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: July 25, 1968

Our File Ref.

In reply to AUG - 7 1968

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Service Road No. 8
And
Black Creek Crossing
Twp. of Willoughby - Co. of Welland
District No. 4 (Hamilton)
W.J. 68-F-32 -- W.P. 167-64-03

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.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

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

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1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the crossing of Black Creek by proposed Service Road No. 8 in Willoughby Twp., Welland County. The request was contained in a memo from the Bridge Division (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated March 25, 1968, which also contained a request for foundation investigations at two other sites in the vicinity. Subsequently, a foundation investigation was carried out by this Section at the above site. This report contains the results of the investigation, together with our recommendations for the design of foundations for the proposed structure as well as the stability of the approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located some 12 miles south of Fort Erie in Willoughby Twp., Welland County. The proposed crossing is located in the immediate vicinity of an existing structure which carries Townline Rd. (County Rd. No. 7) across Black Creek. At this site, Black Creek is a shallow stream, some 110 ft. in width. The topography consists of generally flat-lying land. Areas to the west of the creek are marshy.

Physiographically, the area is located in the "Haldimand Clay Plain" region where lacustrine deposits overlie a glacial till and interbedded shales and dolomites of the Salina formation.

cont'd. /2 ...

3. FIELD AND LABORATORY WORK:

A total of 6 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. Two of the boreholes were put down in the stream from a raft.

Samples were recovered at required depths in a 2" O.D. split-spoon sampler which was hammered into the soil, or in 2" I.D. Shelby tubes which were manually pushed into the cohesive portions of the overburden. The method of driving the split-spoon sampler conformed to the specifications for the Standard Penetration Test. The same method was used to advance the dynamic cone penetration tests. Field vane tests were carried out, where possible, in the cohesive portions of the overburden, to determine the undrained shear strength characteristics. Bedrock was proven at all borehole locations by drilling in AXT core size.

The locations and elevations of the boreholes are shown on Drawing 68-F-32A, together with the estimated stratigraphical profile across the site. Surveying was performed by the Central Region Engineering Surveys Section. Elevations shown are referenced to a geodetic datum.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, laboratory tests were carried out on selected samples in order to determine the following physical properties of the overburden:

Natural Moisture Contents
Atterberg Limits
Bulk Densities
Grain-Size Distributions
Organic Matter Contents
Undrained Shear Strengths

The results of these tests are plotted on the individual Borelog sheets as well as on the Figures in the Appendix to this report.

cont'd. /3 ...

4. SUBSOIL CONDITIONS:

4.1) General:

The surficial stratum across the site is a 3 to 6 ft. thick deposit of soft to firm organic clay. This deposit is underlain by a glacial till stratum, some 8 to 10 ft. in thickness, followed by interbedded shale and dolomite bedrock at depths of 13 to 16 ft. below ground level.

4.2) Organic Clay:

A surficial deposit of organic clay was encountered at Boreholes 1, 2, 3, 4 and 6 to depths ranging between 3 and 6.5 ft. The organic content of the deposit was found to be as high as 10%, with a corresponding liquid limit, plastic limit and natural moisture content of respectively 87%, 32% and 83%. The bulk density of one sample was 96 p.c.f. Undrained shear strengths ranged between 300 and 650 p.s.f., indicating a soft to firm consistency.

4.3) Glacial Till (Clayey Silt to Silty Clay with some Sand and Gravel, changing to a Mixture of Silt, Sand and Gravel):

The glacial deposit was encountered below the organic clay at Boreholes 1, 2, 3, 4 and 6, and below stream bed level at Borehole 5, and was found to extend to the bedrock surface. The total thickness of the deposit ranged between 8 to 10 ft. This stratum is essentially cohesive in the upper portions, consisting of a mixture of clayey silt to silty clay, sand and gravel and changing with depth to a mixture of silt, sand and gravel below about elevation 554. It is believed that the non-cohesive portion of the glacial till deposit may have been derived from the upper weathered portions of the underlying bedrock. The range in the physical properties of the cohesive portions of the deposit are as follows:

cont'd. /4 ...

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

4.3) Glacial Till (Clayey Silt to Silty Clay with some Sand and Gravel, changing to a Mixture of Silt, Sand and Gravel): (cont'd.) ...

Natural Moisture Content (W) - %	16 - 36
Liquid Limit (W_L) - %	19 - 36
Plastic Limit (W_p) - %	12 - 22
Bulk Density (p.c.f.)	120
Standard Penetration Resistance 'N'(Blows/ft.)	23 - >100

The grain-size distribution curves are shown in the Appendix. The Atterberg limits are plotted on the Plasticity Chart which is also given in the Appendix. On the basis of the 'N' values, the cohesive portion of the deposit is considered to be of very stiff to hard consistency, and the non-cohesive glacial till at the base of the deposit is considered to be very dense with 'N' values generally in excess of 100 blows/ft.

4.4) Bedrock:

Bedrock was encountered at all borehole locations between elevations 549 and 552, i.e., some 13 to 16 ft. below ground surface or 9 to 12 ft. below stream bottom.

Examination of the cores recovered indicates the bedrock to be an interbedded gypsiferous shale and siliceous dolomite with occasional seams of gypsum up to 12" in thickness. Core recoveries were generally 90% or greater, indicating the bedrock to be sound.

cont'd. /5 ...

