

# 69-F-13

W.P. 370-65-4

C.N.R. AND  
BARTLETT AVE.

REVISION.

MEMORANDUM

To: Mr. B. R. Davis,  
Bridge Engineer,  
Bridge Office,  
Admin. Bldg.

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

ATTENTION: Mr. S. McCombie

DATE: July 22, 1969

OUR FILE REF.

IN REPLY TO

JUL 24 1969

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossing at  
C.N.R. and Bartlett Avenue Revision  
Twp. of N. Grimsby - Co. of Lincoln  
District No. 4 (Hamilton)  
W.J. 69-F-13 -- W.P. 370-65-4

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

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

AGS/MdeF  
Attach.

cc: Messrs. B. R. Davis (2)  
H. A. Tregaskes  
D. W. Farren  
G. K. Hunter (2)  
H. Greenland  
W. S. Melinyshyn  
T. J. Kovich  
B. A. Singh

Foundations Files  
Gen. Files

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

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FOUNDATION INVESTIGATION REPORT  
For  
Proposed Crossing at  
C.N.R. and Bartlett Avenue Revision  
Twp. of N. Grimsby - Co. of Lincoln  
District No. 4 (Hamilton)  
W.J. 69-F-13      --      W.P. 370-65-4

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation for the above crossing. The request was contained in a memo from the Bridge Office (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated February 18, 1969. Subsequently, an investigation was carried out by this Section at the above site in order to determine the subsoil conditions. This report contains the results of the investigation as well as our recommendations for the design of foundations for the proposed structure and the stability of the approaches.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located in Grimsby Beach, just south-east of the existing County Rd. No. 36 (Park Rd.) and Q.E.W. Underpass. At this location the 2 tracks of the C.N.R. and a siding are bordered to the south by a fruit orchard, and to the north by a fruit stand. A drainage ditch is located between the orchard and the tracks, the depth of the ditch being 10 ft. below the tracks. The ground surface north of the tracks is about 5 ft. higher than the relatively flat ground beyond the drainage ditch to the south of the tracks.

Physiographically, the site is located in the "Niagara Fruit Belt" subsection of the "Iroquois Plain Physiographic Region". The area is underlain by shale bedrock of the Queenston Formation, Ordovician Period.

### 3. FIELD AND LABORATORY WORK:

A total of 10 boreholes, each accompanied by a dynamic cone penetration test, was carried out at the site by means of a standard diamond drill rig adapted for soil sampling purposes. Samples were obtained at the required depths by means of a 2-inch O.D. split-spoon sampler which was hammered into the ground in accordance with the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. The boreholes were advanced in the weathered shale by drilling with a tricone bit. Sound bedrock was proven at 8 boreholes by core drilling in BXL size.

Surveying was carried out by personnel from the Central Region Engineering Surveys Section. The elevations given in this report are referenced to geodetic datum. The locations and elevations of all boreholes are shown on Drawing 69-F-13A, together with a number of estimated stratigraphical sections across the site.

All samples were subjected to careful visual examination in the field and subsequently in the laboratory. Following this examination, the stratigraphical boundaries were established at each borehole, as shown on the Record of Borelog sheets in the Appendix to this report.

### 4. SUBSOIL CONDITIONS:

#### 4.1) General:

The overburden at the site consists either of topsoil or fill material and ranges in thickness from 3 to 9 ft. Bedrock is encountered directly beneath the overburden. The upper 13 to 39 ft. of the bedrock consists of a weathered shale, followed by sound shale bedrock.

#### 4.2) Topsoil, Fill Material:

Fill material consisting of poorly graded fine to medium brown sand was encountered beneath the gravel surfaced area at

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

4.2) Topsoil, Fill Material: (cont'd.) ...

boreholes located in front of the fruit stand at the site. The sand contained traces of organic matter. Standard Penetration Resistance 'N' values ranged between 5 and 12 blows/ft., indicating a loose relative density for the fill material. Topsoil only was encountered at the boreholes located south of the railroad tracks at the edge of the fruit orchard. The average thickness of the topsoil was found to be 3 ft. At Borehole 1, the topsoil was found to be underlain by 3.5 ft. of loose sand with a trace of silt.

4.3) Bedrock:

Bedrock was encountered at depths ranging from 3 to 9 ft. below the ground surface across the site.

4.3.1) Weathered Shale -

The upper 13 to 39 ft. of the bedrock was found to be in a weathered condition. The weathered shale consisted essentially of horizontally oriented shale fragments embedded in a clayey silt matrix derived from the "in-situ" weathering of the shale rock. The thickness of the weathered shale was greatest at Borehole 1 (39 ft.), averaging about 25 ft. at Boreholes 3, 5 and 7, and about 17 ft. at the other boreholes. Standard Penetration Resistance 'N' values ranged from a low of 38 blows/ft. near the surface, increasing to over 100 blows/ft. with depth.

