

MEMORANDUM

30M3-63

TO:

Mr. J. W. MacDougall, (2)
Engineering Claims Office,
Central Bldg., Downsview.

FROM:

Geotechnical Office,
Engineering Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE:

February 6, 1974.

OUR FILE REF.

IN REPLY TO

FEB 14 1974

SUBJECT:

Claim on Contract 72-216 by Becker Drills Ltd.
Rock Slotting, Thorold Tunnel
Hwy. 58 and Welland Canal
District #4 (Hamilton)
W.O. 72-11096 -- W.P. 48-72-02

CONT. 72-216

Attached we are forwarding to you our report
regarding the above-mentioned claim.

We believe that the data and comments contained
therein will be adequate for your requirements in order to
pursue the matter. If additional information or further
clarification is required, please contact this Office.

MD/ao
Attch.

c.c. J. B. Wilkes
C. R. Wilmot
J. E. Callaghan (2)
C. R. Robertson

Files
Documents

M. Devata

M. Devata,
Supervising Foundations Engineer,
For: A. Rutka,
Manager, Geotechnical Office.

TABLE OF CONTENTS

1. INTRODUCTION.
2. HISTORY OF THE PROJECT.
3. COMMENTS TO STATEMENTS MADE BY CONTRACTOR.
4. RELATED INFORMATION.
5. CONCLUSIONS.

Claim on Contract 72-216 by Becker Drills Ltd.
Rock Slotting, Thorold Tunnel
Hwy. 58 and Welland Canal
District #4 (Hamilton)
W.O. 72-11096 -- W.P. 48-72-02

1. INTRODUCTION:

The Soil Mechanics Section of the Geotechnical Office was requested to supply necessary information which may help in the successful assessment of the claims made by Becker Drills Limited. The request was contained in a memo from Mr. J. W. MacDougall, Claims Engineer, dated December 3, 1973.

2. HISTORY OF THE PROJECT:

The subsurface investigation for the Thorold Tunnel at the crossing of Hwy. 58 and St. Lawrence Seaway Canal was carried out during 1964 under the supervision of Acres Consulting Services Ltd. for the Ministry. The drilling services were provided by F. E. Johnston Drilling Co. Ltd. The construction of the tunnel commenced in September 1965, and was completed in March 1968. However, the construction of the West Service Building was completed in July 1967.

In September 1967, some minor horizontal cracks were observed in south tunnel wall under the West Service Building. The number and extent of open cracks at that location have increased steadily since. Following an inspection of the cracking at the West Service Building in May 1971 the Ministry decided to investigate the cause of the cracking. In this regard, the Ministry retained Acres Consulting Services Ltd. to carry out the investigation and to provide necessary remedial measures. In order to determine the rock conditions in the vicinity of the West Service Building, horizontal and inclined boreholes were drilled from inside the tunnel. The drilling services

were provided by Canadian Longyear Limited. The results of the investigations, which were presented in a report dated March 1972, indicated that the horizontal cracking was caused by a horizontal deformation imposed on the wall of the structure by rock squeeze, associated with relief of in situ stresses in the rock due to the excavation for the tunnel, and that the remedial work to be carried out at the West Service Building should be aimed at eliminating the imposed deformation on the tunnel wall. This remedial work would be best accomplished by unloading the walls of the building, possibly by utilizing slots cut in the rock north and south of the structure.

A contract (No. 72-216) was awarded in order to implement the proposed remedial work at the south side of the West Service Building. The successful bidder for this contract was Becker Drills Limited. According to available information, the work commenced on May 1973, and is still in progress.

3. COMMENTS TO STATEMENTS MADE BY CONTRACTOR:

In this part of the report, the statements made by the Contractor, as contained in his claims, are first referred to in block letters then followed by our comments.

"COMPLETE HOLE DATA NOT AVAILABLE AT TIME OF TENDER.

AT TIME OF EXAMINATION OF RECORDS PRE BID THE ONLY LOGS OF BOREHOLES AVAILABLE AT DOWNSVIEW WERE THOSE OF F. E. JOHNSTON FROM 1964."

The following appears on Page 3 of the Special Provisions for Contract No. 72-216, under the heading of INQUIRIES DURING TENDERING:

All inquiries pertaining to this Contract, which may arise during the tendering period, shall be referred to the Contract Control Engineer's Office, Downsview, Telephone: 248-3654.

The following data is available for review:

- a) As-built drawings for the tunnel.
- b) Logs of boreholes at or adjacent to the work area.

- c) Groundwater observations.
- d) Test results for clay-bentonite mix.
- e) Test results for sand-asphalt mix.

Inquirers shall allow the Contract Control Engineer sufficient time to refer to the appropriate sections of the Department, or to arrange for a meeting with the inquirer to discuss the points in question.

The "Data for Tenderers" prepared by Acres Consulting Services Limited, was forwarded to the Ministry on February 20, 1973, as claimed by Acres. The data was bound in blue covers and contained the borelogs for Holes #1006, #1009 and #1024 drilled by F. E. Johnston Drilling Co. Ltd. in 1964, as well as the borelogs for the horizontal and/or inclined holes (Holes D-20, D-21, E-22, E-5, E-6 and P-3) drilled from within the tunnel by Canadian Longyear Limited in 1971. These borelogs are included in Appendix 1. The statement by the Contractor that he only saw the logs by F. E. Johnston Co. Ltd. can only be commented by the Contract Control Office personnel.

OUR ESTIMATES WERE MADE ON THE BASIS OF THESE LOGS, EXPECTING COMPETENT ROCK WHICH WAS NOT SHATTERED. ALSO ON OUR DRILLING EXPERIENCE SOME YEARS BEFORE WHEN SETTING PIEZOMETERS AND OUR EXPERIENCE DRILLING ON THE WELLAND CANAL.

BECAUSE OF LACK OF INFORMATION, AND THE ROCK BEING SHATTERED AND CRACKED BEYOND EXPECTATIONS WE ARE MAKING CLAIM FOR EXTRA COSTS FOR THE MONTH OF AUGUST.

The horizontal and/or inclined holes drilled by Canadian Longyear Co. Ltd. in 1971, showed clearly that some fracturing and jointing of the rock could be expected. These holes were drilled from inside the tunnel and holes D-20, D-21, E-5 and E-22 intersect the line of the slot at levels ranging from elevations 530 and 545 (17 to 32 feet below the bedrock surface in this area) as illustrated on Sketchs No. 3 and 4 in Appendix 2. The vertical holes (#1006 and #1009) drilled by F. E. Johnston Drilling Co. Ltd. in 1964 also revealed some minor fracturing and jointing. These borehole logs are included in Appendix 1 and the relevant data are underlined in red. It should be noted that jointing is a common feature in the bedrock

in the vicinity of Niagara area. The predominant jointing system other than the bedding joint is vertical and it is understood that the vertical joints are extremely difficult to be revealed in vertical boreholes. In addition, due to the excavation for the construction of the tunnel, the Contractor, being experienced in rock drilling in this area could have anticipated some degree of fracturing within close proximity to the rock cut face.