5. GROUNDWATER CONDITIONS:

Observations of the groundwater level in open boreholes during the course of the investigation indicated a groundwater level close to the surface of the ground, i.e., at about elevation 564. It is estimated that the groundwater level is related to the stream level in the immediate vicinity of the stream. During the investigation the depth of water in the stream was about 3 ft.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is contemplated to construct a 3-span structure (35'-75'-35') to carry proposed Service Road No. 8 across Black Creek. The two piers will be located within the creek. Approach fills will have a maximum height of about 1[illegible] ft. above the existing ground surface.

The investigation has revealed the presence of a surficial organic clay deposit of soft to firm consistency, some 3 to 6.5 ft. in thickness overlying a competent glacial till deposit. Bedrock is encountered at depths of 13 to 16 ft. below the ground surface.

6.2) Structure Foundations:

Subsoil conditions at the proposed pier locations are favourable for a spread footing design. The proposed piers may be supported on spread footings located below elevation 555 within the cohesive glacial till deposit and designed for a safe bearing value of 3.0 t.s.f. The actual footing elevation should satisfy the hydrological requirements. A temporary dewatering scheme will be required for the construction of pier footings.

The proposed abutments can be constructed within the approach fills supported on end-bearing piles driven to the bedrock. Care should be taken that no bouldery fill is placed in the areas where piles will be driven. The design load per pile will depend

cont'd. /6 ...

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

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

on the section chosen. For example, 14 BP 73 steel H-piles may be designed for a safe load of 90 tons/pile.

6.3) Approach Embankments:

No stability problems are anticipated for the proposed approach embankments with standard 2:1 slopes, provided that all soft organic clay material is subexcavated and backfilled with suitable granular material as per current D.H.O. methods.

7. MISCELLANEOUS:

The field work, performed during the period May 16 - 22, 1968, was carried out by Mr. Per B. Schnabel and Mr. V. Korlu, Project Foundation Engineers. The preparation of this report was undertaken by Mr. C. Mirza, Project Foundation Engineer.

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

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

July, 1968.

APPENDIX I

FORM OB MT 124
66 4946

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 1

FOUNDATION SECTION

JOB 68-F-32 LOCATION Sta. 405+16 ℄ Prop Service Rd. #8 O/S 18' LT ORIGINATED BY PBS

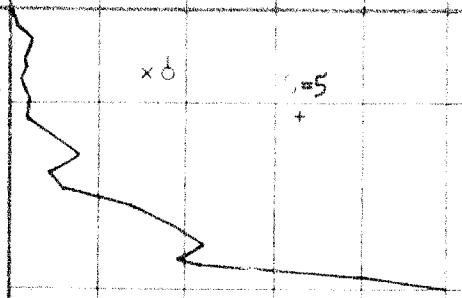
W P 167-64-03 BORING DATE May 22, 1968 COMPILED BY CM

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Nx, Bx casing CHECKED BY

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
565.0	Ground Level					
0.0	Organic clay soft to Firm		1	TW	PM	560
559.0						
6.0	Glacial Till Silty clay with some sand and gravel		2	SS	26	
			3	SS	6	
551.0	Firm to v stiff		4	SS	23	
14.0	Silt, sand and gravel		5	SS	100/1"	550
549.2	v. dense					
15.8	Siliceous dolomite Bedrock with gypsum seams.		6	AXT	90% rec.	
543.8						
21.2	End of Borehole					540

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
20 40 60 80 100

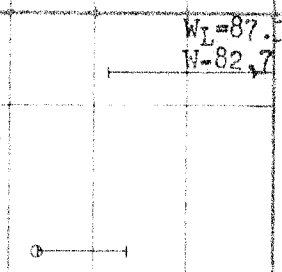
SHEAR STRENGTH P S F
+ Field vane ○ unconfined comp.
× Lab. vane
200 400 600 800 1000



LIQUID LIMIT ——— W_L
PLASTIC LIMIT ——— W_P
WATER CONTENT ——— W

W_P W W_L

WATER CONTENT %
15 30 45



DRY UNIT DENSITY γd P C F

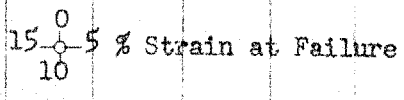
96

REMARKS

% Gr. Sa Si Cl

0 26 57 17

8.4% organic content



% Strain at Failure

FORM 28 MT 126
66-454A

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 68-F-32 LOCATION Sta 405+44 ℄ Prop. Service Rd. #8 O/S 18.0' RT ORIGINATED BY PBS
W P 167-64-03 BORING DATE May 22, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Nx, Bx casing - CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
565.2	Ground Level					
0.0	Organic clay Firm to stiff		1	TW	PM	
558.7						560
6.5	Glacial Till clayey silt with some sand and gravel		2	TW	PM	
			3	SS	32	
551.7	Hard. Brown		4	SS	31	
13.5	Silt, sand and gravel					
549.5	v. dense		5	SS	11 CC 1/2"	550
12.7	siliceous dolomite bed rock with shale and gypsum seams;		6	AXT	90% rec	
547.2						
18.0	End of Borehole					
						540

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P S F
+ Field Vane
200 400 600 800 1000

S=1.5
+

LIQUID LIMIT ——— W_L
PLASTIC LIMIT ——— W_P
WATER CONTENT ——— W

W_P W W_L

WATER CONTENT %
15 30 45

W=10.1%
O
O

UNIT WEIGHT P C F

REMARKS
%
Gr Sa Si Cl

El. 564.5

9.9% organic
42 38 17 3
5 29 47 19

FORM [illegible]
[illegible]

