

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

June 14, 1960.

D.H.C. FOUNDATION INVESTIGATION  
W.P. 259-60 -- W.J. 60-F-36.

Attention: Mr. S. McCombie.

Re: Proposed Crossing at Brookdale Avenue &  
South Raisin River Diversion, Twp. of  
Cornwall, approx. 2-1/2 Miles North of  
Cornwall, District No. 9.

Attached to this memo, we are forwarding to you,  
the Foundation Investigation Report for the above mentioned  
location. The report has been prepared in our Section.

The conclusions and recommendations contained in  
this report are self-explanatory and we believe, adequate  
and sufficient for your future design work.

Should there be any other additional questions in  
connection with this site that you would like to discuss,  
please feel free to call on our Office.

AS/M&R  
Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
D. G. Ramsay  
J. Ford  
L. E. Walker  
J. E. Graspier  
A. Watt  
Foundations Office  
Gen. Files.

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

  
(A. Stermas,  
FOUNDATIONS OFFICE ENGR.)

# FOUNDATION REPORT

For

Proposed Crossing at Brookdale Avenue &  
South Raisin River Diversion, Township  
of Cornwall, approx. 2-1/2 Miles N. of  
Cornwall, District 9.

W.P. 259-60 -- W.J. 60-F-36.

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## INTRODUCTION:

A subsoil investigation has been carried out at a structure location approximately 2-1/2 miles North of Cornwall where Brookdale Avenue crosses the proposed South Raisin River Diversion, at approx. 1410 ft. South of the centre line of proposed Hwy. 401, Line 'F', in the Twp. of Cornwall. This report contains the field and laboratory findings as well as recommendations for the foundation of the structure.

The borehole logs, summary of field and laboratory tests and Drawing No. 60-F-36 A showing the locations of the boreholes as well as their subsoil profile, are included in this report under Appendix 1.

## DESCRIPTION OF THE SITE:

The site and its surrounding area are situated in waterlogged fields. The topography is, in general, level. South Raisin River meanders at the Hwy. 401 crossing, North of the site. The site was partially flooded in Spring thaw periods. At the time of the investigation, the fields at the site were covered with snow. Brookdale Avenue is an unpaved gravel road.

According to available geological information, the site is underlain by marine clay followed by glacial till of sand & gravel overlying limestone bedrock of the Trenton Series.

## FIELD & LABORATORY WORK:

The field work associated with this investigation, consisting of 2 sampled boreholes with accompanying cone tests and 2 separate cone tests, was carried out during the period of the 6th and 8th of April, 1960. In addition, in-situ vane shear tests

FIELD & LABORATORY WORK: (cont'd.) ...

were carried out in each of the sampled boreholes. A continuous flight auger adapted for soil sampling, was used. Samples were recovered at depths required by means of 2" I.D. thin-walled Shelby tube samplers, or a 2" O.D. split-barrelled spoon sampler. The dimensions of this spoon sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test. Immediately upon recovery, samples were examined and identified at the site and wax-sealed or placed in moisture-proof containers for transport to our laboratory.

Upon receipt in the laboratory, samples were visually examined and identified. Triaxial shear, as well as routine index tests were performed on selected representative samples.

SUBSOIL CONDITIONS:

Underneath the frozen topsoil, a thin layer of loose, very fine silty sand was found to be underlain by an 18-ft. thick layer of very soft, bluish-grey marine clay, the upper 6 ft. of which has been oxidized to its present brownish-grey colour. Underneath the stratum of marine clay, a 9-ft. thick layer of soft matrix of marine clay mixed with sand and gravel, was encountered. This was, in turn, underlain by a 5' - 6' thick layer of dense glacial till of sand & gravel followed by bedrock. Bedrock at the site was not proven by coredrilling but, according to our previous boring data in the vicinity, bedrock is anticipated to be encountered at Elev. 161'  $\pm$  3 ft. (cone penetration refusals were met at Elevations 161' - 165').

In general, the soil types encountered, are as follows:-

cont'd. /3 ...

SUBSOIL CONDITIONS: (cont'd.) ...

1. Very Soft Bluish-Grey Marine Clay:

Underneath the frozen topsoil and the thin layer of loose very fine silt, this stratum of marine clay was encountered in each of the sampled boreholes. The upper 6 ft. of the marine clay has been subjected to oxidation and desiccation, resulting in its present brownish-grey colour. Below the oxidized zone, the colour is predominantly bluish-grey. Its thickness is approximately 18 ft.

The material contains approximately 46% clay, 51% silt, and 3% fine sand. The average unit weight and moisture content were found to be 99 p.c.f. and 72%, respectively. The liquid and plastic limits averaged 55% and 23.5%, respectively.

In-situ vane shear and laboratory triaxial shear test results show that the average shear strength in the upper 6-ft. desiccated crust and the lower 12-ft. layer, are approximately 1150 p.s.f. and 300 p.s.f., respectively. The clay liquefies when it is remoulded. An average sensitivity of 10 is representative.

2. Soft Matrix of Marine Clay Mixed with Sand & Gravel:

Immediately underneath the stratum of very soft marine clay, this layer of marine clay mixed with sand & gravel was encountered. Sampling in this material was attempted, but not successful. Its thickness is approximately 9 ft.

