

GEOCRES No:
30L14-9A

THE ST. LAWRENCE SEAWAY AUTHORITY
WELLAND CHANNEL RELOCATION
TOWNLINE ROAD/RAIL TUNNEL

**GEOTECHNICAL INVESTIGATIONS
AND CONSIDERATIONS**

APPENDIX "A"



OCTOBER 1969

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

DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS . . .

MEMORANDUM

TO: Mr. R. Oddson,
Senior Project Design Engineer,
Advanced Development Group,
Systems Design Office,
Central Region,
3501 Dufferin St., Downsview.

FROM: Foundations Office,
Design Services Branch,
Central Bldg., Downsview.

DATE: March 20, 1972.

OUR FILE REF. IN REPLY TO

SUBJECT: Proposed Crossing of Hwy. #3 and the Welland
Canal at Port Colborne, Ontario.
W.P. 448-64 W.O. 71-11131

Enclosed please find the Foundation Investigation Report for the above-mentioned project. It should be noted that the report is of a preliminary nature only and that further investigation will be required when the project reaches the design stage. For your present purposes, however, we believe that the information contained in the report will be sufficient to enable you to complete your feasibility studies and prepare a reasonably accurate cost estimate. If further information is required please contact this Office.

AGS/ao
Encl.


A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER.

cc: Messrs. D. W. Farren
A. Rutka
C. R. Robertson
B. R. Davis
C. Mullerbeck (Gibb, Albery, Pullerits & Dickson)
G. C. E. Burkhardt
W. S. Leach (Pt. Colborne City Engineer)
G. Tustin (St. Lawrence Seaway - Montreal)
T. J. Kovich
Foundations Files ✓
Documents

March 15, 1972
P2955

Mr. A. Rutka
Materials and Testing Engineer
Department of Transportation
and Communications
Downsview 464, Ontario

71-11-131

Dear Sir:

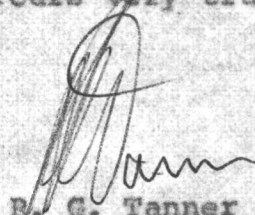
Proposed Port Colborne Tunnel
Highway 3 - WP448-64
Geological Investigations

We are pleased to submit herewith fourteen copies of the above report. The original drawings and basic data used in the report will be forwarded under separate cover.

Should there be any parts of the report requiring further clarification we shall be pleased to meet with you to discuss them at your convenience.

In the meantime, we wish to express our appreciation for having been entrusted with the responsibility for these geological investigations.

Yours very truly,



R. G. Tanner
Executive Engineer

RGT:jah
Encl.

cc - Mr. K. Selby

THE ST. LAWRENCE SEAWAY AUTHORITY

Welland Channel Relocation
Townline Road/Rail Tunnel

GEOTECHNICAL INVESTIGATIONS AND CONSIDERATIONS

Appendix "A"

TABLE OF CONTENTS

DRILLING REPORTS

SUMMARIES OF LABORATORY TESTS

Unconsolidated - Undrained Triaxial Tests on Undisturbed
and Compacted Materials

Unconsolidated - Undrained Direct Shear Tests on Undisturbed
Materials

EXPLANATION OF THE FORM

OF

DRILLING REPORTS AND FIELD BOREHOLE LOGS

LOCATION All boreholes have been surveyed by
SLSA and are referred to one or four
control grids as noted below:

1. 6° Universal Transverse Mercator
grid, e.g., BH No. 153; 37,500N;
11,307E;
2. 3° Universal Transverse Mercator
grid, e.g., BH No. 155;
15,609,777N; 1,076,021E;
3. Contract 863 grid with Canal -
Tunnel intersection defined as
150+00 and increasing Chainage to
the west along tunnel centreline,
e.g., BH No. 146; 129+59 254 feet
south of centreline;
4. Existing Welland Canal grid with
increasing Chainage to the south,
e.g., BH No. 179; 975+10 8 feet
west of existing canal bank.

DATUM All elevations are referred to the
Canadian Geodetic Datum, 1966.

DEPTH All depths are given in feet.

SAMPLE SIZE Dimension is in inches and refers to
the nominal diameter of the sampler.

SAMPLE RET'D Indicates the length in inches of
sample recovered in the sampler.

PENETRATION TEST The value given is the number of blows
of a 140-pound weight falling freely
30 inches, required to advance the
sampler. Where a 2-inch diameter
split spoon sampler is used, this test
is carried out in accordance with the
"Standard Penetration Test Procedure."

"Pushed" indicates that the sample
tube was pushed into the soil by means
of the hydraulic cylinder of the drill
at the hydraulic pressure shown.

"Hammer" indicates that the sample tube was advanced by the 140-pound weight without recording the number of blows.

WATER PRESSURE TEST

1. Units for quantity of water pumped are in imperial gallons.
2. Length of test section is 5 feet unless otherwise noted.

VANE TEST

1. Torque assembly used is as noted and is one of the following:
 - (a) Acker precision head
 - (b) Geonor Vane Borer NR219
 - (c) 25 and 50-lb spring balances.
2. Vane numbers are noted, where applicable.
3. Natural shear strength is determined by rotating the vane at a rate of 1 degree per 10 seconds.
4. Soil is subsequently remolded by rapidly rotating the vane through six complete revolutions, and the test is repeated to determine remolded shear strength.

DRILLING REPORTS

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 102

SITE Welland, Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED 3:00 P.M. Nov. 28 '1967
 FINISHED 5:00 P.M. Dec. 7 '1967

METHOD OF DRILLING: SOIL Power Auger Sand CASING DIAM. NX-106; BX-136
Modified Wash Boring
ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM GSC
 DEPARTURE 5,173.7 E DRILL PLATFORM -
 BEARING - GROUND SURFACE 578.1
 INITIAL DIP 90° ROCK SURFACE 458.1
 OTHER DIPS - BOTTOM OF HOLE 442.1
 WATER TABLE 558

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	Organic top soil	Blackish grey and yellowish brown mottled, very stiff, clayey silt; traces of organic matter, occasional salt inclusions	1	BO	2-7/8	0.5 2.0	6	
			2	BO	2-7/8	2.5 4.0	15	
5.0	Weathered varved clay	Reddish-brown and greyish brown, laminated silty clay with slightly disturbed layers at upper 6 inches; numerous silt layers and lenses	3	BO	2-7/8	5.0 6.5	16	
7.0	Weathered silty clay and clayey silt	Grey to greyish-brown stiff to very stiff silty clay, few silt lenses and occasional oxidized silt pockets; few vertical and inclined fissures filled with gypsum	4	BO	2-7/8	7.5 9.0	15	
			5	BO	2-7/8	10.0 11.5	18	

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 D. Stewart

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail HOLE No. 102
 Tunnel
 SITE Welland Townline Road SHEET No. 2 OF 5

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	
			6	BO	2-7/8	12.5 14.0	18	
			7	BO	2-7/8	15.0 16.5	15	
17.0	Slightly weathered varved clay	Greyish brown, distinctly laminated silty clay, with sand grains and gravel; medium to stiff; distorted red and grey layers at the bottom.	8	BO	2-7/8	17.5 19.0	8	
20.0	Massive silty clay (upper till)	Reddish-brown silty clay, contains silt lenses and pockets, traces of sand and fine to coarse gravel	9	CO	2-7/8	20.0 21.5	18	Pushed
			10	CO	2-7/8	22.5 24.0	18	Pushed
			11	CO	2-7/8	25.0 26.5	20	Pushed
			12	CO	2-7/8	27.5 29.0	18	Pushed
			13	CO	2-7/8	30.0 31.5	18	Pushed
			14	CO	2-7/8	32.5 34.0	18	Pushed
			15	CO	2-7/8	35.0 36.5	16	Pushed
37.0	Varved clay	Reddish-brown and grey distinctly layered clay, with very thin silt layers at the base of grey band, traces of sand and fine gravel occasional silt lenses and pockets	16	CO	2-7/8	37.5 39.0	18	Pushed
			17	CO	2-7/8	40.0 41.5	18	Pushed

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 102
 SITE Welland Townline Road SHEET No. 3 OF 5

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	
41.0	Massive silty clay	Reddish-brown silty clay of medium plasticity, contains numerous silt lenses and layers, traces of sand and fine sand	18	CO	2-7/8	42.5	18	Pushed
						44.0		
			19	CO	2-7/8	45.0	18	Pushed
						46.5		
			20	CO	2-7/8	47.5	18	Pushed
						49.0		
			21	CO	2-7/8	50.0	18	Pushed
57.0	Varved clay	Alternate layers of brown silty clay and grey silty clay with thin (1/16") layer of sand and silt at the base; varves spacing varies from 3" to 8"; scattered sand grains and fine gravel; occasional inclusions of silt				51.5		
			22	CO	2-7/8	52.5	18	Pushed
						54.0		
			23	CO	2-7/8	55.0	18	Pushed
						56.5		
			24	CO	2-7/8	57.5	18	Pushed
62.0	Silt, clay and sand (transition)	Upper Part - brown soft clayey silt with red and grey clay inclusions				59.0		
			25	CO	2-7/8	60.0	18	Pushed
						61.5		
			26	CO	2-7/8	62.5	18	Pushed
						64.0		
			27	CO	2-7/8	66.0	6	Pushed
						67.5		
			28	AQ		72.2	16	
						72.7		
		Middle Part - brown silt and sandy silt with occasional clay and sand inclusions				73.2		32
						73.7		50
						74.2		60
			29	AQ		75.0	18	
						75.5		20
						76.0		35
			76.5		60			

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NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT Welland Canal Relocation Townline Road/Rail Tunnel **HOLE No.** 102
SITE Welland Townline Road **SHEET No.** 4 OF 5

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	
		Lower Part - Fine to medium silty sand contains rounded gravel; occasional silt and clay inclusions	30	AQ		78.0	18	
						78.5		14
						79.0		28
						79.5		48
			31	AQ		80.0	15	
						80.5		24
						81.0		52
						81.5		100
			32	AQ		82.5	15	
						83.0		11
						83.5		19
						84.0		26
			33	AQ		85.0	15	
						85.5		31
						86.0		71
						86.5		100
			34	AQ		87.5	17	
						88.0		20
						88.5		42
						89.0		83
			35	AQ		90.0	17	
						90.5		14
						91.0		18
						91.5		30
			36	AQ		92.5	15	
						93.0		9
						93.5		12
						94.0		19
			37	AQ		95.0	13	
						95.5		6
						96.0		15
						96.5		28

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DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 102
 SITE Welland Townline Road SHEET No. 5 OF 5

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	
			38	AQ		97.5 98.0 98.5 99.0	17	9 25 58
			30	AQ		100.0 100.5 101.0 101.5	12	6 2 3
112.0	Till	Reddish-brown compact granular till, lower part sandy and greyish, contains angular fragments of bedrock (dolomitic shale)						
120.0	Bedrock							
136.0	End of hole							

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DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 103

SITE Welland, Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED 7:30 A.M. Nov. 8 19 67
 FINISHED 5:00 P.M. Nov. 14 19 67

METHOD OF DRILLING: SOIL Power Auger and Modified Wash Boring CASING DIAM. 4-1/2"; NX
 ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM GSC
 DEPARTURE 6,733 E DRILL PLATFORM
 BEARING - GROUND SURFACE 578.4
 INITIAL DIP 90° ROCK SURFACE 488.4
 OTHER DIPS - BOTTOM OF HOLE 473.4
 WATER TABLE 540.9

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	Topsoil and desiccated clayey silt	Yellowish grey and olive grey; mottled clayey silt contains silt layers and lenses; oxidized silt pockets; and occasional salt inclusions	1	BO	2-7/8	0.5 1.7	9	250 psi 550 psi 700 psi
			2	BO	2-7/8	2.5 3.1 4.1	16	325 psi 675 psi 700 psi
			3	BO	2-7/8	5.0 6.0	9	600 psi 750 psi
			4	BO	2-7/8	7.0 7.5 8.5 9.5	20	300 psi 500 psi 575 psi 700 psi
10.0	Weathered varved clay	Reddish brown and grey alternate layers of stiff silty clay; few oxidized silt pockets; traces of sand and fine gravel.	5	BO	2-7/8	10.0 10.5 11.5 12.0	18	250 psi 450 psi 600 psi 700 psi

SAMPLING METHOD

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

E — AUGER
 F — WASH

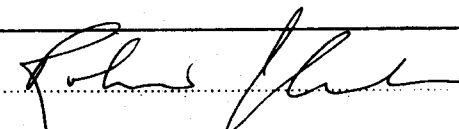
SHIPPING CONTAINER

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

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR D. Stewart

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

DRILLING REPORT

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	
12.0	Weathered clayey silt and silty clay	Yellowish grey, stiff silty clay, contains numerous salt inclusions and silt lenses	6	BO	2-7/8	12.0	18	300 psi
						12.5		600 psi
						14.0		750 psi
			7	BO	2-7/8	15.0	21	750 psi
						17.0		275 psi
								500 psi
17.0	Weathered varved clay	Reddish-brown and grey distinctly laminated silty clay contains silt layers; grey silt pockets; traces of sand grains and gravel	8	BO	2-7/8	17.5	24	600 psi
						19.5		275 psi
								400 psi
			9	BO	2-7/8	20.0	24	500 psi
						22.0		200 psi
								375 psi
20.0	Massive silty clay (upper till)	Reddish-brown and greyish brown, medium to stiff silty clay; few distorted red layers; numerous silt layers and lenses; upper 2 feet slightly weathered; traces of sand grains and fine to coarse gravel	10	BO	2-7/8	22.5	24	525-675 psi
						24.5		100 psi
								250 psi
			11	BO	2-7/8	25.0	24	350-450 psi
						27.0		50 psi
								175 psi
			12	CO	2-7/8	27.5	18	225-300 psi
						29.0		Pushed
			13	CO	2-7/8	30.0	18	Pushed
						31.5		
14	CO	2-7/8	32.5	18	Pushed			
			34.0					

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 103
 SITE Welland, Townline Road SHEET No. 3 OF 5

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	
35.0	Varved clay	Reddish-brown and grey horizontal bands, varying in width from 1/4" to 1/2" with thin silt and fine sand layers; regular spacing between couplets; traces of sand and fine gravel	15	CO	2-7/8	35.0	18	Pushed
						36.5		
39.5	Massive silty clay	Reddish-brown silty clay of medium plasticity, contains numerous silt layers and lenses; occasional distorted reddish laminae; traces of sand and gravel	16	CO	2-7/8	37.5	18	Pushed
						39.0		
			17	CO	2-7/8	40.0	18	
						41.5		
			18	CO	2-7/8	42.5	18	
						44.0		
			19	CO	2-7/8	45.0	18	
						46.5		
			20	CO	2-7/8	47.5	18	
						49.0		
58.0	Varved clay	Reddish-brown and grey alternate layers varying in thickness from 1/4" to 3/4" with irregular spacing between grey and red couplets, contains very thin silt and fine sand layers; traces of sand and gravel	21	CO	2-7/8	50.0	18	
						51.5		
			22	CO	2-7/8	52.5	18	
						54.0		
			23	CO	2-7/8	55.0	18	
						56.5		
			24	CO	2-7/8	57.5	18	
						59.0		
			25	CO	2-7/8	60.0	18	Pushed
						61.5		
			26	CO	2-7/8	62.5	18	
						64.0		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 103
 SITE Welland, Townline Road SHEET No. 4 OF 5

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	
65.0	Clay, silt and sandy silt (transition)	Reddish-brown clayey silt and dilatant sandy silt	27	CO	2-7/8	65.0	18	
						66.5		
			28	CO	2-7/8	67.5		
						69.0		
			29	CO	2-7/8	70.0		
						71.5		
			30	CO	2-7/8	72.5	3	
						74.0		
			31	CO	2-7/8	74.0	0	Sample lost
						75.5		
76.0	Till	Silty, sandy, grey to dark brown, numerous angular and subangular rock fragments	32	CO	2-7/8	75.5		4
						76.0		
						77.0		10
						77.5		52
			33	EQ		77.0		38
						77.4		
			34	AQ	2	77.4		100
						78.0		
			35	AQ	2	78.0		
						79.0		
			36	AQ	2	79.0		42
						80.5		90
								52
			37	AQ	2	80.5	18	17
						82.0		46
								87
			38	AQ	2	82.0	15	17
						83.5		39
								100
			39	AQ	2	83.5	3	4
						85.0		18
								100
			40	AQ	2	85.0	5	42
						85.5		90
								96
			41	DQ		86.4	3	
						86.6		
			42	AQ	2	87.0		40
							24	42

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 103
 SITE Welland Townline Road SHEET No. 5 OF 5

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	
90.0	Bedrock		43	AQ	2	89.0		76
98.0		Piezometer tip	49	DQ		89.8 90.0	3	109
105.0	End of hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 104 & 104B

SITE Welland Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 3:40 P.M. Oct. 31 19 67
 FINISHED 5:00 P.M. Dec. 20 19 67

METHOD OF DRILLING: SOIL Power Auger CASING DIAM. 4-1/2"
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM GSC
 DEPARTURE 7,658 E DRILL PLATFORM -
 BEARING - GROUND SURFACE 580.1
 INITIAL DIP 90° ROCK SURFACE 489.5
 OTHER DIPS - BOTTOM OF HOLE 478.5
 WATER TABLE -

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	Topsoil and desiccated clayey silt	Grey and brownish grey, mottled; clayey silt contains organic matter and few salt inclusions	1	BO	2-7/8	0.5	10	Pushed
						2.5		
			2	BO	2-7/8	2.5	11 1/2	325 psi
						4.1		725 psi
								725 psi
			3	BO	2-7/8	5.0	15	650 psi
						6.4		750 psi
								750 psi
			4	BO	2-7/8	7.5	15	400 psi
						9.5		650 psi
								750 psi
10.0	Weathered varved clay	Brown, greyish-brown and grey distinctly layered; stiff clay, contains thin silt lenses and rusty brown silt pockets	5	BO	2-7/8	10.0	20	200 psi
						12.0		325 psi
								400 psi
								500 psi

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 D. Stewart

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 104 & 104B
 SITE Welland Townline Road SHEET No. 2 OF 4

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	
12.0	Weathered clayey silt and silty clay	Brownish-grey and greyish brown, stiff, mottled, clayey silt and silty clay, brown silt lenses and pockets, contains 2-foot thick weathered varved clay zone	6	BO	2-7/8	12.5	24	200 psi
						14.5		325 psi
								450 psi
								525 psi
			7	BO	2-7/8	15.0	24	100 psi
						17.0		200 psi
								275 psi
								350 psi
			8	BO	2-7/8	17.5	24	25 psi
						19.5		125 psi
								225 psi
								300 psi
20.0	Massive silty clay (upper till)	Reddish-brown silty clay contains silt lenses and pockets; traces of sand and fine to coarse gravel	9	CO	2-7/8	20.0	18	Pushed
						21.5		
			10	CO	2-7/8	22.5	18	Pushed
						24.0		
			11	CO	2-7/8	25.0	18	Pushed
						26.5		
			12	CO	2-7/8	27.5	18	Pushed
						29.0		
			13	CO	2-7/8	30.0	18	Pushed
						31.5		
			14	CO	2-7/8	32.5	18	Pushed
						34.0		
45.0	Varved clay	Reddish-brown and grey, distinctly layered clay, contains silt layers 1/4" to 1/8" thick, traces of sand and fine gravel	15	CO	2-7/8	35.0	18	Pushed
						36.5		
			16	CO	2-7/8	37.5	18	Pushed
						39.0		
			17	CO	1-7/8	40.0	18	Pushed
						41.5		
			18	CO		42.5	18	Pushed
						44.0		
			19	CO		45.0	18	Pushed
						46.5		
			20	CO		47.5	18	Pushed
						49.0		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 104 & 104B
 SITE Welland Townline Road SHEET No. 3 OF 4

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	
49.0	Massive silty clay	Reddish-brown, silty clay contains numerous silt layers and lenses, traces of sand and fine gravel	21	CO		50.0	18	Pushed
			22	CO		51.5	18	Pushed
			23	CO		52.5	18	Pushed
			24	CO		54.0	18	Pushed
			25	CO	2-7/8	55.0	18	Pushed
						56.5	18	Pushed
61.0	Varved clay	Reddish-brown, light-brown and grey alternate bands, with irregular spacing between couplets contains very thin silt and fine sand layers; traces of sand and fine to coarse gravel	26	CO		57.5	18	Pushed
			27	CO		59.0	18	Pushed
			28	CO		60.0	18	Pushed
						61.5		
69.0	Silt, sand and clay (transition)	Reddish-brown, clayey silt and sandy silt, dilatant	29	CO		62.5	18	Pushed
			30	CO		64.0	18	Pushed
						70.0	18	Pushed
79.0	Till	Reddish-brown, silty sandy, compact; contains angular rock fragments	31	EQ		71.5	10	Pushed
			32	EQ		72.5		
			33	EQ		74.0		
			34	BY		77.0		
90.5	Bedrock	End of hole				79.0		
						81.0		
						81.5		
						-		
						-		
						-		
						88.5		
						90.5		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 104 & 104B
SITE Welland, Townline Road SHEET No. 4 OF 4

Torque Assembly: Acker Precision Head

Vane No.: 245 and 246

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
245-568.6	1,505	455	3.3
566.6	1,205	341	3.5
564.6	1,820	795	2.3
561.6	1,090	273	4.0
559.1	659	296	2.2
556.6	545	-	-
246-554.1	891	375	2.4
551.6	1,105	341	3.2
549.1	891	411	2.2
546.6	775	293	2.6
544.1	950	364	2.6
541.6	1,033	400	2.6
539.1	845	411	2.1
536.6	704	282	2.5
534.1	692	270	2.6
531.6	870	223	3.9
528.1	962	352	2.7
526.6	845	305	2.8
524.1	716	211	3.4
521.6	868	316	2.7
519.1	1,172	364	3.2
516.6	1,370	481	2.9
514.1	1,000	599	1.7
511.6	1,110	704	1.6

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 105

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 7:30 A.M. Oct. 26 19 67

METHOD OF DRILLING: SOIL Power Auger FINISHED 1:30 P.M. Oct. 31 19 67

ROCK Diamond Drill CASING DIAM. 4-1/2"

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM GSC

DEPARTURE 8,258 E DRILL PLATFORM -

BEARING 90° GROUND SURFACE 580.3

INITIAL DIP 90° ROCK SURFACE 479.7

OTHER DIPS BOTTOM OF HOLE 464.3

 WATER TABLE 566

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	Topsoil and desiccated clayey silt	Yellowish-grey and greyish-brown, very stiff; contains silt layers salt inclusions and organic matter	1	BO	2-7/8	0.8	10	Pushed
						2.8		750 psi
			2	BO	2-7/8	3.0	13	Pushed
						5.0		750 psi
7.5	Weathered varved clay	Reddish, yellowish-brown and grey, distinctly layered, few silt layers and lenses; traces of sand grain and fine gravel	3	BO	2-7/8	5.0	11	Pushed
						7.0		750 psi
			4	BO	2-7/8	7.5	20	Pushed
						9.5		750 psi
11.0	Weathered silty clay	Greyish-brown and brownish grey, very stiff, fissured, and mottled silty clay, contains yellowish-brown silt lenses and pockets	5	BO	2-7/8	10.0	17	Pushed
						12.0		700 psi
			6	BO	2-7/8	12.5	24	Pushed
						14.5		700 psi
			7	BO	2-7/8	15.0	24	Pushed
						17.0		650 psi

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 Osborne & Stewart

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 105
 SITE Welland, Townline Road SHEET No. 2 OF 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	
17.5	Weathered varved clay	Reddish-brown and grey 1/4" thick horizontal and distorted clay bands, numerous silt layers and lenses, traces of sand and fine gravel	8	BO	2-7/8	17.5	22	Pushed
						19.5		500
			9	BO	2-7/8	20.0	24	Pushed
						22.0		250
21.0	Massive silty clay (upper till)	Reddish-brown silty clay, exhibit medium plasticity, contains silt layers and lenses, traces of fine to coarse gravel, occasional faint reddish laminae	10	BO	2-7/8	22.5	22	Pushed
						24.5		250 psi
			11	BO	2-7/8	25.0	22	Pushed
						27.0		250 psi
			12	BO	2-7/8	27.5	22	Pushed
						29.5		250 psi
			13	BO	2-7/8	30.0		Pushed
						32.0		250 psi
			14	CO	3	32.5	20	Pushed
						34.5		
42.0	Silt and clay	Reddish-brown and dark brown silt with clay inclusions				35.0	18	Pushed
						37.0		
			16	CO	3	37.5	18	Pushed
						39.5		
			17	CO	3	40.0	18.5	Pushed
						42.0		
45.0	Varved clay	Reddish-brown and grey, distinctly laminated clay, contains silt layers and few sandy pockets				42.5	18.5	Pushed
			18	CO	3	44.5		
						45.0	19	Pushed
			19	CO	3	47.0		

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation Townline Road/Rail Tunnel	HOLE No.	105
SITE	Welland Townline Road	SHEET No.	3 OF 4

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	
47.0	Massive silty clay	Reddish-brown, mottled, numerous silt layers and lenses, traces of sand and fine gravel	20	CO	3	47.5	18.5	Pushed
			21	CO	3	49.5	18	Pushed
			22	CO	3	50.0	19	Pushed
			23	CO	3	52.0		Pushed
			24	CO	3	52.5		Pushed
62.0	Varved clay	Reddish-brown and grey, distinctly layered, very thin silt and fine sand layers, irregular spacing between varves; contains brown silt lenses and sandy pockets	25	CO	3	54.5		
						55.0		
67.0	Silt, sand and clay (transition)	Reddish-brown and brown, silt, sandy silt and silty sand, with reddish brown clay inclusions, contains subangular to rounded gravel, exhibit dilatency	26	CO	3	57.0		
			27	CO	3	57.5	18	Pushed
			28	CO	3	59.5	15	Pushed
			29	CO	3	65.0	18	Pushed
			30	CO	3	67.0		Pushed
			31	CQ		72.0	16	Pushed
			32	FQ		72.5		
91.0	Till	Reddish-brown, compact, contains angular and subangular rock fragments	33	DQ		74.5		
			34	DQ		75.0		
			35	DQ		77.0		
						77.5		

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

D R I L L I N G R E P O R T

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 105
SITE Welland, Townline Road Tunnel SHEET No. 4 OF 4

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	
101.6	Bedrock							
107.0		Piezometer tip						
116.0	End of hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 106
 SITE Welland Townline Road SHEET No. 1 OF 5
 CONTRACTOR: Peninsula Soil Investigation STARTED 2:00 P.M. Sept. 21 19 67
 FINISHED 8:30 AM. Sept. 29 19 67
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL
 LOCATION: LATITUDE 37,557 N ELEVATIONS: DATUM GSC
 DEPARTURE 9,490 E DRILL PLATFORM -
 BEARING 90° GROUND SURFACE 577.6
 INITIAL DIP 90° ROCK SURFACE 482.6
 OTHER DIPS BOTTOM OF HOLE 477.6
 WATER TABLE 571

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	Topsoil and desiccated clayey silt	Yellowish-grey and brownish-grey, very stiff, few grey seams with salt and organic inclusions	1	BO	3	2.0	18	Pushed
						4.0		
			2	BO	3	5.0	10	Hammer
						6.0		
			3	BO	3	6.0	8	Hammer
8.0	Weathered varved clay	Reddish-brown and brownish-grey alternate equally spaced layers, few oxidized silt lenses and pockets, occasional sand grain				6.5		
			4	HQ		6.5	12	9
						7.5		13
						8.0		16
			5	BO	3	8.0	18	Hammer
						10.0		

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.A. S/R. Stewart

LOGGED BY A. Mirza

APPROVED *[Signature]*

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 106
SITE Welland Townline Road SHEET No. 2 OF 5

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	
10.0	Weathered silty clay and clayey silt	Brownish-grey, very stiff, mottled, occasional fine gravel and silt lenses	6	BO	3	10.0	14	Hammer
						11.5		
			7	BO	3	12.0		Hammer
			8	BO	3	13.5		
15.0	Weathered varved clay	Reddish-brown and brownish-grey, distinctly layered, contains silt lenses, and few distorted varves				14.0		Hammer
						16.0		
			9	BO	3	17.5	22	Pushed
18.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity, silt layers and lenses, sand grains and fine to coarse gravel, occasional faint disturbed reddish clay layer	10	B	3	18.0	0	Hammer
						19.5		
			10A	B	3	20.0	0	Hammer
						22.0		
			10B	BO	3	22.0	20	Hammer
						24.0		
			11	BO	3	24.0	20	Pushed
						26.0		
			12	BO	3	26.0	18	Pushed
						28.0		
			13	BO	3	28.0	18	Pushed
						30.0		
			14	BO	3	30.0	22	Pushed
						32.0		
38.0	Silt and clay	Brown silt with reddish brown clay inclusions	15	BO	3	32.0	22	Pushed
						34.0		
			16	BO	3	34.0	24	Pushed
						36.0		
			17	BO	3	36.0	20	Pushed
						38.0		
40.0	Varved clay	Reddish-brown and grey, 1/4" to 1/8" distinct horizontal bands, very thin silt layers, occasional sand grain	18	BO	3	38.0	24	Pushed
						40.0		
			19	BO	3	42.5		Pushed
						44.5		

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

D R I L L I N G R E P O R T

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation Townline Road/Rail Tunnel	HOLE No.	106
SITE	Welland Townline Road	SHEET No.	3 OF 5

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	
44.0	Massive silty clay	Reddish-brown silty clay, contains numerous silt layers and lenses, few sand grains and fine to coarse gravel	20	BO	3	45.0	22	Pushed
						47.0		
			20	BO	3	47.0	22	Pushed
						49.0		
			21	BO	3	50.0	24	Pushed
						52.0		
			22	BO	3	52.5	23	Pushed
						54.5		
			23	BO	3	55.0	23	Pushed
						57.0		
			24	BO	3	57.5	22	Pushed
						59.5		
			26	BO	3	60.0	22	Pushed
						62.0		
			27	BO	3	62.5	21	Pushed
						64.5		
			28	BO	3	65.0	24	Pushed
						67.0		
67.0	Varved clay	Reddish-brown, light brown and grey, distinctly laminated, very thin silt and fine sand layers, occasional grey silt pockets, traces of fine to coarse gravel, spacing between varves varies from 1/2" to 8"	29	BO	3	67.5	22	Pushed
						69.5		
			30	BO	3	70.0	22	Pushed
						72.0		
			31	BO	3	72.5	23	Pushed
76.0	Silt sand and clay (transition)	Brown sandy silt and silty sand with reddish-brown clay inclusions, exhibit dilatancy				74.5		
			32	BO	3	75.0	21	Pushed
						77.0		
			33	BO	3	77.5	18	Pushed
						79.5		
			34	BO	3	80.0	10	Pushed
						81.5		
			35	A		81.5		4
						82.5		4
			36	B		82.5		
						84.0		
			37	AQ		84.0		
						84.5		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 106
 SITE Welland Townline Road SHEET No. 4 OF 5

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	
91.0	Till	Brown and greyish-brown, silty, sandy, contains angular rock fragments	38	AQ		86.5		10
						87.0		10
						87.5		15
			39	AQ		88.0	11	9
						88.5		4
						89.0		6
			40	AQ		89.5	16	18
						90.0		22
						91.0		
			41	AQ		91.5		12
						92.0		15
						92.5		25
95.0	Bedrock		42	A		93.0	0	6
						93.5		6
						94.8		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 106B
SITE Welland, Townline Road SHEET No. 5 OF 5

Torque Assembly: Acker Precision Head

Vane No.: 244, 245 and 246

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
245-565.6	3,625	1,570	2.3
560.6	1,275	1,048	1.2
244-558.6	1,390	468	3.0
556.6	1,470	515	3.9
554.6	1,520	620	2.5
552.6	1,410	592	2.4
246-550.6	1,152	436	2.6
548.6	1,305	571	2.3
546.6	1,195	472	2.5
544.6	1,110	365	3.0
542.6	1,130	259	4.4
540.6	1,470	294	5.0
538.6	695	271	2.6
536.6	1,035	347	3.0
534.6	955	306	3.1
532.6	910	318	2.8
530.6	990	376	2.6
528.6	918	318	2.9
526.6	918	283	3.2
524.6	1,083	330	3.3
522.6	990	330	3.0
520.6	986	294	3.4
515.6	1,200	541	2.2

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 107

SITE Welland Townline Road SHEET No. 1 OF 6

CONTRACTOR: Peninsula Soil Investigation STARTED 12:30 P.M. Sept. 29 19 67
FINISHED 5:00 P.M. Oct. 11 19 67

METHOD SOIL Modified Wash Boring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,580 N ELEVATIONS: DATUM GSC
 DEPARTURE 10,186 E DRILL PLATFORM -
 BEARING - GROUND SURFACE 569.9
 INITIAL DIP 90° ROCK SURFACE 446.9
 OTHER DIPS - BOTTOM OF HOLE 414.4
 WATER TABLE 572

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	Desiccated clayey silt and silty clay	Greyish-brown, yellowish-brown and reddish-brown, very stiff, weathered, mottled, clayey silt and silty clay, numerous silt layers and pockets, traces of sand and gravel, occasional salt and organic inclusions, contains distorted layered zones	1	BO	3	0.0		
						2.0		
			2	AQ		3.0		
						4.0		
			3	AQ		4.0		8
						4.5		10
						5.0		14
			4	AQ		5.5		20
						6.5		21
						7.5		24
			5	AQ		8.0		6
						9.0		17
						9.5		13
			6	AQ		10.0		3
						10.5		5
						11.5		6
			7	BO	3	12.0		
						13.5		
			8	BO	3	15.0		
						16.5		
			9	BO	3	18.0		
						19.5		

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 D. Stewart

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

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

D R I L L I N G R E P O R T

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684

PROJECT Welland Canal Relocation Townline Road/Rail **HOLE No.** 107

SITE Welland Townline Road **SHEET No.** 2 OF 6

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	
20.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity, numerous silt layers and lenses, traces of sand and fine to coarse gravel	10	BO	3	20.0		
						21.5		
			11	BO	3	23.0		
						24.0		
			12	BO	3	25.0		
						27.0		
			13	BO	3	28.0		
35.0	Varved clay	Reddish-brown and grey, distinctly laminated, very thin silt and fine sand layers, upper one foot of varves considerably disturbed, regular spacing between the couplets, contains silt lenses and pockets, traces of sand and fine gravel				30.0		
			14	BO	3	30.0		
						32.0		
			15	BO	2	35.0		
			16	BO	2	35.0		
						37.0		
40.0	Massive silty clay	Reddish-brown silty clay of medium plasticity, numerous silt layers and lenses, occasional faint distorted reddish laminae, traces of sand and fine gravel	17	BO	2	38.0		
						40.0		
			18	BO	2	40.0		
						42.0		
			19	BO	2	43.0		
						45.0		
			20	BO	2	45.0		
						47.0		
			21	BO	2	48.0		
						50.0		
			22	BO	2	50.0		
						52.0		
			23	BO	2	53.0		
						55.0		
			24	BO	3	55.0		
						57.0		
			25	BO		58.0		
						60.0		
			26	BO	3	60.0		
						62.0		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 107
 SITE Welland Townline Road SHEET No. 3 OF 6

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	
69.0	Massive silty clay (cont'd)		27	BO	3	63.0		
						64.5		
			28	BO	3	65.0		
						67.0		
	Varved clay	Reddish-brown and grey 1/4" to 1/2" thick distinct bands, spacing between the grey and reddish-brown couplets varies from 2" to 8", silt lenses and grey silt pockets, traces of sand and fine to coarse gravel	29	BO	3	68.0		
						70.0		
			30	BO	3	70.0		
						72.0		
			31	BO	3	73.0		
						75.0		
81.0	Silt, sand and clay (Transition)	Brown to reddish brown, silt and clay, sandy silt and silty sand, lower part contains sub-angular to well-rounded pebbles.	32	BO	3	75.0		
						77.0		
			33	BO	3	78.0		
						80.0		
			34	BO	3	80.0		
						82.0		
			35	BO	3			
						83.0		
						84.2		
			36	BO	3	85.0		
						87.0		
			37	AQ		88.0		4
						89.0		5
						89.5		8
			38	AQ		90.0		2
						91.5		
			39	AQ		93.0		
						94.5		
			40	BO		95.0		
			41	BW				
						96.0		
			42	BO		98.0		
						99.0		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT Welland Canal Relocation Townline Road/Rail Tunnel **HOLE No.** 107
SITE Welland Townline Road **SHEET No.** 4 OF 6

