

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

IN YOUR REPLY REFER TO
FILE 872

May 9, 1960

Materials and Research Section,
Ontario Department of Highways,
Parliament Buildings,
Toronto 2, Ontario.

Attention: Mr. L.G. Soderman,
Principal Soils and
Foundation Engineer

Gentlemen: Ontario Department of Highways
WP-95-59

Enclosed with this letter is the preliminary log of hole No. 872-1, which was drilled on the site of the project WP-95-59. This hole is typical of five holes which were drilled.

The soil stratigraphy consists of a 16-foot thick stratum of dense sand which overlies clay of undetermined thickness but which is at least 74 feet thick. The clay is overconsolidated and stiff and the shear strength is greater than 2,000 pounds per square foot.

In our report, we have recommended the use of spread footings to support the bridge piers and we have also recommended net allowable bearing pressures from 4 to 7 kips per square foot, depending upon the width of the footings.

Our report on WP-95-59 should be in your hands during the week of May 9, 1960.

Yours very truly,

H.G. ACRES & COMPANY LIMITED

D. H. MacDonald.

TCK:hb
Encl.

D.H. MacDonald
Geotechnical Engineer

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

DRILLING REPORT

CLIENT : Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP-95-59) HOLE No. 872-1
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 1:00 P.M. April 4, 1960
 FINISHED 9:00 A.M. April 7, 1960
 METHOD OF DRILLING: SOIL Penndrill 4-Inch Auger CASING DIAM.
 ROCK CORE DIAM.

LOCATION: LATITUDE Ch. 383+69.3 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 46 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 607.0
 WATER TABLE 695.0

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE *	SIZE	DEPTH	RET'D	
0.0	Medium sand	Grey, wet, medium dense	1	AQ	2 Inches	Feet	Inches	# Blows
						4.0		
						4.5		6
						5.0		7
						5.5	18	13
			2	AQ	2	9.0		
						9.5		6
						10.0		9
						10.5	18	17
			3	AQ	2	14.0		
						14.5		8
						15.0		11
						15.5	18	13
15.2	Clay till	Grey, firm very stiff tenacious with scattered pebbles.	4	AQ	2	19.0		
						19.5		3
						20.0		5
						20.5		11
					Vane Test	24.5		
			5	BO	2	29.0		
						30.5	18	Pushed
					Vane Test	34.5		

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 — PLASTIC BAG
 Q — CASSIDY

INSPECTOR J. Bateson

LOGGED BY J. MacLeod

PRELIMINARY

APPROVED

DATE

May, 1960

DRILLING REPORT

JOB No. 372

HOLE No. 872-1

SHEET No. 2 OF 2

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.	* Blows
					Inches	Feet	Inches	
			6	BO	2	39.0		
						40.5	18	Pushed
					Vane Test	49.0		
			7	BO	2	59.0		
						59.5		4
						60.0		29
						60.5	16	29
			8	BO	2	69.0		
						70.5	18	Pushed
			9	BO	2	79.0		
						80.0		Pushed
						80.5	15	45
90.0		End of hole	10	BO	2	89.0		
						90.0		Pushed
						90.5	14	36
		<u>Note: * Penetration Test</u>						
		This is the number of blows of a 140-lb weight falling 30 inches required to advance the sampler to depth indicated.						

- ① What will be the bearing pressure if the width of the footing (bied) 6' instead of 10'.
- ② ~~Comparative~~ Pile Capacity - tubular piles.
(14" diameter).
Jim ~~the~~ Keen / Bridge office.

Report by Acres.

Proposed crossing Hwy 401 & County Rd (old 77)

W.P. 95-59

May 1960.

079

JACK TATARA (10/20)

$$4N_e A_p + \frac{Q A_f}{100} \quad \bar{N} = 20 \quad N = 20'$$

$$4 \times 20 \times 0.8 + \frac{20 \times 3.14 \times 15}{100} =$$

$$64 + \frac{105}{100} = 65$$

If factor of safety 2

Pile bearing capacity 20T

If factor of safety 3

Pile bearing capacity 20T

PILES SHOULD
BE DRIVEN
DOWN TO ELEV
685.0

$$411 + \frac{10}{50}$$

$$4 \times 22 \times 0.8$$

$$\frac{88 - 0.8}{70.8}$$

1000

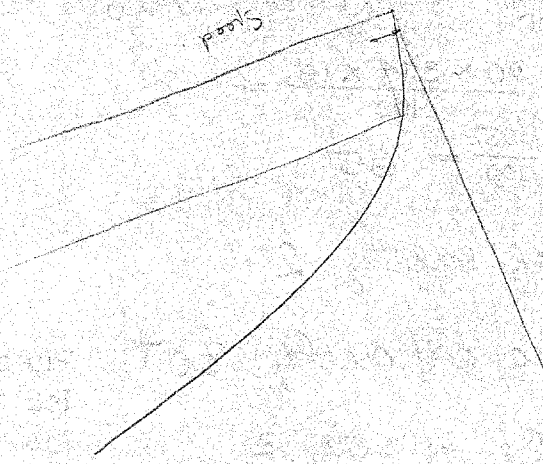
$$314 \times 10$$

$$\frac{31}{50}$$

$$\frac{31 \times 20}{50} = 1$$

12-20 100

1000



Mr. A. M. Toye,
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, Hwy. 401 and County Road to
Rodney (Old Hwy. 77), Between Lots 8 & 9,
W.P. 95-59.

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.

L. G. Soberman,
PRINCIPAL FOUNDATIONS ENGR.

Per:

AS/MdsF
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.


(A. Stornac,
FOUNDATIONS OFFICE ENGR.)

September 16, 1960.

Dr. D. H. MacDonald,
Geotechnical Engineer,
H. G. Acres Company, Limited,
Niagara Falls, Ontario.

Re: Hwy. 401 Structures -- *H.G. ACRES - 1960*
W.P.'s 92-59, 95-59, 97-59 & 99-59.

Dear Sir:-

In our deliberation of the type of structure to use for these locations which are presumably in the till material East of Chatham, the problem of differential movement is the one which must be resolved. It is our feeling that settlements will not be of a magnitude that will rule out the use of continuous structures; nevertheless, the absolute values which you have quoted, indicate that differential movements could be serious.

In this regard, we would be pleased to have you submit to us, one detailed settlement calculation for each of the above-noted structures. Photostat copies of your office notes will be quite adequate. These will be used by our Section, only, to fully appreciate the assumptions and approximations which you have had to make to come with an answer. Could you please submit these to our Office as soon as possible.

Yours very truly,

L. G. Soderman

LGS/MdeF

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGINEER

cc: Foundations File

Ger. Files.

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

Mr. B. R. Davis,
Bridge Design Engineer,
Bridge Division.

Attention: Mr. J. Keen

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

November 14, 1963

Proposed Crossing, Twp. of Aldborough,
Hwy. 401 and County Rd. to Rodney (Old Hwy. 77)
Lots 8 & 9, District No. 2 -- W.P. 95-57-59.

At the above-mentioned location, it is proposed to construct a four-span, simply supported structure with perched abutments. The Bridge Division recently requested us to give recommendations as to the type and tip elevation of the piles for the abutment foundations.

We have reviewed the subsoil conditions described in the report by H. G. Acres Ltd., and find that the site is generally underlain by 15 to 18 ft. of compact sand followed by very stiff to stiff clay till. Our recommendations for the abutment foundations are as follows:

Abutments for the structure may be supported on large displacement timber piles. A safe design load of 25 tons/pile may be used for #14 treated timber piles driven to elev. 683.0. As an alternative, the abutments may be supported on large displacement steel tubular piles. For example, a 12 $\frac{1}{2}$ O.D. steel tubular pile driven to the above-mentioned tip elevation, can support a safe design load of 30 tons. In either case, the piles should not be advanced beyond elev. 683.0. However, the choice of piles should depend upon economical considerations.

MD/MdeF

cc: Foundations Office
Gen. Files

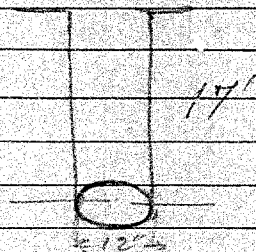
M. Devata

M. Devata,
SENIOR FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

$$Q = 4NA_p + \frac{NA_c}{50} \quad 1.07$$

$$= 4 \times 22 \times 0.8 + \frac{22 \times 53.4}{50}$$

$$= 70 + 23.5 = 93.5$$



$$\frac{Q}{3} = \frac{93.5}{3} = 31 \text{ T}$$

$$N = 22$$

$$= 70 + 7.2 A_p + C N_c A_p$$

$$+ 1000 \times 16 + 2000 \times 9 \times 0.8$$

$$= 70 + 8 + 7.2 = 85$$

$$A_p = 3.14 \times \frac{34^2}{4}$$

$$= 0.8$$

$$1 \times 3.14 \times 17 = 53.4$$

$$\frac{17}{21.98}$$

$$\frac{51.4}{53.38}$$

$$= \frac{85}{3} = 28.3 \text{ T}$$

$$\begin{array}{r} 1.07 \\ 22 \\ \hline 214 \\ 23.54 \end{array}$$

$$\begin{array}{r} 3.2 \\ 32.2 \\ \hline 64 \\ 64 \\ \hline 70.4 \end{array}$$

$$\begin{array}{r} 3.14 \\ 5 \\ \hline 15.70 \end{array}$$

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

at

PROPOSED CROSSING
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND COUNTY ROAD TO
RODNEY (OLD HIGHWAY 77)
BETWEEN LOTS 8 AND 9
WP 95-59

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 COUNTY ROAD TO
RODNEY (OLD HIGHWAY 77)
BETWEEN LOTS 8 AND 9
WP 95-59

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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 COUNTY ROAD TO
RODNEY (OLD HIGHWAY 77)
BETWEEN LOTS 8 AND 9
WP 95-59

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 the old Highway 77 over Highway 401 approximately one mile north of Rodney, Ontario. The proposed grade of Highway 401 at the site of the overpass is approximately one foot above the present ground surface. The approach embankments of the overpass will rise approximately 20 feet above the ground surface. A plan of the site is shown on Plate I of 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

of H.G. Acres & Company Limited. Field work commenced on April 4, 1960, using one Penndrill; a second Penndrill was brought to the site on April 11. The program of field work was completed on April 12, 1960, and laboratory testing of the soil samples was performed during the latter part of April, 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 five holes, No. 872-1 to No. 872-5 inclusive. Hole No. 872-1 was drilled to a depth of 90 feet, whereas the other holes were drilled to depths of about 40 feet. In addition, five cone penetration test holes, No. 872-6 to No. 872-10 inclusive, were made to determine the characteristics of a 17-foot thick sand stratum which covered the 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

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sand samples. Samples of clay were obtained with the use of 2-inch diameter thin-walled tubes, and vane tests were performed to measure in situ the shear strength of the soil where it was found sufficiently soft to test.

The program of work is outlined in Appendix A and the drilling reports are given on Plates II to XI inclusive.

Site Conditions and Soil Properties

The site is located in flat, featureless country and the general ground surface elevation is approximately 700 feet. It is highly fertile agricultural country which is extensively drained by field tile and ditches. While the drilling work was in progress, there were considerable amounts of surface water and all field drainage ditches were flowing.

The materials which were encountered in the exploratory holes are described in the attached drilling reports, Plates II to VI inclusive. The soil stratigraphy, as shown on Plate I, consists of a 16-foot thick sand stratum overlying clay at least 75 feet thick.

(a) - Sand - Medium to fine sand is found from the ground surface to an average depth of 16 feet. The grain size distribution curves of three samples taken from hole No. 872-1 are given on Plate XXIII. The average result of standard penetration tests was 24 blows per foot; the results varied from 20 to 30 blows per foot with the exception of one result which was 14 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, a value of the angle of shearing resistance equal to 40 degrees ($\phi' = 40$ degrees) may be assumed.

(b) - Clay - The elevation of the surface of the clay is approximately 681 feet. From elevation 681 feet to approximately elevation 666 feet, the soil is a plastic clay and contains no pebbles. The average liquid limit is 45 per cent and the average plastic limit is 21 per cent. The natural water content is about 28 per cent. The natural undrained shear strength of this soil decreases from approximately 3,000 psf immediately below the sand to 2,000 psf at the bottom of the deposit.

Below elevation 666 feet, the soil is less plastic, contains more pebbles, and is similar to the clay tills found in the Tilbury area. The average liquid limit of this soil is 32 per cent and the average plastic limit is 17 per cent. The natural water content is just above the plastic limit. Its natural undrained shear strength is higher than the overlying plastic clay and decreases from approximately 4,000 psf at elevation 666 feet to 3,200 psf at elevation 610 feet.

The results of the vane tests and the results of the laboratory tests are summarized on Appendixes B and C respectively, and are shown on Plates XII to XVI inclusive, and Plate XXIV.

The results of six consolidation tests are given on Plates XVII to XXII inclusive, and these results are compared on Plate XXV. It can be seen that the clay which overlies the clay till is appreciably more compressible than the clay till which is preconsolidated. The apparent maximum consolidation pressures to which these samples have been naturally consolidated were estimated from the results of the consolidation tests and these pressures are plotted on Plate XXIV. The accuracy of

these preconsolidation pressures is subject to considerable doubt because the very slight curvature of the compressibility curves renders graphical analysis difficult.

(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. For the purposes of this report, the pessimistic assumption has been made that the water pressures in the clay correspond to a ground water level two feet below the ground surface.

Design Considerations

(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:

- (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 corresponding to an earth pressure coefficient of 0.6.

The results of these calculations have been summarized on Plate XXVI 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 immediately below the sand. 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, whereas 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 XXVI.

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. The average undrained shear strength of the foundation clay is greater than 2.5 kips per square foot and, therefore, the safety factor against ultimate foundation failure due to this load 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 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 decrease rapidly with depth below the footings. To make the prediction of possible settlement of the bridge footings, it has been assumed that these footings will settle the same amount as the foundation below the approach embankments.

