

G.I.-30 SEPT. 1976

GEOCRES No. 40P1-54DIST. 4 REGION W.P. No. 160-60CONT. No. 75-132W. O. No. STR. SITE No. 1-154HWY. No. 403LOCATION Relocated Hwy 24ANo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS

MEMORANDUM

TO: Mr. A. P. Watt, (2)
Regional Bridge Planning Eng.,
Southwestern Region,
London, Ontario.

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

ATTENTION:

DATE: February 16, 1972.

OUR FILE REF.

IN REPLY TO

EEB 16 1972

GEOCRE # 40P1-54

SUBJECT:

CONT. 75-132

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossing at Hwy. #24A,
Line 'J' and Hwy. #403, Line 'G',
County of Brant, Twp. of Brantford,
Con. 2, Lot 10 and 11, District #24
W.O. 71-11109 -- W.P. 160-60
(Formerly 65-F-31)

Enclosed please find our complete foundation investigation report for the above-mentioned project. The report is a slightly revised version of the original report numbered 65-F-31. We believe that the information contained in the report will prove to be sufficient for your design purposes. If any questions arise, however, you are requested to contact this Office.

Please destroy any copies you may have of the original report 65-F-31.

A. G. Stermac

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER.

AGS/ao
Encl.

cc: Messrs. D. W. Farren
A. Rutka
B. R. Davis
B. J. Giroux
C. R. Robertson
J. R. Roy
G. A. Wrong
B. A. Singh

Foundations Office ✓
Documents

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Compact to Very Dense.
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-

FOUNDATION INVESTIGATION REPORT

For

Proposed Crossing at Hwy. #24A,
Line 'J' and Hwy. #403, Line 'G',
County of Brant, Twp. of Brantford,
Con. 2, Lot 10 and 11, District #2.
W.J. 65-F-31 -- W.P. 160-60

1. INTRODUCTION:

A request to carry out a foundation investigation at the proposed crossing of Hwy. #24A, Line 'J' and Hwy. #403, Line 'G' at Paris, Ontario, was received from Bridge Location Engineer, Mr. G. Scott, dated November 3, 1964.

It is proposed to erect a new bridge to carry Hwy. #24A, Line 'J' over Hwy. #403, Line 'G'. The site of the proposed bridge is located approximately 1.5 miles south-west of the City of Paris, County of Brant, Twp. of Brantford, Con. #2, Lot 10 and 11.

In order to determine the soil properties and decide on the type of foundations, an investigation was carried out by this Office. Results and the discussion of the field and laboratory investigations, as well as conclusions and recommendations for the future design work, are contained in the following paragraphs of this report.

2. DESCRIPTION OF SITE:

The site of the proposed bridge is located approximately 1.5 miles south-west of the City of Paris. The surrounding area is generally flat terrain. Physiographically, the site is located in the so-called Norfolk Sand Plain.

3. FIELD AND LABORATORY WORK:

In order to obtain sufficient information on the type and properties of the subsoil, five sampled boreholes and five penetration tests were carried out at this site.

Split-spoon samples were taken at various depth intervals. Samples were used to determine the following physical properties:

1. Natural Moisture Content.
2. Grain-Size Distributions.

Results of these laboratory tests are summarized in the Appendix.

4. SUBSOIL CONDITIONS:

4.1) General:

The stratigraphy of the soil at the site was found to be generally uniform. A detailed description of various soil types encountered during the investigation, is shown in Appendix I of this report and is also given in subsequent paragraphs. The estimated stratigraphical profile, shown on Dwg. No. 65-F-31A, is based upon this information.

4.2) Silty Sand with Traces of Clay and Gravel - Compact to Very Dense:

This stratum, which extends to the depth investigated, was found immediately below the topsoil or highway fill.

The percentage of sand in this stratum is 57%, silt 32%, gravel 6%, and the rest of 5%, is clay. Moisture content determinations for this layer averaged about 12%, ranging from 7% to 18%. The overall stratum was found in a compact to very dense condition, with an average 'N' value in excess of 100 blows/foot. The 'N' value varied from 17 blows/foot to over 150 blows/foot.

5. GROUNDWATER CONDITIONS:

The groundwater level, at the time of the investigation, was found at approximate El. 867.0. It may be assumed that the water level will vary with the seasons of the year. No artesian water conditions were encountered.

