59-F-256C

HWY. # 69

BOYNE RIVER

REPORT ON FOUNDATION INVESTIGATION
FOR THE
PROPOSED CROSSING OF HIGHWAY NO. 69
REVISION LINE "J"
AT THE
BOYNE RIVER - PARRY SOUND, ONTARIO

for the

DEPARTMENT OF HIGHWAYS - ONTARIO

by the

Engineering Division

HUNTING TECHNICAL AND EXPLORATION SERVICES LIMITED

Toronto, Ontario

January, 1959.

ORDER OF CONTENTS

Section 1.1

PURPOSE OF REPORT

1.11 GENERAL

The purpose of this report is to present the results of a sub-surface soil investigation on the proposed site of a new bridge on Revision Line "J" to replace the existing double-lane concrete Boyne River bridge on Highway No. 69 near Parry Sound, and to offer recommendations regarding a safe foundation for the new structure.

Section 1.2

DISCUSSION OF PROCEDURES

1.21 LOCATION OF BOREHOLES

The field location of the site for this investigation was established by Department of Highways Surveyors. Hunting Technical and Exploration Services Limited engineers established the actual borehole locations by chaining to all boreholes from the centre line of the proposed Revision Line "J". Elevations for all boreholes were established by level from B. M. elevation 671.14 located 46 feet left of station 435+69. At the completion of the work each borehole was marked with a large stake denoting the hole number for future reference. The locations and elevations at top of the boreholes are shown on the plan in Appendix 1.71.

The D. H. O. Bridge Site plan was not available at the time of preparing this report. Except for the soil profiles and locations of the boreholes, all information shown on our plan in Appendix 1.71 is approximate.

1.22 SUBSURFACE DRILLING AND SAMPLING

At the discretion of the Soils Consultant, a primary program of 2 soil borings and 2 cone penetration tests was carried out in the vicinity of the proposed bridge site.

A skid-mounted, hydraulic head Junior Longyear diamond drilling rig was used on this project. All boring and sampling operations were completed by an experienced soil sampling crew under the supervision of engineering personnel experienced in soil sampling procedures.

All soil borings were performed by the standard washboring procedure. By this method, drill casing was driven into the soil by a 350 lb. hammer to a depth determined by the boring supervisor. All the soil contained inside the casing during this operation was thoroughly washed out to the bottom of the casing and the resultant wash water was observed to determine stratum changes. Sampling tools were then lowered to the bottom of the hole. The sample was then taken and the sampling tools removed from the hole. Additional lengths of casing were added as required and the procedure repeated.

Attempts were made to obtain samples in the cohesionless soils by means of a 2-inch O. D. standard split spoon sampler. The standard penetration test using a 140 lb. hammer falling 30 inches was recorded for each foot of sampler penetration. When necessary, recovery of samples for identification and correlation was obtained with a side slit sampler. All samples were visually examined and classified on the site, then placed in jars and forwarded to the engineering office.

Cone penetration tests were made as a quick means of probing to rock. The number of blows required by a 140 lb. hammer falling 30 inches for each foot of penetration was recorded.

Bedrock core samples were obtained by diamond drilling techniques and were visually examined and classified on site. Representative samples were chosen and forwarded to the engineering office.

Section 1.3

DISCUSSION OF SITE

1.31 GEOGRAPHIC LOCATION

The proposed bridge site is located on the King's Highway No. 69 at the proposed new crossing of the Boyne River on Revision Line "J", approximately three miles southeast of Parry Sound. The site is in the District of Parry Sound, Township of Foley on Lot 139, Concession B.

1.32 SITE GEOLOGY

Physiographically the site lies within a region of Precambrian rock which was covered by continental glaciation during the Pleistocene epoch. The soil at the site consists, in general, of coarse sand with gravel which is a glacio-fluvial deposit left by the retreating glacier. The underlying bedrock, encountered at approximately elevation 644, is a Precambrian granitic gneiss. The rock close to the surface appears to be fresh and sound.

1.33 WATER CONDITIONS

At the time of this investigation, the water table in the boreholes and the water level in the river were both found to be at Elevation 651.5 approximately.

The flow in the river appears to have an appreciable velocity in the site vicinity due to the presence of a series of rapids in the form of rock outcrops about 150 feet upstream. From the nature of the topography of the river valley, it is anticipated that during periods of high flooding, the water level in the river will be considerably higher than Elevation 651.5.

