#62-F-327M

BARRON BRIDGE

TROUT CREEK

BRIDGE LOT 33,

CON I/II

WEST ZORRA TWP.

cc: Foundations Office (Rm. 110).

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Division,

(Foundation Section)

Attention: Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.

April 3, 1962.

REVIEW OF SOILS REPORT BY ASSOC. GEOTECHNICAL SERVICES, LTD., and PRELIMINARY BRIDGE DWGS. BY M. M. DILLON & CO., LTD.

(Bridge Office Ref. BA 1370)
D.H.O. Dist. #3.

Re: Upstream Bridges - Proposed Wildw... Reservoir, Twp. of West Zorra, Barron Bridge ...ot 33, Con. I/II, County Oxford, and Trou... reek Bridge.

We have reviewed the Soils Report submitted by Associated Geotechnical Services, Ltd. and the preliminary bridge design drawings prepared by M. M. Dillon & Co., Ltd. for the above-mentioned structures and below, are submitting our comments for your consideration:-

1. Barron Bridge:

Spread footings as well as footings on piles, are considered in the Soils report. For the spread footing elevation 1047.5, the Consultant has presented a chart showing that after a certain width of the footing has been reached, the requirement that the deeper lying clay layer not be overstressed becomes the governing factor. A similar relationship exists for a footing of constant width but founded at different elevations. The deeper the foundation elevation, the more governing the clay layer becomes.

The Bridge Consultant has designed the abutment footings to be supported on piles, while for the piers, he has chosen spread footings enclosed within steel sheeting. A 2'6" tremie concrete pad is to be placed below the footing elevation of 1058.5. The sheet piles should be driven down to elevation 1045.0 and the river bed finally excavated to elevation 1050.0 or slightly lower. This would mean that 5 feet of sheeting containing the footing and the tremie pad would be above the creek bottom and five feet or slightly less would be below creek bottom - i.e., embedded in the ground. Because the possibility of some scour cannot be discarded, it becomes questionable whether the sheet piling is driven deep enough. A sheet pile wall stability calculation with the most unfavourable assumptions should be made and the correct penetration depth should thus be determined.

cont'd. /2 ...

Mr. A. M. Toye, Bridge Engr.
Attn: Mr. K. L. Kleinsteiber.

April 3, 1962.

1. Barron Bridge: (cont'd.) ...

We understand that the values shown on the Soil Consultant's chart "b" of his report pertaining to the clay layer do not represent the allowable bearing capacities and therefore, if deeper sheeting is used, the right bearing capacities should be calculated.

It appears that, in the light of all the above-mentioned problems, footings on piles could be a more feasible and possibly also a more economical proposition. Either tube or 'H' piles could be used. It is believed that practical refusal would be reached in the very dense bouldery till layer, at approx. elevation 1020, and a safe load of up to 50 tons per pile, could be used.

2. Trout Creek Bridge:

The problems at this bridge site are of the same nature as at the Barron Bridge site except that here, the conservative scour depth elevation estimate is 1042.0 leaving only 2 feet of sheeting buried in the ground which would undoubtedly, be insufficient. It appears therefore, that here also, piled footings could be more economical and construction wise, an easier solution.

It is our opinion that both bridge designs should be reviewed and revised in the light of the above-mentioned problems.

Should there be any other questions you would like to discuss, please feel free to call on our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Encls.

cc: Foundations Office
Gen. Files.

P.S. -- Attached, we are returning to you,
all the drawings concerning the two bridges.

PRELIMINARY REPORT BA
ON SITE INVESTIGATION 1370
FOR UPSTREAM BRIDGES
PROPOSED WILDWOOD RESERVOIR

UPPER THAMES RIVER CONSERVATION AUTHORITY

Submitted by

ASSOCIATED GEOTECHNICALSERVICES LIMITED
211 Davenport Road Toronto 5,Ontario
December 4, 1961

TABLE OF CONTENTS

PRELIMINARY REPORT

ON SITE INVESTIGATION

PROPOSED BARRON BRIDGE NO. I

Introduction

The purpose of this report is to present the results of a foundation investigation carried out in connection with the proposed raising of Barron Bridge No. 1. The site is located on Concession Line 1 and 2 in West Zorra Township where it crosses Trout Creek.

Field Procedures

The borehole layout for this investigation was established by Mr. A. Phillips of M. M. Dillon & Co. Ltd. The boreholes were located in the field by chaining from the existing structure and a recently established set of chainage stakes (presumably by M. M. Dillon & Co. Ltd. Surveyors). The elevation of the collar of each borehole was established by spirit level using the deck of the existing bridge as a bench mark (elevation 1062.8). The location of the boreholes is shown in the plan (figure 1) in the Appendix.

A primary drilling program consisting of four soil borings and four dynamic cone probes was carried out in the vicinity of the proposed structure. One trailer-mounted Longyear hydraulic-feed drilling rig was used on this project. All soil boring and sampling operations were completed by an experienced soil sampling crew under the full time supervision of a qualified Soils Technician.

The soil boring was carried out by diamond drilling techniques in which the bottom of the casing was fitted with a diamond set casing shoe bit. Samples of cohesionless soil were obtained in split spoon samplers in conjunction with the standard penetration test. Samples of cohesive soil for laboratory testing were obtained by pushing a 2-inch diameter Shelby tube into the soil. Dynamic cone probes were made by using a 2-inch O.D. 60 degree cone point attached to the end of an A-rod. The probe was advanced into the soil by ramming, using a 140 lb. hammer falling freely 30 inches. The number of blows for each foot of penetration was recorded. The depths at which samples were taken in each borehole as well as the dynamic cone probe penetration resistance have been plotted on the borehole logs in the Appendix.

Laboratory Testing

Various laboratory tests have been carried out on representative samples of the clay layer found beneath the proposed structure. These include:

1. Plastic and Liquid Limit
2. Unit weight
3. Moisture Content
4. Unconfined Compression
5. Consolidation

All soil tests were carried out in the soils laboratory of Associated Geotechnical Services Ltd. In general, the methods of test followed those outlined in "Soil Testing for Engineers" by T.W. Lambe. The results of these tests are shown on the borehole logs and on the charts in the appendix.

Discussion of Site

The soils at the site are shown in profile on figures 1 and 2 in the Appendix. The soil details for each boring are shown on the Borehole Logs and in the laboratory test results. Bedrock was not encountered in any of the borings at the site.

The main types of soil encountered in the soil borings are listed below in order of their occurences below ground surface.

1. loose organic sand
2. dense brown sand with gravel becoming finer with depth to dense brown sand, some gravel
3. dense brown silt, some fine sand (found at south abutment only)
4. stiff brown clay with silt
5. dense gravel with sand (found at south abutment only)
6. very dense sand with silt, some gravel, till texture

Discussion of Proposed Structure

At the time of writing this report, it had been proposed to raise the existing bridge from elevation 1062.8 to elevation 1076.25 and to construct new abutments at the location of the existing ones. Considering this proposal, we wish to comment as follows on the foundation conditions.

(a) Scour

Although no detailed estimate of scour action has been undertaken, for the purposes of this report it has been assumed that the loose organic sand will be removed in the vicinity of the abutments as a result of erosive scour action.

(b) Spread Footing Bearing Capacity

Considering the use of spread footings for the foundations of the abutments, and assuming that at least 5 feet of soil surcharge will surround the footings, we have determined the allowable bearing capacity for various effective footing widths. These are shown on the charts b and c overleaf. It should be noted that for the narrower effective footing widths, the bearing capacity depends upon the strength of the sand and gravel layer whereas for wider effective footing widths, the maximum loading which will not overstress the clay layer becomes the governing criterion.

CLIENT U.T.R.C.A.

