

Mr. A. M. Toye,  
Bridge Engineer.  
Materials & Research Section.

May 19, 1960.

FOUNDATION INVESTIGATION -- by  
William A. Trow & Associates,  
Ltd.

Attention: Mr. S. McCombie.

Re: Proposed County Road Underpass  
Hwy. 401, Southwold Township,  
W.P. 62-59 -- District No. 2.

We have reviewed the above mentioned report and have found the comments and recommendations contained therein, adequate and satisfactory for your future design work.

For your convenience, we are summarizing again, these findings and recommendations, as follows:-

1. The soil at this location is very uniform in character, and it exists in a very competent condition. It is described as a hard to very stiff clay with some gravel sizes.
2. The allowable net bearing pressure to be applied at footing elevation 4 - 8 feet below ground level is about 14,000 p.s.f.
3. The resulting settlements will be small and have no practical bearing on the problem.
4. No embankment stability problem exists.

We believe that the above data will prove adequate for all your requirements; however, should there be any additional questions, please feel free to contact us.

AS/MdF  
Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
D. G. Ramsay  
A. Gater  
W. L. Fraser  
A. Watt  
J. Roy  
Foundations Office  
Gen. Files.

L. G. Soderman,  
PRINCIPAL SOILS & FOUNDATIONS ENGR.  
Per:

(A. Sternac,  
FOUNDATIONS OFFICE ENGR.)

Mr. J. L. Keen,  
Senior Engineer,  
Bridge Office.

August 12, 1960.

PILE LENGTH EMBEDMENT.

Materials & Research Section.

Attention: Mr. L. N. Francis.

Re: Southwold Twp. Bridge No. 9,  
W.P. 62-59 -- Highway 401,  
District 2, Twp. of Southwold,  
Elgin Co., Lots 6 & 7, Con. III. - TRWD - 7150

In answer to your request for pile length to sustain a design load of 40 tons/pile on 12" diameter steel tube piles, please note that these piles should meet refusal in the upper stiff crust at elevation 733 ±.

Refusal to this type of pile may be considered as 60 to 70 blows per ft. using a driving energy equivalent to a Delmag D-12 hammer (22,500 ft. lbs./blow). A safe load of 40 tons may then be used on these piles.

It is possible that some of the tube piles may penetrate the upper crust, and in this event, these should not be driven beyond elevation 720.0'. For piles penetrating the upper crust safe capacity will be available at elevation 720.0'.

If we can be of further assistance, please contact the Foundation Section.

L. G. Soderman,  
PRINCIPAL FOUNDATIONS ENGR.

Per:

*for* (K. Peaker,  
FOUNDATION FIELD SUPERVISING ENGR.

KP/MdeF

cc: Foundations Office  
Gen. Files.

DOWNSVIEW AVE.,  
KEELE ST. - HIGHWAY 401  
TORONTO, ONTARIO.



ONTARIO  
DEPARTMENT OF HIGHWAYS

DEPARTMENT OF HIGHWAYS  
PARLIAMENT BUILDINGS,  
TORONTO 2, ONTARIO.

Bridge Division,  
July 28, 1960.

MEMORANDUM TO:

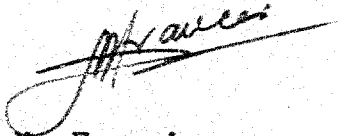
Mr. L. A. Soderman,  
Principal Soils and Foundation Engineer,  
Laboratory Building,  
Downsview, Ontario.

RE: Southwold Twp. Br. #9  
W.P. 62-59 Hwy. 401,  
Dist. 2 Twp. Southwold,  
Co. Elgin, Lot 6 & 7 Con. III

We enclose herewith one copy of our drawing  
D 4638-P1 and would like to know the length of pile  
embedment required to sustain a design load of 40  
tons per pile.

LNF/dd

Enclosure

  
L. N. Francis,  
for J. L. Keen,  
Senior Engineer,  
Bridge Design Office.

733  
738  
734  
738

723  
724  
725  
726

Mr. F. J. Harvey

May 24, 1960.

Location Plans Engineer

Materials & Research

Re: WP62-59, Hwy 401, Cty Rd Btwn Lots 6&7, Southwold Twp.,  
Plan F3530-1, Profile F3530-2, Sta. 246+50 approx.

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Further to your memorandum of Sept. 10, 1959, this will confirm our earlier statement that the alignment and grade at this structure site, as shown on the above plan and profile, appear to be satisfactory.

A foundation investigation has been completed by Consultants, Wm. A. Trow & Associates, and their report was submitted May 13, 1960. The material was determined to be predominantly hard to very stiff clay, and no approach fill stability problems are anticipated. Spread footings were recommended in the report.

I. G. Soderman  
Principal Soils & Foundation Engr.

NBS/tt

Copies to: S. McCombie  
R. Strain  
K. Peaker  
J. Roy (2)  
Files  
N. D. Smith

  
Per:  
N. D. Smith

SITE INVESTIGATIONS  
AND  
SOIL MECHANICS CONSULTATION

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

884 WILSON AVE.,  
DOWNSVIEW, ONT.  
ME. 5-5921

Project: J 493

May 13, 1960.

Mr. A. Rutka,  
Acting Materials and Research Engineer,  
Materials and Research Section,  
Department of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ont.

Attention: Mr. L. G. Soderman, P. Eng.,  
Principal Soils and Foundations Engineer

Foundation Investigation  
County Road Underpass, Highway 401,  
W.P. 62-59

Dear Sirs:

The enclosed report describes the foundation conditions existing at this site.

The county road intersection is underlain by a deep mass of hard to very stiff clay till. Abutment footings can be placed on it at a depth of about 4 feet and the safe bearing value, or net addition of stress to the soil, is about 14,500 p.s.f. The excavations for these footings will be dry. Some very long term settlement will occur under the weight of the embankments, but this movement is of academic interest only. The soil is quite strong enough to support the embankments safely.

