

60-F-314c

W. P. 140-59-2

HOOPLE CREEK

BA 1108

FOUNDATION INVESTIGATION REPORT

60-F-314C

Proposed Structure: Proposed Crossing

at Doherty Creek, Lot 19, Concession III

FOOTLE

County of Stormont, Twp. of Osnabruck

W. P. No. 140-59-2, District No. 9

60-F-314C

DEPARTMENT OF HIGHWAYS OF ONTARIO

Submitted by

ASSOCIATED GEOTECHNICAL SERVICES LIMITED

211 Davenport Road, Toronto 5, Ontario.

July, 1960.

Mr. A. M. Toye,

August 23, 1960.

Bridge Engineer.

FOUNDATION INVESTIGATION REPORT

Materials & Research Section.

by: Associated Geotechnical Services,
Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Structure: Proposed Crossing
at Doherty Creek, Lot 19, Con. III,
County of Stormont, Twp. of Osnabruck,
W.P. 140-59-2 -- Dist. 9.

Attached, we are forwarding to you the above mentioned report submitted by Associated Geotechnical Services, Ltd. We have reviewed the factual data presented in the report. The sand is in a relatively loose to medium dense condition, and it is our opinion that in this particular case, the best solution would be to put the footings on piles. Depth to bedrock is approximately 43 feet which means that piles of approx. 38 feet in length, could be used. Steel 'H' piles, driven down to bedrock, are recommended, and an allowable load of 60 Tons per pile, is suggested.

The values for allowable loads on spread footings given in the report, are, in our opinion, too high.

No approach fill stability problems are expected.

We believe that the data given in the report, together with our additional recommendations, would prove adequate for your future design work. However, should there be any other information or problem you would like to discuss, please feel free to call on our Office.

AS/MdeF

Attach.

cc: Messrs. A. M. Toye (2)

H. A. Tregaskes

D. G. Ramsay

J. Ford

L. E. Walker

J. E. Gruspier

A. Watt

Foundations Office

Gen. Files.

L. G. Soderman,

PRINCIPAL FOUNDATIONS ENGR.

Per:

A. Stermac
(A. Stermac,
FOUNDATIONS OFFICE ENGR.)

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SECTION 1

INTRODUCTION

The purpose of this report is to present the results of a foundation investigation conducted near Ingleside, Ontario, in connection with the proposed structure on the revised route on County Road No. 18A over Doherty Creek.

This study was authorized by the A/Materials and Research Engineer, Department of Highways of Ontario, on June 10, 1960.

SECTION 2

SUMMARY AND RECOMMENDATIONS

The soils at the site can be summarized as follows in order of their occurrence below the natural ground surface:

- Stratum 1 about 2 ft. of silty topsoil
- Stratum 2 between 35 and 42 feet of loose to medium dense till-textured soil.
- Stratum 3 between 0 and 4 feet of very dense till-textured material overlying limestone bedrock.

The structure may be founded on spread footings at elevation 247. At this elevation, with a minimum surcharge of 5 feet, the allowable bearing capacity, with a factor of safety of 3 against shear failure, for a 5 foot wide footing would be 6.2 kips per square foot and for a 10 foot wide footing would be 9.3 kips per square foot. Total settlements in this case would not likely exceed 1 inch nor differential settlements exceed 1/2 inch.

Alternatively the structure may be supported on steel H-piles driven to refusal in the till-textured soil or to bedrock.

No stability problems are foreseen with the approach fills.

SECTION 3

DISCUSSION OF PROCEDURES

The borehole and probe hole locations for this investigation were established by the Field Soils Engineer by chaining from the centre line for the proposed revision of County Road No. 18A. The borehole locations are shown on Figure 1, Appendix I.

The elevation of each borehole and probe hole was referred to a D. H. O. turning point near station 28+10. The elevation of this turning point was given as 251.23 by the surveyor in the field. Station 28+10 was given an elevation of 252.0.

