24 + 128 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 03 CHECKED BY DA

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					
170.3	Shoulder Surface																
0.0	Asphalt						170										
169.1	Sand some silt gravel (Fill)		1	SS	26												
1.2	Silty Clay with sand		2	SS	38												2 30 48 20
167.4	trace gravel Very Stiff		3	SS	22		168										2 31 47 20
2.9	Sand and silt trace clay gravel (slightly cohesive)		4	SS	53												
			5	SS	149												
			6	SS	143		166										
			7	SS	85												
	Very Dense		8	SS	49		164										3 48 43 6
163.3																	
7.0	Silty clay and sand trace gravel		9	SS	95												
161.8	Hard						162										5 43 41 11
8.5			10	SS	72												
	Sand some silt trace gravel																
	clay		11	SS	107		160										6 67 (27)
158.1	Very Dense		12	SS	30	**											
12.2	End of Borehole																
	* Groundwater level measured at completion of borehole. Level may not be stabilized.																
	** Sample disturbed; 'N' value not representative; Sand boiling																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 16

METRIC

W P 202-87-00 LOCATION Sta. 24 + 266 O/S 2.1 m Lt. ORIGINATED BY MJ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LP
DATUM Geodetic DATE 87 02 02 CHECKED BY SD

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		WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
168.3	Shoulder Surface															
0.0	Asphalt						168									
	Sand with gravel trace silt, clay (Fill)		1	SS	43											38 51 10 1
165.8			2	SS	13		166									
2.5	Silty Clay with sand		3	SS	17											0 34 49 17
164.3	Very Stiff		4	SS	15											1 41 44 14
4.0			5	SS	22		164									
	Sand trace gravel silt, clay (well graded)		6	SS	44											10 82 (8)
161.3	Dense		7	SS	50											
			8	SS	52		162									
7.0																
	Fine Sand with silt		9	SS	61		160									0 33 66 1
	silt content increasing gradually with depth		10	SS	17											
	Compact to Very Dense		11	SS	62		158									
156.1																
12.2	Silt with sand		12	SS	40		156									1 26 68 5
	Very Dense		13	SS	52											
153.4			14	SS	75		154									
14.9	End of Borehole															
	* Groundwater level measured at completion of borehole May not represent stabilized level															