It should be realized that the bridge site would be situated just downstream of a sharp bend in the river and that the river valley narrows at this bend. Because of these topographic features, and the danger of excess hydraulic pressures caused by debris damming at the upstream ends of the abutments, plus the fact that the rock surface dips downstream, we suggest that the possibility of horizontal downstream sliding of the abutments be thoroughly investigated. It may be necessary to fix the abutments into bedrock for horizontal stability.

There is a swamp area covering the south approach from Station 420+50 (see plan in Appendix 1.71). The overlying soil, which consists of decomposed vegetation, is expected to be in the order of 1 to 3 feet deep. Excavation in this area will have to be performed under water during periods of high flooding.

Because of the possible great difference between high and low water levels in the river, the effect of scouring is expected to extend down to the bedrock surface. Upstream, where backfill is not protected by retaining walls, rip-rap should be provided at the toe of the embankment fills to protect against erosion.

1.34 SOIL CONDITIONS

The material encountered at the site consisted generally of two structural types overlying the bedrock in the following order of their occurrence below ground surface.

1. Topsoil - decomposed organic material intermixed with some sand.

2. Loose to medium dense brown coarse sand and gravel.

The approximate physical properties of each stratum are listed as follows:

1. Decomposed organic material intermixed with some sand:

This layer of topsoil exists about 1 foot to 3 feet in depth at the site. This material is highly compressible and is considered to have no structural value. It should be removed before the construction of the abutment and the approaches to the bridge.

2. Loose to medium dense brown coarse sand and gravel:

This material underlies the organic layer described in 1 above and is encountered in both boreholes. The stratum appears homogeneous throughout although there is evidence of some grey medium sand within the stratum on the north bank of the river. This material varies in depth from 8 feet on the south bank to 14 feet on the north bank. The physical properties of the layer are listed below:

Average thickness	-	11 feet
Top Elevation Range	-	653.5 feet to 657.3 feet
Bottom Elevation Range	-	641.7 feet to 647.0 feet
Penetration Resistance Average	-	15 blows/foot
Penetration Resistance Range	-	10 to 18 blows/foot

1.35 BEDROCK CONDITIONS

Granitic gneiss bedrock was encountered at approximately Elevation 644 at the site. This is believed to be capable of providing a bearing load of about 30 tons/square foot, however, for design purposes we recommend that an allowable bearing load of 18 tons/square foot be used. Recovery of the rock core from the borehole was 100% indicating that the bedrock is quite sound. The boreholes indicate that the rock dips approximately to the southwest.

Section 1.4

COMMENTS ON FOUNDATIONS OF STRUCTURE

1.41 GENERAL

Our understanding of the proposed bridge structure is that abutments are contemplated in the vicinity of Chainages 422+65 and 423+05. We have assumed that the approaches to the bridge will be on granular fill contained and protected by wing walls and retaining walls where necessary. We have also assumed that the maximum height of the approach fills will be in the order of 22 feet.

1.42 SPREAD FOOTING FOUNDATION

We consider that a spread footing foundation on the subsoil would not be feasible because of the loose nature of the soil and the shallow depth to bedrock at the site.

In our opinion, spread footings on bedrock are the most suitable method of securing a safe foundation for the new bridge. Bedrock exists at more or less Elevation 644, and is generally about 8 feet and 14 feet below the present ground surface on the south bank and the north bank respectively.

Due to the fact that the overburden is generally loose and very permeable, we anticipate that excavation to bedrock will present a drainage problem. In order to facilitate the excavation, we suggest that a system of water-tight sheet-piling be used. The piling may have to be anchored or strutted and should be driven to bedrock to form a curtain wall. Pumping will no doubt have to be employed in conjunction with this system. An allowable bearing capacity of 18 tons/square foot may be used for designing the footings on rock. Because of the topographic conditions at the site, the danger of debris damming, and the downstream dip of the rock surface at the site, we consider it advisable to set or key the abutment footings into bedrock so as to provide sufficient horizontal resistance against sliding. Another effective means of overcoming this danger would be to use dowels. The dowels (bars No. 8 to No. 11) if properly embedded into bedrock should provide a good fixity and continuity between footings and bedrock. If these conditions are obtained, the bridge or culvert could be economically designed as a rigid-framed structure.

