

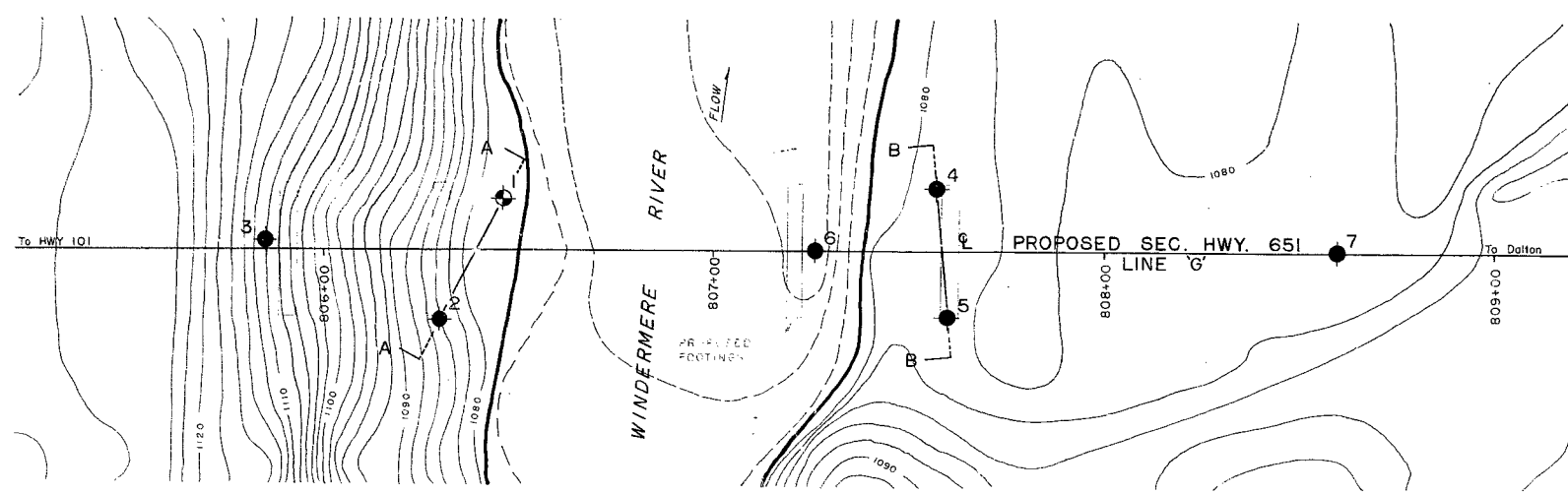
#65-F-225

W.P. #21-65

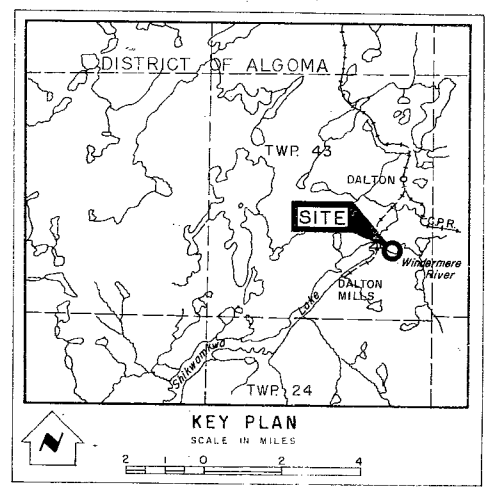
HWY #651

WINDERMERE

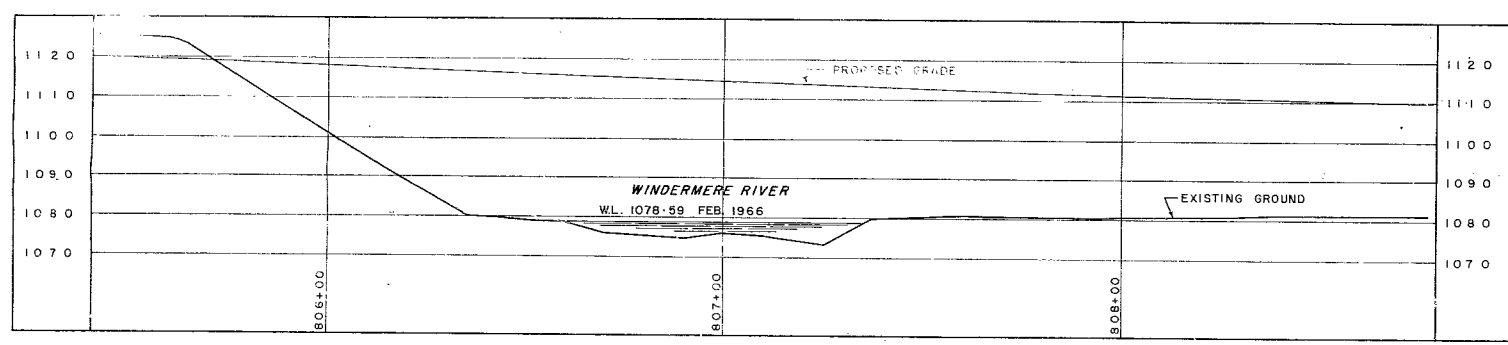
RIVER



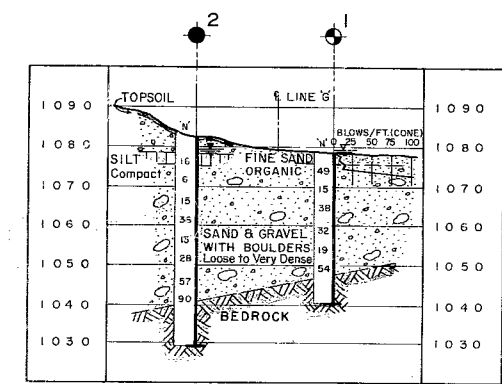
PLAN
SCALE
20 10 0 20 40 FT.



KEY PLAN
SCALE IN MILES



PROFILE LINE G'



SECTION A-A

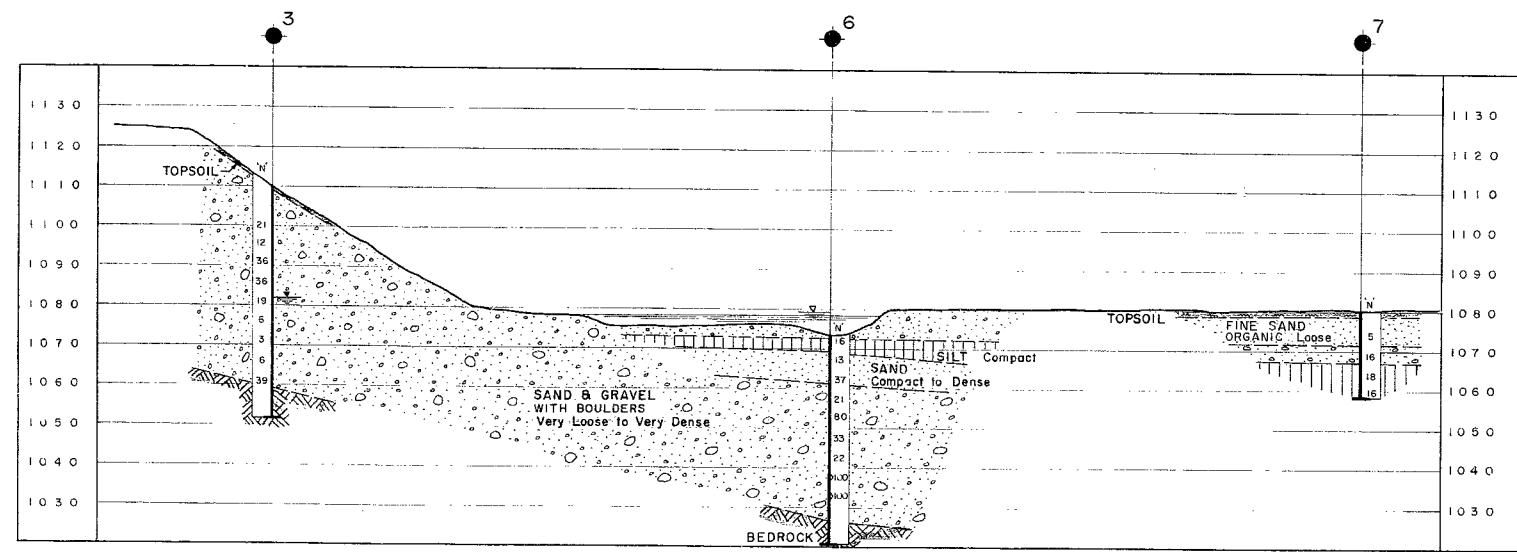
LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. (Mar. 1966)		
	Artesian Water condition.		
NO.	ELEVATION	STATION	OFFSET
1	1078.8	806+46	13' LT.
2	1082.4	806+30	18' RT.
3	1109.9	805+85	2' LT.
4	1080.4	807+57	16' LT.
5	1079.9	807+60	17' RT.
6	1078.5	807+26	E
7	1080.1	808+60	E

