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GEOCRES No. 40P1-52

DIST. 4 REGION _____

W.P. No. 156-60-00

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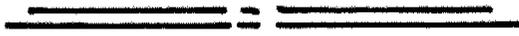
STR. SITE No. 1-140

HWY. No. 403

LOCATION CNR O'HEAD

(0.4 MILES WEST OF BRANTFORD W. LIMITS)

No OF PAGES - _____



OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

G.I.-30 SEPT. 1976

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. G. C. E. Burkhardt, (2)
Regional Bridge Planning Engineer,
Central Region,
90 Floral Pkwy., Downsview.

FROM: Foundations Office,
Design Services Branch,
Central Bldg., Downsview.

ATTENTION:

DATE: February 17, 1972.

OUR FILE REF.

IN REPLY TO

MAR 1 1972

SUBJECT:

40 P1 - 52
GEOGRES No.

FOUNDATION INVESTIGATION REPORT

For

The C.N.R. Overhead of Hwy. #403, Line 'K'
0.4 Mi. West of Brantford W. Limits
District #4 (Hamilton)
W.O. 71-11107 - W.P. 156-60-00

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

Alfsterman

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER.

AGS/ao
Attach.

cc: Messrs. D. W. Farren
B. R. Davis
A. Rutka
G. K. Hunter
C. R. Robertson
B. J. Giroux
T. J. Kovich
G. A. Wrong
B. A. Singh

Foundations Files ✓
Documents

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5. MISCELLANEOUS.

FOUNDATION INVESTIGATION REPORT

For

The C.N.R. Overhead of Hwy. #403, Line 'K'
0.4 Mi. West of Brantford W. Limits
District #4 (Hamilton)
W.O. 71-11107 - W.P. 156-60-00

1. INTRODUCTION:

A foundation investigation was requested at the site of the proposed C.N.R. overhead of Hwy. #403, Line 'K', 0.4 Mi. West of Brantford W. limits, by Mr. A. P. Watt, Regional Bridge Planning Engineer, Southwestern Region. The memo containing the request was dated September 29, 1971.

A foundation investigation had already been carried out in 1965 for Hwy. #403, Line 'A', approximately 100 ft. south of the present proposal. The results of this previous investigation were compiled in a report numbered 65-F-33. Some additional boreholes were found to be necessary at the locations of the proposed footings along Line 'K', and these were carried out under the supervision of this Office. The borings were staked out and surveyed by personnel of the Engineering Surveys Office of the Southwestern Region.

Following are the results of the investigations, together with recommendations concerning foundations and approach fill stability.

2. DESCRIPTION OF THE SITE, FIELD AND LABORATORY INVESTIGATIONS:

The vicinity of the proposed crossing is gently undulating terrain, occupied by farmlands and some woods. At the present time the C.N.R. line consists of two tracks with provision to build two additional tracks in the future. Geologically the area belongs to the Horseshoe moraines physiographic region. This eastern arm of the horseshoe is more hilly and stony than

the rest, and the drift contains much less clay and more gravel and sand. The terraces are important sources of gravel, large sand and gravel pits are located at this area.

A total of five boreholes and eight cone penetration tests, numbered 9-16 inclusive was carried out during the recent field work. Some additional eight boreholes, numbered 1-8 inclusive, drilled in 1965 were also incorporated in this report. The locations and elevations of the borings are shown on Drawing #71-11107A in the Appendix, together with the estimated stratigraphical sections at the proposed footing locations. Borings were implemented by means of a hollow stem auger (C.M.E.) taking samples at frequent intervals. Split-spoon samplers were advanced by performing Standard Penetration Tests. Penetration resistances (N = blows per ft.) as well as the results of the laboratory tests are marked on the attached borelog sheets.

All the soil samples were visually examined upon recovery and again in the laboratory. Specimens were further tested in the laboratory in order to determine natural moisture contents and grain-size distributions of the subsoil.

3. SOIL CONDITIONS:

The soil stratigraphy was found to be fairly uniform, consisting of granular deposits of silty fine sands to fine sandy silts, with traces of clay and pockets of gravel. The relative density of the uppermost 6-10 ft. is generally loose with penetration "N" values of 5-10 blows per ft. At the locations of the west abutments, however, the depth of loose sand was noted to extend to some 19-20 ft. below ground level, to elevation 772 ft. Below the loose surficial sands the density increases rapidly, with penetration resistances ranging from 60 blows per ft. to well above 100 blows per ft.

Numerous grain-size analyses were performed in the laboratory resulting in rather steep particle size curves, indicating uniform grain-size distributions. The constituent

particle sizes of the tested samples, expressed in percent, are marked on the borelogs.

The groundwater level was observed to lie between elevation 758 ft. and 764 ft., some 28-35 ft. below existing ground surface.

