REPORT ON
SOILS INVESTIGATION
FOR
GOLFLINKS ROAD UNDERPASS
HIGHWAY 403, DISTRICT #4
HAMILTON

DEPARTMENT OF HIGHWAYS, ONTARIO
Reference W.P. 200-58

Submitted by

ASSOCIATED GEOTECHNICAL SERVICES LIMITED
211 Davenport Road, Toronto, 5 Ontario.

December, 1964.

TABLE OF CONTENTS

SECTION 1

INTRODUCTION

The purpose of this report is to present the results of the soils and foundation investigation carried out in connection with the proposed Golflinks Road Underpass in the Township of Ancaster. The site is located at the intersection of the proposed Highway No. 403 alignment and the revised alignment of Golflinks Road.

The work was authorized by Mr. A. Rutka, Materials and Testing Engineer, of the Department of Highways, Ontario on November 4, 1964.

SECTION 2

SUMMARY

The project consists of a 4 span, 2 lane bridge to provide grade separation between the proposed alignment of Golflinks Road and Highway No. 403. The two end spans are 45 feet in length and the intermediate spans are 102 and 121 feet long.

The site was underlain by two soil strata resting on relatively flat lying bedrock. The upper soil stratum consisted of brown to grey non plastic silts and the stratum was 22 to 32.5 feet thick relative to surface elevations of 758.8 to 768.3 feet. The top several feet of this stratum was loose and slightly organic. The remainder was of medium to dense relative density.

The soil stratum overlying bedrock was approximately 11 feet thick. Both till textured silt and interglacial silts and clays were encountered in this stratum. The soils were dense to very dense.

Ground water level was determined to be 1.9 to 9.5 feet below ground surface (elevation 756.3 to 759.5). Water levels roughly followed the surface topography.

The use of spread footings, founded in the medium to dense silt stratum, was considered for pier and abutment support. To keep settlements within tolerable limits a maximum allowable bearing capacity of 2 t.s.f. is recommended. Because required depths of spread footings are as much as 7.7 feet below measured ground water level, piping ("quicksand" condition) could occur during excavation. To ensure against piping, ground water must be kept below footing level during excavation and construction. A vacuum well point

system should be suitable. In addition foundation soils loosened during construction would have to be recompacted prior to footing placement.

In view of the dewatering difficulties associated with spread footings an alternative piled foundation was considered. The use of steel H piles or pipe piles driven to bedrock or when necessary, into the dense soil stratum overlying bedrock is feasible. Pile loadings of up to 50 and 75 tons may be used for BP-12 and 12 inch diameter pipe piles respectively. In actual fact pile strengths may govern pile loadings.

No stability problems are anticipated from approach fills having side slopes of 2 horizontal to 1 vertical or flatter.

SECTION 3

DISCUSSION OF PROCEDURES

3.1 Field Procedures

The drilling program consisted of 10 Boreholes and 9 Dynamic Cone Probes located at the proposed abutment and pier locations as shown on the accompanying drawing appended to this report.

The locations of all boreholes and cone probes were established in relation to the proposed Highway No. 403 centre line. A spirit level was used to establish surface elevations at borehole and cone probe locations. The D.H.O. bench mark located in the south east root of a 3.5 foot oak tree 145 feet left of Highway No. 403 station 175+33 was used as the reference elevation.

Two drilling rigs were used to carry out the boring on this project. Full time supervision of field operations was provided by a qualified soils engineer assisted by a qualified soils technician.

Boring and sampling operations were carried out with standard diamond drilling equipment. Generally a wash boring procedure was used whereby the casing was driven to the required sample depth by means of a 350 pound hammer and the soil in the casing was then washed out to the bottom of the casing by means of a side jet chopping bit. Special care was taken to ensure against washing beyond the bottom of the casing and to keep the casing full of water at all times. When the denser "till textured" zones were encountered driving of the casing often was extremely slow. Accordingly the procedures were modified to allow a partial washing ahead of the casing. Soil samples were taken at intervals of 5 feet or less by means of the standard split spoon sampler. The blows of the 140 pound hammer falling 30 inches were recorded for each 6 inches of sampler penetration. In addition several thin wall tube samples were obtained. In all cases the tube samples had to be driven.

A five foot long double tube AXt core barrel was used to obtain continuous samples of bedrock. All samples were retained and forwarded to the testing laboratory for detailed classification and testing.

The dynamic cone probe test consisted of driving a 2 inch diameter cone into the soil by means of a 140 pound hammer falling 30 inches. The blows for each foot of penetration were recorded.

Water level observations were taken in the open boreholes. Measurements were taken during and on completion of the exploratory works. A further check of water levels was made 11 days subsequent to drilling operations.

3.2 Laboratory Procedures

Unit weight, moisture content, maximum and minimum density and grain size distribution characteristics of the overburden were investigated by laboratory tests.

The unit weight determinations were made by the mercury immersion method and grain size distributions were investigated by standard hydrometer methods.

Maximum and minimum density was determined generally following the procedures outlined in the ASTM "Procedures for Soil Testing". The Harvard Miniature mold (1.4 inch ∅ and 2.8 inches long) was used for this determination. For comparative purposes a Harvard Miniature test using 50 blows per layer for 5 layers was carried out.

SECTION 4

SITE CONDITIONS

The site area consisted of undulating cultivated farmland with surface elevations varying from approximately 758 to 770. Two separate soils strata were encountered over flat lying bedrock at elevation 725. Information on soils and the assumed soils profile are shown on the borehole logs and drawing appended to this report.

The uppermost soil stratum was found to vary in thickness from 22 to 32.5 feet. It consisted predominately of lenses of uniformly graded silty soil varying in composition from silt to silt containing a minor percentage of sand or clay. Typical gradation curves for these soils are contained in the Appendix. Occasionally thin lenses or seams of sandy and red-brown clayey soils were encountered. Almost all the soils in this stratum were non plastic. Traces of organic matter were observed in the first several feet below ground surface.

The colour of this upper soil stratum varied from brown to grey. The change from brown to grey occurred at depths varying from 6.3 to 12.4 feet (Elevations varied from 748.9 to 756.1). The elevation of colour change was not uniform nor did it consistently follow the topography. Consequently it has been assumed that the depth of colour change w depended on factors other than previously existing minimum water levels.

The upper soil deposit has a variable density. Cone probe penetration resistances showed a marked increase from approximately 5 to more than 20 blows per foot at depths varying from 3 to 8 feet below ground surface. Accordingly the soils above this point of rapid change have been assumed to be loose. Below this point standard penetration values varied from 15 to 46 blows per foot indicative of medium to dense relative density. Most of these penetration resistances came within the 18 to 30 range suggesting that the deposit is predominately of medium relative density. Generally the blows were higher at the east end of the site. Dry unit weights of soil samples from boreholes 5, 7 and 9 varied from 102 to 113 p.c.f. relative to moisture contents of 24.3 to 17.6 respectively. Unit weights tended to be lower in boreholes 5 and 7 than in borehole 9. The maximum and minimum dry soil densities were determined to be 120 and 78.5 p.c.f. respectively. These values are in close agreement with the 118 and 80 p.c.f. suggested by Hough (Basic Soils Engineering) for similar soils.

The lower soil stratum was generally about 11 feet thick but varied from 8.7 to 13.7 feet in thickness. This deposit was found to contain two distinct soil types which have been grouped on the basis of apparent relative density. Both of these soils were found to be considerably denser than the soils above. At boreholes 1, 2, 3, 4 and 8, the lower soil consisted of grey and brown inter-glacial lacustrine sediments of silt and silt some clay. The soils were found to be layered in some locations and lensed in others.

In the remainder of the boreholes, the lower soil was composed of grey till-textured silt containing variable amounts of clay and gravel. It should be noted that on the centreline soil profile and sections on the drawing included in this report, the sumbol used to designate "till" has been deleted in areas of interglacial soils.

Standard penetration values in this lower stratum varied from 33 to more than 100 with values in excess of 50 blows per foot most common.

Bedrock consisted of flat laying light grey dolomite with top elevations from 725.1 to 725.7. The upper several feet of bedrock contained a moderate number of small voids (less than 3/8 inch diameter) most of which were coated or filled with calcareous deposits. The voids became smaller and less frequent with increasing depth.

In two borings, evidence of thin clayey scams were observed. These locations are indicated on the borehole logs.

Water return, during bedrock drilling, varied from 50 to 100 percent but several times complete water losses occurred. Connections were observed between boreholes 3 and 4, and 5 and 6 during drilling of the upper 2 to 4 feet.

Ground water levels determined by measurement in open boreholes varied from elevation 756.3 to 759.5. These elevations were found to follow the general topography of the ground surface. Water levels determined shortly after completion of drilling were not appreciably different from those recorded 11 days after completion. The high water table is consistent with the wet and somewhat swampy depression approximately 150 yards north east of the site.

SECTION 5

DISCUSSION OF PROPOSED STRUCTURE

5.1 General

The proposed structure will provide the grade separation at the intersection of the proposed alignments of Highway 403 and Golflinks Road. The Golflinks Road structure will consist of a 4 span, 2 lane bridge supported on two abutments and three intermediate piers. Two end spans of 45 feet and two middle spans of 102 and 121 feet are contemplated for the structure. Approach fills will also be required.

Spread footings and piled foundations have been considered for the structure. Each is discussed separately as follows:

5.2 Spread Footings

Considering the use of spread footings for the new structure, the presence of loose soil and small amounts of organic material in the first several feet below ground surface requires that spread footings be founded on the medium dense to dense silt stratum as shown on the following table:

Foundation	Nearest Boreholes	Maximum Footing Elev.
west abutment	1 and 2	755
west pier	3 and 4	750
centre pier	5 and 6	755
east pier	7 and 8	756
east abutment	9 and 10	755

The soil properties considered in the assessment of bearing capacity were as follows:

From sample observation, the majority of the upper soil stratum was clearly non plastic and accordingly non plastic behaviour has been considered for design purposes.

The relative density of the soils was investigated by three separate means.

(a) Correlation of standard penetration values with relative density as shown on the classification chart in the Appendix. This will be referred to as the "conventional method."

(b) Correlation of standard penetration values with relative density by means of the Gibbs and Holtz chart.

(c) Direct determination of relative density on the basis of laboratory measurements of unit weight relative to laboratory maximum and minimum densities.

The "conventional" method, (a), indicates that although the penetration resistance of the soils below proposed footing level were within the medium to dense range (values varied from 15 to 46) they were for the most part medium dense (the majority of values obtained were less than 30). The Gibbs and Holtz chart (method b) indicated that the same soils were predominately very dense but locally dense. The laboratory determination of relative density indicated a predominately dense deposit (63 percent of determinations were between 65 to 85 percent relative density) with occasional values in the very dense range.

These various approaches to density interpretation suggest that in this instance, the "conventional" method underestimates relative density. This is discussed further in the subsequent section on settlement. For design calculations the unit weight of the silt stratum was assumed to be 100 p.c.f above the ground water level and 62 p.c.f. in the submerged condition.