B.M. 1090.79 Geodetic Datum
N.E.W. in top of 0.4 Birch Stp.
III-C Rt. of Sta. 809+69

NOTE

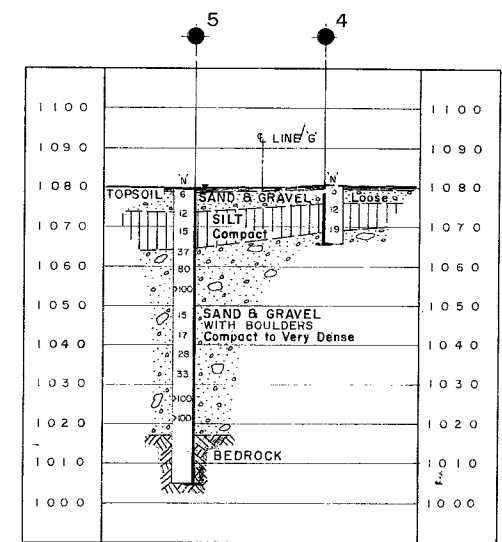
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE



SECTION ALONG LINE G'

SCALE
20 10 0 20 40 FT.



SECTION B-B

REVISIONS	DATE	BY	DESCRIPTION

GEOCON LTD

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

WINDERMERE RIVER BRIDGE

KING'S HIGHWAY NO. 651 DIST NO. 18
DISTRICT OF ALGOMA
TWP. 43 LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA			
CHECKED H.L.M.	CHECKED D.B.O.	WP NO. 21 - 65	DRAWING NO. 17857-1
DRAWN A.E.L.	CHECKED H.L.M.	JOB NO.	BRIDGE DRAWING NO.
DATE APRIL 4, 1966	SITE NO.		
APPROVED R. L. Oakes	CONT NO.		

There is also an other
report prepared by
Groom, dated March 29/65,
for an alternative
crossing which was
finally adopted

Afternoon

Dec 19/66

Hwy. 401 & Keele St.,
 Downsview, Ontario.

February 23, 1966

Materials and Testing Division

Geocor, Limited,
14 Haas Road,
Markham, Ontario.

Attention: Mr. D. Gates, P. Eng.

Re: - Foundation Investigation -
W.F. 21-65, Windermere River Bridge,
Site 38C-29, 15.3 Miles N. of Hwy. 101,
Hwy. 651, District 18 (Sault Ste. Marie)
- Letter of Authority -

Dear Sir:

This is to authorize you to carry out a foundation investigation at the above mentioned site. An investigation of the now abandoned crossing of the Windermere River was carried out by your organization and the findings submitted in the report dated March 29, 1965. In case you find the subsoil conditions at the new site comparable to those at the abandoned location, you may consider limiting the extent of the work to a bare minimum. However, as discussed with your Mr. Gates, the decision on the amount of work to provide adequate information, is left entirely to you.

This investigation is to be carried out in conjunction with the investigation of the crossing of the Goldie River which is only a mile away.

The exact location of the crossing will be shown to your Engineer by Mr. Frank De Visser, Regional Bridge Location Engineer, whom you should contact and advise of the date of arrival of your representative at Dalton.

As agreed, the work in the area will be commenced during the current week, and you are requested to submit eleven (11) copies of the final report by not later than April 13, 1966. Previous requirements as to preliminary borehole information and laboratory testing program, should be followed. We would appreciate being advised should any reasons for delay arise.

cont'd. /2

February 23, 1966

Since the drawing accompanying the foundation report, showing the location of borings, the inferred subsoil conditions, etc., is to become a contract drawing, you are requested to prepare it in accordance with the D.H.O. standards. To enable you to do this, we are supplying you with a sample drawing with all the necessary explanations, together with a linen sheet for your drawing. You are also requested to provide us with a Cronaflex copy of the drawing.

Charges for the work will be in accordance with your Schedule of Rates, dated March 4, 1960, and invoice to be addressed to the attention of the undersigned.

We are attaching Purchase Order J 30806, covering the purchase of any new material required for this work, in order that you may use this as a basis for exemption from the Federal Tax for such purchases. The Exemption Certificate is printed thereon.

Yours very truly,



A. Rutka,

MATERIALS & TESTING ENGINEER

AGS/8407
Attach.

cc: Messrs. S. McCombie
H. W. Surrell
J. A. Knowles
E. A. Saint
F. De Visser
H. Konings
Mr. I. Steinberg
A. Crowley
H. Szymanski (2)
Foundations Office
Gen. Files (2)

Mr. B. A. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. E. McCombie

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

April 18, 1966

FOUNDATION INVESTIGATION REPORT BY:
Geocon, Limited, Consulting Engineers -
Proposed Windermere River Bridge,
Sec. Highway #651 -- W.P. 21-63,
District #18 (Sault Ste. Marie).

Attached, please find the above mentioned report prepared and submitted by the consultant, Geocon, Limited.

We have reviewed the report and have found the factual information adequate and well presented. With respect to the recommendations, we wish to make the following comments:

It is also our opinion that a piled foundation could be more economical than one using spread footings. Due to the presence of boulders, we would recommend the use of steel H-piles; however, we would not suggest the use of the "Oalo-points" because of the relatively high cost, but would rather suggest reinforcing of the pile flanges only. Should the piles meet practical refusal at an elevation above bedrock, an attempt should be made to penetrate farther, but we see no harm if farther penetration cannot be achieved and the piles end on a higher elevation.

We believe that the information contained in the report will be sufficient for your further design work. Should you, however, have any additional information that you would require, please feel free to call on our Office.

AGS/ndsf
Attach.

cc: Messrs. B. A. Davis (2)

H. A. Tregaskes

D. J. Farron

H. W. Burrell

J. A. Knowles

E. E. Saint

F. De Visser

A. Watt

Foundations Office ✓

Gen. Files

A. G. Sternac
A. G. Sternac,
PRINCIPAL FOUNDATION ENGINEER

GEOCON LTD

HEAD OFFICE

420 MICHEL JASMIN, DORVAL, QUEBEC
TELEPHONE 631-9827

DISTRICT OFFICES

14 HAAS ROAD
REXDALE, TORONTO, ONT.
TEL. 244-6476

295 EAST 11TH AVENUE
VANCOUVER 10, B.C.
TEL. 879-2620

Rexdale, Ontario,
April 13th, 1966.

