

Mr. A. M. Toye,

May 19, 1960.

Bridge Engineer.

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

Materials & Research Section.

Attention: Mr. S. McCombie.

Re: Proposed County Road Underpass,  
Hwy. 401, Twps. Southwold & Delaware,  
W.P. 64-59 -- District No. 2

We have reviewed the above mentioned report submitted by W. A. Trow & Associates, Ltd., and have found the findings and consequent foundation recommendations adequate for your further design work. For your convenience, we are summarizing once again, these comments and recommendations, as follows:-

1. The soil at this site consists of a very stiff to hard sandy clay which extends without significant variation, to a depth of 100 feet.
2. Abutment footings can be founded just below frost level in the hard upper crust of this material. The safe bearing value to apply between Elev. 764' and 768', is 9400 p.s.f.
3. The long-term settlement resulting from the weight of the approach embankment, is of the order of less than 4 inches. It will be uniform and extend over a long period of time, and should, therefore, have no harmful influence on the structure.
4. The soil conditions at the crossing sites of diverted portions of the creek have been found to be the same as exist at the main structure, and no foundation or stability problems should be expected.

We trust that the above information meets your requirements, and should there be any further questions, please feel free to contact our Office.

AS/MGP  
Attach.

cc: Messrs. A. M. Toye (2)

R. A. Tregaskes

D. G. Ramsay

A. Cater

W. L. Fraser

J. Roy

A. Watt

L. G. Soderman,

PRINCIPAL SOILS & FOUNDATIONS ENGINEER

Per:

(A. Stermac,  
FOUNDATIONS OFFICE ENGR.)

Foundations Office -- Gen. Files.

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

September 14, 1960.

REVIEW OF DRAWING by  
Foundation Section.

Attention: Mr. S. McCombie.

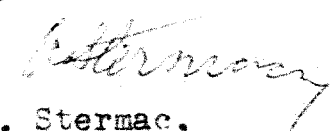
Re: Proposed County Road Underpass,  
Hwy. 401, Twps. Southwold & Delaware,  
W.P. 64-59 -- District No.2.

We have reviewed the proposed general arrangement for the bridge No. 2, Delaware Township, submitted by De Leuw, Cather & Company of Canada, Limited, Consulting Engineers.

The recommendations for the foundation of the structure have been followed except in the case of the abutment footings. These footings are placed directly on the existing ground surface, as shown on Drawing No. D-4686-P. In the Foundation Report it is stated that the upper 2 1/2 feet of the ground are top soil with root hairs. Such a material is not suitable as a foundation support and should, therefore, be excavated and the footings placed at a lower level.

L. G. Soderman,  
PRINCIPAL FOUNDATIONS ENGR.

Per:

  
(A. Stermac,  
FOUNDATIONS OFFICE ENGR.)

AS/MdeF

Mr. A. M. Toye,

November 29, 1960.

Bridge Engineer.

CORRECTION TO FOUNDATION REPORT

Materials & Research Section. by:

William A. Trow & Assoc., Ltd.

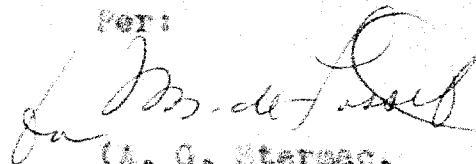
Attention: Mr. L. McCombie.

Re: Proposed Crossing at Cty. Road  
Revision between Twp. of Southwold  
and Delaware on Hwy. 401 -  
W.P. 64-59 -- District No.2.

The attached self-explanatory letter and accompanying sketch, submitted by the Consultants, W. A. Trow & Associates, Ltd., are being forwarded for insertion in the above-mentioned Foundation report previously distributed.

L. G. Soderman,  
PRINCIPAL FOUNDATION ENGR.

Per:



(A. G. Sternac,  
FOUNDATION OFFICE ENGR.)

AGL/MSBP  
Attach.

cc: Messrs. A. M. Toye (2)  
E. A. Tregaskes  
D. G. Lamsay  
A. Gater  
W. L. Fraser  
J. Roy  
A. Watt

Foundations Office  
Gen. Files.

Nov. 25, 1960

Mr. A. Rutka,  
Acting Materials & Research Engineer,  
Dept. of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ontario

Attention: Mr. L.G. Soderman, P.Eng.

Re: Correct Borehole Position - Hwy. 401 Underpass  
EP 64 - 59

Dear Sirs:

We have learned that our borehole location plan for the above project shows one borehole plotted in the wrong position. This drawing forms part of our report of May 13, 1960 for the Hwy. 401 Underpass, Southwold Township.

The station locations were referred to correctly but the plotted position of one hole was incorrect. In error we have also interchanged the locations of holes 2 and 4. The attached sketch, which is an overlay of part of this borehole plan, shows the correct locations of the holes.

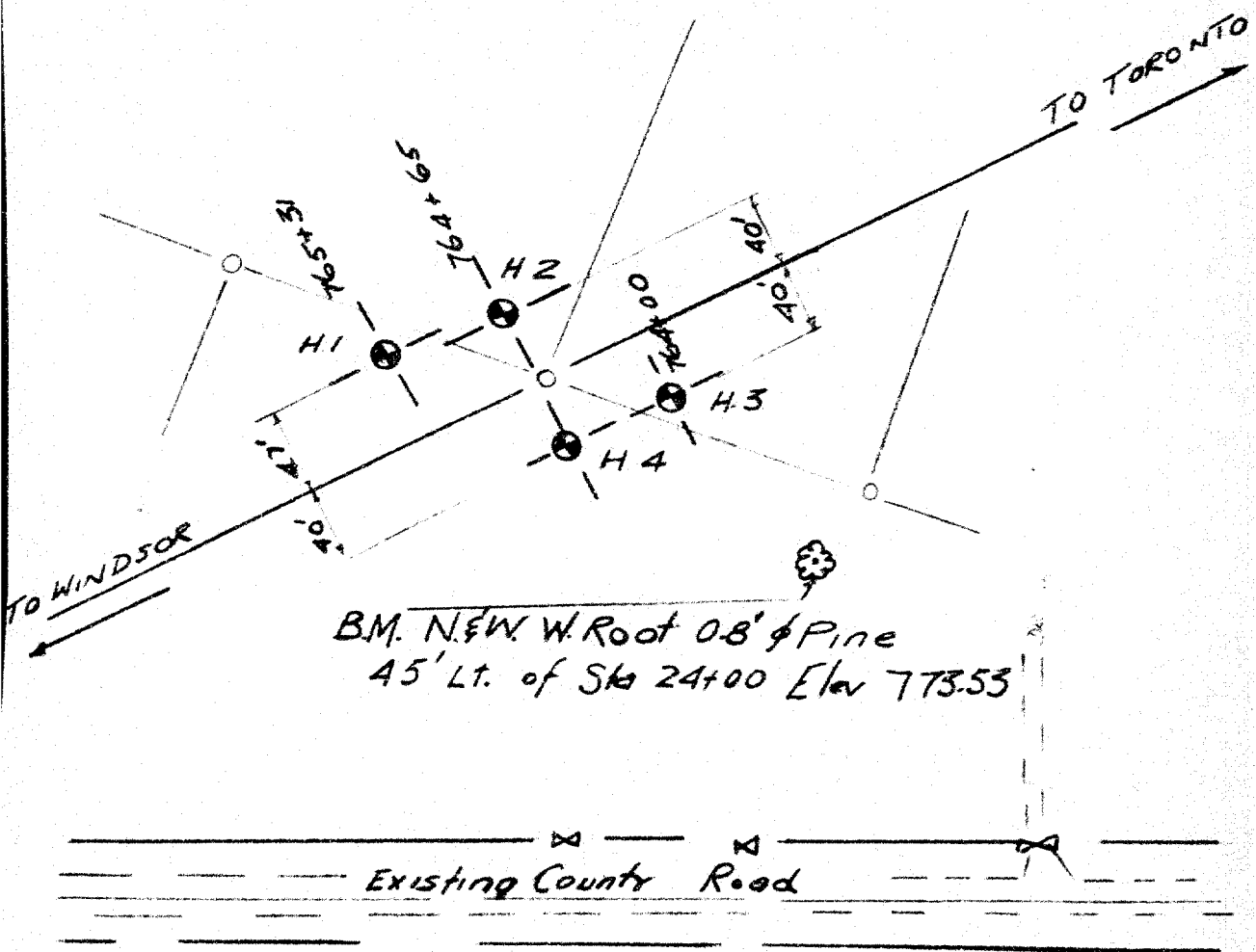
We regret any inconvenience to you resulting from this draughting error on our part.

Yours very truly,

*W. A. Trow*

William A. Trow, P.Eng.

WAT/gc  
Encl.



Sketch showing correct position  
of borings WP 64-59 HWY 401  
underpass.

Mr. S. McCombie,

May 24, 1960.

Bridge Planning Engineer.

Materials & Research Section.

Attention: Mr. G. Scott.

Re: Soil Conditions - Station 41 + 00,  
Proposed County Road Diversion Crossing  
Hwy. 401 Twps. Southwold & Delaware -  
W.P. 64-59 -- District 2.

As per your request of May 19th, our comments regarding soil conditions at the above location, are as follows:-

A detailed foundation report prepared by W. A. Trow & Associates, includes sites in the immediate vicinity. This report states that competent soil conditions exist in the area. Based on this information and a general knowledge of the site, it is assumed that soil conditions at the above site are also competent.

Spread footings for the proposed structure at the above site should be placed just below frost level, and designed for a bearing pressure of 3 T/sq. ft.

If we can be of further assistance in connection with this site, please contact the Foundation Section.

KP/MdeF

cc: Foundations Office  
Gen. Files.

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

*KF*  
(K. Peaker,  
FOUNDATION FIELD SUPERVISING ENGR.)

File 107

Mr. P. J. Harvey

May 24, 1960.

Location Plans Engineer

Materials & Research

Re: WP64-59, Hwy 401, Cty Rd Btwn Twps of Southwold & Delaware,  
Plan F3529-18, Profile F3529-16, Sta. 765 approx.

Further to your memorandum of Sept. 11, 1959, this will confirm our earlier verbal 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 very stiff to hard Sandy Clay, and no approach fill stability problems would be anticipated. Spread footings were recommended in the report.

L. G. Soderman  
Principal Soils & Foundation Engr.

NDS/tt

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

  
Per:  
N. D. Smith

Mr. F. J. Harvey

March 11, 1960.

