



THURBER ENGINEERING LTD.

MEMORANDUM

To: Christopher Schueler, P.Eng.
AECOM

Date: September 22, 2015

From: Alastair Gorman, P.Eng.
(Reviewed by P.K. Chatterji, P.Eng.)

File: 19-4406-20

PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN SWITZERVILLE ROAD UNDERPASS (SITE 17-64) WP 4010-13-01, GEOCRES NO: 31C-230

1 INTRODUCTION

This memo presents a brief summary of the factual findings from a foundation review carried out for the existing Highway 401 Underpass at Switzerville Road in the geographic township of North Fredericksburgh, Ontario. It also presents preliminary geotechnical recommendations for use in assessment of the existing foundations at the site. It is noted that the proposed structural alternatives are not yet defined.

The recommendations provided in this memorandum are for planning, structure evaluation and preliminary design purposes only. Additional investigation and analysis may be required in any subsequent detail design phase of the project.

The following reference numbers apply to this site:

- Current W.P. 4010-13-01
- Site No. 17-64
- GEOCRES No. 31C00-057
- Historic W.P. 291-60

2 SITE DESCRIPTION

The site is located approximately 3.7 km east of Palace Road (County Road 5) and 13 km west of Wilton Road (County Road 6) on Highway 401 in the North Fredericksburgh Township, just east of the boundary of the Town of Greater Nappanee. Based on the historic GA, the existing underpass is a 4-span concrete T-beam structure with a total span length of about 69.2 m and a width of 10.36 m. It accommodates 2 lane traffic on Switzerville Road and spans a total of 4 traffic lanes plus median and shoulders on Highway 401. The minimum vertical clearance between Highway 401 and the underpass was about 4.7 m.



The natural terrain in the vicinity of the bridge is generally flat. The historic GA indicates that the original grade in the vicinity of the bridge ranged from elevation 129.7 to 130.5 m (425.5 to 428 ft). Highway 401 was constructed to approximately elevation 128.1 m (420.1 ft) with a 1.6 to 2.4 m cut. The approach fills were constructed by placing 3.5 to 4.3 m of fill with sideslopes inclined at 2H:1V, resulting in an overall approach embankment height of about 5.9 m.

3 SUBSURFACE CONDITIONS

The site is located within the physiographic region known as the Nappanee Plain, which is a flat to undulating limestone plain. The limestone bedrock is typically covered by a mantel of glacial drift. Scattered drumlins are present across the Nappanee Plain and the site is located on one of these thin, subdued drumlins.

A site investigation was completed by Universal Geotechnique Limited between June 22 and 28, 1960. Three boreholes were drilled in conjunction with Standard Penetration Tests (SPTs) to depths of 6 to 7.8 m below the original ground surface. Adjacent to the 3 boreholes and at 2 other locations, dynamic cone penetration tests (DCPTs) were advanced to 1.7 to 2.9 m depth below the original ground surface where practical DCPT refusal (80 blows per 0.3 m penetration) was encountered. All boreholes and DCPTs were completed in the vicinity of the abutments and pier for the two-span structure anticipated at the time of the investigation. The actual abutment locations are somewhat outside the area that was investigated originally.

Soil conditions encountered in the boreholes generally consist of topsoil over competent glacial till to the depth investigated. The topsoil was described as being 0.3 m thick. Below the topsoil, glacial till comprising silty sand with variable amounts of gravel were encountered. The upper 0.3 to 0.6 m of the silty sand till was described as being in a "loose to firm state due to extensive weathering". For the unweathered silty sand till, the recorded SPT 'N' values ranged from 38 blows per 0.3 m penetration to 89 blows for 0.175 m of penetration, indicating a dense to very dense relative density. Where conducted, the moisture contents of the samples typically ranged from 7 to 13% and the unit weights from 22.5 to 24 kN/m³.

Although not discussed in the original report, glacial tills inherently contain cobbles and boulders.

Observed water levels in the boreholes during the geotechnical investigation indicate that the groundwater table was at elevation 128.2 m (420.5 ft) or about 1.5 to 2.3 m below the original ground surface.

The available GEOCRE files are attached in Appendix A.

4 SITE OBSERVATIONS

Foundations engineering staff from Thurber visited the site to observe conditions related to the geotechnical performance.

There were no obvious signs of settlement or distress in the foundations.



The approach embankments and forward slopes appeared to be stable, with no obvious signs of instability or bulging. There were indications of erosion problems in the approaches.

There were steps between the wing walls and the adjacent curbs that suggest there may have been 50 to 75 mm of settlement of the approaches since construction was completed. This is not unusual and is not considered to be an indication of any on-going settlement problems. Provided the approach fills are not disturbed, there is no reason to expect any future settlement at these locations.

Photographs of the structure and the approaches are attached in Appendix B.

5 GEOTECHNICAL ASSESSMENT

5.1 Existing Foundations

Based on the historic General Arrangement drawing for the structure, D-4743-1 dated February 1961, the abutments are supported on driven H-piles and the three piers are supported on spread footings.

Based on the GA, 10 BP 42 piles were driven to Elevation 411.75 ft and were designed to resist a working stress load of 57 tons. The equivalent in metric terms is an HP 250 X 62 pile driven to Elevation 125.5 and designed to resist a load of approximately 500 kN. This is a working stress value and is approximately equivalent to an SLS value in Limit States Design.