4.3.2) Sound Shale -

Sound shale bedrock was encountered across the site at between elevations 273 to 284 with the exception of Borehole 1, where sound rock was encountered at elevation 255. The rock is red in colour with grey seams and mottling occurring at random. Occasional gypsum inclusions were observed in the shale.

The core recoveries ranged between 60 and 100 per cent with one exception. At Borehole 5, in one run, core recovery was

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

4.3) Bedrock: (cont'd.) ...

4.3.2) Sound Shale: (cont'd.) ...

only 25 per cent, indicating the likelihood of random weathered seams being present within the sound bedrock.

5. GROUNDWATER CONDITIONS:

Water level observations were carried out in the open boreholes upon completion of the field work. These observations are shown on the individual Borelog sheets as well as on Drawing 69-F-13A. The groundwater at this site is located near the surface of or within the weathered shale and is encountered at depths ranging from 6 to 13 ft. below the ground surface - i.e., at between elevations 290 and 295.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a 4-span (55'-68.5'-58.5'-55') structure, 66 ft. in width, to accommodate the southerly extension of Bartlett Avenue Revision below the existing C.N.R. tracks in Grimsby Beach, Ontario. The profile grade of Bartlett Avenue Revision at this site will be at about elevation 282. The existing elevation of the C.N.R. tracks is about 305.

It is understood that the C.N.R. will be temporarily diverted away from the structure site, so that construction may be carried out in an open excavation.

The investigation has shown the existence of shale bedrock at this site at depths of 3 to 9 ft. below the ground surface. The upper 13 to 39 ft. of the shale is in a weathered condition. The groundwater level is situated at or slightly below the upper surface of the weathered shale rock.

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

6.2) Structure Foundations:

The subsoil conditions at this site are favourable for the support of the proposed structure on spread footing type foundations. It is recommended that the piers and abutments be supported on spread footings located at the surface of or within the weathered shale and designed for a safe allowable bearing pressure of 5 TSF. In view of the proposed grade for Bartlett Avenue Revision, the pier footings should be located at or below about elevation 278 for adequate frost protection.

Since the shale bedrock is considered susceptible to frost action, all footings should be provided with an adequate thickness of soil cover for frost protection. In addition, the weathered shale is also susceptible to further deterioration upon exposure to water. Therefore, it is recommended that a working slab of lean concrete be poured as soon as the footing excavation bottoms are reached.

In order to simplify dewatering of the proposed structure, it is recommended that the approach cuts along Bartlett Avenue Revision be completed to profile grade. This could be done in conjunction with the excavations to be made for the Bartlett Ave. - Q.E.W. structure (see Foundation Report 69-P-12 dated July 11, 1969). If this procedure is followed, the resulting depths of footing excavations will be in the order of 4 to 5 ft. below finished grade. Any seepage from the weathered shale can be handled by ordinary pumping methods.

6.3) Approach Cuts:

The approach cuts for Bartlett Avenue Revision will vary in depth from about 20 ft. north of the C.N.R. tracks to 16 ft. south of the tracks. The cuts, which will be made in weathered shale, should be treated as earth cuts and should be constructed with standard 2:1 slopes. The cut slopes should be



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

6.3) Approach Cuts: (cont'd.) ...

provided with an adequate cover of topsoil and either seeded or sodded.

The existing groundwater level is situated some 8 to 12 ft. above the base of the proposed cut; some seepage through, and local sloughing of the weathered shale can therefore be expected when the excavation is carried below the groundwater level. However, this problem will only be temporary and of a minor nature, since the overall excavation will result in a general lowering of the groundwater level across the site.

7. MISCELLANEOUS:

The field work, performed during the period April 9 - 17, 1969, was carried out by Mr. V. Korlu, Project Foundation Engineer.

Equipment used was owned and operated by Dominion Soil Investigation Ltd.

This report was prepared by Mr. C. Mirza, Project Foundation Engineer.

General supervision of the project and review of this report was undertaken by Mr. M. Devata, Supervising Foundation Engineer.

July 1969

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

MATERIALS &amp; TESTING OFFICE

JOB 69-F-13 LOCATION Sta 11+74 CNR o/s 58.5' Rt. Bartlett Ave. Rev'n. ORIGINATED BY VK  
 W.P. 370-65-04 BORING DATE April 9, 1969 COMPILED BY WH & CM  
 DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone CHECKED BY

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH PSF	PLASTIC LIMIT	WATER CONTENT		
300.5	Ground Level									
0.0	Topsoil			300						
297.5										
3.0	Sand with trace silt.	1	SS	8						
294.5	Loose Brown	2	SS	65						294.5
6.0		3	SS	177/9"	290					
		4	SS	100/4"						
		5	SS	100/5"						
	Weathered	6	SS	100/1"	280					
		7	SS	100/2"						
		8	SS	100/4"	270					
		9	BXL	12%						
		10	BXL	No Rec						
		11	SS	100/1"	260					
255.3		12	BXL	No Rec						
45.2	Shale Bedrock	13	SS	100/2"						
	Sound	14	BXL	100%	250					
246.5		15	BXL	100%						
54.0	End of Borehole				240					

DEPARTMENT OF HIGHWAYS - ONTARIO

## RECORD OF BOREHOLE No. 2

CONTINUATION SECTION

JOB 69-F-13

LOCATION Sta. 11+78 CNR o/s 50.5' Lt. Bartlett Ave. Rev'n.