A primary drilling programme consisting of 4 soil borings and 4 dynamic cone probes was carried out in the vicinity of the proposed bridge site. One Boyles screw feed drilling rig, mounted on a wheeled trailer, was used to carry out the work. All boring and sampling operations were completed by an experienced soil sampling crew under the full time supervision of a qualified Soils Engineer.

In general, the soil borings were performed by standard wash boring sequence; however, in order to expedite the advance of the casing into the pebbly till layers, the bottom end of the casing was fitted with a diamond shoe bit and the casing fed into the ground by diamond drilling techniques. Water, in this case, was used to clean and cool the diamond drill bit as well as to carry the sludge out of the hole during the actual drilling operations.

Attempts were made to obtain soil samples by means of a 2" 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 soil material was not retained in the sampler, a sand-trap was fitted to the end of the sampler and the sampler was re-driven. All samples were visually examined and classified on the site, then placed in jars and forwarded to the engineering office.

Natural Moisture Content and Grain Size Analysis tests were performed in the laboratory on selected samples. Where split-spoon samples seemed relatively undisturbed, apparent insitu density tests were carried out by the mercury displacement method. The results of these tests are given in the Appendices.

Dynamic cone probes were made using a 2" O. D. 60° cone point fastened to the end of an A-rod. The number of blows required by a 140 lb. hammer falling 30 inches to drive the cone 12 inches were recorded for each foot of penetration.

SECTION 4

DISCUSSION OF SITE

4.1 Geographical Location

The proposed bridge site is located in the Township of Osnabruck, County of Stormont, where the proposed relocation route of County Road No. 18A will cross Doherty Creek.

4.2 Geology of Site Area

The Pleistocene and Recent geology of the site are outlined in paper 51-12 of the Geological Survey of Canada.

The overburden at the site is predominantly a loose to medium dense grey till. The boreholes on the north side of Doherty Creek revealed a stratum of very dense well-graded till immediately overlying bedrock.

Limestone bedrock of the Ordovician Period was found in the four boreholes at depths ranging approximately from elevation 209 in Borehole 3 to elevation 212 in Borehole 1.

4.3 Soil Conditions

The investigation revealed that the material overlying the bedrock was predominantly a till-textured loose to medium dense grey sand, with silt, some gravel and occasional cobbles.

The top two feet was a silty topsoil. Beneath this topsoil, a loose to medium dense till-textured soil having a grading as shown on the chart in Appendix II was found. The penetration resistance of this soil was in a general range of 4 to 38 blows per foot. In a few instances, higher penetration resistances were recorded.

The natural moisture content of this stratum ranged approximately from 5% to 12%, the lower values being found toward the deeper parts of the layer. The apparent unit weight of this material as determined from the split spoon samples ranged from 146 to 150 lbs. per cubic foot. These unit weights should be used with caution, however, as it is possible that the samples were compacted in the split-spoon while driving. For design purposes the material in this layer was considered to have an angle of internal friction equal to 35° and a unit weight of 140 lbs. per cubic foot. In addition, the soil

was considered to be completely submerged beneath the water table.

In Borehole No. 1, approximately 3 ft. of medium grey clay was encountered at a depth of 29 feet below the ground surface. The moisture content of this material was determined to be 30.8%.

Immediately overlying bedrock on the north side of Doherty Creek, approximately 3-1/2 feet of till-textured very dense gravel, with sand, some silt was encountered. Its moisture content was found to be about 4.5%.

4.4 Water Conditions

At the time of this investigation (June, 1960) the water level of Doherty Creek, at the proposed crossing, was observed to be at elevation 249.4. The maximum depth of water in the creek was about one foot.

Artesian flow was first encountered in all four boreholes at approximately 18 feet below the ground surface. The artesian pressure, at this depth, had a static head of about one foot above ground surface. The flow was less than one gallon per minute at ground surface. With increasing depths the pressure became more pronounced and static heads of 2 to 4 feet were recorded. In B.H. 3 at elevation 212, a static head of approximately 4 feet above ground surface was observed. The flow from this depth was about 3 gallons per minute at ground surface.

