#63-F-263 M

AVENING BRIDGE

MAD RIVER

LOT 4, CON. II / III

NOTTAWASAGA TWP.

Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.
Bridge Division.

Attn: Mr. G. C. E. Burkhardt.

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

February 3, 1964

County of Simcoe - Structure No. 49 over Mad River,
Township of Nottawasaga - Lot 4, Con. II/III,
Structure Site No. 31-190 - Your File No. BA 1747

We have reviewed the above-mentioned report submitted by the Consultant, Universal Geotechnique Ltd. of Toronto. We understand that the bridge drawing submitted by McCormick & Rankin Ltd. of Port Credit, was prepared before the soil report was available. Because of that fact, we will not comment on the footing design.

In his report, the Soil Consultant discusses two footing alternatives: spread footings and footings supported on piles. Because of scour danger, elev. 754 is suggested for spread footings of the piers. This will require excavations in the order of 10 to 14 feet in depth. Dewatering may also prove to be quite a problem. Apart from that, most probably some positive and permanent scour protection measure will have to be adopted.

Piles seem to be a more appropriate solution for this particular site. We feel that piles driven 20 ft. into the granular stratum will indeed be able to safely carry a load of 40 T/pile. It is our opinion that H-piles, if used, would develop a plug and could also provide excellent support. A pile driven into granular material cannot be considered as deriving its capacity from friction only, but also from end bearing, the latter contributing more.

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Encls.
cc: Foundations Office
Gen. Files

P.S. -- As requested, we are returning herewith, drawings by McCormick & Rankin Limited.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

TO. Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Bldg.

FROM: G. C. E. Burkhardt

DATE: January 31, 1964

OUR FILE REF.

IN REPLY TO

SUBJECT: County of Simcoe - Structure No. 49 over Mad River
Twp. of Nottawasaga - Lot 4, Con. II/III
Structure Site No. 31-190 - Our File No. BA 1747

Attached please find one copy of the Foundation Report, by Universal Geotechnique Limited, and one copy (2 sheets) of the Preliminary Plans for your comments.

We would appreciate it very much, if we could have your comments at your earliest convenience.

Could we have the plans back, which we are forwarding to you today, since these are our only file copies.

GCEB/bm

G. C. E. Burkhardt,
for K. L. Kleinsteiber,
Municipal Bridge Liaison Engineer.

c.c. J. Walter

UNIVERSAL
GEOTECHNIQUE
LIMITED

BA 1947

BA 1747

REPORT

on

FOUNDATION INVESTIGATION

for

AVENING BRIDGE

TOWNSHIP OF NOTTAWASAGA

SIMCOE COUNTY

ONTARIO

Report N° T.536/63

100 University Avenue,
Toronto 1, Ontario.

STRUCTURE SITE No. 31-190

REPORT

on

FOUNDATION INVESTIGATION

for

AVENING BRIDGE

TOWNSHIP OF NOTTAWASAGA

SIMCOE COUNTY

ONTARIO

INTRODUCTION

The Engineer for Simcoe County, Mr. L. E. Clark, is proposing the abandonment of the existing single-span bridge that at present carries County Road N° 13 over the Mad River at Avening and the construction of a new bridge to carry the realigned County Road over the river at a point just east of the existing structure.

Designs for the new bridge are being prepared by McCormick & Rankin Limited, Consulting Engineers of Port Credit, Ontario, and Universal GEOTECHNIQUE Limited were requested by the County Engineer to carry out subsurface exploration to ascertain the soil conditions in relation to foundation design and this Report contains the pertinent data and relevant information.

AVAILABLE INFORMATION

The existing bridge is a single-span structure carrying the existing County Road over the Mad River, the structure being approximately square with the river at this point.

The new bridge is to be located about 100' downstream towards the south-east and will be a skew structure relative to the river to accord with the realignment of the County Road: Tentative designs by the Consulting Engineers envisage a double lane three-span structure each span being approximately 50'.

THE SITE

The site is understood to have been the location of a small dam associated with a mill and remnants of the old dam still exist.

The location of the new bridge in Avening is in the Township of Nottawasaga, Lot 4, Concessions 2 & 3.

SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 18th of December, 1963 to the 6th of January, 1964 and comprised 4 exploratory boreholes in locations as shown on drawing N° 2 accompanying this Report.

Boreholes BH.1 & 4 are associated with the abutments to the new bridge whilst boreholes BH.2 & 3 are related to the river piers, with borehole BH.2 somewhat off the line of the proposed river pier in order to suit the conditions of the river ice at the time of exploration. Conditions of the river ice were hazardous at times but by moving the positions of 2 of the boreholes the use of temporary man-made support was avoided. Operations were interrupted on several days by heavy snowfalls and unsafe ice conditions.

The positions of the boreholes were staked and the ground surface elevations obtained by the Staff of GEOTECHNIQUE, the elevations being related to the benchmark cut in the concrete on top of the southeast corner of the southeast wing wall of the existing bridge and given as elevation 782.30.

During the operation of soil boring, soil samples were obtained at frequent intervals and where noticeable changes of strata occurred the depths of such changes were recorded.

The state of compaction of essentially cohesionless strata and the general consistency of cohesive strata was determined by means of standard penetration tests taken during the operation of soil sampling. (The standard penetration test, as referred to in this Report, involves the recording of the number of blows (N) of a 140 lb. hammer falling 30 inches that are required to drive a 2 inch diameter split barrel sampler 1 foot into the soil at the bottom of the borehole.)

Visual examination and classification of all soil samples was carried out in the laboratory and the results of such examination together with the values of the standard penetration tests are given on the borehole logs which form part of this Report. Also included with the Report are the results of the standard penetration tests plotted graphically, key plan, borehole location plan, and geological section.

Subsurface conditions given in this Report are those indicated by material encountered in the boreholes. The accuracy of extrapolation to obtain the soil profile should be associated directly with the geological conditions and inversely with the spacing of the boreholes.