Locations Plans Engineer

Materials & Research Section

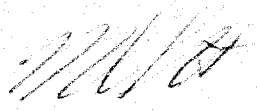
Re: WP64-59, Hwy. 401, Cty Rd Btwn Southwold & Delaware,  
Plan F3529-18, Profile F3529-16, Sta. 765 approx.

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Further to your memorandum of Sept. 11, 1959, we would agree that the alignment and grade at this structure site, as shown on the above plan and profile, appear to be satisfactory.

The foundation investigation will be undertaken by Consultants, Wm. A. Trow & Associates, and their report will be available in the fairly near future. Although exact soil conditions are not yet known, the material will probably consist of a stiff upper crust of clay till overlying softer clay. No approach fill stability problems would be anticipated in this case, and spread footings founded in the stiff upper crust would probably be recommended.

L. G. Soderman  
Principal Soils & Foundation Engr.



NLS/tt

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

Per:

N. D. Smith



Mr. A. M. Toye,  
Bridge Engineer.

November 29, 1960.

Materials & Research Section. by:

CORRECTION TO FOUNDATION REPORT

William A. Trow & Assoc., Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Crossing at Cty. Road  
Revision between Twps. of Southwold  
and Delaware on Hwy. 401 -  
W.P. 64-59 -- District No.2.

The attached self-explanatory letter  
and accompanying sketch, submitted by the Consultants,  
W. A. Trow & Associates, Ltd., are being forwarded  
for insertion in the above-mentioned Foundation report  
previously distributed.

L. G. Soderman,  
PRINCIPAL FOUNDATION ENGR.

Per:

*for [Signature]*  
(A. G. Stermac,  
FOUNDATION OFFICE ENGR.)

AGS/MdeF  
Attach.

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

Foundations Office  
Gen. Files.

Nov. 25, 1960

Mr. A. Rutka,  
Acting Materials & Research Engineer,  
Dept. of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ontario

Attention: Mr. L.G. Soderman, P.Eng.

Re: Correct Borehole Position - Hwy. 401 Underpass  
WP 64 - 59

Dear Sirs:

We have learned that our borehole location plan for the above project shows one borehole plotted in the wrong position. This drawing forms part of our report of May 13, 1960 for the Hwy. 401 Underpass, Southwold Township.

The station locations were referred to correctly but the plotted position of one hole was incorrect. In error we have also interchanged the locations of holes 2 and 4. The attached sketch, which is an overlay of part of this borehole plan, shows the correct locations of the holes.

We regret any inconvenience to you resulting from this draughting error on our part.

Yours very truly,

WAT/go  
Encl.

*WAT*  
William A. Trow, P.Eng.

Nov. 25, 1960

Mr. A. Rutka,  
Acting Materials & Research Engineer,  
Dept. of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ontario

Attention: Mr. L.G. Soderman, P.Eng.

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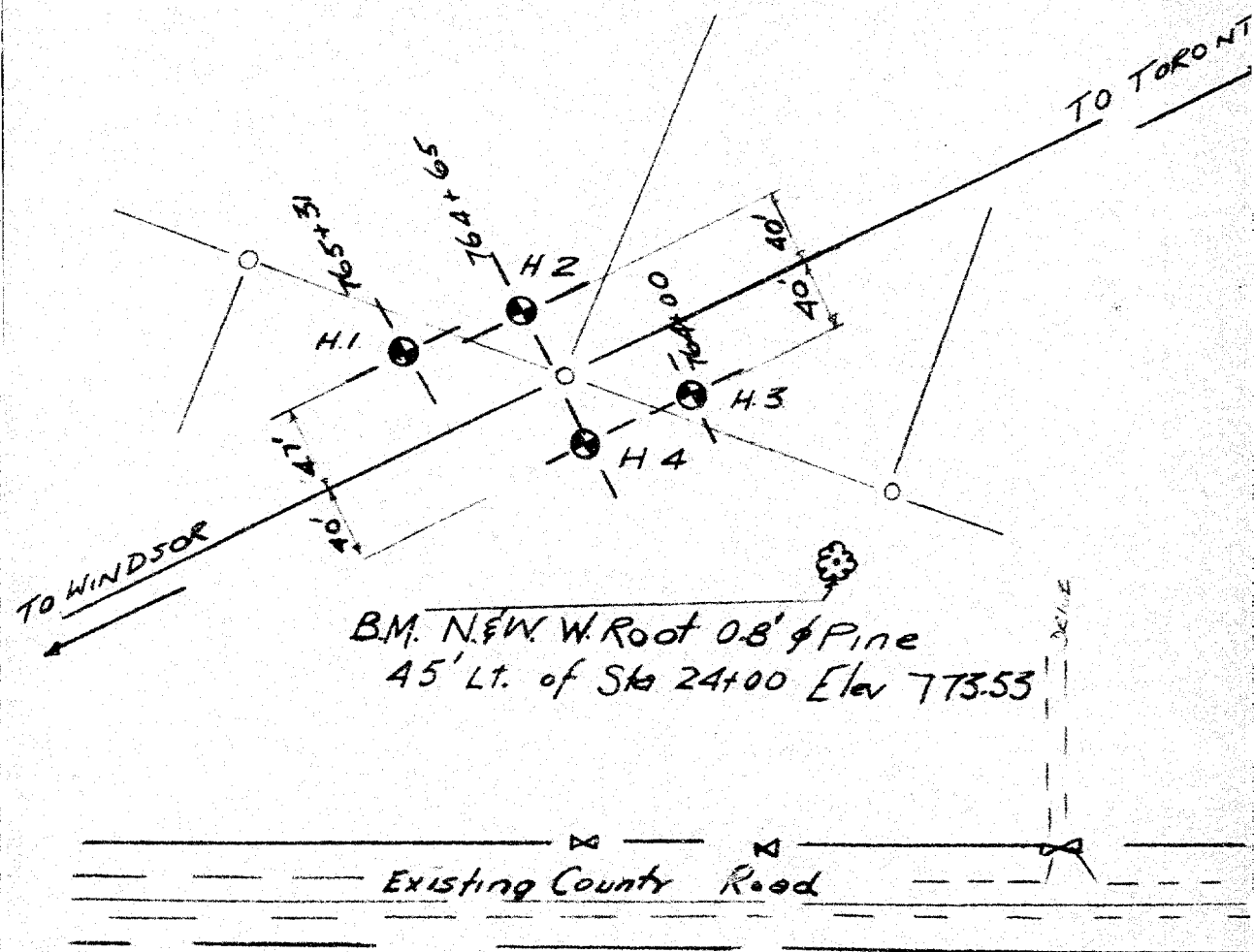
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We regret any inconvenience to you resulting from this draughting error on our part.

Yours very truly,

WAT/go  
Encl.

*WAT*  
William A. Trow, P.Eng.



Sketch showing correct position  
of borings WP 64-59 HWY 401  
underpass.



**Memo to** Mr. A. M. Toye, **Date** November 29, 1960.  
Bridge Engineer. **Subject** CORRECTION TO FOUNDATION REPORT  
**From** Materials & Research Section. **by:** William A. Trow & Assoc., Ltd.  
Attention: Mr. S. McCombie.

Re: Proposed Crossing at Cty. Road  
Revision between Twps. of Southwold  
and Delaware on Hwy. 401 -  
W.P. 64-59 -- District No.2.

The attached self-explanatory letter and accompanying sketch, submitted by the Consultants, W. A. Trow & Associates, Ltd., are being forwarded for insertion in the above-mentioned Foundation report previously distributed.

L. G. Soderman,  
PRINCIPAL FOUNDATION ENGR.

Per:

*(Signature)*  
(A. G. Stermac,  
FOUNDATION OFFICE ENGR.)

AGS/MdeF  
Attach.

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

Foundations Office  
Gen. Files.

Mr. A. Rutka,  
Acting Materials & Research Engineer,  
Dept. of Highways of Ontario,  
Parliament Buildings,  
Toronto, Ontario

Re: Correct Borehole Position - Hwy. 401 Underpass  
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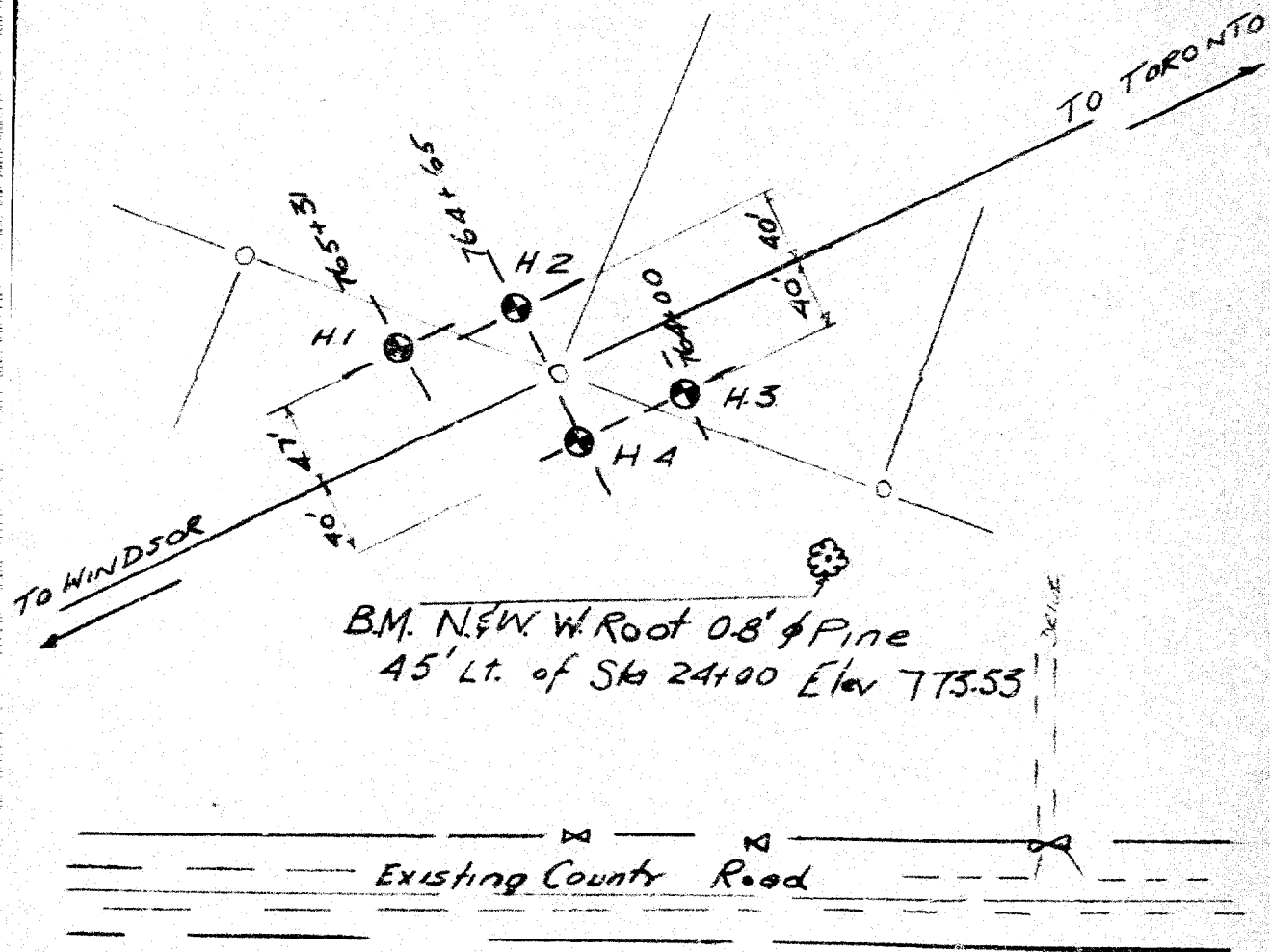
The station locations were referred to correctly but the plotted position of one hole was incorrect. In error we have also interchanged the locations of holes 2 and 4. The attached sketch, which is an overlay of part of this borehole plan, shows the correct locations of the holes.

