DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

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

Attention: Mr. S. McCombie

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

Date: June 19, 1968

Our File Ref.

In reply to

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Underpass Structure
At the Crossing of
Sunset Drive and the Q.E.W.
District No. 4 (Hamilton)
W.J. 68-F-23 -- W.P. 447-65

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 do not hesitate to contact our Office.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeP
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

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For
Proposed Underpass Structure
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1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the site of the crossing of the Sunset Drive Revision and the Q.E.W., in the Twp. of Bertie, County of Welland. The request was contained in a memo from the Bridge Division (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated March 22, 1968. An investigation was subsequently carried out by this Section to determine the subsoil conditions at the site.

This report contains the results of the investigation, together with recommendations pertaining to the foundations of the proposed structure and the stability of the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located about 3 miles west of the town of Fort Erie. At this location the Queen Elizabeth Way grade is some 4 ft. above the surrounding ground surface. The highway itself consists of four paved lanes with grassed median and associated gravel shoulders. Along each side of the highway there is a wide flat drainage ditch the invert of which is about 4 ft. below the surrounding ground surface. The ditch side slopes, on the highway side, are approximately 4:1, while away from the highway the ditch rises gradually to the flat surrounding ground. The existing Sunset Drive diagonally crosses the Q.E.W., rising from ground level to meet the Q.E.W. grade at the intersection. Sunset Drive is only paved at the approaches. The surrounding area is flat and open except for a lightly wooded area northeast of the intersection. A few hundred yards westerly along the Q.E.W. is an interchange where Bowen Rd. intersects the Q.E.W.

cont'd. /2 ...

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

Physiographically, the site is situated in the "Haldimand Clay Plain". Based on available geological information, it is known that the overburden of this region consists of lacustrine clay deposited in glacial Lake Warren formed during the retreat of the last continental glacier. The bedrock in the area is composed of dolomite of the Norfolk formation.

3. FIELD AND LABORATORY WORK:

Six boreholes, each with an accompanying dynamic cone penetration test, were carried out during the field investigation. Fourteen additional dynamic cone penetration tests were carried out to obtain a well defined bedrock profile. The borings were advanced by means of a conventional diamond drill rig adapted for soil sampling purposes. In addition, two boreholes, each with a dynamic cone penetration test, were carried out on August 23, 1966, by H. Q. Golder and Associates as part of the preliminary investigation. These preliminary boreholes were advanced by a continuous flight auger.

Samples were obtained at required depths in a 2-inch O.D. split-spoon sampler which was hammered into the soil in accordance with the specifications for the standard penetration test. Bedrock was proven in five of the borings by obtaining AXT size rock core samples. During sampling and drilling operations, detailed logs of the borings were made. These logs contain a record of the drilling and sampling techniques used, together with the soil types encountered and the groundwater elevations observed in the borings during the period of the investigation.

The locations and elevations of all the borings were surveyed in the field by personnel from the Central Region Engineering Surveys Section and are shown on Drawing 68-F-23A, together with the estimated stratigraphical profile.

cont'd. /3 ...

3. FIELD AND LABORATORY WORK: (cont'd.) ...

All samples were subjected to a careful visual inspection in the laboratory. Following this inspection, tests were carried out on certain samples to determine the engineering properties of the various soil types, namely:

Natural Moisture Contents
Atterberg Limits
Grain-Size Distributions

On completion of these tests, the various soil samples were classified as to type and consistency in accordance with the Unified Soil Classification System (Oct. 1963).

The results of the laboratory tests are summarized and plotted on the Record of Borelog sheets contained in the Appendix of the report.

4. SOIL TYPES AND SOIL CONDITIONS:

4.1) General:

Subsoil at the site consists of a thin (6") surface layer of topsoil overlying 2 to 3 ft. of fill material (silty clay) in the area of the E.E.W. embankment. Underlying this fill material and immediately below the topsoil, over the remainder of the site, is a 5 to 9 ft. thick deposit of silty clay to clayey silt with a trace of sand and gravel. The overburden is underlain by sound siliceous and shaley dolomite bedrock.

The boundaries between the various soil strata are shown on the Record of Borelog sheets contained in the Appendix of the report. The estimated stratigraphical profiles shown on Dwg. #68-F-23A, are based on this information.

From ground level downwards, the different soil types are described in detail as follows:

cont'd. /4 ...

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.2) Fill Material (Silty Clay with a trace of Sand and Gravel):

Underlying the topsoil in B.H.'s #5, 11 and 16, a 2 to 3 ft. layer of brown to reddish-brown silty clay with traces of sand, gravel and organics, was encountered. 'N' values ranging from 8 to 11 blows per foot indicate a stiff consistency. This deposit is believed to be fill material placed during construction of the Queen Elizabeth Way.

