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GEOCRES No. 31F-76

DIST. 9 REGION

W.P. No. 197-62-00

CONT. No. 78-42

W. O. No.

STR. SITE No.

HWY. No. 17N

LOCATION Arnprior By-Pass

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ministry of Transportation and Communications

Ontario

31F-76

GEOCRES No.

Memorandum

To: T.C. Kingsland (2)
Reg. Structural Planning Engineer
Eastern Region
Kingston

Attention:

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Date: June 2, 1975

Our File Ref.

In Reply to

Subject:

PRELIMINARY FOUNDATION INVESTIGATION REPORT

for

Proposed Hwy. 17N Arnprior Bypass
Twp. of McNab, Co. of Renfrew
W.P. 197-62-00
DIST. 9

Attached we are forwarding to you our Preliminary Foundation Investigation Report on the subsoil conditions existing at the above mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

M. Devata

M. DEVATA
Supervising Engineer

c.c. E.J. Orr
B.R. Davis
B.J. Giroux
G.A. Wrong
A.J. Percy
E.R. Saint
J.M. Childs
R. Hore

J. Anderson) memo only
R. Forest)

Files
Record Services

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PRELIMINARY FOUNDATION INVESTIGATION REPORT
for
Proposed Hwy. 17N Arnprior Bypass
Twp. of McNab, Co. of Renfrew
W.P. 197-62-00

1. INTRODUCTION

The Foundation Section was requested to carry out a preliminary foundation investigation at the proposed Hwy. 17N crossings of:

(i) Hwy. 29 Interchange Underpass
(ii) C.P.R. Overhead over relocated C.P.R. tracks
(iii) Madawaska River Bridge
(iv) Baskin Drive Underpass
(v) White Lake Road (County Road 2) Interchange Underpass

all located in the Township of McNab, County of Renfrew.

The request for this foundation investigation was contained in a memo from Mr. T. C. Kingsland, Regional Structural Planning Engineer, Eastern Region, dated October 31, 1974. An investigation was subsequently carried out by this Section to determine the subsoil conditions at the structure sites.

Preliminary Foundation Investigations on the previous alignments for the Arnprior Bypass were carried out by this Section, and the findings were presented in our Foundation Report, WJ-69-F-19, dated June 1969.

This report presents information on the subsoil and groundwater conditions encountered at the proposed structure locations along the most recent alignment. Included are recommendations pertaining to foundation design, as well as the stability of the approach fills.

2. DESCRIPTION OF THE SITE AND GEOLOGY

The portion of the proposed Hwy. 17N under consideration is located due south of Arnprior, bounded by Hwy. 29 on the east and existing Hwy. 17 on the west. The tableland in the area is flat to gently undulating in relief between about elevations 340 and 350. This land is cultivated and being used for farming purposes.

The Madawaska River is deeply incised into the topography within this area. The river is approximately 1,400 feet wide from crest to crest with the water level being at about elevation 259 - i.e., approximately 80 feet below the high ground. The slope of the banks vary from fairly steep (3:1) to moderately flat. Visual observations, made during the period of the investigation, indicate that, in the vicinity of the crossings, bedrock outcrops in the river and partially up the west bank, and also at certain locations west of the Madawaska River.

The present C.P.R. track traverses along the east bank of the Madawaska River. The track is situated on a terrace located between 30 and 40 feet below the tableland. The Ontario Hydro Dam Project in Arnprior necessitates the relocation of the C.P.R. The relocated C.P.R. tracks will be about 525 feet east of the present tracks location. Cuts up to 35 feet with 2.0:1 slopes will be made to accommodate the new C.P.R. Line, which is constructed in conjunction with the Hydro Project.

In Renfrew County there are prominent east-west trending scarps (fault zones) on both sides of a valley which encompasses the alignments being investigated. The south-westerly one, lying south of Calabogie Lake and Clear Lake, is known as the St. Patrick fault, while on the north-eastern side the Coulonge fault separates the valley from the Laurentian Plateau. Thus a block, 35 miles in width, has been down-dropped, forming a depression which is geologically known as the "Ottawa-Bonnechère" graben. Within it are many minor breaks, the major of which is, as far as this project is concerned, the Packenham fault; this north facing scarp traverses between Packenham and Arnprior.

East of the Madawaska River the bedrock is overlain by up to 70 feet of overburden, while west of the river it is generally covered by only a thin surficial mantle. On the east side the overburden consists of clay covered by a thin discontinuous veneer of sand. These sediments were both laid down in the Champlain Sea. The sand is a deltaic alluvial deposit, while the clay is of marine origin. On the west bank a thin deposit of clay directly overlies bedrock.

The drainage in the area is provided by the Madawaska River.

3. FIELD AND LABORATORY WORK

Nine boreholes were put down recently along the proposed Hwy. 17N. The borings were advanced by using a conventional diamond drill rig adapted for soil sampling purposes. B.H. #102 was accompanied by a dynamic cone penetration test. The information for Boreholes No. CP-29, -34, and -39 was prepared by Acres Consulting Services Ltd. for The Hydro-Electric Power Commission of Ontario (CPR Relocation). The findings of these boreholes are incorporated in our Drawing No. 1976200-A. The field work for Borehole Y-4 was done by this Section in April 1969 (for the former alignment) and is also shown on the same drawing.

Samples of the overburden were obtained at specified intervals, in a 2" O.D. split-spoon sampler, which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used for the Standard Cone Penetration Test. In the cohesive portion of the overburden the aforementioned was supplemented by taking 2" I.D. Shelby tubes, which were pushed hydraulically into the soil. In addition, field vane tests were carried out, where feasible, to determine the undrained shear strength of the clay stratum. Bedrock was proven in 5 of the 9 boreholes put down recently by obtaining from 4 to 10 feet of BXL size rock core samples. B.H.'s CP-34, CP-39, and CP-29 put down in conjunction with the Ontario Hydro Project were also cored.

The groundwater level conditions across the site were determined, during the course of the investigation, by recording the water levels in the open boreholes.

The soil conditions encountered at the boring locations are presented on the Record of Borelog sheets. The location and elevation of the various boreholes were provided by personnel from the Eastern Region Engineering Surveys Section. The elevations in this report are referenced to geodetic datum. Boring locations and elevations are shown on Drawing 1976200-A, together with an estimated stratigraphical profile along Hwy. 17N E.B.L.

All the samples were subjected to a careful visual examination in the field, and subsequently in the laboratory. Following this examination, laboratory testing was carried out on selected representative samples to determine the following engineering properties of the overburden:

Bulk Densities
Natural Water Contents
Atterberg Limits
Grain-Size Distributions
Undrained Shear Strengths
Consolidation Characteristics

The results of this testing are plotted on the Record of Borelog sheets and Figures 1 and 2, contained in Appendix I of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The extent and type of the overburden varies within the area under investigation. On the east side of the Madawaska River, the predominant stratum is a firm to very stiff silty clay to clayey silt varying from 20 to 44 feet in thickness; the thickness generally increases in a southerly direction. In the vicinity of the river the clay is capped by a mantle of loose to compact sand to silty fine sand between 1 and 14 feet in depth. The clay stratum is underlain by sound crystalline limestone bedrock. In some of the boreholes, a thin deposit (up to about 2 feet) of silty sand to sandy silt was sandwiched between the cohesive material and bedrock.

As discussed previously, bedrock outcrops in the river bed, and partially along the west slope of the river bank. On the west side of the Madawaska River, the bedrock is capped by various thicknesses of silty clay to clayey silt deposits. However, few hundred feet east of Baskin Drive bedrock was encountered either at ground surface or immediately below a thin cover of granular material.

The stratigraphy encountered at the borings is plotted on the Record of Borelog sheets. A stratigraphical profile along the proposed Hwy. 17N, E.B.L. has been inferred from this data and plotted on Drawing No. 1976200-A. The subsoil encountered from ground surface downward, is presented in the following sub-sections.

4.2) Surficial Deposits:

A thin layer of topsoil (0.5' to 2.0') was encountered in most of the boreholes. The area in the immediate vicinity of the east bank of the Madawaska River is surficially covered with a deposit composed

of loose to compact fine sand to silty fine sand. Some gravel was also encountered within the granular material at B.H. CP-34. Clayey silt seams were present within this deposit at B.H. CP-39. The thickness of this deposit in Boreholes CP-34 and CP-39 is 14 and 3 feet respectively.

