

GEOCRES No. 40P12-7DIST. 3 REGION W.P. No. CONT. No. W. O. No. 73-11202 MSTR. SITE No. HWY. No. LOCLOCATION BAYFIELD RIVER @ GODERICH & STANLEY TWP BOUNDARYLOTS 40 & 41 BAYFIELD CONCESSION OF GODERICH TWP.LOTS 31 & 32 CON 4 OF STANLEY TWP.No of PAGES - OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

40 P12-7

GEOCRES No.

- 73-F-202M -

DOMINION SOIL INVESTIGATION LIMITED

CONSULTING ENGINEERS

TORONTO

KITCHENER

LONDON

WINDSOR

THUNDER BAY

STRUCTURE SITE No. 12-192



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40P12-7
GEOCRES No:

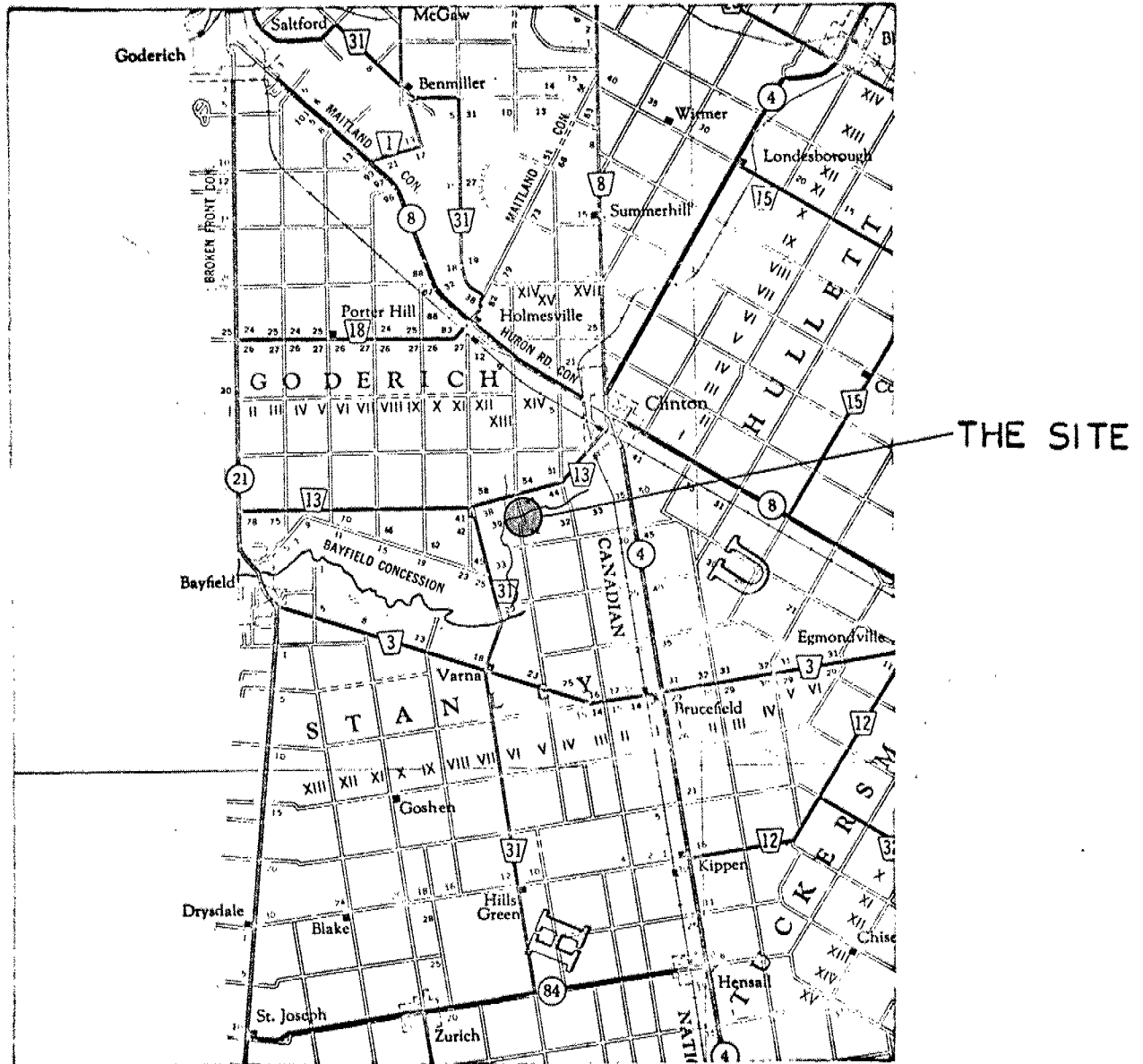
Report On *DIST. 3*
SOIL INVESTIGATION
for
PROPOSED BRIDGE
BAYFIELD RIVER
GODERICH & STANLEY TOWNSHIP BOUNDARY