6. DISCUSSION AND RECOMMENDATIONS:

As can be seen from the previously described soil stratigraphy, the soil consists of compact to very dense silty sand with traces of gravel and clay. The investigation has

revealed that within the upper 20 feet of the deposit, the properties are such that adequate support for spread footings could be obtained. In the case of the proposed piers, it is recommended to place the footings approximately 4'0" below future finished ground levels at elevation 861.0 \pm . A net allowable pressure of 3 tons/sq.ft. may be assumed for design purposes.

The proposed abutments should be founded within the approach fills on 12-3/4" x 1/4" steel tube piles driven to approximate elevation 860.0. A design load of 50 tons per pile may be used in this event.

The granular type soils are susceptible to conditions of unbalanced hydrostatic head. In view of this some dewatering scheme will be necessary for the excavations extending below the groundwater level (elevation 867 ft. \pm) in the event of quick conditions of the excavation bottoms occur. If the contractor decides to use sheet piles around the perimeter of the excavations, piles should be driven to a minimum distance below the bottom of the excavation equal to the distance of the water level above it. It is to be pointed out that due to the very dense nature of the soil, sheet pile driving will be very difficult. Dewatering of the excavations might be achieved by over size excavations and open pumping from shallow sumps, dug around the perimeter, outside the locations of the footings.

7. MISCELLANEOUS:

The field work, performed during the period from March 18 to March 25, 1965, together with the preparation of this report, was undertaken by Mr. W. W. Kulmatickas, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. K. G. Selby, Senior Foundation Engineer.

Certain revisions to this report were made by Mr. A. K. Barsvary, Senior Foundation Engineer, in February 1972.

February 1972.

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-31 LOCATION Hwy 403 Line "C" & Hwy 24A Line "J" Ch 336+09 30'0" Lt. ORIGINATED BY W.W.K.
W.P. 160-60 BORING DATE March 18, 1965. COMPILED BY W.W.K.
DATUM 875.5 BOREHOLE TYPE Washboring - BX Casing. CHECKED BY K.G.S. *AK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY Y P.C.F.	REMARKS				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		WATER CONTENT %							
							20	40	60	80			100	WP	W	WL
							SHEAR STRENGTH P.S.F.									
875.5	Groundlevel															
873.5	Sand & gravel-compact	0.9														
2.0	hwy Fill															
	Silty sand with traces of clay and gravel.		1	SS	17	870						WL El 867.3				
			2	SS	51							Observed in casing.				
	Compact to very dense.		3	SS	63	860										
			4	SS	65											
			5	SS	68	850										
			6	SS	119	840										
834.0																
41.5	End of borehole.					830										

DEPARTMENT OF HIGHWAYS - ONTARIO


MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 65-F-31 LOCATION Hwy #403 Line "G" & Hwy 24A Line "J" Ch 337/38 30'-0" ORIGINATED BY W.W.K.
W.P. 160-60 BORING DATE March 19, 1965. COMPILED BY W.W.K.
DATUM 875.6 BOREHOLE TYPE Washboring - BX Casing. CHECKED BY K.G.S. *KL*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	WP	W	WL		
875.6	Groundlevel															
873.6	Sand & gravel compact Hwy Fill	873.6														
2.0	Silty sand with traces of clay and gravel. Compact to very dense.		1	SS	20	870										
			2	SS	60											
					for 1"											
			3	SS	84	860										
			4	SS	106	850										
839.1			5	SS	100	840										
36.5	End of borehole.				for 4"											
						830										

WL El 867.3

Observed in casing.

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

LOCATION Hwy #403 Line "G" & Hwy 24A Line "J" Ch 334+92 30' Lt

ORIGINATED BY W.W.K.

BORING DATE March 23, 1965.

COMPILED BY W.W.K.

BOREHOLE TYPE Washboring - BX Casing.

