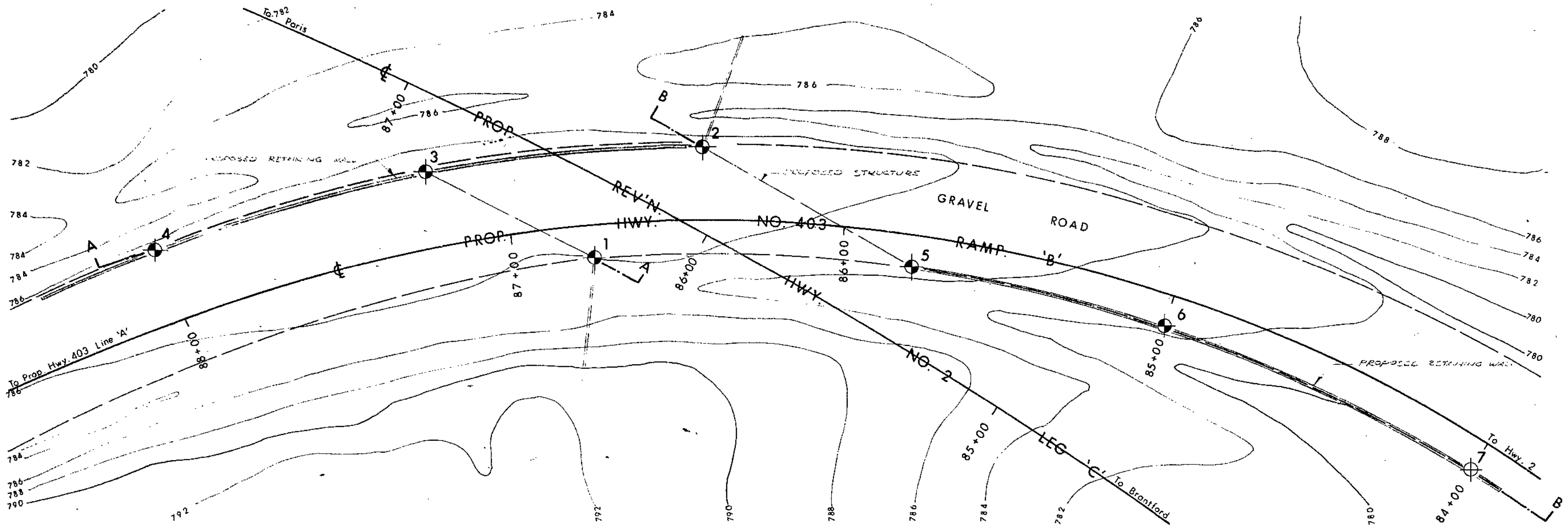
#65-F-34

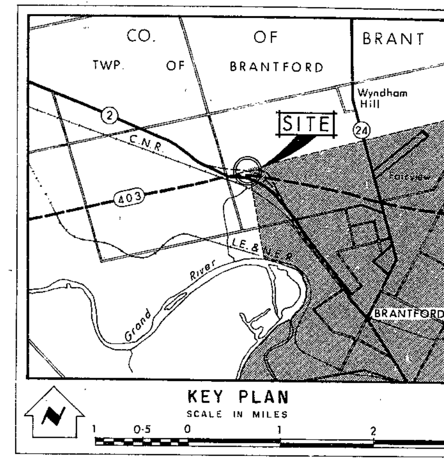
W.P.# 69-62

Hwy. #403 &

Hwy. #2



PLAN
SCALE
20 10 0 20 40 FT.