GEOLOGICAL FEATURES

The site is situated at the base of the Niagara Escarpment on the borders of a physiographic region known as The Simcoe Lowlands. To the north and to the south of Avening there is a till moraine whilst to the east of Avening and to the north of Glencairn the sands of glacial Lake Algonquin appear.

The bridge site is actually situated in a glacial spillway with the old Algonquin shoreline about 2 miles to the east and generally following the base of the Corn Hill Moraine. The Banks Moraine passes to the west of Avening but it is missing on the escarpment near Creemore but reappears on the lower slope west of Banda: This moraine is predominantly sandy and associated with outwash.

The entire area was subjected to glaciation and as the glacier retreated from the area towards the north-east, melt water piled sand on the crest of the interlobe moraine and during this period glacial Lake Schomberg was formed. The position of the ice front during the Lake Schomberg stage of deglaciation held the waters of this lake against the Kame Terraces of the Niagara Escarpment and the sediments at the site are probably of Lake Schomberg origin. This glacial lake existed for only a short time and under conditions of a fluctuating ice front and the sediments at the site under consideration are thought to have been deposited in a spillway of Lake Schomberg.

The Mad River flows directly down a belt of sandy moraines and terraces on the Niagara Escarpment and is often swift flowing but down cutting at the bridge site has been relatively slow because at this point the river flows in cohesive strata. From the information obtained from the exploratory boreholes it may be concluded that the strata down to the explored depths can be classified as follows:

FLUVIAL DEPOSITS

These essentially loose sandy and gravelly deposits were encountered in the riverbed at boreholes BH.2 & 3 and on the riverbank at boreholes BH.1 & 4.

GLACIO-LACUSTRINE SEDIMENTS

Under this heading has been included the thinly bedded deposits of silty clay and clayey silts that were encountered in all boreholes and which form the relatively impermeable stratum in which the river flows at this point. The underside of this stratum varies from about elevation 758 in borehole BH.1 to elevation 749 in BH.4.

LACUSTRINE SANDS

Under this heading has been included the generally fine sands interbedded in parts with thin layers of silt having a thickness generally of not more than 1 or 2 inches and spaced generally between 1 to 2 foot intervals. These sands and thin layers of silt exist in a dense state of compaction and extend for a considerable depth.

DISCUSSION

The results of the subsurface exploration and subsequent study have revealed that the site of the proposed bridge is underlain by preconsolidated sediments comprising a stratum of thinly bedded silty clay overlying a deep bed of generally fine sand in a dense state of compaction but containing thin layers of dense silt.

The geological conditions to be generally associated with these strata are complicated by the probable fluctuations of the ice front in this vicinity and the proximity to the Niagara Escarpment but it is clear that the sediments have the characteristics of ice contact deposits which often comprise accumulations of well stratified sands and silts along the sides of valleys, and furthermore the overlying stratum of thinly bedded silty clay and clayey silt has clearly been subjected to considerable pre-consolidation which cannot be attributed to dessication and is therefore obviously due to previous overburden pressure.

Depth of Scour

The depth to which scour is likely to occur in the vicinity of the foundations to the new bridge should receive careful consideration because if such scour ever removed the overlying clay in the main channel and reached the fine sands, the rate of further scour would quickly increase due to the much greater susceptibility of such sands to erosion compared with the overlying clay.

The protective clay stratum undoubtedly extended to an elevation of at least 780 and quite possibly higher in the past before the final withdrawal of the ice front allowed the normal processes of erosion of the land surface to produce the present topography.

The Mad River closely follows the base of the escarpment and at the bridge site has scoured the clay to at least elevation 757 and there are suggestions that to the east of station 110 + 25.00 where the river cuts into the east bank just downstream of the location of an old dam, the depth of scour may be even greater.

Furthermore, it will be noted that the underside of this clay stratum in which the river flows is far from level, varying from about elevation 758 to the north to 749 to the south in the boreholes, and it is just possible that scour downstream of the location of the old dam may have already reached the underlying sands in what presumably would have been the plunge pool of the old dam.

The land surface and river were obscured by heavy snow during the period of exploration but from the boreholes there appears to be no obvious indication of sharp downcutting of the river channel at the site but considerations of flood records in relation to the constriction of the waterway by the new structure together with the performance of the existing bridge should be studied before a decision is reached on the depth of potential scour.

Types of Foundations

At this particular site, spread footings are a natural choice from an economic standpoint when considerations of adequate bearing capacity and tolerable settlement are considered: However, the third condition that must be satisfied, namely safety against scour, requires serious thought in view of the name of the river which aptly describes its behaviour at times. If scour is likely to endanger spread footings, then consideration of pile foundations are a logical step and will be discussed in detail later in this Report.

Spread Footings

Confining the discussion initially to the river piers and assuming potential scour is limited to elevation 757 which is the top of the clay near the downstream end of the south river pier, the underside of a spread footing at this point could be located at elevation 754 to leave a minimum of 4' of clay below the footing so as to avoid a blow in the cofferdam due to the hydrostatic head in the underlying sands, the construction of such cofferdams obviously requiring care with respect to this potential danger. The foregoing construction of spread footings within sheeted cofferdams where the sheeting was not driven below the underside of the footing in order to preserve the continuity of the clay stratum so as to contain the underlying hydrostatic pressure in the sands, is an operation where a mistake could result in serious difficulties. Apart from the foregoing considerations the footings could be stepped to accord with the changing elevations of the clay stratum and designed for an allowable bearing capacity of 2.0 tons/sq.ft., but the unknown variations in level of the underside of the clay stratum over the entire site and the limited thickness of this stratum makes the foregoing construction of the river piers hazardous.

Protection of spread footings against scour to a greater depth could be accomplished either by surrounding the footings with interlocking steel sheet piling of appropriate section driven to penetrate a safe distance below the greatest potential depth of scour or by providing suitable pile foundations.

