

Mr. A. M. Toye,

August 4, 1961.

Bridge Engineer

Materials & Research Section,

(Foundations Office)

Attention: Mr. S. McCombie.

Re:- W.P. 94-59, Black's Lane
H'Piles, Aldborough Twp.
Pile #11, District #2.

In response to a request from Mr. K. G. Bassi we have reviewed the Preliminary plan (D-4897-P1). It is understood from your letter that the designer wishes to use 10 BP 42 Steel 'H' Piles for abutment supports using a safe load of 35 Tons. Calculation for the safe bearing load were carried out and your attention is drawn to the following comments:-

1) H. G. Acres and Company Ltd., Niagara Falls carried out the sub-soil investigation for the above-mentioned crossing. Their bore holes were advanced to an Elev. ~~628.0~~ ^{628.0 ←}. In order to obtain a design load of 35 Tons, using 10 BP 42 Steel 'H' Piles, the piles have to be driven to an Elev. 620.0 assuming the sub-soil condition are uniform. It should be pointed out however we have no information about soil condition below Elev. 628.0.

2) It is our recommendation that 12"Ø tubular piles be driven to an Elev. 692.0 in the dense sand stratum. A safe bearing load of 30T per pile can be used for design.

If we can be of further assistance in this matter please contact our office.

MD/tt

c.c. G. Scott
K. G. Bassi,
Foundation Office
General File

L. G. Soderman
Principal Foundation Engineer

M. Devata
Per:
M. Devata.
Project Foundation Engineer.

← 628.0?
over 100
of pile?

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

June 9, 1960.

FOUNDATION INVESTIGATION --
by H.G. Acres & Co., Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Crossing, Township of Aldborough,
District No. 2, Highway 401 and Road
Allowance, Between Lots 2 and 3.
W.P. 94-59.

Attached to this memo, we are forwarding to you the
above mentioned report submitted by H.G. Acres and Company,
Ltd., Niagara Falls.

The conclusions and recommendations contained in this
report are self-explanatory, and we are in agreement with them.

We believe that this information will prove sufficient
and adequate for your future design work. Should there be any
questions that you would like to discuss with us, please feel
free to call on our Office.

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

Foundations Office
Gen. Files.

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

(A. Sternac,
FOUNDATIONS OFFICE ENGR.)

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT
on
FOUNDATION INVESTIGATION
at

PROPOSED CROSSING
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND ROAD ALLOWANCE
BETWEEN LOTS 2 AND 3
WP 94-59

H.G. ACRES & COMPANY LIMITED
Consulting Engineers
Niagara Falls, Canada

May, 1960

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

at

PROPOSED CROSSING
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND ROAD ALLOWANCE
BETWEEN LOTS 2 AND 3
WP 94-59

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ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

at

PROPOSED CROSSING
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND ROAD ALLOWANCE
BETWEEN LOTS 2 AND 3
WP 94-59

Introduction

Soil explorations were carried out by H.G. Acres & Company Limited to determine the foundation conditions for a bridge to be built to carry Black's Lane over Highway 401, approximately 2.5 miles west of Rodney, Ontario. The proposed grade of Highway 401 at the site of the overpass is approximately two feet above the present ground surface. The top of the approach embankments of the overpass will be approximately 20 feet above the ground surface. The plan of the site is shown on Plate I in this report.

The F.E. Johnston Drilling Company Limited was retained to perform the soil drilling and field sampling, under the supervision of Mr. J.A. MacLeod

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of H.G. Acres & Company Limited. Field work commenced on March 29, and was completed on April 8, 1960.

The results of the field and laboratory work are contained in this report.

Exploratory Work

The exploratory work consisted, in part, of drilling and sampling four holes, No. 871-1 to No. 871-4 inclusive. Hole No. 871-1 was drilled to a depth of 80 feet whereas the other holes were drilled to depths of about 40 feet. In addition, four cone penetration test holes, No. 871-5 to No. 871-8 inclusive, were made to determine the characteristics of a 16-foot thick sand stratum which covered the entire area. The locations of these holes are shown on Plate I.

A Penndrill was used for the drilling.

In the sand stratum, the holes were supported with 5-inch diameter casing, whereas in the clay, the holes were left uncased. A 2-inch diameter split-spoon sampler was used at 5-foot intervals to obtain sand samples. Samples of clay were obtained with the use of 2-inch diameter thin-walled tubes and in situ vane shear tests were attempted

to measure the natural shear strength of the clay, but it was found that the clay was too stiff to fail by means of the vane apparatus.

The program of work is given in Appendix A, and the results of the drilling are given in the attached drilling reports, Plates II to IX inclusive.

Site Conditions and Soil Properties

The site is located in flat, featureless country and the general ground surface elevation is approximately 709 feet. It is highly fertile agricultural country with fairly extensive drainage by means of field tile and ditches. While the drilling work was in progress, there were considerable amounts of surface water and all the field drainage ditches were flowing.

The materials which were encountered in the exploratory holes are described in the attached drilling reports, Plates II to XI inclusive. The soil stratigraphy, as shown on Plate I, consists of a 16-foot thick sand stratum which overlies clay at least 65 feet in thickness.

(a) - Sand - Medium sand to fine gravel is found from the ground surface to an average depth of 16 feet. The grain size distribution curves of

- 4 -

three samples taken from hole No. 871-1 are given on Plate XV. The average result of the standard penetration tests was 30 blows per foot; the results varied from 18 to 58 blows per foot. In view of the fact that the water level in the sand is close to the ground surface, these results indicate that the sand exists in a dense state and that its relative density is greater than 80 per cent. For design purposes, an angle of shearing resistance equal to 40 degrees ($\phi' = 40$ degrees) may be used.

(b) - Clay - The elevation of the surface of the clay is approximately 691 feet. To a depth of 65 feet, the clay was found to be extremely uniform and stiff. The average liquid limit is 31 per cent and the average plastic limit is 17 per cent. The natural water content varies between 17 and 20 per cent.

The clay was found to be extremely stiff, as evidenced by the fact that the field vane was unable to fail the soil in shear. The natural undrained shear strength determined from laboratory compression tests varied from 2,000 psf to 5,200 psf, the average value being greater than 3,600 psf.

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The results of the field vane tests and the laboratory tests are summarized in Appendix B and Appendix C, respectively. These results are shown graphically on Plate XVI.

The results of five consolidation tests are shown on Plates X to XIV, inclusive, and these results are compared on Plate XVII. The clay is preconsolidated and relatively incompressible. The maximum consolidation pressures to which the samples have been naturally subjected are estimated, but these estimations are subject to considerable doubt as the compressibility curves are quite flat. These results are plotted on Plate XVI.

(c) - Ground Water Conditions - The water level in the sand was found to be approximately two feet below the ground surface and at the same general level as the water in the drainage ditches. It is probable that the water level in the sand is subject to large seasonal fluctuations.

No water pressure measurements were made in the clay. The pessimistic assumption that the water pressures in the clay correspond to a ground water level two feet below the ground surface has, therefore, been made for the purposes of this report.

Design Conditions

(a) - Bearing Capacity

Bridge Footings - The general method of analysis to determine the bearing capacity of footings founded on a sand stratum overlying clay is extremely complex. Therefore, for the purpose of this report, the approach to the problem has been:

- (i) - To consider strip footings sufficiently narrow that their stability is essentially governed by the properties of the sand and the water pressure conditions in the sand.
- (ii) - To consider strip footings sufficiently wide that their stability is essentially governed by the clay underlying the sand.
- (iii) - To combine judiciously the results of these two analyses to determine the stability for footing widths intermediate between those considered above.

In the case of strip footings of widths less than the depth of sand beneath the footings, net allowable bearing pressures have been calculated for the following conditions:

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(i) - Sand properties

Angle of shearing
resistance, ϕ' = 40 degrees

Wet density, γ = 135 pcf

Submerged density, γ' = 73 pcf

(ii) - Safety factor, F = 1.80

(iii) - Ground water level at the
ground surface.

(iv) - A horizontal pressure acting
on the bridge abutment corres-
ponding to an earth pressure
coefficient of 0.6.

The results of these calculations have been summarized on Plate XVIII where the governing conditions are shown by the solid lines.

In the case of strip footings appreciably wider than the depths of sand beneath the footings, stability is governed primarily by the shear strength of the clay which is approximately 3,000 psf. Using a factor of safety equal to 3 against ultimate failure, the net allowable bearing pressure has been calculated to be 6 kips per square foot.

The footing width which will be used for bridge design will probably be of the order of 16 feet. In this case, the sand will have the primary influence on the stability of the footings, while the clay will

have the secondary effect. For simplicity, therefore, the net allowable bearing pressures for footing widths greater than the thickness of the sand stratum beneath the footing, are taken as constant at 7 kips per square foot, as shown by the full line on Plate XVIII.

Embankment - The stability of the embankment is dependent upon the shear strength properties of the sand stratum and the underlying clay. However, because the thickness of the sand stratum is small in comparison with the dimensions of the embankment, its properties have been assumed to be equivalent to those of the clay. This assumption will underestimate the stability of the embankment foundation.

The maximum bearing pressure transferred to the foundation due to the embankment loading is approximately 2.7 kips per square foot and the average undrained shear strength of the foundation clay is greater than 3.0 kips per square foot. Therefore, the safety factor against ultimate foundation failure due to this embankment loading, is greater than 5.