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

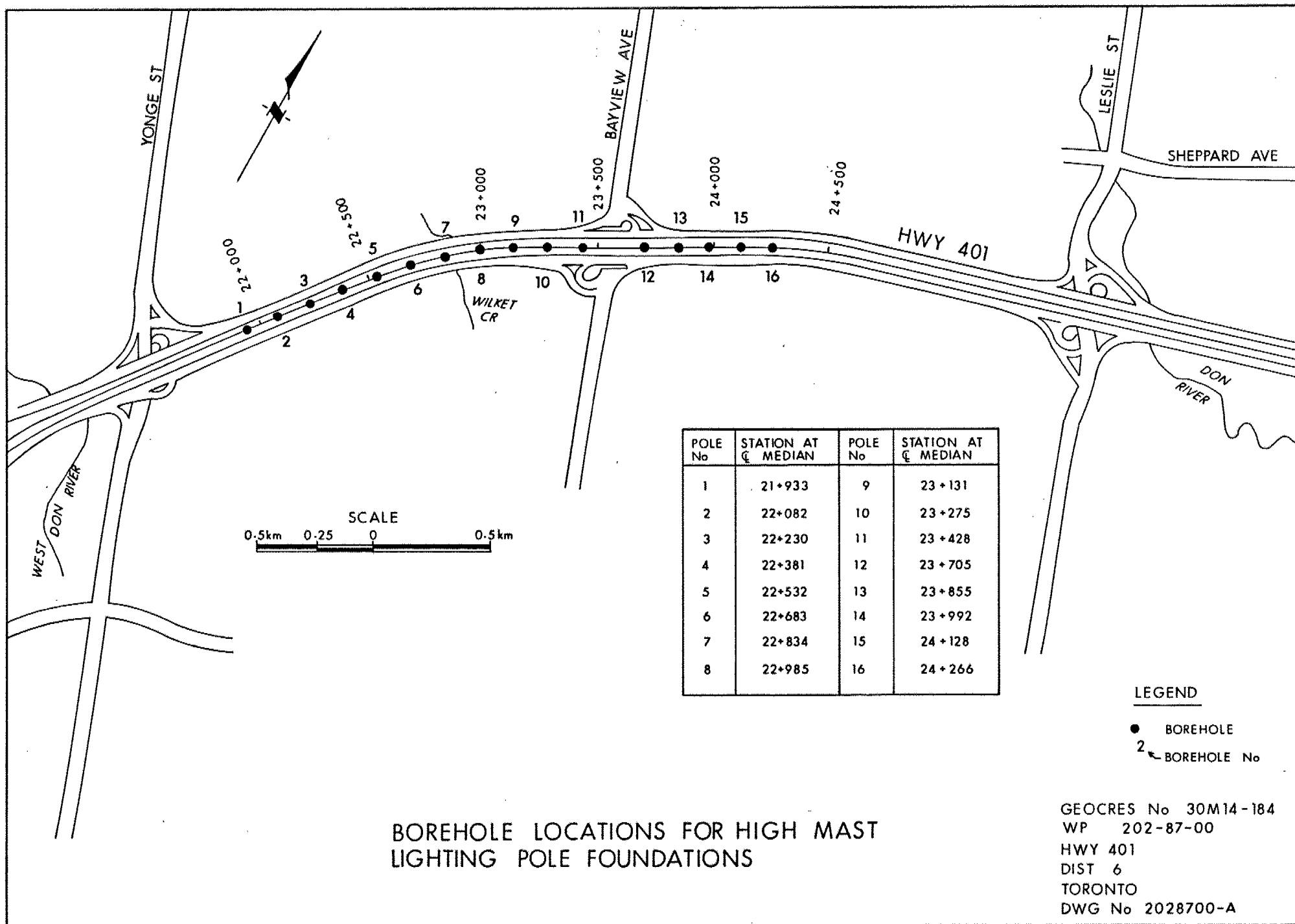
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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



Dwg. No. 105840102-A (attached) indicates in plan, the proposed location of each HML.

Draft versions of the Record of Borehole Sheet for each location have been attached for your information.

Design Considerations

As per current MTC design guidelines each HML pole will be supported on a single concrete caisson. For the design of the caisson, the Structural Office has adopted the method described by Broms in the following two papers.

Broms, B.B.

Lateral Resistance of Piles in Cohesive Soils,

Journal of the Soil Mechanics and Foundations Division, ASCE,

Vol. 90, No. SM2

Paper 3825, March 1964

and

Broms, B.B.

Lateral Resistance of Piles in Cohesionless Soils,

Journal of the Soil Mechanics and Foundations Division, ASCE,

Vol. 90, No. SM3

Paper 3909, May 1964

In the design of the HML foundations, the contribution of the surficial sand and gravel fill should be neglected from a lateral resistance viewpoint. In certain areas, silty clay fill was encountered under the sand and gravel. Under these circumstances, reduced unconfined compressive strength values have been given for the cohesive fill since fill material is, by nature, inconsistent in composition.

It should also be assumed that material in the zone of frost penetration does not provide any lateral resistance to the caisson loads. At this site, the depth of frost penetration through earth cover is approximately 1.2 m.