We believe that the information contained in this report should be sufficient for the independent appraisal of foundation conditions at this site. We shall be pleased to discuss any problems that come to mind after you have reviewed the contents.

Yours very truly,

*W. Trow*

William A. Trow (P. Eng.)

WAT/lt  
Encl.

DEPARTMENT OF HIGHWAYS OF ONTARIO  
MATERIALS AND RESEARCH SECTION  
PARLIAMENT BUILDINGS, TORONTO, ONT.

FOUNDATION INVESTIGATION  
COUNTY ROAD UNDERPASS, HIGHWAY 401,  
W.P. 62-59

Project: J 493

William A. Trow and Associates Ltd.

May 13, 1960.

TABLE OF CONTENTS

Site Description	P. 1
Soil Description	1
Discussion of Foundation Requirements	1
Summary of Comments	3

APPENDIX

Field Investigation Methods	(i)
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ENCLOSURES

Borehole Location Plan	Dwg. 1
Borehole Profiles	2-6
Stress Strain Curves, Undrained Triaxial Tests	7
Consolidation Test Results, WP 63-59	8

FOUNDATION INVESTIGATION  
COUNTY ROAD UNDERPASS, HIGHWAY 401.  
W.P. 62-59

The report which follows describes the soil conditions existing at this intersection of Hwy. 401 and the county road in the vicinity of Lots 5 and 7, Southwold Township, south-west of London, Ont. Recommendations concerning safe bearing pressures and permissible foundation depths have been made.

Site Description

The terrain in the vicinity of this county road underpass can be described as flat to gently rolling farmland. The route of Hwy. 401 passes through wood lots a few hundred yards to the east and west of the road. It intersects this road more or less at right angles.

The ground was quite soft at the time of the investigation because the frost was coming out but in drier weather much harder conditions probably prevail. A shallow ditch bounds the west side of the road.

Soil Description

The soil conditions at this location were determined by 5 borings, made at the locations shown in Dwg. 1. Two of these borings were extended to depths of 120 feet and 100 feet, but the remainder were terminated at 25 to 30 feet.

Descriptions of the materials encountered at each test position together with a graphical record of some of their physical properties are presented in Dwgs. 2 to 6 of this report. Stress strain curves for undrained triaxial tests on this soil also are included. Reference to these drawings shows that the soil is remarkably uniform in character at all test locations and it does not vary appreciably with depth. It has been described as a hard to very stiff clay with some gravel sizes. The hard conditions prevail in a dessicated zone which extends about 20 feet below ground surface, and the soil above this level exists at a moisture content at the plastic limit. The shear strength of this material decreases from about 9000 to 4500 p.s.f.

Below 20 feet the soil becomes somewhat less stiff with a moisture content somewhat above the plastic limit, and a shear strength in the order of 3000 p.s.f. The liquid limit of the entire soil mass ranged from about 46 to 38 percent dry weight, with the more plastic condition prevailing, for the most part, in the upper dessicated zone.

Discussion of Foundation Requirements

The foundation conditions at this county road crossing of Hwy. 401 are considered to be excellent. Footings can be founded just below the maximum depth of frost penetration, or about 4 feet and the safe net bearing



value or permissible addition of stress, in excess of over-burden pressure, that may be applied at this depth, is in the order of 14,500 p.s.f. This net pressure is computed from the expression:

$$q = \frac{C}{F} N$$

where C - the shear strength of the soil, is in the order of 7000 p.s.f.  
 F is the required factor of safety, which, for these conditions, is equal to 3.  
 N is a bearing capacity factor, equal here to 6.3.

Settlement associated with the application of this footing pressure should not exceed 1 inch.

Even though the underlying clay is quite stiff, some long term settlement must be expected, merely because the weight of the abutment fill will extend to such great depths. No consolidation tests have been performed on this material, but the result of a test performed on similar soil obtained during an investigation for another county road intersection, WP 63-59, about 2 miles to the east is believed to be representative for conditions below 20 feet. This test result is shown in Dwg. 8. The soil above 20 feet is considered to be essentially incompressible under the embankment weights involved.

The settlement below 20 feet can be determined from the expression:

$$S = H M_v \Delta p$$

where:

H is the thickness of an increment of soil at any depth.

M<sub>v</sub> is the coefficient of compressibility for the pressure range applicable here.

Δp is the increment of pressure added to this increment of depth.

In view of the approximate nature of settlement calculations, detailed computations of the total long term movement have not been made. Rather, reference is made to the results of calculations made for a similar situation involving an overpass structure in the Blenheim area\*. The theoretical compression between depths of 20 and 85 feet at this location was estimated to be in the order of 5½ inches and the value of M<sub>v</sub> used in this instance was 0.00622 sq.ft.per kip.

According to the results of Dwg. 8, the applicable value of M<sub>v</sub> for this site is 0.00524 sq.ft.per kip. Accordingly, the theoretical settlement, noted above, should be reduced proportionately to a value of about 4½ inches. In keeping with the arbitrary corrections made for other bridge sites in this area, this estimate should be halved to a value of about 2¼ inches.

\* Foundation Investigation - Proposed County Road Overpass, Hwy. 401,  
 W.P. 83-59

This is done in order to account approximately for the overestimation of settlement involved in normal consolidation tests on heavily overconsolidated clay. The correction is particularly applicable for this material, since it contains gravel particles, some of which had to be removed in the preparation of the test specimen. The movement indicated above will extend over a period of many decades and therefore is not of practical significance, even if a centre pier is required in this overpass structure.

Summary of Comments

- 1) The soil at this location is very uniform in character and it exists in a very competent condition. It has been described as a hard to very stiff clay with some gravel sizes.
- 2) The safe net bearing pressure to apply at footing level is about 14,500 p.s.f. This represents the net addition of pressure in excess of present overburden.
- 3) Some long term settlement should be expected at this location but it should be only in the order of  $2\frac{1}{4}$  inches.
- 4) No embankment stability problem exists.