(b) - Settlement - The settlement of the bridge abutments will be influenced primarily by the approach embankment loads. Although the stresses transferred to

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the foundation soil at the bases of the bridge footings are much larger than those transferred to the foundation by the embankment, the areas on which the bridge loads are applied are small and, therefore, these stresses will dissipate rapidly with depth below the footings. To predict the probable settlement of the bridge footing, it has been assumed that these footings will settle the same amount as the foundation below the approach embankments.

The consolidation characteristics of the clay are shown on Plate XVII, and to estimate the elastic or immediate settlement of the clay, an apparent modulus of elasticity of 800 kips per square foot was chosen.

The embankment loading was assumed to be a uniform strip loading of 2.7 kips per square foot. The calculated settlements are as follows:

Sand

Settlement assumed to be < 0.05 feet

Clay

Elastic settlement	0.1 feet
Consolidation settlement.....	0.3 feet

Total ultimate settlement 0.4 - 0.5 feet

- 10 -

The elastic settlement and most of the expected settlement in the sand stratum will occur during the period of construction of the embankment, and the time taken for the settlement to reach 50 per cent of the total ultimate settlement is estimated to be 20 years.

Conclusions

(a) - On the basis of the drilling work done at the site, the general soil profile consists of a 16-foot thick sand stratum overlying clay till of undetermined thickness. The water level in the sand was found approximately two feet below the ground surface. This water pressure does not necessarily reflect the water pressures in the underlying clay.

(b) - The results of the standard penetration tests in the sand indicate that it exists in a dense condition, and for design purposes an angle of shearing resistance, ϕ' , equal to 40 degrees can be used.

(c) - The clay underlying the sand is very stiff and relatively incompressible. Its properties are summarized on Plates XVI and XVII.

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(d) - The 20-foot high embankment approaching the bridge can be safely supported by the foundation soils. The maximum ultimate settlement of the embankment foundation which can be expected is 0.4 - 0.5 feet.

(e) Net allowable bearing pressures ranging from 5 to 7 kips per square foot can be used for the design of bridge footings. The relationships between width and depth of footing and net allowable bearing pressure is given on Plate XVIII.

Recommendations

In view of the fact that the foundation soil consists of dense sand and stiff clay to a total depth greater than 100 feet, it is recommended that the bridge be supported on spread footings. Net bearing pressures from 5 to 7 kips per square foot are permissible, depending upon the size and depth of the footing.

The soil in which the excavations for the bridge footings will be made, is pervious sand. It is, therefore, recommended that construction of the footings be done in the summer or early autumn, when the water level in the sand is likely to be below the bottom of the required excavations.

APPENDIX AProgram of Work

- March 29, 1960 - Penndrill arrived on site and commenced hole No. 871-1.
- April 4, 1960 - Hole No. 871-1 was completed to a depth of 80 feet. Cone penetration test hole No. 871-5 was completed.
- April 5, 1960 - Hole No. 871-2 was commenced.
- April 6, 1960 - Hole No. 871-2 was completed to a depth of 40 feet. Cone penetration test hole No. 871-6 was completed.
- April 7, 1960 - Hole No. 871-3 was completed to a depth of 40 feet. Cone penetration test holes No. 871-7 and 871-8 were completed.
- April 8, 1960 - Hole No. 871-4 was completed to a depth of 40 feet.

Summary of Time

<u>Work Type</u>	<u>No. of Holes</u>	<u>Total Length Feet</u>	<u>Total Time Hours</u>
Soil Drilling	4	200	39
Cone Penetration Tests	4	104	7-1/2

APPENDIX BSummary of Laboratory Test Results

Hole No.	Sample No.	Elevation Feet	Water Content %	Liquid Limit %	Plastic Limit %	Su _n Psf	e _f %	Su _r Psf	St
871-1	4	688	19.6	-	-	1,960	15	-	-
	5	683	15.5	22.0	12.1	-	-	-	-
	8	668	17.7	30.4	16.7	5,045	20	-	-
	11	648	19.1	30.9	16.6	2,525	19	1,358	1.9
	13	628	17.2	30.5	15.8	3,870	20	2,195	1.8
871-2	5	683	18.5	30.4	16.0	2,640	20	-	-
	7	668	18.2	30.2	14.9	4,575	20	-	-
871-3	5	684	18.0	30.5	16.1	5,195	16	-	-
	7	669	18.5	33.4	17.3	3,675	20	-	-
871-4	4	689	18.2	-	-	3,795	16	-	-
	6	669	17.3	30.9	17.1	5,300	17	-	-

e_f - Failure StrainSu_r - Remoulded undrained shear strengthSu_n - Natural undrained shear strength

St - Sensitivity

APPENDIX CList of Plates

Plate	I	-	Exploratory Holes, Plan and Section
Plate	II	-	Drilling Report, Hole No. 871-1
Plate	III	-	Drilling Report, Hole No. 871-2
Plate	IV	-	Drilling Report, Hole No. 871-3
Plate	V	-	Drilling Report, Hole No. 871-4
Plate	VI	-	Drilling Report, Hole No. 871-5
Plate	VII	-	Drilling Report, Hole No. 871-6
Plate	VIII	-	Drilling Report, Hole No. 871-7
Plate	IX	-	Drilling Report, Hole No. 871-8
Plate	X	-	Consolidation Test; Hole No. 871-1 Sample Elevation 683 feet
Plate	XI	-	Consolidation Test; Hole No. 871-1 Sample Elevation 668 feet
Plate	XII	-	Consolidation Test; Hole No. 871-1 Sample Elevation 648 feet
Plate	XIII	-	Consolidation Test; Hole No. 871-1 Sample Elevation 628 feet
Plate	XIV	-	Consolidation Test; Hole No. 871-4 Sample Elevation 669 feet
Plate	XV	-	Grain Size Distribution - Gradation of Typical Sand Samples from Hole No. 871-1
Plate	XVI	-	Summary of Drilling and Test Results - Comparison of All Tests
Plate	XVII	-	Consolidation Test - Comparison of All Tests
Plate	XVIII	-	Net Allowable Bearing Pressures for Bridge Abutment Footings

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871

PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-1

SITE Township of Aldborough Between Lots Nos. 2 and 3 SHEET No. 1 OF 2
 Ontario

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 8:00 A.M. March 29 19 60
 FINISHED 2:00 P.M. April 4 19 60

METHOD OF DRILLING: SOIL Drill 4-Inch Auger CASING DIAM. CORE DIAM.

LOCATION: ~~EXTREME~~ Chainage 503+46 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 48 Ft Left DRILL PLATFORM -
 BEARING GROUND SURFACE 708.2
 INITIAL DIP 90 Degrees ROCK SURFACE -
 OTHER DIPS BOTTOM OF HOLE 628.2
 WATER TABLE 705.6

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST Blows *
			NO.	TYPE *	SIZE	DEPTH	RET'D	
0.0	Medium Sand	Wet, medium dense	1	A.Q.	Inches 2	Feet 5.0	Inch	
						5.5		2
						5.0		5
						6.5	18	13
			2	A.Q.	2	10.0		
						10.5		4
						11.0		6
						11.5	18	20
16.3	Clay Till	Grey firm, very stiff and tenacious, with scattered pebbles.	3	A.Q.	2	15.0		
						15.5		5
						16.0		10
						16.5	18	16
			4	B.O.	2	20.0		
						20.5		6
						21.0		15
						21.5	10	18
			5	B.O.	2	25.0		
						25.5		6
						26.0		9
						26.5	15	18

SAMPLING METHOD

* A — SPLIT TUBE E — AUGER
 B — THIN WALL TUBE F — WASH
 C — PISTON SAMPLER
 D — CORE BARREL

SHIPPING CONTAINER

N — INSERT R — CLOTH BAG
 O — TUBE S — PLIOFILM BAG
 P — WATER CONTENT: T N Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. MacLeod
 LOGGED BY J. MacLeod

APPROVED *D. H. Macdonald*
 DATE May, 1960

PLATE IIA
 PHOTO IIA

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS
 NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 871

PROJECT Highway 401, Black's Lane Underpass (WP-94-59)

HOLE No. 871-1

SITE Twp of Aldborough Between Lots 2 and 3, Ontario

SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST Blows
			NO.	TYPE	SIZE	DEPTH	RET'D	
					Inch	Feet	Inch	
16.3	Clay Till	Continued	6	A.Q	2	30.0		
						30.5		11
						31.0		19
						31.5	13	25
			7	B.O	2	35.0		
						35.5		12
						36.0		18
						36.5	15	25
			8	B.O	2	40.0		
						40.5		13
						41.0		19
						41.5	18	24
			9	B.O	2	45.0		
						45.5		11
						46.0		17
						46.5	18	24
			10	B.O	2	50.0		
						50.5		12
						51.0		16
						51.5		20
						52.0	24	25
			11	B.O	2	60.0		
						60.5		11
						61.0		11
						61.5	18	24
			12	B.O	2	70.0		
						70.5		14
						71.0		21
						71.5		25
80.0		End of hole.	13	B.O	2	80.0		
						80.5		19
						81.0		27
						81.5		34
		Note: *Penetration Test:						
		This is the number of						
		blows of a 140-lb						
		weight falling 30 inches						
		required to advance						
		the sampler to depth						
		indicated.						