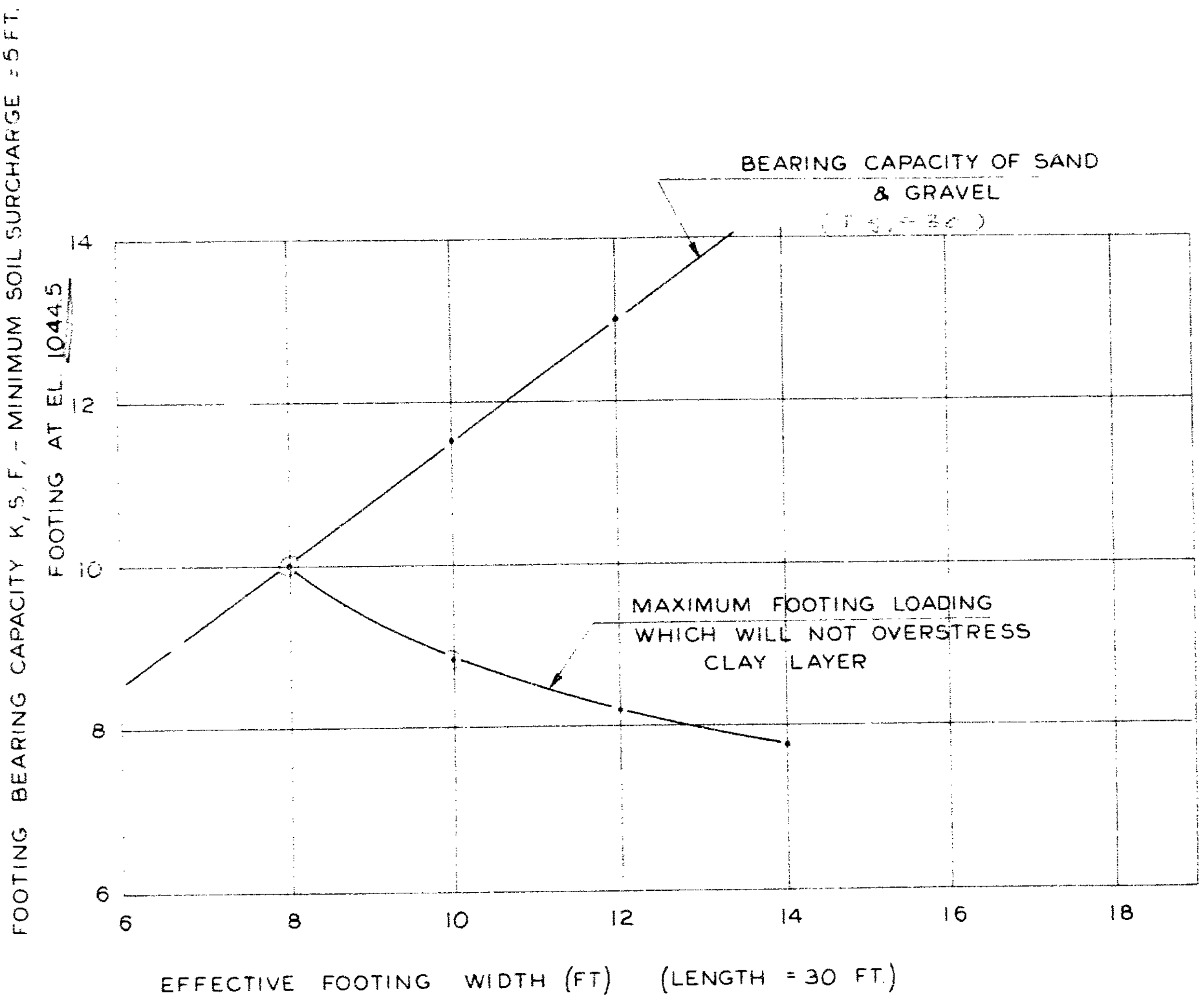
JOB. NO. 6117 LOCATION BARRON BRIDGE #1

BOREHOLE NUMBER DEPTH

SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES Limited

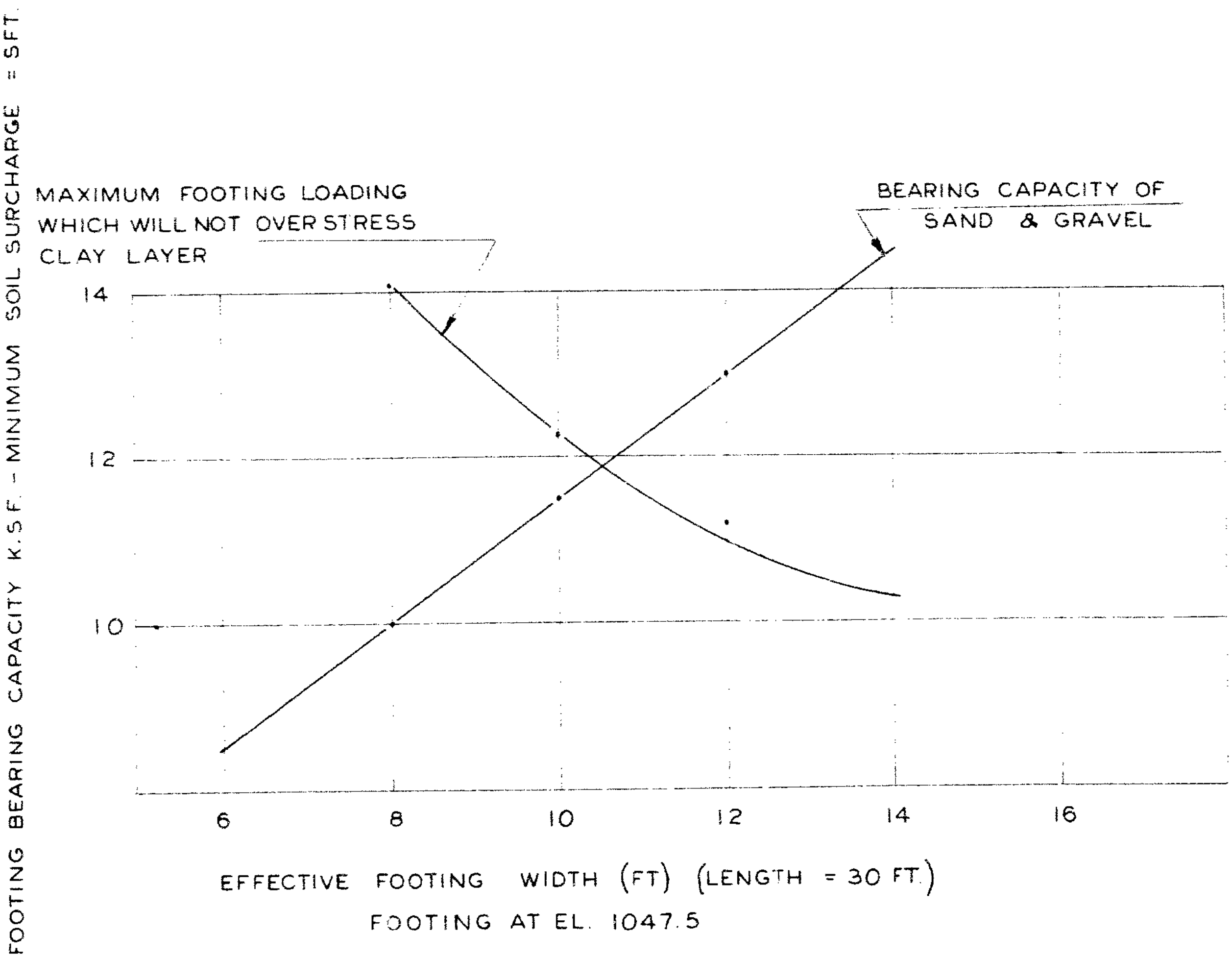
BEARING CAPACITY CHART
NORTH ABUTMENT



NOTE: FOR VERTICAL LOADS ONLY

FIGURE b

CLIENT U.T.R.C.A.	ASSOCIATED GEOTECHNICAL SERVICES Limited
JOB. NO. 6117 LOCATION BARRON BRIDGE #1	
BOREHOLE NUMBER ... DEPTH ...	BEARING CAPACITY CHART SOUTH ABUTMENT
SAMPLE NUMBER ... DATE ...	



NOTE: FOR VERTICAL LOADS ONLY

FIGURE C

The bearing pressure on the soil beneath the footing is a function of the earth pressure and the weight of the structure and in this case, the resultant load will be both eccentric and inclined on the foundation. To avoid excess settlement and undesirable tilting of the wall, the maximum pressure at the toe should not exceed the allowable bearing capacity of the soil. While the customary method of assessing the bearing capacity from the maximum toe pressure is on the safe side for cohesive soils, it can be unsafe for cohesionless soils. Thus Meyerhoff and others have suggested that for cohesionless soils, the bearing capacity should be assumed to be the same as for a centrally loaded base but of reduced width. Thus for a wall foundation of actual width B under a resultant load R with an eccentricity e on the base (see figure a and formulae overleaf), the <u>effective</u> contact width is defined as

$$B' = B - 2e$$

Charts b and c indicate the allowable bearing capacity for various effective footing widths. The bearing capacities shown on these charts will also have to be corrected for the inclination of the resultant load R as shown on chart a. For determination of the bearing capacity of the sand and gravel stratum, the relative density of the sand has been corrected by the Gibbs and Holtz method. A density chart showing the basis for their corrections is included in the appendix. The angle of internal friction of the sand and gravel was estimated at 37.5 degrees and this value was used in the calculations. A footing length of 30 feet was used for the determination of the maximum loading which will not overstress the clay layer. Where the stress imposed on the clay layer becomes the governing factor determing the bearing capacity, the allowable bearing capacity may have to be altered when the actual footing length is known.

The footing elevations for which charts b and c have been calculated are shown on the charts. It should be noted that due to the fact that the clay layer has less strength than the sand, footings at deeper elevations will have less bearing capacity.

(c) <u>Settlement of Spread Footings</u>

We have determined that for a 30 foot long footing with an effective width of eight feet and a loading of 10 kips per square foot, placed at the elevations shown on the charts, the settlement of the north abutment will be about 2.5 inches and the settlement of the south abutment will be about 1.5 inches. Changes in the loading, width, length, or elevation of the footing will affect the amount of settlement which should be recalculated when the details of the footings are fixed.

CLIENT U.T.R.C.A.

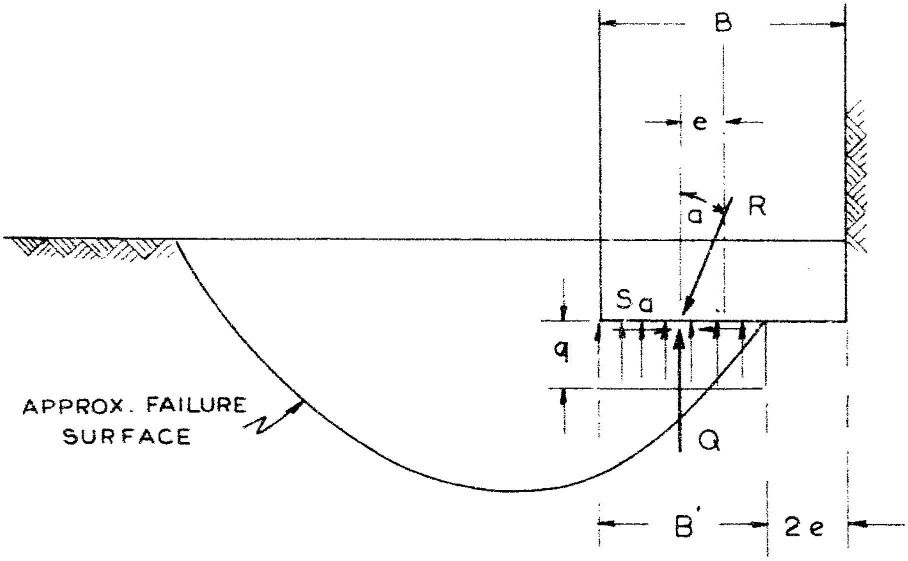
JOB. NO. 6117 LOCATION

BOREHOLE NUMBER DEPTH

SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES Limited

CALCULATION SHEET



BASE UNDER ECCENTRIC INCLINED LOAD AT FAILURE

$B' = B - 2e$

WHERE B' = EFFECTIVE CONTACT WIDTH

B = ACTUAL FOUNDATION FOOTING WIDTH

e = ECCENTRICITY OF RESULTANT LOAD R

$$Q = q_o B' \left(1 - \frac{a}{\phi}\right)^2$$

WHERE Q = THE TOTAL VERTICAL BEARING CAPACITY UNDER AN ECCENTRIC INCLINED LOAD R ON THE BASE.

q_o = AVERAGE UNIT BEARING CAFACITY UNDER VERTICAL LOAD.

B' = EFFECTIVE FOOTING WIDTH

a = INCLINATION OF R

ϕ : ANGLE OF INTERNAL FRICTION OF THE SOIL BENEATH THE FOOTING.

FIGURE a

(d) Pile Foundation

End bearing piles driven to refusal in the bouldery till textured stratum encountered at about elevation 1020 beneath the abutments can be considered as an alternative method of foundation support. Refusal can be expected within a few inches or a few feet of penetration into this stratum depending upon the presence of boulders beneath the pile tip.