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS · ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 68-F-32 LOCATION Sta 406+68 ₵ Prop. Service Rd #8 O/S 18.0' Lt. ORIGINATED BY PBS

W.P. 167-64-03 BORING DATE May 21, 1968 COMPILED BY CM

DATUM Geodetic BOREHOLE TYPE Diamond Drill - Nx, Bx casing CHECKED BY

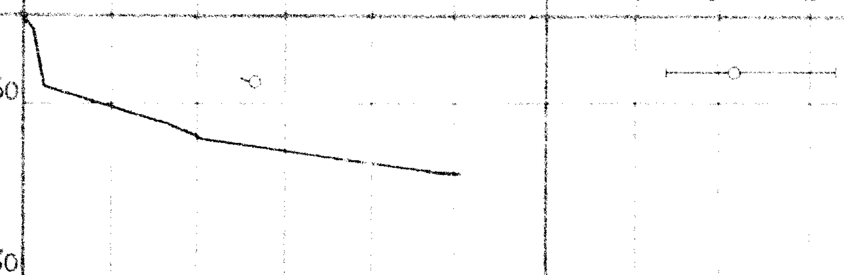
ELEV DEPTH	SOIL PROFILE DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE	REMARKS % Gr. Sa Si cl
565.0	Ground Level					▼ EL 564.5
0.0 562.0	Organic clay firm					
3.0	Glacial Till clayey silt to silty clay with sand and gravel. Hard	1	TW	PM	560	
		2	SS	30		
556.0		3	SS	100/4"		
9.0 552.0	silt, sand and gravel v. dense	3A	AXT	No rec		
		4	SS	100/5"		30 36 32 2
13.0 550.5	shale and dolomite Bedrock with gypsum	5	AXTRC	25% rec	550	
14.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F. ○ unconf. comp. 200 400 600 800 1000

LIQUID LIMIT, PLASTIC LIMIT, WATER CONTENT — WATER CONTENT % 15 30 45

P.C.F. 120



0
15 ○ 5 % strain at Failure
10

540

FORM CB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 4

FOUNDATION SECTION

JOB 68-F-32 LOCATION Sta. 406+00 ℄ Prop. Service Rd. #8 O/S 18.0' RT. ORIGINATED BY PBS
W P 167-64-03 BORING DATE May 16, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Bx casing - CHECKED BY

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	UNIT DENSITY γ P C F	REMARKS
564.5	Water Level							WATER CONTENT % 15 30 45		
561.6	Stream Bottom									
2.9	Organic clay									
559.1	soft - firm		1	TW	PM	560				
6.4	Glacial Till clayey silt with some		2	SS	115					
552.5	sand and gravel Hard		3	SS	44					
12.9	Silt, sand and gravel		4	SS	109					
548.8	v. dense					550				
14.6	interbedded shale and		5	AXT	61% rec					
545.0	silicepus dolomite bedrock with gypsum inclusions.		6	AXT	80% rec					
19.5	End of Borehole					540				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

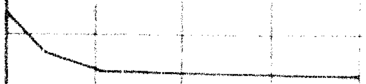
FOUNDATION SECTION

JOB 68-F-32
W P 167-64-03
DATUM Geodetic

LOCATION Sta. 406+31 ⊄ Prop. Service Rd. #8 O/S 18.0' LT.
BORING DATE May 16-17, 1966
BOREHOLE TYPE Diamond Drill, - Nx, Bx casing - AXT core

ORIGINATED BY PBS
COMPILED BY CM
CHECKED BY

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	SAMPLE 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 % Gr Sa Si Cl
564.5 / 0.0	Water Level								
560.3 / 4.2	Stream Bottom				560				
	Glacial Till clayey silt with some sand and gravel Hard	1	SS	37					
554.0 / 10.5	silt, sand and gravel v. dense	2	SS	104			wP – w (approx. 15–20)		15 36 47 2
550.8 / 13.7	interbedded shale and siliceous dolomite bedrock with gypsum	3	SS	100/2"	550				
		4	AXT	45% rec.					
545.5 / 19.0	End of Borehole	5	AXT	70% rec.					
					540				



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OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