WAT/lt  
May 13, 1960.  
J 493



*W. Trow*  
William A. Trow (P. Eng.)

APPENDIXField Investigation Methods

The borings of this investigation were performed using continuous flight auger equipment. The holes were uncased to full depth.

Two of the holes, Nos. 1 and 3, were taken to depths of 120 and 100 feet below ground surface. The remainder were terminated at shallow levels of 25 to 30 feet. The holes remained clean to full depth and water had to be added in some instances in order to facilitate augering.

Samples were taken at about 5 foot intervals beginning about 3 feet below ground surface. These were recovered either in a 2 inch O.D. split spoon or in 2 inch I.D. shelly tubes. Three 3-inch diameter shelly tubes were also obtained, but no tests were performed on them. In all cases, it was necessary to drive the sampling equipment into the ground, using an energy of 350 ft.lbs. per blow.

All shelly tubes were carefully sealed soon after recovery. Representative material from the split spoon was wiped clean of surface water, wrapped in tinfoil and placed with the remainder of the sample in air-tight plastic bags.

The elevations of all holes were related to the reference indicated in Drg. 1.

## WILLIAM A. TROW &amp; ASSOCIATES LTD.

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

Hwy. 401

PROJECT County Rd. Underpass WP 62-59

LOCATION Lots 5 &amp; 7 Twp. of Southwold

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 747.4

BOREHOLE NO. 1

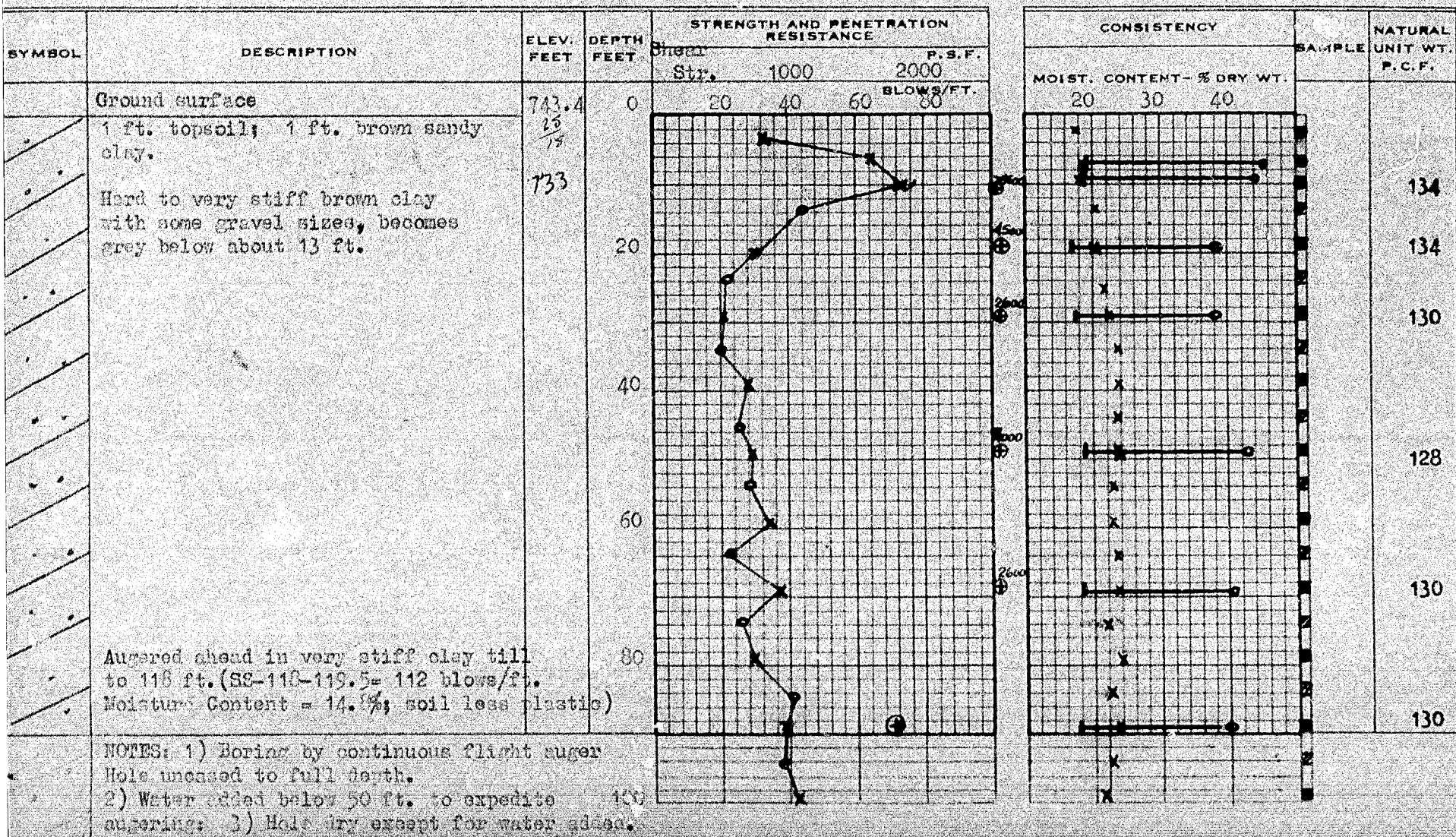
FIELD SUPERVISOR

DRILLER

PREP.

## LEGEND

2" DIA. SPLIT TUBE	—
2" SHELBY TUBE	—
2" SPLIT TUBE	—○—
2" DIA. CONE	—
CASING	—
2" SHELBY	—
1/2 UNCONFINED COMPRESSION (Qu)	—x—
VANE TEST (C) AND SENSITIVITY (S)	—x—
NATURAL MOISTURE AND LIQUIDITY INDEX	—x—
LIQUID LIMIT	—○—
PLASTIC LIMIT	—





J 493

WILLIAM A. TROW & ASSOCIATES LTD.

