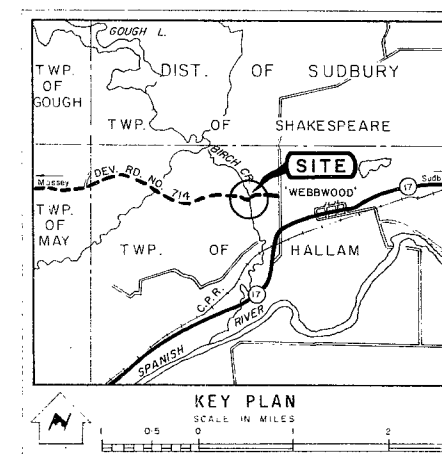


#63-F-49


W.P. #701-63

DEV. RD. #714


& BIRCH CREEK




LEGEND




Bore Hole



Cone Penetration Hole



Bore & Cone Penetration Hole


 Water Levels established at time of field investigation. May 13, 1962

NO.	ELEVATION	STATION	OFFSET
1	638.2	4+08	63' RT.
2	610.8	2+38	31' RT.
3	621.1	3+92	16' RT.
4	619.4	2+00	15' LT.
5	615.1	3+76	46' LT.
6	620.4	2+02	53' LT.

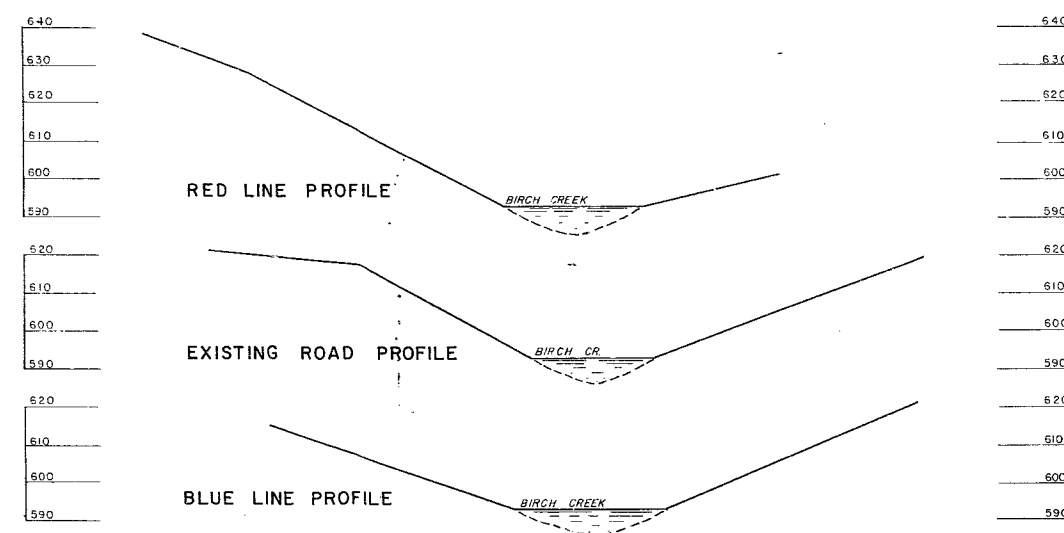
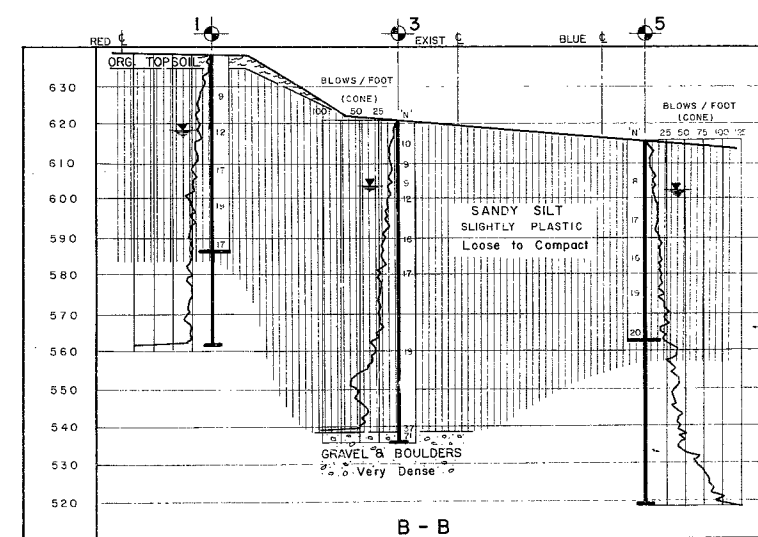
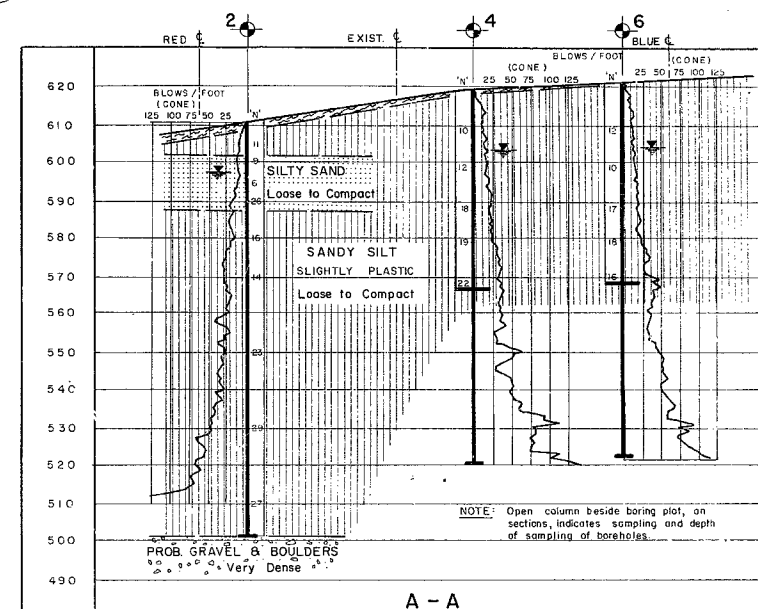
- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