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For convenience in calculating the settlement of the embankment foundation, the foundation soil was divided into the following strata:

- (i) - 17 Feet of sand.
- (ii) - 15 Feet of plastic clay.
- (iii) - 100 Feet of clay till.

The consolidation characteristics of the clay strata are shown on Plate XXV. The following values of apparent modulus of elasticity, E, were used:

- (i) - Plastic clay, E = 400 kips per square foot
- (ii) - Clay till, E = 800 kips per square foot

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	0.2 feet
Consolidation settlement	0.4 feet

Total ultimate settlement 0.6 - 0.7 feet

- 11 -

The elastic settlement and most of the expected settlement in the sand stratum would 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 10 years.

Conslusions

(a) - On the basis of drilling work done at the site, the general soil profile consists of 17 feet of sand overlying clay of undetermined thickness. The ground water level in the sand was found to be approximately two feet below the ground surface. This water level may be seasonably high and, therefore, it does not necessarily reflect the water pressures in the underlying clay.

(b) - The results of 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 soil underlying the sand is composed of two types of clay, a 15-foot thickness of plastic clay, and a thick deposit of clay till. Both

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these soils exist in a preconsolidated state and their properties are summarized on Plates XXIV and XXV.

(d) - The 20-foot high embankment approaching the bridge can be safely supported by the sand stratum and underlying clay soils. The maximum ultimate settlement of the embankment foundation is estimated to be 0.6 - 0.7 feet.

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

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

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footings be done in the summer or early autumn,
when the water level in the sand is below the bottom
of the required excavations.

APPENDIX A

Program of Work

- April 4, 1960 - Penndrill No. 2 arrived on site and hole No. 872-1 was commenced.
- April 7, 1960 - Hole No. 872-1 was completed to 90 feet. Cone penetration test hole No. 872-6 was completed. Hole No. 872-2 was commenced.
- April 8, 1960 - Hole No. 872-2 was completed. Cone penetration test hole No. 872-7 was completed.
- April 11, 1960 - Penndrill No. 1 arrived on site and completed hole No. 872-5 to 40 feet. Cone penetration test hole No. 872-10 was completed. Penndrill No. 2 completed hole No. 872-3 to 40 feet. Cone penetration test hole No. 872-8 was completed.
- April 12, 1960 - Penndrill No. 2 completed hole No. 872-4 to 44 feet. Cone penetration test hole No. 872-9 was completed.

Summary of Time

<u>Work Type</u>	<u>No. of Holes</u>	<u>Total Length Feet</u>	<u>Total Time Hours</u>
Soil Drilling	5	260	49-1/2
Cone Penetration Tests	5	118	11

APPENDIX BSummary of Field Vane Test Results

Hole No.	Elevation Feet	Undrained Shear Strength Psf		Sensitivity
		Natural	Remoulded	
872-1	672.5	3,350	2,170	1.6
	662.5	3,350	2,170	1.6
	647.5	3,250	2,010	1.6
872-2	678.0	3,250	1,550	2.1
872-3	677.0	1,860	805	2.3
	667.0	2,020	1,300	1.5
872-4	676.0	2,170	775	2.8
	665.5	1,550	620	2.5
	658.0	3,410	1,920	1.8
872-5	677.0	3,100	1,400	2.2
	667.0	2,020	525	3.8
	657.0	2,940	1,550	1.9

APPENDIX C
Summary 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
872-1	5	668	20.0	33.2	16.2	3,123	20	1,740	1.8
	6	658	19.4	32.1	16.1	4,000	16	-	-
	7	638	20.1	32.7	16.4	3,880	16	1,433	2.7
	10	608	18.2	30.8	16.5	3,325	20	1,090	3.0
872-2	3	668	29.7	44.2	21.2	1,473	14	641	2.3
	5	653	20.7	31.9	16.2	2,295	20	1,360	1.7
873-3	3	672	33.4	45.9	22.1	1,793	11	-	-
	4	662	28.4	44.5	20.5	2,300	11	878	2.6
872-4	3	671	28.3	42.6	21.0	1,940	15	723	2.5
	4	663	23.0	38.8	18.2	3,645	19	-	-
	5	653	19.4	32.2	16.5	4,325	11	1,540	2.8
872-5	3	672	28.7	46.0	21.8	1,723	12	-	-
	4	662	18.8	32.0	16.8	4,595	16	-	-

e_f - Failure strain
Su_n - Natural undrained shear strength

Su_r - Remoulded undrained shear strength
St - Sensitivity

APPENDIX DList of Plates

Plate	I	-	Exploratory Holes, Plan and Section
Plate	II	-	Drilling Report, Hole No. 872-1
Plate	III	-	Drilling Report, Hole No. 872-2
Plate	IV	-	Drilling Report, Hole No. 872-3
Plate	V	-	Drilling Report, Hole No. 872-4
Plate	VI	-	Drilling Report, Hole No. 872-5
Plate	VII	-	Drilling Report, Hole No. 872-6
Plate	VIII	-	Drilling Report, Hole No. 872-7
Plate	IX	-	Drilling Report, Hole No. 872-8
Plate	X	-	Drilling Report, Hole No. 872-9
Plate	XI	-	Drilling Report, Hole No. 872-10
Plate	XII	-	Summary of Drilling and Test Results, Hole No. 872-1
Plate	XIII	-	Summary of Drilling and Test Results, Hole No. 872-2
Plate	XIV	-	Summary of Drilling and Test Results, Hole No. 872-3
Plate	XV	-	Summary of Drilling and Test Results, Hole No. 872-4
Plate	XVI	-	Summary of Drilling and Test Results, Hole No. 872-5
Plate	XVII	-	Consolidation Test; Hole No. 872-1, Sample Elevation 667.5 Feet
Plate	XVIII	-	Consolidation Test; Hole No. 872-1, Sample Elevation 657.5 Feet

Appendix D - 2

- Plate XIX - Consolidation Test; Hole No. 872-1,
Sample Elevation 637.5 Feet
- Plate XX - Consolidation Test; Hole No. 872-1,
Sample Elevation 607.5 Feet
- Plate XXI - Consolidation Test; Hole No. 872-4,
Sample Elevation 671.0 Feet
- Plate XXII - Consolidation Test; Hole No. 872-4,
Sample Elevation 652.5 Feet
- Plate XXIII - Grain Size Distribution - Gradation
of Typical Sand Samples from Hole
No. 872-1
- Plate XXIV - Summary of Drilling and Test Re-
sults - Comparison of all Tests
- Plate XXV - Consolidation Test - Comparison of
all Tests
- Plate XXVI - Net Allowable Bearing Pressure for
Bridge Abutment Footings

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP-95-59) HOLE No. 872-1
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 2
 CONTRACTOR: F.E. Johnston Drilling STARTED 1:00 P.M. April 4, 1960
 Company Limited FINISHED 9:00 A.M. April 7, 1960
 METHOD SOIL Pennrill 4-Inch Auger CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: LATITUDE Ch. 383+69.8 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 46 Feet. Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 607.0
 WATER TABLE 695.0

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST # Blows
			NO.	TYPE *	SIZE	DEPTH	RET'D	
					Inches	Feet	Inches	
0.0	Medium sand	Grey, wet, medium dense	1	AQ	2	4.0		
						4.5		6
						5.0		7 26
						5.5	18	13
			2	A2	2	9.0		
						9.5		6
						10.0		9 32
						10.5	18	17
			3	AQ	2	14.0		
						14.5		8
						15.0		11 32
						15.5	18	13
15.2	Clay till	Grey, firm very stiff tenacious with scattered pebbles.	4	AQ	2	19.0		
						19.5		3
						20.0		5 19
						20.5		11
					Vane Test	24.5		
			5	BO	2	29.0		
						30.5	18	Pushed
					Vane Test	34.5		

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 TIN Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. Bateson

LOGGED BY J. MacLeod

APPROVED

DATE

D. H. MacDonald

May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP-95-59) HOLE No. 872-1
 SITE Township of Alaborough, Between Lots 8 and 9, Ontario SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	*Blows
					Inches	Feet	Inches	
			6	BO	2	39.0		
						40.5	18	Pushed
					Vane Test	49.0		
			7	BO	2	59.0		
						59.5		4
						60.0		29
						60.5	16	29
			8	BO	2	69.0		
						70.5	18	Pushed
			9	BO	2	79.0		
						80.0		Pushed
						80.5	15	45
90.0		End of hole	10	BO	2	89.0		
						90.0		Pushed
						90.5	14	36
		<u>Note: *Penetration Test</u>						
		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. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-2
 SITE Township of Aldborough Between Lots 8 and 9 Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 1:00 P.M. April 7 1960
 FINISHED 12:00 A.M. April 8 1960
 METHOD OF DRILLING: SOIL Penndrill CASING DIAM.
 ROCK CORE DIAM.

LOCATION: ~~LATITUDE~~ Ch.383+69.8 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 49 Feet Left DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 652.0
 WATER TABLE 695.0

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE*	SIZE	DEPTH	RET'D	
					Inches	Feet	Inches	*Blows
0.0	Medium sand	Grey, medium dense	1	AQ	2	9.0		
						9.5		6
						10.0		9
						10.5	18	13
17.0	Clay till	Grey, stiff and tenacious with scattered pebbles	2	AQ	2	14.0		
						14.5		4
						15.0		8
						15.5	18	14
44.0		End of hole			Vane Test at	19.0		
		<u>Notes:</u>	3	BO	2	29.0		
		Penetration Test:				30.5	18	Pushed
		This is the number of						
		blows of a 140-foot	4	AQ	2	39.0		
		weight falling 30 inches				39.5		6
		required to advance the				40.0		11
		sampler to depth indicated.				40.5	18	18
			5	BO	2	44.0		
						45.5	18	Pushed

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 — PLIOPILM BAG
 P — WATER CONTENT TIN Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. Bateson
 LOGGED BY J. MacLeod

APPROVED *A. H. MacDonald*
 DATE May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-3
 SITE Township of Aldborough Between Lots 8 and 9 Ontario SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 8:00 A.M. April 11 1960
 FINISHED 3:00 P.M. April 11 1960
 METHOD OF DRILLING: SOIL Penndrill CASING DIAM.
 ROCK CORE DIAM.

LOCATION: LATITUDE Ch. 383+19 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 50 Feet Left DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 657.0
 WATER TABLE 695.0

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	
					Inches	Feet	Inches	*Blows
0.0	Medium sand	Wet, medium dense		AZ	2	5.0		
						5.5		6
						6.0		11
						6.5	18	13
18.5	Clay till	Grey, wet, stiff and tenacious with scattered pebbles.	1	AQ	2	10.0		
						10.5		6
						11.0		10
						11.5	18	12
			2	AQ	2	15.0		
						15.5		3
						16.0		6
						16.5	18	8
					Vane test	20.0		
			3	BO	2	25.0		
						25.5		6
						26.0		9
						26.5	18	12
					Vane test	30.0		

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 TIN Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. Bateson
 LOGGED BY J. MacLeod

APPROVED

Dr. H. Macdonald

DATE

May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 872

PROJECT Highway 401, County Road Interchange (WP95-59)

HOLE No. 872-3

SITE Township of Aldborough Between Lots 8 and 9 Ontario

SHEET No. 2 OF 2

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	
					Inches	Feet	Inches	* Blows
18.5	Clay till		4	BQ	2	35.0		
	Cont'd					36.5		Pushed
		<u>Note:</u>	5	BQ	2	40.0		
		Penetration Test:				41.5		Pushed
		This is the number of						
		blows of a 140-pound						
		weight falling 30 inches						
		required to advance the						
		sampler to depth indicated.						
40.0		End of hole						

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-4
 SITE Township of Aldborough Between Lots 8 and 9 Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling STARTED 8:00 A.M. April 12 1960
 Company Limited FINISHED 3:00 P.M. April 12 1960

METHOD SOIL Penndrill CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.

LOCATION: LATITUDE Ch. 383+19 ELEVATIONS: DATUM G.S.O.
 DEPARTURE On Centreline DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 653.0
 WATER TABLE 695.0

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	
					Inches	Feet	Inches	*Blows
0.0	Sand	Fine to medium, grey, wet, medium dense.	1	AQ	2	9.0		
						9.5		6
						10.0		11
						10.5	18	14
15.2	Clay till	Wet, gray stiff and tenacious with scattered pebbles to 1 1/4 inch	2	AQ	2	14.0		
						14.5		5
						15.0		12
						15.5	18	14
					Vane test	21.0		
44.0		End of hole	3	BO	2	26.0		
						27.5	18	Pushed
		Note:						
		Penetration test			Vane test	31.5		
		This is the number of blows of a 140-pound weight falling 30 inches required to advance the sampler to depth indicated.	4	BO	2	34.0		
						35.5	18	Pushed
					Vane test	39.0		
			5	BO	2	44.0		
						45.5	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. Bateson

LOGGED BY J. MacLeod

APPROVED

DATE

May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-5
 SITE Township of Aldborough Between Lots 8 and 9 Ontario SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 8:00 A.M. April 11 1960
 FINISHED 3:00 P.M. April 11 1960
 METHOD OF DRILLING: SOIL Penndrill CASING DIAM. _____
 ROCK _____ CORE DIAM. _____
 LOCATION: LATITUDE Ch. 383+19 ELEVATIONS: DATUM C.S.C.
 DEPARTURE 55 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 657.0
 WATER TABLE 695.0

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	
					Inches	Feet	Inches	* Blows
0.0	Medium sand	Grey, medium dense	1	AQ	2	10.0		
						10.5		6
						11.0		9
						11.5	18	15
16.2	Clay till	Grey, moist, very stiff and tenacious with scattered pebbles.	2	AQ	2	15.0		
						15.5		5
						16.0		12
						16.5	18	18
					Vane test	20.0		
			3	BO	2	25.0		
40.0		End of hole				25.5		6
						26.0		13
						26.5	18	16
		*Note:						
		Penetration Test:			Vane test	30.0		
		This is the number of						
		blows of a 140-pound	4	BO	2	35.0		
		weight falling 30 inches				35.5		6
		required to advance the				36.0		13
		sampler to depth indicated.				36.5	18	17
					Vane test	40.0		

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

APPROVED *A. H. MacDonald*

LOGGED BY J. MacLeod

DATE May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP-95-59) HOLE No. 872-6
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling STARTED 10:00 A.M. April 7 19 60
 Company Limited FINISHED 12:00 A.M. April 7 19 60
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: ~~LATITUDE~~ Ch. 383+69.8 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 51 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.4
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 677.4
 WATER TABLE 695.4

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	
0.0	Sand					Feet		Blows
		<u>Note:</u>				1		5
		D.H.O. Penetration Test:				2		11
		This is the number of				3		13
		blows of a 140-pound				4		19
		weight falling 30 inches				5		26
		required to advance the				6		44
		cone one foot.				7		36
						8		34
						9		48
						10		65
						11		68
						12		64
						13		84
						14		71
15.2	Clay till					15		37
						16		47
						17		52
						18		62
						19		77
						20		87

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. Bateson

APPROVED *D. H. MacLeod*

LOGGED BY J. MacLeod

DATE May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-7
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 2
 CONTRACTOR: F.E. Johnston Drilling STARTED 1:00 P.M. April 8 1960
 Company Limited FINISHED 2:00 P.M. April 8 1960
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: LATITUDE Ch. 383+69.8 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 44 Feet Left DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE
 WATER TABLE 695.4

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					Feet		Blows
		<u>Note:</u>				1		5
		D.H.O. Penetration Test:				2		9
		This is the number of				3		10
		blows of a 140-pound				4		9
		weight falling 30 inches				5		25
		required to advance the				6		36
		cone one foot.				7		37
						8		36
						9		39
						10		45
						11		49
						12		51
						13		56
						14		56
						15		66
						16		38
17.0	Clay till					17		43
						18		47
						19		53
						20		77
						21		77
						22		77
						23		92
						24		90
						25		90

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

JOB No. 872

HOLE No. 872-7

SHEET No. 2 OF 2

[illegible]

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-8
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 3:00 P.M. April 11 1960
 FINISHED 5:00 P.M. April 11 1960
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.

