DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

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

Attention: Mr. S. McCombie

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

Date: January 16, 1969

Our File Ref.

In reply to

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing at
Christie Street Revision & the C.E.N.
Town of Grimsby -- County of Lincoln
District No. 4 (Hamilton)
W.J. 68-F-83 -- W.P. 367-65-01

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. Steinmac
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. Melnyshyn
T. J. Kovich
B. A. Singh

Foundations Office
Gen. Files

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Proposed Crossing at
Christie Street Revision & the Q.E.W.
Town of Grimsby -- County of Lincoln
District No. 4 (Hamilton)
W.J. 68-F-83 -- W.P. 367-65-01

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation at the above mentioned site. The request was contained in a memo from the Bridge Office - (Mr. W. S. Melinyshyn, Regional Bridge Location Engineer), dated October 30, 1968. The memo also contained requests for additional investigations at two other sites near Grimsby, Ontario. Subsequently, an investigation was carried out by this Section at the above site, concurrently with investigations at the two other sites, in order to determine the subsoil conditions.

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 approaches.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located in the Town of Grimsby, Lincoln County, at the existing Patton St. - Q.E.W. crossing. At this location Patton St. is carried over the Q.E.W. by means of a 2-span, reinforced concrete structure with profile grade located some 18 ft. above the Q.E.W. grade. The Q.E.W. at this site is located in a cut. The ground surface slopes down in a south-easterly direction, with a difference in elevation of as much as 30 ft. across the site.

The general area lies within the Niagara Fruit Belt which forms a portion of the Iroquois Plain physiographic region.

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

According to available information, the site was inundated by Lake Iroquois during the Pleistocene Period, resulting in the present relatively flat topography. The overburden consists of glacial till overlying Queenston shale of the Ordovician Period.

3. FIELD AND LABORATORY WORK:

A total of 8 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. In addition, one borehole (No. 10), put down previously at this site under W.J. No. 65-F-28, has been included in this investigation.

Samples were recovered at the 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. The same method was used to advance the dynamic cone penetration tests. Bedrock was proven in all the boreholes by core drilling a minimum of 5 ft. in either AXT or BXL size.

Surveying was carried out by the 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 borings are shown on Drawing 68-F-83A, together with the estimated stratigraphical profile across the site.

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory, after which they were classified in accordance with the Unified Soil Classification System (Oct. 1963).

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4. SUBSOIL CONDITIONS:

4.1) General:

The site is underlain by a stratum of extensively decomposed weathered shale varying in thickness from 3 ft. to 25 ft. followed by sound shale bedrock.

4.2) Weathered Shale:

Weathered shale was encountered from ground surface downwards at all the borehole locations, the thickness varying from about 3 ft. at Boreholes 8 and 9, to 25 ft. at Borehole 6. From an examination of the samples recovered from this deposit it appears that the material has been formed by the "in-situ" decomposition of the parent rock. The material consists essentially of a clayey silt matrix containing shale fragments. In the upper 5 ft. of the deposit, at Borehole 1, a few sub-rounded gravel sizes were noted, whereas at Borehole 6, occasional organic pockets containing root debris were encountered.

In the upper 5 to 10 ft. of the deposit at Boreholes 2, 5, 6, 7 and 10 the Standard Penetration Resistance 'N' values ranged from 7 to 35 blows/ft. Below these depths and also immediately below ground surface at the other boreholes, the 'N' values ranged between 60 to over 100 blows/ft. This indicates that in the upper 5 to 10 ft. of the above mentioned boreholes, the shale is more extensively weathered than in the remainder of the deposit.

4.3) Shale Bedrock:

Sound bedrock was encountered below the weathered shale at elevations ranging from 264 at Borehole 1 to 273 at Borehole 10. The bedrock is red in colour, with occasional grey mottling. Gypsum inclusions were also noted in isolated pockets within the bedrock.

The core recoveries varied from 70 to 100%, the lower recoveries being associated with drilling in AXT size. Examination of the cores recovered indicates the bedrock to be in a generally sound condition.