BIRCH CREEK			
KING'S HIGHWAY NO. PROP.		DEV. RD. NO. 714	DIST. NO. 17
CO. SUDBURY			
TWP. HALLAM	LOT 9	CON. VI	
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D W.K.	CHECKED <i>gc</i>	W.P. NO. 701-63	M.B.R. DRAWING NO.
DRAWN <i>gc</i>	CHECKED <i>gc</i>	JOB NO. 63-F-49A	63-F-49A
DATE JUNE 20, 1963	SITE NO.		BRIDGE DRAWING NO.
APPROVED <i>A. J. Thomas</i>		CONT NO.	



PROFILES & SECTIONS

SCALE IN FEET

20 10 0 20 40 60 FEET

REF. NO. B-639-9

Mr. A. M. Towe,
Bridge Engineer,
Bridge Division.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

Attn: Mr. K. L. Kleinstelber,
Mun. Bridge Liaison Engr.

July 9, 1963

D.H.C. FOUNDATION INVESTIGATION REPORT --
Proposed New Bridge - Dev. Road No. 714
and Birch Creek, Lot 9, Con. VI, Dist. #17.
W.J. 63-F-49 -- W.P. 701-63

Attached, we are forwarding to you, our detailed
foundation investigation report on the subsoil conditions
existing at the above structure site.

