MEMORANDUM

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

Attention: Mr. S. McCombie

From: Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

Date: February 26, 1964

Our File Ref.

In reply to

Subject:

FOUNDATION INVESTIGATION REPORT

For

Proposed Culvert at Sta. 151+07,
Hwy. #2, Whitby to Oshawa, Ont.
District #6, Toronto

W.J. 64-F-10 -- W.P. 38-62.

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 future design work. If further information concerning this project is required, please do not hesitate to contact our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
G. K. Hunter (2)
C. Fraser
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

FOUNDATION INVESTIGATION REPORT

For

Proposed Culvert at Sta. 151+07,
Hwy. #2, Whitby to Oshawa, Ont.
District #6, Toronto
W.J. 64-F-10 -- W.P. 38-62

A request for a foundation investigation at the site of the proposed culvert at the above location was received on February 18, 1964. from Mr. P. J. Kovich, Regional Materials Engineer.

A field investigation, utilizing a Penn drill was subsequently carried out at the site. The investigation consisted of 2 boreholes and 2 cone penetration tests. Samples were recovered by means of a split-spoon, as well as Shelby tube samplers.

The samples were visually examined in the laboratory as well as in the field. Laboratory tests were carried out on a selection of representative samples to determine the Atterberg limits, moisture contents, undrained shear strengths and unit weights.

Subsoil at the site consists mainly of 4 ft. of loose silty sand, followed by 5 ft. of stiff silty clay and by glacial till (heterogeneous mixture of clay, silt, sand and gravel). The till stratum was investigated to a depth of 26 ft. in B.H. #1 and 22 ft. in B.H. #2.

The undrained shear strength of this deposit as determined from the field vane and laboratory tests, was found to vary from a low of 430 p.s.f. to a maximum of over 2000 p.s.f. The Standard Penetration or 'N' values ranged from 7 to 42, generally increasing

cont'd. /2 ...

with depth. From these results, it is estimated the consistency of the till stratum varies from firm to very stiff.

It is proposed to construct either one of the following types of structures at this site:

a) Box type culvert.

b) Rigid frame standard open type culvert.

The subsoil conditions are such that either type of structure may be constructed at this location. A safe bearing pressure of 1 T.S.F. may be used, provided the footings are located at elevation 274 at below.

A soft pocket of glacial till was observed between approx. elevations 270 and 267 in B.H. #2.

If a rigid frame open type structure is proposed, it is recommended that this soft material be sub-excavated for the entire width of the footing and backfilled with suitable granular material to the required elevation.

If required, this Section could give the necessary assistance for determining the extent of this sub-excavation. A two-day advance notice would be necessary.

The field work, performed during February 1964, together with the preparation of this report, was undertaken by Mr. R. Magi, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Dominion Soil Investigation, Ltd. of Toronto.

February 1964.

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 64-F-10 LOCATION 59 Rt. Sta. 151+30 ORIGINATED BY R.M.
W 38-62 BORING DATE Feb. 20, 1964. COMPILED BY R.M.
DATUM 279.0 BOREHOLE TYPE Auger CHECKED BY M.D.

ELEV. DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100	SHEAR STRENGTH PSF + Vane Test ○ Unconf. Comp. Test 500 1000 1500 2000 2500	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w WATER CONTENT % 10 20 30	UNIT WEIGHT γ PCF	REMARKS
279.0	Groundlevel									
0	Silty sand									
275.0	Loose		1	SS	5					▼ W.L. 275.5
4	Silty clay		2	TW	P					
			3	SS	16	270				
269.0	Stiff									
10	Glacial till (Het. mixt. of clay, silt, sand and gravel).		4	SS	8					
			5	SS	7					
			6	TW	P					
			7	SS	42	260				
253.5	Firm to v. stiff		8	SS	20					
25.5	End of borehole.									

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 64-F-10 LOCATION 62' Lt. Sta. 150/98 ORIGINATED BY R.N.

W P 38-62 BORING DATE Feb. 20, 1964. COMPILED BY R.N.

DATUM 278.5 BOREHOLE TYPE Auger CHECKED BY M.D.

