

MEMORANDUM

GEN. FILES

Jan 28-4

cc: Mr. R. G. Burnfield,  
Regional Functional  
Planning Engr.,  
Central Region,  
Admin. Bldg.

FROM: Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

DATE: January 14, 1966

Our File Ref.

IN REPLY TO

JAN 25 1966

SUBJECT:

PRELIMINARY  
FOUNDATION INVESTIGATION REPORT FOR  
FUNCTIONAL STUDY OF RECONSTRUCTION  
OF THE QUEEN ELIZABETH HIGHWAY NEAR  
JORDAN HARBOUR, DISTRICT 4 (HAMILTON)

W.J. 65-P-113 -- W.P. (N11)

In order to provide the necessary information for the functional study, we are forwarding to you, three (3) copies of our Preliminary Foundation Investigation Report on subsoil conditions existing at the above site.

We believe that the factual data and recommendations contained therein, although preliminary in nature only, will prove adequate for your present requirements.

Should there be any queries regarding this report, please do not hesitate to contact our Office.

AGS/MdeP  
Attach.

*Alstermac*  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. R. G. Burnfield (3)  
B. R. Davis  
G. K. Hunter (2)  
H. Greenland  
T. J. Kovich

Foundations Office  
Gen. Files

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PRELIMINARY  
FOUNDATION INVESTIGATION REPORT FOR  
FUNCTIONAL STUDY OF RECONSTRUCTION  
OF THE QUEEN ELIZABETH HIGHWAY NEAR  
JORDAN HARBOUR, DISTRICT 4 (HAMILTON)  
W. J. 65-F-113    --    W. P. (N11)

1. INTRODUCTION:

It is proposed to reconstruct the existing Q.E.W. to a six-lane controlled access highway between the Stoney Creek traffic circle and St. Catharines. In addition, two-lane service roads are proposed to be built on both sides of the future Q.E.W.

A verbal request for a foundation investigation at the Twenty-Mile Creek Pond near Jordan Harbour, was received from Mr. R. G. Burnfield, Regional Functional Planning Engineer.

Subsequently, a foundation investigation consisting of 21 boreholes and 10 dynamic cone penetration tests, was carried out at the site. Presented in this report are the results of this investigation, together with our preliminary recommendations pertaining to the stability of the future embankment.

2. DESCRIPTION OF SITE AND GEOLOGY:

The site is located in an area commonly known as the Niagara Fruit Belt, which is located between Lake Ontario and the Niagara Escarpment, and extends eastward from Hamilton to the Niagara River. Physiographically, this area is known as the Iroquois Plain. The plain is not cut by any large streams, but a number of smaller water-courses cross it to Lake Ontario. These streams produce lagoons or marshes, cut off from Lake Ontario by barrier beaches. The Twenty-Mile Creek, located near Jordan Harbour, has produced such a lagoon. This lagoon, known as Twenty-Mile Creek Pond, is approximately 2,400 ft. wide near the highway and tapers off southward to river size over a distance of approximately one mile. The lagoon is separated from

2. DESCRIPTION OF SITE AND GEOLOGY: (cont'd.) ...

Lake Ontario by a barrier beach approximately 300 ft. wide. A narrow opening has been formed in the centre of this barrier beach to permit free water flow into Lake Ontario.

3. FIELD AND LABORATORY WORK:

The borings in the field were carried out by means of two diamond drills adapted for soil sampling purposes and one Penn. auger. Rafts were used for drilling eleven boreholes and all four dynamic cone penetration tests.

Samples were recovered at the required depths by means of a 2-in. O.D. split-spoon sampler and by 2-in. I.D. Shelby tube samplers. The dimensions of the split-spoon sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test. In-situ vane tests were carried out wherever possible, in order to determine the undrained shear strength of the cohesive deposits.

The locations and elevations of all boreholes are shown on the accompanying borehole log sheets, included in the Appendix of this report. The borehole elevations were supplied by a Department of Highways survey crew from Hamilton District, and are based on geodetic datum.

Samples were visually examined and identified in the laboratory as well as in the field. Laboratory tests were performed on a number of selected samples to determine:

- 1) Natural moisture contents.
- 2) Atterberg limits.
- 3) Bulk densities.
- 4) Undrained shear strengths.
- 5) Grain size distributions.
- 6) Organic contents (for organic soil only).

Laboratory tests are summarized and are included in the Appendix.

#### 4. SUBSOIL CONDITIONS:

##### 4.1) General:

Subsoil at the site consists of deposits of silty sand, organic silt, glacial till and clayey silt.

The boundaries of the deposits, as determined in the boreholes, are shown on the accompanying borelog sheets, and the estimated stratigraphical profile contained in Drawing 65-F-113A, is based on this information.

##### 4.2) Embankment Fill:

This material was observed in all the boreholes drilled on the south shoulder of the highway (B.H.'s 1, 3, 11 and 14). The fill consists of a heterogeneous mixture of silty sand and gravel with occasional lumps of clay. The average thickness of the fill was 15 ft. and its lower boundary ranged between elevations 240 and 245. Standard Penetration Test (N) results in the fill, ranged from 7 blows/ft. to 18 blows/ft., indicating a relative density of loose to compact.

##### 4.3) Silty Sand with Gravel:

This deposit was observed immediately below the road fill or from ground surface in all boreholes between stations 48+00 and 64+00, and also below the clayey silt in borehole 15. The lower boundary of this stratum varies between elevations 218 and 230, with the exception of borehole 15. Standard Penetration Test (N) values varied from 4 blows/ft. to 108 blows for 2-in. From these values a relative density of loose to very dense, may be estimated.

##### 4.4) Organic Silt with occasional Sand and Gravel:

With the exception of boreholes 9, 15 and 19, this deposit was observed immediately below the silty sand stratum or ground surface in all boreholes. The thickness of the layer varied irregularly, ranging from 15 ft. to 40 ft.

cont'd. /4 .....

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.4) Organic Silt with occasional Sand and Gravel: (cont'd.) ...

Physical properties of the material in the deposit as determined from laboratory and field tests, are summarized as follows:

Liquid Limit ( $W_L$ )	21% - 198% (oven-dried)
	33% - 86% (air-dried)
Plastic Limit ( $W_P$ )	17% - 170% (oven-dried)
	29% - 75% (air-dried)
Moisture Content	40% - 120%
Organic Content	3% - 17% (by weight)

	<u>Sta.48+00 to Sta.64+00</u>	<u>Sta.64+00 to Sta.70+00</u>
Unconfined Shear Strength	300 - 2,100 p.s.f.	160 - 900 p.s.f.
Field Vane Shear Strength	300 - > 2,000 p.s.f.	240 - 1,140 p.s.f.
'N' Values	2 - 19 blows/ft.	2 - 5 blows/ft.

4.5) Glacial Till:

Underlying the organic silt, a stratum of glacial till was encountered in all boreholes with the exception of borehole 15. The texture of the material varies irregularly between clayey silt with sand and gravel and silty sand or sandy silt with gravel. Standard Penetration Test (N) values for the overall deposit, range from 60 blows/ft. to 100 blows/1 in. Based on these results, the consistency of the cohesive portion is estimated as hard, while the relative density of the non-cohesive portion is estimated as very dense.

cont'd. /5 .....

4. SUBSOIL CONDITIONS: (cont'd.) ...

4.6) Clayey Silt:

A 38-ft. thick surface deposit of clayey silt was observed only in B.H.'s 15 and 19. These two boreholes are located east and west of the Pond, where the Q.E.W. is in or about to enter cuts. Standard Penetration Test (N) results in the stratum varied from 10 blows/ft. to 139 blows/8 in. It is believed that these values reflect a shear strength range of stiff to hard with the predominant portion of the stratum in the very stiff to hard range.

5. DISCUSSION:

The reconstruction of Q.E.W. will necessitate construction of fills up to 45 ft. high in the vicinity of Jordan Harbour, where the highway will be widened to accommodate future 6-lane main traffic, together with 2-lane service roads on either side. The new centre-line at this location will be approximately 50 ft. south of the existing one. From the available information, it can be assumed that fills will extend 200 ft. to 250 ft. transversely into the Twenty-Mile Creek Pond.

The investigation revealed that the subsoil generally consists of deposits of silty sand, organic silt and glacial till.

Stability problems can be foreseen for the proposed fills in view of the presence of very soft to stiff organic silt. In order to improve the overall stability of the fill, certain measures are required and are discussed below.

SCHEME 1.

a) Berms are required on the south side between station 48+00 and station 64+00.

cont'd. /6 .....

5. DISCUSSION: (cont'd.) ...

SCHEME 1. (cont'd.) ...

b) All the soft organic material between station 64+00 and station 70+00 on the south side should be subexcavated and replaced with suitable granular material prior to the placing of the new fills. Techniques like dredging or displacement should be investigated.

c) The exact dimensions of the berms and of the subexcavation can be determined when final design details are available.

d) It should be noted that berms are also required in the longitudinal direction at the Twenty-Mile Creek structure.

e) Because of the more favourable subsoil conditions and lower height of fill, berms may not be required on the north side of the highway, provided standard 2:1 side slopes are adopted.

f) The presence of organic silt below the ground surface will cause differential settlements within the length and width of the proposed embankment. In view of this, a flexible type of pavement should be considered in order to enable practical and economical maintenance.

SCHEME 2.

The highway may be carried on a multi-span trestle structure. This structure could be supported on bored-in concrete caissons or some other type of pile bearing on the very dense or hard glacial till.

6. MISCELLANEOUS:

The field work, undertaken in November 1965, together with the preparation of this report, was undertaken by Mr. R. Magi and Mr. P. Wang, Project Foundation Engineers. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report. The equipment was owned and operated by Dominion Soil Investigation Ltd. of Toronto.

January 1966.



APPENDIX I

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

### TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

### SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
s	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$c_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	$\approx 3.1416$
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

## STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

## FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

## SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

DE LEUW, CATHER & COMPANY  
OF CANADA LIMITED

CONSULTING PROFESSIONAL ENGINEERS

1127 LESLIE STREET

DON MILLS, ONTARIO

445-2221

January 7th, 1966

Mr. M. Devata,  
Materials and Testing Division,  
Department of Highways of Ontario,  
Downsview, Ontario.