We regret any inconvenience to you resulting from this draughting error on our part.

Yours very truly,

WAT/gc  
Encl.

William A. Trow, P. Eng.



Sketch showing correct position  
of borings WP 64-59 HWY 401  
underpass.

WILLIAM A. TROW AND ASSOCIATES LTD.

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 491

BA 1045

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  
Proposed County Road Underpass, Hwy. #401,  
Twps. Southwold and Delaware; WP-64-59.

Dear Sirs:

The enclosed report describes the foundation conditions existing at the proposed county road crossing of Hwy. 401 noted above.

Very stiff sandy clay was encountered at this location and no foundation problem of consequence appears to exist. Abutment and pier footings for the bridge structure can be founded at shallow depth and a safe bearing value of about 9000 p.s.f. is indicated.

Because of the great depth of clay, long term settlement will occur, even though the soil is quite stiff. In view of the approximate nature of any settlement computation, we have based our estimates on the results of a previous investigation in the Ridgetown area, where the loading and compressibility conditions are somewhat similar. We have estimated that the long term movement will be in the order of 4 inches.

Very competent soil conditions also exist at the sites of possible creek crossings associated with the diversion of streams in this vicinity.

We have avoided detailed computations in this report, and some of the opinions are based upon calculations made on previous investigations.



If you wish to consider these problems in greater detail, we shall be pleased to discuss them with you.

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  
PROPOSED COUNTY ROAD UNDERPASS, HWY. 401,  
TWPS. SOUTHWOLD AND DELAWARE: WP- 64-59.

Project: J 491

William A. Trow & Associates Ltd.

May 13, 1960.

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FOUNDATION INVESTIGATION  
PROPOSED COUNTY ROAD UNDERPASS, HWY. 401,  
TWPS. SOUTHWOLD AND DELAWARE, W.P.-64-59

This report describes the foundation conditions encountered at the bridge site noted above. Recommendations have been made concerning the permissible bearing pressures to apply at this location and estimates have been prepared of the settlements to be anticipated as a result of the application of the bridge and embankment loading. The construction of the underpass also involves the diversion of an existing creek in at least two locations. The soil conditions at these diversion sites are also reported.

Site Description

The site of this underpass lies in a cornfield immediately north of a gravel county road. The terrain is flat to gently rolling and part of the countryside remains as bushland.

Dodd creek winds through the fields and treed areas in the vicinity of this underpass. During this investigation it was in flood and cakes of ice were left stranded in the fields and on low parts of the county road. The maximum flood level was estimated to be up to Elev. 760 feet. Sloughing and scouring of thawing portions of the river banks was taking place, but the amount of erosion was considered to be normal. The three concrete bridge structures over the creeks appeared to be in reasonable condition, except for some traffic damage. Scouring of the ground in the approach areas and under the bridge was not noticeable although the water was too deep and muddy for an accurate appraisal of the condition of the river bed.

Subsoil Conditions

Four borings were made at the site of the underpass and three shallow holes were put down at points of possible diversion of the creek. Two of the bores at the main structure were taken to a depth of 100 feet. The locations of all tests are indicated in Dwg. 1 and the field and laboratory results are presented in the borehole logs, Dwgs. 2 to 8 of this report.

Reference to these logs shows that the soil at all locations and for the investigated depth of 100 feet, consists of sandy clay which is hard for the first approximately 10 feet and then becomes very stiff to stiff in the unweathered material below this level. In general, the moisture content of the soil is at or close to the plastic limit. Some intrusions or pockets of silty sand were noted above a depth of 7 feet in Holes 3 and 4. The somewhat lower shear strength measurement obtained in an undrained test on a sample from 6 feet in Hole 4 was caused by the presence of one of these sand pockets.

Neither bedrock nor refusal was encountered in either of the deep borings. According to the advice of a local well driller, bedrock lies about 300 feet below the surface in this area.

Accurate ground water measurements were not obtained because surface water ran into all of the borings. The ground was thawing at the time of the investigation.

### Examination of Foundation Conditions

#### A. Main Bridge Structure

A review of the factual data available from the laboratory and field measurements at this site indicates that the foundation conditions for the support of the bridge structure are excellent. With the exception of one measurement in hole 4, the shear strength of the first 10 feet of soil is equal to, or well in excess of, 3700 p.s.f. As mentioned in an early section, the lower strength obtained from a depth of 6 feet in hole 4 was caused by the presence of a sand pocket in the test sample. Below 10 feet, the shear strength decreases somewhat but is still appreciable.

The safe bearing value for a rectangular abutment or pier footing on clay is determined from the expression:

$$q = \frac{c}{F} N + P *$$

where: the first term is equal to the net bearing pressure or permissible addition of load to the soil in excess of the surcharge pressure P.

c is the cohesive resistance of the soil, taken here equal to 4000 p.s.f.

N is a bearing capacity factor. For a rectangular footing about 5 feet wide and 35 feet long, founded at El. 768 feet, or about 4 to 6 feet below ground surface, N =

$$(1 + 0.2 \times \frac{5}{35}) 6.4 = 6.6.$$

F is the factor of safety required to keep settlement within tolerable limits. For the soil conditions and footing dimensions applicable at this site, a value of F = 3 should suffice to limit settlement to one inch or less. This comment neglects the settlement resulting from the weight of approach fill.

\* The Bearing Capacity of Clays - A. W. Skempton - Building Research Congress, 1951.

Inserting these values in the foregoing expression:

$$q = 9400 \text{ p.s.f.}$$

This pressure can be applied at any level between Elev. 764 and 768 feet.

Although the underlying clay is quite stiff at least to a depth of 100 feet, it will be affected to some extent by the weight of the embankment fill adjacent to the bridge structure. This effect will be in the form of long term consolidation of the clay. In order to determine the magnitude of settlement to be anticipated, two consolidation tests were performed on specimens believed to be representative of the entire clay mass. These samples were recovered from depths of 17 and 35 feet in hole 3.

The results of these tests are indicated in Dwg. 9 of this report. The significant measurement required for the estimation of the magnitude of settlement is the coefficient of compressibility,  $M_v$ . This coefficient is defined by the expression:

$$M_v = \frac{\Delta e}{\Delta p(1+e_0)}$$

where:  $\Delta e$  is the change in void ratio in the soil for an increase in stress  $\Delta p$  and  
 $e_0$  is the initial void ratio.

For the approximate pressure range of 1 to 3 ksf., applicable in this problem, the values of  $M_v$ , from these consolidation curves, are noted to be 0.0062 for a depth of 35 feet, and 0.0055 for the sample from 17 feet. The higher compressibility of the sample from 35 feet is to be expected because its moisture content within the plastic limit is somewhat higher. It is probably not as representative as the test result for the 17 foot depth. The settlement at any given depth is equal to:

$$S = H M_v \Delta p$$

where  $H$  is the thickness of an increment of soil at any given depth.  
 $\Delta p$  is the increase in stress at the mid-depth of this soil increment.

Calculations have been made on previous occasions of the theoretical settlement to be anticipated for an abutment-approach fill composite similar to the arrangement required at this site. The coefficient of Compressibility used on one of these occasions was 0.00622 sq.ft./kip, and the estimated long term settlement resulting from the compression of about 80 feet of clay was found to be approximately 10 inches\*. At this

\* Foundation Investigation - County Road Underpass Hwy.401 - Ridgetown, Ont. WP 83-59: William A. Trow & Assoc.Ltd.

site the computed settlement should be somewhat less than this because the value of  $M_v$ , of the order of 0.0055, should apply.

In these previous calculations all settlement estimates were reduced by approximately 50 percent. This was done in order to allow for disturbances to the test specimen during sampling and preparation for test. Both these samples contained small particles of gravel, some of which had to be removed and replaced with compacted soil in order to obtain a specimen of uniform dimension.

With the application of these reductions to theoretical settlement, a long term movement of the order of 4 inches is obtained. In view of the great depth of the clay, this settlement will occur at a very slow rate extending in time over several decades. If the bridge is to be single span, the movement is not of practical importance. If a centre pier is proposed, long term differential movement between the pier and the abutments will result. However, it is felt that the structure will be able to accommodate the gradual changes of stress resulting from this slow differential movement.

The foregoing settlement computations have been concerned only with the compression of materials within the first 80 feet of depth. Below this level, the stresses from the embankments begin to overlap under the centre pier and as a consequence, the tendency for differential movement ceases.

It is noted that the relocated county road intersects Hwy. 401 at an angle and, as a consequence, the overpass structure will be built on a slight skew. However, the foundation soil is sufficiently strong to resist its share of the resulting eccentric loading against the abutments, provided that the bridge structure can accommodate the twisting force imposed on it.

