

Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.
May 21, 1963

D.H.O. FOUNDATION INVESTIGATION REPORT --
Proposed Overhead where the Proposed Realignment
of Hwy. #24, Line "j" crosses the Michigan Central
Railway Tracks, 2 Miles West of Waterford, Ontario.
W.J. 63-F-40 - District No. 2 - W.P. 34-62

Attached, we are forwarding to you, our detailed foundation investigation report dealing with the subsoil conditions existing at the above structure site.

We believe that you will find the factual data and recommendations contained therein, adequate for your future design work.

Should additional information be required, please do not hesitate to contact our Office.

KYL/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
E. A. Tregaskes
H. D. McMillan
A. Cater
H. C. Dernier
J. Roy
A. Watt

Foundations Office
Gen. Files ✓


K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:

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FOUNDATION INVESTIGATION

For

Proposed Overhead where the Proposed Realignment
of Hwy. #24, Line 'J' crosses the Michigan Central
Railway Tracks, 2 Miles West of Waterford, Ontario
W.J. 63-F-40 - District No. 2 - W.P. 34-62

INTRODUCTION:

A request dated March 25, 1963, for a foundation investigation at the site where the proposed realignment of Hwy. 24, Line 'J' is to cross the Michigan Railway tracks by means of an overhead, was received from the Bridge Location Section.

A field investigation was carried out by this Section during April 1963, to determine the subsoil conditions at the site of the proposed structure. Presented in this report, are the results of this investigation, together with recommendations pertaining to the design of the bridge foundations and approach embankments.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located on County Road 18, where it crosses the Michigan Central Railway tracks in the Township of Townsend and Windham, some 2 miles west of Waterford. The general area is characterized by a flat topography.

Physiographically, the site lies in the area known as the "Norfolk Sand Plain". The sands and silts of this region were deposited as a delta in the glacial lakes Whittlesey and Warren covering the Galt and other moraines.

3. DESCRIPTION OF THE FIELD AND LABORATORY INVESTIGATION:

The field work consisted of four sampled boreholes and eight dynamic cone penetration tests. Disturbed samples were obtained by means of a 2" O.D. split-spoon sampler. The dimensions of the split-spoon sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test.

All samples were visually identified in the field and then returned to the laboratory where further tests were carried out to determine the Atterberg Limits, moisture contents, density and particle size distribution.

The location of the boreholes, together with the inferred soil stratigraphy, are shown on Dwg. 63-F-40A of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The overburden at the site consists of a layer of very loose to compact, fine to medium sand, some 16 feet in thickness overlying a stratum of very dense glacial till containing irregular layers of very dense, fine sand. Beneath the till is a stratum of very dense, fine to medium sand, which was proved to a maximum depth of 60 feet below the ground surface in B.H. #1.

4.2) Upper Layer of Fine to Medium Sand:

A layer of fine to medium sand was found in all the boreholes, varying in thickness from 15 feet in B.H. #1, to 17 feet in B.H. #4. The lower 12 inches, approximately, of this stratum

cont'd. /3 ...

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

4.2) Upper Layer of Fine to Medium Sand: (cont'd.) ...
in B.H.'s #4 and #6, contains gravel size particles. Particle size distribution curves for this material are contained in the report. The standard penetration resistances or 'N' values, vary from 2 near the surface, to 31 at the lower portion, with an overall average of 13, indicating that the relative density of the material is generally loose to compact, increasing with depth.

4.3) Glacial Till with Layers of Fine to Medium Sand:

Beneath the upper fine to medium sand, a heterogeneous deposit of glacial till containing irregularly layers of fine to medium sand, was found varying in thickness from 10 feet in B.H. #4 to 15 feet in B.H. #1. The glacial till consists of clayey silt and dispersed sand and gravel. Particle size distribution curves for this material are contained in the report and show the following percentage compositions: 6% silt and clay sizes, 80% sand sizes, and 14% gravel sizes. Average Atterberg limits are: Liquid limit 16%, plastic limit 11%, and an average moisture content is 10%. An average unit weight for this material is 143 P.C.F. The standard penetration resistances or 'N' values for this material vary from 24 to in excess of 100, with an overall average of 70, indicating the relative density to be very dense.

