DEPARTMENT OF HIGHWAYS ONTARIO

W.P. 148-63

MEMORANDUM

To: Mr. R. Burnfield,
Regional Functional
Planning Engineer,
Admin. Bldg.
Attn: Mr. R. Draycott

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

Date: July 15, 1964

Our File Ref.

In reply to

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Surplus Fill Dump Area in
Old Welland Canal near the C.P.R.
and Ontario St., St. Catharines, Ont.
District No. 4, Hamilton.
W.J. 64-F-32 -- W.P. 148-63

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

We believe that the information contained therein, will be adequate for your requirements. Should there be any queries concerning this project, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT

For

Proposed Surplus Fill Dump Area in
Old Welland Canal near the C.N.R.
and Ontario St., St. Catharines, Ont.
District No. 4, Hamilton.
W.J. 64-F-32 -- W.P. 148-63

1. INTRODUCTION:

A request for a foundation investigation at the above site was received from Mr. T. J. Kovich, Regional Materials Engineer.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions at the proposed dump site. Presented in this report are the results of this investigation, together with our conclusions regarding the possible encroachment on the canal waterway by material being displaced due to future dumping operations.

2. DESCRIPTION OF SITE:

The proposed dump area is located at the east side of the Old Welland Canal, just south of the Henley Bridge and extends southward some 700 ft. along the canal bank. The river here is confined by steep banks, up to 45 ft. high. South of the bridge and to the right, the river has eroded the banks, forming a bay-like area measuring about 1300 ft. by 600 ft., which is covered by shallow water averaging about 2 ft. to 3 ft. in depth. It is proposed to use a portion of this bay area, away from the main channel as a dump area for surplus fill materials.

cont'd. /2 ...

3. FIELD INVESTIGATION PROCEDURE:

A total of 6 boreholes and 12 dynamic cone penetration tests were carried out during the course of the field investigation. In addition, vane tests were carried out adjacent to the dynamic cone penetration test locations. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes and was carried out from a raft. Undisturbed soil samples were obtained by means of 2-inch I.D. Shelby tubes, pushed into the soil manually. Disturbed samples were recovered by means of a standard 2-inch split-spoon sampler.

The locations and elevations of all boreholes are shown on Dwg. 64-F-32A which accompanies this report. The borehole elevations were obtained by a D.H.O. survey crew and are referred to by a bench mark located on the Henley Bridge on the C.B.M.

4. LABORATORY TESTS:

Samples were visually examined in the laboratory as well as in the field. Tests were carried out in the laboratory for the determination of Atterberg limits, moisture contents, shear strength measurements, bulk densities and organic contents.

The laboratory test results have been summarized on borehole logs and are included in this report in Appendix I.

5. SUBSOIL CONDITIONS:

5.1) General:

The stratigraphy at the site was found to be generally uniform with minor variations only. All boreholes except B.H. #1

cont'd. /3 ...

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

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

were drilled from a raft, through water ranging from 1 ft. to 6 ft. in depth. B.H. #1 was drilled from the water's edge.

Detailed descriptions of various soil types in each borehole are given in the Appendix of this report. The estimated stratigraphical profiles of Dwg. 64-F-32A are based upon this information.

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

5.2) Organic Silt-Clay:

Underlying a thin layer of topsoil in B.H. #1 and extending from the canal bottom in the other boreholes, a stratum of organic silt-clay was found. The thickness of the stratum was found to vary from 4 ft. in B.H. #9 to 11 ft. in B.H. #8.

Tests carried out in the laboratory and in the field indicated the following physical properties:

Liquid Limit	31.5% - 74.4%
Plastic Limit	20.6% - 35.7%
Moisture Content	21.7% - 70.6%
Bulk Density	103 p.c.f. - 105 p.c.f.
Organic Content	2.3% - 6.7%
Field Vanes	100 p.s.f. - 560 p.s.f.
Unconfined Compression ..	85 p.s.f. - 750 p.s.f.
Standard Penetration	3 blows/ft.

The consistency of the deposit may be described as ranging from very soft to firm and, generally, can be described as "soft".

cont'd. /4 ...

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

5.3) Clayey Silt:

This deposit was found underlying the stratum of organic silt-clay. The material consists of a grey-brown clayey silt and was observed in all boreholes. The thickness of the stratum varies from 1 ft. in B.H. #1 to 10 ft. in B.H. #2.

The physical properties of this stratum are as follows:

Liquid Limit	28.2% -	32.9%
Plastic Limit	16.2% -	18.9%
Moisture Content	19.9% -	29.2%
Bulk Density	123 p.c.f. -	131 p.c.f.
Field Vanes	320 p.s.f. -	> 2000 p.s.f.
Unconfined Compression ..	533 p.s.f. -	1100 p.s.f.
Standard Penetration	10 - 19 blows/ft.	

The consistency of the deposit may be described as soft to very stiff.

5.4) Silt to Sandy Silt:

This stratum was found in B.H. #1 only, immediately following the thin layer of clayey silt. The thickness of the layer was 10 ft., and the material ranged from silt to sandy silt. Standard Penetration values in the stratum were 15 and 24 blows per foot, indicating a compact relative density.

5.5) Glacial Till (Sandy Silt with Gravel to Clayey Silt with Sand and Gravel):

A stratum of glacial till extends immediately below the deposit of clayey silt in all the boreholes except B.H. #1, where it follows the stratum of silt to sandy silt. The lower boundary

cont'd. /5 ...