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871
 PROJECT Highway 401, Black's Lane Underpass (WF-94-59) HOLE No. 871-2
 SITE Twp of Aldborough Between Lots 2 and 3, Ontario SHEET No. 1 OF 2
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 8:00 A.M. April 6 19 60
 FINISHED 12:00 A.M. April 6 19 60
 METHOD OF DRILLING: SOIL Penndrill 4-Inch Auger CASING DIAM.
 ROCK CORE DIAM.
 LOCATION: ~~XACTUDE~~ Chainage 503+01 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 50 Feet Left DRILL PLATFORM
 BEARING GROUND SURFACE 708.0
 INITIAL DIP 90 Degrees ROCK SURFACE -
 OTHER DIPS BOTTOM OF HOLE 668.0
 WATER TABLE 705.5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST Blows*
			NO.	TYPE *	SIZE	DEPTH	RET'D	
0.0	Gravel and Sand	Medium sand and fine gravel. Wet, gravel hard and rounded, medium to dense.	1	A.Q.	Inch 2	Feet 5.0	Inch	
						5.5		14
						6.0		23
						6.5		35
			2	A.Q.	2	10.0		
						10.5		12
						11.0		13
						11.5		20
15.0	Medium Sand	Wet, medium dense	3	A.Q.	2	15.0		
						15.5		6
						16.0		11
						16.5		19
16.5	Clay Till	Grey, firm, very stiff, tenacious with scattered pebbles.	4	B.O.	2	20.0		
						20.5		7
						21.0		13
						21.5		19
			5	B.O.	2	25.0		
						25.5		7
						26.0		16
						26.5		23

SAMPLING METHOD

A — SPLIT TUBE
 B — THIN WALL TUBE
 C — PISTON SAMPLER
 D — CORE BARREL

E — AUGER
 F — WASH

SHIPPING CONTAINER

N — INSERT
 O — TUBE
 P — WATER CONTENT TIN
 Q — GLASS JAR

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J. MacLeod

LOGGED BY J. MacLeod

APPROVED

D. H. MacDonald

DATE

May, 1960

DRILLING REPORT

JOB No. 871

PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-2

SITE Twp of Aldborough Between Lots 2 and 3, Ontario SHEET No. 2 OF 2

[illegible]

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871
 PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-3
 SITE Two of Aldborough Between Lots 2 and 3, Ontario SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 3:00 P.M. April 6 19 60
 FINISHED 9:00 A.M. April 7 19 60
 METHOD OF DRILLING: SOIL Penndrill 4-Inch Auger CASING DIAM.
 ROCK CORE DIAM.
 LOCATION: ~~X~~ CHAINAGE Chainage 503+01 ELEVATIONS: DATUM G.S.O.
 DEPARTURE 49 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 708.5
 INITIAL DIP 90 Degrees ROCK SURFACE -
 OTHER DIPS BOTTOM OF HOLE 668.5
 WATER TABLE 706.5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST Blows
			NO.	TYPE *	SIZE	DEPTH	RET'D	
					Inch	Feet	Inch	
0.0	Gravel	Medium sand and fine	1	A.Q.	2	5.0		
	and	gravel. Wet, gravel hard				5.5		10
	Sand	and rounded.				6.0		10
						6.5	18	17
			2	A.Q.	2	10.0		
						10.5		9
						11.0		12
						11.5	18	20
15.0	Medium	Wet, medium dense	3	A.Q.	2	15.0		
	Sand					15.5		8
						16.0		11
						16.5	18	19
16.5	Clay	Grey, firm, very stiff	4	B.C.	2	20.0		
	Till	and tenacious with				21.5		Machine
		scattered pebbles.					18	pushed
			5	B.C.	2	25.0		Machine
						25.5	18	pushed
			6	B.C.	2	30.0		Machine
						31.5	18	pushed
			7	B.C.	2	40.0		Machine
40.0		End of hole				41.5	18	pushed

SAMPLING METHOD
 * A — SPLIT TUBE
 B — THIN WALL TUBE
 C — PISTON SAMPLER
 D — CORE BARREL

E — AUGER
 F — WASH

SHIPPING CONTAINER
 N — INSERT
 O — TUBE
 P — WATER CONTENT TIN
 Q — GLASS JAR

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J. MacLeod
 LOGGED BY J. MacLeod

APPROVED

DATE

H. MacDonald

May, 1960

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871
 PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-4
 SITE Township of Aldborough Between Lots Nos. 2 and 3 SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 1:00 P.M. April 7 1960
 FINISHED 10:00 A.M. April 8 1960
 METHOD OF DRILLING: SOIL Penndrill 4-Inch Auger CASING DIAM. _____
ROCK CORE DIAM. _____
 LOCATION: X-1000 Chainage 503+46 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 50 Ft. Right DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 708.5
 INITIAL DIP 90 Degrees ROCK SURFACE -
 OTHER DIPS _____ BOTTOM OF HOLE 668.5
 WATER TABLE 706.5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST Blows
			NO.	TYPE *	SIZE	DEPTH	RET'D	
					Inch	Feet	Inch	
0.0	Medium sand	Wet, medium dense	1	A.Q	2	5.0		
						5.5		3
						6.0		7
						6.5	18	13
14.5	Fine sand		2	A.Q	2	10.0		
						10.5		12
						11.0		14
						11.5	18	20
16.0	Clay till	Grey, firm, very stiff, tenacious with scattered pebbles	3	A.Q	2	15.0		
						15.5		10
						16.0		16
						16.5	18	23
			4	B.O	2	20.0		Machine
						21.5	18	pushed
			5	B.O	2	30.0		
						30.5		10
						31.0		15
						31.5	18	20
			6	B.O	2	40.0		
						40.5		17
						41.0		20
						41.5	18	27

SAMPLING METHOD

* A — SPLIT TUBE
 B — THIN WALL TUBE
 C — PISTON SAMPLER
 D — CORE BARREL

E — AUGER
 F — WASH

SHIPPING CONTAINER

N — INSERT
 O — TUBE
 P — WATER CONTENT TIN
 Q — GLASS JAR

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J.A. MacLeod
 LOGGED BY J.A. MacLeod

APPROVED D. H. Macdonald
 DATE May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871
 PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-5
 SITE Township of Aldborough between Lots 2 and 3, SHEET No. 1 OF 1
 Ontario
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 2:00 P. M. April 4 1960
 FINISHED 5:00 P. M. April 4 1960
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: ~~EASTING~~ Chainage 503+46 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 53 Feet left
 BEARING
 INITIAL DIP 90 Degrees
 OTHER DIPS
 DRILL PLATFORM
 GROUND SURFACE 708.2
 ROCK SURFACE
 BOTTOM OF HOLE 682.2
 WATER TABLE 705.6

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST *
			NO.	TYPE *	SIZE	DEPTH	RET'D	
0.0	Sand	Note: D.H.O. Penetration test:				1		2
						2		2
						3		3
						4		15
						5		25
		*This is the number				6		38
		of blows of a 140-				7		39
		pound weight falling				8		41
		30 inches required				9		52
		to advance the cone				10		54
		one foot.				11		58
						12		76
						13		88
						14		90
						15		83
						16		41
16.3	Clay till					17		33
						18		76
						19		74
						20		75
						21		91
						22		103
						23		115
						24		123
						25		145

SAMPLING METHOD

A — SPLIT TUBE E — AUGER
 B — THIN WALL TUBE F — WASH
 C — PISTON SAMPLER
 D — COR. BARREL

SHIPPING CONTAINER

N — INSERT R — CLOTH BAG
 O — TUBE S — PLIOFILM BAG
 P — WATER CONTENT TIN Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. MacLeod

LOGGED BY J. MacLeod

APPROVED

DATE

May, 1960
 Plate VI

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS
 NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 871
 PROJECT Highway 401, Black's Lane Underpass (WP-94-59) HOLE No. 871-6
 SITE Township of Aldborough between Lots 2 and 3, SHEET No. 1 OF 1
 Ontario
 CONTRACTOR: F.E. Johnston Drilling STARTED 1:00 P.M. April 6 1960
 Company Limited FINISHED 2:30 P.M. April 6 1960
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: ~~INTERSECT~~ Chainage 503+01 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 55 Feet left
 BEARING
 INITIAL DIP 90 Degrees
 OTHER DIPS
 DRILL PLATFORM
 GROUND SURFACE 708.0
 ROCK SURFACE
 BOTTOM OF HOLE 681.0
 WATER TABLE 705.5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE*	SIZE	DEPTH	RET'D	
0	Sand and gravel	Note: D.H.O. Penetration test				Feet		Blows*
						1		2
						2		2
						3		5
						4		7
						5		12
						6		44
						7		37
						8		35
						9		38
						10		45
						11		50
						12		46
						13		68
						14		62
						15		51
16.5	Clay till					16		29
						17		35
						18		45
						19		53
						20		69
						21		88
						22		88
						23		95
						24		100
						25		115
						26		125
						27		132

SAMPLING METHOD

* A — SPLIT TUBE
 B — THIN WALL TUBE
 C — PISTON SAMPLER
 D — CORE BARREL

E — AUGER
 F — WASH

SHIPPING CONTAINER

N — INSERT
 O — TUBE
 P — WATER CONTENT TIN
 Q — GLASS JAR

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J. MacLeod
 LOGGED BY J. MacLeod

APPROVED *D. H. MacDonald.*
 DATE May, 1960
 Plate VII

DRILLING REPORT

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPAGTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE *	SIZE	DEPTH	RET'D	Blows*
0	Sand and gravel	Note: D.H.O. Penetration test:				Feet		
						1		2
						2		2
						3		3
						4		8
						5		13
		*This is the number of				6		15
		blows of a 140-pound				7		18
		weight falling 30 inches				8		24
		required to advance the				9		26
		cone one foot.				10		28
						11		37
						12		51
						13		71
						14		66
						15		62
16.5	Clay till					16		31
						17		29
						18		44
						19		49
						20		82
						21		90
						22		92
						23		101
						24		112
						25		120
						26		140
						27		150