The spread footings for the piers are shown as being founded at the following elevations:

Pier	Imperial (ft)	Metric (m)
Pier 1 (south)	413.25	126.0
Pier 2 (centre)	411.25	125.3
Pier 3 (north)	413.25	126.0

Based on the recommendation from Universal Geotechnique, the footings were designed for an allowable bearing pressure of 4 tons/sq. ft. (working stress design) below Elevation 414. That is approximately equivalent to a SLS geotechnical resistance of 380 kPa below Elevation 126.2.

6 ASSESSMENT OF EXISTING FOUNDATIONS

Based on the soil conditions shown to exist at this site and the information contained on the historical GA, Limit State Design geotechnical resistances have been calculated in accordance with the requirements of the CHBDC. The following values can be used in carrying out an assessment of the existing structure and for preliminary design of any modifications that may be necessary:

ULS _r	600 kPa
SLS	400 kPa



6.1 Driven H-Piles

The existing piles have been assessed based on the assumption that they were driven to Elevation 125.5, though there does not appear to be any corroborating evidence of this.

6.1.1 Axial Resistance

Assessment of the existing structure and its foundations may be carried out using the following geotechnical resistances for the existing piles:

ULS _f	800 kN
SLS	600 kN

6.1.2 Lateral Resistance

It appears that the existing design is based on the lateral forces being carried by the battered piles. It is recommended that no soil lateral resistance be assumed in this case.

7 EXCAVATION AND ROADWAY PROTECTION

If the selected rehabilitation strategy requires excavation in the approach fills behind the abutments, it is recommended that site investigation and field testing be carried out in each approach fill in order to characterize the fill and to select parameters for the design of roadway protection. One borehole within each approach fill and within the probably extent of excavation is considered to be appropriate. The boreholes should extend for the full depth of fill or to twice the depth of excavation, whichever is the greater.

8 CLOSURE

The factual subsurface information used in the preparation of this memorandum was taken from the report by Universal Geotechnique Limited titled "Foundation Investigation for Highway 401 & Switzerville Road, Township of Ernestown, County of Lennox and Addington" and dated July 1960.



The memorandum was prepared by Mr. Alastair Gorman, P.Eng., Senior Foundations Engineer and was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Alastair Gorman, P.Eng.
Associate, Senior Foundation Engineer



P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

Attachments

Appendix A
GEOCRES Information

#60-F-251C

W.P. #291-60

Hwy #401

SWITZERVILLE
RD.



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** July 22, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION REPORT
From Materials & Research Section. **BY:** UNIVERSAL GEOTECHNIQUE, LIMITED
Attention: Mr. S. McCombie.

Re: Proposed Crossing, Hwy. 401 and
Switzerville Rd., Twp. of Ernestown.
W.P. 291-60 -- District No. 8.

A review of the foundation report prepared by Universal Geotechnique, for the above site, has been completed by the Foundation Section. No foundation problems appear to exist at this site. The conclusions reached by the Consultant are summarized below:-

1. The site is underlain by a layer of dense, sandy till.
2. Foundations for the proposed structure should be designed as spread footings. The spread footings may be designed for a net bearing pressure of 4 tons/ft.², and founded at or below elevation 420.0'.
3. Settlements associated with the suggested loading, will be small. Maximum differential settlement should be less than 1/2 inch.
4. No problems associated with approach fill stability, exist at this site.
5. If a multi-span structure is proposed for this site, and if the abutments are supported by piles, large displacement steel piles will develop a capacity of 35 tons at approx. elevation 420.0 ± 5'. Control of fill placement in the area of piles should eliminate the need for pre-boring to facilitate placing of these piles. If pre-boring is specified through the fill material, boring should not be permitted beyond the original ground level.

If further queries arise in connection with these comments, please contact the Foundation Section.

KP/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay A. Watt
J. Ford Fdns. Office
T. A. Sharpe Gen. Files.
J. E. Gruspier

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.

Per:

K. Peaker
(K. Peaker,
FIELD SUPERVISING FDNS. ENGR.)

UNIVERSAL
GEOTECHNIQUE

LIMITED



REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED CROSSING

HIGHWAY 401 & SWITZERVILLE ROAD

TOWNSHIP OF ERNESTOWN

COUNTY OF LENNOX & ADDINGTON

for

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 291-60)

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REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED CROSSING

HIGHWAY 401 & SWITZERVILLE ROAD

TOWNSHIP OF ERNESTOWN

COUNTY OF LENNOX & ADDINGTON

for

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 291-60)

INTRODUCTION

The Ontario Department of Highways are planning an Underpass at the intersection of Highway 401 and Switzerville Gravel Road in the Township of Ernestown.

In order to determine the subsurface conditions for purposes of foundation design the Materials & Research Section of DHO authorized Universal GEOTECHNIQUE Limited to proceed with an investigation at the proposed site generally in accordance with their requirements as stated in a letter of authorization dated 24th June, 1960. This Report contains the results of the subsurface exploration together with information relative to foundation design.