LOCATION: ~~LATITUDE~~ Ch. 383+19 ELEVATIONS: DATUM U.S.C.
 DEPARTURE 45 Feet Left DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 676.0
 WATER TABLE 695.0

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	
0.0	Sand					0		Blows
						1		5
						2		7
		Note:				3		8
		D.H.O. Penetration Test:				4		9
		This is the number of				5		20
		blows of a 140-pound				6		42
		weight falling 30 inches				7		54
		required to advance the				8		50
		cone one foot.				9		54
						10		53
						11		49
						12		61
						13		61
						14		48
						15		70
						16		43
						17		34
13.5	Clay till					18		40
						19		48
						20		73
						21		81

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 TIN Z — DISCARDED
 Q — GLASS JAR

INSPECTOR J. MacLeod

APPROVED

D. H. 2 McDonald

LOGGED BY J. MacLeod

DATE

May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872
 PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-9
 SITE Township of Aldborough, Between Lots 8 and 9, Ontario SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 3:00 P.M. April 12 1960
 FINISHED 5:00 P.M. April 12 1960
 METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.
 OF
 DRILLING: ROCK CORE DIAM.
 LOCATION: LATITUDE Ch. 383+19 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 5 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 676.0
 WATER TABLE 695.0

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	
0.0	Sand					Feet		Blows
						0		
						1		3
						2		7
						3		8
						4		10
						5		33
						6		37
						7		38
						8		38
						9		38
						10		21
						11		45
						12		64
						13		86
						14		81
15.2	Clay till					15		71
						16		67
						17		48
						18		50
						19		53
						20		63
								79

SAMPLING METHOD		SHIPPING CONTAINER	
* A — SPLIT TUBE	E — AUGER	N — INSERT	R — CLOTH BAG
B — THIN WALL TUBE	F — WASH	O — TUBE	S — PLIOFILM BAG
C — PISTON SAMPLER		P — WATER CONTENT TIN	Z — DISCARDED
D — CORE BARREL		Q — GLASS JAR	

INSPECTOR J. MacLeod
 LOGGED BY J. MacLeod
 APPROVED *D. H. Macdonald*
 DATE May, 1960

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 872

PROJECT Highway 401, County Road Interchange (WP95-59) HOLE No. 872-10

SITE Township of Alborough Between Lots 8 and 9 Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 3:00 P.M. April 11 19 60
 FINISHED 5:00 P.M. April 11 19 60

METHOD SOIL D.H.O. Cone Penetration Test CASING DIAM.

OF DRILLING: ROCK CORE DIAM.

LOCATION: LATITUDE Ch. 383+19 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 50 Feet Right DRILL PLATFORM
 BEARING GROUND SURFACE 697.0
 INITIAL DIP 90 Degrees ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 677.0
 WATER TABLE 695.0

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	
						Feet		* Blows
0.0	Sand					0		
						1		2
						2		6
		<u>Note:</u>				3		8
		D.H.O. Cone Penetration Test				4		13
		This is the number of				5		27
		blows of 140-pound weight				6		27
		falling 30 inches required				7		25
		to advance the cone one				8		29
		foot,				9		36
						10		38
						11		44
						12		53
						13		52
						14		39
						15		33
16.2	Clay till					16		25
						17		30
						18		40
						19		49
						20		60

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

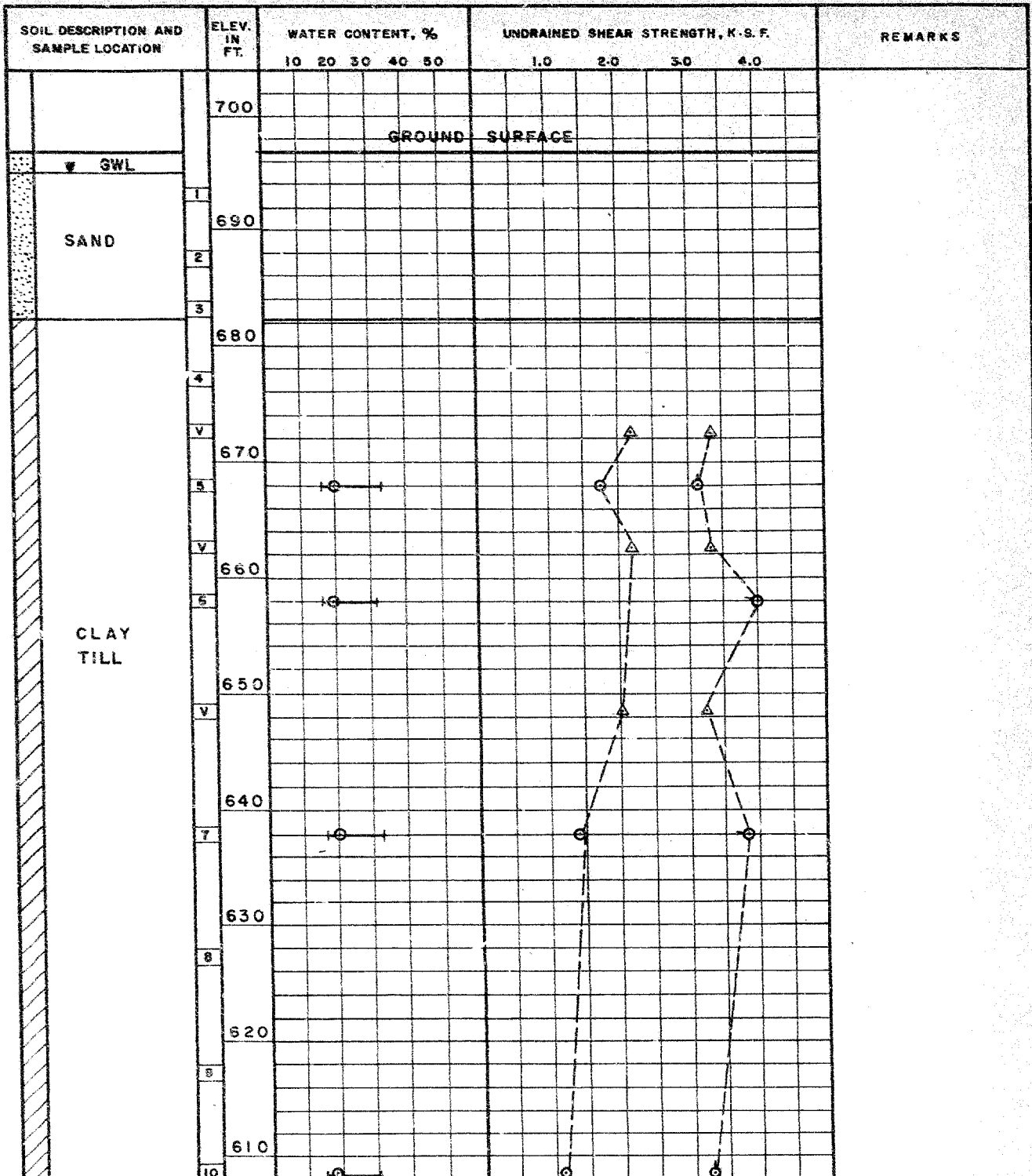
R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J. MacLeod