INCOMPLETE INFORMATION AT TIME OF TENDER AND ON CONSULTATION WITH ACRES PRIOR TO TENDER.

DATA ON ROCK SHOWED NO STEEL IN ROCK AND ON FURTHER CHECKING WITH ACRES BECKER WERE ADVISED NO STEEL IN ROCK AND ONLY SOME IN CEMENT WALL BETWEEN PHASE I AND II TO BE ERECTED AFTER TENDER.

THIS CLAIM IS MADE BECAUSE OF STEEL IN ROCK DESTROYING BITS, AND BREAKING EQUIPMENT CAUSING EXTRA WORK AND TIME AS PER ATTACHED SHEET, AND ADVISED ON DAILY DRILL LOGS SUBMITTED TO ENGINEER IN CHARGE.

It is our opinion that steel could not have been expected by the Contractor and that he is entitled for necessary compensation.

4. RELATED INFORMATION:

- a) This Office reviewed critically the rock core samples obtained in two boreholes (#I-1 & #I-2) approximately 3 feet from the proposed slot. The locations of these two boreholes are shown on Fig. 3 in Appendix 2. These two boreholes were put down for installation of various instrumentations to monitor the rock movement. These borings were drilled after the award of this contract. The core samples (HQ size, approximately 2-1/2 inches diameter) only exhibited minor vertical jointing and fracturing in the upper 20 feet. Based on this information, it can be inferred that the bedrock is not badly shattered and cracked as claimed by the Contractor.
- b) The Contractor originally proposed to drill the slot in a continuous fashion, using overlapping 6-1/4" diameter

holes. A copy of this proposal is included in Appendix 3. However, a different method was used shortly after the job began, in which alternate holes were drilled on first pass from one end of the slot to the other and then the portion between two holes were drilled out on the second pass.

- c) According to information supplied by Acres during December 1973, the completed section of the slot has closed as much as 1/3 inch due to rock squeeze since the drilling commenced. It should be noted that the closing of the slot during the construction period would have been much smaller, had the slot been completed on schedule.
- d) According to information supplied by Acres, Becker originally proposed to carry out the drilling with a Failing 1500 drill (CFD 1) mounted on I beam rails (see minutes of meeting on April 24, 1973, contained in Appendix 4). However, the drill used on the job appears to be a modified Failing 1000 which is a much lighter machine than Failing 1500. In addition, since the start of this job, the drilling equipment has been plagued by many breakdowns. This would substantiate the fact that the drilling equipment used is underpowered for this type of work.
- e) According to available information, F. E. Johnston Drilling Company Ltd. carried out test holes in the vicinity of Hwy. 58 and Hwy. 406 interchange where bedrock is exposed. The purpose of these holes was to determine the most effective method of cutting the slot. Three overlapping test holes (approximately 12 inches diameter) to a depth of about 20 feet using a Chicago pneumatic W-650 drill, were successfully completed, without any major drilling problem, in 8 hrs.

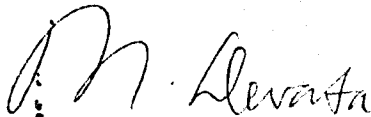
It appears to us that the Chicago pneumatic W-650 drill is a more powerful machine than the equipment used by the Contractor for this job.

5. CONCLUSIONS:

- a) All pertinent borelogs were included in the Data for Tenderers, which was available on and after February 20, 1973. The Contractor should have had ample time to review these data (tender closing date - March 28, 1973). Based on these data, the Contractor should have been able to anticipate some jointing and fracturing of the rock, and hence to select the most suitable drilling method and equipment.
- b) If the Contractor had adhered to his original plan of drilling by carrying out overlapping holes continuously from one end to the other, he would have experienced less problems caused by rock movement. In addition, had heavier and more powerful equipment been used, the Contractor would have completed the job successfully and on schedule.
- c) It is beyond the Contractor's anticipation to encounter steel during the drilling of the slot in rock and hence the Contractor is justified for compensation.



Prepared by: C. S. Poon, P. Eng.
Project Foundations Engineer.



Reviewed by: M. Devata, P. Eng.
Supervising Foundations Engineer.

APPENDIX I

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
 (Ontario)

PROJECT Thorold Tunnel HOLE No. D-20

SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED M. Oct. 26 19 71
 FINISHED M. Oct. 26 19 71

METHOD SOIL CASING DIAM.
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM.
 Station
 LOCATION: ELEVATIONS: 54 + 58 At wall face: 533.91 ft
 DEPARTURE DRILL PLATFORM
 BEARING South GROUND SURFACE
 INITIAL DIP 26° (above horizontal) ROCK SURFACE 538.70 ft
 OTHER DIPS BOTTOM OF HOLE
 WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0 to 6.6		Tunnel Wall Concrete: The concrete core is fractured locally and the chemical weathering and leaching is confined to the fracture faces.	
6.6		Bentonite Seal.	
6.62 to 9.0		Bulkhead Concrete: The concrete core at the bentonite bulkhead interface is badly fractured and the fractures are partly filled with calcareous material. Substantial flow of water from the drill hole was observed.	
9.0 to 16.0	Dolomite	Lockport formation (Goat Island/Gasport Member). Medium grey, fine grained, massive, dense, shaly locally, fractured occasionally.	95.28
16.0		End of Borehole.	

INSPECTOR

APPROVED

LOGGED BY

DATE

March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT: Department of Transportation and Communications, JOB NO P2499.02

(Ontario)

PROJECT Thorold Tunnel.....

HOLE NO D-20

SITE South Tunnel Wall

SHEET NO 1 OF 2

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING *	STAINING **	BLEACHING	
0.0 to 0.4	Fracture, minor chemical leaching along the fracture faces.	15°						X					
1.5 to 1.9	Fracture, exhibits chemical leaching.							X					
2.0 to 2.1	Fracture, exhibits chemical leaching.							X					
2.1 to 2.4	Fracture*							X					
2.4 to 2.8	Fracture, chemical leaching, partly filled with clay.							X					
4.65	Fracture*							X					
6.60	Bentonite Seal* (1/4-inch thick) slightly contorted.												
8.1 to 8.2	Fracture exhibits chemical leaching.							X					
9.0 to 11.0	Rock badly fractured, filled with calcareous material locally.							X	C Gy				
11.8	Joint, partly filled with clay.	60°	X		X				C Gy				
12.6	Joint, partly filled with clay.		X		X				C Gy				

C = CARBONATE H = HEMATITE K = CHLORITE

++ Br = BROWN + Gy = GRAY

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT (CORE DETAILS)

CLIENT: Department of Transportation and Communications (Ontario) JOB NO P2499.02

PROJECT Thorold Tunnel.....