4.3) Clayey Silt to Silty Clay (Sensitive)

4.3.1) General:

Underlying the surficial deposits, except where bedrock outcrops, is the predominant stratum across the area; this stratum is composed of a brown to grey clayey silt to silty clay with occasional sand or silt seams.

In general, the thickness of the cohesive subsoil (20 to 44 feet) is more extensive along the east side of the Madawaska River valley. However, on the west side of the river valley, the cohesive deposit varies randomly in depth and its thickness in certain locations is as much as 23 feet. The upper portion of the stratum is mottled grey-brown in colour, indicating this zone has been desiccated. Occasional sand and silt seams and partings were encountered within the stratum.

Atterberg limit tests were carried out on representative samples of the clay; the results of this testing, which are given on the Borelog sheets, are summarized on the Plasticity Chart, Figure #2. The results indicate that the liquid and plastic limits vary from 30 to 50 (average 39) and 15 to 27 (average 21), respectively. Based on these values, it is estimated that the stratum is inorganic with the plasticity being typically in the low to intermediate range. The natural moisture contents range from 25 to 53 percent, (average 39).

4.3.2) Shear Strength - Compressibility Characteristics:

The field and laboratory undrained shear strength results are plotted on the Record of Borelog sheets. The consolidation characteristics of the stratum were determined by carrying out 4 consolidation tests, the results of which are shown as Void Ratio vs. Pressure plots on Figure #1. The clay is most extensive east of the river; the correlated engineering properties, in this area, are summarized below.

i) Area Immediately East of the Madawaska River - (B.H.'s 106 and 107) -

The undrained shear strength, in this stratum exceeds 2,000 p.s.f. Based on these results, it is estimated that the consistency of this zone is very stiff. The consolidation testing carried out for the former alignments within this area indicates that the clay is preconsolidated in excess of existing overburden pressure by approximately 3 to 4 t.s.f. throughout.

ii) Hwy. #29 Interchange - (B.H.'s 108 and 109)

The undrained shear strength in the upper desiccated portion (upper 15 feet) varies from 1,830 to greater than 2,000 p.s.f. In the lower zone, however, the strength varies between 1,440 and 720 p.s.f. It is estimated, therefore, that the consistency of the desiccated zone ranges from stiff to very stiff. Below this zone, however, it ranges from stiff to firm. The consolidation testing indicates that the clay is preconsolidated in excess of existing overburden pressure by approximately 1 to 2 t.s.f. throughout.

iii) White Lake Road Interchange (B.H. 110)

The undrained shear strength in the upper desiccated portion (upper 14 feet), exceeds 2000 p.s.f. In the lower zone, however, the strength varies between 680 and 880 p.s.f. Based on these results, it is estimated that the consistency of the desiccated zone is very stiff, and firm for the lower zone. The consolidation test indicates that the clay is preconsolidated on excess of existing overburden pressure by approximately 1.3 t.s.f.

iv) Approaches for the Madawaska River (B.H. 102)

The undrained shear strength in this stratum exceeds 2,000 p.s.f. Based on these results, it is estimated that the consistency of this zone is very stiff. The consolidation testing indicates that the clay is preconsolidated in excess of existing overburden pressure by approximately 4 t.s.f.

4.4) Bedrock:

Bedrock outcrops in the river, partially up the west bank and in the vicinity of B.H. 101. For the rest of the area, however, it underlies the overburden described in the previous sub-sections.

Bedrock was proven at 5 of the 9 borings put down recently by obtaining between 4 and 10 feet of BXL rock core. The surface of the bedrock is quite variable across the area in question, ranging from elevation 340 (B.H. 101) to elevation 263 (in the Madawaska River). The bedrock profile is shown in detail on Drawing 1976200-A.

The bedrock is a massive, medium to coarse grained crystalline limestone with occasional calcite inclusions. Where drilled the bedrock was sound, as evidenced by the high percentage of core recovered. Numerous faults cross this physiographic region, however, (refer to Section 2); some areas may, therefore, be badly fractured.

5. GROUNDWATER CONDITIONS:

Groundwater level observations have been carried out, during the period of the investigation, in the open boreholes. The observations are recorded on the borelog sheets and summarized on Drawing 1976200-A. It is considered that the lower levels observed adjacent to the river are indicative of the natural drawdown occurring towards the river level (elev. 259).

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

Proposed Hwy. 17N will be a 4-lane divided highway incorporating a 100' median. The discussion presented herein is applicable for that portion of the proposed highway traversing between the proposed relocation of Hwy. #29 and White Lake Road (County Rd. No. 2). This section will form the Arnprior By-Pass network. Preliminary Foundation Investigations on the previous alignments for the Arnprior Bypass were carried out by this Section, and the results were presented in our Foundations Report W.J. 69-F-19. The Ontario Hydro Dam Project in Arnprior necessitates the presently proposed new alignment for Hwy. 17N. The Hydro Project also results in the relocation of the C.P.R. tracks. The relocated C.P.R. tracks will be about 525 feet east of the present tracks location.

For the proposed Hwy. 17N, the following structures are being considered within the study area of this Report:

i) Hwy. 29 Interchange Underpass
ii) C.P.R. Overhead over relocated C.P.R. tracks
iii) Madawaska River Bridge
iv) Relocated Baskin Drive Underpass
v) White Lake Road (County Road 2) Interchange Underpass

Preliminary recommendations pertaining to structure foundations, as well as stability of the approach fills, are given in the tables to follow.

I

FOUNDATION RECOMMENDATIONS

LOCATION Proposed Hwy. 17N & Hwy. 29 Interchange Underpass

SITE No. BOREHOLE (S) No. 108, 109, & Y-4

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
345.8 B.H. #108	0.0 - 0.9 Topsoil (0.9') 0.9 - 2.0 Clayey silt, some sand (1.1') 2.0 - 2.5 Sand (0.5') 2.5 - 45.0 Silty clay to clayey silt -brittle and sensitive Very stiff- 2.5 to 15.0 Stiff to firm - 15.0 to 45.0 (42.5') 45 - 47.3 Silty sand some gravel Very Loose (2.3') Refusal to augering elev. 298.5-probable bedrock Water Level - elev.343.8	Pier(s) Spread Footings - as high as possible within the very stiff zone of silty clay stratum-allowable bearing pressure - 2 t.s.f. alternatively, End-Bearing Piles - driven to bedrock Designed for the maximum capacity of the pile section chosen. Abutments Spread Footings - perched within the approach fills constructed of granular material - allowable bearing pressure - 2.5 t.s.f. alternatively, End-Bearing Piles - driven to bedrock -designed for the maximum capacity of the pile section chosen	Stability - up to 25 ft. fills are proposed - the proposed fill heights constructed with 2:1 slopes will be stable with respect to an overall deep-seated failure. Settlement Considerations The induced stresses beneath the proposed embankment heights will not exceed the preconsolidation pressure of the soil. Therefore settlement will be of a recompression nature - i.e., take place during or immediately following the construction period. The amount of settlement will be about 4 to 5 inches.	Proposed grades: Hwy. 17 - 352 ft. Hwy. 29 - 374 ft.

FOUNDATION RECOMMENDATIONS

LOCATION Proposed Hwy. 17N & Hwy. 29 Interchange Underpass (Continued)

SITE No. BOREHOLE (S) No. 108, 109, and Y-4

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
346.4 B.H.#109	0.0 - 1.0 Topsoil (1.0') 1.0 - 39.0 Silty clay to clayey silt -brittle and sensitive Very Stiff - 1.0 to 15.5 Stiff to Firm - 15.5 to 39 (38.0') 39.0 - 40.5 Sandy silt, some gravel Very Loose (1.5') Sound limestone bedrock-elev. 305.9 Water level - elev.346.4			
348.5 B.H. #Y-4	0.0 - 1.5 Topsoil (1.5') 1.5 - 21.8 Clayey silt to silty clay, trace of sand V.Stiff to Stiff-1.5 to 13.0 Stiff to firm - 13.0 to 21.8 (20.3') Sound limestone bedrock-elev. 326.7 Water level-elev.345.9			

FOUNDATION RECOMMENDATIONS

LOCATION CPR Overhead over relocated CPR tracks (cont'd)

SITE No. BOREHOLE (S) No. CP-39

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
340.4 B.H. # CP-39	0.0 - 2.0 Topsoil (2.0') 2.0 - 5.0 Silty sand with clay Loose to Compact (3.0') 5.0 - 35.5 Silty clay Very Stiff to Stiff (30.5') 35.5 - 36.2 Silty sand & gravel (0.7') Sound limestone bedrock- elevation 304.2 Water Level - elev.333.4			

FOUNDATION RECOMMENDATIONS

LOCATION C.P.R. Overhead Over Relocated C.P.R. tracks

SITE No. BOREHOLE (S) No. CP-29, -34, and -39

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
342.1 B.H. # CP-29 341.5 B.H. # CP-34	0.0 -19.7 Silty Clay with lenses of fine silt and sand Firm (19.7') Sound limestone bedrock -elev. 322.4 0.0 - 0.5 Topsoil (0.5') 0.5 - 9.5 Sand with some gravel- loose to compact (9.0') 9.5 - 14.5 silty sand, some clay loose (5.0') 14.5 - 52.1 silty clay stiff to firm (37.6') Sound limestone bedrock- elevation 289.4	Abutments End-Bearing Piles - driven to bedrock -designed for max. capacity of the pile section chosen Spread Footings - within silty clay stratum - allowable bearing pressure - 2 t.s.f. Piers Spread Footings - on sound bedrock allowable loads up to 20 t.s.f.	Cuts up to 35' in depth with 2 horizontal to 1 vertical slope made to relocate the C.P.R. tracks (in conjunction with the Ontario Hydro Project)	Bedrock elevation will be determined when the footing locations are finalized.