Using the bearing capacity equation in Terzaghi and Peck "Soil Mechanics in Engineering Practice" an allowable bearing value of 3 t.s.f. was obtained. Settlement considerations may however be more critical than shear strength considerations.

Expected settlements were investigated for both medium and dense soil conditions under a range of loadings. Following the procedures suggested by Hough "Basic Soils Engineering", estimated settlements of 1.4, 2.5 and 3.4 inches were calculated for loadings of 1, 2 and 3 t.s.f. respectively on a dense soil (in place density of 106 p.c.f.). For a medium dense soil (in place density of 102 p.c.f.) the corresponding settlements would be approximately 25 percent higher, i.e., 1.8, 3.2 and 4.3 inches. As a check on the relative magnitude of these settlements, a linear extrapolation from the settlement chart in Terzaghi and Peck "Soil Mechanics in Engineering Practice" was made. For a medium dense soil (Standard Penetration average of 20) settlements in the range of 2 inches could be expected with a loading of 2 t.s.f. For a dense soil (Standard penetration value of 35) settlements would be in the order of 1.3 inches for a loading of 2 t.s.f.

The "Hough" procedure is obviously conservative but the calculations do illustrate the variation of settlement with load. They can also be used to represent a maximum possible settlement. The determinations from the Terzaghi and Peck charts are believed to be more representative.

Considering the silty nature of the soil a substantial portion of the settlement should occur due the abutment and pier loading prior to deck placement. i.e. For a 2 t.s.f. loading more than one half the settlement would occur under a load of 1 t.s.f. (as might be assumed for the load prior to deck placement.) This is of significance where deck total and differential settlements are of major importance.

From the previous calculations it can be seen that, even for the "Hough" method of settlement calculation, the total deck settlements i.e. settlement from 1 to 2 t.s.f. would be in the order of 1.4 inches. For the more realistic Terzaghi and Peck calculations the corresponding total settlements would be less than 1 inch for a medium dense soil and about 0.6 inches for a dense soil. On the basis of the previous discussion of relative density it would be reasonable to assume an intermediate density to be applicable. Accordingly total and differential deck settlements under a 2 t.s.f. loading should be within tolerable limits. A maximum allowable bearing value of 2 t.s.f. could therefore be used for design purposes.

With respect to excavation for the footings, it is likely that material will have to be removed to a maximum depth of 7.7 feet below ground water level as shown on the following table.

Foundation	Maximum Footing Elevation	Average Ground Water Elevation
West abutment	755	759
West pier	750	757.7
Centre pier	755	757
East pier	756	757.7
East abutment	755	758.3

Considering the low permeability and high relative density of the silty soils, it is unlikely that they can be drained from sumps in open excavation without danger of excess upward hydraulic pressure. This would lead to piping of the soil on the bottom of the excavation (quicksand condition) as well as subsidence of the ground surrounding the excavation. Therefore, in order to prevent reduction of soil bearing capacity it will be necessary to lower the ground water level to below footing level prior to excavation and to keep it there until the footings are constructed and backfilled. In our opinion, a vacuum well point system would provide the most adequate system of dewatering at the site. In addition, since some soil distrubance may occur during excavation, recompaction of the soils immediately below the footings should be stipulated before footing concrete placement.

5.3 Piles

In view of the difficulties of installing and operating a ground water control system for spread footings, the use of piles has also been considered as an alternative means of foundation support. For this site, end bearing piles such as H piles or pipe piles driven to bedrock or, when impossible, the very dense soil overlying bedrock are recommended.

Considering the use of steel H piles for this structure, it is expected that BP 12 piles will be capable of supporting loads in excess of 50 tons each if driven to bedrock. It is, however, conceivable that it may not be possible to drive some piles completely through the dense soil overlying bedrock as some sections of this stratum are extremely dense. In order to reduce the possible effects of load transfer from piles founded in soil to those founded on bedrock it is recommended that every reasonable effort be made to drive all piles to bedrock. Provisions should be made for reinforcing the lower end of the piles to withstand high driving resistance without pile damage where required. Such reinforcing should not generally be necessary but could be used if considerable difficulty is encountered in driving piles in any particular area. Under these circumstances pile loadings of up to 50 tons each may be used. The refusal criteria should not be less than 15 blows per inch using a D-12 Delmag hammer.

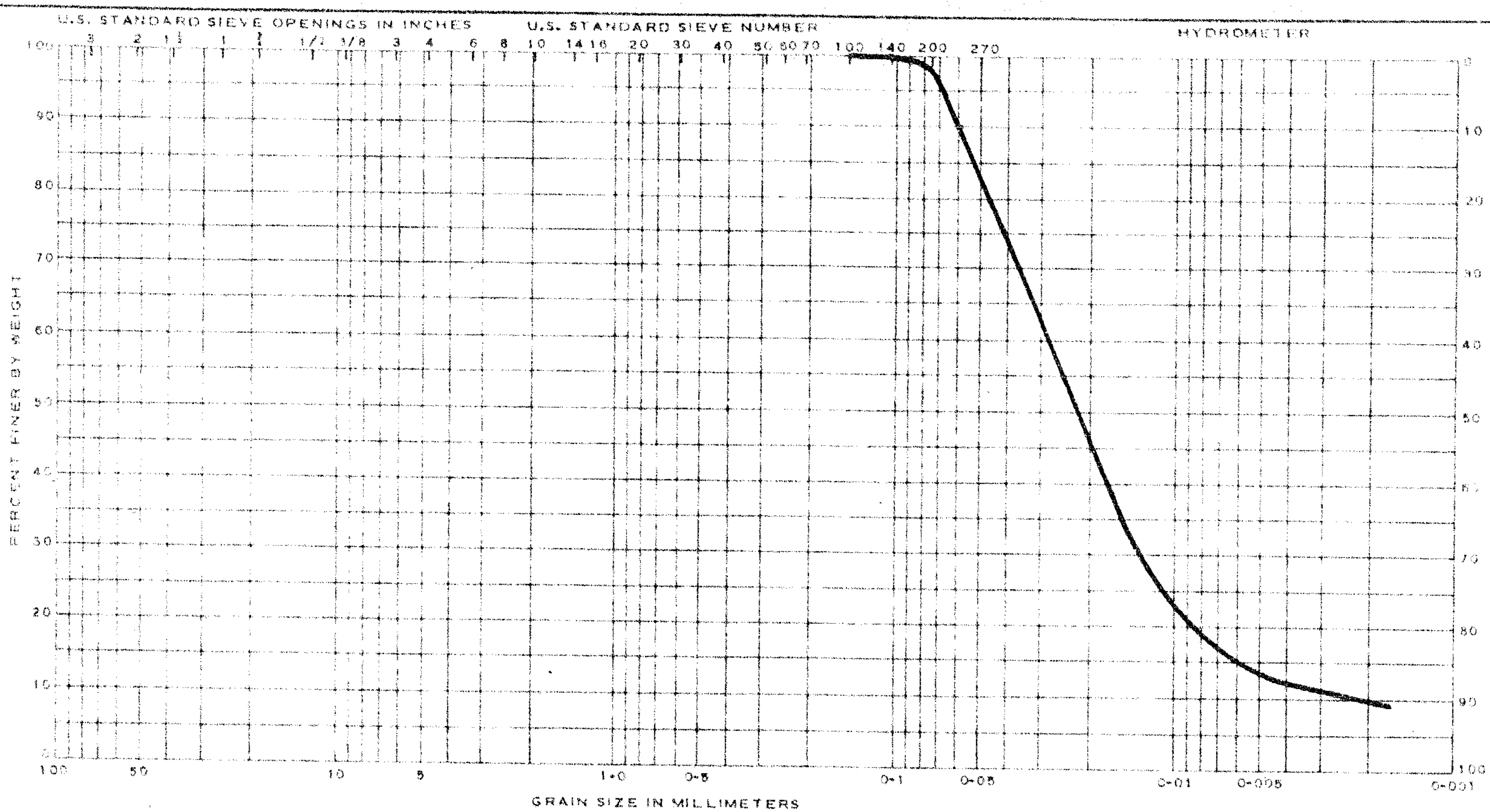
Closed end or open end pipe piles may also be used for foundation support subject to the qualifications included in the discussion on H piles. The allowable bearing capacity of 12 inch diameter pipe piles would be in the order of 75 tons per pile if taken to bedrock although the actual bearing capacity would be determined by the structural strength of the pile.

5.4 Approach Fills

No stability problems are anticipated for approach fills with side slopes of 2 horizontal to 1 vertical or flatter.

If the spread footing alternative for foundation support is used some abutment settlement due to soil loading may occur. Such settlements should be relatively small. However, in order to remove this settlement influence from the deck it is advisable to place the approach fills prior to deck placement. Also in connection with the spread footing alternative it should be noted that soils from the excavations would be too wet for direct use as fill.

APPENDIX



M.I.T. CLASSIFICATION

STONES	GRAVEL	SAND			SILT			CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

U.S. BUREAU OF SOILS

GRAVEL	SAND			SILT	CLAY
	COARSE	FINE	V.F.		