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	
100.0	Till	Reddish-brown, silty and sandy, contains angular gravel	43	BO	3	100.0		
						101.0		
			44	AQ		101.0		22
						101.5		38
						102.0		60
			45	AQ		102.5		29
						103.5		38
						104.0		64
			46	AQ		105.0		29
						105.5		29
						106.0		48
			47	AQ		106.5		30
111.0	Gravel and cobbles	Reddish-brown and grey, silt, silty sand, angular gravel and cobbles				107.5		34
						108.0		61
			48	AQ		112.8		
			49	AQ		113.1		111
						113.1		200
123.0	Bedrock					113.5		
			50	DQ		115.5		
						117.5		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT Welland Rail/Road Tunnel

HOLE No. 107

SITE Welland, Townline Road

SHEET No. 5 OF 6

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
535.9	900	370	2.4
534.9	630	220	2.9
533.9	1,000+	200	5.0
532.9	1,000	240	4.1
531.9	1,000+	200	5.0
530.9	1,000+	250	4.0
529.9	840	250	3.4
528.9	860	250	3.4
527.9	840	350	2.4
526.9	880	310	2.8
525.9	860	260	3.8
524.9	1,000	440	2.3
523.9	920	330	2.8
522.9	950	430	2.2
521.9	920	410	2.2
520.9	950	440	2.2
519.9	920	380	2.4
518.9	920	380	2.4
517.9	1,000	480	2.1
516.9	990	400	2.5
515.9	710	400	1.8
514.9	950	360	2.6
513.9	1,000	500	2.0
512.9	990	550	1.8
511.9	990	500	2.0
510.9	920	500	1.8
509.9	760	440	1.7
508.9	1,000	-	-
507.9	900	380	2.4
506.9	860	460	1.9
505.9	920	500	1.8
504.9	950	460	2.1
503.9	860	380	2.3
502.9	930	400	2.3
501.9	1,000+	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 107
SITE Welland, Townline Road SHEET No. 6 OF 6

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
500.9	1,000	310	3.2
499.9	1,000+	-	-
498.9	1,000+	-	-
497.9	1,000+	-	-
496.9	1,000+	-	-
495.9	1,000+	-	-
494.9	1,000+	-	-
493.9	1,000+	-	-
492.9	1,000+	-	-
491.9	1,000+	-	-
490.9	1,000+	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
108B
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. & 108
Tunnel
SITE Welland Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED 10.20 A.M. October 2 19 67
FINISHED 17.00 P.M. October 5 19 67

METHOD SOIL Power Auger (Pendril) CASING DIAM. 4.5"
OF
DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE N37488 ELEVATIONS: DATUM G.S.C.
DEPARTURE E11302 DRILL PLATFORM -
BEARING GROUND SURFACE 580.7
INITIAL DIP 90° ROCK SURFACE 506.7
OTHER DIPS BOTTOM OF HOLE 438.6
WATER TABLE 569.5

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	
0.0	Desiccated silty clay and clayey silt	Light greyish-brown to reddish-brown silty clay and clayey silt with rusty brown silt pockets and lenses, occasional grey fissures filled with salt, mottled, traces of sand, stiff to very stiff.	1	BO	2-7/8	2.5	13	Pushed
						3.0		
			2	BO	2-7/8	5.9		
						6.7	7	Pushed
			3	BO	2-7/8	7.5	11	Pushed
						8.5		
10.0	Weathered varved clay	Reddish-brown and grey alternate layers of silty clay, stiff, with silt pockets and lenses and occasional sand grains.	4	BO	2-7/8	10.0	22	Pushed
						11.8		

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 R. Osborne
LOGGED BY A. Mirza
Bedrock by J. S. Scott

APPROVED

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684.
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 108B & 108
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 5

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	
12.0	Weathered silty clay and clayey silt	Reddish-brown, stiff silty clay, contains grey clay pockets and rusty brown silt lenses, traces of sand and fine gravel.	5	BO	2-7/8	12.5	20	Pushed
			6	BO	2-7/8	14.0 15.5	20	Pushed
			7	BO	2-7/8	17.0 18.0 19.5	20	Pushed
20.0	Massive silty clay (till)	Reddish-brown silty clay, contains silt lenses and pockets, traces of fine to coarse sand and fine to coarse gravel, medium plasticity.	8	BO	2-7/8	20.0	20	Pushed
			9	BO	2-7/8	21.5 22.5	21	Pushed
			10	BO	2-7/8	24.0 25.0	20	Pushed
			11	BO	2-7/8	26.5 28.0	22	Pushed
			12	BO	2-7/8	29.5 30.0	21	Pushed
			13	BO	2-7/8	31.5 32.5	22	Pushed
			14	BO	2-7/8	34.0 35.0	22	Pushed
			15	BO	2-7/8	36.5 37.5	22	Pushed
			16	BO	2-7/8	38.8 40.0	24	Pushed
			17	BO	2-7/8	42.5	24	Pushed
42.5	Varved clay	Reddish-brown and grey distinctly laminated clay, with very thin silt layers at the base of grey clay, contains silt pockets and lenses, traces of sand and gravel.	18	BO	2-7/8	44.5 45.0	24	Pushed
			19	BO	2-7/8	47.0 47.5	23	Pushed
			20	BO	2-7/8	49.0 50.0	23	Pushed
			21	BO	2-7/8	52.0 52.5	23	Pushed
			22	BO	2-7/8	54.2 55.0	20.5	Pushed
						56.8		

DRILLING REPORT

JOB No. 1684

HOLE No. 108B & 108

SHEET No. 3 OF 5

FORM NO. 91-B

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 108
 Tunnel
 SITE Welland, Townline Road SHEET No. 4 OF 5

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
74.0	Wavy bedded dolomite	Medium brown, finely laminated, wavy bedded dolomite containing hydrocarbons and gypsum encrustations on bedding surfaces.	
76.5	Shaly dolomite	Dark grey, very fine grained shaly dolomite.	
76.5	Seed texture dolomite	Light brown, fine grained dolomite with a "seed like" texture and gypsum partings.	
81.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
95.5	Seed texture dolomite	Light brown, laminated, fine grained, somewhat wavy bedded dolomite with a seed-like texture; contact with overlying shale grades through gypsum layers.	
139.0	Wavy bedded dolomite	Medium brown, fine grained, wavy bedded dolomite with thin hydrocarbons and gypsum films on bedding surfaces.	
		Overall	84
142.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 108B
SITE Welland, Townline Road SHEET No. 5 OF 5

Torque Assembly: Acker Precision Head

Vane No.: 245 and 246

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
245-569.4	1,780	726	2.5
567.1	2,040	489	4.2
564.4	1,175	352	3.3
560.1	950	352	2.7
559.4	682	354	1.9
555.1	880	254	3.5
554.4	660	171	3.9
551.9	569	230	2.5
549.4	772	277	2.8
546.9	890	244	3.7
246-544.4	615	183	3.4
541.9	883	200	4.4
539.4	566	161	3.5
536.9	684	212	3.2
534.4	618	177	3.5
531.9	-	335	-
529.4	908	171	5.3
526.9	955	284	3.4
524.4	1,107	218	5.1
521.9	1,130+	418	2.7+

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Road/Rail Tunnel HOLE No. 109

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 1.15 P.M. October 5 19 67
FINISHED .M. October 10 19 67

METHOD SOIL Power auger CASING DIAM. 4.5", NX

OF
DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37.501N ELEVATIONS: DATUM G.S.C.
DEPARTURE 12.147E DRILL PLATFORM
BEARING GROUND SURFACE 583.9
INITIAL DIP 90° ROCK SURFACE 517.4
OTHER DIPS BOTTOM OF HOLE 454.4
WATER TABLE 569

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	Desiccated clayey silt and silty clay	Greyish-brown, grey and reddish-brown very stiff, mottled, weathered silty clay and clayey silt, numerous silt layers and lenses, few salt and organic inclusions, occasional sand grain, contains layered clay zones.	1	BO	2-7/8	0.0	13	Pushed
						2.0		
			2	BO	2-7/8	2.5	13	Pushed
						4.2		
			3	BO	2-7/8	5.0	12	Pushed
						6.7		
			4	BO	2-7/8	7.5	12	Pushed
						9.0		
			5	BO	2-7/8	10.0	16	Pushed
						11.7		740 psi
			6	BO	3	12.5	18	Pushed
						14.2		600 psi
			7	BO	3	15.0	16	Pushed
						16.7		
			8	BO	3	17.5	22	Pushed
						19.5		

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 R. Osborne

LOGGED BY A. Mirza

Bedrock by J. S. Scott

APPROVED

DATE

[Signature]
February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland - Channel Relocation, Townline Road/Rail HOLE No. 109
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 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	
20.0	Massive silty clay (upper till)	Reddish-brown silty clay containing silt layers and lenses, numerous sand grains and fine to coarse gravel; medium plasticity.	9	BO	3	20.0	15	Pushed
			10	BO	3	22.0	22	Pushed
			11	BO	3	22.5		
						24.5		
			12	BO	3	25.0		
						27.0		
			13	BO	3	27.5	21	Pushed
						29.5		
40.0	Varved clay and silt	Reddish-brown and grey, layered, 3 to 4" thick silt layers with red and grey silty clay bands 1/4" to 1/2" wide and few reddish brown clay inclusions.	14	BO	3	30.0	20	Pushed
						32.0		
			15	BO	3	32.5	23	Pushed
						34.5		500 psi
			16	BO	3	35.0	23	Pushed
						37.0		
						37.5	23	Pushed
						39.5		
			17	BO	3	40.0	22	Pushed
						42.0		300 psi
			18	BO	3	42.5	23	Pushed
						44.5		250 psi
			19	BO	3	45.0	23	Pushed
						47.0		

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

D R I L L I N G R E P O R T

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland - Channel Relocation, Townline Road/Rail HOLE No. 109

SITE Welland, Townline Road Tunnel SHEET No. 3 OF 4

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	
47.0	Silty clay	Reddish-brown, medium plasticity, numerous silt lenses and pockets, traces of sand and fine grained gravel	20	BO	3	47.5 49.5	23	Pushed 250 lbs
50.0	Varved clay	Reddish-brown and grey, distinctly laminated, thin silt and fine sand layers, upper part contains irregular and widely spaced varves, traces of sand and fine to coarse gravel.	21	BO	3	50.0 52.0	23	Pushed
			22	BO	3	52.5 54.5	12	Pushed
			23	BO	3	55.0 57.0	23	Pushed
			24	BO	3	57.5 59.5	23	Pushed
60.5	Silt, sand and clay (transition)	Brown silt with clay inclusions, and sandy silt	25	BO	3	60.0 62.0	2	Pushed
62.0	Till	Reddish-brown, compact, granular till	26	BO	3	62.0 63.3	14	Pushed
			27	AQ	2	62.5 63.5 64.0		30 31 30
			28	AQ	2	65.5		41
			29	AQ	2	66.0		81
66.5	Bedrock	See next page.						

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 109
Tunnel

SITE Welland, Townline Road SHEET No. 4 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
66.5	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite, traces of gypsum and hydrocarbons on bedding surfaces.	
68.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	
70.0	Wavy bedded dolomite	Grey-brown, wavy bedded dolomite with thin hydrocarbons and gypsum layers on bedding surfaces.	
79.0	Shaly dolomite	Dark grey, very fine grained shaly dolomite.	
80.7	Seed texture dolomite	Grey-brown, fine grained dolomite with seed-like texture.	
84.3	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum	
97.0	Seed texture dolomite	Grey-brown, fine grained shaly dolomite with gypsum.	
99.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
139.5	Seed texture wavy bedded dolomite	Dark brown, fine grained, slightly wavy bedded dolomite with seed-like texture contains traces of hydrocarbons and gypsum.	
		Overall	86
151.7	End of Hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 110

SITE Welland, Townline Road SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soil Investigation STARTED 4:30 P.M. Oct. 12 19 67
Power Auger FINISHED 5:00 P.M. Oct. 31 19 67

METHOD OF DRILLING: SOIL Power Auger CASING DIAM. _____

ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 37,501 N ELEVATIONS: DATUM GSC
 DEPARTURE 13,000 E DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 586.5
 INITIAL DIP 90° ROCK SURFACE 523.0
 OTHER DIPS _____ BOTTOM OF HOLE 494.5
 WATER TABLE 574

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	Desiccated clayey silt and silty clay	Yellowish-grey, brownish-grey, and reddish brown, very stiff, mottled, numerous silt layers and lenses, occasional salt inclusion, contains weathered varved clay zones	1	BO	2-7/8	0.5	6	Pushed
						2.2		740 psi
			2	BO	2-7/8	2.5	14	Pushed
						3.3		750 psi
			3	BO	2-7/8	5.0	15	Pushed
						6.5		750 psi
			4	BO	2-7/8	7.5	14	Pushed
						9.5		750 psi
20.0	Massive silty clay (upper till)	Reddish-brown silty clay contains silt layers and lenses, traces of fine to coarse gravel	5	BO	2-7/8	10.0	8	Pushed
						11.1		750 psi
			6	BO	2-7/8	12.5	19	Pushed
						14.5		260 psi
			7	BO	2-7/8	15.0	24	Pushed
						17.0		600 psi
			8	BO	2-7/8	17.5	20	Pushed
						19.5		600 psi
			9	BO	2-7/8	20.0	19	Pushed
						22.0		250 psi

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 R. Osborne

LOGGED BY A. Mirza

APPROVED _____

DATE _____

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 110
 SITE Welland, Townline Road SHEET No. 2 OF 3

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	
36.0	Sandy silt and distorted varves	Reddish-brown, brown and grey, clayey silt, silt and sandy silt with inclusions of red and grey distorted bands	10	BO	2-7/8	22.5	19	
						24.5		
			11	BO	2-7/8	25.0	16	Pushed
						26.7		
			12	BO	2-7/8	27.5	23	Pushed
						29.5		
			13	BO	2-7/8	30.0	24	Pushed
						32.0		450 psi
44.0	Varved clay	Reddish-brown, light brown and grey, distinctly layered, thin silt and fine sand layers, traces of sand and fine to coarse gravel	14	BO	2-7/8	32.5	24	Pushed
						34.5		
			15	BO	2-7/8	35.0	24	Pushed
						37.0		
			16	BO	2-7/8	37.5	24	Pushed
						39.5		
			17	CO	3	40.0	18	Pushed
						41.7		
52.0	Silt sand and clay (transition)	Brown, silt and sandy silt, contains coarse gravel	18	CO	3	42.5	20	Pushed
						44.0		
			19	CO	3	45.0	20	Pushed
						46.7		
			20	CO	3	47.5	20	Pushed
						49.0		
			21	CO	3	50.0		Pushed
						51.7		
			22	CO	3	52.5	14	Pushed
						54.0		
			23	BO	3	54.2	17	Pushed
						55.7		300 psi
			24	BO	3	55.7	4	Pushed
						57.7		500 psi

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT Welland Canal Relocation Townline Road/Rail **HOLE No.** 110
 Tunnel
SITE Welland Townline Road **SHEET No.** 3 OF 3

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	
58.0	Till	Brown, silty and sandy, angular rock fragments	25	AQ	2	58.2 59.0 59.5 60.0	2	15 18 34
			26			60.0 61.5		
			27			62.5 63.0		
63.5	Bedrock							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 111

SITE Welland Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 4:00 P.M. Oct. 16 19 67
Investigation FINISHED 9:00 A.M. Nov. 3 19 67

METHOD OF DRILLING: SOIL Auger CASING DIAM. _____

ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 37.501 N ELEVATIONS: DATUM GSC
 DEPARTURE 14.002 E DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 585.2
 INITIAL DIP 90° ROCK SURFACE 500.2
 OTHER DIPS _____ BOTTOM OF HOLE 462.7
 WATER TABLE 577

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	Desiccated clayey silt and silty clay	Olive grey, reddish-grey and greyish-brown, clayey silt and silty clay, mottled, contains numerous silt layers and lenses, and occasional salt inclusion, lower 2 feet distinctly layered	1	BC	2-7/8	0.5	21	Pushed
			2	BC	2-7/8	2.5		
			3	BC	2-7/8	3.0		Pushed
			4	BC	2-7/8	5.0	19	Pushed
			5	BC	2-7/8	6.5		
			6	BC	2-7/8	7.5	17.5	Pushed
			7	BC	2-7/8	9.5		
			8	BC	2-7/8	10.0	24	Pushed
			9	BC	2-7/8	12.0		
			10	BC	2-7/8	12.5	24	Pushed
			11	BC	2-7/8	14.5		
22.0	Massive silty clay (upper till)	Reddish-brown silty clay, contains numerous silt layers and lenses; traces of sand and fine to coarse gravel	12	BC	2-7/8	15.0	24	Pushed
			13	BC	2-7/8	17.0		
			14	BC	2-7/8	17.5	23	Pushed
			15	BC	2-7/8	19.5		
			16	BC	2-7/8	20.0	23	Pushed
			17	BC	2-7/8	22.0		
			18	BC	2-7/8	22.5	24	Pushed
			19	BC	2-7/8	24.5		
			20	BC	2-7/8	25.0	24	Pushed
			21	BC	2-7/8	27.0		

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 R. Osborne

LOGGED BY A. Mirza

APPROVED _____

DATE

February, 1969

DRILLING REPORT

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				
	Massive silty clay (upper till) (cont'd)		12	BO	2-7/8	27.5	24	Pushed			
						29.5					
			13	BO	2-7/8	30.0	20	Pushed			
						32.0					
			14	BO	2-7/8	32.5	23	Pushed			
						34.5					
			15	BO	2-7/8	35.0	20	Pushed			
						37.0					
			16	BO	2-7/8	37.5	24	Pushed			
						39.5					
			17	BO	2-7/8	40.0	23	Pushed			
						42.0					
			18	BO	2-7/8	42.5	24	Pushed			
						44.5					
			19	BO	2-7/8	45.0	24	Pushed			
						47.0					
			47.5	Silt and distorted varves	Reddish-brown and greyish-brown silt and clay, with distorted brownish-grey layering, one layer almost vertical, numerous silt lenses and pockets	20	BO	3	47.5	20	Pushed
								49.5			
			21			BO	3	50.0	23	Pushed	
								52.0			
22	BO	3	52.5			24	Pushed				
						54.5					
			23	BO	3	55.0	23	Pushed			
						57.0					
			57.0	Massive silty clay	Reddish-brown silty clay of medium plasticity contains numerous silt layers and lenses, traces of sand and fine gravel	24	CO	3	57.5	20	Pushed
								59.5			
			25			CO	3	60.0	20	Pushed	
								62.0			
			26			BO	3	62.5	24	Pushed	
									64.5		
						27	BO	3	65.0	24	Pushed
						67.0					

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 111
 SITE Welland Townline Road SHEET No. 3 OF 4

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	
67.0	Varved clay	Reddish-brown, light brown and grey, distinctly laminated, spacing between varves varies from 1/4" to 10", very thin silt and fine sand layers, contains numerous silt lenses; traces of sand and gravel	28	BO	3	67.5	24	Pushed
			29	BO	3	69.5	24	Pushed
			30	BO	3	70.0	24	Pushed
			31	BO	3	72.0	24	Pushed
			32	BO	3	72.5	24	Pushed
						74.5	24	Pushed
						75.0	24	Pushed
						77.0	24	Pushed
						77.5	24	Pushed
						79.5		
80.0	Silt and sand (transition)	Brown silt and sandy silt, with subangular to rounded gravel	33	BO	3	80.0	24	
			34	BA		82.0		
						82.0		
						82.3		
82.0	Till	Brown, silty and sandy contains rock fragments angular to subangular						
85.0	Bedrock							
93.0		Piezometer tip installed						
122.5		End of Hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 111
SITE Welland, Townline Road SHEET No. 4 OF 4

Torque Assembly: Acker Precision Head

Vane No.: 246

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
573.7	1,848	682	2.71
571.0	955	295	3.24
568.7	847	306	2.78
566.2	1,050	235	4.47
563.7	935	270	3.46
561.2	953	417	2.28
558.7	874	300	2.91
556.2	846	435	1.95
553.7	900	494	1.82
551.2	799	382	2.09
548.7	987	546	1.81
546.2	1,027	535	1.92
543.7	928	526	1.77
541.2	781	470	1.66
538.7	822	488	1.69
536.2	1,620	835	1.94
533.7	1,065	512	2.08
531.2	1,168	365	3.20
528.7	1,020	446	2.29
526.2	1,170+	700	1.67
523.7	895	353	2.54
521.2	653	400	1.64
518.7	916	329	2.78
516.2	1,400	458	3.07
513.7	1,270	470	2.70
511.2	1,363	435	3.13
508.7	1,600	695	2.30
506.2	2,210	-	-
503.9	1,710	1,620	1.05

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 114

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 10:30 AM. Oct. 26 19 67
Modified Wash Boring FINISHED 3:30 PM. Nov. 11 19 67

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 36,927 N ELEVATIONS: DATUM GSC
 DEPARTURE 9,988 E DRILL PLATFORM -
 BEARING 90° GROUND SURFACE 568.8
 INITIAL DIP 90° ROCK SURFACE 452.8
 OTHER DIPS BOTTOM OF HOLE 421.2
 WATER TABLE 566.3

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	Desiccated clayey silt and silty clay	Reddish-brown and greyish-brown silty clay, very stiff, pale grey silt layers and oxidized pockets, occasional salt inclusions, traces of sand and fine gravel; contains two weathered varved clay zones	1	BO	2-7/8	2.0	13	
						2.5		15
						3.0		44
						3.5		56
			2	AQ		3.5	13	
						4.0		11
						4.5		21
						5.0		32
			3	AQ		5.5	18	
						6.0		5
						6.5		18
						7.0		27
			4	AQ		7.0	10	
						7.5		
						8.0		5
						8.5		15
						9.0		17
			5	AQ		9.0	8	
						9.5		
						10.0		18
						10.5		2
						11.0		3

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 T. Svircev

LOGGED BY J. S. Scott

APPROVED *[Signature]*

DATE February, 1969

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel

HOLE No. 114

SITE Welland, Townline Road

SHEET No. 2 OF 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	
20.0	Desiccated clayey silt and silty clay (cont'd)		6	BO	2-7/8	12.0	9	
						12.5		
						13.0		
						13.5		5
						14.0		8
			7	BO	2-7/8	14.0	13	Hammer
						15.5		
			8	BO	2-7/8	15.5	13	Hammer
						17.0		
			9	BO	2-7/8	17.0	13	Hammer
20.0	Massive silty clay (upper till)	Reddish-brown, medium stiff, silty clay, silt layers and lenses, occasional very faint banding, traces of sand and fine to coarse gravel				18.5		
			10	BO	2-7/8	18.5	22	Hammer
						20.5		
			11	BO	2-7/8	20.5	17	Hammer
						22.5		
			12	BO	2-7/8	22.5	15	Hammer
						24.5		
			13	BO	2-7/8	24.5	14	Hammer
						26.5		
			14	BO	2-7/8	26.5	16	Hammer
35.0	Varved clay	Alternating layers of reddish-brown, grey and medium-brown clay, very thin silt layers, traces of sand and gravel				28.5		
			15	BO	2-7.8	28.5	14	Hammer
						30.5		
			16	BO	2-7/8	30.5	15	Hammer
						32.5		
			17	B			0	
			18	BO	2-7/8	35.0	18	Pushed
						37.0		
			19	BO	2-7/8	37.0	20	Pushed
						38.5		
35.0	Varved clay	Alternating layers of reddish-brown, grey and medium-brown clay, very thin silt layers, traces of sand and gravel	20	BO	2-7/8	38.5	22	Pushed
						40.5		

DRILLING REPORT

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	
39.0	Massive silty clay	Reddish-brown silty clay, pockets and lenses of silt, traces of fine to coarse gravel	21	BO	2-7/8	41.0	22	Pushed
			22	BO	2-7/8	42.9	22	Pushed
			23	BO	2-7/8	44.9	22	Pushed
			24	BO	2-7/8	45.0	22	Pushed
			25	BO	2-7/8	46.9	22	Pushed
			26	BO	2-7/8	47.0	22	Pushed
			27	BO	2-7/8	48.9	22	Pushed
			28	BO	2-7/8	49.0	22	Pushed
			29	BO	2-7/8	50.9	22	Pushed
			30	BO	2-7/8	51.0	22	Pushed
			31	BO	2-7/8	52.9	22	Pushed
			32	BO	2-7/8	53.0	22	Pushed
			33	BO	2-7/8	54.9	22	Pushed
			34	BO	2-7/8	55.0	22	Pushed
			35	BO	2-7/8	56.9	22	Pushed
			36	CO	2-7/8	57.0	19	Pushed
			68.0	Varved clay	Reddish-brown, grey and medium-brown, distinctly laminated clay, 1/4" and 1/16" silt partings, traces of sand and gravel	37	CO	2-7/8
38	CO	2-7/8				59.0	18	Pushed
39	CO	2-7/8				60.0	18	Pushed
40	CO	2-7/8				61.0	18	Pushed
41	CO	2-7/8				62.5	18	Pushed

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail HOLE No. 114
 SITE Welland Townline Road SHEET No. 4 OF 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	
76.5	Silt, sand and clay (transition)	Brown clayey silt, silt and dilatant sandy silt	40	CO	2-7/8	77.5	18	Pushed
						79.0		
			41	CO	2-7/8	81.0	16	Pushed
						82.5		
			42	CO	2-7/8	83.0	13	Pushed
						84.5		
			43	CO	2-7/8	87.0	18	Pushed
						88.8		
89.0	Till	Brown, silty, sandy and gravelly till	44	AQ	2	89.5	8	
						90.0		18
						90.5		20
						91.0		38
			45	AQ	2	93.0	13	
						93.5		14
						94.0		34
			46	AQ	2	95.3	4	
						96.0		8
						96.5		16
						97.0		48
			47	DQ		97.0		
						99.5		
			48	DY		100.0	6	
						102.0		
			49	DY		102.0	6	
						106.0		
			50	DY		106.0	9	
						108.0		
107.0	Gravel and cobbles	Silty sand, gravel and cobbles	51	DY		108.0	10	
						113.0		
113.5	Bedrock							
122.0		Piezometer Tip						
147.6	End of Hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 123

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil STARTED 7:00 A.M. Dec. 14 1967
Investigation FINISHED 7:30 P.M. Dec. 22 1967

METHOD SOIL Modified Washboring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,405 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 581.5
 INITIAL DIP 90° ROCK SURFACE 510.5
 OTHER DIPS BOTTOM OF HOLE 402.0
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
71.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite, traces of hydrocarbons and gypsum on bedding planes.	
75.8	Shaly dolomite	Dark grey, finely laminated, very fine grained shaly dolomite.	
77.6	Seed-texture dolomite	Light brown, fine grained, dolomite with seed-like texture, traces of hydrocarbons.	
78.8	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum, fine vuggy porosity, minor hydrocarbons and gypsum on bedding surfaces.	
94.5	Seed-texture dolomite	Medium brown, fine grained, wavy bedded dolomite with seed-like texture and thin gypsum partings.	
97.0	Shaly dolomite with gypsum	Dark grey, very fine grained, massive shaly dolomite with gypsum, occasional evidence of gypsum solutioning.	
139.0	Wavy bedded dolomite	Light brown, fine grained wavy bedded dolomite with traces of hydrocarbons and thin gypsum films in bedding layers.	

INSPECTOR R. Osborne A. Svircev

LOGGED BY J. S. Scott

APPROVED 

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 123
 Tunnel
 SITE Welland, Townline Road SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
142.6	Shaly bedded dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	86
162.6	Seed-texture dolomite	Grey brown, fine grained, wavy bedded dolomite with seed-like texture, traces of hydrocarbons and gypsum.	
164.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
		Overall	
179.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 124

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil STARTED 7:00 A.M. January 7 1968

Investigation FINISHED 9:00 P.M. January 18 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX

ROCK Diamond drill CORE DIAM. NXL

LOCATION: LATITUDE 37.560N ELEVATIONS: DATUM G.S.C.

DEPARTURE 11.505E DRILL PLATFORM 581.1

BEARING 90° GROUND SURFACE 510.1

INITIAL DIP 90° ROCK SURFACE 510.1

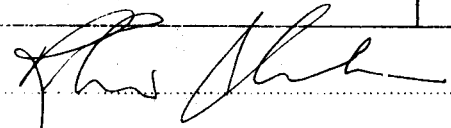
OTHER DIPS BOTTOM OF HOLE 400.9

 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
71.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with traces of gypsum and hydrocarbons on bedding planes.	
77.5	Shaly dolomite	Dark grey, very fine grain shaly dolomite.	
79.0	Seed-texture dolomite	Light brown, fine grained dolomite with seed like texture and minor gypsum.	
82.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
94.0	Seed-texture dolomite	Light brown, fine grained, wavy bedded dolomite with seed-like texture and gypsum partings.	
95.6	Shaly dolomite with gypsum	Dark grey, very fine grained massive shaly dolomite with gypsum.	
135.0	Wavy bedded dolomite	Dark grey brown, fine grained, wavy bedded dolomite with traces of gypsum and hydrocarbons.	

INSPECTOR J. Carella

LOGGED BY J. S. Scott

APPROVED 

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 124
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
138.0	Shaly dolomite with gypsum	Dark grey and black, very fine grained, shaly dolomite and dolomitic shale with gypsum.	82
180.2	End of hole	Overall	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 125

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 15.00 M. Jan. 19 19 68
 FINISHED 17.00 M. Jan. 30 19 68

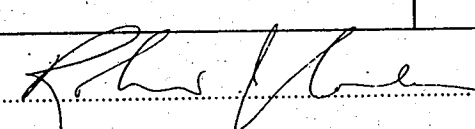
METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,500N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,700E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 582.5
 INITIAL DIP 90° ROCK SURFACE 512.0
 OTHER DIPS BOTTOM OF HOLE 402.5
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
70.5	Massive dolomite	Medium brown, fine grained, massive dolomite with minor gypsum.	
75.8	Shaly dolomite	Medium to dark grey, very fine grained shaly dolomite.	
77.4	Seed texture dolomite	Medium brown, fine grained dolomite with sand-like texture, minor gypsum.	
80.9	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
94.4	Seed texture dolomite	Light brown, fine grained dolomite with a seedlike texture, minor gypsum and hydrocarbon on bedding surfaces.	
95.7	Shaly dolomite with gypsum	Dark grey, very fine grained, massive shaly dolomite with gypsum.	
139.5	Seed texture dolomite	Medium brown, thin bedded dolomite, minor seedlike texture, and gypsum encrustation on bedding.	

INSPECTOR J. Carella

LOGGED BY J. S. Scott

APPROVED 

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 125
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
142.5	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
161.5	Wavy bedded dolomite	Dark brown, fine grained, wavy bedded dolomite with gypsum and hydrocarbon layers.	
164.5	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
170.0	Wavy bedded dolomite	Medium brown and dark grey, interbedded dolomite, partly wavy bedded, slight seedlike texture, minor gypsum.	
172.0	Shaly dolomite with gypsum	Dark grey and black shaly dolomite with gypsum.	
		Overall	68%
178.5	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 126

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soils Investigations STARTED 13.00 .M. Jan. 24 19 68
FINISHED 15.00 .M. Feb. 2 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,450 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 581.9
 INITIAL DIP 90° ROCK SURFACE 514.9
 OTHER DIPS BOTTOM OF HOLE 399.4
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
67.0	Wavy bedded dolomite	Light brown, fine grained, thin wavy bedded dolomite. Traces of gypsum and hydrocarbons.	
77.0	Shaly dolomite	Dark grey, very fine grained, shaly dolomite.	
79.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture and gypsum partings.	
82.8	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with massive gypsum layers and inclusions.	
96.0	Seed texture dolomite	Light brown, fine grained dolomite with seed-like texture. Some gypsum inclusions. Transitional contact with underlying shaly dolomite.	
98.5	Shaly dolomite with gypsum	Dark grey, very fine grained, massive shaly dolomite with gypsum.	
141.0	Wavy bedded dolomite	Medium brown, fine grained, wavy bedded dolomite with minor gypsum and hydrocarbons.	

INSPECTOR J. Carella

LOGGED BY J. S. Scott

APPROVED

DATE

[Signature]
 February, 1969

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 126

SITE Welland, Townline Road SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
144.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum, minor muggy porosity.	
165.0	Wavy bedded dolomite	Medium to dark brown, fine grained wavy bedded dolomite, minor hydrocarbons.	
166.0	Shaly dolomite with gypsum	Dark grey and black, very fine grained, shaly dolomite and dolomatic shale with gypsum; evidence of gypsum solutioning.	
		Overall	90

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 127
 SITE Welland Townline Road SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soil Investigation STARTED 10:00 AM. Jan. 29 19 68
 FINISHED 9:30 AM. Feb. 2 19 68
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 38.140 N ELEVATIONS: DATUM GSC
 DEPARTURE 4,809.6 E DRILL PLATFORM 570.0
 BEARING 90° GROUND SURFACE 537.5
 INITIAL DIP 90° ROCK SURFACE 439.3
 OTHER DIPS BOTTOM OF HOLE 425.1
 WATER TABLE

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		Barge platform						
32.6		Bottom of canal						
33.0	Varved clay	Reddish-brown, light brown and grey, distinctly laminated clay, with thin silt and fine sand layers; few grey sandy pockets, traces of fine to coarse gravel	1	BO	2-7/8	32.6	24	Pushed
						34.6		
			2	BO	2-7/8	35.0	24	Pushed
						37.0		
			3	BO	2-7/8	37.5	17	Pushed
						39.0		
	Silt and silty sand	Grey and brown, silt, sandy silt, silty sand, and fine to medium sand, with occasional inclusions of clayey silt and coarse sand, traces of fine to coarse gravel	4	BO	2-7/8	40.0	22	Pushed
						41.8		
			5	BO	2-7/8	42.5	19	Pushed
						44.0		
			6	BO	2-7/8	45.0	14	Pushed
						46.5		
46.5			7	AQ		55.0	9	Sank
						56.5		
			8	AQ		60.0	9	Pushed
						61.5		
			9	AQ		64.2	6	
						64.5		6
						65.0		8
						65.8		9

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 R. Stewart

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

H. G. ACRES & COMPANY LIMITED – CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail HOLE No. 127
 Tunnel
 SITE Welland Townline Road SHEET No. 2 OF 3

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	
	Silt and silty sand (cont'd)		10	AQ		70.0	17	
						70.5		7
						71.0		7
						71.5		11
			11	AQ		75.0	14	
						75.5		12
						76.0		15
						76.5		16
			12	AQ		80.0	18	
						80.5		7
						81.0		23
						81.5		20
			13	AQ		82.5	7	
						83.0		
						83.5		3
						84.0		6
			14	AQ		85.0	5	
						85.8		
			15	AQ		87.5	18	
						88.0		
						88.5		8
						89.0		9
			16	AQ		90.0	2	
						90.5		1
						91.0		3
						91.5		6
			17	AQ		91.5	5	
						92.0		
			18	FQ		95.0		
			19	HQ		99.0	18	
						100.5		
			20	FQ		103.0		
			21	AQ		105.0		
			22	FQ		107.5		
			23	FQ		110.0		
			24	FQ		112.5		
			25	FQ		115.0		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 127
 SITE Welland Townline Road SHEET No. 3 OF 3

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	
	Silt and silty sand (cont'd)		26	FQ		117.5		
			27	FQ		120.0		
			28	FQ		122.5		
			29	FQ		125.0		
			30	FQ		127.5		
			31	FQ		129.0		
			32	FQ		130.0		
			33	FQ		132.5		
			34	FQ		133.8		
133.7	Bedrock							
144.9	End of Hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 128
 SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soils Investigations STARTED 13.30 .M. Jan. 30 19 68
 FINISHED 15.30 .M. Feb. 2 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,560N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,360E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 580.1
 INITIAL DIP 90° ROCK SURFACE 512.6
 OTHER DIPS BOTTOM OF HOLE 400.1
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
67.5	Wavy bedded dolomite (salina fm)	Light brown, fine grained, wavy bedded dolomite, evidence of solutioning, minor gypsum, traces of hydrocarbons on bedding surfaces; vuggy porosity.	
76.6	Shaly dolomite	Dark grey, very fine grained shaly dolomite.	
77.6	Seed texture dolomite	Light brown, fine grained, wavy bedded dolomite with seedlike texture, partly argillaceous, gypsum on bedding planes.	
81.5	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum layers; stringers of shaly dolomite contained in the gypsum.	
91.5	Seed texture dolomite	Light brown, fine grained, wavy bedded dolomite with seedlike texture and gypsum inclusions.	
95.5	Shaly dolomite with gypsum	Dark grey, very fine grained, massive shaly dolomite with gypsum layers and blobs occasionally pale pink. Evidence of solutioning, iron oxide stain on some bedding surfaces.	