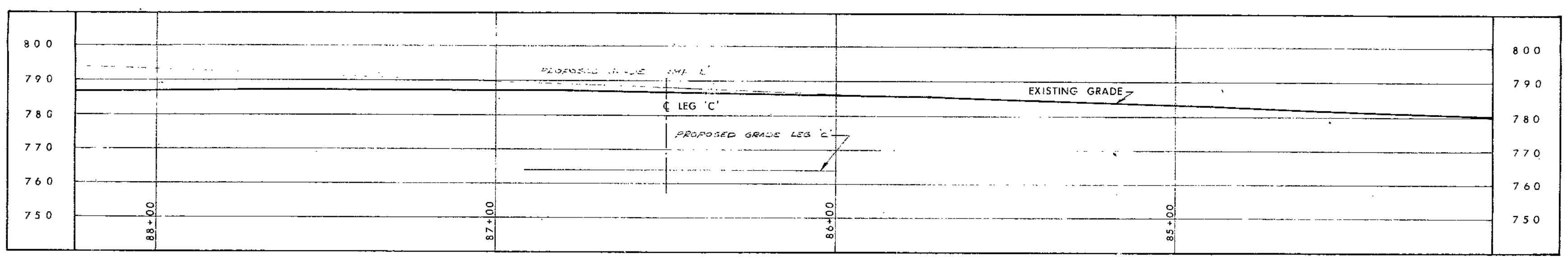


KEY PLAN
SCALE IN MILES
1 0.5 0 1 2

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. (JULY 1965)

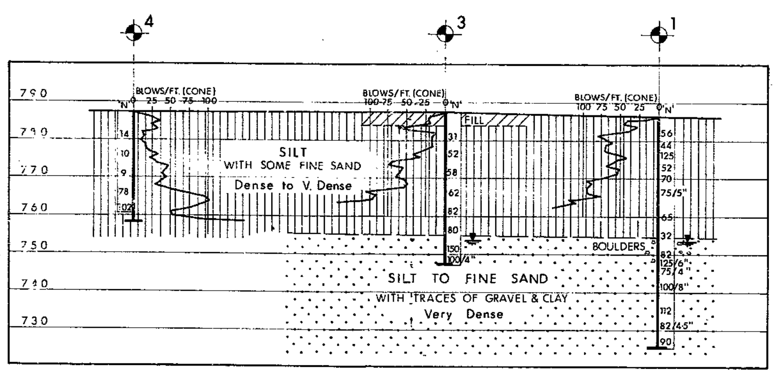
NO.	ELEVATION	STATION	OFFSET
1	786·1	86+75	9·5' LT.
2	787·2	86+42	22' RT.
3	787·6	87+20	22' RT.
4	787·0	88+00	22' RT.
5	784·6	85+79	9·5' LT.
6	782·4	85+00	9·5' LT.
7	778·4	84+00	9·5' LT.



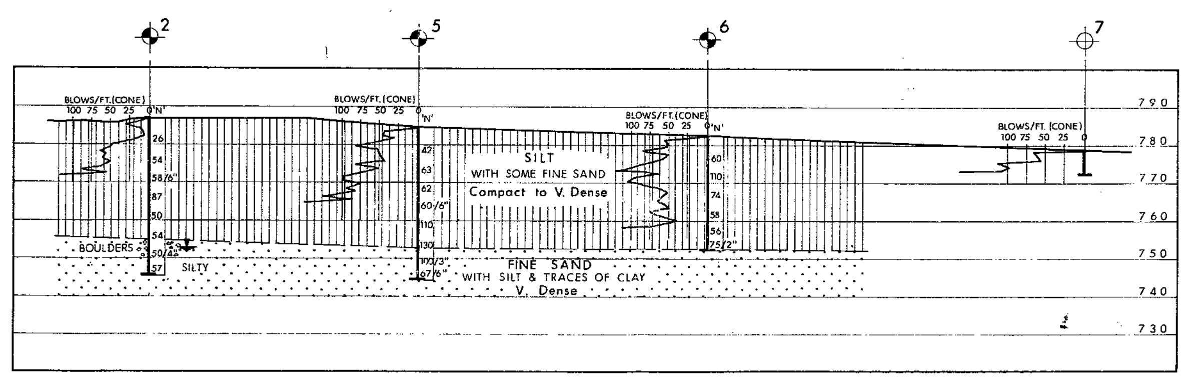
℄ PROFILE - RAMP 'B'
SCALE
20 10 0 20 40 FT.

- 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.

PRINT RECORD		
NO	FOR	DATE



A - A



SECTIONS
SCALE
20 10 0 20 40 FT.