AVAILABLE INFORMATION

DHO plan F 3056-1 shows the proposed location of the Underpass of Highway 401 relative to the proposed relocation of Switzerville Gravel Road. This drawing also indicates the suggested positions for exploratory boreholes and dynamic cone penetration tests. DHO section F 3056-2 indicates that the grade elevation of proposed Highway 401 at the Underpass is to be about 419, and the new bridge will be designed to carry the minor road over Highway 401.

THE SITE

The site of the proposed bridge is located within Lot 3, Concession VI in the Township of Ernestown in the County of Lennox & Addington.

SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 22nd to 28th of June, 1960, under the supervision of a Soils Engineer in charge of field operations and comprised 3 exploratory boreholes and 5 dynamic cone penetration tests located in positions as shown on drawing N° 2, the cone penetration tests being positioned within the distance of 2 to 3 feet of the boreholes except as otherwise shown on the plan.

The positions of all boreholes and penetration tests were staked and ground elevations given by the DHO Survey Crew. During the operation of exploratory boring, soil samples were obtained generally at intervals of 2-1/2 feet 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 were determined by 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).

A continuous record of the general state of compaction of the soil was also obtained adjacent to all boreholes and at two additional positions by means of dynamic cone penetration tests which were carried to depths where virtually refusal conditions were encountered. The results of these tests are given graphically on drawings included in the appendix.

Visual examination and classification of all soil samples was carried out in the laboratory and the descriptions of the strata obtained from such examination together with the results of standard penetration tests are given on the borehole logs, and a summary of laboratory index property tests are given in Table N° 1.

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 in the Napanee Plain which exhibits a thin mantle of glacial drift covering the underlying limestone. The glaciers that have stripped the plain of the larger part of the overburden have, in scattered locations, left somewhat thin subdued drumlins. The proposed site is located on top of one of these drumlins.

From the information obtained from the boreholes it may be concluded that the strata down to the explored depths can be classified as follows:

TOP SOIL

About a foot of brown loam containing organic matter covers the site.

BROWN SANDY TILL

From 15 to 18-1/2 feet of generally dense to very dense brown somewhat silty sand containing fine to coarse subangular gravel was encountered on the site. From about 1 to 2 feet below its upper surface it is loose to firm and contains traces of organic matter.

GREY SANDY TILL

The very dense grey somewhat silty sand containing gravel that was recorded in boreholes BH.1 & 2 is the same in composition as the overlying brown till and is the unweathered parent material of the brown till.

GROUND WATER

Free water was recorded during the period of exploration at elevation 420.5.

Water in all the boreholes was easily removed by bailing with a 2" diameter bailer.

LABORATORY TESTS

In addition to visual examination of all soil samples, index property tests were carried out and the results are given in Table N° 1.

DISCUSSION

The results of the subsurface exploration disclosed that the site of the proposed bridge is underlain by glacial till beneath a limited thickness of topsoil. The upper few feet of the till exists in a loose to firm state due to extensive weathering.

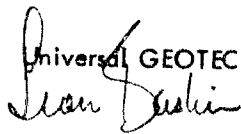
The glacial till has been subdivided into the upper brown till which extends to about elevation 410 in boreholes BH.1 & 2 and probably somewhat lower in borehole BH.3. Both tills with the exception of the upper part of the brown till exist in a dense to very dense state, and as the proposed pavement elevation of Highway 401 is about 419 it is suggested that normal spread footings can be supported on the brown till.

If the underside of such footings are located at elevation 414 the allowable bearing capacity may be taken as 4 tons/sq.ft.

CONCLUSIONS

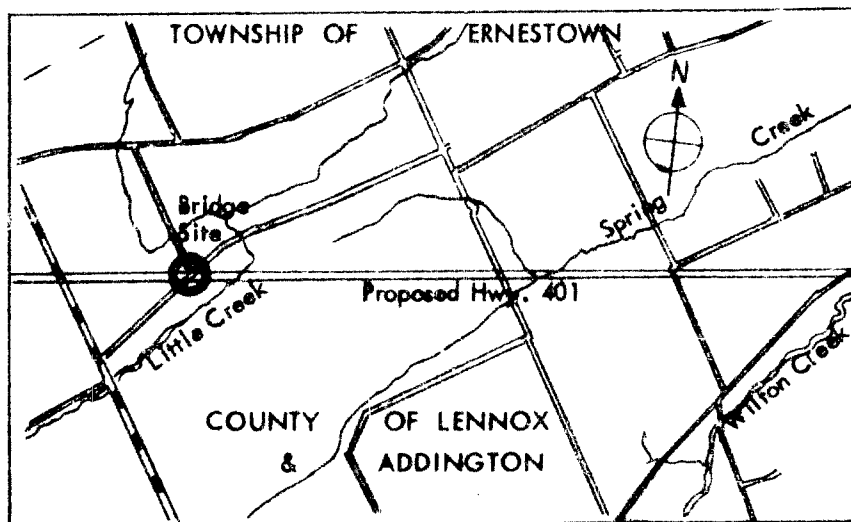
From a consideration of the soil and groundwater conditions as disclosed by the subsurface exploration the following conclusions concerning foundation design may be drawn:

1. The subsurface conditions beneath the proposed site of the bridge consist of a limited thickness of topsoil underlain by glacial till.
2. The most suitable type of foundation would be spread footings to the two abutments and central pier of the proposed bridge, such footings being supported on the brown till.
3. The allowable bearing capacity for the design of spread footings located at elevation 414 may be taken as 4 tons/sq.ft.
4. No difficulties need be expected in dewatering excavations for purposes of construction as the till is well graded and is generally in a very dense state.