Department of Highways, Ontario,
Materials and Testing Division,
Downsview, Ontario.

Attention: Mr. A. G. Stermac, P. Eng.,
Principal Foundation Engineer.

Re: Soil Conditions and Foundations,
Proposed Windermere River Bridge,
Sec. Highway 651-W.P. 21-65,
Sault Ste. Marie, Ontario.

Dear Sirs:

This letter accompanies our detailed report
on the above investigation.

We find that the overburden consists of irregular layers of silts, sands and gravel up to 18 feet thick underlain by an extensive generally compact sand and gravel with boulders stratum which overlies bedrock. The soil conditions encountered are described in detail in this report.

Based on the findings of this investigation it is considered that the proposed bridge may be carried on spread footings if measures such as scour protection are applied as discussed in the report. However, in view of construction problems that would have to be contended with in order to use spread footings, it is probable that a more economical foundation solution would be the use of piles. Recommendations from a soil mechanics standpoint covering construction generally, are given in the report.

Department of Highways, Ontario,
Materials and Testing Division,
April 13th, 1966,
Page 2.

We believe this report presents all the information required from this investigation. Should you have any questions, or if we can be of further assistance otherwise, please do not hesitate to call us.

Yours very truly,

GEOCON LTD



D. B. Oates, P. Eng.,
District Engineer.

DBO/reb

T7857
REPORT
TO
DEPARTMENT OF HIGHWAYS, ONTARIO
ON
SOIL CONDITIONS AND FOUNDATIONS
PROPOSED WINDERMERE RIVER BRIDGE
SEC. HIGHWAY 651-W.P. 21-65
SAULT STE. MARIE ONTARIO

Distribution:

- 11 copies - Department of Highways, Ontario,
Downsview, Ontario.
- 3 copies - Geocon Ltd

GEOCON

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Construction	7
CONCLUSIONS AND RECOMMENDATIONS	8
PERSONNEL	9

APPENDIX I

Procedure

Site and Geology

Soil Conditions

Water Conditions

Office Reports on Soil Exploration

APPENDIX II

Figures - Laboratory Testing

DRAWING (in pocket at rear of report)

INTRODUCTION

Geocon Ltd has been retained by the Department of Highways, Ontario, by letter dated February 23rd, 1966, Work Permit No. 21-65, to carry out a soil investigation for the proposed crossing at Windermere River about 2 direct miles south of Dalton, Ontario.

The purpose of the investigation was to determine the soil and ground water conditions at the proposed crossing as required for design of foundations for the proposed structure.

SUMMARISED SOIL CONDITIONS

With the exception of the river bed the site is covered by a layer of black topsoil from 0.3 to 1.5 feet thick. Underlying the topsoil and the river bed the soil conditions consist of irregular deposits of brown organic fine sand and grey and brown sand and gravel from about 1 to 7 feet thick. The organic sand and the sand and gravel deposits are generally underlain by a discontinuous layer of compact grey silt with an observed thickness ranging from 3 to 9 feet. At one location the silt is underlain by an 8.5 foot thick layer of compact to dense grey sand. Underlying the various strata mentioned above is an extensive deposit of very loose to

very dense brown and grey sand and gravel with boulders. Greater concentration of boulders than indicated in Appendix I may occur in the stratum. The maximum observed thickness of the above stratum was about 50 feet. The bed-rock which underlies this granular deposit is a grey to pink granite.

The water level in Windermere River at the time of investigation was at elevation 1078.5. In two of the boreholes an artesian water level about 0.8 feet above river level was observed at the time of investigation.

DISCUSSION

General

It is understood that it is proposed to construct a bridge over Windermere River at the location of proposed Secondary Highway No. 651. As presently proposed, the bridge will consist of a three-span structure as shown on Department of Highways, Ontario, Drawing No. E-4545-1, and will involve construction of approach embankments up to about 30 feet above existing ground level. Other design details relative to the proposed bridge are not available to us at the time of writing. It is further understood that a proposed dam structure to be

General (continued)

located at the south-west end of Shikwamkwa Lake will cause a rise in water level at the bridge site of about 20 feet above existing water level.

Foundations

The soil conditions at the site consist generally of silts, sands and gravel up to about 18 feet thick, underlain by an extensive deposit of generally compact sand and gravel with boulders, containing very loose and loose pockets or areas.

Subject to suitable provisions being made to prevent undermining by scour it is believed that the proposed structure could be satisfactorily founded on spread footings carried within the sand and gravel with boulders stratum at a net allowable bearing value of 2 tons per square foot. This would apply particularly to the case where a simply-supported superstructure were used for the bridge. The south abutment would therefore need to be founded at about elevation 1075 and the south main pier at about elevation 1070. The north abutment and north main pier would similarly have to be carried at about elevation 1060 but in any event below the compact silt stratum. The provisions required to prevent undermining

Foundations (continued)

by scour, such as suitable surface placed rip-rap, would have to be designed on the basis of hydraulic considerations beyond the scope of this report. Founding as discussed above will, with the exception of the south abutment, require excavation in some cases of up to 20 feet below observed ground water level, and up to 30 feet below reported maximum flood level. Construction will thus probably require the use of sheeted and braced cofferdams incorporating suitable dewatering measures such as the use of sanded-in well points, or deep wells where the use of well points is impractical. In view of the construction problem, it is probable that a pile supported foundation will prove the most economical solution, and such a foundation type may also have advantages from the point of view of protection against scour and enabling the superstructure to be designed continuous over the supports.

A variety of pile types are considered to be suitable in this instance, such as steel H piles driven to bedrock, displacement types such as steel tube piles or precast concrete piles, or driven cast-in-place concrete pedestal piles. If steel H piles are used, it is recommended that they be provided with

Foundations (continued)

"Oslo" type hardened steel points since in our experience these facilitate penetration through areas containing small boulders where unprotected pile tips would likely be damaged. If displacement piles are used they would probably require jetting to assist penetration to design depth, and protection of the tips against damage by boulders. Of the various pile types available, the choice would appear to be between steel H piles driven to bedrock, and concrete pedestal piles founded in the sand and gravel with boulders stratum, at a safe depth below possible scour. Timber piles might also be considered, although even with a protective shoe and jetting during installation considerable care would be required to prevent damage during driving due to the presence of boulders in the sand and gravel stratum. As a result, timber piles are not considered as positive a solution as the types already mentioned.

All pile caps and footings subject to frost action should be provided with a minimum of 6 feet of protective earth cover.

Approach Embankments

It is recommended that all surface organic material together with the immediately underlying fine sand which is heavily contaminated with organics be removed prior to embankment construction. With the grade as proposed and with removal of the surficial organic material, the maximum overall height of embankment will be about 15 feet. In view of the granular nature of the subsoil generally, and of the compact state of the silt where it occurs, it is considered that the stability of the approach embankments with side slopes of 1 vertical to 2 horizontal will be adequate, assuming these are built of clean granular material. It is recommended that rip-rap be provided where necessary to above maximum high river level to prevent scour. Provision should be made to provide further rip-rap in the event that the river level is raised by the proposed dam as discussed earlier.

In view of the fact that the water level will be raised to about elevation 1110 due to the damming of Shikwamkwa Lake, it is recommended that the river embankment locally on the south side be flattened to a slope of 1 vertical to 2 horizontal so as to be stable under the new ground water conditions which will be developed.