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED

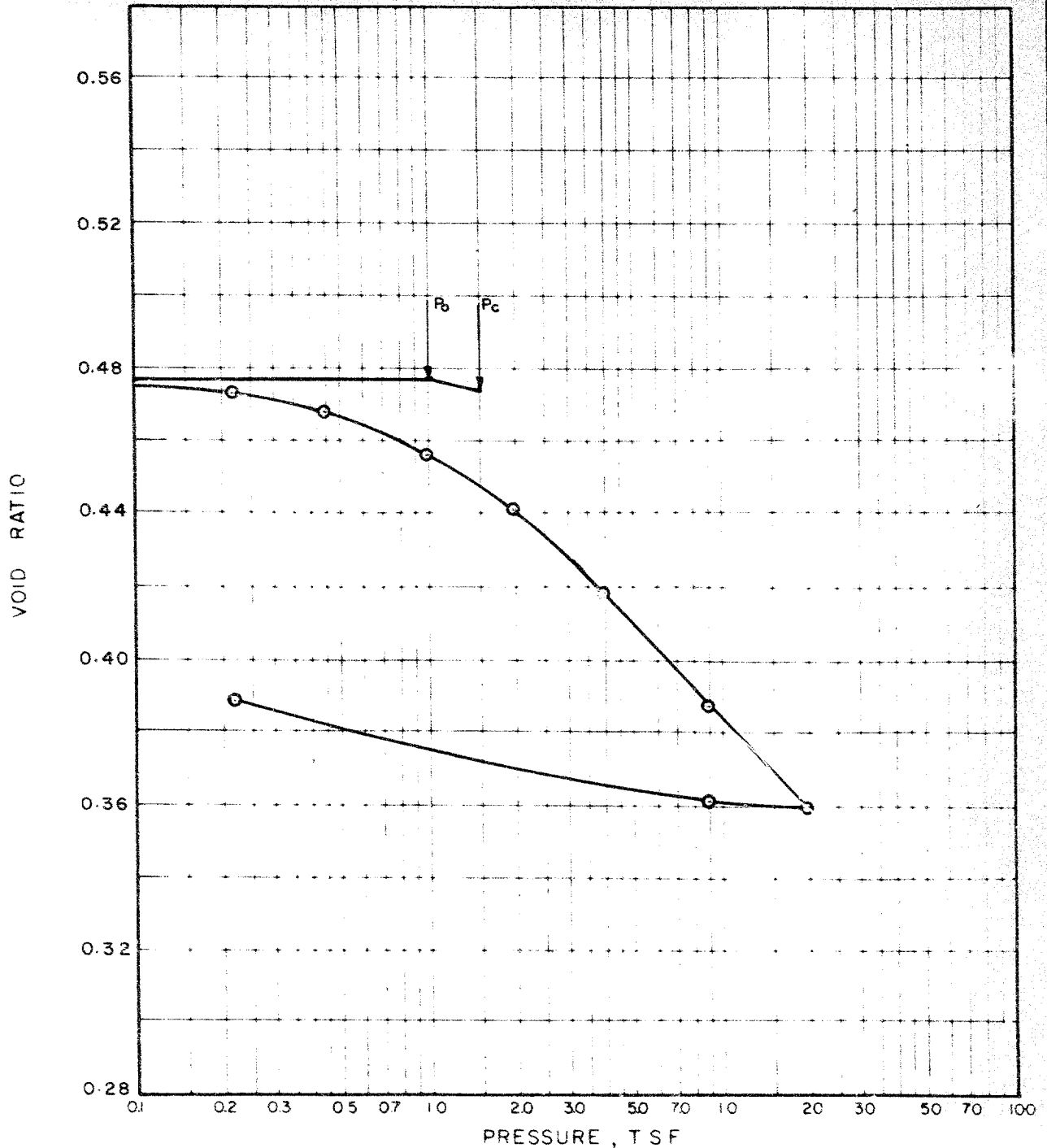
May, 1960
Plate VIII

DRILLING REPORT

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE *	SIZE	DEPTH	RET'D	Blows*
0.0	Sand	Note: D.H.O. Penetration test:				Feet		
						1		1
						2		1
						3		2
						4		17
						5		26
						6		36
						7		38
						8		42
						9		50
						10		53
						11		56
						12		78
						13		91
						14		80
						15		39
16.0	Clay till					16		31
						17		52
						18		78
						19		68
						20		66
						21		90
						22		101
						23		112
						24		126
						25		142

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED

D. H. Macdonald.
May, 1960
Plate IX



OVERBURDEN PRESSURE - $P_0 = 1.0$ TSF
 CONSOLIDATION PRESSURE - $P_c = 1.5$ TSF

NATURAL WATER CONTENT = 16.61%
 LOADING INTERVAL - 25 MIN.

SAMPLE No 871-B0-7

TEST DATE APRIL 27, 1960

TEST No 871-9-2

TESTED BY R. G. & J. B.

H G ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

CONSOLIDATION TEST

HOLE No 871-1 SAMPLE ELEV 683'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

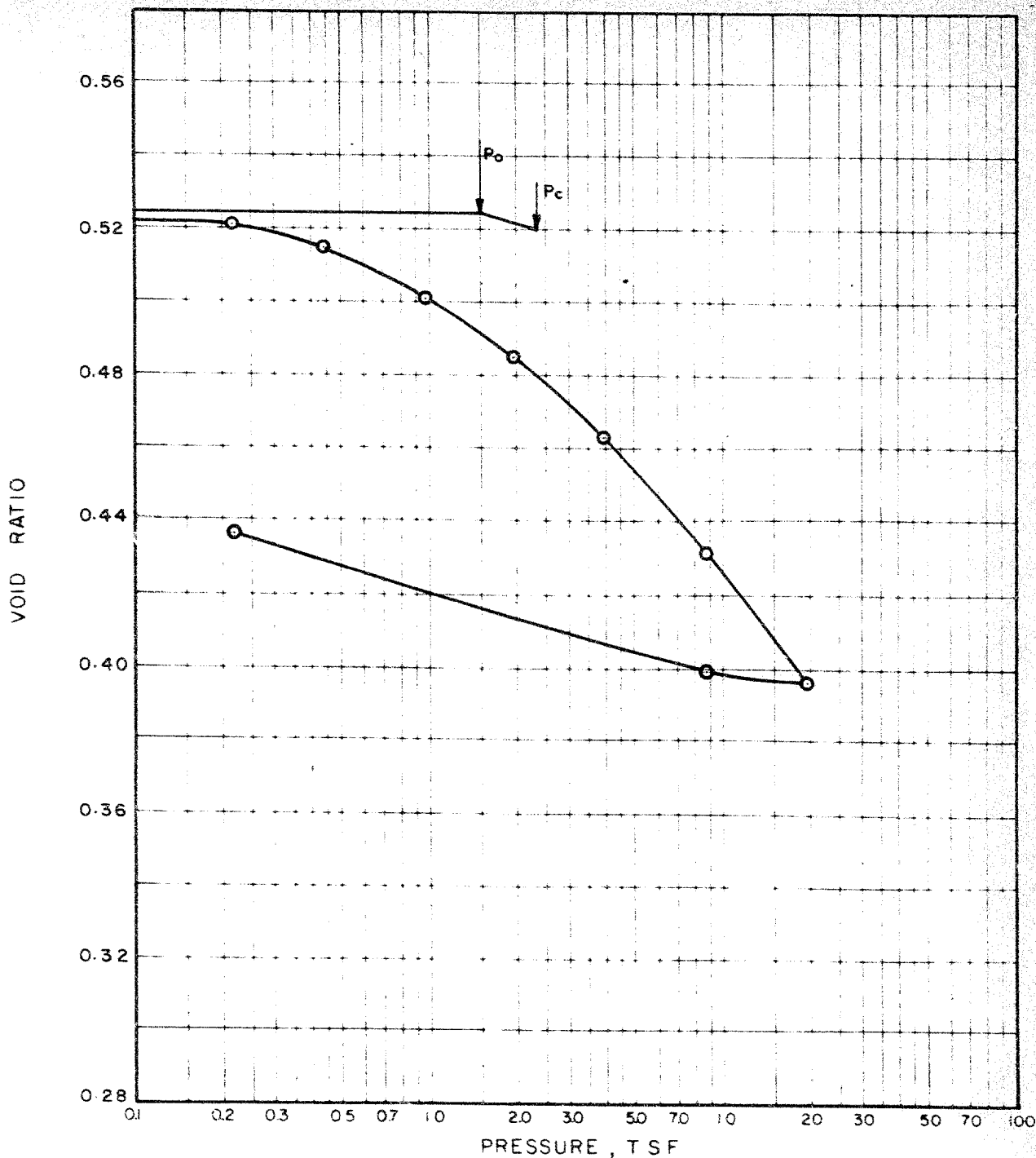
DATE MAY, 1960

HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)

D. H. Macdonald
 H G ACRES & COMPANY LTD

JOB No 871

PLATE - X



OVERBURDEN PRESSURE - $P_0 = 1.5$ TSF
 CONSOLIDATION PRESSURE - $P_c = 2.3$ TSF

NATURAL WATER CONTENT = 17.75 %
 LOADING INTERVAL - 25 MIN.

SAMPLE No 871-80-3
 TEST No 871-9-1

TEST DATE APRIL 27, 1960
 TESTED BY R. G. & J. B.