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5. WATER CONDITIONS:

Water level observations were carried out in the open boreholes upon completion of the field work. The water levels were found to be at about elevation 270 in Boreholes 1, 2, 6 and 7 and at about elevation 281 in Boreholes 3 and 4 within the weathered shale.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to construct a new structure at the crossing of Christie Street Revision and the Q.E.W. The existing structure, which carries Patton Street over the Q.E.W., will be demolished in order to accommodate the new structure at this location. Present proposals call for a 4-span (35'-77'-77'-35') structure having a width of about 85 ft. The proposed embankment at the south approach will have a maximum height of some 35 ft. above the present ground surface. At the north approach, the fill heights will be generally less than 5 ft. in view of the existing topography and proposed grade for Christie Street Revision. It is assumed that the proposed grade of the Q.E.W. will be at the same elevation as the existing Q.E.W. grade - i.e., around elevation 278.

Subsoil at this site consists of a variable thickness (3 to 25 ft.) of weathered shale overlying sound shale bedrock.

6.2) Structure Foundations:

In view of the variable nature of the subsoil conditions across the site, recommendations pertaining to each footing are discussed separately.

a) North Abutment: The north abutment can be supported on spread footings constructed within the weathered shale at or below elevation 286 and designed for a safe bearing pressure of 3 TSF.

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

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

b) North End and Centre Piers: At the locations of these piers, sound bedrock can be reached within a depth of 5 ft. below the proposed Q.E.W. grade. It is therefore recommended that these piers be founded on spread footings located on the sound bedrock and designed for a safe bearing pressure of 10 TSF. No major dewatering problems are anticipated for the construction of these footings. Any minor seepage can be handled by standard pumping methods.

c) South End Pier: This pier can be supported on spread footings located at or below elevation 273. At this elevation, part of the footing will be within the weathered shale and part will be resting on sound bedrock. It is therefore recommended that a suitable construction joint be provided between the two portions of the footing in order to accommodate any possible differential settlements. Such a spread footing may be designed for a safe bearing pressure of 3 TSF for the portion within the weathered shale and 10 TSF for the portion on sound bedrock.

d) South Abutment: The footing may be constructed within the approach fill and be supported on steel H-piles driven to bedrock or practical refusal within the weathered shale. The maximum allowable load for the section selected may be used for design purposes (e.g., 12 BP 73 piles may be designed for 90 tons/pile). Care should be taken to ensure that no bouldery fill is placed at the locations through which piles have to be driven.

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

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

In view of the susceptibility of the weathered shale to further deteriorate, and the sound bedrock to decompose rapidly upon exposure to water, it is recommended that the footing excavations be kept dry by constructing a working slab of lean concrete as soon as excavation bottom is reached.

In addition, since both the weathered shale and the sound shale bedrock are considered susceptible to frost action, it is further recommended that a minimum soil cover of 4 ft. be provided above the underside of the footings in order to prevent frost heaving.

6.3) Approach Fills:

No stability problems are anticipated for approach fills constructed with standard 2:1 slopes.

7. MISCELLANEOUS:

The field work, performed during the period November 5 - 13 and December 16 - 19, 1968, was carried out by Mr. V. Korlu, Project Foundation Engineer.

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

The entire project was under the general supervision of Mr. M. Devata, Supervising Foundation Engineer.

Equipment used was owned and operated by Canadian Longyear Company Limited.

January 1969

APPENDIX I

FORM RS-ME-126

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 31 + 09 Ø Christie St. Rev. o/s 14' Lt. ORIGINATED BY VK

W P 367-65-01 BORING DATE November 5, 1968 COMPILED BY CM

DATUM Geodetic BOREHOLE TYPE Washboring; BX Casing; Cone CHECKED BY

SOIL PROFILE			SAMPLES				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 w_P w w_L WATER CONTENT %	BULK DENSITY γ P C F	REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE				
268.6	Ground Level									▼ 268.6
0.0	(weathered)									
264.0	Occ. gravel		1	SS	118/10"					
4.4	Shale bedrock fractured to 6.5' depth (sound)		2	AXT RC	100% Rec					
260.6						260				
8.0	End of Borehole									

FORM 28 MT 126
68 4545

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 2

JOB 68-F-83 LOCATION Sta. 30 + 69 ℄ Christie St.Rev. o/s 38' Lt. ORIGINATED BY VK
W P 367-65-01 BORING DATE November 6, 1968 COMPILED BY
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing; Cone CHECKED BY

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 w_P w w_L WATER CONTENT %	UNIT WEIGHT P C F	REMARKS
275.1	Ground Level									
0.0	(weathered)		1	SS	35	270				▼ 270.1
			2	SS	60					
265.1			3	SS	119					
10.0	(sound) Shale Bedrock		4	AXT RC	100% Rec	260				
	Red		5	AXT RC	100% Rec					
255.1						250				
20.0	End of Borehole									