(e) Dewatering

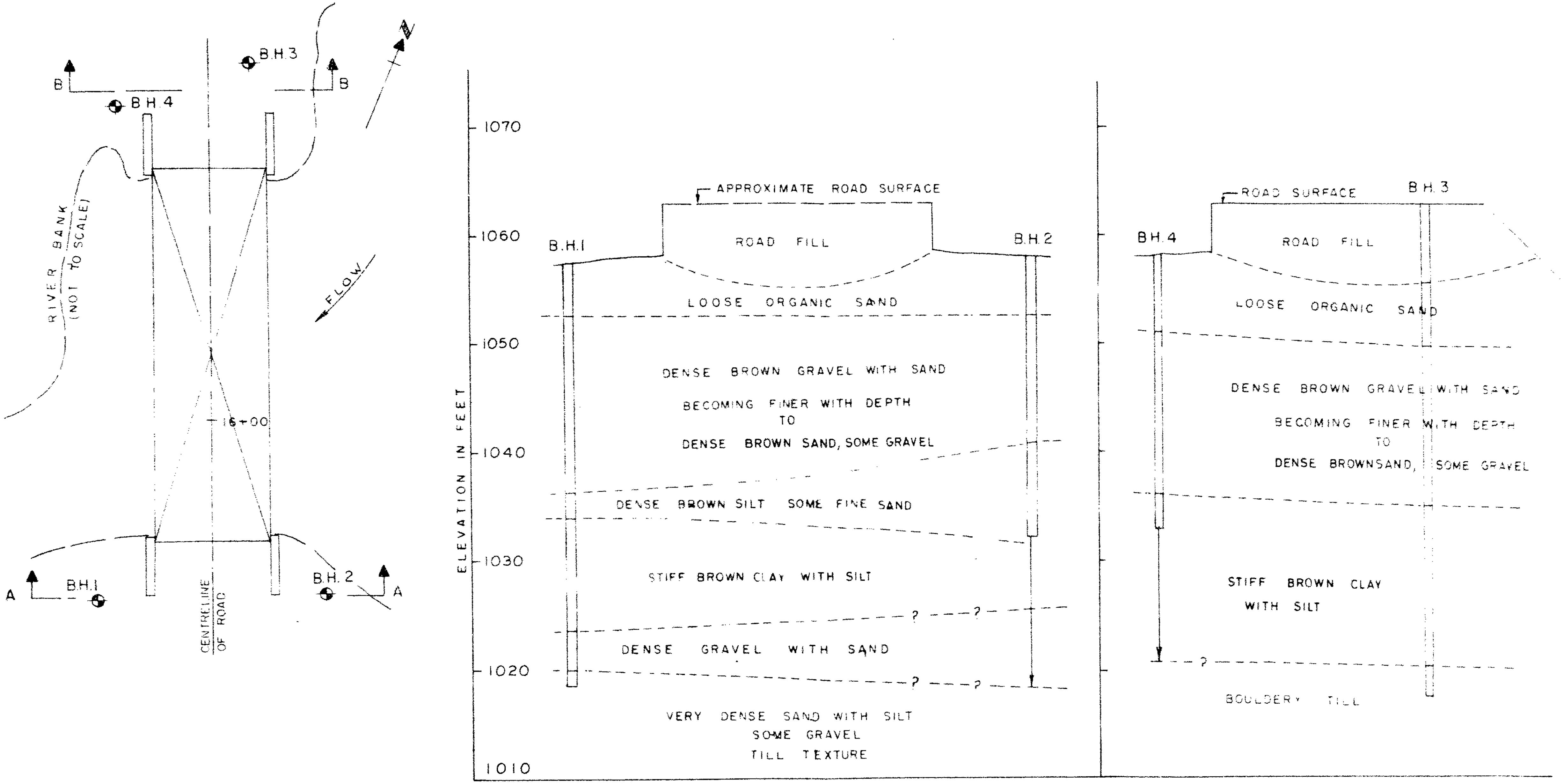
With respect to excavation for the footings or the pile cap, material will be removed down to elevation 1044.5 for the north abutment footing and 1047.5 for the south abutment footing. With a ground water table at about elevation 1055, considerable excavation will take place below the water level. It is unlikely that the soils at the site can be drained down to the required elevations from sumps in an open excavation without danger of excess upward hydraulic pressures, i.e., a quick sand condition. This quicksand condition will lead to piping of the soil on the bottom of the excavation as well as subsidence of the ground surrounding the excavation. Thus in order to prevent destruction of the soil bearing capacity due to piping it will be necessary to provide a complete excavation drainage control using well points or filter wells. In other words, the water level must be maintained at a low enough elevation to keep the free water surface in the soil far enough below the bottom of the excavation to prevent the occurence of piping.

(f) Approach Fills

No stability problems are anticipated with the approach fill earth section shown on M. M. Dillon & Co. Ltd. Drawing No. P-2.

APPENDIX

CLIENT: U.T.R.C.A. JOB NO. 6117 LOCATION BARRON BRIDGE NO.1 PROJECT WILDWOOD RESERVOIR DATE FIELD INVESTIGATION NOV, 1961 DATE REPORT ___ BY ___ CHKD. ___	LEGEND	SCALES HORIZONTAL 1" = 20' (PLAN) 1" = 10' (PROFILE) VERTICAL 1" = 10'	ASSOCIATED GEOTECHNICAL SERVICES Limited BOREHOLE PLAN AND ABUTMENT SOIL PROFILES



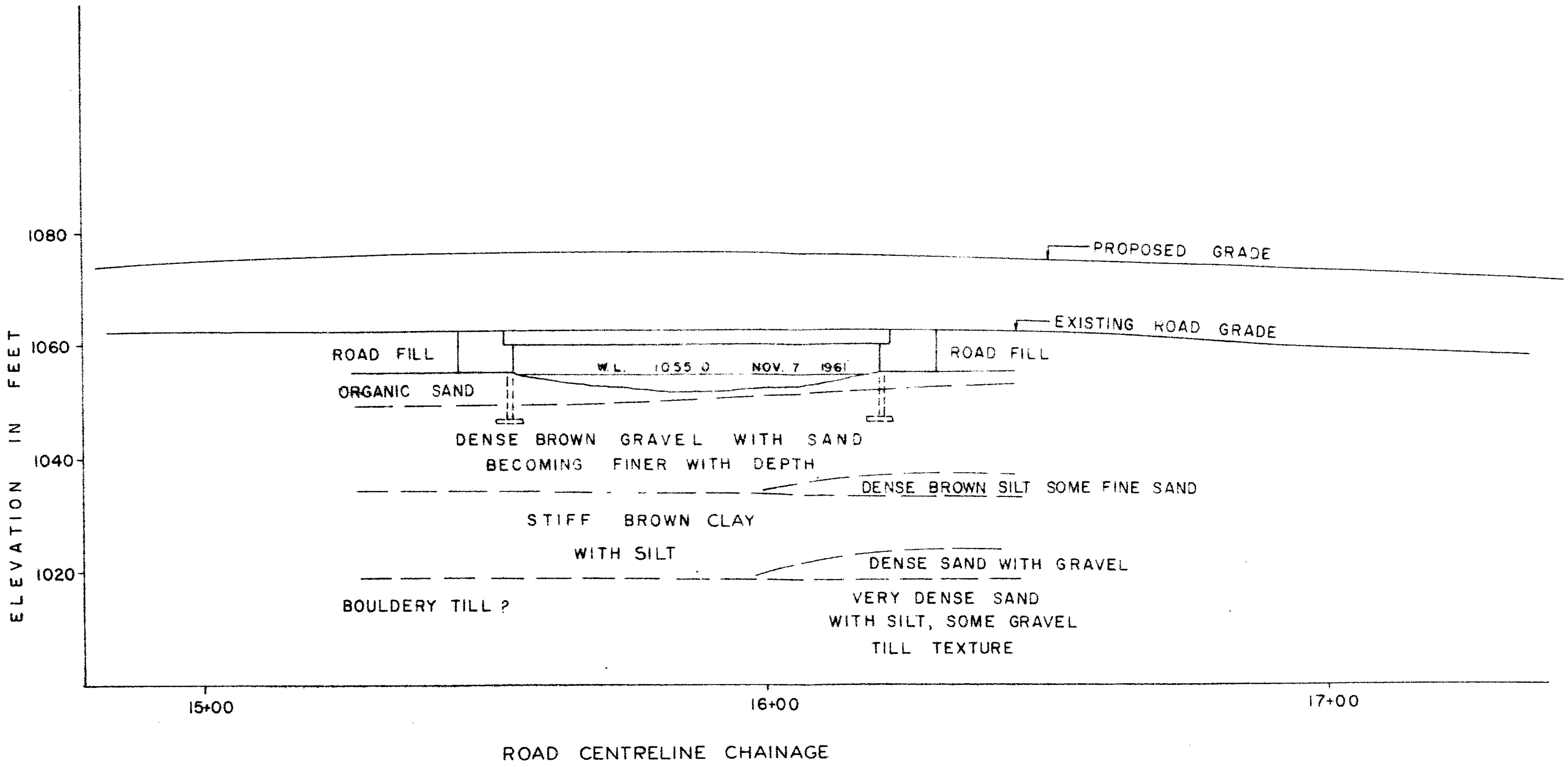
PROBABLE SOILS PROFILE A - A

PROBABLE SOILS PROFILE B-B

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

FIGURE 1

CLIENT: U.T.R.C.A JOB NO.: 6117 LOCATION: BARROW BRIDGE NO.1 PROJECT: WILDWOOD RESERVOIR DATE FIELD INVESTIGATION: NOV. 1961 DATE REPORT: ______ BY: ______ CHKD.: ______	LEGEND	SCALES HORIZONTAL: 1" = 20' VERTICAL: 1" = 20'	ASSOCIATED GEOTECHNICAL SERVICES Limited SOILS PROFILE ALONG ROAD CENTRELINE



DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

FIGURE 2

CLIENT: U.T.R.C.A.
JOB NO. 6117 LOCATION: BARRON BRIDGE NO. 1
CO-ORDINATES: CHNG. 15+67 - 21' Lt.
ELEVATION (SURFACE) 1057.6 (COLLAR) ___ DATUM ___
DATE (STARTED) Nov 2/61 (FINISHED) Nov. 3/61 (COMPILED) J.K.
RIG. NO. 1 TYPE L FIELD SUP. R. J. G.