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

May. 401

PROJECT County Rd. Underpass WP 62-59

LOCATION Lot 5 & 7, Twp. of Southwold

HOLE LOCATION See Insert 1

HOLE ELEVATION AND DATUM 741.6

BOREHOLE NO. 2

FIELD SUPERVISOR

DRILLER

**PREP.**

DRAWING NO. 3

### LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

CASING

2" SHELBY

1/2 UNCONFINED COMPRESSION (QU)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

### PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				Shear Str.	P.S.F. BLOWS/FT.
	Ground surface	748.6	0	1000	2000
	Approx. 8 ins. tar-soil; 16 ins. sandy cl. s.	739	10		
	Hard to very stiff brown clay with some gravel sizes; gray in colour below about 14 ft.		20		
	End of bore.	718	30		
NOTES: 1. in Hole 1 					

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
20	30	40	

**WILLIAM A. TROW & ASSOCIATES LTD.**

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

Hwy. 401

PROJECT County Rd. Underpass WP 62-59

LOCATION Lots 5 & 7, Trp. of Southold

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM. 748.6

BOREHOLE NO. 3

FIELD SUPERVISOR.

DRILLER

PREP.

DRAWING NO. ....

## LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

## CASING

219 SHELBY

1/2 UNCONFINED COMPRESSION (QU)

VANE TEST [C] AND SENSITIVITY [S]

## NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

### PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE		
				Shear Str.	BLOWS/FT.	P.S.F.
	Ground surface	748.6	0			
	Approx. 1 ft. topsoil; 1 ft. sandy clay.					
	Hard to stiff brown clay with some gravel sizes; gray in colour below about 14 ft.					
	NOTES: As in Hole 1					
	End of bore,	642.0	100			

CONSISTENCY		SAMPLE	NATURAL UNIT WT P.C.F.
MOIST. CONTENT- % DRY WT.			
20	30	40	
<div>3"</div> <div>5"</div>			



PROJECT NO. J 493

## WILLIAM A. TROW &amp; ASSOCIATES LTD.

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

Key. 401

PROJECT County Road Underpass WP62-59

LOCATION Lots 5 &amp; 7, Twp. of Southwold

HOLE LOCATION See Day. 1

HOLE ELEVATION AND DATUM 745.7

BOREHOLE NO. 4

FIELD SUPERVISOR

DRILLER

PREP.

DRAWING NO. 5

## LEGEND

- 2" DIA. SPLIT TUBE  
 2" SHELBY TUBE  
 2" SPLIT TUBE  
 2" DIA. CONE  
 CASING  
 2" SHELBY  
 1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
 VANE TEST ( $C$ ) AND SENSITIVITY ( $S$ )  
 NATURAL MOISTURE AND  
 LIQUIDITY INDEX  
 LIQUID LIMIT  
 PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE			
				3000	1000	2000	P.S.F.
	Ground surface	745.7	0				
	Brown sandy clay with some organics (root hairs) to 3 1/2 ft.						
	Hard to very stiff brown clay with some gravel sizes.						
	Gray in colour below about 14 ft.						
	End of bore.	721.2					

NOTES: As in Hole 1.

CONSISTENCY			SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.				
20	30	40		
				132

PROJECT NO. J 493

**WILLIAM A. TROW & ASSOCIATES LTD.**

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Underpass WP 62-59

LOCATION Dots 5 & 7, Top. of Southyold

HOLE LOCATION Son Dr. 1

HOLE ELEVATION AND DATUM 748.6

BOREHOLE NO. 5

FIELD SUPERVISOR

DRILLER

PREP.

DRAWING NO.

## LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2 DIA, CONE

## CASING

211 SHELBY

1/2 UNCONFINED COMPRESSION (Qu)

VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

### PLASTIC LIMIT

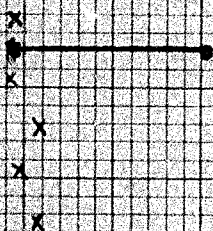
SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE	
				Shear Str.	P. S. F. BLOWS/FT.
	Ground surface	748.6	0		
	Sandy clay to approx. 2 ft.				
	Hard to very stiff brown clay with small gravel sizes; grey in colour below about 14 ft.				
	End of bore.	724			