Universal GEOTECHNIQUE Limited,

L. Baskin, P. Eng.

Report N° T.440/60

July, 1960.



KEY PLAN

Scale: 1" = 1 Mile

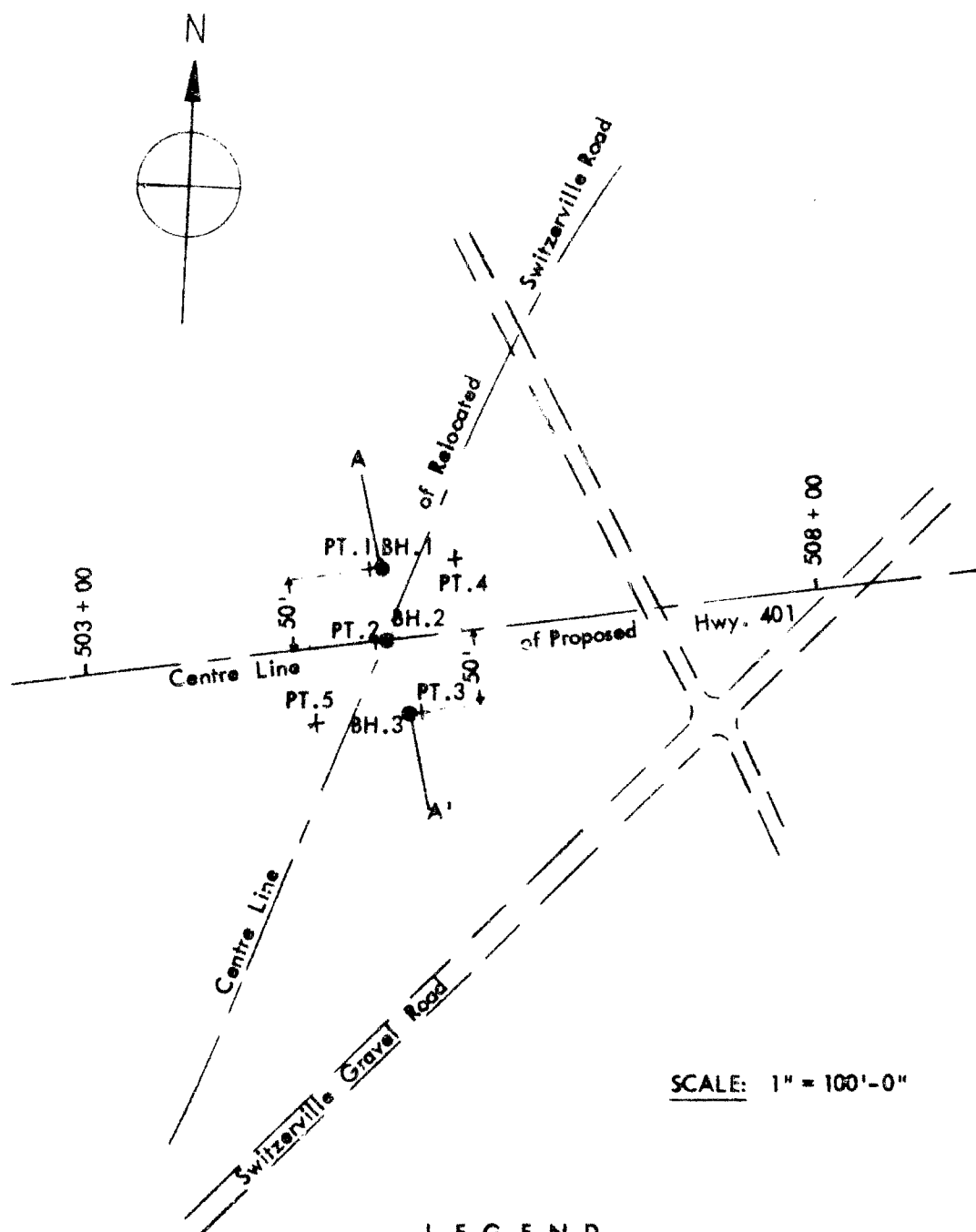
PROJECT Proposed Crossing Hwy. 401 & Switzerville Rd.

TITLE Key Plan

DRG NO. 1 ORDER NO. T.440/60



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LEGEND

+ Penetration Test

● Borehole

PROJECT Proposed Crossing, Hwy. 401 & Switzerville Rd.

