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AVON RIVER BRIDGE

LAKE VICTORIA

ST RAT FORD

WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS  
LABORATORY TESTING  
SOIL MECHANICS CONSULTATION

*municipal*

W. A. TROW, M.A.Sc., M.E.I.C., P.ENG.

1850 JANE ST.,  
WESTON, ONT.  
CH. 1-4644

Project: J1275

January 6, 1964

Mr. A. Rutka, P.Eng.,  
Materials and Soils Engineer,  
Department of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ontario

Attention: Mr. K.Y. Lo, P.Eng.

Re: Foundation Conditions  
Proposed Avon River Bridge  
Lake Victoria, Stratford, Ontario

Dear Sirs:

This letter confirms our telephone conversation of January 3rd, in which the possibility of boiling during the excavation for footing installation at the above noted site was discussed.

The bridge site, as revealed by the investigation, is covered by an approximately 9 feet thick layer of alluvial silty sand. The alluvium overlies a stratum of very dense silty sand till upon which the footings of the proposed structure are to be founded. If Lake Victoria is to be maintained at the present drained condition, the highest groundwater table that could be expected, would be the level coinciding with the river bed. Should such a situation exist during the period of the construction, a differential hydrostatic head of approximately 9 feet would be involved in the excavating work.

In our foundation report for this project dated November 22, 1963, we recommended that excavation difficulties due to the presence of groundwater table could be overcome by driving tongue and groove sheeting into the till and by simple pumping from sumps.

The above recommendation was made on the basis of visual examinations of samples of the till. It definitely held together as a hard compact chunk when removed from the split spoon and it was dry. The report shows that unit weight determinations were made on split spoon samples.

The opinion is also based on the experience of a test pit excavation made for the Proposed Bloor - Danforth Subway just east of Symington Avenue. The subsoil conditions at this location are summarized below:

- 0 - 9 ft. loose to medium dense fine sand
- 9 - 20 ft. medium dense to dense sandy silt  
with occasional sand seams
- 20 - 30 ft. dense to very dense medium sand  
with occasional silt seams.

The groundwater level at this location was observed, by piezometer installation and by open hole, to be at a depth of approximately  $10\frac{1}{2}$  feet below the ground surface.

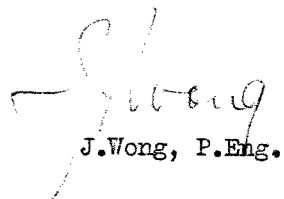
The test pit was approximately 5 feet square in size and was made by driving tongue and groove sheetings as excavating work proceeded ahead of these sheetings. No boiling or instability was observed as the excavation extended through the silt stratum. Boiling was noted, however, when the underlying sand stratum was reached at a depth of 20 feet. Excavations by Peel County personnel, for abutment footings in dense silt well below water level in the Credit River near Cheltenham also were carried out without difficulty.

A number of open excavations, made in very dense till or very dense silt with a differential hydrostatic head of about or slightly greater than 10 feet did not experience the condition of boiling.

On the basis of these observations in soil that is considered to be similar to the material existing at the Stratford site, it is believed that the excavation method outlined in our report will be satisfactory.

We shall be pleased to discuss this matter more fully if you so desire.

Yours very truly,

  
J. Wong, P. Eng.

JW/gc

# AVON RIVER BRIDGE

## REVIEW OF TROUS REPORT

### (1) SPREAD FTGS.

This recommendation is O.K.

provided the excavations can be dewatered successfully. The sheetpiling should be of a heavy section say 27 lbs / ft or more and it should be possible to drive it to a depth of about 5.0' into the till. Probably building will not occur.

### (2) PILES

An alternative solution using H piles should be considered as this may be cheaper. 20' long piles should be alright for 30 tons pile.

Discussed with Burkhardt. Sheet piling solution adopted but leave to Contractor to save his sheet pile section. Since the excavation may not boil + it's winter construction. Requested letter from W. Town

WJH  
3/1/64

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Project: J1275

November 22, 1963

1850 JANE ST.,  
WESTON, ONT.  
CH. 1-4644

Canadian Mitchell Associates Ltd.,  
Consulting Engineers and Town Planners,  
70 Bramalea Road,  
Bramalea, Ontario

Attention: Mr. A. Hayworth, P.Eng.