4. DISCUSSION AND RECOMMENDATIONS:

4.1) General:

The proposal calls for a three span twin overhead structure at the crossing of CAH #403 and the C.N.R. tracks. The future grade of the highway will be roughly at elevation 826-827 ft. with approach fills of 34-35 ft. heights. It is assumed that the abutments will be perched with 2 horizontal to 1 vertical slopes.

Beneath the loose surficial sands the very dense granular deposits are competent materials to support the structure on spread footings. Recommendations pertaining to the various footing locations are as follows.

4.2) East Abutment:

Spread footings may be designed for the skewed as well as for the square structure and the probable adjacent retaining walls. Footings should be placed at a minimum depth of 7 ft. below existing ground level. 3 TSF safe loads may be used for design purposes at the suggested depths. Due to the sloping ground surface, there is a gradient of approximately 15-16 ft. between the north end of the westbound structure footing and the south end of the eastbound footing. Since the eventual length of the individual footings will be around 100-140 ft. it would appear economical to step the footings, maintaining the recommended 7 ft. distance between existing ground level and the underside of the footings. Perched abutments may also be supported on large displacement piles, pile caps being formed within the fill. In using 12-3/4" O.D. steel tubes, driven to approx. elevation 760 ft. safe design loads of 70 ton per pile may be achieved. Pile driving should be controlled in the field by means of the Hiley formula according to DTC Standards #DD-1218 and 1219.

4.3) East Pier:

Spread footings may be designed for the east pier as well; excavations, however, of some 10-14 ft. will be necessary to reach the competent bearing stratum. Spread footings for the westbound structure should be placed at elevation 785 ft. at the north end stepping down to elevation 779 ft. at the south end. The north end of the eastbound footing may be put at elevation 778 ft., the south end being at elevation 772 ft. with steps in between. Design loads of 3 TSF may be used on above footings.

As an alternative, footings may be placed at 4 ft. below finished ground and supported on piles. It is anticipated that 12-3/4" O.D. steel tubes, having some 20 ft. embedded lengths will support loads of 70 tons per pile. Notwithstanding pile driving should be controlled by the Hiley formula as mentioned earlier.

4.4) West Pier:

Subsoil conditions under the west pier were found to be similar to the ones beneath the east pier. Again spread footings may be built with safe loads of 3 TSF; the base of the footing beneath the westbound lane being placed at elevation 788 ft. at the north end, stepping down to elevation 782 ft. at the south end. The corresponding footing elevations under the eastbound lane structure are 781 ft. below the north end and 778 ft. below the south.

If piled foundation is preferred, it may also be implemented according to the recommendations given for the east pier.

4.5) West Abutment:

In view of the rather extensive depth of the loose material at the location of the west abutments, the construction of spread footings appear to be uneconomical. As a consequence, piled foundations are suggested, piles being driven through the approach fills and pile caps formed within the fill. It is estimated that 12-3/4" O.D. steel tubes, driven to approximate elevation 765 ft. will develop safe bearing pressures of 70 tons per pile. Loads should be checked during pile driving as suggested earlier.

4.6) General Comments:

- a) No bouldery material should be placed in the fill at the locations of the abutments, if piled foundations are adopted.
- b) No dewatering scheme will be necessary for the excavations in view of the deep groundwater levels.
- c) No stability problems are foreseen for the approach fills, provided that they are constructed with 2 horizontal to 1 vertical slopes.

5. MISCELLANEOUS:

The field work was carried out during the period of January 10-12, 1972, under the supervision of Mr. P. Korgemagi, Project Foundation Engineer. Equipment used was owned and operated by PVK Drilling Company, Burford, Ontario.

This report was prepared by Mr. A. K. Barsvary, Senior Foundation Engineer and reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

A. K. Barsvary

A. K. Barsvary, P. Eng.

K. G. Selby

K. G. Selby, P. Eng.

AKB/ao
Feb. 15/72



APPENDIX I

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1 (65-F-33) FOUNDATION SECTION

JOB 73-11107 LOCATION Hwy. 403 Line 'K' Sta. 346 + 90 o/s 62' Lt. ORIGINATED BY WVK
 W.P. 156-60-00 BORING DATE March 29-30, 1965 COMPILED BY WVK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY WVK

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w	BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100			
777.4	Ground Level													
775.4	Black Org. Topsoil													
2.0	Silty sand to sandy silt with traces of clay and gravel. Loose to Very Dense		1	SS	6									
			2	SS	5 1/2									
			3	SS	73									
			4	SS	43									
			5	SS	52									
			6	SS	100									
			7	SS	115/11"									
			8	SS	147/10"									
			9	SS	152/9"									
730.9														
46.5	End of Borehole													

▽ 771.3

for 9"

