

61-F-239M

TOWNSHIP BRIDGE

BRANT

WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS
LABORATORY TESTING
SOIL MECHANICS CONSULTATION

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

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

Project: J765

November 27, 1961

McDowell and Jewitt,
Consulting Engineers,
92 Kent Street South,
Simcoe, Ontario

Attention: Mr. W. McDowell

Re: Foundations - Proposed Township Bridge
Tuscarora Twp., Brant Cty.

Dear Sirs:

In a recent telephone conversation you indicated that you proposed to construct a 3 span structure at this bridge site and that the centre piers, spanning the creek, will be 50 feet apart. In order to facilitate construction operations, you wish to raise the cut-off level of the timber piles to slightly above the water surface.

In our report of October 17, we recommended that the piles be cut off 1 foot below creek bed level. Our reason for specifying this was to provide protection against abrasion damage in the event that the river bed is eroded below the bottom of the concrete piers. However, we understand that you proposed to install steel sheeting around each pier and that it will be driven 7 feet below stream bed level. With this protection, we see no reason why the cut-off level cannot be raised.

You advised that the tops of the piles will be slightly above water level and that you propose to treat these projections to prevent deterioration. We have no experience on the permanence of the treatment proposed, and therefore are not qualified to comment on it. You advised, however, that you have used this procedure with success on other occasions.

You also advised that you do not plan to rip-rap the slopes of the river bank in the vicinity of the bridge. You have noted that another nearby structure on this creek has a much shorter span

and yet it has shown no evidence of erosion. In our opinion, this is a useful observation regarding the conditions to be anticipated when the creek flows through a constriction in its course during flood periods. It was our uncertainty regarding the hydraulic changes that would take place in the creek flow following the installation of the new bridge that caused us to recommend the use of rip-rap. Since the proposed spans will offer very little resistance to the flow of the creek, no rip-rapping would appear to be necessary.

Yours very truly,

W. A. Trow

William A. Trow, P.Eng.

WAT/go

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SITE INVESTIGATIONS
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BA-1328

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

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

Project: J765

October 17, 1961

McDowell and Jewitt,
Consulting Engineers,
92 Kent Street South,
Simcoe, Ontario

61-F-239M

Attention: Mr. W. McDowell

Re: Foundation Conditions - Proposed Township Bridge
Concession IV, Lot 19, Tuscarora Twp., Brant Cty.

Dear Sirs:

In conformance with your written request of September 25th, we have performed a foundation investigation on the site of the proposed replacement bridge in the section of Tuscarora Township noted above.

We have found that the first 32 to 38 feet of soil consists of a medium stiff to stiff clay which has a maximum permissible bearing value ranging from 2000 to 2500 psf. This stress is believed to be too low for economic footing design. We, therefore, recommend that the structure should be founded on timber piles driven to refusal in the very dense sandy silt glacial till underlying this clay. Piles, cut off below stream bed level, will be about 27 feet long under the southeast corner of the bridge increasing to a maximum of approximately 34 feet long under the northwest corner. A working load of 20 tons for a Class B timber pile can be developed.

Our observations and comments arising out of this investigation and which form the basis for these recommendations are considered briefly in the following sections.

Site Description

An indication of the general topography in the area is provided by the enclosed photographs and the sketch of the site shown in Dwg. 1. The ground in this part of the township forms part of a large level clay plain. At this crossing McKensie Creek has eroded a valley into the plain for a depth approaching 15 feet. The creek flows in a shallow channel cut into this valley.

The creek flows in a northerly direction at this site. The stream bed consists of soft mud and the water was about 2 feet deep at the time of the investigation. During flood periods, it is understood that the creek rises about 7 feet, which is sufficient to overflow both banks as well as the low grassy land to the south of the existing bridge.

The present access along this township road takes the form of a footbridge about 57 feet wide. The original bridge failed as a result of traffic overloading; portions of the concrete deck lie in the creek bed.

According to well drilling records, bedrock lies 50 feet below the ground surface. This information was obtained for wells on concession 2, Lot 1 and concession 5, Lot 18, the latter being about $1\frac{1}{2}$ to 2 miles to the northeast of this site.

