DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

23-68-10 & 6T-1
W.P. 275-64-1

TO: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie

FROM: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

DATE: February 3, 1966

OUR FILE REF.

IN REPLY TO FEB 9 1966

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Storm Sewer Tunnel at Q.E.W.
and Hwy. #27 Interchange,
District #6 (Toronto).

W.J. 66-F-2-- --W.P. 275-64-1

Attached, we are forwarding to you, our detailed foundation investigation report on 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 design requirements.

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

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
J. C. Thatcher
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Storm Sewer Tunnel at Q.E.W.
and Hwy. #27 Interchange,
District #6 (Toronto).
W.J. 66-F-2 -- 275-64-1

1. INTRODUCTION:

Following a request dated December 29, 1965, by the Bridge Location Section, a field investigation has been carried out at the site of the proposed storm sewer tunnel at Q.E.W. and Hwy. #27 interchange. This report contains a description of subsoil conditions as revealed by the investigation.

2. FIELD WORK:

Three borings were carried out during the course of the field work. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. Borings were advanced to a depth some five feet below the proposed sewer invert level. All survey work in the field was carried out by personnel from the construction staff of District #6. The locations and elevations of all borings together with the estimated stratigraphical profile, are shown on the attached Drawing #66-F-2A.

3. SUBSOIL CONDITIONS:

Subsoil at the site consists of sand and gravel (highway fill material) overlying a dense to very dense deposit of glacial till about 10 feet thick, which overlies shale bedrock. The

cont'd. /2 ....

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

boundaries between the different deposits are shown on the attached borelog sheets together with a description of the subsoil types. The glacial till deposit consists of a heterogeneous mixture of clayey silt, sand and gravel, with Standard Penetration Test 'N' values ranging from 36 to more than 100 blows per foot. The relative density of this deposit ranges from dense to very dense, but is generally very dense.

A description of the bedrock encountered in the borings has been made, after careful examination of the rock core samples, by Mr. B. K. Glassford, Geologist, and is as follows:

> "The rock encountered in the drilling of holes 1, 2, and 3 of project 66-F-2 is of the Dundas shale of Ordovician age. This rock is a thin to medium-bedded, grey-green, soft, platy shale containing numerous thin, hard, limy beds that occur in the top section of the formation. The shale body of rock minus the hard limy layers has a low plasticity and a water absorption of 8 - 10 percent. It is a poor rock structurally and disintegrates rapidly on exposure to the atmosphere."

The following ground water levels were observed in the boreholes at completion of drilling operations:

B.H. 1 -- El. 362.8

B.H. 2 -- El. 361.3

B.H. 3 -- El. 355.1

cont'd. /3 .....

4. MISCELLANEOUS:

The field work for this project was carried out by Johnston Drilling Co. Ltd., under the supervision of Mr. W. W. Kulmatickas, Project Foundation Engineer, during the period January 6 - 17, 1966. This report was written by Mr. K. G. Selby, Senior Foundation Engineer.

February 1966

APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-2 LOCATION W.E.W. & Hwy. 27 Co.-Ord. 177,580 N & 208,260 E ORIGINATED BY W.W.K.
W.P. 275-64-1 BORING DATE Jan. 6, 1966. COMPILED BY B.G. & H.R.
DATUM G.S.C. BOREHOLE TYPE Washboring & BX Core CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
364.0	Groundlevel									
0.0 / 363.0	Black organic topsoil									
1.0	Silty sand with traces of clay. Dense.		1	SS	40	360				W.T. 1'2" B.G.L.
356.0										
8.0	(Glacial Till) Clayey silt with sand & traces of gravel. V. dense.		2	SS	65	350				
348.0			3	SS	145					
16.0 / 345.5	Disintegrated shale.									
18.5	Limestone bands		4	RC	89%					
19.5										
20.0			5	RC	89%	340				
25.5	Shale with thin limestone bands.		6	RC	100%					
27.4										
28.5										
29.0			7	RC	98%	330				
			8	RC	98%					
			9	RC	98%	320				
45.6 / 317.4										
46.6	End of borehole.									