III

FOUNDATION RECOMMENDATIONS

LOCATION Madawaska River Bridge

SITE No. BOREHOLE (S) No. 102, 105, 106, and 107

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
289.6 B.H. #105	0.0 - 1.0 Topsoil (1.0') Sound Limestone bedrock - elev. 288.6	Abutments East Bank End-Bearing Piles - driven to bedrock -designed for max. capacity of the pile section chosen Or, Spread Footings - within the clay stratum - allowable bearing pressure - 2 t.s.f. West Bank End-Bearing Piles - driven through fill to bedrock -designed for max. capacity of the pile section chosen Piers Spread Footings - founded on sound bedrock -allowable bearing pressure up to 20 t.s.f.	Stability 1) No stability problems anticipated for the shallow cuts (up to 8 ft.) required at the east bank, if constructed with standard 2:1 slopes. 2) Fills up to 33 feet are proposed in order to form the approaches on the west side of the river. No stability problems anticipated for fills with standard 2:1 slopes. Forward slopes of the approaches, near the river banks, should not be trimmed steeper than the existing slopes. Settlement Considerations 2 to 4 inches of settlement anticipated due to the construction of the approaches on the west side of the river. Settlements will occur during or immediately following the construction period.	All surficial organic material should be removed. The precise location of footings are not known at present. Piles may have to be fitted with Oslo Points to penetrate into sloping bedrock. Dewatering for the piers construction required if footings placed within river channel.
272.2 B.H. #106	0.0 - 0.5 Topsoil (0.5') 0.5 - 4.0 Clayey silt, trace to some sand Stiff (3.5') Sound limestone bedrock-elev. 268.2			

FOUNDATION RECOMMENDATIONS

LOCATION Madawaska River Bridge (cont'd)

SITE No. BOREHOLE (S) No. 102, 105, 106 and 107

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
334.4 B.H. #107	0.0 - 2.0 Topsoil (2.0') 2.0 - 3.0 Silty Sand Loose (1.0') 3.0 - 33.5 Clayey silt to silty clay - occ.silt and fine sand seams V. Stiff to Stiff (30.5') Refusal to augering elev. 300.9 - probable bedrock Water level - elev.323.2			
290.2 B.H. #102	0.0 - 2.0 Topsoil (2.0') 2.0 -23.0 Clayey silt to silty clay some silt and fine sand seams Stiff to V. Stiff (21.0')			

FOUNDATION RECOMMENDATIONS

LOCATION Madawaska River Bridge (cont'd)

SITE No. BOREHOLE (S) No. 102, 105, 106 and 107

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
	Refusal to augering elev. 267.2 - probable bedrock Water level elev. - 274.2			

FOUNDATION RECOMMENDATIONS

LOCATION Baskin Drive Underpass

SITE No. BOREHOLE (S) No. 101

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
346.6 B.H. #101	0.0 - 1.0 Topsoil (1.0') 1.0 - 2.1 Sandy Silt Compact (1.1') Sound limestone bedrock - elev. 344.5 Water level - elev. 342.6	Pier(s) Spread Footings - founded on sound bedrock -allowable bearing pressure up to 20 t.s.f. Abutments Closed Type Spread Footings - For closed type abutments founded on bedrock - allowable bearing pressure up to 20 t.s.f. perched type perched within the approach fills constructed of granular material -allowable bearing pressure 2.5 t.s.f. or, End Bearing Piles - driven through fill to bedrock -approx. tip elev. 344 -designed for max. capacity of the pile section chosen	Stability Approaches 20-25 feet high will be constructed. No stability problems are anticipated for the embankments if constructed with 2:1 slopes. Settlements Negligible	Relocated Baskin Drive will be situated about 250' east of the present location. The proposed elevation of 17N in this area is about 349. The proposed grade of the relocated Baskin Drive is not known at present. All surficial organic material should be removed.

V

FOUNDATION RECOMMENDATIONS

LOCATION White Lake Road (County Road 2) Interchange Underpass

SITE No. BOREHOLE (S) No. 110

GROUND ELEV.	SUBSOIL CONDITIONS (STRATUM THICKNESS FT.)	STRUCTURE	APPROACHES	REMARKS
350.6 B.H. No. 110	0.0 - 24.0 Silty Clay to Clayey Silt Very Stiff to Firm (24.0') Sound - limestone bedrock - elev. 326.6 Water level - elev. 347.0	Abutments Spread Footings - perched within the approach fills constructed of granular material - allowable bearing pressure - 2.5 t.s.f. Or, End Bearing Piles - driven to bedrock. Estimated tip elev.325 - designed for the maximum capacity of the pile section chosen. Piers: spread footings at elev. 350 - allowable bearing pressure 2.0 t.s.f. -alternatively on end bearing piles to bedrock approx. elev. 325 - designed for the maximum capacity of the pile section chosen.	Stability Up to about 22 ft. fills are proposed. The proposed embankments constructed with 2:1 slopes will be stable. Settlement Considerations The induced stresses beneath the proposed embankment heights will not exceed the preconsolidation pressure of the soil. Therefore settlement will be of a recompression nature - i.e. take place during or immediately following the construction period. The amount of settlement will be about 3 to 4 inches.	Proposed grades Hwy. 17 354 ft. Cty. Rd.2 372 ft.

7. MISCELLANEOUS

The field work, performed between December 3, 1974 and December 18, 1974, was supervised by V. Katic, Technician for H.Q. Golder and Associates, Ltd.

The equipment used was owned and operated by Atcost Soil Drilling Inc.

This report was written by Mr. H. Shah, Project Engineer, and was reviewed by Mr. M. Devata, Supervising Engineer.

H. Shah

H. SHAH
Project Engineer

M. Devata

M. DEVATA
Supervising Engineer

May 1975

APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 101

W.P. 197-62-00 LOCATION Sta. 755+30 55' Rt. of ℄ E.B.L.(Arnprior By-Pass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 17 & 18, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	UNIT WEIGHT	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV.	20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	W_P W W_L WATER CONTENT %	γ	% GR. SA. SI. CL.
346.6	Ground Level									
0.0	Topsoil	~~								
1.0	Sandy silt. Compact	·:·:·	1	SS	12					
2.1	Crystalline Limestone Bedrock	///	2	RC BXL	100%	340				
339.3	Grey Sound									
7.3	End of Borehole					330				

20
15 ⊹ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 102

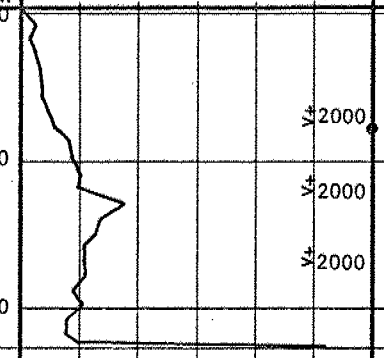
W.P. 197-62-00 LOCATION Sta.778+00 ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 12, 1974 COMPILED BY SO

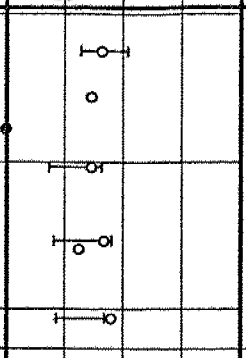
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.
290.2	Ground Level					290
0.0	Topsoil					
2.0	Clayey silt to Silty clay		1	SS	10	
			2	SS	9	
	Some Silt & Fine Sand Seams Grey		3	TW	PH	280
	Stiff to Very Stiff		4	TW	PH	
267.2			5	SS	5	270
23.0	End of Borehole Refusal to Augering Probable Bedrock					260

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000



LIQUID LIMIT —— W_L
PLASTIC LIMIT —— W_P
WATER CONTENT —— W
W_P W W_L
WATER CONTENT %
20 40 60



UNIT WEIGHT γ

122

REMARKS

% GR. SA. SI. CL.

