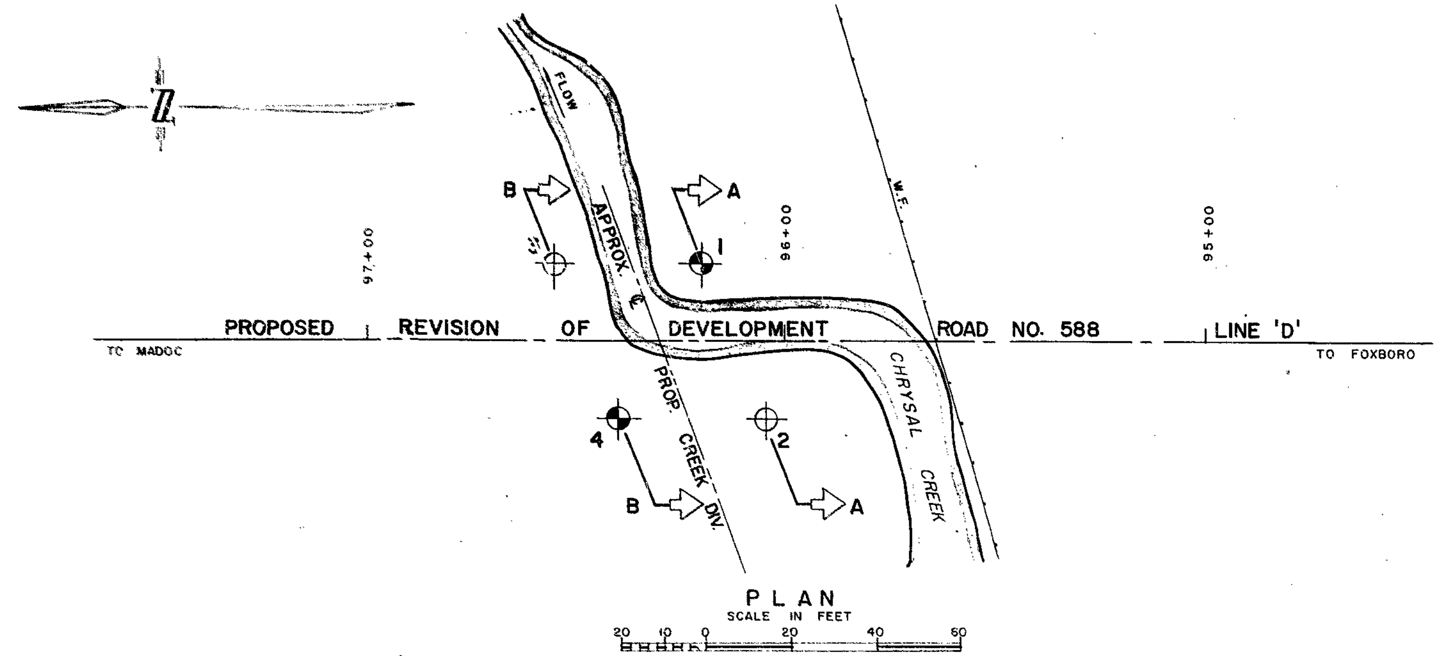
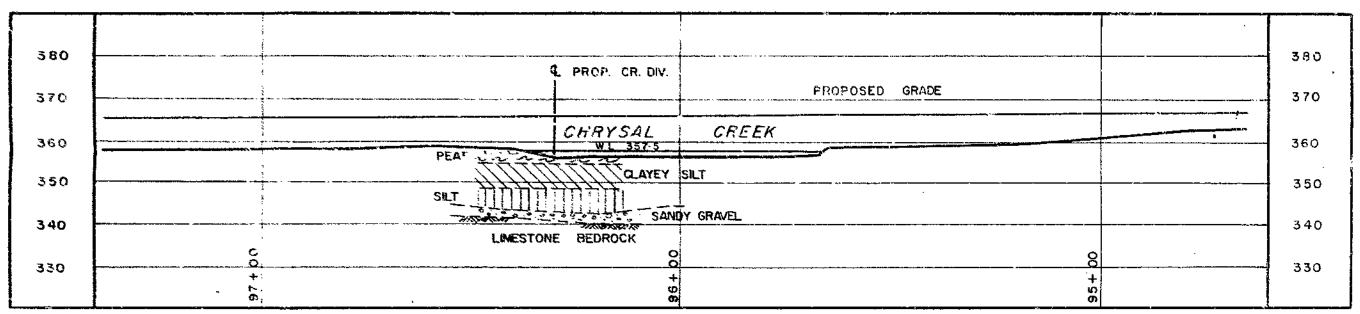
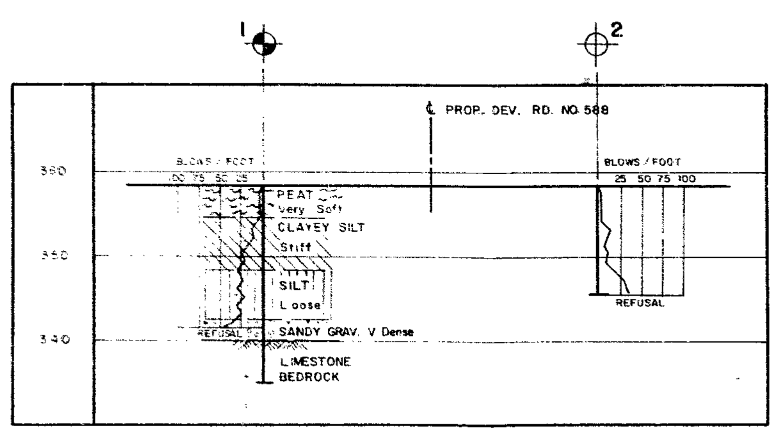
#62-F-94
WP-191-62
NEW. WP-704-62
DEV. RD #588
CROSSING
CHRYSAL. CR.