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION
⊗ UNCONFINED COMPRESSION

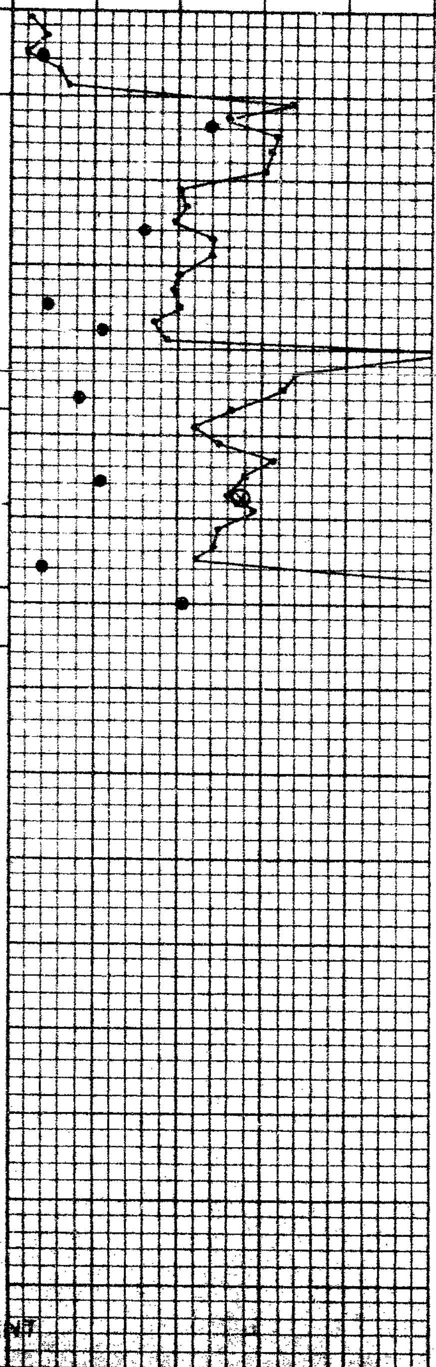
ABBREVIATIONS:
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 1

BORING LOG / FIELD TESTS / SAMPLING / LABORATORY TESTS



Depth (feet)	Elev. (feet)	Description	Penetration Resistance (blows per foot)	Sample Number	From (feet)	To (feet)	Type	Recovery Length Rec./Dist. Driv.	Remarks
3.3	1054.3	LOOSE ORGANIC SAND	9	1	2.0	4.0	SS	7/24	
5.0	1052.6	DENSE BROWN SAND SOME GRAVEL BECOMING FINER WITH DEPTH	48	2	6.0	8.0	SS	15/24	
			32	3	12.0	14.0	SS	19/24	
			10	4	16.0	18.0	SS	0/24	SOIL ROSE IN CASING PRIOR TO SAMPLING
			23	5	18.0	20.0	SS	12/24	
21.5	1036.1	DENSE BROWN SILT	17	6	22.0	24.0	SS	24/24	
23.8	1033.8	STIFF BROWN CLAY WITH SILT	23	7	26.0	28.0	SS	24/24	
				8	28.0	30.0	ST	16/24	PLASTIC LIMIT = 15.8% LIQUID LIMIT = 30.1%
			8	9	32.0	34.0	SS	22/24	
34.3	1023.3	DENSE GRAVEL WITH SAND	42	10	34.0	36.0	SS	19/24	
37.8	1020.8	VERY DENSE SAND WITH SILT SOME GRAVEL TILL TEXTURE	171	11	36.1	38.1	SS	11/24	
39.2	1018.4	END OF BOREHOLE	435	12	38.1	39.2	SS	8/13	

G.W.T.

Laboratory: UNIT WEIGHT PCF (DY) 130 140; ATTERBERG LIMITS WP — WN — WL 30 40

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

Client	U.T.R.C.A.		
Job No.	6117	Location	BARRON BRIDGE NO.1
Coordinates	CHNG. 15 + 68 - 21 RT.		
Elevation Surface	1057.8	(Collar)	Datum
Date Started	Nov. 6/61	(Finished) Nov. 7/61	Compiled J.K.
Sheet No.	1	Type L	Field Sup. R & G

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL

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

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST

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

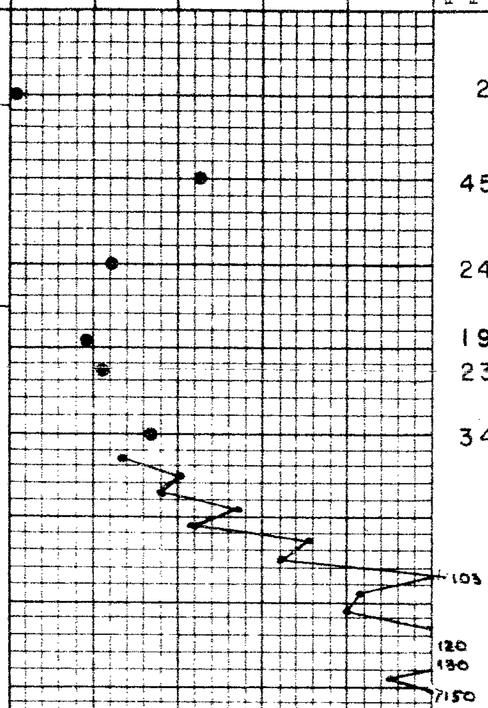
ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 2

BORING LOG — FIELD TESTS — SAMPLING — LABORATORY TESTS

Depth (feet)	Elev. (feet)	Water observation	Description	Penetration resistance (blows per foot)	Sample number	Condition	From feet	To feet	Type	Recovery length rec./dist. driv.
2.4	1055.4		LOOSE ORGANIC SAND							
5.5	1052.3	G.W.T.		2	1		4.0	6.0	SS	24/24
			DENSE BROWN GRAVEL WITH SAND BECOMING FINER WITH DEPTH	45	2		9.0	11.0	SS	15/24
				24	3		14.0	16.0	SS	10/24
17.7	1040.1		DENSE BROWN SILT SOME FINE SAND	19		LOST	18.1	20.1	SS	0/24
				23	4		20.0	22.0	SS	13/24
26.0	1031.8			34	5		24.0	26.0	SS	14/24
			END OF BOREHOLE							

SHEAR STRENGTH (TONS PER SQUARE FOOT)
STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80



UNIT WEIGHT PCF

ATTERBERG LIMITS WP — WN — WL

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

CLIENT U. T. R.C. A
JOB NO. 6117 LOCATION BARRON BRIDGE NO. I
CO-ORDINATES CHNG. 16+66 - 7.5' Rt.
ELEVATION (SURFACE) 1062.3 (COLLAR) DATUM
DATE STARTED Nov. 3/61 (FINISHED) Nov. 4/61 (COMPILED) J.K.
RIG NO. 1 TYPE L FIELD SUP. R. J. G.

SYMBOLS

SILT · CLAY · SAND · GRAVEL · PEAT · FILL

▲ - VANE SHEAR (NATURAL)
O - VANE SHEAR (REMOLDED)
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U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

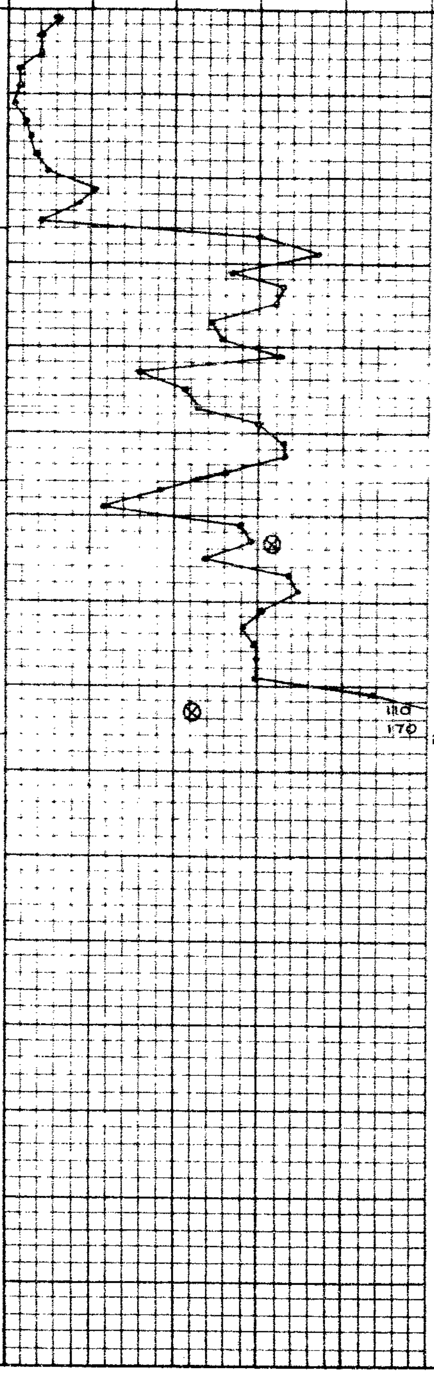
BOREHOLE NO. 3

BORING LOG

DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION
7.3	1055	GWT	ROADWAY FILL OVERLYING ORGANIC SAND
13.0	1049.3		DENSE GRAVEL & SAND BECOMING FINER WITH DEPTH
28.0	1034.3		STIFF BROWN CLAY WITH SILT
43.0	1019.3		LIMESTONE BOULDERS WITH SILT AND SAND
45.8	1016.5		END OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) 0.5 1.0 1.5 2.0
STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80



SAMPLING

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	REMARKS
4	1	11.0	13.0	SS	19/24	
54	2	11.70	19.0	SS	14/24	
30	3	23.0	25.0	SS	14/24	
21	4	29.0	31.0	SS	24/24	
	5	31.0	32.7	ST	14/19	
24	6	33.4	35.4	SS	24/24	
	7			WS		
	8	40.0	42.4	ST	18/24	
	9	43.4	43.6	SS	2/2	
	10	43.6	45.8	DB	18/26	BOULDER CORE RECOVERED

LABORATORY TESTS

UNIT WEIGHT PCF DRY 130 140
ATTERBERG LIMITS WP × — ● WN — O WL 30 40

DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENT

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 4

CLIENT: U.T.R.C.A.
JOB NO.: 6117 LOCATION: BARRON BRIDGE NO. 1
CO-ORDINATES: CHNG. 16+58 17' LT.
ELEVATION (SURFACE): 1057.9 COLLAR: DATUM:
DATE (STARTED): Nov. 6/61 (FINISHED): Nov 6/61 (COMPILED): J.K.
H.R. NO.: 1 TYPE: L FIELD SUP.: R.J.G.