STRENGTH AND PENETRATION RESISTANCE	
Shear Str.	P. S. F. BLOWS/FT.
1000	2000
20	40
60	80

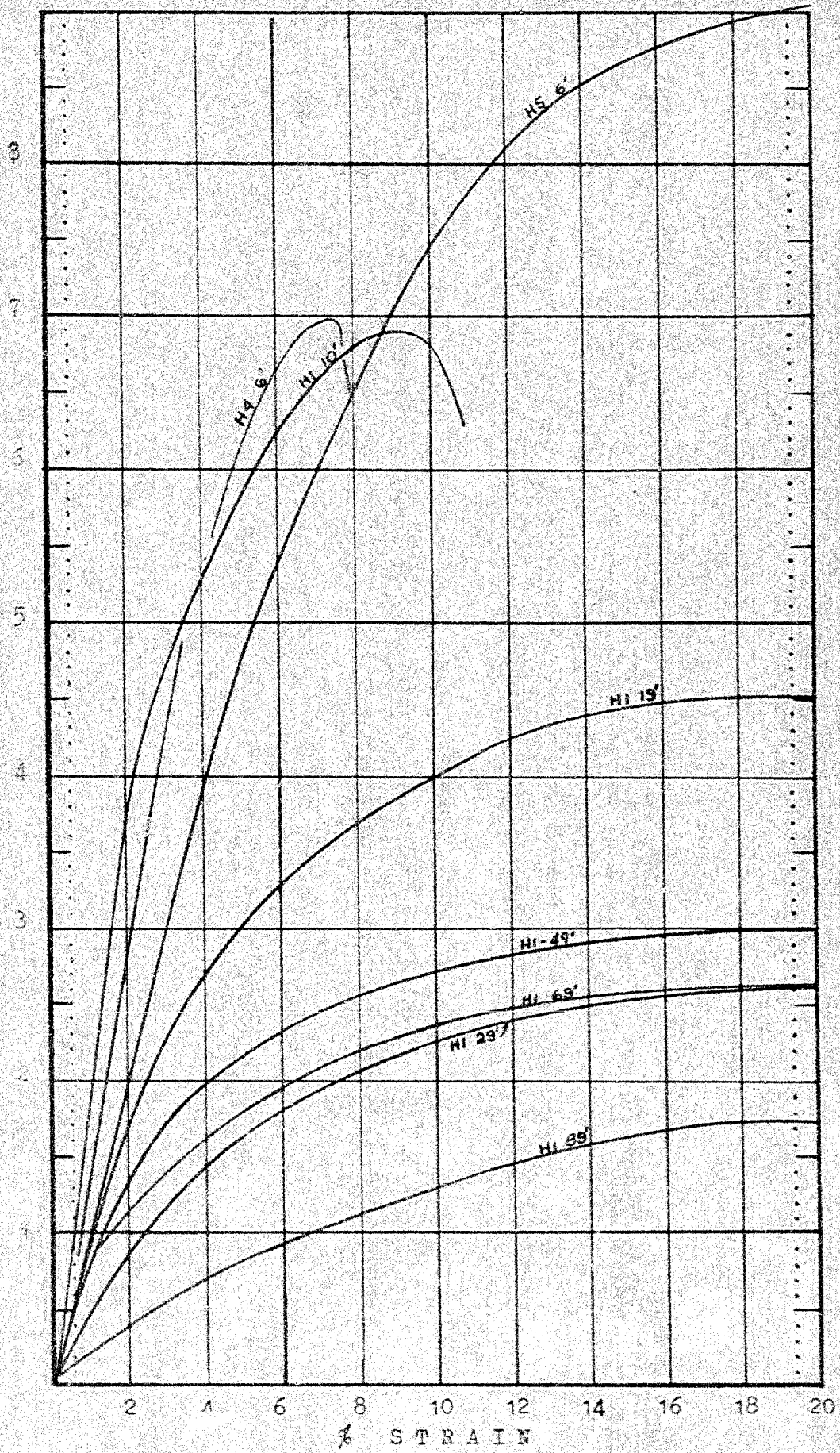
  

NOTES: As in Hole 1

CONSISTENCY			SAMPLE	NATURAL UNIT WT P.C.F.
MOIST. CONTENT - % DRY WT.				
20	30	40		136
				

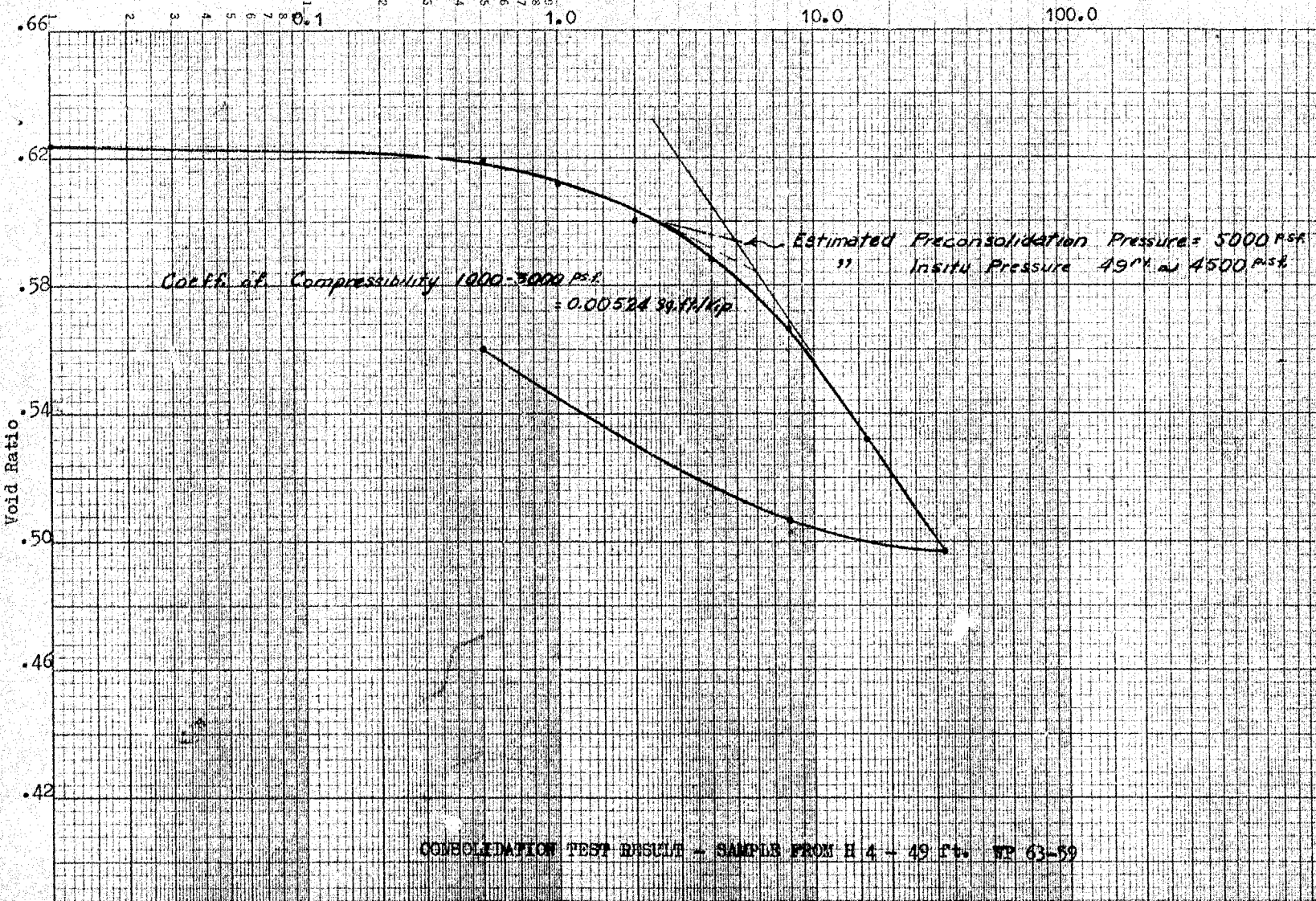


SHEAR STRESS kef



STRESS-STRAIN CURVES - UNIDIRECTIONAL TENSILE TEST RESULTS

All tests at 103.1°F. (39.5°C.)