INSPECTOR J. Carella

APPROVED

LOGGED BY J. S. Scott

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 128
 SITE Welland Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
137.2	Wavy bedded dolomite	Medium brown, fine grained, wavy bedded dolomite with thin gypsum layers along bedding surfaces; fine vuggy porosity in several zones.	
141.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum layers and blobs, minor vuggy porosity and iron oxide stains.	
161.8	Wavy bedded dolomite	Dark brown and dark grey, somewhat shaly, wavy bedded dolomite with gypsum encrustation on bedding planes.	
163.8	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
		Overall	80%
180.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 130

SITE Welland, Townline Road SHEET No. 1 OF 1

CONTRACTOR: Peninsula Soils Investigations STARTED 08.00 .M. Feb. 5 19 68
FINISHED 15.00 .M. Feb. 16 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,500N ELEVATIONS: DATUM G.S.C.
DEPARTURE 12,000E DRILL PLATFORM
BEARING 90° GROUND SURFACE 581.5
INITIAL DIP 90° ROCK SURFACE 513.0
OTHER DIPS BOTTOM OF HOLE 401.5
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden: Silty clay and till.	
68.5	Wavy bedded dolomite	Light brown, thinly laminated, wavy bedded, fine grained dolomite, with minor gypsum on bedding planes.	
83.0	Seed texture dolomite	Light brown, fine grained dolomite with seed-like texture.	
87.0	Shaly dolomite with gypsum	Dark grey to blackish-grey, very fine grained massive shaly dolomite with layers, lenses, and pockets of gypsum.	
143.0	Seed texture dolomite	Medium brown, fine grained, wavy bedded dolomite with seedlike texture and minor gypsum partings.	
146.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum layers and inclusions.	
		Overall	91
180.0	End of hole		

INSPECTOR J. Carella

LOGGED BY J. S. Scott

APPROVED

DATE

[Signature]
February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 132

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 11:00 A.M. February 12 1968

FINISHED 2:00 P.M. February 14 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 32,560N ELEVATIONS: DATUM G.S.C.

DEPARTURE 11,900E DRILL PLATFORM

BEARING 90° GROUND SURFACE 583.8

INITIAL DIP 90° ROCK SURFACE 515.3

OTHER DIPS BOTTOM OF HOLE 403.8

 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
68.5	Wavy bedded dolomite	Dark brown, fine grained, wavy bedded dolomite with thin hydrocarbons and gypsum layers.	
81.5	Shaly dolomite	Dark grey, very fine grained shaly dolomite.	
82.8	Seed texture dolomite	Dark grey-brown, fine grained, wavy bedded dolomite with seed-like texture.	
86.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum; evidence of solutioning.	
99.0	Wavy bedded dolomite	Dark grey-brown, fine grained wavy bedded dolomite with gypsum inclusions.	
101.0	Shaly dolomite with gypsum	Dark grey, very fine grained massive shaly dolomite with gypsum.	
140.0	Wavy bedded dolomite	Dark grey-brown, fine grained wavy bedded dolomite with thin hydrocarbons and gypsum layers.	

INSPECTOR J. Carella

LOGGED BY J. S. Scott

APPROVED

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 132
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
143.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
162.5	Wavy bedded dolomite	Dark grey-brown fine grained wavy bedded dolomite with gypsum and hydrocarbons in bedding layers.	
164.8	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
		Overall	76
179.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 133

SITE Welland, Townline Road SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soil Investigation STARTED 8:00 AM. Feb. 19 19 68
FINISHED 3:00 PM. Feb. 26 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37.405 N ELEVATIONS: DATUM GSC
DEPARTURE 16.110 E DRILL PLATFORM -
BEARING - GROUND SURFACE 584.9
INITIAL DIP 90° ROCK SURFACE 501.9
OTHER DIPS - BOTTOM OF HOLE 491.4
WATER TABLE 572.8

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	Desiccated clayey silt and silty clay	Grey, brownish-grey and reddish-brown, very stiff, clayey silt and silty clay, mottled, contains silt layers and lenses, occasional inclusions of salt and organic matter	1	BO	2-7/8	5.0	8	400 psi Hammer
			2	BO	2-7/8	8.0	13	
			3	BO	2-7/8	10.0	17	23
			4	BO	2-7/8	13.0	20	23
			5	BO	2-7/8	15.0	24	Pushed
18.0	Massive silty clay (upper till)	Reddish-brown silty clay contains silt lenses and traces of fine to coarse gravel	6	BO	2-7/8	18.0	24	Pushed
			7	BO	2-7/8	20.0	24	Pushed
			8	CO		22.5	20	Pushed
			9	CO		25.0	18	100 psi Pushed
						27.0		100 psi

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. Carella

LOGGED BY A. Mirza

APPROVED

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 133
 SITE Welland Townline Road SHEET No. 2 OF 3

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	
46.0	Silt and distorted varves	Reddish-brown, silt and clayey silt with inclusions of distorted reddish-brown and grey layers of clay	10	CO		27.5	20	Pushed
						29.5		
			11	CO		30.0	15	Pushed
						32.0		
			12	CO		33.0	20	Pushed
						34.5		
			13	CO		35.0	20	Pushed
						37.0		
			14	CO		37.5	20	Pushed
						39.5		
			15	CO		40.0	18	Pushed
						42.0		
			16	CO		42.5	20	Pushed
						44.5		
61.0	Massive silty clay	Reddish-brown silty clay of medium plasticity, contains numerous silt layers and lenses; traces of sand and fine gravel	17	CO		45.0	20	Pushed
						47.0		
			18	CO		47.5	20	Pushed
						49.5		
			19	CO		50.0	20	Pushed
						52.0		
			20	CO		52.5	20	Pushed
						54.5		
			21	CO		55.0	18	Pushed
						57.0		
			22	CO		57.5	21	Pushed
						59.5		
			23	CO	2-7/8	60.0	20	Pushed
						62.0		
			24	CO	2-7/8	62.5	20	Pushed
						64.5		
			25	CO	2-7/8	65.0	12	Pushed
						67.0		
			26	CO	2-7/8	67.5	18	Pushed
						69.5		
			27	CO	2-7/8	70.0	20	Pushed
						72.0		

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

D R I L L I N G R E P O R T

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation Townline Road/Rail Tunnel	HOLE No.	133
SITE	Welland Townline Road	SHEET No.	3 OF 3

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	
71.0	Varved clay	Reddish-brown, grey and light-brown, distinctly layered clay, thin layers of silt and fine sand, irregular spacing between the varves, contains silt pockets and fine to coarse gravel	28	CO	2-7/8	72.5	20	Pushed
						74.5		
			29	CO	2-7/8	75.0	21	Pushed
						77.0		
			30	CO	2-7/8	77.5	20	Pushed
82.0	Till	Reddish-brown compact, granular till				79.5		
			31	CO	2-7/8	80.0	17	Pushed
						82.0		
83.0	Bedrock							
93.5	End of Hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 134

SITE Welland Townline Road SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soil Investigation STARTED 7:00 AM. Feb. 19 19 68
FINISHED 3:00 PM. Feb. 22 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 37,036 N ELEVATIONS: DATUM GSC
DEPARTURE 5,125 E DRILL PLATFORM 570.0
BEARING - GROUND SURFACE 537.1
INITIAL DIP 90° ROCK SURFACE 481.0
OTHER DIPS - BOTTOM OF HOLE 450.3
WATER TABLE

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		Barge platform						
32.9		Bottom of canal						
33.0	Massive silty clay	Reddish-brown clay of medium plasticity contains silt lenses and traces of sand and fine gravel	1	BO	2-7/8	33.0	20	Pushed
						34.5		
			2	BO	2-7/8	35.0	23	Pushed
						37.0		
			3	BO	2-7/8	37.5	18	Pushed
						39.0		
	Varved clay	Reddish-brown, light-brown and grey layered clay with thin silt and fine sand layers	4	BO	2-7/8	40.0	18	Pushed
						41.5		
			5	BO	2-7/8	42.5	12	
						43.5		
			5A	AQ		43.5		
						44.0		
44.0			6	BO	2-7/8	45.0	18	Pushed
						46.5		
			7	BO	2-7/8	47.5	18	Pushed
						49.0		
			8	BO	2-7/8	50.0	18	Pushed
						51.5		

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 E. Carlson

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 134
 SITE Welland Townline Road SHEET No. 2 OF 3

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	
52.0	Silt clay and sandy silt (transition)	Brown silt, sandy silt, and sand with clay inclusive	9	BO	2-7/8	54.2	16	Pushed
						54.0		
			10	BO	2-7/8	55.0	18	Pushed
						56.5		
			11	BO	2-7/8	57.5	15	Pushed
						59.0		
			12	BO	2-7/8	60.0	15	Pushed
						61.5		
			13	BO	2-7/8	62.5	17	Pushed
						64.0		
			14	BO	2-7/8	65.0		Pushed
						66.5		
			15	AQ		67.5	18	
						68.0		8
						68.5		20
						69.0		14
			16	AQ		70.0	12	
						70.5		12
						71.0		32
						71.5		63
			17	AQ		72.5	14	
						73.0		4
						73.5		14
						74.0		20
			18	AQ		75.0	14	
						75.5		6
						76.0		12
						76.5		15
			19	AQ		77.5	17	
						78.0		15
						78.5		23
						79.0		28

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel

HOLE No. 134

SITE Welland Townline Road

SHEET No. 3 OF 3

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	
80.0	Till	Grey and reddish-grey, silty, sandy till, contains angular rock fragments	20	AQ		80.0	18	
						80.5		13
						81.0		42
						81.5		60
			21	AQ		82.5	17	
						83.0		14
						83.5		49
						84.0		69
			22	AQ		85.0		40
						85.5		51
						86.0		90
			23	AQ				
			24	BQ		86.5		
			25	AQ		87.5		
						88.0		20
						88.2		100
89.0	Bedrock							
119.7	End of Hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 140

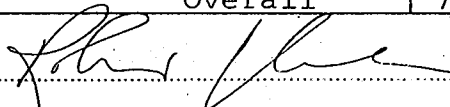
SITE Welland, Townline Road SHEET No. 1 OF 1

CONTRACTOR: Peninsula Soil Investigation STARTED 13.30 M. April 2 19 68
 FINISHED 11.15 M. April 8 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NX - BX

LOCATION: LATITUDE 136+60 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 29' north of DRILL PLATFORM
 BEARING line GROUND SURFACE 586.5
 INITIAL DIP 90° ROCK SURFACE 523.5
 OTHER DIPS BOTTOM OF HOLE 471.3
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden: Silty clay and till.	
63.0	Shaly dolomite	Dark grey, very finely laminated, shaly dolomite with distinct shaly partings and minor gypsum. Upper part badly broken and weathered.	
82.0	Wavy bedded dolomite	Medium-grey-brown, fine grained, finely laminated, wavy bedded dolomite with thin hydrocarbon and gypsum layers.	
84.3	Shaly dolomite	Dark grey, very fine grained, shaly dolomite with traces of hydrocarbons. Transitional contact with overlying dolomite.	
85.8	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture and dissiminated gypsum.	
89.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
100.8	Seed texture dolomite	Medium brown, fine grained dolomite with seedlike texture.	
102.5	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
115.2	End of hole		
Overall			79

INSPECTOR R. Stewart APPROVED 

LOGGED BY J. S. Scott DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 141

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 8:00 AM. April 4 19 68
 FINISHED 9:30 AM. April 8 19 68

METHOD OF DRILLING: SOIL Power Auger CASING DIAM. 6"

ROCK - CORE DIAM. -

LOCATION: LATITUDE 37.500 N ELEVATIONS: DATUM GSC
 DEPARTURE 11.700 E DRILL PLATFORM -
 BEARING - GROUND SURFACE 580.2
 INITIAL DIP 90° ROCK SURFACE -
 OTHER DIPS - BOTTOM OF HOLE 516.7
 WATER TABLE -

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown clayey silt and silty clay with silt lenses and oxidized pockets; organic matter and salt inclusions						
20.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity, contains silt lenses and traces of sand and gravel	1	CO	4-3/4	21.0	48	Pushed
			2	CO	4-3/4	25.0	48	750 psi
			3	CO	4-3/4	29.0	49	Pushed
			4	CO	4-3/4	33.0	48	750 psi
						37.0		Pushed
37.0	Varved clay	Reddish-brown, brown, and grey, distinctly laminated, silt layers 1/4" to 3/8" thick, traces of gravel in red and grey clay bands	5	CO	4-3/4	37.0	48	750 psi
			6	CO	4-3/4	41.0	24	Pushed
			7	CO	4-3/4	44.0	0	750 psi
						48.0		Pushed
								550 psi

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. Carella

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 141
 SITE Welland Townline Road 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	
46.0	Silty clay	Reddish-brown silty clay with few distorted red and grey layers, contains numerous silt lenses and layers	1	CO	4-3/4	46.0 50.0	48	Pushed 500 psi
50.0	Varved clay	Reddish-brown, light brown and grey, distinctly laminated clay, very thin silt and fine sand layers, few silt lenses and grey sandy pockets, traces of fine gravel	8	CO	4-3/4	50.0 54.0	48	Pushed 500 psi
			9	CO	4-3/4	54.0 58.0	48	Pushed 750 psi
			10	CO	4-3/4	58.0 62.0	48	Pushed 800 psi
59.0	Silt, clay and sand (transition)	Brown silt, grey sand, angular to subangular gravel few distorted clay layers	11	AQ		62.0 62.5 63.0 63.5	0	 3 6 11
63.5		End of hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail Tunnel HOLE No. 142
 SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 7:00 AM April 8 19 68
 FINISHED 4:00 PM April 10 19 68

METHOD OF DRILLING: SOIL Power Auger CASING DIAM. 6"
 ROCK _____ CORE DIAM. _____

LOCATION: LATITUDE 37,496 N ELEVATIONS: DATUM GSC
 DEPARTURE 13,997 E DRILL PLATFORM -
 BEARING _____ GROUND SURFACE 585.4
 INITIAL DIP 90° ROCK SURFACE -
 OTHER DIPS _____ BOTTOM OF HOLE 504.7
 WATER TABLE _____

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	Dessicated clayey silt and silty clay	(No sample was taken)						
20.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity with silt layers and lenses; traces of fine to coarse sand, upper 4 feet contain red and grey distorted slightly vertical clay layers	1	CO	4-3/4	20.0	48	Pushed
						24.0		800 psi
			2	CO	4-3/4	24.0	48	Pushed
						28.0		800 psi
			3	CO	4-3/4	28.0	36	Pushed
						31.0		800 psi
			4	CO	4-3/4	32.0	48	Pushed
						36.0		
			5	CO	4-3/4	36.0	46	Pushed
						39.4		800 psi
			6	CO	4-3/4	40.0	40	Pushed
						44.0		850 psi
			7	CO	4-3/4	44.0	48	Pushed
						48.0		750 psi
			8	CO	4-3/4	48.0	48	Pushed
						52.0		700 psi

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. Carella

LOGGED BY A. Mirza

APPROVED _____

DATE

February, 1969

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation Townline Road/Rail Tunnel	HOLE No.	142
SITE	Welland, Townline Road	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	
50.0	Silt and distorted varves	Reddish-brown and brown silt, clayey silt with distorted grey and reddish-brown clay layering	9	CO	4-3/4	52.0 56.0	48	Pushed 600 psi
54.0	Massive silty clay	Reddish-brown silty clay of medium plasticity, contains numerous silt lenses and layers, traces of sand and fine gravel	10	CO	4-3/4	56.0 60.0	48	Pushed 600 psi
			11	BO	4-3/4	60.0 64.0	48	Pushed 500 psi
			12	CO	4-3/4	64.0 68.0	48	Pushed 600 psi
68.0	Varved clay	Reddish-brown and grey distinctly layered thin 1/16" silt and fine sand layers, few sandy silt pockets, traces of fine to coarse gravel	13	CO	4-3/4	68.0 72.0	48	Pushed 550 psi
			14	CO	4-3/4	72.0 76.0	48	Pushed 500 psi
			15	CO	4-3/4	76.0 78.0	48	Pushed 750 psi
			16	AQ		80.0 81.0	18	
81.0		End of hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 143
Tunnel

SITE Welland, Townline Road SHEET No. 1 OF 6

CONTRACTOR: Peninsula Soil STARTED 09.00 A.M. April 10 1968
Investigation FINISHED 17.00 P.M. April 17 1968

METHOD SOIL Modified Wash Boring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond drill CORE DIAM. NXL

LOCATION: LATITUDE 129+76 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 235' north of centre- DRILL PLATFORM
 BEARING 90° line GROUND SURFACE 585.7
 INITIAL DIP 90° ROCK SURFACE 507.7
 OTHER DIPS BOTTOM OF HOLE 458.2
 WATER TABLE 574.2

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	
0	Desiccated clayey silt and silty clay	Greyish-brown, brown, and reddish brown silty clay, mottled, contains silt lenses, oxidized pockets and occasional salt inclusions.	1	AY		5.0	15	
						5.5		3
						6.0		9
						6.5		17
						7.0		23
			2	AY		7.5	22	
						8.0		4
						8.5		6
						9.0		8
						9.5		10
			3	AY		10.0	22	
						10.5		4
						11.0		8
						11.5		12
						12.0		19
			4	AY		12.5	15	
						13.0		4
						13.5		5
						14.0		7
						14.5		8

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
 Y — Core Box

INSPECTOR R. Stewart

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 143
 SITE Welland, Townline Road SHEET No. 2 OF 6

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			
17.0	Desiccated clayey silt and silty clay (Cont'd)	Reddish-brown silty, clay, medium plasticity contains silt layers and lenses, traces of sand and fine to coarse gravel.	5	AY		15.0	18			
						15.5		2		
						16.0		3		
						16.5		5		
						17.0		6		
	Massive silty clay (Upper till)		6	AY	17.5	18				
					18.0		2			
					18.5		3			
					19.0		3			
					19.5		4			
					7		AY	20.0	19	
								20.5		2
								21.0		2
								21.5		3
								22.0		4
					8		AY	22.5		
								23.0	2	
								23.5	2	
								24.0	4	
								24.5	4	
			9	AY	25.0	22				
					25.5		1			
					26.0		2			
					26.5		3			
					27.0		4			
			10	AY	27.5	22				
					28.0		2			
					28.5		2			
					29.0		3			
					29.5		4			
			11	AY	30.0	23				
					30.5		16			
					31.0		25			
					31.5		17			
					32.0		12			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 143
 SITE Welland, Townline Road Tunnel SHEET No. 3 OF 6

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	
43.0	Massive silty clay (Upper till) (Cont'd)		12	AY		32.5	24	
						33.0		2
						33.5		2
						34.0		4
						34.5		4
			13	AY		35.0	24	
						35.5		2
						36.0		2
						36.5		3
						37.0		4
			14	AY		37.5	24	
						38.0		1
						38.5		3
						39.0		4
						39.5		4
			15	AY		40.0	19	
						40.5		2
						41.0		3
						41.5		4
						42.0		4
			16	AY		42.5	13	
						43.0		9
						43.5		17
						44.0		10
						44.5		10
			17	AY		45.0	24	
						45.5		1
						46.0		1
						46.5		2
						47.0		1
47.0	Silty clay	Reddish-brown and greyish brown silty clay, silt lenses and pockets, few very faint distorted red clay bands.	18	AY		47.5	24	
						48.0		1
						48.5		2
						49.0		2
						49.5		2

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 143
 SITE Welland, Townline Road Tunnel SHEET No. 4 OF 6

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		
52.0	Silty clay (Cont'd)	Reddish-brown, light brown and grey, distinctly laminated clay with thin silt and fine sand layers underlying the grey bands, traces of fine to coarse gravel.	19	AY		50.0	24	1	
					50.5		2		
					51.0		3		
					51.5		2		
					52.0				
	Varved clay		20	AY		52.5	24	2	
						53.0		2	
						53.5		3	
						54.0		3	
			21	AY		54.5	24	2	
						55.0		2	
						55.5		4	
						56.0		4	
						56.5			
						57.0			
60.5	Silt and sand (Transition)	Brown silt and sand with clay inclusions and rounded gravel.	23	AY		57.5	24	1	
						58.0		3	
						58.5		3	
						59.0		3	
						59.5		3	
62.0	Till	Reddish-brown, compact granular till.	24	AY		60.0	24	6	
						60.5		10	
						61.0		8	
						61.5		22	
						62.0			
				25	AY		62.5	16	13
							63.0		33
							63.5		40
							64.0		69
							64.5		
						65.0	20	18	
						65.5		30	
						66.0		40	
						66.5		65	
						67.0			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 143
 SITE Welland, Townline Road Tunnel SHEET No. 5 OF 6

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	
	Till (Cont'd)		26	AY		67.5	5	
						68.0		90
						68.3		100
			27	AY		69.0	16	
						69.5		16
						70.0		52
						70.5		57
						71.0		90
			28	AY		71.0	3	
						71.5		43
						72.0		90
			29	AY		72.8	3	
						73.0		
						73.5		29
						74.0		44
						74.5		56
						75.0		73
			30	AY		75.0		
						75.5		33
						76.0		44
						76.5		71
						77.0		74
78.0	Bedrock	See next sheet.						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 143

SITE Welland, Townline Road Tunnel SHEET No. 6 OF 6

CONTRACTOR: Peninsula Soil Investigations STARTED 9.00A.M. April 10 1968

METHOD OF DRILLING: SOIL Modified Wash Boring FINISHED 7.00P.M. 1968

ROCK Diamond drill CASING DIAM. NX

Core DIAM. NXL

LOCATION: LATITUDE 129+76 ELEVATIONS: DATUM G.S.C.

DEPARTURE 235' north of centre- DRILL PLATFORM -

BEARING line GROUND SURFACE 585.7

INITIAL DIP 90° ROCK SURFACE 507.7

OTHER DIPS BOTTOM OF HOLE 458.2

WATER TABLE 574.2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
78.0	Shaly dolomite	Dark grey, very fine grained shaly dolomite	
79.0	Seed texture dolomite	Medium brown, fine grained, somewhat wavy bedded dolomite with seed-like texture	
81.8	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum	
94.0	Seed texture dolomite	Medium brown, fine grained, slightly wavy bedded dolomite with seed-like texture and gypsum stringers	
97.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum	
127.5	End of hole	Overall	82

INSPECTOR R. Stewart APPROVED _____

LOGGED BY J. S. Scott DATE February, 1969

DRILLING REPORT

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	Desiccated clayey silt and silty clay	Reddish-brown, weathered, stiff, mottled, silty clay with silt layers and lenses. Lower 4 feet contain distorted layering.	1	AY		15.0	24	
						15.5		2
						16.0		2
						16.5		4
						17.0		7
			2	AY		17.0	24	
						17.5		3
						18.0		4
						18.5		6
						19.0		8
			3	AY		19.0	18	
						19.5		2
						20.0		2
						20.5		3
						21.0		6

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED
Y - Core Box

February, 1969

DRILLING REPORT

JOB No. 1684

HOLE No. 144

SHEET No. 2 OF 5

FORM N° 91-B

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 144
 SITE Welland, Townline Road Tunnel SHEET No. 3 OF 5

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	
40.0	Massive silty clay (Upper till) (Cont'd)	Reddish-brown, brown and grey, silt and clayey silt with reddish-brown and grey distorted layers of clay. Traces of coarse sand.	12	AY		37.0	23	
						37.5		4
						38.0		6
						38.5		6
						39.0		6
			13			39.0	24	
						39.5		4
						40.0		5
						40.5		70 psi
						41.0		pushed
	Silt and distorted varves		14	AY		42.5	24	
						43.0		0
						43.5		0
						44.0		3
						44.5		4
			15	AY		44.5	24	
						45.0		6
						45.5		6
						46.0		6
						46.5		6
48.0	Silty clay	16	AY		46.5	24		
					47.0		2	
					47.5		3	
					48.0		4	
					48.5		5	
		17	AY		48.5	24		
					49.0		2	
					49.5		4	
					50.0		5	
					50.5		5	
	18	AY		50.5	24			
			51.0		3			
			51.5		6			
			52.0		5			
			52.5		5			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 144
 SITE Tunnel SHEET No. 4 OF 5

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	
52.0	Varved clay	Reddish-brown, light brown and grey distinctly laminated clay, contains thin silt layers and traces of fine gravel.	19	AY		52.5	24	
						53.0		2
						53.5		3
						54.0		4
						54.5		6
			20	AY		54.5	24	
						55.0		1
						55.5		3
						56.0		5
						56.5		5
			21	AY		56.5	23	
						57.0		2
						57.5		4
						58.0		5
						58.5		7
			22	AY		58.5	24	
						59.0		2
						59.5		3
						60.0		4
						60.5		
62.0	Clay, sand and silt	Grey and brownish-grey clay, sand and silt with numerous rounded pebbles.	23			60.5	24	
						61.0		3
						61.5		4
						62.0		9
						62.5		10
			24	AY		62.5		
						63.0		3
						63.5		4
						64.0		6
						64.5		8
						64.5		
						65.0		3
						65.5		8
						66.0		26
						66.5		31

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 144
 SITE Welland, Townline Road Tunnel SHEET No. 5 OF 5

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	
66.0	Till	Reddish-brown, compact granular till with sand and sandy silt inclusions.	26	AY		66.5	12	7
						67.0		33
						67.5		22
						68.0		21
			27	AY		68.5	20	
						69.0		4
						69.5		14
						70.0		28
						70.2		38
			28			70.5	20	
						71.0		15
						71.5		13
						72.0		19
						72.5		30
			29	AY		72.5	4	
						73.0		75
73.0		End of Hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 146
Tunnel

SITE Welland, Townline Road SHEET No. 1 OF 6

CONTRACTOR: Peninsula Soil Investigation STARTED 08.00 a.m. April 19 19 68
FINISHED 17.00 p.m. April 25 19 68

METHOD SOIL Modified wash boring CASING DIAM. NX

OF

DRILLING: ROCK Diamond drill CORE DIAM. NXL

LOCATION: LATITUDE 129+59 ELEVATIONS: DATUM G.S.C.
DEPARTURE 254' south of centre- DRILL PLATFORM -
BEARING line GROUND SURFACE 584.6
INITIAL DIP 90° ROCK SURFACE 504.8
OTHER DIPS BOTTOM OF HOLE 454.6
 WATER TABLE 574.2

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		
0.0	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, mottled, very stiff, silty clay and clayey silt, occasional salt inclusion, few silt lenses and oxidized pockets, contains two varved clay zones.	1	AY		5.0	20		
						5.5		9	
						6.0		21	
						6.5		20	
			2	AY		7.0		21	
						7.5	15		
						8.0		8	
						8.5		10	
						9.0		11	
						9.5		14	
			3	AY		10.0	20		
						10.5		6	
						11.0		7	
						11.5		10	
			4	AY		12.0		12	
						12.5	20		
						13.0		6	
						13.5		8	
						14.0		11	
						14.5		11	

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
Y — Core Box

INSPECTOR J. Carella

LOGGED BY A. Mirza
Bedrock by J. S. Scott

APPROVED 

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 146
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 6

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	
22.0	Desiccated clayey silt and silty clay (Cont'd)		5	AY		15.0	18	
						15.5		2
						16.0		3
						16.5		3
						17.0		5
			6	AY		17.5	24	
						18.0		1
						18.5		1
						19.0		2
						19.5		3
	Massive silty clay (Upper till)	Reddish brown silty clay, numerous silt layers and lenses, medium plasticity, traces of fine to coarse gravel	7	AY		20.0	24	
						20.5		1
						21.0		1
						21.5		3
						22.0		5
			8	AY		22.5	24	
						23.0		1
						23.5		1
						24.0		2
						24.5		3
			9	AY		25.0	20	
						25.5		1
						26.0		2
						26.5		3
						27.0		3
			10	AY		27.5	18	
						28.0		1
						28.5		2
						29.0		3
						29.5		4
			11	AY		30.0	18	
						30.5		0
						31.0		4
						31.5		5
						32.0		7

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 146
 SITE Welland, Townline Road SHEET No. 3 OF 6

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	
	Massive silty clay (upper till) (Cont'd)		12	AY		32.5	22	
						33.0		0
						33.5		2
						34.0		4
						34.5		5
			13	AY		35.0	19	
						35.5		1
						36.0		2
						36.5		3
						37.0		3
			14	AY		37.5	24	
						38.0		1
						38.5		3
						39.0		4
						39.5		5
			15	AY		40.0		
						40.5		1
						41.0		2
						41.5		4
						42.0		4
			16	AY		42.5	24	
						43.0		1
						43.5		2
						44.0		2
						44.5		4
			17	AY		45.0	24	
						45.5		1
						46.0		2
						46.5		3
						47.0		4
47.0	Silt and distorted varves	Reddish-brown, silt and clayey silt with few red and grey distorted clay bands.	18	AY		47.5	18	
						48.0		0
						48.5		9
						49.0		7
						49.5		8
			19	AY		50.0	24	
						50.5		0
						51.0		0
						51.5		2
						52.0		3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 146
 SITE Welland, Townline Road SHEET No. 4 OF 6

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	
52.0	Massive silty clay	Reddish-brown silty clay of medium plasticity contains numerous silt layers and lenses.	20	AY		52.5		
						53.0		0
						53.5		2
						54.0		2
						54.5		3
			21	AY		55.0		
						55.5		0
						56.0		1
						56.5		2
						57.0		3
			22	AY		57.5		
						58.0		1
						58.5		1
						59.0		3
						59.5		4
			23	AY		60.0	24	
						60.5		1
						61.0		2
						61.5		3
						62.0		5
			24	AY		62.5	24	
						63.0		0
						63.5		1
						64.0		1
						64.5		4
			25	AY		65.0	24	
						65.5		1
						66.0		2
						66.5		3
						67.0		4
66.5	Varved clay	Reddish-brown, light brown and grey, distinctly laminated clay, very thin silt and fine sand layers, irregular spacing between varves, traces of fine to coarse gravel.	26	AY		67.5	24	
						68.0		1
						68.5		1
						69.0		3
						69.5		5

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation, Townline Road/Rail Tunnel	HOLE No.	146
SITE	Welland, Townline Road	SHEET No.	5 OF 6

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	
	Varved clay		27	AY		70.0	24	
						70.5		0
						71.0		1
						71.5		3
						72.0		5
			28	AY		72.5	24	
						73.0		1
						73.5		1
						74.0		3
						74.5		4
			29	AY		75.0	24	
						75.5		2
						76.0		2
						76.5		4
						77.0		3
			30	AY		77.5		
						78.0		0
						78.5		0
						79.0		6
						79.5		16
78.5	Till	Reddish-brown sandy, silty and gravelly till						
79.8	Bedrock	See next sheet						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 146
 SITE Welland, Townline Road Tunnel SHEET No. 6 OF 6

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
79.8	Shaly dolomite	Dark grey, very fine grained shaly dolomite	80
81.0	Seed texture dolomite	Dark brown, fine grained, dolomite with seed-like texture, containing minor layers and lenses of gypsum	
85.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum	
97.7	Seed texture dolomite	Medium brown, fine grained, slightly wavy bedded dolomite with seed-like texture, contains gypsum layers and thin partings	
100.8	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum layers and inclusions	
		Overall	
130.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 147

SITE Welland Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED .M. April 24 19 68
FINISHED .M. April 26 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. BX
ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 15,608,576 N ELEVATIONS: DATUM G.S.C.
DEPARTURE 1,069,372 E DRILL PLATFORM 581.7
BEARING 90° GROUND SURFACE 581.7
INITIAL DIP 90° ROCK SURFACE 496.7
OTHER DIPS BOTTOM OF HOLE 496.7
WATER TABLE

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	Desiccated silty clay and clayey silt	Greyish, yellowish and reddish-brown clayey silt and silty clay. Very stiff, mottled, silt lenses and oxidized pockets, occasional salt inclusions.	1	AY		5.0	18	13
						5.5		20
						6.0		23
						6.5		32
						7.0		
			2	AY		7.5	18	17
						8.0		17
						8.5		17
						9.0		19
						9.5		
			3	AY		10.0	24	2
						10.5		4
						11.0		7
						11.5		11
						12.0		
			4	AY		12.5	24	4
						13.0		4
						13.5		6
						14.0		9
						14.5		

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
Y — Core Box

INSPECTOR R. Manuel

LOGGED BY A. Mirza

APPROVED *[Signature]*

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 147
 SITE Welland, Townline Road SHEET No. 2 OF 5

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	
15.0	Weathered varved clay	Brown, light brown, grey and reddish-brown distinctly layered clay contains silt lenses and traces of sand and fine gravel.	5	AY		15.0	24	
						15.5		3
						16.0		3
						16.5		6
						17.0		7
			6	AY		17.5	24	
						18.0		2
						18.5		2
						19.0		3
						19.5		4
			7	AY		20.0	24	
						20.5		1
						21.0		2
						21.5		3
						22.0		4
			8	AY		22.5	24	
						23.0		2
						23.5		2
						24.0		3
						24.5		3
24.0	Massive silty clay (upper till)	Reddish-brown, silty clay, medium plasticity. Numerous silt lenses and pockets. Traces of sand and fine to coarse gravel.	9	AY		25.0	18	
						25.5		1
						26.0		3
						26.5		3
						27.0		4
			10	AY		27.5	22	
						28.0		1
						28.5		3
						29.0		3
						29.5		5
			11	AY		30.0	22	
						30.5		1
						31.0		3
						31.5		4
						32.0		4
			12	AY		32.5	22	
						33.0		2
						33.5		4
						34.0		4
						34.5		6

DRILLING REPORT

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	
42.0	Massive silty clay (upper till) (Cont'd)		13	AY		35.0	22	
						35.5		1
						36.0		3
						36.5		3
						37.0		6
			14	AY		37.5	22	
						38.0		1
						38.5		2
						39.0		3
						39.5		3
			15	AY		40.0	24	
						40.5		2
						41.0		3
						41.5		3
						42.0		3
			42.0	Silt and distorted varves	Brown, reddish-brown and grey, clayey silt with occasional distorted clay layers.	16	AY	
						43.0		0
						43.5		3
						44.0		3
45.0	Massive silty clay	Reddish-brown silty clay, medium plasticity. Numerous silt lenses and pockets, indistinct bands. Traces of sand and fine gravel.	17	AY		45.0	24	
						45.5		1
						46.0		2
						46.5		3
						47.0		4
			18	AY		47.5	24	
						48.0		2
						48.5		3
						49.0		2
						49.5		3
			19	AY		50.0	24	
						50.5		3
						51.0		3
						51.5		3
						52.0		3
			45.0			20	AY	
						53.0		2
						53.5		3
						54.0		3
						54.5		3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 147
 SITE Welland Townline Road SHEET No. 4 OF 5

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	
58.0	Massive silty clay (Cont'd)	Reddish-brown, light brown and grey layered clay. Very thin silt and fine sand layers underlying the grey bands. Irregular spacing between couplets. Traces of sand and fine gravel.	21	AY		55.0	24	
					55.5		2	
					56.0		2	
					56.5		3	
					57.0		3	
	22		AY		57.5	24		
					58.0		2	
					58.5		4	
					59.0		3	
					59.5		4	
	23		AY		60.0	24		
					60.5		3	
					61.0		4	
					61.5		4	
					62.0		4	
	24		AY		62.5	24		
65.0	silt, sand and clay (transition)	Brown and reddish-brown silt and sandy silt. Lower part contains some gravel.				63.0		3
						63.5		4
						64.0		3
						64.5		4
			25	AY		65.0	23	
						65.5		5
						66.0		1
						66.5		10
						67.0		20
			26	AY		67.5	22	
						68.0		10
						68.5		15
						69.0		11
						69.5		15
			27	AY		70.0	0	
						70.5		19
			71.0		12			
			71.5		9			
			72.0		7			
28	AY		72.5	24				
			73.0		12			
			73.5		20			
			74.0		21			
			74.5		36			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 147
 SITE Welland Townline Road Tunnel SHEET No. 5 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, ELASTICITY, COMPACTNESS, VOLUME LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	
74.0	Till	Reddish-brown compact granular till.	29	AY		75.0	18	
						75.5		14
						76.0		25
						76.5		35
						77.0		49
			30	AY		77.0	6	
						77.5		38
						78.0		53
						78.5		53
						79.0		60
			31	AY		80.0	6	
						80.5		29
						81.0		49
						81.5		65
						82.0		100
			32	AY		82.5	6	
						83.0		38
						84.0		57
						84.5		90
85.0		End of hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 148