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 + Vane Test ⊙ Unc. Comp. Test 500 1000 1500 2000 2500	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT % 10 20 30	DUE DENSITY P C F	REMARKS
278.5	Groundlevel					280				
0	Silty sand									
274.5	Loose		1	SS	5					W.L. 275.5
4	Silty clay		2	TW	P					
269.5	Stiff					270			121	
9	Glacial till(silt with sand and some gravel).		3	TW	P				137	
			4	SS	12					
			5	SS	9					
						260				
	Firm to v. stiff.		6	SS	16					
						250				
246.7										
31.8	End of borehole.									

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

Q_u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q_{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q_d	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 $= \frac{-\Delta e}{(1+e)\Delta \bar{\sigma}'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \bar{\sigma}'}$
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 $\tau_f = c' + \bar{\sigma}' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION — IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \bar{\sigma}' \tan \phi'$
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
$\bar{\sigma}'$	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 (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

MEMORANDUM

To: Mr. A. Stermac,
Principle Foundations Engr.

From: T.J. Kovich.

Date: February 18th, 1964.

Our File Ref.

In reply to

Subject: Hwy. #2, Whitby to Oshawa, WP#38-62,
Culvert at Station 151/07.

At the above-noted station near the eastern limits of Whitby, a 20' x 8' x 115' concrete culvert is to be built. At present, no decision has been reached as to whether a box or open footing type is to be used.

We have made a boring at one end of the present culvert and have not been able to arrive at any conclusions. We would therefore request that you initiate a proper foundation investigation at your earliest convenience.

For your use, I am enclosing herewith the typical sections.

T.J. Kovich,
Regional Materials Engineer.

TJK/hl
c.c. T.J. Kovich,
Files.