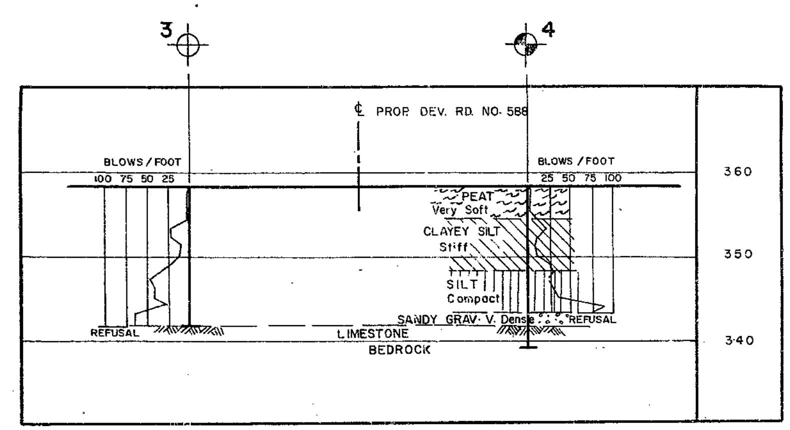
PLAN
SCALE IN FEET



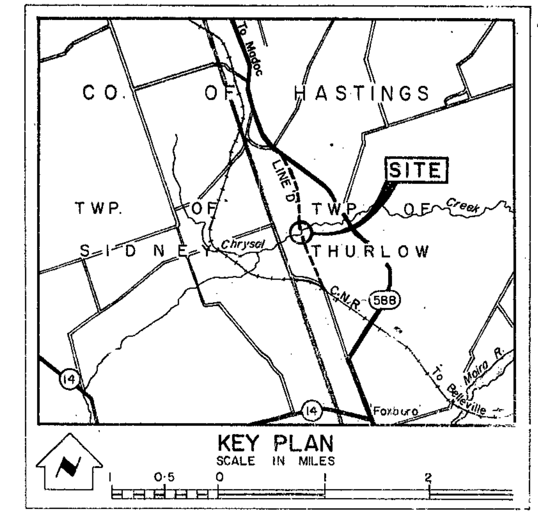
LINE 'D' PROFILE
SCALE IN FEET



A - A
SCALE IN FEET



B - B
SCALE IN FEET



KEY PLAN
SCALE IN MILES

31 C/6
E. 304300
N. 4905400
Z. 18

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation July 24, 1962

NO.	ELEVATION	STATION	OFFSET
1	358·0	96+20	19' RT.
2	358·0	96+05	19' LT.
3	358·0	96+55	17' RT.
4	358·0	96+40	19' 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.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION

CHRYSAL CREEK AND DEVELOPMENT ROAD NO. 588

PROPOSED REVISION - LINE 'D'

ORIGINATED A. BARSVARY	DISTRICT NO. 8	DATE AUG. 28, 1962
DRAWN F. CLARK	W.P. NO. 191-62	JOB NO. 62-F-94
CHECKED [signature]	CONT. NO.	DRAWING NO. 62-F-94A
APPROVED [signature]		

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Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Division,

(Foundation Section)

Attention: Mr. S. McCombie.

August 15, 1962.

D.H.O. FOUNDATION INVESTIGATION REPORT.

W.J. 62-F-94 -- W.P. ~~191-62~~.

Re: Proposed Crossing at Chrysal Creek and Prop. Rev'n. of Dev. Road #588, Line 'D', District #8, Kingston.

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe you will find the factual data and recommendations contained therein, adequate for your future design work. Should further information be required, please do not hesitate to contact our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
J. Ford
E. A. Cash
J. E. Gruspier
T. J. Kovich
J. Roy
E. R. Saint
F. Norman
A. Watt
Foundations Office
Gen. Files.

TABLE OF CONTENTS

FOUNDATION INVESTIGATION

For

Proposed Crossing at Chrysal Creek and
Prop. Rev'n. of Dev. Road #588, Line 'D',
District #8, Kingston.
W.J. 62-F-94 -- W.P. ~~191-62.~~ 7

1. INTRODUCTION:

A request dated July 17, 1962, for a foundation investigation at the site of the proposed crossing of Chrysal Creek and proposed revision of Development Road #588, Line 'D', was received from the Bridge Location Section.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the location of the proposed structure. Presented in this report are the results of this investigation, together with recommendations pertaining to the design of the proposed foundations and approach fills.

2. DESCRIPTION OF THE SITE:

The site is located approximately 0.4 miles west of the existing crossing of Chrysal Creek and Dev. Rd. #588. The creek at the site is about 8 - 10' wide, 2 - 2.5' deep; its flow is sluggish. Along the banks of the creek the area is flat and swampy, and covered with shrubs and trees.

Physiographically, the site belongs to the Napanee Plain geographical region. The Napanee Plain is a flat to undulating plain of mainly Black River Limestone, from which the glaciers

cont'd. /2 ...

2. DESCRIPTION OF THE SITE: (cont'd.) ...

stripped most of the overburden. While the soil is only a few inches deep over much of the region, in the south the depressions often have deeper deposits of stratified clay.

3. FIELD INVESTIGATION PROCEDURE:

A total of two boreholes and four dynamic cone penetration tests was carried out during the course of the field investigation. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. Samples were obtained by means of a standard split-spoon sampler driven into the soil with an energy of 350 ft.-lbs. per blow. Driving energy of the dynamic cone penetration tests was the same as that used for the split-spoon sampler. Rock samples were taken by means of an AXT core barrel.

The locations and elevations of the boreholes and penetration tests are shown on Drawing#62-F-94A which accompanies this report.

4. LABORATORY TESTS:

Soil samples were visually examined and classified at the site as well as in the laboratory. Tests in the laboratory were carried out on various representative samples to determine the natural moisture content and Atterberg limits of the soil. Additional tests on cohesive soil samples were performed to define

cont'd. /3 ...

4. LABORATORY TESTS: (cont'd.) ...

the undrained shear strength and density of the samples.

Laboratory and field test results are included under Appendix I of this report.

5. SUBSOIL CONDITIONS:

5.1) General:

Subsoil at the site consists of deposits of peat, clayey silt and silt layers, underlain by limestone bedrock.