#### B. Auxiliary Creek Crossings

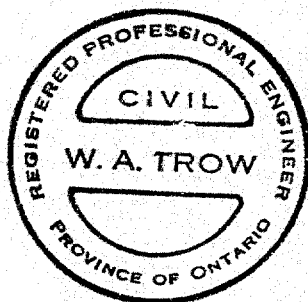
It is proposed to change the course of the existing creeks at two locations when the county road is diverted to cross Hwy. 401. Bore 5, 6 and 7 were made to confirm that the soil, at the sites of potential crossings of these creeks, was similar to the materials encountered at the main underpass structure. Reference to the logs of these borings indicates that this is the case. Accordingly, the bearing capacity recommendations for the main structure apply at these locations as well.

Some rip rap protection should be applied to the soil banks immediately upstream and downstream of these structures, in order to protect them during flood periods. The footings of the bridges should be taken about 6 feet below river bed level for scour protection and the river bed adjacent to the footings should be strewn with large stones.

Summary of Comments and Conclusions

1. The soil at this site consists of a very stiff to hard sandy clay which extends without significant variation at least to a depth of 100 feet.
2. Abutment footings can be founded just below frost level in the hard upper crust of this material. The safe bearing value to apply between Elev. 764 and 768 feet, is 9400 p.s.f.
3. The long term settlement resulting from the weight of the approach embankments has been discussed. An ultimate movement in the order of 4 inches has been estimated.
4. The soil conditions at the crossing sites of diverted portions of the creeks have been found to be the same as exist at the main structure.

WAT/lt  
May 13, 1960.  
J 491



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



(i)

APPENDIX

Field Investigation Methods

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

Samples were taken generally at 5 foot intervals of depth and were obtained either using the conventional 2-inch split spoon or a shelby tube. The samples had to be driven in most instances using a driving energy of 350 ft.lbs.per blow. Field vane tests were attempted but in most instances the strength of the soil exceeded the capacity of the vane device.

The elevations of all bores were referred to bench marks, as indicated in Dwg. 1.

WILLIAM A. TROW & ASSOCIATES LTD.

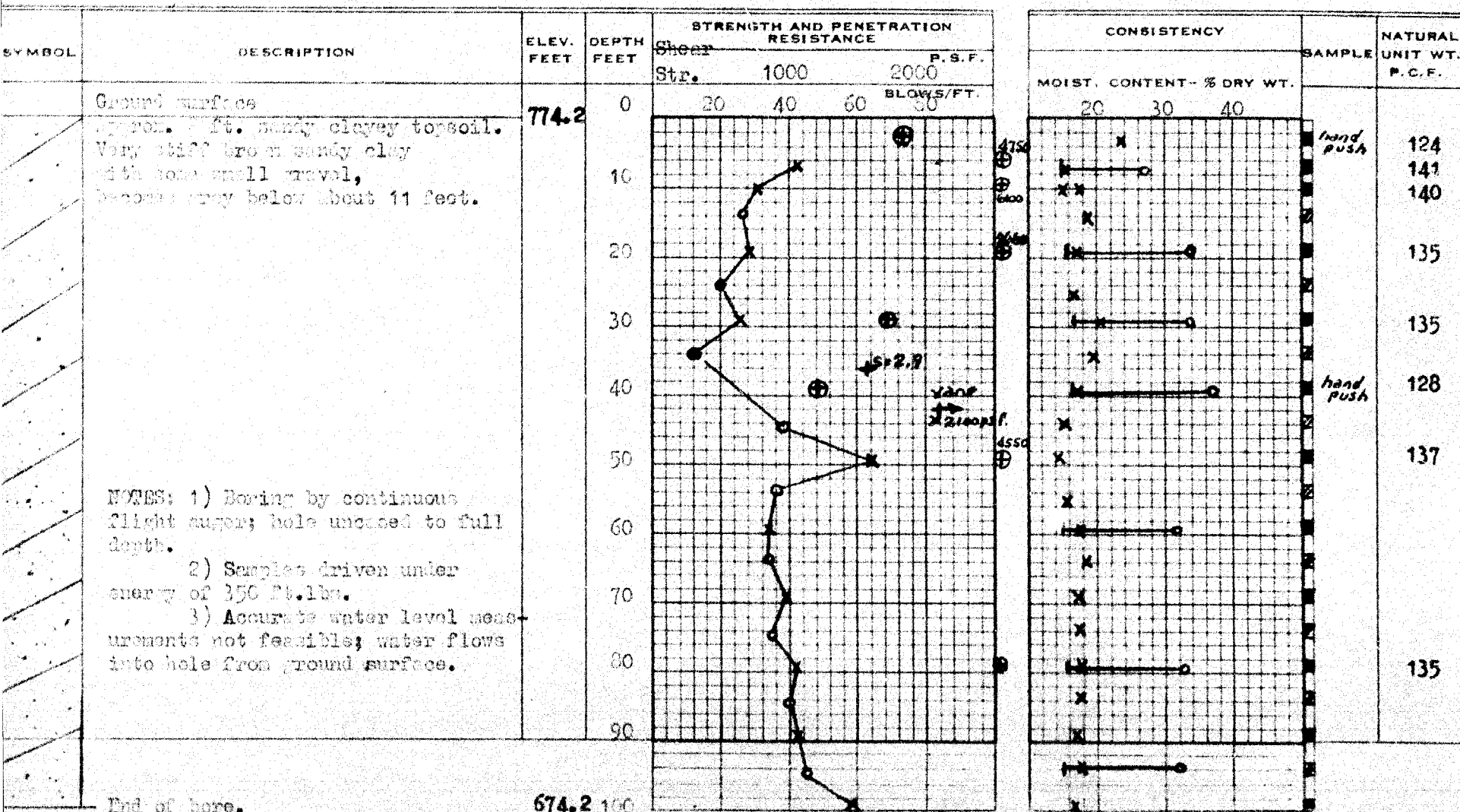
SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Rd. Underpass Hwy. 401  
LOCATION Tps. Southold & Delaware WP 64-59  
HOLE LOCATION See Dig. 1  
HOLE ELEVATION AND DATUM 774.2

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)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT



PROJECT NO. J 491

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

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Rd. Underpass Hwy 401 WP64-59

LOCATION Twp. Southwold &amp; Delaware

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 774.9

BOREHOLE NO. 2

FIELD SUPERVISOR

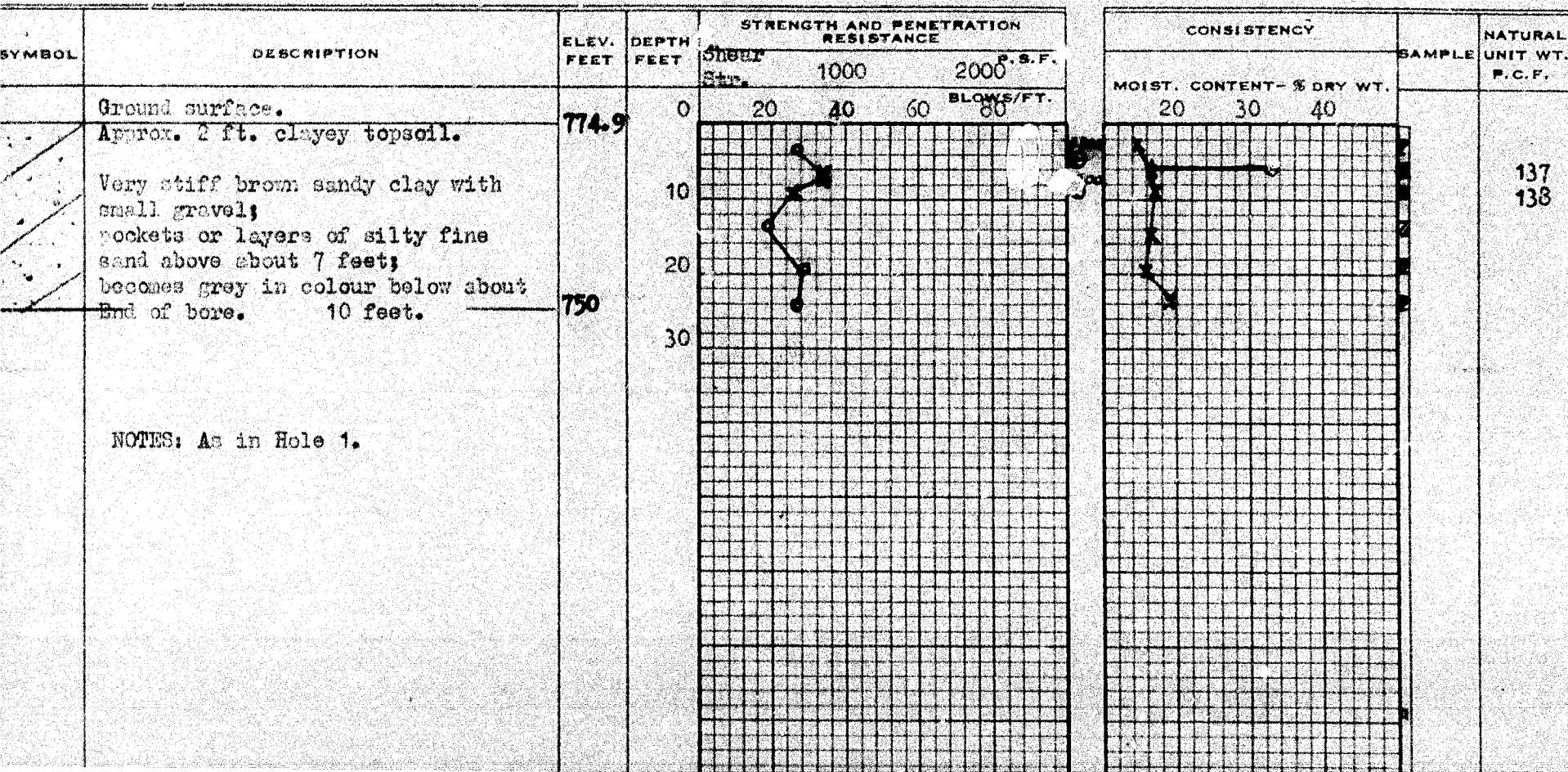
DRILLER

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



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












## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Rd. Underpass Hwy. 401 WP64-59  
LOCATION Twp. Southwold & Delaware  
HOLE LOCATION See Dwg. 1  
HOLE ELEVATION AND DATUM 773°

BOREHOLE NO. 3  
FIELD SUPERVISOR  
DRILLER  
PREP.