In view of a proposed approach fill height of 22 feet, we anticipate that retaining walls will have to be provided beyond the ends of the abutments. Where retaining walls are required, they may be designed in the same manner as the abutments. Rip-rap or other effective means should be provided at the upstream toe of the approach fills to protect against the erosive action of the river.

1.43 PILE FOUNDATION

We do not consider a pile foundation would be of any practical advantage at this site. Unless the pile caps were located above water level and the piles are adequately anchored into bedrock to obtain certain fixity, we expect that permanent sheet-piles will be necessary to protect against scouring and erosion.

Section 1.5

RECOMMENDATIONS

1. In our opinion, spread footings on bedrock will provide the best method of securing a satisfactory foundation for the new bridge. The allowable bearing capacity of the bedrock may be taken as 18 tons/square foot.

2. The possibility that it may be necessary to key or dowel the footings into bedrock to prevent sliding should be investigated. (See Sections 1.33 and 1.42)

3. Excavation to bedrock will present a drainage problem which may be overcome with the use of water-tight sheet-piling and pumping. (See Section 1.42)

4. We do not envisage any stability problems in connection with the 22 foot high approach fills provided that the highly compressible organic material is removed. The approach embankments may be constructed on a slope of 2 horizontal to 1 vertical.

5. Rip-rap or other appropriate material should be provided at the upstream toe of the embankment in order to protect against erosive action of the river.

Section 1.6

PERSONNEL

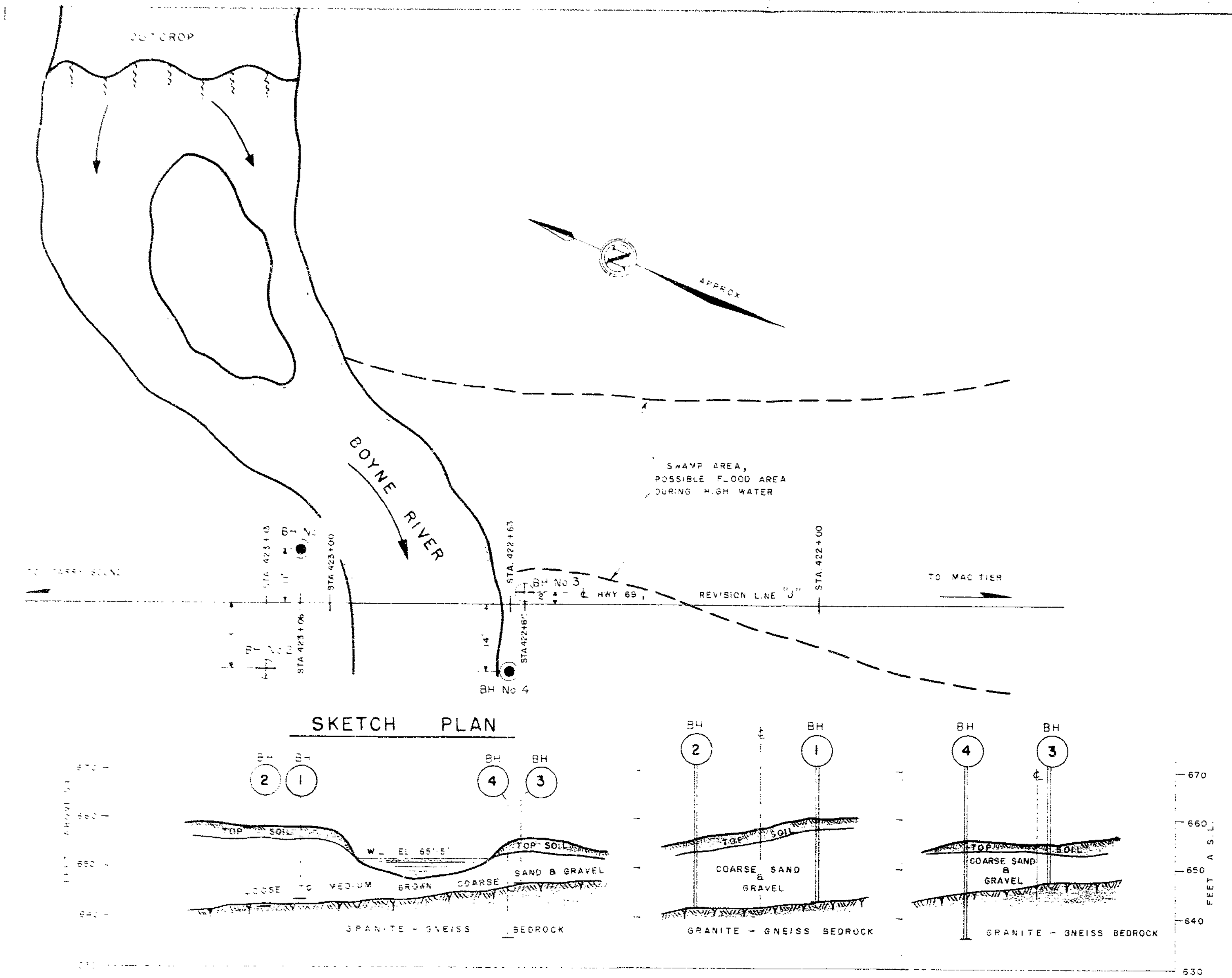
The field work for this project and the writing of this report were performed by Mr. W. W. F. Wong, P. Eng., assisted by Mr. A. B. MacArthur, B.A.Sc.