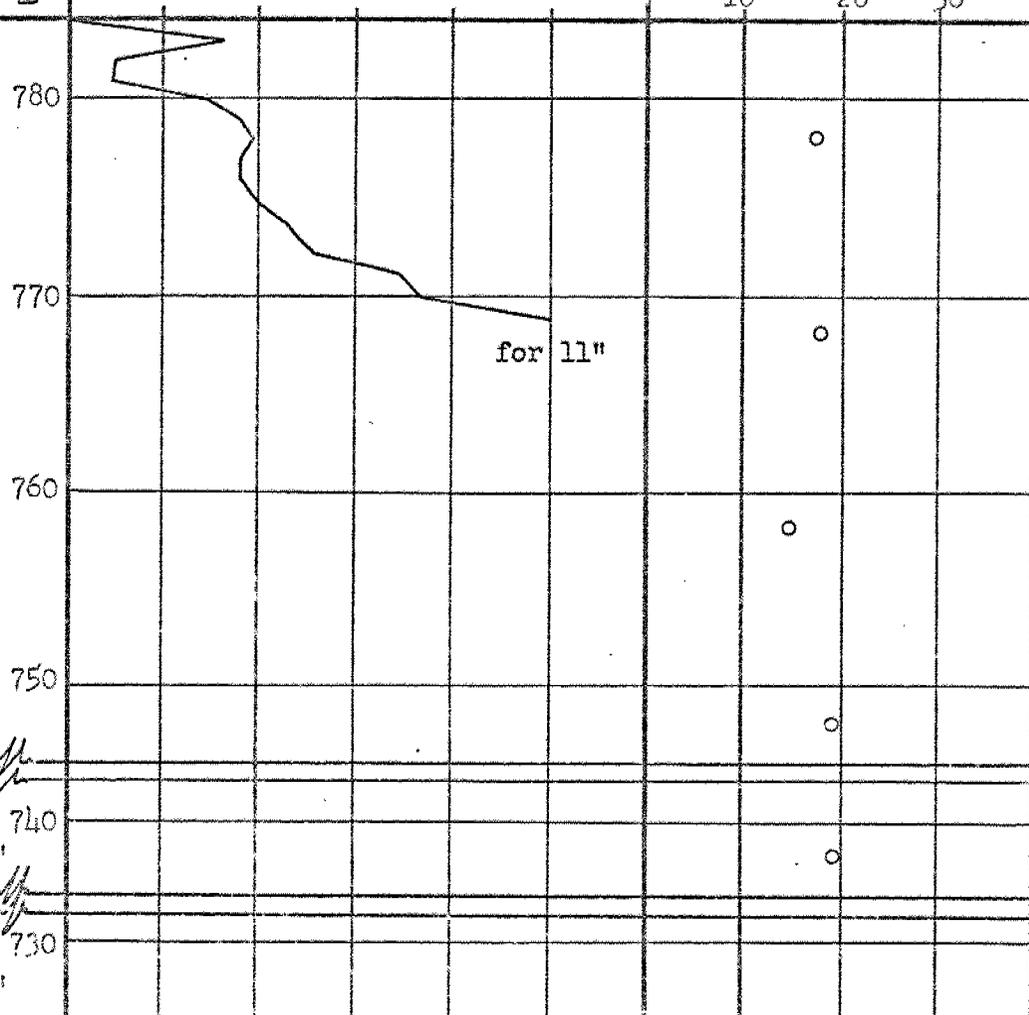
RECORD OF BOREHOLE No.2 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 348 + 05 o/s 5th Lt. ORIGINATED BY WJK
 W.P. 156-60-00 BORING DATE April 2, 1965 COMPILED BY WJK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casings CHECKED BY WJK

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %				
783.9	Ground Level															
782.2	Black Org. Topsoil															
1.7	Silty sand to sandy silt with traces of clay and gravel. Loose to very dense.		1	SS	19											
			2	SS	59											
			3	SS	51											
			4	SS	80/3"											
			5	SS	111/8"											
			6	SS	161/8"											
727.4																

DYNAMIC PENETRATION RESISTANCE
 BLOWS / FOOT: 20, 40, 60, 80, 100
 SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

LIQUID LIMIT ——— w_L
 PLASTIC LIMIT ——— w_p
 WATER CONTENT ——— w
 WATER CONTENT %
 10 20 30



771.7

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 349 + 15 o/s 90' Lt. ORIGINATED BY WVK
 W.P. 156-60-00 BORING DATE April 5, 1965 COMPILED BY WVK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY S.C.