PREPARED BY

VK

M/P 370-65-01

BORING DATE April 10, 1969

COMPILED BY

WH &amp; CM

CALUM Weodetic

BOREHOLE TYPE Washboring - NX Casing; Cone

CHECKED BY

DEPTH	DESCRIPTION	SAMPLE NO.	TEST	RESULT	DISTANCE	REMARKS
303.0	Ground Level					
0.0	Fill Material					
	Fine Sand	1	SS	6	300	
295.0	Loose Brown	2	SS	6		
8.0		3	SS	100/6"		
		4	SS	100/5"	290	
		5	SS	100/6"		
	Weathered	6	SS	100/3"		
277.9		7	SS	100/1"	280	
25.1		8	BXL	96%		
	Shale Bedrock	9	BXL	70%	270	
	Sound	10	BXL	100%		
263.0						
40.0	End of Borehole				260	

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 3

### FOUNDATION SECTION

69-F-13

LOCATION Sta. 12+29 CNR o/s 56.5' Rt. Bartlett Ave. Rev'n.

ORIGINAL 39

W

N 270-65-04

FORING DATE April 11, 1969

COMPLET 21

W. E. C. M.

Geodetic

Washboring - NX Casing: Cone

1. *Phragmites* 2. *Phragmites* 3. *Phragmites* 4. *Phragmites* 5. *Phragmites* 6. *Phragmites* 7. *Phragmites* 8. *Phragmites* 9. *Phragmites* 10. *Phragmites* 11. *Phragmites* 12. *Phragmites* 13. *Phragmites* 14. *Phragmites* 15. *Phragmites* 16. *Phragmites* 17. *Phragmites* 18. *Phragmites* 19. *Phragmites* 20. *Phragmites* 21. *Phragmites* 22. *Phragmites* 23. *Phragmites* 24. *Phragmites* 25. *Phragmites* 26. *Phragmites* 27. *Phragmites* 28. *Phragmites* 29. *Phragmites* 30. *Phragmites* 31. *Phragmites* 32. *Phragmites* 33. *Phragmites* 34. *Phragmites* 35. *Phragmites* 36. *Phragmites* 37. *Phragmites* 38. *Phragmites* 39. *Phragmites* 40. *Phragmites* 41. *Phragmites* 42. *Phragmites* 43. *Phragmites* 44. *Phragmites* 45. *Phragmites* 46. *Phragmites* 47. *Phragmites* 48. *Phragmites* 49. *Phragmites* 50. *Phragmites* 51. *Phragmites* 52. *Phragmites* 53. *Phragmites* 54. *Phragmites* 55. *Phragmites* 56. *Phragmites* 57. *Phragmites* 58. *Phragmites* 59. *Phragmites* 60. *Phragmites* 61. *Phragmites* 62. *Phragmites* 63. *Phragmites* 64. *Phragmites* 65. *Phragmites* 66. *Phragmites* 67. *Phragmites* 68. *Phragmites* 69. *Phragmites* 70. *Phragmites* 71. *Phragmites* 72. *Phragmites* 73. *Phragmites* 74. *Phragmites* 75. *Phragmites* 76. *Phragmites* 77. *Phragmites* 78. *Phragmites* 79. *Phragmites* 80. *Phragmites* 81. *Phragmites* 82. *Phragmites* 83. *Phragmites* 84. *Phragmites* 85. *Phragmites* 86. *Phragmites* 87. *Phragmites* 88. *Phragmites* 89. *Phragmites* 90. *Phragmites* 91. *Phragmites* 92. *Phragmites* 93. *Phragmites* 94. *Phragmites* 95. *Phragmites* 96. *Phragmites* 97. *Phragmites* 98. *Phragmites* 99. *Phragmites* 100. *Phragmites*

Borehole		SAMPLES		FEET SCALE	DYNAMIC PENETRATION RESISTANCE BLANK FOOT	LIQUID LIMIT	REMARKS
DEPTH	DESCRIPTION	NUMBER	TYPE		20 40 60 80 100	PLASTIC LIMIT	
					SHEAR STRENGTH PS	WATER CONTENT %	
					O UNCONSOLIDATED FIELD LANE		
					● QUICK TRIAXIAL LAB LANE	WATER CONTENT %	
300.5	Ground Level			300			
0.0	Topsoil						
297.0		1	SS 22				
3.5		2	SS 100/5"				
		3	SS 100/2"				
	Shale Bedrock	4	SS 100/4"	290			
	Weathered	5	SS 100/6"				
		6	SS 100/3"	280			
		7	SS 100/3"				
270.4		8	SS 100/1"	270			
30.1	End of Borehole						