Approach Embankments (continued)

It is recommended that the backfill to abutments consist of well compacted free draining non-frost susceptible clean granular material. With this provision, a coefficient of lateral earth pressure of 0.5 is recommended for the case of pile supported abutments.

Construction

Should excavations be required below water level at the pier or abutment locations, they will involve excavation within the surficial strata of silts, sands and gravel, and therefore, some means will be required to control water inflow.

In view of the boulder content and occasionally very dense nature of the sand and gravel stratum, it may not be practical to drive sheeting effectively continuous to the depth required to prevent heaving of the base of the excavation for the case where pumping from sumps is used inside a sheeted cofferdam. Should excavations be carried 20 to 30 feet below river level as already mentioned, it would probably be most suitable to use well points or deep wells for the dewatering of sheeted and braced cofferdams. In the case where piles are

Construction (continued)

used, the excavations for construction of the pile caps would be comparatively shallow and the use of open excavations dewatered by a suitable well point system should be a satisfactory construction method. Sheet piling, if used as a means for preventing base heave, should be carried down below excavation level a distance at least equal to the maximum head differential likely to be encountered, and the cofferdam design should also consider the possibility of pressure beneath the silt layer which might require special measures to prevent base heave.

CONCLUSIONS AND RECOMMENDATIONS

- 1) The site is covered by irregular layers of silts, sands and gravel up to 18 feet thick underlain by an extensive sand and gravel deposit with boulders. The sand and gravel stratum overlies bedrock and is generally compact but contains very loose and loose areas. Bedrock elevation varies considerably over the site.
- 2) At the time of investigation the water level in the river was at elevation 1078.5. An artesian water level about 0.8 feet above existing river level was encountered in the sand and gravel stratum overlying bedrock.

- 3) Based on the findings of this investigation it is considered that either spread footings or pile foundations could be used as discussed in the report, the choice being predicated ultimately by economic considerations.
- 4) Construction of piers and pile caps will probably require excavation below water level. Recommendations are given on possible measures to handle dewatering of such excavations.
- 5) Recommendations covering other soil mechanics aspects of construction are discussed herein.

PERSONNEL

The field work for this investigation was carried out under the supervision of Messrs. H. L. MacPhie and B. T. Coleman. This report was written by Mr. H. L. MacPhie checked by Mr. D. B. Oates, P. Eng., and reviewed by Mr. M. A. J. Matich, P. Eng.

HLM/reb

H. L. MacPhie

H. L. MacPhie, P. Eng.,
Senior Soils Engineer.

APPENDIX I

PROCEDURE

SITE AND GEOLOGY

SOIL CONDITIONS

WATER CONDITIONS

OFFICE REPORTS ON SOIL EXPLORATION

GEOCON

PROCEDURE

The field work for this investigation was carried out between March 2nd, 1966 and March 24th, 1966. The site is located about 2 miles south of Dalton, Ontario at the proposed crossing at Windermere River and proposed Secondary Highway No. 651. The drilling equipment was mobilized to Dalton by rail and transported to the site by truck using an existing bush road passing within 250 feet of the site. The field crew was transported between Dalton and the site by auto-boggan.

Seven boreholes were put down using a standard skid-mounted machine drill rig and the first borehole put down was accompanied by a dynamic penetration test. Further dynamic penetration tests were not carried out due to the general presence of boulders over the site and the limited depth penetrated by the frost. Bedrock was encountered and proved in 5 of the 7 boreholes.

Sampling of the overburden was carried out at 5 foot intervals using a 2 inch split spoon sampler with a foot valve to assist recovery. Where recovery was not achieved with the assistance of a foot valve, slotted tube or washed samples were taken.

A complete log of each borehole is given on the Office Reports on Soil Exploration in this Appendix . The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing T7857-1, located in the pocket at the rear of this report.

The results of the laboratory testing are shown in the Figures in Appendix II. All samples remaining after testing will be stored until May 1st, 1967 at which time you will be contacted for instructions regarding their disposal.

All elevations given in this report are referred to Geodetic datum. The location and elevation of the bench mark used is shown on Department of Highways, Ontario Drawing No. E-4545-1. The bench mark is a nail and washer in the top of a 0.4 foot diameter birch stump located 111 feet right of station 809+69 and has an elevation of 1090.79. The above bench mark was established by the Department of Highways, Ontario.

SITE AND GEOLOGY

The site is located about 2 direct miles south of Dalton, Ontario. At the time of investigation the river was about 100 feet wide in the area of the proposed crossing. At the location of the proposed crossing the bottom of the river

valley is about 500 feet wide and is generally flat lying between elevations 1080 and 1090. The bottom of the river valley is about 45 feet below adjacent ground level. Frequent boulders up to 3 feet in diameter occur in the river bed and on the banks of the river.

From available geological information and previous experience in the area, it is known that the overburden cover is composed of sands and silts of post glacial fluvial origin. Previous work in the area indicates that the bedrock types in the general area are granite, syenite and gabbro.

SOIL CONDITIONS

The principal soil conditions encountered in the boreholes are as follows:

Topsoil

A thin layer of black topsoil was encountered in 5 of the 7 boreholes. The topsoil ranged in thickness from 0.3 feet at borehole 3 to 1.5 feet at borehole 7. The topsoil was generally silty and contained roots and decayed vegetation.

Loose Brown Organic Fine Sand

At the location of borehole 1 a surficial deposit of dark brown organic fine sand was encountered. The organic sand layer at borehole 1 had a thickness of 3 feet. Decayed wood and vegetation traces were observed in the brown organic fine sand deposit. Underlying the topsoil at the location of borehole 7 a similar deposit of dark brown organic fine sand was encountered. The thickness of this stratum was about 7 feet.

One standard penetration resistance determined in this stratum at borehole 7 gave an "N" value of 5 blows per foot indicating a loose relative density.

Loose to Compact Brown and Grey Sand and Gravel

Underlying the topsoil at boreholes 2, 4 and 5 and the brown organic sand at Borehole 7, a layer of brown and grey sand and gravel was encountered. Also at borehole 6 on the river bottom 0.8 feet of sand and gravel was encountered. This stratum is described separately from the extensive deposit of sand and gravel with boulders described later since it is separated from the extensive deposit of sand and gravel with boulders by a silt layer and is directly underlain by the silt layer. The stratum was brown in boreholes 2, 4 and 5 and was grey in boreholes 6 and 7. The stratum was fully penetrated at the above boreholes and the

Loose to Compact Brown and Grey Sand
and Gravel (continued)

thickness of the stratum varied from about 1 to 5 feet. At boreholes 4 and 5 the stratum was predominantly sand.

Four standard penetration resistances determined in this stratum gave "N" values of 5, 5, 6 and 16 blows per foot indicating a loose to compact relative density. From the results of the above standard penetration resistances it is believed that the relative density of this stratum is generally loose.

Compact Grey Silt

Underlying the brown and grey sand and gravel stratum at boreholes 2, 4, 5, 6 and 7 a layer of compact grey silt was encountered. The silt stratum was fully penetrated in the above boreholes except borehole 7 which was terminated in the silt stratum. The observed thickness of the silt stratum ranged from 3 to 9 feet.

One mechanical analysis test was carried out on a sample obtained from this stratum in borehole 2. The results are plotted on Figure 1 of Appendix II. The sample was found to contain 81 percent silt sizes and 14 percent sand sizes and 5

Compact Grey Silt (continued)

percent clay sizes.

Eight standard penetration resistances determined in the silt stratum gave "N" values ranging from 12 to 19 blows per foot with an average of 16 blows per foot indicating a compact relative density. From the results of the above standard penetration tests it is believed that the relative density of the grey silt stratum is generally compact.