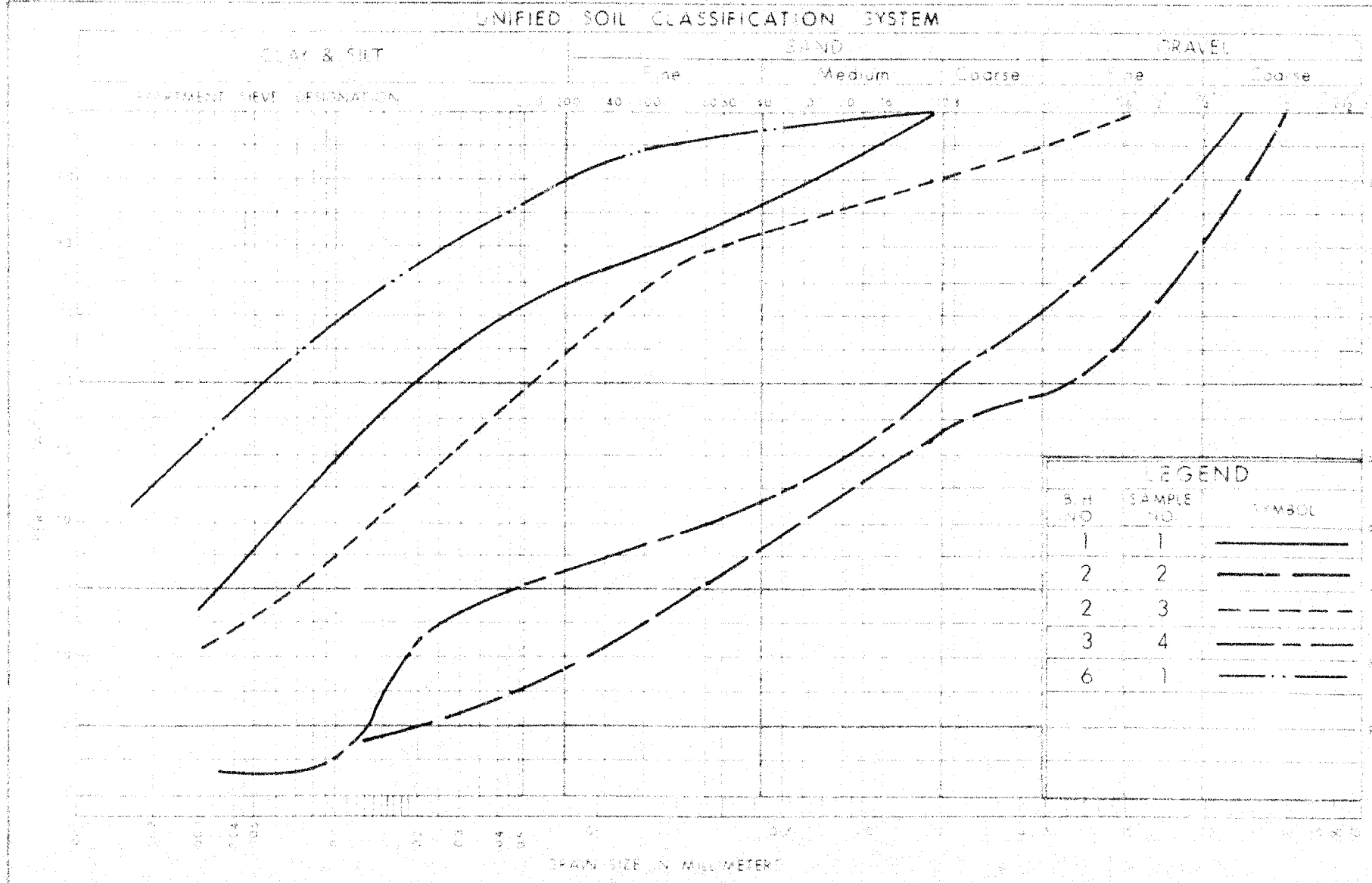
RECORD OF BOREHOLE NO 6

FOUNDATION SECTION

JOB 68-F-32 LOCATION Sta. 406+84 ℄ Prop. Service Rd. #8 O/S 18.0' RT. ORIGINATED BY PBS
W P 167-64-03 BORING DATE May 17, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Diamond Drill - Nx, Px casing - 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 ○ unconfined compression 200 400 600 800 1000	LIQUID LIMIT — W_L PLASTIC LIMIT — W_P WATER CONTENT — W W_P W W_L WATER CONTENT % 15 30 45	UNIT WEIGHT P C F	REMARKS % Gr. Sa Si Cl
564.8	Ground Level									
0.0	Organic clay									
561.0	Soft - firm		1	TW	PM	560			123	1 9 45 45
3.8	Glacial Till									
	Clayey silt to silty clay with some sand and gravel		2	SS	45					
553.8	Hard		3	SS	89					
11.0	silt, sand and gravel									
551.2	v. dense		4	SS	52					
13.6	siliceous dolomite		5	AXP	65%	550				
	bedrock with gypsum									
545.7	seams		6	AXT	80%					
19.1	End of Borehole					540				