SITE Welland, Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED 12.00 A.M. April 26 19 68
 FINISHED 12.00 P.M. May 1 19 68

METHOD SOIL Modified Wash Boring CASING DIAM. NX

OF ROCK Diamond Drill CORE DIAM. BX

DRILLING: ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 15,608,209 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 1,077,152 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 584.6
 INITIAL DIP 90° ROCK SURFACE 501.6
 OTHER DIPS BOTTOM OF HOLE 498.6
 WATER TABLE 572.8

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown clayey silt and silty clay, mottled, silt lenses and oxidized pockets, traces of organic matter.	1	AY		5.0	20	2
						5.5		5
						6.0		7
						6.5		11
						7.0		
			2	AY		7.5	22	3
						8.0		7
						8.5		9
						9.0		9
						9.5		
			3	AY		10.0	24	2
						10.5		2
						11.0		4
						11.5		4
						12.0		4
			4	AY		12.5	22	3
						13.0		3
						13.5		4
						14.0		7
						14.5		

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
 Y - Core Box

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED *[Signature]*

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 148
 SITE Welland, Townline Road SHEET No. 2 OF 5

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	
15.0	Varved clay	Reddish-brown, greyish-brown and grey, alternate clay bands, very stiff, occasional sandy pockets.	5	AY		15.0 15.5 16.0 16.5 17.0	22	1 1 2 4
17.0	Massive silty clay (Upper Till)	Reddish brown silty clay of medium plasticity, few silt lenses and pockets, traces of sand and fine to coarse gravel.	6	AY		17.5 18.0 18.5 19.0 19.5	23	1 2 2 3
			7	AY		20.0 20.5 21.0 21.5	23	1 2 2 2
			8	AY		22.0 22.5 23.0 23.5 24.0 24.5	18	1 2 2 2 3
			9	AY		25.0 25.5 26.0 26.5 27.0	24	1 2 2 3
			10	AY		27.5 28.0 28.5 29.0 29.5	20	1 2 2 3
			11	AY		30.0 30.5 31.0 31.5 32.0	21	1 2 2 3
			12	AY		32.5 33.0 33.5 34.0 34.5	22	1 2 2 3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail

HOLE No. 148

Tunnel

SITE

SHEET No. 3 OF 5

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	
45.0	Massive silty clay (Upper till) (Cont'd)		13	AY		35.0		
						35.5		2
						36.0		3
						36.5		3
						37.0		4
			14			37.5	22	
						38.0		0
						38.5		3
						39.0		3
						39.5		5
			15	AY		40.0	24	
						40.5		2
						41.0		2
						41.5		3
						42.0		4
			16	AY		42.5	24	
						43.0		2
						43.5		4
						44.0		4
						44.5		5
45.0	Silt and distorted varves	Reddish-brown clayey silt, silt and sandy silt with few distorted clay bands.	17	AY		45.0	24	
						45.5		2
						46.0		2
						46.5		3
						47.0		4
			18	AY		47.5	24	
						48.0		3
						48.5		3
						49.0		3
						49.5		4
49.5	Massive silty clay	Reddish-brown silty clay numerous silt layers and lenses, medium plasticity, traces of sand and fine gravel; indistinct bands.	19	AY		50.0	24	
						50.5		3
						51.0		3
						51.5		5
						52.0		6
			20	AY		52.5		
						53.0		2
						53.5		3
						54.0		3
						54.5		4

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

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 148
SITE Welland, Townline Road SHEET No. 4 OF 5

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	
49.5	Massive silty clay (Cont'd)		21	AY		55.0	24	
						55.5		2
						56.0		3
						56.5		3
			22	AY		57.0	24	4
						57.5		
						58.0		2
						58.5		4
						59.0		5
						59.5		5
			23	AY		60.0	24	
						60.5		0
63.0	Varved clay	Reddish-brown, light-brown and grey, alternate clay bands, thin silt layers, irregularly spaced varves, traces of fine to coarse gravel	24	AY		61.0		2
						61.5		3
						62.0		4
						62.5	24	
			25	AY		63.0		0
						63.5		2
						64.0		2
						64.5		4
			26	AY		65.0	24	
						65.5		2
						66.0		3
						66.5		4
70.5	Silt, sand and clay (Transition)	Brown silt, clay, sandy silt and silty sand	27	AY		67.0	24	4
						67.5		
						68.0		0
						68.5		1
						69.0		3
						69.5		2
						70.0	24	
						70.5		0
						71.0		2
						71.5		2
						72.0		4

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 148
 SITE Welland, Townline Road SHEET No. 5 OF 5

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	
	Silt, sand and clay (Transition) (Cont'd)		28	AY		72.5		
						73.0		10
						73.5		12
						74.0		11
						74.5		27
			29	AY		75.0		
						75.5		24
						76.0		28
						76.5		33
						77.0		44
77.0	Till	Reddish-brown, clayey compact till, contains angular rock fragments.	30	AY		77.5	24	
						78.0		42
						78.5		34
						79.0		44
						79.5		46
			31	AY		80.0	12	
						80.5		40
						81.0		120
			32	DY		81.0	6	
						81.5		
						82.0		
						82.5		
						83.0		
			33	DY		83.0	36	
						83.5		
						84.0		
						84.5		
						85.0		
						85.5		
						86.0		
83.0	Bedrock							
86.0	End of Hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 149

SITE Welland, Townline Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soil Investigation STARTED April 29 19 68 FINISHED May 1 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 15,609,681 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 1,609,339 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 583.9
 INITIAL DIP 90° ROCK SURFACE 493.4
 OTHER DIPS BOTTOM OF HOLE 490.9
 WATER TABLE

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, mottled, very stiff silty clay and clayey silt. Few oxidized pockets and salt inclusions. Traces of organic matter, contains 2 feet thick varved clay zone.	1	AY		5.0	18	6
						5.5		11
						6.0		15
						6.5		24
						7.0		
			2	AY		7.5	20	12
						8.0		20
						8.5		24
						9.0		21
						9.5		
			3	AY		10.0	24	3
						10.5		3
						11.0		4
						11.5		5
						12.0		
			4	AY		12.5	20	2
						13.0		3
						13.5		5
						14.0		6
						14.5		

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
 Y — Core Box

INSPECTOR R. Manuel

LOGGED BY A. Mirza

APPROVED *[Signature]*

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 149
Tunnel
SITE Welland, Townline Road SHEET No. 2 OF 5

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	
	Desiccated clayey silt and silty clay (Cont'd)		5	AY		15.0 15.5 16.0 16.5 17.0	20	2 3 3 5
17.0	Varved clay	Reddish-brown and grey distinctly layered clay, regularly spaced horizontal bands. No sign of weathering.	6	AY		17.5 18.0 18.5 19.0 19.5	24	1 2 2 2
20.0	Massive silty clay (upper till)	Reddish-brown silty clay few silt lenses, traces of sand and fine to coarse gravel; medium plasticity.	7	AY		20.0 20.5 21.0 21.5 22.0	24	1 1 2 2
			8	AY		22.5 23.0 23.5 24.0 24.5	24	1 1 2 3
			9	AY		25.0 25.5 26.0 26.5 27.0	8	3 3 3 5
			10	AY		27.5 28.0 28.5 29.0 29.5	24	1 2 2 4
			11	AY		30.0 30.5 31.0 31.5 32.0	24	1 2 3 3
			12	AY		32.5 33.0 33.5 34.0 34.5	24	1 2 3 4

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 149
 SITE Welland, Townline Road Tunnel SHEET No. 3 OF 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	
40.0	Massive silty clay (upper till) (Cont'd)		13	AY		35.0	24	1
						35.5		2
						36.0		3
						36.5		3
						37.0		1
						37.5		3
	Varved clay	Reddish-brown and grey alternate clay layers, thin silt layers and pockets. Traces of sand and gravel.	14	AY		37.5	24	1
						38.0		3
						38.5		4
						39.0		6
						39.5		
42.0	Massive silty clay	Reddish-brown, silty clay of medium plasticity, contains silt layers and lenses. Traces of sand and fine gravel.	15	AY		40.0	24	1
						40.5		1
						41.0		2
						41.5		2
						42.0		
			16	AY		42.5	24	1
						43.0		2
						43.5		3
						44.0		3
						44.5		
			17	AY		45.0	24	1
						45.5		2
						46.0		2
						46.5		3
						47.0		
			18	AY		47.5	24	1
						48.0		2
						48.5		2
						49.0		4
						49.5		
			19	AY		50.0	24	1
						50.5		2
						51.0		2
						51.5		3
						52.0		
			20	AY		52.5	24	1
						53.0		2
						53.5		3
						54.0		3
						54.5		

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation, Townline Rail/Road Tunnel	HOLE No.	149
SITE	Welland, Townline Road	SHEET No.	4 OF 5

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	
65.0	Massive silty clay (Cont'd)		21	AY		55.0	24	
						55.5		2
						56.0		2
						56.5		3
						57.0		3
			22	AY		57.5	24	
						58.0		2
						58.5		3
						59.0		4
						59.5		4
			23	AY		60.0	24	
						60.5		3
						61.0		4
						61.5		5
						62.0		5
	Varved clay	Reddish-brown, light-brown and grey, horizontal 1/4" to 1/2" wide clay bands. Spacing between the couplets varies from 3" to 6". Thin silt and fine sand layers.	24	AY		62.5	24	
						63.0		3
						63.5		4
						64.0		4
						64.5		4
			25	AY		65.0	24	
						65.5		3
						66.0		3
						66.5		4
						67.0		4
			26	AY		67.5	24	
						68.0		1
						68.5		3
						69.0		4
						69.5		5
			27	AY		70.0	24	
						70.5		2
						71.0		2
						71.5		3
						72.0		3
			28	AY		72.5	24	
						73.0		2
						73.5		3
						74.0		3
						74.5		4

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 149
 SITE Welland, Townline Road Tunnel SHEET No. 5 OF 5

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	
75.0	Silt, sand and clay (transition)	Brown silt and sandy silt with occasional clay inclusions.	29	AY		75.0	22	
						75.5		1
						76.0		2
						76.5		2
						77.0		1
			30	AY		77.5	24	
						78.0		6
						78.5		11
						79.0		15
						79.5		11
			31	AY		80.0	20	
						80.5		9
						81.0		10
						81.5		12
						82.0		13
			32	AY		82.5	20	
						83.0		17
						83.5		16
						84.0		16
						84.5		18
			33	AY		85.0	20	
						85.5		6
						86.0		7
						86.5		7
						87.0		9
88.0	Till	Reddish-brown compact, granular, clayey till.	34	AY		87.5	7	
						88.0		7
						88.5		7
						89.0		12
						89.5		24
			1	DY		90.0	2' 6"	
						90.5		50
						90.5		
90.5	Bedrock					93.0		Core
93.0	End of hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 150

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soils Investigations STARTED M. May 2 19 68
FINISHED M. May 3 19 68

METHOD SOIL Modified Wash Boring CASING DIAM. NX

OF DRILLING: ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 136+34 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 610' south of centre- DRILL PLATFORM
 BEARING line GROUND SURFACE 584.7
 INITIAL DIP 90° ROCK SURFACE 519.7
 OTHER DIPS BOTTOM OF HOLE 517.7
WATER TABLE 570.8

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown clayey silt and silty clay, mottled, very stiff, few oxidized pockets and salt inclusions.	1	AY		5.0	22	
						5.5		6
						6.0		14
						6.5		15
						7.0		15
			2	AY		7.5	23	
						8.0		8
						8.5		10
						9.0		14
						9.5		16
			3	AY		10.0	22	
						10.5		3
						11.0		6
						11.5		8
						12.0		10
12.5	Weathered varved clay	Reddish-brown and grey distinctly laminated stiff clay. Lower part contains clayey silt and silt with few distorted clay bands.	4	AY		12.5	24	
						13.0		2
						13.5		2
						14.0		4
						14.5		5

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
 Y — Core Box

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED 

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 150
 SITE Welland, Townline Road SHEET No. 2 OF 4

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	
20.0	Weathered varved clay (Cont'd)	Reddish-brown silty clay of medium plasticity, contains silt layers and lenses. Traces of sand and fine to coarse gravel.	5	AY		15.0	22	
						15.5		1
						16.0		1
						16.5		1
						17.0		2
			6	AY		17.5	24	
						18.0		1
						18.5		1
						19.0		2
						19.5		2
	Massive silty clay (upper till)		7	AY		20.0	24	
						20.5		1
						21.0		2
						21.5		2
						22.0		3
			8	AY		22.5	23	
						23.0		1
						23.5		2
						24.0		2
						24.5		3
			9	AY		25.0	23	
						25.5		1
						26.0		2
						26.5		2
						27.0		3
			10	AY		27.5	20	
						28.0		1
						28.5		1
						29.0		2
						29.5		2
			11	AY		30.0	24	
						30.5		0
						31.0		1
						31.5		2
						32.0		2
12	AY		32.5	24				
			33.0		0			
			33.5		1			
			34.0		3			
			34.5		3			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 150
 SITE Welland, Townline Road SHEET No. 3 OF 4

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	
40.0	Massive silty clay (upper till) (Cont'd)		13	AY		35.0	24	
						35.5		1
						36.0		1
						36.5		2
			14	AY		37.0	24	3
						37.5		
						38.0		1
						38.5		1
	Silt and distorted varves	Reddish-brown and brown silt and clayey silt with few reddish brown and grey distorted clay bands, inclusions.	15	AY		39.0	24	2
						39.5		4
						40.0		
						40.5		1
			16	AY		41.0	24	2
						41.5		4
						42.0		4
						42.5		
47.0	Silty clay	Reddish-brown medium to soft silty clay. Numerous silt layers and lenses. Traces of sand and gravel.	17	AY		43.0	24	1
						43.5		3
						44.0		5
						44.5		5
			18	AY		45.0	24	
						45.5		0
						46.0		2
						46.5		1
			19	AY		47.0	24	5
						47.5		
						48.0		1
						48.5		2
52.0	Varved clay	Reddish-brown, light brown and grey alternate bands of clay with thin layers of				49.0		2
						49.5		3
						50.0		
						50.5		0
						51.0		1
						51.5		1
						52.0		2

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 150
 SITE Welland, Townline Road SHEET No. 4 OF 4

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	
62.0	Varved clay (Cont'd)	silt and fine sand. Traces of fine gravel.	20	AY		52.5	24	
						53.0		0
						53.5		1
						54.0		2
						54.5		2
			21	AY		55.0	24	
						55.5		0
						56.0		1
						56.5		2
						57.0		2
			22	AY		57.5	24	
						58.0		0
						58.5		1
						59.0		2
						59.5		2
			23	AY		60.0	24	
						60.5		1
						61.0		1
62.0	Till	Reddish-brown and greyish-brown, silty sandy, granular till.	24	AY		62.5	24	
						63.0		0
						63.5		6
						64.0		15
						64.5		24
			25	DY		65.0	24	
65.0	Bedrock					67.0		
67.0		End of hole						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 151

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED .M. May 6 19 68
Modified Wash Boring FINISHED .M. May 22 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 153+59 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 610' north of centre- DRILL PLATFORM
 BEARING 90° line GROUND SURFACE 578.3
 INITIAL DIP 90° ROCK SURFACE 511.3
 OTHER DIPS BOTTOM OF HOLE 508.8
 WATER TABLE

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, very stiff, mottled, silty clay and clayey silt. Few salt inclusions, occasional silt lenses and oxidized pockets. 12.5' to 14.5' weathered varved clay.	1	AY		5.0	20	7
						5.5		16
						6.0		27
						6.5		31
						7.0		
			2	AY		7.5	18	23
						8.0		29
						8.5		35
						9.0		36
						9.5		
			3	AY		10.0	24	9
						10.5		17
						11.0		20
						11.5		23
						12.0		
			4	AY		12.5	18	6
						13.0		12
						13.5		17
						14.0		19
						14.5		

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
 Y — Core Box

INSPECTOR R. Manuel

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

DRILLING REPORT

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	
17.5	Desiccated clayey silt and silty clay (Cont'd)	Reddish-brown silty clay of medium plasticity, contains silt lenses and pockets. Traces of sand and fine to coarse gravel	5	AY		15.0	20	
						15.5		3
						16.0		5
						16.5		7
						17.0		7
	Massive silty clay (upper till)		6	AY		17.5	22	
						18.0		5
						18.5		7
						19.0		7
						19.5		7
			7	AY		20.0	22	
						20.5		2
						21.0		3
						21.5		6
						22.0		7
			8	AY		22.5	22	
						23.0		3
						23.5		3
						24.0		5
						24.5		6
			9	AY		25.0	21	
						25.5		1
						26.0		2
						26.5		2
						27.0		4
			10	AY		27.5	22	
						28.0		1
						28.5		2
				29.0		3		
				29.5		4		
11		AY		30.0	24			
				30.5		1		
			31.0		2			
			31.5		2			
			32.0		3			
12	AY		32.5	22				
			33.0		1			
			33.5		2			
			34.0		3			
			34.5		3			

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Rail/Road HOLE No. 151
 SITE Welland Townline Road Tunnel SHEET No. 3 OF 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	
35.0	Silt and distorted varves	Brown silt and clayey silt with occasional distorted clay bands.	13	AY		35.0	20	
						35.5		2
						36.0		9
						36.5		6
						37.0		6
			14	AY		37.5	22	
						38.0		2
						38.5		3
						39.0		3
						39.5		3
			15	AY		40.0	24	
						40.5		2
40.5	Massive silty clay	Reddish-brown, medium to soft, silty clay, numerous silt lenses and pockets. Traces of sand and fine gravel.				41.0		3
						41.5		3
						42.0		2
			16	AY		42.5	22	
						43.0		2
						43.5		2
						44.0		3
						44.5		3
			17	AY		45.0	24	
						45.5		1
						46.0		2
						46.5		2
						47.0		3
			18	AY		47.5	24	
						48.0		1
						48.5		2
						49.0		3
						49.5		3
50.0	Varved clay	Reddish-brown, light brown and grey, 1/4" to 1/2" wide horizontal clay bands with 1/16" silt and fine sand layers. Spacing between varves varies from 3" to 9", traces of sand and fine to coarse gravel.	19	AY		50.0	24	
						50.5		1
						51.0		2
						51.5		2
						52.0		3
			20	AY		52.5	24	
						53.0		2
						53.5		3
						54.0		3
						54.5		3

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

DRILLING REPORT.

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Rail/Road HOLE No. 151
 SITE Welland Townline Road Tunnel SHEET No. 4 OF 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	
	Varved clay (Cont'd)		21	AY		55.0	22	1
						55.5		1
						56.0		1
						56.5		2
						57.0		2
			22	AY		57.5	24	
						58.0		2
58.5	Silt, sandy silt and clay (transition)	Brown silt and sandy silt with occasional clay inclusions.				58.5		2
						59.0		3
						59.5		4
			23	AY		60.0	24	
						60.5		2
						61.0		3
						61.5		3
						62.0		4
			24	AY		62.5	20	
						63.0		2
						63.5		3
						64.0		3
64.0	Till	Reddish-brown, compact granular till				64.5		4
			25	AY		65.0	12	
						65.5		26
						66.0		16
						66.5		11
						67.0		50
			1	DY		67.0	2'8"	
						67.5		
						68.0		
						69.0		
						69.8		
67.0	Bedrock							
69.5	End of hole							

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 152

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soil Investigation STARTED 13.00 M. May 6 19 68
 FINISHED 17.00 M. May 8 19 68

METHOD OF DRILLING: SOIL Mod. Wash Boring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 153+80 ELEVATIONS: DATUM G.S.C.

DEPARTURE 668' south of centre-line DRILL PLATFORM

BEARING 90° GROUND SURFACE 581.3

INITIAL DIP ROCK SURFACE 512.3

OTHER DIPS BOTTOM OF HOLE 509.3

..... WATER TABLE 571.4

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, very stiff mottled, silty clay and clayey silt. Lower 2' weathered varved clay.	1	AY		5.0	22	
						5.5		6
						6.0		7
						6.5		15
						7.0		16
			2	AY		7.5	22	
						7.0		7
						7.5		15
						8.5		23
						9.5		30
			3	AY		10.0	23	
						10.5		7
						11.0		15
						11.5		17
						12.0		23
			4	AY		12.5	23	
						13.0		2
						13.5		4
						14.0		5
						14.5		7

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
 Y — Core Box

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED

DATE

February, 1969

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

DRILLING REPORT

CLIENT: St. Lawrence Seaway Authority JOB No. 1684
 PROJECT: Welland Canal Relocation, Townline Road/Rail HOLE No. 152
 Tunnel
 SITE: Welland Townline Road SHEET No. 2 OF 4

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	
17.5	Desiccated clayey silt and silty clay (Cont'd)	Reddish-brown silty clay of medium plasticity, some silt lenses and pockets. Traces of fine to coarse gravel.	5	AY		15.0	24	0
						15.5		1
						16.0		2
						16.5		3
						17.0		
	Massive silty clay (upper till)		6	AY		17.5	20	2
						18.0		4
						18.5		4
						19.0		4
						19.5		2
			7	AY		20.0	24	2
						20.5		3
						21.0		3
						21.5		5
						22.0		1
			8	AY		22.5	22	3
						23.0		3
						23.5		3
						24.0		5
						24.5		1
			9	AY		25.0	22	3
						25.5		3
						26.0		3
						26.5		4
						27.0		1
			10	AY		27.5	24	2
						28.0		3
						28.5		5
						29.0		1
						29.5		3
			11	AY		30.0	24	3
						30.5		3
						31.0		3
						31.5		5
				32.0		1		
12		AY		32.5	23	3		
				33.0		3		
				33.5		3		
				34.0		3		
				34.5		3		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 152
 SITE Welland, Townline Road SHEET No. 3 OF 4

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	
37.5	Massive silty clay (upper till) (Cont'd)		13	AY		35.0	23	
						35.5		1
						36.0		3
						36.5		3
						37.0		5
37.5	Silt and distorted varves	Brown silt and clayey silt with distorted layered clay inclusion.	14	AY		37.5	24	
						38.0		3
						38.5		5
						39.0		4
						39.5		7
			15	AY		40.0	24	
						40.5		1
42.0	Silty clay	Reddish-brown medium to soft, silty clay. Traces of sand and fine gravel.				41.0		3
						41.5		3
						42.0		5
			16	AY		42.5	24	
						43.0		1
						43.5		1
						44.0		3
42.0	Silty clay	Reddish-brown medium to soft, silty clay. Traces of sand and fine gravel.				44.5		3
			17	AY		45.0	24	
						45.1		1
						46.0		2
						46.5		2
						47.0		3
46.0	Varved clay	Reddish-brown, light brown and grey distinctly laminated clay. Thin silt and fine sand layers underlying the grey bands. Unevenly spaced varves. Traces of fine to coarse sand.						
			18	AY		47.5	24	
						48.0		1
						48.5		3
						49.0		3
						49.5		5
			19	AY		50.0	24	
						50.5		1
						51.0		1
46.0	Varved clay	Reddish-brown, light brown and grey distinctly laminated clay. Thin silt and fine sand layers underlying the grey bands. Unevenly spaced varves. Traces of fine to coarse sand.				51.5		2
						52.0		3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 152
 SITE Welland, Townline Road SHEET No. 4 OF 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	
53.0	Silt and sandy silt (transition)	Brown, dilatant, silt and sandy silt	20	AY		52.5	24	
						53.0		1
						53.5		1
						54.0		3
						54.5		2
			21	AY		55.0	22	
						55.5		2
						56.0		6
						56.5		7
						57.0		8
			22	AY		57.5	20	
						58.0		28
						58.5		25
						59.0		32
						59.5		79
			23	AY		60.0	18	
						60.5		15
						61.0		41
						61.5		52
						62.0		69
			24	AY		62.5	18	
						63.0		19
						63.5		29
						64.0		36
						64.5		42
			25	AY		65.0	18	
						65.5		12
						66.0		20
						66.5		30
						67.0		34
			26	AY		67.5	12	
						68.0		31
						68.5		41
69.0	Bedrock		27	DY				
72	End of Hole					69.2	24	
						71.2		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 153

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED .M. May 7 19 68
 FINISHED .M. May 7 19 68

METHOD OF DRILLING: SOIL _____ CASING DIAM. NX
 ROCK _____ CORE DIAM. _____

LOCATION: LATITUDE 37,500 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,307 E DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 581.2
 INITIAL DIP 90° ROCK SURFACE _____
 OTHER DIPS _____ BOTTOM OF HOLE 524.2
 WATER TABLE _____

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	Silty clay							
40.0		Vane test every one and one-half feet from 40'-0" to 57'-0" (see next sheet)						
57.0	End of hole							

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 R. Manuel

LOGGED BY _____

APPROVED _____

DATE _____

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 153
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
538.8	820	-	-
537.3	920	-	-
535.8	880	-	-
534.3	1,000	-	-
532.8	1,000	-	-
531.3	1,000	-	-
529.8	1,000	-	-
528.3	1,000	-	-
526.8	1,000	-	-
525.3	1,000	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 154

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soil Investigation STARTED .M. May 8 19 68
 FINISHED .M. May 10 19 68

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

LOCATION: LATITUDE 165+50 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 45' north of centre- DRILL PLATFORM
 BEARING 90° line GROUND SURFACE 574.0
 INITIAL DIP 90° ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE 494.0
 WATER TABLE

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	Silty clay							
35.0		Vane test from 35 feet to 80 feet (see next sheet)						
80.0	End of hole							

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 R. Manuel

LOGGED BY

APPROVED John Phil

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 154
SITE Welland, Townline Road SHEET No. 2 OF 3

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
539.0	900	370	2.4
538.0	630	220	2.9
537.0	1,000+	200	5.0
536.0	1,000	240	4.2
535.0	1,000+	200	5.0
534.0	1,000+	250	4.0
533.0	840	250	3.4
532.0	860	250	3.4
531.0	840	350	2.4
530.0	880	310	2.8
529.0	860	260	3.3
528.0	1,000	440	2.0
527.0	920	330	2.8
526.0	950	430	2.2
525.0	920	410	2.2
524.0	920	440	2.1
523.0	920	380	2.4
522.0	920	380	2.4
521.0	1,000	480	2.1
520.0	990	400	2.5
519.0	710	400	1.8
518.0	950	390	2.4
517.0	1,000	500	2.0
516.0	990	550	1.8
515.0	990	500	2.0
514.0	920	500	1.8
513.0	760	440	1.7
512.0	1,000+	-	-
511.0	900	380	2.4
510.0	860	460	1.9
509.0	920	500	1.8
508.0	950	460	2.1
507.0	860	380	2.2
506.0	930	400	2.3
505.0	1,000+	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 154
SITE Welland, Townline Road SHEET No. 3 OF 3

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
504.0	1,000+	310	3.2
503.0	1,000+	-	-
502.0	1,000+	-	-
501.0	1,000+	-	-
500.0	1,000+	-	-
499.0	1,000+	-	-
498.0	1,000+	-	-
497.0	1,000+	-	-
496.0	1,000+	-	-
495.0	1,000+	-	-

DRILLING REPORT

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, very stiff mottled, silty clay and clayey silt. Numerous silt lenses and oxidized pockets, occasional salt inclusions.	1	AY		5.0	22	
						5.5		9
						6.0		23
						6.5		26
			2	AY		7.0	24	26
						7.5		6
						8.0		6
						8.5		10
			3	AY		9.0	24	12
						9.5		
						10.0		5
						10.5		6
			4	AY		11.0	16	8
						11.5		10
						12.0		
						12.5		6
	13.0	10						
	13.5	11						
		14.0		13				
		14.5						

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED
Y-Core Box

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail

HOLE No. 155

SITE Welland, Townline Road

Tunnel

SHEET No. 2 OF 5

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	
17.0	Desiccated clayey silt and silty clay (Cont'd)		5	AY		15.0	23	
						15.5		2
						16.0		3
						16.5		4
						17.0		3
17.0	Varved clay	Reddish-brown, greyish-brown and grey, alternate layers of clay. Traces of sand and fine gravel.	6	AY		17.5	24	
						18.0		0
						18.5		1
						19.0		1
			7	AY		19.5	24	2
						20.0		
						20.5		1
						21.0		1
21.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity, contains silt lenses and pockets. Traces of sand and fine to coarse gravel.	8	AY		21.5	24	1
						22.0		1
						22.5		2
						23.0		2
						23.5		2
			9	AY		24.0	24	2
						24.5		2
						25.0		1
						25.5		1
						26.0		2
			10	AY		26.5	24	3
						27.0		1
						27.5		2
						28.0		3
						28.5		3
			11	AY		29.0	24	3
						29.5		1
						30.0		1
						30.5		2
						31.0		2
						31.5		4
						32.0		

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	Welland Canal Relocation Townline Rail/Road Tunnel	HOLE No.	155
SITE	Welland Townline Road	SHEET No.	3 OF 5

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COM-PACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RET'D	
	Massive silty clay (upper till) (Cont'd)		12	AY		32.5	22	
						33.0		1
						33.5		1
						34.0		3
						34.5		5
			13	AY		35.0	18	
						35.5		0
						36.0		2
						36.5		4
						37.0		4
			14	AY		37.5	23	
						38.0		1
						38.5		2
						39.0		2
						39.5		4
			15	AY		40.0	24	
						40.5		0
						41.0		2
						41.5		2
						42.0		4
			16	AY		42.5	24	
						43.0		0
						43.5		2
						44.0		3
						44.5		4
			17	AY		45.0	24	
						45.5		1
						46.0		3
						46.5		3
						47.0		4
			18	AY		47.5	24	
						48.0		2
						48.5		3
						49.0		4
						49.5		7
49.0	Silt and distorted varves	Brown and reddish-brown silt and clayey silt with occasional distorted layers of clay	19	AY		50.0	24	
						50.5		0
						51.0		0
						51.5		1
						52.0		2

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No. 1684
PROJECT	Welland Canal Relocation Townline Rail/Road Tunnel	HOLE No. 155
SITE	Welland Townline Road	SHEET No. 4 OF 5

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	
54.0	Silt and distorted varves (Cont'd)	Reddish-brown, medium to soft silty clay. Numerous silt layers and lenses. Traces of sand and subangular gravel.	20	AY		52.5	24	1
					53.0		3	
					53.5		4	
					54.0		7	
					54.5			
	21		AY		55.0	23	0	
					55.5		2	
					56.0		2	
					56.5		3	
					57.0		0	
	22		AY		57.5		1	
					58.0		3	
					58.5		3	
					59.0		0	
					59.5		2	
	23		AY		60.0	24	3	
					60.5		3	
					61.0		0	
					61.5		3	
					62.0		3	
	24		AY		62.5	24	0	
					63.0		3	
					63.5		3	
					64.0		5	
					64.5			
	25		AY		65.0	24	0	
					65.5		6	
					66.0		6	
			66.5		6			
			67.0					
26	AY		67.5	22	0			
			68.0		1			
			68.5		2			
			69.0		9			
			69.5					

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No. 1684
PROJECT	Welland Canal Relocation Townline Rail/Road Tunnel	HOLE No. 155
SITE	Welland Townline Road	SHEET No. 5 OF 5

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	
70.0	Varved clay	Reddish-brown, light brown and grey, distinctly laminated clay. Thin silt and fine sand layers under the grey bands. Interval between couplets varies from 3" to 11". Traces of sand and gravel.	27	AY		70.0	24	
						70.5		0
						71.0		1
						71.5		2
						72.0		2
			28	AY		72.5	24	
						73.0		0
						73.5		2
						74.0		3
						74.5		5
			29	AY		75.0	24	
						75.5		0
						76.0		2
						76.5		3
						77.0		4
			30	AY		77.5		
						78.0		0
						78.5		1
						79.0		3
						79.5		4
80.0	Till	Reddish-brown, compact clayey till contains all sizes of unsorted angular rock fragments.	31	AY		80.0	24	
						80.5		0
						81.0		12
						81.5		31
						82.0		55
			32	AY		82.5	10	
						83.0		19
						83.5		39
						84.0		50
						84.5		77
			33	AY		85.0	15	
						85.5		0
						86.0		39
						86.5		46
						87.0		77
			34	AY		87.5	8	
						88.0		39
						88.5		45
						89.0		71
91.0	Bedrock	End of hole	35	DY		91.0	15	
94.5						94.5		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 156
SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2
CONTRACTOR: Peninsula Soil Investigation STARTED .M. May 13 19 68
METHOD OF DRILLING: SOIL Vane Test FINISHED .M. May 14 19 68
CASING DIAM. _____
ROCK _____ CORE DIAM. _____
LOCATION: LATITUDE 126+83 ELEVATIONS: DATUM G.S.C.
DEPARTURE 34' north of centre- DRILL PLATFORM _____
BEARING _____ line GROUND SURFACE 585.1
INITIAL DIP 90° ROCK SURFACE _____
OTHER DIPS _____ BOTTOM OF HOLE 505.1
WATER TABLE _____

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	Silty clay	Vane test at every one foot interval, from 45'-0" to 80'-0" (see next sheet)						
45.0								
80.0	End of hole							

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 R. Manuel

LOGGED BY _____

APPROVED _____

DATE _____

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 156
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
540.1	1,000+	-	-
539.1	1,000+	-	-
538.1	990	460	2.1
537.1	980	460	2.1
536.1	920	340	2.7
535.1	1,000+	-	-
534.1	1,000+	-	-
533.1	950	350	2.7
532.1	1,000+	350	2.8
531.1	1,000+	-	-
530.1	1,000+	-	-
529.1	1,000+	-	-
528.1	1,000+	-	-
527.1	1,000+	-	-
526.1	1,000+	-	-
525.1	1,000+	-	-
524.1	860	400	2.1
523.1	1,000+	-	-
522.1	1,000+	-	-
521.1	1,000+	-	-
520.1	1,000+	-	-
519.1	1,000+	-	-
518.1	1,000+	-	-
517.1	1,000+	-	-
516.1	1,000+	-	-
515.1	1,000+	-	-
514.1	1,000+	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 157A

SITE Welland, Townline Road SHEET No. 1 OF 7

CONTRACTOR: Peninsula Soils Investigations STARTED .M. May 20 19 68
 FINISHED .M. May 27 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX, EX
 ROCK _____ CORE DIAM. _____

LOCATION: LATITUDE 37,369 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 4210.1 E DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 596.5
 INITIAL DIP 90° ROCK SURFACE 443.5
 OTHER DIPS _____ BOTTOM OF HOLE 443.5
 WATER TABLE _____

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	Hydraulic fill	No sample taken.	2	AY		17.5 18.0 18.5 19.0 19.5	10	6 10 21 28
20.0	Massive silty clay (upper till)	Grey, greyish-brown and reddish-brown silty clay, Occasional silt lenses and pockets. Traces of sand and subangular gravel, medium plasticity	3	AY		20.0 20.5 21.0 21.5 22.0	18	5 5 7 7
			4	AY		22.5 23.0 23.5 24.0 24.5	20	6 8 14 22
			5	AY		25.0 25.5 26.0 26.5 27.0	21	6 7 11 12

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
 Y — Core Box

INSPECTOR R. Manuel

LOGGED BY A. Mirza

APPROVED _____

DATE _____

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Road/Rail HOLE No. 157A
 SITE Welland Townline Road Tunnel SHEET No. 2 OF 7

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	
	Massive silty clay (upper till) (Cont'd)		6	AY		27.5	12	
						28.0		1
						28.5		2
						29.0		3
						29.5		3
			7	AY		30.0	24	
						30.5		1
						31.0		1
						31.5		1
						32.0		2
			8	AY		32.5	24	
						33.0		1
						33.5		1
						34.0		2
						34.5		2
			9	AY		35.0		
						35.5		0
						36.0		1
						36.5		1
						37.0		2
	40.0 Varved clay	Reddish-brown and grey, alternate 1/4" thick bands of clay, few thin silt layers.	10	AY		37.5		
						38.0		0
						38.5		1
						39.0		2
						39.5		2
	42.0 Massive silty clay	Reddish-brown, silty clay of medium plasticity, contains silt layers and lenses. Traces of sand and fine gravel.	11	AY		40.0	24	
						40.5		0
						41.0		1
						41.5		1
						42.0		2
			12	AY		42.5	24	
						43.0		0
						43.5		1
						44.0		1
						44.5		2
			13	AY		45.0	24	
						45.5		0
						46.0		1
						46.5		1
						47.0		2