CLASSIFICATION

NON PLASTIC FINES

SOIL MECHANICAL ANALYSIS

BOREHOLE - DEPTH -

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

JOB NO. 6449 LOCATION HIGHWAY 403

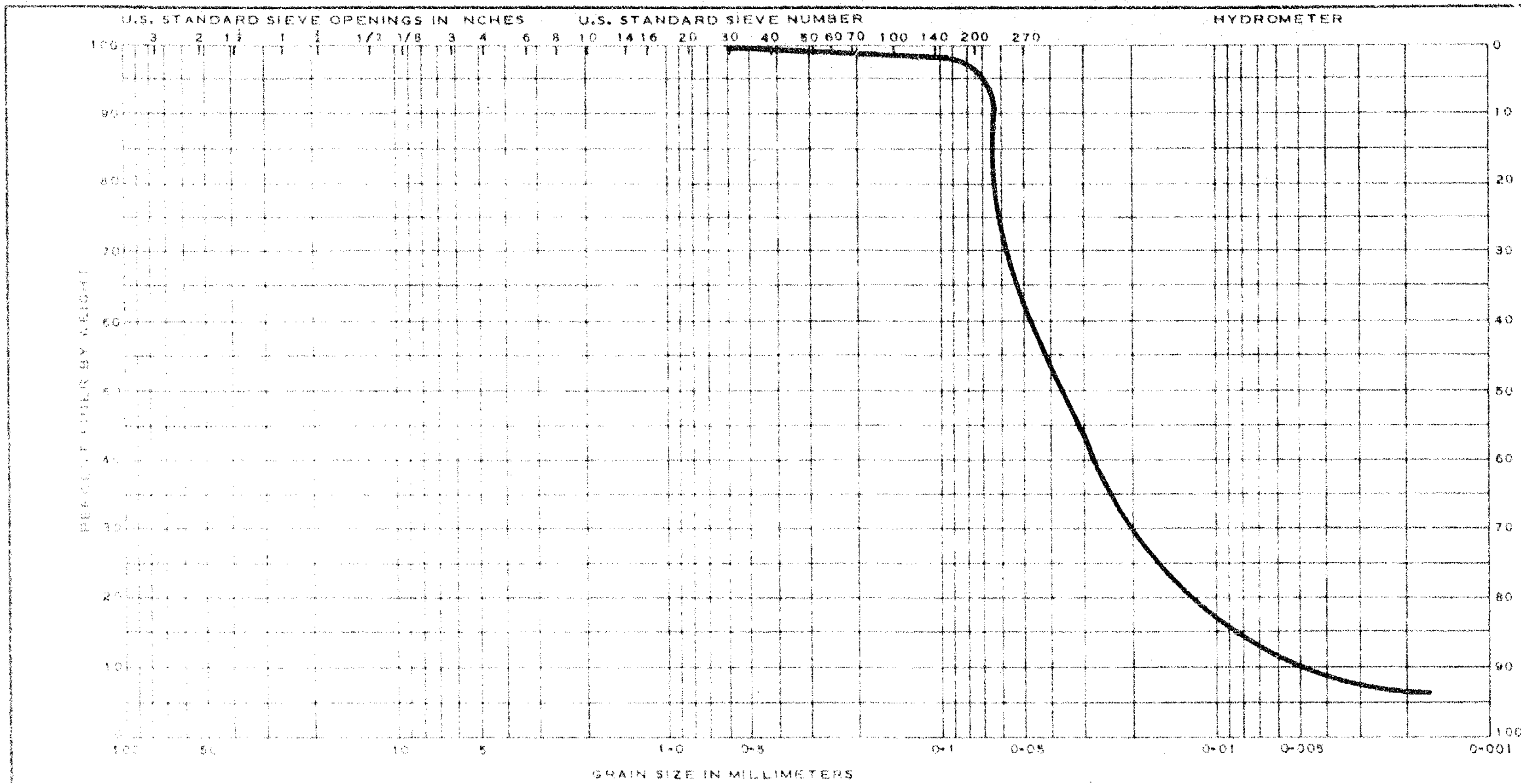
BOREHOLE NUMBER 3 DEPTH 5'0-6'5

SAMPLE NUMBER 1 DATE DEC/64

ASSOCIATED GEOTECHNICAL SERVICES Limited

SOIL MECHANICS LABORATORY

MECHANICAL ANALYSIS



M.I.T. CLASSIFICATION

STONES	GRAVEL	SAND			SILT			CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

U.S. BUREAU OF SOILS

GRAVEL	SAND			SILT	CLAY
	COARSE	FINE	V.F.		

CLASSIFICATION

NON PLASTIC FINES

SOIL MECHANICAL ANALYSIS

BOREHOLE -

DEPTH -

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

JOB. NO. 6449 LOCATION HIGHWAY 403

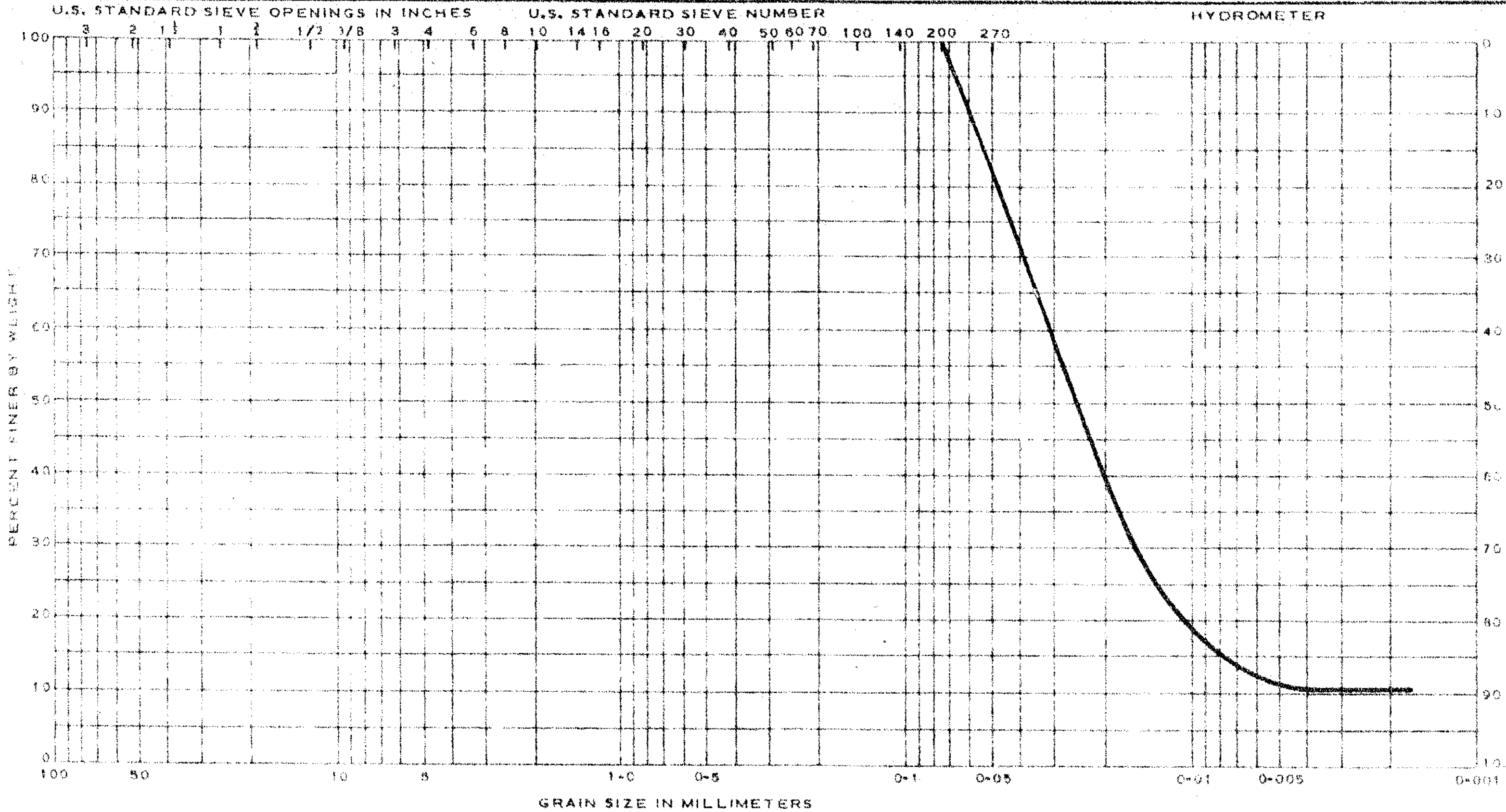
BOREHOLE NUMBER 3 DEPTH 15.0-16.5

SAMPLE NUMBER 3 DATE DEC/64

ASSOCIATED GEOTECHNICAL SERVICES Limited

SOIL MECHANICS LABORATORY

MECHANICAL ANALYSIS



M.I.T. CLASSIFICATION

STONES	GRAVEL	SAND			SILT			CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

U.S. BUREAU OF SOILS

GRAVEL	SAND			SILT	CLAY
	COARSE	FINE	V.F.		

CLASSIFICATION

NON PLASTIC FINES

SOIL MECHANICAL ANALYSIS

BOREHOLE - DEPTH -

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

JOB NO. 643 LOCATION HIGHWAY 403

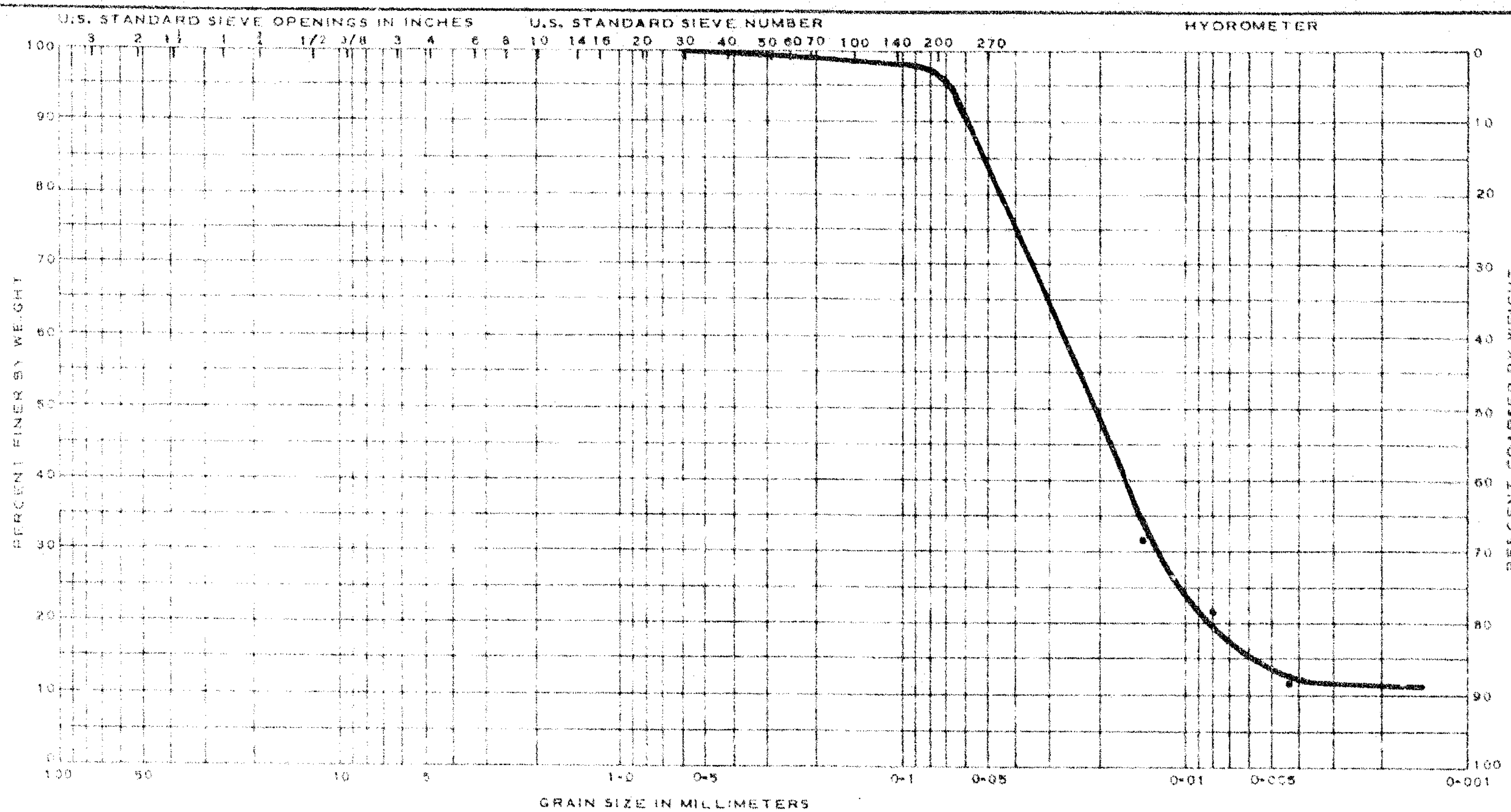
BOREHOLE NUMBER 9 DEPTH

SAMPLE NUMBER 3-4-5 DATE DEC/64

ASSOCIATED GEOTECHNICAL SERVICES Limited

SOIL MECHANICS LABORATORY

MECHANICAL ANALYSIS



M.I.T. CLASSIFICATION

STONES	GRAVEL	SAND			SILT			CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

U.S. BUREAU OF SOILS

GRAVEL	SAND			SILT	CLAY
	COARSE	FINE	V.F.		