The ground water in the boreholes was found to be slightly higher than the level of Doherty Creek. It varies from elevation 251.8 in B.Hs. 1 and 2 to elevation 249.6 in B.Hs. 3 and 4. The ground water level in all boreholes was measured about 24 hours after the casing was withdrawn from the hole. Therefore, the introduction of artesian pressure appeared to have no effect on the ground water table.

SECTION 5

DISCUSSION OF FOUNDATIONS

5.1 General

The proposed structure will be designed to take County Road No. 18A over Doherty Creek.

5.2 Spread Footings

Considering the use of spread footings for the foundations of this structure, and assuming that the footings are placed at elevation 247 with a minimum surcharge to elevation 252, the allowable bearing capacity, with a factor of safety of 3 against shear failure, for various footing widths is given in Table No. 1 as follows:

TABLE NO. 1						
Allowable Bearing Capacity Minimum Surcharge = 5 Ft.						
Effective Footing Width (ft)	5	6	7	8	9	10
Allowable Reactive Pressure (k. s. f.)	6.2	6.8	7.4	8.1	8.7	9.3
Allowable Reactive Load (k/ft)	31.0	40.8	51.8	64.3	78.3	93.0

With the bearing values given above, the total settlements are not expected to exceed one inch, nor differential settlements to exceed one-half inch.

It is expected that excavations can be made down to elevation 247 without difficulty.

5.3 Piles

Should design or construction requirements dictate the consideration of a pile supported structure, it would be feasible

in our opinion, to use steel H-piles. Refusal is expected to be encountered at about elevation 220 in the vicinity of the south abutment and between elevation 218 and 209 from the east side to the west side of the north abutment.

5.4 Approach Fills

Assuming that about two feet of topsoil is removed prior to fill placing operations, the maximum height of approach fill is not expected to exceed 10 feet. In our opinion, approach fills with slopes of 1.5 horizontal to 1 vertical may be constructed without exceeding a reasonable factor of safety for stability.

SECTION 6PERSONNEL

The site drilling supervision was performed by
D. S. Oaks, P. Eng.

The writing of this report was the responsibility
of J. Kilgour, P. Eng.