CHECKED BY K.G.S. *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— WP	WATER CONTENT ——— W		
875.3	Groundlevel											
873.3	Sand & gravel compact Hwy Fill											
2.0	Silty sand with traces of clay and gravel. Compact to very dense.		1	SS	58	870						
			2	SS	51							
			3	SS	69	860						
			4	SS	60	850						
				for 3"								
838.5			5	SS	80	840						
36.5	End of borehole.			for 3"								

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 65-F-31 LOCATION Hwy 403 Line "G" & Hwy 24A Line "J" Ch 336+91 30' Rt. ORIGINATED BY W.W.K.
W.P. 160-60 BORING DATE March 25-26, 1965. COMPILED BY W.W.K.
DATUM 875.0 BOREHOLE TYPE Washboring - BX Casing. CHECKED BY K.G.S. *dlr*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL		BULK DENSITY	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT		PLASTIC LIMIT — WP				
							20	40	60	80			100
							SHEAR STRENGTH P.S.F.		WP — W — WL				
									WATER CONTENT %				
										5 10 15			
875.0	Groundlevel												
873.0	Black org. topsoil												
2.0	Silty sand with traces of clay and gravel. Compact to very dense.		1	SS	51	870							
			2	SS	51								
			3	SS	51	860							
			4	SS	57	850							
			5	SS	81	840							
838.5	End of borehole.					830							
36.5													

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 65-F-31

LOCATION Hwy 403 Line "G" & Hwy 24A Line "J" Ch 335/26 30' Rt.

ORIGINATED BY W.W.K.

W.P. 160-60

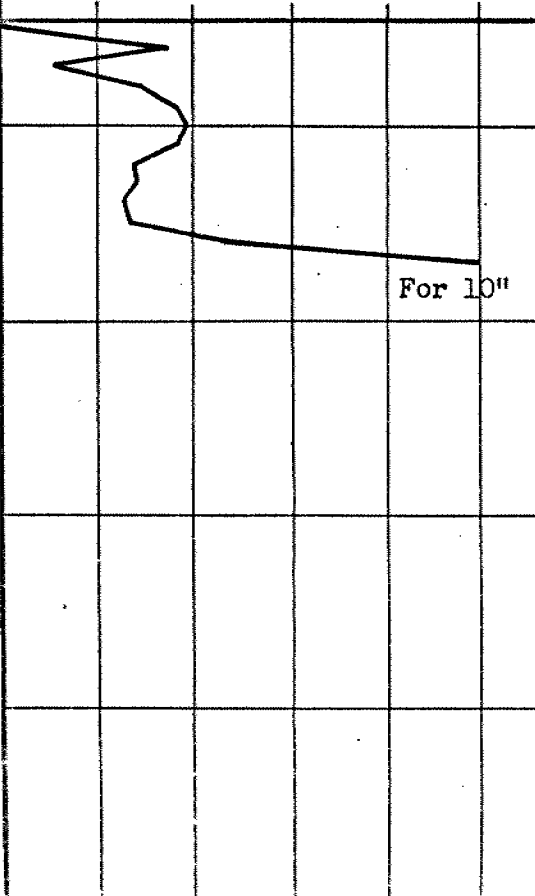
BORING DATE March 24, 1965.

COMPILED BY W.W.K.

DATUM 875.6

BOREHOLE TYPE Washboring - BX Casing.

CHECKED BY K.G.S. *dk*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT — WL			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	PLASTIC LIMIT — WP	WATER CONTENT — W	WATER CONTENT %		
							20 40 60 80 100					
							SHEAR STRENGTH P.S.F.					
875.6	Groundlevel											
873.6	Black org. topsoil	{ }										
2.0	Silty sand with traces of clay and gravel. Compact to very dense.	1	SS	29	870						
			2	SS	35							
			3	SS	52	860						
			4	SS	69							
			5	SS	108	850						
			6	SS	138	840						
834.1												
41.5	End of borehole.					830						