3. Dense Glacial Till of Sand & Gravel:

The layer of marine clay mixed with sand and gravel was found to be underlain by this stratum of glacial till. It exists in a dense state of packing with 'N' value well in excess of 40 registered during sampling operations. The matrix is composed of predominantly sand & gravel with occasional boulders. Its thickness is approximately 5 ft.

cont'd. /4 ...

SUBSOIL CONDITIONS: (cont'd.) ...

4. Bedrock:

Bedrock was not proven in Borings 1 & 3, since the flight auger was not equipped to take rock-core samples. According to our previous boring data in the vicinity, bedrock is anticipated to be encountered at Elev. 161'  $\pm$  3 ft. (cone penetration refusals were met at Elev. 161' - 165' at the locations of the 4 borings.) Bedrock is believed to be composed of limestone of the Trenton Series.

WATER CONDITIONS:

Field measurements and observations carried out during the boring programme, indicate that the ground water table at the site is at or slightly below the existing ground surface at approx. Elev. 194'. No artesian water condition was encountered.

FOUNDATION CONSIDERATIONS:

The very soft marine clay cannot provide adequate spread footing foundation support for the proposed structure. A pile-supported foundation is necessary. The structure should be supported on end-bearing piles driven to refusal at the bedrock contact. In view of the presence of the dense glacial till of sands & gravel with occasional boulders immediately above bedrock, it is doubtful whether tubular or timber piles can be driven through this layer to bedrock without damaging the piles. For this reason, tubular or timber piles are not recommended. The higher penetration as well as load-bearing capacity of steel 'H' piles, leads us to conclude that they are more suitable and should therefore be used. Steel 'H' piles are also advantageous in that they have smaller displacements. It is anticipated that pile refusals will be met at approximately Elev. 161'  $\pm$  3 ft.

It is understood that a single-span structure incorporating abutments at the toes of the bank slopes of the diverted channel of South Raisin River is contemplated. It appears that sheet piles should be provided around the abutments such that the soil

FOUNDATION CONSIDERATIONS: (cont'd.) ...

around the steel 'H' piles will be protected from stream erosion and scour. The necessity and the depth of sheet pile protection will depend upon the hydrological conditions. For the sheet piles to remain in place, they should be driven into the layer of marine clay mixed with sand & gravel at or below Elev. 174'.

Under the proposed grade line, the maximum height of fill is of the order of 3 ft. The subsoil can safely support this embankment loading.

STABILITY OF BANK SLOPE CUTS OF THE CHANNEL:

We have carried out stability analyses for the bank slopes of the channel based on an average shear strength of 300 p.s.f. for the very soft marine clay. Results of the analyses show that on a long-term basis, the depth of channel excavation should be limited to 8 ft. Side slopes of the banks should be 2:1 or flatter. In view of the fact that the marine clay is very sensitive, extreme care should be exercised during construction such that a "flow" caused by liquefaction of the marine clay will not result. At any time during construction, no heavy equipment should be sitting at or near the edges of excavations.

SUMMARY OF RECOMMENDATIONS:

1. It is our recommendation that the structure be supported on steel 'H' piles driven to refusal at the bedrock contact. It is anticipated that pile refusals will be met at approximately Elev. 161'  $\pm$  3 ft.
2. Sheet piles should be provided around the steel 'H' piles for stream erosion and scour protection. The depth of penetration required will depend upon the hydrological conditions. For the sheet piles to remain in place, they should be driven to Elev. 174' or below.

cont/ 6 ...

SUMMARY OF RECOMMENDATIONS: (cont'd.) ...

3. No approach fill stability problem is anticipated.
4. It is our recommendation that the depth of channel excavations be limited to 8 ft. Bank slopes should be 2:1 or flatter. It is further recommended that no heavy equipment be sitting at or near the edges of excavations and that extreme care should be exercised in order to avoid a "flow" caused by liquefaction of the marine clay, during construction.

June 1960

REPORT PREPARED BY:

*AKGL*  
A. K. Loh,  
Project Fdns. Engr.

REPORT APPROVED BY:

*Atterbury*  
A. Stermac,  
Foundations Office Engr.

# APPENDIX I.



# SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-36

W.P. 259-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH P.S.F.	UNIT WEIGHT P.C.F.	REMARKS
1	S1	3'-4.5'	Soft to medium grey brown marine clay.	P	43.8	-	-	-	-	
	vane	4.5'	"	-	-	-	-	880	-	Sens: 8.8
	T2	6'-7.5'	"	P	-	-	-	-	-	No recovery.
	vane	7.5'	"	-	-	-	-	1080	-	Sens: 11
	T3	9'-10.5'	Very soft bluish-grey marine clay.	P	67.8	22.2	50.5	200	100.0	
	vane	10.5'	"	-	-	-	-	-	-	Disturbed
	T4	15'-16.5'	"	P	-	-	-	-	-	No recovery
	vane	16.5'	"	-	-	-	-	300	-	Sens: 15.0
	T5	20'-21.	"	P	-	-	-	-	-	No recovery
2		Cone only								
3	vane	4.5'	Med. grey-brown marine clay.	-	-	-	-	1280	-	Sens: 6.4
	T1	5'-6.5'	"	P	-	-	-	-	-	
	Vane	7.5'	"	-	-	-	-	1280	-	Sens: 17.0
	vane	10.5'	Very soft bluish-grey varved clay.	-	-	-	-	400	-	Sens: 10.0
	T2	10'-11.5'	"	P	65.8	23.3	58.5	270	99.0	

# SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-36

W.P. 259-60

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH psi	UNIT WEIGHT pcf	REMARKS
3	T3	15'-16.5'	Very soft bluish-grey marine clay.	P	41.3	25.0	55.6	400	99.0	
	Van	16.5'	"	-	-	-	-	-	-	Disturbed
	T4	20'-21.5'	"	P	-	-	-	-	-	
	T5	25'-25.5'	Soft bluish-grey marine clay with sand & gravel.	P	-	-	-	-	-	No recovery.
	S6	30'-31.5'	Dense sand and gravel (glacial till)	44	7.5	-	-	-	-	
	S7	35'-35.2'	"	50-2"	-	-	-	-	-	No recovery
4	Cone only		S denotes split spoon sample T denotes shelby tube sample.							

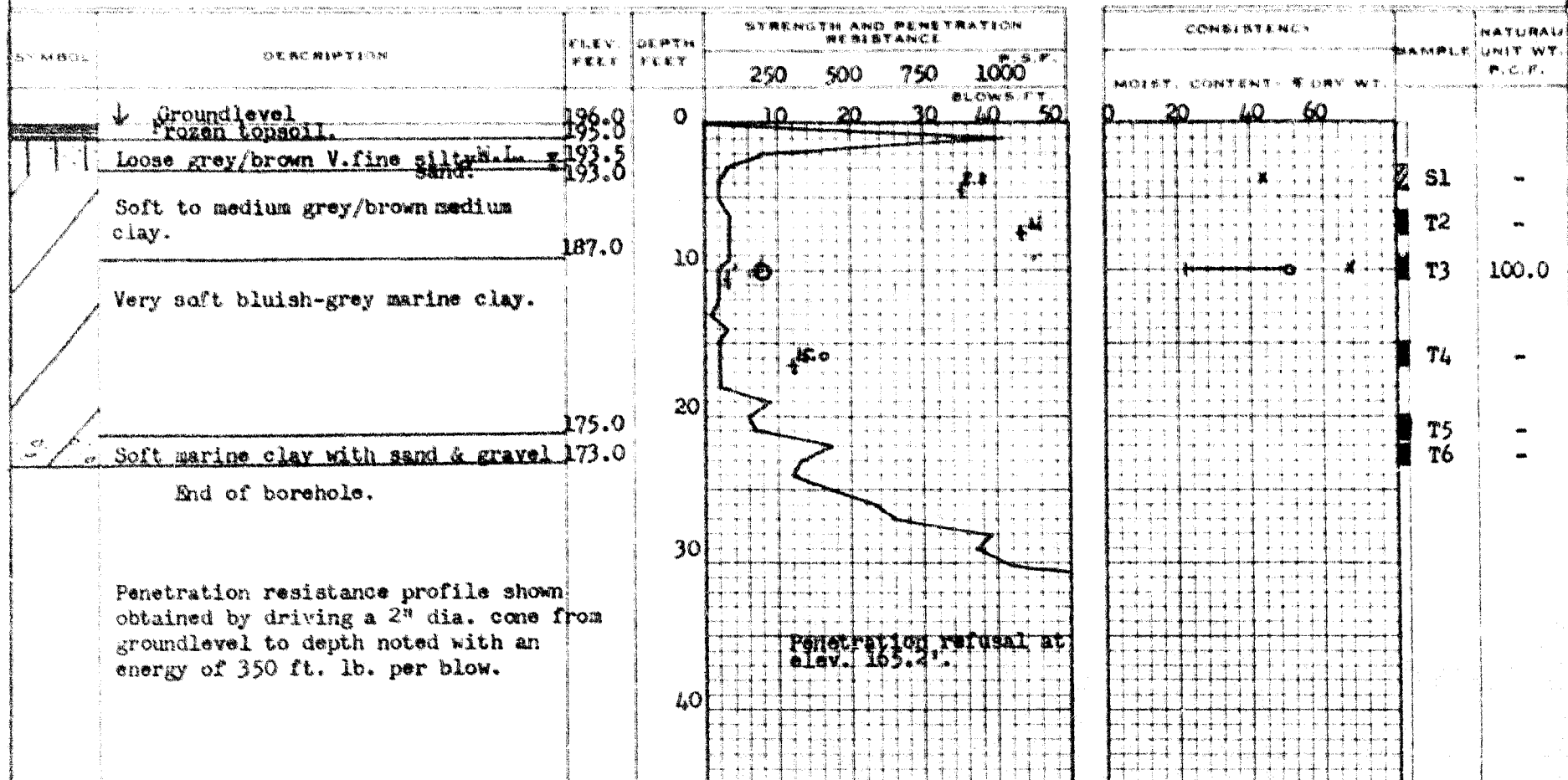
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 259-60 BORE HOLE NO. 1  
 JOB 60-P-36 STATION 9+78 (30' L.)  
 DATUM 196.0 COMPILED BY B.K.  
 BORING DATE April 6/60 CHECKED BY B.H.G.