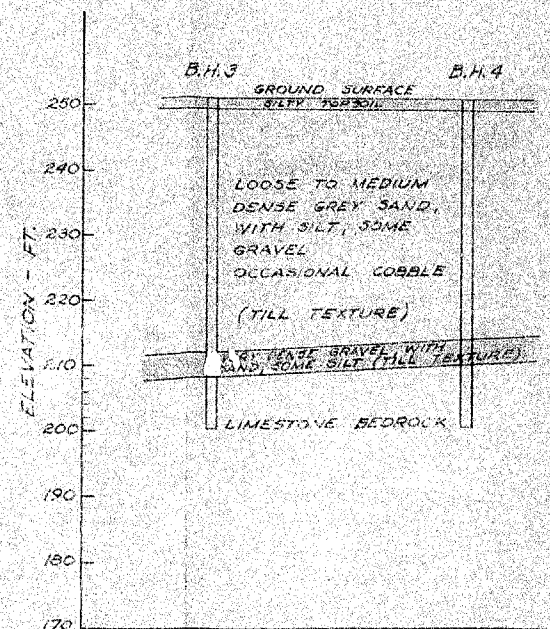
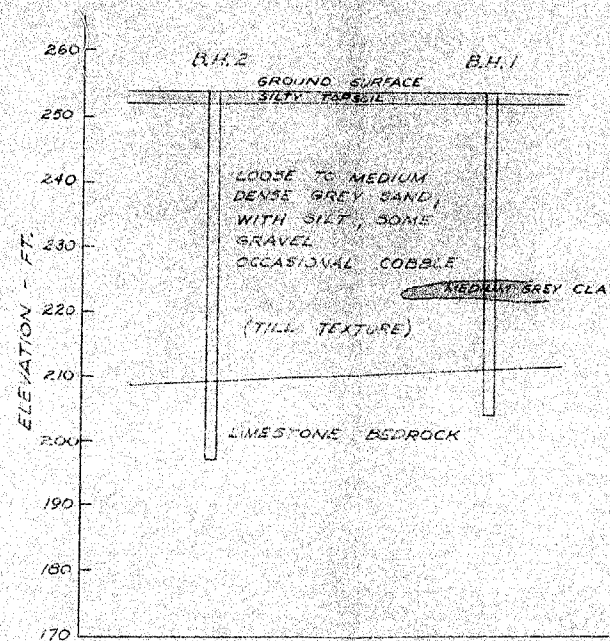
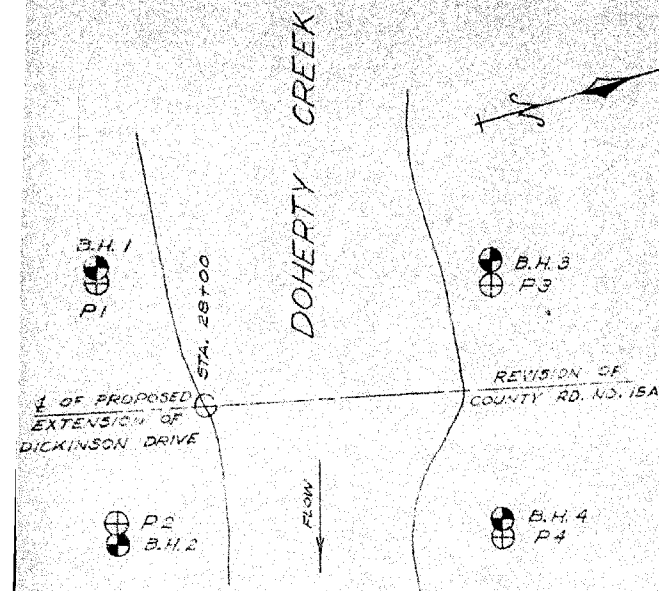
APPENDIX I

CLIENT: DEPT. OF HIGHWAYS - ONTARIO
 JOB NO. 6019 LOCATION INGLESIDE, ONT.
 PROJECT BRIDGE SITE - DOHERTY CREEK
 DATE FIELD INVESTIGATION 16/6/60 TO 5/7/60
 DATE REPORT _____ BY _____ CHKD. _____

⊕ BOREHOLE
 ⊕ DYNAMIC CONE PROBE

HORIZONTAL 1" = 20'
 VERTICAL 1" = 20'

ASSOCIATED GEOTECHNICAL SERVICES
 Limited
 PLAN OF BOREHOLE LOCATIONS
 AND
 SOIL PROFILES



CLIENT Department of Highways of Ontario

JOB NO. 6019 LOCATION Near Ingleside, Ontario.

CO-ORDINATES Sta 27+84 - 23' Lt.

ELEVATION (SURFACE) 253.8 (COLLARI) _____ DATUM DHC

DATE (STARTED) 27/6/60 (FINISHED) 28/6/60 (COMPILED) D.S.O.

RIG. NO. 1 TYPE Boyle FIELD SUP. D. S. Oaks

SYMBOLS

SILT

GRAVEL

CLAY

SAND

PEAT

FILL

A - VANE SHEAR (NATURAL)

O - VANE SHEAR (REMOLDED)

STANDARD PENETRATION

UNDISTURBED

DISTURBED BUT REPRESENTATIVE

FAIR

LOST

ABBREVIATIONS

SS - SPLIT SPOON

ST - SHELBY TUBE

TWP - THIN WALLED PISTON

DB - DIAMOND BIT

C - CONSOLIDATION TEST

M - MECHANICAL ANALYSIS

T - TRIAXIAL COMPRESSION

K - PERMEABILITY

U - UNCONFINED COMP.