4.3) Silty Clay to Clayey Silt with a trace of Sand and Gravel:

Underlying the topsoil and/or fill material, a 5 to 9 ft. deposit of reddish-brown to brown silty clay to clayey silt with traces of sand and gravel was encountered. On the north side of the Q.E.W. the cohesive deposit contains occasional layers of sand up to 3" in thickness, whereas on the south side the deposit contains thin (1/2") layers of silt. The percentage of sand is somewhat variable throughout the deposit. In B.H.'s 16 and 19 a distinct layer (8" thick) of very dense sandy silt was encountered below the cohesive deposit and above the bedrock. However, in general, the deposit may be described as clayey silt to silty clay.

Physical properties of this deposit as determined from the laboratory tests, are:

Moisture Content	(w)	=	9 - 30%
Liquid Limit	(w_L)	=	19 - 58%
Plastic Limit	(w_P)	=	12 - 26%
Grain-Size Distribution			
- Gravel		=	1 - 22%
- Sand		=	7 - 29%
- Silt		=	35 - 63%
- Clay		=	14 - 45%

'N' values for the overall deposit ranged from 11 to 64 blows per foot, indicating a stiff to hard consistency.

cont'd. /5 ...

4. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

4.4) Dolomite Bedrock:

Bedrock was proven in five of the borings by obtaining from 5 to 8 ft. of AXT rock core. One additional borehole and fourteen dynamic cone penetration tests were carried out; at these locations bedrock contact was assumed where the cone test, or the split-spoon sampler met practical refusal. The depth at which bedrock was encountered ranged from elevations 601 to 608 - i.e., 4 to 13 ft. below existing ground surface. The bedrock slopes towards the south, dropping 7 ft. in about 400 ft.

The bedrock is composed of a grey siliceous dolomite with some shaley dolomite layers. It is generally in a sound condition as evidenced by the high core recovery (86% - 100%). Near the surface of the bedrock there are occasional vertical fractures.

5. GROUNDWATER CONDITIONS:

Groundwater level observations were made in the open boreholes during the period of the investigation. These observations which are recorded on the borehole logs and summarized on Dwg. No. 68-F-23A, indicate that the groundwater level ranges from elevation 606 to 608.5, or some 2 to 10 feet below existing ground level.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct an underpass structure to carry the Sunset Drive Revision over the Queen Elizabeth Way. The proposed Sunset Drive realignment is situated parallel to and about 50 feet west of the existing road. At present there are two proposals for construction of this underpass.

One calls for a four-span (56'-128'-128'-56') structure having strip footings running parallel to the Q.E.W. The other

cont'd. /6 ...

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

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

proposal calls for a four-span (69'-128'-128'-69') structure with square pier footings supporting a single column and with the abutment footings perpendicular to Sunset Drive. Approach fills for both proposals will have a maximum height of about 20 ft. above the existing S.B.N. grade.

Subsoil at the site generally consists of a shallow deposit of silty clay to clayey silt with a trace of sand and gravel. The overburden is underlain at a depth of 4 to 13 ft. below existing ground surface by sound siliceous and shaley dolomite bedrock.

6.2) Structure Foundations:

6.2.1) Pier Footings:

For both proposals the pier footings may be founded on spread footings placed at elev. 609 within the stiff to hard silty clay to clayey silt with a safe design load of 2.5 t.s.f. In all cases, a minimum cover of 4 ft. should be provided for the footings in order to have adequate frost protection.

In view of the proximity of the bedrock, an alternate proposal would be to found the piers directly on the sound bedrock with a safe bearing pressure of up to 15 t.s.f.

6.2.2) Abutment Footings:

The abutments for both proposals may be supported on spread footings placed within the approach fills. The fill material, below the tops of the footings, should consist of well compacted G.B.C., Class 'A' material and should extend for a horizontal distance of at least 10 ft. from the footing edges in the plane of the footing tops. This portion of the fill should be constructed with slopes of 2:1. All topsoil and fill material in the vicinity of the abutments should be removed before placing

cont'd. /7 ...

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

6.2) Structure Foundations: (cont'd.) ...

6.2.2) Abutment Footings: (cont'd.) ...

the approach fills. The remainder of the fill should be completed to above profile grade for a distance of at least 50 feet behind the abutments before re-excavating for the abutment footings. A safe design load of 2 t.s.f. may be used for the abutment foundation. Differential settlements will be of a negligible order for any of the above mentioned structure proposals.