We believe you will find the factual data and
recommendations contained therein, adequate for your
future design work. Should additional information be
required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. K. L. Kleinstelber (3)
J. P. Howard
J. E. Wice
E. R. Saint
A. Watt

Foundations Office
Gen. Files ✓

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

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 2. DESCRIPTION OF SITE.
 3. FIELD AND LABORATORY WORK.
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 - 4.3) Sandy Silt - Slightly Plastic - Loose to Compact.
 - 4.4) Gravel and Boulders (Till) - Very Dense.
 5. GROUND WATER CONDITIONS.
 6. DISCUSSION AND RECOMMENDATIONS.
 7. SUMMARY.
 8. MISCELLANEOUS.
-

FOUNDATION INVESTIGATION

For

Proposed New Bridge - Dev. Road No. 714
and Birch Creek, District of Sudbury,
Twp. of Hallam, Lot 9, Con. VI, Dist. #17.
W.J. 63-F-49 -- W.P. 701-63

1. INTRODUCTION:

A request to carry out a foundation investigation at the existing and two proposed crossings of Dev. Road No. 714 and Birch Creek, was received from the Bridge Planning Engineer, Mr. J. C. McAllister, dated April 23, 1963.

It is proposed to erect a new bridge, to carry Dev. Road No. 714 over Birch Creek. The site of the proposed bridge is located approx. 1.5 miles west of the Village of Webbwood, Twp. of Hallam. At this location, the chainage of Dev. Road No. 714 is from 2+00 to 4+08.

In order to determine the soil properties and decide on the type of foundations, an investigation was carried out by this Section. Results and the discussion of the field and laboratory investigation, as well as conclusions and recommendations for the future design work, are contained in the following paragraphs of this report.

2. DESCRIPTION OF SITE:

The site of the proposed bridge is located approx. 1.5 miles west of the Village of Webbwood. The surrounding area is hilly. The width of the Birch Creek at the proposed crossing, is about 25 feet, and the depth of water, approx. 5'-0" to 6'-0".

cont'd. /2 ...

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

The deck of the previous concrete bridge, which was built in 1922, collapsed in 1961. At present, a Bailey Bridge, supported on the original concrete piers, carries Dev. Road No. 714 over the Birch Creek. From the information gathered at the site, it seems that the existing piers were founded on 30'-0" to 40'-0" long timber piles.

3. FIELD AND LABORATORY WORK:

In order to obtain sufficient information on the type and properties of the subsoil, six sampled boreholes, and six dynamic cone penetration tests, were carried out at this site.

Split-spoon samples were taken at various depth intervals. Samples recovered in the split-spoon sampler were used to determine the following physical properties:

1. Natural Moisture Content
2. Atterberg Limits
3. Grain Size Distribution

Results of these laboratory tests are summarized in Appendix I of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The stratigraphy of the soil at the site was found to be generally uniform. A detailed description of various soil types encountered during the investigation, is shown in Appendix I of

cont'd. /3 ...

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

4.1) General: (cont'd.) ...

this report, and is also given in subsequent paragraphs. The estimated stratigraphical profile, shown on Dwg. No. 63-F-49A, is based upon this information.

4.2) Silty Sand - Loose to Compact:

This layer, which extends from approx. El. 602.8 to El. 588.8 for a depth of about 14'-0", was found in B.H. #2, only. The sand in this layer has been subjected to oxidation and exhibits a predominantly brownish colour. The percentage of sand in this layer is 93%, and silt forms the rest of 7%. Moisture content determinations for this layer averaged about 23%. The overall layer was found in a loose to compact state with an average 'N' value of 17 blows/foot.

4.3) Sandy Silt - Slightly Plastic - Loose to Compact:

Immediately below the topsoil is a containing stratum of slightly plastic sandy silt, extending to about 83' to 110' below existing ground elevation.

Liquid limits for this stratum vary from 12.7% to 23.3%, while plastic limits range from 11.7% to 19.1%. Moisture content determinations for this stratum varied from about 15.1% to 28.8%. Plasticity Charts for all boreholes are given in Appendix I of this report. Grain size distribution curves indicated that the percentage of silt in this layer is 86%, sand forms 8%, and the rest of 6% is clay. The overall stratum is in a loose to compact condition, with an average 'N' value of approx. 16 blows/foot, ranging from 8 to 29 blows/ft.

cont'd. /4 ...