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

5.5) Glacial Till (Sandy Silt with Gravel to Clayey Silt with Sand and Gravel): (cont'd.) ...

of the till deposit was not determined, but the stratum extends at least 32 ft. below the water level. In boreholes 1, 5, 9 and 11, the glacial till consists of a heterogeneous mixture of silt, sand and gravel, while in boreholes 3 and 8, it consists of clayey silt with sand and some gravel.

Atterberg test results for the clayey silt with sand and gravel (glacial till) are as follows:

Liquid Limit	25% - 33%
Plastic Limit	15% - 21%
Moisture Content	19% - 27%

Standard Penetration Test results in the sandy silt portion range from 8 blows/ft. to 100 blows/6", and in the clayey silt portion from 17 to 42 blows/ft.

6. CONCLUSIONS:

It is proposed to utilize the site area as a dumping ground for surplus fill material. Since the area is adjacent to the main channel of the Old Welland Canal, it was felt that there was some danger of the future dumped material causing base failures in the channel bottom with consequent damage to the canal waterway.

The investigation has shown that subsoil in the area at present covered by water, consists of deposits of very soft organic clay-silt, soft to stiff clayey-silt and glacial till,

cont'd. /6 ...

6. CONCLUSIONS: (cont'd.) ...

while at the dry land locations, subsoil consists of glacial till.

In view of the above facts, it is believed that the fill may be placed on the present river banks without danger of base failure since the subsoil here consists of glacial till. When the future fill is dumped in the area covered by water, however, failures will take place in the form of displacement of the soft organic soil and shallow base failures of the underlying clayey-silt material. Since the boundary of the proposed dump area is for the most part, several hundred feet away from the main channel, the afore-mentioned failures should have no effect on the main channel. It would be, of course, most advantageous to commence dumping operations at the locations which are farthest away from the main channel edge.

7. MISCELLANEOUS:

The field work, performed April 30 to May 8, 1964, together with the preparation of this report, was undertaken by Mr. R. Magi, Project Foundation Engineer, under the general supervision of Mr. M. Dévata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Dominion Soil Investigation Ltd. of Toronto.

July 1964

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE Apr. 30, 1964. COMPILED BY R.M.

DATUM 260.1 BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
260.1	Groundlevel					
0	Org. silt-clay.		1	SS	-	
251.1	Soft to firm.					
250.1	Clayey silt firm.		2	TW	P	250
10	Silt to sandy silt.		3	SS	24	
			4	SS	15	
			5	TW	P	
240.1	Compact.					240
20	Glacial till (silt, sand and gravel).		6	SS	51	
			7	SS	132	
						230
228.6	Very dense.		8	SS	100	
31.5	End of borehole.				(6")	

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
○ Unconf. Comp. Test
500 1000 1500 2000 2500

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

BULK DENSITY
P.C.F.

126

REMARKS

259.0

4.18% Org'

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 4, 1964. COMPILED BY R.M.

DATUM 258.8 BOREHOLE TYPE Cone Penetration & Vane Tests CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS / FOOT	ELEV. SCALE
258.8	Waterlevel					
0	Water					
256.8	Groundlevel					
2						
						250
						240
230.6						
28.2	End of borehole.					230

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
500 1000 1500 2000 2500

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

BULK DENSITY P.C.F.

REMARKS

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 4, 1964. COMPILED BY R.M.

DATUM 258.8 BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
258.8	Waterlevel					
0	Water					
255.8	Groundlevel					
	Org. silt-clay.		1	TW	P	
			2	TW	P	250
245.8	Very soft to firm.		3	SS	3	
13	Clay silt.					
			4	TW	P	
241.8	Soft to firm.					
17	Glacial till (clayey silt with sand and gravel).		5	SS	18	240
			6	TW	P	
			7	SS	18	
232.3	Very stiff to hard.		8	SS	42	
26.5	End of borehole.					230

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
O Unconf. Comp. Test
500 1000 1500 2000 2500

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

Air
Oven

BULK DENSITY
P.C.F.
105
126

REMARKS
2.79%Org's

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 5, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Cone Penetration & Vane Tests CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION
258.7	Waterlevel
257.7	Water
1	
223.7	
35.	End of borehole.

STRAT. PLOT | SAMPLES: NUMBER, TYPE, BLOWS/FOOT | ELEV. SCALE

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
500 1000 1500 2000 2500

ELEV. SCALE: 250, 240, 230

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

BULK DENSITY P.C.F.

REMARKS

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 6, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
258.7	Waterlevel					
0	Water					
253.7	Groundlevel					
5	Org. silt-clay to					
			1	TW	P	250
			2	TW	P	
243.7	very soft to soft.					
15	Clayey silt		3	TW	P	
241.7	Soft					
17	Glacial till (silt, sand and gravel).		4	SS	9	240
			5	SS	8	
232.2	Loose to v. dense		6	SS	100	
26.5	End of borehole.				(6")	230

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
○ Unconf. Comp. Test
500 1000 1500 2000 2500

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

	Air	Oven
1	○	
2		○
3	○	

BULK DENSITY γ P.C.F.: 103

REMARKS:
- 4.60%Org's
- 2.32%Org's
- 1.84%Org's

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 6, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Cone Penetration & Vane Tests CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100; SHEAR STRENGTH P.S.F. + Field Vane 500 1000 1500 2000 2500	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
258.7	Waterlevel									
0	Water									
255.7	Groundlevel									
3						250				
						240				
						230				
227.9										
30.8	End of borehole.									