Field Investigation and Subsoil Description

The borings of this investigation were performed using conventional wet sampling methods. Each hole was cased with BX pipe and samples were taken at approximately 5 foot intervals of depth.

Work was begun at the hole 1 location near the southeast corner of the proposed bridge. The soil conditions at this test position are as noted in the borehole log, Dwg. 2. It is seen that stiff to medium stiff clay was encountered from the ground surface to a depth of $34\frac{1}{2}$ feet. Several undisturbed Shelby tube samples were recovered of this material and in-situ vane shear tests were performed between these sampling intervals. This latter test indicated that the undrained shear strength of this material ranged from 1250 to 930 psf approximately.

Since this strength is considered to be too low for the economic support of the bridge abutments, attempts were made to locate and prove up a stratum of dense soil for the support of end-bearing piles. This stratum was encountered in hole 1 at relative elevation 58.4 feet or about $34\frac{1}{2}$ feet below the ground surface. It was identified, from split spoon samples, as a very dense sandy silt; glacial till which contained numerous fine to coarse gravel sizes. Essential refusal, except to diamond drilling methods, was encountered at 39.8 feet and the hole was terminated at this depth.

In order to define the vertical extent of this dense stratum, cone penetration tests were made near the other three corners of the bridge. In this test, a 2 inch diameter tapered cone, attached to the end of $1\frac{5}{8}$ " diameter A rods, is driven into the ground under an energy

of 350 ft.lbs. per blow, the same as is used in sampling. The blows for each foot of depth are recorded. Practical refusal to the cone was encountered at relative elevation ~~54.2~~ at the north-east corner, elevation ~~55.5~~ feet at the southwest corner, and ~~59.4~~ in hole 2 at the northwest corner. 622.95

Sampling was carried out in hole 2 to a depth of 17 feet in order to determine if the slightly stiffer crust noted in the upper levels of hole 1, existed here. The soil was found to be relatively softer with a shear strength in the order of 850 pcf above 10 feet and some organic material was noted to this depth. A cone was driven below casing level from 17 feet to refusal at 39 feet.

Because the upper clay exists in this medium stiff, relatively compressible condition, and since an indication of its strength has been obtained from field vane tests, no laboratory tests have been performed, or are they considered to be warranted.

The elevations of all holes have been referred to the top of the northeast wing wall of the existing bridge which has been taken equal to ~~108.2~~ feet. 672.55

Discussion of Foundation Requirements

As inferred in the foregoing section, the upper clay stratum is considered to be too soft and compressible for the economic support of the proposed bridge structure. Therefore the investigation program was modified in order to define the approximate lengths for end-bearing piles.

The results of the borings and penetration tests indicate that refusal to timber piles will be encountered in sandy silt glacial till at depths ranging from 27 to 34 feet below the creek bed. It is expected that sound, Class B timber piles should develop a safe capacity of 20 tons and refusal to driving should be encountered after a penetration of approximately 2 feet into the till. The driving energy should not exceed 8700 ft.lbs. per blow when this dense till stratum is reached and refusal should be taken as 8 blows per inch under this energy. The piles should be cut off about 1 foot below creek bed level and the inside face of the abutment and the creek channel approaches to it should be protected with rip-rap.

The embankment approaches to this proposed skew bridge will reach a maximum height of approximately 11 feet. This will be the equivalent of a bearing stress of about 1400 pcf. Immediately adjacent to the abutments the stress will not reach this value since the load will have an opportunity to distribute itself out under the creek channel as well as laterally on each side of the roadway. In addition, since the ground rises out of the flood plain of the creek, the embankment height will become less with distance away from the crossing.

Plastic zones of overstressed soil first develop in a deep deposit of clay when the applied bearing stress, P , exceeds the limit in the expression:

$$\frac{P}{\pi} > s$$

where: s is the shear strength of the soil.

