

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

FROM: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: October 30, 1969

OUR FILE REF.

IN REPLY TO

OCT 30 1969

SUBJECT:

FOUNDATION INVESTIGATION REPORT -
By Geocon Ltd., Consulting Engrs.
McKellar Lake Outlet - Hwy. #124
W.P. 205-15 - Dist. #11 (Huntsville)

Attached please find the above mentioned report prepared and submitted by the Consultant, Geocon Ltd.

We have reviewed the report and believe it contains sufficient information for further design work.

We agree with the Consultant's recommendations that the entire structure be founded on bedrock. However, because of the depth of bedrock below the water table (up to 14 ft. at the time of investigation), difficulties in unwatering must be expected. Bedrock is granite, and we have reservations as to whether penetration of sheeting into the rock, in order to assure watertightness, could be achieved.

If piles are used, we would suggest that H-piles with reinforced tips be chosen and that they be driven reasonably hard once they have reached bedrock.

As far as retaining walls are concerned, a coefficient of earth pressure of 0.3 rather than 0.5, should be used.

Should you have any questions regarding the report, please feel free to contact this Office.

AGS/adeF

Attach.

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

H. A. Tregaskes

D. W. Farren

H. McArthur

W. S. Aitken

J. C. McAllister

E. R. Saint

B. A. Singh

Foundations Files

Gen. Files

A. G. Stermac

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

For

GEOCON LTD

HEAD OFFICE

420 MICHEL JASMIN, DORVAL, QUEBEC
TELEPHONE 631-9827

69-F-2042

DISTRICT OFFICES

14 HAAS ROAD
REXDALE, TORONTO, ONT.
TEL. 743-3031

295 EAST 11TH AVENUE
VANCOUVER 10, B.C.
TEL. 679-2620

P.O. BOX 351
FREDERICTON, N.B.
TEL. 475-8967

Rexdale, Ontario
October 7th, 1969

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

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

Re: Soil Conditions and Foundations,
McKellar Lake Outlet,
McKellar Lake, Ontario.

Dear Sirs:

This letter accompanies our report on the above investigation.

We found that the site is underlain by a variable thickness of very loose to compact sand with gravel, through which bedrock frequently outcrops.

Based on the findings of this investigation the culvert and wing wall foundations should be carried on bedrock either directly or by such means as piers or end bearing piles. The choice of foundation will largely be decided on the basis of economics. A number of recommendations are given in the report covering design and construction.

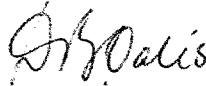
We believe that this report contains all of the information required from this investigation. Should you have any questions regarding any aspect of the report or if we can

Department of Highways, Ontario
October 27th, 1969
Page 2.

be of assistance otherwise, please do not hesitate to call us.

Yours very truly,

GEOCON LTD



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

T 9261
sb

T 9261
REPORT
TO
DEPARTMENT OF HIGHWAYS, ONTARIO
ON
SOIL CONDITIONS AND FOUNDATIONS,
McKELLAR LAKE OUTLET,
McKELLAR LAKE ONTARIO.

Distribution: 11 copies - Department of Highways, Ontario
 Downsview, Ontario.

2 copies - Geocon Ltd

GEOCON

I N D E X

Page

PART I

1.0	INTRODUCTION	1
2.0	SUMMARIZED SOIL CONDITIONS	1
3.0	DISCUSSION	1
4.0	PERSONNEL	6

APPENDIX I

1.0	PROCEDURE	1
2.0	FIELD EQUIPMENT	2
3.0	SITE AND GEOLOGY	2
4.0	SOIL CONDITIONS	3
5.0	WATER CONDITIONS	4
6.0	BEDROCK	5

OFFICE REPORTS ON SOIL EXPLORATION

APPENDIX II

FIGURES - LABORATORY TESTING

APPENDIX III

PHOTOGRAPHS

DRAWING AT REAR OF REPORT.