CLASSIFICATION

NON PLASTIC FINES

SOIL MECHANICAL ANALYSIS

BOREHOLE - DEPTH -

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

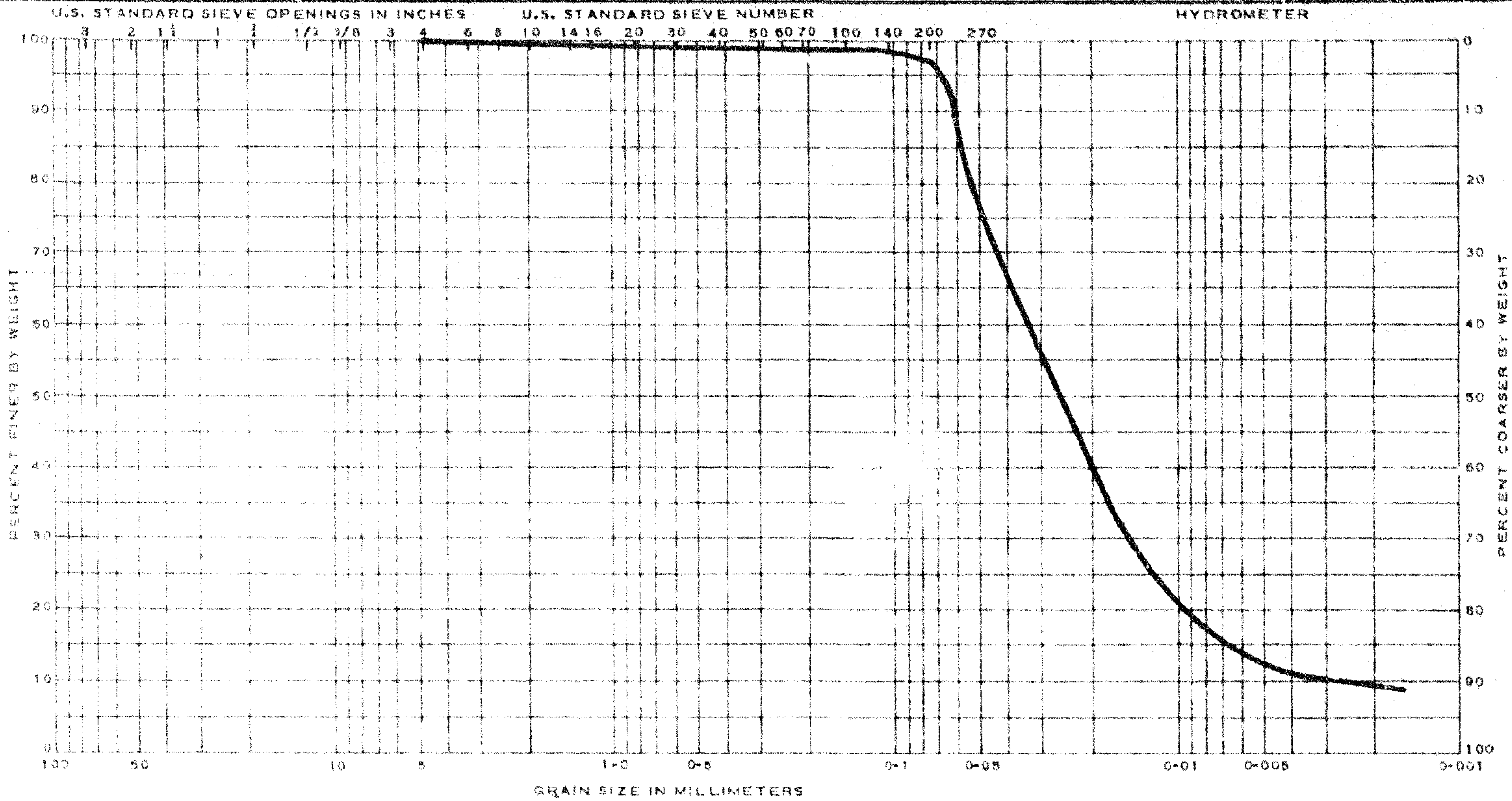
JOB. NO. 6449 LOCATION HIGHWAY 403

BOREHOLE NUMBER 10 DEPTH 5'0-6'5

SAMPLE NUMBER 1 DATE DEC/64

ASSOCIATED GEOTECHNICAL SERVICES
Limited

SOIL MECHANICS LABORATORY
MECHANICAL ANALYSIS



M.I.T. CLASSIFICATION

STONES	GRAVEL	SAND			SILT			CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	

U.S. BUREAU OF SOILS

GRAVEL	SAND			SILT	CLAY
	COARSE	FINE	V.F.		

CLASSIFICATION

NON PLASTIC FINES

SOIL MECHANICAL ANALYSIS

BOREHOLE - DEPTH -

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

JOB. NO. 6449 LOCATION HIGHWAY 403

BOREHOLE NUMBER 10 DEPTH 15'0-16'5

SAMPLE NUMBER 3 DATE DEC/64

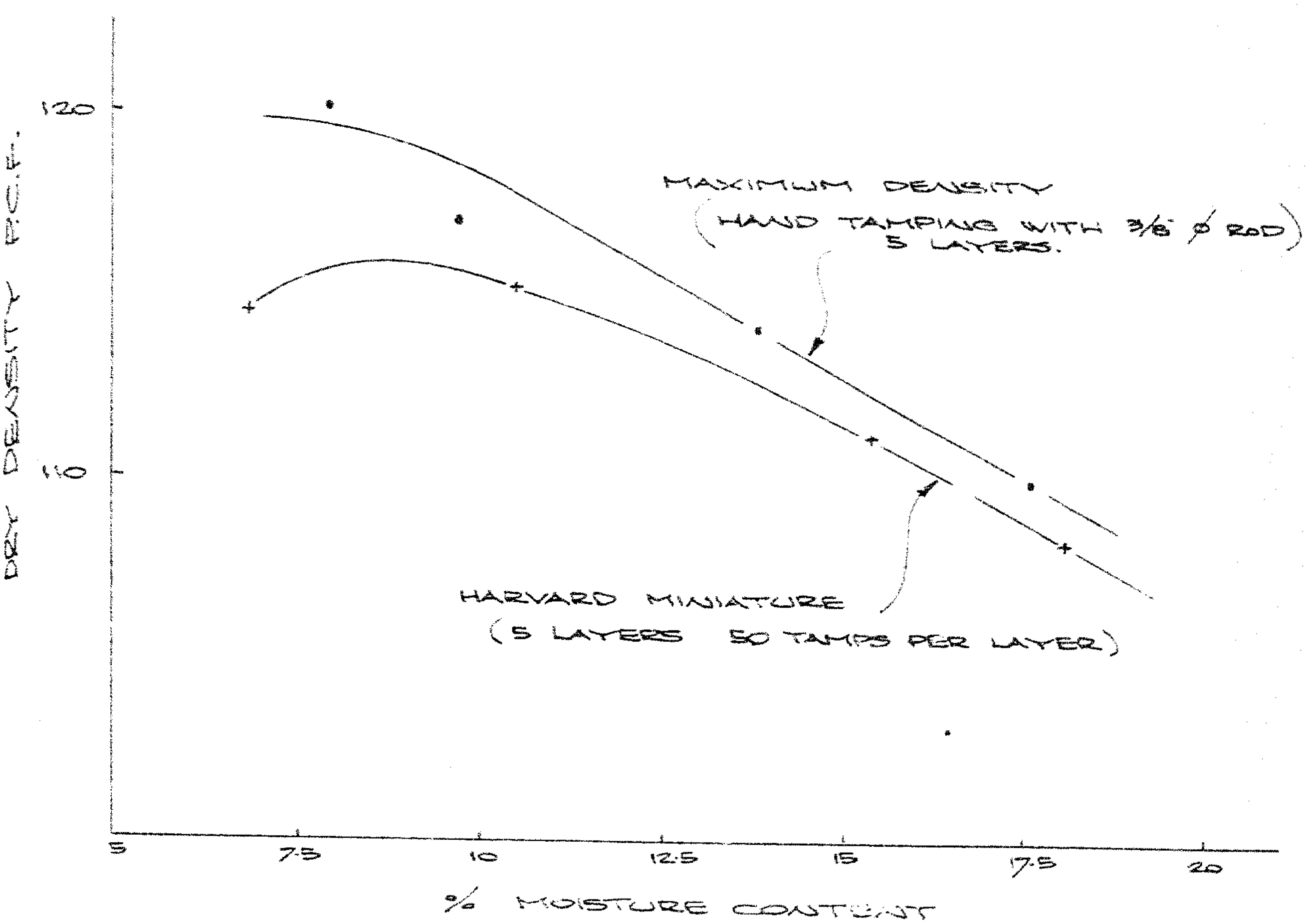
ASSOCIATED GEOTECHNICAL SERVICES Limited

SOIL MECHANICS LABORATORY

MECHANICAL ANALYSIS

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS	**ASSOCIATED GEOTECHNICAL SERVICES** Limited
JOB. NO. 6449 LOCATION HIGHWAY 403	
BOREHOLE NUMBER ______ DEPTH ______	HARVARD MINIATURE AND MAXIMUM DENSITY TEST
SAMPLE NUMBER ______ DATE DEC/64	

USED COMBINED SAMPLES FOR BOTH TESTS
BH-7 SAMPLES 3, 4 & 5, BH-5 SAMPLES 3 & 4



ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 1

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6448 LOCATION: GOLFLINKS RD. & HWY 405
CO-ORDINATES: 174+80 115' LT (REF. HWY 405)
ELEVATION (SURFACE): 763.6 (COLLAR) ______ DATUM ______
DATE (STARTED): 4/11/64 (FINISHED): 6/11/64 (COMPILED): R.E.M.
RIG. NO. 1 TYPE D.D. FIELD SUP. R.E.M.