The soil parameters in TABLE 2 are recommended for the design of the HML foundations. The following notation has been adopted:

ϕ = apparent angle of friction for cohesionless soils

q_u = unconfined compressive strength in kPa ($q_u = 2c_{cu}$)

γ = bulk unit weight in kN/m³

TABLE 2 - Soil Parameters

Pole	Elev. (m) From - to	Type of Soil	Denseness or Consistency	ϕ	qu kPa	γ kN/m ³
1	174.5-173.7	Fill(Non-Coh.)	-	-	-	19.3
	173.7-172.4	Fill(Cohesive)	Well Compacted	-	100	20.5
	172.4-169.5	Cohesive	Very Stiff	-	240	20.4
	169.5-165.0	Cohesive	Hard	-	340	21.2
	165.0-163.0	Cohesive	Hard	-	500	21.2
	163.0-159.0	Non-Cohesive	Dense	36°	-	20.4
2	172.9-172.0	Fill(Non-Coh.)	-	-	-	19.3
	172.0-168.5	Fill(Cohesive)	Mod. Compacted	-	90	19.9
	168.5-164.5	Cohesive	Very Stiff	-	190	20.1
	164.5-163.5	Non-Cohesive	Compact	33°	-	20.1
	163.5-160.5	Cohesive	Hard	-	300	21.0
	160.5-157.5	Cohesive	Hard	-	500	21.2
3	171.2-170.2	Fill(Non-Coh.)	-	-	-	19.3
	170.2-168.0	Fill(Cohesive)	Well Compacted	-	150	19.9
	168.0-166.5	Cohesive	Firm	-	95	19.3
	166.5-164.5	Cohesive	Very Stiff	-	225	20.4
	164.5-162.0	Cohesive	Stiff	-	150	19.9
	162.0-159.0	Cohesive	Hard	-	270	20.7
	159.0-155.5	Cohesive	Hard	-	500	21.2
4	169.6-168.6	Fill(Non-Coh.)	-	-	-	19.3
	168.6-166.0	Cohesive	Firm	-	75	19.3
	166.0-164.0	Cohesive	Stiff	-	150	19.9
	164.0-161.0	Cohesive	Very Stiff	-	250	20.6
	161.0-158.0	Cohesive	Hard	-	500	21.2
	158.0-155.5	Non-Cohesive	Very Dense	43°	-	21.2
5	168.7-167.7	Fill(Non-Coh.)	-	-	-	19.3
	167.7-165.5	Cohesive	Very Stiff	-	160	19.9
	165.5-163.5	Cohesive	Hard	-	500	21.2
	163.5-161.0	Non-Cohesive	Very Dense	43°	-	21.2
	161.0-154.5	Cohesive	Hard	-	500	21.2
6	167.9-167.0	Fill(Non-Coh.)	-	-	-	19.3
	167.0-166.0	Fill(Cohesive)	Well Compacted	-	120	20.1
	166.0-163.0	Cohesive	Hard	-	320	21.1
	163.0-161.0	Cohesive	Hard	-	450	21.3
	161.0-158.0	Non-Cohesive	Very Dense	43°	-	21.2
	158.0-152.0	Cohesive	Hard	-	500	21.2
7	167.1-165.7	Fill(Non-Coh.)	-	-	-	19.3
	165.7-164.0	Fill(Cohesive)	Mod. Compacted	-	50	19.3
	164.0-162.5	Cohesive	Soft	-	40	19.3
	162.5-161.0	Non-Cohesive	Compact	30°	-	19.6
	161.0-158.0	Non-Cohesive	Very Dense	39°	-	21.2
	158.0-152.0	Non-cohesive	Very Dense	43°	-	21.2