GEOCON

Geocon Ltd has been retained by the Department of Highways, Ontario by letter of October 2nd, 1969 to carry out a foundation investigation for a proposed culvert at McKellar where Highway 124 crosses the McKellar Lake Outlet. The proposed culvert will extend south from an existing concrete and steel beam bridge.

The purpose of the investigation was to determine the soil conditions at the culvert site as required for foundation design.

2.0 SUMMARIZED SOIL CONDITIONS

A deposit of very loose to compact sand with gravel of an encountered thickness of up to about 9 feet is underlain by bedrock. Extensive bedrock outcrops occur to the north and south of the site. To the west of the proposed culvert location an area of wood fill exists.

3.0 DISCUSSION

3.1 General

It is understood from information obtained from Department of Highways, Ontario Plan No. B 1083-4 that the proposed culvert will be constructed as part of the Highway 124 Revision project and will be required to carry the natural drainage from McKellar Lake to Manitouwabing Lake under the new highway.

It is understood that the width of the culvert

GEOCON

3.1 General - Continued

bay will be approximately the same as the span of the existing bridge and will form an extension to the existing bridge to the south. The axis of the proposed culvert is understood to lie at a slight angle to the west of existing bridge axis, running approximately parallel to the present west shoreline.

Two wing walls will be provided at the south east corners of the culvert, one parallel to the culvert axis and the other at approximately right angles. In addition the existing wing wall at the north east corner of the existing bridge will be replaced by a wing wall parallel to the culvert axis.

3.2 Foundations

Bedrock outcrops at the north section of the culvert. This outcrop extends to about 50 feet south of the existing bridge and its elevation varies from about 794 to 789. Bedrock also outcrops approximately 140 feet to the south at an elevation of about 789. Photographs of the site and outcropping are in Appendix III.

The investigation indicates that very loose to compact sand with gravel overburden of a maximum encountered thickness of about 9 feet occurs between the two outcrops .

GEOCON

3.2 Foundations - Continued

As located on Department of Highways, Ontario Plan No. B 1083-4 the culvert would be constructed on exposed bedrock over the section about 50 feet south of the existing bridge. The south west wing wall will also be partly located on exposed bedrock. Over the remainder of the culvert and south east wing wall site the bedrock was found to slope to a maximum encountered depth at about elevation 775 beneath the overburden.

It is understood from an internal memorandum dated September 10th, 1969 from the Bridge Planning Northern Region Office that consideration is being given to founding the culvert in part on bedrock with certain sections of the culvert and the wing walls supported on piles. In view of the variable and loose relative density of the existing overburden, where it occurs, we concur that the foundations for the culvert and wing walls should be supported on bedrock either directly or by means of endbearing piles. The final choice of foundation treatment will largely be dependent on economic considerations of construction, which are beyond the terms of this report. For spread foundations carried directly on bedrock a bearing pressure of 20 tons per square foot may be used. Where piles are used to support sections of the

3.2 Foundations - Continued

structure, it is recommended that suitable pile tips be provided to facilitate keying of the piles on sloping bedrock surfaces. Pile caps where subject to frost action should be provided with at least five feet of earth cover for frost protection purposes.

3.3 Approach Embankments - Continued

It is understood that the grade of the approach embankments will be about 805 . Assuming that clean granular fill is used for embankment construction and that normal side slopes of 1 vertical to 2 horizontal are adopted, it is considered that the stability of the approach embankments will be adequate.

It is recommended however that the sawdust and wood fill be removed from beneath locations of the embankment to the west of the site . It is understood that this filled area extends to about 50 feet west of the existing shoreline as far north as the edge of the present highway.

It is recommended that the backfill to the culvert and wing walls consist of well compacted free draining non-frost susceptible granular material and that adequate provision be made for drainage of the backfill. In this event the walls of the

3.2 Approach Embankments - Continued

culvert and wing walls should be designed for a lateral earth pressure coefficient of 0.5 with due allowance for surcharge.

The wing walls should incorporate a factor of safety of at least 1.5 against lateral sliding. Where founded directly on bedrock a coefficient of friction of 0.35 between concrete and bedrock would apply. Resistance to lateral sliding could be increased by dowels into bedrock acting in tension or shear.