FORM MAT 126
66 4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 28 + 99 ℄ Christie St.Rev. o/s 33' Rt. ORIGINATED BY VK
W P 367-65-01 BORING DATE November 7, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing; Cone CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
291.2 / 0.0	Ground Level					290
	(weathered)		1	SS	92	
			2	SS	100/6"	
			3	SS	100/6"	
			4	SS	~~100/4~~"	280
			5	SS	~~150/4~~"	
271.2						
20.0	(sound) Shale Bedrock		6	AXT RC	90% Rec	270
	Red occasional grey mottling		7	AXT RC	90% Rec	
261.2						
30.0	End of Borehole					260

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
W_P W W_L
WATER CONTENT %

UNIT WEIGHT
P C F

REMARKS

▼ 281.2

FORM 108 M 126
66 4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 4

FOUNDATION SECTION

JOB 63-P-83 | LOCATION Sta. 28 + 20 ℄ Christie St.Rev. o/s 31' Lt. | ORIGINATED BY VK
W P 367-65-21 | BORING DATE November 8, 1968 | COMPILED BY CM
DATUM Geodetic | BOREHOLE TYPE Washboring - BX Casing; Cone | CHECKED BY

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 w_c	UNIT WEIGHT P C F	REMARKS
291.4	Ground Level									
0.0	(weathered)		1	SS	133	290				▼ 281.4
			2	SS	~~100/5"~~					
			3	SS	~~100/2"~~					
			4	SS	~~100/2"~~	280				
			5	SS	145					
271.4										
20.0	(sound) Shale Bedrock Red		6	AXT RC	80% Rec	270				
			7	AXT RC	100% Rec.					
260.4										
31.0	End of Borehole					260				

FORM MB-MT-126
66-454A

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 5

FOUNDATION SECTION

JOB 68-F-33 LOCATION Sta. 30 + 84 Ø Christie St. Rev. o/s 30' Rt. ORIGINATED BY VK
W.P 367-65-01 BORING DATE November 13, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - BX Casing; Cone CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH P S F	LIQUID LIMIT — W_L; PLASTIC LIMIT — W_P; WATER CONTENT — W; W_P ⊗ W_L; WATER CONTENT %	UNIT WEIGHT P C F	REMARKS
295.4	Ground Level									
0.0	(weathered)		1	SS	9	290				
			2	SS	27					
			3	SS	32					
280.4			4	SS	135/10"					
15.0	(sound) Shale Bedrock Red		5	AXT RC	90% Rec	280				
			6	AXT RC	60% Rec					
266.4			7	AXT RC	100% Rec	270				
29.0	End of Borehole									

FORM 108 MT-126
66 4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 6

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 31 + 11 ℄ Christie St.Rev. o/s 43.5' Rt. ORIGINATED BY VK
W P 367-65-01 BORING DATE December 17, 1968 COMPILED BY CM
DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone CHECKED BY

SOIL PROFILE			SAMPLES			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 w_P w w_L WATER CONTENT %	UNIT WEIGHT γ P.C.F	REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT					
293.4	Ground Level									
0.0	Occ. organic pockets and root fragments		1	SS	7	290				
			2	SS	26					
			3	SS	18					
			4	SS	170	280				
	weathered		5	SS	~~100/3"~~					▼ 270.4
268.3			6	SS	~~100/1"~~	270				
25.1	⸗ (sound) Shale Bedrock		7	BXL RC	100% Rec					
			8	BXL RC	100% Rec	260				
			9	BXL RC	100% Rec.					
248.4	Red		10	BXL RC	100% Rec	250				
45.0	End of Borehole									

FORM • DB MT-126
66-4548

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 7

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 30 + 77 ℄ Christie St.Rev. o/s 10' Lt. ORIGINATED BY VK

W P 367-65-01 BORING DATE December 18, 1968 COMPILED BY CK

DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing; Cone CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P S F	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT %	UNIT WEIGHT P C F	REMARKS
278.1	Ground Level									
0.0	(weathered)		1	SS	27					▼ 272
			2	SS	156/9"	270				
266.6			3	SS	100/3"					
11.5	(sound)									
261.6	Shale Bedrock		4	BXL RC	83% Rec					
16.5	End of Borehole					260				