#60-F-284-C

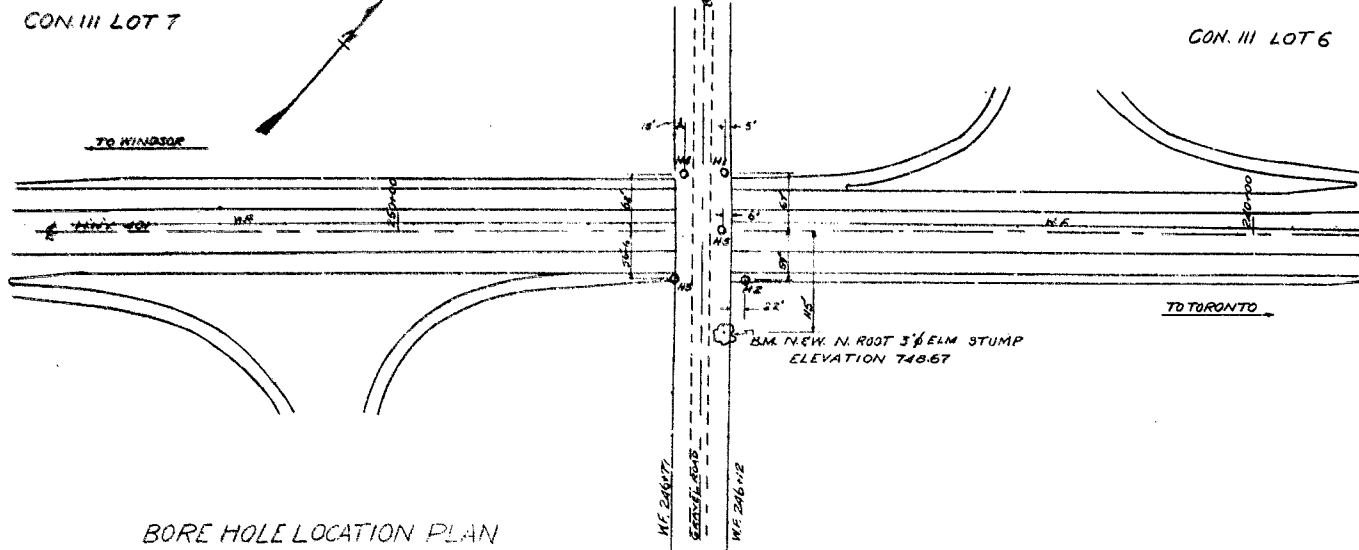
W.P.#62-59

HWY.#401, CTX.

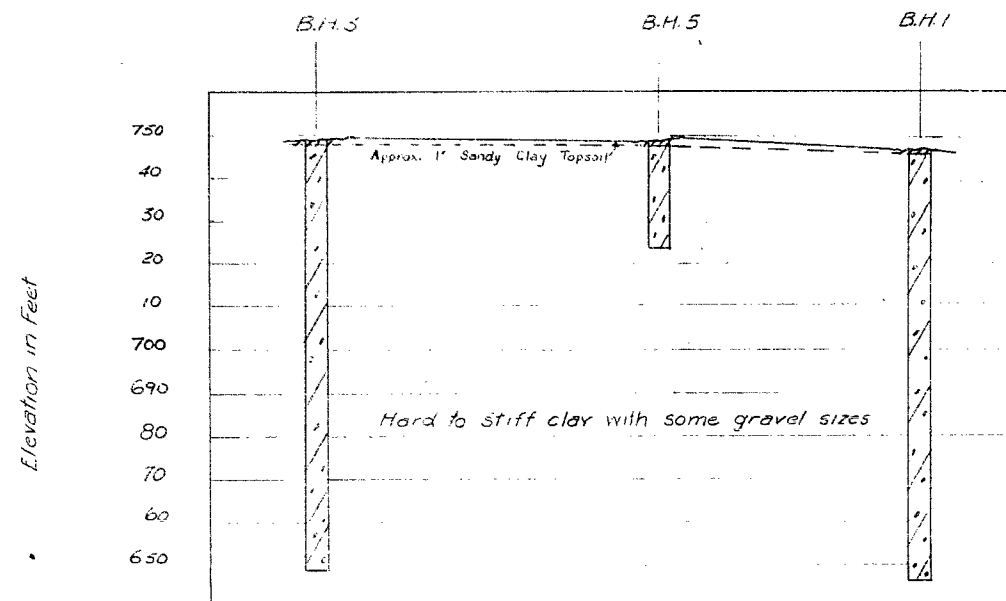
RD. UNDERPASS,

SOUTHWOLD TWP.

BRIDGE NO. 9



BORE HOLE LOCATION PLAN  
Scale 1 in. = 100 ft.