3.3 Construction

With the culvert founded directly on bedrock, construction would involve excavation into the sand and gravel for a distance of 14 feet below observed river level. Some means therefore would be required to control water inflow. For this purpose close sheeting extending to bedrock could be used with pumping from sumps.

Alternatively, the pool could be drained by pumping and the excavations could be dewatered using a well point system in conjunction with dykes to control the inflow of water from McKellar Lake and Manitouwabing Lake. The use of sheeting or wellpoints would have to contend with possible boulders in the overburden. Temporary slopes in the sand and gravel, after dewatering, could be cut

3.3 Construction - Continued

to about 1 horizontal to 1 vertical.

4.0 PERSONNEL

The field work of this investigation was carried out under the supervision of Mr. P. G. Williams. This report was written by Mr. P. G. Williams and checked by Mr. D. B. Oates, P.Eng.

Respectfully submitted,

P G Williams

P. G. Williams

D B Oates

D. B. Oates, P. Eng.

T 9261

GEOCON

APPENDIX I

PROCEDURE

FIELD EQUIPMENT

SITE AND GEOLOGY

SOIL CONDITIONS

WATER CONDITIONS

BEDROCK

OFFICE REPORTS ON SOIL EXPLORATION

GEOCON

The field work for this project was carried out between October 2nd and 10th, 1969. A total of four boreholes were put down in BX casing size through the overburden and cored in AXT size into the underlying bedrock to depths ranging from 18.6 to 24.0 feet below the water surface. Standard penetration resistances were also obtained in conjunction with the samples.

The boreholes were located using as reference the abutments of the existing concrete and steel beam bridge and the centre line of the proposed revision of Highway 124 as indicated on Department of Highways, Ontario Plan B 1083-4. The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing T 9261-1 at the rear of this report.

The soil testing was carried out in our Soil Mechanics Laboratory. The soil samples remaining after testing will be stored until November 1st, 1970 at which time you will be contacted for instructions regarding their disposal.

All elevations mentioned in this report are referred to Geodetic datum. They were established using Bench Mark No. P 101 which is located on the top of a hill of rock on the south side of the road, west of Highway 124 and 370 feet west of the concrete bridge. The elevation of this bench mark was given as 825.54 by the Engineering Staff of Department of Highways, Ontario in Huntsville.

GEOCON

2.0 FIELD EQUIPMENT

The four boreholes were put down using a diamond drill mounted on a floating drill platform.

The granular overburden was sampled using a 2 inch O. D. split spoon sampler, adapted with a foot valve to aid in the recovery of the material, at minimum intervals of 5 feet.

3.0 SITE AND GEOLOGY

The site is located in the village of McKellar about thirteen miles north of Parry Sound. The proposed culvert location extends south of an existing concrete and steel beam bridge over which Highway 124 crosses an outlet of McKellar Lake flowing into Manitouwabing Lake. The actual drilling program was carried out in a pool, shown on the photographs - Appendix III, directly south of an outcrop of bedrock on which the concrete bridge is founded. It is understood from conversations with local inhabitants that the flow of water used to be farther to the west of its existing course in the region of the site and that this area was filled with stone slabs, sawdust and wood logs from a nearby sawmill. This area is understood to extend about fifty feet to the west of the existing shoreline.

It is known from available geological information¹ that the area was glaciated during Pleistocene times and

¹ Geology and Mineral Deposits of the Parry Sound -
Huntsville Area : Ontario Department of Mines. 1967.

3.0 SITE AND GEOLOGY - Continued

deposits of glacial till and sand and gravel are present in the area. The overburden is generally sparse, underlain by granite and metamorphic gneisses or sedimentary and derived metamorphic rock.

4.0 SOIL CONDITIONS

The following soil strata were encountered by the boreholes:

4.1 Decayed Wood Fill with Some Sand & Gravel

A layer of decayed sawdust and wood with some sand and gravel was encountered in Borehole 4 to a depth of about 2 feet. One Standard Penetration Resistance or 'N' value of 40 blows per foot was obtained in the fill stratum.