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

4.4) Gravel and Boulders (Till) - Very Dense:

Following the stratum of slightly plastic sandy silt is a layer of very dense gravel and boulders (till). The boulders encountered in this layer are up to 12" in diameter and tightly packed.

The only one possible split-spoon sample showed an 'N' value of 71 blows/foot.

5. GROUND WATER CONDITIONS:

The ground water level, at the time of the investigation, was found between El. 597.5 and 618.0, about 13'-10" to 20'-2" below existing ground elevations. It may be assumed that the water level will vary with the seasons of the year.

No artesian water conditions were encountered.

6. DISCUSSION AND RECOMMENDATIONS:

As can be seen from the previously described soil stratigraphy, the soil consists of loose to compact, slightly plastic sandy silt, with a pocket of loose to compact, silty sand (encountered in B.H. #2, only), followed by very dense gravel and boulders(till).

The investigation has revealed that the properties of the upper 20 ft. are such that an adequate support for spread footings could not be obtained. It is therefore, suggested that the future structure be founded on displacement friction piles

cont'd. /5 ...

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

driven some 45 ft. into the ground. Timber piles would be most suited for this purpose and an allowable load of 15 tons per pile could be obtained. If a higher design load per pile is required, a pile loading test is recommended.

The Hydrology Section of the D.H.O. indicated that a 4'-0" deep scour may be expected in the Birch Creek channel. Therefore, the bottom of the footings should be placed at approx. El. 531.0.

The subsoil being basically of a granular cohesionless nature, and the ground water table being relatively high, dewatering during construction may present a problem. If pile caps are formed below water level, it will be necessary to use sheet piling in a dewatering scheme. These should be driven to a depth below the footing bottom equal to the height of water above it. Footing bases, should be formed either on a granular pad, or a suitable concrete working slab. All material of an organic nature should be removed below footings.

7. SUMMARY:

The stratification of the subsoil at the site is relatively uniform and consists of topsoil, underlain by loose to compact, slightly plastic sandy silt, with a pocket of loose to compact, silty sand (encountered in B.H. #2, only), followed by very dense gravel and boulders (till).

The investigation has revealed that adequate support for spread footings could not be obtained; therefore, the future structure

7. SUMMARY: (cont'd.) ...

should be founded on displacement piles. Timber piles driven some 45 ft. into the ground, would be most suitable for this purpose. An allowable load of 15 tons per pile could be obtained. If a higher design load per pile is required, a pile loading test is recommended.

The bottom El. of the pile caps should be 4 ft. below creek bottom level at approx. El. 581.0. Footing bases, should be formed either on a granular pad, or a suitable concrete working slab. All material of an organic nature should be removed below footings.

A dewatering scheme will be necessary; recommendations contained in the body of the report should be followed.

8. MISCELLANEOUS:

The field work, performed during the period from May 7 to May 13, 1963, together with the preparation of this report, was undertaken by Mr. W. W. Kulmattickas, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. K. G. Selby, Senior Foundation Engineer, who reviewed this report.

July 1963

APPENDIX I.

FOUNDATION SECTION

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-49 LOCATION Birch Crk. and Dev. Road No. 714 Ch. 2/38-31'-0" Rt. ORIGINATED BY W.W.K.
W.P. 701-63 BORING DATE May 7, 1963. COMPILED BY W.W.K.
DATUM 610.8 BOREHOLE TYPE Wash Boring - BX Casing. CHECKED BY K.G.S.

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.					WP	W	WL		
							20	40	60	80	100					
610.8	Ground Elevation					610										
608.9	Black Org. Topsoil															
2.5	Sandy Silt.		1	SS	11											
602.8	Slightly Plastic Compact.		2	SS	9	600										
8.0	Silty sand. Loose to compact.		3	SS	6											
588.8			4	SS	26	590										
22.0			5	SS	16	580										
	Sandy Silt.		6	SS	14	570										
	Slightly Plastic.		7	SS	23	550										
	Loose to compact.		8	SS	29	530										
			9	SS	27	510										
500.5	Probable					500										
410.3	Gravel & Boulders V. dense End of borehole.					490										
						480										

WL El.
597.5
Observed in
Casing.