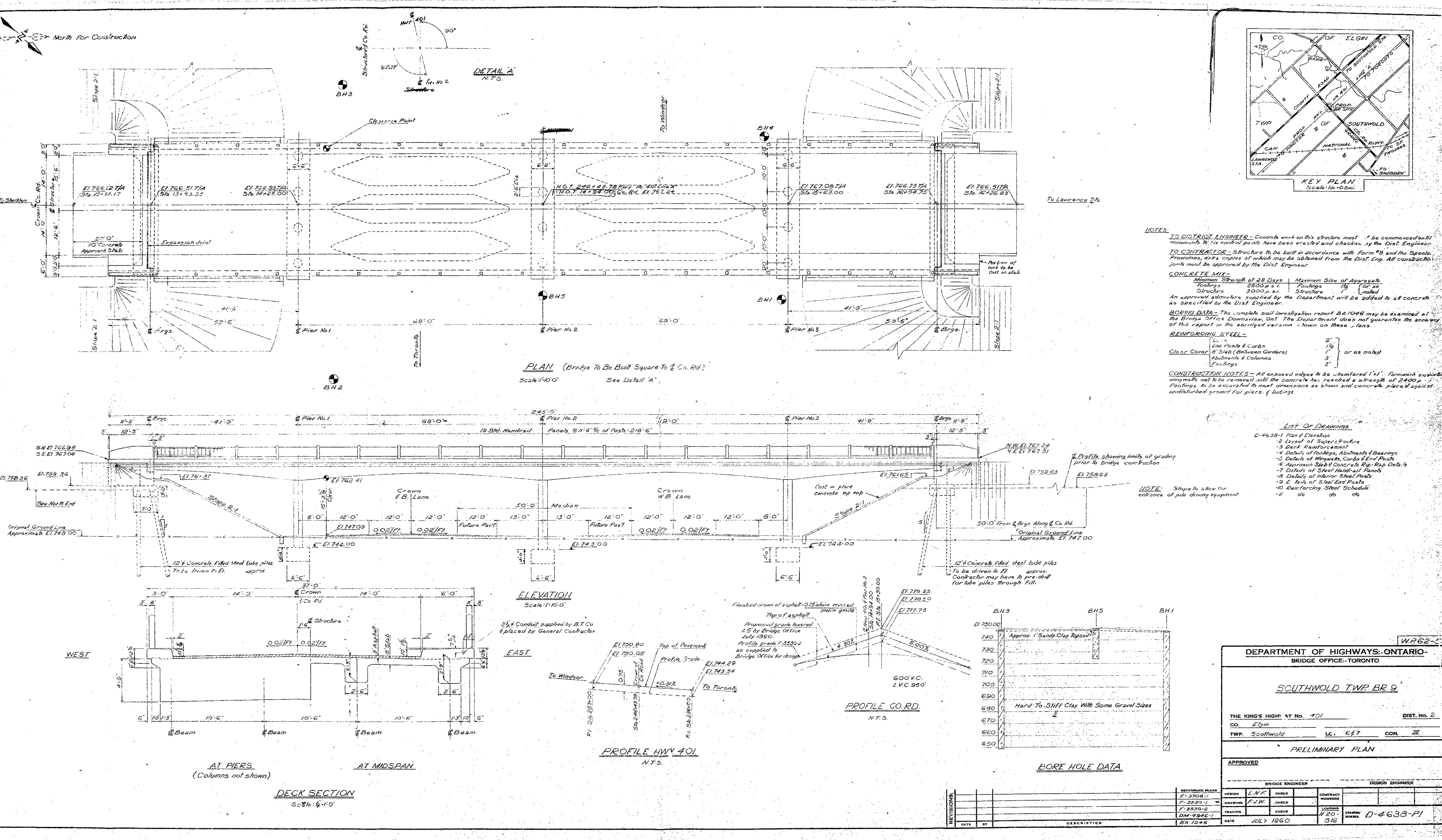
SUBSOIL STRATIGRAPHY BOREHOLES 3 5 & 1  
Horizontal Scale 1 in. = 20 ft.

COUNTY ROAD UNDERPASS HIGHWAY 401  
W.P. 62-59

WILLIAM A TROW & ASSOCIATES LTD.

J 493

DRAWING 1



**NOTES:**

**TO DISTRICT ENGINEER:** Concrete work on this structure must be commenced until monuments to the control points have been erected and checked by the Dist. Engineer.

**TO CONTRACTOR:** Structure to be built in accordance with Form #9 and the Specifications, extra copies of which may be obtained from the Dist. Eng. All construction joints must be approved by the Dist. Engineer.

**CONCRETE MIX:**  
Minimum Strength of 28 Days  
Footings 2500 p.s.i.  
Structure 3000 p.s.i.  
An approved admixture, supplied by the Department will be added to all concrete as specified by the Dist. Engineer.