Foundation Conditions  
Proposed Avon River Bridge  
Lake Victoria, Stratford, Ontario

Dear Sirs:

In conformance with your letter of authorization dated November 7, we have carried out a foundation investigation at the above noted bridge site.

We understand that the replacement to the existing bridge will incorporate an increase in width, and that the length and the bridge grade will essentially remain unchanged.

On the basis of two borings both taken to a depth of 25 feet, it was found that the river bed near the existing approaches is underlain by an approximately 9 feet thick layer of medium dense silty sand alluvial deposits with some boulders. The alluvium overlies very dense silty sand glacial drift material to the depth explored.

Because of the low bearing value, the heterogeneous composition and the scour-susceptible nature of these alluvial deposits, it is recommended that the new bridge be supported on

footings taken through the alluvium and placed on or in the underlying very dense sand till stratum, which is competent to carry a safe net bearing pressure of 4 tef. This recommended bearing pressure incorporates an allowance for submergence since the footings are to be situated below the groundwater table level. The settlement resulting from this loading will be well within tolerable limits.

Some difficulties may be experienced in excavation below the groundwater table to required footing level. However, these difficulties can be overcome if tongue and groove sheeting is driven into the till and then braced as the excavation proceeds. The ground water can be removed by simple pumping from sumps in the excavation.

Since the alluvium and the underlying glacial deposits are granular in nature, they will adjust immediately to the weight of fill applied. Therefore, long term settlement as well as embankment stability will not be a problem in this project.

The factual information and soil mechanics reasoning which form the basis for the foregoing comments are considered in a more detailed manner under the following sections.

#### SITE

The bridge site is located along a paved roadway crossing over the Avon River connecting the east end of William Street on the north bank and Lakeside Drive on the south side of the river in Stratford, Ontario.

The existing bridge is a single span steel truss structure with wooden beams and decking, 14 feet wide and 450 feet long. The bridge deck is at El 78.5 feet, which is approximately 10 feet above the river surface. Due to the damage to one of the structural beams, the bridge sags near the north east corner, and is presently closed to traffic. The fill, which appears to consist of sandy silt with numerous large boulders and concrete chunks, is confined by planks, which are in turn laterally retained by timber piles. The bridge seems to be supported directly on this fill.

The water in the river at the crossing was 6 inches to 1 foot deep during the period of the investigation. The flooding mark left on the retaining planks is generally at El 72 feet; however, local information indicates that, during the Spring flood period, the water level in the river rises to El 76.5 feet, which is 2 feet below the bridge deck and is approximately 2 feet above the grade of Lakeside Drive.

A Canadian Pacific Railway bridge, a single span wooden structure supported on four rows of timber piles, is situated about 400 feet upstream, and a concrete bridge resting on abutments, is located along Romeo Road approximately 1000 feet east of the site.

The river banks at the crossing are 4 to 6 feet high, and the water in the river flows to the west.

#### FIELD WORK

A total of 2 borings was put down at the bridge site using conventional wet sampling methods and cased holes. Because of the bouldery nature of the approach fill, boreholes were made on the river bed near the ends of the bridge instead of on top of the approaches,



as originally planned. Due to the high frictional resistance to driving EK casing into the very dense granular subsoil, only hole 1 was cased to the full sampled depth, while hole 2 was cased to a depth of 14 feet. All of the samples were recovered by driving a conventional 2 inch O.D. split spoon into the soil under a driving energy of 350 ft. lbs. per blow.

A cone penetration test was carried out adjacent to hole 1, in order to determine more closely the transition zone between the medium dense alluvium and the very dense sand till.

The locations of the boreholes, together with the interpreted subsoil stratigraphy, are shown on Dwg. 1. The elevations of the borings are referred to the City of Stratford Datum. The red x mark on top of the concrete base of the flag pole located in front of the R.C.S.C.C. Building was given as El 75.03 feet by R.M. Dawson, Consulting Engineer of Stratford.