B - B

REVISIONS	DATE	BY	DESCRIPTION

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

PROPOSED REV'N. HWY. 2
LEG 'C'

KING'S HIGHWAY NO. 403 RAMP 'B' DIST. NO. 2 4
CO. BRANT
TWP. BRANTFORD LOT 26 CON. II

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. P.Mc.	CHECKED	W.P. NO. 69-62	M.& T. DRAWING NO. 65-F-34 A
DRAWN S.O.	CHECKED	JOB NO. 65-F-34	
DATE 8 SEPT. 1965		SITE NO	BRIDGE DRAWING NO.
APPROVED A.G. Stermac PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

REF. NO. E-4343-1

cc: GEN. FILES

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

W.P. 69-62

TO: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie

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

DATE: August 20, 1965

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing by Prop. Hwy. #403,
Ramp 'B' of Prop. Revision, Hwy. #2,
Leg 'C', Lot 26, Con. II, City of 4
Brantford, County of Brant, Dist. #2.
W.J. 65-F-34 -- W.P. 69-62

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

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements. Should you require additional information, please feel free to contact our Office.

KYL/MdeF
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
A. Gater
H. C. Dernier
J. Roy
A. Watt

Foundations Office
Gen. Files ✓

K. Y. Lo,
SUPERVISING FOUNDATION ENGINEER
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

TABLE OF CONTENTS

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossing by Prop. Hwy. #403, Ramp 'B' of Prop. Revision, Hwy. #2, Leg 'C', Lot 26, Con. II, City of Brantford, County of Brant, Dist. #2.4

W.J. 65-[illegible] -- W.P. 69-22

1. INTRODUCTION:

A request dated March 26, 1965, for a foundation investigation at the site of the proposed crossing of Hwy. #403, Ramp 'B' and Rev'n. Hwy. #2, Leg 'C', was received by this Office from Mr. N. Zoltay, for Mr. G. Scott (Regional Bridge Location Engineer).

A field investigation was subsequently carried out by this Section. Presented in this report are the results of this investigation, together with recommendations pertaining to the design of foundations for this structure and its retaining walls.

2. SITE DESCRIPTION AND PHYSIOLOGY:

The vicinity of this site is undulating to flat arable and pasture farmland with the occasional copse.

Physiologically, this area is part of the Horseshoe Moraines of Southern Ontario.

3. FIELD INVESTIGATION AND LABORATORY TESTS:

A total of six sampled boreholes and seven dynamic cone penetration tests was carried out during the course of the field

cont'd. /2 ...

3. FIELD INVESTIGATION AND LABORATORY TESTS: (cont'd.) ... investigation, using a conventional diamond drill adapted for soil sampling purposes.

Samples were obtained using a 2" O.D. split-spoon soil sampler advanced by blows of a 140-lb. hammer falling a distance of 30" thus imparting an impulse of 350 ft.-lbs./blow.

The locations and elevations of all boreholes were surveyed by personnel from the nearby Hwy. #403 construction project, and are shown on Dwg. #65-F-34A, which accompanies this report.

Samples were visually examined in the field prior to transportation to the laboratory where they were re-examined. Subsequently, combinations of the following tests were carried out on selected samples:

Atterberg Limits

Moisture Contents

Grain Size Distributions

The laboratory test results are summarized in the Appendix to this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil conditions at this site were found to be generally uniform.

Detailed descriptions of the soil in each borehole are appended to this report, together with a stratigraphical profile

cont'd. /3 ...

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

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

of the area in question.

From ground level downwards, the various soil types encountered, are as follows:

4.2) Silt with some Fine Sand:

This brown layer extends from the surface in all boreholes, to a depth of between 30 and 32 ft. below ground level. Its denseness generally ranges from compact to very dense, although one sample was found to fall into the 'loose' category.

Its constituents are mostly granular in the silt to fine sand range, although occasionally, traces of gravel and clay were found.

Some stratifications are occasionally noticeable.

4.3) Silt and Fine Sand with traces of Gravel and Clay:

This very dense material ranges in colour from grey to brown, and appears to underlie the silt to fine sand in all places.

In boreholes #1 and #2, boulders were encountered at 32 ft. to 34 ft. below ground level, and all other holes penetrating to this depth, showed an exceedingly hard layer there.

5. GROUND WATER:

Water level was observed only in B.H.'s #1, #2 & #3, where it varied between 32 ft. below ground level and 34 ft. below ground level.