**DRAWING NO.**

### 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		
				Sheet Str.	1000	2000 P.S.F. BLOWS/FT.
	Ground surface.	773 <sup>0</sup>	0			
	Brown sandy clay topsoil with root beins to approx. 2 $\frac{1}{2}$ feet.					
	Very stiff brown sandy clay with some small pebbles (pockets and layers of silty sand above 7 feet) becomes grey in colour below about 11 feet.					
	NOTES: As in Hole 1.					
	End of bore.	673 <sup>0</sup>	100			

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT- % DRY WT.			
20	30	40	
		3" 3" 3"	

PROJECT NO.

J 451

DRAWING NO.

5

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

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Rd. Underpass Hwy. 401 WP 64-59

LOCATION Type. Southwold &amp; Delaware

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 772.8

BOREHOLE NO. 4

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)

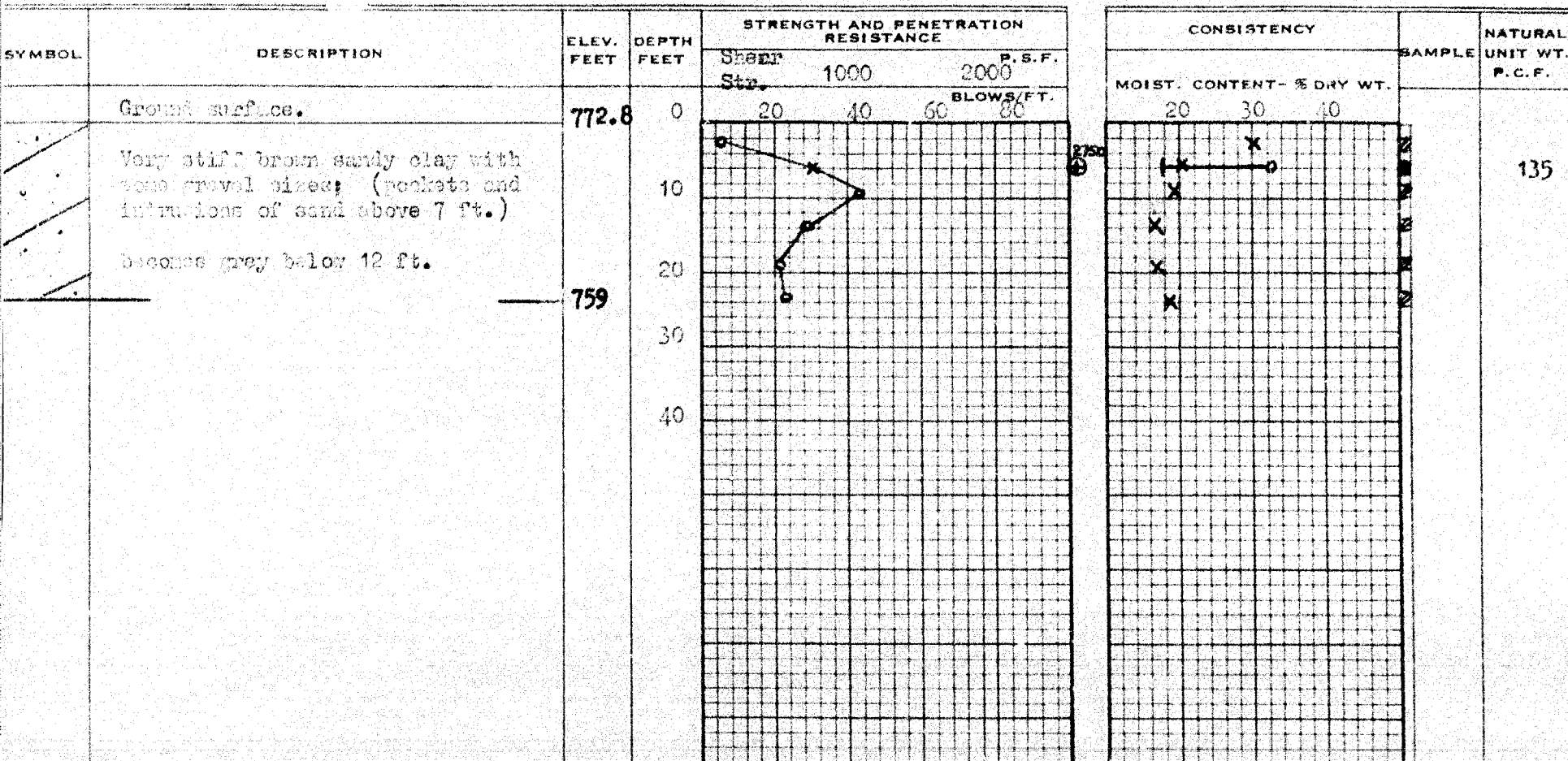
VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT





PROJECT NO. J 491

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

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Rd. Underpass Hwy. 401 WP 64-59

LOCATION Twp. Southwold & Delaware

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 769.9

BOREHOLE NO. 5

**FIELD SUPERVISOR**

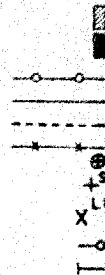
**DRILLEN**

**PREP.**

**DRAWING NO.**

### 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	
				Sheet Str.	P.S.F. BLOWS/FT.
	Ground surface	769.9	0		
	Approx. 12 ins. topsoil.				
	Very stiff brown sandy clay with some gravel sizes, becomes grey below about 13 feet.		10		
			20		
	End of bore.	740	30		
			40		
NOTES: As in Hole 1.					

[illegible]

PROJECT NO. J 491

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

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

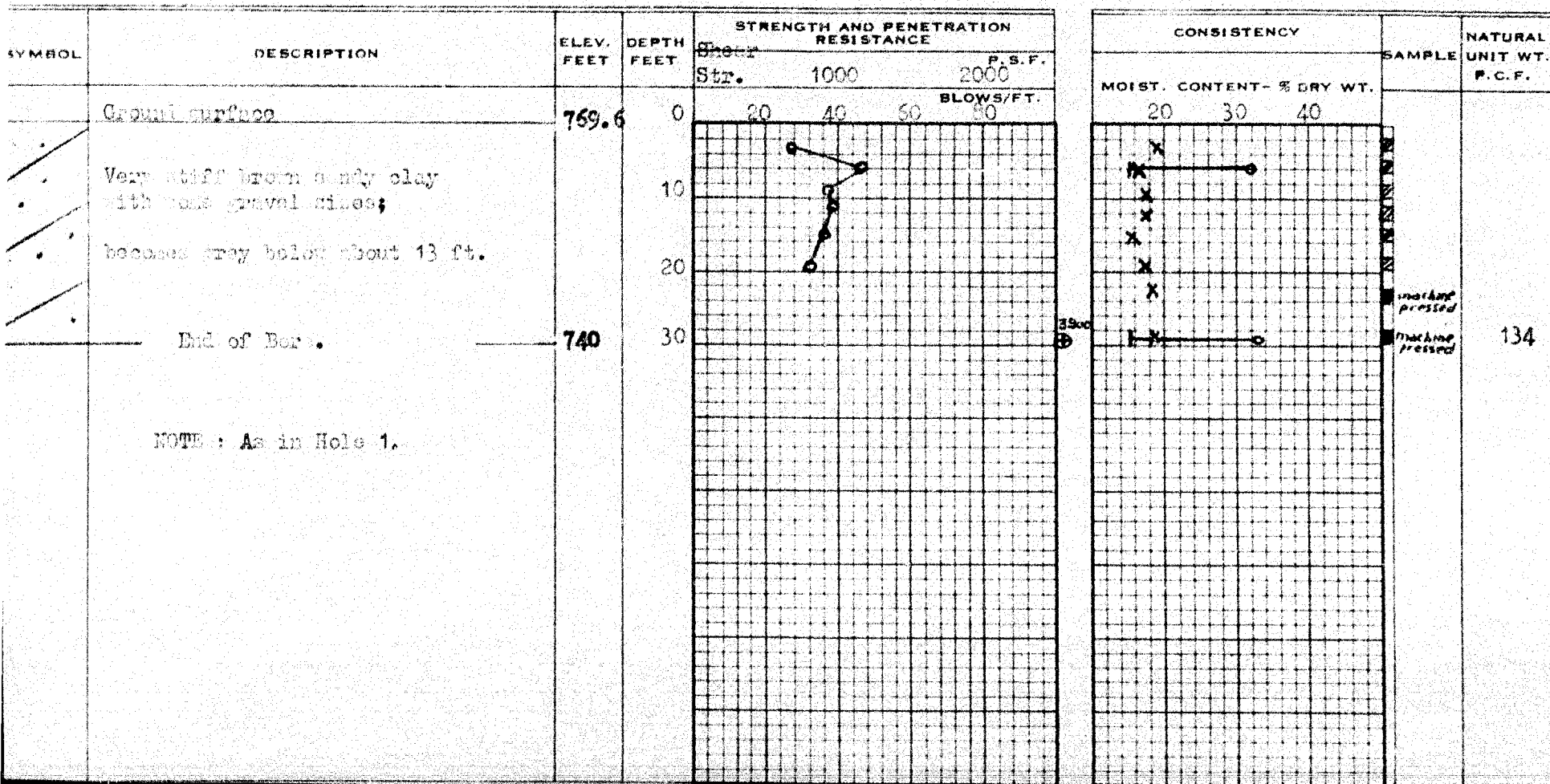
PROJECT County Rd. Underpass Hwy. 401 WP 64-59 BOREHOLE NO. 6  
 LOCATION Twp. Southwold & Delaware  
 HOLE LOCATION See Dig. 1  
 HOLE ELEVATION AND DATUM 769.6

FIELD SUPERVISOR  
 DRILLER  
 PREP.

DRAWING NO. 7

## 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



PROJECT NO.

J 491

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

## SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

**PROJECT** County Rd. Underpass Hwy. 401 WP 64-59

BOREHOLE NO. 7

LOCATION Twp. Southwold and Delaware.