4.2 Very Loose to Compact Grey Brown to Grey Sand with Gravel

Underlying the surface fill stratum in Borehole 4 and through the full depth of overburden penetrated in Boreholes 1 to 3, very loose to compact sand with gravel was encountered. The thickness of this stratum was found to range from about 1 foot in Borehole 1 to about 9 feet in Borehole 3. Traces of decayed wood particles were encountered in samples recovered from the upper region of this stratum. Some silt was encountered in the sand with gravel at depth in Boreholes 2 and 3. The sand with gravel is generally grey brown in colour in the upper region changing to grey with depth. Although no boulders were encountered within this stratum it is possible that boulders do occur in-situ.

Grain size analyses were carried out on representative samples of this stratum and the results of these tests are presented as grain size distribution curves on Figure 1 in Appendix II. These curves show that the granular material as tested contained 18 to 40 percent gravel, 60 to 76 percent sand and from about 0 to 10 percent silt sized particles.

Standard Penetration Resistances or 'N' values obtained in the sand with gravel ranged from 1 blow per foot near

GEOCON

4.0 SOIL CONDITIONS - Continued

4.2 Very Loose to Compact Grey Brown to Grey Sand with Gravel Continued

the surface to 25 blows per foot at depth. The relative density is considered therefore to range from very loose to compact.

Two falling head permeability tests were carried in the lower region of the overburden in Boreholes 2 and 3. The computed⁽¹⁾ permeabilities were 5.0×10^{-3} and 5.8×10^{-4} centimeters per second.

5.0 WATER CONDITIONS

During the time of the investigation the river elevation in the pool where drilling took place remained at an approximately constant elevation of 788.9. It is understood the water level in the outlet is subject to considerable variations partly due to seasonal effects and also to control by dams in McKellar Lake and Manitouwabing Lake. At the time of the investigation it is understood from local inhabitants that the water flow through the outlet was less than normally anticipated for the time of the year.

6.0 BEDROCK

Bedrock was core drilled in AXT size in all the four boreholes for a depth of about 10 feet. The rock surface was encountered at depths of between 8.6 and 14.0 feet below the water surface. In all cases the rock core

(1) M.J. Hvorslev. Time Lag and Soil Permeability in Ground Water Observations - Bulletin No. 36 Waterways Experiment Station - U.S. Corps of Engineers (1951)

6.0 BEDROCK - Continued
was 100 percent.

The rock was identified by our Geological Engineer as sedimentary granite with biotite and quartzite phases.

Bedrock outcrops were visible to the north of the borehole locations, on which the concrete bridge was founded; and also to the south, about 140 feet from the bridge. The approximate elevation and location of the bedrock encountered in the boreholes in relation to these outcrop is given on Drawing T 9261-1 at the rear of this report.

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 Tons/sq. ft.</u>	<u>Relative Density</u>	<u>Standard Penetration 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".

GEOCON

GEOCON

OFFICE REPORT ON SOIL EXPLORATION

CONTRACT 19261 BORING # 1 and 2 DATUM GEODETIC CASING BX
 BORING DATE Oct. 8, 1963 REPORT DATE Oct 10, 1963 COMPILED BY AEL CHECKED BY PCW
 SAMPLER HAMMER WT 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. - LBS. ENERGY)