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 6, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Cone Penetration & Vane Tests CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FOOT	ELEV. SCALE
258.,	Waterlevel					
0	Water					
255.7	Groundlevel					
3						
						250
						240
231.7						
27	End of borehole.					230

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
500 1000 1500 2000 2500

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

BULK DENSITY
P.C.F.

REMARKS

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing. ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 6, 1964. COMPILED BY R.M.

DATUM 258.8 BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	BULK DENSITY γ P.C.F.	REMARKS
258.8	Waterlevel							
0	Water							
256.8								
2	Org. silt-clay.							
			1	TW	P			
						250		
			2	TW	P		104	2.44% Org's
245.8	Very soft							
13	Clayey silt.		3	TW	P			2.79% Org's
			4	TW	P		131	
			5	SS	10	240		
236.8	Stiff to v. stiff.							
22	Glacial till (clayey silt with sand and gravel).		6	SS	17			
			7	SS	25	230		
227.1	Very stiff							
31.7	End of borehole.							

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
+ Field Vane
O Unconf. Comp. Test
500 1000 1500 2000 2500

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

Air
Oven

MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 7, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Washboring & Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) SHEAR STRENGTH P.S.F. + Field Vane O Unconf. Comp. (500 1000 1500 2000 2500)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % (20 40 60)	BULK DENSITY P.C.F.	REMARKS
258.8	Waterlevel									
0	Water									
252.7	Groundlevel									
6	Organic silt-clay.					250				
248.7	Firm		1	TW	P				124	
10	Clayey silt		2	SS	19					
			3	TW	P					
			4	SS	19					
240.7	Very stiff.					240				
18	Glacial till (silt sand and gravel)		5	SS	33					
232.2	Dense to v. dense		6	SS	62					
26.5	End of borehole.					230				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 10

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 7, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Cone Penetration & Vane Tests CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE: BLOWS/FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F. (Field Vane: 500 1000 1500 2000 2500)	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
258.8	Waterlevel									
0	Water									
256.7										
2						250				
						240				
232.7										
26	End of borehole.					230				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 11

FOUNDATION SECTION

JOB 64-F-32 LOCATION See Drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 7, 1964. COMPILED BY R.M.

DATUM 258.7 BOREHOLE TYPE Washboring, Cone Penetration. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) SHEAR STRENGTH P.S.F. + Field Vane O Unconf. Comp. Test (500 1000 1500 2000 2500)	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.	REMARKS
258.8	Waterlevel									
0	Water									
256.7										
2	Organic silt-clay.		1	TW	P					6.70% Org's
			2	TW	P	250				3.73% Org's
244.7	Very soft		3	TW	P					3.64% Org's
12	Clayey silt.		4	TW	P				123	
240.7	Firm		5	TW	P	240				
18	Glacial till (silt sand and gravel)		6	SS	13					
			7	SS	42					
234.0	Compact to dense									
24.7	End of borehole.					230				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 12