Compact to Dense Grey Sand

At borehole 6, located in the river, a stratum of grey sand was encountered. The sand stratum was overlain by the silt layer described above and occurred only at borehole 6. The grey sand deposit generally consisted of fine to medium sand sizes and had a thickness of 8.5 feet.

One mechanical analysis test was carried out on a sample taken from the sand stratum. The results of the above test are plotted on Figure 2 of Appendix II. The sample was found to contain 91 percent sand sizes and 9 percent gravel sizes.

Compact to Dense Grey Sand (continued)

Two standard penetration resistances determined in the sand stratum gave "N" values of 13 and 37 blows per foot indicating a compact to dense relative density. From the results of the above standard penetration tests it is believed that the relative density of the grey sand deposit is generally compact.

Very Loose to Very Dense Brown and Grey Sand and Gravel with Boulders

Underlying the brown organic fine sand at borehole 1, the topsoil at borehole 3, the grey silt at boreholes 2, 4 and 5, and the grey sand at borehole 6, is an extensive deposit of brown and grey sand and gravel with boulders overlying bedrock. The stratum was generally grey but was brown at the top in borehole 3. This stratum was encountered in 6 of the boreholes put down and was fully penetrated in 5 of the 6 boreholes. The maximum observed thickness of this stratum was about 50 feet at borehole 3.

The observed boulder content of this stratum varied between the north and south sides of the river. At borehole 3 on the south side of the river numerous boulders were observed to occur in the top 8 feet of the sand and gravel stratum.

Very Loose to Very Dense Brown and Grey Sand
and Gravel with Boulders (continued)

Boulder sizes up to 2 feet existed near ground level in the area of borehole 3. Small boulders were encountered at the bottom of the stratum in borehole 2 and no further evidence of boulders was encountered on the south side of the river. On the north side of the river boulder sizes up to 10 inches were encountered occasionally throughout the stratum.

On the south side of the river the sand and gravel stratum became silty at depth in boreholes 1 and 2 and sand sizes were predominant in this stratum in borehole 3. On the north side of the river gravel sizes were predominant at the top of this stratum in borehole 5. Generally silt traces were encountered throughout the stratum.

Three mechanical analysis tests were carried out on samples taken from the sand and gravel stratum. The resulting grain size curves are shown on Figure 3 of Appendix II. From the samples tested the stratum was found to contain from 15 to 38 percent gravel sizes, from 52 to 79 percent sand sizes and from 6 to 10 percent silt sizes. The wide range in these percentages reflects the variations in grain size throughout the stratum mentioned above. The grain size curves represent samples recovered using a 2 inch O. D. split spoon sampler

Very Loose to Very Dense Brown and Grey Sand
and Gravel with Boulders (continued)

with generally low recovery and as such, they do not indicate the presence of larger sizes which exist in-situ.

Standard penetration resistances determined in this stratum gave "N" values ranging from 3 to greater than 100 blows per foot with an average of 40 blows per foot, indicating a very loose to very dense relative density. Very loose and loose relative densities were observed at two locations, the top of the stratum at borehole 2 and about the bottom half of the stratum at borehole 3. Apart from the very loose and loose areas of sand and gravel mentioned above it is believed that the relative density of the sand and gravel stratum may be described generally as compact, although the presence of coarse gravel sizes probably affect the standard penetration test. However, further very loose or loose pockets of sand and gravel may occur over the proposed bridge site.

Bedrock

Bedrock was encountered directly underlying the sand and gravel with boulders stratum in 5 of the 7 boreholes put down. The bedrock was proved by diamond core

Bedrock (continued)

drilling in AXT size for depths ranging from 6.5 to 11.5 feet. Bedrock surface elevation was found to vary between about elevations 1017 at borehole 3 and 1051 at borehole 5 and bedrock surface slopes generally downward to the north,

Bedrock was identified as syenite and gabbro.

WATER CONDITIONS

Water level observations were taken in the cased holes during the investigation. An artesian water level was encountered in the sand and gravel with boulders stratum at about elevation 1050. The artesian water level was about 0.8 feet above river level in boreholes 1 and 6 at the time of investigation, that is, at elevation 1079.3. River level at the time of investigation was at elevation 1078.5.

From discussions with employees of Austin Lumber Company it is understood that in their experience the river rises to a maximum elevation of 1086 at which time part of the river valley is flooded. Due to snow cover at the time of the investigation, this could not be verified by observation of flood effects.

EXPLANATION OF THE FORM "OFFICE REPORT ON SOIL EXPLORATION"

The object of this form is to enable a comprehensive study of the soil to be made by combining on one sheet all of the information obtained from the boring. An explanation of the various columns of the report follows.

ELEVATION AND DEPTH

This column gives the elevation and depth of boundaries between the various soil strata. The elevation is referred to the datum shown in the general heading.

WATER CONDITIONS

In this column the water level in the casing at the time of boring or the water table in the ground, determined by a series of observations in a piezometer or standpipe, is indicated to scale by a horizontal line with the symbol W.L. or W.T. above the line. A notation of any complicated groundwater conditions will be made in this column.

DESCRIPTION

A description of the soil, using standard terminology, is contained in this column. The consistency of cohesive soils and the relative density of non-cohesive soils are described by the following terms:

<u>Consistency</u>	<u>U-Strength</u> <u>Tons/sq. ft.</u>	<u>Relative Density</u>	<u>Standard Penetration</u> <u>Resistance. Blows/ft.</u>
Very soft	0.03 to 0.25	Very loose	0 to 4
Soft	0.25 to 0.5	Loose	4 to 10
Firm	0.5 to 1.0	Compact	10 to 30
Stiff	1.0 to 2.0	Dense	30 to 50
Very stiff	2.0 to 4.0	Very dense	over 50
Hard	over 4.0		

STRATIGRAPHIC PLOT

The stratigraphic plot follows the standard symbols of the National Research Council, Canada.

ELEVATION SCALE

The information in all columns is plotted to a true elevation scale which is shown in this column.

GRAPHS

The main body of the report forms a graph which is used to plot to correct elevation the important soil properties which are obtained through field and laboratory tests. The scales and symbols for the plotting are shown at the head of the column.

OTHER TESTS

In this column are shown, by symbol, the other field or laboratory tests which have been performed on the soil and for which the results have not been plotted on the above graph.

SAMPLES

The first three columns describe the condition, type and number of each sample obtained from the boring. The location and extent of each sample is plotted to scale.

In the last column is shown the penetration resistance in blows of 4200 inch-pounds required to drive one foot of the sampler into the ground. When a 2 inch Drive Sampler is used the result obtained is termed the "Standard Penetration Resistance".