Our Reference T-262

Dear Sir:

Re: Q.E.W. Study  
Hamilton to St. Catharines

This letter will confirm our telephone conversation, concerning the Jordan Harbour Study, on January 6th, 1966, in which you stated that from 48+00 to 64+00, in the Township of Louth,

- 1) berm construction is necessary for fills in excess of 25 feet (measured from the existing ground), on the south side of the Q.E.W. only.
- 2) berms will be required under the structure at the Jordan Harbour gap.
- 3) the height of the berm should be one-half the height of the fill.
- 4) a reasonable berm width for cost estimates would be 75 feet with the width varying from 0 to 75 feet as the fill varied from 25 to 45 feet.

You also noted that no berm would be required for the south side of the highway between stations 64+00 to 70+00, as the 30 feet of organic clay would have to be removed. An approximate cost of \$0.50 per cubic yard was quoted.

Yours very truly,

DE LEUW, CATHER & COMPANY OF CANADA LIMITED

EF:sg

cc: Mr. R.G. Burnfield,  
Attention: L. Schwabl

E. Fearnley,  
Project Engineer.

DE LEUW, CATHER & COMPANY  
OF CANADA LIMITED  
CONSULTING PROFESSIONAL ENGINEERS  
1127 LESLIE STREET  
DON MILLS, ONTARIO  
445-2221

65-F-113

October 1st, 1965

Mr. M. Devata,  
Materials and Testing Division,  
Department of Highways of Ontario,  
Downsview, Ontario.

Our Reference C-262

Dear Sir:

We are enclosing a plan and profile of the proposed alignment through the Jordan Harbour area in the Township of Louth. Structures with minimum clearances of twenty-two feet have been proposed for the Q.E.W. and the service roads at this location.

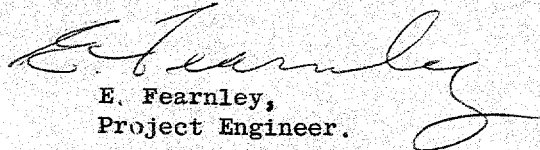
According to the Department of Highways Foundation Investigation, W.J. 60-F-63, for the anticipated ten foot fill, no stability problems were foreseen from the layer of organic clay varying in thickness from five feet to thirty feet. However, as can be seen from the profile, there will be an additional fill of twenty-five feet at this location.

Would you please investigate the area and give us your recommendations ?

445-2221

Yours very truly,

DE LEUW, CATHER & COMPANY OF CANADA LIMITED

  
E. Fearnley,  
Project Engineer.

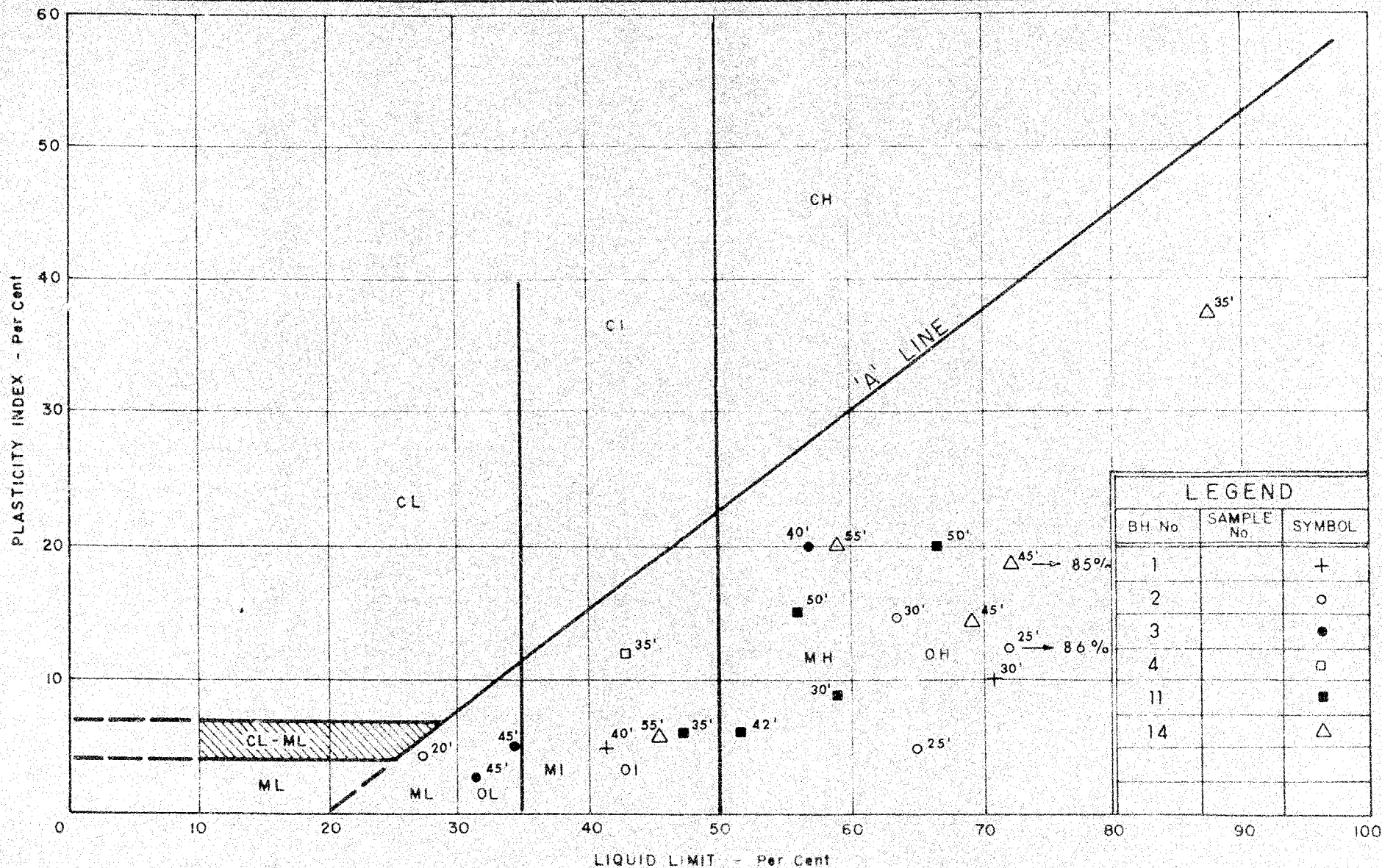
EF:sg  
cc: Mr. R.G. Burnfield



# FIELD BORING LOG

DRILLING CO. \_\_\_\_\_ DATUM ELEV. \_\_\_\_\_ B.H. NO. \_\_\_\_\_  
 DRILLER \_\_\_\_\_ GROUND ELEV. \_\_\_\_\_ JOB NO. 65-F-113  
 ENGINEER \_\_\_\_\_ CASING SIZE \_\_\_\_\_ DATE -115  
 SITE LOCATION \_\_\_\_\_  
 HOLE LOCATION Summary of use of boats & rafts.  
 REMARKS \_\_\_\_\_

DEPTH FEET		DESCRIPTION	SAMPLE TYPE, NO. & RECOVERY	METHOD OR BLOWS & DISTANCE
FROM	TO			
Raft #1		S. Leschysyn		
Raft #2		R. Chastand		
Boat #1 + water		from Dam Soil		
Boat #2		Campbell's boats		
Boat #2		Ungava Marine St. Kitts		
<hr/>				
Raft #1		From Nov. 1 to <sup>noon</sup> Nov. 17 (except Nov. 12) Welland 5 days Jordan Harbour 6 1/2 days		11 1/2 days
Boat #1		From Nov. 1 to noon Nov. 23/65 (except Nov. 12)  Welland 5 days Jordan Harbour		
Raft #2		From & noon Nov. 4 to noon Nov. 23/65 (except Nov. 12/65)  Jordan		
Boat #1 water		From noon Nov. 4 to noon Nov. 19 (water 2w + 1d.)		
#2		From Nov. 4 to Nov. 22 (incl.)		