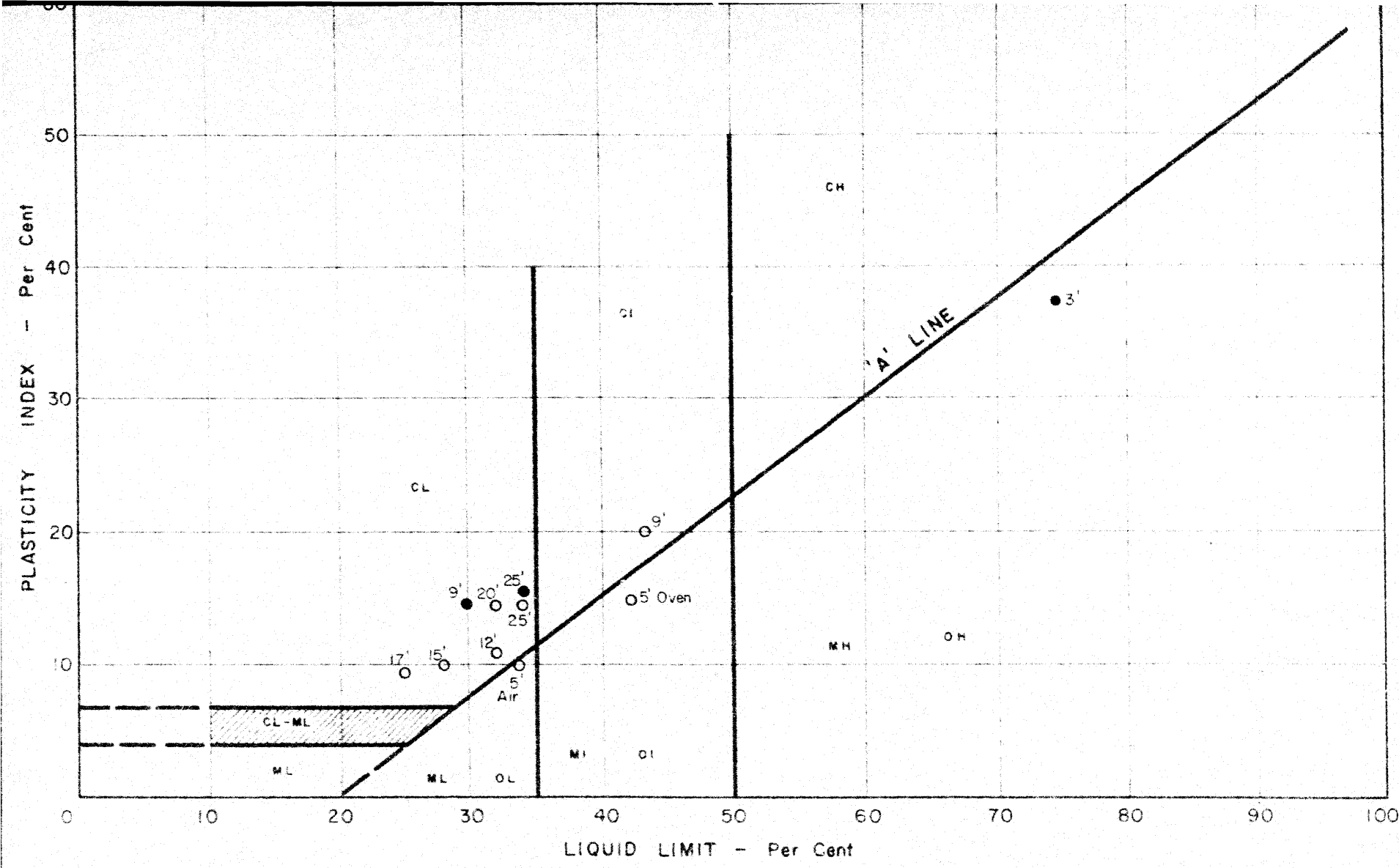
FOUNDATION SECTION

JOB 64-F-32 LOCATION See drawing ORIGINATED BY R.M.

W.P. 148-63 BORING DATE May 8, 1964. COMPILED BY R.M.

DATUM 258.8 BOREHOLE TYPE Cone Penetration, Vane Tests. CHECKED BY M.D.

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. + Field Vane 500 1000 1500 2000 2500	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		NUMBER	TYPE	BLOWS / FOOT					
258.8	Waterlevel									
0	Water									
255.8										
3						250				
						240				
233.3										
25.5	End of borehole.					230				



