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GEOCRES No. 40 P15-21

W.P. No. _____

CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. _____

LOCATION BRIDGE, CONS. 6-7
MINTO TWP., WELLINGTON CO.

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

NONE

REMARKS: _____

GEOTECHNIQUE



40P15-21

BA 1306

10826

REPORT

on

FOUNDATION INVESTIGATION

for

BRIDGE

CONCESSIONS 6 - 7

TOWNSHIP OF MINTO

COUNTY OF WELLINGTON

ONTARIO

FM 24157

Report N° T. 462/60

100 University Avenue,
Toronto 1, Ontario.

REPORT

on

FOUNDATION INVESTIGATION

for

BRIDGECONCESSIONS 6 - 7TOWNSHIP OF MINTOCOUNTY OF WELLINGTONONTARIOINTRODUCTION

The Township of Minto, whose Road Superintendent is Mr. Chester Shannon, is proposing to construct a new bridge to replace the old structure that at present spans Harriston Brook about 4 miles west of Harriston, to designs being prepared by Mr. B. M. Ross, Consulting Engineer of Goderich, Ontario.

To determine the subsurface conditions for purposes of foundation design, the Consulting Engineer requested Universal GEOTECHNIQUE Limited to proceed with an investigation at the bridge site in accordance with the requirements of the project, and this Report contains the results of the subsurface exploration together with information relative to foundation design and construction.

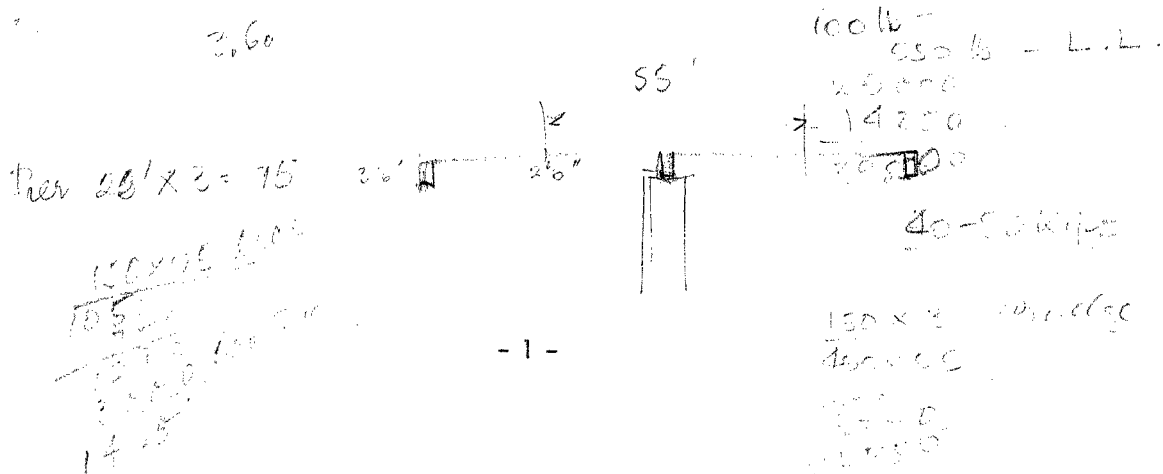
AVAILABLE INFORMATION

The existing structure is a single-span steel through truss bridge with a timber deck, the overall length of the bridge being about 66 feet.

The design for the new bridge contemplates a reinforced concrete structure having two 55 foot spans with the west abutment located 5 feet west of the west abutment of the existing bridge: The east abutment of the new bridge is to be located approximately 38 feet east of the east abutment of the existing structure.

THE SITE

The new bridge is to be located on the same centreline as the existing structure but it will have a greater overall length. The location of the site is on Lot 35, Concessions 6-7, in the Township of Minto.



SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 22nd to the 28th of November, 1960, and comprised 3 exploratory boreholes located in positions as shown on drawing N° 2.

The locations of the boreholes were staked and the ground surface elevations adjacent to the boreholes obtained by the Staff of GEOTECHNIQUE, all elevations being referred to the elevation of the bridge floor at the centreline of the stream which is understood to be 52.85.

During the operation of soil boring, soil samples were obtained generally at intervals of 2-1/2 feet to a depth of 15 feet and thereafter at intervals of about 5 feet. Where noticeable changes of strata occurred the depths of such changes were recorded.