15 0 5 10 % Strain at Failure



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

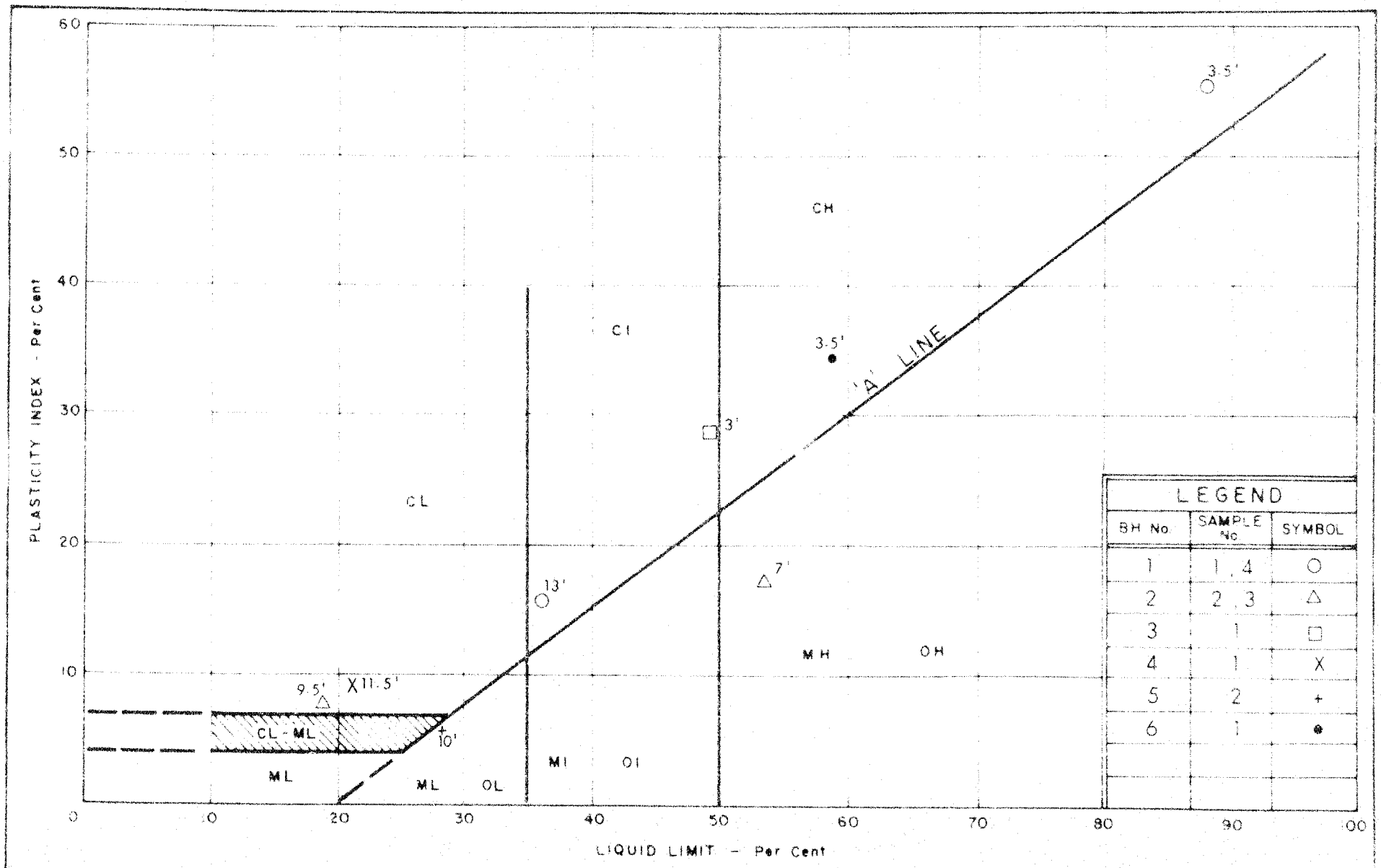
GRAIN SIZE DISTRIBUTION

W.P. No. 167 - 64 - 03

JOB No. 68 - F - 32

FIG. 1

FORM OH-MT-252
REVISED JUL[illegible] 966



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION

PLASTICITY CHART

WP No. 167-64-03
JOB No. 68-F-32
FIG. 2

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

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: A. Stermac,
Principal Foundation Engineer,
Room 107, Central Bldg.

From: Structural Office,
West Bldg., Downsview.

Attention:

Date: May 5, 1972.

Our File Ref.

In reply to

Subject: Re: Black Creek Bridge,
(Service Rd. #8),
W.P. #167-64-3, Site #34-209,
Hwy.-Serv.Rd. #8, District #4.

68-F-32

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.

C.S. Grebski,
Structural Design Engineer.

CSG:sr
Attach.

c.c. Foundation Office

No comments

Apr 11/72

15/4/72

Dwg. 68-F-32 and Dwg. 68-F-33

FOUNDATIONS OFFICE

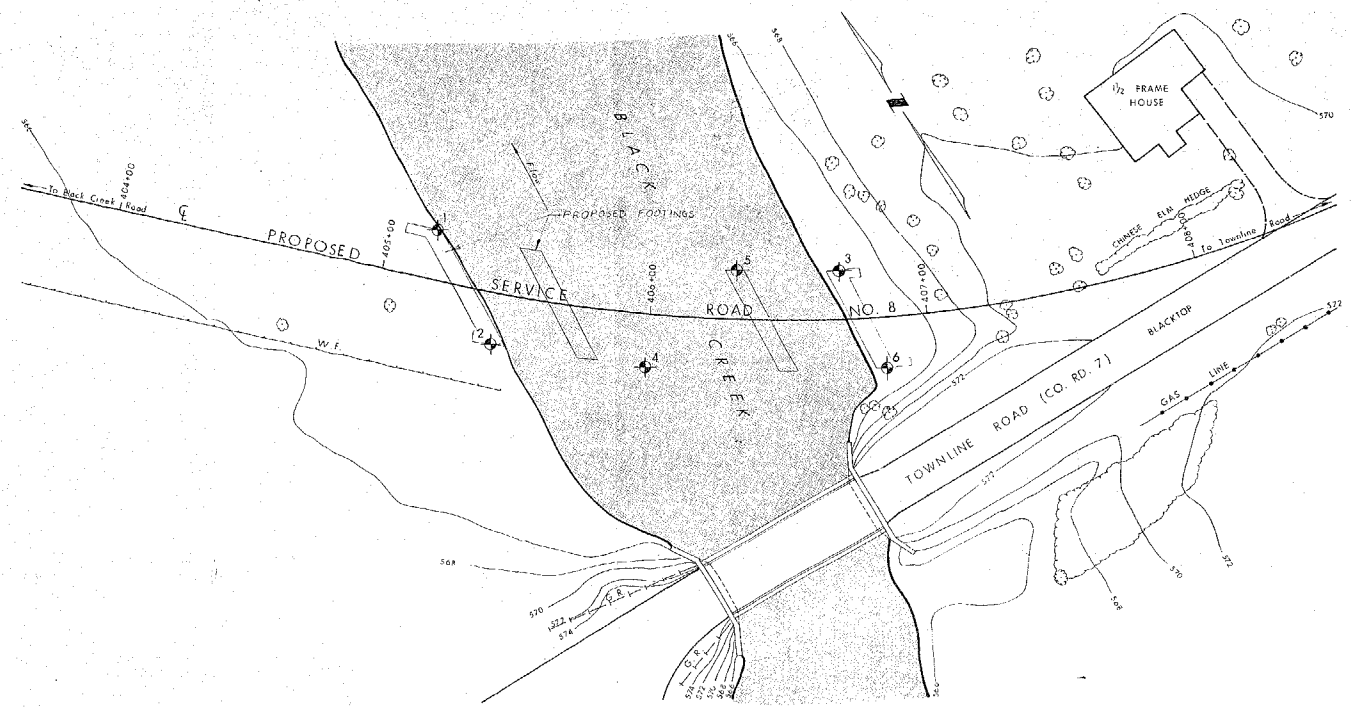
REVIEW OF DESIGN DRAWINGS: W.P. 167-64-03
W.O. 68-F-32