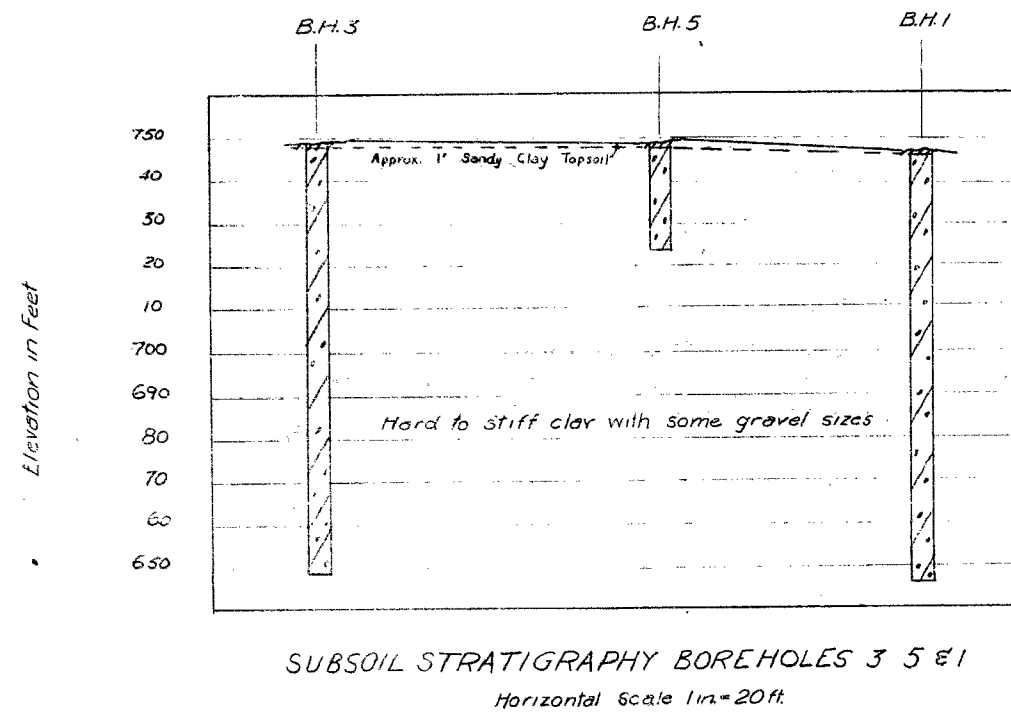
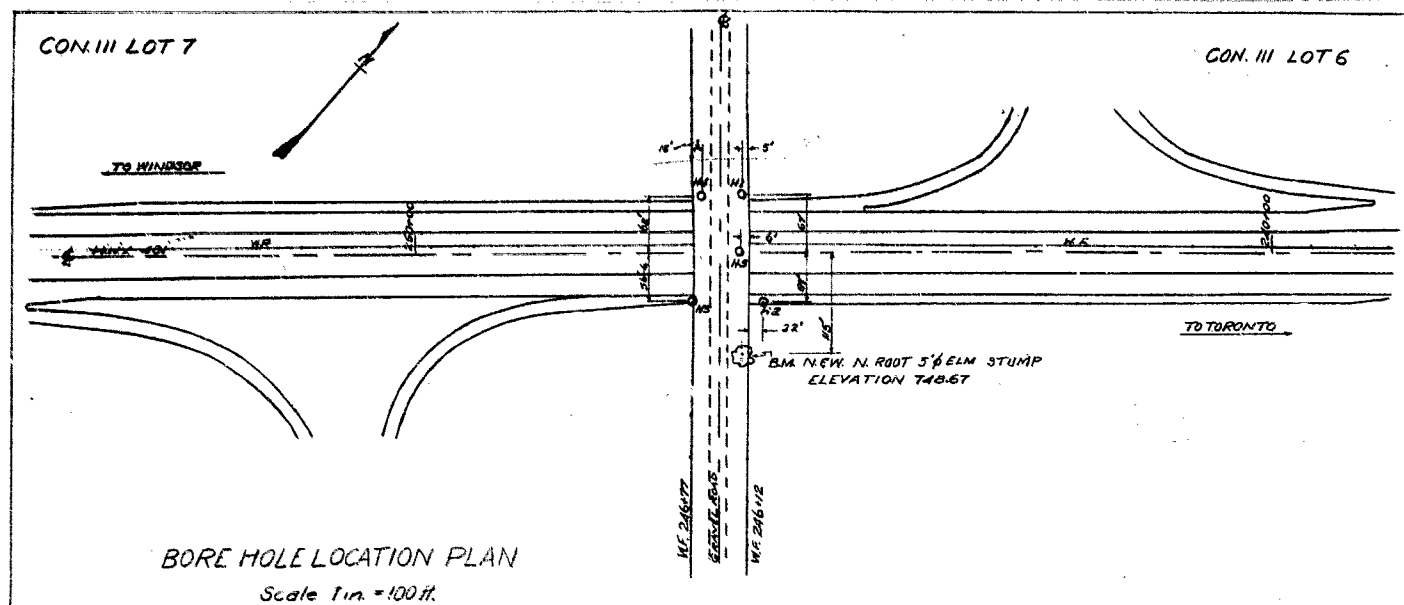
**BORE HOLE DATA:** The complete soil investigation report BA/046 may be examined at the Bridge Office Downsview, Ont. The Department does not guarantee the accuracy of this report or the abridged version shown on these plans.

**REINFORCING STEEL:**  
Clear Cover 3" Slab (Between Curbs) 2"  
Abutments & Columns 1 1/2"  
Footings 3"  
or as noted

**CONSTRUCTION NOTES:** All exposed edges to be chamfered (1"x1"). Formwork supporting wingwalls not to be removed until the concrete has reached a strength of 2400 p.s.i. Footings to be excavated to neat dimensions as shown and concrete placed against undisturbed ground for piers & footings.

- LIST OF DRAWINGS**
- D-4638-1 Plan of Elevation
  - 2 Layout of Superstructure
  - 3 Deck Reinforcement
  - 4 Details of Footings, Abutments & Bearings
  - 5 Details of Wingwalls, Curbs & End Posts
  - 6 Approach Slab & Concrete to Right of Bridge
  - 7 Details of Steel Handrail Panels
  - 8 Details of Interior Steel Posts
  - 9 Details of Steel End Posts
  - 10 Reinforcing Steel Schedule
  - 11 do do do
  - 12 do do do

DEPARTMENT OF HIGHWAYS-ONTARIO			
BRIDGE OFFICE-TORONTO			
SOUTHWOLD TWP BR 9			
THE KING'S HIGHWAY No. 401		DIST. No. 2	
CO. Elgin		TWP. Southwold	
LC. 6#7		CON. III	
PRELIMINARY PLAN			
APPROVED			
BRIDGE ENGINEER		DESIGN ENGINEER	
DESIGN LNF		CHECK	
DRAWING F.W.		CHECK	
TRACING		CHECK	
DATE JULY 1960		DATE	
DESCRIPTION		DESCRIPTION	
REFERENCE PLANS		CONTRACT NUMBERS	
F-3708-1		LOADING	
F-3530-1		DRAWING	
F-3530-2		REVISION	
DM-5546-1		D-4638-P1	
BA 15-6			



COUNTY ROAD UNDERPASS HIGHWAY 401  
W.P. 62-59  
WILLIAM ATROW & ASSOCIATES LTD.  
J 493 DRAWING 1