TABLE 2 - Continued

Pole	Elev. (m) From - to	Type of Soil	Denseness or Consistency		qu kPa	kN/m ³
8	167.2-166.0	Fill(Non-Coh.)	-	-	-	19.6
	166.0-164.3	Fill(Cohesive)	Well Compacted	-	150	20.1
	164.3-161.0	Non-Cohesive	Very Dense	39°	-	21.4
	161.0-158.0	Non-Cohesive	Compact	30°	-	19.6
	158.0-155.5	Cohesive	Hard	-	500	21.2
	155.5-153.0	Non-Cohesive	Very Dense	43°	-	21.2
9	168.1-166.8	Fill(Non-Coh.)	-	-	-	19.3
	166.8-153.0	Non-Cohesive	Very Dense	43°	-	21.2
10	169.8-168.6	Fill(Non-Coh.)	-	-	-	19.3
	168.6-167.0	Fill(Cohesive)	Well Compacted	-	150	20.5
	167.0-165.5	Non-Cohesive	Very Dense	39°	-	21.2
	165.5-164.5	Cohesive	Very Stiff	-	220	20.2
	164.5-157.0	Non-Cohesive	Very Dense	43°	-	21.2
11	174.0-172.8	Fill(Non-Coh.)	-	-	-	19.3
	172.8-169.5	Fill(Cohesive)	-	-	50	19.3
	169.5-168.0	Cohesive	Stiff	-	110	19.9
	168.0-162.0	Cohesive	Hard	-	270	20.7
	162.0-159.0	Cohesive	Hard	-	450	21.2
12	176.0-174.7	Fill(Non-Coh.)	-	-	-	19.3
	174.7-171.5	Cohesive	Very Stiff	-	150	19.9
	171.5-166.0	Cohesive	Hard	-	320	21.2
	166.0-165	Non-Cohesive	Very Dense	43°	-	21.2
13	174.3-173.4	Fill(Non-Coh.)	-	-	-	19.3
	173.4-172.5	Fill(Cohesive)	Mod. Compacted	-	90	19.6
	172.5-167.0	Cohesive	Very Stiff	-	230	20.6
	167.0-165.5	Cohesive	Hard	-	500	21.2
	165.5-163.5	Non-Cohesive	Very Dense	43°	-	21.2
14	172.4-171.5	Fill(Non-Coh.)	-	-	-	19.3
	171.5-169.5	Cohesive	Hard	-	300	21.2
	169.5-168.0	Non-Cohesive	Dense	34°	-	20.4
	168.0-167.0	Cohesive	Hard	-	270	20.7
	167.0-161.5	Non-Cohesive	Very Dense	40°	-	21.2
15	170.3-169.1	Fill(Non-Coh.)	-	-	-	19.3
	169.1-167.5	Cohesive	Very Stiff	-	200	20.2
	167.5-163.0	Non-Cohesive	Very Dense	43°	-	21.2
	163.0-161.5	Cohesive	Hard	-	500	21.2
	161.5-158.0	Non-Cohesive	Very Dense	39°	-	21.2
16	168.3-165.8	Fill(Non-Coh.)	-	-	-	19.3
	165.8-164.3	Cohesive	Very Stiff	-	150	20.0
	164.3-153.5	Non-Cohesive	Very Dense	39°	-	21.2

This Section should be contacted in the event that a caisson extending below the investigated depth is required.

Groundwater levels were measured in the open boreholes immediately upon the completion of each boring. In view of the very dense or hard nature of some of the soils, it is believed that the measured levels do not represent the stabilized conditions. For design purposes, it should be assumed that the groundwater level is found at 4.5 m below the pavement surface.

Construction Considerations

The investigation revealed that the subsurface conditions across the site are not consistent, as both cohesive and cohesionless deposits are encountered throughout. In addition, it was noted that some of the cohesive deposits contain zones and seams of cohesionless material, some of which are water-bearing.

In zones where the soil is slightly plastic or cohesionless, and below the groundwater level, it is possible that the sides of an unsupported augered hole will cave in. If caving, and as a result, disturbance occurs, the lateral resistance of the soil may be drastically reduced. Therefore, given the nature of the subsoils across the site, it is recommended that all caissons be constructed utilizing a temporary liner which could be withdrawn as the concrete is poured.

In situations where the caisson will be founded on cohesionless soils below the groundwater table, balancing of the hydrostatic pressures will be required during construction.