Foundation Report By: G. Moya
Review of Design Drawings By: A. Fragoso
Design Drawing No.'s: 34-209-1.2 & 3

1. Does footing design comply with our report or subsequent memos? No
2. If answer to 1. is No, is present design acceptable? Yes
3. Has sufficient field work been done? Yes
4. Are estimated pile lengths shown on Drawings correct? If not, make a new list. N.A.
5. If excavation of unsuitable soil is recommended, is this shown on Drawings? Yes
6. Are approaches designed in accordance with our report? Check slopes and berm lengths. Yes
7. Do you anticipate any construction problems? i.e., dewatering, stability of temporary slopes or excavations. No.
8. Summarize your comments; on separate sheet if necessary.

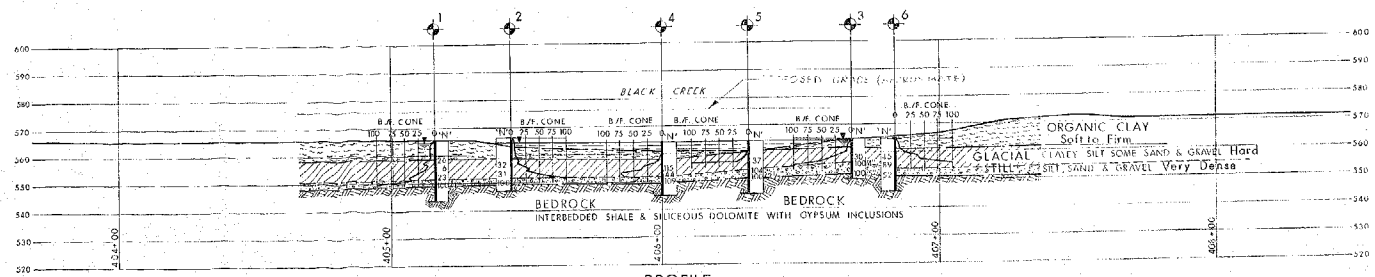
Drawings Received May 10 19 72
Reviewed May 11 19 72

Signed A. Fragoso



PLAN

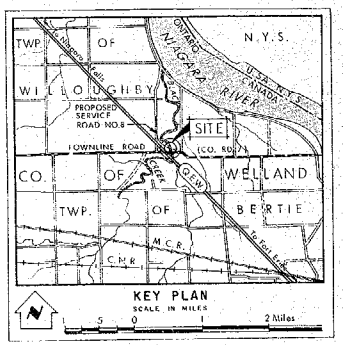
SCALE 20 10 0 20 40 FT.



PROFILE

SCALE 20 10 0 20 40 FT.

REF. NO. E-4905-1



LEGEND

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

NO.	ELEVATION	STATION	OFFSET
1	565.0	405+16	18' LT.
2	565.2	405+44	18' RT.
3	565.0	406+68	18' LT.
4	564.5	406+00	18' RT.
5	564.5	406+31	18' LT.
6	564.8	406+84	18' RT.

– 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

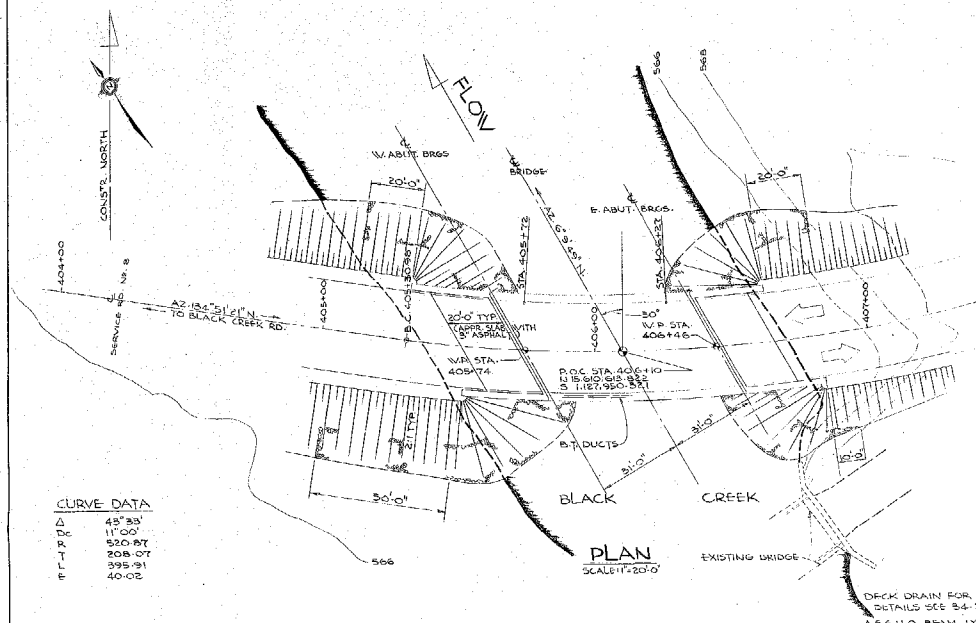
DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION – FOUNDATION SECTION