PCF - POUNDS PER CUBIC FOOT

WN - NATURAL WATER CONTENT

ASSOCIATED GEOTECHNICAL SERVICES

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OFFICE BOREHOLE LOG

BOREHOLE NO. 1

BOREING LOG

FIELD TESTS

SAMPLING

LABORATORY

TESTS

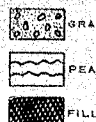
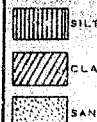
REMARKS

Appendix I - Fig. 2

[illegible]

CLIENT **Department of Highways of Ontario**
 JOB NO. **6019** LOCATION **Ingleside**
 CO-ORDINATES **Sta. 28+46 - 20' Rt.**
 ELEVATION (SURFACE) **251.6** (COLLAR) **20.6/6** DATUM **DHO**
 DATE (STARTED) **29/6/60** (FINISHED) **30/6/60** (COMPILED) **SO**
 RIG NO. **1** TYPE **Boyle** FIELD SUP. **D. S. Oaks**

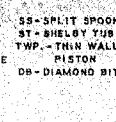
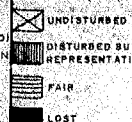
SYMBOLS



A - VANE SHEAR (NATURAL)
 O - VANE SHEAR (REMOLDED)
 S - STANDARD PENETRATION



ABBREVIATIONS



SS - SPLIT SPOON
 ST - SHIELD TYPE
 TWP - THIN WALLED
 PISTON
 DB - DIAMOND BIT

C - CONSOLIDATION TEST
 M - MECHANICAL ANALYSIS
 Y - TRIAXIAL COMPRESSION
 K - PERMEABILITY
 U - UNCONFINED COMP.
 PCF - POUNDS PER CUBIC FOOT
 WN - NATURAL WATER CONTENT

ASSOCIATED GEOTECHNICAL SERVICES

Limited

OFFICE BOREHOLE LOG BOREHOLE NO. 4

BORING L

FIELD TESTS

SAMPLING

LABORATORY

TESTS

SCALE FEET	DEPTH FEET	ELEV. FEET	WATER OBSERVATION	LOG	DESCRIPTION	SHEAR STRENGTH (TONS PER SQUARE FOOT)		PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	CONDITION	DEPTH		RECOVERY LENGTH REC. DIST. DRIV.	UNIT WEIGHT PCF □ Y 145 150 ATTERBERG LIMITS WP X 10 WN 15 OWL		REMARKS
						STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80					FROM FEET	TO FEET		TYPE		
	2.0	249.6	GWT		Silty topsoil											
5	6.0	245.6	Artesian Flow		Medium dense light brown sand with silt some gravel occasional cobble (till texture)			26	1b		3.8 5.3 SS 5.3 5.9 SS	0/18			*	
10					Medium dense grey sand with silt, some gravel, occasional cobble (till texture)			17	2b		8.9 10.4 SS 10.4 10.9 SS	0/18			*	
15								11	3		13.5 15.0 SS	9/18				
20	18.0	233.6						23	4		18.8 20.3 SS	10/18				
25								16	5		24.2 25.7 SS 25.7 26.2 SS	0/18			*	
30								13	6b		29.0 30.5 SS 30.5 31.0 SS	0/18			*	
35	37.0	214.6						36	7		33.9 35.4 SS	12/18				
40	40.9	210.7				Very dense grey gravel with sand, some silt, (till texture)		123	8		39.4 40.4 SS 40.8 41.8 DB 41.8 45.7 DE	10/12 10/12 47/47				
45						Limestone bedrock					45.7 51.0 DB	62/62				
50	51.0	200.6														
55					End of borehole											
																* Sample recovered with sand trap

Appendix I - Fig 5.