6.3) Dewatering:

No major dewatering problems are anticipated for any of the excavations; however, any seepage from the thin silt or sand seams can be controlled by using ordinary pumping methods. Care should be taken to prevent softening of the foundation base by surface runoff. A working slab or granular pad should be placed immediately after the required excavation is completed.

6.4) Approach Embankments:

There will be no overall stability problems for the proposed 20-ft. high approach embankments provided that standard slopes of 2 horizontal to 1 vertical are used.

7. SUMMARY:

The results of a foundation investigation for the proposed underpass structure at the crossing of Sunset Drive and the Queen Elizabeth Way are presented.

Subsoil at the site generally consists of a shallow deposit of stiff to hard silty clay to clayey silt with traces of sand and gravel, followed by sound siliceous and shaley dolomite bedrock.

The pier footings can be founded 1) on spread footings placed within the overburden using a safe bearing pressure of

cont'd. /8 ...

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

2.5 t.s.f., or ii) directly on the sound bedrock using a safe bearing pressure of up to 15 t.s.f. The abutments can be founded on spread footings located within the approach fill.

The differential settlement between the various structure foundations should be within tolerable limits.

No major dewatering nor embankment stability problems are anticipated.

8. MISCELLANEOUS:

The field work carried out during April 18 to April 22, 1968, was supervised by Mr. W. Button, Project Foundation Engineer, who also wrote this report.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who reviewed this report.

The equipment was owned and operated by Dominion Soil Investigation Ltd.

June, 1968.

APPENDIX I

FORM CO-MT-126
66-4546

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 1 to 4

FOUNDATION SECTION

JOB 68-F-23
W P 447-65
DATUM Geodetic
LOCATION Q. E. W. - Sunset Drive
BORING DATE April 18, 1968
BOREHOLE TYPE Dynamic Cone Penetration Test
ORIGINATED BY WH
COMPILED BY TC
CHECKED BY

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) / SHEAR STRENGTH P S F	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % (15 30 45)	BULK DENSITY γ P C F	REMARKS
	Nº1 STA 27+82 19'RT									
611.8	Ground Level									
0.0						610	Hammer bouncing			
608.0 / 3.8	End of Cone Test Probably Bedrock					600				
	Nº2 STA 28+00 19'RT									
612.5	Ground Level									
0.0						610	Hammer bouncing			
608.2 / 4.3	End of Cone Test Probably Bedrock					600				
	Nº3 STA 28+00 16'LT						WASHBORING - DIAMOND DRILL			
612.3	Ground Level									
0.0	Clayey silt with tr. of sand & gravel. Some sand layers up to 3" thick. Very stiff to hard. Brown.		1	SS	16	610				608.4
			2	SS	64					
			3	CS						
607.1			4	SS	37/7"		Hammer bouncing			
5.2	Siliceous dolomite with shaley solomite inclusions		5	RC	100% Rec					
599.5	Occasional vertical fractures. Sound. Grey		6	RC	100% Rec	600				
12.8	End of Borehole									
	Nº4 STA 28+33 16'LT									
613.0	Ground Level									
0.0						610	hammer bouncing			
606.9 / 6.1	End of Cone Test Probably Bedrock					600				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 5 to 8

FOUNDATION SECTION

JOB 68-F-23 LOCATION Q. E. W. - Sunset Drive ORIGINATED BY WH
W P 447-65 BORING DATE April 18, 1968 COMPILED BY TC
DATUM Geodetic BOREHOLE TYPE Washboring - Diamond Drill CHECKED BY
Dynamic Cone Penetration Tests

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
	Nº 5 STA 28+48 19'RT					
614.9	Ground Level					
612.9	Fill mat'l. Stiff. Reddish-brown.		1	SS	10	
2.0	Silty clay to clayey silt with trace of sand & gravel. Hard.		2	SS	51	
			3	SS	36	610
607.6	Reddish-brown to brown		4	CS		
			5	SS	26/10"	
7.3	Siliceous dolomite with shaley dolomite incls.		6	RC	97% Rec.	
602.7	Sound. Grey.		7	RC	100% Rec.	
12.2	End of Borehole					600
	Nº 6 STA 28+61 8'LT					
613.6	Ground Level					
0.0						610
607.1						
6.5	End of Cone Test Probably Bedrock					600
	Nº 7 STA 28+81 10'RT					
615.7	Ground Level					
0.0						610
607.1						
8.6	End of Cone Test Probably Bedrock					600
	Nº 8 STA 28+93 16'LT					
614.9	Ground Level					
0.0						610
606.7						
8.2	End of Cone Test Probably Bedrock					600