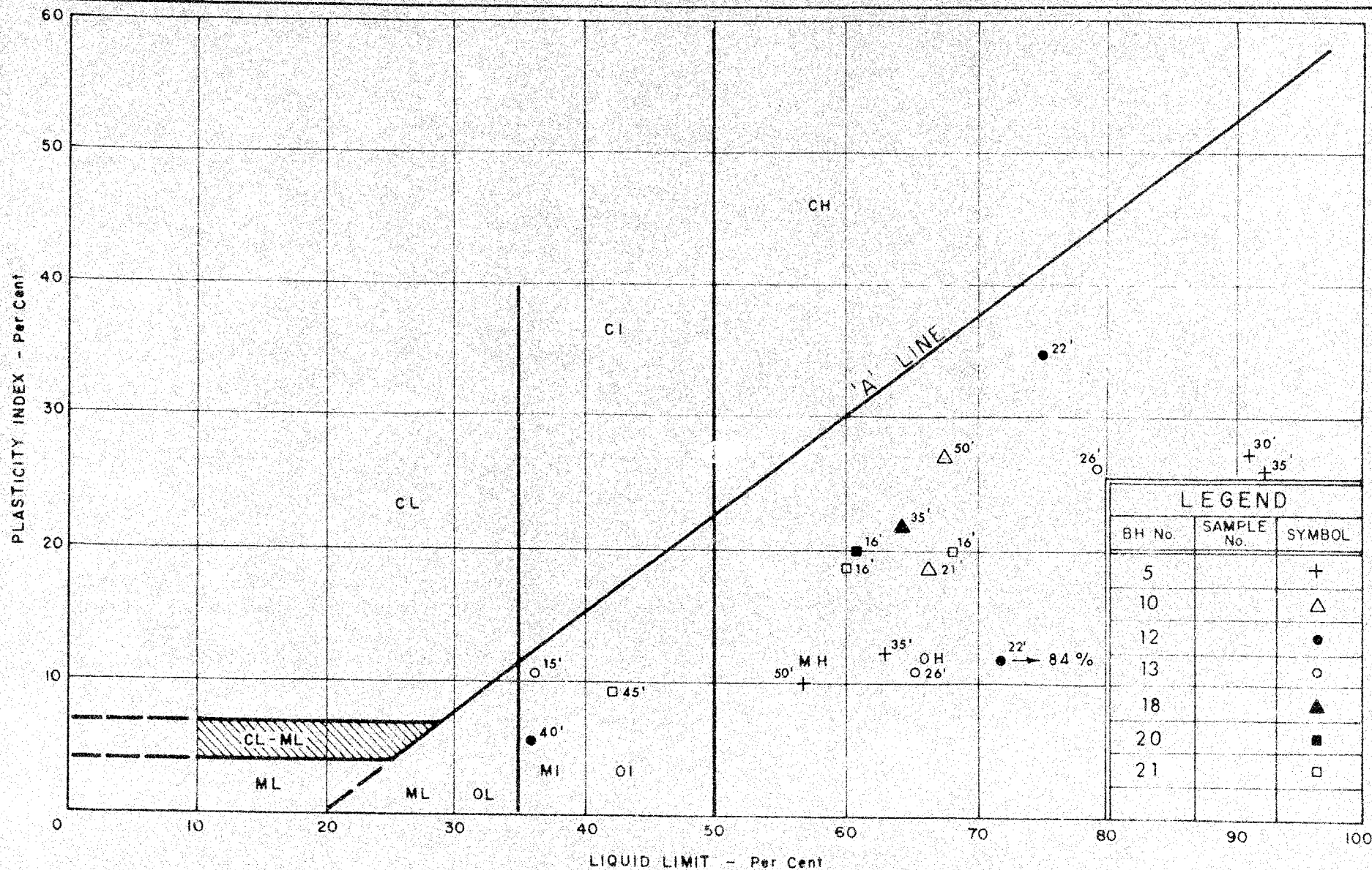


DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

# PLASTICITY CHART ORGANIC SILT

W.P. No.

JOB No. 65-F-113



LEGEND		
BH No.	SAMPLE No.	SYMBOL
5		+
10		△
12		●
13		○
18		▲
20		■
21		□



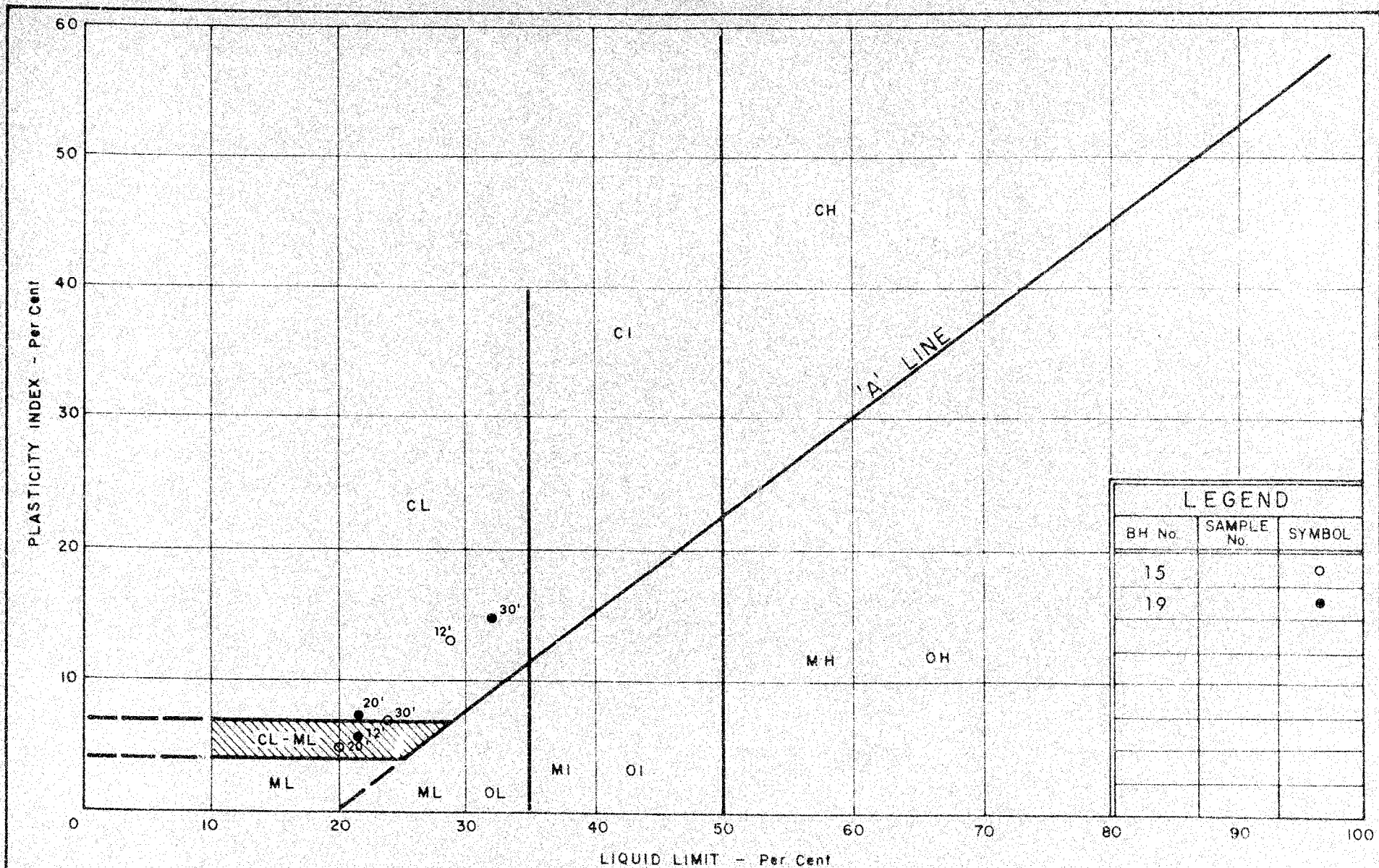
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TESTING  
DIVISION

# PLASTICITY CHART ORGANIC SILT

W.P. No.

JOB No. 65-F-113





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MATERIALS and  
TESTING  
DIVISION

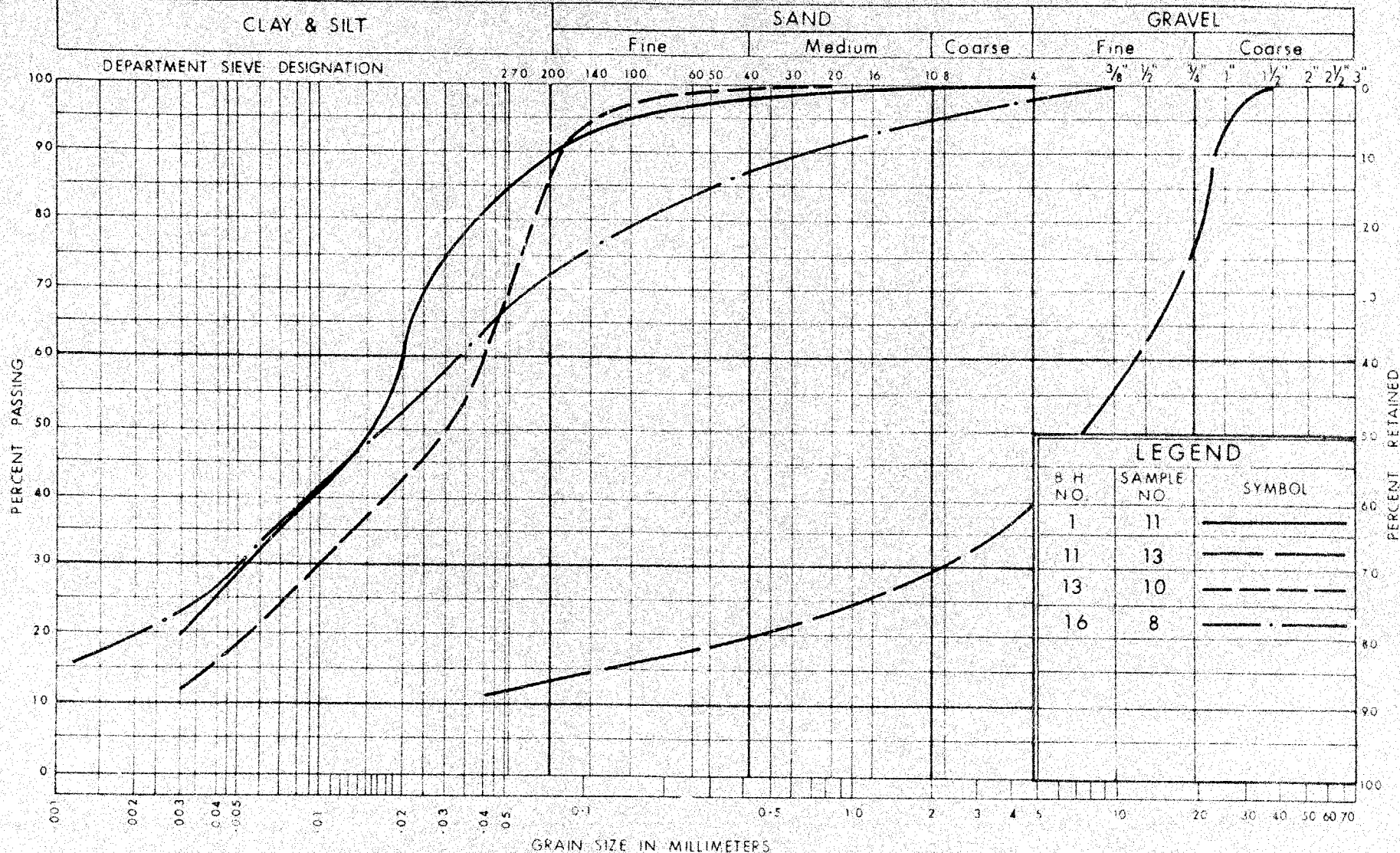
# PLASTICITY CHART CLAYEY SILT

WP No.