20
15 ⊹ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 105

W.P. 197-62-00 LOCATION Sta. 784+60 124' Lt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 17, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE BXL Core Barrel CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W	UNIT WEIGHT	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV.	20 40 60 80 100 — SHEAR STRENGTH: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	W_P — W — W_L WATER CONTENT %	γ	% GR. SA. SI. CL.
289.6	Ground Level									
0.0	Topsoil					Dry				
1.0	Crystalline Limestone Bedrock		1	BXL RC	100%					
	Grey Sound		2	BXL RC	100%	280				
278.3										
11.3	End of Borehole					270				

OFFICE REPORT ON SOIL EXPLORATION

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 106

W.P. 197-62-00 LOCATION Sta. 794+23 20' Lt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 11, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P — W — W_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL.
272.2	Ground Level									
0.0	Topsoil									
0.5	Clayey silt, trace to some sand. Brown Stiff		1	SS	10	270		○		0 6 76 18
4.0	Crystalline Limestone Bedrock. Grey Sound		2	BXL RC	81%					
263.0										
9.2	End of Borehole					260				

20
15 ◇ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 107

W.P. 197-62-00 LOCATION Sta. 796+80 124' Lt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 10, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [illegible]

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W	UNIT WEIGHT γ	REMARKS / % GR. SA. SI. CL.
334.4	Ground Level						20 40 60 80 100; 400 800 1200 1600 2000	WATER CONTENT % 20 40 60		
0.0 / 332.4	Topsoil									
2.0	Silty sand. Loose		1	SS	9					
3.0	Clayey silt to silty clay, occasional silt & fine sand seams. Grey Stiff to V. Stiff		2	SS	20	330				
			3	TW	PH		●2800 ×2000		111	
			4	TW	PH	320	×2000			
			5	SS	3		×2000			
			6	TW	PH	310	×2000			
300.9			7	SS	8		×2000			
33.5	End of Borehole Refusal to Augering Probable Bedrock					300				

20
15 ⊹ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS - ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 108

W.P. 197-62-00 LOCATION Sta. 832+41 55' Rt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 3 & 4, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w	UNIT WEIGHT	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES	ELEV.	20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 400 800 1200 1600 2000	w_P — w — w_L WATER CONTENT % 20 40 60	γ	% GR. SA. SI. CL.
345.8 0.0	Ground Level Topsoil									
343.8 2.0	Clayey silt, some sand									
343.3 2.5	Sand		1	SS	13					
			2	SS	5	340				
	Silty clay to clayey silt, occ. layered brown becoming grey V. Stiff		3	TW	PH		+2,000 ● + s10.4		111	
	Stiff to Firm		4	SS	1	330	+ s13.0 + s9.6			
	Brittle and sensitive		5	TW	PH		+ s16.0 + s10.0			
			6	SS	1	320	+ s13.0 + s13.3			
			7	TW	PH		+ s13.0 + s23.0			
			8	TW	PH	310	● +		111	
300.8			9	SS	2		+ s20.0			
298.5 47.3	silty sand, some gravel. Very Loose		10	SS	6	300	+ s16.5			
47.3	End of Borehole Probable Bedrock					290				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 109

W.P. 197-62-00 LOCATION Sta. 832+51 187' Lt. of ℄ E.BL. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 5 to 9, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger-BX Casing-BXL R.C. CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (400 800 1200 1600 2000)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL.
346.4	Ground Level									
0.0	Topsoil									
345.4	Silty clay to Clayey silt, occ. layered		1	SS	11					
			2	TW	PH	340				
	Brown becoming Grey		3	TW	PH		≥2000 ≥2000			
	V. Stiff									
	Stiff to Firm		4	SS	1	330	+ s24.0			
			5	TW	PH		● ○ + s24.0 + s18.0		109	
	Brittle and Sensitive		6	TW	PH	320	+ s22.0 + s 10.8		113	
			7	SS	2		+ s 26.0			
			8	TW	PH	310	+ s18.0 + s6.7		112	
307.4	Sandy silt, some gravel, very loose		9	SS	2					
40.5	Crystalline Limestone Bedrock		10	BXL RC	95%					
298.4	Grey Sound		11	BXL RC	100%	300				
48.0	End of Borehole					290				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH - GEOTECHNICAL OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº 110

W.P. 197-62-00 LOCATION Sta. 725+20 70' Rt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY VK

DIST. 9 HWY. 17N BORING DATE December 19 & 20, 1974 COMPILED BY SO

DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger-BX Casing; BXL Rock Core CHECKED BY

SOIL PROFILE ELEV./DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	LIQUID LIMIT W_L, PLASTIC LIMIT W_P, WATER CONTENT W, WATER CONTENT %	UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL.
350.6	Ground Level						20 40 60 80 100 / 400 800 1200 1600 2000	20 40 60		
0.0	Silty clay to clayey silt Brown becoming Grey		1	SS	16	350				
			2	SS	9					
			3	TW	PH		●2,435		114	
	V. Stiff to Stiff		4	TW	PH	340				
	Firm		5	SS	4					
	(Sensitive)		6	SS	2		+ s44.0			
326.6			7	TW	PH	330	+ s34.0			
24.0 322.5	Crystalline Limestone Bedrock. Grey Sound		8	BXL RC	100%					
28.2	End of Borehole					320				

20
15 ◇ 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS – ONTARIO

ENGINEERING SERVICES BRANCH – GEOTECHNICAL OFFICE – SOIL MECHANICS SECTION

RECORD OF BOREHOLE Nº Y-4 (69-F-19)

W.P. 197-62-00 LOCATION Sta. 830+20 523' Lt. of ℄ E.B.L. (Arnprior ByPass) ORIGINATED BY BTD

DIST. 9 HWY. 17N BORING DATE April 24 & 25, 1969 COMPILED BY BTD

DATUM Geodetic BOREHOLE TYPE Washboring-NX, AX Casing – AXT Rock Core CHECKED BY [illegible]

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (400 800 1200 1600 2000)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) / WATER CONTENT % (20 40 60)	UNIT WEIGHT γ P.C.F	REMARKS % GR. SA. SI. CL.
348.5	Ground Level									
0.0	Clayey silt topsoil	~~	1	SS	5					
1.5	Clayey silt to silty clay, trace of sand (numerous sand layers up to 4" in thickness below elev. 340) (mottled Grey & Brown) Desiccated. Stiff to		2	TW	PM	340	× 3664 + 2000		117.5	
335.5	Very Stiff		3	TE	PM					
13.0	(layers of sand up to 6" in thickness) (particulary below elev. 329)		4	TW	PM	330	× s7 + s2.5	○	111	2 8 62 28 0 94 (6)
326.7	Grey. Stiff to Firm		5	SS	9					
21.8	Crystalline Limestone Bedrock with pockets of coarsley crystalline calcite (Medium grained)		6	AXT	94%					
321.0	Grey Sound									
27.5	End of Borehole					320				

20
15 ⊹ 5 % STRAIN AT FAILURE
10

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

WATER PRESSURE TESTS

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-28

SITE CPR Relocation SHEET No. 4 OF 4

DEPTHS (FEET)	PRESSURE-PSI (GAUGE)	TIME (MIN)	TOTAL ABSORPTION (IMP. GAL.)	GPM	IMP. GAL. / MIN. x FT x PSI	REMARKS
10.0 to 19.0	25	-	0	0		W.L. 6.0 BW Casing to 9.0

FORM NO. 91-9

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-29

SITE CPR Relocation SHEET No. 1 OF 4

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 7:30 A.M. Sept. 27 1972 FINISHED 2:45 P.M. Sept. 27 1972