The state of compaction of essentially cohesionless strata and the general consistency of cohesive strata was determined by the standard penetration test taken during the operation of soil sampling. (The standard penetration test, as referred to in this Report, involves the recording of the number of blows (N) of a 140 lb. hammer falling 30 inches that are required to drive a 2 inch diameter split barrel sampler 1 foot into the soil at the bottom of the borehole).

Visual examination and classification of all soil samples was carried out in the laboratory and certain samples were subjected to additional examination and testing. The descriptions of the strata obtained from the foregoing examination together with the results of the standard penetration tests are given on the borehole logs included with this Report.

In boreholes BH.2 & 3, diamond core drilling was carried out to prove the composition of dense strata which gave refusal conditions for normal soil boring.

Subsurface conditions given in this Report are those indicated by material encountered in the boreholes. The accuracy of extrapolation to obtain the soil profile should be associated directly with the geological conditions and inversely with the spacing of the boreholes.

GEOLOGICAL FEATURES

The site is located on the south-east margin of the Teeswater Drumlin Field, a low drumlin being situated just west of the site. To the east of the site there exists a flat bottomed valley of a glacial spillway.

Although the topography of the site is comparatively well defined, the nature of the deposits encountered during the exploration tends to be more complex.

The fluvial deposits which cover the explored area consist partly of alluvial material laid down by the waters of Harriston Brook, and partly of glaciofluvial sands and gravels. Underlying the fluvial mantle are clays and silts which are believed to be of lacustrine origin, the depositional features being blurred by the presence of intervening till-like material at different horizons. Below the silts and clays there exists sands, gravels and boulders of what is probably an older till. With depth this till contains progressively higher percentages of large boulders of local origin making its separation from the underlying bedrock hazardous and difficult.

From the information obtained from the exploratory boreholes it may be concluded that the strata down to the explored depths can be classified as follows:

TOP SOIL

About 2 feet of brown loam containing organic matter is present in borehole BH.1.

FLUVIAL DEPOSITS

Beneath the topsoil in borehole BH.1 and from the ground surface in BH.2 & 3 there exists generally firm sands and gravels often containing organic matter in the upper part of the stratum. The thickness of these deposits range from 6 feet to 8-1/2 feet in the boreholes.

LACUSTRINE DEPOSITS

Under this classification are included the stiff to very stiff brown silty clays containing lenses or partings of silt and sometimes a variable amount of generally fine gravel. At certain horizons these clays and silts present an interbedded appearance. The thickness of these deposits vary from 22' in borehole BH.2 to nearly 19' in borehole BH.3.

SANDS, GRAVELS & BOULDERS

Firm to dense sands, gravels & boulders underlie the lacustrine deposits and all boreholes were terminated in these materials.

GROUND WATER

Water under artesian pressure was encountered in the sands, gravels & boulders existing beneath the lacustrine deposits.

LABORATORY TESTS

In addition to visual examination of all soil samples and cores from drilling, certain of the samples were subjected to additional tests for index properties and these are given in Table N° 1. Unconfined compression tests were carried out on samples obtained with shelly tubes and a summary of these results are as follows:

Borehole N°	Sample N°	Depth Below Ground Surface	Unconfined Compression Strength lbs./sq.ft.	Sensitivity
BH.2	T.1	12'-5" to 12'-11"	4,400 1,700 (remould)	2.6
		12'-11" to 13'-5"	5,800	
	T.2	18'-11" to 19'-5"	2,200 1,500 (remould)	1.5
		19'-5" to 19'-11"	3,000 1,800 (remould)	

Note: All samples from 2" diameter shelly tubes

DISCUSSION

The results of the subsurface exploration disclose that beneath a limited thickness of fluvial deposits the site is underlain by a rather complex arrangement of clays and silts which have been classified as lacustrine deposits. As will be seen from the geological section on drawing N° 3, the thickness of the clays and silts is approximately 20 feet and as mentioned earlier in this Report the depositional features of these deposits are complicated by the presence of till-like material at different horizons.

Considering first of all the possibility of adopting spread footings for the foundations to the new bridge, it will be apparent that the highest elevation at which such footings would be located is approximately elevation 30 and support would therefore be derived directly from the material classified as lacustrine deposits. Whilst the material near the upper surface of these lacustrine deposits is relatively stiff due partly to dessication, there is a marked deterioration in strength below elevation 30 especially in boreholes BH. 1 and 2. Another feature which merits consideration is the much lower strength of these deposits in boreholes BH. 1 and 2 compared with the material encountered in BH. 3.