B.H.'s #4, #5 & #6 were dry with B.H. #4 caved in to

cont'd. /4 ...

5. GROUND WATER: (cont'd.) ...

24.5 ft. below ground level and B.H. #5 caved in at 31.5 ft. below ground level.

As the observed water levels are below recommended footing base levels, no major dewatering problems are anticipated.

6. DISCUSSION AND RECOMMENDATIONS:

A cut, approximately 25 ft. deep, is proposed to carry Hwy. #2, Leg 'C', under prop. Hwy. #403, Ramp 'B'. A bridge and retaining walls for this cut are proposed.

It is recommended that abutments for this bridge be founded on spread footings with a design load of 3.0 tons/ft.^{2}. The elevations of these footings will depend only on the provision of enough cover to prevent frost damage, hence a depth of 6 ft. below finished surface level at El. 758 is suggested.

Spread footings with 2.0 T/ft.^{2} design load are recommended for the retaining walls. A frost cover of 6 ft. is suggested here, as well.

These design loads are calculated, assuming a maximum design settlement of 1", hence differential settlement should not exceed 1". In the event of loose material being found immediately below footing level, this should be removed and replaced with mass concrete.

No major dewatering problems are anticipated.

No stability problems are anticipated for standard 2:1 slopes.

There appears to be a layer of boulders at or about El. 755.

cont'd. /5 ...

7. SUMMARY:

A foundation investigation at the site of the proposed bridge to carry prop. Hwy. #403, Ramp 'B' over prop. Rev'n. Hwy. #2, Leg. 'C', is reported.

Spread footings are recommended for both the bridge abutments and the retaining walls. Design pressures recommended are 3.0 T/ft.^{2} and 2.0 T/ft.^{2}, respectively.

No major dewatering problems are anticipated.

No stability problems with standard 2:1 slopes are anticipated.

8. MISCELLANEOUS:

The field equipment was owned and operated by the F. E. Johnston Drilling Co. Ltd. This project was supervised by Mr. P.M.A. McGlone, Project Foundation Engineer, who also prepared this report.

The investigation was carried out under the general supervision of Mr. K. G. Selby, Senior Foundation Engineer, who also reviewed this report.

August 1965

APPENDIX I.

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop Hwy #403 Ramp 'B' Sta. 86+75, 9.5' Lt. ORIGINATED BY P. McG
W.P. 69-62 BORING DATE July, 1965. COMPILED BY
DATUM G.S.C. BOREHOLE TYPE Washboring - NX & BX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
786.1					
0.0	Silt with some fine sand.	1	SS	56	
		2	SS	44	780
		3	SS	125	
	Brown.	4	SS	52	
		5	SS	70	770
	Dense to very dense.	6	SS	75 for 5"	
		7	SS	65	760
754.6		8	SS	32	
31.5	Silt to fine sand with traces of gravel	9	SS	82	750
	Boulders	10	SS	125 for 6" / 75 for 4"	
	Grey to brown.	11	SS	100 for 8"	740
		12	SS	112	
	Very dense.	13	SS	82 for 4½"	730
725.1		14	SS	90	
61.0	End of borehole.				720

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 25 50 75 100 125
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
WATER CONTENT % 20 40 60

BULK DENSITY P.C.F.

REMARKS

Sa14% Si74% Cl 11%

Gr6% Sa30% Si57% Cl 7%

G.W.L.

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop. Hwy #403 Ramp 'B' Sta. 86+42, 22' Rt. ORIGINATED BY P. McG
W.P. 69-62 BORING DATE July, 1965. COMPILED BY
DATUM G.S.C. BOREHOLE TYPE Washboring - NX & BX Casing. CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (25 50 75 100 125) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS
787.2										
0.0	Silt with some fine sand. Brown. Compact to very dense.		1	SS	26	780				
			2	SS	54					
			3	SS	58 for 6"	770		o		Sa4%Si94% Cl 2%
			4	SS	87					
			5	SS	50	760				
755.7			6	SS	54			H		Gr7%Sa27% Si62% Cl 4% ▼ G.W.L.
31.5	Silt with some fine sand. Grey to brown. Very dense. Boulders			RC						
			7	SS	50 for 4"	750				
745.7			8	SS	57					
41.5	End of borehole.					740				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop. Hwy. #403 Ramp 'B' Sta. 87+20, 22' Rt. ORIGINATED BY P. McG