In this instance the maximum value for $\frac{P}{\pi}$ will be $\frac{1400}{\pi} = 445$ psf. The lowest shear strength, according to field vane tests in hole 2, is about 840 psf. Therefore the subsoil appears to be sufficiently strong to support the weight of the embankment safely and without danger of gradual subsurface movements.

Despite this fact, however, some batter piles will be required to resist the horizontal force exerted by the approach fill against the abutments. If the fill consists of sand or pit-run gravel adjacent to the bridge, the horizontal pressure against each abutment will have a value of

$$P_H = K \frac{1}{2} \gamma H^2$$

where: B = 40 feet approximately is the width of the abutment

K = 0.3 is the estimated active earth pressure coefficient for granular fill

γ = 125 is the estimated in-place unit weight of the fill

H is the height of the fill, assumed here to be about 11 feet.

Inserting these values in this equation, P_H is computed to be about 45 tons. The value of H in this expression has been taken equal to 11 feet rather than the 16 or 17 feet depth down to the bottom of the abutment because the clay below 11 feet has more than enough strength to resist the horizontal pressures set up in it by the fill. In addition, considerable passive resistance will be provided by the soil and rip-rap against the inside face of the abutments. Therefore the estimate of 45 tons probably is conservative.

Some settlement of the natural clay will occur following the application of embankment fill. However, this should take the form of a recompression of the clay, since, at one time, before creek erosion took place, the ground must have been more or less level with the surrounding countryside.

No consolidation tests were performed on this material, since any settlement computations and analyses would appear to be of academic interest only. A very approximate estimate can be obtained from the expression:

$$S = H_m \Delta p$$

where:

H = 30 feet = 360 inches is the approximate thickness of compressible clay

H_v is the coefficient of compressibility of the clay estimated, for this slightly overconsolidated material, to be equal to 0.01 sq.ft./kip

Δp is the average pressure added to the clay mass by the fill. Immediately adjacent to the abutments under 11 feet of fill Δp should have a value in the order of 800 p.s.f.

Inserting these values, s , is computed to be 3 inches very approximately. This movement will take place at a decreasing rate over several years.

As indicated in a previous paragraph, some rip-rap should be applied around the base of the abutments. In addition, this protection should be applied up to flood level on the stream and embankment approaches to the bridge. The rip-rap should be placed on a bed of pit-run gravel about 1 foot thick.

Stripping of topsoil will be required under the higher portions of the embankment fill. On the west side, adjacent to hole 2, it may be necessary to remove soil for a depth of about 3 feet, since the soil above depths of 3 to 4 feet represents recent flood plain deposits.

We hope that the comments of this letter assist you in the design of this structure. Please contact us if you have any queries on the subject.



Yours very truly,

WAT

William A. Trow, P.Eng.

WAT/go
Enc.