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P S F

Hammer bouncing
Hammer bounding
Hammer Bouncing
Hammer Bouncing

LIQUID LIMIT ——— w_L
PLASTIC LIMIT ——— w_P
WATER CONTENT ——— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY
γ P C F

REMARKS
Gr.Sa.Si.Cl.
3 7 45 45
4w14 63 19
608.0

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 9 to 12

FOUNDATION SECTION

JOB 68-F-23 LOCATION Q. E. W. - Sunset Drive ORIGINATED BY WH
W P 447-65 BORING DATE April 19, 1968 COMPILED BY TC
DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY
Washboring - Diamond Drill

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P S F	LIQUID LIMIT WL PLASTIC LIMIT WP WATER CONTENT W WP W WL WATER CONTENT % 15 30 45	BULK DENSITY P C F	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT					
615.9	Nº 9 STA 29+73 19'RT Ground Level									Gr.Sa.Si.Cl
0.0 605.8						610 600	Hammer bouncing			
10.1	End of Cone Test Probably Bedrock									
617.3	Nº 10 STA 29+91 8'LT Ground Level									
0.0 605.1						610 600	Hammer bouncing			
12.2	End of Cone Test Probably Bedrock									
616.1	Nº 11 STA 30+00 ℄ Ground Level									
0.0 613.1	Clayey topsoil & silty clay fill matl.with tr. of sand & gr.&organics		1	SS	8					
	Stiff. Brown.		2	SS	24					0 2 25 73
3.0	Silty clay to clayey silt with trace of some sand & trace of gravel.		3	SS	21	610	Hammer bouncing			
	Very stiff to hard.		4	SS	22					
604.9	Reddish-brown.		5	SS	34					606.0
11.2	Siliceous Dolomite		6	SS	29/9"					11-14 55 20
599.5	with shaley dolomite incls. Sound. Grey.		7	RC	86% Rec	600				
16.6	End of Borehole									
617.0	Nº 12 STA 30+23 16'LT Ground Level									
0.0 604.3						610 600				
12.7	End of Cone Test									

FORM DB-MT-12A
OFFICE — IN SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 13 to 16

FOUNDATION SECTION

JOB 68-F-23 — LOCATION Q. E. W. -- Sunset Drive — ORIGINATED BY WH
W P 447-65 — BORING DATE April 18, 1968 — COMPILED BY TC
DATUM Geodetic — BOREHOLE TYPE Dynamic Cone Penetration Test, Washboring-Diamond Drill — CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P S F	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 15 30 45	BULK DENSITY P C F	REMARKS
610.9	Nº 13 STA 31+02 19'RT Ground Level									Gr.Sa.Si.Cl
0.0 603.4						610 600				
7.5	End of Cone Test									
	Nº 14 STA 31+19 8'LT									
614.0	Ground Level									
0.0 602.6						610 600	Hammer Bouncing			
11.4	End of Cone Test Probably Bedrock									
	Nº 15 STA 31+39 10'RT									
609.4	Ground Level									
0.0 602.3						600	Hammer Bouncing			
7.1	End of Cone Test Probably Bedrock									
	Nº 16 STA 31+ 0 16'LT									
612.4	Ground Level									
0.0 609.4	Clayey topsoil & silty clay till mat'l. with gr. of sand & organics. Stiff. Brown.		1	SS	11	610				1 16 59 24
3.0	Clayey silt with trace of sand & gravel. Some thin (¼") sand seams. More sand & gr. below elev. 605. Hard. Brown.		2	SS	32		Hammer bouncing			▼606.6
			3	SS	33					
			4	SS	63					
602.1			5	SS	58		86/3"			
			6	SS	8/5"					
10.3	Siliceous dolomite with shaley dolomite incls. Sound. Brey.		7	RC	100% Rec.	600				22 29 35 14
597.0						590				
15.4	End of Borehole									