METHOD OF DRILLING: SOIL Hollow Stem Auger CASING DIAM. BW

ROCK Diamond Drill CORE DIAM. BX

LOCATION: LATITUDE 10,078 N DEPARTURE 15,370 E BEARING - INITIAL DIP 90° OTHER DIPS

ELEVATIONS: DATUM G.S.C. DRILL PLATFORM - GROUND SURFACE 342.1 ROCK SURFACE 322.4 BOTTOM OF HOLE 309.1 WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION; COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0.0	Silty Clay	Firm greyish brown silty clay with lenses of fine silt and sand	1	CO	2-7/8	4.5 6.0	18	Pushed
			2	CO	2-7/8	9.5 11.0	18	Pushed
			3	CO	2-7/8	14.5 16.0	18	Pushed
19.7	Bedrock	For description, see following pages						
33.0		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 - POLYTHENE BAG
Z - DISCARDED

INSPECTOR D. Lee
LOGGED BY W. Lawden
APPROVED
DATE October 1973

FORM NO. 91-8

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-29

SITE CPR Relocation SHEET No. 2 OF 4

DEPTH	ROCK TYPE	DESCRIPTION: COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC.	LENGTH OF RUN	% CORE
0.0	Overburden	For description, see preceding page		
19.7	Crystalline Limestone	Grey medium to coarse grained crystalline limestone. Joints are widely spaced and mostly tight with slight weathering limited to joint planes, foliation where present dips 30° to 40°		99
33.0		End of Hole		

ACRES CONSULTING SERVICES LIMITED

DRILLING REPORT
(CORE DETAILS)

CLIENT The Hydro-Electric Power Commission of Ontario JOB NO P3197

PROJECT Arnprior Generating Station (NAF9) HOLE NO CP-29

SITE CPR Relocation SHEET NO 3 OF 4

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION: SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING*	STAINING*	BLEACHING	MUTUAL ANGLE
19.7	Top of Bedrock												
20.9	Joint, tight	80	x		x								
21.8	Joint, tight	70	x		x								
22.0	Joint, tight	80	x		x								
22.9	Joint, open, weathered	70		x			x				Br		
23.9	Joint, tight	70		x				x					
24.1	Joint, tight	50	x		x								
27.4	Joint, tight	40		x				x			Br		
29.6	Joint, open	50		x				x					
30.3	Joint, tight	70	x		x						Br		
30.7	Joint, open	70		x				x			Br		
32.2	Joint, open	65		x				x			Br		
33.0	End of Hole												

C = CARBONATE H = HEMATITE K = CHLORITE

* Br = BROWN Gy = GRAY

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT: The Hydro-Electric Power Commission of Ontario — JOB No.: P3197

PROJECT: Arnprior Generating Station (NAF9) — HOLE No.: CP-34

SITE: CPR Relocation — SHEET No.: 1 OF 4

CONTRACTOR: F.E. Johnston Drilling Company Limited — STARTED: 7:30 A.M. Nov. 13 19 72 — FINISHED: 1:30 P.M. Nov. 14 19 72

METHOD OF DRILLING: SOIL: Hollow Stem Auger — CASING DIAM.: BW

ROCK: Diamond Drill — CORE DIAM.: BS

LOCATION: LATITUDE: 10,028 N — DEPARTURE: 14,002 E — BEARING: – — INITIAL DIP: 90° — OTHER DIPS:

ELEVATIONS: DATUM: G.S.C. — DRILL PLATFORM: – — GROUND SURFACE: 341.5 — ROCK SURFACE: 289.4 — BOTTOM OF HOLE: 279.2 — WATER TABLE:

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0.0	Topsoil	Brown, sandy topsoil with organics						
0.5	Sand with some Gravel	Loose to compact, fine brown sand with some coarse sand and fine gravel	1	AQ	2.0	4.5 5.0 5.5 6.0	18	 6 12 13
9.5	Silty Sand	Brownish-grey silty sand with some clay	2	AQ	2.0	9.5 10.0 10.5 11.0	18	 3 4 5
14.5	Silty Clay	Firm, grey silty clay	3	AQ	2.0	14.5 15.0 15.5 16.0	18	 2 3 5
			4	BO	2-7/8	19.5 21.0	18	Pushed
			5	BO	2-7/8	24.5 26.0	18	Pushed

SAMPLING METHOD: A – SPLIT TUBE; B – THIN WALL TUBE; C – PISTON SAMPLER; D – CORE BARREL; E – AUGER; F – WASH

SHIPPING CONTAINER: H – INSERT; O – TUBE; P – WATER CONTENT TIN; Q – GLASS JAR; R – CLOTH BAG; S – POLYTHENE BAG; Z – DISCARDED

INSPECTOR: W. Nichol

LOGGED BY: W. Bawden

APPROVED:

DATE: October 1973

FORM NO. 91-A

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario — JOB No P3197

PROJECT Arnprior Generating Station (NAF9) — HOLE No. CP-34

SITE CPR Relocation — SHEET No 2 OF 4

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
			6	BO	2-7/8	29.5 31.0	18	Pushed
	Silty Clay	Stiff, grey silty clay, brittle and slightly sensitive	7	BO	2-7/8	34.5 36.0	18	Pushed
			8	CO	2-7/8	39.5 41.0	18	Pushed
			9	CO	2-7/8	44.5 46.0	18	Pushed
		Some fine sand lenses	10	CO	2-7/8	49.5 51.0	18	Pushed
52.1	Bedrock	For description see following pages						
62.3		End of hole						

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-34

SITE CPR Relocation 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	LENGTH OF RUN	% CORE
0.0	Overburden	For description, see preceding pages		
52.1	Crystalline Limestone	Grey, medium to coarse grained crystalline limestone. Joints are widely spaced and mostly tight, and overall weathering is nil. Foliation, where present, dips 40 degrees to 50 degrees		99
57.3	Granite	Light grey, medium to coarse grained granite. Contacts are tight and mica-rich.		
59.5	Crystalline Limestone	As previously described		
62.3		End of hole		

ACRES CONSULTING SERVICES LIMITED

DRILLING REPORT
(CORE DETAILS)

CLIENT The Hydro-Electric Power Commission of Ontario JOB NO P3197

PROJECT Arnprior Generating Station (NAF9) HOLE NO CP-34

SITE CPR Relocation SHEET NO 4 OF 4

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION: SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING *	STAINING * *	BLEACHING	MUTUAL ANGLE
52.1	Top of bedrock												
52.3	Joint, open, weathered	40		x	x					Cy			
57.4	Joint, tight	40		x	x				x				
59.3 to 59.7	Joint, tight	30		x			x						
59.1	Joint, tight	60		x		x							
62.3	End of hole												

C = CARBONATE H = HEMATITE K = CHLORITE * * Br = BROWN * Gy = GRAY

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-39

SITE CPR Relocation SHEET No. 1 OF 6

CONTRACTOR: Canadian Longyear Limited STARTED 3:30 P.M. Jan. 10 19 73
FINISHED 2:00 P.M. Jan. 16 19 73

METHOD OF DRILLING: SOIL Hollow Stem Auger CASING DIAM. NW
ROCK Diamond Drill CORE DIAM. NX

LOCATION: LATITUDE 10,035 N DEPARTURE 15,068 E BEARING - INITIAL DIP 90° OTHER DIPS

ELEVATIONS: DATUM G.S.C. DRILL PLATFORM - GROUND SURFACE 340.4 ROCK SURFACE 304.2 BOTTOM OF HOLE 284.3 WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE*	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
0.0	Topsoil	Brown, organic topsoil						
2.0	Silty Sand with Clay	Loose to compact, brown silty sand with clay	1	AQ	2.0	2.0 2.5 3.0 3.5	12	 5 6 4
			2	AQ	2.0	3.5 4.0 4.5 5.0	12	 4 8 11
5.0	Silty Clay	Stiff to very stiff grey-brown silty clay	3	AQ	2.0	5.0 5.5 6.0 6.5	15	 4 8 8
			4	AQ	2.0	6.5 7.0 7.5 8.0	16	 4 7 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 – POLYTHENE BAG
X – DISCARDED