TITLE Borehole Location Plan

DRG. NO. 2 ORDER NO. T.440/60

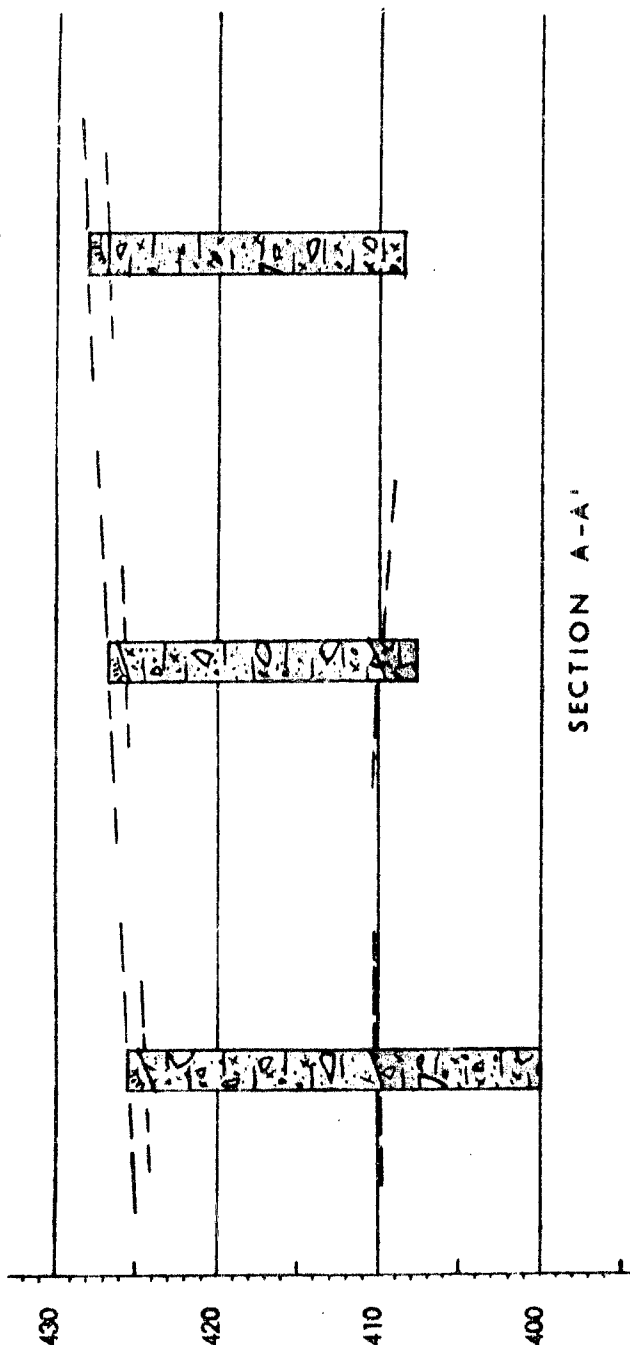


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BH.3

BH.2

BH.1



LEGEND



TOP SOIL



BROWN SANDY TILL



GREY SANDY TILL

SCALE

Horizontal 1" = 20'-0"
Vertical 1" = 10'-0"

PROJECT Proposed Crossing Hwy. 401 & Switzerville Rd.

TITLE Geological Section


DRG. NO. 3 ORDER NO. T.440/60



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SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Proposed Crossing Hwy. 401 & Switzerville Road (W.P. 291-60) ORDER NO. T. 440/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION 505+00/50' North INCLINATION Vertical BEARING FORM G-11A 800
UNION STATIONERY CO.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown loam with organic matter. Firm brown clayey silty SAND, occasional fine gravel & some organic matter. Dense light brown silty SAND with fine to coarse subangular gravel, considerable exfoliation and some iron staining.	425.5		• 1	Zero		13	Damp. Medium to high dry strength.
	420.0		• 2			50	Damp. Medium dry strength.
Very dense do No iron staining.			• 3			87	do.
do			• 4			-	do
do			• 5			70 (9")	do
do			• 6			98 (9")	do
With some sand pockets.	410.0		• 7			89 (7")	Damp.
Very dense grey silty SAND with fine to coarse subangular gravel, some exfoliation. Pockets of sandy silt.			• 8			60 (6")	Medium dry strength.
do No silt pockets			• 9			59 (6")	do
do	400.0		• 10	25'-6"		92 (9")	do
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Proposed Crossing Hwy. 401 & Switzerville Road (W.P. 291-60) ORDER NO. I.440/60

CLIENT Ontario Department of Highways

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

BOREHOLE LOCATION 505 + 05 INCLINATION Vertical BEARING —

FORM G-1A 800
UNION STATION, CO.

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown loam with organic matter. Loose brown silty SAND, occasional gravel, traces of organic matter.	426.8		• 1	Zero		9	Damp. Medium dry strength.
Dense light brown silty SAND with fine to coarse subangular gravel, iron stained, some exfoliation.			• 2			38	do
	420.0		• 3			49	do
do No iron staining.			• 4			63	do
Very dense do			• 5			139	do
			• 6			113	
Very dense grey silty SAND with fine to coarse subangular gravel.	410.0			19'-0" End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG


PROJECT Proposed Crossing Hwy. 401 & Switzerville Road (W.P. 291-60) ORDER NO. T.440/60