JOB No.

65 - F - 113

# UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

## GRAIN SIZE DISTRIBUTION GLACIAL TILL

W.P. No.  
JOB No. 65-F-113



DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE NO. 2 &amp; 2A

FOUNDATION SECTION

MATERIALS &amp; TESTING DIVISION

JOB 65-F-113

LOCATION Sta. 53+85 65' Lt.

ORIGINATED BY R.M.

W.P.

BORING DATE Nov. 2, 1965.

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Washboring.

CHECKED BY M.D. *LR*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. + Field Vane    □ Lab Vane • Unconf Compr.    ■ Tor Vane					WP	W	WL		
249.8	Groundlevel						500	1000	1500	2000	2500	20	40	60		
0	Silty sand with occasional gravel.		1	SS	37											WL Elev. 245.9
			2	SS	36											
			3	SS	26	240										
			4	SS	36											
			5	SS	14											
229.8	Compact to dense.					230										
20	Organic silt.		6	TW	P										122	N=5
			7	TW	P											N=6
			8	TW	P	220									102	N=6
214.8	Firm to stiff.		9	SS	26											
35	Glacial till (silt to clayey silt).		10	SS	95/6"	210										
			11	SS	100/3"											
198.5	Very stiff to hard.		12	SS	100/3"	200										
51.3	End of borehole.				3"											

0  
15 + 5 Percent strain at failure.  
10

FOUNDATION SECTION

CHECKED BY                      M.D.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. + Field Vane      □ Lab. Vane • Unconf. Comp.    ■ Tor Vane 500   1000   1500   2000   2500					WATER CONTENT % 20   40   60			
254.8	Groundlevel														
0	Fill (silty sand with gravel).		1	SS	16	250									
			2	SS	7										
242.3	Loose to compact.		3	SS	15										
12.5	Silty sand with occasional gravel.		4	SS	80	240									
			5	SS	48										
			6	SS	16	230									
			7	SS	15										
218.8	Compact to very dense.		8	SS	14	220									
36	Organic silt with occasional gravel.		9	Tw	P									102	N=11
			10	Tw	P	210								104	68% Org's
			11	SS	11										
			12	SS	10	200									
192.8	Soft to hard.		13	SS	18										
62	Glacial till (clayey silt with occasional gravel).		14	SS	100	190									
					6"										
184.5	Hard.		15	SS	100										
70.3	End of borehole.				4"										

0  
15 + 5 Percent strain at failure.  
10



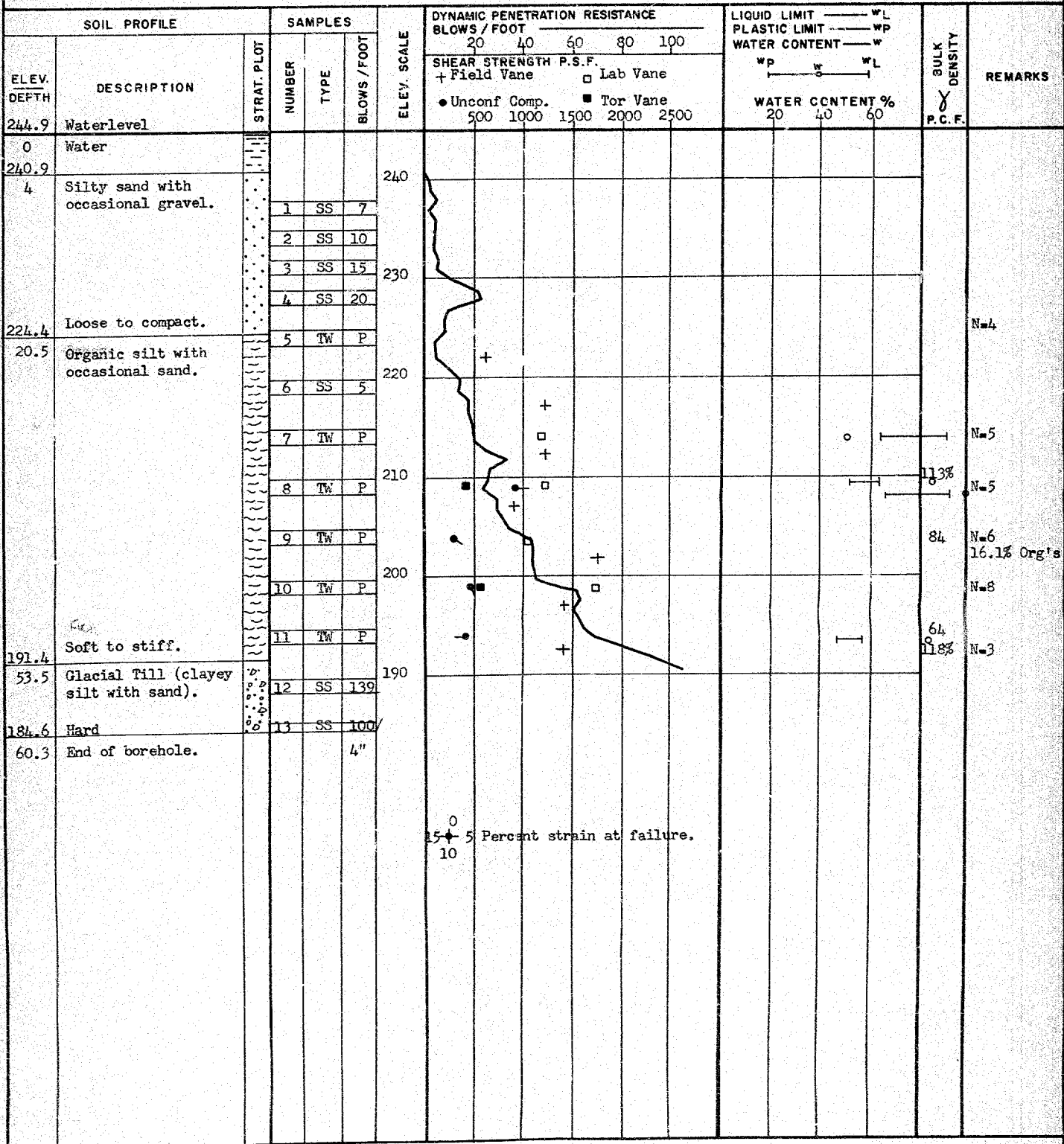


DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5 & 5A

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 57+90 250' Rt. ORIGINATED BY R.M.  
W. P.                      BORING DATE Nov. 5, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Washboring & Cone Penetration CHECKED BY M.D. *[Signature]*



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION  
JOB 65-F-113  
W. P. \_\_\_\_\_  
DATUM Geodetic

# RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

LOCATION Sta. 62+90 65' Lt. ORIGINATED BY R.M.  
BORING DATE Nov. 8, 1965. COMPILED BY R.M.  
BOREHOLE TYPE Penndrill CHECKED BY M.D. *dk*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					W P — W — W L 20 40 60 WATER CONTENT %				
							● Unconf Comp.	□ Lab Vane	500	1000	1500	2000	2500			
250.0	Groundlevel															
248.0	Fill														WL Elev. 245.0	
2	Silty sand with occasional gravel.		1	SS	17											
			2	SS	24	240										
			3	SS	23											
			4	SS	8											
230.0	Loose to compact.		5	SS	5	230										
20	Organic silt.		6	SS	9											
			7	TS	P	220	● □						○	102		
			8	SS	10											
212.0	Firm to stiff.					210							○ —			
38.0	Glacial till (clayey silt with sand & occasional gravel).		9	SS	130/12"											
			10	SS	148/12"											
198.5	Hard.		11	SS	115/6"	200										
51.5	End of borehole.				6"											

0

15

10

5

Percent strain at failure.

0  
15 — 5 Percent strain at failure.  
10



**FOUNDATION SECTION**

CHECKED BY M.D.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 65-F-113

LOCATION Sta. 62+90 250' Rt.

ORIGINATED BY R.M.

W.P.

BORING DATE Nov. 9, 1966

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Washboring & Cone Penetration.

CHECKED BY M.D.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. + Field Vane    □ Lab Vane ● Unconf. Comp.    ■ Tor Vane	WATER CONTENT % WP — W — WL			
244.9	Waterlevel										
0	Water					240					
239.9											
5	Silty sand with occasional gravel.		1	SS	7						
			2	SS	4						
			3	SS	9						
			4	SS	12						
224.9	Loose to compact.		5	SS	4						
20	Organic silt.		6	Tw	P						
			7	SS	4						
			8	Tw	P						
			9	SS	4						
			10	Tw	P						
195.9	Firm to v. stiff.		11	SS	146/15"						
49	Glacial Till (silty sand with occasional gravel).		12	SS	100/3"						
189.6	Very dense.										
55.3	End of borehole.										

83

L.L. 197.9%  
P.L. 170.4%  
M.C. 112.2%

15 0 5  
10 5

Percent strain at failure.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JOB 65-F-113

LOCATION Sta. 48+80 65' Lt.

ORIGINATED BY R.M.

W. P.

BORING DATE Nov. 9, 1965.

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Pennndrill

CHECKED BY M.D. *dk*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT % 20 40 60				
251.1	Groundlevel					250								
0	Silty sand with occasional gravel.		1	SS	8									
			2	SS	16									
			3	SS	33	240								
			4	SS	31									
	Loose to dense.		5	SS	10	230								
225.1			6	SS	15									
26	Glacial Till (clayey silt with occasional gravel).		7	SS	76	220								
			8	SS	92/1"									
211.0	Hard.		9	SS	100/1"	210								
40.1	End of borehole.													