The boundaries of the different deposits are shown on the accompanying borelog sheets. The estimated stratigraphical cross sections shown on Drawing#62-F-94A are based upon this information. A more detailed description of the various soil types is as follows:

5.2) Peat:

The upper soil stratum at the site was found to be peat, extending for a depth of 4.0'. The deposit is black in colour, highly compressible with an excess of decayed vegetable matter and roots. The material has no load bearing or other engineering values.

5.3) Clayey Silt:

Under the peat layer, a clayey silt deposit was encountered in both boreholes. The layer has an approximate depth of 6 ft., extending from elevation 354.5 down to El. 348.5. The average standard penetration 'N' value of this stratum (13 blows per foot) indicates a stiff consistency. The minimum and maximum

cont'd. /4 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.3) Clayey Silt: (cont'd.) ...

values of shear strength, based upon laboratory unconfined compression tests, were found to be 935 p.s.f. and 1420 p.s.f., respectively. The sensitivity of the deposit was calculated by performing laboratory unconfined compression tests on undisturbed and remoulded soil samples, and was found to be between 1.1 - 2.9. The layer has low plasticity, corresponding to average values of liquid and plastic limit of 31.0% and 18.0%, respectively. The bulk density of the material was found to be 130.0 p.c.f. The deposit is grey in colour.

5.4) Silt:

Underlying the clayey silt, a grey silt stratum was observed in the boreholes extending for a depth of about 6' down to elevations 343.5 and 342.5. This material has a loose to compact relative density and low plasticity, the average liquid limit value being 20.0%, and average plastic limit 19.5%. An insitu vane test, performed in borehole #1, gave a shear strength value of 480.0 p.s.f. The bulk density of this layer is roughly 123.0 p.c.f.

5.5) Bedrock:

At the approximate elevation of 343.5 - 342.5, bedrock was found in the two boreholes. The upper 2 - 3' of the rock is weathered to such an extent that considering the particle size distribution of the disintegrated rock, it can be considered to be sandy gravel. However, because of the obviously similar nature

cont'd. /5 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.5) Bedrock: (cont'd.) ...

of the broken rock and its very dense relative density, it is part of the bedrock. The bedrock in the core barrel was found to be fine-grained limestone of the Trenton Black River group, with thin seams of black shale.

In order to establish the elevation of the upper surface of the bedrock at both sides of the proposed abutments, two dynamic cone penetration tests were carried out additionally, as shown on Drawing #62-F-94A. In B.H. #2, refusal of the penetration was reached at elevation 345.5. This elevation is considered to be the upper surface of the broken rock and refusal is probably due to larger size boulders or cobbles. In B.H. #3, however, the dynamic cone penetrated the 2' deep weathered portion of bedrock as indicated by the penetration values. It seems a fair estimate to consider the elevation of the upper surface of disintegrated rock to be at 344.0, and the sound bedrock at elev. 341.5.

6. GROUND WATER OBSERVATIONS:

The elevation of the water level of the creek was established at 357.5, at the time of the field investigation. The average depth of the creek at the proposed crossing is about 2.5 - 3.0'. The ground water level in the boreholes was found to be at the same elevation as the creek water, that is, at El. 357.5 No artesian waterhead was observed in the boreholes.

cont'd. /6 ...

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a single span bridge at the site of the proposed revision of Development Road No. 588 and Chrysal Creek crossing. The proposal calls for diversion of the creek as shown on Drawing #62-F-94A.

At the location of the proposed structure, subsoil consists of approximately 14 - 15' deep overburden, underlain by limestone bedrock. The overburden contains layers of peat, clayey silt and silt.