In order to provide any worthwhile protection by steel sheet piling driven around the periphery of the footings, such sheeting would have to penetrate the limited thickness of underlying clay and be driven some distance into the fine sands which are far more susceptible to scour than the clay. No artesian pressure was observed in the underlying sands during the period of exploration but during Spring run-off this is a possibility. Assuming, however, that hydrostatic pressure in the underlying sands is equivalent to the river level and this is taken as elevation 767, the clay below the excavated level of 754 at the east end of a cofferdam for the south river pier would then be under an uplift pressure of over 1,000 lbs. per square foot with the cofferdam dewatered, and adhesion between the sheet piling and clay within such a cofferdam of 6' width would have to be greater than about 400 lbs. per square foot to prevent a blow or heave: Such a degree of adhesion is quite probable but does not preclude all possibility of a blow. If it is assumed in the interests of safety that at some point the excavation penetrated into the underlying sands, the sheet piles of the cofferdam would have to penetrate to about elevation 740 to ensure against a blow or piping. If such interlocking steel sheet piling was adequately tied into the footing and left in place as permanent protection against scour the sheet piling could be designed to have sufficient strength so as to resist scour down to an elevation of about 744 at this particular point, but appreciable unbalanced scour along one side of the sheet piling could cause failure by tilting: For such scour protection down to elevation 744 the sheet piling at this particular point would have to penetrate to about elevation 734.

Due to the several difficulties and the necessity for sheet piling to penetrate deeply into the underlying sands to give any worthwhile protection against scour in this easily eroded material, permanent protection by steel sheet piling is not considered a suitable solution for these narrow pier foundations.

Pile Supported Footings

Pile supported footings could be constructed within cofferdams that do not penetrate the clay stratum, but difficulties could arise when the bearing piles were driven through the clay within the cofferdams: For example, excess hydrostatic pressure would undoubtedly be created adjacent to the piles beneath the clay and this could lead to heave in the cofferdams and other difficulties if the piles were of the normal displacement type.

Temporary steel sheet pile cofferdams could be used with the sheet piles driven to penetrate to a substantial depth into the underlying sands and excavation within the cofferdams carried out to appropriate levels and bearing piles then driven without the dangers attendant with cofferdams having limited length of sheeting. However, such a method is more appropriate to a larger bridge having heavily loaded piers and is unlikely to be economical at the site under consideration.

Pile supported footings do not therefore appear to be particularly applicable at this site unless for any reason it is desired to have substantial concrete piers above low water level

Pile Foundations

Still confining the discussion at this stage primarily to the river piers, it may be concluded that because of the possible difficulties in constructing pile supported footings, a suitable alternative to river piers would be pile foundations extended to the bridge deck and capped to form a pile bent on which the longitudinal beams of the bridge could rest. Such a system would have the advantage that the full thickness of the clay stratum would be available to resist scour before any further downcutting of the river reached the more susceptible underlying sands.

Assuming for the moment that scour under the new conditions is unlikely to reach the underside of the clay, such pile bents could be formed of 12" diameter steel pipe piles of 0.312" minimum thickness driven to a minimum penetration of 20' in the sands to support a working load of 40 tons per pile. This allowable loading has been limited to 40 tons to ensure that the pile can act predominantly as a friction pile to accord with the presence of silt layers in the sand. Due to the hard driving that obtains in dense sands, the piles may be driven open-ended as this would allow a considerable measure of control if the plug which naturally forms near the toe of the pile makes driving extremely difficult: Under such circumstances some of the material inside the pile may be carefully removed whilst maintaining a head of water in the pile so as to avoid any inflow of soil from below the pile tip, and the pile than redriven further until it reaches its specified penetration. The foregoing procedure requires careful attention but it avoids the necessity for jetting which should be prohibited where the pile is designed to obtain support from friction. After final penetration has been reached the interior of the pile should be filled with concrete, reinforced if necessary, down to at least the maximum anticipated scour level.

Steel pipe piles driven open-ended would also have the advantage of limiting disturbance to the clay stratum which is an important consideration in relation to resistance against scour.

A factor that is probably of importance at the site of this bridge is the possibility of an ice jam and the subsequent pressure that could be imposed on the river piers: Pile bents would be somewhat more vulnerable than piers to such forces and if this factor is combined with the possibility of scour extending to the underside of the clay, a 14" diameter steel pipe pile is probably a minimum size. Such a pile, with scour extending down to elevation 750, would probably have an unsupported length of about 30 feet and 14" diameter by 0.375" thick would be a reasonable choice.

Having reviewed briefly several of the alternative forms of construction it becomes clear that the depth to which scour has to be provided for is the determining factor in the decision as to the suitable type of foundation for this site. In our opinion it is advisable to minimize disturbance of the clay stratum which at the moment provides protection to the more easily scoured fine sands underlying the site, and this would suggest that the most suitable type of foundation for the river piers is either a bent formed of steel pipe piles extending up to the deck level and connected by a capping beam or alternatively a pier supported on a system of pipe piles driven at a batter and capped by a substantial reinforced concrete beam or footing cast with its upper surface at about low water level. Both the foregoing solutions could provide for scour extending to elevation 750 or even lower. Drawing N° 6 is a sketch to illustrate these two possibilities.

Abutments

As the east end of the south abutment extends into the river channel similar types of pile foundations to those suggested for the river piers would also be applicable and pipe piles of 12" diameter by 0.312" thick would be suitable for the support of stub abutments protected against scour. If stub abutments were unsuitable because of the possibility of scour it may indicate the desirability of moving the abutment towards the south to higher virgin ground or alternatively providing suitable protection against scour. Generally it can be estimated that pipe piles designed for a working load of 40 tons per pile would have to penetrate into the fine sands for a distance of 20 feet.

Stability of Approach Fill

No soft clays or loose silts were encountered in the exploratory boreholes and consequently it need not be anticipated that any difficulties will arise concerning adequate bearing capacity for the approach fills in the immediate vicinity of the bridge and due to the pre-consolidation of the clay stratum and underlying sediments consisting of predominantly fine sand, no appreciable settlement of these strata need be anticipated.