Mr. J. Kilgour, P. Eng., reviewed the report and the interpreted results.

Section 1.7

APPENDICES

1.71 General Plan of Site and Subsurface Sections



SKETCH - PROFILE ALONG CENTRE LINE OF HWY. No. 69, REVISION LINE "J"

SOIL PROFILE ALONG BOREHOLES (1) & (2)

SOIL PROFILE ALONG BOREHOLES (3) & (4)

LEGEND

- BOREHOLE
- CONE PENETRATION HOLE

HUNTING TECHNICAL & EXPLORATION SERVICES LTD.
TORONTO

DEPARTMENT OF HIGHWAYS - ONTARIO

LOCATION OF BOREHOLES
AND
SUBSURFACE SOIL PROFILES
FOR
PROPOSED CROSSING AT BOYNE RIVER
AND
THE KING'S HIGHWAY No. 69 REVISION LINE "J"

BRIDGE SITE

SCALE - 1 in. = 20 ft.	Drawn by - C. I. B.	Date - Dec 1958

REFERENCE : Plan No. 28451

1.72 Office Logs of Boreholes

JOB No. H742/58 LOCATION Boyne River

CLIENT Department of Highways - Ontario

COORDINATES CHN. 423+06.0, Offset 11' Rt. of ℄

ELEV. (surface) 659.3 (collar) Datum D.H.O.

BOREHOLE NUMBER 1

DATE (started) Dec.19/58 (finished) Dec.20/58

RIG No. TYPE Longyear Jr. A

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 1

Legend: silt, clay, sand, gravel, peat, fill

x — standard penetr. 2 s.s.
△ — vane shear
o — pocket penetrometer

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— fair
— lost

S.S — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

BORING LOG

SCALE FT	DEPTH FT	ELEV. FT	WATER OBSERVATION	DESCRIPTION
0	0.0	659.3		Ground Surface
				Organic Top Soil
	2.0	657.3		
5				Loose To Medium Brown Coarse Sand And Gravel
	7.8	651.5	▽	
10				
15				
	16.0	643.3		(End of Boring - BX Casing Bouncing on Rock)
20				

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 1 1/2

STANDARD PENETRATION TEST x (BLOWS PER FOOT) 20 40 60

SAMPLES

No.	COND.	DEPTH FROM Ft.	DEPTH TO Ft.	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	PENETRATION RESISTANCE (BLOWS PER FOOT)
1	disturbed but represent.	5.5	7.0	S.S	14/18	18
2	disturbed but represent.	10.5	12.0	S.S	13/18	17

LABORATORY TESTS

ATTERBERG LIMITS wp x — o wl

● — NATURAL WATER CONTENT

REMARKS

JOB No. H742/58 LOCATION Boyne River

CLIENT Department of Highways - Ontario

COORDINATES CHN. 423-+ 13 .0, Offset 13.0' Lt. of ℄

ELEV (surface) 655.5' (collar) Datum D.H.O.