SYMBOLS: SILT; GRAVEL; CLAY; PEAT; SAND; FILL
▲ - VANE SHEAR (NATURAL)
O - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
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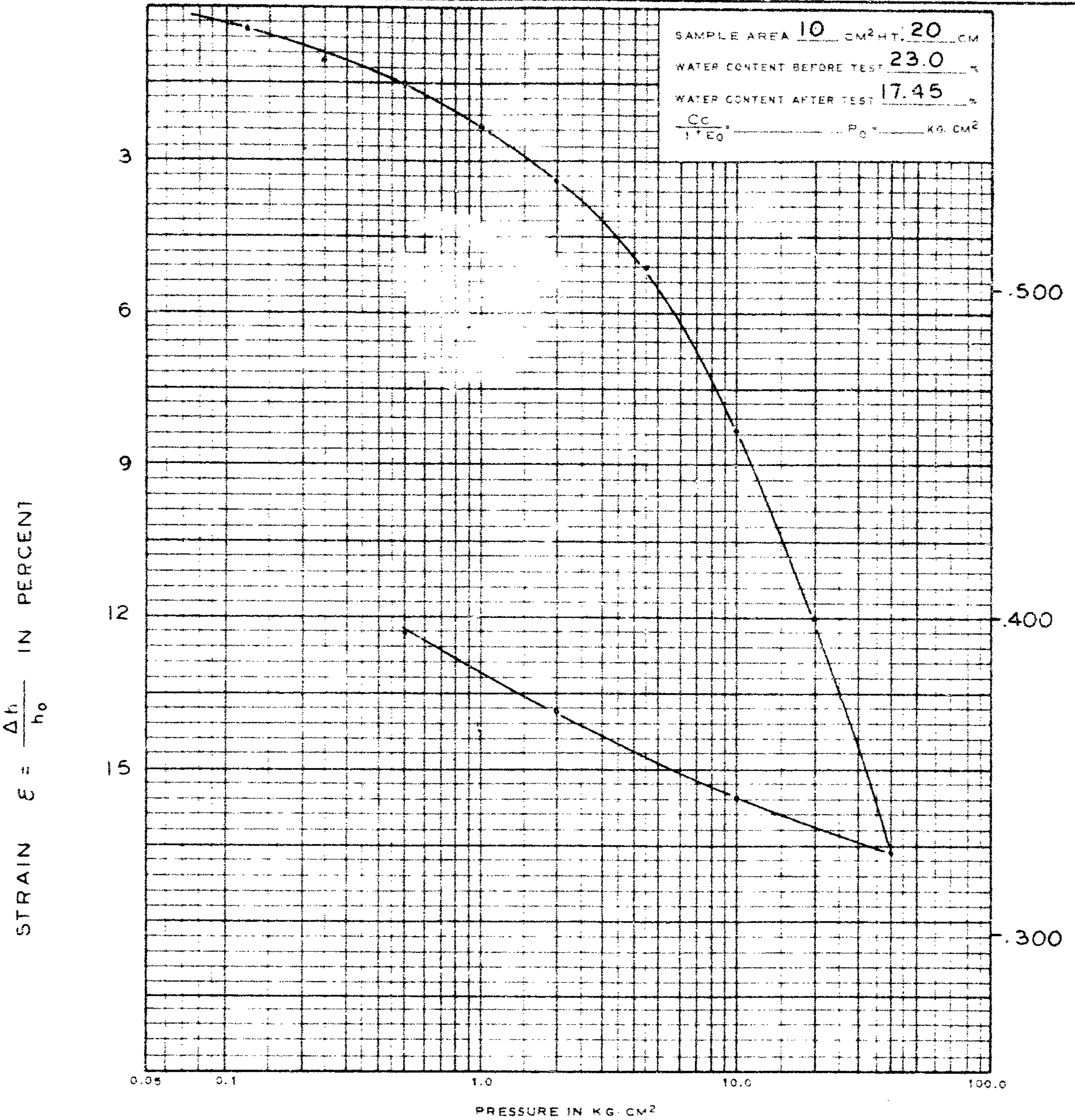
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

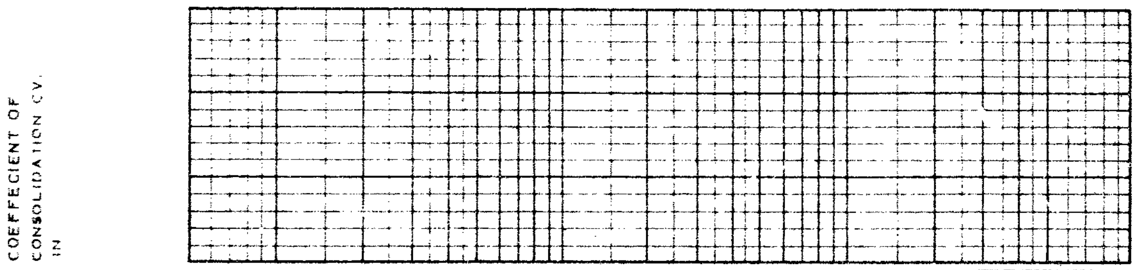
BORING LOG / FIELD TESTS / SAMPLING / LABORATORY TESTS

Shear strength (tons per square foot); Standard penetration test (blows per foot): 2.0 4.0 6.0 8.0

Depth (feet)	Elev. (feet)	Water observation	Description	Penetration resistance (blows per foot)	Sample number	From (feet)	To (feet)	Type	Recovery length Rec./Dist. Driv.	Remarks
2.9	1055.0		LOOSE ORGANIC SAND	3	1	4.0	6.0	SS	20/24	
7.0(?)	1050.9	GWT								
			DENSE SAND AND GRAVEL BECOMING FINER WITH DEPTH	29	2	9.0	11.0	SS	19/24	
					3			WS		
				15	4	14.0	16.0	SS	6/24	
22.0	1035.9		BROWN CLAY WITH SILT	26	5	23.0	25.0	SS	19/24	
25.0	1032.9		END OF BOREHOLE							
37.3	1020.6		END OF CONE PROBE							

CLIENT U. T. R. C. A.	**ASSOCIATED GEOTECHNICAL SERVICES Limited**
JOB NO. 6117 LOCATION BARRON BRIDGE # 1	**SOIL MECHANICS LABORATORY**
BOREHOLE NUMBER 1 DEPTH	CONSOLIDATION TEST
SAMPLE NUMBER 8 DATE 28/11/61	





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.

Soil Components	Particle Size
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.

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

Example

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

CLIENT ____________________

JOB NO. ____________ LOCATION ____________

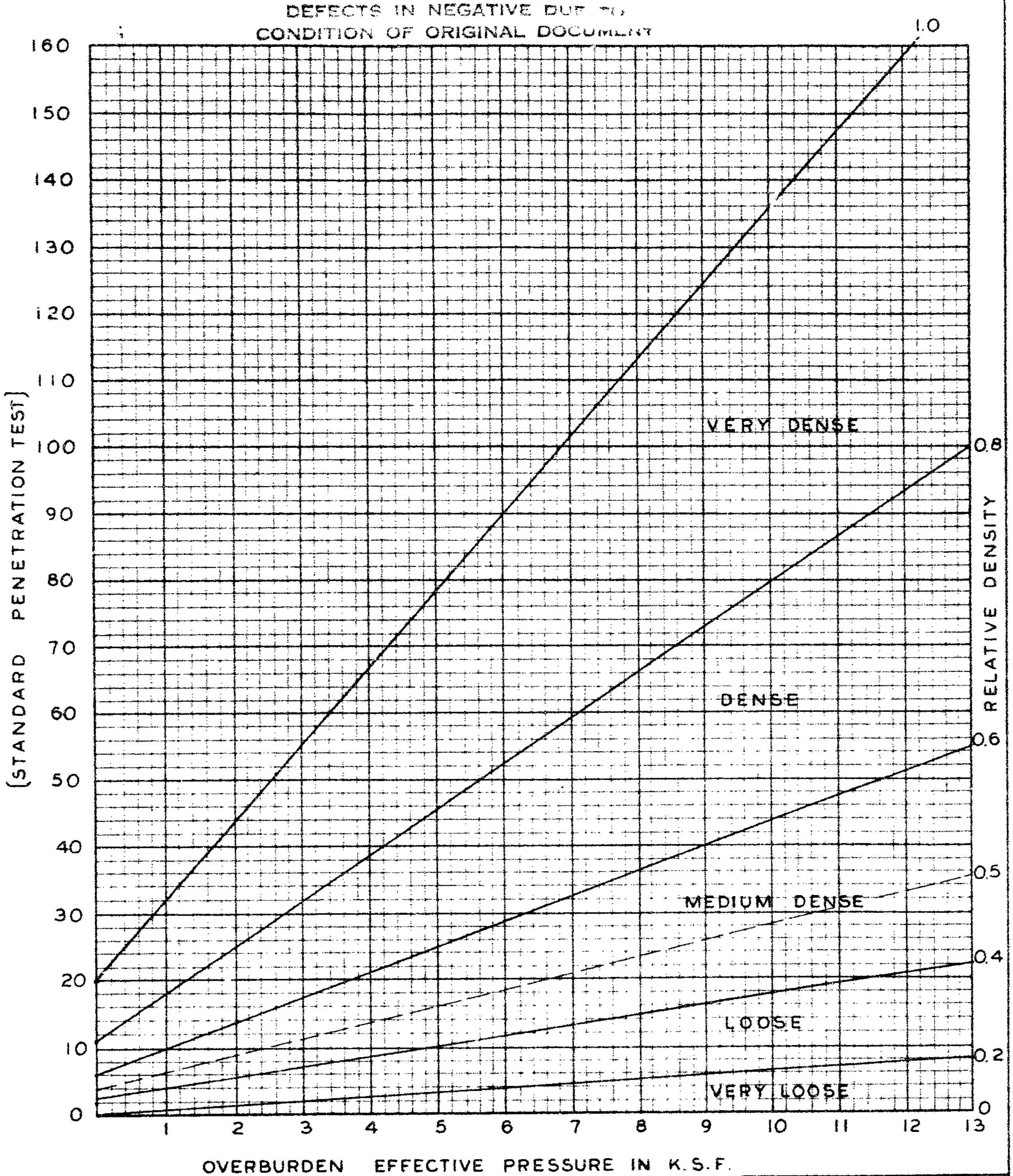
BOREHOLE NUMBER ____________ DATE ____________

SAMPLE NUMBER ____________ DEPTH ____________

ASSOCIATED GEOTECHNICAL SERVICES
Limited

SOIL MECHANICS LABORATORY
DENSITY CHART

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT



DIVISION 2 BRIDGE NO. 2

Appendix

PRELIMINARY REPORT

ON SITE INVESTIGATION

PROPOSED BRIDGE NO. 2

Introduction

The purpose of this report is to present the results of a foundation investigation carried out in connection with the proposed replacement of the West Zorra - East Nissouri Township Line Bridge over Trout Creek.

Field Procedures

The boreholes for this investigation were established in the field to a pattern suggested by Mr. A. Phillips of M. M. Dillon & Co. Ltd. by chaining from the existing bridge and referencing the locations to the previously surveyed chainage marker stakes. The elevation of each borehole was referenced by spirit level to the elevation of the deck of the existing bridge which was taken as 1060.0. The location of the borings is shown on the plan in the appendix.

The methods of soil boring and sampling used on this investigation are identical to those described for the Barron Bridge No. 1.

Laboratory Testing

Atterberg Limit determinations were carried out on samples from the clay layer encountered near the proposed North Abutment. No other laboratory tests were carried out.

Discussion of Site

The soils at the site are shown in profile in figures 1 and 2 in the appendix. The soil details for each boring are shown on the Borehole Logs.

The main types of soil encountered in the soil borings are listed below in order of their occurence below ground surface.

(a) South Abutment Area
1. dense brown sand, trace of gravel
2. very dense grey sand, trace of gravel
3. bouldery gravel with sand

(b) North Abutment Area
1. loose grey sand, some gravel and shell fragments
2. medium dense to dense gravel with sand
3. medium dense to dense brown fine sand
4. very stiff brown clay with silt
5. bouldery gravel with sand, trace of silt

The ground water table at the site was found to be at approximately elevation 1051.

Discussion of Proposed Structure

At the time of the writing of this report, it had been proposed to replace the existing one span structure with a three span continuous structure having a deck elevation of about 1077. Considering this proposal, we wish to comment on the foundation conditions as follows.

(a) Spread Footing at Abutments

The existing stream bed elevation is shown at elevation 1045.0 on M.M. Dillon & Co. Ltd. Drawing No. P-2. Assuming that scour does not take place, then for a minimum soil surcharge of 5 feet, the footing must be placed down to elevation 1040.0. The allowable bearing capacity, for various effective footing widths at elevation 1040, has been computed and is shown on charts b and c for the north and south abutments. It should be noted that for the north abutment, the bearing capacity of the wider footing widths is dependant on the maximum loading which will not overstress the clay layer.