Hammer Bouncing

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-F-49 LOCATION Birch Creek and Dev. Road No. 714 Ch. 3/92 - 16'-0" Rt. ORIGINATED BY W.W.K.
W.P. 701-63 BORING DATE May 13, 1963. COMPILED BY W.W.K.
DATUM 621.1 BOREHOLE TYPE Washboring - BX Casing CHECKED BY K.G.S.

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	NUMBER	TYPE			SHEAR STRENGTH P.S.F.					WATER CONTENT %			
					20	40	60	80	100	15	30	45		
621.1	Ground Elevation			620										
	Sandy Silt. Slightly Plastic. Loose to compact.	1	SS	10										
		2	SS	9	610									
		3	SS	9										
		4	SS	12	600									
		5	SS	16	590									
		6	SS	17	580									
		7	SS	19	560									
				570										
				550										
539.1		8	SS	37	540									
537.6	Gravel & Boulders V. Dense	9	SS	71										
83.5	End of borehole.													
				530										

▼ WL El.
602.8
Observed in
Casing.

100 Blows for 9"

▼ WL Elev.
602.6
Observed
in Casing.

FOUNDATION SECTION

0.0

Loose to compact.

563.6

51.5	End of borehole.
------	------------------

51.5

610

600

590

580

570

560

550

540

530

520

SHEAR STRENGTH P.S.F.

20 40 60 80 100

wp w wL

WATER CONTENT %
15 30 45

BULK
DENSITY
Y
P.C.F

REMARKS

▼ WL Elev.
601.4
Observed
in Casing.