As has been mentioned under Section #5, the clayey silt and silt layers have such low shear strengths that they cannot provide sufficient support for spread footings. Placing the spread footings on the sandy gravel stratum (weathered rock) would involve 12.5' - 15.5' deep excavations and would require an expensive dewatering scheme, because of the high ground water level and the rather permeable nature of the silt layers. As an alternative, the proposed single span structure can be supported on piled type foundations, driven into the broken rock. In this case, the organic peat deposit should be removed and the pile caps be put at the approximate depth of 4.0'. As can be seen, the length of the piles would be rather short (less than 10') and uneconomical to use. These problems were presented by the writer to Mr. F. Wilkie of the Bridge Planning Section, and Mr. J. Keen of the Bridge Design Section, and it was agreed to change the preliminary plan of a single span structure to a multi-span timber trestle bridge.

cont'd. /7 ...

7. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

By utilizing timber trestles, no dewatering scheme will be necessary. The timber piles driven down into the broken rock should support a design load of 20 - 25 T/pile, depending on the type of timber pile used. Timber piles should be treated if not completely below the lowest established water level.

Prior to construction of the approach fills, the highly compressible, black, organic peat should be completely removed and replaced by acceptable material. The embankments should then be constructed with side slopes of 2 horizontal to 1 vertical to eliminate stability problems.

8. SUMMARY:

It is proposed to construct a single span bridge at the site of the proposed revision of Development Road #588 and Chrysal Creek crossing.

Subsoil at the site consists of 14' - 15' deep overburden of peat, clayey silt and silt underlain by limestone bedrock.

Recommendations pertaining to the foundation of the proposed structure are as follows:

(1) Due to the low shear strength of the overburden, it cannot provide sufficient support for spread footings.

(2) Placing the spread footings on the bedrock would involve 12.5' - 15.5' deep excavation and an expensive dewatering scheme.

cont'd. /8 ...

8. SUMMARY: (cont'd.) ...

(3) Utilizing piles driven to bedrock for a single span bridge would result in pile lengths less than 10' which is uneconomical.

(4) Therefore, a timber trestle bridge is recommended for this location.

(5) Timber piles driven into the weathered portion of bedrock will support a design load of 20 - 25 T/pile, depending on the type of timber pile used. No dewatering scheme will be necessary in this case.

(6) Timber piles should be treated if not completely below the lowest water level.

(7) No stability problems are likely to occur provided the organic peat is removed under the approach fills and replaced by acceptable material, and the fills are constructed with side slopes of 2 horizontal to 1 vertical.

9. MISCELLANEOUS:

The field work, performed during the period from July 20th to 27th, 1962, together with the preparation of this report, was undertaken by Mr. A. K. Barsvary. The investigation was carried out under the general supervision of Mr. K. G. Selby, who reviewed this report.

August 1962.

APPENDIX I.