The bearing capacities shown on charts b and c are for vertical loads on effective footing widths. These must be corrected for eccentricity and inclination of resultant load R at the abutments as shown on chart a overleaf.

For computation of the allowable bearing capacities, the relative densities of the cohesionless soils have been determined by the Gibbs and Holtz method.

A computation of the amount of settlement of the north abutment due to consolidation of the underlying clay layer has been made and found to be 1.2 inches. This calculation was made for the maximum allowable bearing pressure of 9.8 kips per square foot. Computation of the stresses imposed by the new embankment was made by Osterberg's method.

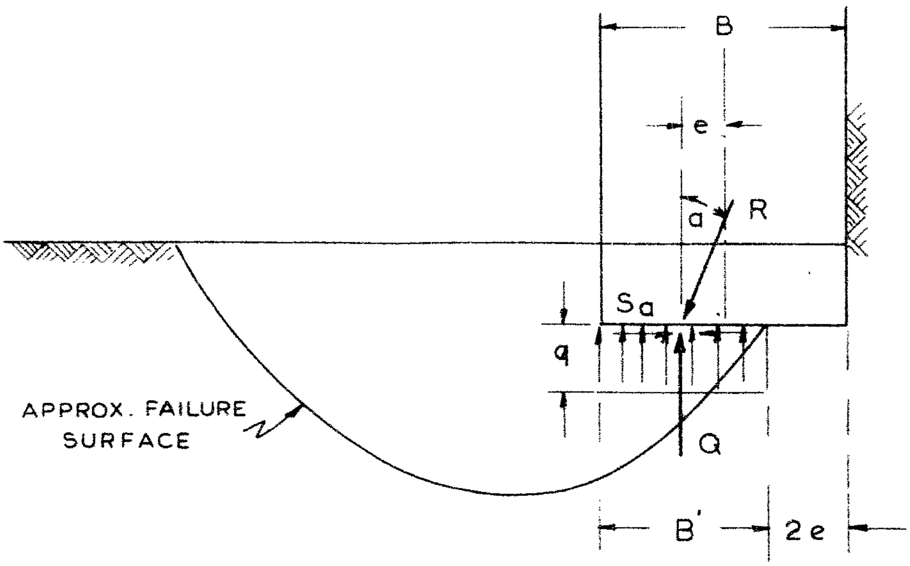
(b) Piers

Assuming that the existing abutments are on a type of foundation that has not disturbed the original ground conditions beneath elevation 1040, then for preliminary design the piers may be considered with a footing at elevation 1040 using the north abutment bearing capacity chart for the north pier and the south abutment bearing capacity chart for the south abutment. However, for construction purposes, the foundation conditions beneath each pier should be confirmed in the event that spread footings are to be utilized.

(c) Pile Foundation

End bearing piles resting on the bouldery gravel with sand stratum are expected to provide an alternative method of foundation support. Due to the presence of boulders in this stratum, it is our opinion that piles could not be driven into it.

CLIENT U.T.R.C.A. JOB. NO. 6117 LOCATION BOREHOLE NUMBER DEPTH SAMPLE NUMBER DATE	**ASSOCIATED GEOTECHNICAL SERVICES Limited** **CALCULATION SHEET**



BASE UNDER ECCENTRIC INCLINED LOAD AT FAILURE

$B' = B - 2e$

WHERE B' = EFFECTIVE CONTACT WIDTH

B = ACTUAL FOUNDATION FOOTING WIDTH

e = ECCENTRICITY OF RESULTANT LOAD R

$Q = q_o B' \left(1 - \frac{a}{\phi}\right)^2$

WHERE Q = THE TOTAL VERTICAL BEARING CAPACITY UNDER AN ECCENTRIC INCLINED LOAD R ON THE BASE.

q_o = AVERAGE UNIT BEARING CAPACITY UNDER VERTICAL LOAD.

B' = EFFECTIVE FOOTING WIDTH

a = INCLINATION OF R

ϕ = ANGLE OF INTERNAL FRICTION OF THE SOIL BENEATH THE FOOTING.

FIGURE a

CLIENT U. T. R. C. A.

JOB, NO. 6117 LOCATION BRIDGE NO. 2

BOREHOLE NUMBER DEPTH

SAMPLE NUMBER DATE

ASSOCIATED GEOTECHNICAL SERVICES Limited

BEARING CAPACITY CHART
NORTH ABUTMENT

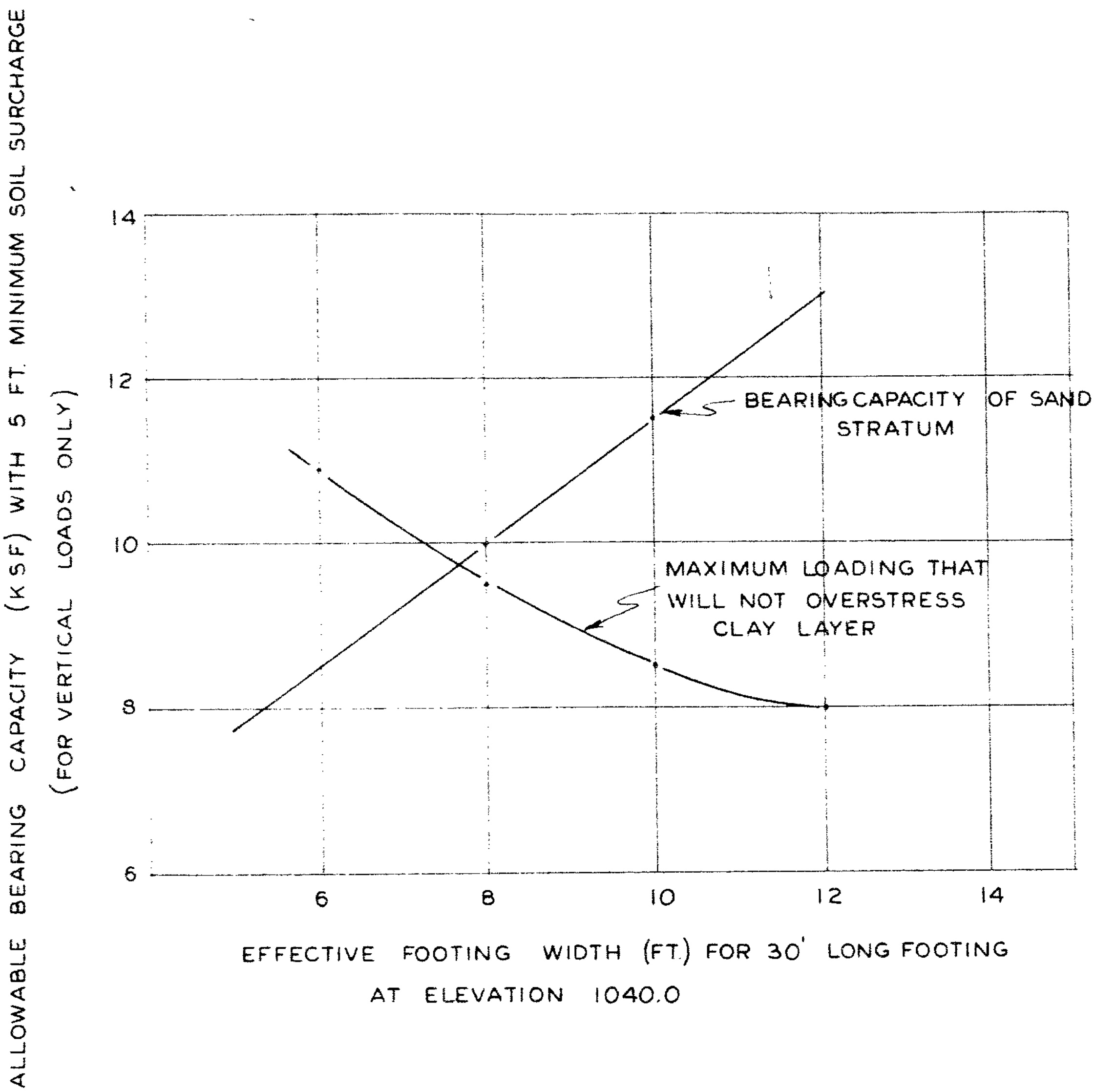


FIGURE b

CLIENT U.T.R.C.A.

JOB. NO. 6117 LOCATION BRIDGE NO. 2

BOREHOLE NUMBER DEPTH

SAMPLE NUMBER A.T.P.

ASSOCIATED GEOTECHNICAL SERVICES
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BEARING CAPACITY CHART
NORTH ABUTMENT

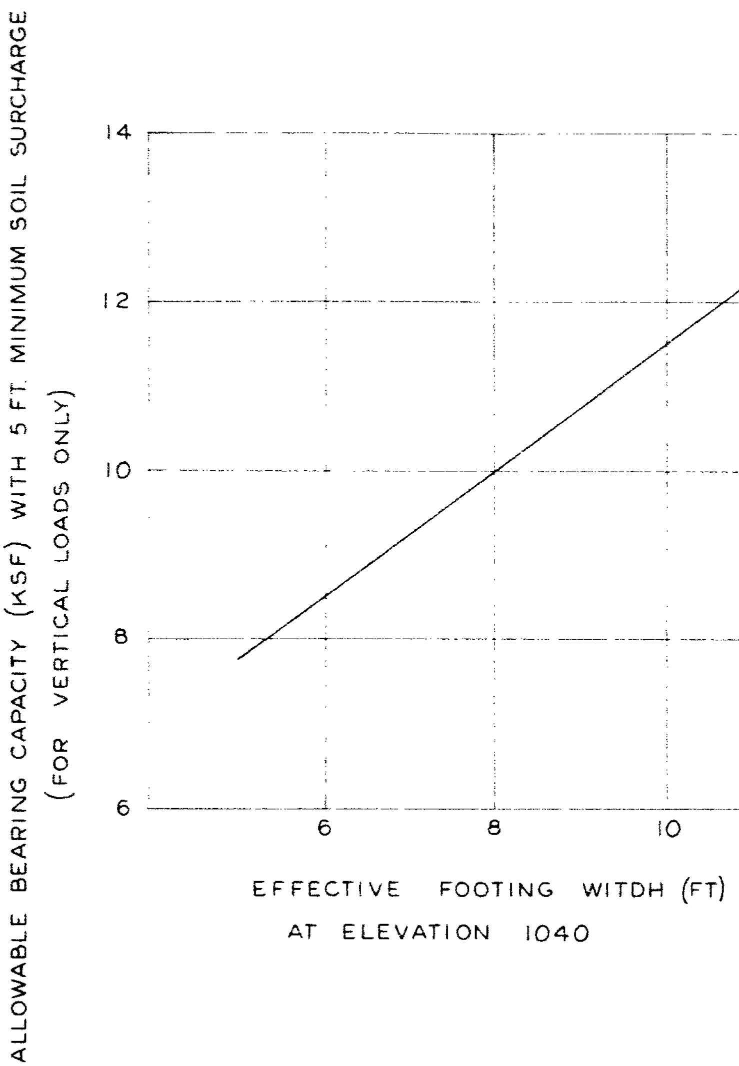


FIGURE C

(d) Dewatering

Where the footing or pile cap excavation is in sand below the water table, it will be necessary to maintain the freewater surface far enough below the bottom of the excavation to prevent the occurence of piping during the construction period. Drainage control by well points or filter wells will probably be required under these circumstances.