FORM 108 MT (5/67)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 17 to 20

FOUNDATION SECTION

JOB 68-F-23 LOCATION C.E.W. -- Sunset Drive ORIGINATED BY WH

W P 447-65 BORING DATE April 19, 1968 COMPILED BY TC

DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test, Washboring - Diamond Drill CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH PSF	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w — WATER CONTENT % 15 30 45	BULK DENSITY γ PCF	REMARKS
610.1	**No 17 STA 31+61 19'RT** Ground Level					610				Gr.Sa.Si.Cl
0.0							Hammer bouncing			
601.6										
8.5	End of Cone Test Probably Bedrock					600				
609.5	**No 18 STA 31+98 16'LT** Ground Level									
0.0										
601.0							Hammer bouncing 12"/6"			
8.5	End of Cone Test Probably Bedrock					600				
609.5	**No 19 STA 31+98 19'RT** Ground Level									
0.0	Silty clay to clay with trace of sand & gravel & many thin (½") silt seams. Reddish		1	SS	11					
			2	SS	29					▼ 606.2
603.5	Stiff to hard. Brown.		3	SS	32					
6.0	Clayey silt with some sand & trace of grav.occ.silt		4	SS	54		Hammer bouncing			
600.8	seams. Hard. Brown.		5	SS	100/8"					5 25 54 16
8.7	Siliceous dolomite with shaley dolomite incls.		6	RC	91% Rec	600				
595.3	Sound. Grey.									
14.2	End of Borehole					590				
	No 20 STA 32+19 16'LT Ground Level						DRY BORING			
609.0										
0.0	Clayey silt with some sand & gravel. Hard. Brown. Sandy silt below elev.601.7.		1	SS	38					▼ 607.1
601.0	Very dense. Brown		2	SS	150		250/8"			
8.0	End of Borehole Probably Bedrock					600				

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 21 & 22 (Golder 23 & 24)

FOUNDATION SECTION

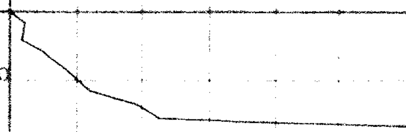
JOB 68-F-23
W.P. 447-65
DATUM Geodetic
LOCATION Q.E.W. -- Sunset Drive
BORING DATE August 23, 1966
BOREHOLE TYPE Power Auger Boring
ORIGINATED BY Golder
COMPILED BY MW
CHECKED BY ✓

Column headings: SOIL PROFILE (ELEV / DEPTH; DESCRIPTION; STRAT PLOT) · SAMPLES (NUMBER; TYPE; BLOWS / FOOT) · ELEV SCALE · DYNAMIC PENETRATION RESISTANCE, BLOWS / FOOT 20 40 60 80 100; SHEAR STRENGTH P.S.F. · LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % 15 30 45 · BULK DENSITY P.C.F. · REMARKS

Nº 21 STA 28+96 65'LT

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	REMARKS
615.3	Ground Level				
613.3	Clayey topsoil. Stiff. Brown.	1	SS	9	
2.0	Silty clay with some sand & gravel. Very stiff to hard. Brown.	2	SS	28	▼608.4 in standpipe Sept.12/66
606.9 / 8.4	Siliceous dolomite with shaley dolomite incls. occ.near vert.fractures Sound. Grey.	3	AXT RC	93% Rec	
601.9 / 13.4	End of Borehole				

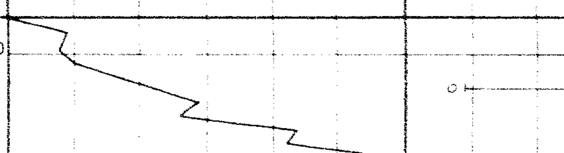
Elev scale: 610, 600, 590



Nº 22 STA 32+29 74'LT

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	REMARKS
612.7	Ground Level				
611.7	Silty topsoil. Brown.	1	SS	19	
1.0	Silty clay with some sand & gravel. Hard. Brown.	2	SS	84	▼608.5 Sept.12/66
		3	SS	>100	
600.8 / 11.9	End of Borehole. Refusal to augering. Probable Bedrock				