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

BORING LOG

Depth (feet)	Elev. (feet)	Water observation	Description
4.1	759.5	▼	
			MEDIUM TO DENSE BROWN TO GREY SILT SOME LENSES CONTAINING VARIABLE AMOUNT OF SAND OR CLAY
29.0	734.6		
			VERY DENSE ERRATIC LENSES OF GREY TO BROWN SILT TO SILT SOME CLAY
38.3	725.3		
			BEDROCK DOLOMITE
48.3	715.3		BOTTOM OF BOREHOLE

FIELD TESTS / SAMPLING

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

Penetration resistance (blows per foot)	Sample number	Condition	Depth from (feet)	Depth to (feet)	Type	Recovery length rec./dist. driv.
30	1		5.0	6.5	SS	18"/18"
45	2		10.0	11.5	SS	17"/18"
41	3		15.0	16.5	SS	18"/18"
27	4	LOST	19.5	21.0	SS	0"/18"
27	5		22.5	24.0	SS	13"/18"
24	6		26.5	28.0	SS	14"/18"
53	7		31.5	33.0	SS	18"/18"
100	8		36.5	38.0	SS	14"/18"
	9	UNDISTURBED	38.3	43.3	DB	60"/60"
	10	UNDISTURBED	43.3	48.3	DB	59"/60"

LABORATORY: UNIT WEIGHT PCF DY; ATTERBERG LIMITS WP × —— ● WN —— O WL

TESTS

REMARKS

CULTIVATED TOPSOIL 0.0 - 0.8

COLOUR CHANGE AT 7.5

SAND SEAMS IN SAMPLES 1 & 3

OCCASIONAL THIN BROWN RED CLAYEY SEAMS 11.0 TO 29.0

RECOVERED 4" WITH SAND-TRAP

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 2

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO.: 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 175+39 125' LT (REF. HWY 403)
ELEVATION (SURFACE): 760.9 (COLLAR): ______ DATUM: ______
DATE (STARTED): 17/11/64 (FINISHED): 18/11/64 (COMPILED): R.E.M.
RIG. NO.: 1 TYPE: D.D. FIELD SUP.: R.E.M.

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

DEPTH FEET	ELEV. FEET	DESCRIPTION
2.3	758.6	MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNTS OF SAND OR CLAY
22.0	738.9	VERY DENSE ERRATIC LENSES OF GREY TO BROWN SILT SOME SAND TO SILT SOME CLAY
35.7	725.2	BEDROCK DOLOMITE
46.9	714.0	BOTTOM OF BOREHOLE

FIELD TESTS / SAMPLING

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

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC./DIST. DRIV.
18	1	4.5	6.0	SS	17"/18"
17	2	9.5	11.0	SS	12"/18"
16	3	14.5	16.0	SS	16"/18"
36	4	18.0	19.5	ST	14.5"/18"
32	5	19.5	21.0	SS	17"/18"
71	6	25.0	26.5	SS	12"/18"
	7	29.0	30.1	ST	12"/14"
88	8	30.5	32.0	SS	11.5"/18"
	9	35.7	40.7	DB	60"/60"
	10	40.7	44.9	DB	50"/50"
	11	44.9	46.9	DB	22"/24"

LABORATORY TESTS

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

REMARKS

CULTIVATED TOPSOIL 0'0–0'9
SAND SEAM IN SAMPLE 2
COLOUR CHANGE AT 12'0
PUMP BREAKDOWN CAUSED BLOCKAGE.

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 3

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS

JOB NO. 6449 LOCATION GOLFLINKS RD. & HWY 403

CO-ORDINATES 175+14 58' LT (REF. HWY. 403)

ELEVATION (SURFACE) 760.6 (COLLAR) ______ DATUM ______

DATE (STARTED) 13/11/64 (FINISHED) 14/11/64 (COMPILED) R.E.M

RIG. NO. 1 TYPE DD FIELD SUP. R.E.M.

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

DEPTH FEET	ELEV. FEET	DESCRIPTION
2.0	758.6	(water level)
		MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNT OF SAND OR CLAY
22.7	737.9	DENSE GREY SILT SOME CLAY AND GRAVEL (TILL TEXTURE)
27.2	733.4	VERY DENSE ERRATIC MIXTURE GREY AND BROWN SILT TO SILT SOME CLAY
35.0	725.6	BEDROCK DOLOMITE
46.5	714.1	BOTTOM OF BOREHOLE

FIELD TESTS / SAMPLING

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

DYNAMIC CONE PROBE

114 BLOWS

75 BLOWS/7"

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.	REMARKS
						CULTIVATED TOPSOIL 0-0.5
29	1	5.0	6.5	SS	13/18	COLOUR CHANGE AT 6.5
26	2	10.0	11.5	SS	18/18	
29	3	15.0	16.5	SS	16/18	OCCASIONAL BROWN-RED CLAYEY SEAMS 10.2 TO 22.7
22	4	19.5	21.0	SS	5/18	
33	5	24.5	26.0	SS	16/18	
75	6	29.5	31.0	SS	15/18	
80/6"	7	34.5	35.0	SS	3.5/6"	REFUSAL AT 35.0
	8	35.0	36.6	DB	19"/19"	
	9	36.6	41.5	DB	58/59	
	10	41.5	46.5	DB	60/60	

LABORATORY TESTS

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

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 4

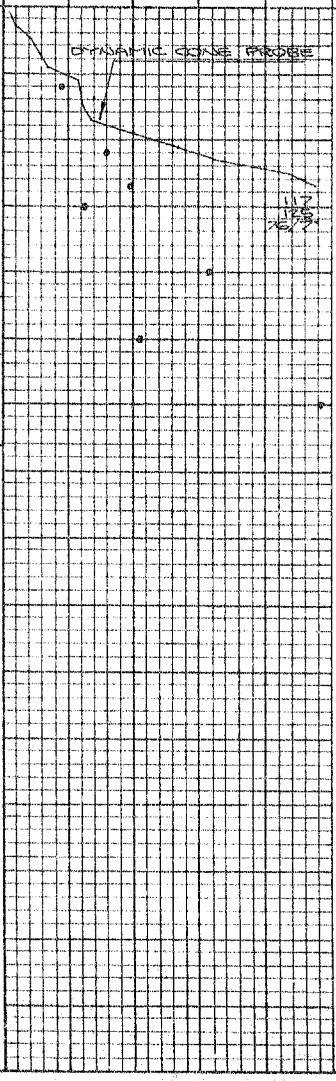
CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 175+70 90' LT (REF. HWY 403)
ELEVATION (SURFACE): 758.8 (COLLAR) ______ DATUM ______
DATE (STARTED): 13/11/64 (FINISHED): 14/11/64 (COMPILED): R.E.M.
RIG NO. 2 TYPE D.D. FIELD SUP. H.E.K.

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

Depth (feet)	Elev. (feet)	Description	Penetration resistance (blows per foot)	Sample number	Depth from (feet)	Depth to (feet)	Type	Recovery length rec./dist. driv.	Remarks
1.9	756.9	LOOSE TO MEDIUM BROWN SILT, TRACE TO SOME SAND							CULTIVATED TOPSOIL 0-0'6
									SLIGHTLY ORGANIC TO 8.0
			18	1	5.0	6.5	SS	18"/18"	
9.4	749.4	MEDIUM TO DENSE GREY SILT, WITH LENSES CONTAINING VARIABLE AMOUNT OF CLAY							COLOUR CHANGE AT 9.4
			32	2	10.0	11.5	SS	18"/18"	
			39	3	12.5	14.0	SS	18"/18"	
			25	4	14.0	15.5	SS	18"/18"	
			63	5	19.0	20.5	SS	18"/18"	
22.0	736.8	DENSE TO VERY DENSE SILT TO SILT SOME CLAY SOME LAYERING AND PEBBLES							NUMEROUS PEBBLES 9.5 TO 13.0 AND 16.0 TO 21.0
			42	6	24.0	25.5	SS	18"/18"	
			97	7	29.0	30.5	SS	18"/18"	
33.1	725.7	BEDROCK DOLOMITE		8	33.1	33.7	DB	7"/7"	BLOCKED AT 33.7
				9	33.7	36.7	DB	32"/36"	BLOCKED AT 36.7
				10	36.7	41.4	DB	56"/56"	
41.4	717.4	BOTTOM OF BOREHOLE.							

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



LABORATORY TESTS — UNIT WEIGHT PCF; ATTERBERG LIMITS WP — WN — WL

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6449 LOCATION GOLFLINKS RD. & HWY 403
CO-ORDINATES 175+96 ℄ (REF. HWY 403)
ELEVATION (SURFACE) 761·3 (COLLAR) ______ DATUM ______
DATE (STARTED) 11/11/64 (FINISHED) 12/11/64 (COMPILED) R.E.M.
RIG. NO. 2 TYPE DD FIELD SUP. H.E.K.

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

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 5

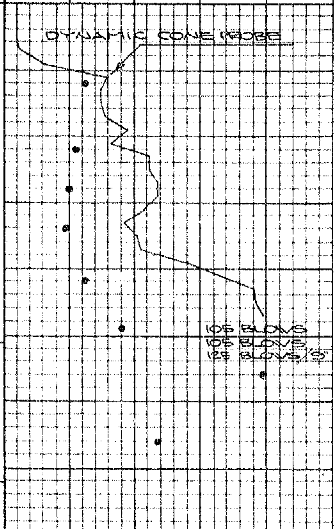
BORING LOG

DEPTH FEET	ELEV. FEET	DESCRIPTION
3·5	758·0	(Water observation)
25·5	735·8	MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNT OF CLAY OR SAND.
36·1	725·2	DENSE TO VERY DENSE GREY SILT SOME CLAY AND GRAVEL. (TILL TEXTURE.)
45·9	715·4	BEDROCK DOLOMITE

BOTTOM OF BOREHOLE

FIELD TESTS

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



SAMPLING

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	FROM FEET	TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.
25	1	5·0	6·5	SS	18"/18
22	2	10·0	11·5	SS	15"/18"
20	3	13·0	14·5	SS	12"/18"
19	4	16·0	17·5	SS	10"/18"
25	5	20·0	21·5	SS	12"/18"
36	6	23·5	25·0	SS	13"/18"
79	7	27·0	28·5	SS	0"/18"
47	8	32·0	33·5	SS	18"/18"
	9	36·1	41·1	DB	60"/60"
	10	41·1	45·9	DB	52"/57"

LABORATORY TESTS

DRY UNIT WEIGHT PCF γ 110 120
ATTERBERG LIMITS WP x — ● WN — o WL 10 20

REMARKS

CULTIVATED TOPSOIL 0-0·6
COLOUR CHANGE AT 8·7
REDROVE - RECOVERED 6"

CLIENT	ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO.	6449
LOCATION	GOLFLINKS RD. & HWY 403
CO-ORDINATES	176+58 ℄ (REF. HWY 403)
ELEVATION (SURFACE)	762.8 (COLLAR)
DATUM	
DATE (STARTED)	11/11/64
(FINISHED)	12/11/64
(COMPILED)	R.E.M.
RIG. NO.	1
TYPE	D.D.
FIELD SUP.	R.E.M.