H G ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

CONSOLIDATION TEST

HOLE No 871-1 SAMPLE ELEV 668'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE MAY, 1960

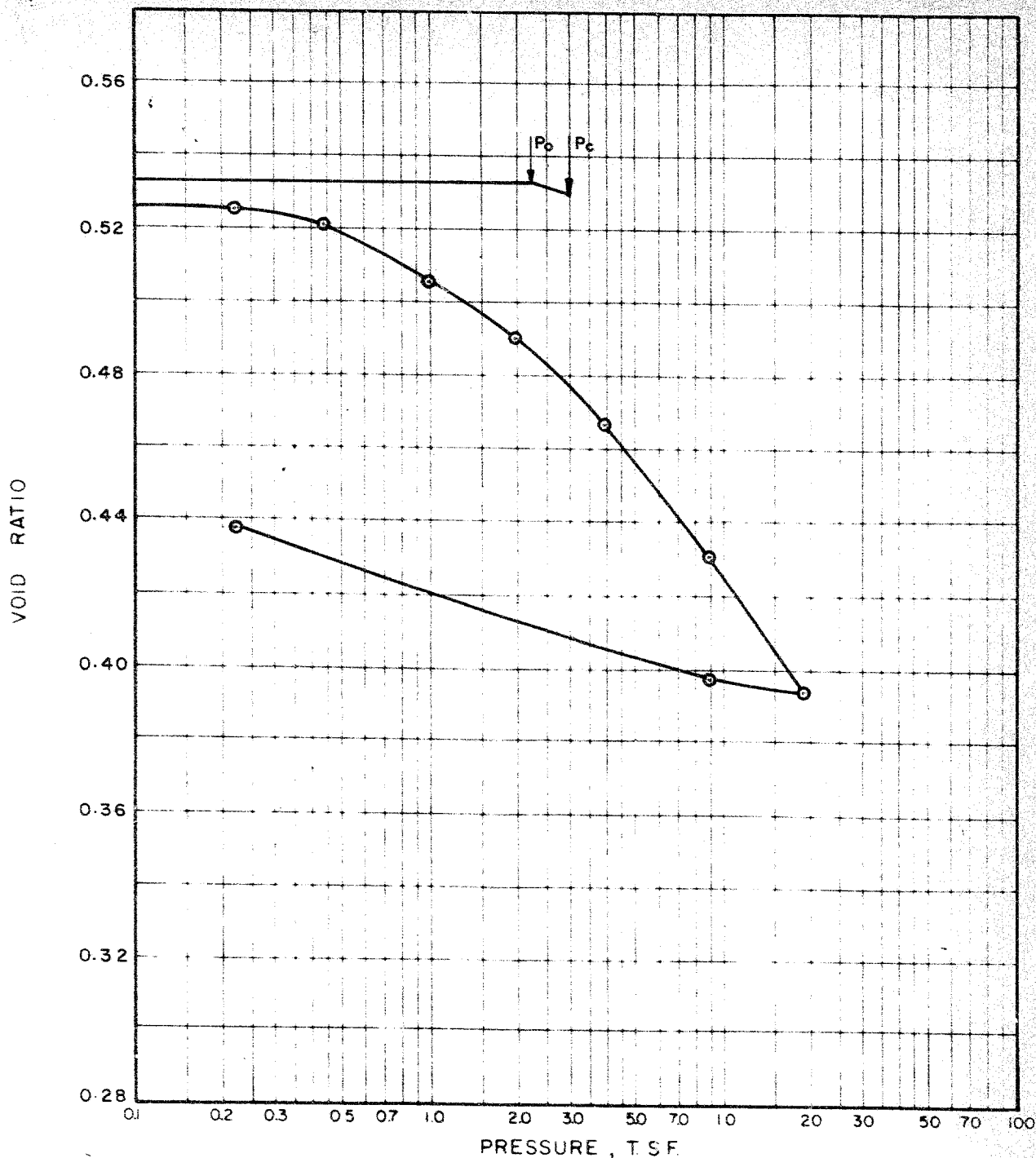
HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)

R. H. Macdonald
 H G ACRES & COMPANY LTD

JOB No 871

PLATE - XI

SK-871-LS-11



OVERBURDEN PRESSURE - $P_0 = 2.2$ TSF
 CONSOLIDATION PRESSURE - $P_c = 3.0$ TSF

NATURAL WATER CONTENT = 18.77 %
 LOADING INTERVAL - 25 MIN.

SAMPLE No 871-B0-6

TEST DATE APRIL 27, 1960

TEST No 871-9-3

TESTED BY R. G. & J. B.

H. G. ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

CONSOLIDATION TEST

HOLE No. 871-1 SAMPLE ELEV 648'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE MAY, 1960

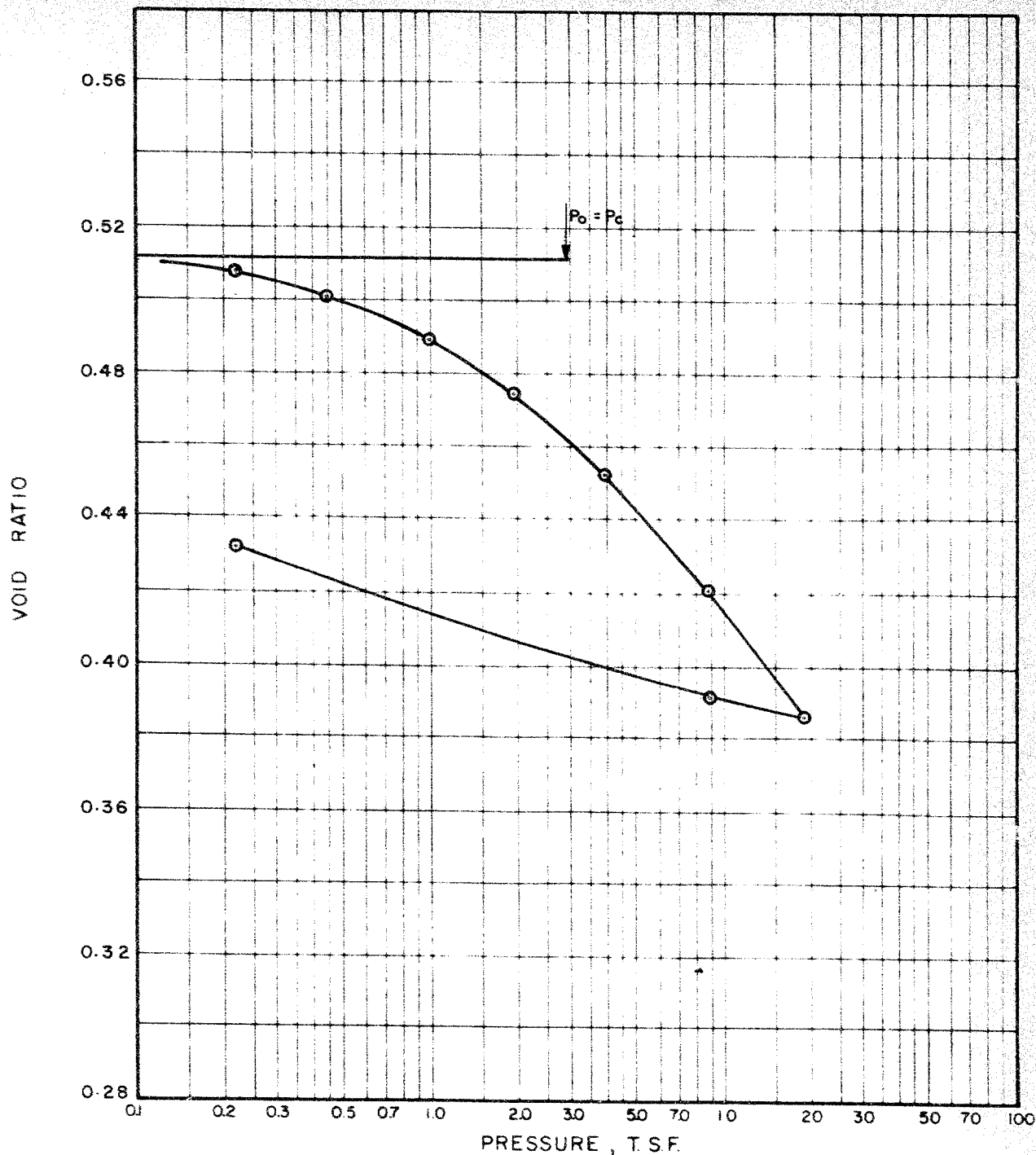
HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)

D. H. McDonald
 H. G. ACRES & COMPANY LTD

JOB No 871

PLATE-XII

SK-871-1S-12



OVERBURDEN PRESSURE — $P_0 = 2.9$ TSF
 CONSOLIDATION PRESSURE — $P_c = 2.9$ TSF

NATURAL WATER CONTENT = 17.03 %
 LOADING INTERVAL — 25 MIN.

SAMPLE No. 871-B0-9.

TEST DATE APRIL 27, 1960

TEST No. 871-9-4

TESTED BY R. G. & J. B.