INSPECTOR H. Ozbey
LOGGED BY A. Mirza
APPROVED
DATE October 1973

FORM NO. 91-A

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-39

SITE CPR Relocation SHEET No. 2 OF 6

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE RET'D	PENETRATION TEST
	Silty Clay		5	AQ	2.0	8.0 8.5 9.0 9.5	15	 3 5 6
			6	AQ	2.0	9.5 10.0 10.5 11.0	12	 3 4 5
			1	CO	2-7/8	11.0 12.5	18	Pushed
			2	CO	2-7/8	12.5 14.0	18	Pushed
		Some lenses of silt and fine sand	3	CO	2-7/8	14.0 15.5	18	Pushed
			4	CO	2-7/8	17.0 18.5	18	Pushed
			5	CO	2-7/8	18.5 20.0	18	Pushed
			6	CO	2-7/8	20.5 22.0	18	Pushed
			7	CO	2-7/8	22.5 24.0	18	Pushed
		Grey silty clay, brittle, sensitive	8	CO	2-7/8	24.5 26.0	18	Pushed
			9	CO	2-7/8	26.5 28.0	18	Pushed
			10	CO	2-7/8	28.5 30.0	19	Pushed
			11	CO	2-7/8	30.5 32.0	18	Pushed
			12	CO	2-7/8	32.5 34.0	18	Pushed

FORM NO. 91-A

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-39

SITE CPR Relocation SHEET No. 3 OF 6

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCE, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RECD.	
35.5	Silty Sand and Gravel	Fine to medium brown silty sand with a trace of gravel	13	CO	2-7/8	35.5 36.2	9	Pushed
36.2	Bedrock	For description, see following pages						
56.1		End of hole						

FORM NO. 91-B

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-39

SITE CPR Relocation SHEET No. 4 OF 6

DEPTH	ROCK TYPE	DESCRIPTION COLOUR, TEXTURE, FOLIATION, JOINTING, FRACTURING, FAULTING, ALTERATION, WATER LOSS OR GAIN, CAVING, LOST CORE, CEMENTING, ETC	LENGTH OF RUN	% CORE
0.0	Overburden	For description, see preceding pages		
36.2	Crystalline Limestone	Light grey, medium to coarse grained crystalline limestone. Solid, competent rock with a few open and tight joints. Foliation, where present, dips 50 degrees to 60 degrees.		99
56.1		End of hole		

ACRES CONSULTING SERVICES LIMITED

DRILLING REPORT
(CORE DETAILS)

CLIENT The Hydro-Electric Power Commission of Ontario JOB NO P3197

PROJECT Arnprior Generating Station (NAF9) HOLE NO CP-39

SITE CPR Relocation SHEET NO 5 OF 6

DEPTH (FT.)	DISCONTINUITY (JOINT, FAULT, BEDDING PLANES, CLEAVAGE, LINEATION)	ANGLE WITH CORE AXIS	DESCRIPTION: SLICK	SMOOTH	ROUGH	PLANE	CURVED	IRREGULAR	SLICKENSIDED	FILLING *	STAINING **	BLEACHING	MUTUAL ANGLE
36.2	Top of bedrock	"											
36.5	Joint, open	70			x		x						
36.8	Joint, open	-			x		x						
40.5	Joint, tight	30			x		x			Br			
41.2	Joint, tight	70											
41.8	Joint, tight	80			x		x			Br			
43.8	Joint, tight	80								Br			
46.2 to 47.1	Joint, open	15	x		x					Br			
48.2	Joint, tight	70				x		x					
56.0	Joint, tight	80				x		x					
56.1	End of hole												

C = CARBONATE H = HEMATITE K = CHLORITE ** Br = BROWN * Gy = GRAY

ACRES CONSULTING SERVICES LIMITED
NIAGARA FALLS, CANADA

WATER PRESSURE TESTS

CLIENT The Hydro-Electric Power Commission of Ontario JOB No. P3197

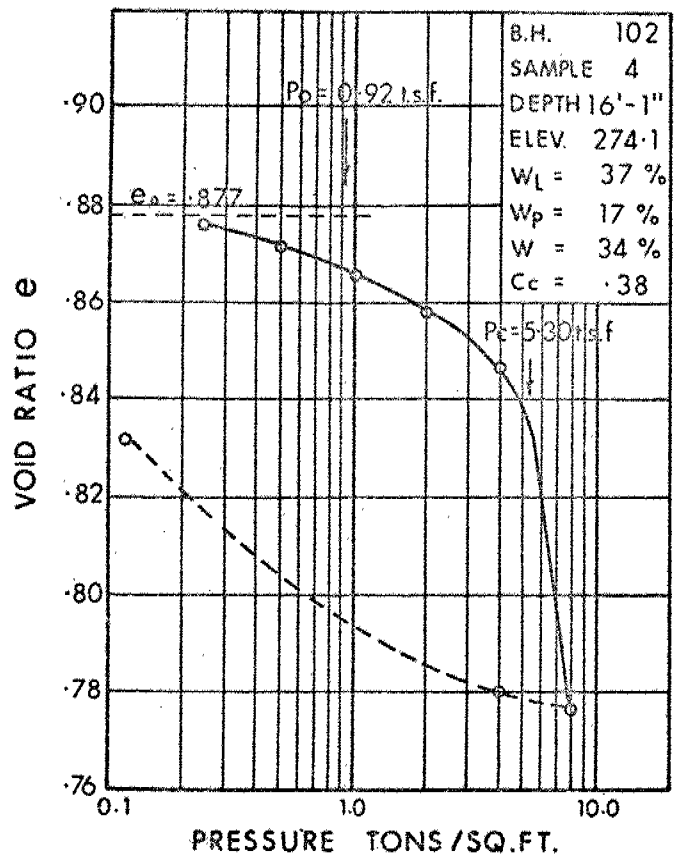
PROJECT Arnprior Generating Station (NAF9) HOLE No. CP-39