Downstream looking from
the existing crossing



Existing bridge from the south



Existing bridge from east approach



Existing bridge from the south east



Downstream looking from
the existing crossing



Existing bridge from the south



Existing bridge from east approach



Existing bridge from the south east



Drill on Hole 1 looking west



View of site from north west



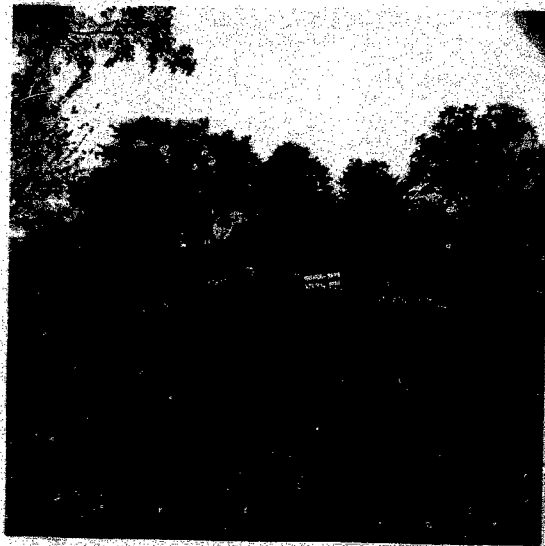
Looking south from existing bridge



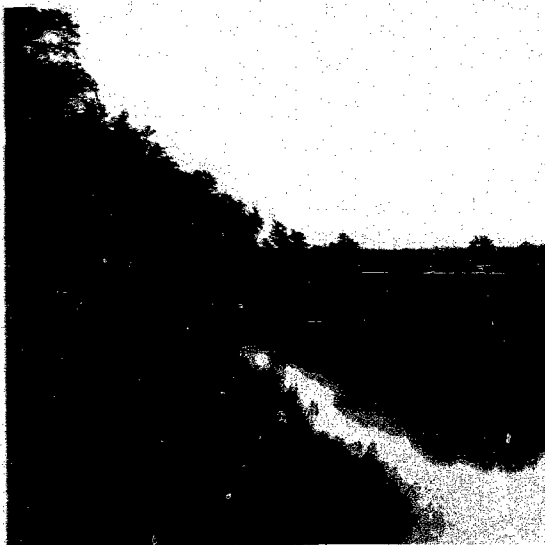
Existing bridge from the west



Grill on Hole 1 looking west



View of site from north west



Looking south from existing bridge



Existing bridge from the west


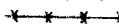

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SITE INVESTIGATIONS - SOIL MECHANICS CONSULTATION




DRAWING NO. 2
PROJECT NO. J765

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 



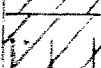
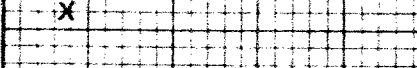


ATTERBERG LIMITS

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 Bridge Replacement
LOCATION Township Road, Between Cons. III & IV
HOLE LOCATION See Dwg. 1. Across Lots 21 & 22
HOLE ELEVATION 93.1 ft. Tuscarora Twp., Brant Cty.
DATUM Top northeast wing wall, existing bridge = 100.0 ft.
See Dwg. 1.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE 350 FT. LB BLOWS/FT				NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.
				20	40	60	80			
	Ground Surface	93.1	0	1000 2000						
	2 ft. of dense dry brown silt, tepcoil and roots. CLAY-brown, very stiff, fine organic spots, few root hairs, desiccated, some silt partings.	84.6	10						SS 1	
	CLAY-grey, stiff, slightly silty, some gravel sizes.	58.4	30						TW 2 9" Lever TW 3 6" Lever TW 4 Levered TW 5 Levered TW 6 Levered TW 7 Levered	9" 12Blows 6" 12Blows
	GLACIAL TILL-very dense, grey cohesive fine sandy silt, fine to coarse gravel sizes, some gypsum.	53.3	40						SS 8 SS 9 SS 10 SS 11	
	End of Bore									

Notes: 1) Boring by wet sampling methods; hole cased to full depth.
2) Hole cased to 4 ft. & wet after casing withdrawn.

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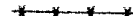

SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

LEGEND




DRAWING No. 3
PROJECT No. J765


BOREHOLE NO. 2
PROJECT Proposed Bridge Replacement
LOCATION Township Road, Between Cons. III & IV
HOLE LOCATION See Dwg. 1. Across Lots 21 & 22
HOLE ELEVATION 89.4 ft. Tuscarora Twp., Brant Cty.
DATUM As hole 1.

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) 