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS	
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT — w_p					
						20	40	60	80	100	WATER CONTENT — w					
						SHEAR STRENGTH P.S.F.					WATER CONTENT %					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					w_p — w — w_L 10 20 30					
786.8	Ground Level															
785.3	Black Org. Topsoil															
1.5																
	Silty sand to sandy silt with traces of clay and gravel. Loose to very dense.	1	SS	19												
		2	SS	31												
		3	SS	104/10"	770											
		4	SS	105/9"	760											
		5	SS	80/8"	750											
		6	SS	80/8"	740											
740.3																
16.5	End of Borehole				740											

▽ 771.3

RECORD OF BOREHOLE No. 4 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 350 + 32 o/s 76' Lt. ORIGINATED BY WWK
 W.P. 156-60-00 BORING DATE April 6-7 1965 COMPILED BY WWK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_P WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FOOT	20	40	60	80	100	WATER CONTENT % w_p ——— w ——— w_L				
789.9	Ground Level															
787.9	Black Org. Topsoil															
2.0	Silty sand to sandy silt with traces of clay and gravel Loose to very dense.	[Strat. Plot]	1	SS	6											
			2	SS	5	780										
			3	SS	87											
			4	SS	80/5"	770										
			5	SS	117/11"	760										
			6	SS	152/8"	750										
			7	SS	151/8"	740										
738.4	End of Borehole															

▽ 772.7

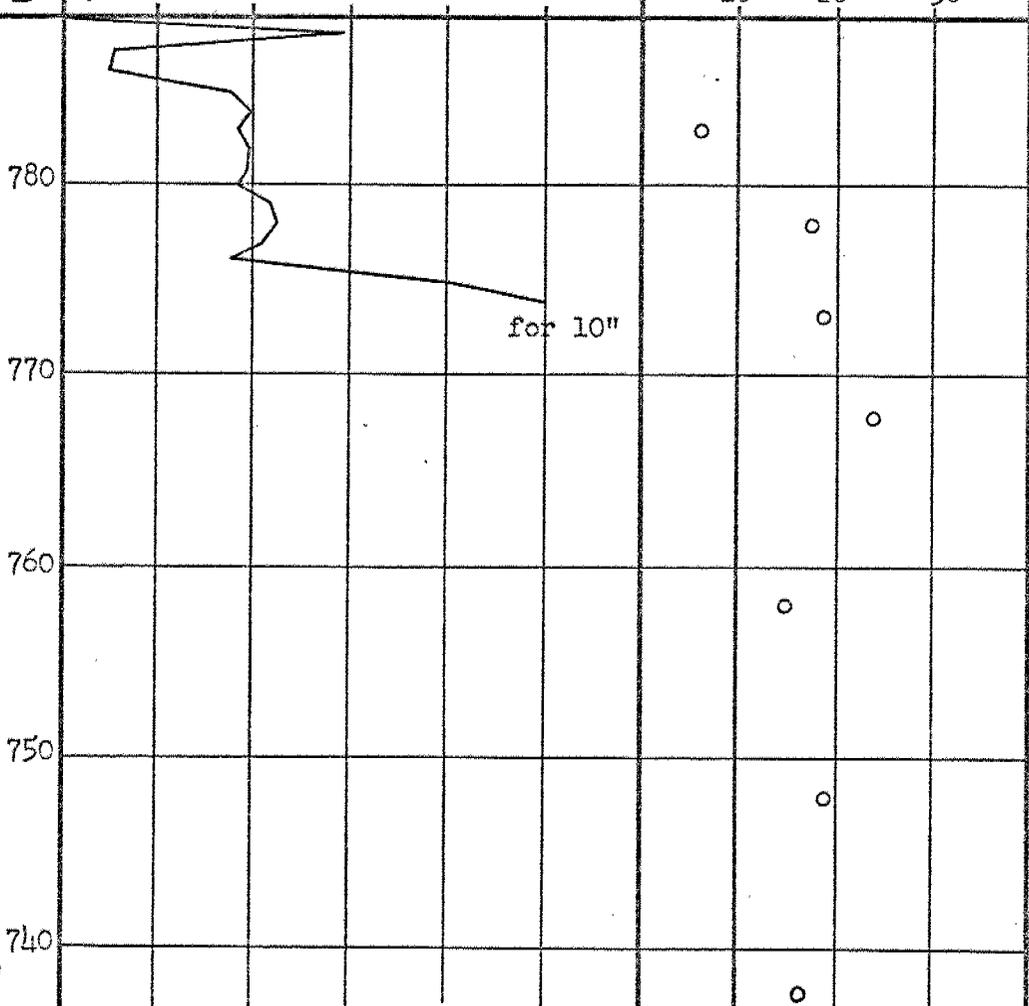
RECORD OF BOREHOLE No. 5 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 348 + 43 o/s 4' Lt. ORIGINATED BY WVK
 W.P. 156-60-00 BORING DATE March 31, 1965 COMPILED BY WVK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY S.R.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY Y P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	w_p	w	w_L		
789.0	Ground Level															
787.0	Black Org. Topsoil															
2.0	Silty sand to sandy silt with traces of clay and gravel. Loose to very dense		1	SS	25											
			2	SS	62											
			3	SS	66											
			4	SS	63											
			5	SS	121											
			6	SS	80/4"											
			7	SS	150/9"											
737.5																