CLIENT Ontario Department of Highways

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

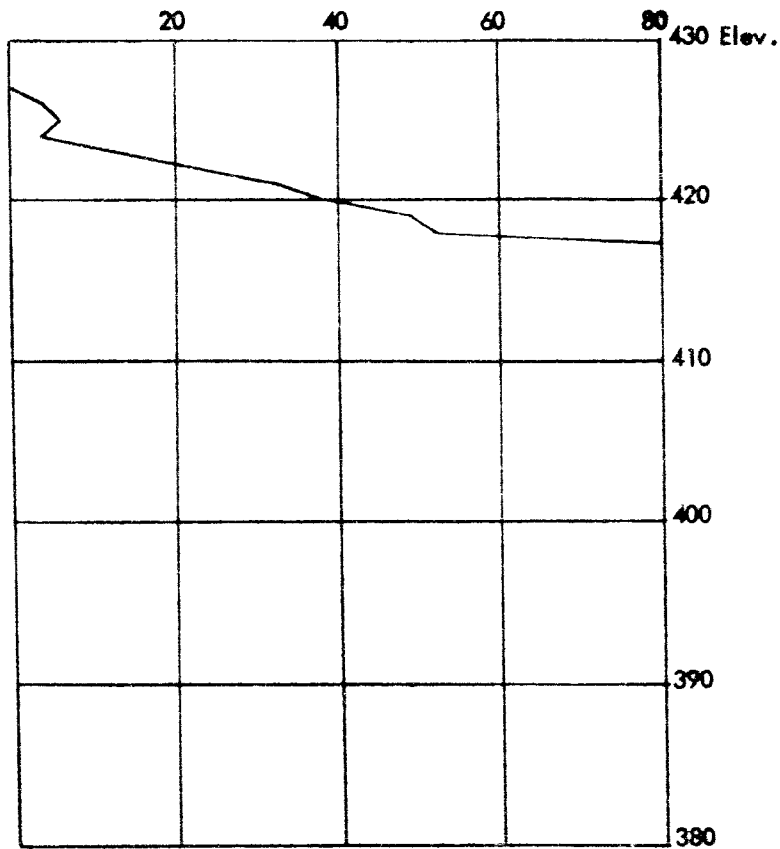
BOREHOLE LOCATION 505+10/50' South INCLINATION Vertical BEARING

FORM G-1A 800
UNITED STATES OF AMERICA

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown loam with organic matter. Loose brown silty SAND with occasional gravel and some organic matter.	428.0		• 1	Zero 1'-3"		7	Damp. Medium dry strength
Dense light brown silty SAND with fine to coarse subangular gravel, some exfoliation and iron staining.			• 2			54	do
do	420.0		• 3			54	do
Very dense do No iron staining.			• 4			62	do
do			• 5			56	do
Includes wet sand pockets.			• 6			-	
Very dense light brown silty SAND with fine to coarse subangular gravel.	410.0		• 7			67 (6")	do
do			• 8	19'-8" End of Borehole		98 (8")	do

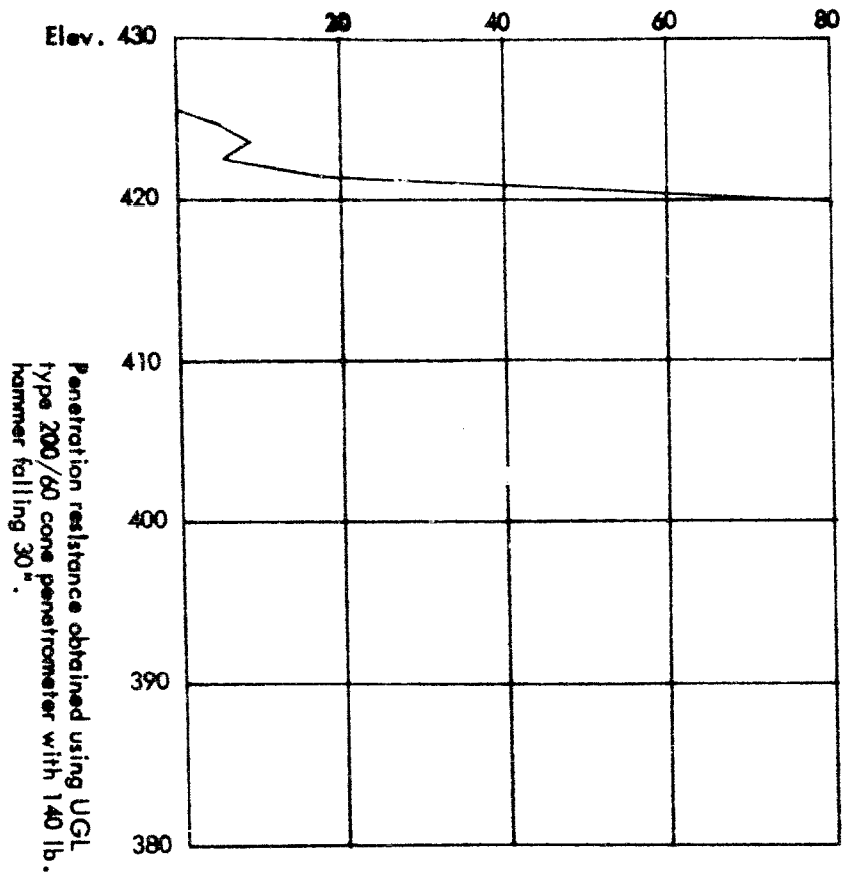
PT. 2

Blows Per Foot of Penetration



PT. 1

Blows Per Foot of Penetration



PROJECT Proposed Crossing Hwy. 401 & Switzerland Rd.