In considering the use of spread footings, attention is focused on the somewhat complex features of the deposits which have been classified as lacustrine. From the results of the exploration and the laboratory tests, it is clear that these deposits have been subjected to precompression and this fact together with the presence of till-like material would suggest that the site may be on part of a drumlin composed of a mixture of till and stratified materials which have been overridden by an ice sheet. Under such conditions somewhat erratic variations in the composition and strength of the material is not unlikely.

Based on the results of the investigation it would not be justifiable to adopt a safe bearing capacity of more than 2.0 tons/sq. ft. for the design of spread footings at elevation 30, and under such loading the long term settlement may amount to 2 or 3 inches for a footing 15 feet in width. It is presumed that the central pier of a modern bridge having two 55 foot spans would impose a loading of possibly 30 tons per lineal foot on the foundation, whereas the existing bridge is of a much lighter construction.

From the foregoing review it is apparent that if spread footings are to be adopted, the possibility of differential settlement must be considered with respect to any continuous or rigid frame structure.

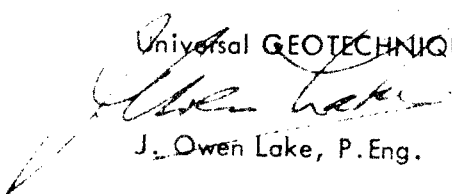
If it is desired to adopt a continuous or rigid frame structure which cannot accommodate the anticipated long term settlement to be associated with spread footings, then pile foundations could be adopted. Theoretically timber piles driven to a very slight penetration of the sand, gravel and boulder stratum would support a working load of 20 tons per pile mainly by friction in the overlying strata. However, it is to be observed that artesian pressure was encountered in the sand, gravel and boulder stratum and for this reason it would be expedient to ignore the friction in the overlying materials and rely entirely on the resistance which can be obtained in end bearing. Under such conditions there is however a practical difficulty insofar as timber piles may easily be over-driven and damaged in the sand, gravel and boulders and consequently steel tube piles driven closed-ended and subsequently filled with concrete would be a more appropriate choice. Steel tube piles 12 inches in diameter and driven to obtain the required resistance in the sands and gravels could easily be designed to sustain a working load of 50 tons per pile.

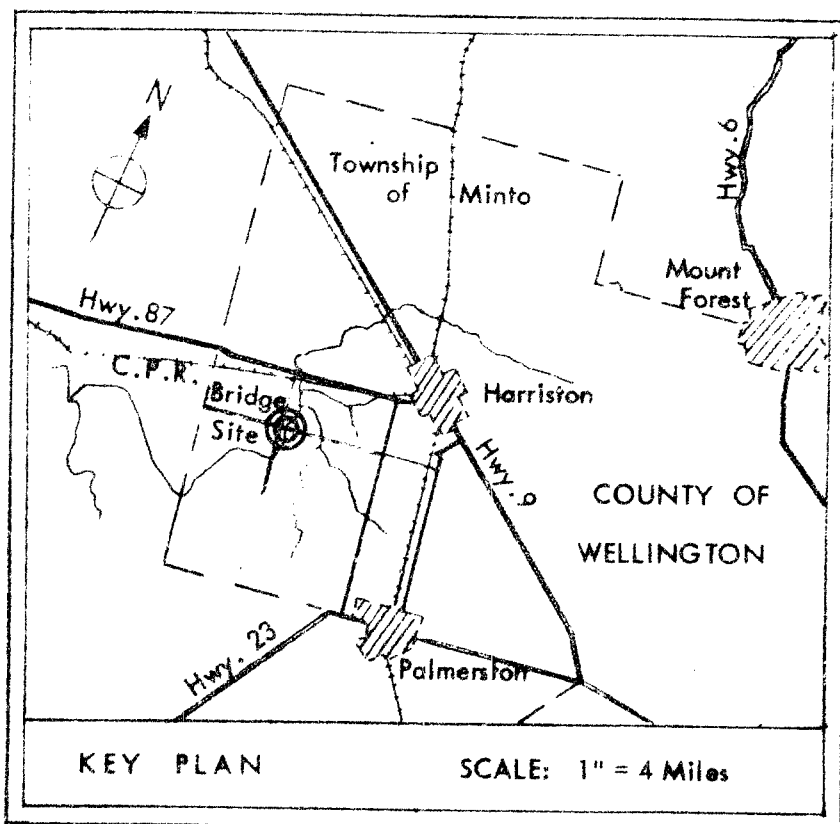
CONCLUSIONS

From the results of the subsurface exploration and the subsequent study it is possible to state the following conclusions:

1. The site is underlain by a limited depth of fluvial deposits resting on about 20 feet of materials classified as lacustrine on the geological section but containing complex features which when associated with other factors suggest that these materials have been overridden by an ice sheet and are not entirely lacustrine.
2. If considerations of scour allow normal spread footings to be located at elevation 30 the allowable bearing capacity for the design of such footings should not exceed 2.0 tons/sq.ft. and the possible effects of long term settlement amounting to 2 or 3 inches should be considered. In effect this may mean that if spread footings are adopted it would be expedient to consider a simply supported structure. The foregoing opinions are based on the assumption that a modern bridge having two 55 foot spans would impose a load of about 30 tons per lineal foot on the central pier. Such a loading is considerably in excess of the load imposed on the foundations of the existing bridge and it is therefore quite conceivable that settlement of the existing structure has not been a problem.
3. If it is desired to adopt a continuous or rigid frame type of structure for the new bridge, it may be necessary to consider the use of pile foundations. Such piles should preferably be of steel so as to obtain adequate driving resistance in the underlying sands, gravels and boulders and 12" diameter tubes could easily be designed for a working load of 50 tons per pile. Variations in the driving resistance and depth of penetration within the sand and gravel stratum is to be expected but penetration beyond elevation zero would be unlikely.
4. Artesian pressure was encountered in the sands and gravels and for this and other reasons timber piles should not be used.