SAMPLE CONDITION



AS - AUGER SAMPLE
 ST - SLOTTED TUBE
 WS - WASHED SAMPLE
 DO - DRIVE-OPEN
 SF - DRIVE-FOOT VALVE
 CS - CHUNK SAMPLE

SAMPLE TYPES

FS - FOIL SAMPLE
 SO - SLEEVE-OPEN
 SF - SLEEVE-FOOT VALVE
 TO - THIN WALLED OPEN
 RC - ROCK CORE

ABBREVIATIONS

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

SOIL PROFILE				SAMPLES								
ELEVX DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT ELEVATION SCALE	WATER CONTENT W% S NAT PLW A PW			OTHER TESTS	CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.	DEPTH - FEET
				DYNAMIC PENETRATION TEST BLOWS PER FOOT								
<div>1</div>												
786.9 3.0	▼	WATER LEVEL	790									0
781.6 7.3		RIVER BOTTOM	785									5
780.6 8.6		VERY BROWN SAND AND GRAVEL	780				M RC RECOV	2" DO	1	1		10
		BEDROCK	775				100%	1	RC	1		15
770.4 18.5		END OF HOLE	770				100%	4	AXT. RC	1		20
<div>2</div>												
786.9 0.0	▼	WATER LEVEL	790									0
785.9 0.5		RIVER BOTTOM	785									5
		VERY LOOSE, TO COMBACT GREY BROWN TO GREY SAND WITH GRAVEL	780				M	2" DO	1	<1		10
		(Color change is a clay with depth)	775									15
778.7 10.2		BEDROCK	770				M RC RECOV	2" DO	3	24		20
768.1 20.8		END OF HOLE	765				100%	4	AXT. RC	1		
							100%	5	1	1		

CONTRACT 19261 BORING = 3 and 4 DATUM GEODETIC CASING BX
BORING DATE OCT 6 1969 REPORT DATE OCT 10, 1969 COMPILED BY AEI CHECKED BY PGW
SAMPLER HAMMER WT. 140 LBS. DROP 30 INCHES (PENETRATION RESISTANCES CONVERTED TO BLOWS OF 4200 IN. - LBS. ENERGY)

SAMPLE TYPES



DISTURBED
FAIR
GOOD
LOST

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

F.S - FOIL SAMPLE
SO - SLEEVE-OPEN
SF - SLEEVE-FOOT VALVE
TO - THIN WALLED OPEN
RC - ROCK CORE

Y - IN-SITU VANE TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
QC - TRIAXIAL CONSOLIDATED UN
Q - TRIAXIAL UNDRAINED
S - TRIAXIAL DRAINED

ABBREVIATIONS

W - WET UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE				WATER CONTENT W ₉ _____ G NAT _____ G LW _____ G PW _____				OTHER TESTS	SAMPLES				DEPTH - FEET			
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	DYNAMIC PENETRATION TEST BLOWS PER FOOT				CONDITION	TYPE	NUMBER	PENETRATION RESISTANCE BLOWS/FT.				
785.9 0.0	▼	WATER LEVEL		790	<div>3</div>											
784.4 1.5		RIVER BOTTOM		785												
		LOOSE TO COMPACT GREY BROWN TO GREY SAND WITH GRAVEL (Color change @ 5' Silty with depth)		780								M	×	DO	1	5
774.4 4.0				775									×	DO	10	12
		BEDROCK		770												
764.0 14.0		END OF HOLE		765												
785.9 0.0	▼	WATER LEVEL		790	<div>4</div>											
785.0 0.9		RIVER BOTTOM		785												
783.3 2.6		DECAYED WOOD FILL WITH SOME SAND AND GRAVEL											×	DO	1	PUSH 40
779.0 6.9		GREY SAND WITH GRAVEL		780												
		BEDROCK		775												
769.0 16.0		END OF HOLE		770												