DEPARTMENT OF HIGHWAYS  
MATERIALS & TESTING OFFICE

# RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 69-F-13 LOCATION Sta. 12+34 CNR o/s 53.5' Lt. Bartlett Ave. Rev'n.  
MP 370-65-04 BORING DATE April 11, 1969  
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone  
ORIGINATED BY VK  
COMPILED BY WH & CM  
CHECKED BY

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — PLASTIC LIMIT — WATER CONTENT —		REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	20	40	60	80	100	
303.0	Ground Level										
0.0	Fill Material										
	Fine sand, trace organic matter.	1	SS	6							
296.0	Loose Brown	2	SS	21							
7.0		3	SS	88							
		4	SS	177	290						
	Weathered	5	SS	100/6"							
		6	SS	100/4"							
277.9		7	SS	100/1"	280						
25.1	Shale Bedrock	8	BXL	80%							
273.0	Sound										
30.0	End of Borehole				270						

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 69-F-13

LOCATION Sta. 12+98 CNR o/s 56.5' Rt. Bartlett Ave. Rev'n.

ORIGINATED BY VK

M.P. 370-65-04

BORING DATE April 14, 1969

COMPILED BY WH &amp; CM

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing; Cone

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT _____ % PLASTIC LIMIT _____ % WATER CONTENT _____ %		BULK DENSITY PCF GR SA SI CL	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			
300.0	Ground Level													
0.0	Topsoil													
297.0														
3.0		1	SS	59										
		2	SS	100/6"										
		3	SS	100/4"	290									
	Weathered	4	SS	122/10"										
		5	SS	100/5"										
		6	SS	100/2"	280									
		7	SS	100/2"										
273.0		8	BXL	25%										
27.0	Shale Bedrock	9	BXL	80%	270									
		10	BXL	25%										
	Sound	11	BXL	100%										
261.0														
39.0	End of Borehole				260									

▼ 292.0

DEPARTMENT OF HIGHWAYS, ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 69-R-13

LOCATION Sta. 13 + 03 CNR o/s 53' Lt. Bartlett Ave. Rev'n.

TRIP/DATE 31

VK

N.P. 370-65-04

BORING DATE April 14, 1969

COMPILED BY

CM

DATUM Geodetic

BOREHOLE TYPE Washboring-NX Casing; Cone

DATE RECORDED

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT	SHEAR STRENGTH (PSF)	UNSATURATED WATER CONTENT (%)	SATURATED WATER CONTENT (%)	REMARKS
DEPTH	DESCRIPTION	NUMBER	TYPE					
303.0	Ground Level							
0.0	Fill Material							
	Silty sand with trace clay.	1	SS 12					
295.5	Loose Brown	2	SS 4					
7.5		3	SS 100/6"					
		4	SS 70					
	Weathered	5	SS 100/4"					
		6	SS 100/5"					
277.9		7	SS 100/1"					
25.1		8	BXL 82%					
	Shale Bedrock	9	BXL 100%					
	Sound	10	BXL 100%					
263.0								
40.0	End of Borehole							

▼ 290.1



DEPARTMENT OF HIGHWAYS, ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No 7

JOB 69-F-13

LOCATION Sta. 13+56 CNR o/s 59' Rt. Barlett Ave. Rev'n.