Elev scale: 610, 600, 590



FORM 08-MT-252
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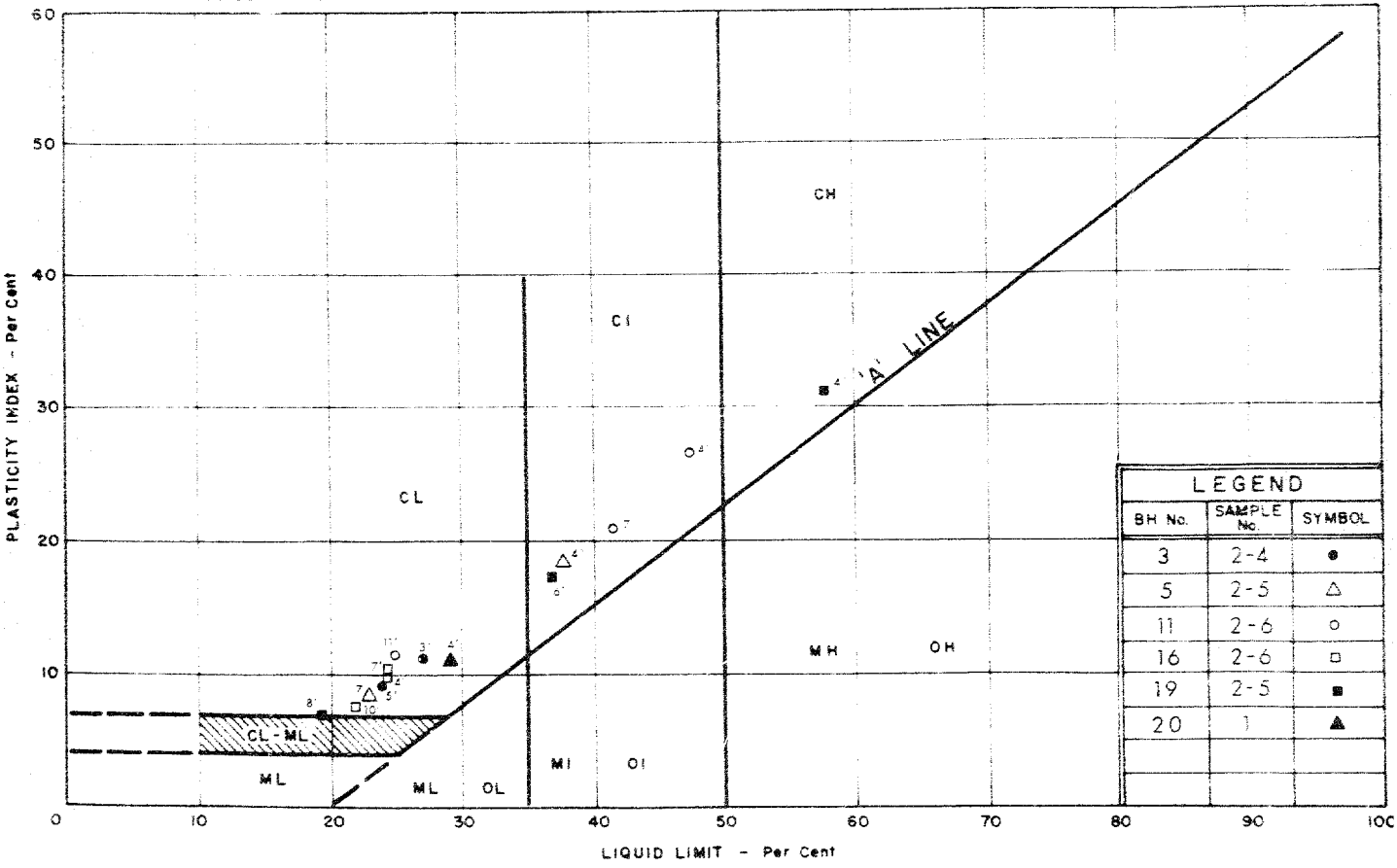


DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

W.P. No. 447-65
JOB No. 68-F-23

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

Q_u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q_{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q_d	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 } IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION } IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi_u$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi_u$
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

a	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

Telephone: 843-3446

Mr. W. Miglo,
Program Engineer,
Administration Files.

E.J. McCabe,
Toronto Regional Road Design.

March 13, 1968.

Re: Queen Elizabeth Way from Highway 405 to Fort Erie, District 4, Hamilton.

Your letter of February 12, 1968 requesting a program for placement of early fills as recommended by the Foundation Section has been passed on to me for comment.

This afternoon Mr. Devata, Foundations Section, Mr. Melinyshyn, Bridge Planning Section, and the writer met to consider our needs for early fill placement. It was determined that early fill would be placed:

1) If required for bridge construction.

2) If required for grading purposes. A 6" settlement or more was used as a basis to determine the need for early fill placement for grading purposes.

The following is a summary of our conclusions:

1) Mountain Road Interchange - W.P. 154-64.

Bridge Office to decide in one month whether early fill placement required for bridge purposes.

2) Thorold Stone Road - W.P. 155-64-03.

No early fill placement required.

3) Noland Road - W.P. 156-64.
4) Northbound West Service Road - W.P. 157-64-2.

Both bridges will be on piles. An 8½" settlement is predicted. We propose delaying the final paving of the fill areas from one to two years.

Continued .... /2

March 13, 19[illegible].

Mr. H. Wigle - Re: Queen Elizabeth Way.

5) Lyons Creek - W.P. 158-64-01.
6) Beck Road - W.P. 442-65.
7) Rossert Road - W.P. 443-65.
8) Sodom Road - W.P. 159-64.
9) Baker Road - W.P. 445-65.
10) Townline Road, Black Creek, Service Road - W.P. 167-64.
11) Ridgemount Road - W.P. 165-64.
12) Bowen Road
13) Sunset Drive - W.P. 447-65.
14) Gilmore Road - W.P. 448-65.