* Sample recovered with sand trap

DYNAMIC CONE PROBE

No. P-3

Location:

Station: 28+45
Offset: 16.5' Lt.
Elevation: 251.6

<u>Depth</u>	<u>Blows/ft</u>	<u>Depth</u>	<u>Blows/ft</u>
1	2	26	57
2	2	27	48
3	24	28	120
4	52	29	48
5	203	30	46
6	84	31	41
7	44	32	47
8	27	33	52
9	24	34	53
10	24	35	55
11	20	36	55
12	19	37	50
13	20	38	57
14	20	39	56
15	19	40	69
16	19	41	57
17	19	42	72
18	21	42.7	50
19	20		
20	20		
21	22	Refusal at 42.7' (no further penetration with additional 150 blows)	
22	23		
23	25		
24	40		
25	54		

Appendix I - Fig. 8

DYNAMIC CONE PROBE

No. P-4

Location:

Station: 28+46
Offset: 23' Rt.
Elevation: 251.6

<u>Depth</u>	<u>Blows/ft</u>	<u>Depth</u>	<u>Blows/ft</u>
1	2	21	30
2	2	22	32
3	12	23	38
4	35	24	37
5	30	25	37
6	18	26	44
7	18	27	58
8	27	28	72
9	17	29	68
10	16	30	79
11	22	31	68
12	25	32	85
13	29	33	154
14	30	34	131
15	44	35	105
16	55	36	87
17	32	37	92
18	32	37.7	200
19	32		
20	27		

Appendix I - Fig. 9

APPENDIX II

CLIENT Department of Highways of Ontario.

JOB NO. 6019 LOCATION Ingle side, Ont.

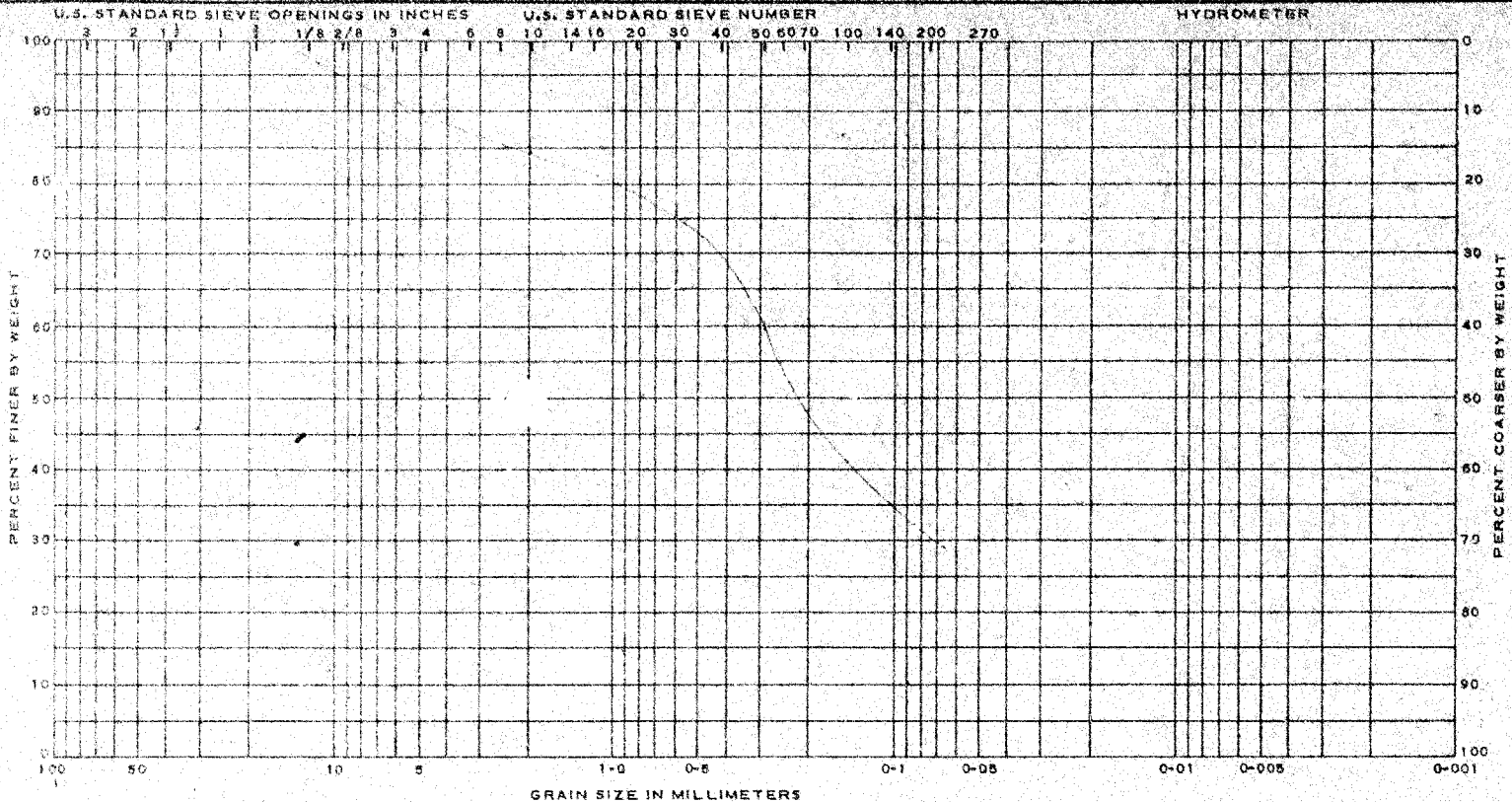
BOREHOLE NUMBER 3 DEPTH 20'