by

Dominion Soil Investigation Limited
1220 Trafalgar Street
London Ontario

Ref: 73-2-L2

February 28, 1973



KEY PLAN



C O N T E N T S

	<u>PAGE</u>
I INTRODUCTION	I & II
II FIELD WORK	II & III
III SUBSURFACE CONDITIONS.	III, IV & V
IV GROUNDWATER CONDITIONS	V
V DISCUSSION AND RECOMMENDATIONS	V, VI, VII & VIII

APPENDIX 'A' - The Standard Penetration Test

E N C L O S U R E S

	<u>NO.</u>
SYMBOLS ABBREVIATIONS AND NOMENCLATURE	1
LOCATIONS OF BOREHOLES	2
SUBSURFACE PROFILE	3
BOREHOLE LOGS	4 & 5
GRAIN SIZE DISTRIBUTION CURVES	6
UNIFIED SOIL CLASSIFICATION PLASTICITY CHART . .	7



73-2-L2

I

INTRODUCTION

In accordance with a letter of authorization dated February 7, 1973, from B. M. Ross & Associates Limited, Consulting Engineers, a soil investigation has been carried out on the Stanley-Goderich Township boundary, where it is proposed to construct a new bridge.

The existing structure is located on the north-south sideroad between Lots 40 and 41, Bayfield Concession of Goderich Township, and Lots 31 and 32, Concession 4 of Stanley Township. The sideroad crosses the Bayfield River which forms the townline at this point.

The existing structure is a 112 foot span steel truss bridge, and it is understood that the new bridge will be constructed about 180 feet downstream from the existing bridge to allow for realignment of the road. The requirements of the project were discussed with Mr. K. G. Dunn, P.Eng., who supplied the foregoing information.



The purpose of the investigation was to reveal the sub-surface conditions at the site and to determine the relevant soil properties for the design and construction of the new foundations.

II

FIELD WORK

The field work, consisting of two boreholes, was carried out on February 15 and 16, 1973, at the locations shown on Enclosure 2. The holes were advanced to the sampling depths by a self-propelled continuous flight auger machine, which was equipped with hollow-stem augers.

Standard penetration tests were performed at frequent intervals of depth, as detailed in Appendix 'A', and the results are recorded on the borehole logs as 'N' values. The split-spoon samples were stored in air-tight containers and transferred to our London laboratory for classification and testing.

A dynamic cone penetration test was attempted adjacent to borehole 1 location, however due to the very dense nature of the subsoil it was only possible to penetrate to a depth of 4 feet.

The field work was supervised by a soils engineer, who also determined the ground surface elevations. These were



referred to the low steel of the existing bridge, which was established by the client at El. 817.73 feet.

III

SUBSURFACE CONDITIONS

Detailed descriptions of the strata, which were encountered in each borehole, are given on the borehole logs comprising Enclosures 4 & 5, and a general picture of the soil stratigraphy is presented in the form of a Subsurface Profile on Enclosure 3. The following notes are intended only to amplify this data.