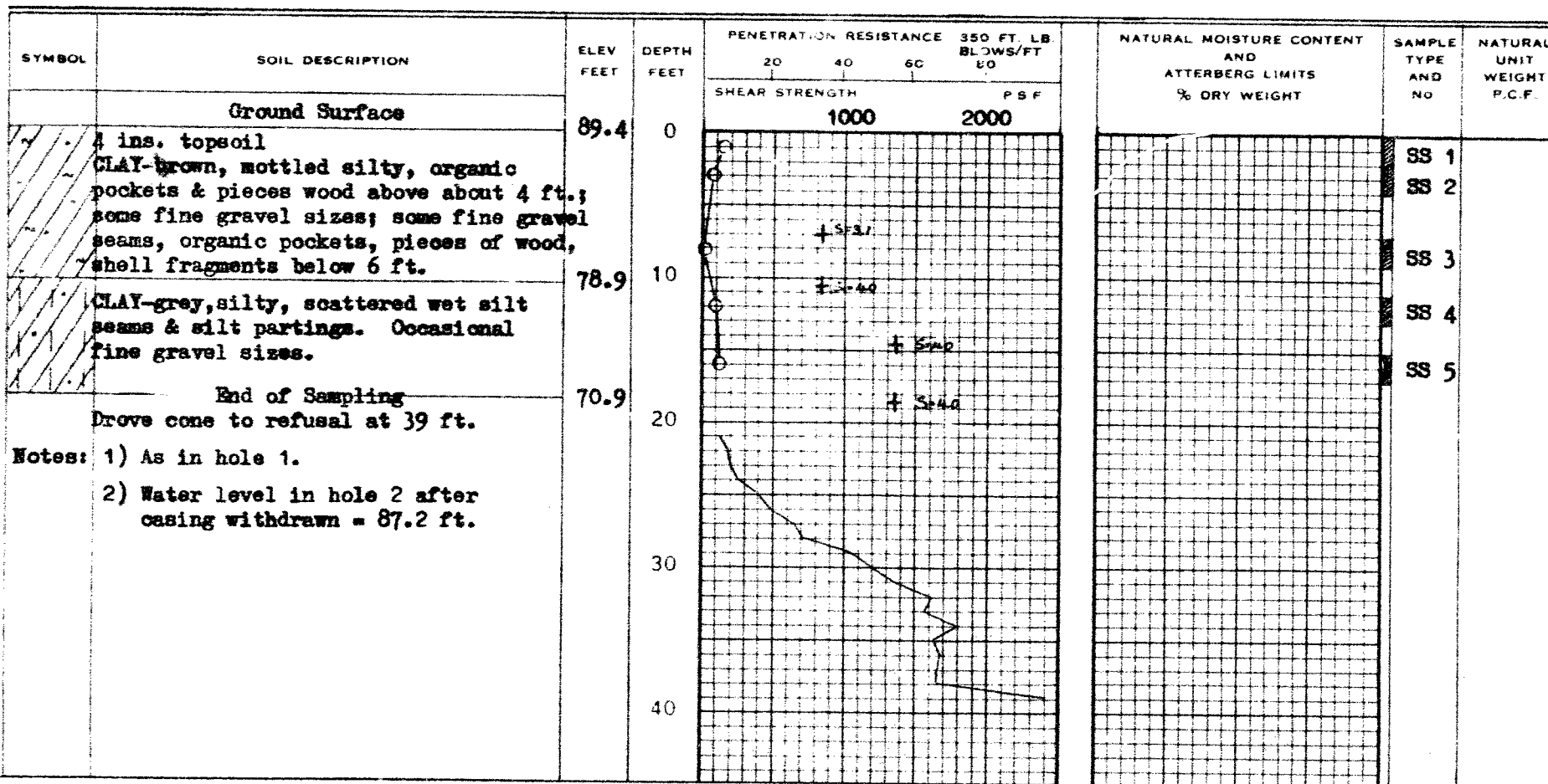
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX 

ATTERBERG LIMITS

LIQUID LIMIT 
PLASTIC LIMIT 

SAMPLE TYPE


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





SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING NO. 4
PROJECT NO. J765

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

ATTERBERG LIMITS

LIQUID LIMIT

PLASTIC LIMIT

SAMPLE TYPE

2" O.D. SPLIT TUBE.

2" I.D. SHELBY TUB

3" O.D. SHELBY TUBE.

BOREHOLE NO. Cones 3 & 4

PROJECT Proposed Bridge Replacement

LOCATION Township Road, Between Cons. III & IV

LOCATION _____
HOLE LOCATION _____

Across Lots 21 & 22
Tuscarora Twp., Brant Cty.

HOLE ELEVATION _____

DATUM _____

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE		350 FT. LB BLOWS/FT 80	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.
				20	40				
	Cone penetration tests only El Hole 3 = 91.1 El Hole 4 = 90.5	91.2	0	