**FIELD SUPERVISOR**

HOLE LOCATION See Dwg. 1

**BRILLEN**

HOLE ELEVATION AND DATUM 762.4

**PREP.**

**DRAWING NO.**

### LEGEND

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

211 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

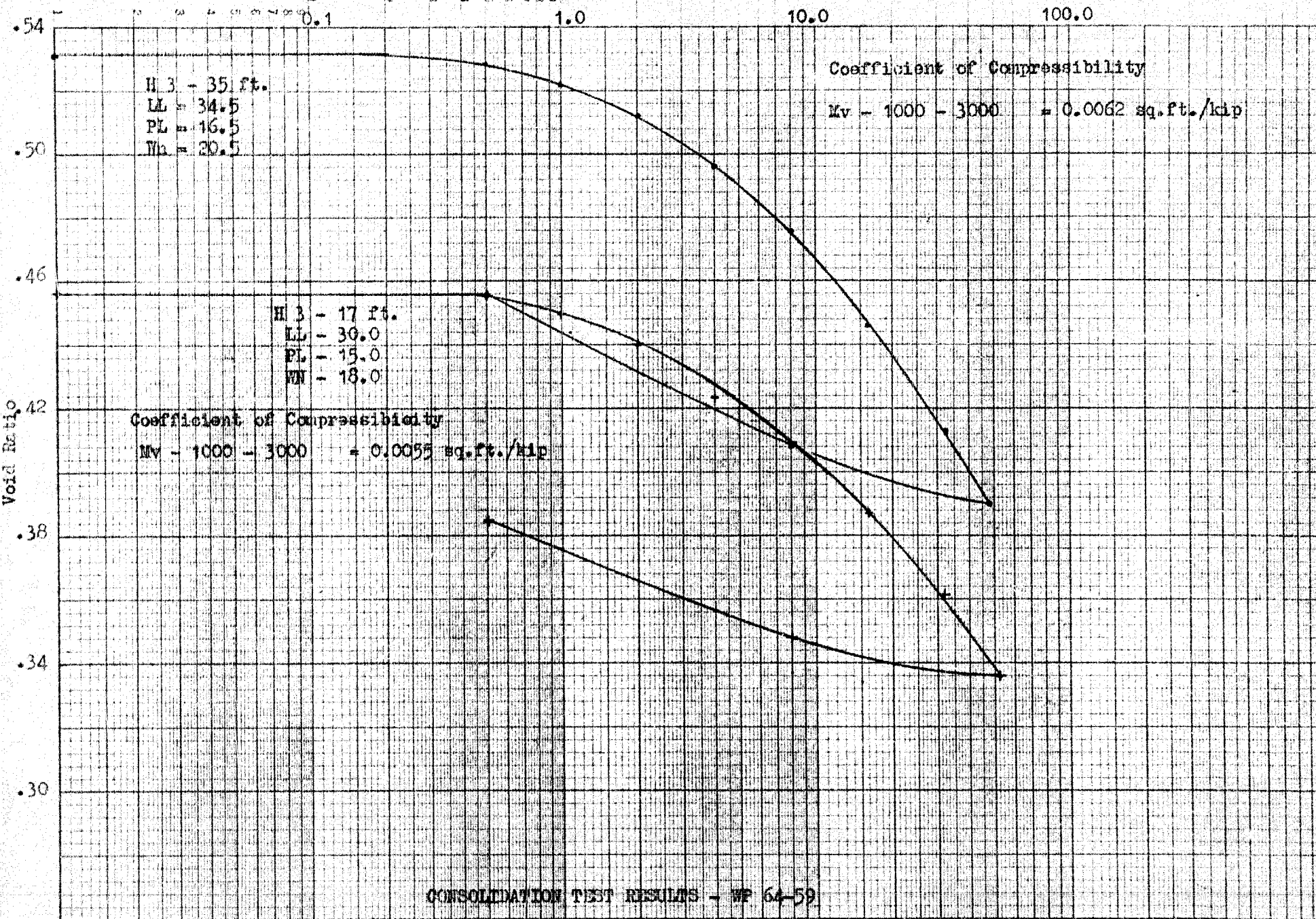
SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION		
				Shear Str.	1000	2000
				P.S.F. BLOWS/FT.		
	Ground surface	762.4	0		20	40
	Approx. 1 ft. topsoil.					
	Very stiff brown sandy clay with some gravel sizes;		10			
	becomes gray below about 13 ft.		20			
	End of bore.	733	30			
			40			

NOTES: As in Hole 1

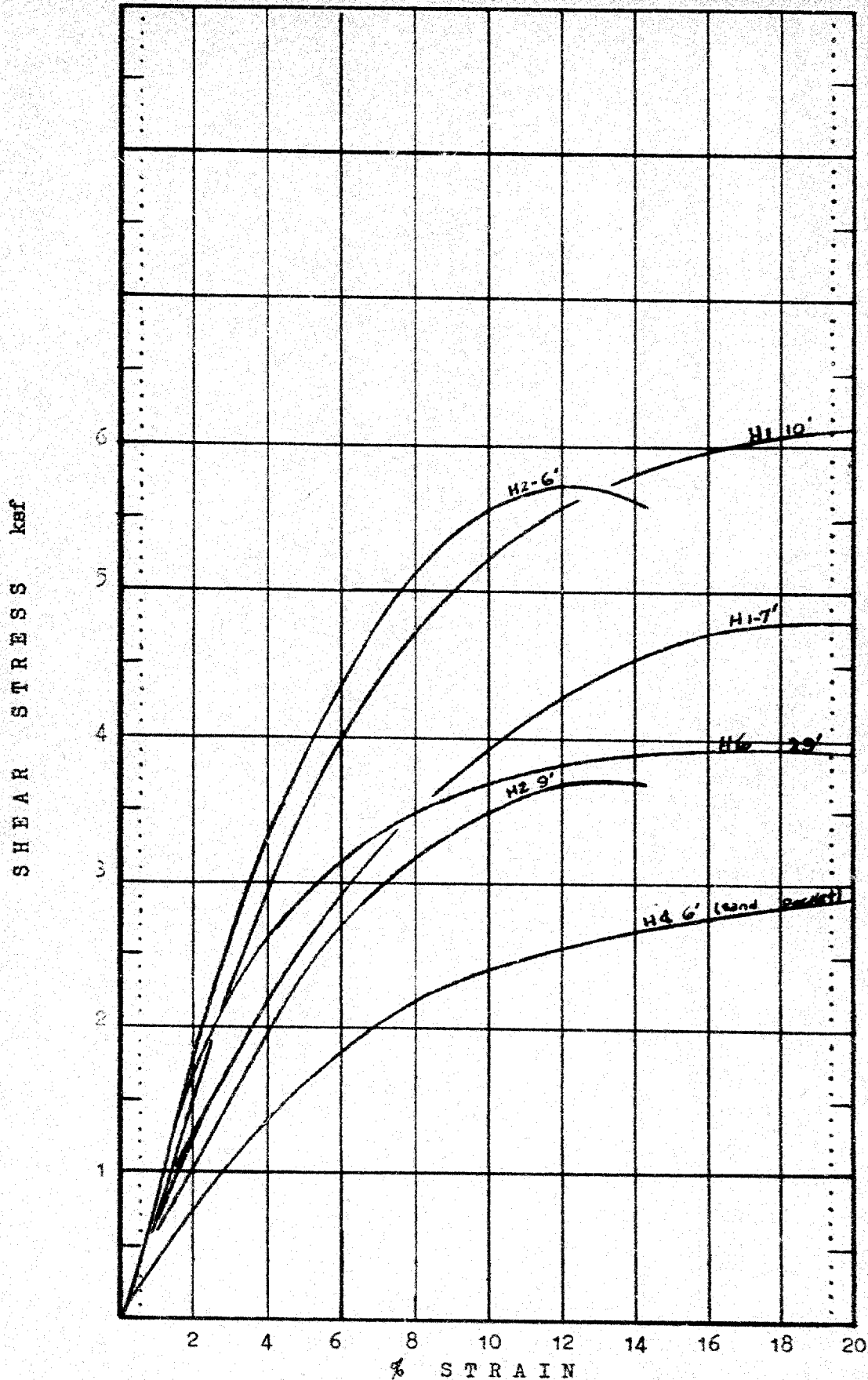
CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
20	30	40	
<p>The flowchart plots three soil consistency limits against Moisture Content (% Dry Wt.) on the x-axis (20 to 40). The y-axis is logarithmic, ranging from 0.001 to 100. A horizontal line at approximately 0.7 connects the Liquid Limit (X) and Plastic Limit (O). The Shrinkage Limit (triangle) is plotted at a lower moisture content and higher plasticity index than the other two points.</p>			
		<i>Machine pressed</i>	