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

WATER CONTENT %
 10 20 30



▽ 770.9

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 103 'K' Sta. 349 + 58 o/s 21' Rt. ORIGINATED BY W/K
 W.P. 156-60-00 BORING DATE March 30, 1965 COMPILED BY W/K
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT 20 40 60 80 100					WATER CONTENT % 10 20 30				
						SHEAR STRENGTH P.S.F.										
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE										
791.0	Ground Level															
789.5	Black Org. Topsoil	SS														
1.5	Silty sand to sandy silt with traces of clay and gravel. Loose to very dense.	SS	1	SS	17											
			2	SS	25											
			3	SS	61											
			4	SS	112 for 10"											
			5	SS	118 for 9"											
			6	SS	80 for 2"											
			7	SS	80											
744.5	End of Borehole															

for 9"

▽ 771.3

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 350 + 69 o/s 24' Lt. ORIGINATED BY WRK
 W.P. 156-60-00 BORING DATE April 7, 1965 COMPILED BY WRK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY WRK

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT — w_p				
						20	40	60	80	100	WATER CONTENT — w					
						SHEAR STRENGTH P.S.F.					WATER CONTENT %					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE					w_p — w — w_L 10 20 30					
														P.C.F.	GR. SA. SI. CL.	
790.9	Ground Level															
788.9	Black Org. Topsoil															
2.0	Silty sand to sandy silt with traces of clay and gravel Loose to Very Dense	[Strat. Plot]	1	SS	12											
			2	SS	18											
			3	SS	140 for 9"											
			4	SS	80 for 5"											
			5	SS	158 for 10"											
			6	SS	80											
744.4	End of Borehole															

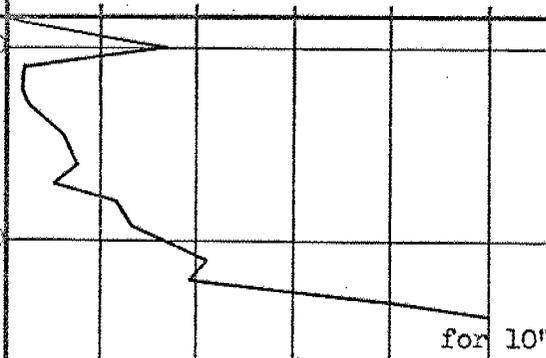
▽ 771.6

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8 (65-F-33) FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy.403 Line 'K' Sta. 351 + 87 o/s 7' Rt. ORIGINATED BY WVK
 W.P. 156-60-00 BORING DATE April 8, 1965 COMPILED BY WVK
 DATUM Geodetic BOREHOLE TYPE Washboring BX Casing CHECKED BY S.R.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS						
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	WATER CONTENT % w_p — w — w_L				GR.	SA.	SI.	CL.		
791.4	Ground Level																				
789.4	Black Org. Topsoil					790															
2.0	Silty sand to sandy silt with traces of clay and gravel. Loose to Very Dense	[Stratigraphic Plot]	1	SS	3																
			2	SS	14	780															
			3	SS	9																
			4	SS	72	770															
			5	SS	132	760															
			6	SS	141	750															
749.9	End of Borehole																				
41.5																					



771.4
observed in casing

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11

FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 351 + 05 o/s 82' Rt. ORIGINATED BY JK
 W.P. 156-60-00 BORING DATE Jan. 11, 1972 COMPILED BY AKB
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger (GMB) CHECKED BY S.R.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS		
			NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L				
796.6	Ground Level																	
0.0	Silty uniform fine sand occasionally sandy silt, traces of clay. Loose to very Dense Brown		1	SS	6													
			2	SS	10													0 70 (30)
			3	SS	5													0 35 61 L
			4	SS	15													0 3 85 12
			5	SS	100/5"													
			6	SS	100													0 92 (8)
			7	SS	97													
			8	SS	100.9"													0 8 (92)
			9	SS	100.8"													
			10	SS	100.11"													0 95 (5)
753.2				11	SS		100/11"											
43.4	End of Borehole																	

SHEAR STRENGTH P.S.F.
 ○ UNCONFINED + FIELD VANE
 ● QUICK TRIAXIAL x LAB. VANE

WATER CONTENT %
 10 20 30

BULK DENSITY
 γ
 P.C.F.

REMARKS
 GR. SA. SI. CL.