BOREHOLE NUMBER 2

DATE (started) Dec. 20/58 (finished) Dec. 20/58

RIG No. TYPE Longyear Jr. A

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 2

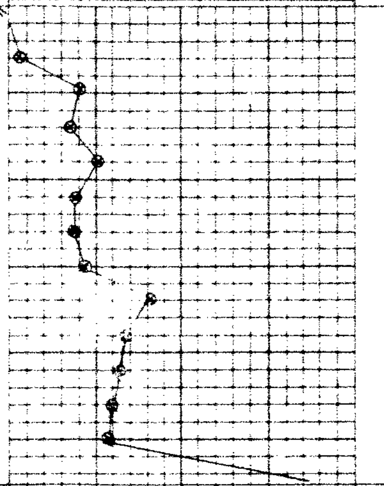
Soil legend		Test symbols	Sample condition	Sample types	Laboratory tests
silt	gravel	x — standard penetr. 2 s.s.	undisturbed	SS — split spoon	C — consolidation test
clay	peat	Δ — vane shear	disturbed but represent.	ST — shelby tube	M — mechanical analysis
sand	fill	o — pocket penetrometer	fair	T.W.P — thin walled piston	T — triaxial shear
		● — cone penetration	lost	D.B. — diamond bit	K — permeability
					U — unconfined compression

BORING LOG — FIELD TESTS — LABORATORY TESTS

SCALE FT	DEPTH FT	ELEV. FT	WATER OBSERVATION	LOG	DESCRIPTION
0		655.5			Ground Surface
5					
10					
	13.8'	641.7			Top of Rock
15					
20					
25					

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 1 1/2

~~STANDARD~~ PENETRATION TEST Cone (BLOWS PER FOOT at standard energy) 20 40 60



SAMPLES: N | COND. | DEPTH FROM TO | TYPE | RECOVERY LENGTH REC. DIST. DRIV | PENETRATION RESISTANCE (BLOWS PER FOOT)

(End of Penetration Hole)
Refusal & Bouncing on Rock at 13.8'

ATTERBERG LIMITS wp x — o wl

● — NATURAL WATER CONTENT

REMARKS

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 3

JOB No. H742/58 LOCATION Boyne River
CLIENT Department of Highways - Ontario
COORDINATES CHN. 422+60.0; Offset 2' Rt. of ℄
ELEV (surface) 655.0 (collar) Datum D.H.O.
BOREHOLE NUMBER 3
DATE (started) Dec.21/58 (finished) Dec.21/58
RIG No. TYPE Longyear Jr.A

Legend: silt; clay; sand; gravel; peat; fill

x — standard penetr. 2 s s
△ — vane shear
○ — pocket penetrometer
⊘ — cone penetration

SAMPLE CONDITION: undisturbed; disturbed but represent.; fair; lost

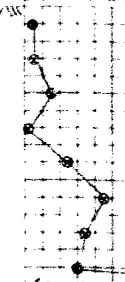
SS — split spoon
ST — shelby tube
TWP — thin walled piston
D.B. — diamond bit

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

BORING LOG — FIELD TESTS — LABORATORY TESTS

SCALE	DEPTH	ELEV.	WATER OBSERVATION	LOG	DESCRIPTION
0	0.0	655.0			Ground Surface
5					
	8.0	647.0			Top of Rock
10					
15					

SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2 1 1/2
~~STANDARD~~ Cone PENETRATION TEST (BLOWS PER FOOT AT STANDARD ENERGY) 20 40 60



(End of Penetration Hole)
Refusal & Bouncing on Rock at 8.0'

SAMPLES: N | COND. | DEPTH FROM | TO | TYPE | RECOVERY LENGTH REC / DIST. DRIV | PENETRATION RESISTANCE (BLOWS PER FOOT)

ATTERBERG LIMITS wp x — o wl
● NATURAL WATER CONTENT

REMARKS

JOB No. H572/58 LOCATION Boyne River

CLIENT Department of Highways - Ontario

COORDINATES CHN. 422+63.0, Offset 14.0' Lt. of ℄

ELEV (surface) 655.5 (collar) Datum D.H.O.