CONCLUSIONS

From the results of the subsurface exploration and subsequent study in relation to foundation design for the new bridge, the following conclusions have been obtained:

1. The site of the proposed bridge is underlain by a stratum of generally stiff to very stiff thinly bedded silty clays overlying sediments comprising generally fine sand with thin layers of compact silt. The clay varies in thickness from about 7' in borehole BH.3 to 15' in borehole BH.4 and is generally very stiff in consistency having been subjected to pre-consolidation.

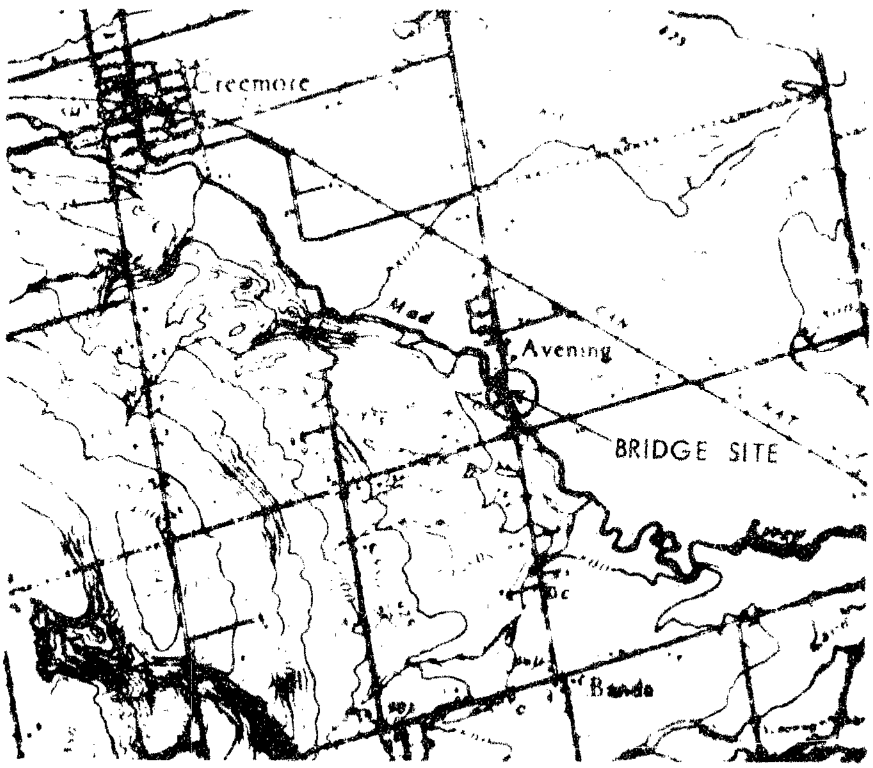
2. Adequate support for normal spread footings designed for an allowable bearing capacity of 2.0 tons/sq.ft. can be obtained a few feet below the upper surface of the clay stratum: However, consideration of flood records and the changed flow conditions imposed by the new bridge may make it desirable to provide protection of such footings against scour. Such protection is reviewed in this report and it is concluded that if studies indicate that scour may eventually remove the clay stratum, the most economical and satisfactory form of foundation is likely to be either (a) a pipe pile bent or (b) a pier on a system of batter piles as illustrated diagrammatically on drawing N° 6. These types of foundations refer specifically to the river piers but the use of similar piles would also be applicable to the abutments. Because of the dense fine sands into which such piling would be driven, it is suggested that such steel pipe piles can be driven open-ended whilst observing the precautions outlined in this report: By this means the specified minimum penetration can confidently be obtained. Such piles should be designed to support a working load of 40 tons and a minimum driving and redriving resistance of 100 tons as calculated by the Hiley Formula should be specified.

3. The depth of potential scour is the dominant consideration in deciding on the type of foundation for this site, and if detailed study of flood records and the changed flow conditions imposed by the new bridge indicate that during the required life of the bridge there is the possibility of scour removing the clay stratum that overlies and at present protects the more susceptible fine sands, the most suitable form of support for the proposed bridge appears to be pile bents extending to the bridge deck or piers supported on a system of batter piles connected by a substantial reinforced concrete beam cast with its upper surface near low water level: These forms of foundation would allow design to accommodate scour to elevation 750 or even lower. However, if there are indications that scour may extend below elevation 750 it would be desirable to review the proposals in relation to the actual maximum depth of scour anticipated below elevation 750.

Universal GEOTECHNIQUE Limited,

J. Owen Lake,
President.

Report N° T.536/63 January, 1964.