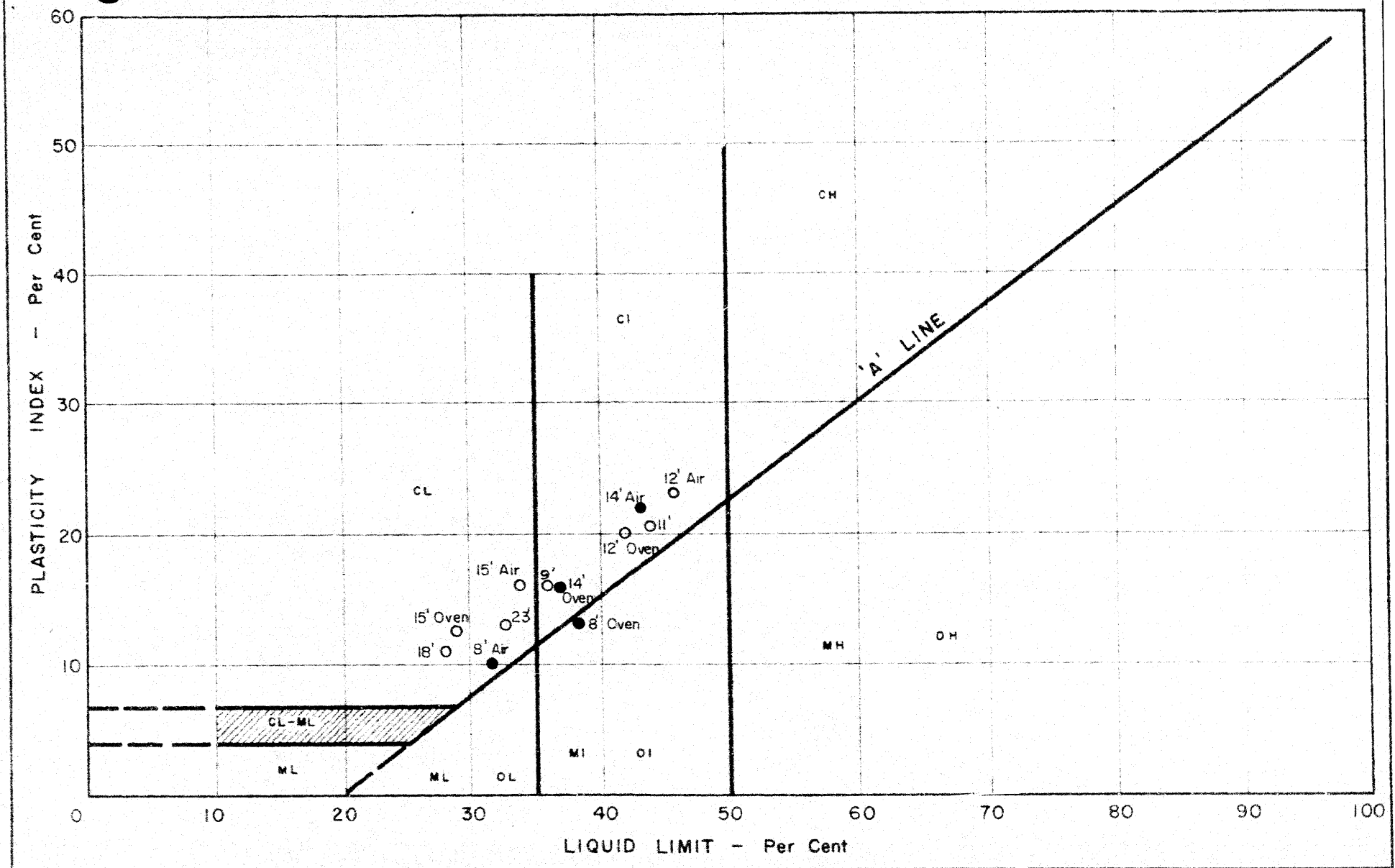
NOTES

● BORE HOLE 1
o BORE HOLE 3

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

PLASTICITY CHART

Job No. 64-F-32 W.P. No. 148-63
Location ST. CATHARINES



NOTES

● BORE HOLE 5

o BORE HOLE 8

DEPARTMENT OF HIGHWAYS - ONTARIO

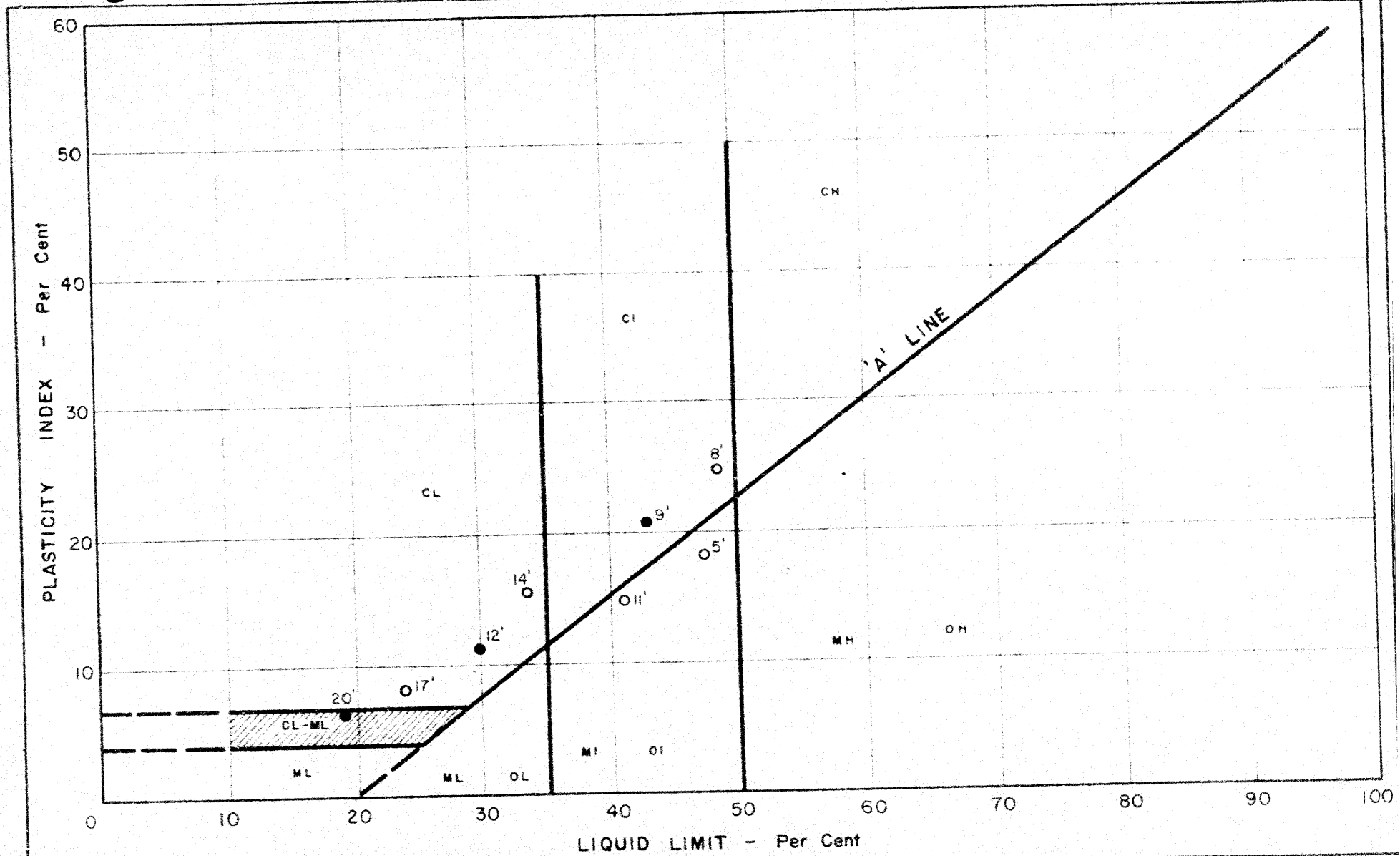
MATERIALS & RESEARCH DIVISION

PLASTICITY CHART

Job No. 64-F-32 W.P. No. 148-63

Location ST. CATHARINES

FORM 08-ML-252 (REV. MARCH 62)



NOTES

● BORE HOLE 9

o BORE HOLE 11

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION

PLASTICITY CHART

Job No. 64-F-32 W.P. No. 148-63

Location ST. CATHARINES

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

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

620 UNIVERSITY AVENUE, TORONTO 2, CANADA

TELEPHONE - 366-6767

January 9, 1964

Mr. R. G. Burnfield, P.Eng.,
Regional Functional
Planning Engineer,
Functional Planning Division,
Central Region,
Department of Highways,
DOWNSVIEW, Ontario.