Borehole 1 was put down on the south bank of the river and penetrated a layer of well-graded silt, sand and gravel, which extends to a depth of seven feet. This stratum was followed by successive layers of sandy silt, silty fine sand and silt, which were each about $2\frac{1}{2}$ feet in thickness, and encountered a silty clay stratum at a depth of $14\frac{1}{2}$ feet (El. 795.5). The silty clay stratum extends down to El. 781.5, at which depth refusal to further penetration by augering was observed and diamond drilling revealed a 12 inch diameter boulder. No recovery of subsoil or rock was obtained below the level of the boulder, however the resistance to the coring operation indicated 'very dense' subsoil.



The upper layers of granular materials, which extend to a depth of 14½ feet have a 'very dense' relative density as indicated by 'N' values ranging from 65 to 168 blows per foot, and the consistency of the silty clay stratum is described as 'hard' based on 'N' values ranging from 65 to 168 blows per foot, which were confirmed by an undrained shear strength of 6300 p.s.f.

Borehole 2 was put down in the flood plain area on the north side of the river and revealed a surface layer of silty fine sand overlying a dense silt, sand and gravel stratum, which is similar to the material encountered in borehole 1. The silty clay stratum was encountered at a depth of 5½ feet (El. 803.3) and extends down to El. 781.8. At this location the consistency of the silty clay was also found to be in the 'hard' range as indicated by 'N' values of 91 to 150 blows per foot, which were confirmed by undrained shear strengths of 5800 and 7400 p.s.f. The borehole was terminated in a 'very dense' silt stratum at El. 778.8.

Atterberg Limit tests were performed on two samples of the silty clay from boreholes 1 & 2, which gave values of Liquid Limit of 28% and 22%, Plastic Limit of 19% and 14%, and Plasticity Index of 9% and 8%. These values, when plotted on the Casagrande Plasticity Chart, indicate that the silty clay has a low plasticity and compressibility.

The Liquidity Indices of the two samples were calculated to be minus 0.9 and minus 0.2, which confirm the 'hard' consistency obtained from visual and tactile examination.

IV

GROUNDWATER CONDITIONS

Water levels were observed in boreholes 1 & 2 at El. 806.3 and El. 807.1 respectively. The ice level in the adjacent river was observed at El. 806.7.

An investigation carried out for the bridge immediately upstream from this structure in August 1965 indicated that the river bed was dry, therefore it may be assumed that a seasonal fluctuation of the water table may be expected and that during the summer months the water levels may be 2 to 3 feet below their present elevations.

V

DISCUSSION AND RECOMMENDATIONS

The Bayfield River flows through an old glacial spillway valley which is typical of this drumlinized area. The topography consists of low broad oval hills with gentle slopes, and the valleys are broad terraces of sand and gravel filling much of the low ground between drumlins.



The natural soil profile consists of 'very dense' granular materials overlying a 'hard' silty clay stratum which was encountered at El. 795 and El. 803 in boreholes 1 and 2 respectively. The 'very dense' nature of the subsoil makes the use of spread footing foundations desirable for this site, and on the basis of the borehole results a maximum allowable soil pressure of 5 tons per square foot is appropriate for the design. This soil pressure incorporates a factor of safety of at least 3 against shear failure of the underlying soil, and total settlement of footings 10 feet in width is estimated to be 0.5 inch or less.

The footing grade should be established at a minimum depth of 4 feet below the riverbed level to provide sufficient protection against frost action, and in view of the susceptibility of the silt and silty fine sand materials to erosion by scour it is recommended that a hydrology study be carried out to determine the maximum anticipated depth of scour.

The coefficient of friction or adhesion between the footings and the underlying soil may be taken as 0.35 or 2000 p.s.f., whichever is the lower value, and the factor of safety against horizontal sliding of the abutments must be at least 1.5.



Construction

The time of year during which the construction is carried out will probably have a considerable effect on the method of excavation due to the seasonal fluctuation of the water table. The silt and silty fine sand layers are susceptible to disturbance if subjected to an out of balance hydrostatic pressure and particular care should be taken to insure that the subsoil below the footing grade is not disturbed prior to pouring the foundation concrete. During exceptionally dry periods the excavations may be carried out by normal open-cut methods, however it is recommended that allowance be made for the use of sheet piling for the south abutment if the water cannot be controlled by sump pumping.