When fine-grain cohesionless soils are subjected to unbalanced hydrostatic pressures, 'boiling' will be experienced. Boiling (or quick) conditions result in complete loss of intergranular friction and the supporting capacity of the soil mass. It will therefore be necessary to prevent such conditions from developing.

Quick conditions could be controlled by balancing the hydrostatic pressures by using either slurry-drilling techniques or balancing the hydraulic head by means of water. The contractor should be informed of the potential of boiling and should be required to prevent the condition from occurring.

CLOSURE

We believe that the parameters and recommendations presented in this memorandum will be sufficient for the design of the HML footings. We will in the very near future issue a complete Foundation Investigation and Design Report which will include brief soil descriptions, Record of Borehole Sheets, laboratory test results and recommendations. The final report will have our normal Central Region distribution unless you request otherwise. In the meanwhile, if you require clarification or any additional information, please do not hesitate to contact the undersigned.

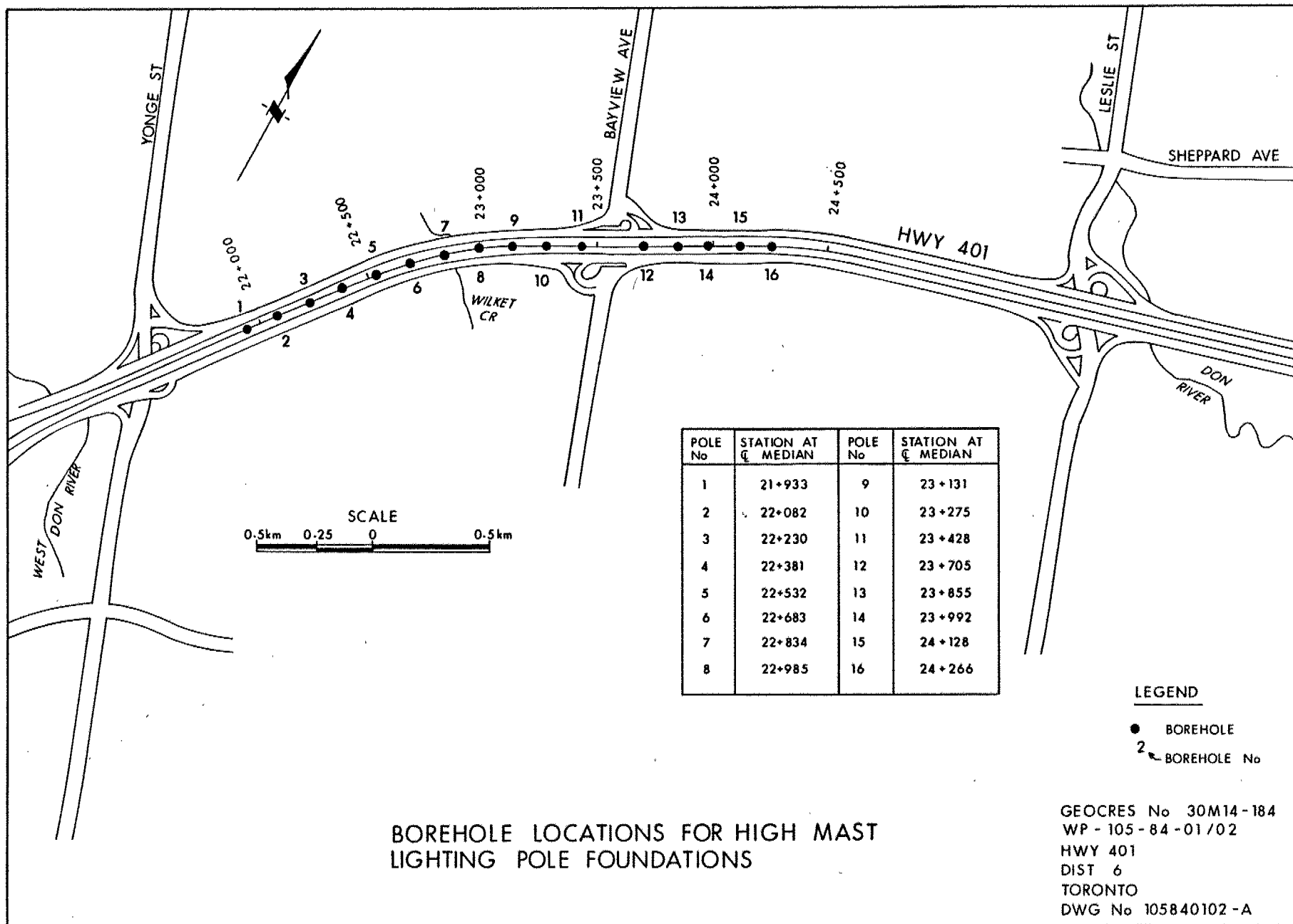
A handwritten signature in dark ink, appearing to read 'L. Politano', with a long horizontal flourish extending to the right.