O. B. Johnston
Hydraulic
Generation Engineer

Attention Mr. R. Draycott

Dear Sir:

Re: Low Fall Engineering Station
W.P. 148-63, Ontario Street and
Queen Elizabeth Way Intersection,
City of St. Catharines, Lincoln District

We have looked into your tentative proposal for the disposal of surplus material in Twelve Mile Creek as outlined in your letter of December 13, 1963.

We can see no objection at this time to your proposal to dispose of approximately 70,000 - 75,000 cubic yards of material provided the Department supply us with information on soil conditions over the area under consideration, which information we would want to review before your final disposal arrangements are made. We would expect the disposal operation to be carried out in accordance with sound engineering practice and the area, as shown outlined on the attached photograph, left suitably graded and sloped for drainage.

As the fill would encroach on adjacent private property, arrangement with the owners for this and for right of access would have to be arranged.

We would stipulate, also, that the Department save the Commission harmless from any claims arising out of the disposal operation.

Yours truly,

Hydraulic Generation Engineer

MEMORANDUM

To: Mr. T. Kovich,
Regional Soils Engr.,
Central Region,
Downsview.

Attn: Mr. P. Weber

From: R.G. Burnfield,
Regional Functional Planning Engr.

Date: February 20th., 1964.

Our File Ref.

In reply to

Subject: W.P. 148-63, Q.E.W. & Ontario Street Interchange, City of St. Catharines, D.M. 4081, Hamilton District #4.

Further to our recent telephone conversations please find attached one additional print of our 100' plan indicating the proposed design for this intersection and a letter copy received from the Hydro relative to the suggested disposal area for the expected surplus material.

I have shaded in red the area where the disposal would take place and your comments on this area and the Hydro's letter would be appreciated at your convenience.

The actual amount of material to be disposed of will not be known until Mr. Celmins pre-engineers this W.P. but it is now anticipated that some 75000 C.Y. will be waste.

I would also appreciate your comments on the soils conditions for this W.P. and your letter of approval and/or comments on our proposals.

R. Draycott

For: R.G. Burnfield,
Regional Functional Planning Engr.

RGB/RD/rmg
Attach.

c.c. H. Greenland
G. Celmins
A. Crowley
File

MEMORANDUM

TO: Mr. A. Stermac,
Principal Foundations Engr.

FROM: T.J. Kovich.

DATE: February 28th, 1964.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P.#148-63, QEW & Ontario St. Interchange.
- St. Catherines -

I am forwarding to you a drawing and pertinent correspondence relating to a request to carry out a foundation investigation in the area intended as a dump for surplus earth material. You will note that Hydro requests a report on soils conditions before they will approve of the scheme.

The area shaded in in red is the section in question. The top of the bank is about 50'± above the water level of the old Canal. Access to the flat area where the borings would be required would be down the slope by winch. The site of the borings is marshy and not frozen over so that the use of a raft would appear to be imperative.

I have very recently visited the site and could brief one of your men on the conditions.

T.J. Kovich,
Regional Materials Engineer.

TJK/hl
c.c. T.J. Kovich,
Files.

cc: Foundations Office

Mr. R. G. Burnfield,
Regional Functional Planning Engr.

Attn: Mr. R. Draycott

Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

March 3, 1964

W.P. 148-63, Q.E.W. & Ontario St. Interchange,
St. Catharines. Dist. 4.

Mr. T. J. Kovich, Regional Materials Engineer, has forwarded to us a copy of your memo to him, dated February 20, 1964, concerning the above subject. Attached, was also a copy of the letter by the Hydro Electric Power Commission of Ontario, dated January 9, 1964.

It is our opinion that due to the adverse present weather conditions, the investigation of the proposed dump area should be postponed until the weather improves. The predominant part of the investigation will have to be carried out from a raft and the maneuvering of the raft in shallow water that is partly frozen and on marshy land that is snow-covered, is extremely difficult and time consuming. We propose to carry out the investigation as soon as possible and will forward to you all the pertinent findings and information.

Should we not hear from you on this matter any further, we will assume that you are in agreement with our thinking and our proposed timing of the investigation.

AGS/MdeF

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Mr. T. J. Kovich

Foundations Office
Gen. Files

Downsview, Ontario,
August 4th, 1964.

Mr. O. E. Johnston,
Hydraulic Generation Engineer,
Hydro Electric Power Commission,
60 Murray Street,
Toronto, Ontario.

Re: W.P. 148-63, Ontario Street and C.N.R. intersection, City of St. Catharines, D.M. 4081, Hamilton, District #4.

Dear Sir:

Please refer to your letter of January 6th, 1964 addressed to Mr. R. G. Burnfield, Regional Functional Planning Engineer, D.H.O., and relating to the possible disposal of surplus materials into the 12 mile creek at St. Catharines.

Since receipt of your letter, a detailed foundation investigation of the subsoil conditions at the site in question has been carried out by the Materials and Research Division of the Department of Highways - Ontario, and one copy of their findings in report form is attached for your information.

The actual amount of material to be disposed of has not been determined to date, but will be established by our Regional Road Design Office during the Pre-Engineering and Contract Preparation of this Work Project.

Continued on page -2-

Your further comments and/or approval of this proposal based on the attached soils report is requested. Would you please forward same to Mr. G. K. Hunter, Sr. Proj. Des. Engineer, Regional Road Design Office, Downsview.