TITLE Dynamic Penetration Test Diagram

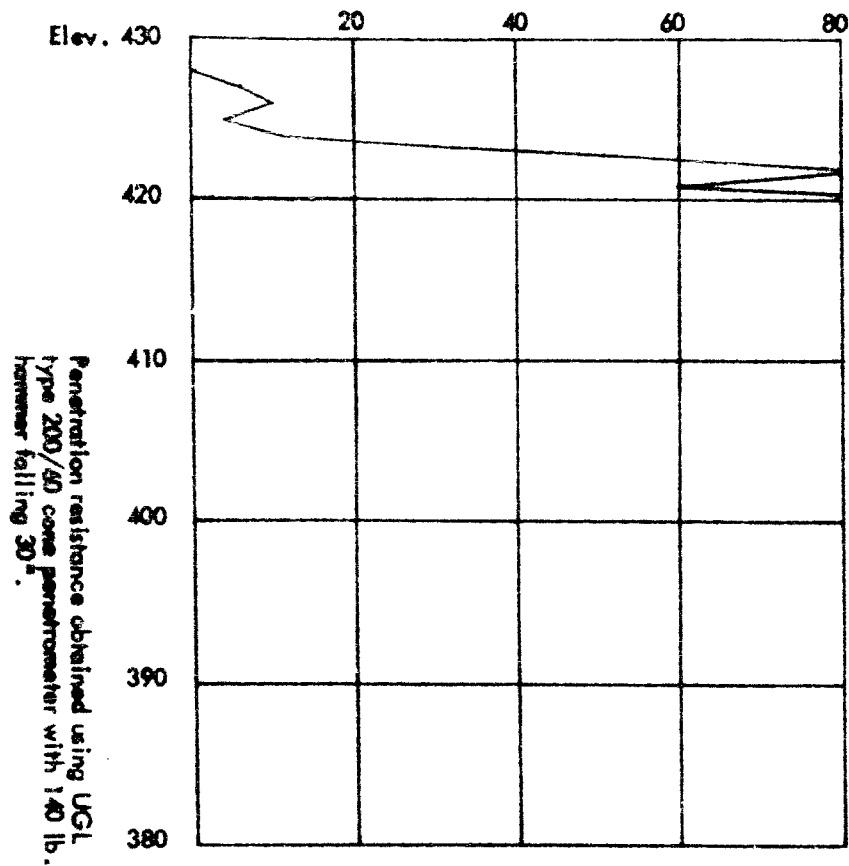
DRG. NO. 4 ORDER NO. I.440/60



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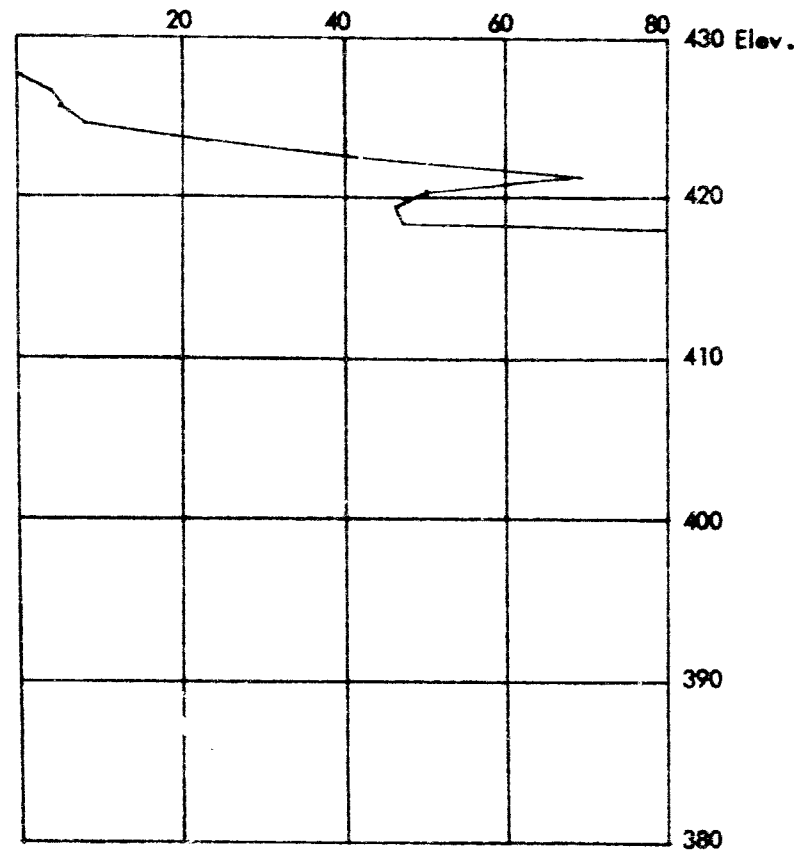
PT. 3