Where the footing or pile cap is in the bouldery gravel stratum, piping of the bottom of the excavation is not expected to occur.

(e) Approach Fills

No stability problems are anticipated with the approach fill earth section shown on M. M. Dillon & Co. Ltd. Drawing No. P-2.

APPENDIX

CLIENT: U.T.R.C.A JOB NO.: 6117 LOCATION: BRIDGE NO. 2 PROJECT: WILDWOOD RESERVOIR DATE FIELD INVESTIGATION: NOV. 1961 DATE REPORT: ______ BY: ______ CHKD.: ______	LEGEND	SCALES HORIZONTAL: 1" = 20' PLAN & PROFILES VERTICAL: 1" = 10	**ASSOCIATED GEOTECHNICAL SERVICES Limited** BOREHOLE PLAN AND ABUTMENT SOIL PROFILES.

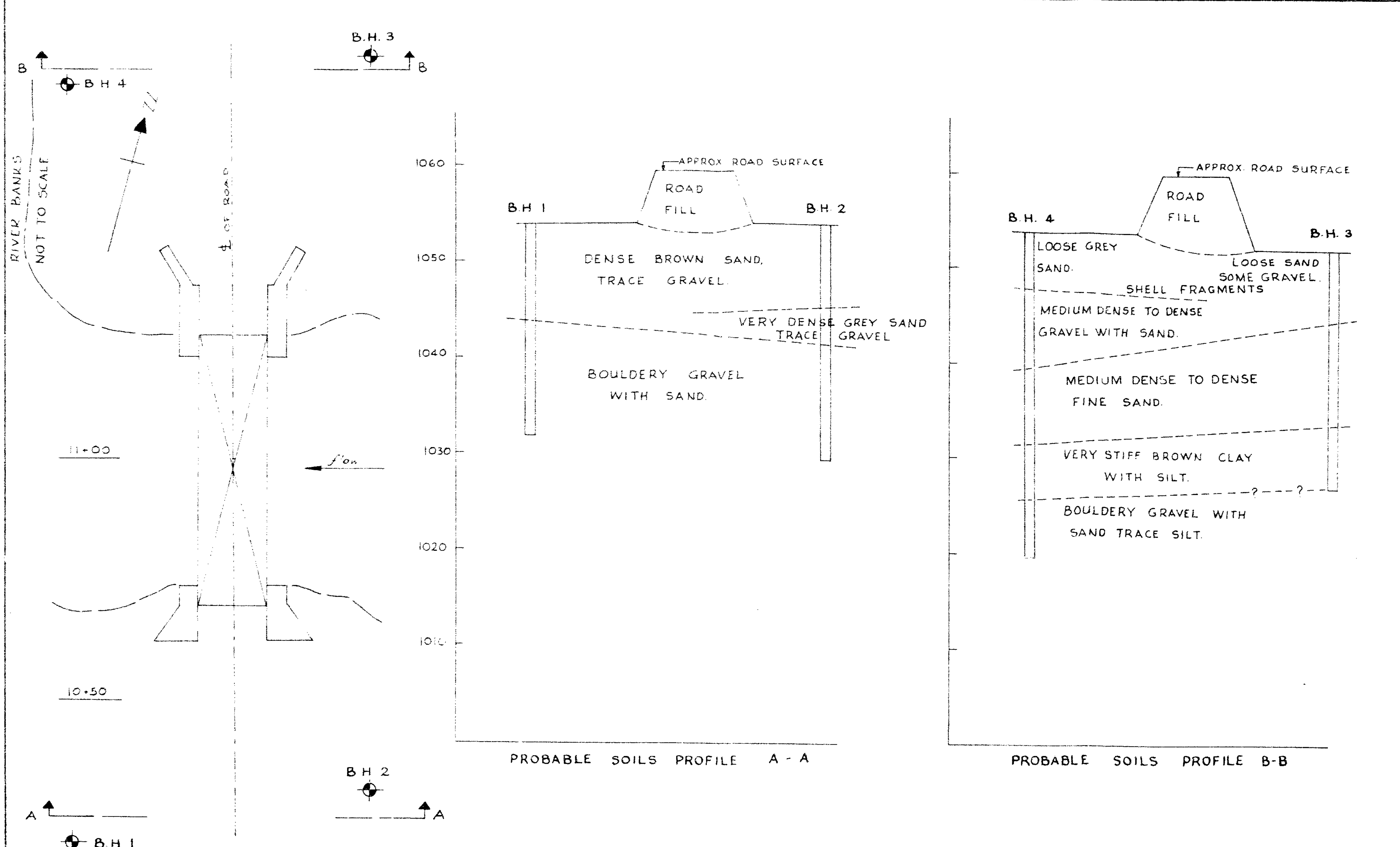


FIGURE 1

CLIENT: U.T.R.C.A
JOB NO.: 6117 LOCATION: BRIDGE NO. 2
PROJECT: WILDWOOD RESERVOIR
DATE FIELD INVESTIGATION: NOV. 1961
DATE REPORT ____ BY ____ CHKD. ____

LEGEND

SCALES
HORIZONTAL: 1" = 20'
VERTICAL: 1" = 20'

ASSOCIATED GEOTECHNICAL SERVICES Limited

SOIL PROFILE ALONG ROAD CENTRELINE.

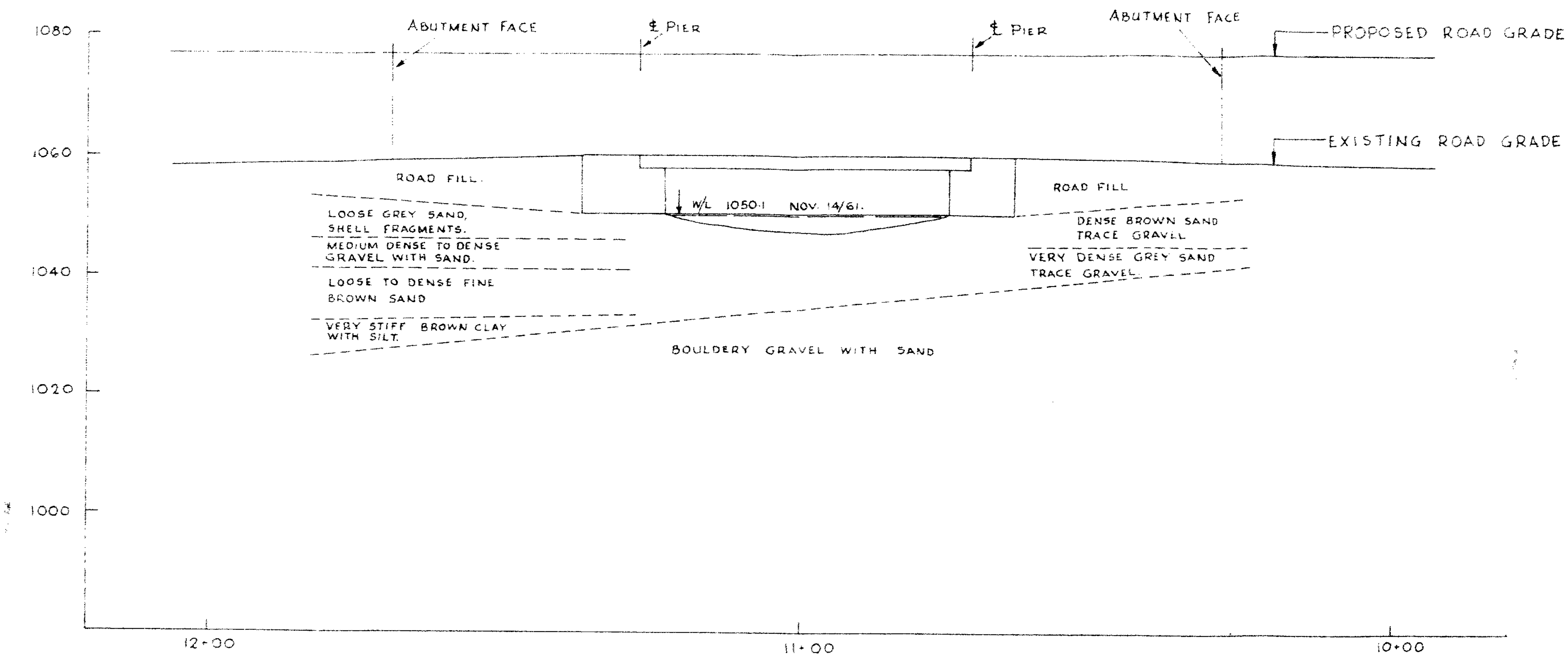


FIGURE 2

ASSOCIATED GEOTECHNICAL SERVICES
Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 1

CLIENT: U.T.R.C.A.
JOB NO.: 6117 LOCATION: BRIDGE NO. 2
COORDINATES: 10+22 34' LT.
ELEVATION (SURFACE): 1053.5 (COLLAR) DATUM
DATE STARTED: 11-11-61 (FINISHED): 11-11-61 (COMPILED): R.J.G.
B.H. NO.: 1 TYPE: L FIELD SUP.: R.J.G.