LOGGED BY J. MacLeod

APPROVED *D. H. MacLeod*

DATE May, 1960



3
○
—
—

SOIL SAMPLE
NATURAL WATER CONTENT
LIQUID LIMIT
PLASTIC LIMIT

○
△

UNDRAINED COMPRESSION TEST
FIELD VANE TEST
NATURAL STRENGTH
REMOULDED STRENGTH

0
15—○—5
10

FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 872-i

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

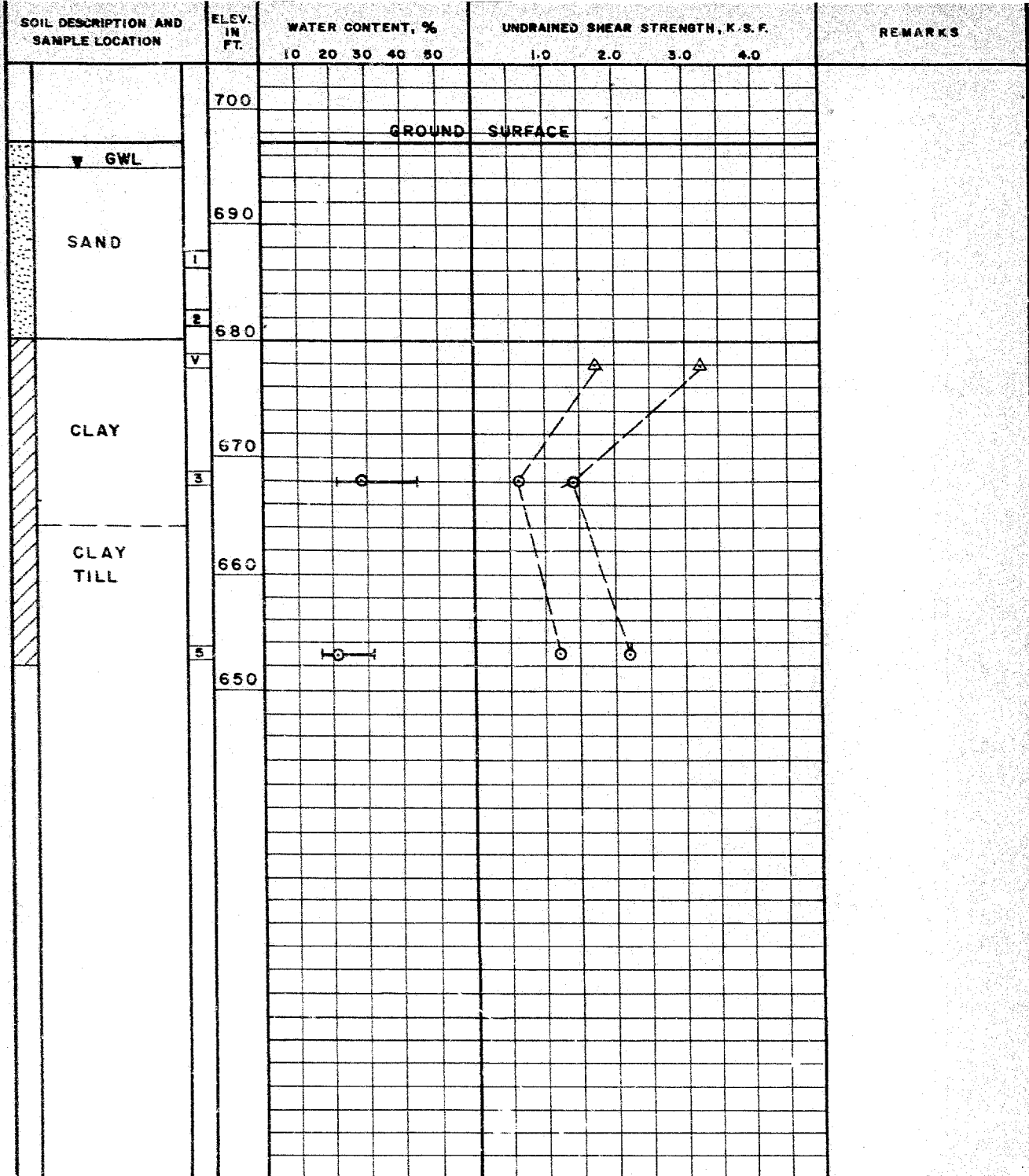
DATE: MAY, 1960

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

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

JOB No. 872

PLATE XII



3

SOIL SAMPLE

○

NATURAL WATER CONTENT

—|—

LIQUID LIMIT

—|—

PLASTIC LIMIT

○

UNDRAINED COMPRESSION TEST

△

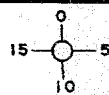
FIELD VANE TEST

— — —

NATURAL STRENGTH

— — —

REMOULDED STRENGTH



FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 872-2

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

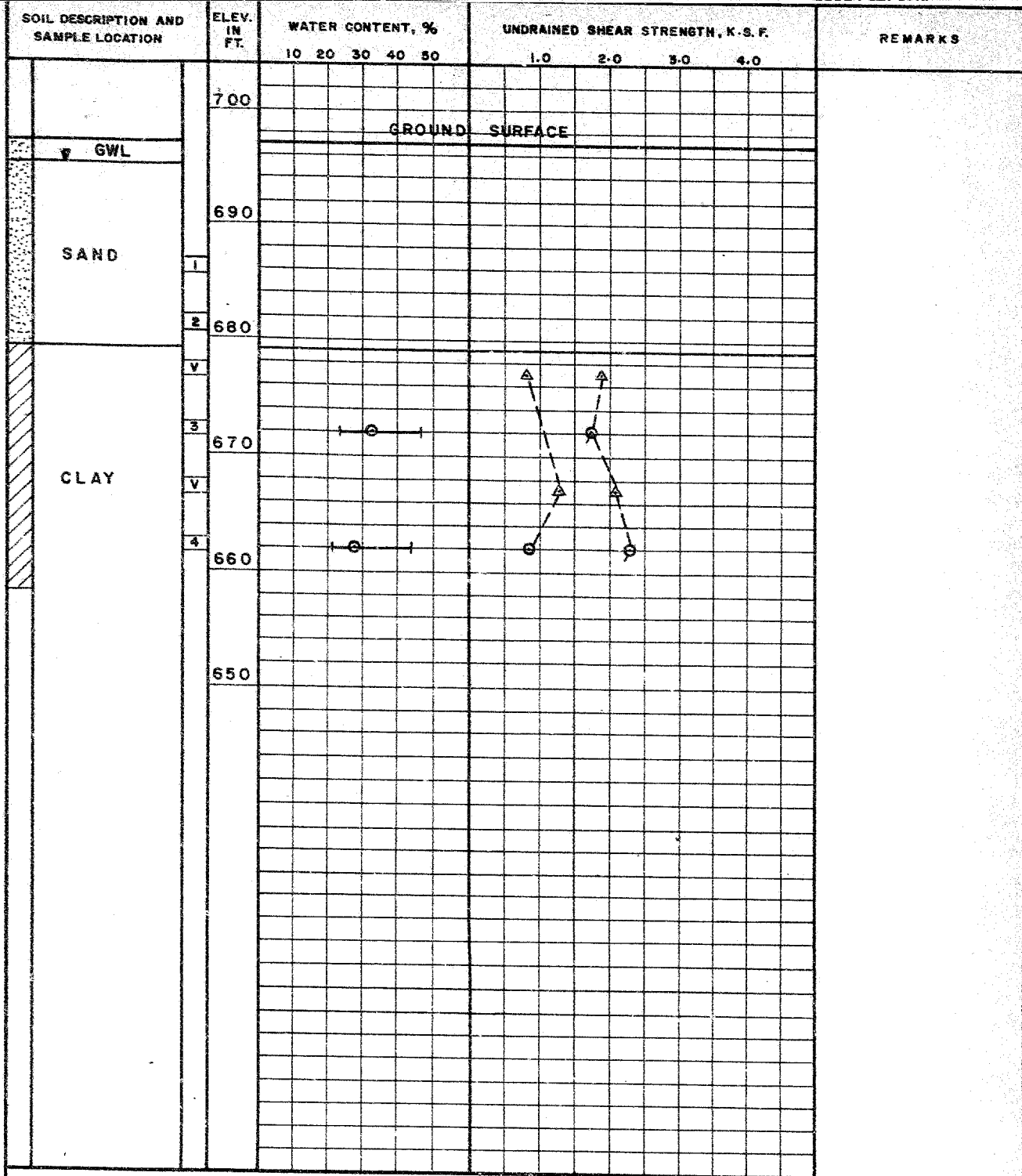
DATE: MAY, 1960

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

H. G. Acres
H.G. ACRES & COMPANY LTD.

JOB No. 872

PLATE XIII



3

SOIL SAMPLE

○

NATURAL WATER CONTENT

○

LIQUID LIMIT

—

PLASTIC LIMIT

○

UNDRAINED COMPRESSION TEST

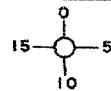
△

FIELD VANE TEST

—

NATURAL STRENGTH

REMOULDED STRENGTH



FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 872-3

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

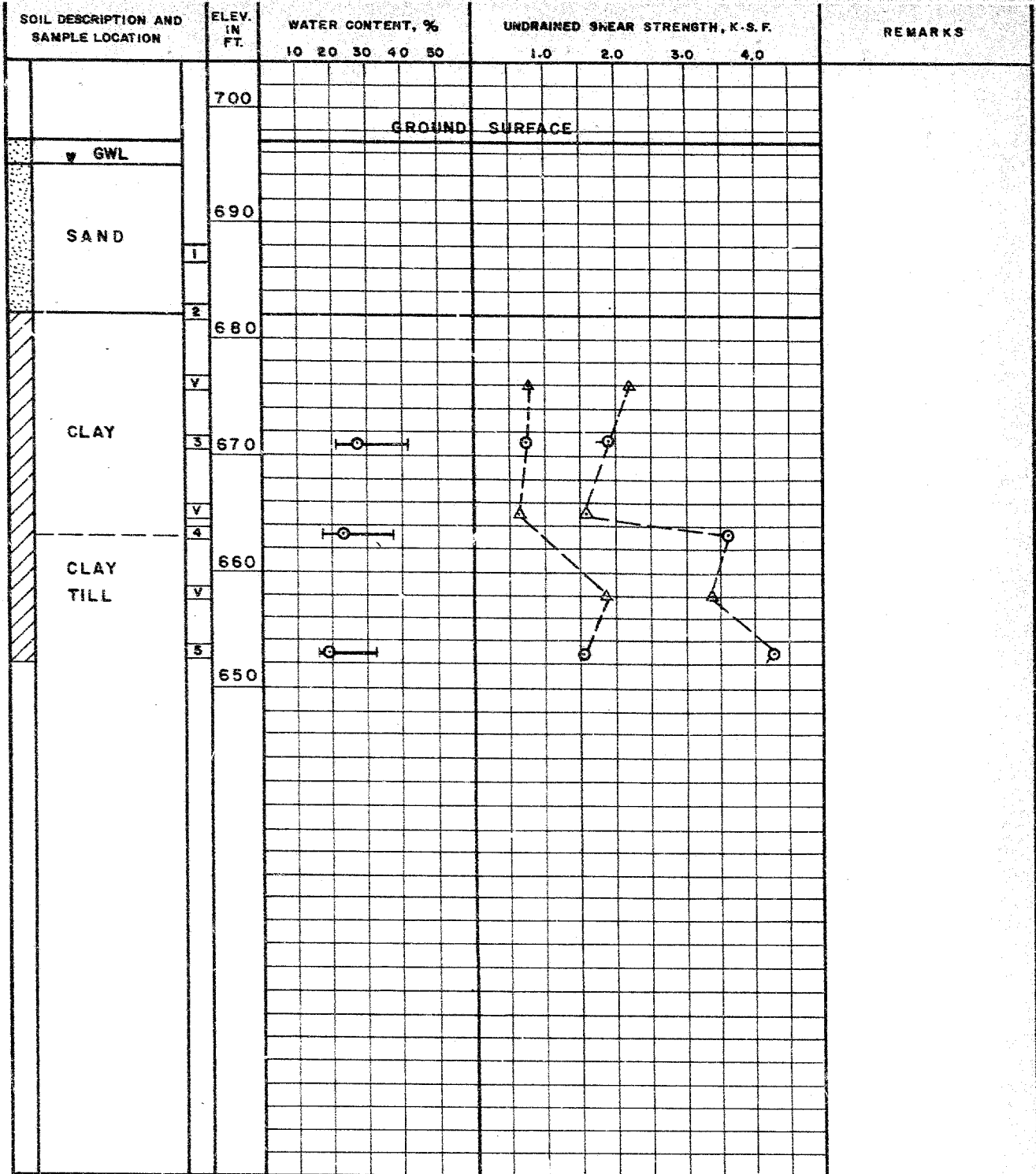
HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