2" DIA SPLIT TUBE  
 2" SHELBY TUBE  
 2" SPLIT TUBE  
 2" DIA CONE  
 2" SHELBY  
 CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
 VANE TEST (C) AND SENSITIVITY (S)  
 NATURAL MOISTURE AND LIQUIDITY INDEX  
 LIQUID LIMIT  
 PLASTIC LIMIT



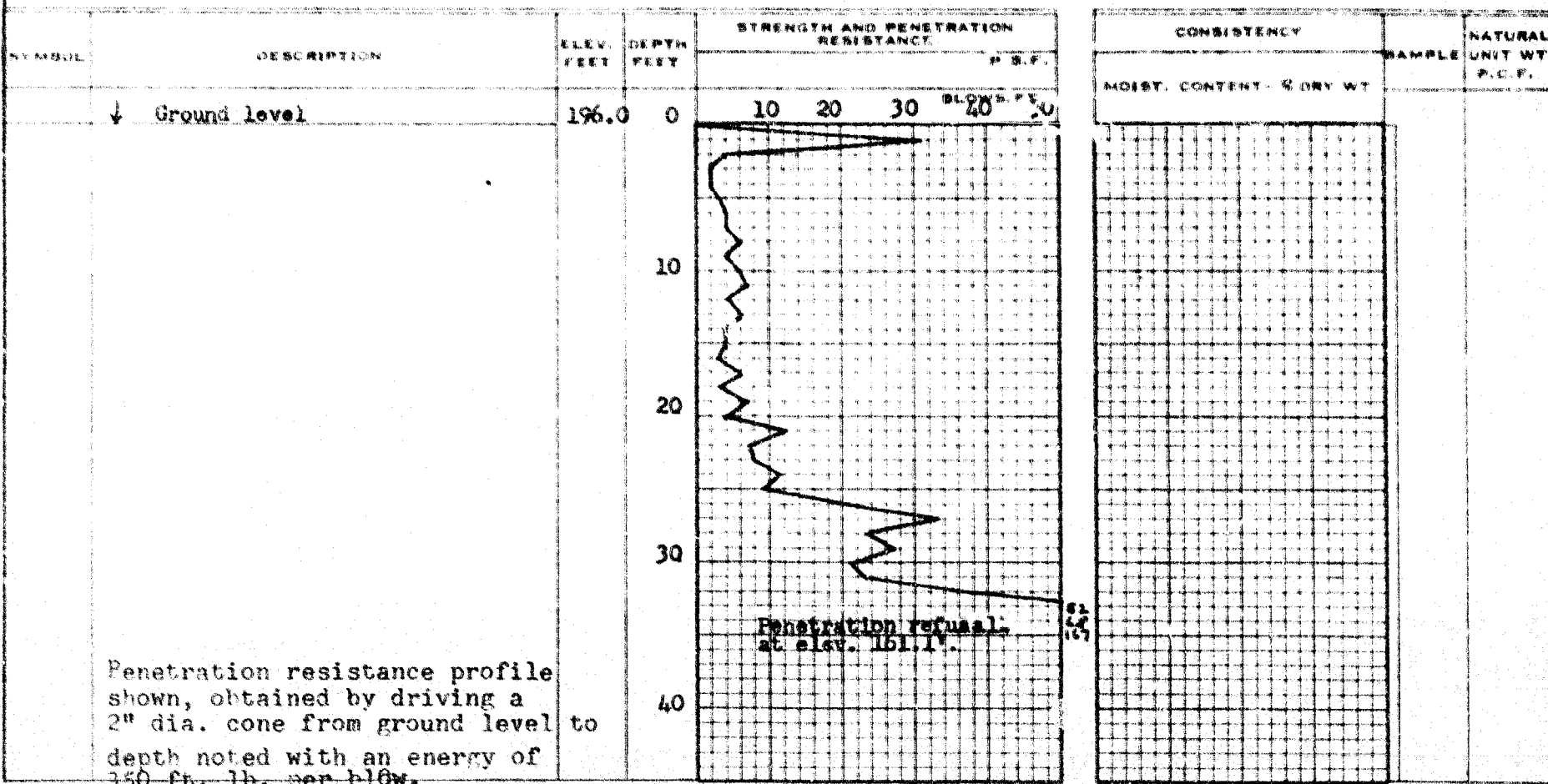
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 259-60 BORE HOLE NO. 2  
JOB 60-F-36 STATION 9+13 (30' Lt.)  
DATUM 196.0' COMPILED BY B.K.  
BORING DATE April 7/60 CHECKED BY B.H.G.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $C_u$ ) O  
VANE TEST (C) AND SENSITIVITY (S) +  
NATURAL MOISTURE AND LIQUIDITY INDEX LI  
LIQUID LIMIT X  
PLASTIC LIMIT