FORM 4 OH MT 126
66 4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 8

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 30 + 04 ℄ Christie St.Rev. o/s 43.5' Rt. ORIGINATED BY VK

W P 367-65-01 BORING DATE December 18, 1968 COMPILED BY CM

DATUM Geodetic BOREHOLE TYPE Power Auger CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — W_L PLASTIC LIMIT — W_P WATER CONTENT — W		REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P S F	W_P W W_L WATER CONTENT %	UNIT WEIGHT P C F	
277.4	Ground Level									
0.0 274.4	Weathered Shale		1	CS	-					
3.0	End of Borehole									
	Probably Shale Bedrock					270				

FORM DB-MT-126
66-4346

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO 9

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 29 + 96 ℄ Christie St.Rev. o/s 43.5' Lt. ORIGINATED BY VK

W P 367-65-01 BORING DATE December 19, 1968 COMPILED BY CK

DATUM Geodetic BOREHOLE TYPE Washboring - NX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT — W_L; PLASTIC LIMIT — W_P; WATER CONTENT — W		REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P S F	W_P ——— W ——— W_L	UNIT WEIGHT P C F	
275.2	Ground Level							WATER CONTENT %		
272.2	(weathered)									Drill with tricone bit
3.0	(sound)					270				
	Shale Bedrock		1	BXL RC	100% Rec					Cone Pen. 1.5'
			2	BXL RC	100% Rec					
			3	BXL RC	100% Rec	260				
	Red		4	BXL RC	100% Rec					
252.2										
23.0	End of Borehole					250				Borehole Dry - No W.L.

FORM OB-MT-126
66-4546

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 10 (formerly BH 9 65-F-28)

FOUNDATION SECTION

JOB 68-F-83 LOCATION Sta. 29 + 20 ℄ Christie St.Rev. o/s 9' Rt. ORIGINATED BY PC

W P 367-65-01 BORING DATE March 24, 1965 COMPILED BY SK

DATUM Geodetic BOREHOLE TYPE Penndrill & washboring CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w		REMARKS
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P S F	w_P w w_L	UNIT WEIGHT γ P C F	
292.5	Ground Level							WATER CONTENT % 10 20 30		
0.0						290				
	(weathered)		1	SS	30					▼ 285.0
			2	SS	102					
			3	SS	83/4"					
			4	SS	80/6.5"	280				
			5	SS	100/6"					
272.8			6	SS	100/1"					
19.7	(sound) Shale Bedrock Red		7	BXT RC	70% Rec.	270				
267.8										
24.7	End of Borehole									
						260				

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 — 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 $\tau_f = c_u + \sigma \tan \phi$
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
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ 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

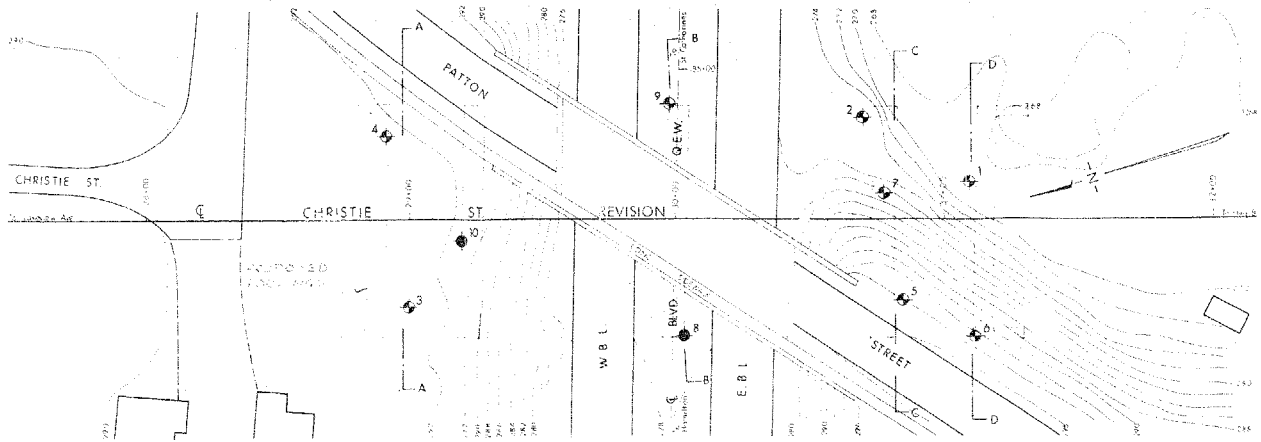
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