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Rail/Road Tunnel HOLE No. 157A
 SITE Welland Townline Road SHEET No. 3 OF 7

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	
	Massive silty clay (Cont'd)		14	AY		47.5	24	
						48.0		0
						48.5		1
						49.0		1
						49.5		2
			15	AY		50.0	24	
						50.5		0
						51.0		1
						51.5		2
						52.0		2
			16	AY		52.5	25	
						53.0		0
						53.5		1
						54.0		2
						54.5		2
			17	AY		55.0	24	
						55.5		0
						56.0		1
						56.5		2
						57.0		3
			18	AY		57.5	24	
						58.0		0
						58.5		0
						59.0		2
						59.5		2
			19	AY		60.0	24	
						60.5		0
						61.0		0
						61.5		2
						62.0		2
61.0	Varved clay	Reddish-brown, greyish brown and grey, distinctly laminated clay. Spacing between the couplets varies from 3" to 5"; Thin silt and fine sand layers. Traces of sand and gravel.	20	AY		62.5	24	
						63.0		0
						63.5		2
						64.0		2
						64.5		3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT Welland Canal Relocation Townline Rail/Road **HOLE No.** 157A
Tunnel
SITE Welland Townline Road **SHEET No.** 4 OF 7

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	
	Varved clay (Cont'd)		21	AY		65.0	24	
						65.5		0
						66.0		1
						66.5		2
						67.0		2
			22	AY		67.5	24	
						68.0		0
						68.5		1
						69.0		2
						69.5		3
			23	AY		70.0	24	
						70.5		0
						71.0		2
						71.5		2
						72.0		4
			24	AY		72.5	24	
						73.0		0
						73.5		0
						74.0		2
						74.5		3
			25	AY		77.5	24	
						78.0		0
						78.5		0
						79.0		3
						79.5		3
			26	AY		80.0	24	
						80.5		0
						81.0		0
						81.5		3
						82.0		3
			27	AY		82.5	24	
						83.0		0
						83.5		15
						84.0		15
						84.5		15
84.0	Sandy silt and sand (transition)	Brown and grey, sandy silt, silty fine sand, medium to coarse sand and coarse sand with rounded gravel.	28	AY		85.0	24	
						85.5		0
						86.0		11
						86.5		18
						87.0		33

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation Townline Rail/Road Tunnel HOLE No. 157A
 SITE Welland Townline Road SHEET No. 5 OF 7

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	
	Sandy silt and sand (transition) (Cont'd)		29	AY		87.5	20	
						88.0		47
						88.5		36
						89.0		25
						89.5		22
			30	AY		90.0	24	
						90.5		26
						91.0		14
						91.5		14
						92.0		14
			31	AY		92.5	24	
						93.0		5
						93.5		4
						94.0		6
						94.5		13
			32	AY		95.0	24	
						95.5		10
						96.0		7
						96.5		21
						97.0		42
			33	AY		97.5		
						98.0		12
						98.5		6
						99.0		18
						99.5		18
			34	AY		100.0		
						100.5		16
						101.0		25
						101.5		37
						102.0		37
			35	AY		102.5		
						103.0		7
						103.5		12
						104.0		21
						104.5		33
			36	AY		107.5		
						108.0		2
						108.5		4
						109.0		6
						109.5		5

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT Welland Canal Relocation Townline Rail/Road **HOLE No.** 157A
Tunnel
SITE Welland Townline Road **SHEET No.** 6 OF 7

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	
	Sandy silt and sand (transition) (Cont'd)		37	AY		110.0		
						110.5		2
						111.0		4
						111.5		4
						112.0		3
			38	AY		112.5		
						113.0		8
						113.5		21
						114.0		22
						114.5		23
			39	AY		115.0		
						115.5		11
						116.0		13
						116.5		17
						117.0		14
			40	AY		117.5		
						118.0		8
						118.5		32
						119.0		24
						119.5		24
			41	AY		120.0		
						120.5		20
						121.0		19
						121.5		22
						122.0		24
			42	AY		125.0		
						125.5		10
						126.0		21
						126.5		28
						127.0		29
			43	AY		137.0		
						137.5		17
						138.0		9
						138.5		9
						139.0		10
			44	DY		140.4		
						145.7		
145.0		No sample taken below this depth.						
153.0	Bedrock	End of the hole.						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 157A
SITE Welland, Townline Road SHEET No. 7 OF 7

Torque Assembly: Geonor Vane Borer NR219

Vane No.:

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
593.5	140	85	1.6
592.5	260	140	1.8
591.5	200	120	1.7
590.5	140	120	1.2
589.5	240	85	2.8
588.5	140	100	1.4
587.5	350	120	2.9
586.5	160	100	1.6
585.5	310	85	3.6
584.5	700	160	4.4
583.5	120	85	1.4
582.5	330	100	3.3
581.5	160	100	1.6
580.5	680	-	-

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 158

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED May 23 19 68
Modified Wash Boring FINISHED May 30 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 142+16 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 97' north of centreline DRILL PLATFORM
 BEARING 900 GROUND SURFACE 585.2
 INITIAL DIP 900 ROCK SURFACE 519.2
 OTHER DIPS BOTTOM OF HOLE 469.2
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
66.0	Shaly dolomite	Light grey, fine grained, thinly bedded, shaly dolomite. Few gypsum inclusions; (core badly broken)	
69.0	Seed texture dolomite	Light brown, fine grained dolomite with seed-like texture; traces of gypsum and hydrocarbons on bedding planes.	
70.0	Shaly dolomite	Light brown and greyish-brown, fine grained, faintly laminated, partly shaly, dolomite with traces of hydrocarbons and gypsum in bedding layers.	
73.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with thin layers of hydrocarbons.	
77.0	Seed texture dolomite	Light brown, fine grained, partly wavy bedded dolomite with seedlike texture, traces of gypsum and hydrocarbons.	
83.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum, iron oxide stains; evidence of solutioning, vuggy porosity.	

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 158
SITE Welland Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
96.6	Seed texture dolomite	Light brown, fine grained, somewhat wavy bedded dolomite with seedlike texture; traces of gypsum and indications of leaching.	
101.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
116.0	End of hole	Overall	82

DRILLING REPORT

LOCATION:	LATITUDE	157+25	ELEVATIONS:	DATUM	G.S.C.
	DEPARTURE	82' north of		DRILL PLATFORM	
	BEARING		line	GROUND SURFACE	579.5
	INITIAL DIP	90°		ROCK SURFACE	501.2
	OTHER DIPS			BOTTOM OF HOLE	451.5
				WATER TABLE	572.7

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 160

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigations STARTED M. May 31 1968
 FINISHED M. June 3 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 142+52 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 54' south of centreline DRILL PLATFORM
 BEARING
 INITIAL DIP 90° GROUND SURFACE 585.8
 OTHER DIPS ROCK SURFACE 522.3
 BOTTOM OF HOLE 472.8
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
63.5	Shaly dolomite	Light grey, very fine grained, thinly laminated shaly dolomite	
65.0	Seed-texture dolomite	Light grey-brown, fine grained dolomite with seed-like texture and thin gypsum partings.	
66.8	Shaly dolomite	Light grey, very fine grained, faintly laminated shaly dolomite with traces of gypsum.	
70.0	Seed-texture dolomite	Light brown, fine grained, partly argillaceous and wavy bedded dolomite with seed-like texture and few gypsum 'blobs' and veinlets.	
75.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with traces of hydrocarbons and thin gypsum film on bedding layers.	
83.5	Shaly dolomite	Light grey faintly laminated aphanitic shaly dolomite.	
87.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum; vuggy porosity, evidence of solutioning.	

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 160
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
101.2	Seed texture dolomite	Medium brown, fine grained, wavy bedded dolomite with sand-like texture.	
102.7	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
		Overall	80
113.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 161

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 1

CONTRACTOR: Peninsula Soil Investigation STARTED 12:00 A.M. June 5 1968
 FINISHED 12:00 P.M. June 12 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 157+63 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 75' south of centreline DRILL PLATFORM
 BEARING 90° GROUND SURFACE 579.6
 INITIAL DIP 90° ROCK SURFACE 509.1
 OTHER DIPS BOTTOM OF HOLE 456.6
 WATER TABLE 572.6

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden = (silty clay and till)	
70.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with thin layers of shale and gypsum on bedding planes.	
74.5	Shaly dolomite	Light grey, aphanitic shaly dolomite with gypsum veinlets.	
75.5	Seed texture dolomite	Medium brown, fine grained, slightly wavy bedded dolomite, partly argillaceous, traces of gypsum on bedding surfaces.	
79.4	Shaly dolomite with gypsum	Bluish grey to dark grey, very fine grained shaly dolomite with gypsum veinlets, blobs and inclusions.	
93.5	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	
94.8	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained massive shaly dolomite with gypsum.	
123.0	End of hole		Overall 90

INSPECTOR J. Carella

APPROVED

LOGGED BY A. Mirza

DATE

February, 1969

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

DRILLING REPORT

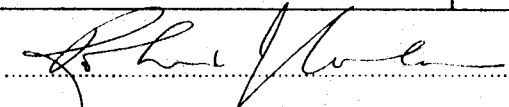
CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 162
 SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil STARTED 9:00 A.M. June 7 1968
Investigation FINISHED 3:00 P.M. June 14 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 144+14 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 49' south of centreline DRILL PLATFORM
 BEARING 90° GROUND SURFACE 584.4
 INITIAL DIP 90° ROCK SURFACE 520.4
 OTHER DIPS BOTTOM OF HOLE 450.4
 WATER TABLE 572.0

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
64.0	Wavy bedded dolomite	Light brown and grey brown, fine grained, partly wavy bedded and argillaceous, and partly seed-textured, dolomite with occasional gypsum inclusions, traces of hydrocarbons and thin gypsum films in bedding layers.	
82.5	Shaly dolomite	Light grey, faintly laminated aphanitic shaly dolomite.	
83.5	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, traces of hydrocarbons.	
87.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum, vuggy porosity, evidence of solutioning.	
98.5	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture and gypsum, iron oxide stains on some bedding surfaces.	
102.0	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained massive shaly dolomite with gypsum layers and inclusions, occasionally pale pink, evidence of solutioning, iron oxide stains on some bedding surfaces.	

INSPECTOR R. Manuel APPROVED 
 LOGGED BY A. Mirza DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 162
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
134.0	End of hole	Overall	85

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 163

SITE Welland, Townline Road SHEET No. 1 OF 1

CONTRACTOR: Peninsula Soils Investigations STARTED 09.00 a.m. June 12 19 68
Modified Wash Boring FINISHED 12.00 a.m. June 19 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 155+41 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 66' south of centre- DRILL PLATFORM
 BEARING 90° line GROUND SURFACE 581.65
 INITIAL DIP 90° ROCK SURFACE 513.65
 OTHER DIPS BOTTOM OF HOLE 462.45
 WATER TABLE 570.90

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
68.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite. Traces of gypsum and hydrocarbons on bedding surfaces.	
76.0	Shaly dolomite	Light grey, faintly laminated aphanitic shaly dolomite.	
77.0	Seed texture dolomite	Medium brown, fine grained partly wavy bedded dolomite with seedlike texture. Evidence of solutioning, iron oxide stains on some bedding surfaces.	
81.0	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum blobs and layers; iron oxide stains on some bedding surfaces.	
93.0	Seed texture dolomite	Medium brown, fine grained, partly wavy bedded dolomite with seedlike texture, minor gypsum, some iron oxide stains.	
96.5	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained massive shaly dolomite with gypsum layers and inclusions. Occasional pale pink gypsum layers.	
119.2	End of hole	Overall	89

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 164

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 8.00A.M. June 17 1968

METHOD SOIL Modified Washboring FINISHED 5.00P.M. June 21 1968

OF DRILLING: ROCK Diamond Drill CASING DIAM. NX

LOCATION: LATITUDE 144+26 ELEVATIONS: DATUM G.S.C.

DEPARTURE 82' N. of centreline DRILL PLATFORM

BEARING 0 GROUND SURFACE 584.1

INITIAL DIP 90 ROCK SURFACE 518.1

OTHER DIPS BOTTOM OF HOLE 469.0

WATER TABLE 570.5

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
66.0	Wavy bedded dolomite	Light brown, fine grained, finely laminated, partly wavy bedded dolomite with seed-like texture, evidence of solutioning.	
71.0	Shaly dolomite	Light grey, very fine grained shaly dolomite.	
72.0	Wavy bedded dolomite	Light brown, fine grained wavy bedded dolomite with traces of hydrocarbons and gypsum in bedding layers, some iron oxide stains.	
80.5	Shaly dolomite	Light grey, faintly laminated aphanitic shaly dolomite.	
81.8	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture, traces of hydrocarbons and gypsum.	
84.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	

INSPECTOR R. Montgomery

LOGGED BY A. Mirza

APPROVED [Signature]

DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. 164
Tunnel
SITE Welland, Townline Road SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
97.8	Seed-texture dolomite	Medium brown, fine grained, slightly wavy bedded dolomite with seed-like texture.	
100.0	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained shaly dolomite with gypsum.	
115.2	End of hole	Overall	92

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail Tunnel HOLE No. 165

SITE Welland, Townline Road SHEET No. 1 Of 1

CONTRACTOR: Peninsula Soil Investigation STARTED 12.00 M. June 19 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring FINISHED 12.00 M. July 3 19 68

ROCK Diamond Drill CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 155+36 ELEVATIONS: DATUM G.S.C.

DEPARTURE 69' North of centre- DRILL PLATFORM

BEARING 90° line GROUND SURFACE 581.6

INITIAL DIP 90° ROCK SURFACE 511.6

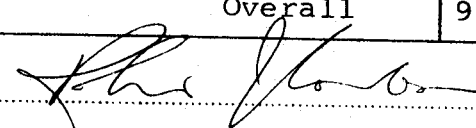
OTHER DIPS BOTTOM OF HOLE 440.6

 WATER TABLE 572.9

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden: Silty clay and till.	
70.0	Wavy bedded dolomite (salina formation)	Light brown, fine grained, wavy bedded dolomite with thin irregular layers of hydrocarbons and gypsum on bedding planes. Core mostly broken.	
79.0	Seed texture dolomite	Light to medium brown, fine grained dolomite with seed-like texture, partly argillaceous, with very thin gypsum films on bedding surfaces	
82.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum layers and inclusions.	
95.5	Seed texture dolomite	Medium brown, fine grained, slightly wavy bedded dolomite with seed-like texture and few gypsum inclusions.	
98.5	Shaly dolomite with gypsum	Dark grey to bluish grey, thin bedded, fine grained, shaly dolomite with gypsum layers and inclusions.	
140.3	Seed texture dolomite	Medium brown, fine grained, finely crystalline dolomite with seed-like texture.	
141.0	End of hole		
Overall			96

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

DRILLING REPORT

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 1

OF DRILLING:	ROCK	Diamond Drill	CORE DIAM	NXL
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OTHER DIPS	BOTTOM OF HOLE	445.5
	WATER TABLE	568.0

WATER TABLE	568.0
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DATE February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 167
 SITE Welland, Townline Road SHEET No. 1 OF 1
 CONTRACTOR: Peninsula Soils Investigations STARTED 12.00 .M. July 12 19 68
 FINISHED 17.00 .M. July 30 19 68
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL
 LOCATION: LATITUDE 37,471 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,255 E DRILL PLATFORM
 BEARING 90° AZIM GROUND SURFACE 581.2
 INITIAL DIP 45° ROCK SURFACE 501.4
 OTHER DIPS BOTTOM OF HOLE 446.7
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden: Silty clay and till.	
113.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with traces of gypsum and hydrocarbons on the bedding planes. Upper 8 feet badly broken.	
128.0	Shaly dolomite	Light grey, thin bedded aphanitic shaly dolomite.	
130.0	Seed texture dolomite	Light to medium brown, fine grained dolomite with seedlike texture and minor gypsum partings.	
136.0	Shaly dolomite with gypsum	Bluish-grey to dark grey, very fine grained shaly dolomite and dolomatic shale with gypsum layers and inclusions.	
190.2	End of hole	Overall	90

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED 

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 170

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED .M. July 29 19 68

METHOD OF DRILLING: SOIL Power Auger FINISHED .M. July 31 19 68

ROCK _____ CASING DIAM. _____

_____ CORE DIAM. _____

LOCATION: LATITUDE 36' south of ELEVATIONS: DATUM G.S.C.

DEPARTURE test shaft DRILL PLATFORM _____

BEARING _____ GROUND SURFACE 571.5

INITIAL DIP 90° ROCK SURFACE _____

OTHER DIPS _____ BOTTOM OF HOLE 491.5

_____ WATER TABLE _____

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	Silty clay	Vane test (see next sheet) from 20'-0" to 80'-0"						
20.0								
80.0	End of hole							

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 R. Manuel

LOGGED BY _____

APPROVED _____

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 170
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: 25 and 50 lb Spring Balances

Vane No.: 242

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
551.5	2,628	-	-
549.5	2,480	-	-
547.5	2,480	-	-
545.5	2,550	-	-
543.5	2,980	-	-
541.5	1,982	-	-
539.5	1,840	530	3.48
537.5	1,095	478	2.39
535.5	1,650	394	4.18
533.5	1,062	372	2.86
531.5	992	372	2.66
529.5	920	530	1.73
527.5	992	530	1.87
525.5	992	478	2.08
523.5	992	478	2.08
521.5	850	425	2.00
519.5	920	478	1.93
517.5	992	478	2.08
515.5	850	478	1.78
513.5	921	425	2.17
511.5	992	478	2.08
509.5	921	530	1.74
507.5	1,070	425	2.52
505.5	1,278	425	3.00
503.5	1,132	478	2.37
501.5	1,070	530	2.02
499.5	1,070	425	2.52
497.5	921	478	1.93
495.5	1,278	478	2.68
493.5	992	478	2.08
492.0	1,558	903	1.73

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 171

SITE Welland, Townline Road SHEET No. 1 OF 1

CONTRACTOR: Peninsula Soils Investigations STARTED .M. July 31 19 68
Modified Wash Boring FINISHED .M. Aug. 13 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,471 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 11,255 E DRILL PLATFORM
 BEARING 240° AZ IM GROUND SURFACE 581.2
 INITIAL DIP 45° ROCK SURFACE 504.9
 OTHER DIPS BOTTOM OF HOLE 446.9
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
108.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite, minor hydrocarbons and gypsum. Core badly broken.	
120.0	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
121.0	Seed texture dolomite	Medium brown, fine grained, partly wavy bedded dolomite with seedlike texture, traces of hydrocarbons and gypsum on bedding surfaces.	
127.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
148.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	
151.0	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum layers, blobs and inclusions; iron oxide stains on some bedding surfaces, evidence of solutioning, stringers of pink gypsum.	
190.5	End of hole	Overall	85

INSPECTOR R. Montgomery APPROVED *[Signature]*

LOGGED BY A. Mirza DATE February, 1969

DRILLING REPORT

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	Silty clay	Vane test every two feet from 15'-0" to 45'-0"						
15.0								
46.0	End of hole							

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 172
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: 25 and 50 lb Spring Balances

Vane No.: 242

RESULTS OF VANE TESTS

Elevation (Feet)	<u>Shear Strength P.S.F.</u>		Sensitivity
	Natural	Remoulded	
557.0	600	225	2.7
555.0	1,050	280	3.7
553.0	675	340	2.0
551.0	790	340	2.3
549.0	790	450	1.8
547.0	730	375	1.9
545.0	845	450	1.9
543.0	790	525	1.5
541.0	900	450	2.0
539.0	790	525	1.5
537.0	730	340	2.1
535.0	730	450	1.6
533.0	790	375	2.1
531.0	790	375	2.1
529.0	900	415	2.2
527.0	1,240	525	2.4
525.0	1,125	450	2.5
523.0	900	450	2.0
521.0	525	450	1.2
519.0	750	510	1.5
517.0	2,180	845	2.6

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 176

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED .M. Aug. 16 19 68
Modified Wash Boring FINISHED .M. Aug. 27 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,475 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 12,085 E DRILL PLATFORM
 BEARING 3000° AZIM GROUND SURFACE 582.7
 INITIAL DIP 45° ROCK SURFACE 509.2
 OTHER DIPS BOTTOM OF HOLE 481.2
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
104.0	Massive dolomite	Light brown, fine grained, massive dolomite; badly broken core, signs of weathering.	
109.5	Seed texture dolomite	Light brown, fine grained dolomite with a seed-like texture; thin films of gypsum and hydrocarbons.	
116.0	Wavy bedded dolomite	Light brown, fine grained wavy bedded dolomite, slight seed-like texture, traces of hydrocarbons and gypsum.	
132.0	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
134.5	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	
142.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
158.0	Dolomite and gypsum	Medium brown dolomite interbedded with 60 to 70% massive gypsum.	

INSPECTOR R. Montgomery

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 176
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
165.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	85
181.5	End of hole	Overall	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 177

SITE Welland, Townline Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soils Investigations STARTED 08.30 .M. Aug. 19 19 68

METHOD OF DRILLING: SOIL Power Auger FINISHED 15.00 .M. Aug. 26 19 68

ROCK Diamond Drill CASING DIAM. 6" CORE DIAM. BX

LOCATION: LATITUDE 15,608,840N ELEVATIONS: DATUM G.S.C.

DEPARTURE 1,078,980E DRILL PLATFORM 585

BEARING 90° GROUND SURFACE 488.5

INITIAL DIP 90° ROCK SURFACE 485

OTHER DIPS BOTTOM OF HOLE

WATER TABLE

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	Desiccated clayey silt and silty clay	Greyish-brown and reddish-brown, very stiff, mottled, clayey silt and silty clay; traces of organic matter fissured, occasional salt inclusion.	1	BO	5"	10.0 11.0 12.0 13.0 14.4	24	625psi 1100psi 1100psi 1100psi
			2	BO	5"	15.0 16.0 17.0 18.0 19.4	0	325psi 675psi 1250psi
17.0	Massive silty clay (upper till)	Reddish-brown silty clay of medium plasticity contains silt lenses and pockets.	3	BO	5"	20.0 21.0 22.0 23.0 24.3	3' 4"	350psi 675psi 1100psi
			4	BO	5"	25.0 26.0 27.0 28.0 29.0	44"	325psi 750psi 1150psi 1225psi

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 R. Manuel

LOGGED BY A. Mirza

APPROVED 

DATE February, 1969

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

D R I L L I N G R E P O R T

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 177

SITE Welland, Townline Road SHEET No. 2 OF 4

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	
	Massive silty clay (upper till) (Cont'd)		5	BO	5"	30.0 31.0 32.0 33.0 34.4	52"	325 psi 625 psi 725 psi 825 psi
			6	BO	5"	35.0 36.0 37.0 38.0 39.4	52"	350 psi 500 psi 825 psi 1100 psi
39.0	Varved clay	Reddish-brown and grey 1/4" wide alternate clay bands with thin silt layers. Traces of sand and gravel.	7	BO	5"	40.0 41.0 42.0 43.0 44.0	52"	250 psi 375 psi 575 psi 1050 psi
44.0	Silt and distorted varves	Reddish-brown and brown silt and clayey silt with few distorted clay bands and inclusions.	8	BO	5"	45.0 46.0 47.0 48.0 49.0	52"	325 psi 650 psi 900 psi 1125 psi
			9	BO	5"	50.0 51.0 52.0 53.0 54.0	52"	250 psi 475 psi 625 psi 1250 psi
52.0	Massive silty clay	Reddish-brown silty clay of medium plasticity; contains brown silt layers and lenses. Traces of sand and fine gravel.	10	BO	5"	55.0 56.0 57.0 58.0 59.4	52"	325 psi 525 psi 775 psi 1050 psi
			1	AY		60.0 60.5 61.0 61.5 62.0	24	6 6 8 7

DRILLING REPORT

SITE Welland, Townline Road Tunnel SHEET No. 3 OF 4

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	
78.0	Massive silty clay (Cont'd)		2	AY		62.5	24	
						63.0		2
						63.5		4
						64.0		3
						64.5		4
			3	AY		65.0	24	
						65.5		2
						66.0		4
						66.5		5
						67.0		6
			4	AY		67.5	24	
						68.0		2
						68.5		3
						69.0		6
						69.5		8
			5	AY		70.0	24	
						70.5		3
						71.0		5
						71.5		7
						72.0		8
			6	AY		72.5	24	
						73.0		3
						73.5		5
						74.0		6
						74.5		6
			7	AY		75.0	24	
						75.5		2
						76.0		8
						76.5		9
						77.00		11
						77.5	24	
						78.0		4
			78.5		5			
			79.0		6			
			79.5		6			
	Varved clay	Reddish-brown, light brown and grey, distinctly layered clay contains thin silt and fine sand layers. Traces of sand and fine to coarse gravel.	9	AY		80.0	24	
					80.5		2	
					81.0		6	
					81.5		6	
					82.0		7	

DRILLING REPORT

JOB No. 1684

HOLE No. 177

SHEET No. 4 OF 4

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			
85.0	Varved clay (Cont'd)	Reddish-brown clayey till contains sand grains, gravel and rock fragments.	10	AY		82.5	24			
					83.0		3			
					83.5		5			
					84.0		6			
					84.5		5			
					11	AY		85.0	24	
								85.5		2
								86.0		5
								86.5		6
								87.0		7
					12	AY		87.5	24	
								88.0		5
								88.5		6
								89.0		7
								89.5		7
					13	AY		90.0	24	
								90.5		6
								91.0		7
								91.5		6
								92.0		9
					14	AY		92.5		
								93.0		3
								93.5		5
						94.0		6		
						94.5		7		
			1	DY		96.5	30"			
						97.0				
						97.5				
						98.0				
						98.5				
						99.0				
96.5	Bedrock									
100	End of Hole									

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 178

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigations STARTED 12.00 .M. Aug. 27 19 68
Modified Wash Boring FINISHED 12.00 .M. Sept. 16 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,475 N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 12,085 E DRILL PLATFORM
 BEARING 270° AZIM GROUND SURFACE 582.5
 INITIAL DIP 45° ROCK SURFACE 512.5
 OTHER DIPS BOTTOM OF HOLE 412.0
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
100.0	Massive dolomite	Light brown, fine grained dolomite (core badly broken.)	
103.0	Seed texture dolomite	Light brown, fine grained, slightly wavy bedded dolomite with minor gypsum and hydrocarbons.	
108.0	Wavy bedded dolomite	Light brown, wavy bedded dolomite with thin gypsum and hydrocarbons layers on bedding surfaces.	
120.0	Seed texture dolomite	Medium brown, fine grained dolomite with seedlike texture.	
122.0	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
125.0	Seed texture dolomite	Medium brown, fine grained dolomite with seedlike texture. Traces of gypsum and hydrocarbons.	
128.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum layers and inclusions.	

INSPECTOR R. Montgomery

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 178
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
146.0	Seed texture dolomite	Medium brown, fine grained dolomite with seedlike texture.	
149.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum, fine vuggy porosity in several zones; iron oxide stains on some bedding surfaces.	
211.0	Seed texture dolomite	Medium brown, fine grained dolomite, partly angillaceous, traces of hydrocarbons.	
215.5	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum.	
241.0	End of hole	Overall	88

DRILLING REPORT

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	Silty clay	Vane test every two feet from 16'-0" to 44'-0"						
16.0								
44.0	End of hole							

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 179
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: 25 and 50 lb Spring Balances

Vane No.: 242

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
556.0	993	584	1.7
554.0	922	637	1.4
552.0	1,062	850	1.2
550.0	993	744	1.3
548.0	922	584	1.6
546.0	780	318	2.5
542.0	993	372	2.7
540.0	993	531	1.9
538.0	1,133	531	2.1
536.0	1,133	584	1.9
534.0	1,420	1,273	1.1
532.0	1,348	796	1.7
530.0	1,205	902	1.3
528.0	1,205	584	2.1

DRILLING REPORT

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	Silty clay	Vane test every two feet from 16'-0" to 36'-0"						
16.0								
36.0	End of hole							

R - CLOTH BAG
S - PLIOFILM BAG
Z - DISCARDED

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Rail/Road Tunnel HOLE No. 180
SITE Welland, Townline Road SHEET No. 2 OF 2

Torque Assembly: 25 and 50 lb Spring Balances

Vane No.: 242

RESULTS OF VANE TESTS

Elevation (Feet)	Shear Strength P.S.F.		Sensitivity
	Natural	Remoulded	
558.0	1,560	-	-
556.0	1,275	531	2.4
554.0	993	425	2.3
552.0	993	318	3.1
550.0	709	372	1.9
548.0	922	425	2.2
546.0	922	425	2.2
544.0	993	584	1.7
542.0	1,348	425	3.2
540.0	922	478	1.9
538.0	1,062	531	2.0

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. 181

SITE Welland, Townline Road SHEET No. 1 Of 2

CONTRACTOR: Peninsula Soils INVESTIGATIONS STARTED M. Oct. 11 19 68

FINISHED M. Oct. 18 19 68

METHOD OF DRILLING: SOIL Diamond Drill CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 149+80 ELEVATIONS: DATUM G.S.C.

DEPARTURE 480' north of centre- DRILL PLATFORM 562.6

BEARING 180° AZIM line GROUND SURFACE 560.7

INITIAL DIP 45° ROCK SURFACE 515.2

OTHER DIPS BOTTOM OF HOLE 434.6

WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
57.4	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with thin films of hydrocarbons and gypsum on bedding planes.	
82.5	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
83.5	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor hydrocarbons and gypsum.	
88.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
105.3	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	
109.0	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum, occasional signs of leaching and iron oxide stains.	
170.0	Seed texture dolomite	Medium brown, fine grained dolomite with seedlike texture.	

INSPECTOR J. Carella

LOGGED BY A. Mirza

APPROVED

DATE

February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. 181
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
174.0	Shaly dolomite	Dark grey, very fine grained, shaly dolomite with gypsum inclusions.	
182.0	End of hole		
		Overall	93

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Rail/Road Tunnel HOLE No. GY-0

SITE Welland, Townline Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigation STARTED 07.00a .M. Oct. 5 19 68

Modified Wash Boring FINISHED 17.00p .M. Oct. 19 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX

ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 150+12.6 ELEVATIONS: DATUM G.S.C.

DEPARTURE 9.4N DRILL PLATFORM 580.5

BEARING 90° GROUND SURFACE 513.5

INITIAL DIP 90° ROCK SURFACE 364.5

OTHER DIPS BOTTOM OF HOLE

 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
67.0	Wavy bedded dolomite	Light brown, fine grained wavy bedded dolomite with hydrocarbons and gypsum on bedding planes.	
75.7	Shaly dolomite	Light grey, finely laminated, aphanitic shaly dolomite.	
77.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum and hydrocarbons.	
80.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
93.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture. Traces of hydrocarbons and gypsum.	
96.0	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum, minor vuggy porosity and iron oxide stains.	
138.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	

INSPECTOR R. Manuel

LOGGED BY A. Mirza

APPROVED

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT Welland Canal Relocation, Townline Rail/Road HOLE No. GY-0
SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
141.0	Shaly dolomite with gypsum	Dark grey and bluish-grey, very fine grained shaly dolomite with gypsum, minor vuggy porosity and iron oxide stains. Indications of solutioning.	
206.0	Seed texture dolomite	Light brown and greyish-brown, fine grained dolomite, partly angillaceous, slight seedlike texture.	
209.0	Shaly dolomite	Dark grey, very fine grained shaly dolomite.	
216.0	End of hole		
Overall			91

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

DRILLING REPORT

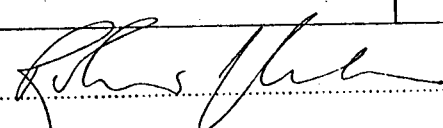
CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. GEY-2
 SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil STARTED M. October 9 1968
Investigation FINISHED M. October 29 1968
 METHOD OF DRILLING: SOIL Modified wash boring CASING DIAM. NX
 ROCK Diamond drill CORE DIAM. NXL

LOCATION: LATITUDE 144+49 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 10.3' south of centre- DRILL PLATFORM
 BEARING line GROUND SURFACE 583.04
 INITIAL DIP 90° ROCK SURFACE 518.0
 OTHER DIPS BOTTOM OF HOLE 379.5
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0		Overburden	
65.0	Massive dolomite	Light brown, fine grained, massive dolomite with minor gypsum (core badly broken).	
74.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with minor gypsum and hydrocarbons.	
80.4	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
81.6	Seed-texture dolomite	Light brown, fine grained, dolomite with seed-like texture and minor gypsum.	
84.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
99.0	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture and minor gypsum.	
102.0	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained shaly dolomite with gypsum	

INSPECTOR R. Manuel
 LOGGED BY A. Mirza

APPROVED 
 DATE February, 1969

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. GEY-2

SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
142.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	
145.0	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained shaly dolomite with gypsum.	
163.0	Seed texture dolomite	Medium brown dolomite with seed-like texture and minor gypsum.	
166.5	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
203.5	End of hole		
		Overall	73

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. GWY-1

SITE Welland, Townline Road Tunnel SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soil Investigations STARTED 12.00 .M. November 7 1968
 FINISHED 15.30 .M. November 12 1968

METHOD OF DRILLING: SOIL Modified Washboring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 156+77 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 12' south of centreline DRILL PLATFORM
 BEARING 90° GROUND SURFACE 578.1
 INITIAL DIP 90° ROCK SURFACE 512.1
 OTHER DIPS BOTTOM OF HOLE 361
 WATER TABLE

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0		Overburden	
66.0	Wavy bedded dolomite	Light brown, fine grained, wavy bedded dolomite with hydrocarbons and gypsum on bedding surfaces.	
71.0	Shaly dolomite	Light grey, faintly laminated, aphanitic shaly dolomite.	
72.3	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	
78.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
91.0	Seed texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	
93.5	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained shaly dolomite with gypsum layers and 'blobs', iron oxide stains on some bedding surfaces.	
134.0	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	

INSPECTOR B. Keleher

APPROVED

LOGGED BY A. Mirza

DATE

[Signature]
 February, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT Welland Canal Relocation, Townline Road/Rail HOLE No. GWY-1
 SITE Welland, Townline Road Tunnel SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
139.0	Shaly dolomite with gypsum	Dark grey, very fine grained, shaly dolomite with gypsum.	
157.0	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture.	
161.0	Shaly dolomite with gypsum	Dark grey, very fine grained shaly dolomite with gypsum.	
166.5	Seed-texture dolomite	Medium brown, fine grained dolomite with seed-like texture, minor gypsum.	
167.5	Shaly dolomite with gypsum	Dark grey and bluish grey, very fine grained shaly dolomite with gypsum inclusions.	
		Overall	91
217.0	End of hole		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 501
Approach Cut

SITE East of Railway Line SHEET No. 1 OF 6

CONTRACTOR: Peninsula Soils Investi- STARTED 12:00 a.m. July 4 19 68
gation FINISHED 12:00 a.m. July 11 19 68

METHOD SOIL Modified Wash Boring CASING DIAM. NX

OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37.900 N ELEVATIONS: DATUM GSC
 DEPARTURE 8,412 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 581.6
 INITIAL DIP 90° ROCK SURFACE 483.1
 OTHER DIPS BOTTOM OF HOLE 460.3
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown medium stiff silty clay and clayey silt	1	AY	2	10.0		
						10.5		
						11.0		4
						11.5		4
						12.0	22	6
			2	AY	2	12.5		
						13.0		
						13.5		6
						14.0		8
						14.5	20	9
16.0	Medium stiff varved clay zone consisting of alternating layers of reddish-brown and grey clay		3	AY	2	15.0		
						15.5		
						16.0		7
						16.5		7
17.0	Reddish-brown soft silty clay and clayey silt					17.0	22	7

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
 y - Core Box

INSPECTOR J. Carelia

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED [Signature]

DATE January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel
 Approach Cut

HOLE No. 501

SITE East of Railway Line

SHEET No. 2 OF 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	
18.0		Soft varved clay zone with alternating bands, as above	4	AY	2	17.5 18.0 18.5		2
19.0		Reddish-brown soft silty clay and clayey silt				19.0 19.5	24	2 2
			5	AY	2	20.0 20.5 21.0 21.5 22.0	24	2 2 3
23.0	Massive silty clay	Reddish-brown soft massive silty clay with sand grains and occasional gravel, silt layers	6	AY	2	22.5 23.0 23.5 24.0 24.5	24	1 2 2
			7	AY	2	25.0 25.5 26.0 26.5 27.0	24	1 2 3
			8	AY	2	27.5 28.0 28.5 29.0 29.5	24	1 2 2
			9	AY	2	30.0 30.5 31.0 31.5 32.0	24	1 2 2
32.5		Numerous silt layers between 32.5' and 34.5'	10	AY	2	32.5 33.0 33.5 34.0 34.5	24	3 4 5