MOLE NO D-20

SITE .. South Tunnel Wall

and SHEET NO . 2 OF 2

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING *	STAINING **	BLEACHING	
13.70 to 14.00	Rock Fractured						X						
14.10	Fracture partly filled with clay.						X						
14.20	Fracture, partly filled with shaly material.						X						
14.55	Fracture, partly filled with shaly material.						X						
14.95	Joint, partly filled with clay.	60°	X		X				CGy				
15.10	Joint, partly filled with clay.	60°	X		X				CGy				
16.00	End of Borehole												
	* Television Camera Study.												

C = CARSONATE H = NEMATITE K = CHLORITE

** B = BROWN * G = GRAY

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
 (Ontario)
 PROJECT Thorold Tunnel HOLE No. D-21
 SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED M. Oct. 26 19 71
 FINISHED M. Oct. 27 19 71

METHOD SOIL CASING DIAM.
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. Nx
 Station

LOCATION: LATITUDE 54 + 28 ELEVATIONS: DATUM at wall face: 536.14 ft
 DEPARTURE
 BEARING South
 INITIAL DIP 30° (above horizontal)
 OTHER DIPS

DRILL PLATFORM
 GROUND SURFACE
 ROCK SURFACE
 BOTTOM OF HOLE
 WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0 to 6.75		Tunnel Wall Concrete: The tunnel wall concrete core is intact. Minor flow of water from the hole after the completion of drilling. Steel reinforcing: 0.40 feet 6.15 feet	
6.75		Bentonite Seal	
6.77 to 11.4		Bulkhead Concrete: The core at the bentonite bulkhead interface is fractured locally.	
11.4		Plastic Seal	
11.4 to 16.0	Dolomite	Lockport Formation (Goat Island/Gasport member). Light grey, fine-grained rock, dense, fractured and jointed locally. Shaly and and silty along the fractures.	
16.0		End of Borehole.	

INSPECTOR W. B. Pratt

LOGGED BY M. Wallia

APPROVED

DATE

March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT. Department of Transportation and Communications (Ontario)

JOB NO P2499.02

PROJECT Thorold Tunnel.....

HOLE NO D-21

SITE South Tunnel Wall.....

SHEET NO 1 OF 1

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING *	STAINING **	BLEACHING	
2.0	Core fracture							X					
6.75	Bentonite seal slightly contorted												
7.30	Core fractured							X					
11.4	Plastic seal												
13.9	Joint	60°	X		X								
14.2	Joint, partly filled with calcareous material		X		X								
14.5	Joint, exhibits minor chemical weathering	60°	X		X								
14.95	Joint, exhibits minor chemical weathering	60°	X		X								
15.2	Joint, partly filled with silt	60°	X		X								
15.5 to 16.0	Rock fractured							X					
16.0	End of Borehole												

C = CARBONATE H = HEMATITE K = CHLORITE

** Br = BROWN * Gy = GRAY

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
 (Ontario)
 PROJECT Thorold Tunnel HOLE No. E-22
 SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED .M. Oct. 27 19 71
 FINISHED .M. Oct. 27 19 71

METHOD SOIL CASING DIAM.
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. Nx
 Station

LOCATION: LATITUDE 54 + 16 ELEVATIONS: DATUM at wall face: 532.91 ft
 DEPARTURE: Due south DRILL PLATFORM
 BEARING 10° GROUND SURFACE
 INITIAL DIP 10° ROCK SURFACE
 OTHER DIPS BOTTOM OF HOLE
 WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION; WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0 to 6.7		Tunnel Wall Concrete: The concrete core from the tunnel wall is fractured locally. The fracture faces do not exhibit chemical weathering or leaching of the concrete mix.	
6.7		Bentonite Seal.	
6.72 to 8.9		Bulkhead Core fractured. Concrete:	
8.9 to 16.0	Shaly Limestone	Lockport formation (Gasport Member). Dark grey, fine grained, dense, distinct sub-horizontal cleavage, abundant fossils in strained state. Core badly fractured locally (15.0 ft to 15.7 ft).	
16.0		End of Borehole.	

INSPECTOR W. B. Pratt

LOGGED BY M. Wallia

APPROVED

DATE

March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT Department of Transportation and Communications
(Ontario)

JOB NO P2499.02

PROJECT Thorold Tunnel

HOLE NO E-22

SITE South Tunnel Wall

SHEET NO 1 OF 1

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING +	STAINING +	BLEACHING	
2.2	Fracture exhibits minor chemical weathering.	70°		x			x						
2.6	Fracture.						x						
4.5	Fracture.					x	x						
5.2	Fracture.	80°		x			x						
5.3	Fracture.	80°		x			x						
6.7	Bentonite Seal.												
7.9 to 8.1	Fracture.						x						
15.0 to 15.7	B. Joint	15°	x		x								
16.0	End of Borehole.												

B. Joint = Bedding Joint

C = CARBONATE H = HEMATITE K = CHLORITE

++ Br = BROWN + Gy = GRAY

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
(Ontario)
PROJECT Thorold Tunnel HOLE No. E-5
SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED .M. Oct. 18 1971
FINISHED .M. Oct. 18 1971

METHOD SOIL CASING DIAM.
OF
DRILLING: ROCK Diamond Drill CORE DIAM. Ax

LOCATION: NADITUDE 54 + 12 ELEVATIONS: DATUM at wall face: 533.15 ft
DEPARTURE
BEARING Due south
INITIAL DIP 10
OTHER DIPS
DRILL PLATFORM
GROUND SURFACE
ROCK SURFACE 531.60 ft
BOTTOM OF HOLE
WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0 to 5.60		Tunnel Wall Concrete: The concrete core from the tunnel wall is generally intact, well-compacted concrete with no evidence of honey-combing, segregation, or deterioration. Steel reinforcing - 0.60 foot Steel reinforcing - 5.25 feet Plastic Sheet - 5.30 feet	
5.60		Bentonite seal.	
5.62 to 9.1		Bulkhead Concrete: The core at the bentonite bulkhead interface is fractured locally and exhibits pronounced chemical leaching.	
9.1		Plastic seal.	
9.1 to 24.0	Shaly Limestone	Lockport Formation (Gasport Member). Dark grey, fine-grained, dense, distinct sub-horizontal cleavage, abundant fossils which show strain flow. The rock exhibits drag folds on a very small scale.	
24.0		End of Borehole.	95.6

INSPECTOR W. B. Pratt
LOGGED BY M. Walia

APPROVED

DATE

March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT Department of Transportation and Communications JOB NO P2499.02
(Ontario)

PROJECT Thorold Tunnel.....