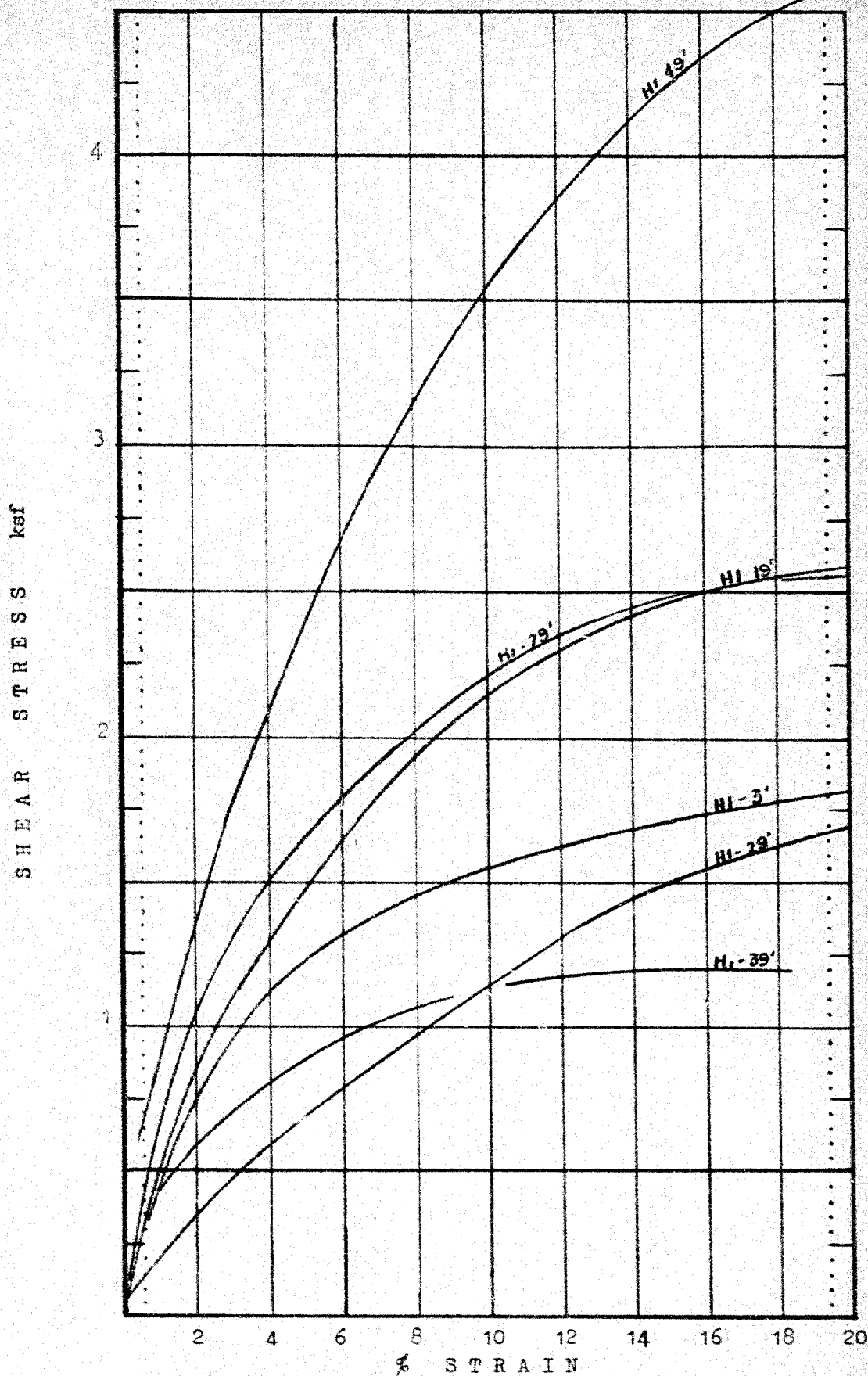
Pressure Ksf



CONSOLIDATION TEST RESULTS - WF 64-59



STRESS STRAIN CURVES - UNDRAINED TRIAXIAL TEST RESULTS  
All tests at total overburden pressure.



STRESS STRAIN CURVES - UNDRAINED TRIAXIAL TEST RESULTS  
ALL TESTS ON 2 OVERLAPED SPECIMENS.

#  
60-F-290-C

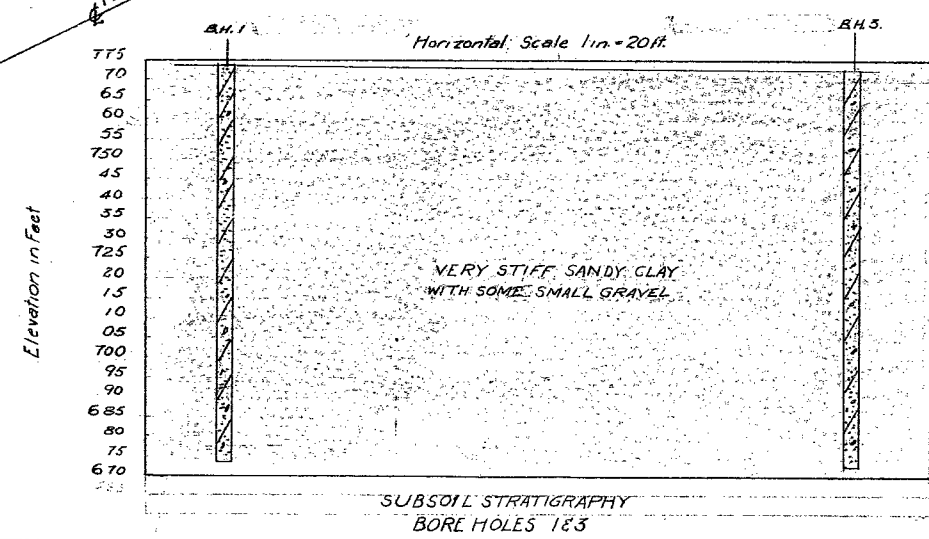
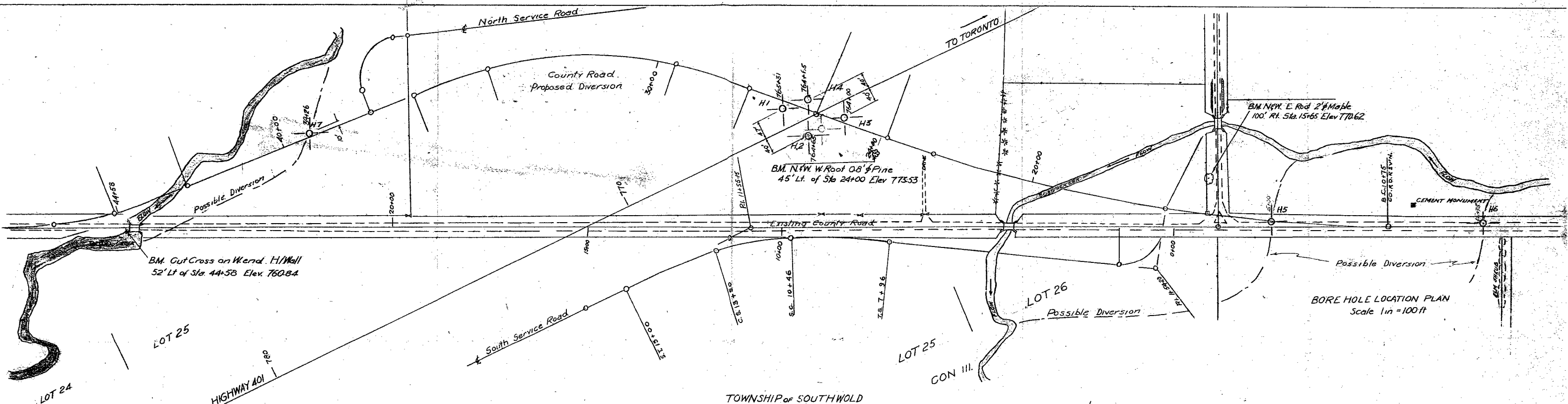
W.P. #64-59

HWY. #401

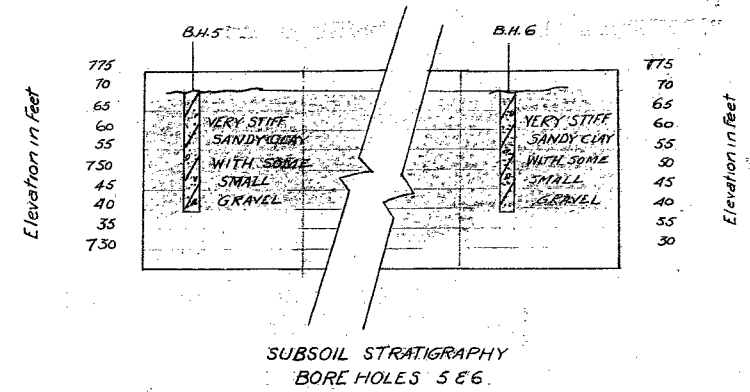
UNDERPASS, CTY.

R.D.