W. P. 69-62 BORING DATE July, 1965. COMPILED BY

DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	REMARKS
787.6							
0.0	Fill						
	Silt with some fine sand.		1	SS	21	780	Gr0%Sa71% Si27% Cl 2%
			2	SS	52		
	Brown		3	SS	58	770	
			4	SS	62		
			5	SS	82	760	
755.6	Dense to very dense.		6	SS	80		Gr8%Sa26% Si60% Cl 8%
32.0	Silt with sand and traces of gravel and clay. Grey		7	SS	150	750	G.W.L. Gr9%Sa33% Si50% Cl 8%
746.8	Very dense.		8	SS	100 for 4"		
40.8	End of borehole.					740	

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 25 50 75 100 125

SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L

PLASTIC LIMIT —— w_P

WATER CONTENT —— w

w_P w w_L

WATER CONTENT % — 20 40 60

BULK DENSITY γ P.C.F.

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 65-F-34
W.P. 69-62
DATUM G.S.C.

LOCATION Prop. Hwy. #403 Ramp 'B' Sta. 88+00, 22' Rt.
BORING DATE July, 1965
BOREHOLE TYPE Washboring NX & BX Casing

ORIGINATED BY P. McG
COMPILED BY
CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (25 50 75 100 125) SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
787.0										
0.0	Silt and fine sand with traces of clay.									Gr 0% Sa 58% Si 38% Cl 14%
	Brown.		1	SS	14	780				Gr 0% Sa 34% Si 52% Cl 14%
	Loose to very dense.		2	SS	10					
			3	SS	9	770				
			4	SS	78					
760.5			5	SS	102	760				
26.5	End of borehole.									B.H. blocked, dry at 24.5'
						750				

FORM OB-ML-125-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop. Hwy. #403 Ramp 'B' Sta. 85+79, 9.5' Lt. ORIGINATED BY P. McG
W.P. 69-62 BORING DATE July, 1965. COMPILED BY
DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
784.6						
0.0	Silt with some fine sand.					
			1	SS	42	
			2	SS	63	
	Brown					
			3	SS	62	
			4	SS	60	
				for	6"	
	Dense to very dense.		5	SS	110	
753.1			6	SS	130	
31.5	Fine sand with some silt and traces of clay.					
	Greyish-brown		7	SS	100	
				for	3"	
744.1	Very dense.			SS	67	
40.5				for	6"	

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %

BULK DENSITY γ P.C.F.

REMARKS

Gr 0% Sa 13%
Si 83%
Cl 4%

B.H. blocked dry at 31.5'
Sa 84% Si 13%
Cl 3%

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop. Hwy. #403 Ramp 'B' Sta. 85+00, 9.5' Lt. ORIGINATED BY P. McG
W.P. 69-62 BORING DATE July, 1965. COMPILED BY
DATUM G.S.C. BOREHOLE TYPE Washboring NX & BX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (25 50 75 100 125) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
782.4										
0.0	Silt and fine sand.					780				
			1	SS	60					
	Brown		2	SS	110	770				Gr1%Sa2% Si&Cl 97%
			3	SS	74					Gr0%Sa60% Si37% Cl 3%
			4	SS	58	760				
	Very dense		5	SS	56					
752.4										
30.0			6	SS	75					
752.2										
30.2	End of borehole.			for	2"	750				Gr1%Sa66% Si31% Cl 2%
	Fine sand with silt.									
	Grey									
	Very dense									