HOLE NO E-5

SITE South Tunnel Wall

SHEET NO 1 OF 1

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING +	STAINING ++	BLEACHING	
1.20	Fracture							X					
3.40	Fracture							X					
5.60	Bentonite seal												
6.80	Fracture, minor chemical weathering							X					
8.50	Fracture, minor chemical weathering							X					
8.85	Fracture, minor chemical weathering							X					
9.60	Fracture						X	X					
17.0	Joint	5°		X	X								
18.2	Rock fractured due to close to jointing												
18.5													
20.2	Fracture							X					
22.0	Fracture							X					
22.9	Fracture							X					
24.0	End of borehole												

C = CARBONATE H = HEMATITE K = CHLORITE

++ Br = BROWN + Gy = GRAY

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
(Ontario)
PROJECT Thorold Tunnel HOLE No. E-6
SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED M. Oct. 18 19 71
FINISHED M. Oct. 18 19 71

METHOD SOIL CASING DIAM.
OF
DRILLING: ROCK Diamond Drill CORE DIAM. AX
Station
LOCATION: 54 + 14 ELEVATIONS: DATUM at wall face: 533.05 ft
DEPARTURE
BEARING Due south
INITIAL DIP 10°
OTHER DIPS
DRILL PLATFORM
GROUND SURFACE
ROCK SURFACE
BOTTOM OF HOLE
WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.00 to 6.30		Tunnel Wall Concrete: The concrete core from the tunnel wall is generally intact. However it is fractured locally exhibiting very minor chemical leaching along the fractures.	
6.30		Bentonite seal.	
6.32 to 9.35		Bulkhead Concrete: The core at the bentonite bulkhead interface is relatively more fractured and chemically leached.	
9.35 to 12.00	Shaly Limestone	Lockport formation (Gasport Member). Dark grey, fine grained, dense, distinct bedding cleavage, abundant fossils in strained state.	
12.0		End of Borehole.	97.2

INSPECTOR W. B. Pratt

LOGGED BY M. Walia

APPROVED

DATE

March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT Department of Transportation and Communications JOB NO P2499.02
(Ontario)

PROJECT Thorold Tunnel.....

HOLE NO E-6.....

SITE South Tunnel Wall

SHEET NO .1 of 1

DEPTH (FT.)	DISCONTINUITY (JOINT, AULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION											MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING +	STAINING ++	BLEACHING		
0.0 to 0.6	Closed fracture	0°					x							
2.8 to 3.0	Core fractured, minor chemical weathering	Vari					x							
6.3	Bentonite seal													
6.7	Core fractured exhibits minor chemical leaching													
8.7	Fracture exhibits chemical leaching	Vari					x							
11.0	Joint	35°	x		x									
11.5	Fracture	Vari		x		x								
12.0	End of borehole													
Vari = Variable														

C = CARBONATE H = HEMATITE K = CHLORITE

++ Br = BROWN + Gy = GRAY

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

DRILLING REPORT

CLIENT Department of Transportation and Communications JOB No. P2499.02
 (Ontario)

PROJECT Thorold Tunnel HOLE No. P-3

SITE South Tunnel Wall SHEET No. 1 OF 1

CONTRACTOR: Canadian Longyear Ltd. STARTED .M. Oct. 15 19 71
 FINISHED .M. Oct. 15 19 71

METHOD SOIL CASING DIAM.
 OF
 DRILLING: ROCK Diamond Drill CORE DIAM. Ax
 Station

LOCATION: LATITUDE 54 + 53 ELEVATIONS: DATUM at wall face: 530.69 ft
 DEPARTURE
 BEARING South DRILL PLATFORM
 INITIAL DIP 10° GROUND SURFACE 529.21 ft
 OTHER DIPS ROCK SURFACE
 BOTTOM OF HOLE
 WATER TABLE

DEPTH Feet	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
0.0 to 6.55		Tunnel Wall Concrete: The concrete core from the tunnel wall is fractured, but the fracture faces do not exhibit chemical weathering or leaching of the cement. Steel reinforcing - 0.2 foot	
6.55		Bentonite seal.	
6.57 to 8.75		Bulkhead Concrete: The core at the bentonite bulk-head interface contains more fractures than the tunnel wall concrete and exhibits minor chemical leaching. Clean water flowed steadily after the hole was drilled.	
8.75 to 10.3	Shaly Limestone	Lockport formation (Gasport Member), dark grey, fine-grained, dense, distinct sub-horizontal bedding cleavage, abundant fossils in strained state.	99.03
10.3		End of Borehole.	

INSPECTOR W. B. Pratt

LOGGED BY M. Walia

APPROVED

DATE

J. Broadshaw
 March 1972

H. G. ACRES LIMITED - NIAGARA FALLS

DRILLING REPORT

(CORE DETAILS)

CLIENT Department of Transportation and Communications JOB NO P2499.02
(Ontario)

PROJECT Thorold Tunnel.....

HOLE NO P-3

SITE South Tunnel Wall

SHEET NO 1 OF 1

DEPTH (FT.)	DISCONTINUITY (JOINT FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION										MUTUAL ANGLE
			SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING +	STAINING ++	BLEACHING	
0.00 to 0.30	Fracture	Vert		x			x						
0.50	Fracture	Vert		x			x						
0.65	Fracture			x		x	x						
1.65 to 2.00	Fracture sub-parallel to the core axis	0°		x		x	x						
2.50	Fracture						x						
6.35	Fracture						x						
6.55	Bentonite seal												
8.10	Fracture, exhibits chemical weathering						x						
8.80	Core fractured exhibits chemical leaching of the cement						x						
10.30	End of Borehole												

C = CARBONATE H = HEMATITE K = CHLORITE

++ Br = BROWN + Gy = GRAY

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1006
 SITE Scheme 3 Alignment SHEET No. 1 OF 4
 CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 2:30 P.M. July 14 1964
 FINISHED 9:00 P.M. July 18 1964
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. H 0-5'
 ROCK Diamond Drilling CORE DIAM. NX 0-20.8'
 LOCATION: Chainage 54 + 43.0 ELEVATIONS: DATUM S.L.S.A.
 Offset 266.0' N DRILL PLATFORM 586.6
 BEARING 90° GROUND SURFACE 565.8
 INITIAL DIP ROCK SURFACE 474.3
 OTHER DIPS BOTTOM OF HOLE 474.3
 WATER Level

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	Sawdust and silty clay containing organic material.*						
2.0	Weathered Stratified Silty Clay Crust	Yellowish-brown, stiff to very stiff, medium to highly plastic, some pockets and layers of reddish-brown silt and clayey silt, occasional sand and gravel particles up to 1/2-inch diameter.	1	B0	2	5.0 6.5	10	Driven
			2	B0	2	10.0 11.5	12	Pushed 6" Driven
			3	B0	2	15.0		Pushed 9"
16.5	Relatively Unweathered Stratified Silty Clay	Reddish-grey, stiff, medium plastic, containing reddish-brown silt and clayey silt layers.				16.5	13	Driven
19.0	Silty Till	Very stiff, gravel particles up to 1-inch diameter, fines composed chiefly of	4,5	AQ	2	20.0 20.5 20.8	9	26 30/3

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 - PLIOPILM BAG
 Z - DISCARDED

INSPECTOR D. Schebesch
 LOGGED BY D. Schebesch

APPROVED

DATE

October 15, 1964

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1006
 SITE Scheme 3 Alignment 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	RETD.	
20.8	Bedrock	brownish-grey and reddish-brown clayey silt. See Sheet 3.						