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

JOB No. 872

PLATE XIV

SK-872-LS-14



3
○
—
—
—

SOIL SAMPLE
NATURAL WATER CONTENT
LIQUID LIMIT
PLASTIC LIMIT

○
△

UNDRAINED COMPRESSION TEST
FIELD VANE TEST
NATURAL STRENGTH
REMOULDED STRENGTH

15
○
10

FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 872-4

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

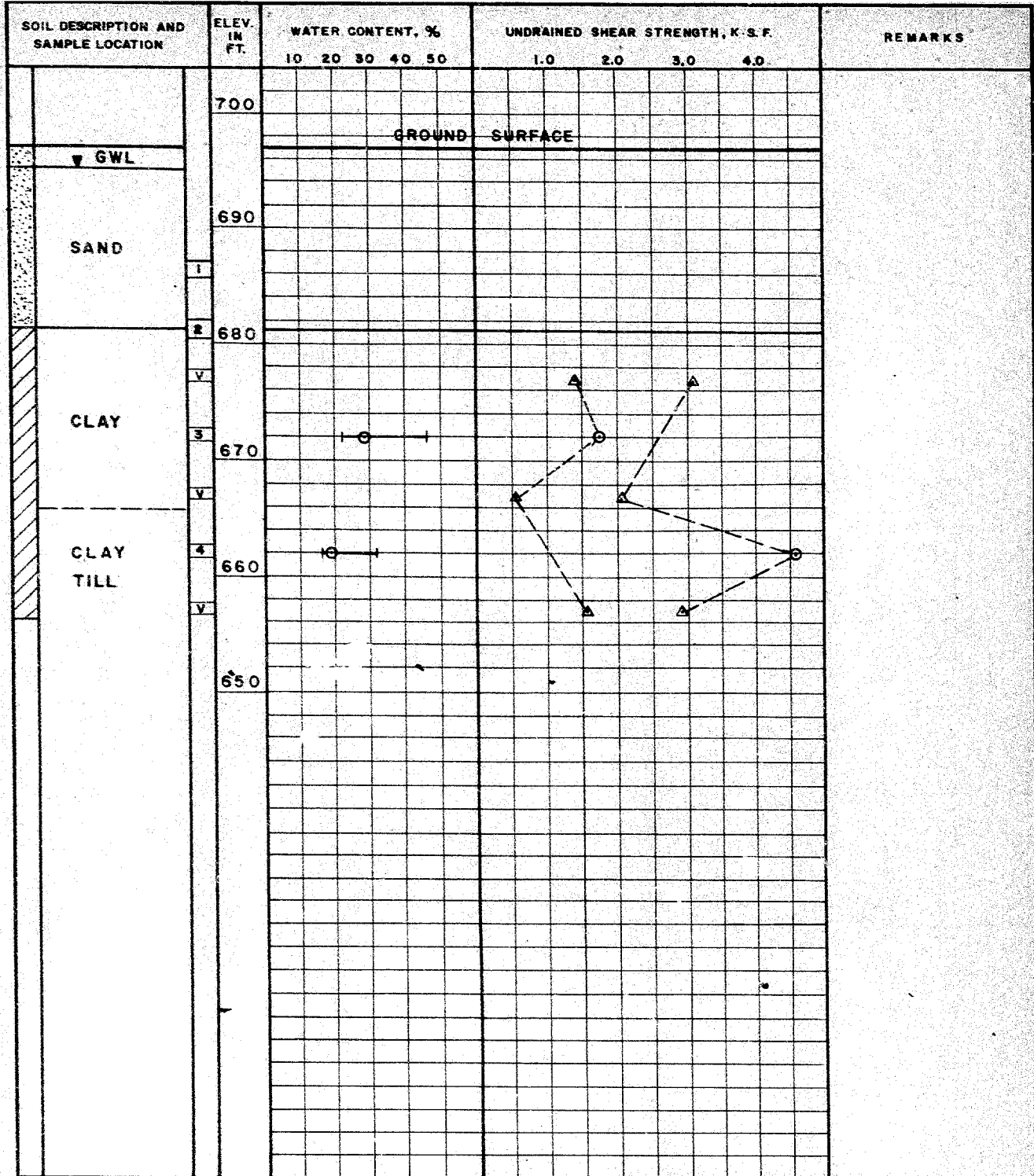
DATE: MAY, 1960

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

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

JOB No. 872

PLATE XV



3

○
○
—
—
—

SOIL SAMPLE
NATURAL WATER CONTENT
LIQUID LIMIT
PLASTIC LIMIT

○

△

—

UNDRAINED COMPRESSION TEST
FIELD VANE TEST
NATURAL STRENGTH
REMOULDED STRENGTH

0
15—○—5
10

FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 872-5

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

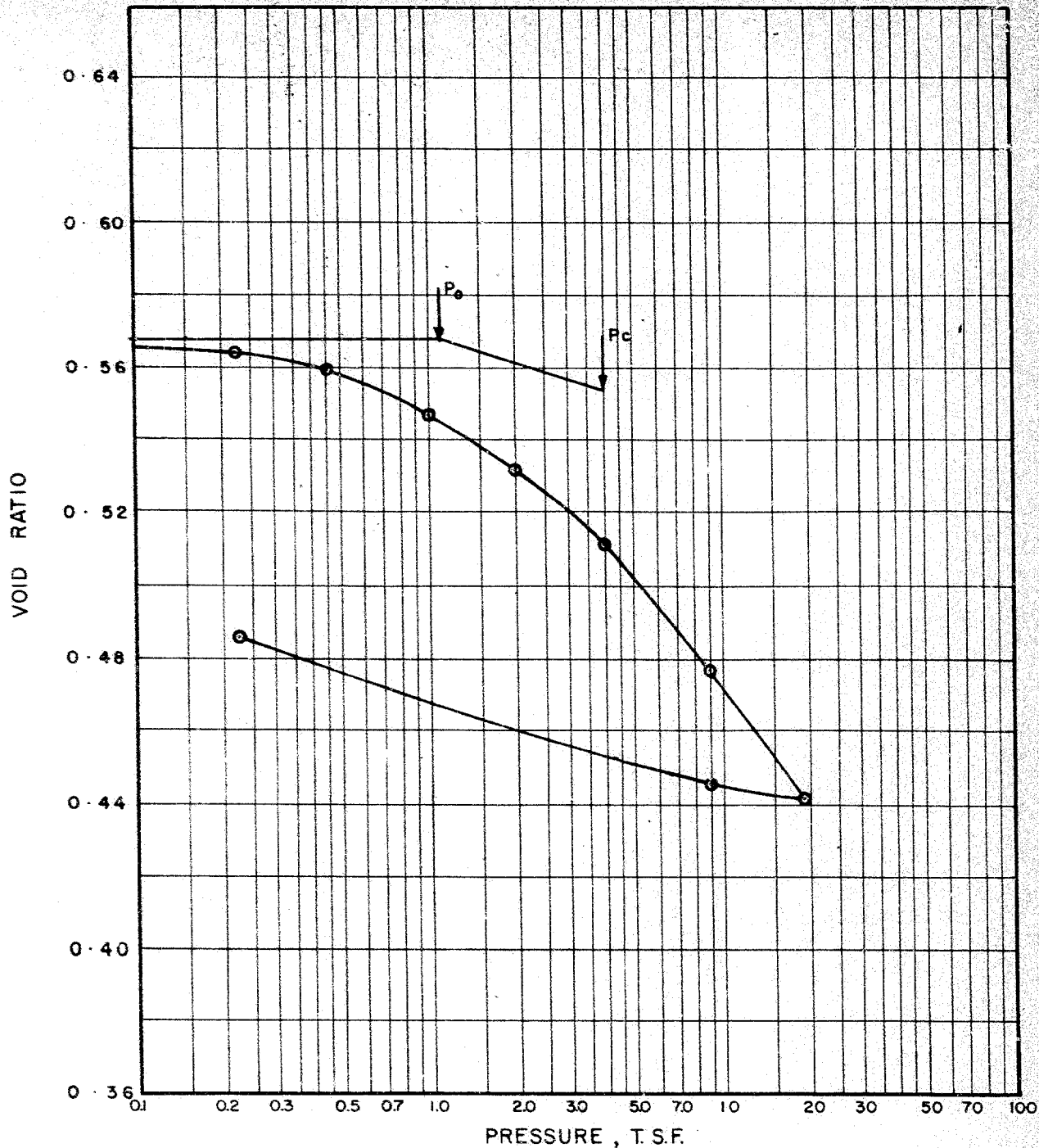
HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

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

JOB No. 872

PLATE XVI

SK-872-LS-16



OVERBURDEN PRESSURE — $P_0 = 1.1$ T.S.F.
 CONSOLIDATION PRESSURE — $P_c = 4.0$ T.S.F.

NATURAL WATER CONTENT = 20.20 %
 LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-80-1

TEST DATE APRIL 20, 1960

TEST No. 872-9-1

TESTED BY R. G.

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

CONSOLIDATION TEST

HOLE No. 872-1 SAMPLE ELEV. 667.5'

APPROVED

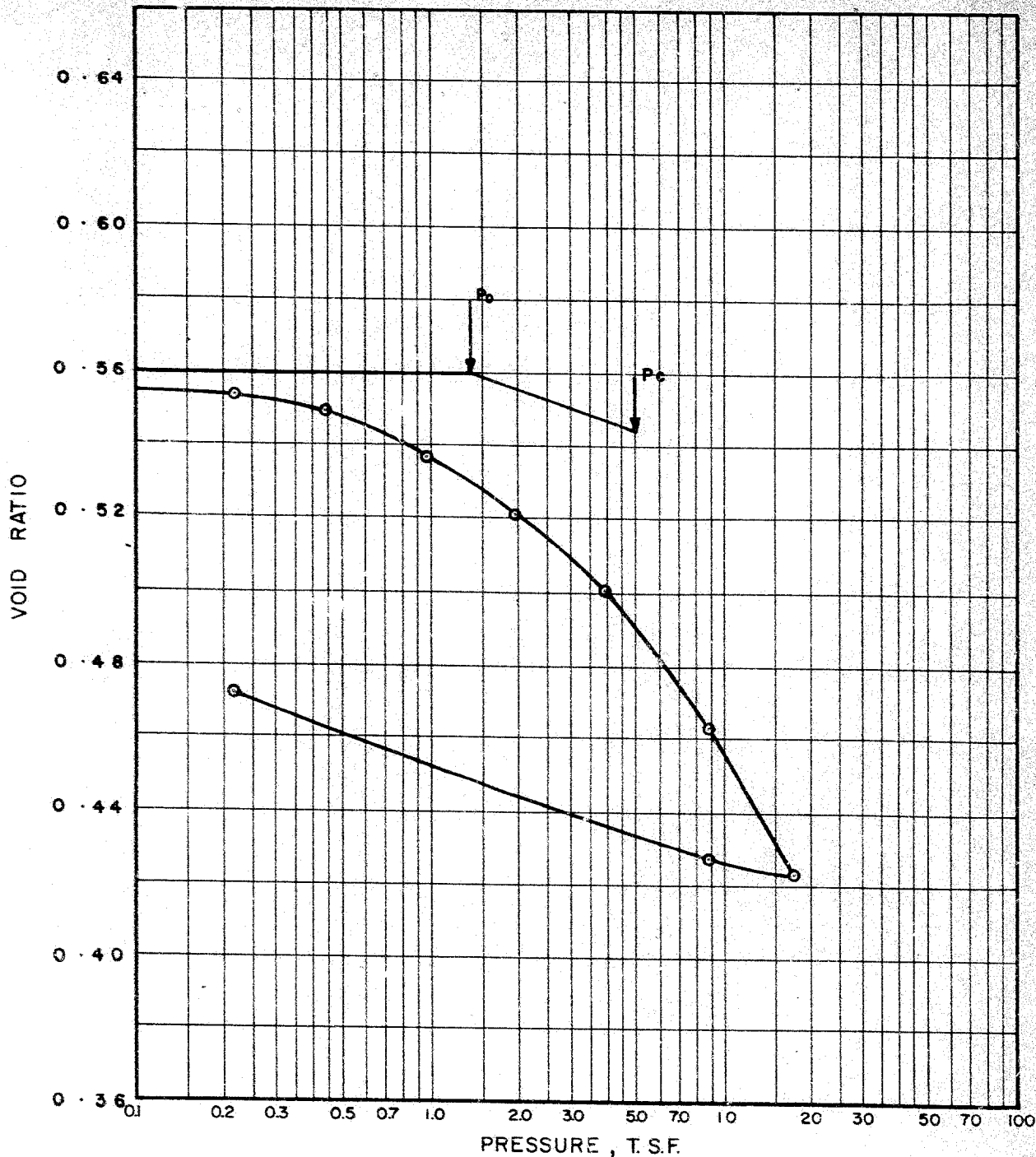
D. H. Macdonald
 H. G. ACRES & COMPANY LTD.

DATE: MAY, 1960

JOB No. 872

PLATE XVII

SK-872-LS-17



OVERBURDEN PRESSURE — $P_0 = 1.4$ T.S.F.
 CONSOLIDATION PRESSURE — $P_c = 5.0$ T.S.F.

NATURAL WATER CONTENT = 19.9 %
 LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-80-2

TEST DATE APRIL 20, 1960

TEST No. 872-9-2

TESTED BY R. G.

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

CONSOLIDATION TEST

HOLE No. 872-1 SAMPLE ELEV. 657.5'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

H. G. Acres
 H. G. ACRES & COMPANY LTD.

JOB No. 872

PLATE XVIII

SK-872-LS-18

VOID RATIO

0.64

0.60

0.56

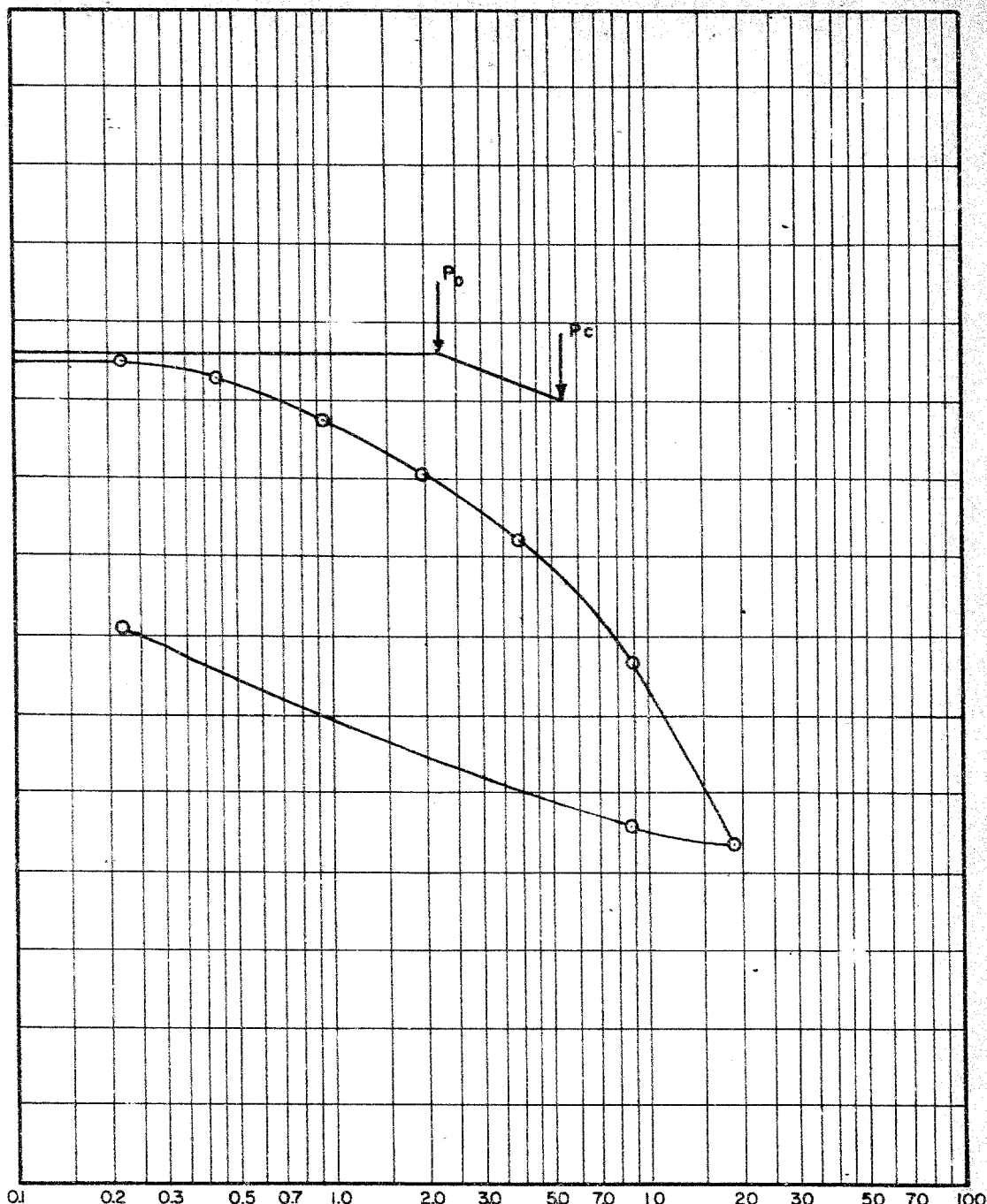
0.52

0.48

0.44

0.40

0.36



PRESSURE, T.S.F.

OVERBURDEN PRESSURE — $P_0 = 2.2$ T. S. F.

NATURAL WATER CONTENT = 19.5 %

CONSOLIDATION PRESSURE — $P_c = 5.4$ T. S. F.

LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-80-3

TEST DATE APRIL 21, 1960

TEST No. 872-9-3

TESTED BY R.G.

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

CONSOLIDATION TEST

HOLE No. 872-1 SAMPLE ELEV. 637.5'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

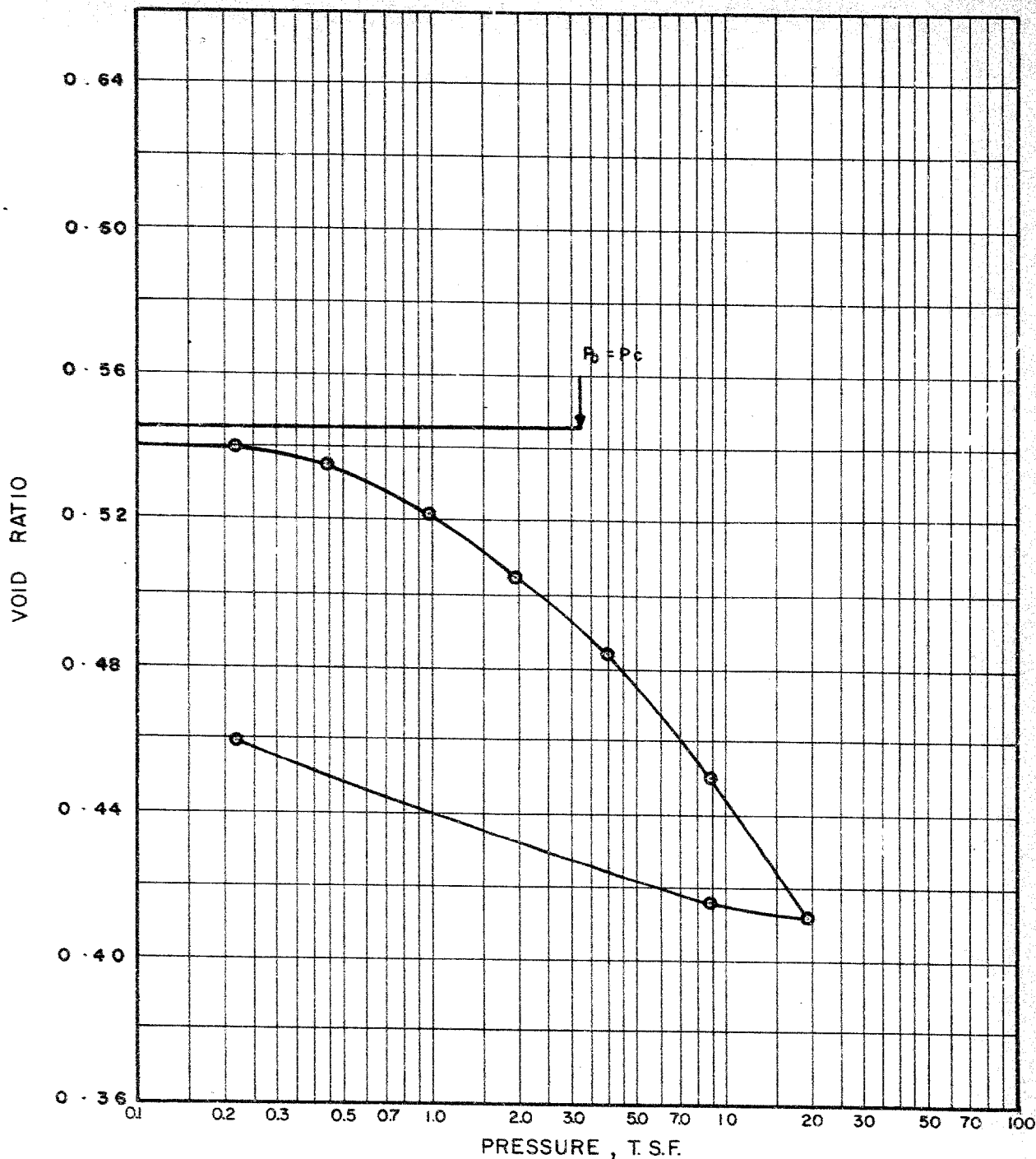
HWY. 401, COUNTY ROAD INTERCHANGE (WP 95-59)

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

JOB No. 872

PLATE XIX

SK-872-LS-19



OVERBURDEN PRESSURE — $P_0 = 3.2$ T.S.F.
 CONSOLIDATION PRESSURE — $P_c = 3.2$ T.S.F.