Yours very truly,

R. Draycott

R. Draycott,

For: R. G. Burnfield,
Regional Functional Planning Engineer.

RGB/RD/mw
Attach.

c.c. H. Greenland,
G. K. Hunter, ✓
A. Stermac. ✓

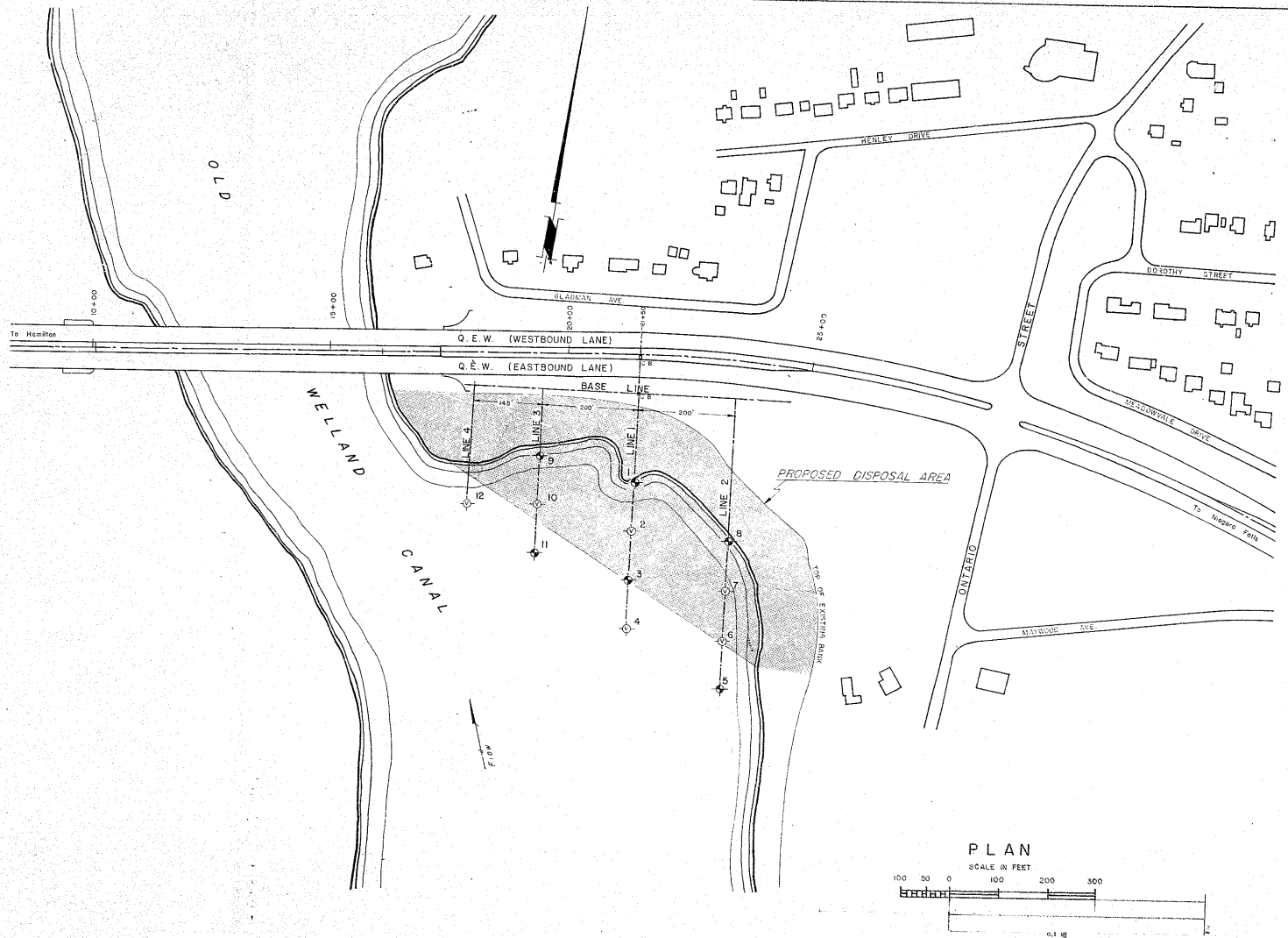
The attached print of your report is surplus to the needs of this office.

Ron.

(Tony - I put the extra copy of memo in our files)

[illegible]

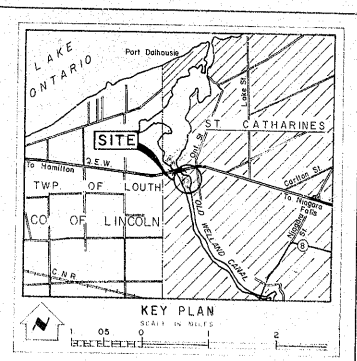
#64-F-32
W.P. # 148-63
Q.E.W. & ONTARIO
ST., PROP. SURPLUS
FILL DUMP AREA
IN OLD WELLAND
CANAL



PLAN

SCALE IN FEET

100 50 0 100 200 300



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, May 1964.
- Cone Penetration & Vane Test

NO.	ELEVATION	LINE	BASE LINE OFFSET
1	260-1	1	185'
2	258-8	1	285
3	258-8	1	385'
4	258-8	1	485'
5	258-8	2	600'
6	258-8	2	500'
7	258-8	2	400'
8	258-8	2	300'
9	258-8	3	140'
10	258-8	3	240'
11	258-8	3	340'
12	258-8	4	245'