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 15

FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 349 + 70 o/s 68' Lt. ORIGINATED BY PK
 W.P. 156-60-00 BORING DATE Jan. 11, 1972 COMPILED BY AKB
 DATUM Geodetic BOREHOLE TYPE Cone Test Only CHECKED BY PK

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT						SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE				WATER CONTENT % w_p ——— w ——— w_L
785.4	Ground Level															
0.0						780										
770.5																
14.9	End of Cone Test					770										100/10"

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 16

FOUNDATION SECTION

JOB 71-11107 LOCATION Hwy. 403 Line 'K' Sta. 352 + 62 o/s 36' Rt. ORIGINATED BY PK
 W.P. 156-60-00 BORING DATE Jan. 12, 1972 COMPILED BY AKB
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY J.L.

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	w_p	w	w_L			GR.	SA.	SI.
769.8	Ground Level																	
0.0	Silty uniform fine sand to fine sandy silt, trace of gravel occasional pockets of gravel. Loose to Very Dense Brown	1	SS	7														
		2	SS	26														
		3	SS	60														
		4	SS	66	780													
		5	SS	100/11"														
		6	SS	105/11"														
		7	SS	100/6"	770													
		8	SS	100/6"														
		9	SS	100/6"	760													
		10	SS	100/8"														
751.6																		
38.2	End of Borehole				750													

100/7"

15 76 (9)

0 30 63 7

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

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
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
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 (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

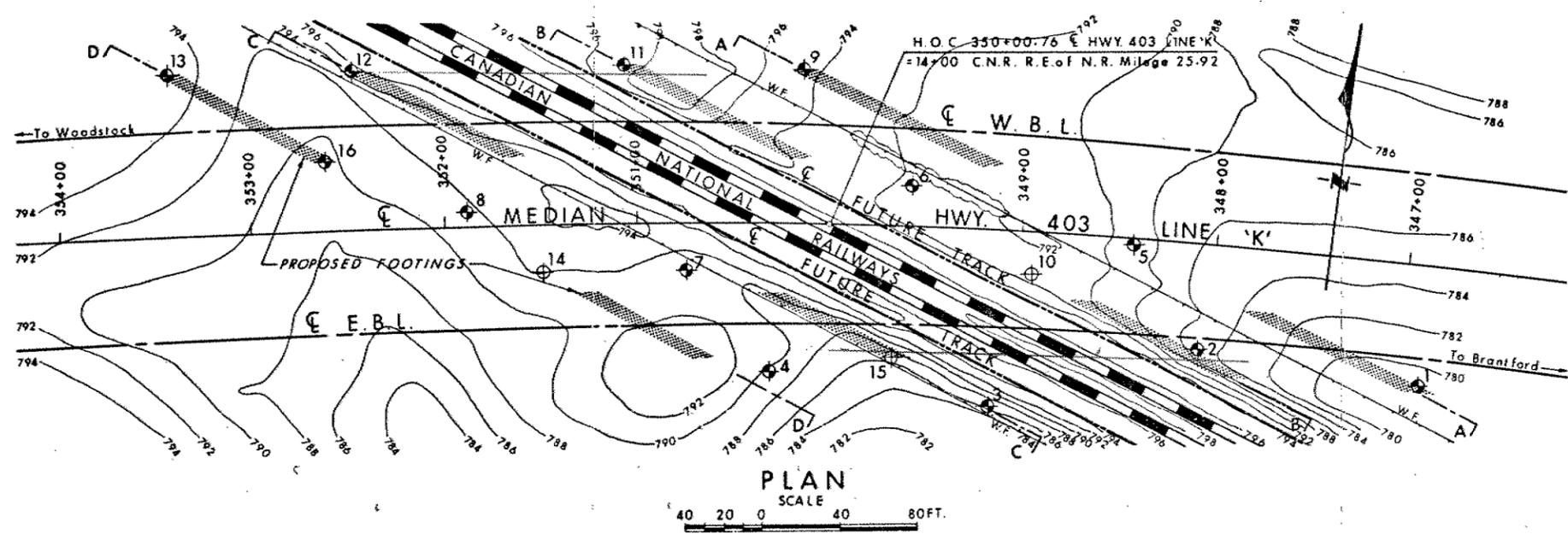
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