NATURAL WATER CONTENT = 18.35%
 LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-80-6

TEST DATE APRIL 21, 1960

TEST No. 872-9-4

TESTED BY R.G.

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

CONSOLIDATION TEST

HOLE No. 872-1 SAMPLE ELEV. 607.5'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

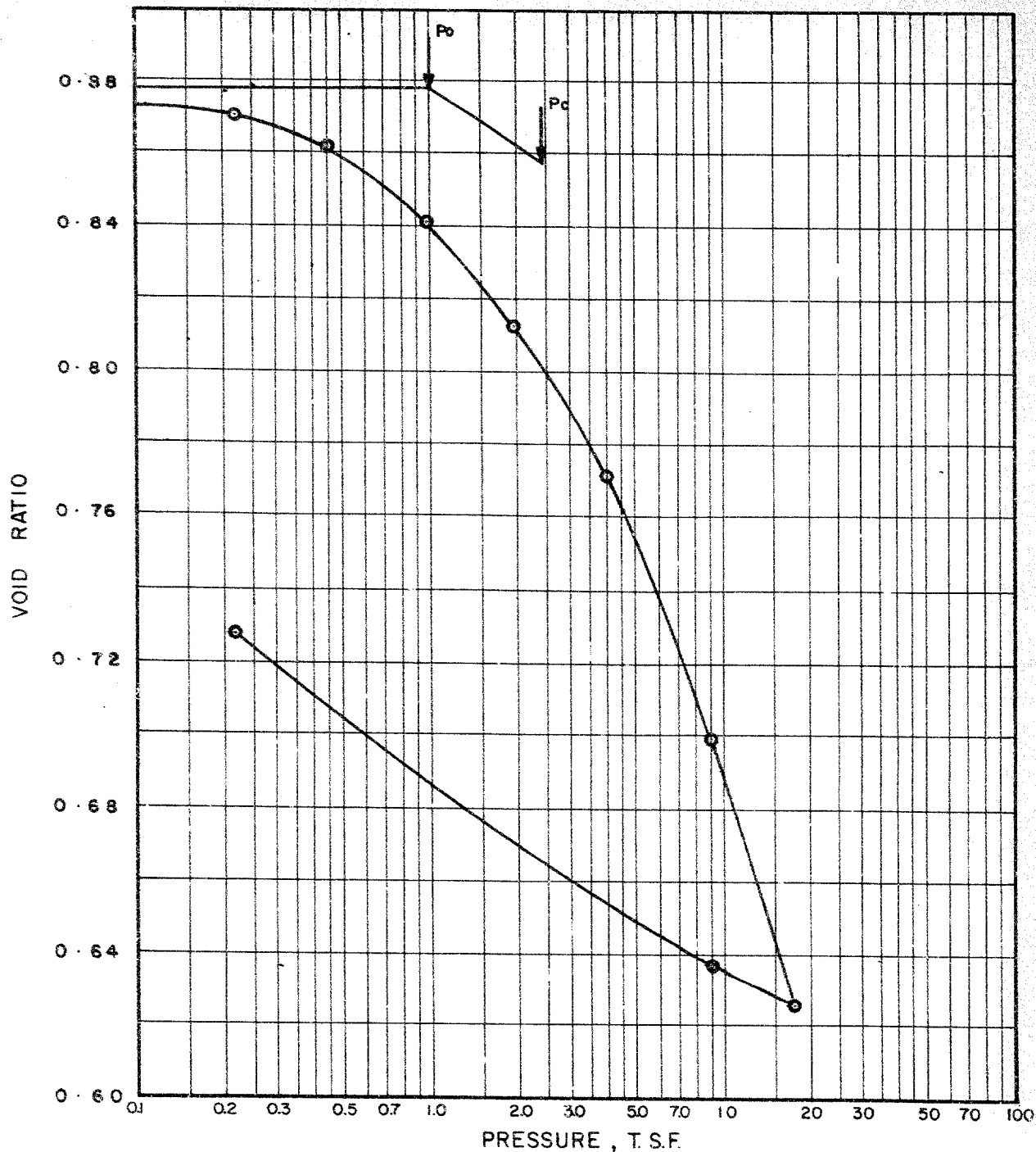
HWY. 401, COUNTY ROAD INTERCHANGE (WP95-59)

H.G. ACRES & COMPANY LTD.

JOB No. 872

PLATE XX

SK-872-LS-20



OVERBURDEN PRESSURE — $P_0 = 1.0$ T.S.F. NATURAL WATER CONTENT = 30.30 %
 CONSOLIDATION PRESSURE — $P_c = 2.4$ T.S.F. LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-B0-12 TEST DATE APRIL 21, 1960
 TEST No. 872-9-5 TESTED BY R.G.

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

CONSOLIDATION TEST

HOLE No. 872-4 SAMPLE ELEV. 671.0'

APPROVED

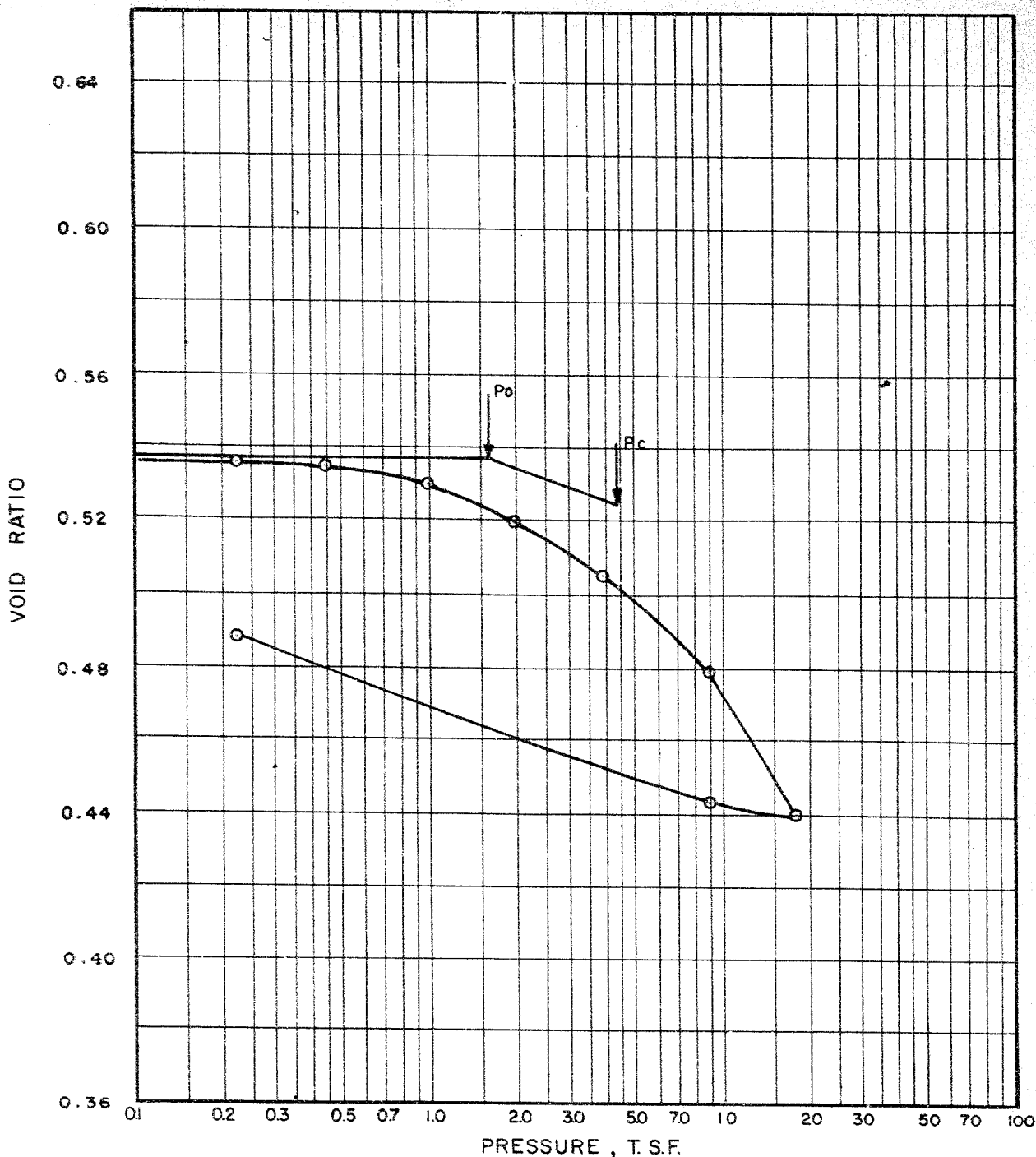
D. H. Macdonald
 H.G. ACRES & COMPANY LTD.

DATE: MAY, 1960

JOB No. 872

PLATE XXI

SK-872-L5-21



OVERBURDEN PRESSURE — $P_0 = 1.6$ T.S.F. NATURAL WATER CONTENT = 18.57 %
 CONSOLIDATION PRESSURE — $P_c = 4.2$ T.S.F. LOADING INTERVAL — 25 MIN.

SAMPLE No. 872-80-15 TEST DATE APRIL 21, 1960
 TEST No. 872-9-6 TESTED BY R. G.

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

CONSOLIDATION TEST

HOLE No. 872-4 SAMPLE ELEV. 652.5'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: MAY, 1960

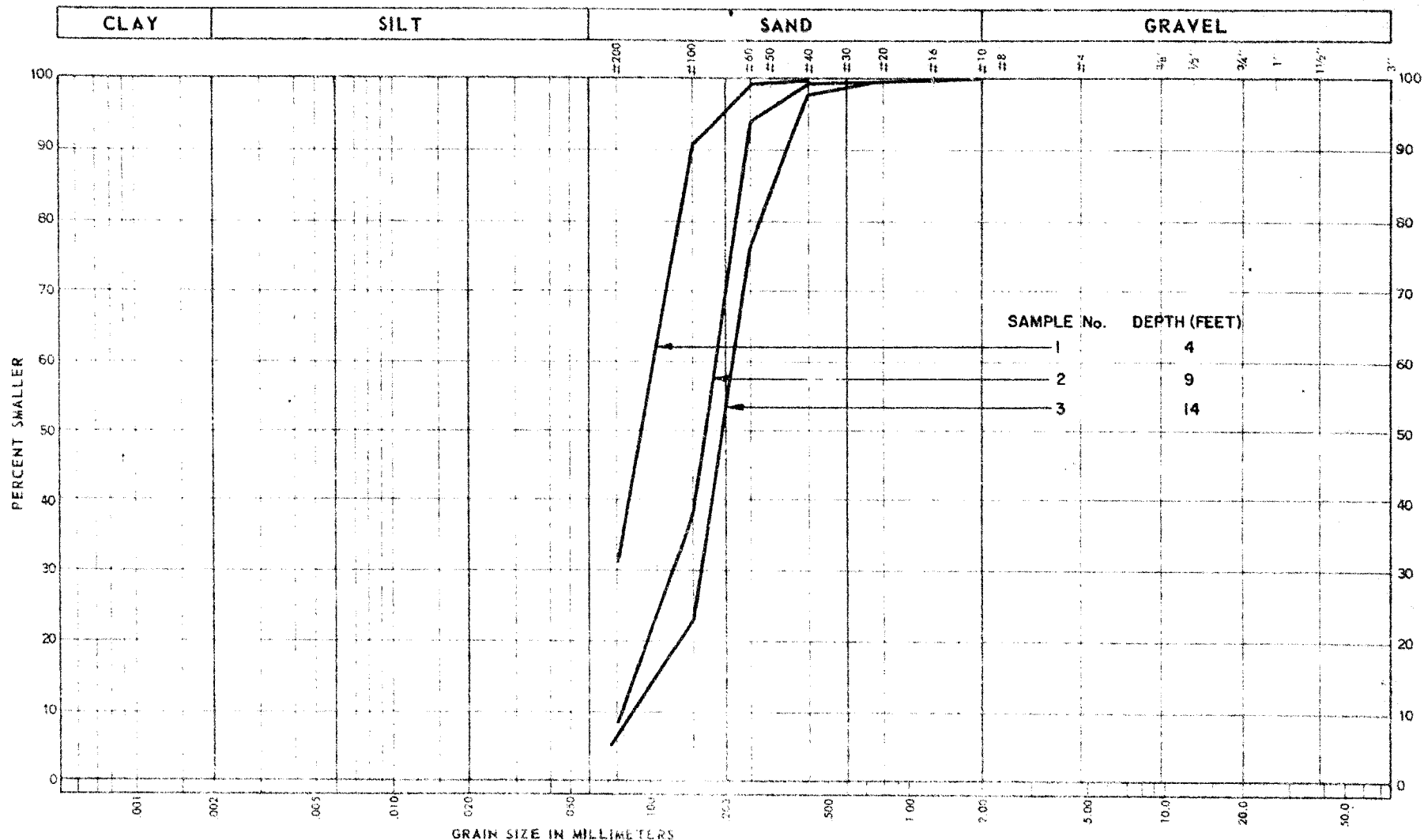
HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

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

JOB No. 872

PLATE XXII

SK-872-LS-22



REMARKS:

GRADATION OF TYPICAL SAND SAMPLES FROM HOLE No. 872-1

GRAIN SIZE DISTRIBUTION

HOLE No. 872 - 1

DATE MAY 1960

SAMPLE No. AS NOTED

TESTED BY

DEPTH AS NOTED

APP.