APPENDIX II

FIGURES -- LABORATORY TESTING

GEOCON

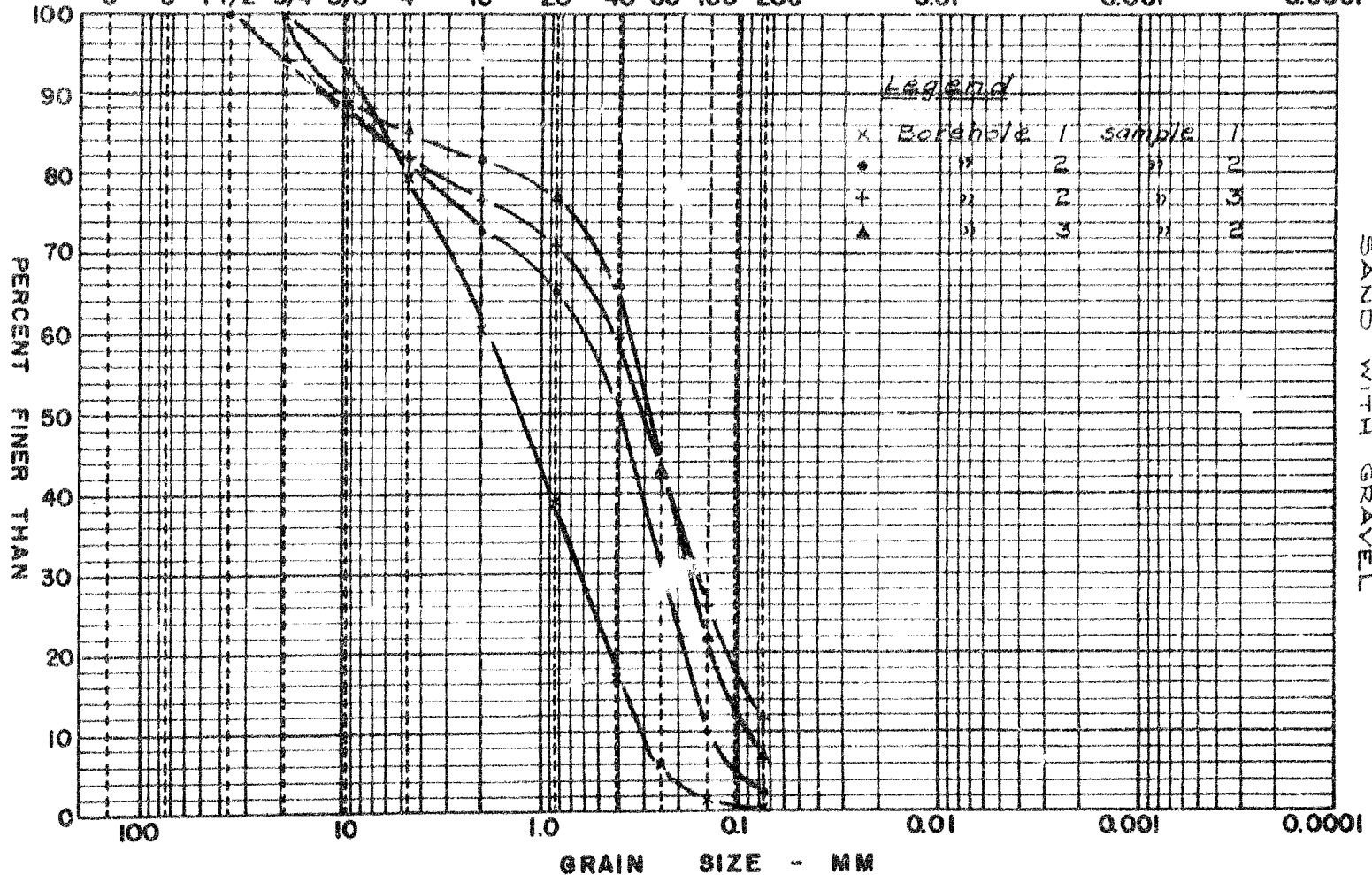
GRAIN SIZE DISTRIBUTION

APPENDIX II
FIGURE 1
PROJECT T9261

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

SIZE OF OPENING - INS. U.S.S. SIEVE SIZE - MESHES / IN. EQUIVALENT GRAIN DIAMETER - MM

6" 3" 1-1/2" 3/4" 3/8" 4 10 20 40 60 100 200 0.01 0.001 0.0001



GEOCON

APPENDIX III

PHOTOGRAPHS



View of Bridge from South

GEOCON



View from Bridge Looking South

GEOCON

#69-F-204C

W.P. 203-65

HWY #24, LINE 'D'

REVISION

McKELLAR LAKE OUTLET