H. G. ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

CONSOLIDATION TEST

HOLE No. 871-1 SAMPLE ELEV. 628'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

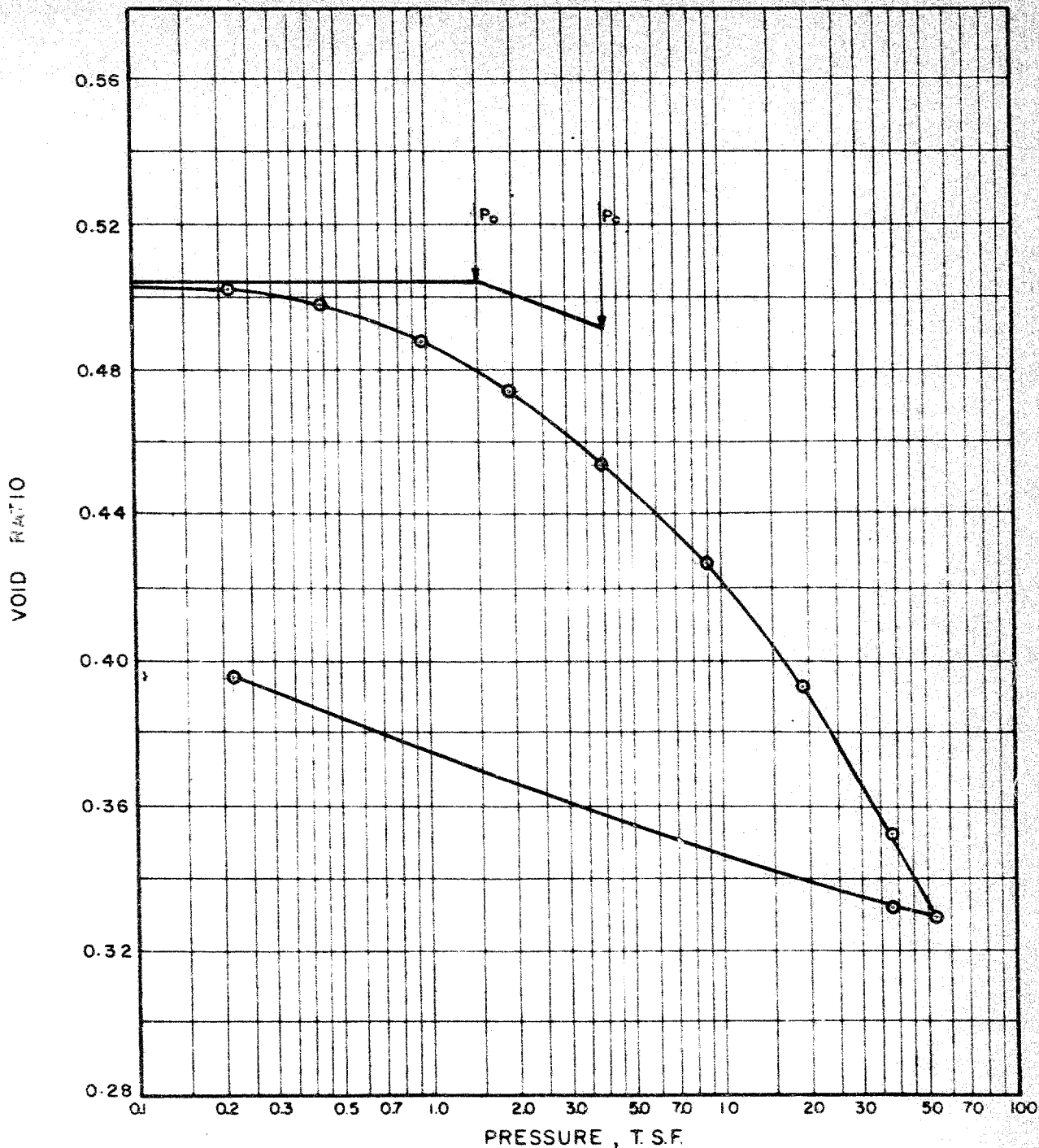
HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)

D. H. MacDonald
 H. G. ACRES & COMPANY LTD.

JOB No. 871

PLATE - XIII

SK-871-LS-13



OVERBURDEN PRESSURE - $P_0 = 1.5$ TSF
 CONSOLIDATION PRESSURE - $P_c = 4.0$ TSF

NATURAL WATER CONTENT = 17.14 %
 LOADING INTERVAL - 25 MIN.

SAMPLE No. 871 - 80 - 20

TEST DATE APRIL 28, 1960

TEST No. 871 - 9 - 5

TESTED BY J. B. & R. G.

H. G. ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

CONSOLIDATION TEST

DEPARTMENT OF HIGHWAYS OF ONTARIO

HOLE No. 871 - 4 SAMPLE ELEV. 669'

HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)

APPROVED

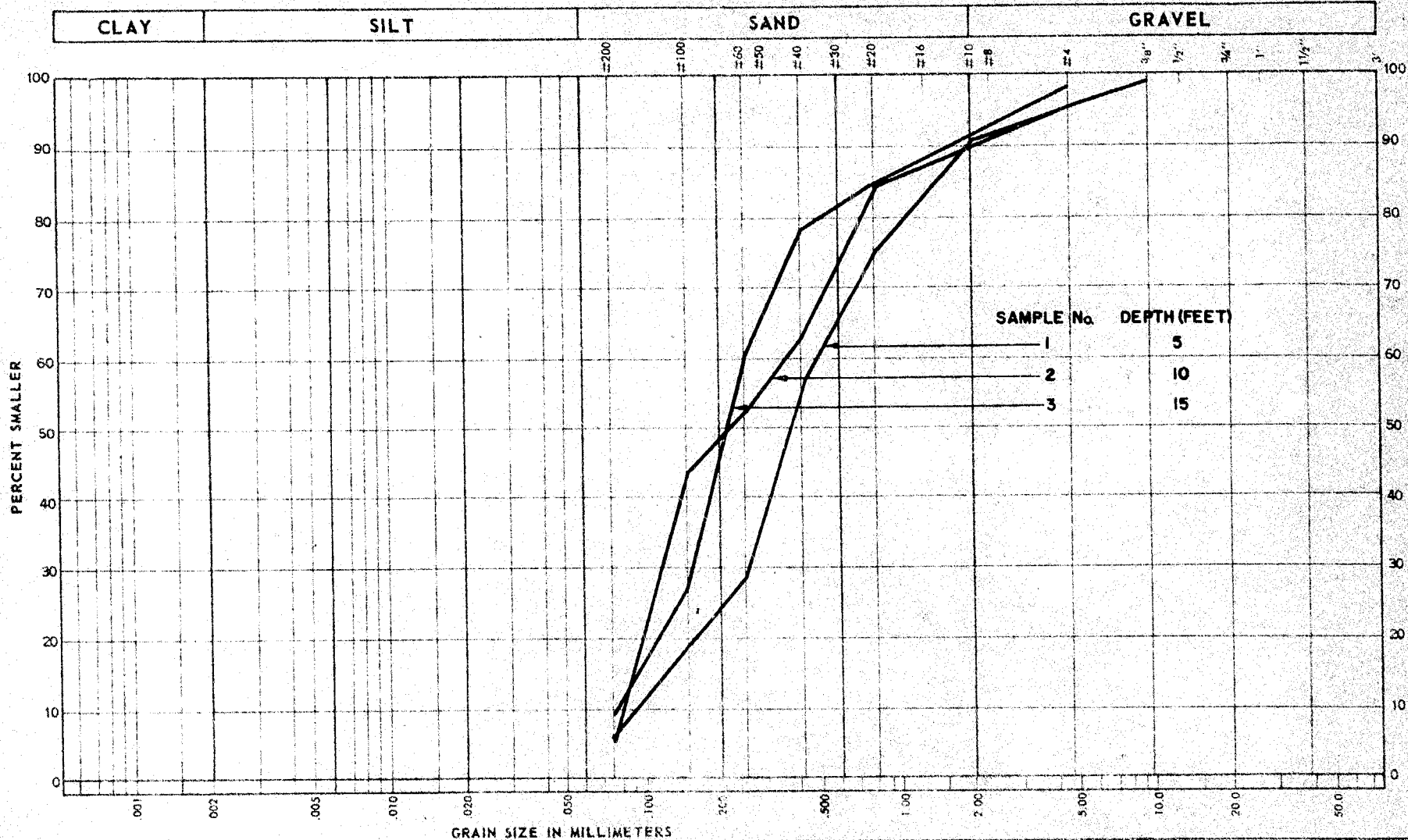
DATE: MAY, 1960

D. H. MacDonald
 H. G. ACRES & COMPANY LTD.

JOB No. 871

PLATE - XIV

SK-871-LS-14



REMARKS:

GRADATION OF TYPICAL SAND SAMPLES FROM HOLE No. 871-1

GRAIN SIZE DISTRIBUTION

HOLE No. 871-1

DATE MAY 1960

SAMPLE No. AS NOTED

TESTED BY

DEPT. AS NOTED

APP. *A.H.2.*

DWG. No. PLATE - XV

JOB No. 871

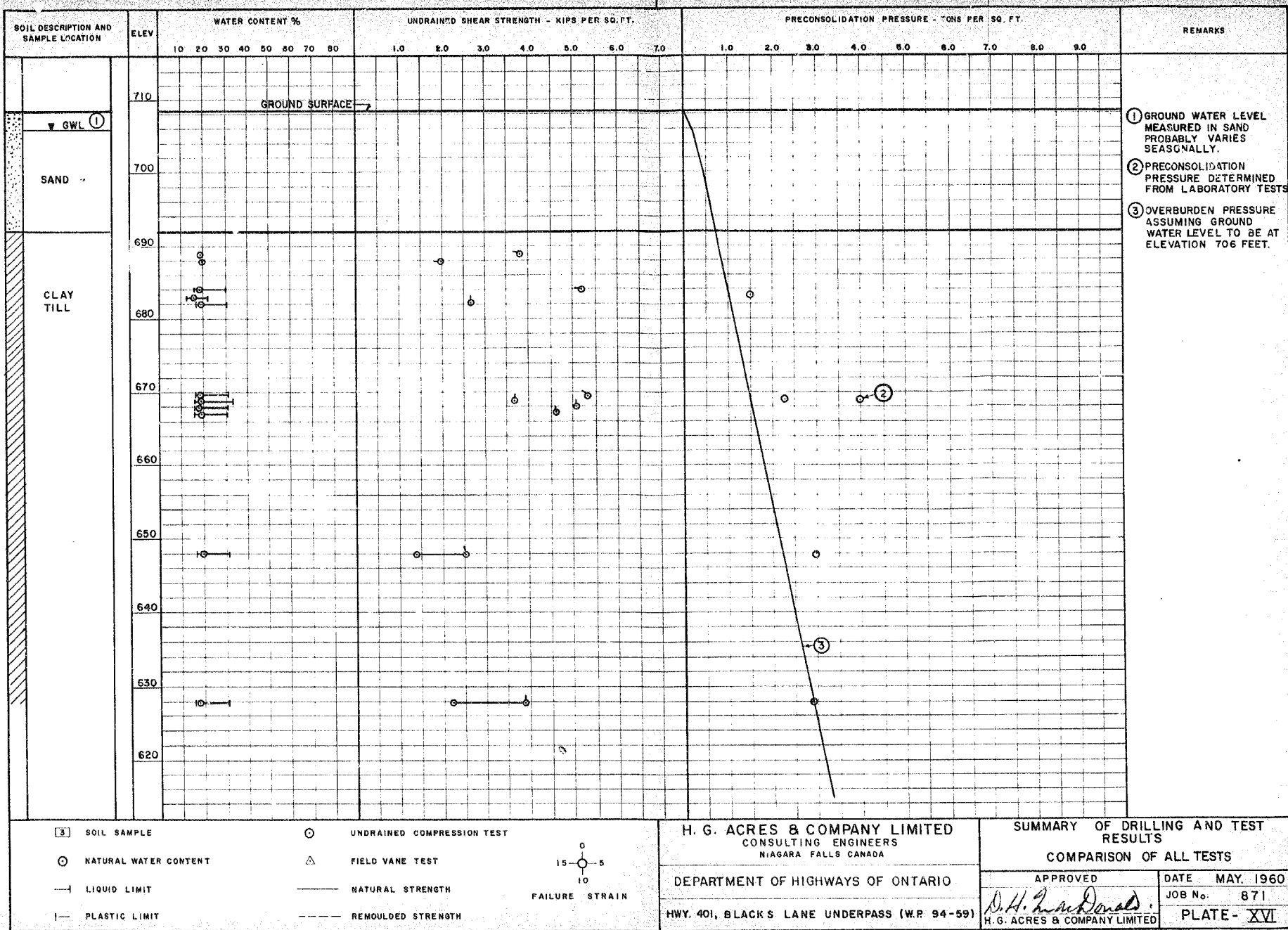
H. G. ACRES & COMPANY LIMITED

CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

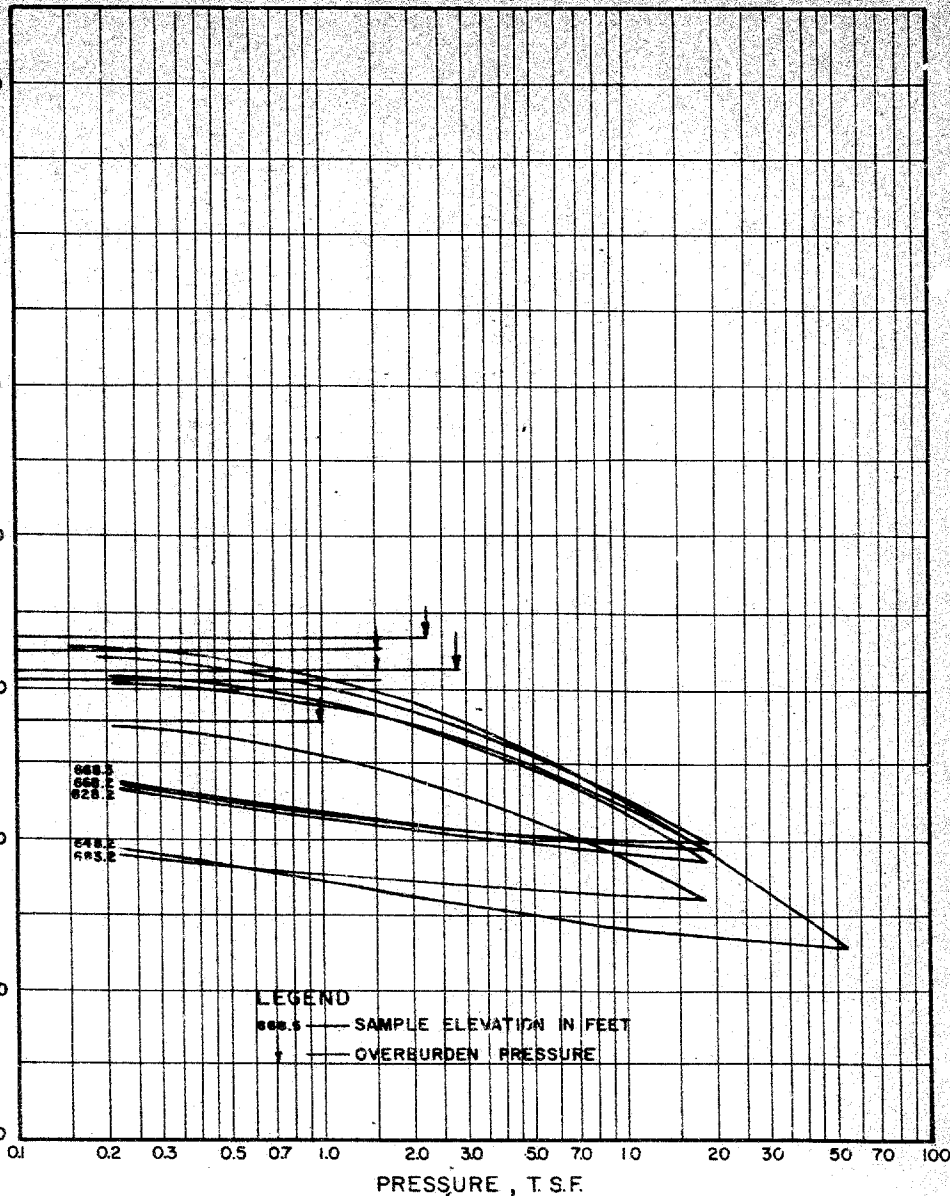
DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, BLACK'S LANE UNDERPASS (WP. 94-59)



VOID RATIO

0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20



OVERBURDEN PRESSURE — P_0 = _____
CONSOLIDATION PRESSURE — P_c = _____

NATURAL WATER CONTENT — _____
LOADING INTERVAL 25 MIN.

SAMPLE No. _____

TEST DATE _____

TEST No. _____

TESTED BY _____

H. G. ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

CONSOLIDATION TEST
COMPARISON OF ALL TESTS

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

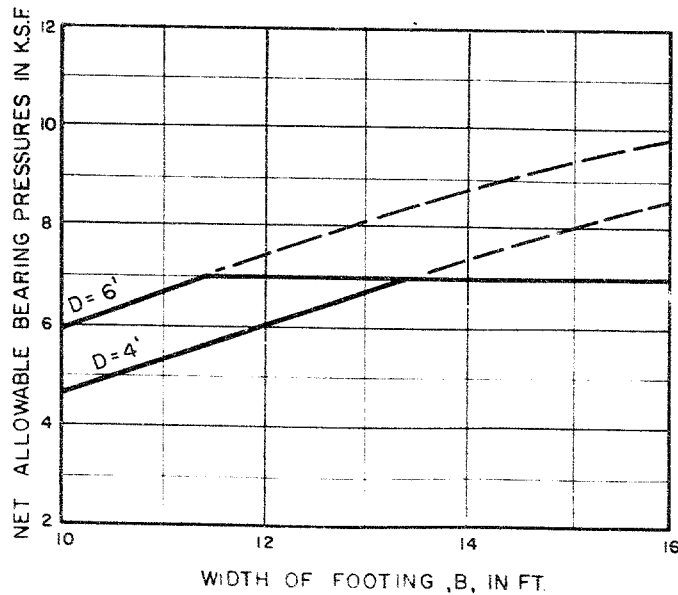
HWY. 401, BLACK S LANE UNDERPASS (W.P. 94-59)

D. H. Richardson
H.G. ACRES & COMPANY LTD.

JOB No. 871

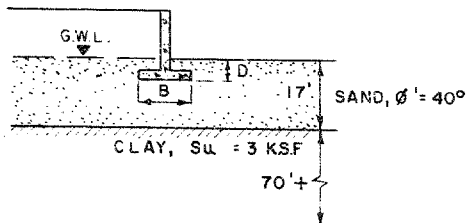
PLATE XVII

SK-871-LS-17



LEGEND

- ALLOWABLE DESIGN PRESSURES
 - - - - - ALLOWABLE DESIGN PRESSURES FOR CONDITION OF SAND FOUNDATION EXTENDING TO DEPTH GREATER THAN 'B' BELOW FOOTING LEVEL.