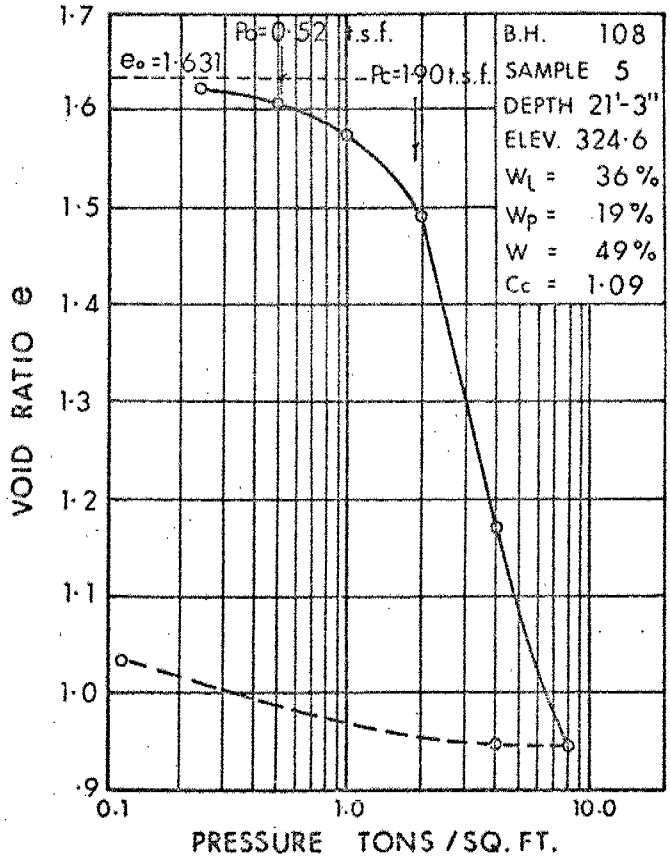
SITE CPR Relocation SHEET No. 6 OF 6

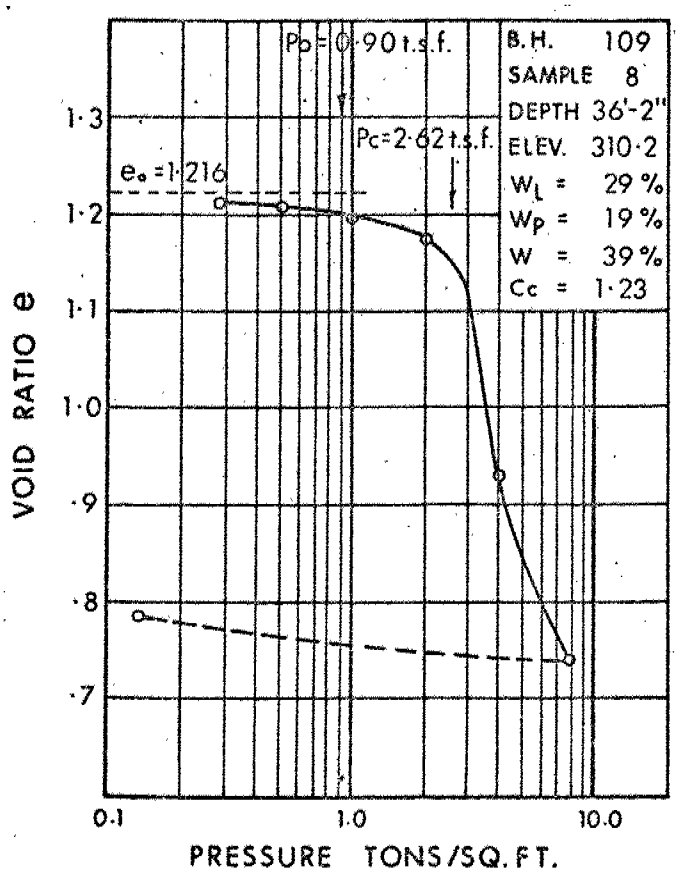
DEPTHS (FEET)	PRESSURE-PSI (GAUGE)	TIME (MIN)	TOTAL ABSORPTION (IMP. GAL.)	GPM	IMP. GAL. / MIN. x FT x PSI	REMARKS
						W.L. in Hole - 7.0
						NW Casing to 36.3
55-50	20	5	20.0	4.0		
	10	5	15.0	3.0		
50-45	20	5	28.0	5.6		
	10	5	19.0	3.8		
45-40	20	3	0.0	0.0		
42-37	5	5	34.0	6.8		

VOID RATIO – PRESSURE CURVES

W.P. NO. 197-62-00







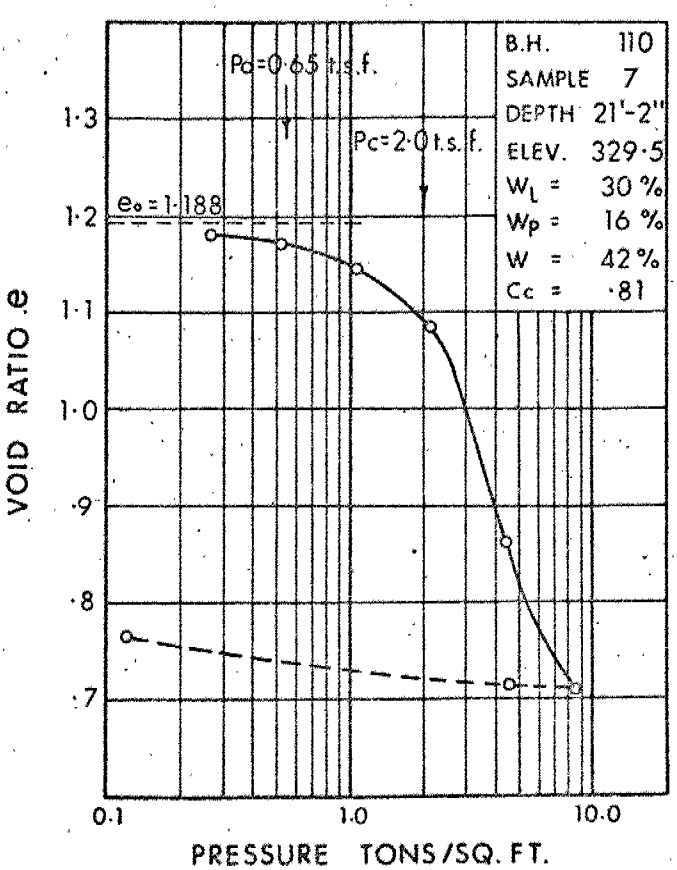


FIG. 1

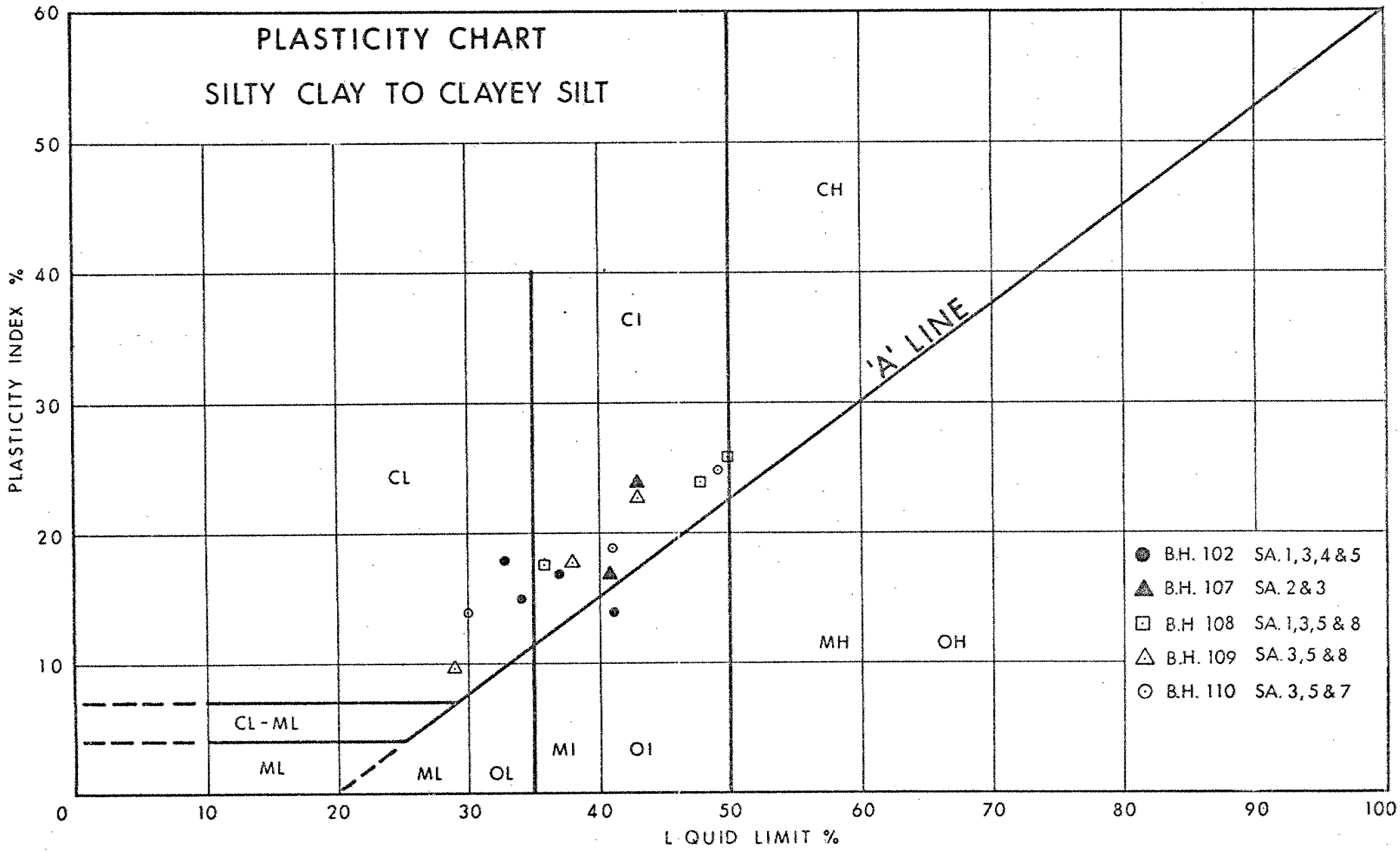


FIG. 2

W.P. 197-62-00

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION RESISTANCE

'N' = STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS : -

CONSISTENCY	c LB./SQ.FT.
VERY SOFT	0 - 250
SOFT	250 - 500
FIRM	500 - 1000
STIFF	1000 - 2000
VERY STIFF	2000 - 4000
HARD	> 4000

DENSENESS	'N' BLOWS / FT.
VERY LOOSE	0 - 4
LOOSE	4 - 10
COMPACT	10 - 30
DENSE	30 - 50
VERY DENSE	> 50

TERMS TO BE USED IN DESCRIBING SOILS :-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
w_S	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