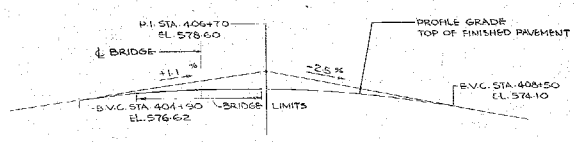
BLACK CREEK

KING'S HIGHWAY NO. PROP. SERVICE RD. NO. 8 DIST. NO. 4
CO. WELLAND
TWP. WILLOUGHBY LOT 22 CON. F.T.B.

BORE HOLE LOCATIONS & SOIL STRATA

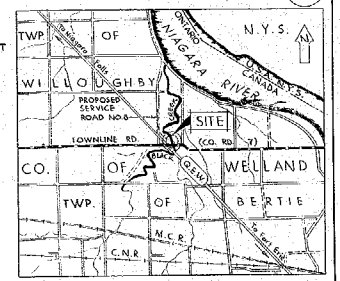
SUBM'D. P.S.	CHECKED	W.P. NO. 167-64-03	M.B.T. DRAWING NO. 68-F-32A
DRAWN G.P.	CHECKED	JOB NO. 68-F-32	
DATE JULY 30 1968		SITE NO.	BRIDGE DRAWING NO.
APPROVED A. A. Thomas PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	





PROFILE OF SERVICE RD. No. 8

N.T.S.



KEY PLAN
SCALE: 1"=0.8 MI.

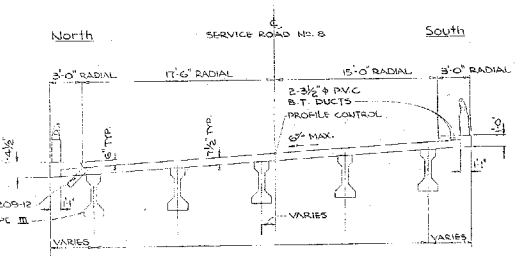
CURVE DATA

Δ	48° 33'
D	11° 00'
R	520.87
T	208.07
L	395.91
E	40.02

B.M. ELEV. 574.16

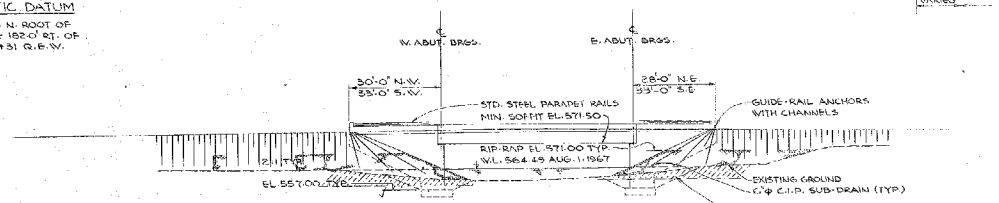
GEODETIC DATUM

N. & W. IN N. ROOT OF 10" MAPLE 152.0' RT. OF STA. 404+31 Q.E.W.



CROSS SECTION

SCALE: 1"=5'-0"



ELEVATION

SCALE: 1"=20'-0"

NOTES

CLASS OF CONCRETE

DECK, CURBS & PARAPET WALLS: 4000 P.S.I.
PRESTRESSED GIRDERS: 5000 P.S.I. REMAINDER: 3000 P.S.I.

CLEAR COVER ON REINFORCING STEEL

FOOTINGS, ABUTMENTS & WINGWALLS:	3"
DECK: 1½" (TOP), 1" (BOTTOM).	
CURBS:	2"
PARAPET WALLS:	1½"

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± ⅛". NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

LIST OF DRAWINGS

1. GENERAL DRAWING
2. BORE HOLE LOCATIONS & SOIL STRATA
3. FOOTING DRAWING
4. W. ABUTMENT & WINGWALLS
5. E. ABUTMENT & WINGWALLS
6. PRESTRESSED GIRDERS & BEARINGS
7. DECK DETAILS
8. DECK REINFORCING
9. PARAPET WALL DETAILS
10. STANDARD STEEL PARAPET RAIL
11. APPROACH SLABS
12. STANDARD DETAILS

PRINT RECORD		
No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

FOR REDUCED PLAN
USE SCALE BELOW

0 1 2 3
3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

68-F-32

BLACK CREEK BRIDGE
(SERVICE RD. No. 8)

KING'S HIGHWAY No. — DIST. No. 4
REGIONAL MUNICIPALITY OF NIAGARA
TOWN OF PORT ERIE LOT 22 CON.