4.4) Lower Deposit of Fine to Medium Sand:

Immediately below the glacial till, a layer of very dense fine to medium sand was found in all the boreholes and was proved

cont'd. /4 ...

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

4.4) Lower Deposit of Fine to Medium Sand: (cont'd.) ...
to a maximum depth of 60 feet below ground surface in B.H. #1.
Grain size distribution curves for this material are contained
in the report. Standard penetration resistances or 'N' values
vary from 44 to 90, with an overall average of 67, indicating
the material is generally very dense.

5. GROUND WATER CONDITIONS:

The water levels, as recorded in the boreholes at the
time of the field investigation, are recorded in the records of
the borelogs. At that time, the water table at the site was found
to be at approx. elev. 781.0, some 5 ft. below the ground surface.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is understood that the proposed realignment of Hwy. #24,
Line 'J' is to cross the Michigan Central Railway tracks by means
of an overhead some 2 miles west of Waterford. The proposed bridge
is to have three spans of 36 ft., 60 ft. and 36 ft. The approximate
location of the abutments and piers are shown on Dwg. 63-F-40A.
The structure is to be some 40 feet wide. The profile grade of the
structure will be at about elevation 814.00 which will necessitate
the placement of approach fills some 28 feet high.

cont'd. /5 ...

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

6.2) Bridge Foundations:

In view of the high water table and the low relative density and thus the low bearing capacity of the upper fine to medium sand, spread footings cannot be placed in this stratum.

Spread footings can be placed on the glacial till stratum at about elevation 770 for the south pier and abutment, and at approx. elev. 770 for the north pier and abutment, with an allowable bearing value of 2 tons per square foot. However, the use of spread footings would require some 16 to 18 feet of excavation below ground surface. Because of the deep excavations and the dewatering problems involved, it is recommended that the structure be supported on a piled foundation.

The footings can be supported on large displacement, end-bearing piles driven to practical refusal in the very dense glacial till. For estimating purposes for 12 $\frac{3}{4}$ " O.D. tubular piles driven some 6 to 8 ft. into the glacial till, a safe design load of 60 tons per pile can be used.

If treated timber piles are driven to contact with the glacial till stratum, a safe design load of 25 tons per pile can be used. All pile driving operations during construction, must be controlled by the use of the Hiley Formula.

As excavation below the water table will result in a dewatering problem in the upper fine to medium sand, it is recommended that the base of the pile caps be placed above elevation 781.0.

cont'd. /6 ...

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

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

The approach embankments should be constructed of well-compacted, acceptable fill. The stability of the embankment should not prove to be a problem.

7. SUMMARY:

1. The subsoil at the site consists of a layer of very loose to compact, fine to medium sand overlying very dense glacial till containing irregular layers of fine to medium sand. Beneath the glacial till is a stratum of very dense fine to medium sand.
2. It is proposed to build an overhead where the proposed revision of Hwy. #24, Line 'J' is to cross the Michigan Central Railway tracks some two miles west of Waterford. The proposed profile grade is to be at an elevation of 814.00.
3. The approach embankments should be constructed of well-compacted, acceptable fill. The stability of the embankments should not prove to be a problem.
4. The footings for the piers and abutments should be supported on large displacement end-bearing piles driven to practical refusal into the very dense glacial till stratum.
5. Dewatering will be a problem if excavations for the pier footings are taken down below the water table in the very loose to compact fine to medium sand. It is suggested that the base of the pile caps be placed above elev. 781.00.

cont'd. /7 ...

8. MISCELLANEOUS:

The field investigation was carried out in the period April 22nd through May 1st, 1963, by the Johnston Drilling Co. Ltd., under the supervision of Mr. T. F. Widdis, Project Foundation Engr., who also prepared this report under the general supervision of Mr. M. Devata, Senior Foundation Engr.

May 1963

APPENDIX I.