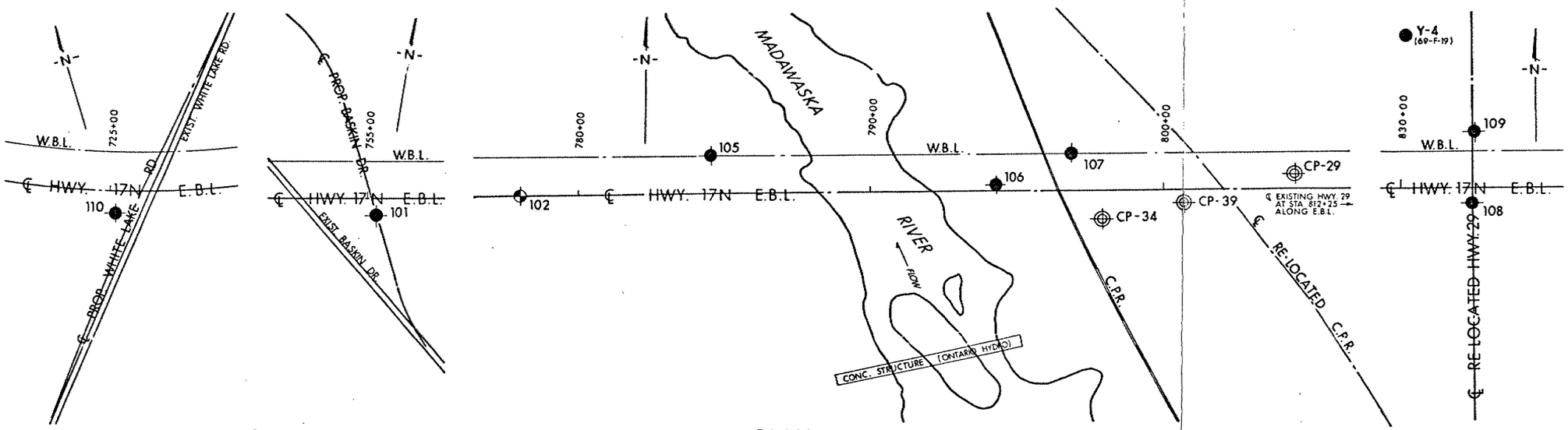
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

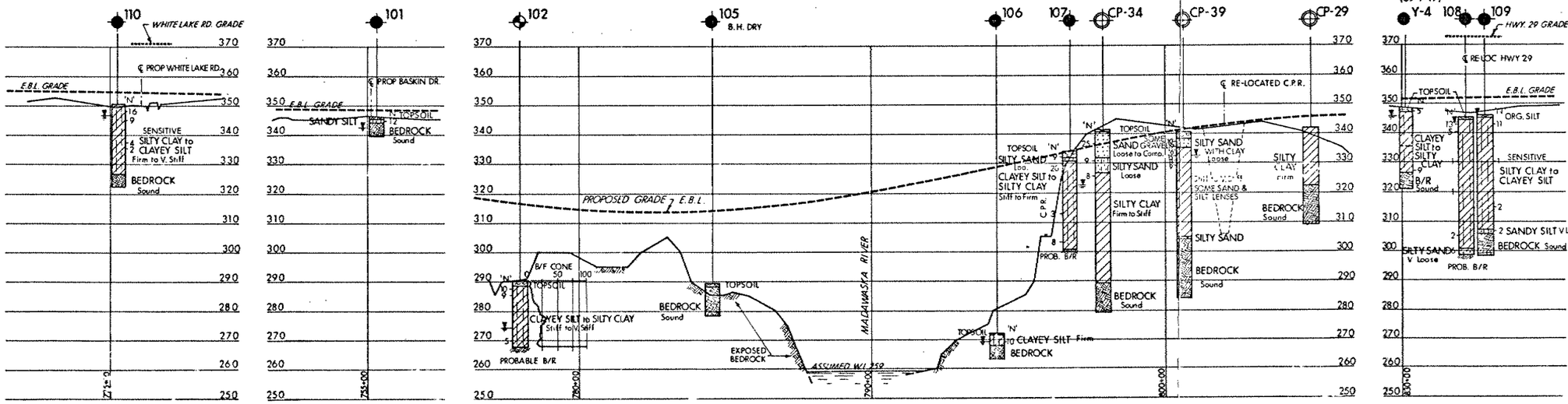
SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



PLAN

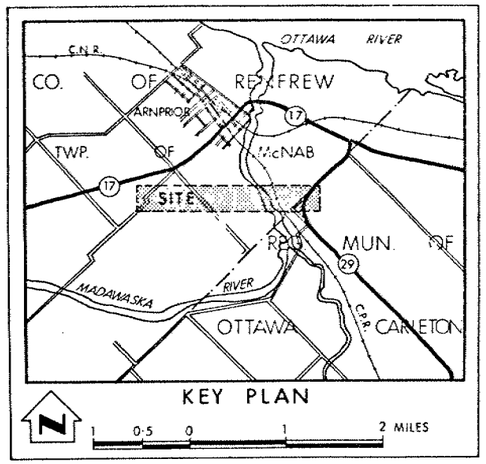
200 100 0 SCALE 200 400 FT.



℄ PROFILE - E.B.L.

VERT. 20 10 0 SCALE 20 40 FT.
HORZ. 200 100 0 200 400

NOTE
SEE RECORD OF BOREHOLE SHEETS FOR DETAILED SUBSOIL DESCRIPTION



LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation DEC. 1974
- Bore Holes done by Acres Consulting Services Ltd.

NO.	ELEVATION	STATION (E.B.L.)	OFFSET ℄ E.B.L.
101	346·6	755+30	55' RT.
102	290·2	778+00	℄
105	289·6	784+60	124' LT.
106	272·9	794+23	20' LT.
107	354·5	796+60	124' LT.
108	345·8	832+41	55' RT.
109	346·4	832+51	187' LT.
110	350·6	725+20	70' RT.
Y-4	348·5	830+20	523' LT.
CP-29	342·1	804+50	50' LT.
CP-34	341·5	797+90	100' RT.
CP-39	340·4	800+68	50' RT.

— NOTE —

The boundaries between soil strata have been established only at Bore Hole locations Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
ENGINEERING SERVICES BRANCH — GEOTECHNICAL OFFICE

PRELIMINARY INVESTIGATION
ARNPRIOR BY-PASS
(WHITE LAKE RD. TO RE-LOCATED HWY. 29)

HIGHWAY NO. 17N E.B.L. DIST NO. 9
CO. RENFREW
TWP. McNAB LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD M.D.	CHECKED	W.P. NO. 97-62-00	DRAWING NO. 1976200-A
DRAWN S.O.	CHECKED	W.O. NO.	
DATE 19 FEB 1975		SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT NO.	

Mr. T.J. Kingsland
Structural Planning Office
Kingston, Ont.

Soil Mechanics Section
Geotechnical Office
West Bldg.

June 15, 1976

Madawaska River Crossing & Related Approaches
Hwy. 17N, Arnprior Bypass, Dist. 9
W.P. ~~197~~-62-00
198-

We have reviewed our subsoil information at the proposed bridge site, and submit the following comments for your preliminary planning purposes.

In general, subsoil at the site consists of a deposit of stiff silty clay/clayey silt, overlying crystalline limestone bedrock. Thickness of the cohesive overburden is variable, ranging from rock outcrops to the order of 45 ft. Bedrock elevations in this locale also show considerable variations.

In view of the stiff consistency of the overburden, we do not foresee deep-seated failures for the approaches. In our opinion, safety of the embankments is likely to be governed by the stability of the fill itself. The following recommendations are presented so that decision on the preliminary structure layout can be made.

EARTH FILL		ROCK FILL	
Fill Ht.	Stable Configuration	Fill Ht.	Stable Configurati
Up to 30 Ft.	2:1	Up to 25 Ft.	1¼:1
Up to 40 Ft.	2.5:1	Up to 35 Ft.	1½:1
50'>H>40'	2:1 with 20' berm at mid-height	45'>H>35'	1¼:1 with 15' berm at mid-height
60'>H>50'	2:1 with 25' berm at mid-height	55'>H>45'	1¼:1 with 20'berm at mid-height

A cut is also required for the upper road to the dam. Because the clay contains seams of sand and silt, it is recommended that a cut up to 20 ft. high should not be constructed steeper than 2:1 and a cut up to 25 ft. not steeper than 2.5:1.

It should be noted that when the footing locations have been decided on, additional foundation investigation should be carried out to obtain detail subsurface information, for design and construction purposes. A foundation investigation is also required for the creek crossing in the vicinity of Sta. 777+50.

From our point of view, lowering of the profile grade at the Madawaska River crossing is advisable, as far as economy and stability are concerned. Therefore, consideration should be given to lowering the grade at Sta. 771+00 to Sta. 776+00, where the road should be brought to bedrock elevations.

B. Ly

Bin Ly
Senior Engineer

For: M. Devata
Supervising Engineer

BL/bp

cc: S. Redborne
E.V. Saint
C. Bassi

Files
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