If sheet piling is used for the south abutment excavation it should be driven into the silty clay stratum to seal the silt and silty fine sand layers and prevent any occurrence of 'bottom heave' when the water table is lowered. Alternatively the excavation can be carried below the water table and timber cribbing installed to reduce lateral flow of water into the excavation. If this procedure is used it may be necessary to pour tremie concrete prior to dewatering the excavation in order to prevent bottom heave occurring due to water seepage below the walls of the crib.

S

All backfill behind retaining walls should be free draining granular material to prevent an out of balance hydrostatic pressure being exerted on the wall by entrapped water. The backfill must also be compacted to at least 95% of the maximum standard Proctor dry density to preclude settlement of the fill and damage to the finished road surface.



Yours very truly,

DOMINION SOIL INVESTIGATION LTD.

A handwritten signature in cursive script, appearing to read 'C.J.W. Atkinson', written over the typed name and title.

C.J.W. Atkinson, M.Sc., P.Eng.,
Branch Manager

CJWA:eg

APPENDIX 'A'

THE STANDARD PENETRATION TEST.

In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30-ins. The tube is first driven an initial 6-inches to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12-in. is recorded. The sample tube is one originally developed by Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.

For Sands:-

Values of 'N'	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very dense

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø	> 8"	3"	¾"	4.76mm	2.0	0.42	0.074	0.002	>	NO SIZE LIMIT		
U.S. Standard Sieve Size:		No.4	No.10	No.40	No.200							

SAMPLE TYPES.

AS	Auger sample	RC	Rock core	TP	Piston, thin walled tube sample
CS	Sample from casing	%	Recovery	TW	Open, thin walled tube sample
ChS	Chunk sample	SS	Split spoon sample	WS	Wash sample

SAMPLER ADVANCED BY	static weight	w	OBSERVATIONS	Steady pressure
"	pressure	p	MADE WHILE	No pressure
"	tapping	t	CORING	Intermittent pressure

Washwater returns	Washwater lost
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PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SYMBOL :



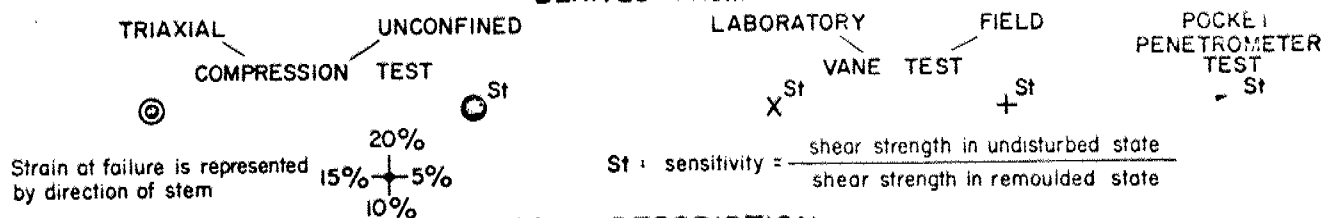
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SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	C	Shear strength in terms of total stress
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int. friction
PI %	Plasticity index	Cv	Coeff. of consolidation	C'	Cohesion in terms of effective stress
LI	Liquidity index	m _v	Coeff. of volume compressibility	ϕ'	Angle of int. friction

UNDRAINED SHEAR STRENGTH.