DESIGNED BY

VK

V.P. 370-65-04

BORING DATE April 16, 1969

DRAWN BY

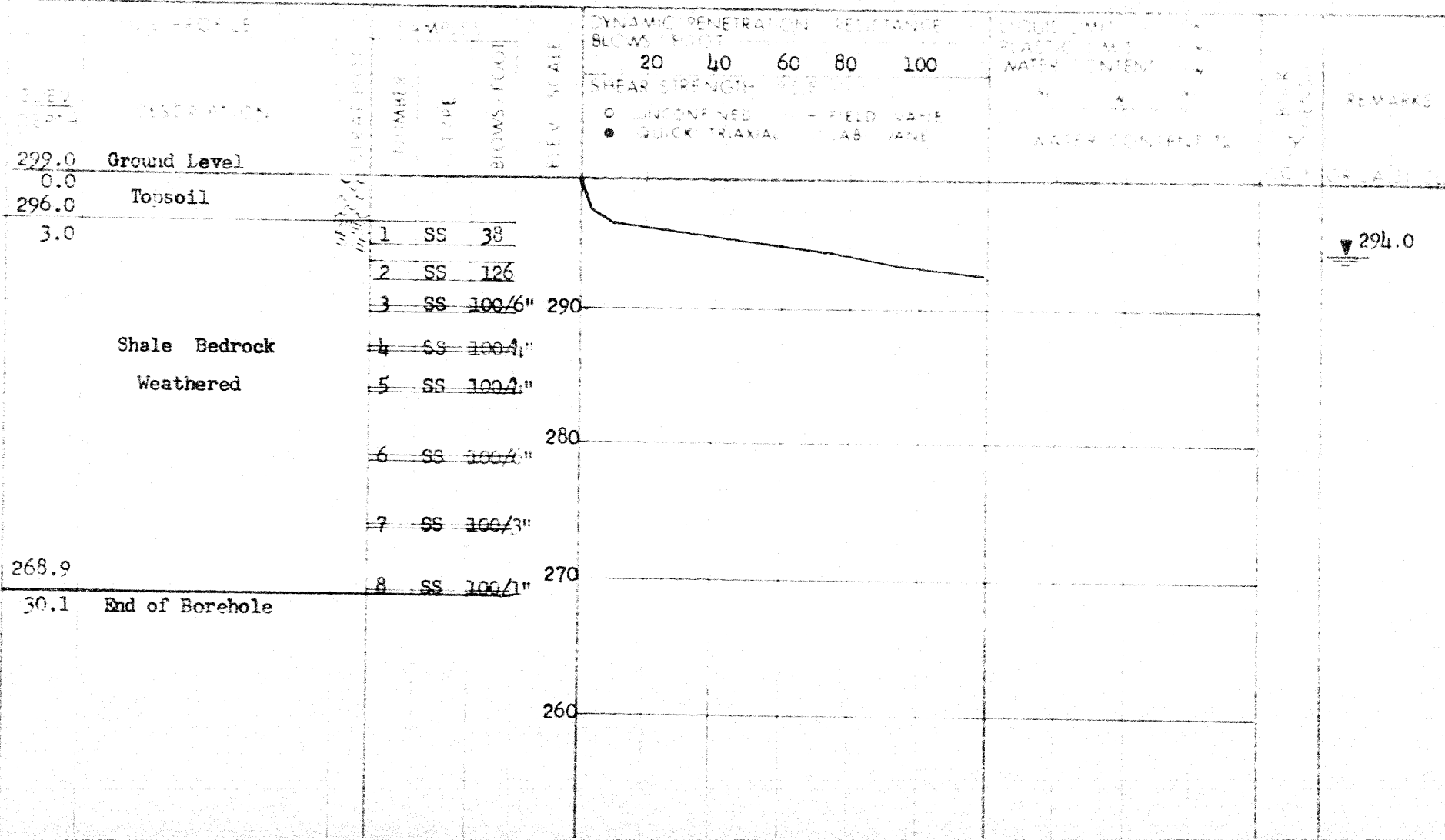
CM

TAXIM Geodetic

BOREHOLE TYPE Washboring - NX Casing; Cone

TESTED BY

/



DEPARTMENT OF HIGHWAYS, ONTARIO  
 MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 69-F-13

N.P. 370-65-04

DATUM Geodetic

LOCATION Sta. 13+60 CNR o/s 23.0' Lt. Bartlett Ave. Rev'n.

DATE April 15, 1969

BOREHOLE TYPE Washboring-NX Casing; Cone

ORIGINATED BY

VK

COMPILED BY

CM

CHECKED BY

ELEV. DEPTH	DESCRIPTION	NO.	SS	BLOWS	ELEV. (ft.)	DYNAMIC PENETRATION, RESISTANCE BLOW					REMARKS
						20	40	60	80	100	
304.2	Ground Level										
0.0	Fill Material										
	Sand with trace silt & gravel.	1	SS	5	300						
295.0	Loose Brown	2	SS	5							
9.2		3	SS	150							
	Weathered	4	SS	100/6"							
	Shale Bedrock	5	SS	100/4"	290						
		6	SS	100/3"							
279.1		7	SS	100/1"	280						
25.1	Sound	8	BXL	60%							
274.2											
30.0	End of Borehole				270						

▼ 294.2

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING OFFICE

## RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 69-F-13

LOCATION Sta. 14+12 CNR o/s 56' Rt. Bartlett Ave. Rev'n.

ORIGINATED BY

VK

W.P. 370-65-04

BORING DATE April 17, 1969

COMPILED BY

CM

DATUM Geodetic

BOREHOLE TYPE Washboring - NX Casing; Cone

CHECKED BY

ELEV. DEPTH	DESCRIPTION	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT PLASTIC LIMIT WATER CONTENT	REMARKS
		NUMBER	TYPE		20	40	60	80	100		
298.0	Ground Level										
0.0	Topsoil										
295.0		1	SS 99								
3.0		2	SS 110/10"								
		3	SS 100/11"	290							
	Weathered	4	SS 100/5"								
		5	SS 100/2"								
		6	SS 100/1"	280							
278.0		7	BXL 60%								
20.0		8	BXL 80%	270							
	Shale Bedrock	9	BXL 100%								
264.0	Sound										
34.0	End of Borehole			260							

▼ 291.0

DEPARTMENT OF HIGHWAYS ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 69-F-13

LOCATION Sta. 14+15 CNR o/s 24.1 Lt. Bartlett Ave. Rev'n.