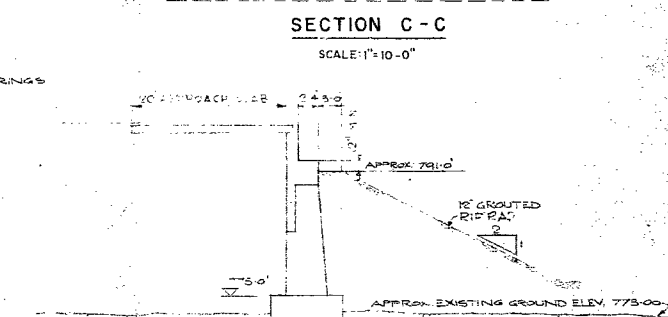
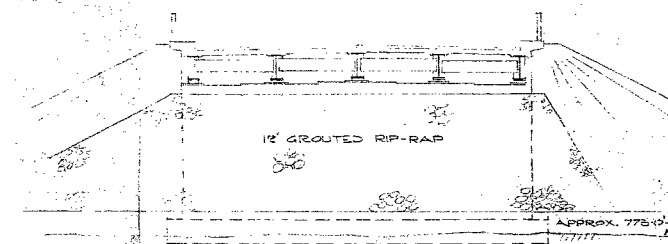
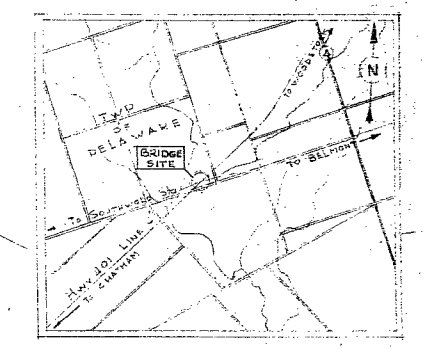
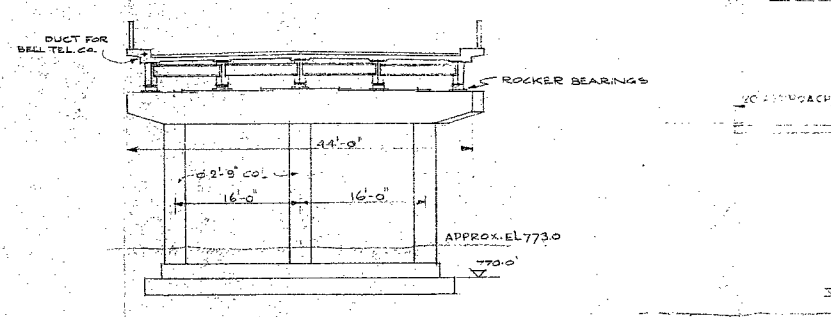
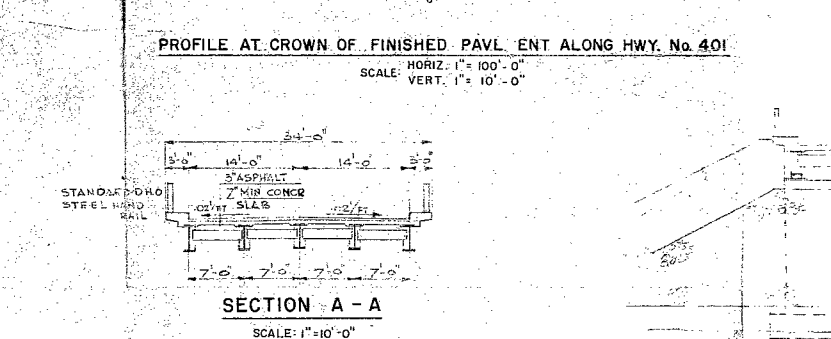
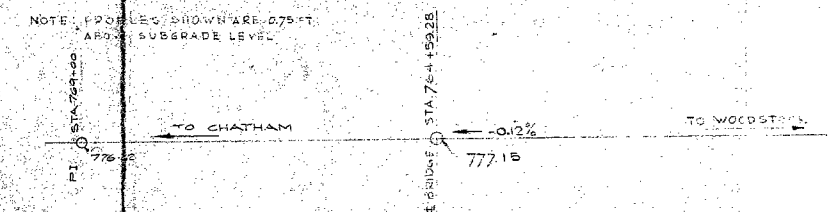
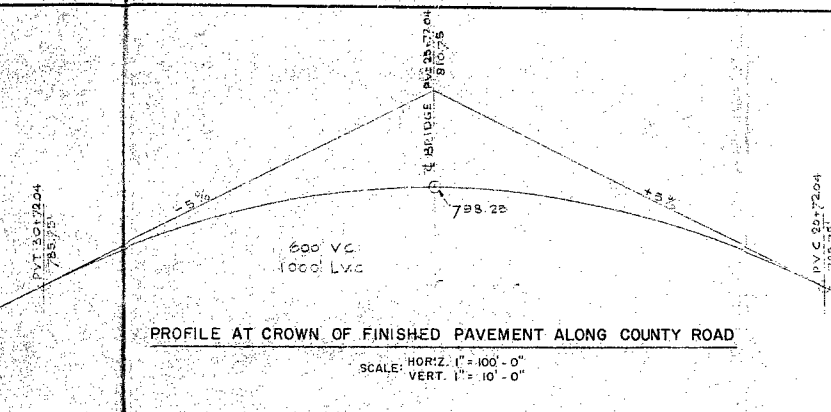
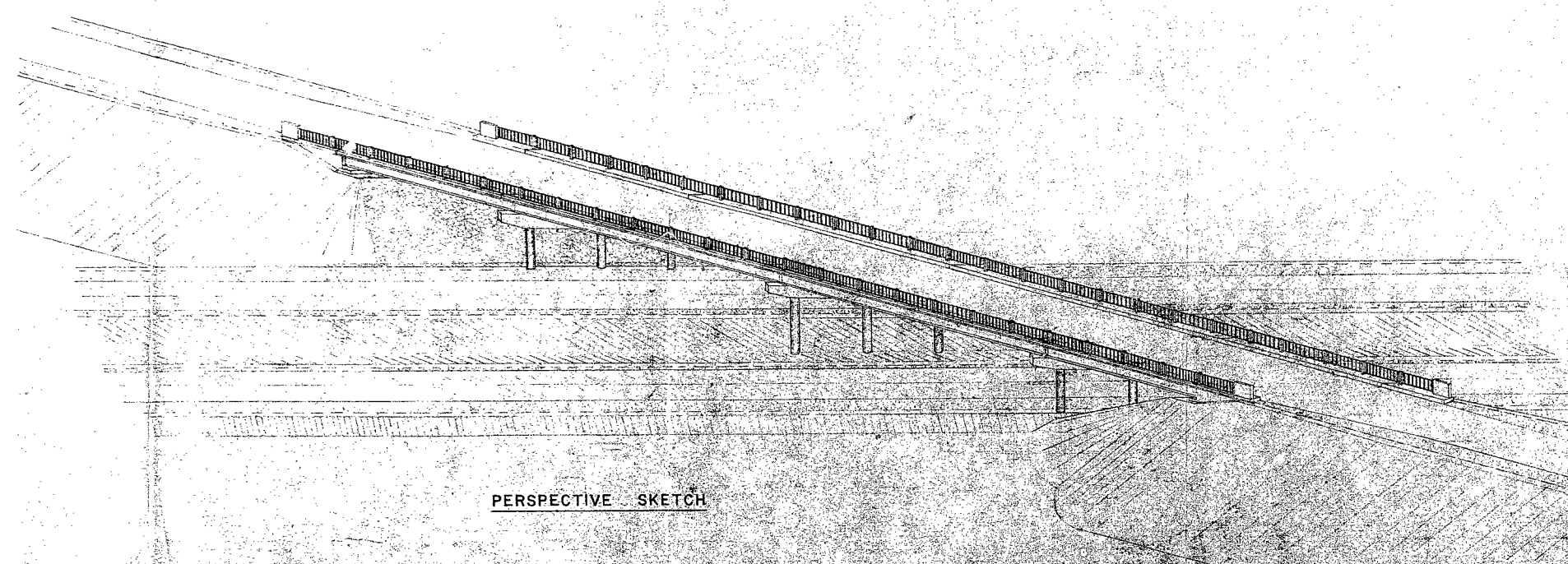
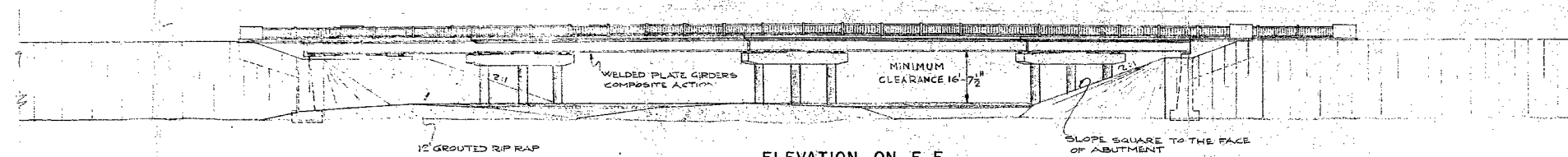
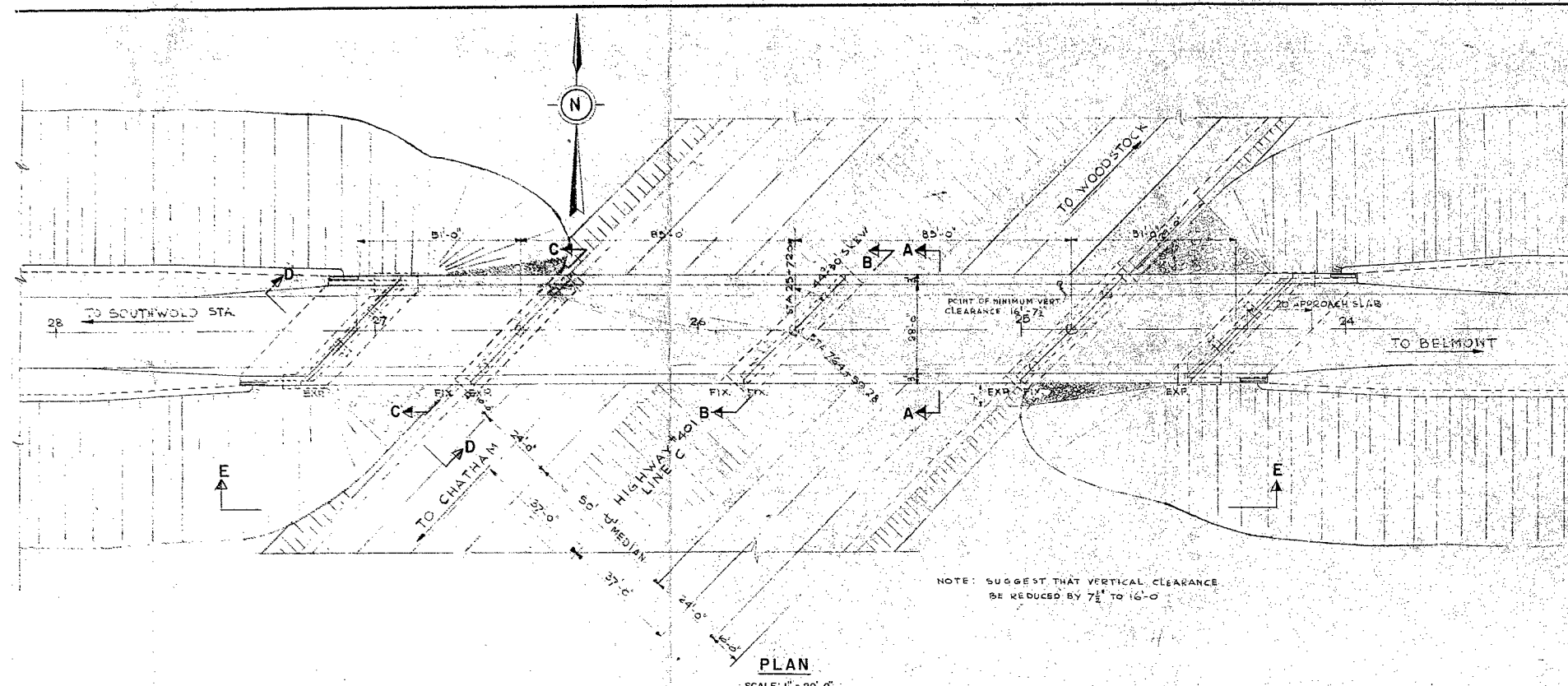
SOUTHOLD TWP.



TOWNSHIP of SOUTHWOLD  
COUNTY of ELGIN



COUNTY ROAD UNDERPASS HIGHWAY 401  
W.P. 64-59  
WILLIAM A TROW & ASSOCIATES LTD. J-491



WP 64-59

LEUW CATHER & COMPANY OF CANADA LIMITED  
CONSULTING ENGINEERS TORONTO

DEPARTMENT OF HIGHWAYS-ONTARIO  
BRIDGE OFFICE-TORONTO

DELAWARE TOWNSHIP  
BRIDGE No. 2

THE KING'S HIGHWAY No. 401 DIST. No. 2  
CO. OF MIDDLESEX  
TWP. OF DELAWARE LOT 24 CON. IX

PROPOSED GENERAL ARRANGEMENT

APPROVED AUG 25 1960

BRIDGE ENGINEER				DESIGN ENGINEER			
DESIGN	HVS	CHECK		CONTRACT NUMBER			
DRAWING	HVS	CHECK		LOADING			
TRACING		CHECK		DATE	JULY 1960		

D-4686-P