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

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1006
 SITE Scheme 3 Alignment SHEET No. 3 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
20.8	Dolomite and Dolomitic Limestone	Rock Surface Lockport Formation, Goat Island Member Light grey, dense, fine grained. Black shaly partings and <u>stylolites</u> . Vugs at 28.7' to 30', gypsum filled 0.05" to 1" in size.	98
45.3	Dolomitic Limestone	Lockport Formation, Gasport Member Light grey, crinoidal, fine to coarse grained. <u>Stylolites</u> filled with black organic shaly material.	100
50.8	Calcareous Shale	Lockport Formation, Gasport Member Dark grey, fissile, fossiliferous.	100
57.9	Dolomitic Limestone	Lockport Formation, Gasport Member Light grey, crinoidal, fine to coarse grained. <u>Stylolites</u> filled with black organic shaly material.	100
72.0	Dolomite and Dolomitic Limestone	Decew Formation Light to dark grey, dense, fine grained. <u>Conchoidal fractures</u> . 82.5-85.0 - transition zone toward shale below	100
85.0	Calcareous Shale and Limestone	Rochester Formation Dark grey, fissile and fossiliferous shale with limestone interbeds 1/2" to 10" in thickness. 95.0 - struck natural gas pocket	100
112.3		End of hole.	

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

WATER PRESSURE TEST RESULTS

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1006
 SITE Scheme 3 - Alignment SHEET No. 4 OF 4

Test Section Tested No. (feet-inches)	Pressure		Test Duration (Min.)	Steady Absorption (lgpm)	Imp. Gal. Min x Ft x Psi
	Gauge (Psi)	Effective (Psi)			
1 31-0 to 36-3	30	37.8	9	5.5	3.1×10^{-2}
2 32-6 to 39-2	40	47.8	7	8.5	2.7×10^{-2}
3 36-6 to 44-1	45	52.8	8	9.9	2.5×10^{-2}
4 41-6 to 48-0	50	57.8	5	9.5	2.5×10^{-2}
5 49-0 to 53-10	50	57.8	6	8.9	3.2×10^{-2}
6 53-0 to 58-8	60	67.8	8	8.5	2.2×10^{-2}
7 57-4 to 62-8	70	77.8	7	10.5	2.5×10^{-2}
8 85-6 to 90-0	90	97.8	8	0.5	1.1×10^{-3}
9 98-6 to 103-0	100	107.8	7	6.1	1.3×10^{-2}
10 107-9 to 112-3	110	117.8	6	4.5	8.6×10^{-3}

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1009
 SITE Scheme 3 Alignment SHEET No. 1 OF 4
 CONTRACTOR: F.F. Johnston Drilling Co., Ltd. STARTED 10:45 A.M. July 17 1964
 FINISHED 9:30 A.M. July 22 1964
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX 0-23.3'
ROCK Diamond Drilling CORE DIAM. NX 23.3'-111.3'
 LOCATION: Chainage 51 + 82.0 ELEVATIONS: DATUM S.L.S.A.
 Offset 10.5' S DRILL PLATFORM 586.8
 BEARING GROUND SURFACE 563.5
 INITIAL DIP 90° ROCK SURFACE 475.5
 OTHER DIPS BOTTOM OF HOLE
 WATER Level See note

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	RETD	
0	Topsoil	Light brown silty clay, medium consistency, containing organic matter.						
2.0	Weathered Silty Clay Crust	Predominantly medium brown, stratified with layers of multi-shades of brown, medium to stiff, medium plastic.	1	BO	2	5.0 5.5	5	Pushed
			2	BO	2	10.0 12.0	12	Pushed Driven
13.0	Relative-ly Unweathered Stratified Silty Clay	Grey and brown, medium consistency with pockets and layers of grey clay, grey silty clay and brown sandy silt, some scattered angular gravel.	3	BO	2	15.0 17.0	12	Driven
			4	BO	2	20.0 22.0	13	Driven
22.5	Silty Till	Brown, stiff, sandy, gravelly, containing traces of grey clay.						

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 - PLIOPILAM BAG
 Z - DISCARDED

INSPECTOR J. Bateson
 LOGGED BY J. Bateson
Core logged by H. Spaven

APPROVED P. J. Morris
 DATE October 15, 1964

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	
23.3	Bedrock	<p>See Sheet 3.</p> <p><u>NOTE:</u> Water levels measured immediately before pressure tests - Elevation 567.5. \pm 0.6</p>						

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

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1009
 SITE Scheme 3 Alignment SHEET No. 3 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	% CORE
23.3	Dolomite and Dolomitic Limestone	Rock Surface Lockport Formation, Goat Island Member Dense, fine grained, <u>stylolites</u> filled with black organic material. Vugs (.05" to 1") gypsum and chert filled. Beds 1.0' to 2.0' in thickness. 25.4-25.6 - broken core 25.5 - lost drill water 27.0 - <u>joint at 20° to CL</u> 32.4-32.8 - broken core 37.5-38.0 - broken core 45.3 - vug filled with lead sulphide (galena) and quartz 45.4-46.1 - broken core	96
47.6	Dolomitic Limestone	Lockport Formation, Gasport Member Light grey, fossiliferous, <u>stylolites common</u> .	100
56.5	Calcareous Shale	Lockport Formation, Gasport Member Shale with dolomitic limestone. Dense, fossiliferous.	100
61.8	Dolomitic Limestone	Lockport Formation, Gasport Member Light to dark grey, dark undulating lenses of organic shaly material, <u>stylolites common</u> . Bedding 0.5' to 1.0' thick. 67.6-71.6 - coarse grained	100
71.6	Dolomite and Dolomitic Limestone	Decew Formation Dark grey, dense, fine grained, thick bedded 1.0' to 2.0' thick. <u>Conchoidal fractures</u> , few stylolites. 74.0-74.5 - crinoidal, coarse grained Lower sections of core grades into calcareous shale.	100
82.2	Calcareous Shale and Limestone	Rochester Formation Dark grey, dense shale with thin limestone interbeds. Natural gas releases at 85.5', 86.3' and 87.1' at back-pressure 30 psi.	98
111.3		End of hole.	