MEMORANDUM

To: Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

FROM: Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

Attention: Mr. S. McCombie.

DATE: May 21, 1963

Our File Ref.

IN REPLY TO

SUBJECT:

D.H.C. FOUNDATION INVESTIGATION REPORT --
Proposed Overhead where the Proposed Realignment
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May 1963

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-40

LOCATION 170796 20.0' Rt.

ORIGINATED BY T.F.W.

W.P. 34-62

BORING DATE April 25, 1963.

COMPILED BY T.F.W.

DATUM G.S.C.

BOREHOLE TYPE Dynamic Cone Penetration Test.

CHECKED BY

SOIL PROFILE		STRAT. PLOT	SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT ——— WL	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION		NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	PLASTIC LIMIT ——— WP		
786.5 0.0	Ground Surface Probably loose to compact brown. Fine to medium sand.						SHEAR STRENGTH P.S.F.	WATER CONTENT ——— W		
767.5 19.0	End of borehole.							WATER CONTENT %		

61-4391

FOUNDATION SECTION

CHECKED BY ML

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 63-F-40 LOCATION 17142 22.0' Rt. ORIGINATED BY T.F.W.
W. P. 34-62 BORING DATE Apr. 25, 1963. COMPILED BY T.F.W.
DATUM G.S.C. BOREHOLE TYPE NK Casing Washboring CHECKED BY TH

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	w_P ——— w ——— w_L				
							SHEAR STRENGTH P.S.F.					WATER CONTENT %				
787.0	Ground Surface.					790										
0.0	Very loose to compact Fine to medium sand.		1	SS	2											
			2	SS	4	780										
			3	SS	22											
	Containing gravel from elev. 771 to elev. 770.0		4	SS	31	770										
17.0	Compact to very dense grey glacial till with layers of very dense fine to medium sand.		5	SS	24											
			6	SS	120	760										
759.5																
27.5	Very Dense, . Brownish-Grey, Fine to Medium Sand.		7	SS	66											
			8	SS	71	750										
745.5			9	SS	81											
41.5	End of Borehole					740										
						730										

▼ 780.5 WL
6.5

FOUNDATION SECTION

ORIGINATED BY T.F.W.

COMPILED BY T.F.W.

CHECKED BY Y/V

SOIL PROFILE			SAMPLES			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	ELEV. SCALE	SHEAR STRENGTH P.S.F.		WATER CONTENT %		
787.5 0.0	Ground Surface. Probably loose to compact, brown fine to medium sand.					790					
763.5 24.0	End of borehole.					740					