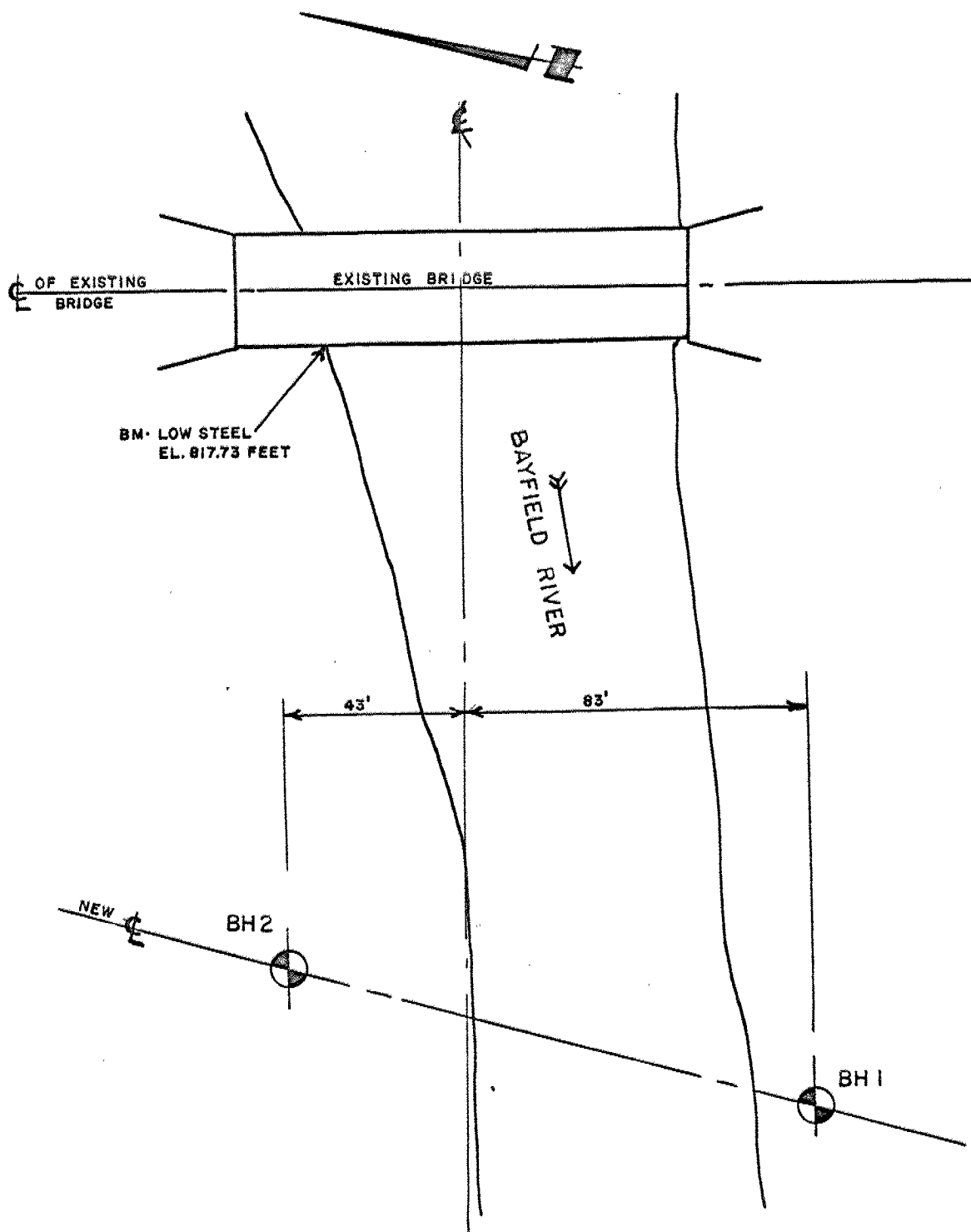
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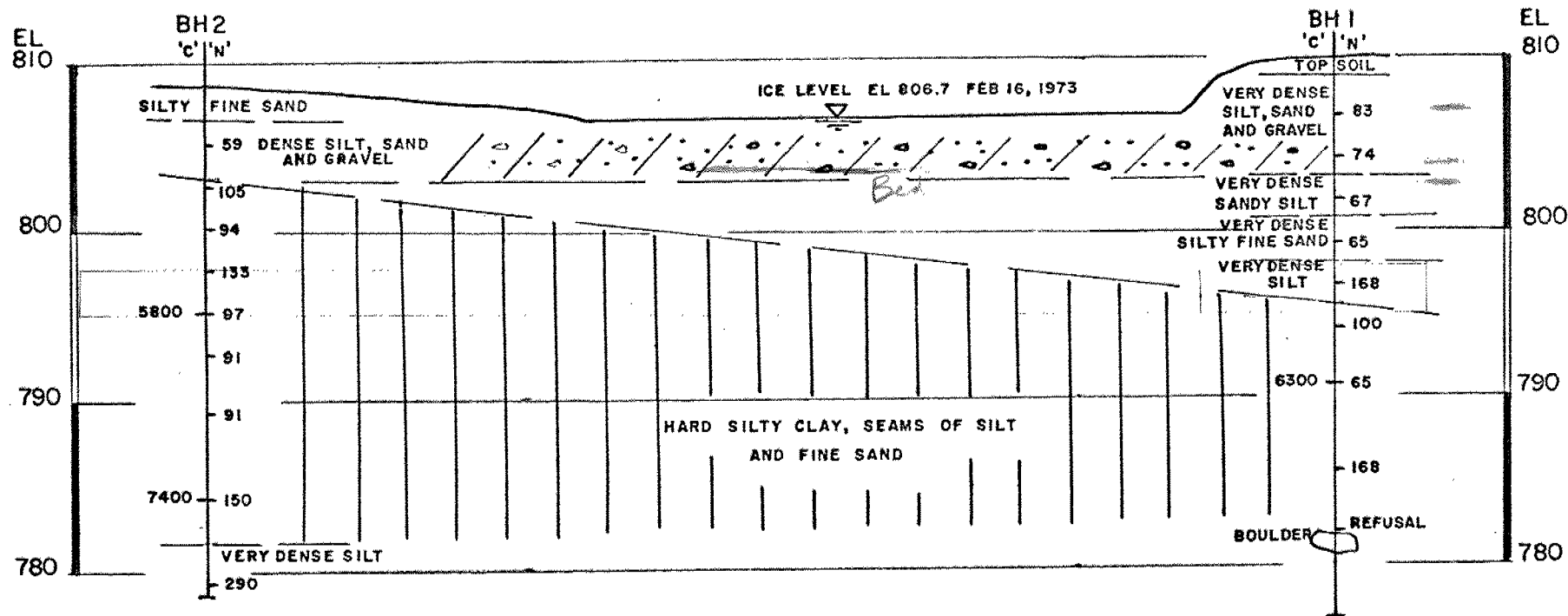
SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS	C lbs/sq ft
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000