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

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 6

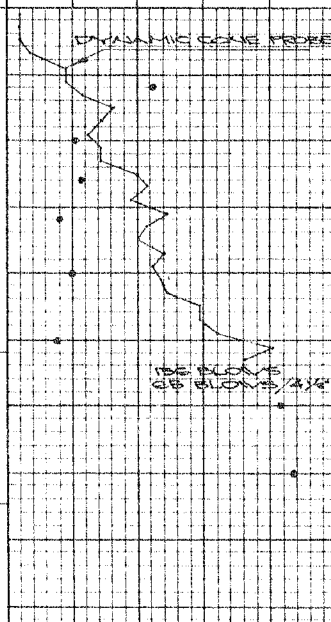
BORING LOG

DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION
6.5	756.3	▽	
			MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNTS OF SAND OR CLAY
26.0	736.8		VERY DENSE GREY SILT TRACE TO SOME CLAY AND GRAVEL (TILL TEXTURE)
37.3	725.5		BEDROCK DOLOMITE
44.7	718.1		BOTTOM OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT)

STANDARD PENETRATION TEST (BLOWS PER FOOT)



SAMPLING

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	CONDITION	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC./DIST. DRIV.
46	1		5.0	6.5	SS	14"/18"
21	2		9.0	10.5	SS	17"/18"
23	3		12.0	13.5	SS	16"/18"
16	4		15.0	16.5	SS	18"/18"
20	5		19.0	20.5	SS	16"/18"
15	6		24.0	25.5	SS	18"/18"
83	7		29.0	30.5	SS	11"/18"
87	8		34.0	35.5	SS	17"/18"
	9		37.3	42.3	DB	60"/60"
	10		42.3	44.7	DB	29"/29"

LABORATORY

UNIT WEIGHT PCF

ATTERBERG LIMITS WP x —— ● WN —— ○ WL

TESTS

REMARKS

CULTIVATED TOPSOIL 0–0'6"

COLOUR CHANGE AT 9'3"

OCCASIONAL THIN BROWN-RED CLAYEY SEAMS 13'0" TO 26'0"

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 7

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 176+70 77' RT (REF. HWY 403)
ELEVATION (SURFACE): 768·3 (COLLAR) ______ DATUM ______
DATE (STARTED): 17/11/64 (FINISHED): 18/11/64 (COMPILED): R.E.M.
RIG. NO. 2 TYPE: D.D. FIELD SUP. H.E.K.

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

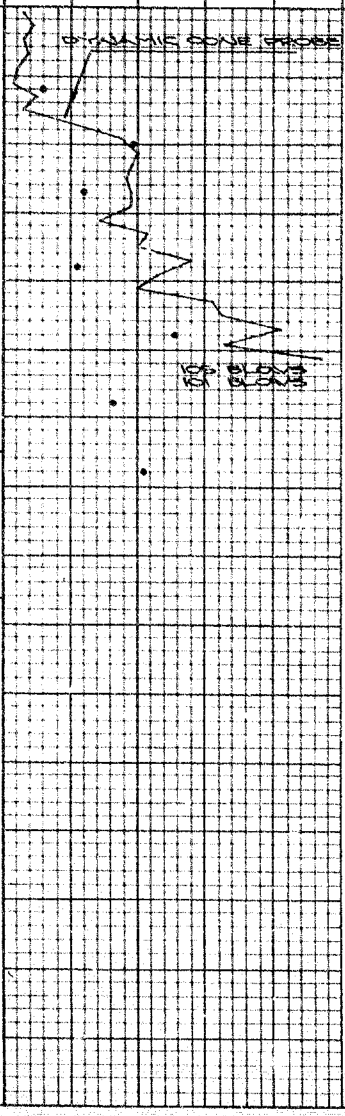
ABBREVIATIONS: UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST
SS - SPLIT SPOON; ST - SHELBY TUBE; TWP. - THIN WALLED PISTON; DB - DIAMOND BIT
C - CONSOLIDATION TEST; M - MECHANICAL ANALYSIS; T - TRIAXIAL COMPRESSION; K - PERMEABILITY; U - UNCONFINED COMP.; PCF - POUNDS PER CUBIC FOOT; WN - NATURAL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

BORING LOG

DEPTH FEET	ELEV. FEET	DESCRIPTION
9·5	758·8	(WATER OBSERVATION)
		MEDIUM TO DENSE BROWN TO GREY SILT, SOME LENSES CONTAINING VARIABLE AMOUNTS OF SAND OR CLAY
32·5	735·8	DENSE TO VERY DENSE GREY SILT, VARIABLE GRAVEL & CLAY CONTENT (TILL TEXTURE)
43·2	725·1	BEDROCK DOLOMITE
53·4	714·9	BOTTOM OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT) / 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.
12	1	5·0	6·5	SS	15"/18"
39	2	9·0	10·5	SS	12"/18"
24	3	12·5	14·0	SS	15"/18"
29	4	16·0	18·0	ST	4"/24"
22	5	18·0	19·5	SS	18" 18"
51	6	23·0	24·5	SS	12"/18"
33	7	28·0	29·5	SS	14"/18"
42	8	33·0	34·5	SS	18"/13"
119/9"	9	38·0	39·2	SS	15"/15
	10	43·2	48·4	DB	62"/62"
	11	48·4	53·4	DB	60"/60"

LABORATORY TESTS

DRY UNIT WEIGHT PCF 110 120
ATTERBERG LIMITS WP x —— ● WN —— o WL 10 20

REMARKS

SILT AND GRAVEL 9·0 - 9·2
COLOUR CHANGE AT 12'4
OCCURANCE OF CLAY INCREASES WITH DEPTH.

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 8

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO.: 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 177+32 70' RT (REF. HWY 403)
ELEVATION (SURFACE): 763.1 (COLLAR) ______ DATUM ______
DATE (STARTED): 15/11/64 (FINISHED): 16/11/64 (COMPILED): R.E.M.
RIG. NO.: 2 TYPE: DD FIELD SUP.: H.E.K.

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

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

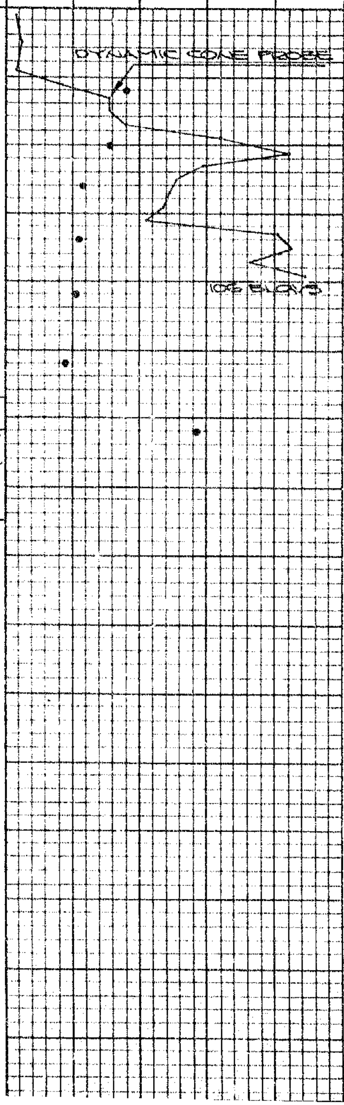
BORING LOG

DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION
6.0	757.1	▼	
			MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNTS OF CLAY OR SAND
28.7	734.4		VERY DENSE GREY SILT TO REDDISH SILT SOME CLAY. OCCASIONAL PEBBLE. LAYERED.
37.4	725.7		BEDROCK DOLOMITE
45.0	718.1		BOTTOM OF BOREHOLE

FIELD TESTS

SHEAR STRENGTH (TONS PER SQUARE FOOT)

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.
56	1	5.0	6.5	SS	18"/18"
31	2	9.0	10.5	SS	12"/18"
25	3	12.0	13.5	SS	13"/18"
22	4	16.0	17.5	SS	14"/18"
21	5	20.0	21.5	SS	14"/18"
18	6	25.0	26.5	SS	13"/18"
57	7	30.0	31.5	SS	14"/18"
122	8	35.0	36.5	SS	14"/18"
	9	37.4	40.0	DB	29"/31"
	10	40.0	45.0	DB	60"/60"

LABORATORY TESTS

UNIT WEIGHT PCF

ATTERBERG LIMITS: WP X —— ● —— O WL (WN)

REMARKS

CULTIVATED TOPSOIL 0-0.6

SOME ORGANIC IN UPPER 5.5 FEET

COLOUR CHANGE AT 10.0

THIN BANDS OF GREY FINE SAND AND OF REDDISH SILT SOME CLAY IN SAMPLES 3, 5 AND 6.

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG
BOREHOLE NO. 9

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 177+02 112' RT (REF. HWY 403)
ELEVATION (SURFACE) 765.0 (COLLAR) ____ DATUM ____
DATE (STARTED) 18/11/64 (FINISHED) 20/11/64 (COMPILED) R.E.M.
RIG. NO. 1 TYPE D.D. FIELD SUP. REM

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

UNDISTURBED; DISTURBED BUT REPRESENTATIVE; FAIR; LOST

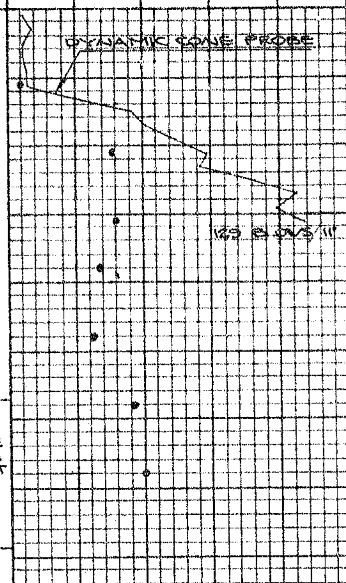
ABBREVIATIONS
SS - SPLIT SPOON
ST - SHELBY TUBE
TWP. - THIN WALLED PISTON
DB - DIAMOND BIT
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

BORING LOG

Depth (feet)	Elev. (feet)	Description
6.5	758.5	(water observation level)
0 – 28.5	765.0 – 736.5	MEDIUM TO DENSE BROWN TO GREY SILT WITH LENSES CONTAINING VARIABLE AMOUNT SAND OR CLAY
28.5 – 39.3	736.5 – 725.7	DENSE TO VERY DENSE GREY SILT, VARIABLE GRAVEL AND CLAY CONTENT (TILL TEXTURE)
39.3 – 44.5	725.7 – 720.5	BEDROCK DOLOMITE
44.5	720.5	BOTTOM OF BOREHOLE

FIELD TESTS

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



SAMPLING

Penetration Resistance (blows per foot)	Sample Number	Condition	Depth From (feet)	Depth To (feet)	Type	Recovery Length Rec./Dist. Driv.
4	1	Disturbed but representative	4.5	6.0	SS	14"/18"
31	2	Disturbed but representative	9.5	11.0	SS	16"/18"
32	3	Disturbed but representative	14.5	16.0	SS	16"/18"
27	4	Disturbed but representative	18.0	19.5	SS	18"/18"
25	5	Disturbed but representative	23.0	24.5	SS	18"/18"
28	6	Undisturbed	24.5	26.0	ST	17"/18"
37	7	Disturbed but representative	28.0	29.5	SS	18"/18"
62/9"	8	Undisturbed	29.5	30.8	ST	9"/9"
40	9	Disturbed but representative	33.0	34.5	SS	16"/18"
77/10"	10	Undisturbed	34.5	35.4	ST	8"/10"
84/7"	11	Disturbed but representative	38.0	39.1	SS	12"/13"
	12	Undisturbed	39.3	44.5	DB	60"/62"

LABORATORY TESTS

DRY UNIT WEIGHT PCF □ γ 110 120
ATTERBERG LIMITS WP X —— ● —— O WL 10 WN 20

REMARKS

TRACE OF ORGANIC TO 7.0

COLOUR CHANGE AT 11.5

OCCASIONAL BROWN-RED THIN CLAYEY SEAMS 14.5 – 28.5

ASSOCIATED GEOTECHNICAL SERVICES Limited

OFFICE BOREHOLE LOG

BOREHOLE NO. 10

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
JOB NO. 6449 LOCATION: GOLFLINKS RD. & HWY 403
CO-ORDINATES: 177+56 110' RT (REF. HWY 403)
ELEVATION (SURFACE) 760.5 (COLLAR) DATUM
DATE (STARTED) 18/11/64 (FINISHED) 20/11/64 (COMPILE.) REM
RIG. NO. 2 TYPE D.D. FIELD SUP. H.E.K.