Universal GEOTECHNIQUE Limited,

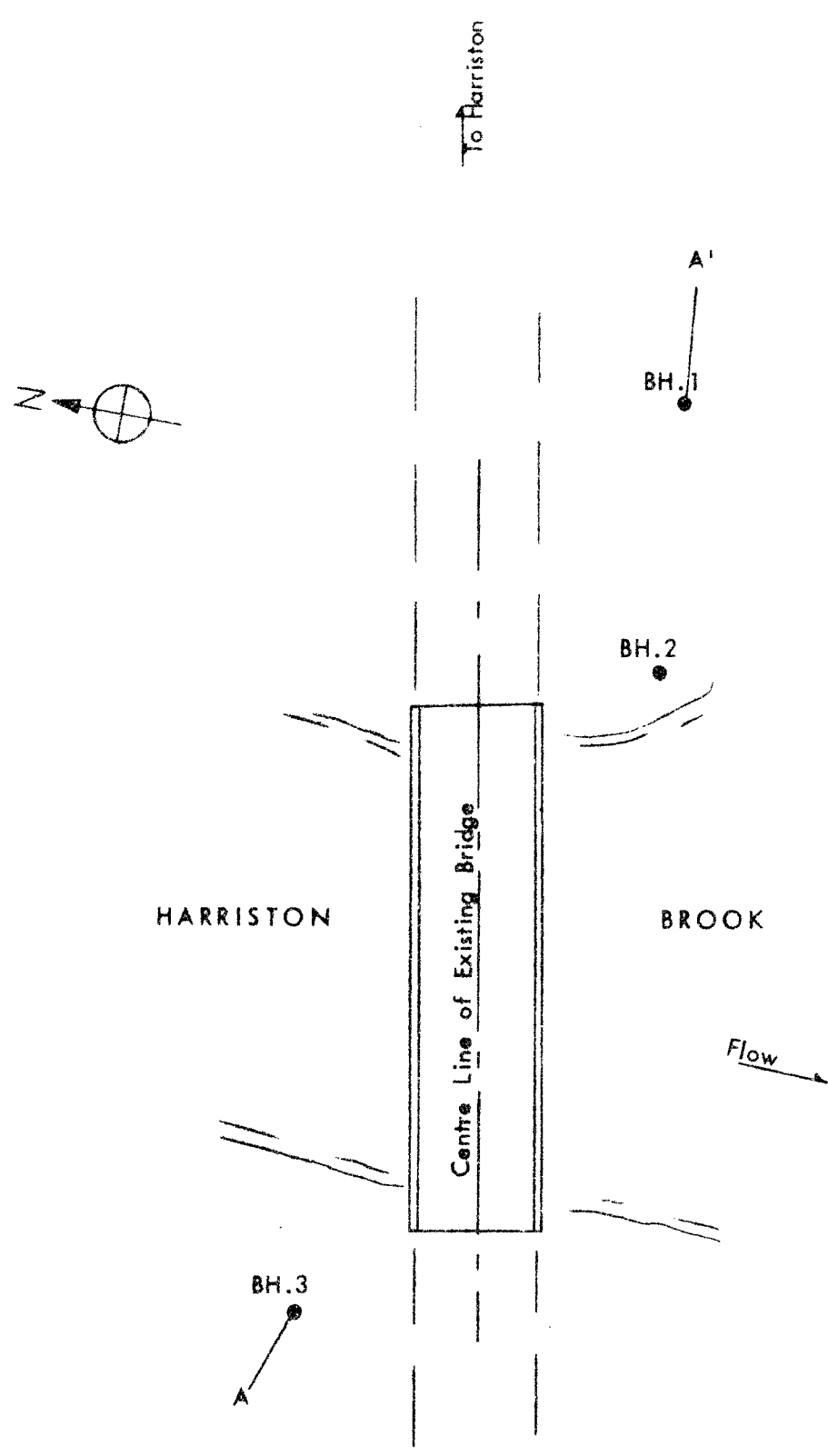

J. Owen Lake, P. Eng.



PROJECT Bridge, Concessions VI & VII, Lot 35,
 TITLE Key Plan Twp. of Minto
 DRG. NO. I ORDER NO. I.462/60



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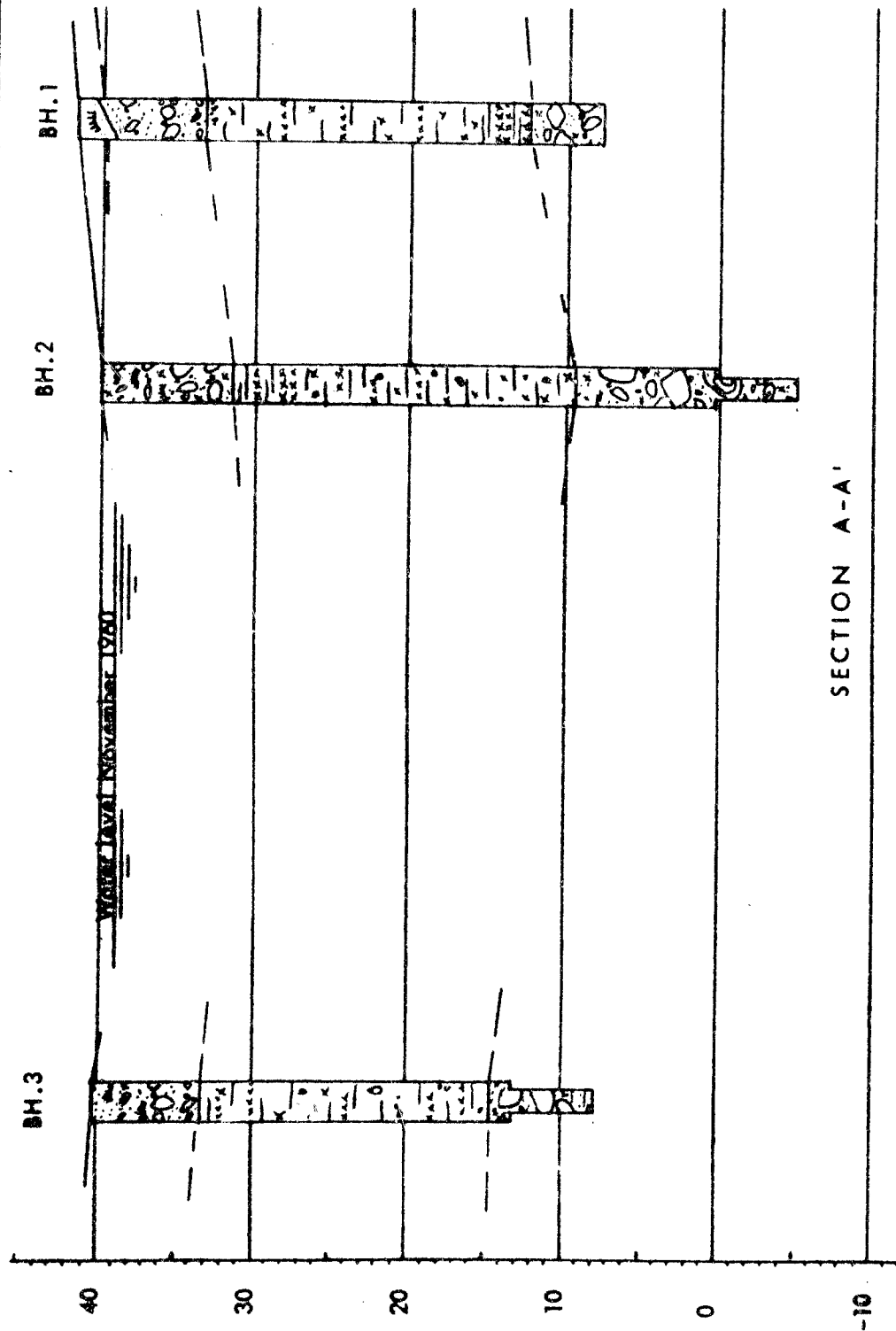