W.L. Elev.  
244.6

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

## RECORD OF BOREHOLE NO. 10

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 53+85 250' Rt. ORIGINATED BY R.M.  
W.P. BORING DATE Nov. 9, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D. *MR*

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.		WATER CONTENT — W		
							+ Field Vane	□ Lab Vane	wp — w — WL		
							● Unconf. Comp.	■ Tor Vane			
244.9	Waterlevel										
242.9	Water										
2	Silty sand with occasional gravel.		1	SS	25	240					
			2	SS	12						
			3	SS	6						
			4	SS	6	230					
	Loose to compact.		5	SS	18						
223.9	Organic silt.		6	TW	P	220					
21			7	SS	5						
			8	TW	P						
			9	SS	4	210					
			10	TW	P						
			11	SS	6	200					
	Firm to stiff.		12	TW	P	190					
188.9	Glacial Till		13	SS	10						
56	Hard.		14	SS	100						
185.4	End of borehole.				0"						
59.4											

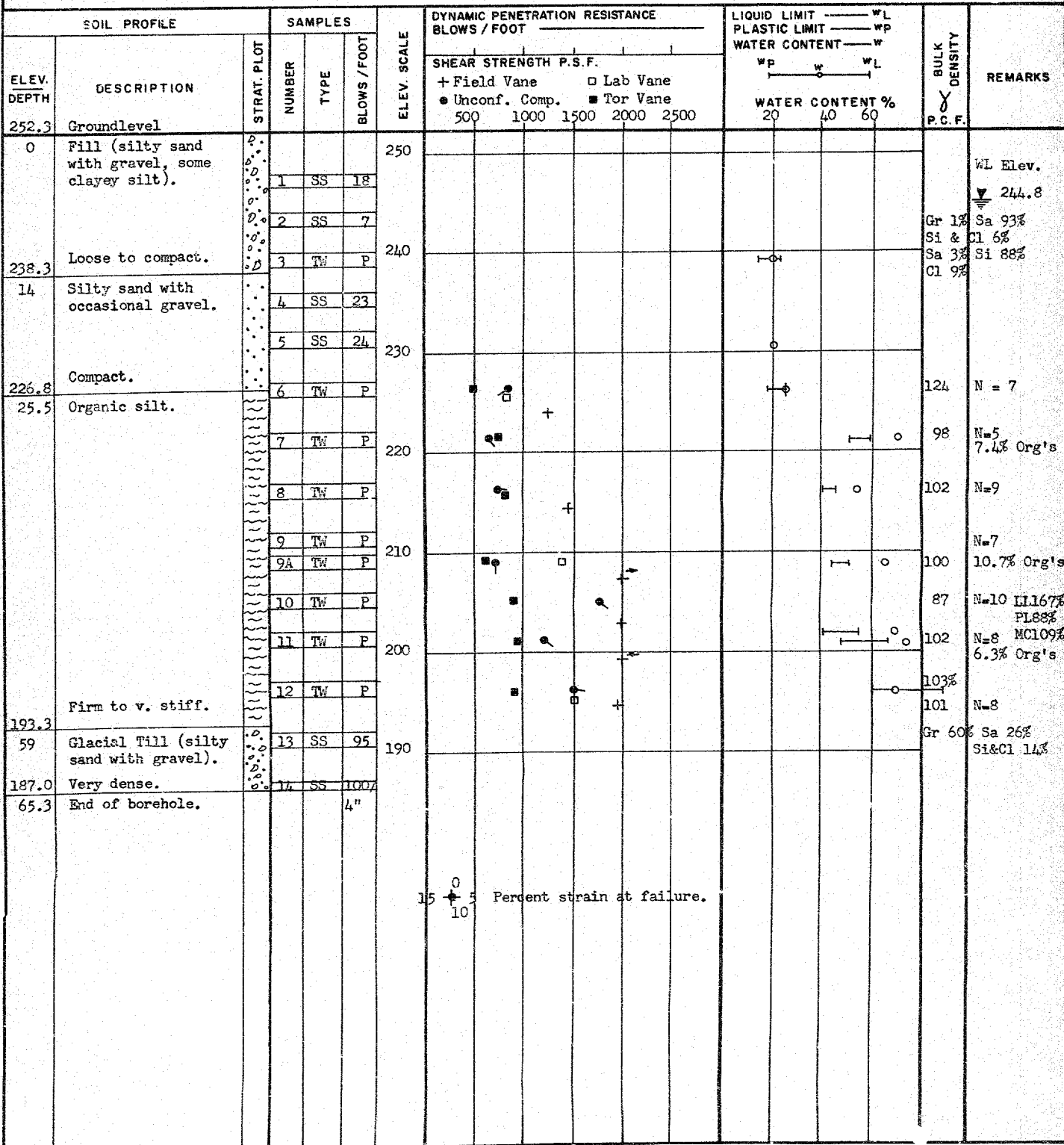
0 15 10 Percent strain at failure.

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 11 & 11A

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 57+90 40' Rt. ORIGINATED BY R.M.  
W.P.                      BORING DATE Nov. 9, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Penndrill CHECKED BY M.D.

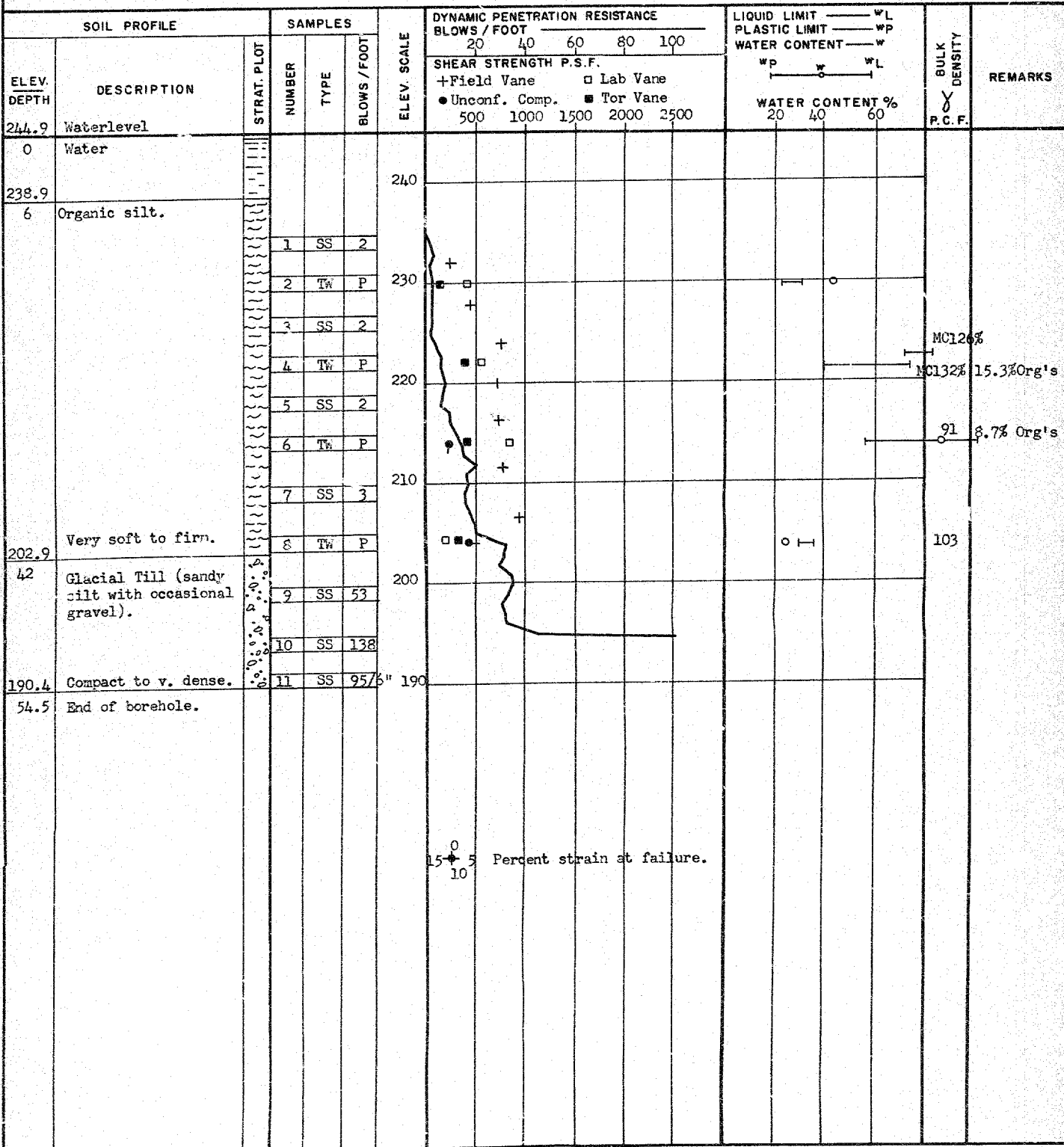


DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION  
JOB 65-F-113  
W.P. \_\_\_\_\_  
DATUM Geodetic

# RECORD OF BOREHOLE NO. 12

FOUNDATION SECTION

LOCATION Sta. 65/35 250' Rt. ORIGINATED BY R.M.  
BORING DATE Nov. 19, 1965. COMPILED BY R.M.  
BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.



**FOUNDATION SECTION**

CHECKED BY                      M.D.

0  
15  $\pm$  5 Percent strain at failure.  
10

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 14 & 14A

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 62+90 40' Rt. ORIGINATED BY R.M.  
W.P.  BORING DATE Nov. 10, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Penndrill CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. + Field Vane      □ Lab Vane ● Unconf. Comp.    ■ Tor Vane					Wp — W — WL 20    40    60				
254.1	Groundlevel						500	1000	1500	2000	2500					
0	Fill (silty sand with gravel).		1	SS	12	250										
			2	SS	7											
241.1	Loose to compact.		3	SS	7	240										
13	Silty sand with occasional gravel.		4	SS	20											
	Loose to dense.		5	SS	31	230										
			6	SS	9											
222.1						220										
32	Organic silt.		7	TW	P											
			8	TW	P											
	Firm to v. stiff.		9	TW	P	210										
			10	TW	P											
			11	TW	P	200										
195.1																
59	Glacial Till (silty sand with gravel).		12	SS	173/15"	190										
188.9	Very dense.		13	SS	100/2"											
65.2	End of borehole.															

35 0 5 Percent strain at failure.  
10

N=9  
14.3% Org's  
N=14  
MC103%  
N=14  
83 N=9  
10.1% Org's  
102 N=10

15-10 5 Percent strain at failure.