PROJECT Avening Bridge, Ontario

TITLE Key Plan

DRG. NO. 1 ORDER NO. T.536/63

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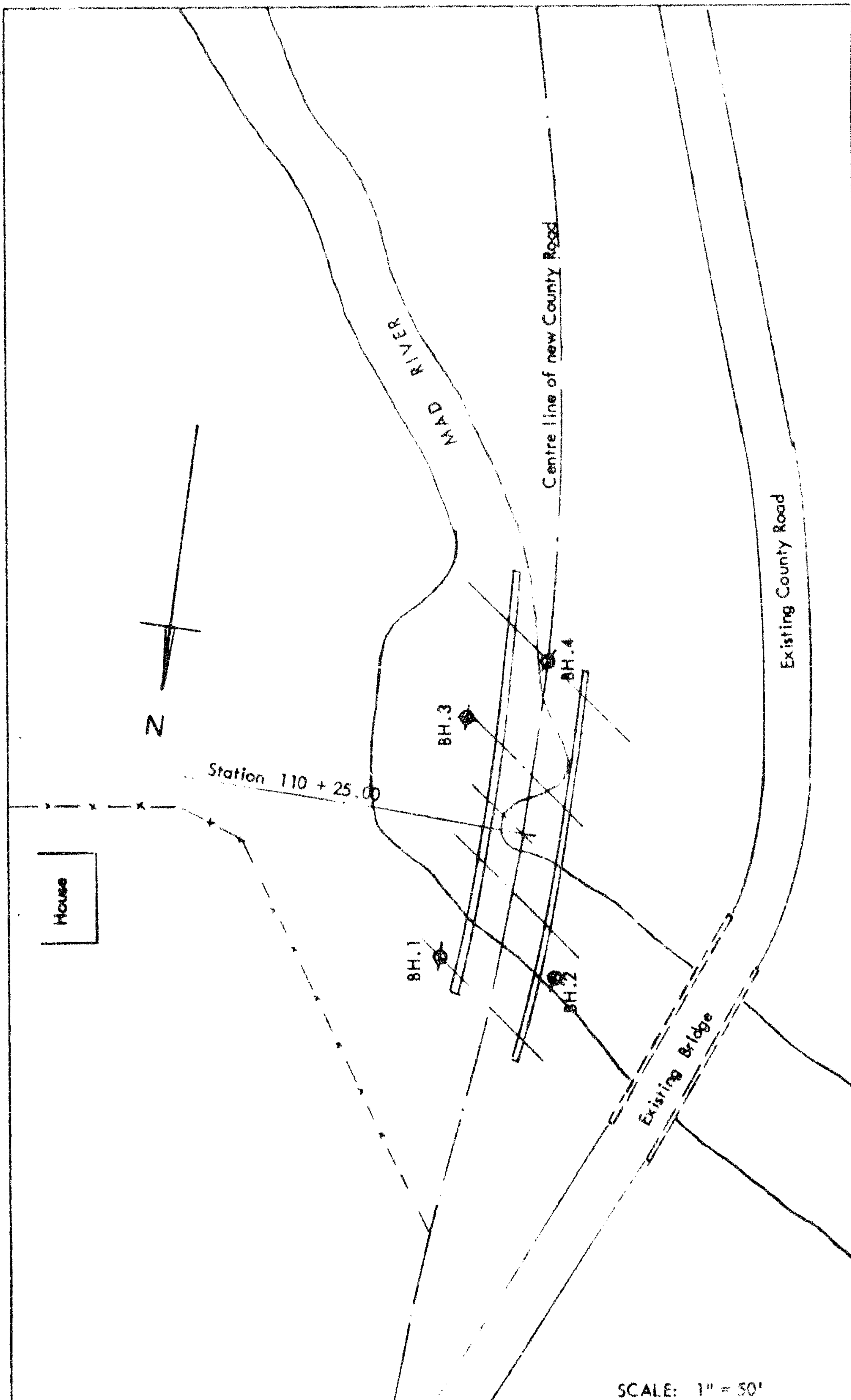


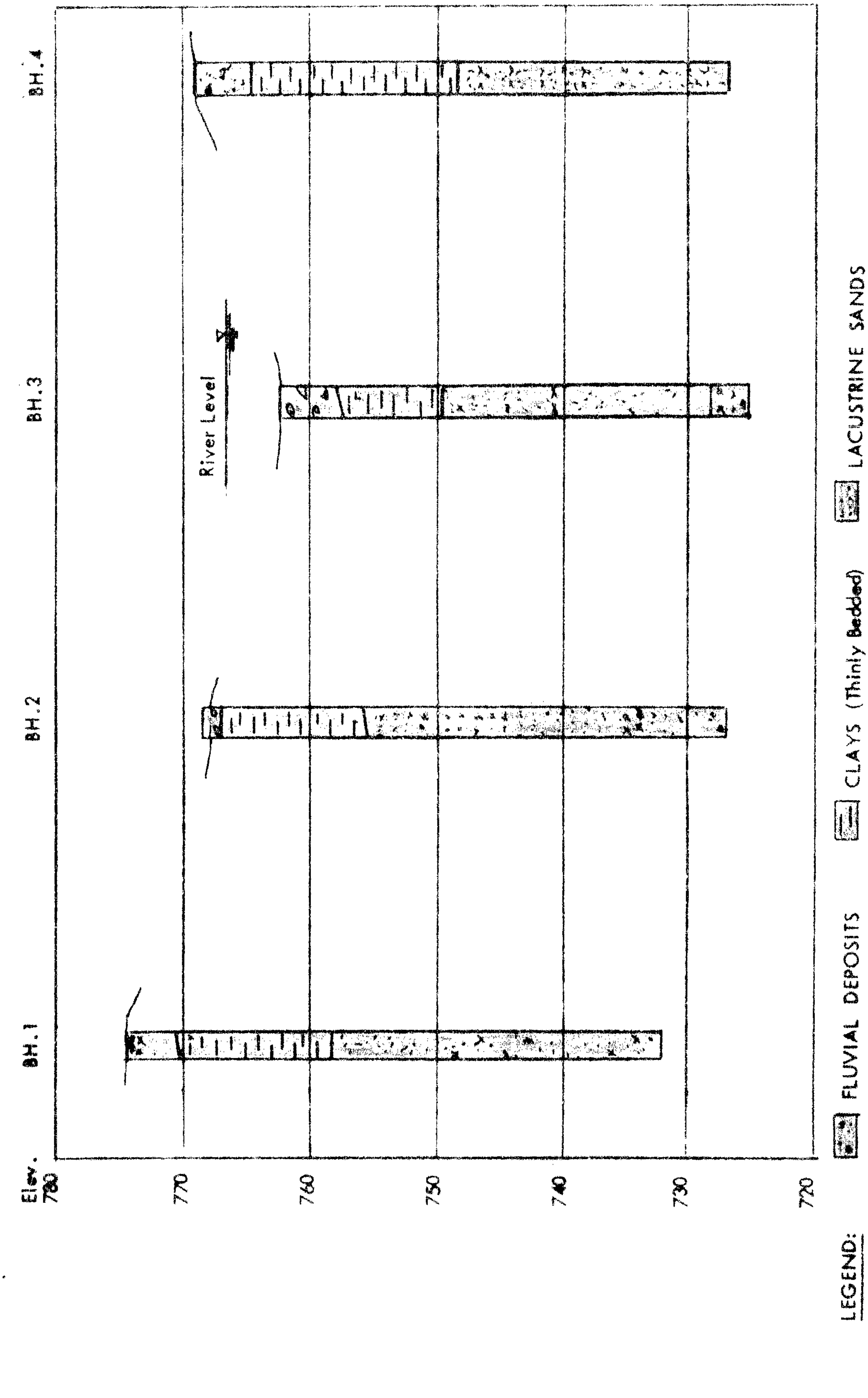
SCALE: 1" = 50'