FORM OB-ML-126 REV 1961

61-4391

OFFICE REPORT ON SOIL EXPLORATION

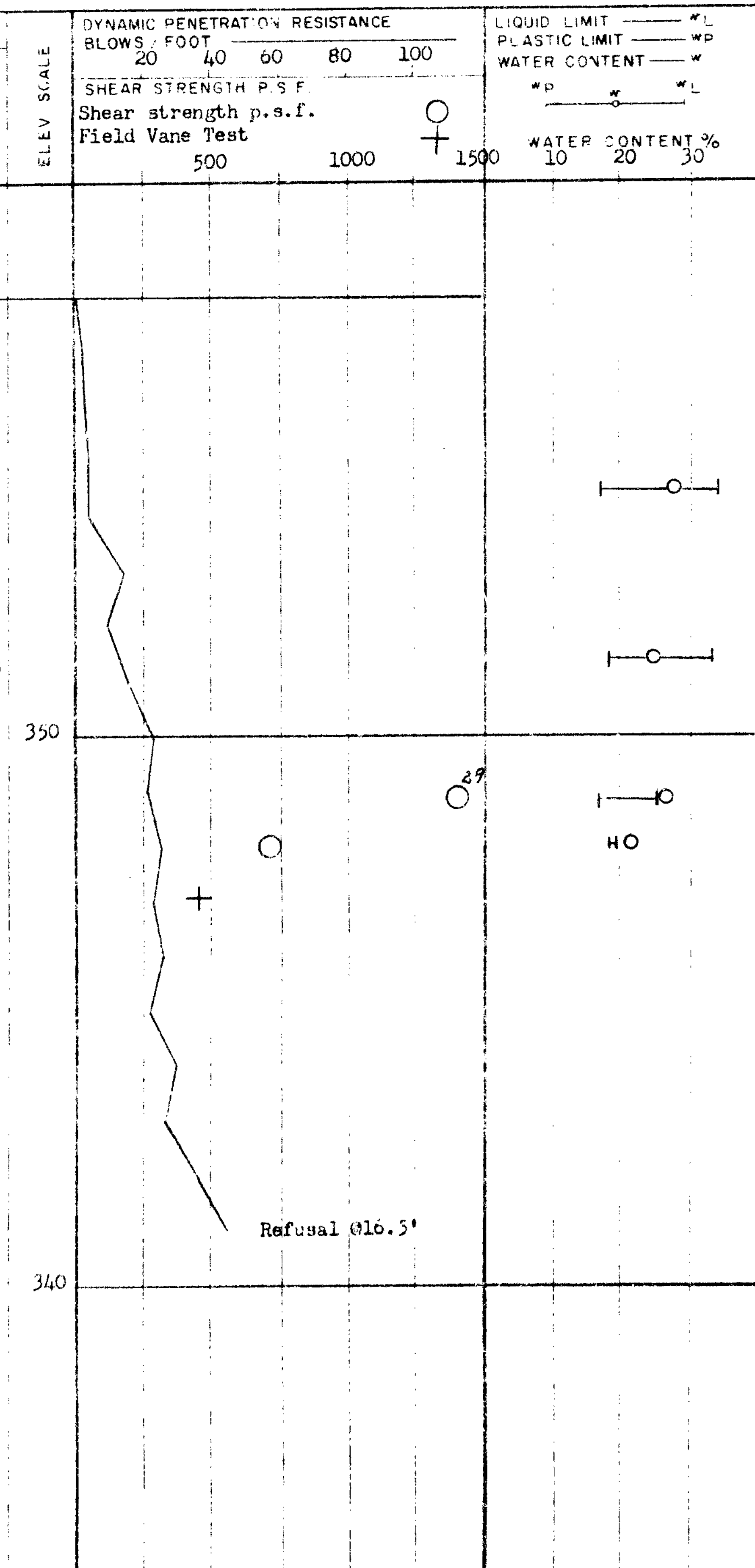
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 62-F-94	LOCATION Sta. 96+20 19' Rt. of ℄	ORIGINATED BY A.B.
W.P. 191-62	BORING DATE July 24 & 25, 1962.	COMPILED BY H.S.
DATUM G.S.C.	BOREHOLE TYPE Washboring BX Casing.	CHECKED BY A.B.

ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	BULK DENSITY γ P.C.F.	REMARKS
358.0	Groundlevel					W.L. in borehole. ▽ 357.5
0.0 / 354.0	Peat very soft black.	1	SS	7		
4.0 / 348.5	Clayey silt stiff grey.	2	SS	13		
		3	TW	P	131.0 / 123.0	
9.5 / 342.5	Silt loose grey.					
15.5 / 340.0	Sandy gravel very dense.	4	SS	100		
18.0 / 335.0	Limestone Bedrock.	5	RC			
23.0	End of borehole.					



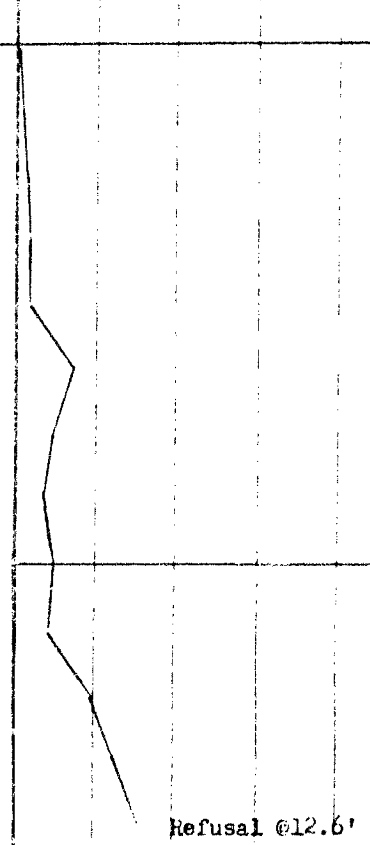
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 62-F-94 | LOCATION Sta. 96+05 19' Lt. of ℄ | ORIGINATED BY A.B.
W.P. 191-62 | BORING DATE July 26, 1962. | COMPILED BY H.S.
DATUM G.S.C. | BOREHOLE TYPE Dynamic Cone Penetration. | CHECKED BY A.B.