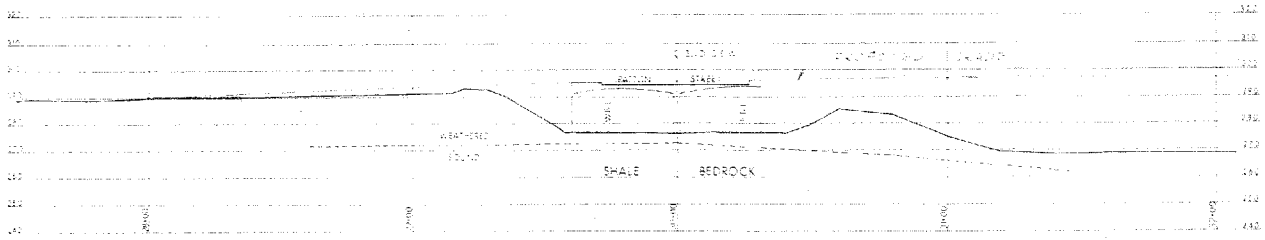
FOUNDATIONS

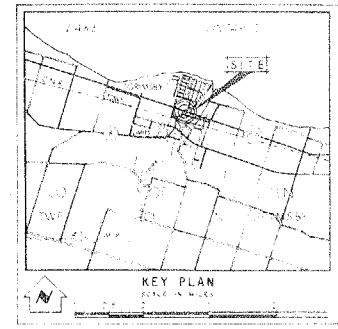
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY
K_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL







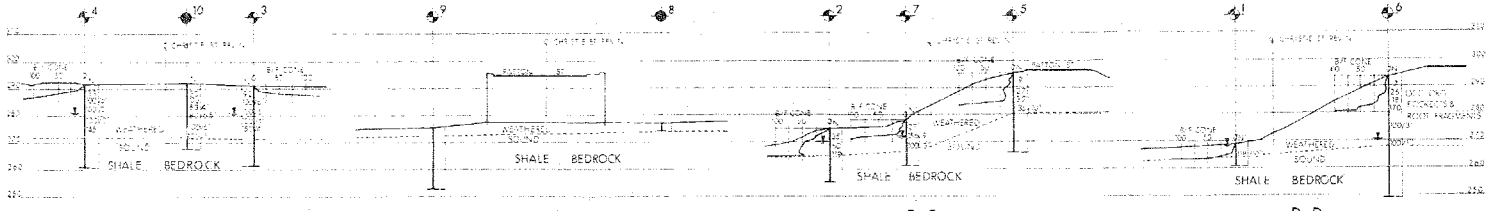
LEGEND

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

NO.	ELEVATION	STATION	OFFSET
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

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.	ITEM	DATE

REVISIONS		
NO.	DATE	DESCRIPTION

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

CHRISTIE STREET

KING'S HIGHWAY NO. QEW DIST. NO. 4
CO. LINCOLN TOWN OF GRIMSBY
TWP. N. GRIMSBY LOT 10 CON. 1

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. C. M.	CHECKED	W.P. NO. 167-65-01	M.T. DRAWING NO. 68-F-83A
DRAWN S. O.	CHECKED	JOB NO. 68-F-83	
DATE 14 JAN. 1969		SITE NO.	FOUNDATION DRAWING NO.
APPROVED		CONT. NO.	

REF. NO. E-4917-1

Foundation Office

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

C.S. Grebski,
Bridge Office

February 11, 1970

Christie St. Underpass
Town of Grimsby
W.P. 367-65-1, Site 18-12
Q.E.W., District No. 4

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,
Bridge Design Engineer

CSG:rd

Attach.

c.c. Foundation Office

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND TESTING DIVISION
FORM OB-MT-30A
NOVEMBER, 1965

MADE BY CM DATE Jan 21/69 JOB No 68-F-83
CHECKED BY _____ DATE _____ SECTION Foundation
SHEET No _____

Christie St. Reversion & GEW.
N P 367-65-01

Re. South End Pier

Since the variation of sound bedrock surface in elevation ~~at~~ this footing location is ~~to~~ not known accurately, the design of the expansion joint and reinforcing for the footing will initially be based on the profile shown on Section C-C of 68F83A.