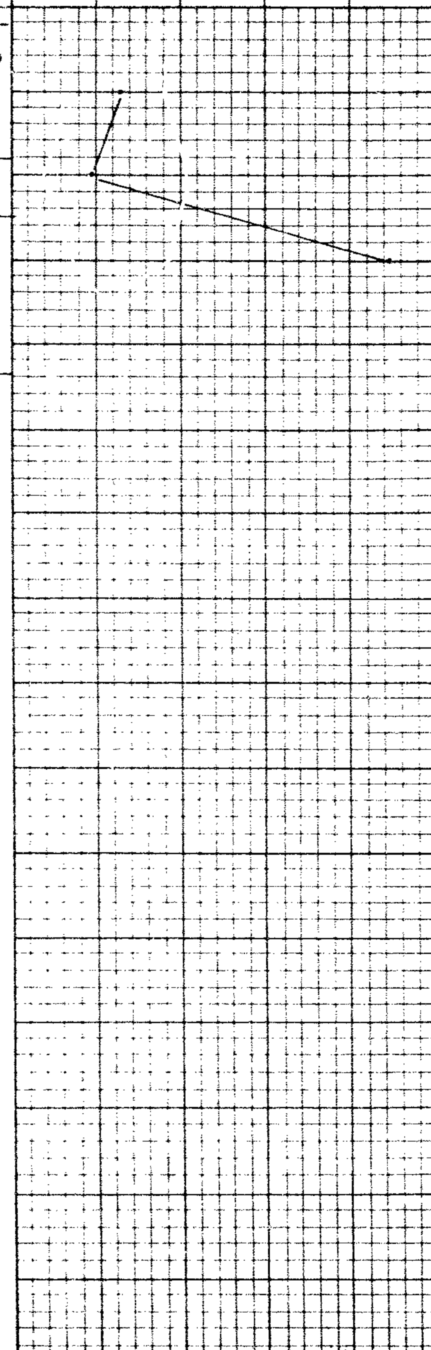
SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS:
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
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

BORING LOG | FIELD TESTS | SAMPLING | LABORATORY TESTS | REMARKS

SCALE FEET	DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION	PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.
	1.0	1052.5		TOPSOL						
	2.3	1051.2	G.W.T.	VERY DENSE BROWN SAND TRACE GRAVEL						
5					66	1	4.0	6.0	S.S.	18/24
10	9.0	1044.5		VERY DENSE GREY SAND TRACE GRAVEL	59	2	9.0	11.0	S.S.	21/24
	12.5	1041.0		BOULDERY GRAVEL WITH SAND			12.5	13.9	D.B.	
15					125	3	13.9	15.9	S.S.	5/24
20						4	15.4	21.9	D.B.	
	21.9	1031.6		END OF BOREHOLE						
25										

SHEAR STRENGTH (TONS PER SQUARE FOOT)
STANDARD PENETRATION TEST (BLOWS PER FOOT): 60 80 100 120



UNIT WEIGHT PCF
ATTERBERG LIMITS: WP × —— ● WN —— ○ WL

REMARKS:
AFTER 12.5 USED BXL CORE BARREL TO DRILL GRAVEL COBBLES & BOULDERS DRILLED 7.9 RECOVERED 6.3' GRAVEL, COBBLE AND BOULDER CORE

ASSOCIATED GEOTECHNICAL SERVICES
Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 2

CLIENT: U.T.R.C.A.
JOB NO.: 6117 LOCATION: BRIDGE NO. 2
CO-ORDINATES: CHNG. 10+134 - 28' RT.
ELEVATION (SURFACE): 1053.3 (COLLAR): DATUM:
DATE (STARTED): NOV. 9, 61 (FINISHED): NOV. 10 (COMPILED): J.K.
RIG. NO.: 1 TYPE: L FIELD SUP.: R.J.G.

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL
▲ - VANE SHEAR (NATURAL)
○ - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS.
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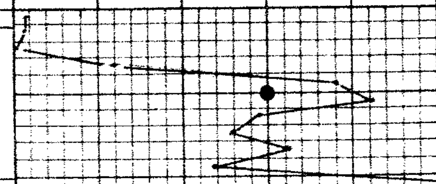
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

BORING LOG / FIELD TESTS / SAMPLING / LABORATORY / TESTS / REMARKS

FIELD TESTS: SHEAR STRENGTH (TONS PER SQUARE FOOT); STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80



LABORATORY: UNIT WEIGHT PCF; ATTERBERG LIMITS WP x —— ● WN —— o WL

DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION	PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC./DIST. DRIV.	REMARKS
1.0	1052.3		TOPSOIL							
3.4	1049.9	GWT	LOOSE TO DENSE BROWN SAND AND GRAVEL	60	1	4.0	6.0	S.S.	14/24	
				62	2	8.0	10.0	S.S.	18/24	
10.0	1043.3		BOULDERY GRAVEL WITH SAND	224/6	3	11.0	11.5	S.S.	6/6	
						11.7	12.6	D.B.		
				114	4	13.5	15.0	S.S.	9/18	BOULDER CORE RECOVERED
					5			D.B.		
					6			D.B.		
					7			D.B.		
				207/7	8	19.5	20.0	S.S.	5/7	TRACE SILT AFTER 21 FEET
					9			D.B.		
				195	10	21.5	23.5	S.S.	16/24	
				165/11	11	23.8	24.7	S.S.	6/11	
24.7	1028.6		END OF BOREHOLE							

ASSOCIATED GEOTECHNICAL SERVICES
Limited

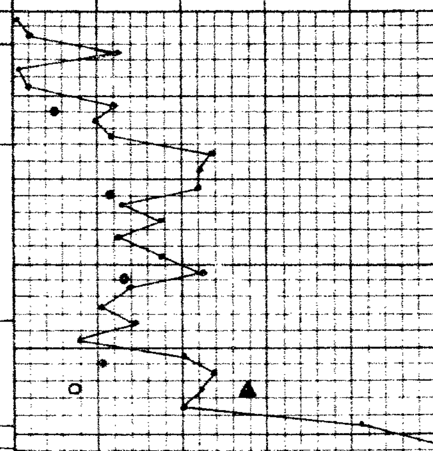
OFFICE BOREHOLE LOG
BOREHOLE NO. 3

CLIENT: U.T.R.C.A.
JOB NO.: 6117 LOCATION: BRIDGE # 2
CO-ORDINATES: CHNG. 11+84 29' RT.
ELEVATION (SURFACE): 1051·1 (COLLAR): DATUM:
DATE STARTED: Nov. 8/61 (FINISHED): Nov. 9/61 COMPILED: J.K.
RIG NO.: 1 TYPE: HYD. FIELD SUP.: R.J.G.

SYMBOLS: SILT, CLAY, SAND, GRAVEL, PEAT, FILL; ▲ - VANE SHEAR (NATURAL); O - VANE SHEAR (REMOLDED); ● - STANDARD PENETRATION

ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT; WS WASH SAMPLE
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL WATER CONTENT

Depth (feet)	Elev. (feet)	Water observation	Description	Penetration resistance (blows per foot)	Sample number	From (feet)	To (feet)	Type	Recovery length rec./dist. driv.
		GWT	TOPSOIL						
2.0	1049·1		LOOSE SAND SOME GRAVEL. SHELL FRAGMENTS.	10	1	5.0	7.0	SS	24/24
7.5	1043·6		MEDIUM DENSE BROWN SAND	23	2	10.0	12.0	SS	14/24
					3			W.S	
				26	4	15.0	17.0	SS	13/24
18·2	1032·9		VERY STIFF BROWN CLAY WITH SILT.		5			W.S	
				21	6	20.0	22.0	SS	21/24
24.4	1026.7		SILT, SAND AND GRAVEL	110	7	24.5	25.9	SS	11/15
25.9	1025.2		END OF BOREHOLE						



REMARKS: WATER LEVEL AT GROUND SURFACE 24 HRS. AFTER COMPLETION.

CLIENT U.T.R.C.A.
JOB NO. 6117 **LOCATION** BRIDGE NO. 2
CO-ORDINATES 11+78 34' LT
ELEVATION (SURFACE) 1053.7 **(COLLAR)** **DATUM**
DATE (STARTED) 9-11-61 **(FINISHED)** **(COMPILED)** R.J.G.
RIG. NO. 1 **TYPE** L **FIELD SUP.** R.J.G.

SYMBOLS: SILT, GRAVEL, CLAY, PEAT, SAND, FILL
▲ - VANE SHEAR (NATURAL)
O - VANE SHEAR (REMOLDED)
● - STANDARD PENETRATION

ABBREVIATIONS
UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
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WS. WASH SAMPLE
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M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

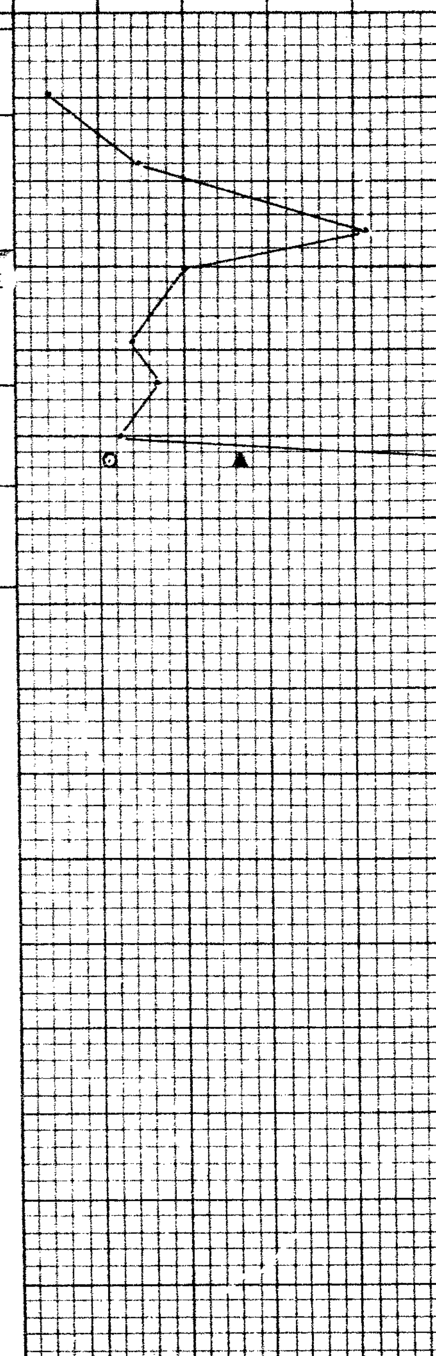
ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 4

BORING LOG — FIELD TESTS — SAMPLING — LABORATORY TESTS

FIELD TESTS: SHEAR STRENGTH (TONS PER SQUARE FOOT) 0.5 1.0 1.5 2.0; STANDARD PENETRATION TEST (BLOWS PER FOOT) 20 40 60 80

LABORATORY: UNIT WEIGHT PCF; ATTERBERG LIMITS WP x — WN ● — O WL, 20 30



DEPTH FEET	ELEV. FEET	DESCRIPTION	PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.
1.0	1052.7	TOPSOIL						
		LOOSE GREY SAND SHELL FRAGMENTS	8	1	4.0	5.5	S.S.	12/18
6.0	1047.7	MEDIUM DENSE TO DENSE GRAVEL WITH SAND	29	2	7.9	9.9	S.S	10/24
14.1	1039.6	MEDIUM DENSE TO DENSE FINE SAND TRACE SILT	83	3	12.0	14.3	S.S.	6/24
			40	4	14.3	16.3	S.S.	11/24
			28	5	18.6	20.0	S.S.	17/24
				6	20.0	21.0	W.S	
22.2	1031.5	VERY STIFF BROWN CLAY WITH SILT	34	7	21.0	23.0	S.S.	10/24
			25	8	24.0	26.0	S.S.	23/24
28.0	1025.7	BOULDERY GRAVEL WITH SAND TRACE SILT		9&10	27.6	30.9	D.B.	19/39
			184	11	30.9	32.6	S.S.	10/20
			394/4"	12	32.6	32.9	S.S.	4"/4"
				13	32.6	34.0	D.B	15/17
34.0	1019.7	END OF BOREHOLE						

REMARKS

RECOVERED GRAVEL AND BOULDER CORE IN SAMPLE 9, 10, & 13.

LIQUID LIMIT 29.0 %
PLASTIC LIMIT 15.75 %

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.

Soil Components	Particle Size			
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.		

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

Example

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