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

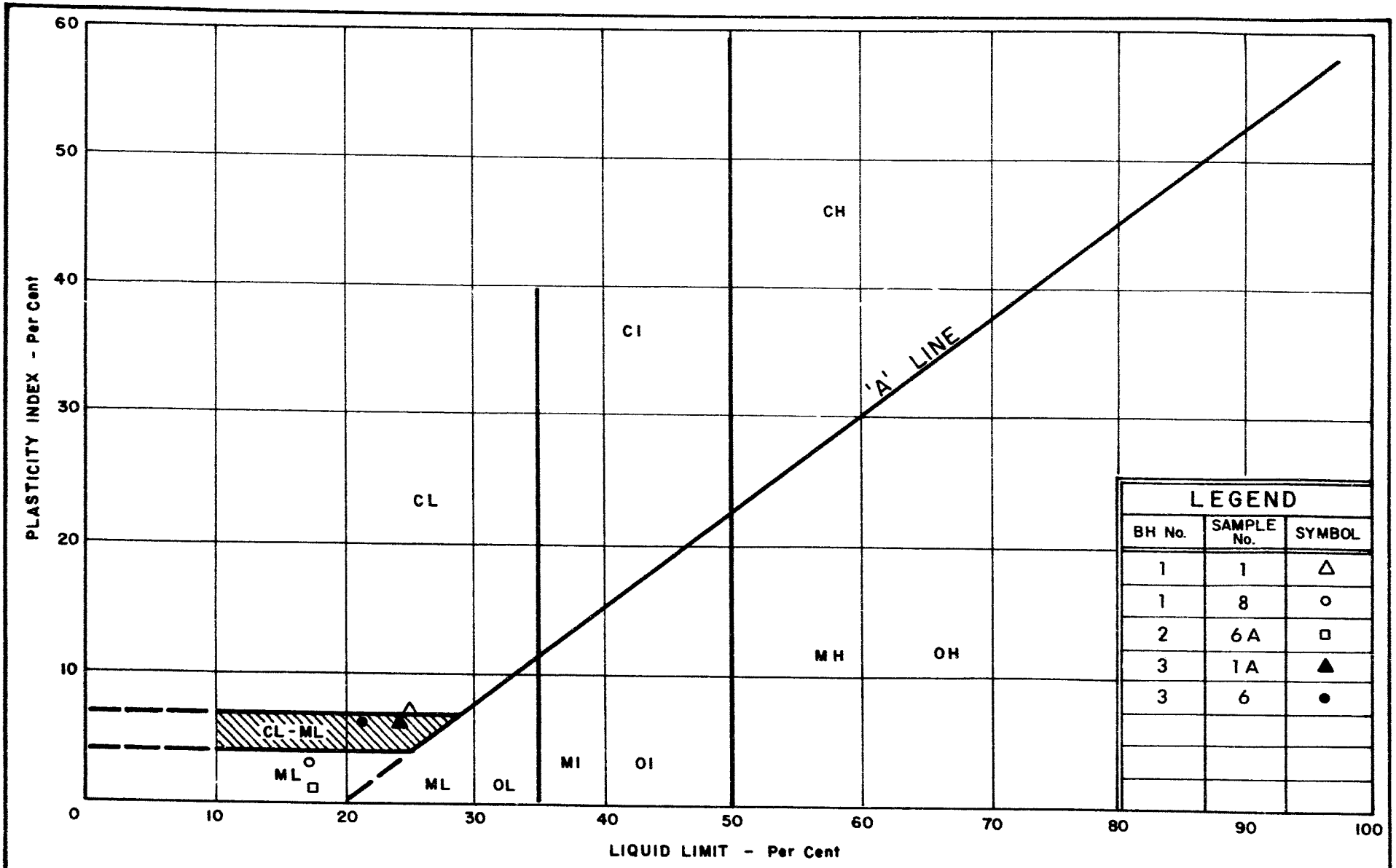
RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 65-F-34 LOCATION Prop. Hwy. #403 Ramp 'B' Sta. 84+00, 9.5' Lt. ORIGINATED BY P. McG
W.P. 69-62 BORING DATE July, 1965. COMPILED BY
DATUM G.S.C. BOREHOLE TYPE Standard Penetration Test. CHECKED BY K.G.S.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 25 50 75 100 125 / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / w_P w w_L / WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
778.4										
0.0	Probably Silt with fine sand Brown Very dense									
771.8										
6.6						770				