Considerable settlement can be anticipated for the above structure sites and approach thereto. We propose that early fill placement be considered two years in advance of the current construction program year.

15) West-North and South Ramp - W.P. 162-64-2.
16) Thompson Road - W.P. 162-64-1.
17) - W.P. 162-64-3.
18) C.N.R. Widening - W.P. 162-64-05.
19) Concession Road (Erie St.) - W.P. 161-64.
20) North Street Revision - W.P. 160-64.

No early fill placement required at these sites.

E.J. McCabe
Expressway Consultant Control Engineer
For:
C.A. Hunter
Regional Road Design Engineer

EJM/GH

c.c. A. Devata
W. Melinyshyn
A.J. Fletcher
E.A. Fletcher

68-F-23

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

TO: Mr. A. G. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Building.

FROM: G. C. E. Burkhardt,
Bridge Planning Section,
Central Building.

ATTENTION: M. Devata

DATE: February 4th, 1971.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 447-65, Site 34-222,
Sunset Drive Underpass,
Hwy. Q.E.W., District 4.

30L-8
GEOCRES No.

This will confirm our discussion of this afternoon regarding the foundation investigation for this structure.

At the request of the Bridge Design Office the alignment of Sunset Drive was altered to reduce the skew angle and thereby the length of the structure. The new alignment is some 400' to 500' east of the location for which investigation W.J. 68-F-23 was made.

It was agreed that the findings of the above report should be used as a guide in the preparation of the preliminary bridge drawing. Following receipt of the preliminary proposal by the Foundation Section they will put down a few more holes at the location of the pier & abutments in order to confirm rock elevation and soils stratification.

Programming should therefore arrange the schedule to allow time within the bridge design period for Foundations to do this work.

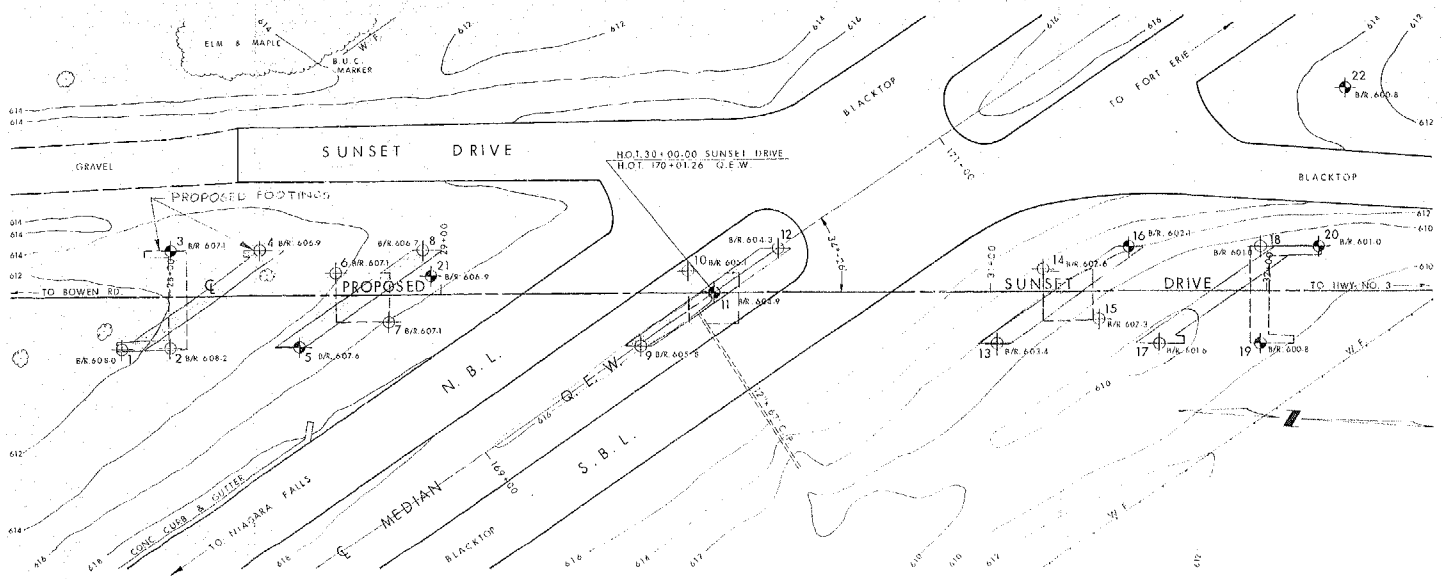
J. F. Walshe.