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

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & RESEARCH DIVISION – FOUNDATION SECTION

PROPOSED

SURPLUS FILL DISPOSAL AREA

OLD WELLAND CANAL

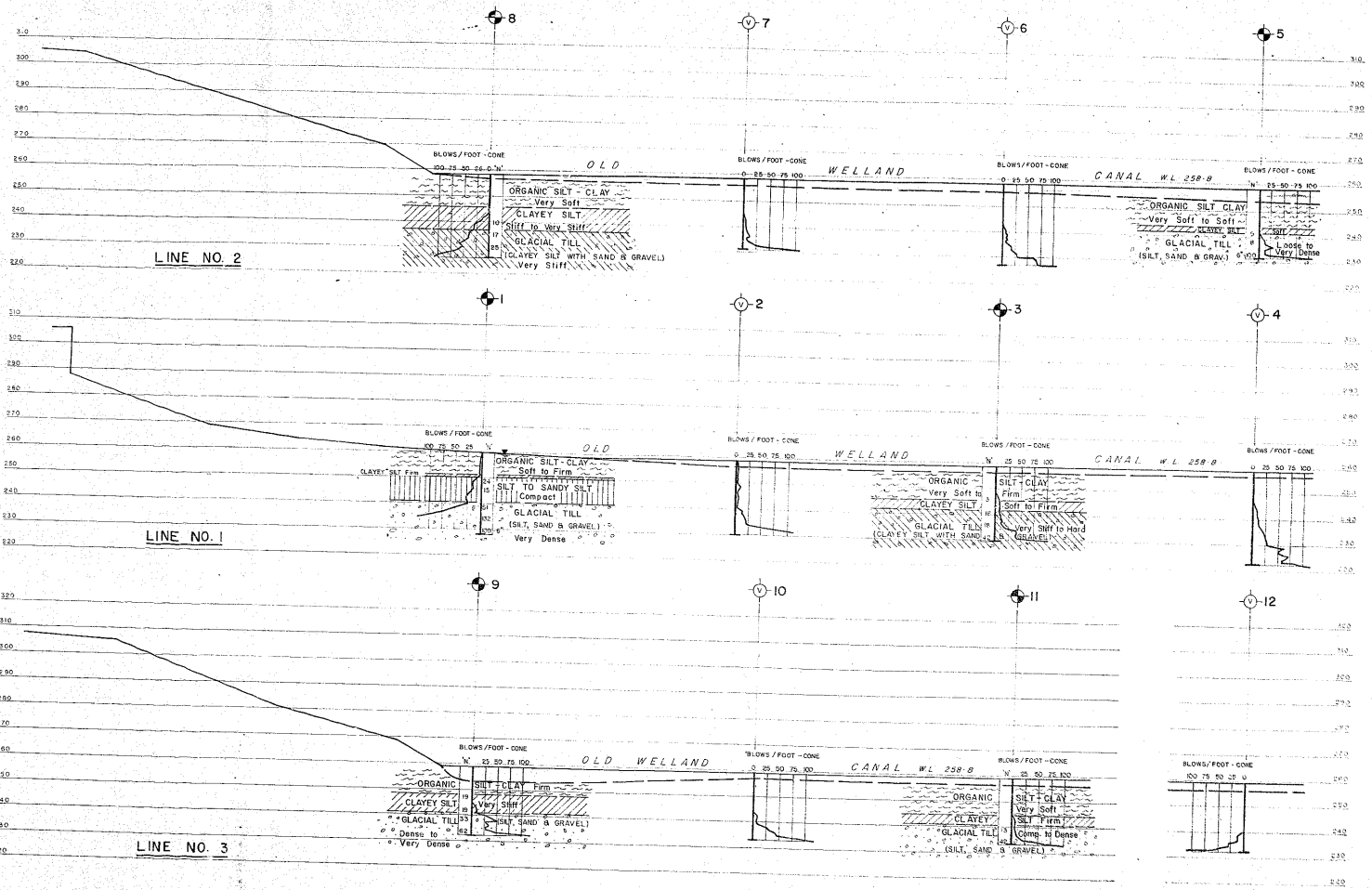
KING'S HIGHWAY NO. Q.E.W. DIST. NO. 4

CO. CITY OF ST. CATHARINES

TWP. LOT CON.

BORE HOLE LOCATIONS

SUBM'D R.M.	CHECKED	W.P. NO. 146-63	M&R DRAWING NO. 64-F-32A
DRAWN FC	CHECKED	JOB NO. 64-F-32	
DATE JUNE 17, 1964		SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	



SEE DRAWING NO. 64-F-32A

KEY PLAN
SCALE IN MILES

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation
- Cone Penetration & Vane Test.

NO.	ELEVATION	STATION	OFFSET

- 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

REVISIONS		
DATE	BY	DESCRIPTION

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

PROPOSED
SURPLUS FILL DISPOSAL AREA
OLD WELLAND CANAL

KING'S HIGHWAY NO. Q.E.W. DIST. NO. 4
CO. CITY OF ST. CATHARINES
TWP. LOT CON.

BORE HOLE SOIL STRATA

SUBMD. R.M.	CHECKED	W.P. NO. 148-63	M.&R. DRAWING NO. 64-F-32B
DRAWN RC	CHECKED	JOB NO. 64-F-32	
DATE JUNE 17, 1964		SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	