FORM 08-MT-252
(REV. JUNE 1965)
65-1624



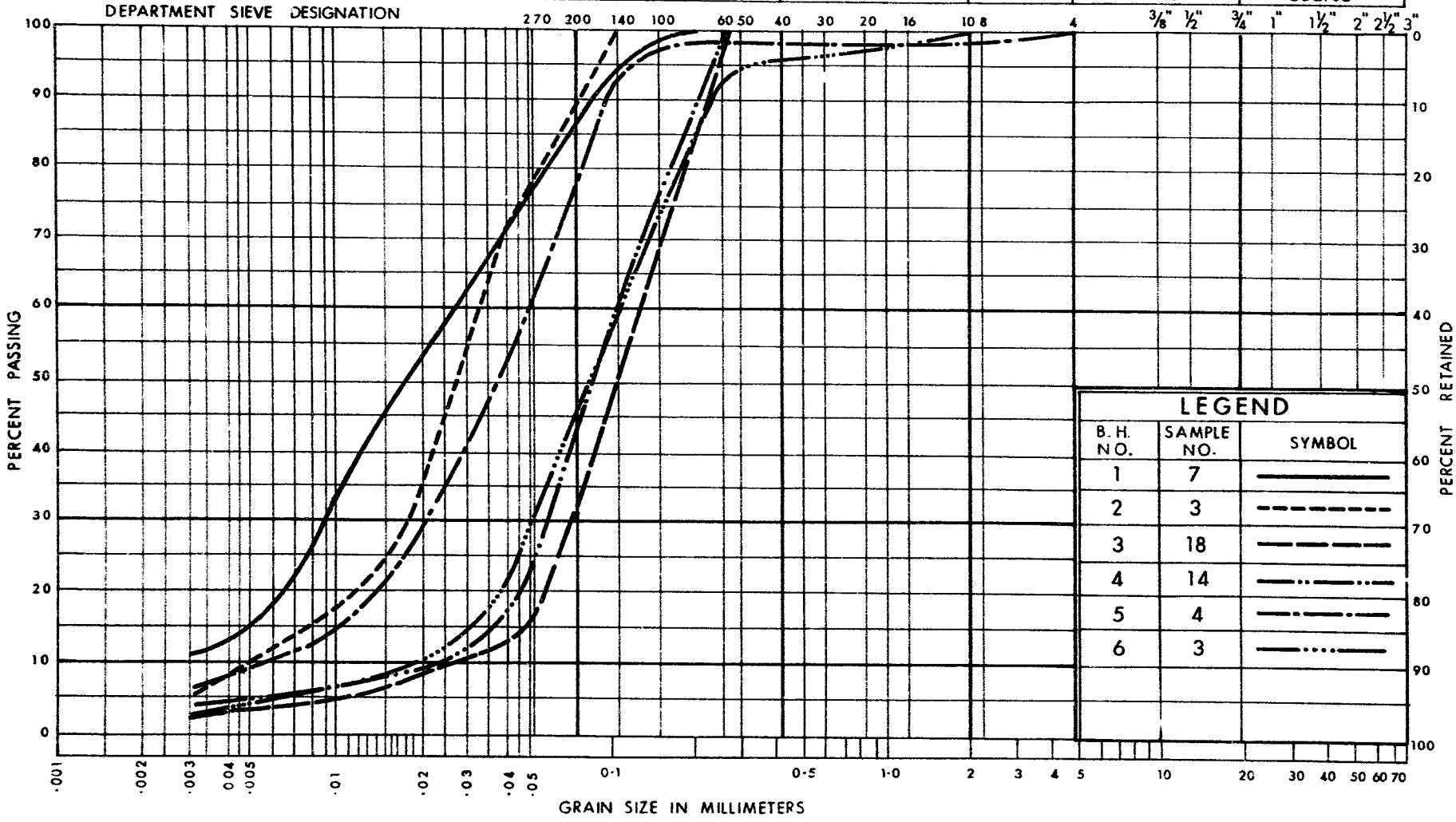
DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

PLASTICITY CHART

W.P. No. 69-62
JOB No. 65-F-34

FORM OB MT-17
REV. APR. 1965
65-414

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND

B. H. NO.	SAMPLE NO.	SYMBOL
1	7	
2	3	
3	18	
4	14	
5	4	
6	3	

DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

GRAIN SIZE DISTRIBUTION

W.P. No. 69-62
JOB No. 65-F-34

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 :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
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_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
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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