In order to ensure that the stratigraphy satisfies the footing design,

THIS FOOTING LOCATION MUST BE FURTHER INVESTIGATED TO DELINEATE ACCURATELY DEPTHS TO SOUND ROCK IN ITS VICINITY ONCE WE RECEIVE THE PRELIMINARY DWGS.

C.M.
as per M.D.
Jan 21/69

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. M. Devata
Sup. Foundation Engineer

From: B. K. Glassford
Materials and Testing Office

Date: January 7, 1969

Our File Ref.

In reply to

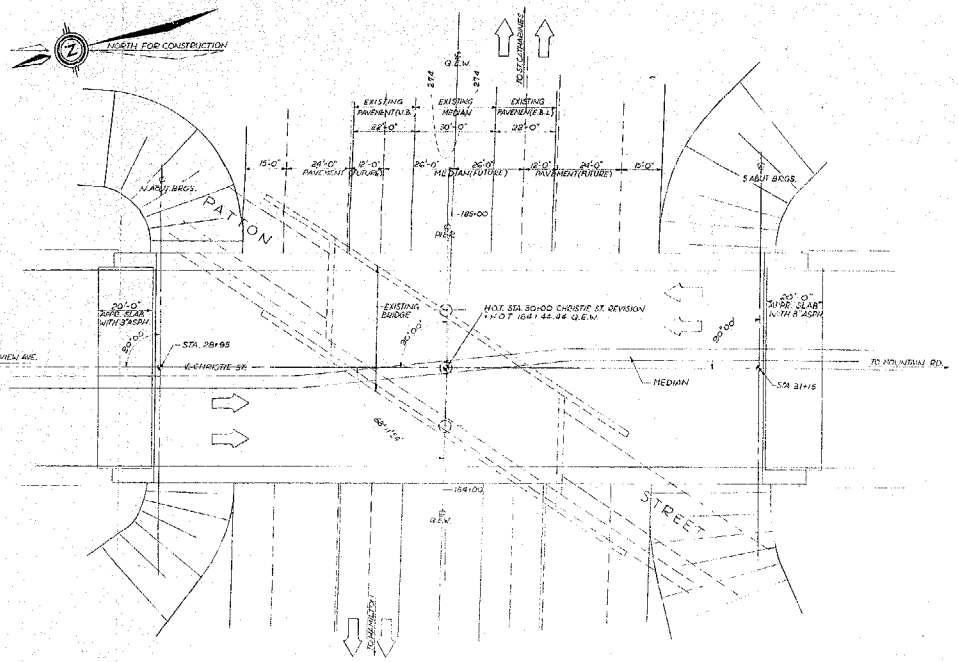
Subject: C.E.W., Grimsby, Ontario
Projects: 68-F-81
68-F-82
68-F-83

Rock cores from these projects consists of shale rock in entirety. This shale is red in colour with a slight amount of grey mottling. Small inclusions of gypsum are present throughout. This shale appears to dehydrate quickly with subsequent crumbling and flaking along the horizontal laminations.

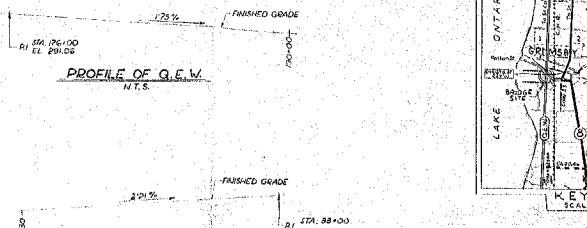
B. K. Glassford
Geologist

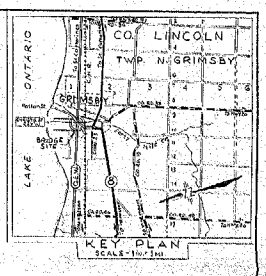
BKG:nm

#68-F-83
W.P #367-65-01
HWY. Q.E.W.
CHRISTIE ST.
UNDERPASS



PLAN
SCALE 1"=20'-0"