ORIGINATED BY

VK

W.P. 370-65-04

BORING DATE April 16, 1969

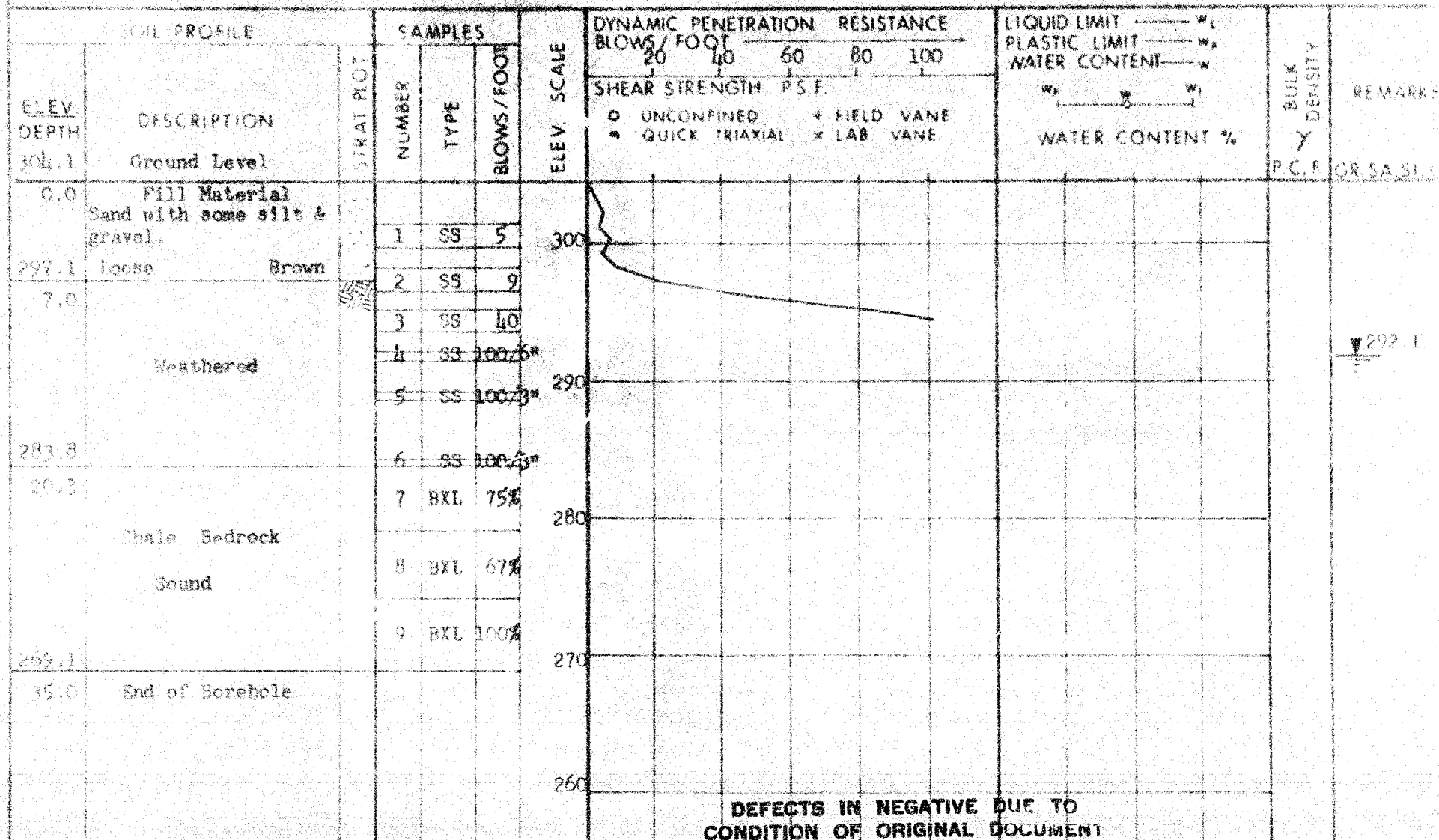
COMPILED BY

CM

DATUM Geodetic

BOREHOLE TYPE Washboring - N X Casing; Cone

CHECKED BY



## 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

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	OS	OESTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH		SAMPLE ADVANCED HYDRAULICALLY
	PM		SAMPLE ADVANCED MANUALLY

### SOIL TESTS

QU	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	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 = $\frac{w_p - w}{I_p}$
$e_{max}$	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
$S_r$	SENSITIVITY

### GENERAL

$\pi$	= 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
$\sigma'$	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