PROJECT Avening Bridge, Ontario

TITLE Borehole Location Plan

DRG. NO. 2 ORDER NO. T.536/63

UNIVERSAL GEOTECHNIQUE LIMITED



PROJECT Avening Bridge, Ontario

TITLE Geological Section

DRG. NO. 3 ORDER NO. T.536/63

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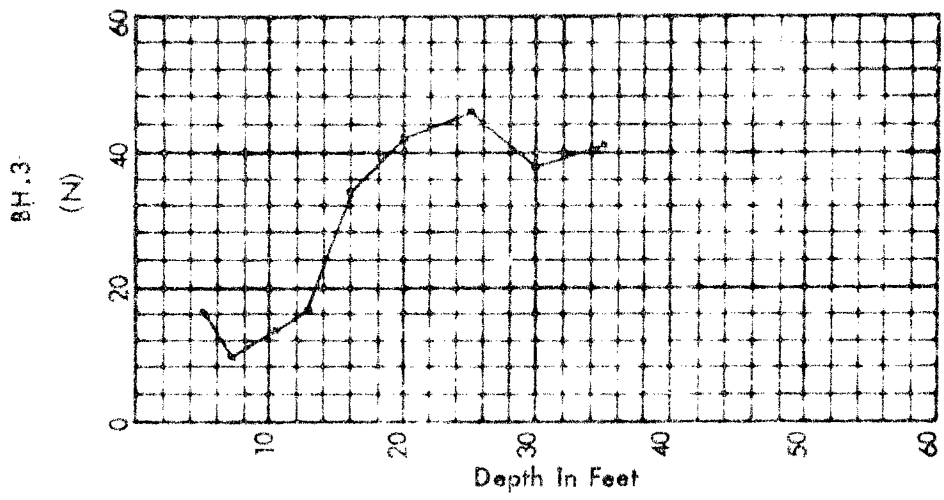
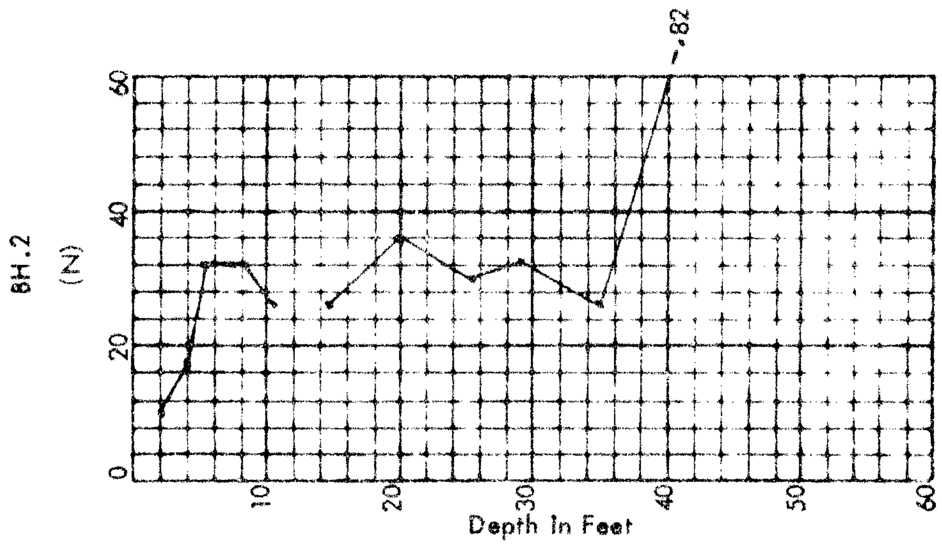
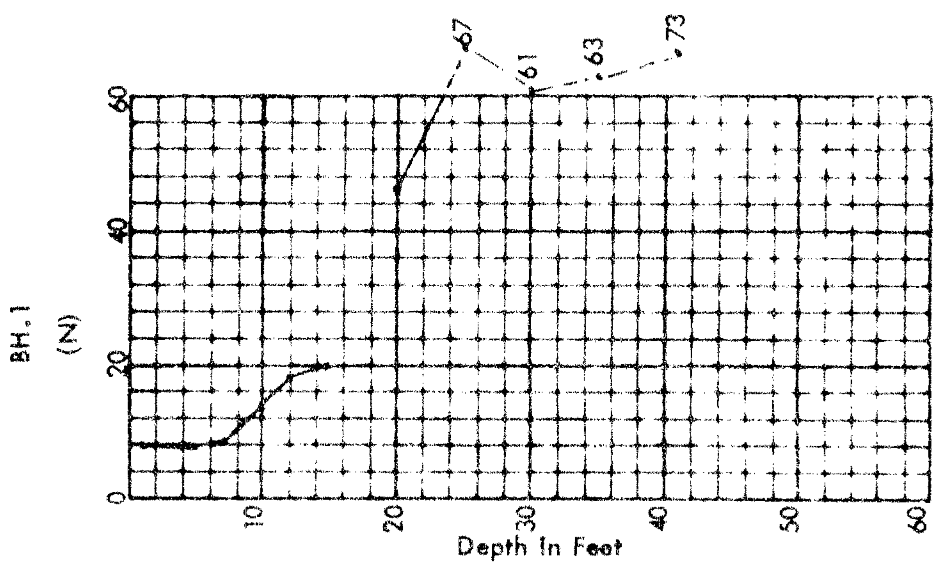