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel
Approach Cut

HOLE No. 501

SITE East of Railway Line

SHEET No. 3 OF 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	
38.5	Varved clay	Medium stiff varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt	11	AY	2	35.0		
						35.5		
						36.0		3
						36.5		5
						37.0	24	5
			12	AY	2	37.5		
						38.0		
						38.5		2
						39.0		4
						39.5	24	4
			13	AY	2	40.0		
						40.5		
47.5	Massive silty clay	Reddish-brown soft massive silty clay with occasional silt layers and pockets				41.0		2
						41.5		2
						42.0	24	3
			14	AY	2	42.5		
						43.0		
						43.5		3
						44.0		4
						44.5	24	4
			15	AY	2	45.0		
						45.5		
						46.0		1
						46.5		2
						47.0	24	2
			16	AY	2	47.5		
						48.0		
						48.5		1
						49.0		2
						49.5	24	3
			17	AY	2	50.0		
						50.5		
						51.0		1
						51.5		1
						52.0	24	3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel Approach Cut

HOLE No. 501

SITE East of Railway Line

SHEET No. 4 OF 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	
			18	AY	2	52.5	24	
						53.0		
						53.5		1
						54.0		2
						54.5		3
			19	AY	2	55.0	24	
						55.5		
						56.0		1
						56.5		1
						57.0		3
			20	AY	2	57.5	24	
						58.0		
						58.5		0
						59.0		2
						59.5		2
			21	AY	2	60.0	24	
						60.5		
						61.0		1
						61.5		2
						62.0		2
			22	AY	2	62.5	24	
						63.0		
						63.5		3
						64.0		4
						64.5		4
65.0	Varved clay	Medium stiff varved clay with alternating layers of reddish-brown and grey clay and containing thin bands of silt.	23	AY	2	65.0	24	
						65.5		
						66.0		3
						66.5		4
						67.0		6
67.5	Clay and silt layers	Transition zone of alternating stiff clay and dense silt bands becoming a sandy silt	24	AY	2	67.5	24	
						68.0		
						68.5		5
						69.0		4
						69.5		5

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 501
Approach Cut
 SITE East of Railway Line SHEET No. 5 OF 6

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	
			25	AY	2	70.0 70.5 71.0 71.5 72.0	20	5 9 22
			26	AY	2	72.5 73.0 73.5 74.0 74.5	19	32 38 24
			27	AY	2	75.0 75.5 76.0 76.5 77.0	15	25 31 34
			28	AY	2	77.5 78.0 78.5 79.0 79.5	22	3 7 10
			29	AY	2	80.0 80.5 81.0 81.5 82.0	6	6 8 7
83.0	Till	Reddish-brown compact granular till	30	AY	2	82.5 83.0 83.5 84.0 84.5	6	15 18 24
98.5		Bedrock						

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority..... JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel..... HOLE No. 501
Approach Cut

SITE East of Railway Line..... SHEET No. 6 OF 6

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
98.5	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite with gypsum and hydrocarbons on bedding surfaces. Gypsum occurs as lenses and inclusions. Top six feet were badly weathered	89
101.5	"		100
102.8	"		100
104.3	"		89
108.5	"		97
110.9	"		100
115.9	"		90
121.3	"	End of hole Water level in hole at El. 567.9 Water loss at depth of 106.0'	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 502
Approach Cut
 SITE Near Yager Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soils Investi- STARTED 8:00 a. M. July 8 19 68
gation FINISHED 5:00 p. M. July 12 19 68

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37.100 N ELEVATIONS: DATUM GSC
 DEPARTURE 8.432 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 579.6
 INITIAL DIP 90° ROCK SURFACE 489.6
 OTHER DIPS BOTTOM OF HOLE 465.3
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff to medium stiff silty clay and clayey silt	1	AY	2	10.0 10.5 11.0 11.5 12.0	18	1 1 5
			2	AY	2	12.5 13.0 13.5 14.0 14.5	18	8 11 11
15.5		Medium stiff varved clay zone consisting of alternating layers of reddish-brown and grey clay	3	AY	2	15.0 15.5 16.0 16.5 17.0	24	3 3 5
17.5		Reddish-brown medium stiff silty clay and clayey silt	4	AY	2	17.5 18.0 18.5		3

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
 Y — Core Box

INSPECTOR R. Montgomery
 LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 502
Approach Cut
 SITE Near Yager Road SHEET No. 2 OF 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	
						19.0		3
						19.5	24	4
			5	AY	2	20.0		
						20.5		
						21.0		4
						21.5		6
						22.0	24	7
			6	AY	2	25.0		
						25.5		
26.0		Medium stiff varved clay zone with alternating bands as above.				26.0		2
						26.5		3
						27.0	24	6
27.0	Massive silty clay	Reddish-brown soft to medium stiff massive silty clay with sand grains and occasional gravel.	7	AY	2	30.0		
						30.5		
						31.0		1
						31.5		2
						32.0	18	4
			8	AY	2	35.0		
						35.5		
						36.0		2
						36.5		4
						37.0	24	4
			9	AY	2	40.0		
						40.5		
						41.0		3
						41.5		4
						42.0	24	6
45.0	Massive silty clay	Reddish-brown medium stiff massive silty clay with sand grains and occasional gravel	10	AY	2	45.0		
						45.5		
						46.0		3
						46.5		4
						47.0	24	5

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel Approach Cut HOLE No. 502
 SITE Near Yager Road SHEET No. 3 OF 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	
60.0	Varved clay	Varved clay with alternating layers of reddish brown and grey clay and containing thin bands of silt.	11	AY	2	50.0		
						50.5		
						51.0		4
						51.5		4
						52.0	24	4
			12	AY	2	55.0		
						55.5		
						56.0		4
						56.5		4
						57.0	24	4
66.0	Clay and silt layers	Transition zone of alternating stiff clay and dense silt bands, becoming a sandy silt	13	AY	2	60.0		
						60.5		
						61.0		3
						61.5		56
						62.0	18	Refusal
			14	AY	2	65.0		
						65.5		
						66.0		5
						66.5		5
						67.0	24	10
75.0	Till	Reddish-brown compact granular till	15	AY	2	70.0		
						70.5		
						71.0		18
						71.5		18
						72.0	20	20
			16	AY	2	75.0		
						75.5		
						76.0		73
						76.5		106
						---	12	Refusal
90.0		Bedrock						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel
 Approach Cut

HOLE No. 502

SITE Near Yager Road

SHEET No. 4 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
90.0	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite with gypsum and hydrocarbons on bedding surfaces. Gypsum occurs as lenses and inclusions. Top eight feet badly broken.	95
95.0	"		
97.0	Gypsum		95
98.0	Dolomite	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum.	
100.0	"	Dolomite as occurring at 90.0 feet	68
104.0	"		
105.5	"		78
108.5	"		69
110.5	"		100
114.3	"	End of hole Water level at El. 566.6'	100

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 503
Approach Cut

SITE East of Railway Line SHEET No. 1 OF 7

CONTRACTOR: Peninsula Soils STARTED M. August 22 1968
Investigation FINISHED M. September 4 1968

METHOD SOIL Modified Wash Boring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37,350 N ELEVATIONS: DATUM GSC
 DEPARTURE 8,432 E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 579.0
 INITIAL DIP 90° ROCK SURFACE 483.3
 OTHER DIPS BOTTOM OF HOLE 433.6
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt.	1	AY	2	2.5		
						3.0		
						3.5		4
						4.0		6
						4.5	18	10
			2	AY	2	5.0		
						5.5		
						6.0		8
						6.5		10
						7.0	13	18
8.0	Stiff to medium varved clay zone consisting of alternating layers of reddish-brown and grey clay.		3	AY	2	7.5		
						8.0		
						8.5		9
						9.0		10
						9.5	24	12
			4	AY	2	10.0		
						10.5		
						11.0		3
						11.5		4
						12.0	24	6

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
 y - Core Box

INSPECTOR D. Cashmore
R. Manuel
 LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
 January 31, 1969

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

D R I L L I N G R E P O R T

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 503
Approach Cut
 SITE East of Railway Line SHEET No. 2 OF 7

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	
12.5		Reddish-brown stiff silty clay and clayey silt.	5	AY	2	12.5		
						13.0		
						13.5		3
						14.0		6
						14.5	23	9
			6	AY	2	15.0		
						15.5		
						16.0		7
						16.5		9
						17.0	16	10
17.5		Medium stiff varved clay zone with alternating bands, as above.	7	AY	2	17.5		
						18.0		
						18.5		3
						19.0		4
						19.5	24	5
20.0	Massive silty clay	Reddish brown medium stiff massive silty clay with sand grains and occasional gravel, also silt layers.	8	AY	2	20.0		
						20.5		
						21.0		2
						21.5		3
						22.0	24	3
			9	AY	2	22.5		
						23.0		
						23.5		3
						24.0		4
						24.5	14	6
			10	AY	2	25.0		
						25.5		
						26.0		2
						26.5		4
						27.0	16	4
			11	AY	2	27.5		
						28.0		
						28.5		2
						29.0		3
						29.5	19	3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 503
 APPROACH CUT
 SITE East of Railway Line SHEET No. 3 OF 7

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	
42.5	Varved clay	Medium stiff to soft varved clay consisting of layers of reddish-brown and grey clay and containing thin bands of silt.	12	AY	2	30.0	18	
						30.5		
						31.0		3
						31.5		3
						32.0		4
			13	AY	2	32.5	19	
						33.0		
						33.5		2
						34.0		3
						34.5		4
			14	AY	2	35.0	18	
						35.5		
						36.0		2
						36.5		3
						37.0		3
			15	AY	2	37.5	18	
						38.0		
						38.5		2
						39.0		2
						39.5		4
			16	AY	2	40.0	20	
						40.5		
						41.0		2
						41.5		3
						42.0		4
			17	AY	2	42.5	20	
						43.0		
						43.5		2
						44.0		3
						44.5		4
			18	AY	2	45.0	15	
						45.5		
						46.0		3
						46.5		5
						47.0		5

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel
Approach Cut

HOLE No. 503

SITE East of Railway Line

SHEET No. 4 OF 7

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	
52.5	Massive silty clay	Reddish-brown soft to medium stiff massive silty clay with occasional silt layers and pockets.	19	AY	2	47.5	24	
						48.0		1
						48.5		2
						49.0		2
						49.5		2
			20	AY	2	50.0	24	
						50.5		
						51.0		1
						51.5		2
						52.0		3
			21	AY	2	52.5	24	
						53.0		
						53.5		1
						54.0		2
						54.5		3
			22	AY	2	55.0	23	
						55.5		
						56.0		1
						56.5		2
						57.0		3
62.5	Varved clay	Medium stiff varved clay with alternating layers of reddish brown and grey clay and containing thin bands of silt.	23	AY	2	57.5	24	
						58.0		
						58.5		1
						59.0		2
						59.5		3
			24	AY	2	60.0	24	
						60.5		
						61.0		2
						61.5		3
						62.0		4
			25	AY	2	62.5	24	
						63.0		
						63.5		1
						64.0		3
						64.5		4

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel Approach Cut HOLE No. 503
 SITE East of Railway Line SHEET No. 5 OF 7

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	
72.5	Clay and silt layers	Transition zone of alternating clay and silt bands, becoming a sandy silt.	26	AY	2	65.0	24	
						65.5		
						66.0		1
						66.5		2
						67.0		4
			27	AY	2	67.5	24	
						68.0		
						68.5		1
						69.0		2
						69.5		2
			28	AY	2	70.0	24	
						70.5		
						71.0		1
						71.5		2
						72.0		2
			29	AY	2	72.5	24	
						73.0		
						73.5		2
						74.0		1
						74.5		4
			30	AY	2	75.0	20	
						75.5		
						76.0		2
						76.5		2
						77.0		4
			31	AY	2	77.5	12	
						78.0		
						78.5		10
						79.0		21
						79.5		24
			32	AY	2	80.0	10	
						80.5		
						81.0		9
						81.5		18
						82.0		25

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR-FCR Welland S/D Bridge Over Welland Tunnel HOLE No. 503
Approach Cut

SITE East of Railway Line SHEET No. 6 OF 7

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	
			33	AY	2	82.5 83.0 83.5 84.0 84.5	8	5 7 7
			34	AY	2	85.0 85.5 86.0 86.5 87.0	18	23 21 18
			35	AY	2	87.5 88.0 88.5 89.0 89.5	2	7 12 14
91.0	Till	Reddish brown compact granular till.	36	AY	2	90.3 90.5 91.0 91.5 92.0	2	23 23 28
93.3	Boulder	Boulder of dolomitic limestone.						
95.2		Bedrock.						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel **HOLE No.** 503
 Approach Cut
SITE East of Railway Line **SHEET No.** 7 OF 7

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
95.2	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces. Gypsum occurs as lenses and inclusions.	94
97.4	"		
99.0	"	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum.	83
102.4	"	Dark-grey dolomite as at 95.2	
106.0	"		98
111.3	"		98
116.7	"		100
122.0	"		75
127.3	"		95
132.5	"		100
137.8	"		100
141.3	Gypsum and Dolomite	3" thick band of dark grey shaly dolomite occurring between thick bands of gypsum.	100
142.8			
143.0	Dolomite	Dolomite with seed-like inclusions of gypsum as at 99.0.	97
145.4		End of hole. Water loss from 107.5' to 126.4'.	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 504
Approach Cut
 SITE East of Railway Line SHEET No. 1 OF 7

CONTRACTOR: Peninsula Soils STARTED 7:00 a.m. September 5 1968
Investigation FINISHED 3:00 p.m. September 12 1968

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
 ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 37.650 N ELEVATIONS: DATUM GSC
 DEPARTURE 8,435 F DRILL PLATFORM
 BEARING 90° GROUND SURFACE 580.7
 INITIAL DIP 90° ROCK SURFACE 482.1
 OTHER DIPS BOTTOM OF HOLE 453.7
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt.	1	AY	2	2.5		
						3.0		
						3.5		2
						4.0		5
						4.5	12	8
			2	AY	2	5.0		
						5.5		
						6.0		8
						6.5		15
						7.0	12	19
8.5	Stiff varved clay zone consisting of alternating layers of reddish-brown and grey clay.		3	AY	2	7.5		
						8.0		
						8.5		10
						9.0		13
						9.5	18	15
10.0	Reddish-brown stiff silty clay and clayey silt.		4	AY	2	10.0		
						10.5		
						11.0		4
						11.5		5
						12.0	24	8

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
 y — Core Box

INSPECTOR R. Manuel
 LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
 January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel
 Approach Cut

HOLE No. 504

SITE East of Railway Line

SHEET No. 2 OF 7

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	
16.0		Medium stiff to soft varved clay zone with alternating bands, as above.	5	AY	2	12.5	18	
						13.0		
						13.5		4
						14.0		6
						14.5		6
			6	AY	2	15.0	24	
						15.5		
						16.0		2
						16.5		2
						17.0		3
			7	AY	2	17.5	24	
						18.0		
22.5	Massive silty clay	Reddish-brown medium stiff massive silty clay with sand grains and occasional gravel, also silt layers. Mottled in top two feet at contact with varved clay.				18.5		1
						19.0		2
						19.5		1
			8	AY	2	20.0	24	
						20.5		
						21.0		1
						21.5		1
						22.0		2
			9	AY	2	22.5	24	
						23.0		
						23.5		1
						24.0		2
						24.5		3
			10	AY	2	25.0	6	
						25.5		
						26.0		3
						26.5		2
						27.0		4
			11	AY	2	27.5	18	
						28.0		
						28.5		2
						29.0		2
						29.5		4

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 504
Approach Cut
 SITE East of Railway Line SHEET No. 3 OF 7

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	
44.0	Varved clay	Medium stiff varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt.	12	AY	2	30.0	18	
						30.5		
						31.0		2
						31.5		4
						32.0		4
			13	AY	2	32.5	18	
						33.0		
						33.5		3
						34.0		3
						34.5		5
			14	AY	2	35.0	18	
						35.5		
						36.0		2
						36.5		3
						37.0		4
			15	AY	2	37.5	18	
						38.0		
						38.5		2
						39.0		2
						39.5		3
			16	AY	2	40.0	24	
						40.5		
						41.0		3
						41.5		4
						42.0		5
			17	AY	2	42.5	18	
						43.0		
						43.5		3
						44.0		4
						44.5		5
			18	AY	2	45.0	24	
						45.5		
						46.0		2
						46.5		2
						47.0		3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 504
Approach Cut
 SITE East of Railway Line SHEET No. 4 OF 7

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	
50.5	Massive silty clay	Reddish-brown medium stiff massive silty clay with occasional silt layers and pockets.	19	AY	2	47.5		
						48.0		
						48.5		1
						49.0		2
						49.5	24	3
			20	AY	2	50.0		
						50.5		
						51.0		2
						51.5		2
						52.0	24	3
			21	AY	2	52.5		
						53.0		
62.5	Varved clay	Medium stiff varved clay with alternating layers of reddish brown and grey clay and containing thin bands of silt.				53.5		1
						54.0		2
						54.5	24	3
			22	AY	2	55.0		
						55.5		
						56.0		2
						56.5		3
						57.0	24	3
			23	AY	2	57.5		
						58.0		
						58.5		2
						59.0		3
						59.5	24	4
			24	AY	2	60.0		
						60.5		
						61.0		1
						61.5		3
						62.0	24	4
			25	AY	2	62.5		
						63.0		
						63.5		1
						64.0		2
						64.5	24	3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel

HOLE No. 504

Approach Cut

SITE East of Railway Line

SHEET No. 5 OF 7

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	
73.0	Clay and silt layers	Transition zone of alternating stiff clay and dense silt bands, becoming a sandy silt.	26	AY	2	65.0	24	
						65.5		
						66.0		1
						66.5		2
						67.0		3
			27	AY	2	67.5	24	
						68.0		
						68.5		1
						69.0		2
						69.5		2
			28	AY	2	70.0	18	
						70.5		
						71.0		1
						71.5		2
						72.0		3
			29	AY	2	72.5	18	
						73.0		
						73.5		2
						74.0		2
						74.5		2
			30	AY	2	75.0	18	
						75.5		
						76.0		14
						76.5		28
						77.0		21
			31	AY	2	77.5	18	
						78.0		
						78.5		7
						79.0		9
						79.5		10
			32	AY	2	80.0	12	
						80.5		
						81.0		9
						81.5		14
						82.0		14

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel **HOLE No.** 504
SITE East of Railway Line **SHEET No.** 6 OF 7

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	
86.0	Till	Reddish brown compact granular till.	33	AY	2	82.5		
						83.0		
						83.5		7
						84.0		7
						84.5	12	7
			34	AY	2	85.0		
						85.5		
						86.0		1
						86.5		1
						87.0	24	5
			35	AY	2	87.5		
						88.0		
98.6	Bedrock					88.5		34
						89.0		39
						89.5	24	60
			36	AY	2	90.0		
						90.5		
						91.0		54
						91.5		56
						92.0	12	75
			37	AY	2	92.5		
						93.0		
						93.5		50
						94.0		63
						94.5	12	75
			38	AY	2	97.0		
						97.5		
						98.0		31
						98.5		55
						98.6	12	50 for 1"

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
PROJECT CNR-PCR Welland S/D Bridge Over Welland Tunnel HOLE No. 504
Approach Cut
SITE East of Railway Line SHEET No. 7 OF 7

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
98.6	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces. Gypsum occurs as lenses and inclusions.	50
100.3	"		
			100
105.3	"		
			97
110.7	"		
			100
115.9	"	End of hole Water level in hole at El. 565.8'	
			94
121.6	"		
			95
127.0	"		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel HOLE No. 601
Approach Cut

SITE West of Yager Road SHEET No. 1 OF 5

CONTRACTOR: Peninsula Soils Investigation STARTED 7:00 a.m. July 29 1968
FINISHED M. August 9 1968

METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX
ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 15.608.623.1 ELEVATIONS: DATUM GSC
DEPARTURE 1.080.030.7 DRILL PLATFORM
BEARING 90° GROUND SURFACE 584.6
INITIAL DIP 90° ROCK SURFACE 508.8
OTHER DIPS BOTTOM OF HOLE 456.4
WATER TABLE

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	Silty clay and clayey silt	Weathered brown medium stiff silty clay and clayey silt	1	AY	2	5.0	20	12	
						5.5			15
						6.0			
						6.5			
			2	AY	2	7.0	24	19	
						10.0		5	
						10.5			
						11.0			
						11.5			
						12.0			
			3	AY	2	15.0	24	13	
						15.5			
						16.0			
						16.5			
						17.0			
20.0	Massive silty clay	Reddish-brown medium stiff to soft massive silty clay with sand	4	AY	2	15.0	10		
						15.5			
						16.0			
						16.5			
						17.0	24	10	
						20.0			
						20.5			
						21.0		10	

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
Y — Core Box

INSPECTOR D. Cashmore

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel
 Approach Cut

HOLE No. 601

SITE West of Yager Road

SHEET No. 2 OF 5

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		
35.0	Varved clay	grains and occasional gravel, also silt layers.	5	AY	2	21.5	18	10	
						22.0		10	
						25.0		11	4
						25.5			
						26.0			
						26.5			
			27.0	6					
			6	AY	2	30.0	24		
						30.5			
						31.0		2	
						31.5		3	
						32.0		4	
		Medium stiff varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt.				7		AY	2
			35.5						
			36.0	2					
			36.5	3					
			37.0	4					
			8	AY	2		40.0		
						40.5			
						41.0	1		
						41.5	3		
						42.0	10		
						Reddish-brown medium dense silt interlayered with a reddish-brown medium stiff silty clay.	9	AY	2
			45.5						
46.0	8								
46.5	4								
47.0	4								
Reddish-brown soft to medium stiff massive silty clay with occasional silt layers and pockets.	10	AY	2	50.0	24				
				50.5					
				51.0			2		
				51.5			2		
				52.0			3		

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel
 Approach Cut

HOLE No. 601

SITE West of Yager Road

SHEET No. 3 OF 5

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	
61.0	Varved clay	Soft to medium stiff varved clay with alternating layers of reddish brown and grey clay and containing thin bands of silt. Varves are widely separated.	11	AY	2	55.0		
						55.5		
						56.0		2
						56.5		3
						57.0	24	5
			12	AY	2	60.0		
						60.5		
						61.0		1
						61.5		2
						62.0	24	4
			13	AY	2	65.0		
						65.5		
						66.0		1
						66.5		2
						67.0	24	4
75.8		Bedrock	14	AY	2	70.0		
						70.5		
						71.0		1
						71.5		2
						72.0	23	3
			15	AY	2	75.0		
						75.5		
						75.8	10	45 blows for 1"

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT CNR Main Line Bridge Over Welland Tunnel **HOLE No.** 601
 Approach Cut
SITE West of Yager Road **SHEET No.** 4 OF 5

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
75.8	Dolomite	Grey-brown very fine grained thinly laminated dolomite with occasional seed-like texture and containing hydrocarbons on the bedding surfaces.	86
77.9	"		
79.5	"		65
83.1	"		74
85.5	"		54
87.3	"		92
90.3	"		100
92.4	"		100
93.8	"		100
97.5	Dolomite and gypsum	Dolomite with bands of gypsum varying in thickness from 4" to more than 12", as well as numerous inclusions.	
106.0	Dolomite	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum.	97
102.6	"		
107.7	"	Dolomite as occurring at 93.8'	97
108.0	"		
113.3	"		90
119.2	"		85
121.4	"		

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority..... JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel..... HOLE No. 601
Approach Cut

SITE West of Yager Road..... SHEET No. 5 OF 5

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
123.0	Dolomite		84
128.2	"	End of Borehole Water loss at 78'-0" Water return at 79'-6" Water return at 86' after casing was driven to this depth	94

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel HOLE No. 602
Approach Cut

SITE West of Yager Road SHEET No. 1 OF 4

CONTRACTOR: Peninsula Soils In- STARTED 10:00 a.m. August 12 1968
vestigations FINISHED 10:00 a.m. August 21 1968

METHOD SOIL Modified Wash Boring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE 15,609,006.2 ELEVATIONS: DATUM GSC
 DEPARTURE 1,080,081.8 DRILL PLATFORM
 BEARING 90° GROUND SURFACE 586.5
 INITIAL DIP 90° ROCK SURFACE 501.8
 OTHER DIPS BOTTOM OF HOLE 476.3
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt.	1	AY	2	5.0		
						5.5		
						6.0		12
						6.5		18
						7.0	20	23
			2	AY	2	10.0		
						10.5		
						11.0		9
						11.5		14
						12.0	24	19
			3	AY	2	15.0		
						15.5		
						16.0		5
						16.5		9
						17.0	24	11
20.0	Massive silty clay	Reddish brown stiff to medium stiff massive silty clay with sand grains and occasional gravel, also silt layers.	4	AY	2	20.0		
						20.5		
						21.0		11
						21.5		17
						22.0	20	19

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
 Y - Core Box

INSPECTOR D. Cashmore

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
 January 31, 1969

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel

HOLE No. 602

SITE Approach Cut
West of Yager Road

SHEET No. 2 OF 4

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	
36.0	Varved clay	Medium stiff varved clay consisting of alternating layers of reddish-brown grey clay and containing thin bands of silt.	5	AY	2	25.0		
						25.5		
						26.0		7
						26.5		7
						27.0	23	8
			6	AY	2	30.0		
						30.5		
						31.0		4
						31.5		5
						32.0	24	6
			7	AY	2	35.0		
						35.5		
						36.0		5
						36.5		5
						37.0	21	7
45.0	Silt and clay	Reddish-brown medium dense silt interlayered with a reddish-brown medium stiff silty clay.	8	AY	2	40.0		
						40.5		
						41.0		1
						41.5		2
						42.0	24	4
			9	AY	2	45.0		
50.0	Massive silty clay	Reddish-brown soft to medium stiff massive silty clay with occasional silt layers and pockets.				45.5		
						46.0		8
						46.5		7
						47.0	12	8
			10	AY	2	50.0		
						50.5		
						51.0		2
						51.5		3
						52.0	24	4
			11	AY	2	55.0		
						55.5		
						56.0		2
						56.5		3
						57.0	24	4

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT CNR Main Line Bridge Over Welland Tunnel HOLE No. 602
 Approach Cut
 SITE West of Yager Road SHEET No. 3 OF 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	
67.0	Varved clay	Soft to medium stiff varved clay with alternating layers of reddish-brown and grey clay containing thin bands of silt	12	AY	2	60.0		
						60.5		
						61.0		3
						61.5		3
						62.0	24	3
			13	AY	2	65.0		
						65.5		
						66.0		3
						66.5		5
						67.0	24	5
			14	AY	2	70.0		
						70.5		
						71.0		2
						71.5		3
						72.0	24	4
84.7	Bedrock		15	AY	2	75.0		
						75.5		
						76.0		
						76.5		3
						77.0	24	4
			16	AZ	2	80.0		
						80.5		
						81.0		6
						81.5		7
						82.0	6	8

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT CNR Main Line Bridge Over Welland Tunnel HOLE No. 602

SITE Approach Cut
West of Yager Road SHEET No. 4 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
84.7	Dolomite	Grey-brown very fine-grained thinly laminated dolomite with occasional seed-like texture, wavy-bedded near contact with shaly dolomite and containing hydrocarbons on the bedding surfaces	93
89.7	Dolomite		
91.5	Dolomite	Dark-grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces, gypsum occurring as lenses and inclusions	
93.5	Dolomite	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum	100
94.7	Dolomite		
97.3	Dolomite	Dolomite as at 91.5'	92
99.9	Dolomite		
105.0	Dolomite		100
106.0	Gypsum and Dolomite	Dolomite band as above, 3" thick, occurring between gypsum bands	
107.3	Gypsum and Dolomite	Dolomite bands of the seed-like variety, about 3" thick, occurring between thicker bands of gypsum	100
110.2	Gypsum and Dolomite	End of Hole	
		Water loss at elevation 91.7'	
		Water return at elevation 92.7'	
		Water return at elevation 93.7'	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 701
Approach Cut

SITE Near Yager Road SHEET No. 1 OF 3

CONTRACTOR: Peninsula Soils STARTED .M. December 9 19 68
Investigations FINISHED .M. December 11 19 68

METHOD SOIL Modified Wash Boring CASING DIAM. NX

OF DRILLING: ROCK Diamond Drilling CORE DIAM. NXL

LOCATION: LATITUDE Offset 373.6S ELEVATIONS: DATUM G.S.C.
DEPARTURE 54+67.3E DRILL PLATFORM
BEARING 90° GROUND SURFACE 586.8
INITIAL DIP 90° ROCK SURFACE 505.8
OTHER DIPS BOTTOM OF HOLE 455.7
 WATER TABLE

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		No samples taken						
25.0	Massive silty clay	Reddish-brown medium stiff to soft massive silty clay with sand grains and occasional gravel, also silt layers	1	AY	2	25.0		
						25.5		
						26.0		3
						26.5		3
						27.0	24	4
30.0			2	AY	2	30.0		
						30.5		
						31.0		2
						31.5		3
						32.0	24	4
40.0	Varved Clay	Stiff varved clay consisting of closely spaced alternating layers of reddish-brown and grey clay and containing bands of silt up to 4" thick.	3	AY	2	40.0		
						40.5		
						41.0		3
						41.5		10
						42.0	21	8

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
Y — core box

INSPECTOR J. Carducci

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel
 Approach Cut

HOLE No. 701

SITE Near Yager Road

SHEET No. 2 OF 3

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	
50.0		Stiff varved clay as above with varves more widely separated.	4	AY	2	50.0 50.5 51.0 51.5 52.0	24	3 10 8
60.0	Clayey silt	Transition zone of dense gravelly clayey silt	5	AY	2	60.0 60.5 61.0 61.5 62.0	24	4 5 7
64.0	Sand and gravel	Dense sand and gravel						
67.0			6	AY	2	67.0 67.5 68.0 68.5 69.0	23	94 56 100
68.5	Till	Very compact greyish gravelly sandy till						
75.0		Reddish-brown compact clayey till	7	AY	2	75.0 75.5 76.0	12	169
77.5			8	DY				
81.0		Bedrock						

H. G. ACRES & COMPANY LIMITED - CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority..... JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel..... HOLE No. 701
Approach Cut

SITE Near Yager Road..... SHEET No. 3 OF 3

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
81.0	Dolomite	Grey-brown very fine-grained wavy-bedded thinly laminated dolomite, possibly a boulder	92
83.0	"		
83.3	"	Dark grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces, possibly a boulder	
84.4	"	Badly weathered and broken grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum and with gypsum on the bedding surfaces	100
88.4	"	Dark-grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces, gypsum occurring as lenses and inclusions	93
93.4	"		
98.4	"		100
98.8	"	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum	100
102.0	"	Dark-grey shaly dolomite as at 88.4	
103.9	"		100
109.3	"		100
113.5	"		100
116.5	"		100
121.9	"		100
127.1	"		98
131.1	"	End of hole	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 702
Approach Cut

SITE Near Yager Road SHEET No. 1 OF 2

CONTRACTOR: Peninsula Soils Investigations STARTED M. December 20 19 68
 FINISHED M. December 30 19 68

METHOD OF DRILLING: SOIL Wash boring CASING DIAM. NX
 ROCK Diamond drilling CORE DIAM. NXL

LOCATION: LATITUDE Offset 373.6N ELEVATIONS: DATUM G.S.C.
 DEPARTURE 55+32.7E DRILL PLATFORM
 BEARING GROUND SURFACE 585.3
 INITIAL DIP 90° ROCK SURFACE 501.0
 OTHER DIPS BOTTOM OF HOLE 475.8
WATER TABLE

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	Silty clay and clayey silt	Silty clay and clayey silt - no samples taken						
75.0	Till	Reddish-brown compact clayey till						
84.3		Bedrock						

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. Carducci

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 702
 Approach Cut
 SITE Near Yager Road SHEET No. 2 OF 2

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
84.3	Dolomite	Grey-brown, very fine-grained wavy-bedded thinly laminated dolomite with gypsum and hydrocarbons on bedding surfaces.	
87.5	"	Dark grey very finely laminated fine grained shaly dolomite with gypsum on bedding surfaces	100
88.5	"	Weathered grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum and with gypsum on the bedding surfaces.	
89.5	"		
92.0	"	Dark-grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces. gypsum occurring as lenses and inclusions	100
92.6	"		100
97.9	"		100
100.0	"		85
105.0			100
109.5		End of hole	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 703
Approach Cut

SITE Near Yager Road SHEET No. 1 OF 6

CONTRACTOR: Peninsula Soils STARTED M. January 2 1969
Investigations FINISHED M. January 10 1969

METHOD OF DRILLING: SOIL Modified Wash boring CASING DIAM. NX
ROCK Diamond drilling CORE DIAM. NXL

LOCATION: LATITUDE Offset 0 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 55+00E DRILL PLATFORM
 BEARING 90° GROUND SURFACE 586.5
 INITIAL DIP 90° ROCK SURFACE 504.5
 OTHER DIPS BOTTOM OF HOLE 480.5
 WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt	1	AY	2	2.5 3.0 3.5 4.0 4.5	19	13 21 28
			2	AY	2	5.0 5.5 6.0 6.5 7.0	10	14 22 27
7.5		Stiff varved clay zone consisting of alternating layers of reddish-brown and grey clay.	3	AY	2	7.5 8.0 8.5 9.0 9.5	22	6 9 13
			4	AY	2	10.0 10.5 11.0 11.5 12.0	24	5 7 10
10.0								

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
 Y — core box

INSPECTOR J. Carducci
 LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
 January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT East Side Highway Bridge over Welland Tunnel
Approach Cut

HOLE No. 703

SITE Near Yager Road

SHEET No. 2 OF 6

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	
13.5		Stiff weathered varved clay zone with alternating bands as above	5	AY	2	12.5 13.0 13.5 14.0 14.5	24	5 5 6
15.0		Reddish-brown stiff silty clay and clayey silt	6	AY	2	15.0 15.5 16.0 16.5 17.0	16	3 4 6
			7	AY	2	17.5 18.0 18.5 19.0 19.5	24	4 7 10
			8	AY	2	20.0 20.5 21.0 21.5 22.0	15	4 6 9
22.5	Massive silty clay	Reddish-brown stiff massive silty clay with sand grains and occasional gravel, also silt layers	9	AY	2	22.5 23.0 23.5 24.0 24.5	15	5 6 7
			10	AY	2	25.0 25.5 26.0 26.5 27.0	15	3 6 7
			11	AY	2	27.5 28.0 28.5 29.0 29.5	17.5	3 5 7

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	East Side Highway Bridge over Welland Tunnel Approach Cut	HOLE No.	703
SITE	Near Yager Road	SHEET No.	3 OF 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	
	Massive silty clay (Cont'd)		12	AY	2	30.0 30.5 31.0 31.5 32.0	23	2 3 4
			13	AY	2	32.5 33.0 33.5 34.0 34.5	24	2 3 4
			14	AY	2	35.0 35.5 36.0 36.5 37.0	24	2 4 5
38.5	Varved clay	Medium stiff to soft varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt	15	AY	2	37.5 38.0 38.5 39.0 39.5	24	2 2 4
		Becoming a clayey silt rather than a silty clay	16	AY	2	40.0 40.5 41.0 41.5 42.0	24	1 3 3
			17	AY	2	42.5 43.0 43.5 44.0 44.5	24	1 1 2
			18	AY	2	45.0 45.5 46.0 46.5 47.0	24	5 5 5

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 703
 SITE Near Yager Road Approach Cut SHEET No. 4 OF 6

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	
50.0	Transi- tion	Distorted reddish-brown and grey silty clay	19	AY	2	47.5	0	
						48.0		
						48.5		3
						49.0		2
						49.5		2
52.5	Massive silty clay	Reddish-brown stiff massive silty clay with occasional silt layers and pockets	20	AY	2	50.0	24	
						50.5		
						51.0		1
						51.5		1
						52.0		4
59.0	Varved clay	Stiff varved clay with alternating layers of reddish-brown and grey clay and silt. Widely spaced couplets.	21	AY	2	52.5	24	
						53.0		
						53.5		2
						54.0		3
						54.5		5
			22	AY	2	55.0	22	
						55.5		
						56.0		2
						56.5		4
						57.0		10
			23	AY	2	57.5	24	
						58.0		
						58.5		4
						59.0		3
						59.5		4
			24	AY	2	60.0	24	
						60.5		
						61.0		2
						61.5		3
						62.0		3
		Closely spaced couplets	25	AY	2	62.5	24	
						63.0		
						63.5		1
						64.0		4
						64.5		3