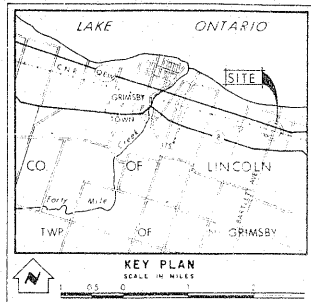
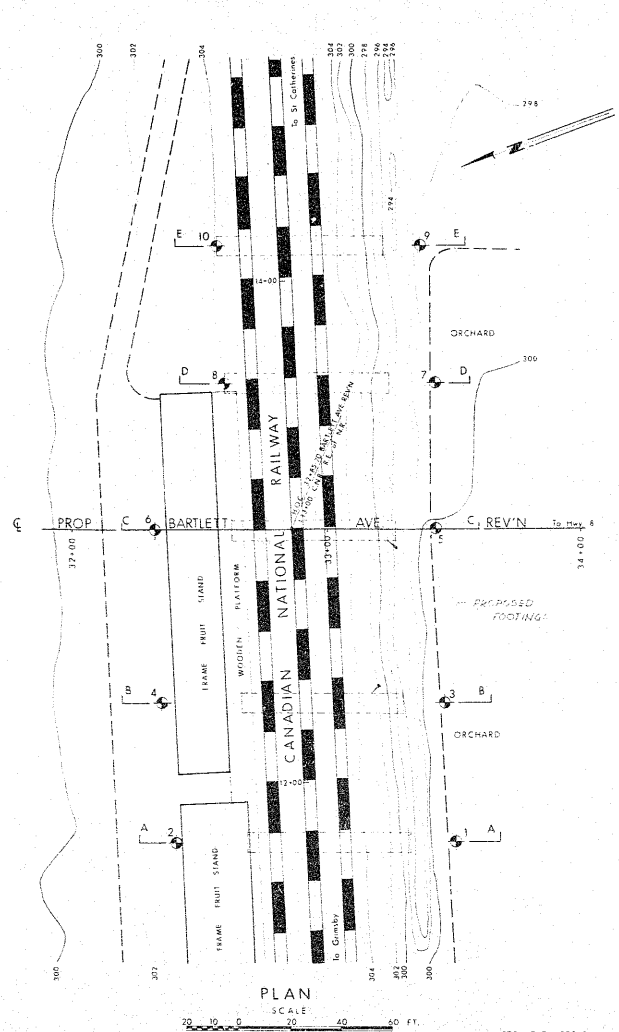
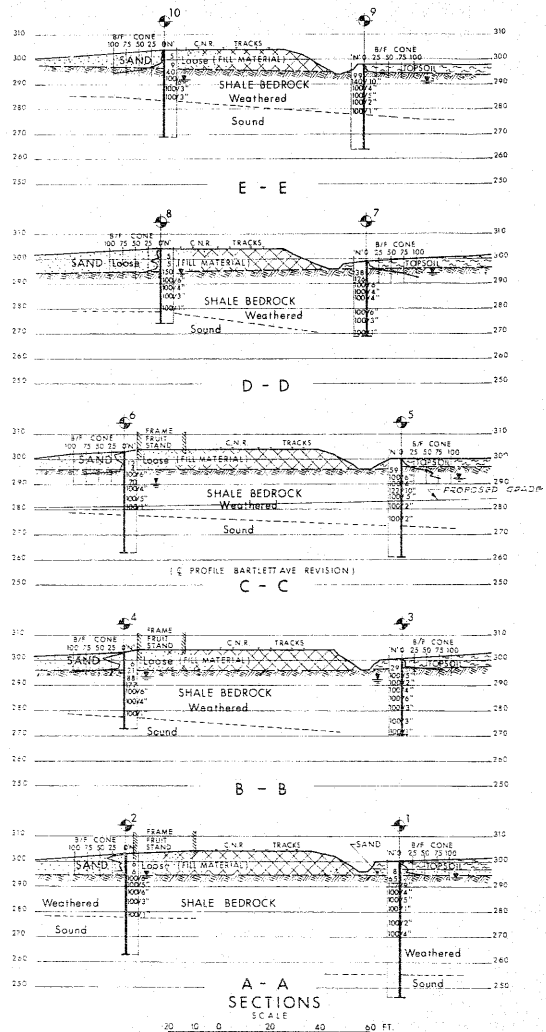
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

### 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



**LEGEND**

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. APPX. 1969

NO.	ELEVATION	STATION	OFFSET
1	300.5	11+74	56.5 FT
2	303.0	11+78	58.5 FT
3	300.5	12+19	50.5 FT
4	303.0	12+24	53.5 FT
5	300.0	12+98	56.5 FT
6	303.0	13+03	53.0 FT
7	299.0	13+58	51.0 FT
8	304.1	13+60	52.1 FT
9	308.0	14+12	59.0 FT
10	304.1	14+15	54.0 FT