BOREHOLE NUMBER 4

DATE (started) Dec.21/58 (finished) Dec.22/58

RIG No. TYPE Longyear Jr.A

HUNTING TECHNICAL AND EXPLORATION SERVICES

BOREHOLE No. 4

Legend: silt; clay; sand; gravel; peat; fill

x — standard penetr. 2 s.s.
Δ — vane shear
○ — pocket penetrometer

SAMPLE CONDITION
— undisturbed
— disturbed but represent.
— fair
— lost

S.S. — split spoon
S.T. — shelby tube
T.W.P. — thin walled piston
D.B. — diamond bit-Rock Core

C — consolidation test
M — mechanical analysis
T — triaxial shear
K — permeability
U — unconfined compression

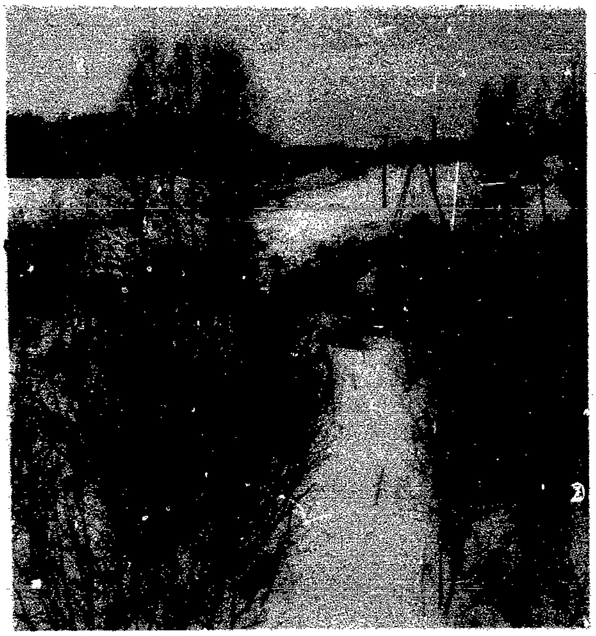
BORING LOG / FIELD TESTS / LABORATORY TESTS

SCALE FT	DEPTH FT	ELEV FT	WATER OBSERVATION	DESCRIPTION	SAMPLE NO	COND	DEPTH FROM Ft.	DEPTH TO Ft.	TYPE	RECOVERY LENGTH REC. / DIST. DRIV	PENETRATION RESISTANCE (BLOWS PER FOOT)	REMARKS
0		655.5		Ground Surface								
				Organic Top Soil								
	2.0	653.5										
	4.0	651.5	▽									
5				Loose Brown Coarse Sand And Gravel	1		5.5	7.0	S.S.	11/18	10	
10	10.0	645.5										
				Granite-Gneiss Bedrock	2		10.0	15.0	D.B	60/60		
15					3		15.0	19.0	D.B	48/48		
	19.0	636.5		(End of Boring)								
20												
25												

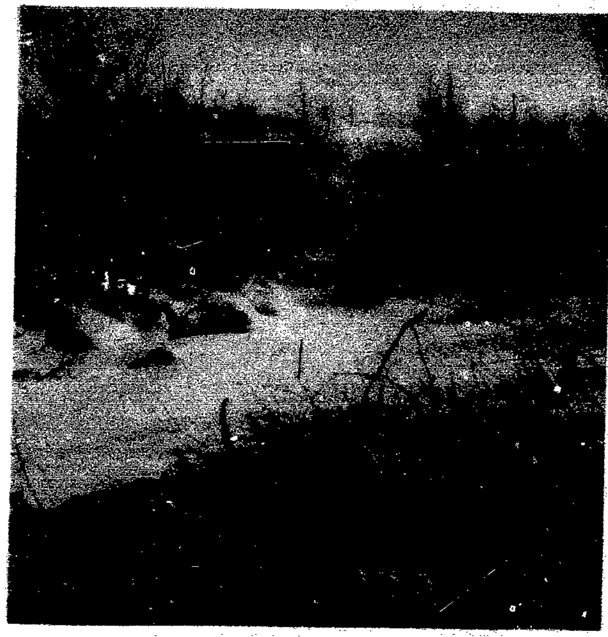
SHEAR STRENGTH (TONS PER SQUARE FOOT) 1/2, 1 1/2; STANDARD PENETRATION TEST (BLOWS PER FOOT) 20, 40, 60

ATTERBERG LIMITS Wp x — o Wl; ● — NATURAL WATER CONTENT

1.73 Photos of Site



General view of site looking North from Stn. 420+50 approximately.



General view of site on South approach looking South from Stn. 422+60 approximately.

General view of site from existing bridge on Highway No. 69 looking East.

General view of site looking North from Stn. 420+50 approximately.

General view of site on South approach looking South from Stn. 422+60 approximately.