Prep. By



LOCATION OF BOREHOLES
SCALE 1-INCH = 40 FEET



SUBSURFACE PROFILE

VERT SCALE 1" = 10'
 HOR. SCALE 1" = 20'

LOG OF BOREHOLE1.....

Our Reference No. 73-2-L2

Enclosure № 3 4

CLIENT: B.M. Ross and Associates Ltd,
PROJECT: Bridge BR-319,
LOCATION: County of Huron,
DATUM ELEVATION: low steel, El. 817.73 feet.

DRILLING DATA

Method: Hollow-stem auger,
Diameter: 8-inch,
Date: Feb. 15, 1973.

[illegible]

VERTICAL SCALE: 1 inch to 5 feet

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MADE:

CHECKED:

LOG OF BOREHOLE 2

Our Reference No. 73-2-12

Enclosure No. 5

CLIENT: B.M. Ross & Associates Limited,
PROJECT: Bridge BR-319,
LOCATION: County of Huron
DATUM ELEVATION: low steel, El. 817.73 feet.

DRILLING DATA

Method: Hollow-stem auger.
Diameter: 8-inch
Date: February 16, 1973.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %					REMARKS
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	N, Blows / Foot	Blows / Foot					PLASTIC LIMIT	NATURAL	LIQUID LIMIT		
								20	40	60	80	100					
								UNDRAINED SHEAR STRENGTH 100 lbs/sq.ft. + FIELD VANE TEST • COMPRESSION TEST									
								20	40	60	80	100	10	20	30	40	50
818.0	0.0	Ground Surface															
	20	Brown silty fine sand.															
805		Dense silt, sand & gravel.			1	SS	59										
	55				2	SS	105										
800					3	SS	94										
		Hard grey silty clay, seams of silt and fine sand.			4	SS	133										
795					5	SS	97										
					6	SS	21										
790					7	SS	91										
					8	SS	150										
785																	
780		Very dense grey silt.			9	SS	290										
800		End of Borehole															