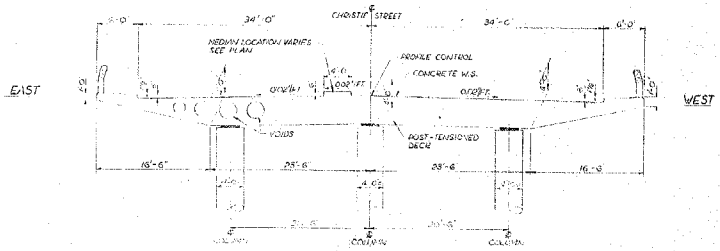




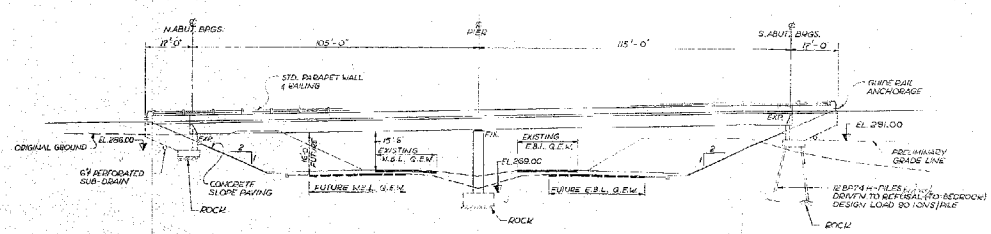
GENERAL NOTES

CLASS OF CONCRETE
DECK CURBS, PARAPET WALLS & COLUMNS – 5 000 P.S.I.
REMAINDER – 3 000 P.S.I.

CLEAR COVER ON REINFORCING STEEL
FOOTINGS, ABUTMENTS AND PIERS – 3"
CURBS – 2"
DECK TOP – 2" BOTTOM – 1"



DECK SECTION
SCALE 1/4"=1'-0"



ELEVATION
SCALE 1"=20'-0"

B.M. 294.76
N 14' W. ON TOP OF C.B. WILSON STR.
110' L.F. OF STA. 178+10

LIST OF DRAWINGS

1. GENERAL DRAWING
2. BORE HOLE LOCATIONS & SOIL STRATA
3. FOOTING LAYOUT & DETAILS
4. ABUTMENTS & WINGWALLS
5. PIER DETAILS
6. DECK DIMENSIONS & ELEVATIONS
7. DECK REINFORCING
8. CABLE DETAILS
9. PARAPET WALL DETAILS
10. APPROACH SLABS
11. STANDARD STEEL PARAPET RAIL
12. DETAILS OF CONC. SLOPE PAVING
13. STANDARD DETAILS

PRINT RECORD		
No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

FOR REDUCED PLAN
USE SCALE BELOW
10 11 12 13
3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

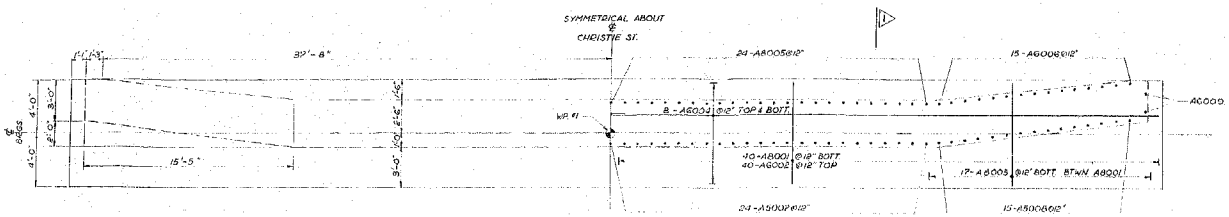
GS-F-83

CHRISTIE ST. UNDERPASS
TOWN OF GRIMSBY

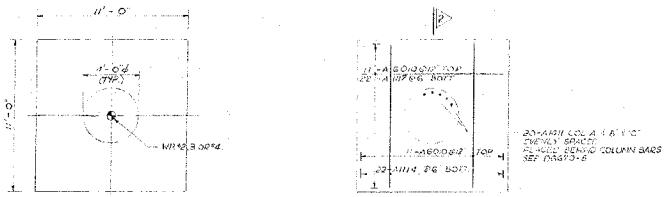
KING'S HIGHWAY No. Q.E.W. — DIST. No. 4
CO. LINCOLN
TWP. TOWN OF GRIMSBY — LOT 10 — CON. 1