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

DRILLING REPORT

CLIENT	St. Lawrence Seaway Authority	JOB No.	1684
PROJECT	East Side Highway Bridge over Welland Tunnel Approach Cut	HOLE No.	703
SITE	Near Yager Road	SHEET No.	5 OF 6

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	
		More widely spaced varves	26	AY	2	65.0 65.5 66.0 66.5 67.0	24	1 3 5
			27	AY	2	67.5 68.0 68.5 69.0 69.5	24	1 1 5
70.0	Clay and silt layers	Transition zone of gravelly sandy silty clay becoming more silty with depth	28	AY	2	70.0 70.5 71.0 71.5 72.0	22	3 7 7
73.0	Till	Compact clayey till	29	AY	2	72.5 73.0 73.5 74.0 74.5	16	23 46 72
80.5	Gravel and sand	Coarse gravel and sand						
82.0		Bedrock						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT East Side Highway Bridge over Welland Tunnel HOLE No. 703
 SITE Near Yager Road Approach Cut SHEET No. 6 OF 6

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
82.0	Dolomite	Very broken and weathered shaly dolomite	100
83.2	"	Grey-brown very fine-grained seed-like shaly dolomite, the seeds in the first foot appearing as solution cavities	100
84.4	"		
85.0	"	Dark-grey very finely laminated fine-grained shaly dolomite with gypsum bands and gypsum on bedding surfaces.	100
86.7	"		
88.0	"	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum and with gypsum on the bedding surfaces	100
89.6	"		
91.0	"	Dark-grey very finely laminated fine-grained shaly dolomite with gypsum on bedding surfaces, gypsum occurring as lenses and inclusions	61
95.6	"		90
100.7	"		
102.5	"	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum	86
105.3	"	" " " 91.0	
106.0	"	End of hole	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684

PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 801
Approach Cut

SITE East Canal Bank on East Side of Road SHEET No. 1 OF 8

CONTRACTOR: Peninsula Soils In- STARTED .M. September 13 1968
vestigations FINISHED .M. September 23 1968

METHOD SOIL Modified Wash Boring CASING DIAM. NX
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. NXL

LOCATION: LATITUDE Offset 175S ELEVATIONS: DATUM GSC
 DEPARTURE Station 212 + 91.6 DRILL PLATFORM
 BEARING GROUND SURFACE 582.4'
 INITIAL DIP 90° ROCK SURFACE 473.1'
 OTHER DIPS BOTTOM OF HOLE 422.4'
 WATER TABLE

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	
5.0	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt	1	AY	2	5.0		
						5.5		
						6.0		3
						6.5		4
						7.0	2	6
			2	AY	2	7.5		
						8.0		
						8.5		8
						9.0		11
						9.5	18	14
10.0		Stiff varved clay zone consisting of alternating layers of reddish brown and grey clay	3	AY	2	10.0		
						10.5		
						11.0		5
						11.5		8
						12.0	22	11
12.5		Reddish-brown stiff silty clay and clayey silt	4	AY	2	12.5		
						13.0		
						13.5		4
						14.0		5
						14.5	23	7

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
 Y — Core Box

INSPECTOR R. Manuel

LOGGED BY R. M. Isaacs
A. Mirza

APPROVED

DATE

[Signature]
 January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684

PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 801
Approach Cut

SITE East Canal Bank, on East Side of Road **SHEET No.** 2 OF 8

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	
17.5		Medium stiff weathered varved clay zone with alternating bands, as above	5	AY	2	15.0		
						15.5		
						16.0		2
						16.5		3
						17.0	23	4
20.0		Medium stiff weathered varved clay zone with alternating bands, as above	6	AY	2	17.5		
						18.0		
						18.5		1
						19.0		2
						19.5	24	3
25.5	Massive silty clay	Soft unweathered varved clay zone with alternating bands as above but distorted from 21.5 to 25.5'	7	AY	2	20.0		
						20.5		
						21.0		1
						21.5		1
						22.0	24	2
			8	AY	2	22.5		
						23.0		
						23.5		1
						24.0		1
						24.5	24	2
		Reddish brown soft massive silty clay with sand grains and occasional gravel, also silt layers	9	AY	2	25.0		
						25.5		
						26.0		1
						26.5		1
						27.0	24	2
			10	AY	2	27.5		
						28.0		
						28.5		1
						29.0		1
						29.5	24	2
			11	AY	2	30.0		
						30.5		
						31.0		1
						31.5		1
						32.0	20	2

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 801
Approach Cut
 SITE East Canal Bank, on East Side of Road SHEET No. 3 OF 8

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	
35.0	Clayey silt	Reddish-brown clayey silt with numerous silt pockets	12	AY	2	32.5		
						33.0		
						33.5		1
						34.0		2
						34.5	24	2
38.5	Varved	Medium stiff to soft varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt	13	AY	2	35.0		
						35.5		
						36.0		3
						36.5		3
						37.0	18	5
			14	AY	2	37.5		
						38.0		
						38.5		2
						39.0		2
						39.5	21	3
47.5	Massive silty clay	Reddish-brown soft massive silty clay with occasional silt layers and pockets	15	AY	2	40.0		
						40.5		
						41.0		1
						41.5		1
						42.0	24	2
			16	AY	2	42.5		
						43.0		
						43.5		1
						44.0		2
						44.5	24	2
			17	AY	2	45.0		
						45.5		
						46.0		1
						46.5		2
						47.0	24	2
			18	AY	2	47.5		
						48.0		
						48.5		1
						49.0		1
						49.5	24	2

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

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 801
 Approach Cut
SITE East Canal Bank, on East Side of Road **SHEET No. 4 OF 8**

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	
58.0	Varved clay	Medium stiff varved clay with widely separated alternating layers of reddish-brown and grey clay and containing thin bands of silt	19	AY	2	50.0		
						50.5		
						51.0		1
						51.5		1
						52.0	24	2
			20	AY	2	52.5		
						53.0		
						53.5		1
						54.0		2
						54.5	24	3
			21	AY	2	55.0		
						55.5		
						56.0		1
						56.5		2
						57.0	24	2
			22	AY	2	57.5		
						58.0		
						58.5		1
						59.0		2
						59.5	24	2
			23	AY	2	60.0		
						60.5		
						61.0		1
						61.5		2
						62.0	24	2
			24	AY	2	62.5		
						63.0		
						63.5		1
						64.0		1
						64.5	24	2
65.0	Clay and silt layers	Transition zone of alternating stiff clay and dense silt bands, becoming a sandy silt	25	AY	2	65.0		
						65.5		
						66.0		1
						66.5		2
						67.0	21	3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 801
Approach Cut
SITE East Canal Bank, on East Side of Road **SHEET No. 5 OF 8**

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	
			26	AY	2	67.5 68.0 68.5 69.0 69.5	24	3 2 5
			27	AY	2	70.0 70.5 71.0 71.5 72.0	16	23 35 55
			28	AY	2	72.5 73.0 73.5 74.0 74.5	20	7 6 3
			29	AY	2	75.0 75.5 76.0 76.5 77.0	18	12 14 15
			30	AY	2	77.5 78.0 78.5 79.0 79.5	18	8 18 22
			31	AY	2	80.0 80.5 81.0 81.5 82.0	18	10 25 27
			32	AY	2	82.5 83.0 83.5 84.0 84.5	16	30 31 25

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 801
Approach Cut
 SITE East Canal Bank, on East Side of Road SHEET No. 6 OF 8

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	
97.5	Sand	Reddish-brown fine silty sand	33	AY	2	85.0		
						85.5		
						86.0		17
						86.5		10
						87.0	18	10
			34	AY	2	87.5		
						88.0		
						88.5		10
						89.0		15
						89.5	20	26
			35	AY	2	90.0		
						90.5		
						91.0		6
						91.5		10
						92.0	16	13
			36	AQ	2	92.5		
						93.0		
						93.5		6
						94.0		15
						94.5	12	20
			37	AQ	2	95.0		
						95.5		
						96.0		8
						96.5		10
						97.0	0	7
100.0	Till	Coarse sand and sub-angular gravel till becoming a reddish-brown clayey till with gypsum	38	AQ	2	97.5		
						98.0		
						98.5		10
						99.0		10
						99.5	1	10
			39	AQ	2	100.0		
						100.5		
						101.0		4
						101.5		10
						102.0	20	10

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 801
Approach Cut
 SITE East Canal Bank on East Side of Road SHEET No. 7 OF 8

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	
			40	AQ	2	102.5 103.0 103.5 104.0 104.5	12	20 22 27
			41	AQ	2	105.0 105.5 106.0 106.5 107.0	9	40 20 27
107.5	Till	Grey clayey sandy gravelly till	42	AQ	2	107.5 108.0 108.5 109.0 109.3	6	15 40 60 blows for 3"
109.3		Bedrock						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 801
 Approach Cut
SITE East Canal Bank, on East Side of Road **SHEET No.** 8 OF 8

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
109.3	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite, with gypsum inclusions	87
115.2	Dolomite		95
120.8	Dolomite		82
126.0	Dolomite		100
131.4	Dolomite		89
136.8	Dolomite		100
139.0	Dolomite	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum	100
141.0	Dolomite	Dolomite as at 109.3	
141.3	Dolomite		100
146.7	Dolomite		79
149.5	Dolomite		97
155.0	Dolomite		90
160.0	Dolomite	End of Hole Water level in hole at elevation 568.6'	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 802
Approach Cut
 SITE East Canal Bank on East Side of Road SHEET No. 1 OF 9

CONTRACTOR: Peninsula Soils In- STARTED M. 19.....
vestigations FINISHED M. 19.....
 METHOD SOIL Modified Wash Boring CASING DIAM. NX for 116.2'
 OF BX for 120.0'
 DRILLING: ROCK Diamond Drilling CORE DIAM. BX

LOCATION: LATITUDE Offset 179N ELEVATIONS: DATUM GSC
 DEPARTURE STA. 213+57.2 DRILL PLATFORM
 BEARING GROUND SURFACE 581.0
 INITIAL DIP 90° ROCK SURFACE 461.0
 OTHER DIPS BOTTOM OF HOLE 436.0
..... WATER TABLE

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	Silty clay and clayey silt	Weathered brown stiff silty clay and clayey silt	1	AY	2"	5.0		
						5.5		
						6.0		7
						6.5		13
						7.0	18	21
			2	AY	2"	7.5		
						8.0		
						8.5		8
						9.0		12
						9.5	19	16
10.0	Stiff varved clay zone consisting of alternating layers of reddish brown and grey clay		3	AY	2"	10.0		
						10.5		
						11.0		4
						11.5		6
						12.0	19	8
12.5	Reddish-brown stiff silty clay and clayey silt		4	AY	2"	12.5		
						13.0		
						13.5		4
						14.0		6

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 — PLOFILM BAG
 P — WATER CONTENT TIN Z — DISCARDED
 Q — GLASS JAR Y — core box

INSPECTOR J. P. Carella
 LOGGED BY R. M. Isaacs
A. Mirza

APPROVED *[Signature]*

DATE January 31, 1969

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 802
Approach Cut
 SITE East Canal Bank, on East Side of Road SHEET No. 2 OF 9

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	
						14.5	24	8
			5	AY	2"	15.0		
						15.5		
						16.0		4
						16.5		4
						17.0	24	3
18.5		Medium stiff weathered varved clay zone with alternating bands as above	6	AY	2"	17.5		
						18.0		
						18.5		2
						19.0		2
						19.5	24	3
21.0		Soft unweathered distorted varved clay zone with alternating bands as above	7	AY	2"	20.0		
						20.5		
						21.0		1
						21.5		1
						22.0	24	1
			8	AY	2"	22.5		
						23.0		
						23.5		1
						24.0		1
						24.5	24	2
25.5	Massive silty clay	Reddish-brown stiff massive silty clay with sand grains and occasional gravel, also silt layers	9	AY	2"	25.0		
						25.5		
						26.0		2
						26.5		3
						27.0	24	4
			10	AY	2"	27.5		
						28.0		
						28.5		1
						29.0		2
						29.5	24	3

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 802
 Approach Cut
SITE East Canal Bank on East Side of Road **SHEET No.** 3 OF 9

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	
38.0	Varved Clay	Medium stiff to soft varved clay consisting of alternating layers of reddish-brown and grey clay and containing thin bands of silt	11	AY	2"	30.0		
						30.5		1
						31.0		2
						31.5		4
						32.0	24	
			12	AY	2"	32.5		
						33.0		2
						33.5		3
						34.0		4
						34.5	24	
			13	AY	2"	35.0		
						35.5		2
						36.0		4
						36.5		6
						37.0	24	
			14	AY	2"	37.5		
45.5	Massive silty clay	Varves of clay and silt becoming widely spaced and distorted				38.0		1
						38.5		1
						39.0		2
						39.5	24	
			15	AY	2"	40.0		
						40.5		1
						41.0		2
						41.5		3
						42.0	24	
			16	AY	2"	42.5		
						43.0		1
						43.5		1
						44.0		2
						44.5	24	
			17	AY	2"	45.0		
						45.5		1
						46.0		2
						46.5		4
						47.0	24	

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority

JOB No. 1684

PROJECT County Road 12A Bridge over Welland Tunnel
 Approach Cut

HOLE No. 802

SITE East Canal Bank, on East Side of Road

SHEET No. 4 OF 9

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	
56.5	Varved clay	Stiff to soft varved clay with alternating layers of reddish-brown and grey clay and containing thin bands of silt	18	AY	2"	47.5	24	
						48.0		
						48.5		1
						49.0		2
						49.5		3
			19	AY	2"	50.0	24	
						50.5		
						51.0		0
						51.5		3
						52.0		3
			20	AY	2"	52.5	24	
						53.0		
						53.5		0
						54.0		3
						54.5		3
			21	AY	2"	55.0	24	
						55.5		
						56.0		1
						56.5		3
						57.0		4
			22	AY	2"	57.5	24	
						58.0		
						58.5		0
						59.0		0
						59.5		0
			23	AY	2"	60.0	24	
						60.5		
						61.0		0
						61.5		1
						62.0		3
			24	AY	2"	62.5	22	
						63.0		
						63.5		9
						64.0		11
						64.5		18
64.0	Clay and silt layers	Transition zone of alternating stiff clay and dense silt bands becoming a sandy silt						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 802
Approach Cut
SITE East Canal Bank on East Side of Road **SHEET No.** 5 **OF** 9

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	
			25	AY	2"	65.0 65.5 66.0 66.5 67.0	20	0 5 13
			26	AY	2"	67.5 68.0 68.5 69.0 69.5	15	8 7 18
			27	AY	2"	70.0 70.5 71.0 71.5 72.0	20	27 34 31
			28	AY	2"	72.5 73.0 73.5 74.0 74.5	18	31 32 33
			29	AY	2"	75.0 75.5 76.0 76.5 77.0	15	18 23 44
			30	AY	2"	77.5 78.0 78.5 79.0 79.5	12	18 31 46
			31	AY	2"	80.0 80.5 81.0 81.5 82.0	18	23 28 33

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

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 802
Approach Cut
SITE East Canal Bank, on East Side of Road **SHEET No.** 6 OF 9

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	
83.0	Silty sand	Reddish-brown fine dense silty sand	32	AY	2"	82.5		
						83.0		
						83.5		29
						84.0		39
						84.5	18	42
			33	AY	2"	85.0		
						85.5		
						86.0		45
						86.5		75
						87.0	22	80
			34	AY	2"	87.5		
						88.0		
						88.5		48
						89.0		42
						89.5	15	44
			35	AY	2"	90.0		
						90.5		
						91.0		34
						91.5		50
						92.0	8	100
95.0	Sandy silt	Reddish-brown sandy silt	36	AY	2"	92.5		
						93.0		
						93.5		28
						94.0		66
						94.3	0	100
								blows for 3"
			37	AQ	2"	95.0		
						95.5		
						96.0		43
						96.5		54
						97.0	15	80

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 802
SITE East Canal Bank, on East Side of Road **SHEET No.** 1 OF 9

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	
97.5	Silty sand	Reddish-brown dense fine silty sand	38	AQ	2"	97.5		
						98.0		
						98.5		75
						98.8	15	100
								for 3"
			39	AQ	2"	100.0		
						100.5		
						101.0		28
						101.5		39
						102.0	16	54
			40	AQ	2"	102.5		
						103.0		
						103.5	7	130 refusal
105.0	Reddish-brown dense medium sand		41	AQ	2"	105.0		
						105.5		
						106.0		
						106.5		Blow count not taken
						107.0	8	
			42	AQ	2"	107.5		
						108.0		
						108.5		2
110.0	Dark brown dense medium to fine silty sand					109.0		4
						109.5	0	10
			43	AQ	2"	110.0		
						110.5		
111.0	Grey dense medium to coarse sand					111.0		35
						111.5		70
						112.0	24	75

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority **JOB No.** 1684
PROJECT County Road 12A Bridge over Welland Tunnel **HOLE No.** 802
 Approach Cut
SITE East Canal Bank on East Side of Road **SHEET No.** 8 OF 9

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	
112.5	Till	Reddish-brown compact silty sand and coarse gravel till	44	AQ	2"	112.5 113.0 113.5 114.0	10	28 100 refusal
			45	AQ	2"	115.0 115.5 116.0 116.2	14	75 65 blows for 2"
			46	DQ	2"	117.0 117.5		
			47	AQ	2"	117.5 118.0 118.5 118.6		
118.6	Gravel	Sub-rounded to rounded coarse gravel					0	50 60 blows for 1"
120.0		Bedrock						

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

DRILLING REPORT

CLIENT St. Lawrence Seaway Authority JOB No. 1684
 PROJECT County Road 12A Bridge over Welland Tunnel HOLE No. 802
 Approach Cut
 SITE East Canal Bank, on East Side of Road SHEET No. 9 OF 9

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
120.0	Dolomite	Dark grey very finely laminated fine-grained shaly dolomite, with gypsum inclusions	
124.0	Gypsum		78
125.2	Dolomite	Dolomite as above	
126.0	Dolomite		100
131.0	Dolomite		
132.8	Dolomite	Grey-brown fine-grained horizontally bedded dolomite with seed-like inclusions of gypsum	87
136.0	Dolomite		
137.0	Dolomite	Dolomite as at 120.0'	100
140.0	Dolomite		100
145.0	Dolomite	End of hole.	
		BX core badly broken and recovery difficult to assess.	

**SUMMARIES OF
LABORATORY TESTS**

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε _f %	α °	i°	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
101	6.5	BO-354B	41.4	112.1				15	2078	11.5		0	0.5	
	12.5	BO-356B	31.1	123.2	61.0	28.4	32.6	15	2725	4.5	40	0	0.5	
	15.5	BO-357B	33.1	120.8	51.5	33.9	17.6	15	2850	5.5	60	0	0.5	
	18.5	BO-358B	31.5	122.8	40.4	21.4	19.0	15	1251	10.0		0	0.5	
	21.5	BO-359B	35.9	118.7	42.8	22.2	20.6	15	1209	3.7	60	0	0.5	
	23.5	CO-360B	32.2	120.8	38.5	23.2	15.3	15	796	8.7		0	0.5	
	48.5	CO-370B	33.6	120.0	41.4	22.0	19.4	15	1133	4.0		0	0.5	
104	11.5	BO-256B	30.3	122.8	45.4	25.5	19.9	30	1813	6.0	55	0	1.0	
	31.0	BO-263B	26.0	126.8	31.4	17.6	13.8	30	1093	2.7	50	0	1.0	
	38.7	BO-267A	27.3	124.9	35.8	18.6	17.2	30	1243	5.2		0	1.0	
	43.5	BO-269B	26.2	126.0	34.4	19.2	15.2	30	1445	6.2		0	1.0	
	48.3	CO-271D	37.2	116.0	38.5	20.1	18.4	30	538	9.0		0	1.0	
	53.7	CO-273C	33.0	120.0	44.1	23.4	20.7	30	644	14.5		0	1.0	
	68.7	CO-279C	34.0	117.0	39.7	20.2	19.5	30	715	10.5	10	0	1.0	Silt seam at 10°
105	11.8	BO-184A	24.8	131.1	42.8	20.6	22.2	30	5240	9.5	60	0	1.0	
	19.0	BO-187B	39.4	115.1	49.3	25.5	23.8	30	1530	2.2	70	0	1.0	
	20.8	BO-188D	43.5	111.1	57.4	25.6	31.8	30	1028	9.0	45	0	1.0	
	23.7	BO-189C	28.4	124.1	37.6	18.7	18.9	30	1320	4.5		0	1.0	
	26.5	BO-190B	28.7	126.0	38.0	20.6	17.4	30	835	19.5		0	1.0	
	31.2	BO-192C	27.5	124.9	36.4	18.5	17.9	30	966	19.0	40	0	1.0	
	34.0	CO-209B	28.3	125.1	37.6	19.8	17.8	30	1023	12.5		0	1.0	
	36.0	CO-210C	28.0	122.5	37.1	18.1	19.0	30	869	13.0		0	1.0	
	39.2	CO-211B	30.2	119.6	39.3	21.1	18.2	30	1055	12.0		0	1.0	
	41.5	BO-212B	25.6	125.8	38.7	20.8	17.9	30	1151	13.5	70	0	1.0	
	44.0	CO-213B	25.0	128.4	32.4	17.7	14.7	30	1213	11.0	60	0	1.0	
	46.2	BO-214C	34.5	120.0	39.9	19.5	20.4	30	467	16.5		0	1.0	Angled Layers (45°)

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε _f %	α °	i°	ċ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
105 Cont'd	54.0	CO-217B	31.6	125.7	43.6	23.3	20.3	30	1211	8.0		0	1.0	Silt Pocket
	56.8	BO-218A	32.6	120.1	41.2	20.9	20.3	30	1598	3.0		0	1.0	
	66.2	CO-219C	42.1	118.1	55.0	27.6	27.4	30	668	14.5	30	0	1.0	
	69.0	BO-220B	34.6	117.5	41.5	22.2	19.3	30	735	7.0	20	0	1.0	
	74.6	BO-222A	25.6	125.1	24.6	15.3	9.3	30	990	4.0		0	1.0	
106	5.8	BO-2A	20.8	132.0	48.0	21.4	26.6	30	12550	1.7	60	0	1.0	Failure along silt zone
	23.0	BO-9C	22.9	132.0	37.0	20.3	16.6	30	2130	19.0	50	0	1.0	
	27.2	BO-11C	23.0	129.5	33.4	17.9	15.5	30	1515	15.5		0	1.0	
	33.2	BO-13C	22.6	128.0	33.3	17.9	15.4	30	1285	18.5		0	1.0	
	34.8	BO-14D	38.1	128.9	34.4	16.0	18.3	30	1410	20.0		0	1.0	
	37.5	BO-15B	24.7	126.6	36.2	19.8	16.4	30	2380	3.5	60	0	1.0	
	48.2	BO-19C	38.5	114.8	53.2	24.5	28.7	30	803	14.0	70	0	1.0	
	53.3	BO-21D	33.5	120.0	46.4	28.7	17.7	30	598	14.0	45	0	1.0	
	56.5	BO-23B	33.2	116.0	43.2	23.1	20.1	30	603	3.0	60	0	1.0	
	61.2	BO-25C	30.5	121.2	38.5	25.5	13.0	30	1535	5.0		0	1.0	
107	66.2	BO-27C	31.3	121.0	41.9	21.7	20.2	30	1150	6.0		0	1.0	
	13.0	BO-63B	35.4	114.8	63.6	25.6	38.0	30	1720	7.0	60	0	1.0	
	16.3	BO-64A	30.6	119.8	51.2	26.5	24.7	30	1940	4.5	60	0	1.0	
	19.0	BO-65B	24.3	129.0	39.7	18.0	21.7	30	3520	10.5	75	0	1.0	
	26.2	BO-68C	24.4	128.9	36.0	19.3	16.7	30	771	11.0		0	1.0	
	29.5	BO-69B		125.0	35.6	17.1	18.5	30	765	15.5	45	0	1.0	
	31.5	BO-70B	27.9	125.2	35.2	19.2	15.9	30	1040	4.5		0	1.0	
	34.2	BO-71C	24.9	126.0	30.3	16.6	13.7	30	643	8.0		0	1.0	
	36.5	BO-72B	42.5	112.0	55.2	30.0	25.2	30	995	7.0	45	0	1.0	
	36.5	BO-72B	46.7	109.2	62.0	26.7	35.3	30	648	8.0		0	1.0	
	39.5	BO-73B	46.1	111.0	54.8	23.6	31.2	30	704	6.5	45	0	1.0	
	40.5	BO-74E	36.3	113.9	43.8	21.0	22.8	30	472	10.5	50	0	1.0	
	44.2	BO-75C	32.0	120.8	40.5	19.7	20.8	30	740	5.5	50	0	1.0	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε f %	α °	i °	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
107 Cont'd	49.5	BO-77B	30.7	120.0				30	915	11.0		0	1.0	
	51.5	BO-78B	29.6	122.2	40.0	18.1	21.9	30	1046	3.5	50	0	1.0	
	53.5	BO-79E	31.0	121.9				30	499	12.0		0	1.0	
	56.5	BO-80B	29.1	122.2	34.9	24.6	10.3	30	985	10.4	45	0	1.0	
	58.8	BO-81D	35.6	117.4	42.7	22.6	20.1	30	709	14.0	55	0	1.0	
	61.5	BO-82B	34.0	115.8	42.6	22.2	20.4	30	659	16.0	60	0	1.0	
	64.0	BO-83B	36.3	118.2	48.7	21.7	27.0	30	914	14.0	45	0	1.0	
	69.5	BO-85B	38.3	115.0	44.1	25.4	18.7	30	748	11.0		0	1.0	
	71.8	BO-86A	43.3	113.0	50.4	23.9	26.5	30	693	12.5		0	1.0	
	71.9	BO-86C	21.0	129.6	32.4	16.8	15.6	30	3190	9.0		0	1.0	
	74.2	BO-87C	45.2	108.9	61.5	29.1	32.4	30	794	8.0	45	0	1.0	
		BO-87C	46.3	110.0				30	819	10.5	50	0	1.0	
	76.5	BO-88B	35.8	117.0	43.9	21.7	22.2	30	1090	7.0	55	0	1.0	
	79.2	BO-89C	40.3	115.2	49.8	22.9	26.9	30	835	11.0	55	0	1.0	
	80.5	BO-90E	24.5	129.0	30.6	16.4	14.2	30	950	13.5		0	1.0	
	85.8	BO-92D	31.7	118.9	39.5	22.9	16.6	30	564	9.0		0	1.0	
108	2.9	BO-38A	22.7	129.6	57.6	24.6	33.0	30	6170	2.5	45	0	1.0	
	8.3	BO-40A	19.8	132.0	36.4	17.6	18.8	30	7920	4.3		0	1.0	
	10.8	BO-41D	38.3	116.2	53.6	32.6	21.0	30	1058	19.0	45	0	1.0	
	14.0	BO-42A	27.9	120.5	36.7	18.3	18.4	30	1541	3.5	50	0	1.0	
	18.7	BO-44C	28.1	128.0	39.0	18.4	20.6	30	1325	10.5	70	0	1.0	
	20.2	BO-45C	25.8	129.0	34.5	18.4	16.1	30	1129	19.5		0	1.0	
	25.6	BO-47E	29.4	122.6	33.3	17.9	15.4	30	1031	12.3		0	1.0	
	28.8	BO-48B	28.2	122.5	36.0	18.1	17.9	30	1008	6.7		0	1.0	
	30.7	BO-49C	25.1	129.0	33.6	18.0	15.6	30	830	19.0		0	1.0	
	33.3	BO-50C	25.9	124.0				30	855	17.5		0	1.0	
	36.2	BO-51B	26.8	123.0	33.5	16.3	17.2	30	1210	5.5		0	1.0	
	37.5	BO-52C	22.5	130.1	26.8	15.3	11.5	30	1151	13.0		0	1.0	
	41.2	BO-53B	30.8	118.1	37.1	19.0	18.1	30	1055	6.0	40	0	1.0	Silt Seams
	46.8	BO-55A	34.5	117.2	45.8	21.2	24.6	30	871	11.7	40	0	1.0	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_3 PSI	S_u PSF	e_f %	α °	i°	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
108 Cont'd	48.7	BO-56B	25.3	124.5	35.8	17.3	18.3	30	930	12.5		0	1.0	Silt Pockets
	50.3	BO-57C	44.6	111.0	57.6	29.1	28.5	30	669	11.0		0	1.0	
	53.9	BO-58A	42.2	112.1	53.3	22.5	30.8	30	1046	4.0		0	1.0	
	55.6	BO-59D	40.5	113.2	52.5	23.8	28.7	30	455	10.5	45	0	1.0	
	58.7	BO-60B	31.4	115.1				30	520	18.7		0	1.0	
	61.3	BO-61B	30.7	120.0	43.7	20.7	23.0	30	478	7.5	55	0	1.0	
109	45.5	BO-114E	36.8	116.8				30	915	10		0	1.0	
	46.8	BO-114A	33.2	120.6	40.7	19.9	20.8	30	1117	5	58	0	1.0	
	50.8	BO-116D	22.5	133.5				30	1246	17		0	1.0	
	54.0	BO-117B	47.4	108.5	61.0	25.9	35.1	30	982	8.5		0	1.0	
	56.5	BO-118B	38.2	115.6	45.9	20.6	25.3	30	931	10.0		0	1.0	
	56.2	BO-118C	43.8	112.2				30	769	11.0		0	1.0	
	59.0	BO-119B	30.7	120.1	32.6	19.2	13.4	30	861	6.5	30	0	1.0	
110	49.5	CO-154B	43.5	112.1	56.3	29.6	26.7	30	806	5.25		0	1.0	
111	2.0	BO-143B	22.8	128.5	54.2	28.3	25.9	30	4280	13.0	50	0	1.0	Silt Seam
	1.8	BO-143C	33.7	120.0	41.5	18.1	23.4	30	1070	2.2	45	0	1.0	
	16.2	BO-149C	40.8	113.0	54.6	26.7	27.9	30	765	6.0	25	0	1.0	
	28.8	BO-159C	25.0	125.2	33.1	18.1	15.0	30	746	12.0		0	1.0	
	30.8	BO-160D	23.0	129.8	34.3	17.4	16.9	30	1341	20.0		0	1.0	
	36.2	BO-162C	23.7	127.8	33.7	17.5	16.2	30	1285	19.5		0	1.0	
	43.8	BO-164C	25.0	127.9	32.1	17.3	14.8	30	857	20.0		0	1.0	
	50.8	BO-167D	23.3	129.0	33.0	17.7	15.3	30	1001	20.0		0	1.0	
	55.5	BO-169E	23.3	123.6	30.3	18.6	11.7	30	683	20.0	10	0	1.0	
	58.3	BO-170D	31.4	118.2	46.2	23.4	22.8	30	861	19.0	30	0	1.0	
											45			

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε _f %	α °	i°	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
111 Cont'd	68.7	BO-174C	47.8	110.0	61.6	26.4	35.2	30	970	11.0		0	1.0	
	70.5	BO-175E	38.8	112.2	55.1	27.1	28.0	30	958	6.5	70	0	1.0	
	74.0	BO-176B	38.0	117.2	46.5	24.8	21.7	30	796	11.5		0	1.0	
	78.3	BO-178D	40.6	110.0	55.2	26.4	28.8	30	808	12.5	45	0	1.0	
112	65.2	BO-194C	30.92	121.7				30	1243	5.0		0	1.0	
114	3.5	BO-196A	28.9	123.2	50.0	22.3	27.7	30	2765	7.0	50	0	1.0	
	13.5	BO-197A	18.1	135.2	38.0	21.4	16.6	30	5310	8.7	70	0	1.0	
	15.3	BO-198A	25.5	125.2	43.1	23.2	19.9	30	2875	5.0	50	0	1.0	
	17.0	BO-199B	25.4	128.0	38.8	19.5	19.3	30	2875	20.0	55	0	1.0	
	18.0	BO-200B	22.7	128.2				30	2865	12.0	60	0	1.0	
	20.3	BO-201A	22.4	131.2	33.6	19.5	14.1	30	2155	17.0		0	1.0	
	22.3	BO-202A	20.8	131.9	34.6	17.7	16.9	30	1943	17.0		0	1.0	
	24.3	BO-203A	23.8	127.9	38.1	19.6	18.5	30	2098	17.0	40	0	1.0	
	26.3	BO-204A	20.8	132.0	32.9	19.2	13.7	30	1809	20.0		0	1.0	
	28.3	BO-205A	21.8	132.7	32.5	17.8	14.7	30	1475	20.0		0	1.0	
	30.3	BO-206A	25.7	127.9	32.2	19.2	13.0	30	1820	18.5	55	0	1.0	
	32.0	BO-207B	22.8	129.9	29.0	17.0	12.0	30	1140	20.0		0	1.0	
	36.3	BO-224A	48.8	109.1	60.6	27.0	33.6	30	980	7.7	50	0	1.0	
	38.5	BO-225A	32.6	119.8	37.0	22.4	14.6	30	1000	5.5		0	1.0	
	40.3	BO-226A	30.9	117.0	38.2	18.7	19.5	30	1290	4.5	60	0	1.0	
	42.7	BO-227A	32.1	120.0	40.2	19.9	20.3	30	1200	2.7		0	1.0	
	44.7	BO-228A	32.0	120.4	39.0	21.3	17.7	30	1160	4.5	60	0	1.0	
	46.7	BO-229A	31.5	120.7	39.2	19.8	19.4	30	1110	3.0		0	1.0	
	48.7	BO-230A	31.8	121.6	36.0	18.4	17.6	30	1339	2.5	60	0	1.0	
	50.7	BO-231A	27.9	122.4	32.6	17.6	15.0	30	1065	1.7	60	0	1.0	
	52.7	BO-232B	22.5	128.0	26.1	16.5	9.6	30	835	16.5		0	1.0	
	54.7	BO-233A	32.6	120.8				30	1245	2.2	60	0	1.0	
	56.7	BO-234A	35.1	117.8	42.6	20.1	22.5	30	849	8.0		0	1.0	
	58.7	BO-235A	35.2	118.8	40.5	19.6	20.9	30	915	10.0		0	1.0	Slanted Layers (20°)