H. G. ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, BLACK'S LANE UNDERPASS (WP - 94-59)

NET ALLOWABLE BEARING PRESSURES
 FOR BRIDGE ABUTMENT FOOTINGS

APPROVED

DATE: MAY 1960

D. H. McDonald
 H. G. ACRES & COMPANY LTD.

SCALE
 JOB No.
 871

PLATE - XVIII

60-F-204

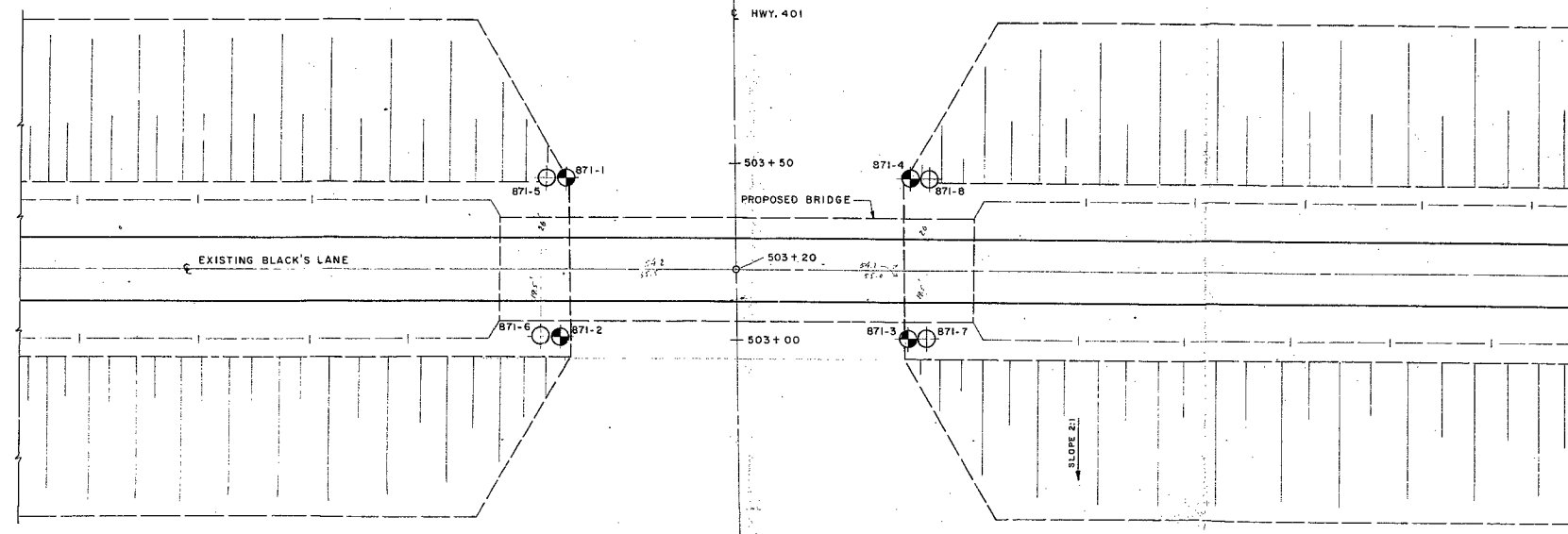
WP # 94-59

HWY # 401

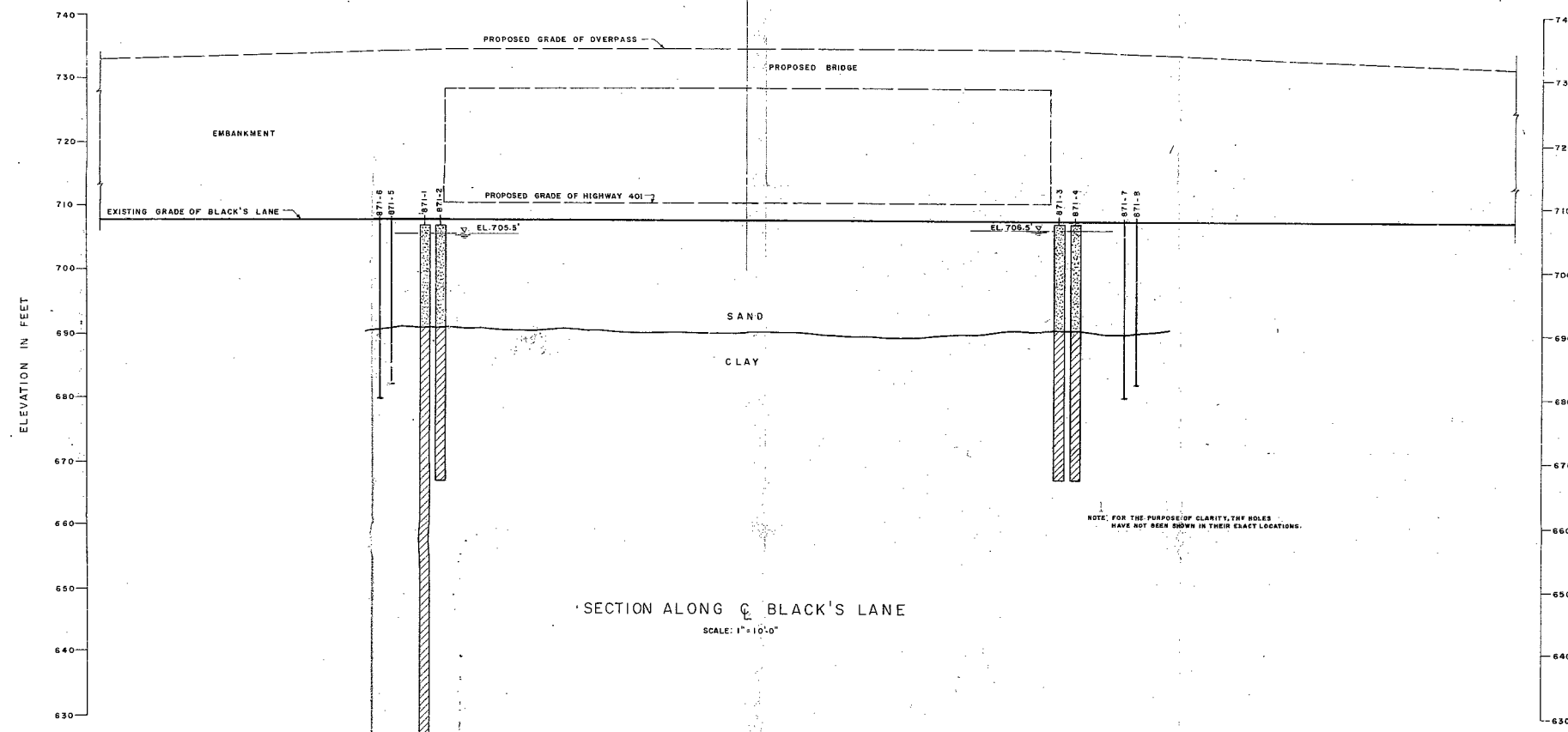
PROP. CROSSING

BLACKS LANE

ALDBOROUGH TWP.



PLAN
SCALE: 1" = 200'



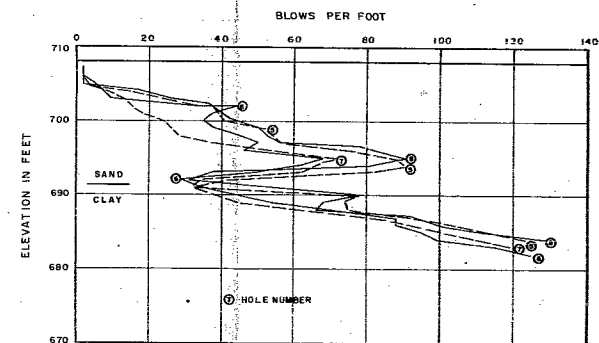
SECTION ALONG C BLACK'S LANE
SCALE: 1" = 10'-0"

LEGEND

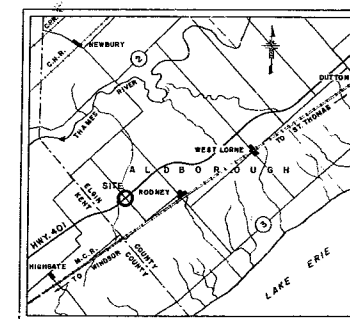
- | | | | |
|--|--------------|--|--|
| | ORGANIC SOIL | | WATER TABLE |
| | CLAY | | EXPLORATORY DRILL HOLE |
| | SILT | | 2 IN. DIA. PENETRATION CONE TEST HOLE |
| | FINE SAND | | BLOWS PER FOOT FOR STANDARD PENETRATION TEST |
| | COARSE SAND | | |
| | GRAVEL | | |
| | BEDROCK | | |

NOTE:
1. STANDARD PENETRATION TESTS WERE PERFORMED USING A 2 IN. OUTSIDE DIAMETER SPLIT SPOON AND A 140 LB. WEIGHT DROPPING 30 INCHES.
2. CONE PENETRATION TESTS WERE PERFORMED USING A 2 IN. DIAMETER D.H.O. CONE AND A 140 LB. WEIGHT DROPPING 30 INCHES.

NOTE: FOR THE PURPOSE OF CLARITY, THE HOLES HAVE NOT BEEN SHOWN IN THEIR EXACT LOCATIONS.



RESULTS OF D.H.O. CONE PENETRATION TESTS



KEY PLAN
SCALE: 1 IN. = 4 MI.

H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS, CANADA	
DEPARTMENT OF HIGHWAYS OF ONTARIO HWY. 401, BLACK'S LANE UNDERPASS (WP-94-59)	
EXPLORATORY HOLES PLAN AND SECTION	
APPROVED <i>D. H. Macdonald</i> H. G. ACRES & COMPANY LIMITED	DATE: MAY, 1960 SCALE: AS NOTED JOB NO. 871 PLATE - I

SK-871-C-1