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

WATER PRESSURE TEST RESULTS

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1009
 SITE Scheme 3 - Alignment SHEET No. 4 OF 4

Test No.	Section Tested (feet-inches)	Pressure		Test Duration (Min.)	Steady Absorption (lqpm)	Imp. Gal. Min x Ft x Psi
		Gauge (Psi)	Effective (Psi)			
1	23-4 to 28-5	30	38.7	5	8.3	4.2×10^{-2}
2	27-6 to 32-11	30	38.7	5	8.7	4.2×10^{-2}
3	32-11 to 38-1	35	43.7	6	8.8	3.9×10^{-2}
4	37-1 to 42-3	40	48.7	5	9.3	3.7×10^{-2}
5	42-3 to 47-5	50	58.7	6	8.8	2.9×10^{-2}
6	46-10 to 53-10	55	63.7	5	8.2	1.8×10^{-2}
7	53-10 to 59-2	60	68.7	5	9.6	2.6×10^{-2}
8	59-2 to 64-4	65	73.2	6	7.8	2.1×10^{-2}
9	64-4 to 69-6	70	78.7	5	1.6	3.9×10^{-3}
10	69-5 to 74-8	75	83.2	5	0	0
11	75-6 to 80-8	80	87.2	6	1.1	2.4×10^{-3}
12	79-9 to 85-8	86	94.7	5	0	0
13	84-9 to 89-11	90	98.2	6	1.9	3.7×10^{-3}
14	89-9 to 95-0	95	103.2	5	0	0
15	95-0 to 100-9	100	108.6	5	0.2	3.2×10^{-4}
16	100-9 to 106-1	105	113.6	5	0.2	3.0×10^{-4}
17	106-1 to 111-4	110	118.2	8	0.7	1.1×10^{-3}

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

DRILLING REPORT

CLIENT Department of Highways Ontario JOB No. 1161
 PROJECT Thorold Tunnel HOLE No. 1024
 SITE Scheme 3 Alignment SHEET No. 1 OF 3
 CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 4:30 P.M. August 7 1964
 FINISHED 4:30 P.M. August 8 1964
 METHOD OF DRILLING: SOIL Modified Wash Boring CASING DIAM. NX 0-5'
ROCK CORE DIAM. _____
 LOCATION: Chainage 53 + 43.5 ELEVATIONS: DATUM S.L.S.A.
 Offset 0.0 DRILL PLATFORM _____
 BEARING _____ GROUND SURFACE 588.9
 INITIAL DIP 90° ROCK SURFACE 563.4
 OTHER DIPS _____ BOTTOM OF HOLE 563.4
 WATER Level _____

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	Topsoil	Black organic silty clay.						
1.0	Sandy Silt	Light brown, containing some organic matter, clay, and occasional gravel particles.						
4.0	Weathered Stratified Silty Clay Crust	Light brown, very stiff to hard, containing layers and pockets of various shades of brown clay and silt, occasional sand and gravel size particles, medium to highly plastic, stiffness and plasticity decreasing with depth.	1	BO	2	4.0		
						4.8	7	Driven
			2	BO	2	4.8		
						5.3		10
						5.8		22
						6.3	10	23
		Thin veins and speckles of calcium carbonate.	3	AQ	2	6.3		
						6.8		27
						7.3		41
						7.8	9	53

SAMPLING METHOD

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

E — AUGER
 F — WASH

SHIPPING CONTAINER

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

R — CLOTH BAG
 S — PLIOFILM BAG
 Z — DISCARDED

INSPECTOR J. Bateson

LOGGED BY J. Bateson

APPROVED

P. J. Morris

DATE

October 15, 1964

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

DRILLING REPORT

CLIENT Department of Highways Ontario

JOB No. 1161

PROJECT Thorold Tunnel

HOLE No. 1024

SITE Scheme 3 Alignment

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	
19.5	Relatively Unweathered Stratified Silty Clay	Reddish-brown, stiff to very stiff, containing layers of brown and reddish-brown clay, brownish-grey silt, clayey silt and silty fine sand, medium plastic, occasional gravel particles and rock fragments.	4	AQ	2	7.8		10
						8.3		19
						8.8		21
						9.3	12	
			5	AQ	1-1/2	9.3		14
						9.8		20
						10.3		25
						10.8	12	
			6	BO	2	10.8		
						12.8	16	Driven
				BO	2	12.8		
						13.5	0	Driven
			7	AQ	2	13.5		2
						14.0		7
						14.5		5
						15.0	12	
			8	BO	2	15.0		
						17.0	15	Driven
			9	BO	2	17.0		
						19.0	18	Driven
			10	BO	2	19.0		
						19.6	7	Pushed