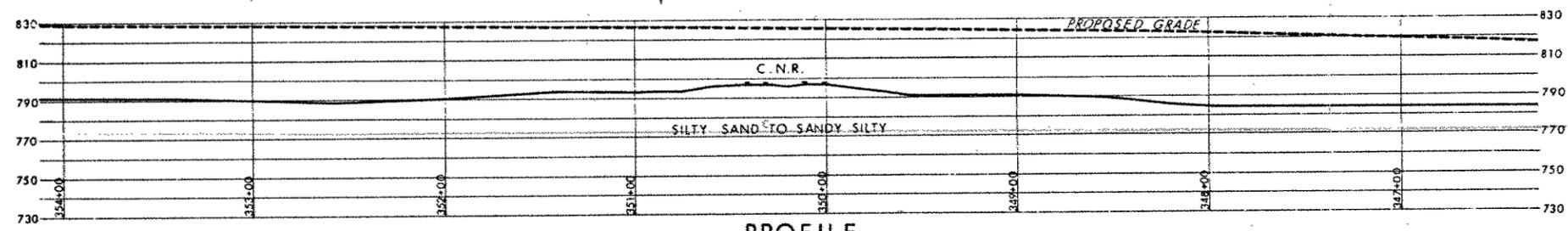
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

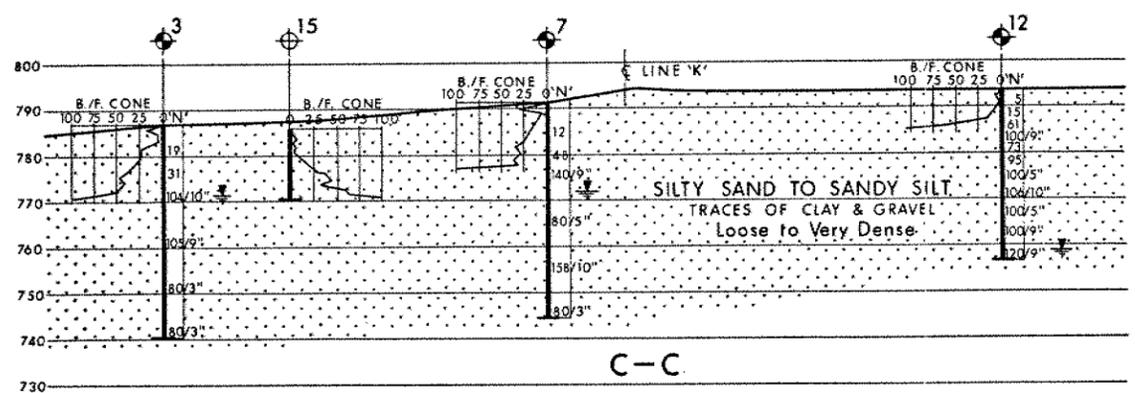
H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



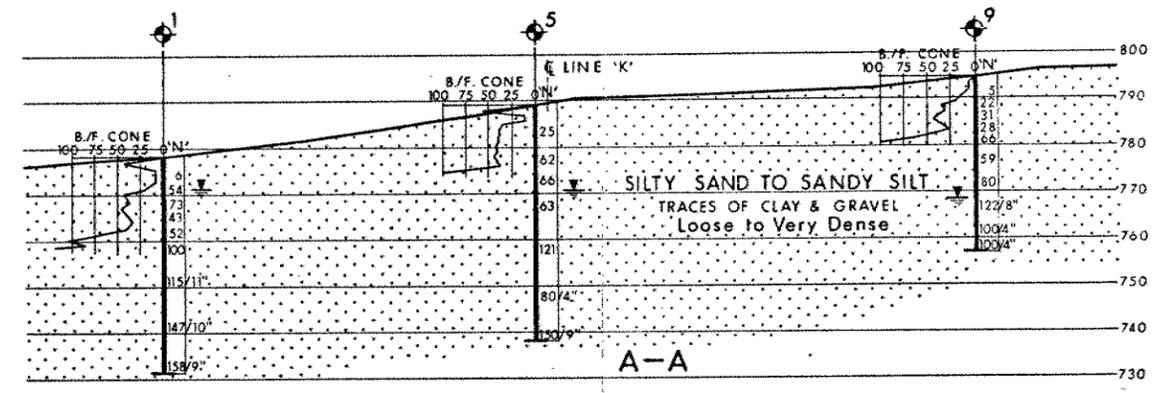
PLAN
SCALE 40 20 0 40 80 FT.



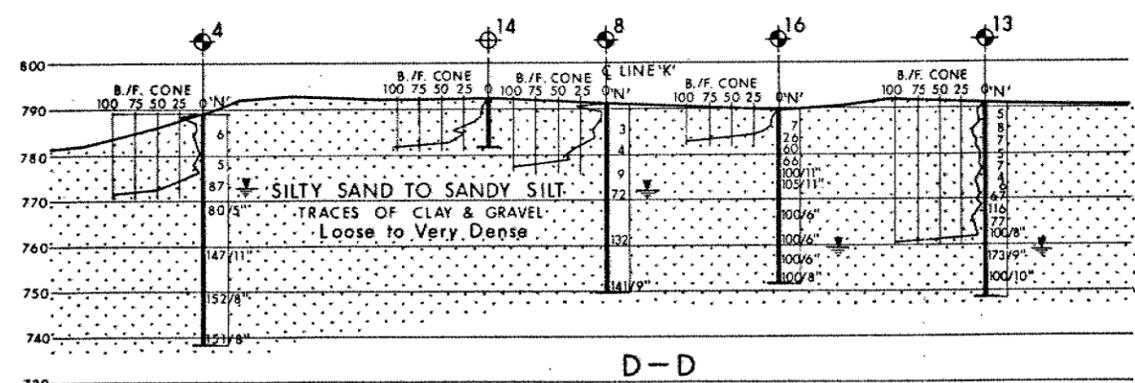
PROFILE
SCALE 40 20 0 40 80 FT.