SCALE: 1" = 20'-0"

PROJECT	Bridge, Concessions VI & VII, Lot 35,
TITLE	Borehole Location Plan
DRG. NO.	2
ORDER NO.	T.462/60



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SCALE: Horizontal 1" = 20'-0"
Vertical 1" = 10'-0"

LEGEND

- | | | | |
|--|------------------|--|-------------------------|
| | TOP SOIL | | LACUSTRINE DEPOSITS |
| | FLUVIAL DEPOSITS | | SAND, GRAVEL & BOULDERS |

PROJECT Bridge, Concessions VI & VII, Lot 35,
TITLE Geological Section Twp. of Minto
DRG. NO. 3 ORDER NO. T.462/60



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SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Bridge, Concessions VI & VII, Lot 35, Twp. of Minto, Ontario ORDER NO. T.462/60CLIENT Mr. B. M. Ross, Consulting Engineer, Goderich, Ontario (Twp. of Minto)BOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING —

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Loose dark brown loam with gravel and organic matter.	41.7			Zero			
Firm light brown silty fine to coarse SAND with fine to medium gravel.	40		• 1			8	Damp.
			• 2			20	Moist.
Firm brown silty fine to coarse SAND and fine to coarse GRAVEL, subangular to rounded.			• 3	4'-6"		23	Low to medium dry strength.
do			• 4			21	Wet.
Stiff brown silty CLAY.			• 5	8'-3"		38	No dry strength.
Very stiff brown silty CLAY, some small sand and gravel lenses.			• 6			38	do
	30						Wet.
Stiff brown silty CLAY.			• 7			12	Moist. High dry strength
			• 8			18	Damp. High dry strength
Stiff brown very silty CLAY with silt partings.			• 9			19	
do							
	20						
Stiff brown silty CLAY, some fine gravel and occasional thin parting of silt.			• 10			24	do
Stiff to very stiff brown silty CLAY with silt partings.			• 11			24	do
			• 12			28	
Stiff darkish brown CLAYS interbedded with firm SILTS.			• 13	29'-3"		59	Damp. Clay: High dry strength. Silt: Medium dry strength.
Dense brownish grey silty SAND with high percentage of fine to coarse gravel.	10		• 14			100(11")	Moist. Medium dry strength.
do				33'-11"			Water under artesian pressure.
				End of Borehole			do

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Bridge, Concessions VI & VII, Lot 35, Twp. of Minto, Ontario ORDER NO. T.462/60CLIENT Mr. B. M. Ross, Consulting Engineer, Goderich, Ontario (Twp. of Minto)BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING —

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Firm grey brown silty sand, gravel and some organic concentrations.	40		• 1	Zero		14	Damp. Low to medium dry strength.
do			• 2			18	Moist. Low to medium dry strength.
Firm light brown silty fine to coarse SAND and fine to coarse GRAVEL, subangular to rounded.			• 3			38	Wet. High N due to gravel.
Stiff brown silty CLAY, occasional fine gravel.	30		• 4	8'-6"		37	Moist. High dry strength.
Hard brown dessicated silty CLAY. Stiff to very stiff brown very silty CLAY with silt lenses.			• 5			22	Damp. Clay: High dry strength. Silt: Medium dry strength
Stiff brown silty CLAY interbedded with firm brown SILT.			• 6			13	do
Stiff brown silty CLAY with silt lenses, occasional fine gravel.			• 7			15	do
do	20		T2				
Stiff brown silty CLAY with fine gravel, tendency to lamination.			• 8			22	Damp. High dry strength.
do			• 9			18	do
do	10		• 10	30'-6"		18	Moist: Medium dry strength. Water under artesian pressure rises to el. 46.0
Firm brownish grey somewhat clayey silty SAND and fine to coarse GRAVEL, some boulders.			• 11			30	No recovery.
			• 12			30	No recovery.
Dense light grey sand, gravel and boulders, some iron staining.	0		• 13	39'-10"		130 (10")	39'-10" to 45'-0" 15% recovery.
Buff limestone, grey chert and sand. Probably sand, gravel & boulders.				45'-0"			End of Borehole

SCALE: 1" = 5'-0"

• DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Bridge, Concessions V1 & V11, Lot 35, Twp. of Minto, Ontario ORDER NO. T.462/60CLIENT Mr. B. M. Ross, Consulting Engineer, Goderich, Ontario (Twp. of Minto)BOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Plan INCLINATION Vertical BEARING

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Firm brown somewhat clayey silty SAND with gravel and dark organic concentrations.	40.2		• 1	Zero		13	Moist. Medium dry strength.
Firm light brown silty SAND and fine to coarse GRAVEL, subangular to subrounded.			• 2			23	Wet. Low dry strength.
do			• 3			34	No recovery.
Very stiff brown very silty CLAY with lenses of silt.				7'-0"			
	30		• 4			24	Damp. Clay: High dry strength.
Very stiff brown silty CLAY, some fine gravel.			• 5			27	Silt: Damp. High dry strength.
do							
with silt lenses.			• 6			27	do
Very stiff brown sandy very silty CLAY with fine to medium gravel.			• 7			33	
Very stiff very silty CLAY with lenses of silt, some fine gravel.	20		• 8			28	Damp. Clay: High dry strength. Silt: Medium dry strength.
do							
Dense brown clayey silty SAND with fine to coarse subangular to subrounded gravel.			• 9	25'-8"		40	Moist. Medium dry strength.
				26'-10"			26'-10" to 28'-0" No recovery.
Light buff limestone and fine sand, probably limestone, gravel & boulders.	10						28'-0" to 31'-6" recovery 60%.
do			• 10	32'-6"		64	
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY INDEX PROPERTIES


FORM G-8 800-6-84
UNITED STATES OF AMERICA

REPORT NO. T.462/60 TABLE NO. 1 SHEET NO. 1

BORE-HOLE NO.	SAMPLE NO.	DEPTH		NATURAL DENSITY LB/FT ³	NATURAL MOISTURE CONTENT %	LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	TYPE OF SAMPLE U - UNDISTURBED D - DISTURBED
		FROM	TO						
BH.2	4	8'-6"	9'-6"		21.8				2" S.B.
	5	10'-0"	11'-0"		20.0				"
	T1	12'-5"	12'-11"	122	22.7	37	18	19	2" Shelby
		12'-11"	13'-5"	122	22.1				
	6	14'-0"	15'-0"		26.3				2" S.B.
	7	16'-0"	17'-0"		23.5				"
	T2	18'-11"	19'-5"	125	22.8				2" Shelby
		19'-5"	19'-11"	125	22.4	35	19	16	"
	8	22'-0"	23'-0"		19.2				2" S.B.
	9	24'-0"	25'-0"		18.7				"
BH.2	6	pH = 6.5							
	10	pH = 6.0							
BH.3	5	11'-0"	12'-0"		20.4				
	6	14'-0"	15'-0"		18.4				
	7	15'-0"	16'-0"		14.8				
	8	19'-0"	20'-0"		17.5				

PROJECT Bridge, Concessions VI & VII, Lot 35
TITLE Laboratory Tests

Twp. of Minto
ORDER NO. T.462/60



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