DRILLING REPORT

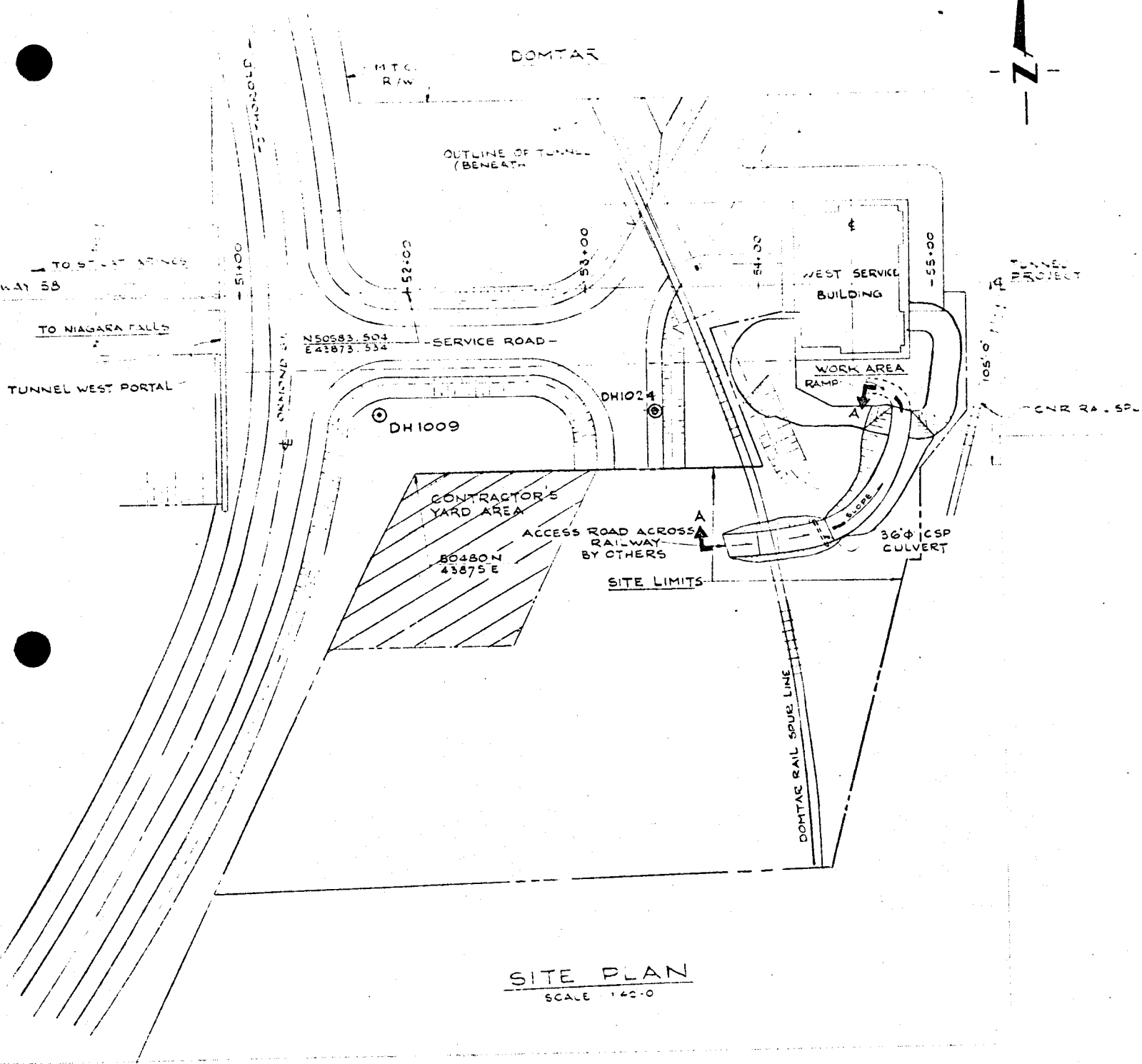
JOB No. 1161

HOLE No. 1024

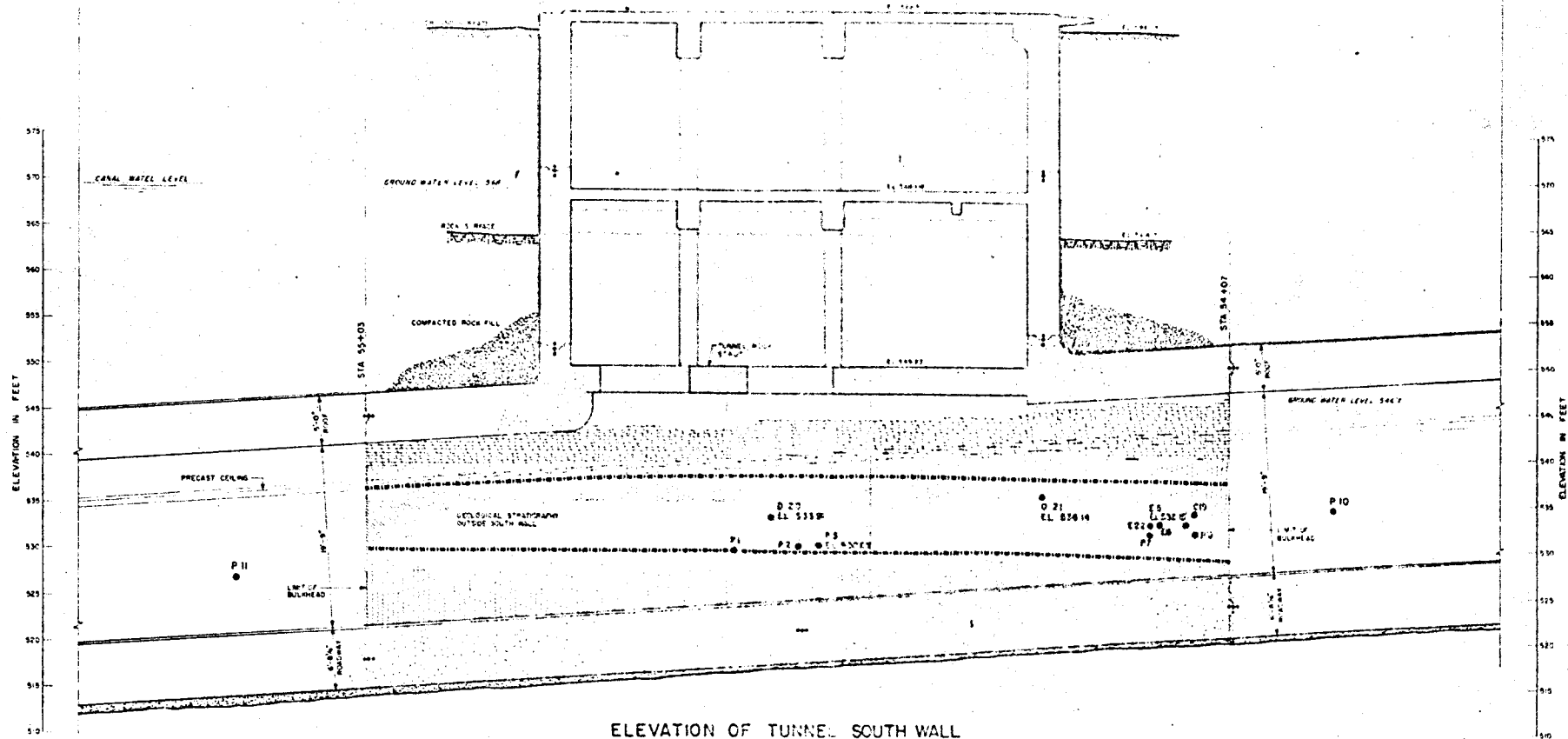
SHEET No. 3 OF 3

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	
		Fine sand seam.	11	AQ	2	19.6 20.1 20.6 21.1	12	4 11 16
			12	BO	2	21.1 23.0	15	Pushed
			13	BO	2	23.0 25.0	18	Pushed
			14	AQ	2	25.0 25.5	6	5
25.5	Bedrock	End of Hole.						

APPENDIX II



BORE HOLE LOCATIONS
 (BY F-E JOHNSTON DRILLING CO. Ltd. in 1964)



ELEVATION OF TUNNEL SOUTH WALL
LOCATIONS OF HORIZONTAL & INCLINED HOLES BY CANADIAN LONGYEAR Ltd. in 1971

FIG. 2 W.O. 72-11096

STATION	ELEVATION	DEPTH	DIAMETER	LENGTH	ANGLE	REMARKS
1	534.00	2.0	1.0	10.0	90°	MINUTE
2	533.97	2.0	1.0	10.0	90°	MINUTE
3	534.00	2.0	1.0	10.0	90°	MINUTE
4	534.00	2.0	1.0	10.0	90°	MINUTE
5	534.00	2.0	1.0	10.0	90°	MINUTE
6	534.00	2.0	1.0	10.0	90°	MINUTE
7	534.00	2.0	1.0	10.0	90°	MINUTE
8	534.00	2.0	1.0	10.0	90°	MINUTE
9	534.00	2.0	1.0	10.0	90°	MINUTE
10	534.00	2.0	1.0	10.0	90°	MINUTE

LEGEND

- SPAT. SAND DOLOMITE WITH SOME DOLOMITIC Limestone
- GASTROST. Limestone (SLIGHTLY DOLOMITIC)
- GASTROST. SHALY Limestone (SLIGHTLY DOLOMITIC)
- APPROXIMATE BOUNDARY OF ZONE OF INCLINED STRATIFICATION

NOTE

- 1. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 2. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 3. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 4. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 5. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 6. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 7. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 8. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 9. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.
- 10. ALL POINTS ARE SHOWN WITH AN ELEVATION OF 534.00 FEET.