L. Politano
Project Foundations Engineer

For

M. Devata
Chief Foundations Engineer (East)

cc: A. Silbeger
K. Bassi
R. Kunkel
B. Ruck



MEMORANDUM TO:

Mr. A. Silbiger,
Head,
Central Region Electrical Design,
5000 Yonge Street,
Willowdale, Ontario.

1987 02 13.

From: Traffic Management and Engineering Office,
Room 236, Central Building. 235-3788

Re: Concrete Median Barrier Design
Highway 401 - Yonge Street to Leslie Street
W.P. 43-79-03 W.O. 26-23054



We have reviewed the proposed design of the concrete median barrier for the above noted location and would recommend the following:

1. The proposed transition from steel beam barrier to concrete barrier should not utilize a concrete end treatment as depicted in OPSD-917.06. Used in this manner may afford a vehicle access to the top of the concrete barrier resulting in subsequent rollover. Instead it is recommended the concrete barrier be truncated at the same height and width as used at the pole locations with the steel beam and channel fastened to the concrete barrier in the same manner as a barrier wall of a structure (see OPSD-904.04). This procedure will be compatible with future median barrier designs yet provide a safe and efficient transition.

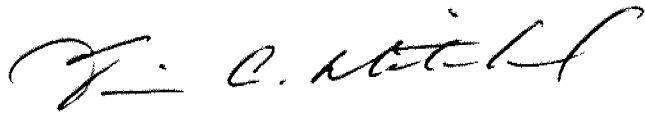
It is noteworthy however that the Highway Design Office is currently developing alternate methods of transitioning from steel beam to concrete which too may be considered.

2. Curb and gutter of any dimension or type must not be used adjacent to concrete barrier of the New Jersey shape. All curb and gutter systems affect the trajectory of an errant vehicle and their use in conjunction with concrete New Jersey shaped barriers is not desirable. On this project, as well as other similar situations, care should be taken to ensure that the curb and gutter of all drainage systems be terminated beyond the concrete barrier at the approach or leaving ends.
3. To virtually eliminate the possibility of errant vehicles mounting the barrier system and striking the poles, the recommended height, at least in the immediate vicinity of the high mast lighting poles should be 1500 mm.

The width of the system as proposed is satisfactory.

4. The vertical face normally constructed to a maximum height of 75 mm should be eliminated when concrete New Jersey shaped walls of the recommended height (1500 mm) are used. Studies in Michigan as well as England indicate maintaining this vertical face with "tall wall" installations increases rollover experience with smaller vehicles.
5. It is critical to the performance of concrete New Jersey shaped barrier that the surface of this device not be brushed to remove blemished or irregularities. Brushing increases the fictional quality of the surface adversely affecting the dynamics of the system and will result in rollover. Trowelling is recommended to obtain a smooth running surface.

I trust the above will be satisfactory. If you have any questions please contact us.



T.A. Mitchell,
Traffic Devices Development
Project Officer,
Traffic Development and
Analysis Section.

TAM/lp

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