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

JOB 65-F-113

LOCATION Sta. 67+90 40' Rt.

ORIGINATED BY R.M.

W.P. \_\_\_\_\_

BORING DATE Nov. 11, 1965.

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Penndrill.

CHECKED BY M.D. *HL*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.		WATER CONTENT % 20 40 60			
266.0	Groundlevel											
0			1	SS	12	260						
			2	SS	11							
			3	SS	27							
250.0	Clayey silt.		4	SS	38	250						
15.0	Stiff to hard.		5	SS	49							
			6	SS	44	240						
			7	SS	72							
			8	SS	125/	230						
228.0					12"							
38			9	SS	100/							
					6"							
	Silty sand with occasional gravel.		10	SS	101/	220						
					7"							
	Very dense.		11	SS	131/							
					11"							
			12	SS	146/	210						
					8"							
			13	SS	126/							
					12"							
200.8			14	SS	108/	200						
65.2	End of borehole.				2"							

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION  
JOB 65-F-113  
W. P. \_\_\_\_\_  
DATUM Geodetic

# RECORD OF BOREHOLE NO. 16

FOUNDATION SECTION

LOCATION Sta. 69+45 250' Rt. ORIGINATED BY R.M.  
BORING DATE Nov. 15, 1965. COMPILED BY R.M.  
BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — w			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	wp	w	wL		
244.9	Waterlevel															
241.9	Water															
	Organic silt with occasional sand and gravel.		1	SS	3	240										Sal5%Si78% Cl 7%
			2	SS	2											
			3	Tw	P											100 30% Org's
			4	Tw	P	230										77
	Soft to stiff.		5	Tw	P											
			6	Tw	P	220										88 5.9% Org's
217.9			7	SS	128											121 Gr3%Sa11% Si68%Cl 18%
27	Glacial Till (clayey silt with gravel).		8	SS	167/											
	Hard.				11"											Gr2%Sa25% Si54%Cl 19%
209.0			9	SS	190/	210										
35.9	End of borehole.				11"											

15 5 10 Percent strain at failure.

FOUNDATION SECTION

CHECKED BY M.D.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

## MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 18

FOUNDATION SECTION

JOB 65-F-113

LOCATION Sta. 48+80 250' Rt.

ORIGINATED BY R.M.

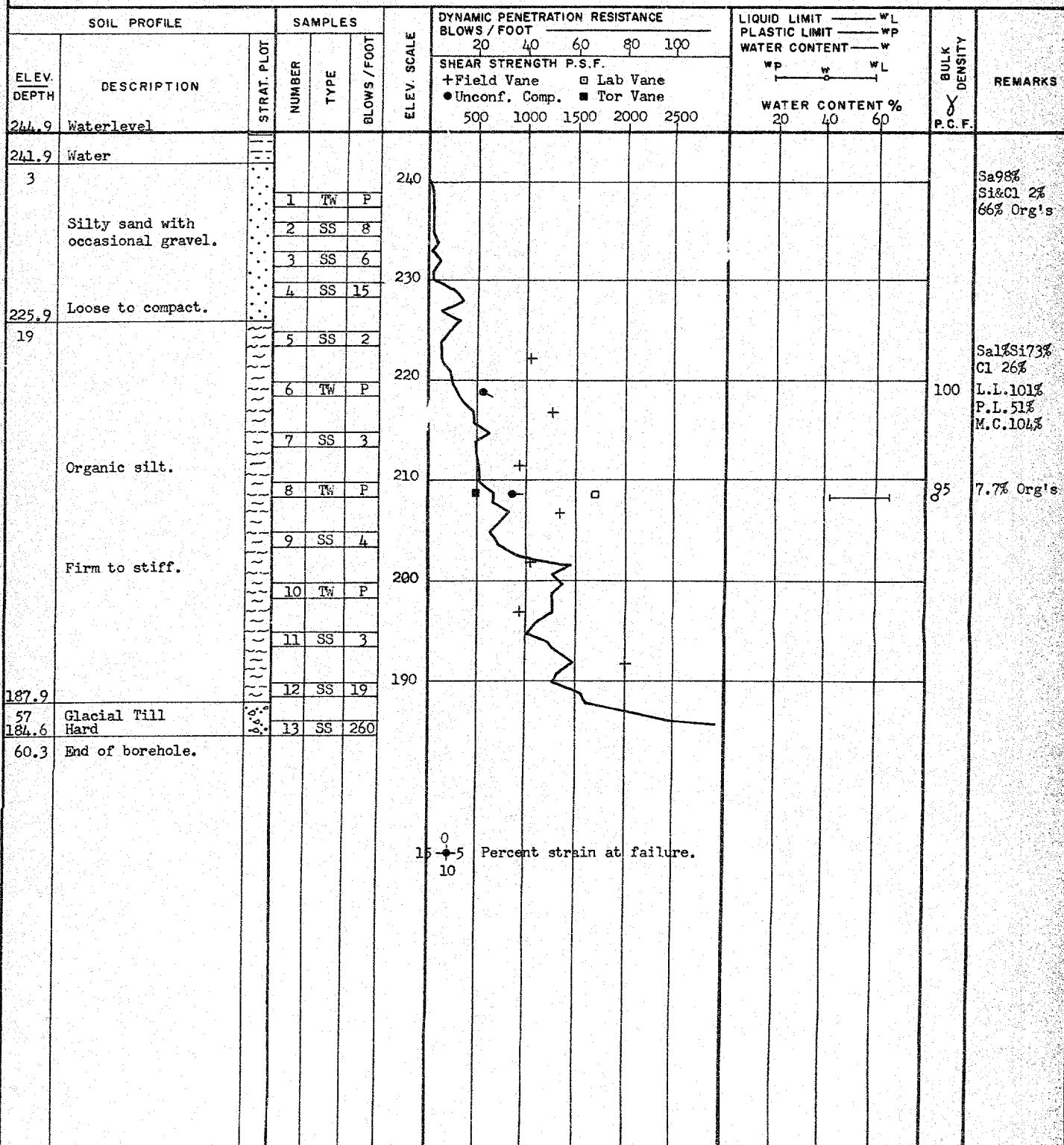
W.P.

BORING DATE Nov. 15, 1965.

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Washboring &amp; Cone Penetration.

CHECKED BY M.D. *MR*

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

## RECORD OF BOREHOLE NO. 19

FOUNDATION SECTION

JOB 65-F-113

LOCATION Sta. 45/15 50' Rt.

ORIGINATED BY R.M.

W.P.

BORING DATE Nov. 19, 1965.

COMPILED BY R.M.

DATUM Geodetic

BOREHOLE TYPE Penndrill

CHECKED BY M.D. *HR*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WP	W	WL		
260.0	Groundlevel															
0																
	Clayey silt.		1	SS	10											
			2	SS	19	250										
			3	SS	90											
			4	SS	40											
			5	SS	43	240										
	Stiff to hard.		6	SS	68											
			7	SS	68	230										
			8	SS	125											
223.0																
37	Glacial Till (clayey															
219.3	silt with sand and		9	SS	139	220										
	gravel. Hard.															
40.7	End of borehole.				8"											

W.L. Elev.  
247.6

FOUNDATION SECTION

CHECKED BY M.D.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	SHEAR STRENGTH P.S.F. + Field Vane      □ Lab Vane • Unconf. Comp.    ■ Tor Vane		WATER CONTENT % WP — OF — WL			
244.9	Waterlevel										
0	Water										
240.4											
45											
	Organic silt.		1	SS	2						
			2	SS	3						
	Soft to firm.		3	Tw	P						
			4	SS	3						
218.4			5	Tw	5						
26.5	Glacial Till (clayey silt with sand and gravel).										
			6	SS	62						
209.4	Hard.		7	SS	95/						
35.5	End of borehole.				6"						

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

# RECORD OF BOREHOLE NO. 21

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 63+65 250' Rt. ORIGINATED BY R.M.  
W.P. Nov. 17, 1965. BORING DATE Nov. 17, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Washboring. CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %				
							+ Field Vane      □ Lab Vane ○ Unconf. Comp. 500 1000 1500 2000 2500					wp — w — WL 20 40 60				
244.9	Waterlevel															
0	Water					240										
238.9																
6	Silty sand with occasional gravel.  Loose to compact.		1	SS	12											
			2	SS	9	230										
224.9			3	SS	24											
20	Organic silt with occasional sand.  Firm to stiff.		4	SS	3	220										
			5	TW	P											
			6	SS	5											
			7	TW	P	210										
			8	SS	6											
			9	TW	P	200										
194.4	Glacial Till (silty sand with gravel). Compact to v. dense.		10	SS	20											
188.4	Compact to v. dense.		11	SS	101	190										
56.5	End of borehole.															

0  
15  
10

Percent strain at failure.

15 0 5 Percent strain at failure.  
10

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 22

FOUNDATION SECTION

JOB 65-F-113 LOCATION Sta. 64+15 250' Rt. ORIGINATED BY R.M.  
W.P.                      BORING DATE Nov. 19, 1965. COMPILED BY R.M.  
DATUM Geodetic BOREHOLE TYPE Washboring. CHECKED BY M.D. *HL*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. + Field Vane    □ Lab. Vane ● Unconf. Comp.					WP	WL	W		
244.9	Waterlevel						500	1000	1500	2000	2500	20	40	60		
0	Water					240										
239.4																
5.5	Silty sand.															
235.9																
9	Organic silt with sand.  Soft to stiff.		1	SS	2											
			2	SS	P	230	+									
			3	SS	2			+								
			4	Tw	P	220			+						89	L.L. 122% P.L. 66% M.C. 86%
			5	SS	3				+							
			6	SS	4	210				+						
			7	Tw	P											
201.9	Glacial Till					200										
43	Very dense.		8	SS	66											
198.4																
46.5	End of borehole.															

0  
15 5 Percent strain at failure.  
10



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 65-F-113

LOCATION Sta. 66+60 250' <sup>alt.</sup>

ORIGINATED BY R.M.

W.P.

BORING DATE Nov. 22, 1965.

COMPILED BY R.M.