#### SUBSOIL CONDITIONS

The results of the borings are described in detail on the borehole logs and in more general form on the stratigraphical profile of Dwg. 1. It can be seen that the river bed at the crossing is underlain by a layer of alluvial deposits about 9 feet thick. The alluvium, consisting of silty sand with some gravel and occasional boulders and thin layers of black organic material, was revealed to exist in a medium dense condition. Immediately beneath the alluvium, there is a stratum of silty sand till with a thickness of 13 feet in hole 1 and 8 feet in hole 2. Natural unit weight determinations performed on the till samples gave values ranging from 142 to 148 pcf, and the corresponding natural moisture contents had a measured variation from 8 to 9 percent. These high unit weights, approaching the unit weight of concrete, together with the low moisture

contents and the extremely high penetration resistances obtained in the field, indicate that the till exists in a very dense condition and is relatively incompressible.

The till overlies a stratum of sandy silt which also is in a very dense state to the depths bored.

#### FOUNDATIONS

It is proposed to replace the existing, damaged bridge by a single span, rigid-framed concrete arch structure approximately 40 feet wide and 50 feet long. The alignment and the grade of the new bridge will be similar to that existing at the crossing.

As indicated in the opening paragraphs, the alluvium underlying the river bed is not strong enough to support the proposed structure in an economical manner. Based on the high penetration resistance measurements obtained during the course of the field work, supplemented by the laboratory tests, the till is estimated to be in a very dense condition, and is competent to support footings exerting a safe net bearing pressure of 4 tsf. This recommended bearing value has taken into account the submerged condition of the footings. The settlement resulting from this loading will be insignificantly small and well within tolerable limits.

Due to the relatively permeable nature of the alluvium and the differential hydrostatic head involved, excavation difficulties during footing construction must be expected. In view of the very dense state and the low permeability of the underlying till, however, it is believed that the use of braced close-sheeting driven into the till, together with the provision of sump pumps,

should suffice to control the ground water entering the excavation. The till will remain stable during this excavation work, although the installation of a mat of lean concrete on the footing bed surface will provide a clean working surface over the construction area, and will minimize disturbances to the foundation soil as well.

Depending on the magnitude of the horizontal reaction of the arch bridge, the resistances developed around the foundation structure should be checked for adequate lateral support. These resistances comprise the passive earth pressure developed on the back of each footing and the frictional resistance generated along the base of each footing. The passive earth pressure,  $P_p$ , on the back of the footing and abutment at any depth,  $h$ , below the surface of the fill can be estimated by the following expression:

$$P_p = K_p \gamma h$$

where:  $K_p$  is the passive earth pressure coefficient conservatively estimated to be equal to 3 for lightly compacted granular backfill and 6 for well compacted backfill.

$\gamma=130$  and  $65$  pcf are the estimated unit weights of the backfill placed above and below the water level respectively.

The frictional force developed along the footing base will equal the vertical load times the coefficient of friction at the contact of the footing and soil. A coefficient of friction value at least equal to 0.7 is considered to be applicable for this dense till.

Should the sum of the passive and the frictional resistance be less than 1.5 times the horizontal thrust of the proposed arch structure, consideration should be given to the installation of a key into the till below footing level.

The widening of the bridge will necessitate the placement of additional fill at the approaches. Since the subsoil strata at the crossing are granular in nature, it will adjust as soon as the weight of fill is applied, and therefore embankment stability or long term settlement will not be a problem in this project.

For adequate protection against scour and erosion, it is recommended that a layer of rip rap be placed in front of the abutment walls, and also on the exposed slopes of the embankments adjacent to the bridge structure.

We hope that the information contained in this report is of assistance to you in the design of this replacement structure. If you have any queries after reviewing its contents, we shall be pleased to discuss them with you.

Yours very truly,

JW/go  
Encls.




*J. Wong*  
J. Wong, P.Eng.


## SITE INVESTIGATIONS : SOIL MECHANICS CONSULTATION


PROJECT NO J1275

### LEGEND

### PENETRATION RESISTANCE

2" O.D. SPLIT TUBE      

2" I.D. SHELBY TUBE      

2" DIA. CONE      

### SHEAR STRENGTH

UNDRAINED TRIAXIAL            ⊕  
AT OVERBURDEN PRESSURE  
UNCONFINED COMPRESSION      ⊗  
VANE TEST AND SENSITIVITY (S) ⊕

### NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

X<sup>L</sup>

### ATTERBERG LIMITS

LIQUID LIMIT \_\_\_\_\_  
PLASTIC LIMIT \_\_\_\_\_

SAMPLE TYPE

2" O.D. SPLIT TUBE.....  
2" I.D. SHELBY TUBE.....  
3" O.D. SHELBY TUBE.....