GENERAL DRAWING

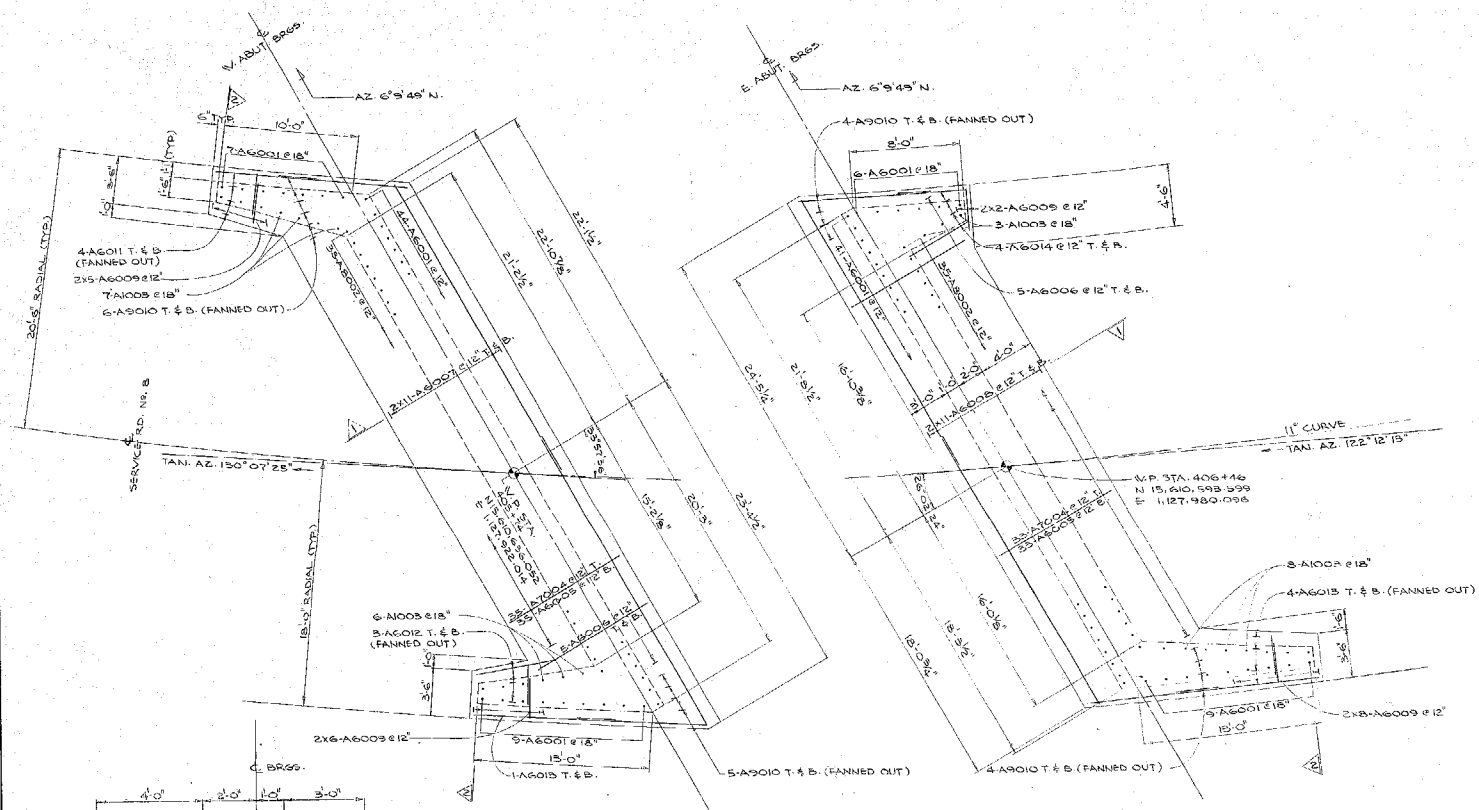
SITE No. 34-209 W.P. No. 167-64-3

APPROVED ..... SIGNATURE & DESIGNATION

CONTRACT Nos.

DESIGN	R. K.	CHECK	D.R.G.
DRAWING	R.M.V.	CHECK	R. K.
DATE	MAY '72	LOADING	HS 20-44

DRAWING No. 34-209-1



W. ABUTMENT FOOTING
SCALE: 1/4"=1'-0"

E. ABUTMENT FOOTING
SCALE: 1/4"=1'-0"

1 1/2"=1'-0"

2 1/2"=1'-0"

FOR REDUCED PLAN
USE SCALE BELOW
3 INCHES ON ORIGINAL PLAN

PRINT RECORD

No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
ONTARIO

68-F-32

BLACK CREEK BRIDGE
(SERVICE RD. No. 8)

KING'S HIGHWAY No. — DIST. No. 4
REGIONAL MUNICIPALITY OF NIAGARA
TOWN OF FORT ERIE — LOT 22 — CON.

FOOTING DRAWING

SITE No. 34-209 — W.P. No. 167-64-3
CONTRACT Nos.
DRAWING No. 34-209-3

APPROVED	STRUCTURAL ENGINEER			
DESIGN	R.K.	CHECK	D.P.G.	
DRAWING	R.M.W.	CHECK	R.K.	
DATE	MAY '72	LOADING	HS20-44	