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OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7857 BORING # 1 DATUM GEODETIC CASING NX & BX
 BORING DATE MAR. 2-4/66 REPORT DATE MAR. 15, 1966 COMPILED BY A.E.L. CHECKED BY ---
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN - LBS. ENERGY)

SAMPLE CONDITION



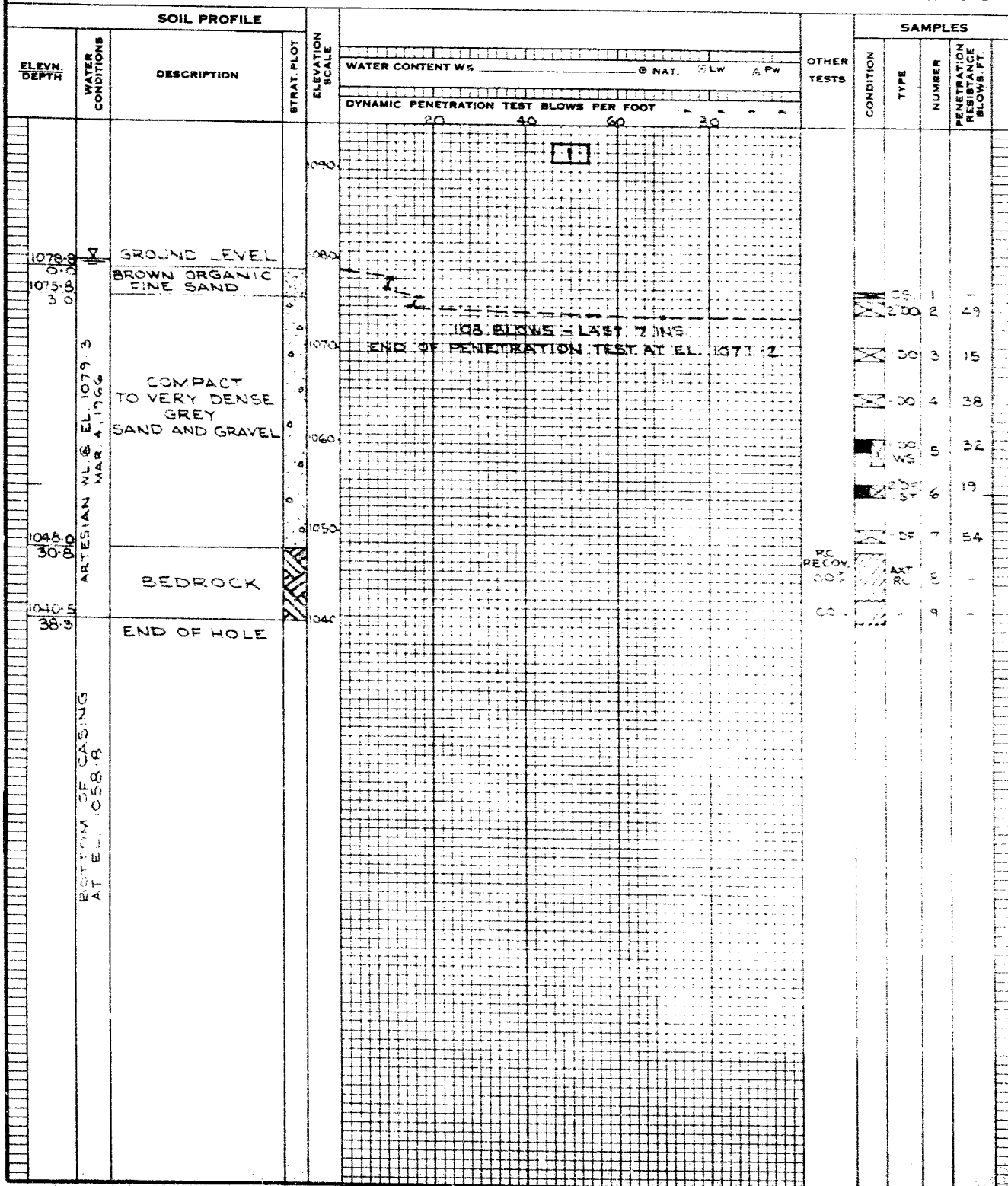
DISTURBED
FAIR
GOOD
LOST

SAMPLE TYPES

A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE
F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
QC - TRIAXIAL CONSOLIDATED UNDRAINED
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED
γ - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL



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OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7857 BORING # 2 DATUM GEODETIC CASING BX
BORING DATE MAR. 5-9/66 REPORT DATE MAR. 29, 1966 COMPILED BY AEL CHECKED BY HLN
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

SAMPLE CONDITION



**DISTURBED
FAIR
GOOD
LOST**

SAMPLE TYPES

A.S. - AUGER SAMPLE
S.T. - SLOTTED TUBE
W.S. - WASHED SAMPLE
D.O. - DRIVE-OPEN
D.F. - DRIVE-FOOT VALVE
C.S. - CHUNK SAMPLE

F.S. - FOIL SAMPLE
S.O. - SLEEVE-OPEN
S.F. - SLEEVE-FOOT VALVE
T.O. - THIN WALLED OPEN
R.C. - ROCK CORE

ABBREVIATIONS

ABBREVIATIONS

V - IN-SITU VANE TEST	γ - WET UNIT WEIGHT
M - MECHANICAL ANALYSIS	K - PERMEABILITY
U - UNCONFINED COMPRESSION	C - CONSOLIDATION
QC - TRIAXIAL CONSOLIDATED UNDRAINED	
Q - TRIAXIAL UNDRAINED	WL - WATER LEVEL IN CASING
S - TRIAXIAL DRAINED	WT - WATER TABLE IN SOIL

SOIL PROFILE				SAMPLES	
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	ELEVATION SCALE	OTHER TESTS
1082.4 0.0		GROUND LEVEL			
1077.9 4.5		BROWN SAND AND GRAVEL			
1074.3 7.5		COMPACT GREY SILT			
1073.4 MAR. 9 1969		LOOSE TO DENSE GREY SAND AND GRAVEL WITH BOULDERS			
1040.6 41.8		BEDROCK			
1029.5 52.9		END OF HOLE			

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OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7857 BORING # 3 AND 4 DATUM GEODETIC CASING BX
 BORING DATE MAR. 11-22/66 REPORT DATE MAR. 27, 1966 COMPILED BY AEL CHECKED BY HLM
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

SAMPLE CONDITION



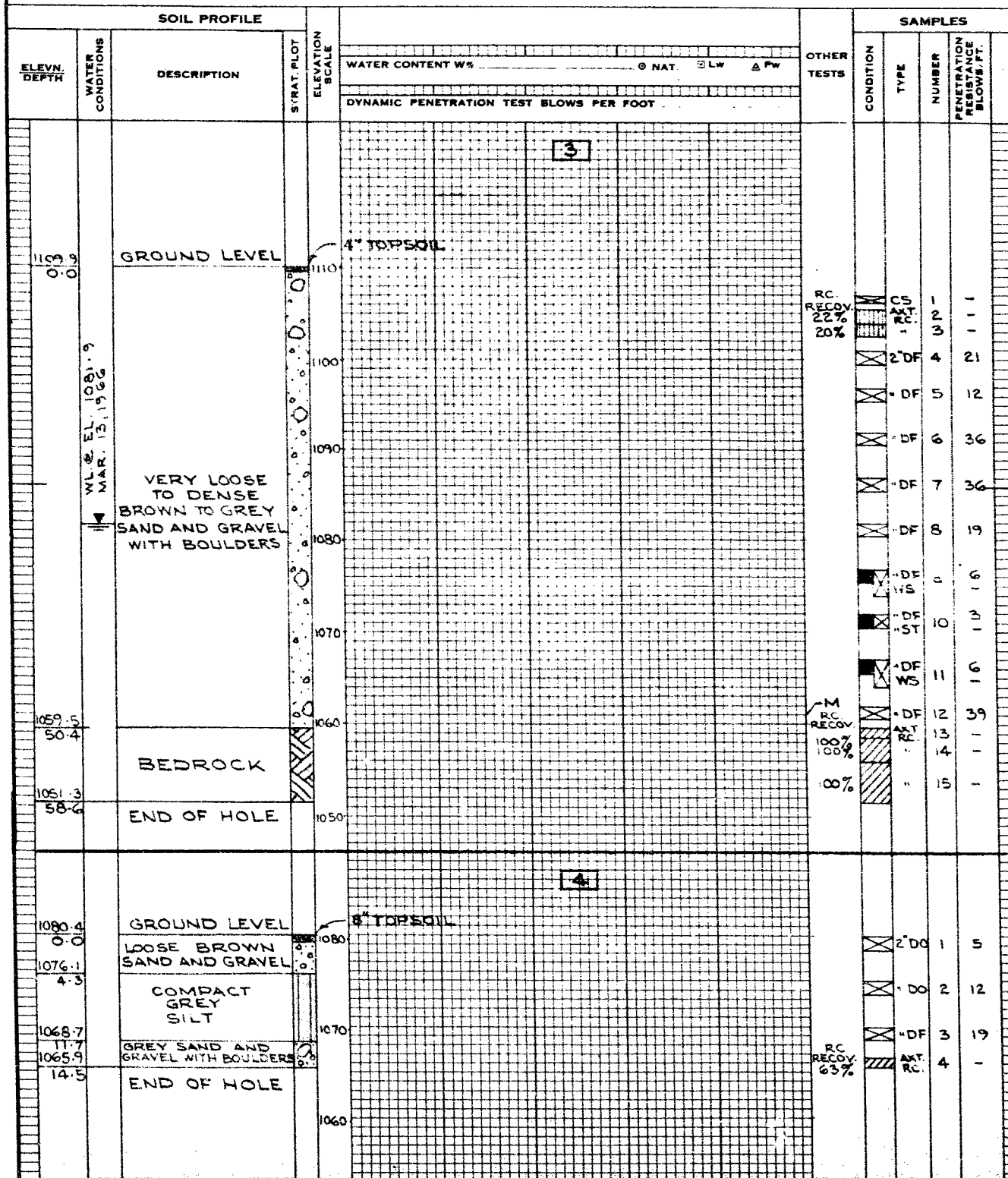
A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE

SAMPLE TYPES

F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
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 U - UNCONFINED COMPRESSION
 GC - TRIAXIAL CONSOLIDATED UNDRAINED
 Q - TRIAXIAL UNDRAINED
 S - TRIAXIAL DRAINED
 γ - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION
 WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL



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OFFICE REPORT ON SOIL EXPLORATION

CONTRACT T7857 BORING # 6 And 7 DATUM GEODETIC CASING BX
 BORING DATE MAR. 16-24/66 REPORT DATE APR. 1, 1966 COMPILED BY AEL CHECKED BY L. M.
 SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. LBS. ENERGY)

SAMPLE CONDITION



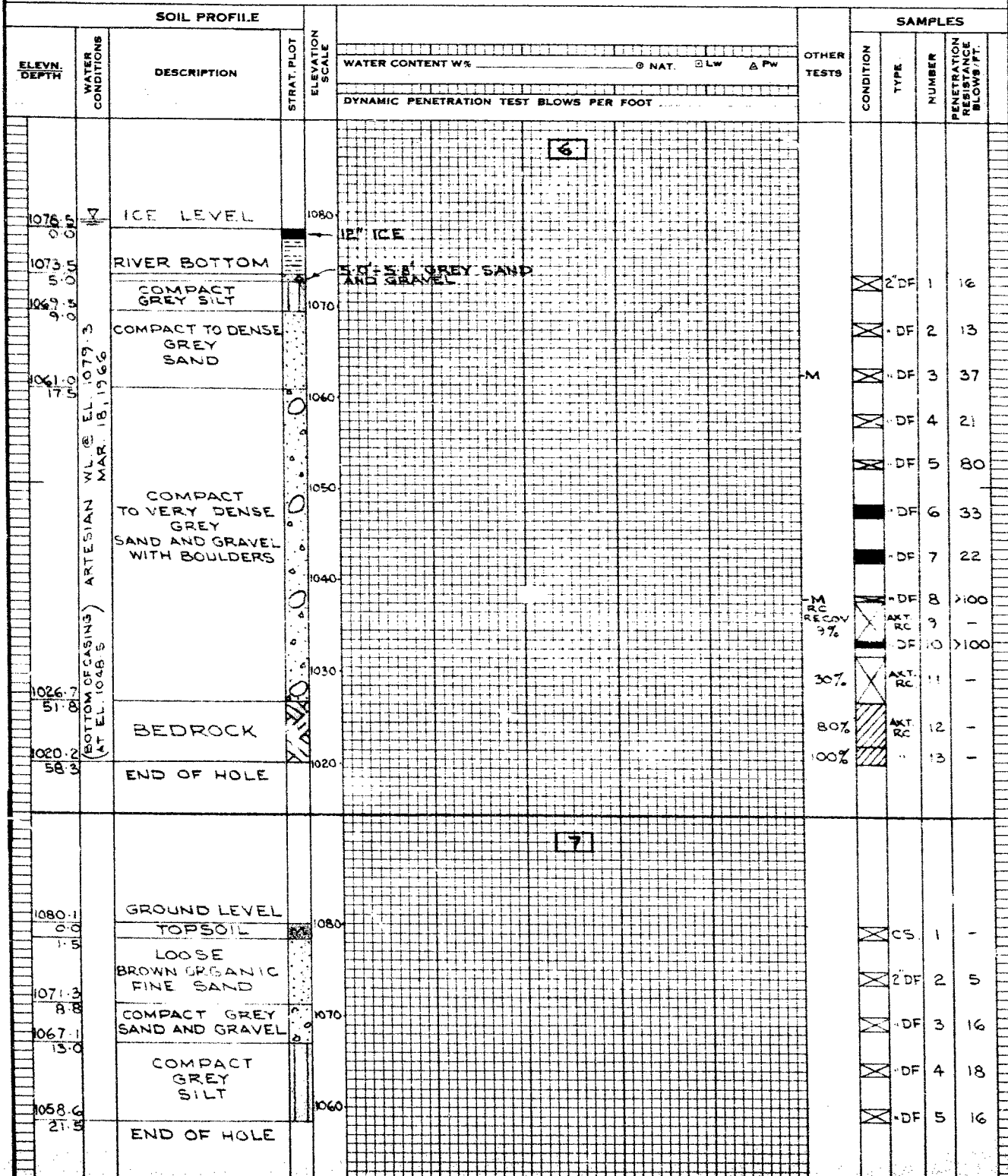
A.S. - AUGER SAMPLE
 S.T. - SLOTTED TUBE
 W.S. - WASHED SAMPLE
 D.O. - DRIVE-OPEN
 D.F. - DRIVE-FOOT VALVE
 C.S. - CHUNK SAMPLE

SAMPLE TYPES

F.S. - FOIL SAMPLE
 S.O. - SLEEVE-OPEN
 S.F. - SLEEVE-FOOT VALVE
 T.O. - THIN WALLED OPEN
 R.C. - ROCK CORE

ABBREVIATIONS

V - IN-SITU VANE TEST
 M - MECHANICAL ANALYSIS
 U - UNCONFINED COMPRESSION
 QC - TRIAXIAL CONSOLIDATED UNDRAINED
 Q - TRIAXIAL UNDRAINED
 S - TRIAXIAL DRAINED
 γ - WET UNIT WEIGHT
 K - PERMEABILITY
 C - CONSOLIDATION
 WL - WATER LEVEL IN CASING
 WT - WATER TABLE IN SOIL