BOREHOLE No. 1

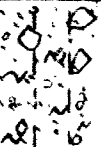
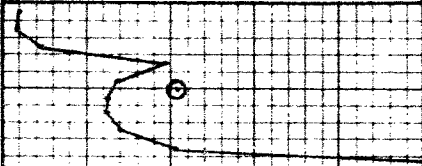
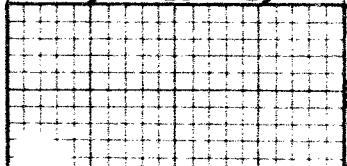
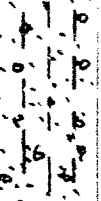
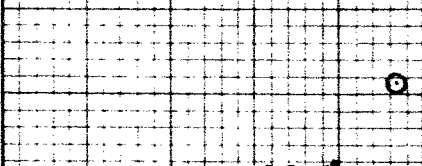
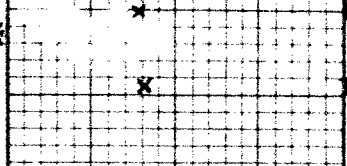
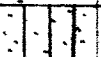
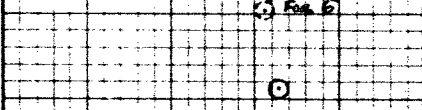
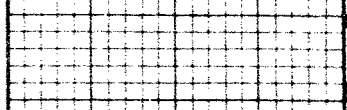
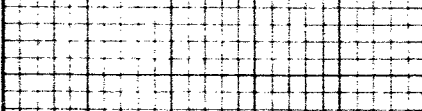
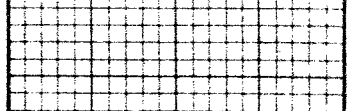
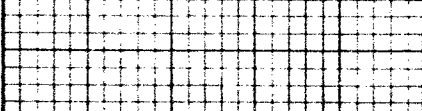
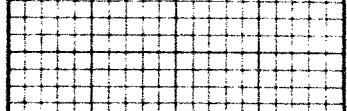
PROJECT Proposed Avon River Bridge

LOCATION Stratford, Ontario

HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 68.5 ft.

DATUM City of Stratford, Ontario

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE		NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.	
				20	40				350 FT. LB BLOWS/FT 80
				SHEAR STRENGTH					PSF
					5	10	15		
	ALLOVIUM-loose to medium dense, silty sand with gravel, occasional cobbles, boulders, and black organic layers.	68.5	0					1	143.0
	SILTY SAND TILL-dense to very dense, silty sand with gravel, occasional cobbles and sand seams.	59.3	10					2	142.0
	SANDY SILT-very dense.	46.5	20					3	
	End of Hole	43.5	30					4	
			40					5	
Notes: 1) Hole bored by wet sampling method; hole cased with BX pipe to 20 ft. No cave-in between 20 and 24 ft. 2) Water level in river at El 68.0 ft. 3) Cone penetration test made at 3 ft. east of hole 1.									

## SITE INVESTIGATIONS      SOIL MECHANICS CONSULTATION

PROJECT NO J1275

2" O.D. SPLIT TUBE  
2" I.D. SHELBY TUBE  
3" O.D. SHELBY TUBE

BOREHOLE No. 2

PROJECT Proposed Avon River Bridge

LOCATION Stratford, Ontario

HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 68.5 ft.

DATUM City of Stratford, Ontario

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE		350 FT. LB BLOWS/FT 80	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS		SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.	
				20	40		60	% DRY WEIGHT			
				SHEAR STRENGTH			P S F				0
	ALLUVIUM-loose to med. dense, silty sand with gravel, occasional cobbles, boulders and black organic layers.	68.5	0								
	SILTY SAND TILL-dense to very dense, silty sand with gravel, occasional cobbles and sand seams.	59.7	10								
	SANDY SILT-very dense.	51.5	20								
	End of Hole	43.5	30								
Notes: 1) Hole bored by wet sampling method; hole cased with BX pipe to 14 ft.; no cave-in below 14 ft. to 18 ft.. Boring terminated at 25 ft., due to gravels jamming the wash rods to the BX pipe. 2) As in Hole 1.				40							