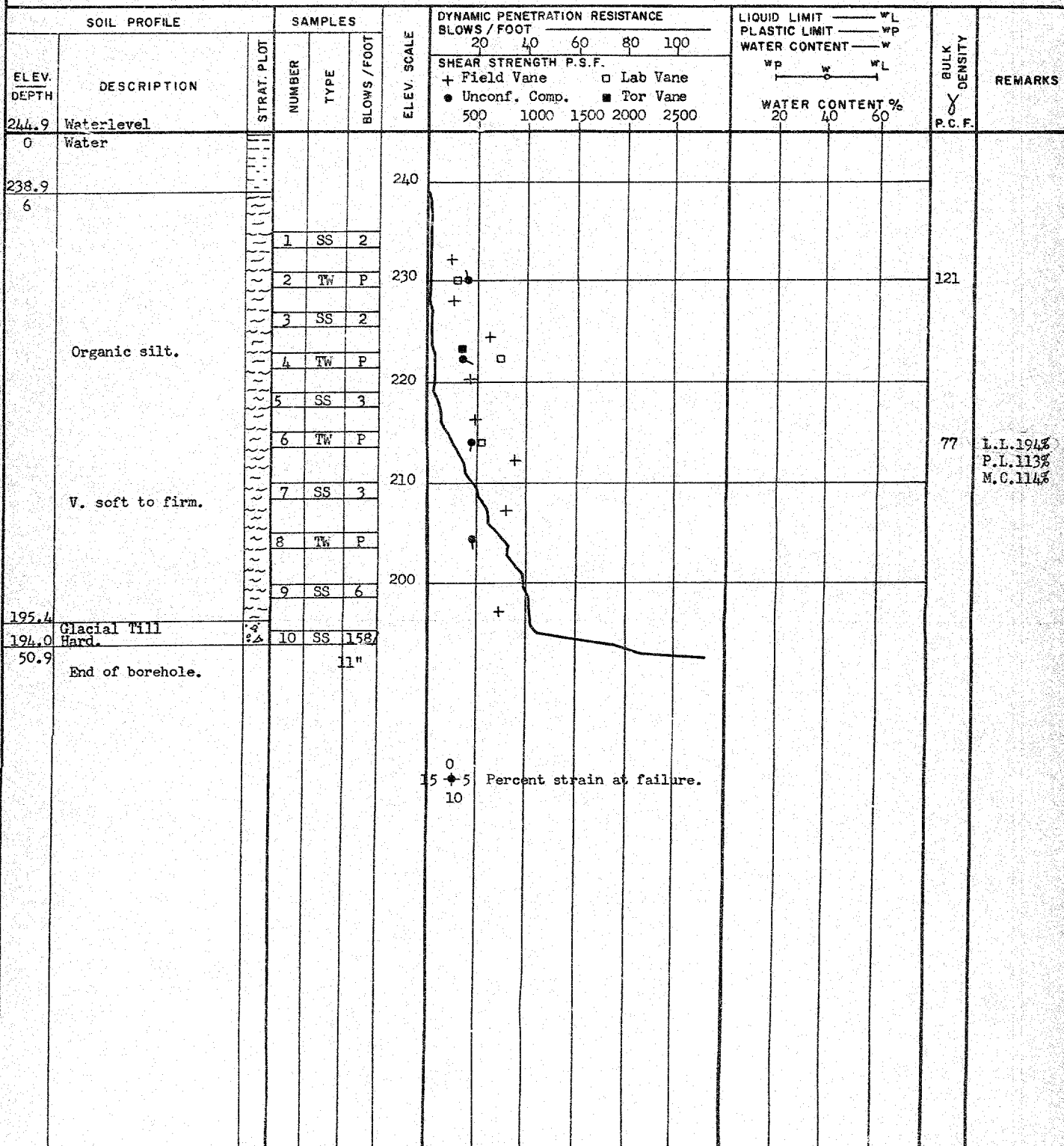
DATUM Geodetic

BOREHOLE TYPE Washboring & Cone Penetration.