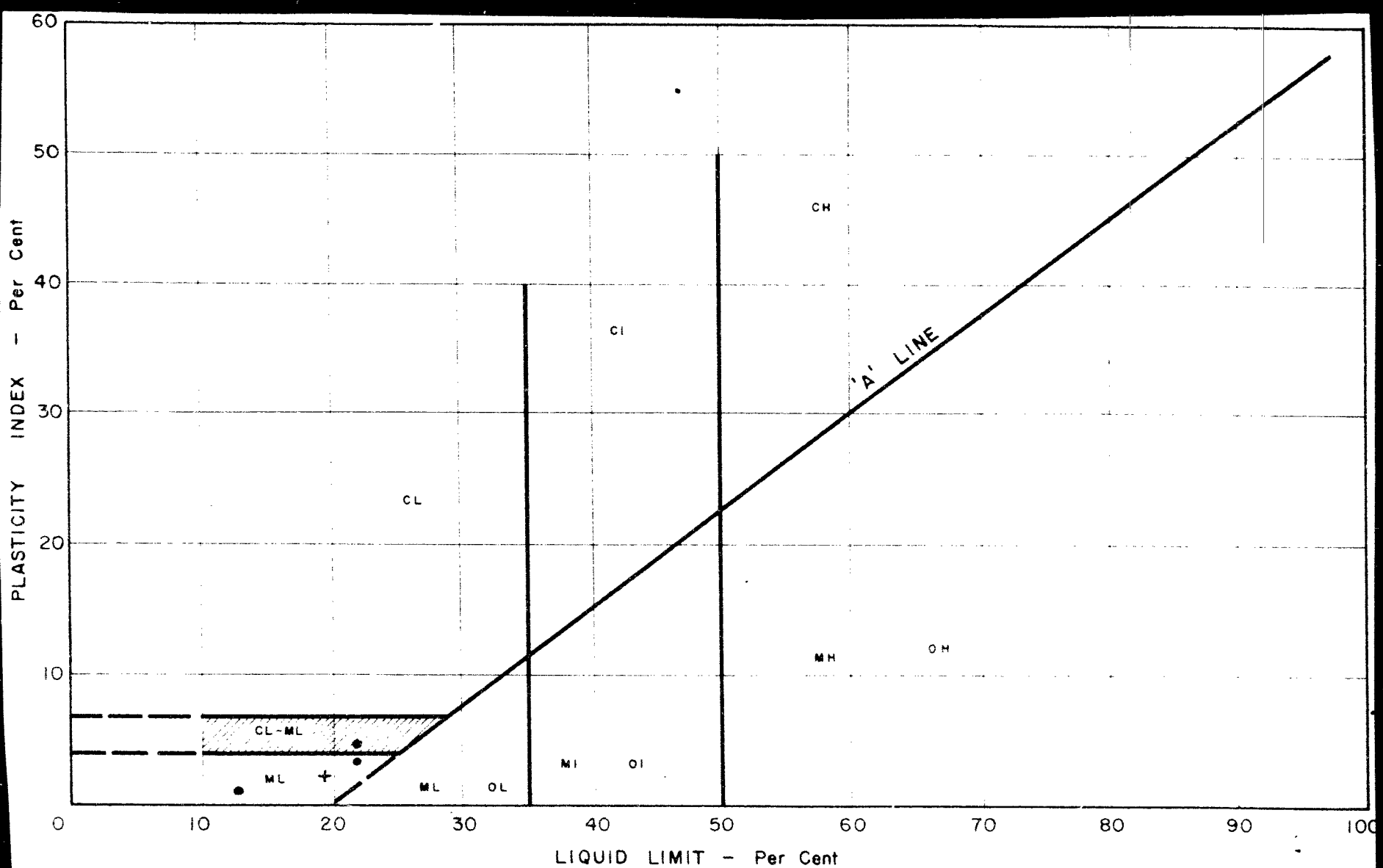
Hammer Bouncing

FOUNDATION SECTION

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. 20 40 60 80 100		WATER CONTENT % 15 30 45		
620.4	Ground Elevation					620					
0.0	Sandy Silt. Slightly Plastic. Loose to compact.		1	SS	12	610					
			2	SS	10	600					
			3	SS	17	590					
			4	SS	18	580					
			5	SS	16	570					
568.9	End of borehole.					570					
51.5						560					
						550					
						540					
						530					

▼ WL Elev.
604.3
Observed
in Casing.