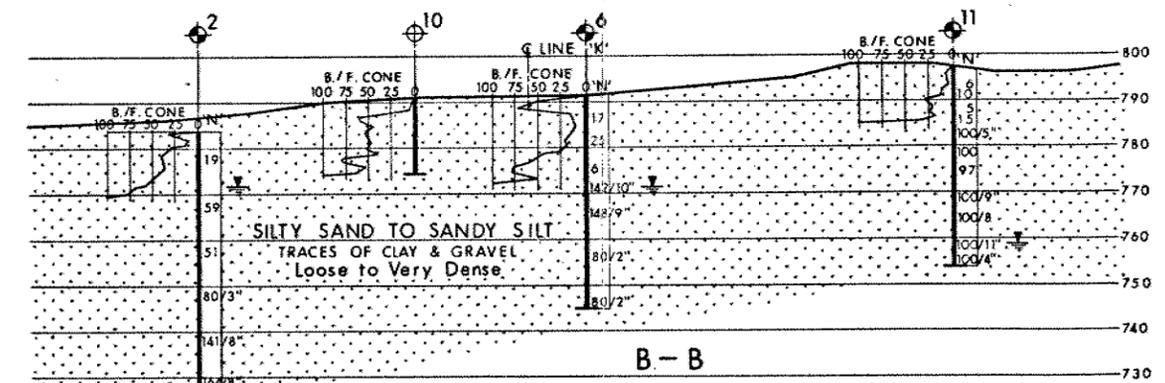
C-C



A-A

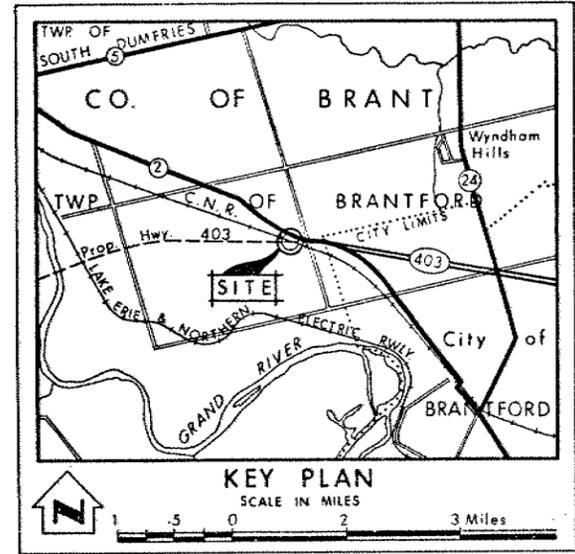


D-D



B-B

SECTIONS
SCALE
HORIZ. 40 20 0 40 80 FT.
VERT. 20 10 0 20 40 FT.



KEY PLAN
SCALE IN MILES

LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation.
Bore Holes 1-8 Mar. & Apr. 1965
Bore Holes 9-16 Jan. 1972

NO.	ELEVATION	STATION	OFFSET
1	777.4	346+90	62' LT.
2	783.9	348+05	54' LT.
3	786.8	349+15	90' LT.
4	789.9	350+32	76' LT.
5	789.0	348+43	4' LT.
6	791.0	349+58	21' RT.
7	790.9	350+69	24' LT.
8	791.4	351+87	7' RT.
9	794.8	350+10	80' RT.
10	791.2	348+95	20' LT.
11	796.6	351+05	82' RT.
12	794.0	352+47	82' RT.
13	791.2	353+42	84' RT.
14	791.8	351+49	24' LT.
15	785.4	349+70	68' LT.
16	789.8	352+62	36' 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.

REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH - FOUNDATION OFFICE

CANADIAN NATIONAL RAILWAYS

HIGHWAY NO. 403 LINE 'K' DIST. NO. 4
CO. BRANT
TWP. BRANTFORD LOT 24 CON. II

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD. A. B. CHECKED <input checked="" type="checkbox"/>	W.P. NO. 156-60-00	DRAWING NO.
DRAWN <input checked="" type="checkbox"/>	JOB NO. 71-11107	71-11107A
DATE Feb. 22, 1972	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.	

PRINCIPAL FOUNDATION ENGINEER