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

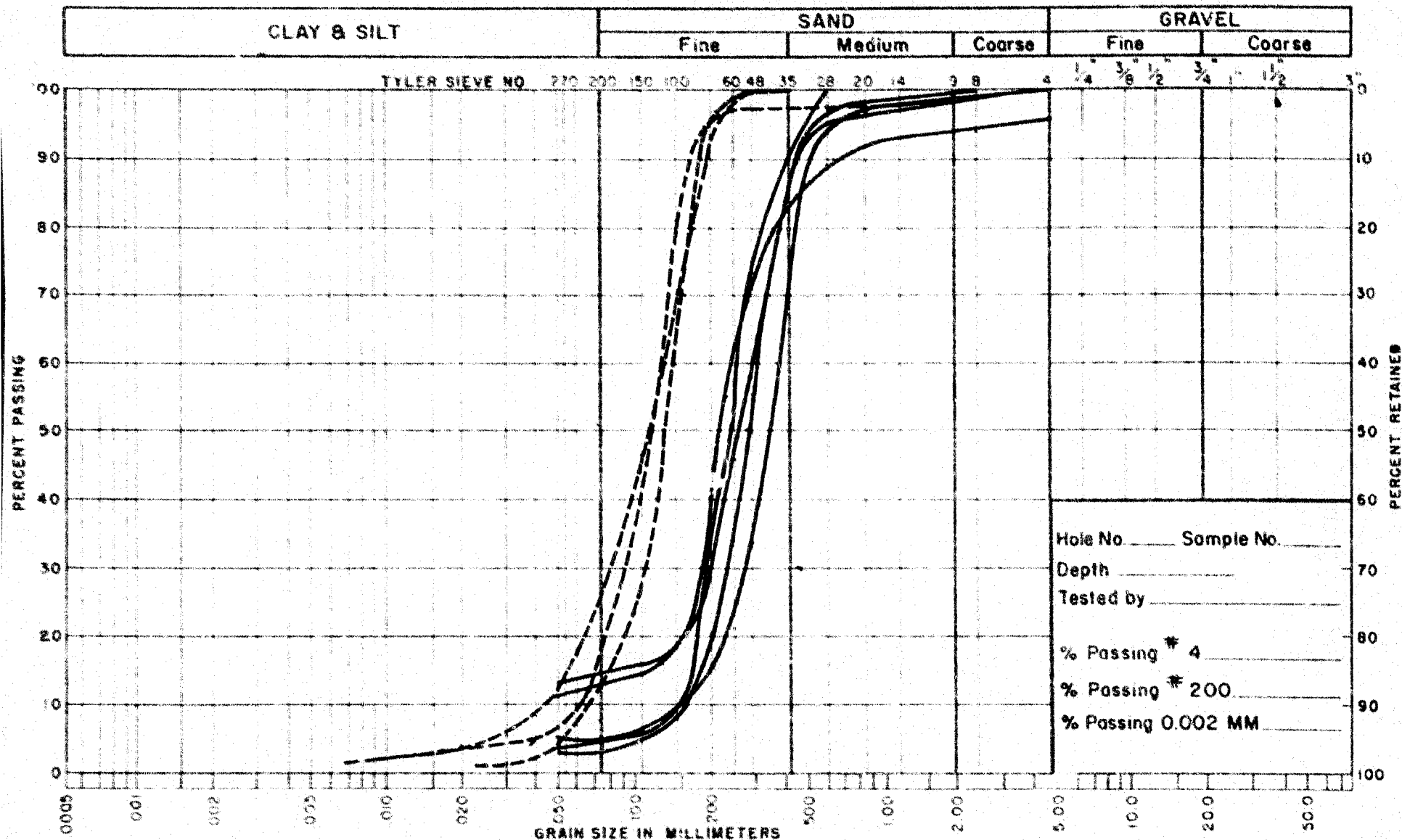
RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 63-F-40 LOCATION 170+52 20.0' Lt. ORIGINATED BY T.F.W.
W.P. 34-62 BORING DATE Apr. 30, 1963. COMPILED BY T.F.W.
DATUM G.S.C. BOREHOLE TYPE Dynamic Cone Penetration Test. CHECKED BY 10/2

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT — WL			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — WP	WATER CONTENT — W	WATER CONTENT %		
785.0	Ground Surface					790							
0.0	Probably loose to compact.					780							
	Brown, fine to medium sand.					770							
769.0						760							
16.0	End of borehole.					750							