	DEPARTMENT OF TRANSPORTATION AND COMMUNICATIONS
	TUNNEL STRUCTURAL INVESTIGATIONS
WEST SERVICE BUILDING FIELD INVESTIGATIONS	
	FEBRUARY 1972
PLATE 4	

CONT. No. 72-216
W. P. No. 48-72-02

8

SHEET

STA. TO STA.

THOROLD TUNNEL

ROCK SLOTTING
PROPOSED INSTRUMENTATION

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS

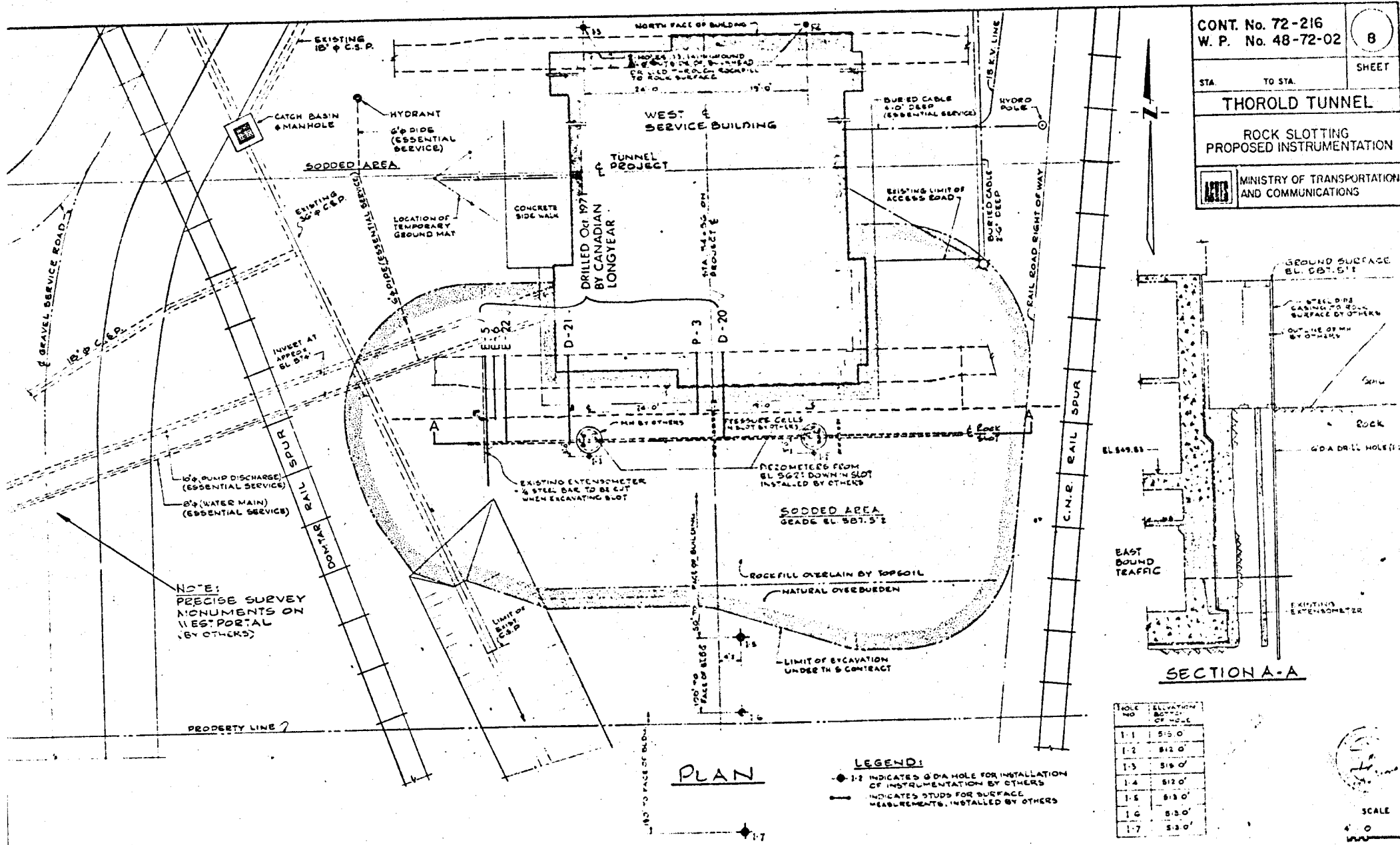


FIG. 3

W.O. 72-11096

BRIDGE SITE No. 34-177

APPENDIX III



Proposed Method

of

Excavation of Slot at Thorold Tunnel.

Contract 72-216.

*Place in
Main File*

Becker will use a rotary drill (Failing type) for the drilling operation.

First a vertical hole using a 6.1/4 inch diameter tricone bit will be drilled at one end of the slot location, within the limits of verticality required and to the depths as per specification. Air will be used as the cleaning medium, with water as an alternative.

A second hole of same diameter will be drilled overlapping the first hole so as to give a minimum of a 4 inch wide slot connecting the two holes. A guide will be placed in the first hole to keep the second hole on line and maintain the 4 inch clearance or slot width.

Subsequent holes will be drilled in line as per specification with the guide being placed in the last hole drilled and the next hole overlapping, and thus the slot will be progressively drilled by overlapping the holes.

The slot will be kept clean as drilled but in the event that debris is left in bottom Becker can clean out with their air lift method.

J.F. Short.

*John started out this way & then changed
to alternate holes in first pass, drill out
with on 2nd pass. Equipment was as proposed*



ORIGINAL



Subsequent

APPENDIX IV

May 3, 1973
P2499.05

THOROLD TUNNEL

CONTRACT 72-216

MINUTES OF MEETING
Held at Thorold Tunnel
on Tuesday, April 24, 1973

PRESENT:

Mr. L. D. Fisher)	Ministry of Transportation
Mr. L. Thomas)	and Communications
Mr. F. Becker)	Becker Drills Limited
Mr. R. Short)	
Mr. R. G. Tanner)	Acres Consulting Services
Dr. C. F. P. Bowen)	Limited
Mr. D. R. Pettey)	

SUMMARY OF DISCUSSIONS

1 - Drilling Equipment

Becker propose to use a Failing drill (1500) CFD1, mounted on I beam rails, to cut the slot. They plan to drill 6-5/8-inch diameter holes and ream them to 9 inches if necessary.

2 - Accuracy of Location

The slot shall be located within 2 inches of the required alignment at the rock surface.

3 - Enlargement of Excavation

Becker requested that the overburden excavation be enlarged in the cross slot area, if possible, to accommodate their drill. It was agreed that any arrangements to enlarge the excavation would have to be made with Moir Construction Company Limited, and approved by Acres, at no extra cost to the Ministry.