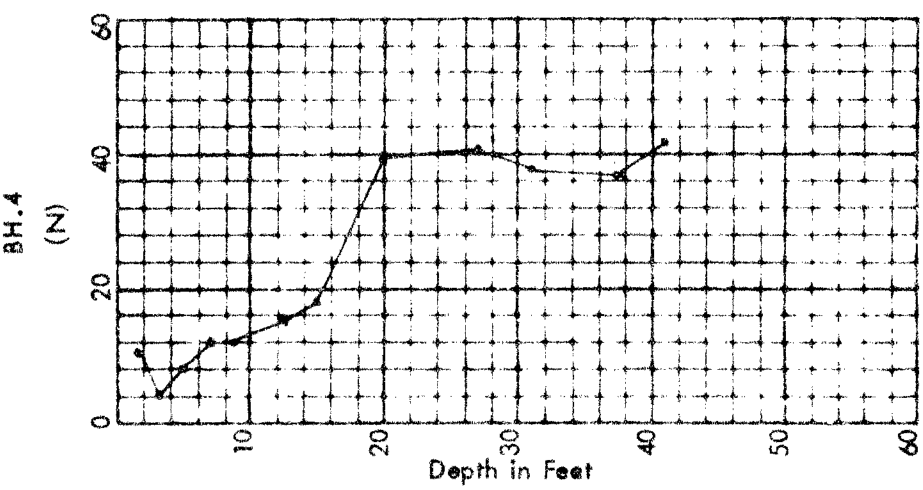


PROJECT Avening Bridge, Ontario

TITLE Standard Penetration Tests

DRG NO 4 ORDER NO T.536/63

UNIVERSAL GEOTECHNIQUE LIMITED



PROJECT Avening Bridge, Ontario

TITLE Standard Penetration Tests

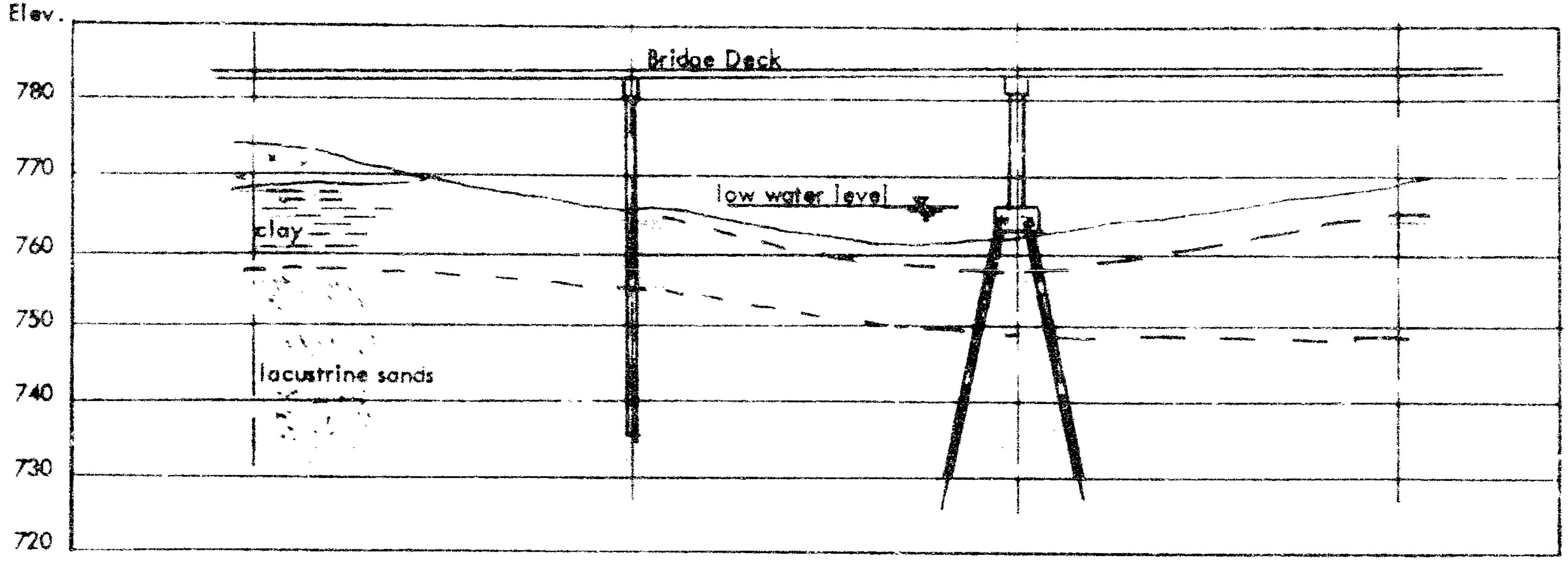
DRG NO 5 ORDER NO T.536/63

UNIVERSAL GEOTECHNIQUE LIMITED

PROJECT Avening Bridge, Ontario

TITLE sketch showing suggested foundation types

DRG. NO. 6 ORDER NO. T.536/63



(a) Typical Pipe Pile Bent

(b) Typical Pier on system of Batter Piles

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UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT: Avening Bridge, Ontario — ORDER NO. T.536/63

CLIENT: County of Simcoe, Ontario.