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_3 PSI	S_u PSF	e_f %	α °	i °	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
114	60.7	BO-236B	34.3	118.0				30	971	1.0	60	0	1.0	
Cont'd	62.3	CO-237A	35.7	115.8	42.7	20.3	22.4	30	1115	2.7	60	0	1.0	
	65.8	CO-239A	35.2	118.0	43.4	20.9	22.5	30	1290	3.0		0	1.0	
	67.3	CO-240A	41.9	113.5	48.2	24.2	24.0	30	811	9.5		0	1.0	
	66.5	CO-240E	40.0	113.3	50.4	24.5	25.9	30	580	11.0	40	0	1.0	
	68.8	CO-241A	48.5	110.2	60.0	25.8	34.2	30	1150	3.2		0	1.0	
	70.5	CO-242B	43.5	112.9	50.0	22.5	27.5	30	668	11.0		0	1.0	
	72.5	CO-243A	35.1	115.0	43.9	19.7	24.2	30	1060	1.2	50	0	1.0	
	74.8	CO-244A	26.4	123.2	32.8	16.7	16.1	30	875	6.2		0	1.0	
	76.7	CO-245A	42.7	112.9	52.4	23.5	28.9	30	689	10.0		0	1.0	
	78.3	CO-246A	33.4	117.9	40.7	18.8	21.9	30	1098	4.7		0	1.0	
	82.3	CO-247C	30.7	119.1	32.7	17.9	14.8	30	1031	3.7		0	1.0	
131	33.5	BO-425B	44.0	114.2	48.5	22.5	26.0	30	558	2.2	50	0	1.0	
	38.3	BO-427	35.6	118.9	40.9	20.9	20.0	30	889	2.5	60	0	1.0	
	43.5	BO-429B	43.4	112.2	48.4	25.1	23.3	30	761	6.5		0	1.0	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	S _u PSF	ε _f %	α °	i °	ė % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
137	43.4	CO-546B	31.2	121.4	38.9	17.4	21.5	30	951	7.5	65	0	1.0	
	47.0	CO-547C	30.6	121.1	38.5	18.9	19.6	30	1126	5.0	52	0	1.0	
	51.0	CO-548C	28.5	123.9	34.0	17.8	16.2	30	1148	6	40	0	1.0	
	62.1	CO-550E	36.6	117.1	47.4	17.8	29.6	30	695	4.5	50	0	1.0	
138	52.9	CO-557H	30.2	123.8	38.8	20.2	18.6	10	940	9.5		0	0.5	
	55.4	CO-557B	27.9	124.8				10	828	9.5	50/60	0	0.5	
	64.5	CO-558I	35.2	118.2				10	680	16		0	0.5	
	64.9	CO-558H	35.4	116.5	42.6	19.8	22.8	10	614	7	45	45	0.5	
	65.3	CO-558G	34.3	117.4	47.3	21.7	25.6	10	696	7	60	90	0.5	
	67.0	CO-558C	35.2	116.6				10	970	2.2	50	90	0.5	
	67.4	CO-558B	35.1	118.2				10	941	1.5	50	0	0.5	
	67.8	CO-558A	44.9	111.3				10	1295	1	60	45	0.5	
	68.5	CO-559I	44.5	113.2				10	588	11.5		0	0.5	
	71.4	CO-559B	42.6	114.2				10	715	9.0		0	0.5	
	72.9	CO-560H	39.9	112.2				10	710	9.0	60	0	0.5	
	75.0	CO-560C	35.9	118.8				10	935	4.5	70	90	0.5	
	75.4	CO-560B	39.1	114.9				10	699	2.2	60	45	0.5	
	75.8	CO-560A	38.0	115.9				10	855	6.5	55	0	0.5	
139	48.8	CO-574A	35.1	118.7	46.8	19.5	27.3	30	869	4.0	54	0	1.0	
	48.8	CO-574A	34.6	119.2				0	844	2.2	57	0	1.0	
	52.0	CO-575C	32.2	120.0	36.2	18.9	17.3	10	869	4.5		0	0.5	
	60.0	CO-577C	22.9	130.0	27.1	16.8	10.3	10	1010	6.0		0	0.5	
	72.0	CO-584C	39.0	115.8	47.8	21.6	26.2	10	771	14.0		0	0.5	
	76.0	CO-585C	41.4	112.0	46.5	23.5	23.0	10	957	6.5	66	0	0.5	
	84.8	CO-587A	30.8	122.1	29.9	16.8	13.1	10	656	10.0		0	0.5	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	S _u PSF	ε _f %	α °	i°	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
141	27.1	CO-592E	28.3	123.3				10	951	7.0		0	0.5	
	36.4	CO-594B	27.5	125.0				10	961	8.5		0	0.5	
	40.4	CO-595B	32.0	119.0	35.0	18.5	16.5	10	497	15.0		0	0.5	
	52.5	CO-597D	47.3	111.2	52.3	38.6	13.7	10	695	9.0		0	0.5	
	57.8	CO-598A	46.2	111.2	56.0	23.4	32.6	10	746	7.0		0	0.5	
141A	49.8	CO-600A	27.9	123.6	34.5	16.8	17.7	10	851	5.0	60	0	0.5	
142	31.8	CO-603A	25.6	127.8	33.4	18.3	15.1	10	1288	8.5		0	0.5	
	35.0	CO-604C	25.8	126.4	32.3	16.1	16.2	10	1138	5.5		0	0.5	
	38.5	CO-605D	26.3	127.0	30.7	16.3	14.4	10	1011	8.0		0	0.5	
	43.0	CO-606C	27.0	125.9	33.5	17.6	15.9	10	1071	6.0		0	0.5	
	47.0	CO-607C	26.4	125.8	32.4	18.7	13.7	10	1070	4.5		0	0.5	
	51.4	CO-608B	29.6	123.0				10	677	6.0		0	0.5	
	55.0	CO-609C	39.4	115.0	50.9	21.4	29.5	10	801	12.0	60	0	0.5	
	55.4	CO-609B	42.3	112.4				10	955	8.0		45	0.5	
	55.8	CO-609A	43.3	112.0				10	581	1.0	50	90	0.5	
	59.8	CO-610A	34.8	118.0	50.6	21.2	29.4	10	931	10.0		0	0.5	
	63.0	CO-611C	32.8	119.2	41.8	20.3	21.5	10	884	9.5	60	0	0.5	
	63.4	CO-611B	32.0	120.2				10	869	4.5	52	45	0.5	
	63.8	CO-611A	32.2	119.8				10	840	4.0	55	90	0.5	
	67.8	CO-612A	43.6	111.0	54.2	23.4	30.8	10	786	7.5	50	0	0.5	
	66.1	CO-613E	49.5	109.9	64.7	26.4	38.3	10	955	9.5	52	0	0.5	
	75.4	CO-614B	42.7	115.6	56.3	23.7	32.5	10	704	12.5		0	0.5	
	75.8	CO-614A	46.2	110.8				10	920	7.5		0	0.5	
	79.0	CO-615C	35.8	117.2	43.8	20.3	23.5	10	825	4.0		0	0.5	
	79.8	CO-615A	42.5	115.0				10	880	10.5		0	0.5	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε _f %	α °	i°	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
145	27.8	BO-617A	33.60	118.6				10	1280	8.0	45	0	0.5	
	35.8	BO-619A	22.70	129.2	31.20	16.50	14.70	10	1375	17.5		0	0.5	
	43.8	BO-621A	32.8	118.0	42.00	19.71	22.29	10	937	8.5	50	0	0.5	
	47.8	BO-622A	39.4	118.8				10	790	8.0	60	0	0.5	
	51.4	BO-623B	28.2	122.1	32.60	16.45	16.15	10	730	8.0		0	0.5	
	54.0	BO-624	36.3	120.2	34.30	18.65	15.65	10	926	2.3	50	0	0.5	
	59.8	BO-625A	33.0	120.9	41.3	17.3	24.0	10	999	8.5		0	0.5	
	57.7	BO-625F	32.9	124.0	41.6	17.4	24.2	10	971	14.0		0	0.5	
	63.8	BO-626A	42.9	114.2	54.90	22.75	32.15	10	980	8.5		0	0.5	
	71.4	BO-628B	26.2	129.9				10	498	12.0		0	0.5	Silty Material
173	17.9	CO-665D	46.9	110.2	56.1	26.7	29.4	10	697	3.0	46	0	0.5	
	22.9	CO-666C	30.2	122.8	36.4	18.0	18.4	10	905	7.0		0	0.5	
	27.9	CO-667C	29.1	124.0				10	1040	10.0		0	0.5	
	31.3	CO-668H	47.0	110.1				10	715	13.5		0	0.5	
	31.7	CO-668G	48.8	109.2	58.8	26.9	31.9	10	505	9.5	50	45	0.5	Failure Across Rd. Brn. and Grey
	32.1	CO-668F	50.0	108.9				10	830	4.5	55	90	0.5	
	32.5	CO-668E	48.1	108.2				10	575	4.5	45	45	0.5	Failure Follows Layering
	32.9	CO-668D		114.4				10	839	1.5	60	90	0.5	
	33.4	CO-668C	42.1	113.3	51.9	32.2	19.7	10	679	3.5	60	0	0.5	
	37.1	CO-669F	30.9	121.0				20	549	14.0	45	45	0.5	Failure in Grey & G/Brn.
	37.5	CO-669E	33.6	122.0	35.6	17.0	18.6	10	615	11.0		0	0.5	
	41.7	CO-670G	37.7	116.1				10	545	12.0	55	45	0.5	
	42.1	CO-670F	39.2	115.0				10	704	3.0	45	45	0.5	
	42.5	CO-670E	38.8	116.2	46.1	21.9	24.2	10	907	4.0	59	0	0.5	
	42.9	CO-670D	39.1	115.1	48.3	23.8	24.5	10	905	2.0		90	0.5	
	43.4	CO-670C	38.4	115.8				10	895	4.0	60	0	0.5	
	43.8	CO-670B	39.0	115.9				10	884	2.5		90	0.5	
	47.5	CO-671E	46.0	112.0				10	827	4.5	50	90	0.5	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	ε _f %	α °	φ °	ē % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
173	47.9	CO-671D	45.1	111.9	53.4	26.4	27.0	10	854	5.5		0	0.5	Failure in Red Brn.
Cont'd	48.4	CO-671C	42.8	113.0				10	644	1.0	50	45	0.5	
	51.1	CO-672E	48.4	109.0				10	884	8.0		0	0.5	
	51.5	CO-672D	44.1	112.2	52.0	24.5	27.5	10	640	5.5	60	45	0.5	
	52.0	CO-672C	44.0	112.2				10	837	2.8	60	90	0.5	
174	13.7	CO-674B	20.1	130.9	22.8	15.1	7.7	10	860	9.0		0	0.5	Failure in Brown Clay
	23.3	CO-676C	20.1	132.8				10	1450	7.0		0	0.5	
	27.8	CO-677D	30.1	121.8				10	1028	2.2	55	45	0.5	
	28.2	CO-677C	33.8	118.8	40.0	21.4	18.6	10	1250	1.7	45	0	0.5	
	28.6	CO-677B	29.1	121.0				10	970	4.0		90	0.5	
	31.6	CO-678G	35.7	116.1	45.6	23.2	22.4	10	890	10.0	50	0	0.5	
	32.8	CO-678D	35.7	118.8	46.2	22.1	24.1	20	941	8.0	45	45	0.5	
	37.8	CO-675D	30.5	123.8	38.0	21.2	16.8	20	1369	2.0	50	45	0.5	
	38.3	CO-675C	29.0	123.2	37.2	22.1	15.1	10	1350	1.7	60	0	0.5	
	42.0	CO-680F	37.9	118.1				25	746	8.5	50	0	0.5	
	42.8	CO-680D	30.9	119.9	47.3	22.5	24.8	25	791	6.0	45	45	0.5	
											55			
	43.3	CO-680C	23.3	131.0				10	284	10.0		90	0.5	
	43.7	CO-680B	25.6	127.9	25.9	23.8	2.1	10	681	7.5		0	0.5	
	44.1	CO-680A	29.2	122.0				10	442	9.0	50	45	0.5	
175	7.4	BO-682B	26.6	124.0				10	1550	14.0	60	0	0.5	Silty Silty Silty
	27.8	BO-683D	33.6	120.0	43.4	23.2	20.3	20	1240	6.0	60	45	0.5	
	28.3	BO-683C	29.1	124.8				10	1308	9.5	55	0	0.5	
	31.2	BO-684H	38.2	116.9	46.9	15.9	31.0	10	815	5.5	50	45	0.5	
	31.6	BO-684G	36.0	116.8				10	1161	3.5	60	90	0.5	
	32.0	BO-684F	39.2	126.2				10	1463	2.5	50	0	0.5	
	32.4	BO-684E	42.8	106.8	51.0	24.4	26.6	25	1278	2.5	45	45	0.5	
	32.8	BO-684D	41.0	114.0				25	1311	2.3		90	0.5	
	33.3	BO-684C	33.5	118.1				25	1478	3.5	60	0	0.5	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	S _u PSF	e f %	α °	i °	ê % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
177	11.0	BO-689C	27.7	127.9				10	4400	3.0	55	0	0.5	Brown Clay Layer
	22.8	CO-685D	25.3	125.8	35.2	19.4	15.8	10	2250	4.0	60	0	0.5	
	27.0	CO-686F	24.4	129.2	32.8	20.2	12.6	15	985	16.0		45	0.5	
	32.0	CO-687F	25.8	126.9				20	884	9.5		90	0.5	
	32.4	CO-687E	27.8	125.0	34.1	20.3	13.8	20	1128	5.5		0	0.5	
	32.8	CO-687D	28.5	124.2				20	1533	4.0		0	0.5	
	36.2	CO-688H	31.8	122.1	39.5	21.2	18.3	15	820	12.0		45	0.5	
	36.6	CO-688G	30.5	121.9				15	969	7.0		0	0.5	
	42.0	CO-690F	43.6	114.0	53.9	24.5	29.4	20	1070	5.0	50	90	0.5	
	42.4	CO-690E	44.6	109.2				20	938	10.0		0	0.5	
	42.8	CO-690D	47.2	110.2	58.1	26.7	31.4	20	815	7.5	45	45	0.5	
	46.6	CO-691G	35.4	119.2				20	600	6.5	60	45	0.5	
	48.7	CO-691B	38.0	117.0				20	936	12.0	60	0	0.5	
	51.6	CO-692G	33.2	120.0				20	688	11.5		45	0.5	
	55.8	CO-693I	33.0	120.2				30	606	4.5	50/55	45	0.5	
	57.4	CO-693E	29.7	125.0	37.4	19.6	17.8	25	1123	10.0		0	0.5	
	57.8	CO-693D	30.1	123.8				30	1040	6.0		45	0.5	
Test Shaft	16.0	HU-2C	31.8	119.0	54.0	24.2	29.8	30	925	24.0			1.0	Remoulded
		HU-2C	36.5	118.2				30	3080	1.0		90	1.0	
		HU-2C	31.9	120.2				30	4535	1.5	40	45	1.0	
		HU-2C	32.7	119.2				30	2595	1.7		0	1.0	
	21.8	HU-5A	23.9	129.2				30	3250	7.0		45	1.0	
		HU-5D	23.3	126.6				30	2615	8.5		90	1.0	Remoulded
		HU-5E	24.1	129.0				30	2655	3.0	60	0	1.0	
		HU-5D	23.3	127.9				30	919	20.0			1.0	
	26.8	HU-7D	22.9	130.8	32.4	16.5	15.9	30	1785	14.0		90	1.0	
		HU-7D	23.2	129.2				30	2130	5.0		0	1.0	
		HU-7D	23.5	125.0				0	694	20.0			1.0	Remoulded

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	Y PCF	ATTERBERG - LIMITS			σ_3 PSI	Su PSF	e f %	α °	ϕ °	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test	26.8	HU-7E	22.9	129.0				30	1860	8.7		45	1.0	
Shaft	Cont'd	HU-7E	22.9	130.9				15	1600	15.5		90	0.5	
Cont'd		HU-7E	22.9	129.0				0	1313	19.5		90	0.5	
		HU-7F	23.2	130.0				0	1450	11.5	60	30	0.5	
		HU-7I	22.8	126.9				15	1830	6.0	60/	0	0.5	
											75			
		HU-7I	22.6	130.0				0	1450	7.0	60	0	0.5	
		HU-7	23.4	129.2				15	1478	10.0	50	30	0.5	
	27.3	HU-7L	23.4	130.0				15	1513	11.0		45	0.5	
		HU-7O	26.5	126.0				0	1033	5.0	60	45	0.5	
		HU-7O	24.0	130.0				15	1638	7.5		0	0.5	
		HU-7O	25.2	126.2				0	1480	7.0	45	60	0.5	
	28.3	BO-377B	25.4	127.2	33.2	16.5	16.7	30	1155	11.5		45	1.0	
	29.0	BO-378A	23.4	129.9	31.1	15.7	15.4	30	2320	3.2		0	1.0	
	28.7	BO-379B	23.9	129.0	35.8	18.3	17.5	30	1700	11.0		90	1.0	
	32.8	BO-386B	26.3	127.2	31.8	15.1	16.7	30	1420	3.2		0	1.0	
	32.7	BO-387B	25.7	126.8	33.1	18.1	15.0	30	1249	7.5		45	1.0	
	31.6	HU-12D	23.5	128.8	30.8	17.8	13.0	0	479	20			1.0	Remoulded
		HU-12D	24.6	128.2				30	1469	3.5		45	1.0	
		HU-12G	24.8	127.2				30	1245	13.5		90	1.0	
		HU-12G	24.3	127.2				30	1958	2.2		0	0.5	
	37.0	HU-14C	43.8	113.2				20	1025	0.9	45	45	0.5	Failure in Red Clay
		HU-14D	42.7	113.2				20	860	0.5	45	45	0.5	Failure in Red Clay
		HU-14F	43.3	112.9				20	853	0.6	45	45	0.003	Failure in Red Clay
	37.5	HU-14M	43.1	114.1				20	1090	0.8	45	45	0.003	Failure in Red Clay
		HU-14P	43.7	113.7				20	1200	0.8	48	45	1.0	Failure in Red Clay
		HU-14M	44.0	114.1				20	780	0.5	48	45	0.0008	Failure in Red Clay
		HU-14P	42.9	114.2				20	1270	0.7	48	45	0.5	Failure in Red Clay
		HU-14I	43.5	113.0				20	720	0.7	45	45	0.0008	Failure in Red Clay

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ ₃ PSI	Su PSF	e _f %	α °	i°	ĕ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test Shaft Cont'd	37.5	HU-15P	45.5	110.3	52.6	22.7	29.9	30	1730	1.2		90	1.0	Remoulded
		HU-15M	44.5	110.0	53.7	23.0	30.7	0	182	19.5			1.0	
Cont'd		HU-15M	45.3	111.0				30	1650	1.1	60	0	1.0	
		HU-15M	46.6	110.2				30	1110	0.7	45	45	1.0	
		HU-15N	43.5	114.7				0	1263	1.0	45	45	0.5	
		HU-15N	43.1	113.2				15	1280	1.0	48	45	0.5	
		HU-15N	46.2	110.3				15	1563	1.2	43	90	0.5	
		HU-15N	47.8	110.1				0	1650	1.0	45	90	0.5	
		HU-15O	44.9	112.0				15	1083	1.2	48	0	0.5	
		HU-15O	44.4	112.2				0	1243	1.2		0	0.5	
		HU-15Q	44.2	112.0				15	1670	1.5	40	30	0.5	
		HU-15R	44.3	112.0				0	1200	1.0	55	30	0.5	
	40.8	HU-17B	37.1	116.3				30	1100	1.4	70	45	1.0	Remoulded
		HU-17B	35.8	112.9				0	250	20			1.0	
		HU-17B	35.1	119.4				30	1113	2.2	40	0	1.0	
		HU-17B	33.9	121.6				0	1575	1.8	45	0	1.0	
		HU-17C	37.6	115.8				30	1060	1.0	60	90	1.0	
	42.4	BO-391D	49.0	108.2				30	940	2.7	50	90	1.0	
		BO-392D	31.3	118.0	40.1	20.6	19.5	30	843	10.0	60	45	1.0	Remoulded
	43.0	BO-393A	31.9	119.0	40.4	19.6	20.8	30	915	7.5	50	0	1.0	
	45.0	HU-20A	30.6	122.8	39.8	18.6	21.2	30	1200	3.0	40	0	1.0	
											60			
		HU-20A	33.2	119.2	40.6	15.9	24.7	30	854	6.5	60	90	1.0	
		HU-20A	32.0	119.2				30	1043	4.0	45	45	1.0	
		HU-20A	31.2	117.0				0	224	20	60		1.0	
	46.1	BO-410D	31.7	122.2	43.0	21.1	21.9	30	976	6.5	50	0	1.0	
	46.5	BO-411B	31.9	120.2	41.9	21.0	20.9	30	822	11.0		45	1.0	
	46.0	BO-412B	37.6	118.0	48.8	23.8	25.0	30	645	12.5	65	90	1.0	
	49.4	HU-23M	33.4	118.9	40.2	18.1	22.1	30	1049	1.5	60	0	1.0	Remoulded
		HU-23M	33.5	119.9				30	1089	3.5	50	45	1.0	
		HU-23L	31.6	123.1	42.5	19.5	23.0	30	942	10.0		90	1.0	
		HU-23L	30.6	120.4				0	243	20.0			1.0	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	Y PCF	ATTERBERG LIMITS			σ_3 PSI	Su PSF	ef %	α °	ϕ °	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test	50.5	BO-422C	34.0	118.0	45.9	23.3	22.6	30	1045	3.7	65	0	1.0	Remoulded
Shaft	50.8	BO-423B	30.7	121.2	47.7	18.4	29.3	30	1150	3.7	50	45	1.0	
Cont'd	50.3	BO-424D	34.3	117.0	46.1	22.5	23.6	30	771	6.0	60	90	1.0	
	51.3	HU-25D	34.9	118.8	41.5	19.4	22.2	30	710	5.0	60	0	1.0	
		HU-25D	34.5	118.9				30	752	7.0	40	45	1.0	
		HU-25D	32.4	120.5	41.1	19.2	21.9	30	744	6.0		90	1.0	
		HU-25F	33.8	120.2				30	1079	8.0	60	0	1.0	
		HU-25D	33.3	117.9				0	225	20.0	60		1.0	
	55.2	BO-551B	30.1	122.8	40.1	17.3	22.8	30	804	10.0		0	1.0	
	55.1	HU-29M	26.7	125.6	34.0	16.6	17.4	30	818	6.0		90	1.0	Remoulded
		HU-29M	26.2	126.8				30	884	5.5		45	1.0	
		HU-29M	26.3	125.1	33.7	16.9	16.8	30	870	3.5		0	1.0	
		HU-29P	27.1	126.3				30	1290	6.0		0	1.0	
		HU-29M	25.7	126.4				0	372	20.0	65		1.0	
	56.8	BO-555B	35.0	119.2	44.3	21.0	23.3	30	1010	6.5		0	1.0	
	59.2	HU-33I	36.5	117.0	44.9	20.0	24.9	15	916	6.0	60	0	0.5	
		HU-33B	35.6	118.0	44.7	19.9	24.8	30	905	5.0		0	1.0	
		HU-33E	36.2	118.3				15	842	4.0	60	30	0.5	
		HU-33G	35.9	118.9				15	809	3.0	55	45	0.5	
		HU-33B	35.9	118.0				30	825	5.5	65	45	1.0	Remoulded
		HU-33F	35.9	120.1				15	765	6.0		60	0.5	
		HU-33I	36.3	118.8				15	894	5.0		90	0.5	
		HU-33B	35.2	118.0				30	874	6.5		90	1.0	
		HU-33I	36.2	119.0				0	840	4.5	60	0	0.5	
		HU-33E	35.8	117.7				0	710	5.0	50	30	0.5	
		HU-33G	36.1	118.0				0	699	3.0	55	45	0.5	
		HU-33F	36.1	118.9				0	805	4.5	55	60	0.5	
		HU-33I	36.2	117.9				0	664	6.5		90	0.5	
		HU-33B	34.9	118.9				0	195	20			1.0	
	60.5	BO-563C	35.1	119.0	45.3	20.8	24.5	30	940	7.0	65	0	1.0	Remoulded
	63.3	HU-34A	37.7	116.1	44.5	20.4	24.1	30	1348	2.2	60	0	1.0	

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	Y PCF	ATTERBERG LIMITS			σ_3 PSI	Su PSF	e f %	α °	I°	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test Shaft Cont'd	63.3	HU-34A	34.2	117.6				30	943	4.0		90	1.0	
		HU-34A	40.5	113.1				30	1070	1.2	50	45	1.0	
		HU-34A	33.7	122.2				0	199	20	63		1.0	Remoulded
	65.5	BO-567B	39.7	115.7	50.5	23.7	26.8	30	1010	4.5	50	0	1.0	
	67.8	HU-40A	44.7	110.0	52.8	22.6	30.2	30	919	4.5		0	1.0	
		HU-40A	45.1	111.1				30	844	4.5	45	45	1.0	
		HU-40A	45.2	111.0				30	855	3.5	60	90	1.0	
		HU-40A	44.1	112.6				0	132	20	57		1.0	Remoulded
		HU-40C	46.0	110.2	51.5	22.6	28.8	30	1065	5.5		0	1.0	
	70.0	BO-571B	48.9	109.3	61.0	28.6	32.4	30	1043	3.0	50	0	1.0	
	71.4	HU-42C	52.1	108.9				30	535	1.2	50	45	0.003	Shear in Reddish Clay
		HU-42C	53.3	108.1				30	598	1.7	50	45	0.5	Shear in Reddish Clay
		HU-42C	52.0	108.0				30	420	1.1	50	45	0.001	Shear in Reddish Clay
		HU-42I	50.7	108.2				30	616	1.7	50	45	0.5	Shear in Reddish Clay
		HU-42F	50.4	108.5				30	725	1.2	50	45	1.0	Shear in Reddish Clay
		HU-42G	51.6	108.1				30	628	1.2	50	45	.0008	Shear in Reddish Clay
		HU-42H	51.2	108.3				30	525	1.2	48	45	.003	Shear in Reddish Clay
	72.9	HU-44A	46.1	111.1	56.4	23.0	33.4	30	1176	2.0		0	1.0	
		HU-44A	48.0	110.0				30	895	1.0	45	0	1.0	
		HU-44A	48.1	113.5				30	1183	2.2	45	0	1.0	
		HU-44A	44.5	110.3				0	140	20	60		1.0	Remoulded
		HU-44H	49.1	109.9				30	595	0.7	45	45	0.001	Shear in Brown Clay
		HU-44H	49.3	109.8				30	766	0.7	38	45	0.5	Shear in Brown Clay
	73.2	HU-44P	46.1	110.8				15	385	0.7	45	45	0.04	Shear in Reddish Clay
		HU-44P	46.7	109.2				0	804	1.2	49	45	0.5	
	73.8	HU-48A	45.6	112.2				30	640	7.5		0	1.0	
		HU-48A	46.0	111.2				30	637	6.0	45	45	1.0	
		HU-48A	43.8	112.0	53.2	22.0	31.2	30	1088	2.7	50	90	1.0	
		HU-48A	43.6	112.4				0	134	20			1.0	Remoulded

SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_3 PSI	S_u PSF	e_f %	α °	ϕ °	$\dot{\epsilon}$ % / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test	76.2	HU-50Q	32.4	120.2	54.0	22.0	32.0	15	1095	5.5	60	0	1.0	Failure in Reddish Clay
Shaft	75.3	HU-50A	36.3	118.6				30	960	6.0	45	0	1.0	
Cont'd	76.2	HU-50K	34.3	119.0				15	915	3.0	56	30	0.5	
		HU-50N	34.1	120.0				15	835	5.0	55	45	0.5	
	75.3	HU-50A	33.9	119.0				30	730	2.2	55	45	1.0	
	76.2	HU-50L	33.4	119.8				15	935	4.0		60	0.5	
	75.3	HU-50A	43.5	111.2				30	1051	3.0	50	90	1.0	
	76.2	HU-50N	33.1	119.2				15	940	7.0	60	90	0.5	
	75.3	HU-50A	43.5	112.2				0	158	20.0	64		1.0	Remoulded
	76.2	HU-50Q	32.9	119.3				0	1040	5.5	60	0	0.5	
		HU-50K	34.3	119.7				0	974	3.7	58	30	0.5	Failure in Reddish Clay
		HU-50N	35.6	119.1				0	791	3.0	53	45	0.5	Failure in Brown Clay
		HU-50L	34.0	118.9				0	875	4.0	60	60	0.5	
		HU-50N	33.7	119.0				0	989	5.2	60	90	0.5	
	77.7	BO-579C	35.0	120.1	38.8	18.0	20.8	30	901	4.0	55	0	1.0	

COMPACTED MATERIALS
SUMMARY OF UNCONSOLIDATED - UNDRAINED TRIAXIAL TESTS

LOC - ATION	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_3 PSI	S_u PSF	e_f %	α °	i°	$\dot{\epsilon}$ %/MIN.	REMARKS
					L.L.	P.L.	P.I.							
8+00W	35	GR-4	22.6	129.6	31.8	17.7	14.1	20	654	20			0.5	Standard Proctor
8+00W	35	GR-4	21.7	130.4				20	605	20			0.5	Harvard Miniature
8+85W	25	GR-5	18.7	133.1	41.2	20.1	21.1	20	4,660	19.5			0.5	Harvard Miniature
8+85W	25	GR-5	22.6	128.2				20	1,200	20			0.5	Harvard Miniature
8+85W	25	GR-5	26.9	123.6				20	503	20			0.5	Harvard Miniature
9+50W	15	GR-6	21.8	128.9	34.1	18.3	15.8	20	873	20			0.5	Harvard Miniature
9+50W	15	GR-6	17.7	134.2				20	2,920	20			0.5	Harvard Miniature
9+50W	15	GR-6	17.9	133.7				40	2,730	20			0.5	Standard Proctor

SUMMARY OF UNCONSOLIDATED - UNDRAINED DIRECT SHEAR TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_N PSI	τ_f PSF	δ_h IN.	δ_v IN.	α °	δ IN / MIN.	REMARKS
					L.L.	P.L.	P.I.							
106	66.8	BO-27A	31.3	119.5				29.9	1258	0.002	0.025	0	0.039	
	66.8	BO-27A	32.1	121.1				29.9	1254	0.003	0.04	90	0.039	
	66.5	BO-27B	31.0	120.6				29.9	1258	0.003	0.03	0	0.039	
	66.5	BO-27B	30.0	120.8				29.9	1302	0.003	0.05	90	0.039	
	65.8	BO-27D	31.0	120.7				29.9	975	0.008	0.06	0	0.039	
	65.8	BO-27D	30.7	113.8				29.9	1011	0.009	0.11	90	0.039	
	65.5	BO-27E	32.1	120.0				29.9	864	0.010	0.08	90	0.039	
	65.5	BO-27E	28.0	123.1				29.9	1230	0.009	0.10	0	0.039	
	65.2	BO-27F	25.8	125.0				29.9	1064	0.010	0.20	90	0.039	
	65.2	BO-27F	24.9	125.1				29.9	974	0.026	0.17	0	0.039	
137	41.3	CO-546G	36.4	111.7				30.0	731	0.015	0.085	0	0.039	
	47.8	CO-547A	32.9	119.0	43.0	19.0	24.0	30.0	780	0.023	0.085	0	0.039	
	49.3	CO-548G	32.8	119.9	42.9	19.0	23.9	30.0	809	0.012	0.085	0	0.039	
	58.5	CO-549D	36.5	118.0	44.4	20.4	24.0	30.0	919	0.033	0.20	0	0.039	
	61.7	CO-550F	37.8	115.2	48.3	20.7	27.6	30.0	755	0.007	0.04	0	0.039	
138	53.3	CO-557G	31.5	121.1	39.3	19.2	20.1	30.0	1003	0.005	0.045	0	0.039	
	65.3	CO-558G	35.4	116.9	47.3	21.7	25.6	30.0	789	0.035	0.20	0	0.039	
	68.9	CO-559H	46.3	111.0	57.8	24.6	33.2	30.0	611	0.030	0.085	0	0.039	Grey layer
	69.3	CO-559G	46.3	113.1	52.9	23.6	29.3	30.0	720	0.037	0.130	12	0.039	Reddish-brown layer
	74.1	CO-560E	49.1	109.5	63.7	25.3	38.4	30.0	846	0.005	0.045	0	0.039	Brown clay
139	74.1	CO-560E	42.0	115.4	48.6	20.9	27.7	30.0	764	0.015	0.06	0	0.039	Reddish-brown clay
	48.0	CO-574C	31.6	121.2	41.2	19.6	21.6	6.9	720	0.002	0.03	0	0.039	
	48.4	CO-574B	34.4	117.8	47.2	21.1	26.1	3.2	649	0.006	0.05	0	0.039	
	48.4	CO-574B	34.9	119.7				30.0	905	0.004	0.03	0	0.039	
	48.4	CO-574B	35.0	117.8				29.9	890	0.003	0.025	0	0.039	

SUMMARY OF UNCONSOLIDATED - UNDRAINED DIRECT SHEAR TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_N PSI	τ_f PSF	δ_h IN.	δ_v IN.	α °	δ IN / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test Shaft	37.0	HU-15K	43.4	112.2	54.0	25.6	28.4	20.0	1180	0.001	0.015	90	0.039	Shear across layers
	37.0	HU-15K	47.0	109.8	54.3	23.6	30.7	20.0	1200	0.002	0.045	90	0.039	Shear across layers
	37.0	HU-15K	48.3	109.5	60.3	26.5	33.8	20.0	1300	0.001	0.018	0	0.039	Brown clay
	37.0	HU-15K	52.7	109.2	58.3	24.7	33.8	20.0	1420	0.001	0.015	0	0.039	Dark brown clay
	37.0	HU-15K	39.6	113.4	58.4	25.5	32.9	20.0	1290	0.001	0.030	0	0.039	Reddish-brown clay
	67.8	HU-40D	46.0	113.3	51.5	23.6	27.9	20.0	620	0.006	0.160	0	0.039	
	67.8	HU-40D	44.5	111.9	52.6	25.5	27.1	20.0	995	0.002	0.040	90	0.039	
	68.5	HU-40R	46.3	110.8	57.1	24.4	32.7	20.0	850	0.002	0.030	0	0.039	
	68.5	HU-40R	46.0	110.6	54.8	25.8	29.0	20.0	865	0.002	0.045	90	0.039	
	72.9	HU-44H	45.4	111.7				5.0	795	-0.003	0.025	45	0.039	Shear across layers
	72.9	HU-44H	44.5	109.8				5.0	730	-0.002	0.020	90	0.039	Shear across layers
	72.9	HU-44I	43.3	112.2				5.0	760	-0.001	0.020	0	0.039	Reddish clay layer
	72.9	HU-44I	49.5	108.9				5.0	1000	-0.003	0.010	0	0.039	Brown clay layer
	72.9	HU-44I	41.2	110.1				5.0	965	-0.004	0.045	0	0.039	Grey clay layer
	72.9	HU-44D	41.9	114.1	52.3	21.6	30.7	20.0	990	0.001	0.025	0	0.039	Brown clay
	72.9	HU-44D	47.1	109.8	62.6	25.7	36.9	20.0	735	0.002	0.040	0	0.039	Reddish clay
	72.9	HU-44D	50.0	108.1	61.7	24.9	36.8	20.0	1250	0.001	0.020	0	0.039	Greyish clay
	72.9	HU-44D	50.2	109.1				20.0	1165	0.000	0.020	0	0.039	Brownish-grey clay
	72.9	HU-44E	46.6	109.9	56.1	24.8	31.3	20.0	790	0.001	0.015	0	0.039	Reddish clay
	72.9	HU-44E	37.9	109.4	44.0	20.5	23.5	20.0	950	0.001	0.040	0	0.039	Grey clayey silt
	72.9	HU-44E	44.4	111.9	53.8	22.0	31.8	20.0	965	0.001	0.035	90	0.039	Various layers
	72.9	HU-44E	47.8	109.9	62.0	25.5	36.5	20.0	1120	0.001	0.030	90	0.039	Various layers
	73.2	HU-44J	45.9	110.4	56.4	23.6	32.8	20.0	760	0.002	0.045	0	0.039	Reddish clay
	73.2	HU-44J	47.4	109.1	57.8	24.8	33.0	20.0	880	0.003	0.040	90	0.039	Various layers
	73.2	HU-44M	46.4	109.7	57.6	23.8	33.8	20.0	920	0.001	0.060	90	0.039	Various layers
	73.8	HU-48C	45.7	110.9	49.7	21.5	28.2	20.0	605	0.002	0.040	0	0.039	Reddish clay
	73.8	HU-48C	47.1	110.8	52.3	22.9	29.4	20.0	735	0.003	0.050	90	0.039	Reddish clay
	74.7	HU-48L	36.5	117.2	43.3	19.0	24.3	20.0	705	0.001	0.035	0	0.039	Brown clay
	74.7	HU-48L	39.1	116.2	46.7	20.4	26.3	20.0	792	0.002	0.045	0	0.039	Reddish clay
	74.7	HU-48L	39.6	114.7	47.8	21.0	26.3	20.0	790	0.002	0.050	90	0.039	Reddish clay

SUMMARY OF UNCONSOLIDATED - UNDRAINED DIRECT SHEAR TESTS

BORE HOLE	DEPTH	LAB SAMPLE NUMBER	W.C. %	γ PCF	ATTERBERG LIMITS			σ_N PSI	τ_f PSF	δ_h IN.	δ_v IN.	α °	$\dot{\delta}$ IN / MIN.	REMARKS
					L.L.	P.L.	P.I.							
Test Shaft cont'd	75.3	HU-50G	42.1	112.5	51.9	22.5	29.4	20.0	690	0.001	0.025	0	0.039	Brown clay
	75.3	HU-50G	40.6	114.3	49.1	22.0	27.1	20.0	705	0.002	0.050	90	0.039	Various layers
	75.3	HU-50G	34.0	116.9	40.6	17.9	22.7	20.0	935	0.011	0.300	0	0.039	Brown clay
	76.2	HU-50P	35.1	119.0	39.2	18.3	20.9	20.0	850	0.001	0.035	0	0.039	Brown clay
	76.2	HU-50P	35.1	118.3	44.0	19.3	24.7	20.0	735	0.001	0.030	0	0.039	Brown clay
	76.2	HU-50M	37.6	115.6	44.3	19.6	24.7	20.0	750	0.002	0.070	90	0.039	Brown clay