VERTICAL SCALE: 1 inch to 15 feet

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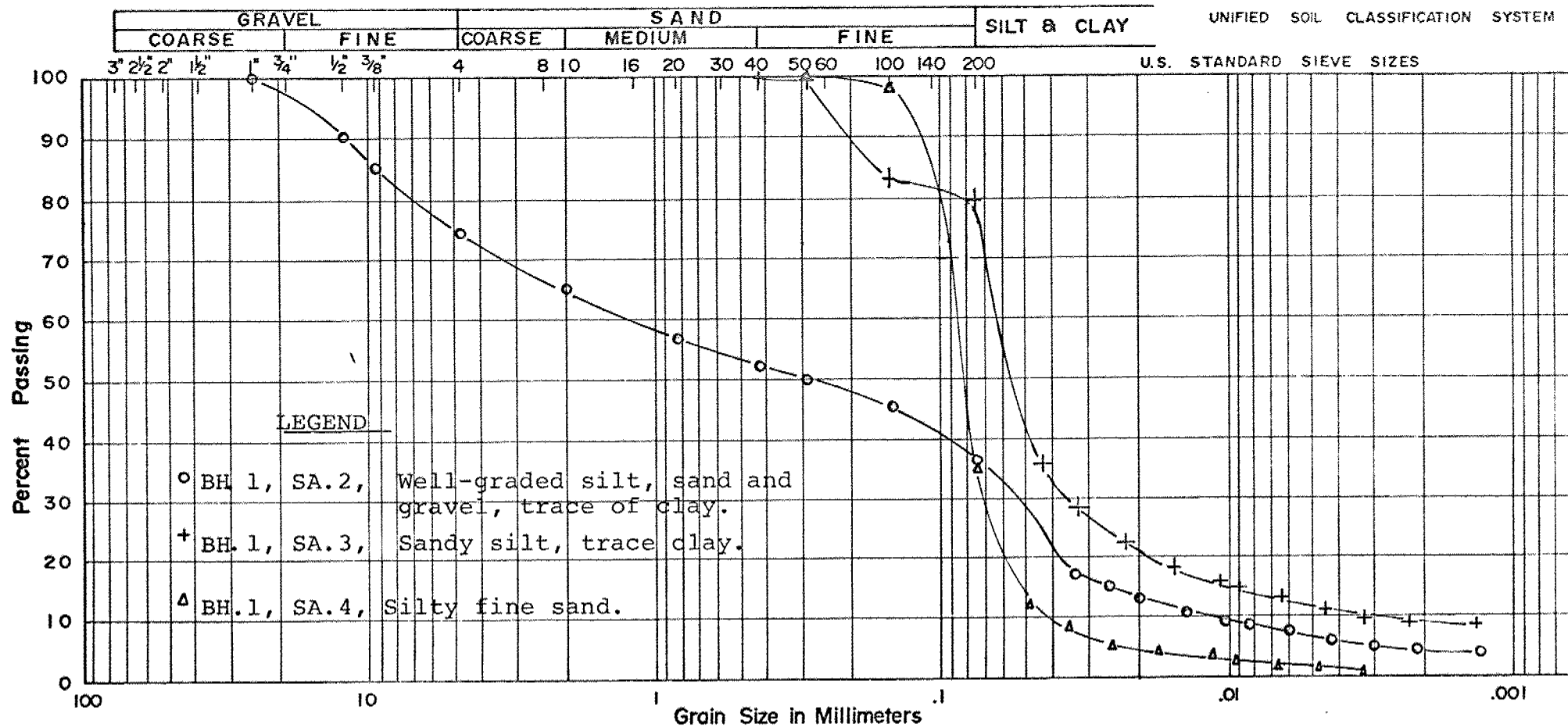
MADE:

CHECKED:

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N^o 73-2-L2



PROJECT: Bridge BR-319
 LOCATION: County of Huron
 BOREHOLE N^o:
 SAMPLE N^o:
 DEPTH:
 ELEVATION:

COEFFICIENT OF UNIFORMITY :
 COEFFICIENT OF CURVATURE :

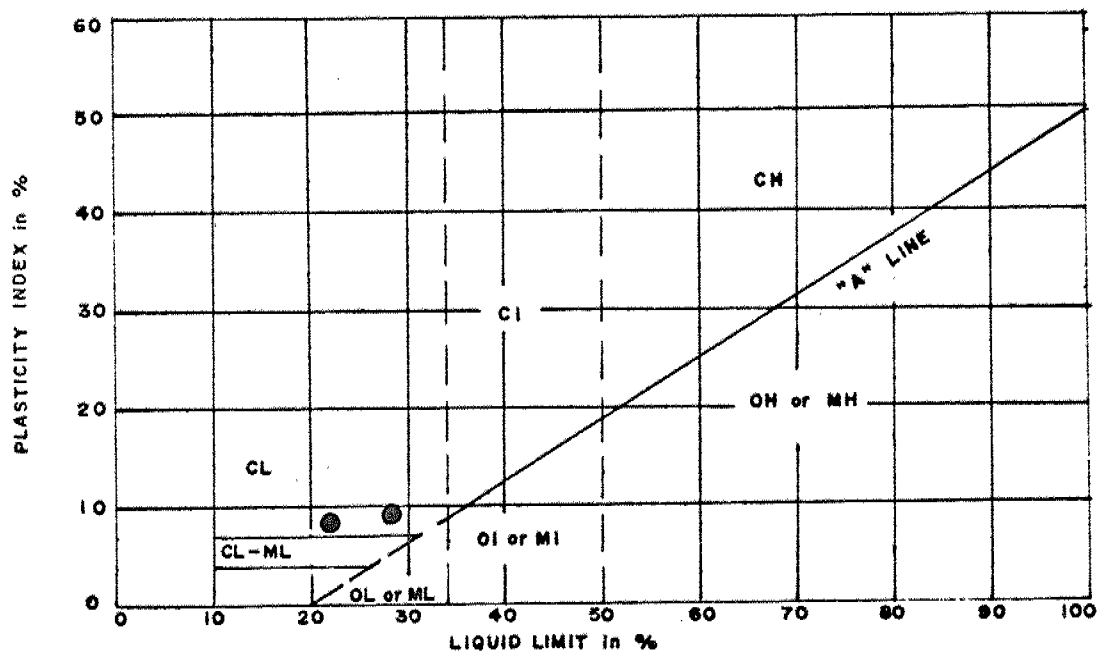
Classification of Sample and Group Symbol:

PLASTIC PROPERTIES

LIQUID LIMIT	% =
PLASTIC LIMIT	% =
PLASTICITY INDEX	% =
MOISTURE CONTENT	% =

Unified Soil Classification Plasticity Chart

- ML Inorganic silts and very fine sands, silty or clayey fine sands, or clayey silts with slight plasticity.
 CL Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays.
 OL Organic silts and organic silty clays of low plasticity.
 MI Inorganic silts, clayey fine sands or clayey silts with medium plasticity.
 CI Inorganic clays with medium plasticity, sandy clays, silty clays.
 OI Organic silts and organic silty clays of medium plasticity.
 MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
 CH Inorganic clays of high plasticity, fat clays.
 OH Organic silts and organic clays of high plasticity.



PROJECT: Bridge BR-319

LOCATION: County of Huron

BOREHOLE NO.:	1	2
SAMPLE NO.:	6	4
DEPTH OF SAMPLE:	16'	11'
ELEVATION OF SAMPLE:	794'	798'
LIQUID LIMIT: %	28	22
PLASTIC LIMIT: %	19	14
PLASTICITY INDEX: %	9	8
MOISTURE CONTENT: %	11	12
LIQUIDITY INDEX:	-0.9	-0.25
LEGEND:	●	●