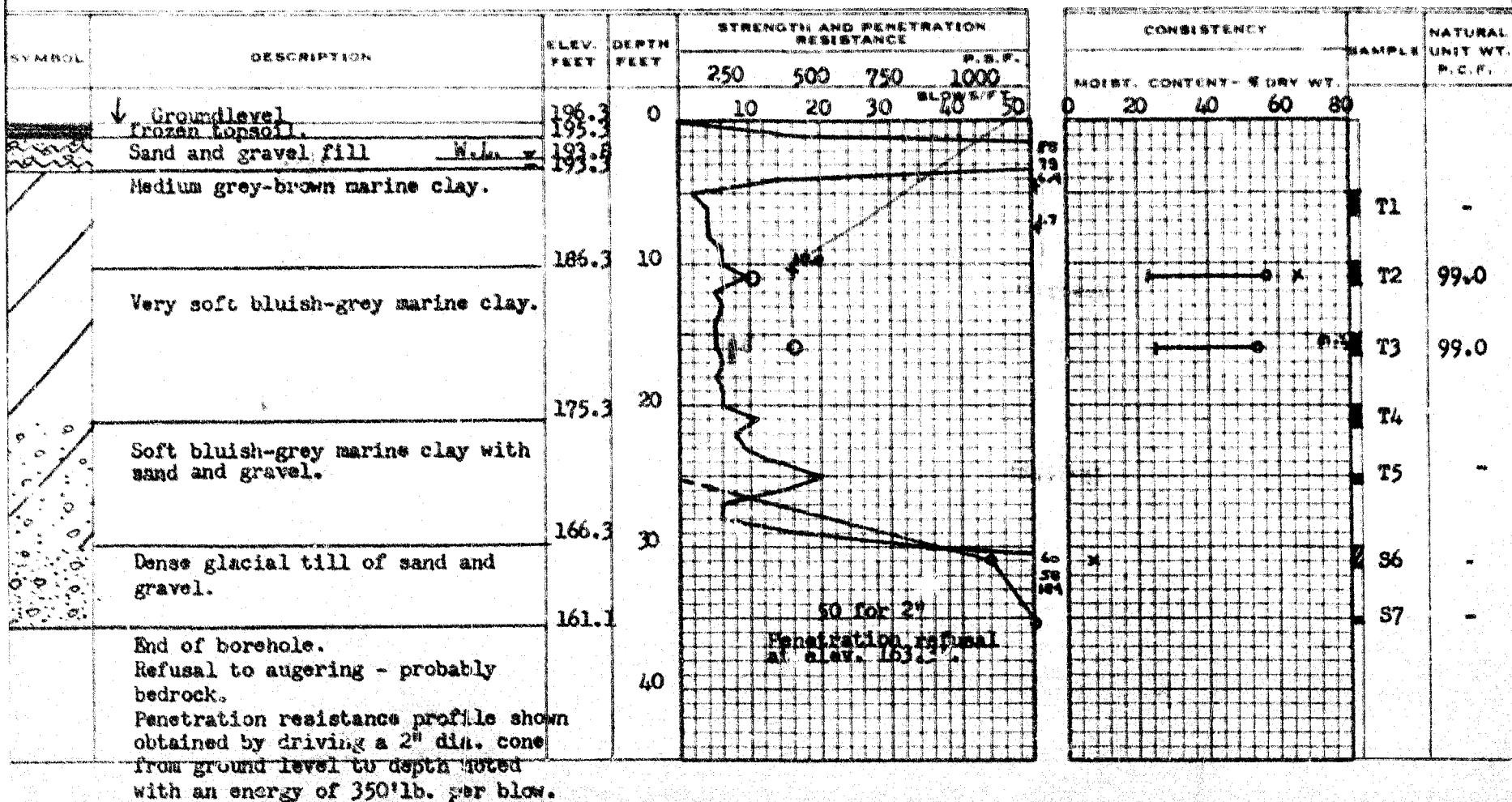
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 259-60 BORE HOLE NO. 3  
JOB 60-C-36 STATION 9+13 (15' R.L.)  
DATUM 196.3' COMPILED BY B.K.  
BORING DATE Apr. 7/60 CHECKED BY B.H.G.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $Q_u$ )  
VANE TEST ( $C$ ) AND SENSITIVITY ( $S$ )  
NATURAL MOISTURE AND LIQUIDITY INDEX  
LIQUID LIMIT  
PLASTIC LIMIT