D. H. R.

DWG. No. PLATE - XXIII

JOB No. 872

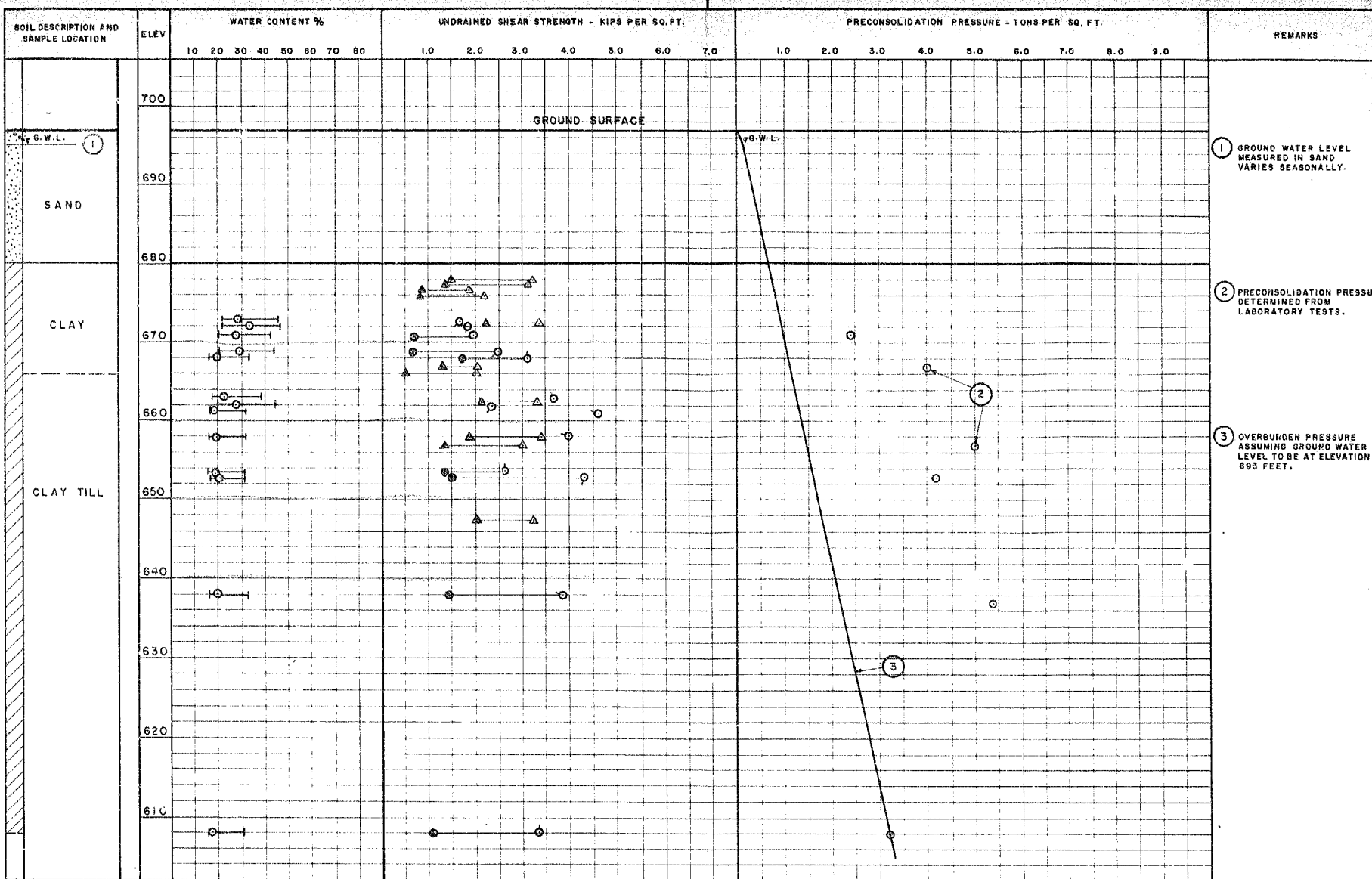
H. G. ACRES & COMPANY LIMITED

CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, COUNTY ROAD INTERCHANGE (W.P.95-59)



③ SOIL SAMPLE

○ NATURAL WATER CONTENT

— LIQUID LIMIT

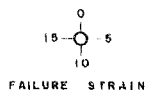
— PLASTIC LIMIT

○ UNDRAINED COMPRESSION TEST

△ FIELD VANE TEST

— NATURAL STRENGTH

— REMOULDED STRENGTH



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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

SUMMARY OF DRILLING AND TEST RESULTS

COMPARISON OF ALL TESTS

APPROVED

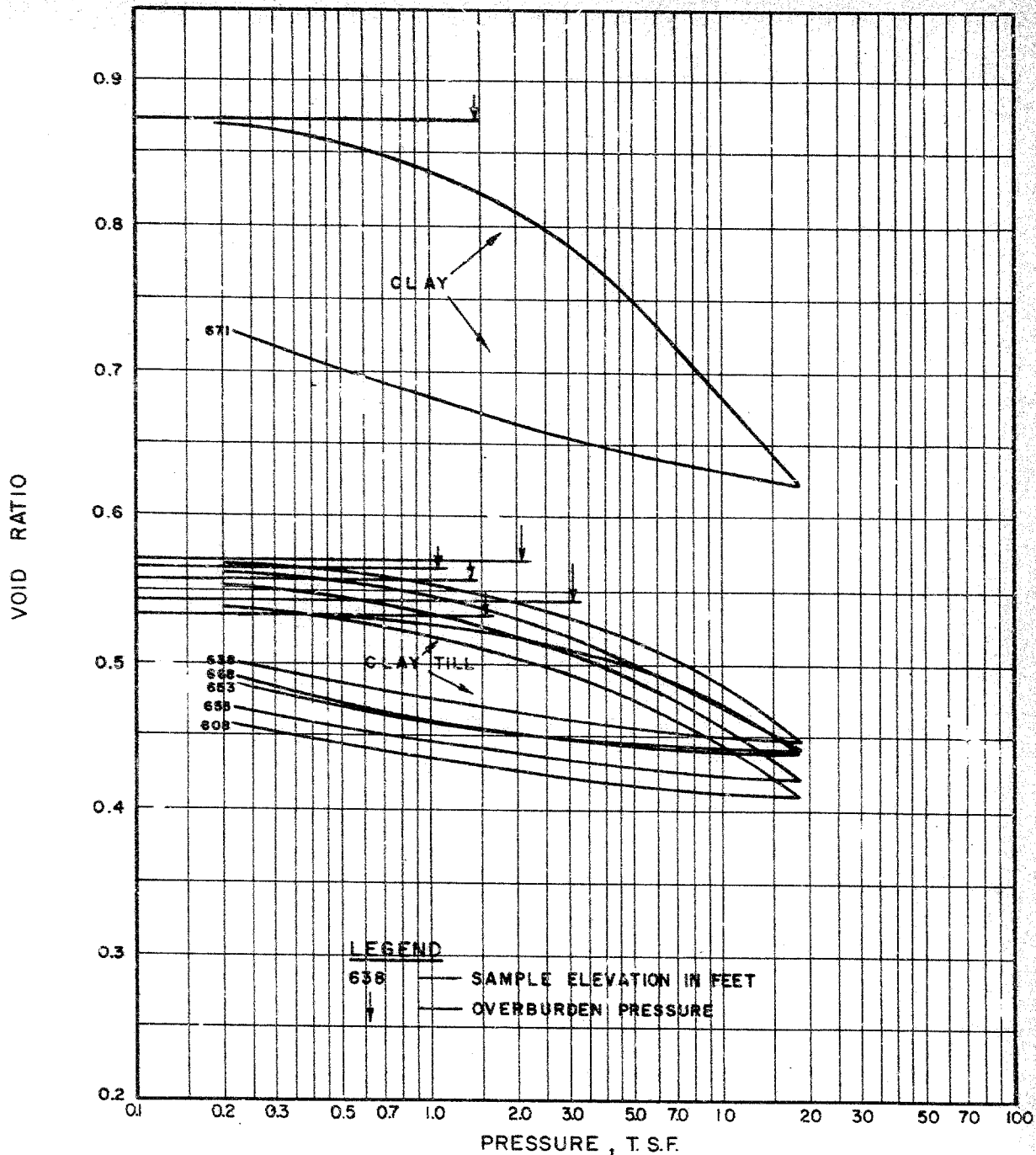
H. G. Acres
H. G. ACRES & COMPANY LIMITED

DATE: MAY, 1960

JOB No. 872

PLATE - XXIV

SK 872-A-24



OVERBURDEN PRESSURE — P_0 = _____ NATURAL WATER CONTENT _____

CONSOLIDATION PRESSURE — P_c = _____ 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

HWY. 401, COUNTY ROAD INTERCHANGE (W.P. 95-59)

APPROVED

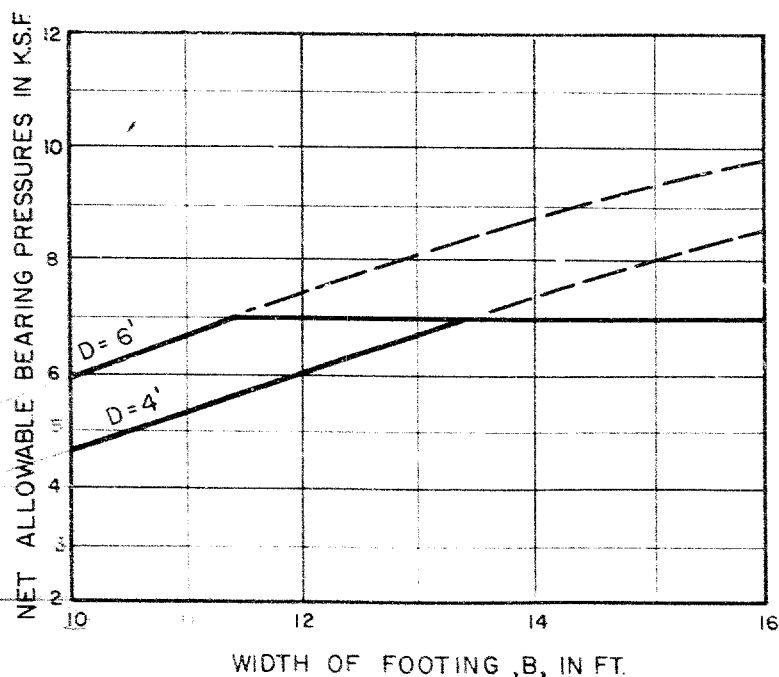
D. H. McDonald
H. G. ACRES & COMPANY LTD.

DATE: MAY, 1960

JOB No. 872

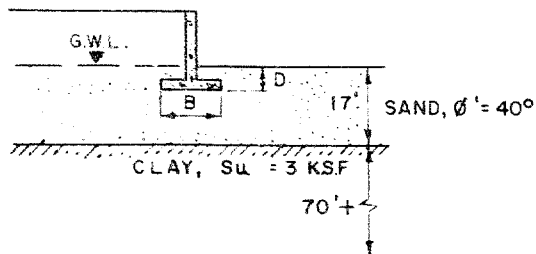
PLATE XXV

CV-672-19-25



LEGEND

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



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

DEPARTMENT OF HIGHWAYS OF ONTARIO
HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)