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

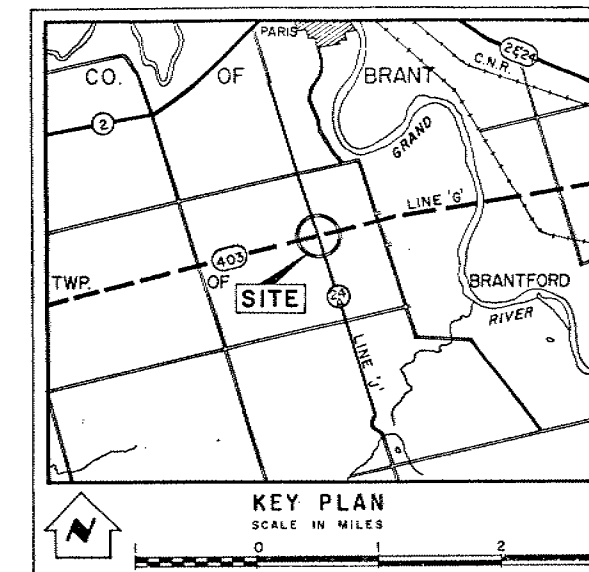
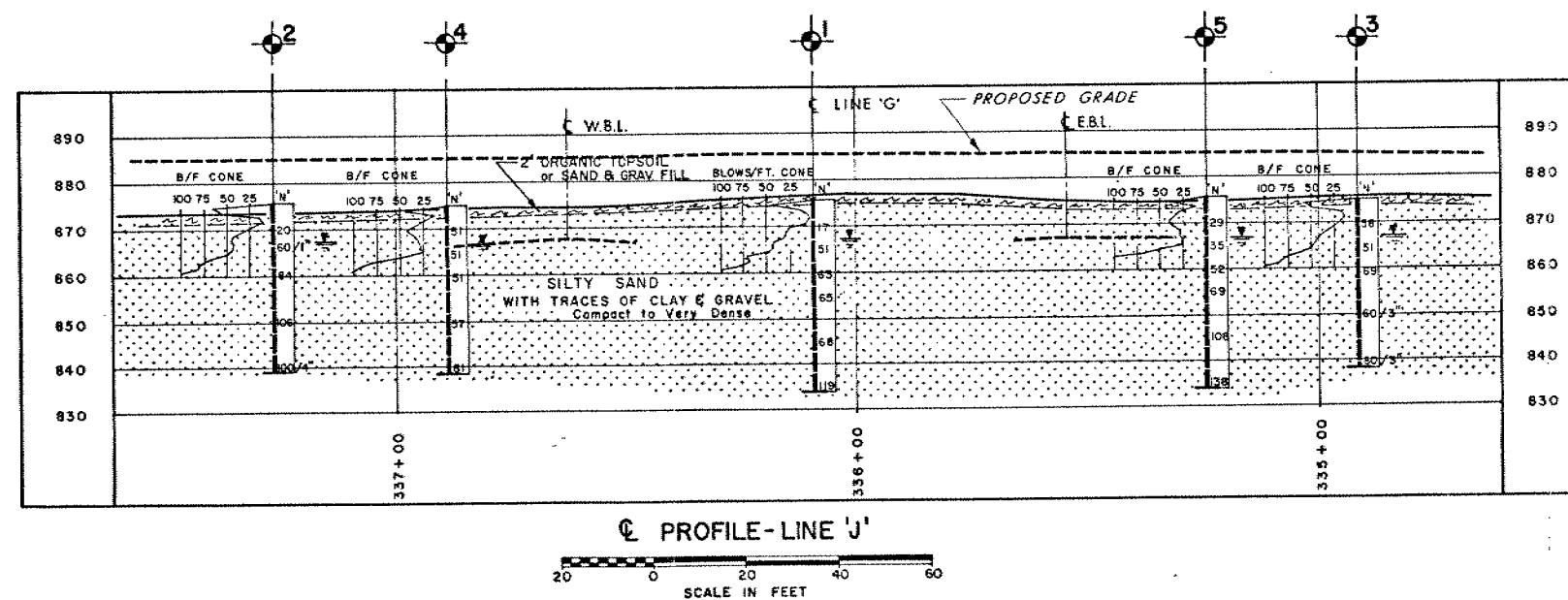
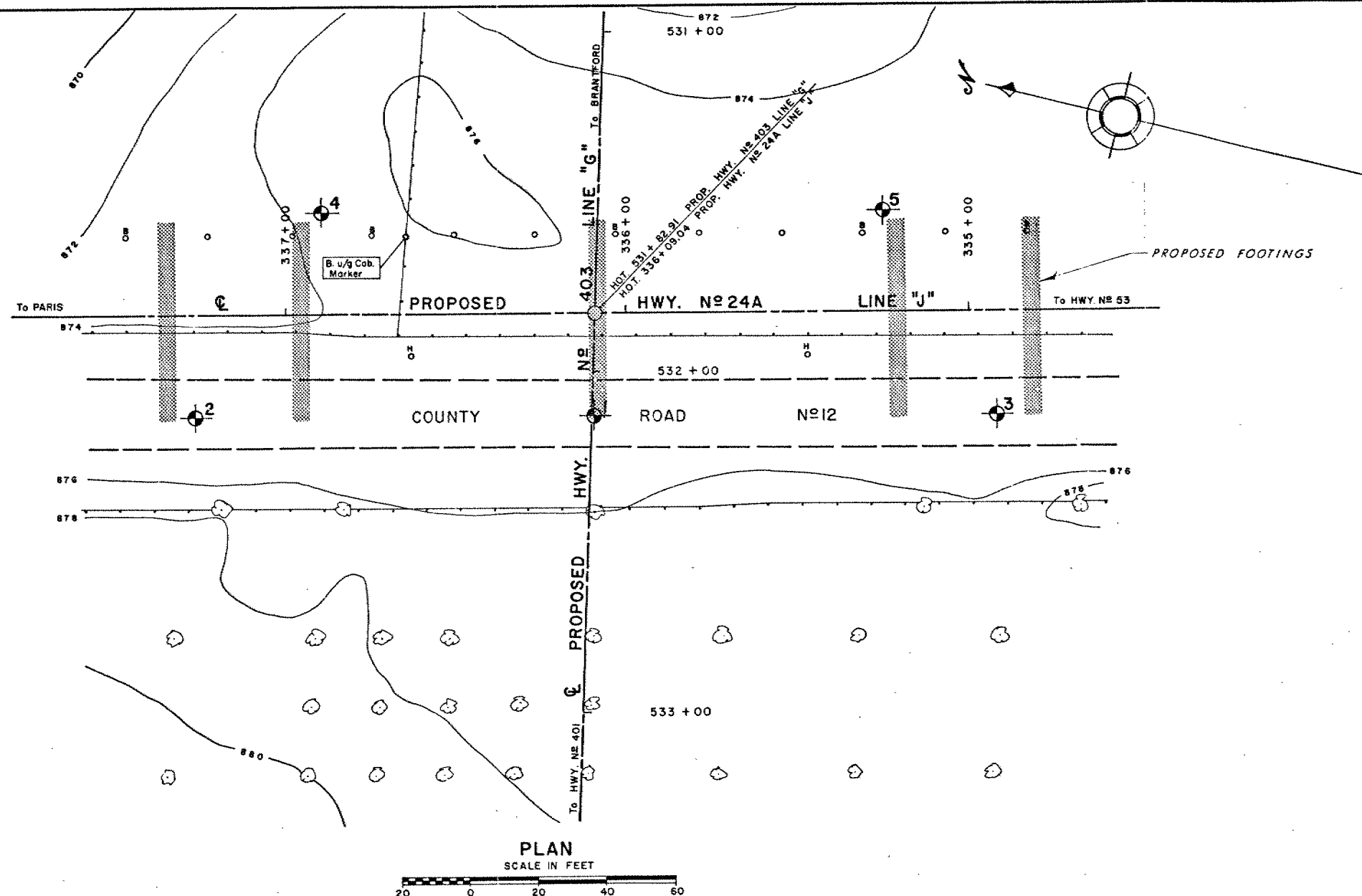
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

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



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, March 1965		

NO.	ELEVATION	STATION	OFFSET
1	875-5	336+09	30' LT.
2	875-6	337+38	30' LT.
3	875-3	334+92	30' LT.
4	875-0	336+91	30' RT.
5	875-6	335+26	30' 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 HIGHWAYS - ONTARIO			
MATERIALS & TESTING DIVISION - FOUNDATION SECTION			
PROPOSED HIGHWAY NO. 24A LINE "J"			
KING'S HIGHWAY NO. 403 LINE "G"		DIST. NO. 2-4	
CO. BRANT		LOT 10 & 11 CON. II	
BORE HOLE LOCATIONS & SOIL STRATA			
SUBM'D. W.K.	CHECKED	W.B. NO. 160-60	M.B.T. DRAWING NO.
DRAWN D.G.H.	CHECKED	JOB NO. 65-F-31	65-F-31A
DATE 17 MAY 1965	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	CCNT. NO.		