UNIFIED SOIL CLASSIFICATION SYSTEM

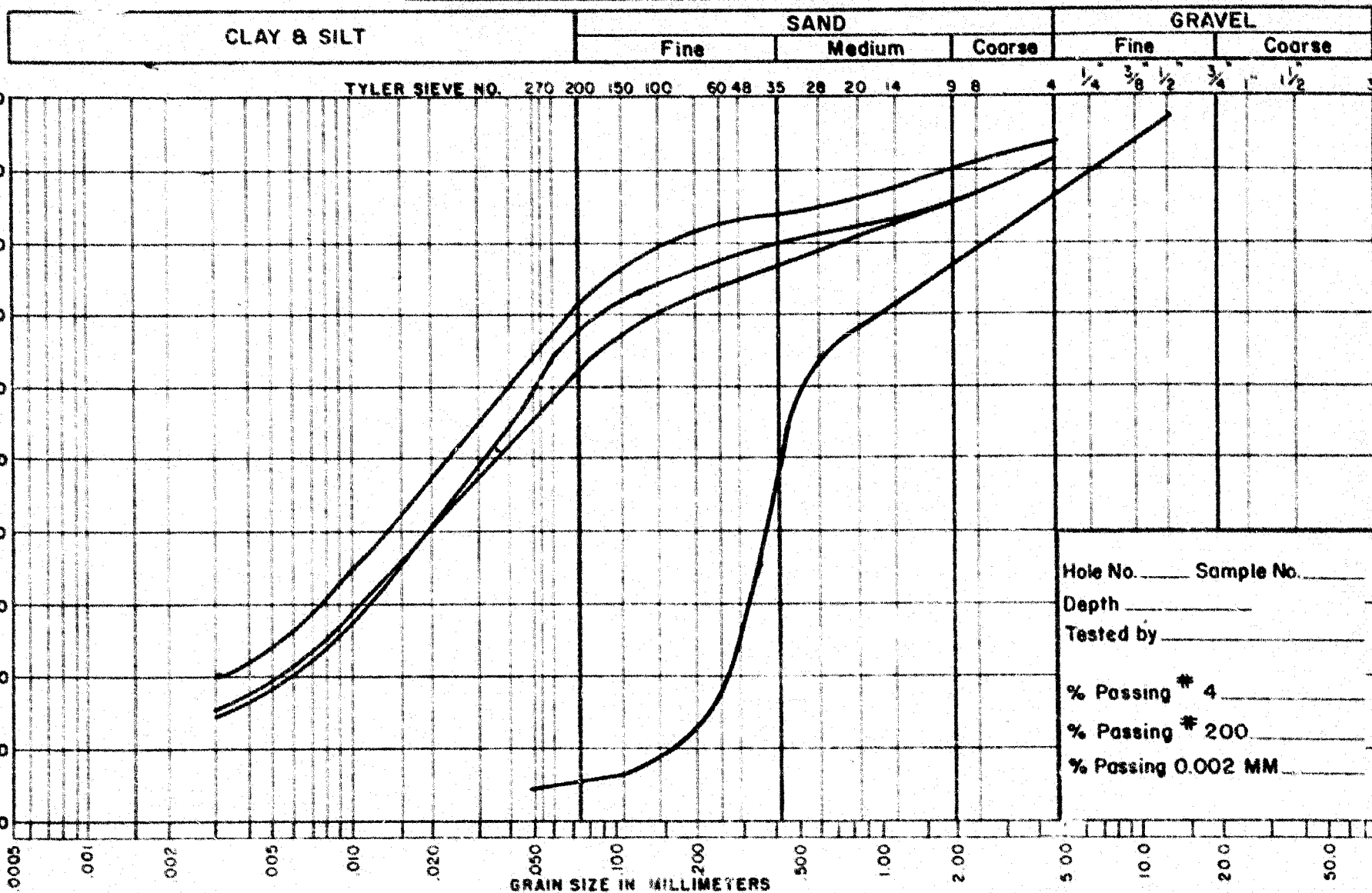


NOTES ——— UPPER FINE TO MED. SAND
 ----- LOWER " " " "

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 63 - F - 40 W.P. No. 34 - 62
 Location HWY. NO. 24 & N.Y.C.R.

UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES GLACIAL TILL

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 63 - F - 40

W.P. No. 34 - 62

Location HWY. NO. 24 & N.Y.C.R.

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
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 LOGARITHM'S 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
$\bar{\sigma}$	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

Mr. S. McCombie,
Bridge Planning Engr.,
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Attention: Mr. G. Scott

Mr. A. G. Stermac,
Principal Foundation Engr.,
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Materials & Research Division.

November 13, 1963

N.Y.C.R. Overhead on Hwy. #24 -
Review of Preliminary Plan #D 5332-P1
W.P. 34-62 -- W.J. 63-F-40
District #2

The designer appears to have followed
the recommendations given in the Foundation Report.