BOREHOLE NO. BH.1 — DIAMETER 2-1/2" — CASING BX

BOREHOLE LOCATION: See Plan — INCLINATION: Vertical — BEARING:

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	774.5			Zero			
Firm dark brown slightly clayey SILT with fine sand; friable with sign of bedding & organic matter.			● 1			8	Damp. Medium dry strength.
	770						
Firm to stiff grey CLAY; trace of medium angular gravel.			● 2			7	do; high dry strength.
Stiff grey thinly bedded CLAY.			● 3			9	do do
Very stiff grey clayey SILT; trace of medium subrounded gravel.			● 4			14	do; medium to high dry strength.
Very stiff grey clayey SILT.			● 5			18	do; do
do do	760		● 6			20	do; do
				16'-6"			
Dense brownish-grey fine SAND.			● 7			46	Moist; no dry strength.
Dense to very dense brownish-grey slightly silty fine SAND.	750		● 8			67	Wet; do
do do			● 9			61	do do
do do	740		● 10			63	do do
do do			● 11	42'-0"		73	do do
			End of Borehole				

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT: Avening Bridge, Ontario. ORDER No. T.536/63

CLIENT: County of Simcoe, Ontario.

BOREHOLE No: BH.2 DIAMETER: 2-1/2" CASING: BX

BOREHOLE LOCATION: See Plan INCLINATION: Vertical BEARING:

FORM 6-1A 500 UNITED STATIONERY Co.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Ice	768.4			Zero 8"			
Loose rounded boulders.				1'-6"			
Soft grey CLAY.			● 1			11	No recovery.
Firm to very stiff grey silty CLAY with trace of coarse angular gravel.			● 2			17	
			● 3			32	Sticky; high dry strength.
Hard grey silty CLAY.	760		● 4			31	Damp. do
do do			● 5			26	do medium dry strengt
Dense brownish-grey fine SAND.			● 6			26	Wet; slight dry strength
	750						
Dense do do			● 7			36	do no dry strength.
Dense grey silty fine SAND.			● 8			31	do low dry strength.
do do	740		● 9			33	do slight dry strength.
Dense grey silty fine SAND.				32'-0"			
Dense grey SILT changing to grey fine SAND with sign of bedding.			● 10			26	do silt has medium dry strength.
				37'-0"			
	730						
Dense grey fine to medium SAND slightly silty in parts with trace of fine rounded gravel.			● 11	41'-6"		82	do; do
			End of Borehole				

SCALE: 1" = 5'-0" ● DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Avening Bridge, Ontario. ORDER NO. T.536/63

CLIENT County of Simcoe, Ontario.

BOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING BX

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING

FORM 8-1A 500 UNITED STATIONERY Co.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Ice	766.4			Zero 6"			
Water							
Loose to firm brown coarse SAND & fine to coarse angular to subangular GRAVEL.	760		• 1	4'- 2"		16	Wet; no dry strength.
			• 2			9	do do
Stiff grey silty CLAY; thinly bedded.			• 3			12	Damp. high dry strength.
Very stiff grey silty CLAY.			• 4			16	do do
Very stiff clayey SILT.			• 5	17'-0"		34	do do
Dense grey silty fine SAND.			• 6			42	Wet; no dry strength
Very stiff grey thinly interbedded clayey SILTS; inclined silt seams.			• 7	26'-0"		46	do medium dry strength.
Dense grey fine SAND with thin seams of clayey silt.			• 8			38	do sand - no dry strength.
do do			• 9			41	do do
				38'-0"			
Dense brownish-grey SILT with trace of fine gravel.			• 10	41'-0"			Damp; low to medium dry strength.
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

UNIVERSAL **GEOTECHNIQUE** LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Avening Bridge, Ontario. ORDER NO. T.536/63

CLIENT County of Simcoe, Ontario.

BOREHOLE NO. BH.4 DIAMETER 2-1/2" CASING BX

BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	769.0			Zero			
Loose fine to coarse brown SAND with fine gravel.			• 1			10	
			• 2			4	No recovery.
Firm to stiff grey thinly bedded silty CLAY.			• 3			8	Damp. High dry strength.
do do			• 4			12	do
do do	760		• 5			12	do do
Stiff grey interbedded clayey SILT.			• 6			15	do do
Firm grey SILT; thinly bedded.			• 7			18	Moist; medium dry strength.
	750						
do do			• 8			29(9")	do do
Dense grey fine SAND interbedded with seams of silt.			• 9			41	Damp. sand - no dry strength.
	740						
Dense greyish-brown thinly bedded fine SAND; occasional silt layer.			• 10			38	Wet. do
Dense grey thinly bedded fine SAND; occasional silt layer.			• 11			37	do do
	730						
do do			• 12			42	do do
				42'-0"			
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE ▮ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY
INDEX PROPERTIES

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BORE-HOLE NO.	SAMPLE NO.	DEPTH FROM	DEPTH TO	NATURAL DENSITY LB/FT³	NATURAL MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	TYPE OF SAMPLE U - UNDISTURBED D - DISTURBED
BH.1	2	4'-6"	5'-6"		23.8				
	3	7'-6"	8'-6"		19.8				
	4	10'-0"	11'-0"		17.9				
	5	12'-0"	13'-0"		17.2				
	6	14'-6"	15'-6"		19.4				
BH.2	1	2'-0"	3'-0"		19.6				
	2	3'-6"	4'-6"		19.8				
	3	5'-0"	6'-0"		18.7				
BH.3	3	10'-0"	11'-0"		20.2				
	4	12'-6"	13'-6"		19.8				
	5	15'-6"	16'-6"		17.2				
	10	39'-0"	40'-0"		20.3				
BH.4	3	4'-6"	5'-6"		20.0				
	6	11'-6"	12'-6"		18.2				
	7	14'-6"	15'-6"		21.5				
	8	20'-0"	21'-0"		19.8				
	9	26'-0"	27'-0"		24.0				

UNCONFINED COMPRESSION TESTS

	Elevation	Moisture Content	Unconfined Compression Strength lbs/sq.ft.
BH.1	769	23.8	2250
	766	19.8	3000
	764	17.9	8000
BH.2	763		4000
	760	19.6	8000
BH.3	753	19.8	6000
BH.4	757	18.2	4500

PROJECT Avening Bridge, Ontario

TITLE Laboratory Tests

ORDER No. I.536/63

UNIVERSAL GEOTECHNIQUE LIMITED