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 66-F-2 LOCATION S.E.W. & Hwy 27 177,746 N & 208,710 E ORIGINATED BY W.W.K.

W.P. 275-64-1 BORING DATE Jan. 10, 1966. COMPILED BY B.G. & S.O.

DATUM G.S.C. BOREHOLE TYPE Washboring & BX CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT %	BULK DENSITY P.C.F.	REMARKS
365.4	Groundlevel									
0.0	Fill Material Sand & gravel.									
361.4										W.T. 4'-1" B.G.
4.0	(Glacial Till) Clayey silt with sand & traces of gravel. V. dense		1	SS	45	360				
			2	SS	114/9"					
351.1										
14.3			3	SS	130/3"	350				
17.0	Limestone bands		4	RC	95%					
17.10										
18.2			5	RC	90%					
21.9										
23.11	Shale with thin limestone bands.					340				
24.9			6	RC	90%					
25.8										
			7	RC	100%					
						330				
			8	RC						
323.4										
42.0	End of borehole.					320				

FORM 08-MT-126 (FORMERLY 08-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-F-2 LOCATION Q.E.W. & Hwy 27 177,993 N & 209,384 E ORIGINATED BY W.W.K.
W.P. 275-64-1 BORING DATE Jan. 1966. COMPILED BY B.G. & S.O.
DATUM G.S.C. BOREHOLE TYPE Washboring & BX CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
362.6 / 0.0	(Glacial Till) Clayey silt with sand & traces of gravel. Dense.		1	SS	36	360
351.8 / 10.8			2	SS	100/2"	350
13.9						
19.6	Limestone Bands					
21.0						
22.3			3	RC		340
23.3	Shale with thin limestone bands.					
						330
32.6						
35.0						
322.6 / 40.0	End of borehole.					320

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
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

W.L. 7'6" B.G.L.

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
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

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

FOUNDATIONS

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

SLOPES

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

66-F-2

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. K. Selby,
Sr. Foundation Engineer,
Foundation Section.

From: B.K. Glassford.

Date: January 21st. 1966

Our File Ref.

In reply to

Subject:

Re: Project 66-F-2, Hwy. 27 and Q.E.W.

The rock encountered in the drilling of holes 1, 2, and 3 of project 66-F-2 is of the Dundas shale of Ordovician age. This rock is a thin to medium-bedded, grey-green, soft, platy shale containing numerous thin, hard, limy beds that occur in the top section of the formation. The shale body of rock minus the hard limy layers has a low plasticity and a water absorption of 8 - 10 percent. It is a poor rock structurally and disintegrates rapidly on exposure to the atmosphere.

BKG:ph

B.K. Glassford,
Geologist.