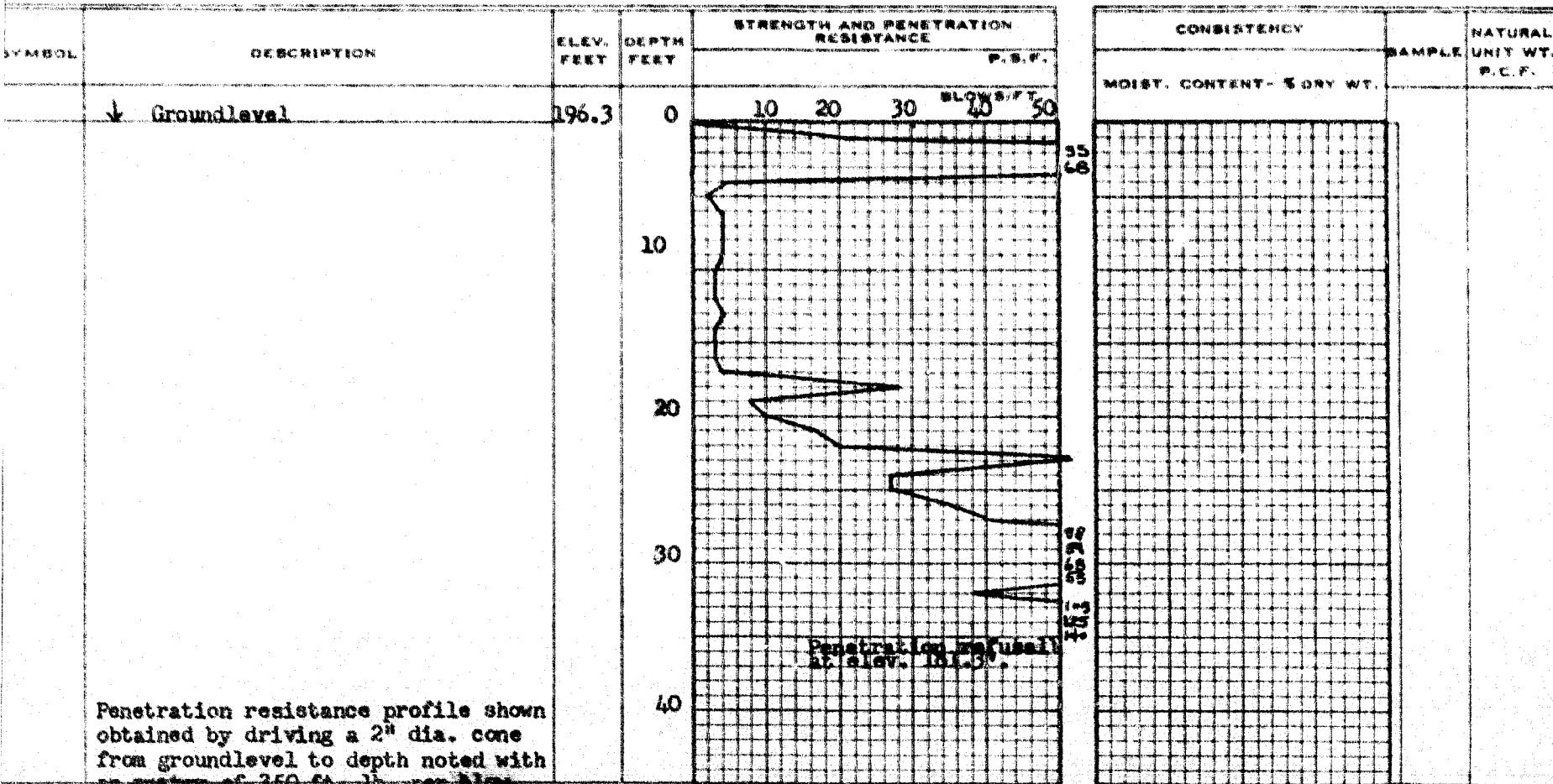
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS AND RESEARCH SECTION