SAMPLE NUMBER 5 DATE 15/6/60

ASSOCIATED GEOTECHNICAL SERVICES

Limited

SOIL MECHANICS LABORATORY
MECHANICAL ANALYSIS



M.I.T. CLASSIFICATION

STONES

GRAVEL

SAND

SILT

CLAY

COARSE

MEDIUM

FINE

COARSE

MEDIUM

FINE

CLASSIFICATION

Sand with silt, some gravel.

SOIL MECHANICAL ANALYSIS

BOREHOLE - 3

DEPTH - 19.7 - 21.2

SOIL CLASSIFICATION SYSTEM

The following system was used to describe the various soils encountered at the site as determined by visual field examination and test. It was also used to classify those soils upon which a laboratory grain size determination had been made.

<u>Soil Components</u>	<u>Particle Size</u>
Clay	< .002 mm
Silt	> .002 mm < .06 mm
Sand	> .06 mm < 2.0 mm
Gravel	> 2.0 mm < 2 in.
Cobbles	> 2 in. < 6 in.
Boulders	> 6 in.

<u>Descriptive Terms</u>	<u>Range of Proportions</u>
and	greater than 40%
with	25% to 40%
some	10% to 25%
trace	less than 10%

Examples

1. Silt (predominant type) with (25% - 40%) sand.
2. Sand and silt (predominant types), some (10% - 25%) gravel, trace (< 10%) clay.

STANDARD PENETRATION CLASSIFICATION

Relative Density of Sands as determined by Standard Penetration Tests		
N	D _d	Designation on Borehole Log
0 - 4	0 - 0.2	Very Loose
4 - 10	0.2 - 0.4	Loose
10 - 30	0.4 - 0.6	Medium Dense
30 - 50	0.6 - 0.8	Dense
Over 50	0.8 - 1.0	Very dense

Shear Strengths of Clays as determined by Standard Penetration Tests		
N	s psf	Designation on Borehole Log
2	250	Very Soft
2 - 4	250 - 500	Soft
4 - 8	500 - 1000	Medium
8 - 15	1000 - 2000	Stiff
15 - 30	2000 - 4000	Very Stiff
30	4000	Hard