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

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING OFFICE - POSITION SECTION

**BARTLETT AVE. REV'N & C.N.R.**

KING'S HIGHWAY NO. \_\_\_\_\_ DIST. NO. 4  
CO. LINCOLN  
TWP. N GRIMSBY LOT 2 CON. 1

**BOREHOLE LOCATIONS & SOIL STRATA**

SUBNO. V.K. CHECKED \_\_\_\_\_ M.P. NO. 370-65-2 M.B.T. DRAWING NO. \_\_\_\_\_  
DRAWN J.N. CHECKED \_\_\_\_\_ JOB NO. 69-F-13 69-F-13A  
DATE 7 JULY 1969 SHEET NO. \_\_\_\_\_ BRIDGE DRAWING NO. \_\_\_\_\_  
APPROVED \_\_\_\_\_ CONT. NO. \_\_\_\_\_  
FORWARDED \_\_\_\_\_ FOR FILE NO. \_\_\_\_\_

## MEMORANDUM

To: Mr. M. Devata  
Supervising Foundation  
Engineer

FROM: K. Ingham  
Materials and Testing Office

DATE: August 14, 1969

OUR FILE REF.

IN REPLY TO

SUBJECT: Foundation Conditions in the Vicinity of the  
Proposed Grimsby Interchange Complex

69-F-13

This memo will summarize our visit to the site, and collective observations concerning the stratigraphy of the area. Attached are a list of the exposures examined, together with a brief description.

Different zones are present which correspond approximately with layers described in foundation reports for the various structures. The Queenston shale bedrock is overlain by a dense till but between the till and the bedrock horizon there can be positively identified as sound and unweathered, a variable thickness of broken or partly weathered shale which is transitional with the till above and the undisturbed shale below.

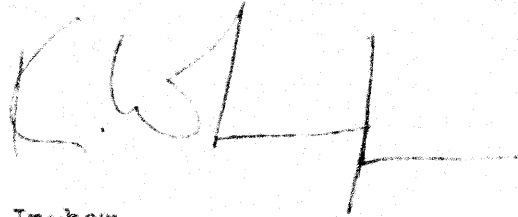
The Queenston shale is thin bedded but relatively homogeneous, that is, it does not possess the characteristic fissility that is common to shale - this may be partly due to the calcareous content. Harder calcareous or sandy bands are occasionally present throughout the sections exposed. The sound shale breaks down slowly in the presence of water by the spalling of small flakes from the surface. This effect becomes progressively slower unless the debris is continually removed. The resulting material will eventually form a relatively plastic clay. It is believed that the zone of broken shale is a preliminary stage in this process. If a veneer of clay originally capped the broken shale this has been incorporated in the till.

The broken shale, although still preserving the original bedding, is fragmented into pieces up to 3' in size; the broader beds are often broken into flat slabs 1 to 2 ft. in thickness. It is assumed that in any out drainage channel the broken fragments would eventually form a stable bed. This zone will in all probability be a water bearing horizon. In open excavations steep but slopes would be stable, however, for a



maintenance point of view your decision to use normal earth slopes seems more logical in this case.

Transitions from till to broken shale and broken shale to sound shale are relatively sharp with only 0.5 to 1.0 ft. of transition zone between each horizon. The transition from broken to sound shale is largely academic as very little difference should be noticed during excavation.

A handwritten signature in dark ink, appearing to read 'K. Ingham', with a long horizontal line extending to the right.

K. Ingham  
Geologist

MI:nm  
Encl.

Exposures

1. The west bank of 40 mile creek and the future centre line of Cristie Street.

0 - 5.0 ft. Dense clayey silt till - 0.5 ft. transition zone with broken shale fragments at the base.

5.0 - 15.0 ft. Broken red and brown shale with occasional green - gray layers. Preserving original stratification.

15.0 - 16.0 ft. Transition from broken to sound shale.

16.0 - 35.0 ft. Red and brown thin bedded shale with minor thin green bands. Occasional grey interbeds of calcareous or sandy shale, 0.1 to 0.3 ft. in thickness.

2. Bank of 40 mile creek south of the intersection of Fairview and Patton Streets. Hand-dug trench.

0 - 7.5 ft. Dense clayey silt till.

7.5 - 8.0 ft. Transition zone, abundant red shale fragments in the lower half.

8.0 - 18.0 ft. Broken red and brown shale.

18.0 - 20.0 ft. Transition from broken to sound shale.

20.0 ft. + Red and brown thin bedded shale with minor thin green bands.

3. Future S.E.W. and Rambley Rd. Interchange, south of S.W. track 10 ft. north of hole No. 5 (7-12) in gravel creek bank.

0 - 1.0 ft. Dense till.

1.0 - 1.7 ft. Transition from till to broken shale.

1.7 - 5.5 ft. Broken shale.

5.5 - 12.0 ft.+ Broken shale in banks of S.E.W. road cut.