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L; PLASTIC LIMIT w_P; WATER CONTENT w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE				
358.0 / 0.0	Groundlevel									
						350				
						340				



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

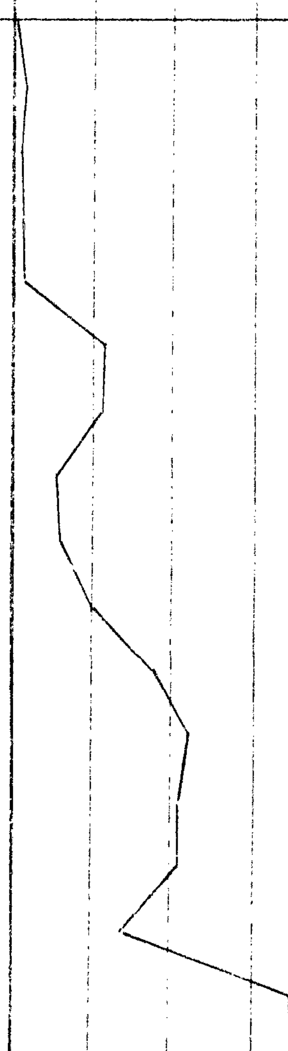
FOUNDATION SECTION

JOB 62-F-94 | LOCATION Sta. 96+55 17' Rt. of ℄ | ORIGINATED BY A.B.

W.P. 191-62 | BORING DATE July 27, 1962. | COMPILED BY H.S.

DATUM G.S.C. | BOREHOLE TYPE Dynamic Cone Penetration. | CHECKED BY A.B.

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT					
358.0 0.0	Groundlevel									
						350	Refusal @16.4'			
						350				