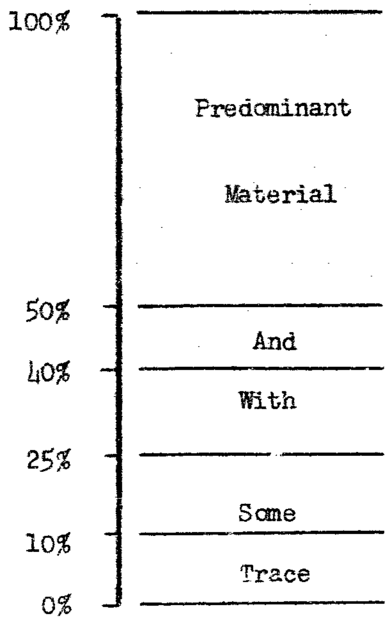
General view of site from existing bridge on Highway No. 69 looking East.

HUNTING TECHNICAL & EXPLORATION SERVICES

1450 O'Connor Drive   Toronto, Ontario

SOIL TYPES

The following system was used in classifying the various soils by name:



Example:

Medium dense	grey	silt	with	fine	sand
(Penet. resist.) or relative density	(colour)	(pred. type)	(25%-40%)	(other type)	

Unless believed to have a significant effect on the soil characteristics the minor soil types (i.e. traces) present are disregarded in the name used on the boring log and cross-sections. The complete classification is given with the gradation analysis.

In all cases the strength characteristics (e.g. penetration resistance) is quoted first, followed by the colour and finally the descriptive name based on the mechanical analysis.

HUNTING TECHNICAL AND EXPLORATION SERVICES LIMITED
1450 O'Connor Drive Toronto, Ontario

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

Soils encountered in sub surface exploration for engineering purposes are composed of organic or inorganic materials, water, air and dissolved salts. The water and air are generally considered to be uniform so that identification is primarily in the nature of organic or inorganic (mineral grains) and dissolved salts.

In the field a soil is generally identified in terms of grain size characteristics, color and mineral content -- properties of the mineral grains. Occasionally, the origin of a soil is included in the identification.

The systems used to describe soils in terms of engineering properties are called classification systems. In the system described below, the soils are first identified and then classified in terms of strength characteristics which are of prime importance in utilizing the soil boring data in designing a safe and economical foundation.

Penetration measured by dropping 140 lb. hammer 30" on 2" O.D. split spoon sampler.

Identification (Soil Type)	Classification	Classification Criteria	
		Unconfined Compressive Strength	
Clay	Soft	Less than 0.50 Tons/Sq. Ft.	
	Medium	0.50 to 1.00 Tons/Sq. Ft.	
	Stiff	1.00 to 2.00 Tons/Sq. Ft.	
	Very Stiff	2.00 to 4.00 Tons/Sq. Ft.	
	Hard	Greater than 4.00 Tons/Sq. Ft.	
		Density	
Silt	Loose	Less than 80 lbs./Cu. Ft.	
	Medium Dense	80 to 95 lbs./Cu. Ft.	
	Dense	Greater than 95 lbs./Cu. Ft.	
		Relative Density	Penetration Resist.
Sand	Loose	0 - 30%	0 - 10 Blows/Ft.
	Medium Dense	30 - 60%	10 - 30 Blows/Ft.
	Dense	60 - 90%	30 - 50 Blows/Ft.
	Very Dense	90 -100%	Over 50 Blows/Ft.
			Penetration Resist.
Gravel	Loose		Less than 30 Blows
	Dense		Over 30 Blows/Ft.
Hardpan		Cemented or partially cemented sandy gravels, sands, gravels with or without some clay and silt and having unconfined compression strength greater than 5 tons/sq. ft.	
Fill	Organic	Very Loose	0 - 4 Blows/Ft.
		Loose	4 - 10 Blows/Ft.
		Medium	10 - 30 Blows/Ft.
	Inorganic	Dense	30 - 50 Blows/Ft.
		Very Dense	Over 50 Blows/Ft.
		Unconfined Compressive Strength	
Peat	Very Soft	Less than 0.30 Tons/Sq. Ft.	
	Soft	0.30 to 0.60 Tons/Sq. Ft.	
	Stiff	Greater than 0.60 Tons/Sq. Ft.	
		Density	
Organic Silt (Muck)	Loose	Less than 30 lbs./Cu. Ft.	
	Medium Dense	Greater than 80 lbs./Cu. Ft.	