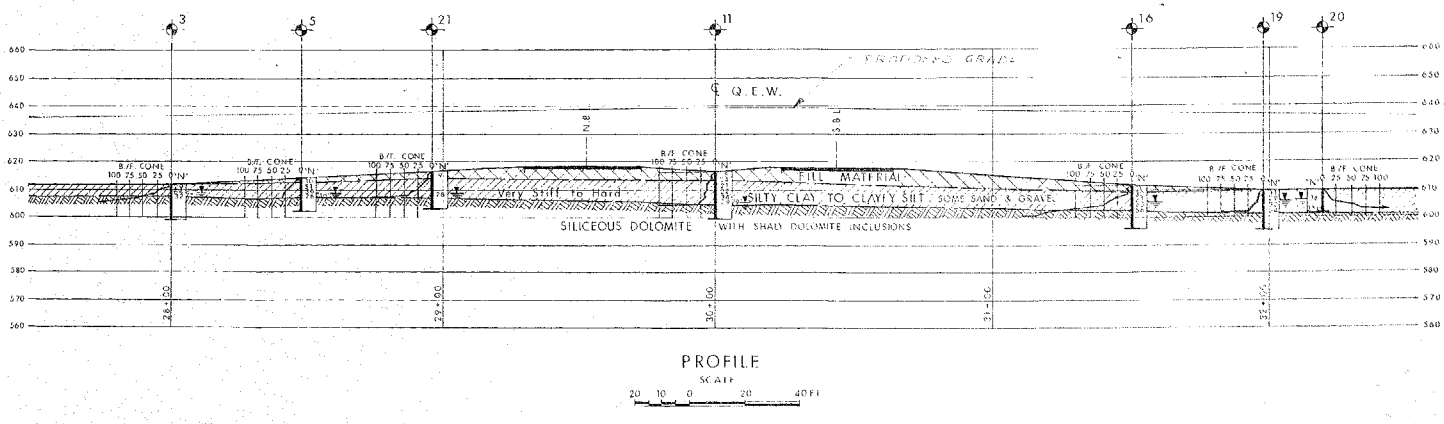
JFW:lc

J. F. Walshe,
REG. BRIDGE PLANNING SUPERVISOR,
for:
G. C. E. Burkhardt,
REG. BRIDGE PLANNING ENGINEER.

c.c. G. K. Hunter
S. McCombie
C. Grebski
R. Fitzgibbon

THE ADDITIONAL WORK WILL BE DONE UNDER THE OLD NUMBER 68-F-23





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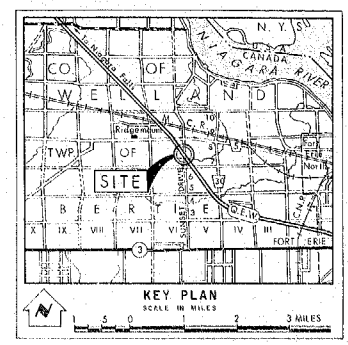

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. April 1968

NO.	ELEVATION	STATION	OFFSET
1	611.8	27+82	19' RT.
2	612.5	28+00	19' RT.
3	612.3	28+00	16' LT.
4	612.0	28+33	16' LT.
5	614.9	28+28	19' RT.
6	612.6	28+61	8' LT.
7	615.7	28+81	19' RT.
8	614.9	29+5.	16' LT.
9	613.9	29+23	19' RT.
10	617.8	29+91	9' LT.
11	616.1	30+00	0
12	617.0	30+23	16' LT.
13	610.9	31+02	19' RT.
14	614.0	31+19	8' LT.
15	609.4	31+19	19' RT.
16	612.4	31+30	16' LT.
17	610.1	31+61	19' RT.
18	609.5	31+98	8' LT.
19	609.5	31+98	19' RT.
20	609.0	32+19	16' LT.
21	613.3	28+96	0 ℄ LL
22	612.3	32+29	79' 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.

REVISIONS			
DATE	BY	DESCRIPTION	

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

SUNSET DRIVE

KING'S HIGHWAY NO. Q.E.W. DIST. NO. 4
CO. WELLAND
TWP. BERTIE LOT 7 & 8 CON. V & VI

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D W. H	CHECKED	H.P. NO. 447-65	M.B.T. DRAWING NO. 68-F-23A
DRAWN G. P.	CHECKED	JOB NO. 68-F-23	
DATE JUNE 19, 1968		SITE NO.	BRIDGE DRAWING NO.
APPROVED (ORIGINAL FOUNDATION ENGINEER)		CONT NO.	