APPENDIX II

FIGURES - LABORATORY TESTING

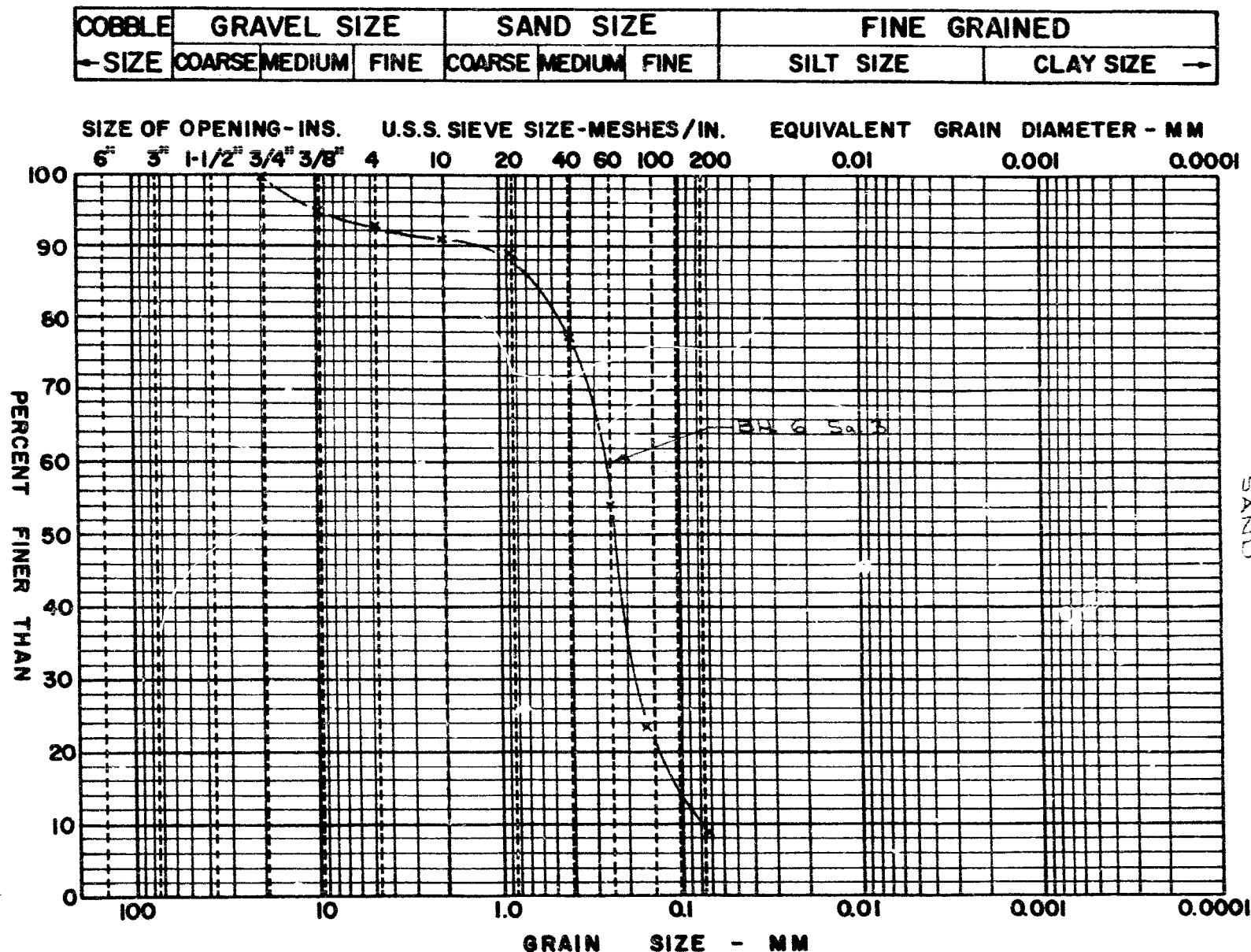
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APPENDIX II
FIGURE 1
PROJECT T7857



GRAIN SIZE DISTRIBUTION

APPENDIX II
FIGURE 2
PROJECT T7857



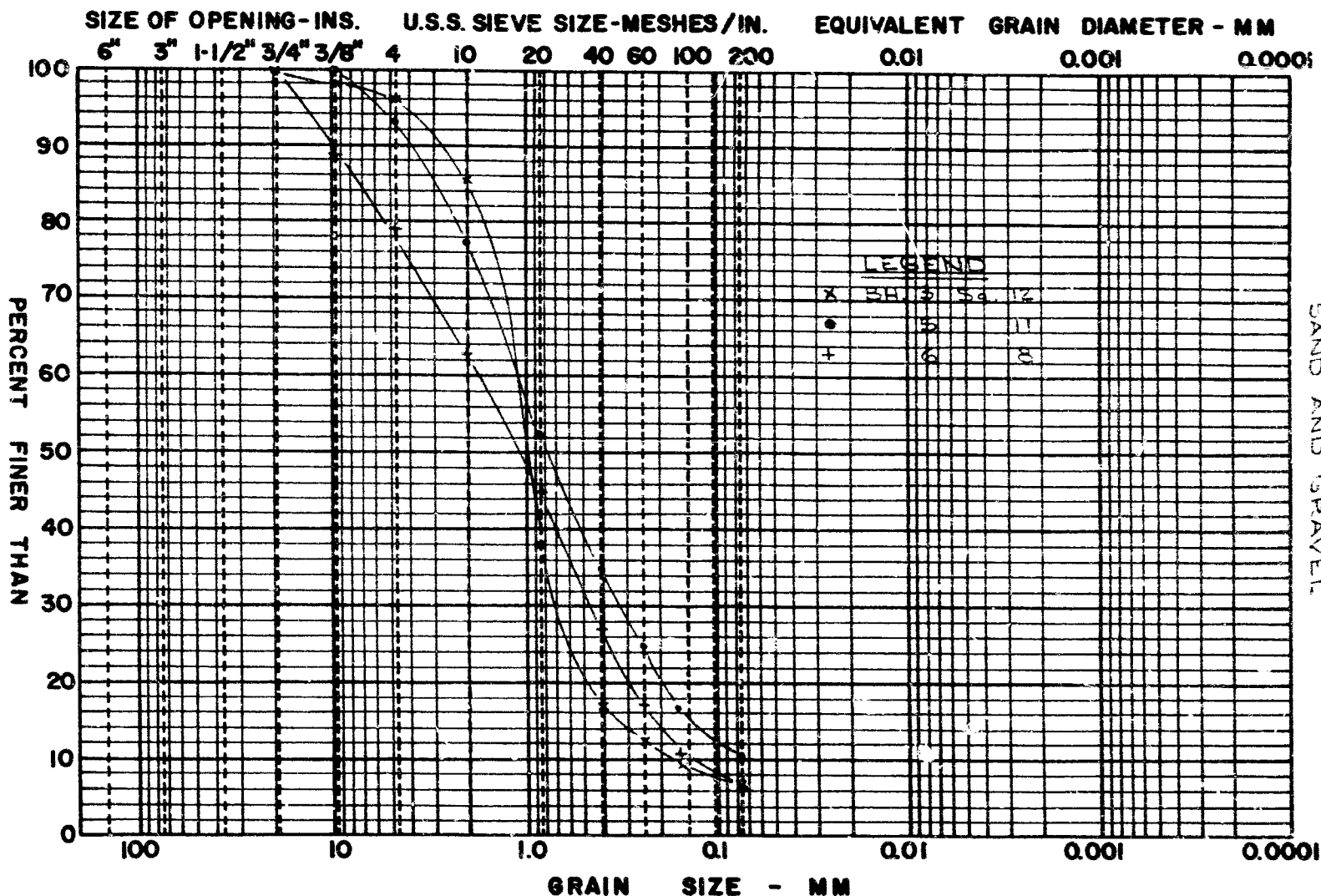
M.I.T. GRAIN SIZE SCALE

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GRAIN SIZE DISTRIBUTION

APPENDIX 11
FIGURE 3
PROJECT T7857

COBBLE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
← SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE →



M.I.T. GRAIN SIZE SCALE

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