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

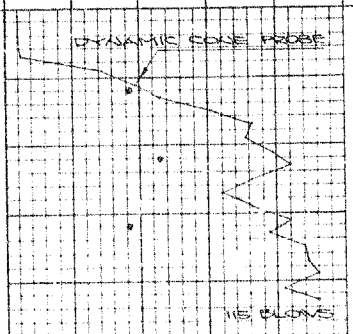
C - CONSOLIDATION TEST
M - MECHANICAL ANALYSIS
T - TRIAXIAL COMPRESSION
K - PERMEABILITY
U - UNCONFINED COMP.
PCF - POUNDS PER CUBIC FOOT
WN - NATURAL WATER CONTENT

BORING LOG

DEPTH FEET	ELEV. FEET	WATER OBSERVATION	DESCRIPTION
2.3	758.2	▼	
			DENSE BROWN TO GREY SILT, WITH LENSES CONTAINING VARIABLE AMOUNT SAND OR CLAY
23.8	736.7		DENSE TO VERY DENSE GREY SILT, VARIABLE GRAVEL AND CLAY CONTENT (TILL TEXTURE)
34.6	725.9		BEDROCK (DOLOMITE)
39.6	720.9		BOTTOM OF BOREHOLE

FIELD TESTS

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



SAMPLING

PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	CONDITION	DEPTH FROM FEET	DEPTH TO FEET	TYPE	RECOVERY LENGTH REC. / DIST. DRIV.
37	1	Disturbed but representative	5.0	6.5	SS	15/18
46	2	Disturbed but representative	10.0	11.5	SS	10/18
37	3	Disturbed but representative	15.0	16.5	SS	14/18
42	4	Undisturbed	20.0	22.0	ST	15.5"/24"
37	5	Disturbed but representative	25.0	26.5	SS	15/18
58	6	Undisturbed	30.0	31.0	ST	10.5/12
58	7	Disturbed but representative	31.0	32.5	SS	12/18
	8	Undisturbed	34.6	39.6	DB	59.6"/60"

LABORATORY TESTS

UNIT WEIGHT PCF
ATTERBERG LIMITS: WP X — ● WN — O WL

REMARKS

TRACE OF ORGANIC TO 7.0

COLOUR CHANGE AT 10.4

OCCASIONAL BROWN-RED THIN CLAYEY SEAMS 13.0 TO 23.8

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

Silt (predominant type) with (25% - 40%) sand, some (10% - 25%) gravel, trace (< 10%) clay.

STANDARD PENETRATION CLASSIFICATION

Relative Density of Sands as determined by Standard Penetration Tests		
No. of Blows/foot N	Relative Density 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		
No. of Blows/foot N	Shear Strength 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

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Eng.
Room 107, Lab. Bldg.

From: Bridge Division,
Downsview, Ontario

Date: March 5, 1965.

Our File Ref.

In reply to

Subject: Golflinks Road Underpass,
Hwy. #403, W.P. 200-58
District #4

Enclosed please find one (1) print of our preliminary plan D 5572 for the proposed structure.

The design utilizes 12 BP steel "H" piles and is based on the recommendation found in the Foundation Report done by Associated Geotechnical Services Limited.

Would you please inform us if you have any comments or let us have your approval if the plan is satisfactory.

W. S. Melinyshyn

W.S. Melinyshyn,
Regional Bridge Location Engineer

WSM/m

cc: Foundations Office (Rm. 110)

Mr. W. S. Melinyshyn,
Regional Bridge Location Engr.,
Bridge Division.

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

March 9, 1965

Golflinks Road Underpass,
Hwy. #403, W.P. 200-58,
District #4.

With reference to the Preliminary Drawing No. D 5572 for the above-mentioned structure, we would like to comment that it is not indicated how far the piles should be driven. If H-piles driven to rock are contemplated, we would have nothing to add.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF

cc: Foundations Office
Gen. Files

cc: Foundations Office (Rm. 110)

Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attention: Mr. A. McCombie

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

January 5, 1965

FOUNDATION INVESTIGATION REPORT BY:
Associated Geotechnical Services Ltd.
Golflinks Road Underpass, Hwy. #403,
District #4, Hamilton. -- W.P. 200-58.

Attached, please find the above-mentioned report submitted by the Consultant, Associated Geotechnical Services Ltd. of Toronto.

We have reviewed the report and have found the factual information well presented and adequate. It is believed that the recommendations contained in the report will be adequate for your further design work. In our opinion, both alternatives - i.e., spread footings or end-bearing piles, are applicable. Consideration should also be given to driving steel sheet piles around the footing excavation as a ground water control measure.

If a continuous type of structure is considered, we feel that end-bearing piles would provide a technically better solution. For spread footings with loads of 2.0 - 2.5 T/sq.ft., we feel that differential settlements will definitely be within tolerable limits.

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

AGStermac

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/McF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
M. D. McMillan
G. A. Hunter (2)
W. Greenland
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

ASSOCIATED GEOTECHNICAL SERVICES LIMITED

CONSULTING ENGINEERS

YOUR REF.

OUR REF.

211 DAVENPORT ROAD
TORONTO 5, ONTARIO
927-3822

December 31st, 1964.

Department of Highways of Ontario,
Highway 401 & Keele Street,
Downsview,
Ontario.

Attention: Mr. M.A. Rutka, P. Eng.
Materials & Research Engineer

Dear Sir,

Re: Golflinks Road Underpass
W.P. 200-58, Hwy #403
District #4, Hamilton.

We have forwarded to you under separate cover, 10 copies of our soils report for the Golflinks Road Underpass and one extra copy of each soil cross section. This information was given directly to Mr. K.Y. Lo.

It should be noted that the report discusses both piled and spread foundations as alternative means of bridge support. Both are feasible and the decision to use either alternative is largely one of economics. There is, however, a possible large variation of time and cost for the required ground water lowering and subsurface soil recompaction associated with the spread footing alternative. Accordingly the piled foundation alternative, in our opinion, is more attractive than spread footings unless there is an obvious and significant saving in cost.

We trust that the information transferred to you is adequate for your purposes. We also look forward to a continuing relationship.

Yours very truly,

ASSOCIATED GEOTECHNICAL SERVICES LIMITED

R. Marttila

R. Marttila

RM:eam

Materials & Testing Division   Hwy. 401 & Keele St.,
Downsview, Ontario.
November 4, 1964.

Associated Geotechnical Services, Ltd.,
211 Davenport Road,
Toronto 5, Ontario.

Attention: Mr. J. Kilgour

Re: Golflinks Road Underpass, W.P. 200-58,
Hwy 401, District #4, Hamilton.

Dear Sir:

Please consider this your authority to carry out a foundation investigation at the above site. Plans and profiles were provided to your representative on November 3, 1964.

It is understood that a qualified Soils Engineer will be in charge of the field work at all times.

Ten copies of the completed foundation report, with one additional copy of each subsoil profile, should be submitted to the Foundation Section prior to December 23, 1964. Previous requirements as to preliminary borehole information, and Laboratory testing program, should be followed.

Because the drawings accompanying the foundation reports, showing the location of borings, the inferred subsoil conditions, etc., are to become contract drawings, you are requested to prepare them in accordance with the D.H.O. standards. To enable you to do this, we are supplying you with sample drawings with all the necessary explanations, together with linen sheets for your drawings. You are also requested to provide the D.H.O. with Cronaflex copies of the drawings.

Charges for the work performed will be in accordance with your Schedule of Rates, dated July 19, 1962, and invoice to be addressed to the attention of the undersigned.

Yours very truly,

A. Rutka

A. Rutka
Materials & Testing Engineer

SMS/PB
cc: Messrs. A. McCauble
G. Hunter
R. Greenland
T.J. Kovich
Found. Office R.D. Smith (2)
Gen. Files. Mrs. P. Hale

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Bldg.

From: Bridge Division,
Downsview, Ontario.

Date: September 28, 1964.

Our File Ref.

In reply to

Subject: Golflinks Road Underpass
Highway 403, W.P. 200-58
District #4

Enclosed please find a print of Plan E 3894-1 with the probable locations of the revised structure footings marked in red.

The bridge previously designed was supported on 12 BP 53 piles driven to bedrock with a design load capacity of 50 tons per pile.

Would you kindly advise us if the recommendations of the original report W.J. 60-F-56 are applicable to the new design. If this report is satisfactory would you please give us the probable bedrock elevations at the new footings locations in order to determine the pile lengths required.

If it is felt that additional holes are necessary, these can be possibly done in early November. At this time new site plans will be available for the Mohawk Interchange (in the immediate area of Golflinks Road) where a foundation investigation will be required.