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

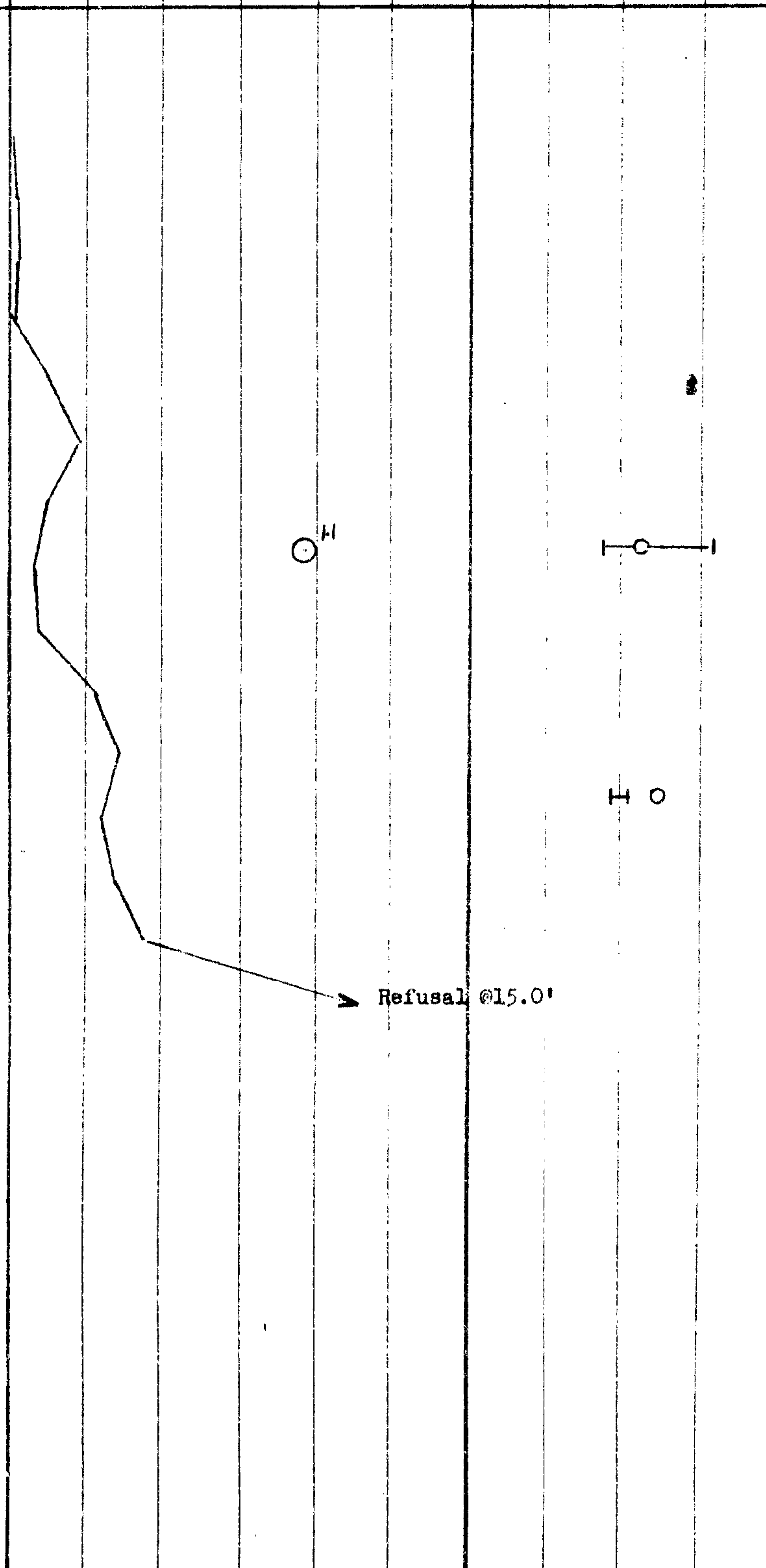
RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 62-F-94 LOCATION Sta. 96+40 19' Lt. of ℄ ORIGINATED BY A.B.
W.P. 191-62 BORING DATE July 26 & 27, 1962. COMPILED BY H.S.
DATUM G.S.C. BOREHOLE TYPE Washboring BX Casing. CHECKED BY A.B.

ELEV. DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BULK DENSITY γ P.C.F.	REMARKS
358.0 0.0	Groundlevel						W.L. in borehole ▽ 357.5
	Peat very soft black.						
354.5 3.5		1	SS	22			
	Clayey silt stiff grey.	2	TW	13		130.0	
					350		
348.5 9.5	Silt compact grey.	3	TW	13			
343.5 14.5	Sandy gravel						
342.0 16.0	Very dense.						
	Limestone Bedrock.	4	RC		340		
339.0 19.0	End of borehole.						

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT: 20, 40, 60, 80, 100
SHEAR STRENGTH P.S.F. ○ Shear strength P.S.F.: 500, 1000
LIQUID LIMIT — w_L; PLASTIC LIMIT — w_P; WATER CONTENT — w
WATER CONTENT %: 10, 20, 30



ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma'}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT } IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION } IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION } IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3·1416
e	BASE OF NATURAL LOGARITHMS 2·7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ε	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNGS MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_o	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY. DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

10th Sept 62.

Re Chrysal Creek

and development Rd No 588

62-F-91 W.P. 181-62

Arthur Watt Bridge Location section called the Foundation section and requested our comments pertaining to the proposal of a box culvert (20' x 9') instead of a timber trestle bridge at the above mentioned location.

Comment by Foundation Section:

The proposed box culvert can be placed on or above the clayey silt stratum, provided all the soft organic material is removed and backfilled ~~to~~ with granular material to the required elevation before placing the culvert.