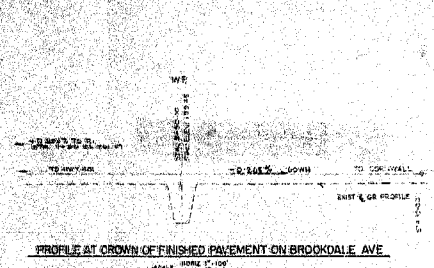
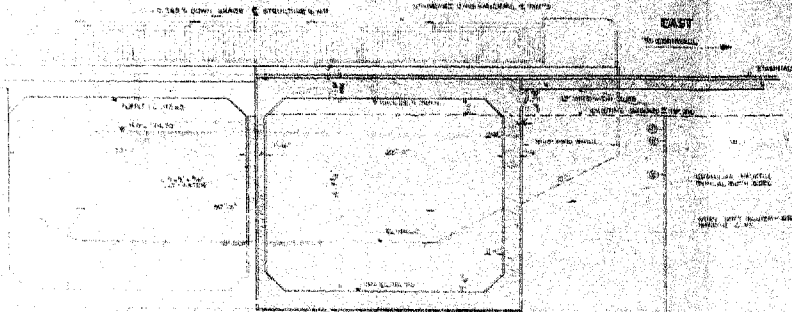
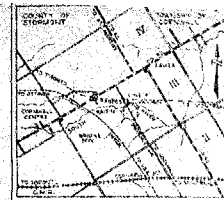
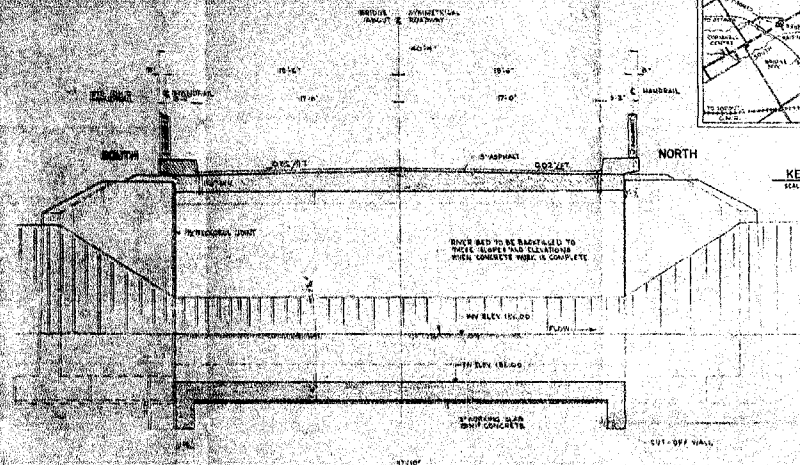
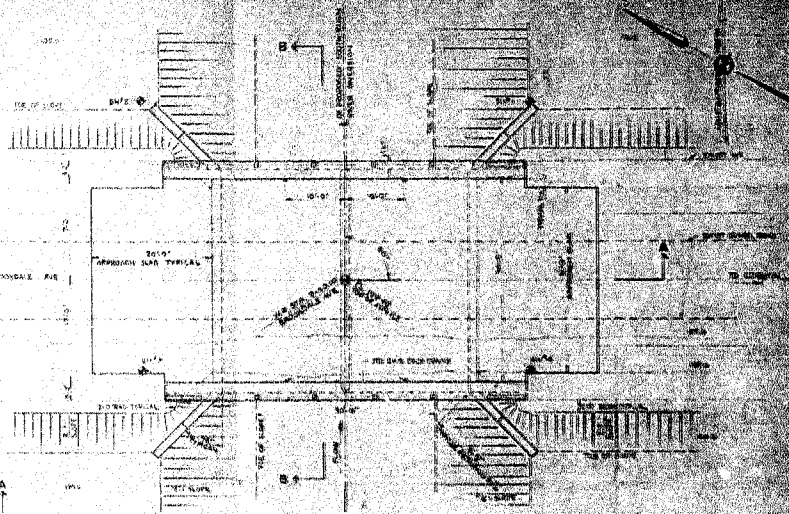
W.P. 259-60 BORE HOLE NO. 4  
JOB 60-F-36 STATION 9+78 (15' Rt.)  
DATUM 196.3' COMPILED BY B.K.  
BORING DATE April 7/60 CHECKED BY B.K.G.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) O  
VANE TEST (C) AND SENSITIVITY (S) +  
NATURAL MOISTURE AND LIQUIDITY INDEX LI  
LIQUID LIMIT X  
PLASTIC LIMIT





**PRELIMINARY**

WP 259-60  
PROCTOR & REDFERN  
CONSULTING ENGINEERS  
TORONTO  
DEPARTMENT OF HIGHWAYS-ONTARIO  
BRIDGE OFFICE-TORONTO  
BROOKDALE AVENUE OVER  
SOUTH RAISIN RIVER  
THE KING'S HIGHWAY No. BROOKDALE AVE  
CO. EIDMONT  
TWP. COYHAWA  
LOT 12 S. 1/2  
CON. III  
GENERAL ARRANGEMENT  
OCT 11 1960  
BRIDGE ENGINEER  
DESIGNER  
CHECKER  
APPROVED  
DATE  
JUL 1960  
D-4617-1