W. S. Melinyshyn

WSM/es

W. S. Melinyshyn,
Regional Bridge Location Engineer.

cc. R. Fitzgibbon
cc. N. D. Smith

Note:- A foundation investigation will be carried out at the revised structure footing locations. This will be carried out at the time of Mohawk Rd interchange investigation. Informed W S M and agreed

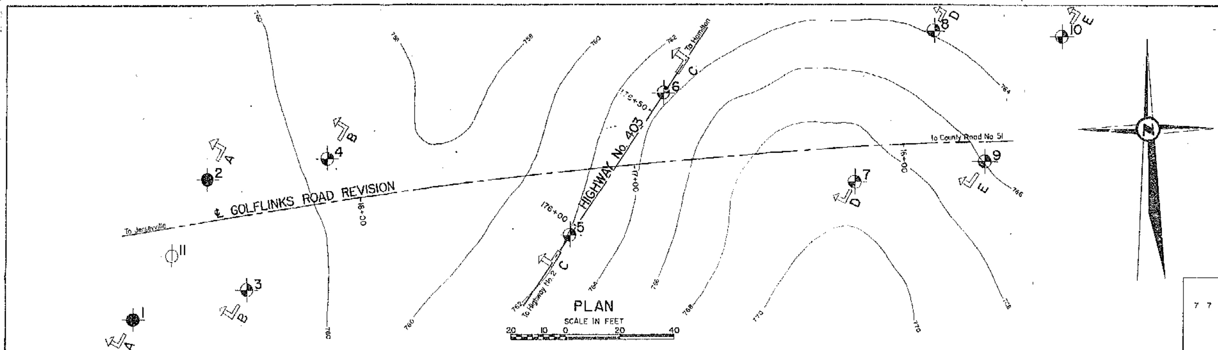
M. Devata
Oct 1/64

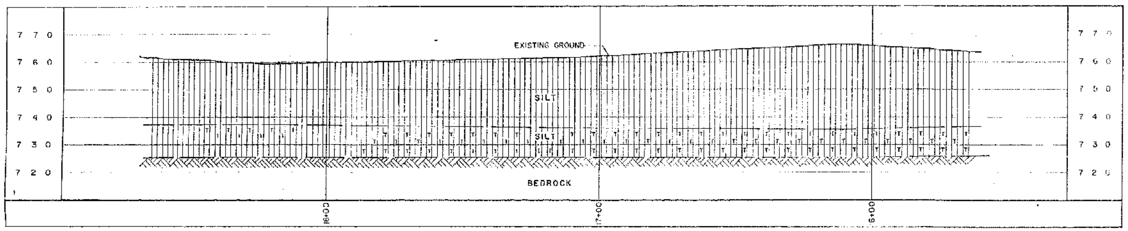
#64-F-201-C

W.P. #200-58

Hwy. #403 &

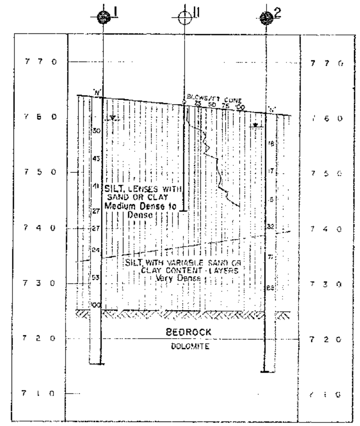
GOLFLINKS RD.





℄ PROFILE GOLFLINKS ROAD

SCALE IN FEET



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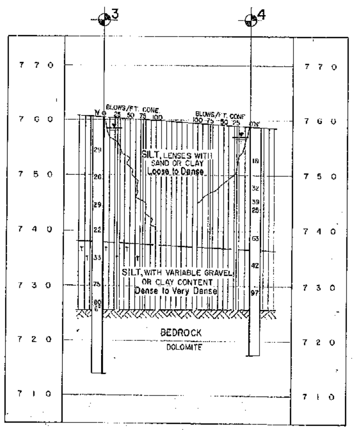

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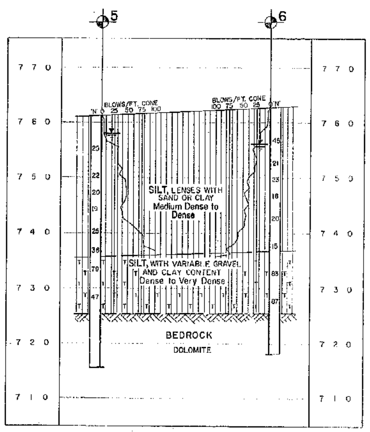
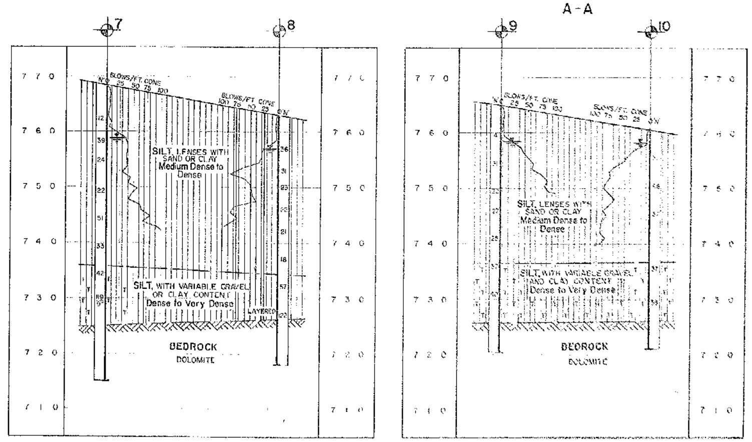


C-C

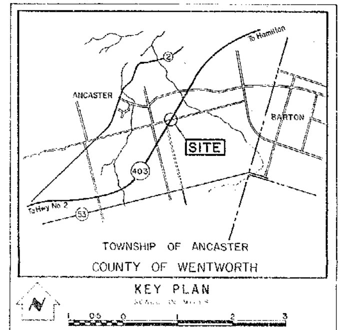


D-D

E-E

SECTIONS

SCALE IN FEET



TOWNSHIP OF ANCASTER

COUNTY OF WENTWORTH

KEY PLAN

SCALE IN MILES

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

NO.	ELEVATION	STATION	OFFSET
1	763.6	174+80	115'LT
2	760.9	175+39	123'LT
3	760.6	175+14	88'LT
4	756.8	175+70	90'LT
5	761.3	175+96	℄
6	762.8	176+58	℄
7	768.3	176+70	77'RT
8	763.1	177+32	70'RT
9	765.0	177+02	112'RT
10	760.5	177+56	110'RT
11	762.3	175+09	120'LT

- 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.

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

GOLFLINKS ROAD UNDERPASS

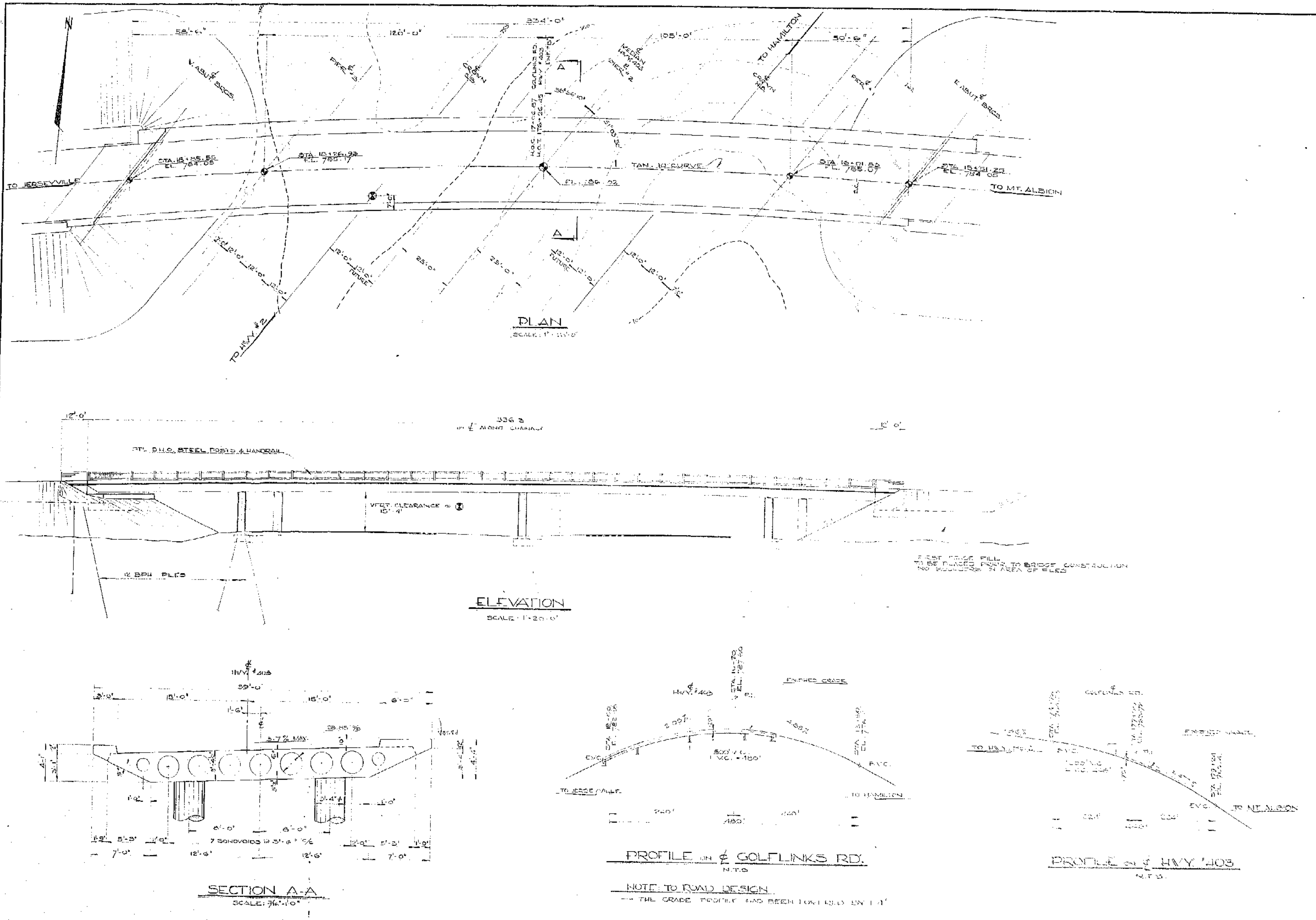
KING'S HIGHWAY NO 403 DIST NO. 4

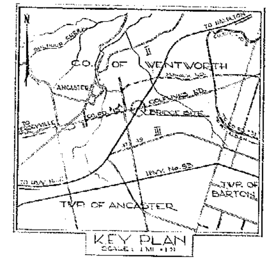
CO. WENTWORTH

TWP. ANCASTER LOT 49 CON. II

BRIDGE SITE

SURVEYED	CHECKED	W.P. NO. 200-58	M.&R. DRAWING NO.
DRAWN H.E.K.	CHECKED R.E.M.	JOB NO	
DATE DECEMBER 1964		SITE NO	BRIDGE DRAWING NO
APPROVED		CONT NO.	





PRINT RECORD

No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

GOLFLINKS RD. UNDERPASS
3.0 MI. EAST OF HIGHWAY #2

KING'S HIGHWAY No. 403 — DIST. No. 4
CO. WENTWORTH
TWP. ANCASTER — LOT 49 — CON. II

PRELIMINARY PLAN

APPROVED .... BRIDGE ENGINEER				SITE No. 36-97	W.P. No. 200-58
DESIGN	C.S.	CHECK		CONTRACT Nos.	
DRAWING	W.V.	CHECK	C.S.	DRAWING No.	D-5572-PI
DATE	FEB.1965	LOADING	H20/S16		