GENERAL DRAWING

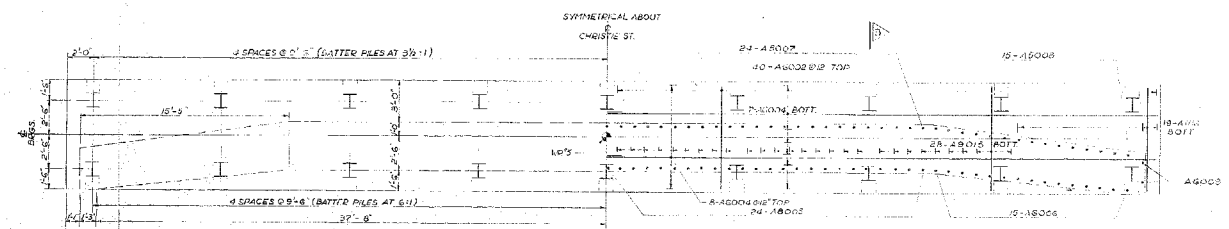
APPROVED	BRIDGE ENGINEER			SITE No. 18-12	W.P. No. 367.65-1
DESIGN	D.R.G.	CHECK	D.K.L.	CONTRACT Nos.	
DRAWING	A.K.	CHECK	D.R.G.		
DATE	FEB. 70	LOADING	HS 20-44	DRAWING No.	D-6670-1



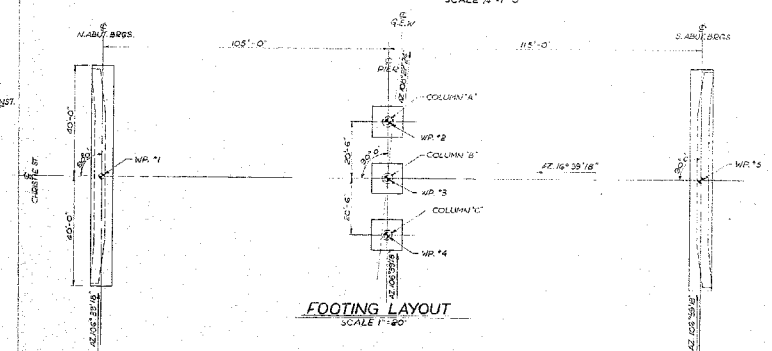
DIMENSIONS — **N. ABUTMENT FOOTING** SCALE 1/4"=1'-0" — REINFORCING



DIMENSIONS — **PIER FOOTINGS** SCALE 1/4"=1'-0" — REINFORCING



DIMENSIONS — **S. ABUTMENT FOOTING** SCALE 1/4"=1'-0" — REINFORCING



FOOTING LAYOUT SCALE 1"=40'

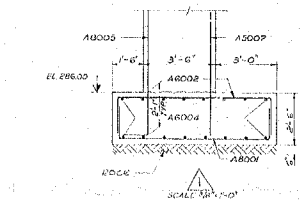
WORKING POINT COORDINATES

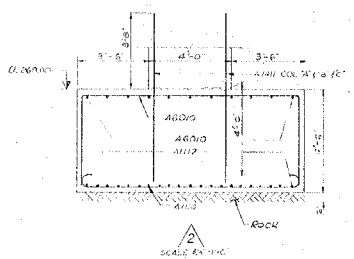
WP. #	NORTH	EAST
1	15,687,871.584	909,905.824
2	15,695,865.065	910,195.393
3	15,695,870.941	910,373.723
4	15,695,876.816	910,552.053
5	15,685,769.765	910,542.708

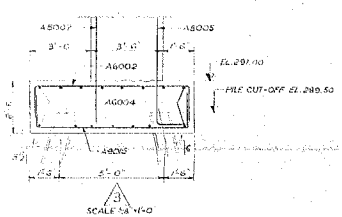
PILE DATA (TYPE B 8BP36)

LOCATION	NO.	LENGTH
SOUTH ABUTMENT	19	37'-0"

DESIGN LOAD 80 TONS PER PILE







PRINT RECORD		
No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
1 — 3 INCHES ON ORIGINAL PLAN

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

CHRISTIE ST. UNDERPASS
TOWN OF GRIMSBY

KING'S HIGHWAY No. Q.E.W. DIST. No. 4
CO. LINCOLN
TWP. TOWN OF GRIMSBY LOT 10 CON. 1

FOOTING LAYOUT & DETAILS

APPROVED		BRIDGE ENGINEER		SITE No. 18-12	W.P. No. 367-65-1
DESIGN	D.R.G.	CHECK	E.K.	CONTRACT Nos.	
DRAWING	A.K.	CHECK	D.R.G.	DRAWING No.	D-6670-3
DATE	FEB. '70	LOADING	MS 20-44		