NET ALLOWABLE BEARING PRESSURES
FOR BRIDGE ABUTMENT FOOTINGS

APPROVED

DATE: MAY 1960

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

SCALE JOB No.
872

PLATE - XXVI

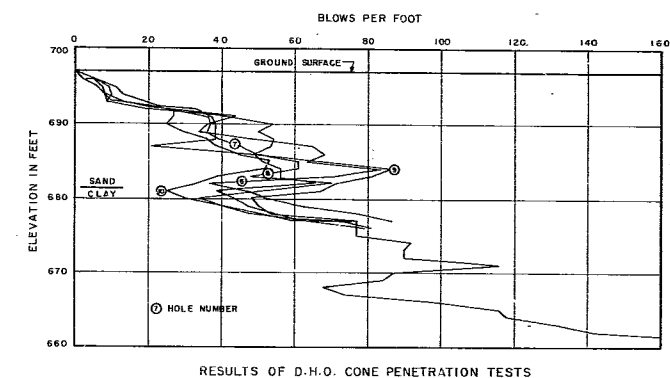
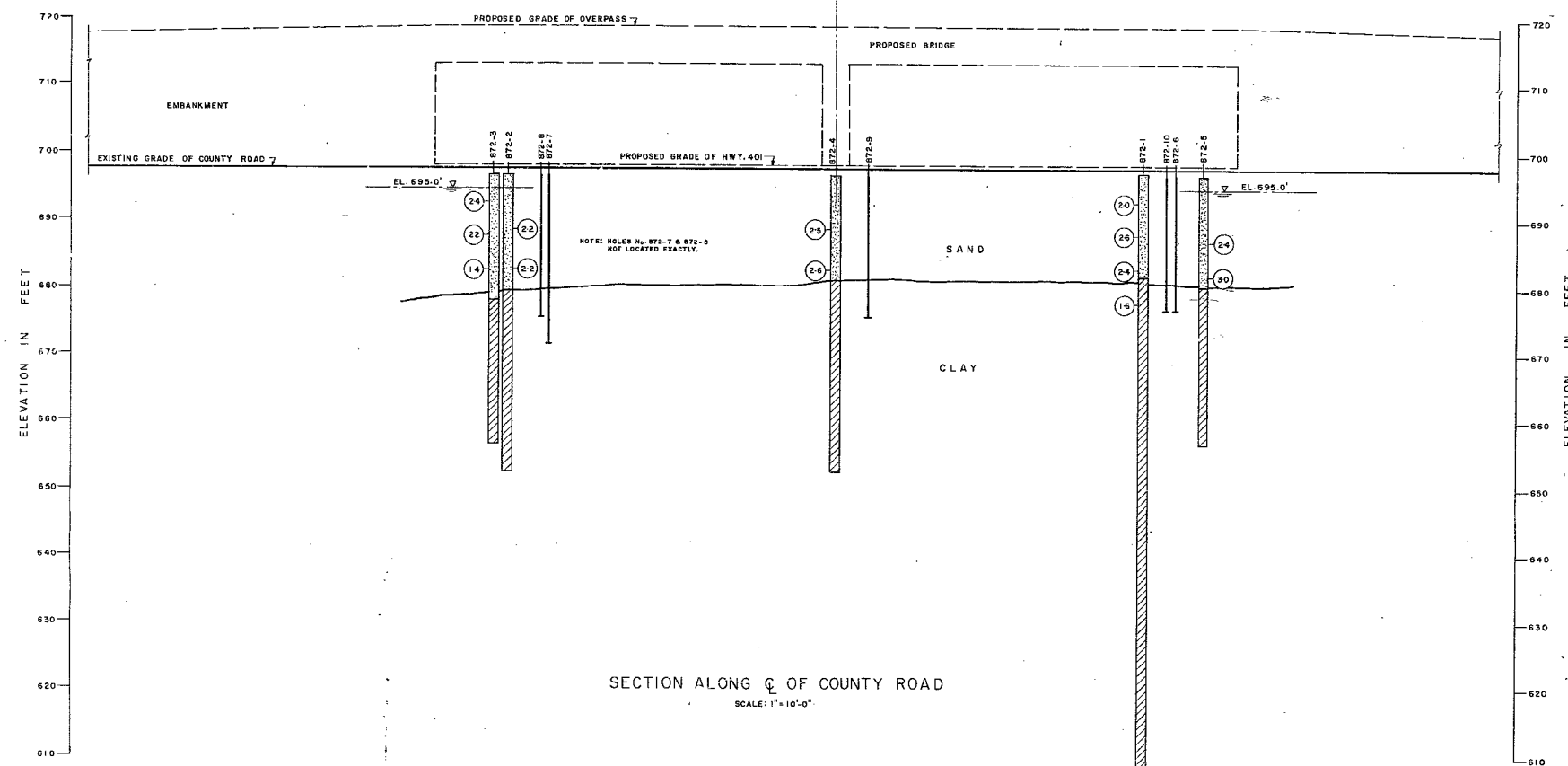
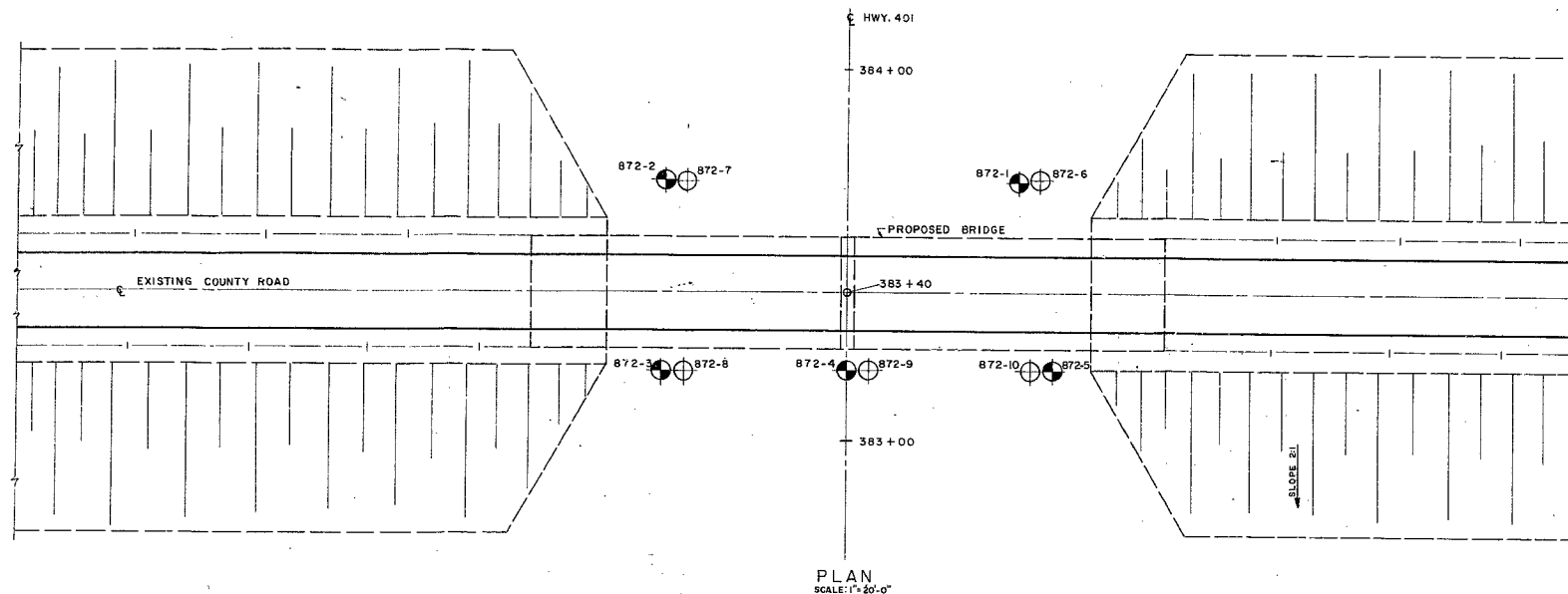
#60-F-206

W.P.# 95-59

Hwy. #401 E'

OLD Hwy. #77

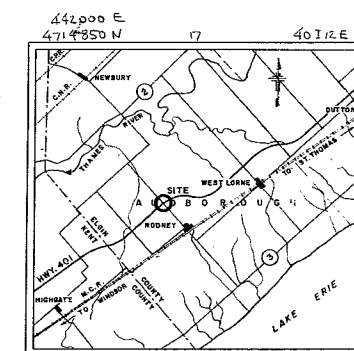
ALDBOROUGH TWP.



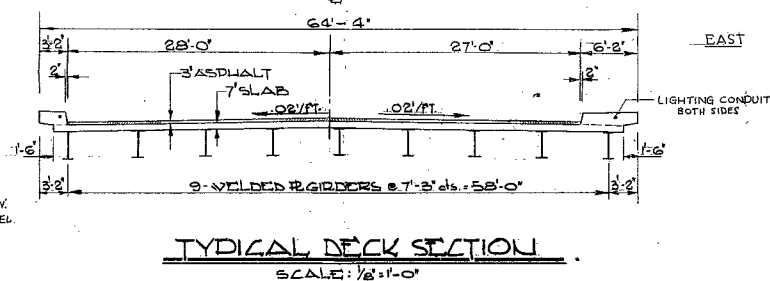
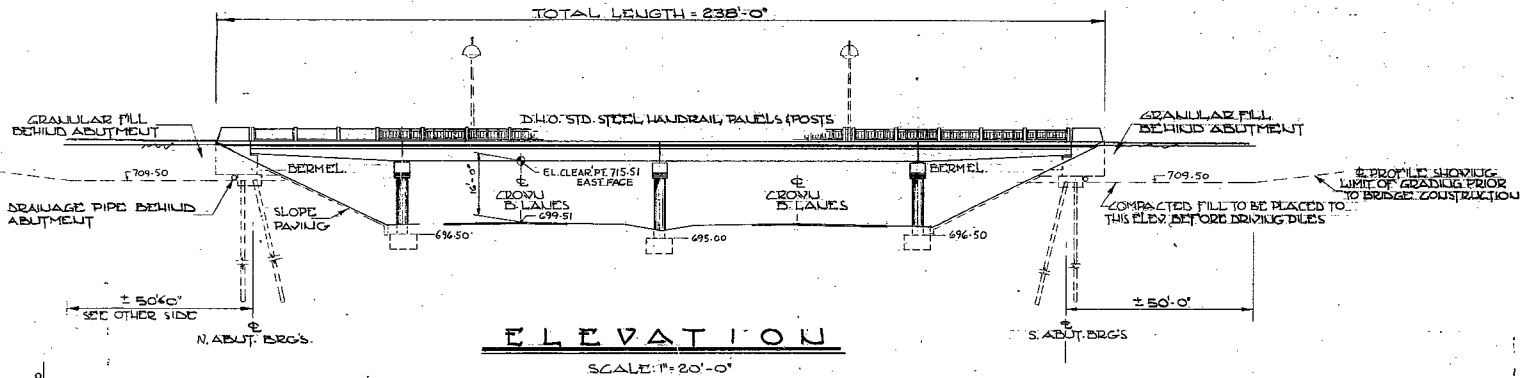
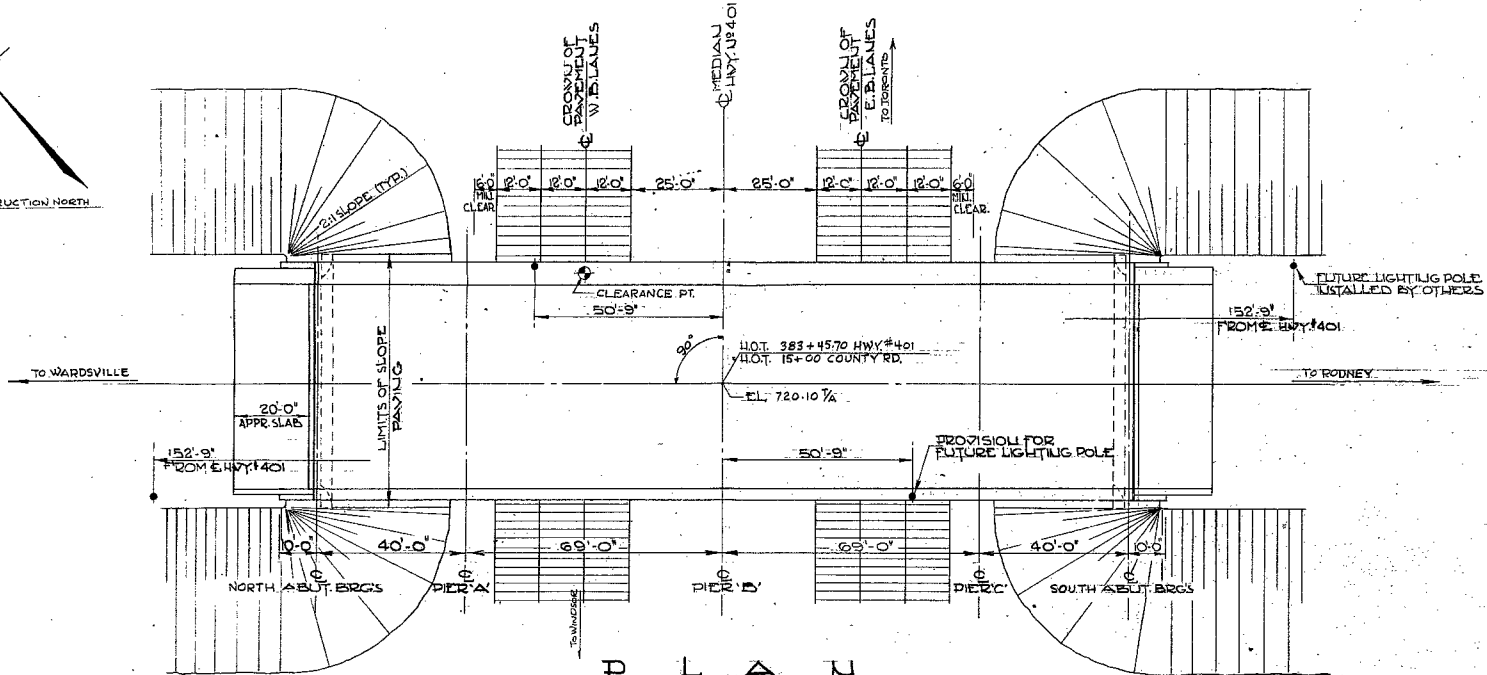
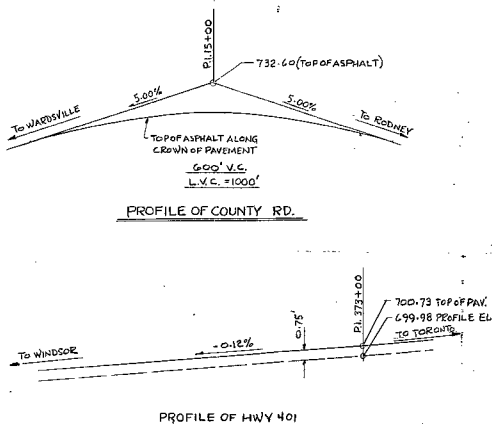
LEGEND

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

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



H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS, CANADA	
DEPARTMENT OF HIGHWAYS OF ONTARIO	
HWY. 401, COUNTY ROAD INTERCHANGE (WP-95-59)	
EXPLORATORY HOLES PLAN AND SECTION	
APPROVED	DATE: MAY, 1960
SCALE AS NOTED	JOB No. 872
N.G. ACRES & COMPANY LIMITED	
PLATE - I	

[illegible][illegible]