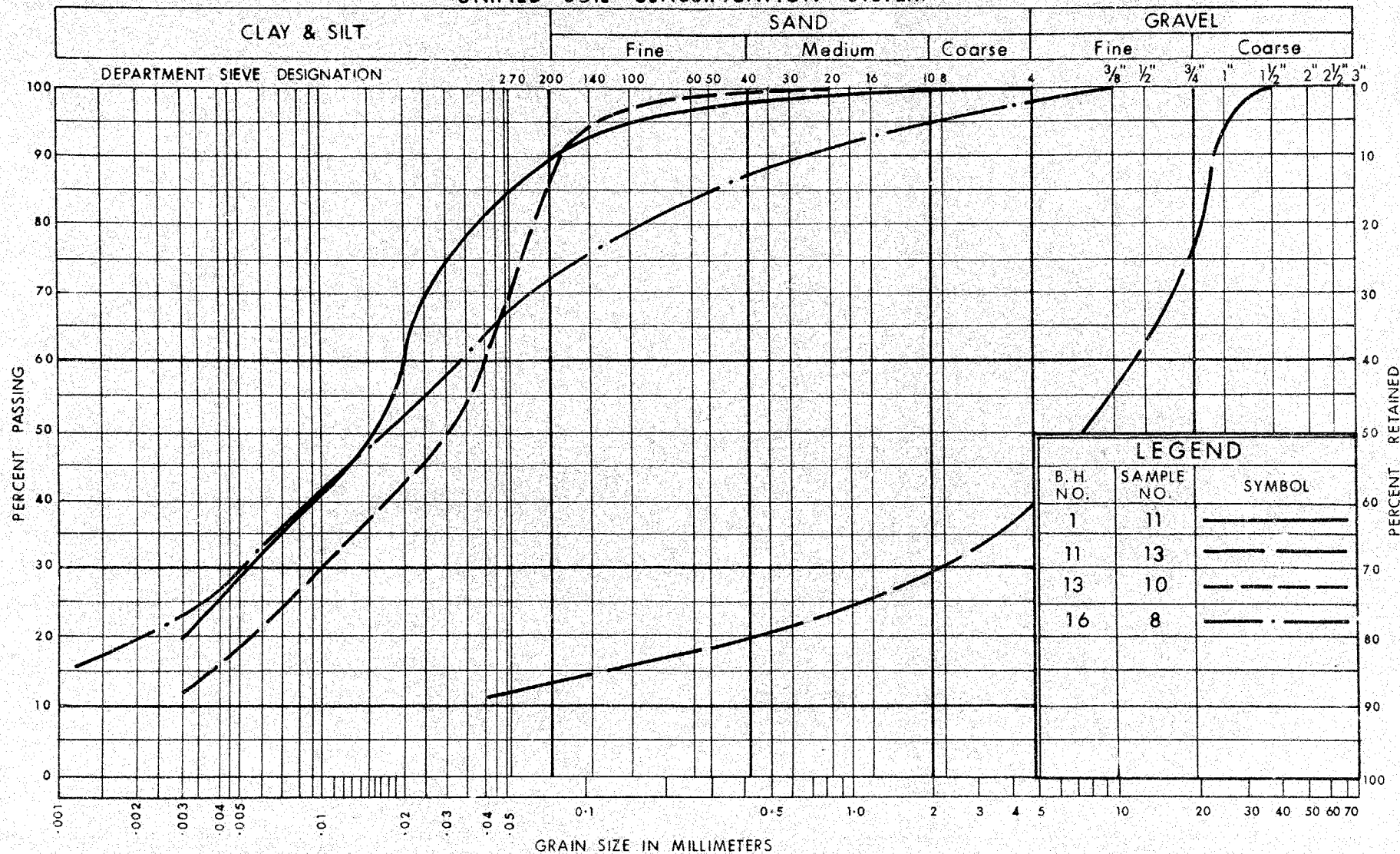
CHECKED BY M.D. *AK*

# RECORD OF BOREHOLE NO. 23

FOUNDATION SECTION



# UNIFIED SOIL CLASSIFICATION SYSTEM



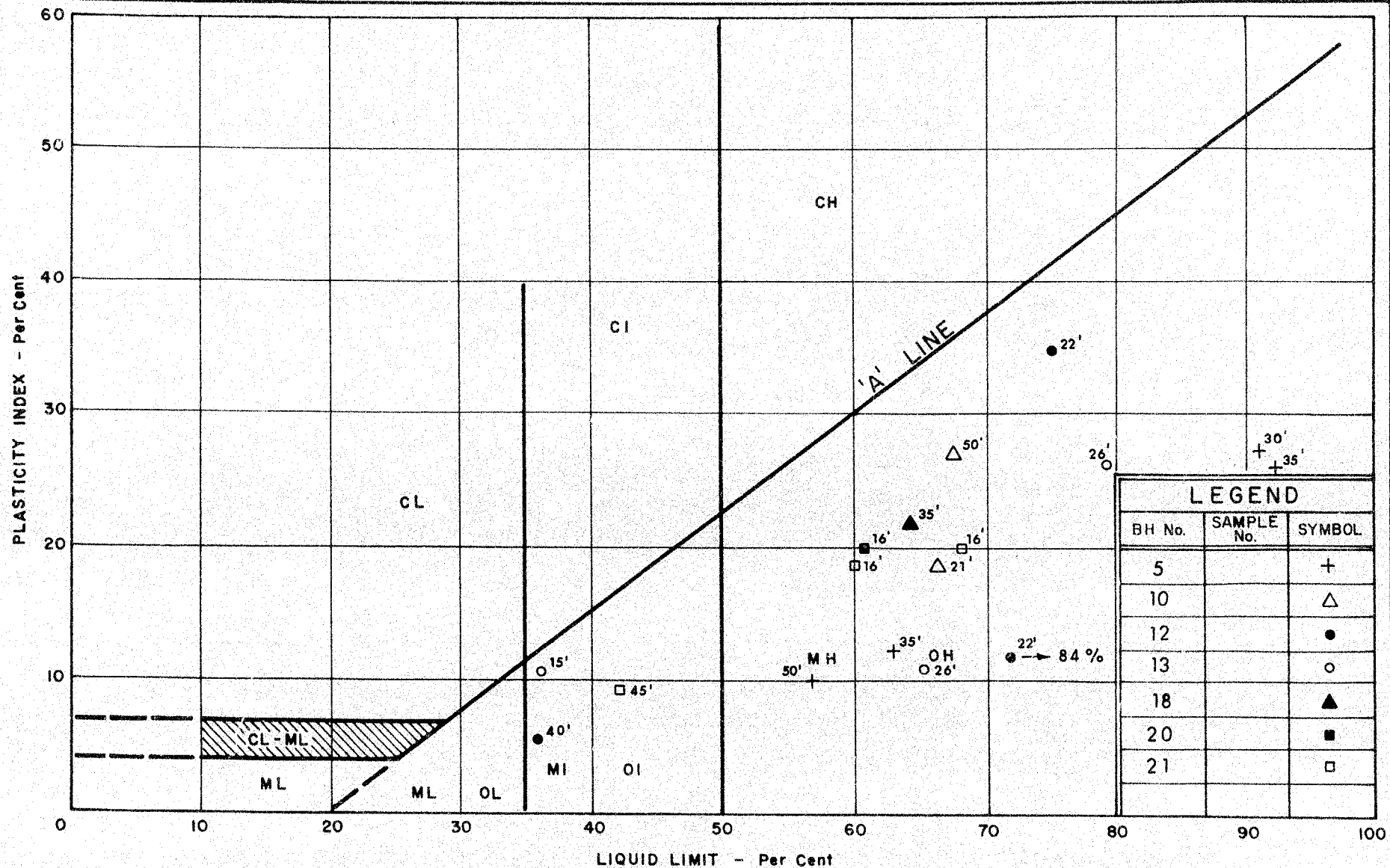
## GRAIN SIZE DISTRIBUTION GLACIAL TILL



DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

W.P. No.

JOB No. 65-F-113

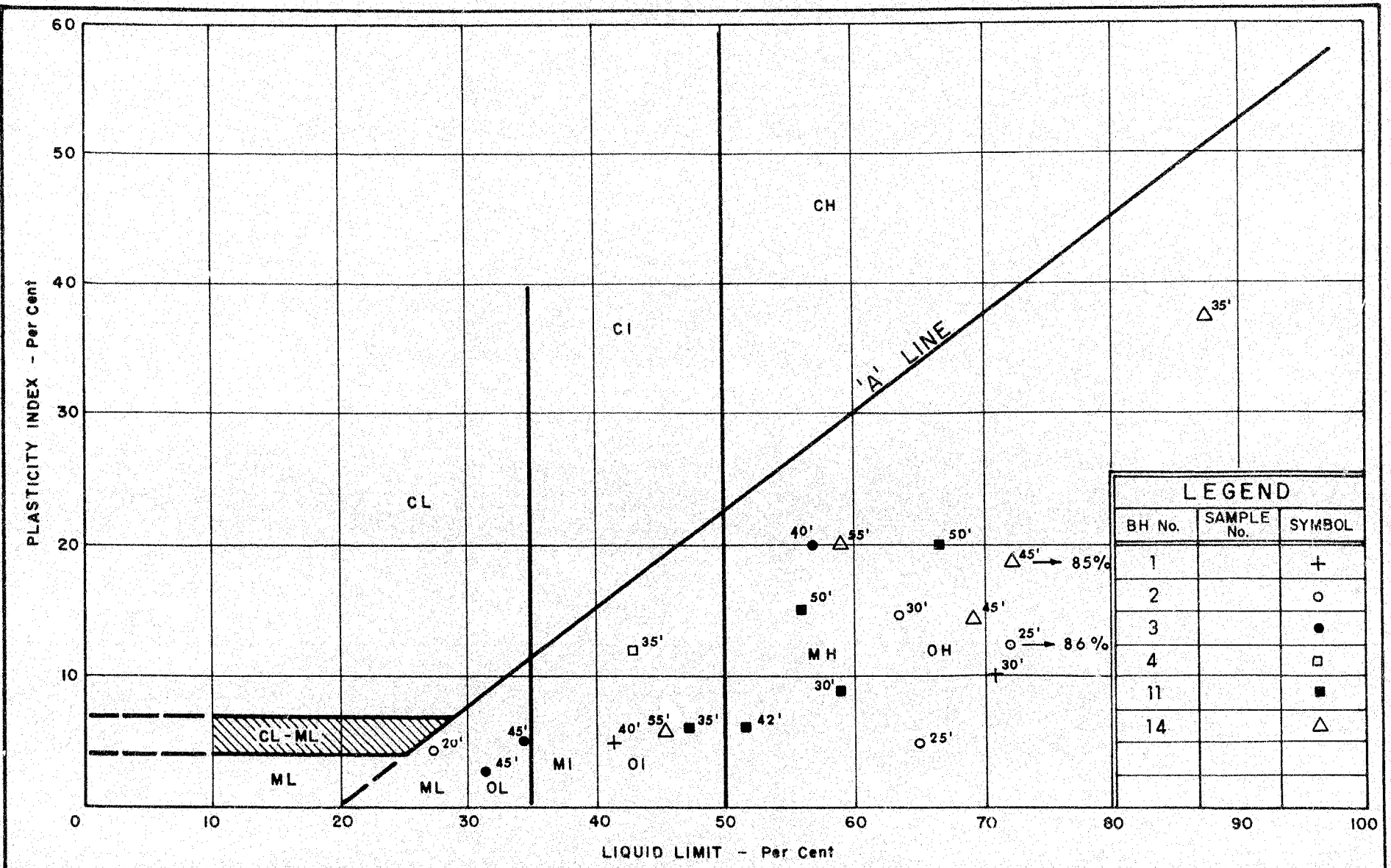


DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

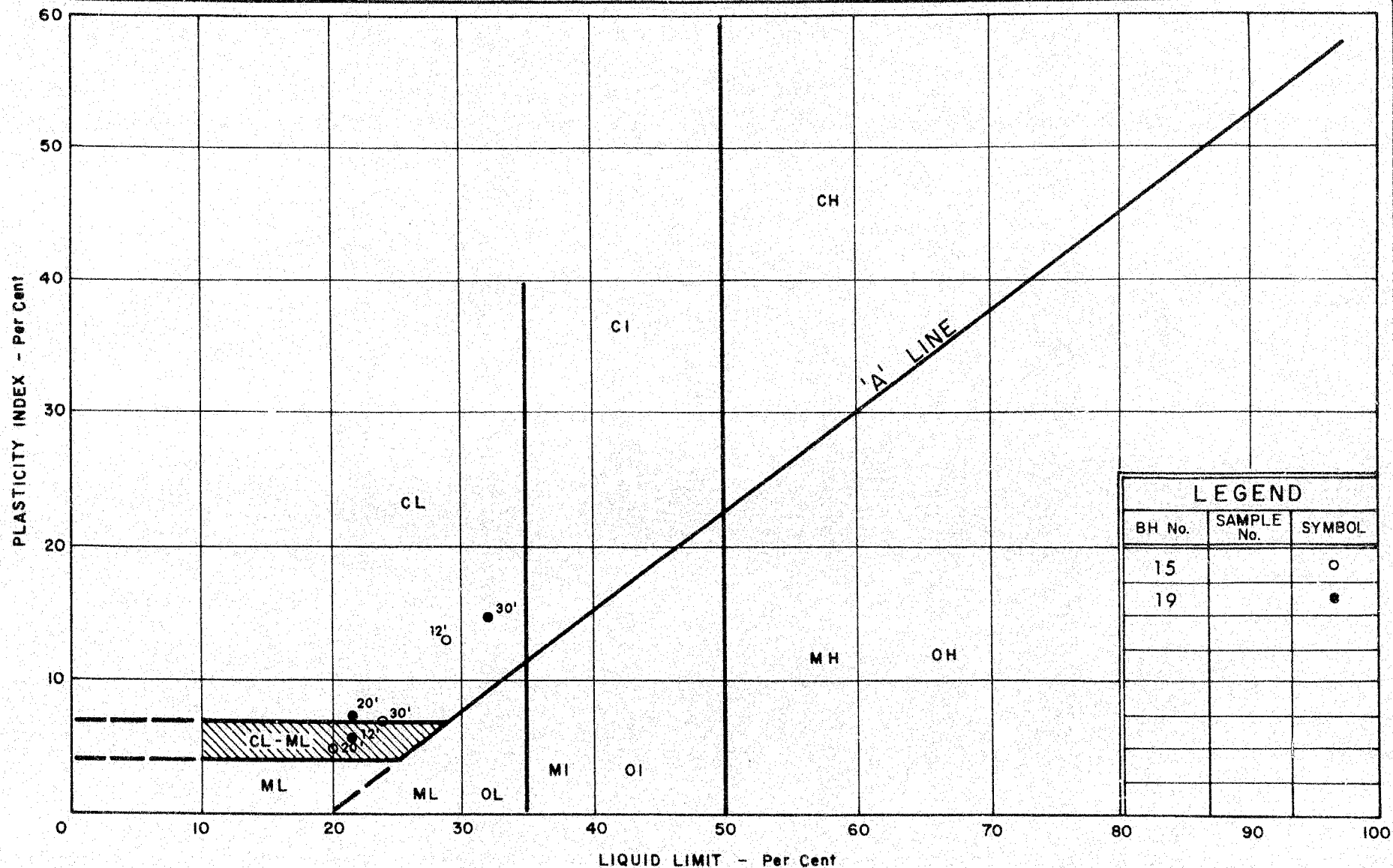
# PLASTICITY CHART ORGANIC SILT

W.P. No.

JOB No. 65 - F - 113



LEGEND		
BH No.	SAMPLE No.	SYMBOL
1		+
2		○
3		●
4		□
11		■
14		△



DEPARTMENT OF HIGHWAYS  
MATERIALS and  
TESTING  
DIVISION

ONTARIO

# PLASTICITY CHART CLAYEY SILT

W.P. No.

JOB No. 65 - F - 113

#65-F-113

Q.E.W.

NEAR JORDAN

HARBOUR