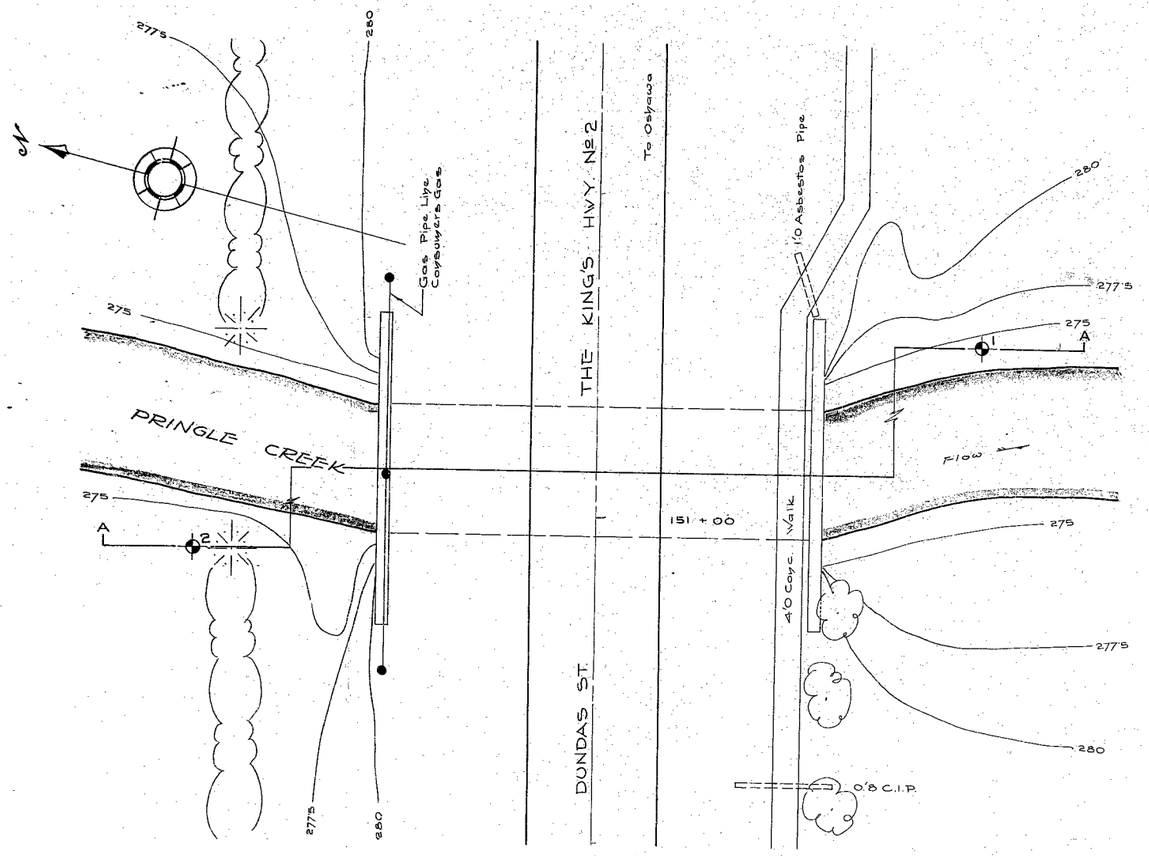
#64-F-10

W.P. # 38-62

HWY. #2

WHITBY TO

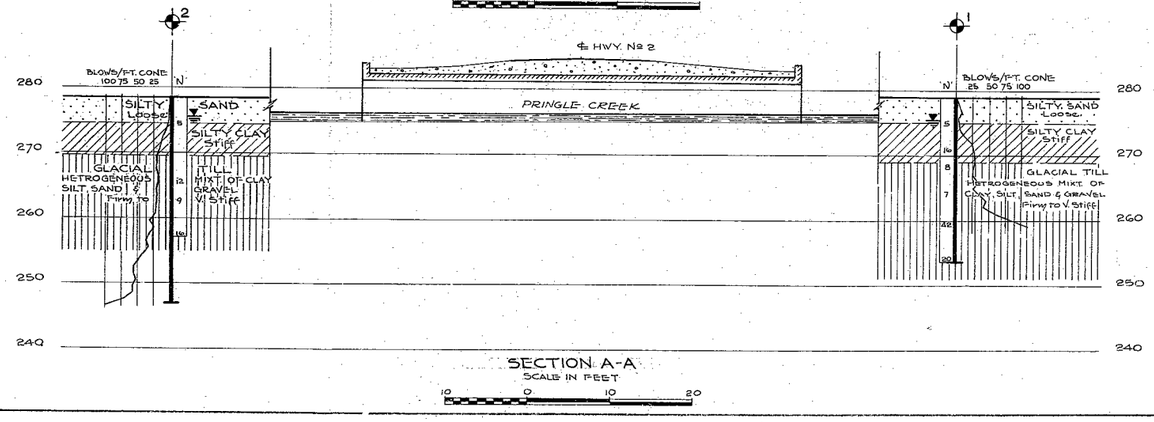
OSHAWA



PLAN

SCALE IN FEET

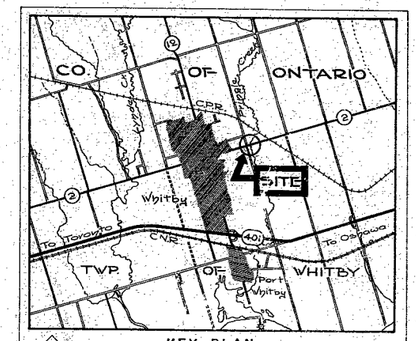
10 0 10 20



SECTION A-A

SCALE IN FEET

10 0 10 20



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. 20 FEB/64

NO.	ELEVATION	STATION	OFFSET
1	279.0	151+07	59'RT.
2	278.5	150+98	62'LT.

30-IN

- 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

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

PROPOSED CULVERT AT STA. 151+07

KING'S HIGHWAY NO. 2 DIST. NO. 6

CO. ONTARIO

TWP. WHITBY LOT - CON. I & II

BOREHOLE LOCATION & SOILS STRATA

SUBM'D. J.M.	CHECKED	W.P. NO. 38-62	M.&R. DRAWING NO. 64 F-10 A
DRAWN D.G.H.	CHECKED	JOB NO. 64 F-10	
DATE 11 MAR/64		SITE NO.	BRIDGE DRAWING NO.
APPROVED A.W. Thomas PRINCIPAL FOUNDATION ENGINEER		CONT. NO -	