Hammer Bouncing

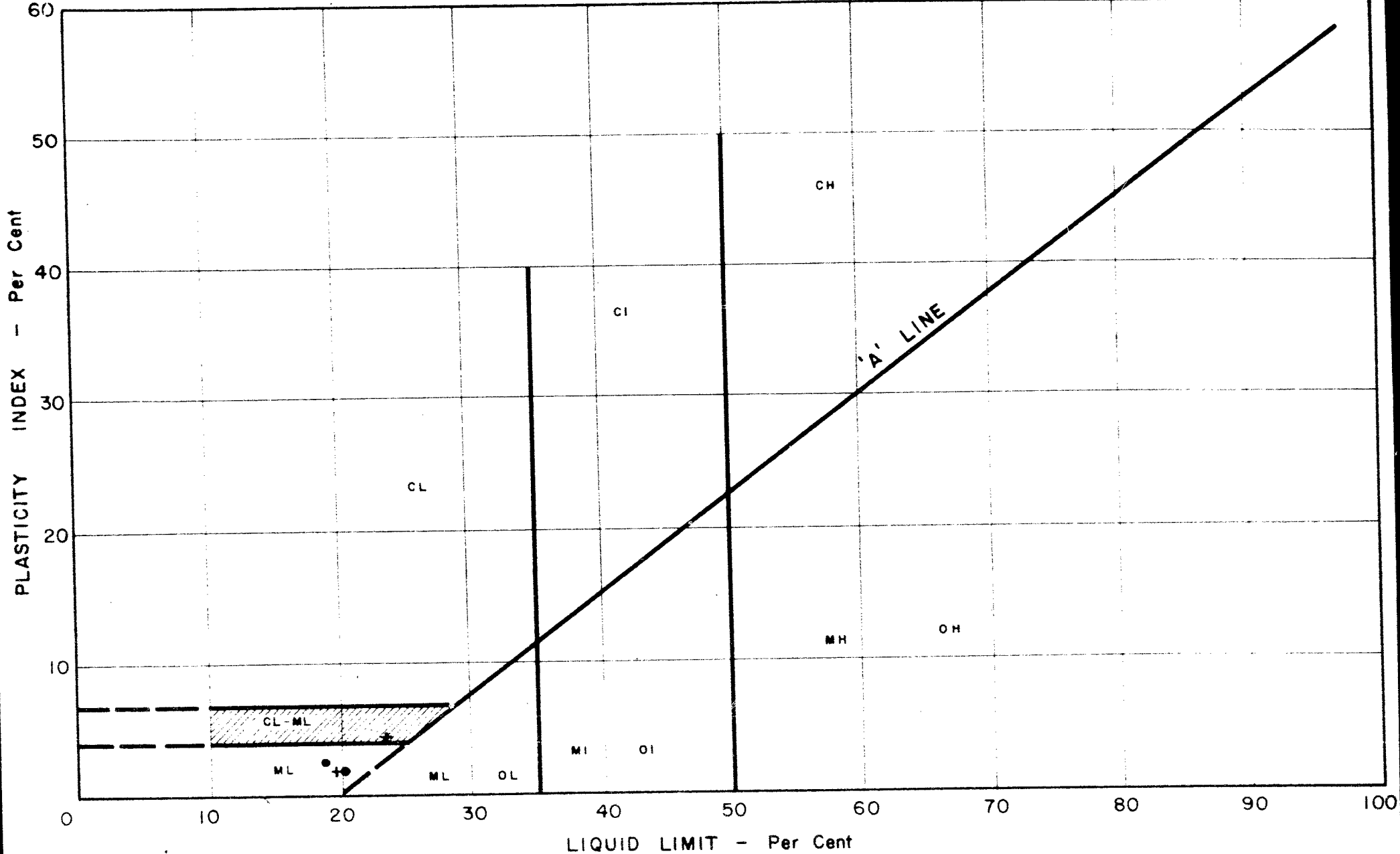


NOTES BORE HOLE No 1 - +
 " " No 2 - •

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
 PLASTICITY CHART

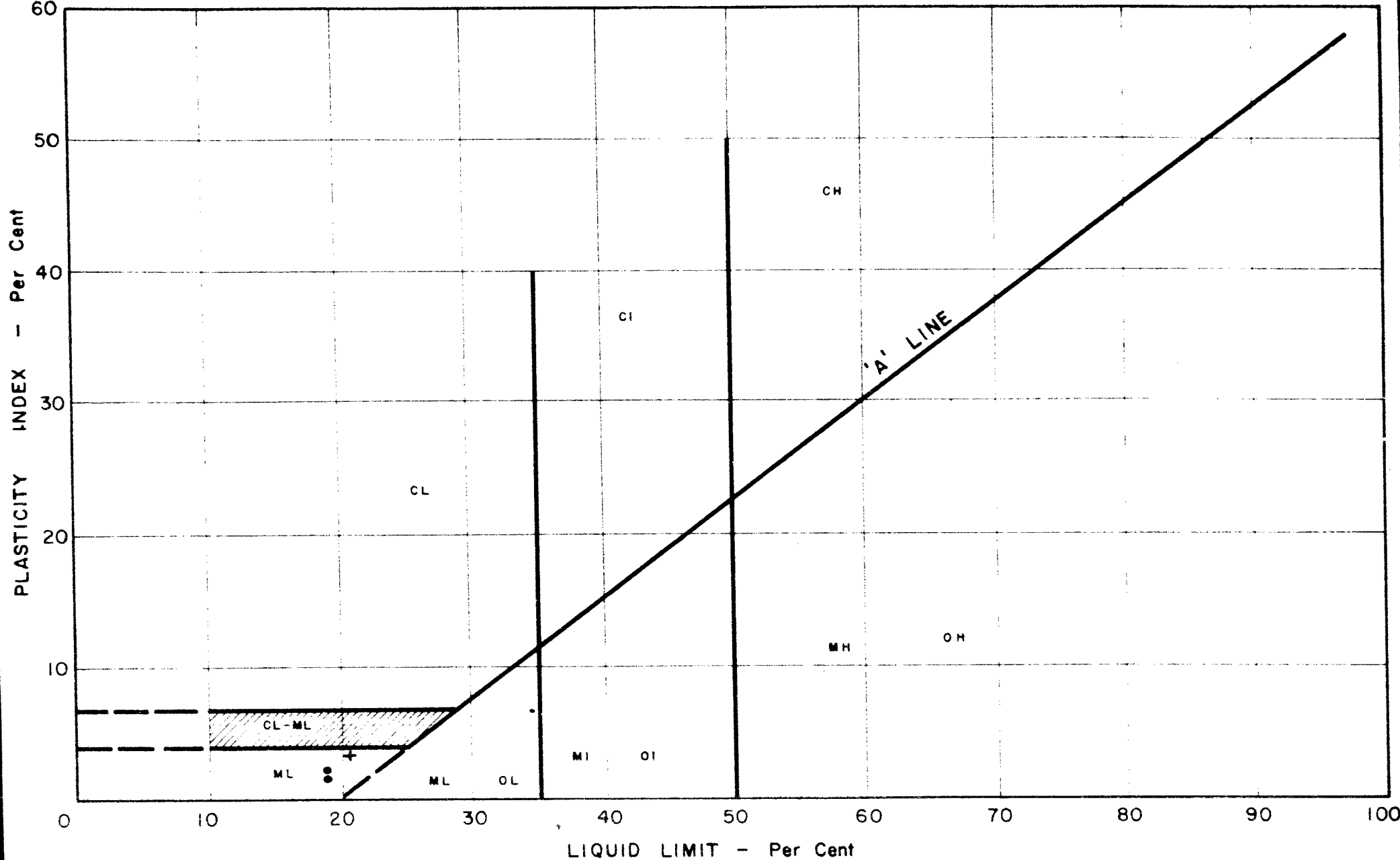
Job No. 63-F-4
 Location Birch Cr.

701-63
Road No 714



NOTES BORE HOLE No 3 - +
" " No 4 - •

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
 PLASTICITY CHART
 Job No. 63-F-49 W.P. No. 701-63
 Location Birch Creek & Dev. Road No 714



NOTES BOREHOLE No 5 - +
" " No 6 - •

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH DIVISION
 PLASTICITY CHART
 Job No. 63-F-49 W.P. No. 701-63
 Location Birch Creek & Dev. Road No 714

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

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	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_o	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
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	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
β	ANGLE OF SLOPE TO HORIZONTAL

1963 JUL 17 AM 8:18

467

DOWN NBAR 19 JULY 16/63 412P

MR A STERMAC, MATS. & RES.

RE: WP 701-63.

I HAVE REVIEWED THE FOUNDATION REPORT NUMBER WJ63-F-49 FOR THE ABOVE-NOTED PROJECT. DUE TO PREVIOUS EXPERIENCE ON BIRCH CREEK ON HIGHWAY NO. 17, I FEEL THAT THE EMBANKMENT STABILITY ON THE STRUCTURE APPROACHES SHOULD BE REVIEWED AND COMMENTED ON AS IT WILL HAVE A DEFINITE BEARING ON THE OVER-ALL COST.

E R SAINT, MATS & RES. NORTH BAY, DS