Blows Per Foot of Penetration



PT. 4

Blows Per Foot of Penetration



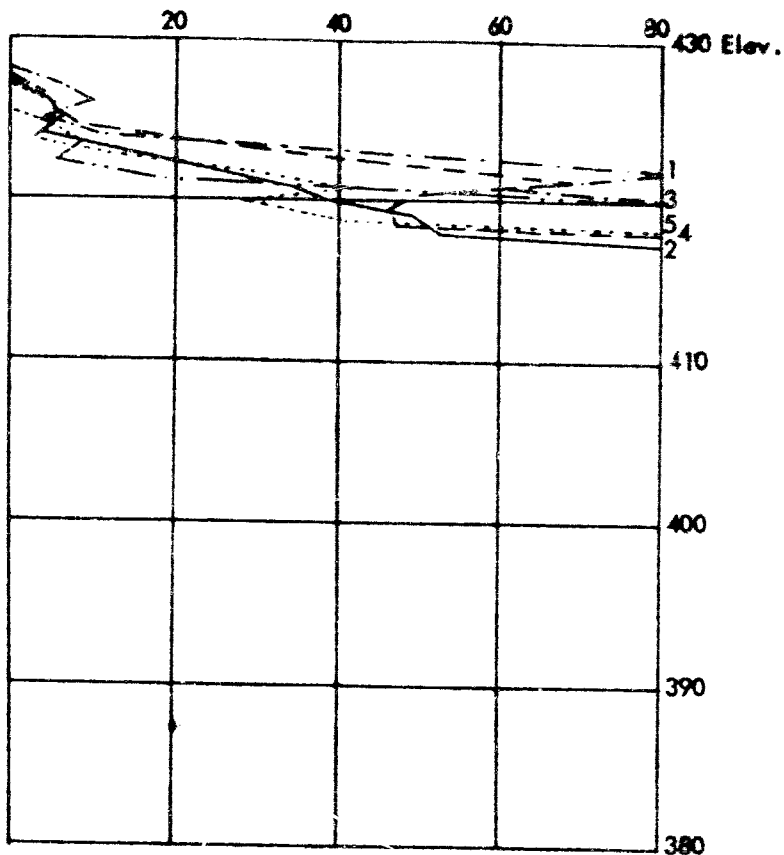
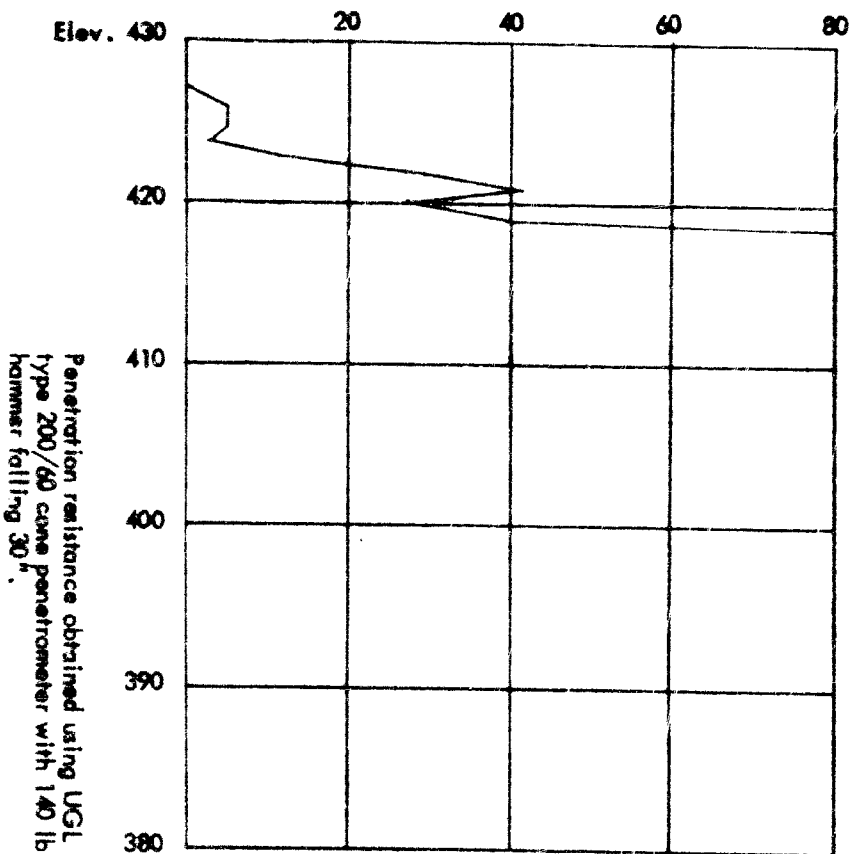
PROJECT Proposed Crossing Hwy. 401 & Switzerville Rd.
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 5 ORDER NO. T. 440/60



UNIVERSAL
GEOTECHNIQUE
LIMITED

PT. 5

Blows Per Foot of Penetration



COMBINED PLOTTING OF PENETRATION TESTS

PROJECT Proposed Crossing Hwy. 401 & Switzerville Rd.
TITLE Dynamic Penetration Test Diagram
Dwg. No. 6 ORDER NO. I.440/60



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1. The first part of the document is a list of names and titles, including "The Hon. Mr. Justice" and "The Hon. Mr. Justice".

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Appendix B
Site Photographs



Photo 1 Highway 401 Switzerville Road Underpass. Looking Eastward from West of Structure



Photo 2 Switzerville Road North Approach Looking South



Photo 3 Switzerville Road South Approach Looking North