B K Glassford

#66-F-2

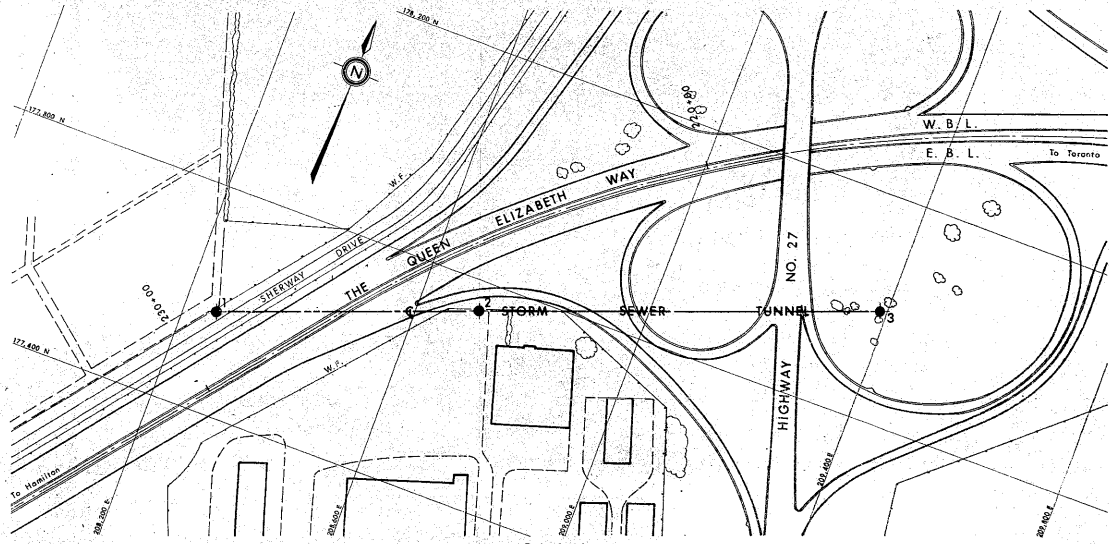
W.P.# 275-64-1

Q.E.W. &

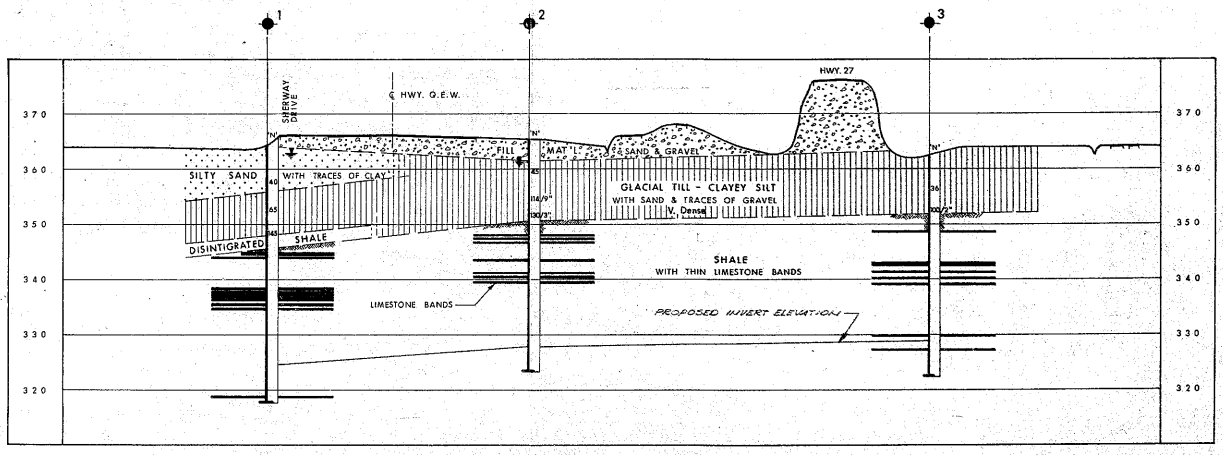
Hwy. #27

STORM SEWER

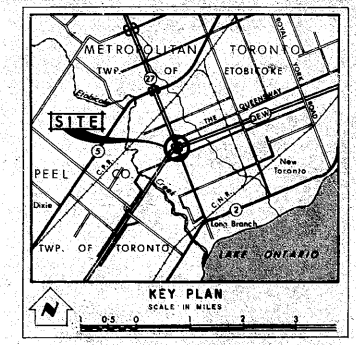
TUNNEL



PLAN
SCALE
100 50 0 100 200 FT.



℄ PROFILE — STORM SEWER
SCALE
VERT. 10 5 0 10 20 FT.
HORT. 100 50 0 100 200 FT.



KEY PLAN
SCALE IN MILES
0·5 0 1 2 3

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. JAN. 10, 1966

NO.	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	364·0	177,580	208,260
2	365·4	177,746	208,710
3	362·6	177,993	209,384

- 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

PRINT RECORD

NO.	FOR	DATE

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

STORM SEWER TUNNEL

KING'S HIGHWAY NO. 27 & Q.E.W. DIST. NO. 6
CO. METROPOLITAN TORONTO
TWP. ETOBICOKE LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D W.K.	CHECKED A.M.T.	W.P. NO. 275-64-1	M.&T. DRAWING NO. 66-F-2A
DRAWN S.O.	CHECKED W.K.	JOB NO. 66-F-2	
DATE 28 JAN., 1966		SITE NO.	BRIDGE DRAWING NO.
APPROVED A.M. Thomas (DIRECTOR AND ENGINEER)		CONT. NO.	