KGS/MdeF

cc: Foundations Office
Gen. Files

K. G. Selby
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SENIOR FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

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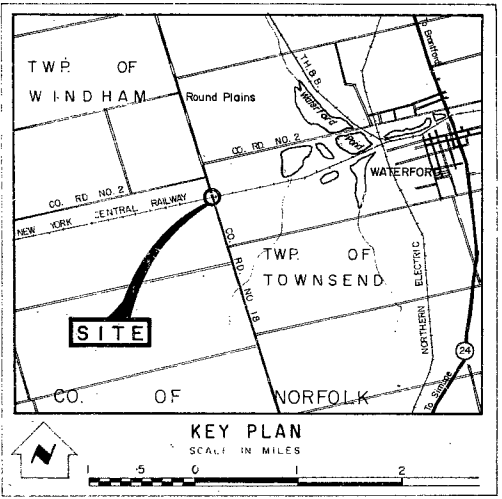
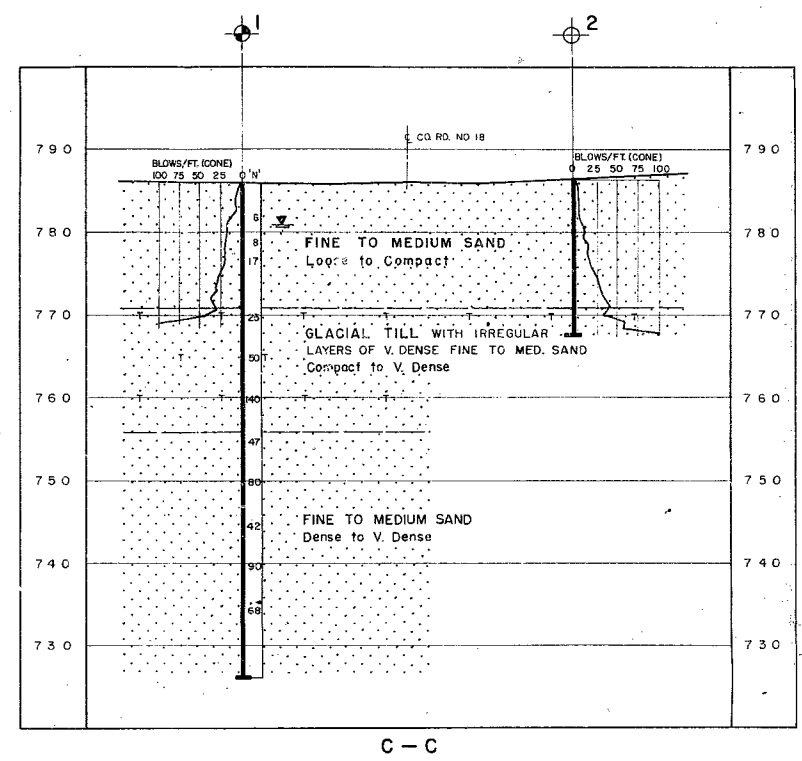
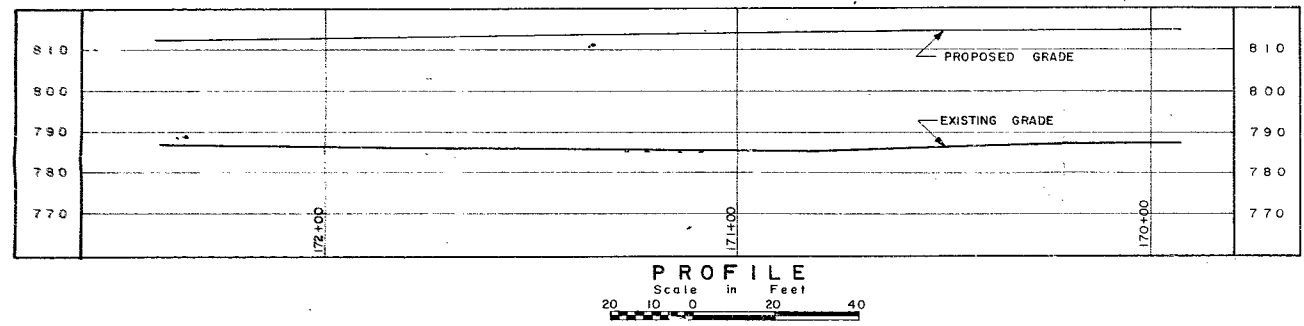
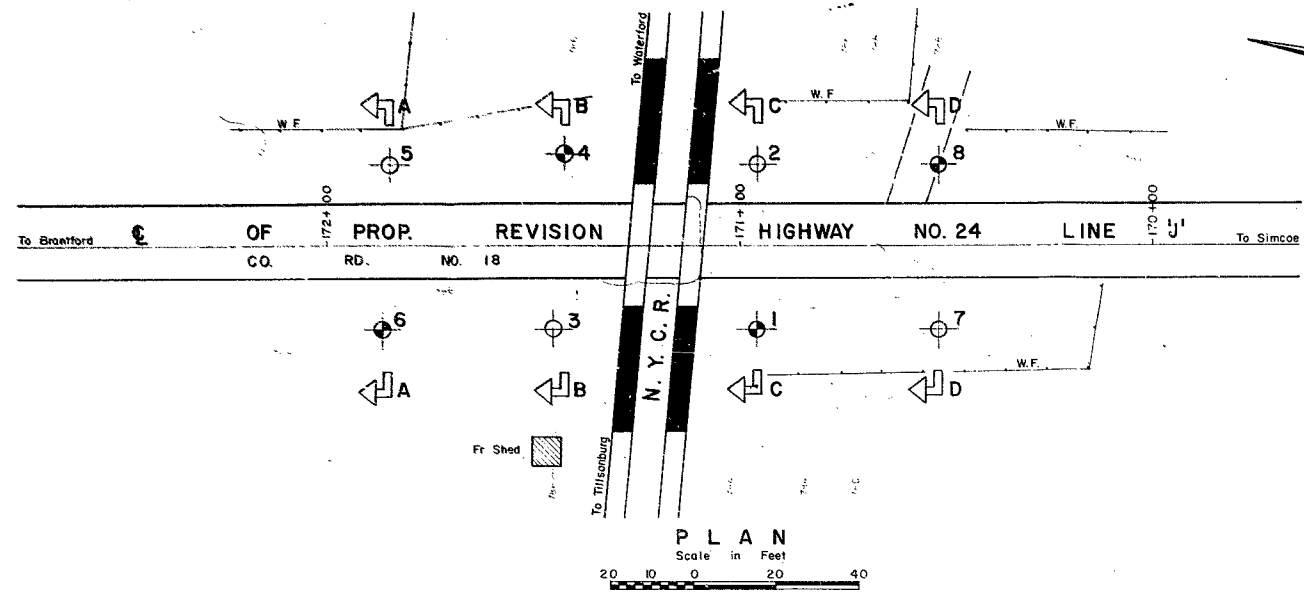
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#63-F-40
W.P. #34-62
HWY# 248
NEW YORK
CENTRAL
RAILWAY



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. (April 1963)		
NO.	ELEVATION	STATION	OFFSET
1	786.0	170+96	20' LT.
2	786.5	170+96	20' RT.
3	788.0	171+45	21' LT.
4	787.0	171+42	22' RT.
5	787.5	171+85	20' RT.
6	786.5	171+87	20' LT.
7	785.0	170+52	20' LT.
8	786.5	170+52	20' 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

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION			
NEW YORK CENTRAL RAILWAY			
KING'S HIGHWAY NO. 24 PROP. REV'N. LINE 'J' DIST. NO. 2			
CO. NORFOLK			
TWP. WINDHAM & TOWNSEND LOT 1 CON. VIII			
BORE HOLE LOCATIONS & SOIL STRATA			
SUB'D T.W.	CHECKED	W.P. NO. 34-62	M.B.R. DRAWING NO.
DRAWN D.M.	CHECKED	JOB NO. 63-F-40	63-F-40 A
DATE 31 MAY 1963	SITE NO.		BRIDGE DRAWING NO.
APPROVED	CONT. NO.		