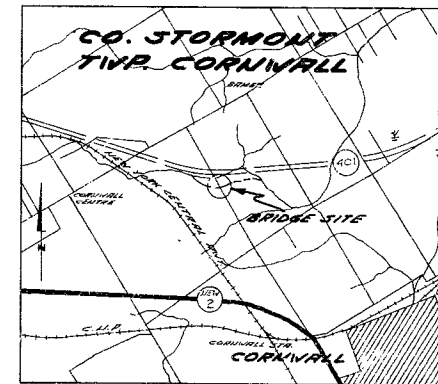
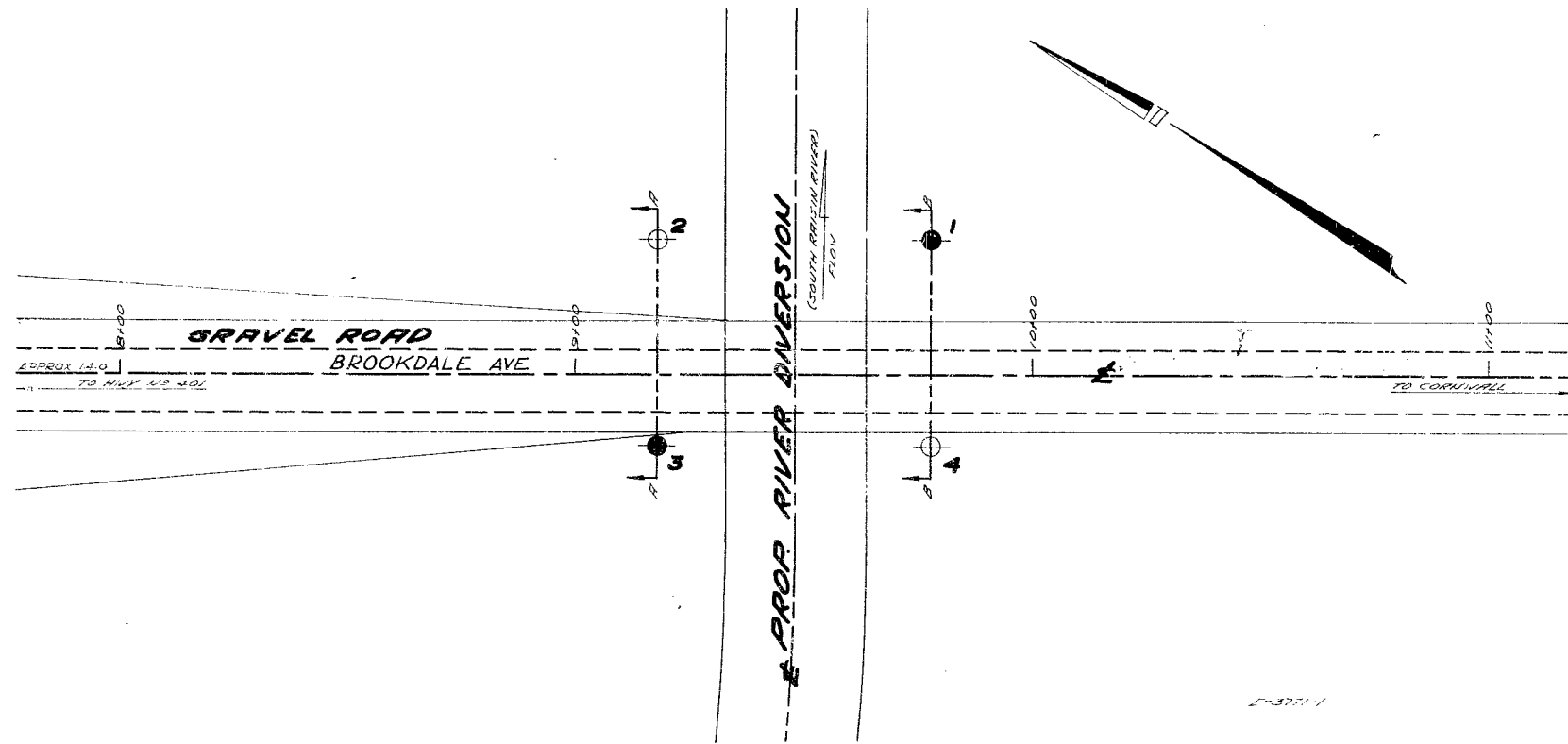
# 60-F-36

W.P. # 259-60

BROOKDALE AVE.

& SOUTH RAISIN R.



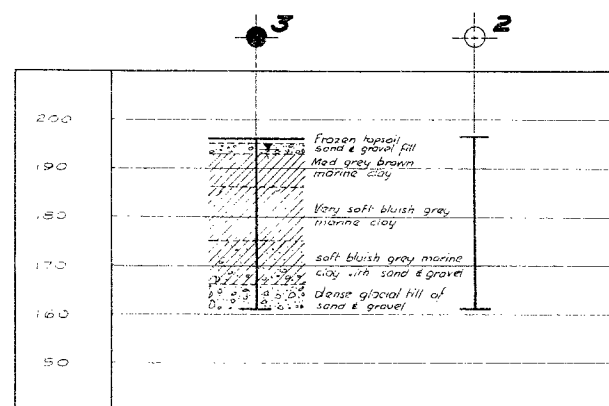


KEY PLAN  
SCALE 1 IN. = 1 MI.

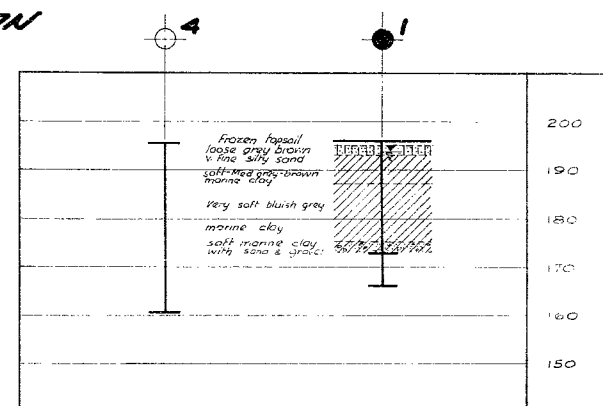
LEGEND			
BORE HOLE			
PENETRATION HOLE			
HOLE NO.	ELEVATION	STATION	DISTANCE FROM E
1	196.0	9+78	30' LT
2	196.0	9+13	30' LT
3	196.25	9+13	15' RT
4	196.25	9+78	15' RT

NOTE -

THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.



A-A



B-B

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION

**S. RAISIN RIVER DIVERSION  
PROPOSED CROSSING**

SHOWING POSITIONS & ELEVATIONS OF HOLES

BROOKDALE AVE. HWY. 42 N.W. DISTRICT 9		COUNTY STORMONT
TOWNSHIP CORNWALL		LOT 12 & 13
LOCATION APP. 2 1/2 MI. N. OF CORNWALL		CON. III
DRAWN BY T. MELLORS	CHECKED BY:	W. 259-60
DATE 20 APRIL 1960	APPROVED BY: <i>AKK</i>	60-F-36A
SCALE 1 IN. = 20 FT.		