ENGINEERING MATERIALS OFFICE
PAVEMENTS AND FOUNDATIONS

WP 88-88-01	**DIST 50**
HWY 17	**STR SITE 29-004**

Grants Creek Bridge Replacement

GEOCRES 31K-4

DATE AUG 3 1 1999

FOUNDATION INVESTIGATION REPORT
For
Grants Creek Bridge Replacement
W.P. 88-88-01, GWP 207-95-00, Site: 29-004
Highway 17, District 54, Sudbury

INTRODUCTION

This report presents the soil information for the proposed Grants Creek Bridge construction on Highway 17. The soil information in this report is obtained from a previous foundation investigation that was carried out for the existing bridge (Geocres 31K-4 dated December 15, 1965). The proposed bridge will replace the existing Grants Creek bridge on Highway 17.

This report is produced at the request of Northern Region Structural Section. This report applies to proposed bridge structure and its approaches within 20m of the structure.

SITE DESCRIPTION

The site of the proposed bridge replacement is located on Highway 17 where an existing bridge crosses over Grants Creek. The site is located approximately 2.2 km west of Stonecliffe, Lot B, Concession 32, Geographic Township of Head, Corporation of the United Townships of Head, Clara, and Maria, and County of Renfrew in the MTO District 54, Sudbury.

Physiographically the site is located in the Algonquin Highlands. This region takes in much of the area underlain by granite and other hard Precambrian rocks. Overall it is broadly dome shaped. Locally, the relief is rough, rounded knobs and ridges. There are frequent outcrops of bare rock but they do not amount to more than 5 per cent of the total area. The soils are generally shallow but thickness over the bedrock varies greatly over short distances. Many of the valleys are floored with outwash sand and gravel. As an exception several areas have deeper till and few rock-outcrops, and the surface of the till is smoothed and moulded with occasional drumlins appearing (Reference: Chapman and Putnam, 'The Physiography of Southern Ontario; 3rd Edition, 1984).

SUBSURFACE CONDITIONS

The Record of Borehole Sheets (produced from a previous foundation investigation for the existing bridge, Geocres 31K-4 dated December 15, 1965) in the Appendix illustrates the

subsurface conditions at the borehole locations. The locations and elevations of the boreholes and cone test, along with stratigraphical sections are shown on Drawing No. 888801-A.

Based on the information from a previous foundation investigation at this site, Geocres 31K-4 dated December 15, 1965, the subsoil at the site consisted of 4.3 to 5.8m of silty sand with some gravel, followed by a 0.3m to 0.6m thick layer of boulder overlying red and blue Granite bedrock. From the recorded N-values ranging from 34 to 90 blows per 0.3m the relative density of silty sand layer is dense to very dense

Groundwater Condition

The groundwater level at the time of the previous Foundation investigations (October 25, 1965) was at elevation 152.6m which was, at that time, slightly higher than the prevailing creek level. It should be noted that the groundwater is subject to seasonal fluctuation.

DISCUSSION AND RECOMMENDATIONS

It is proposed to replace the existing Grants Creek Bridge on Highway 17. The original portion of the existing Grants Creek Bridge was constructed around 1932 and widened around 1969. The original superstructure is a 9.1m single span reinforced concrete, and the substructure consists of concrete abutments and spread footings supported on a silty sand soil stratum. The existing widening consist of a single span reinforced concrete rigid frame with reinforced concrete spread footings supported on a silty sand soil stratum. The existing road grade is approximately 3.4m above the normal water level of Grants Creek.

The existing bridge structure, particularly the concrete deck and abutments of the original structure is generally in poor to fair condition.

The proposed structure will be 11m single span bridge. The span and location of the proposed bridge is roughly equal to that of the existing bridge. A 1.2m grade raise of Highway 17 is required for hydraulic clearance. It is proposed to design the new bridge with integral abutments supported on spread footings to eliminate the need for expansion joints.

Structure Foundations

The existing bridge is constructed on spread footing founded at elevation 151.0m. The proposed bridge can be supported on spread footings founded within the silty sand stratum at or below elevation 151.0. The recommended bearing resistance for the spread footings, at or below elevation 151.0 as per the OHBDC 91, 3rd Edition are given below.

Factored Bearing Resistance @ ULS = 450 kPa
Bearing Resistance @ SLS (for 25mm settlement) = 300 kPa

Embankment Stability

The height of the existing embankment above the creek level is about 3.4m. With the proposed 1.2m grade raise the height of the embankment will be 4.6m. The embankment will be constructed on dense to very dense granular material. There is no stability concern for the proposed height of the embankments if the embankments are constructed as recommended. Acceptable earth fill or granular material shall be used for grade raise and embankment widening. The side slope of the embankment shall be constructed at 2H:1V or flatter. If rockfill is used then the side slope shall be constructed at 1.25H:1V. All surficial topsoil or organic material should be removed within the plan limits of the embankments before placement of the new fill. The embankment widening and grade raise shall be in accordance with current OPSD.

Embankment Settlement

The existing embankment is constructed on dense to very dense granular material. As a result of a grade raise of 1.2m, some settlement will take place in the embankment. However, the settlement will be elastic in nature, and will take place during the construction.

Lateral Earth Pressure

Free draining granular material such as Granular 'A' or 'B', or rockfill is recommended as appropriate backfill to abutment walls to prevent hydrostatic pressure build-up.

If rockfill is used for approaches, then special care will be required to avoid damaging to the abutment. It would be preferable to place a 0.3m cushion of Granular 'A' or smaller rockfill (with diameter of less than 300mm), between the structure and the main mass of rockfill. Granular material may also be used at the approaches.

For design purposes, the following properties for backfill are recommended:

Granular 'A'	$\Upsilon = 22.8$ k/m^3	$\phi = 35^o$
Granular 'B'	$\Upsilon = 21.2$ k/m^3	$\phi = 30^o$
Rockfill	$\Upsilon = 18.0$ k/m^3	$\phi = 35^o$

At rest condition (K_o) may be assumed to apply for unyielding structures. If the structure is designed to be yielding then active condition (K_a) should be used.

Frost Protection

A soil cover of 2.0m or equivalent will be required for frost cover for the spread footing.

Roadway Protection

It is understood that the replacement of the structure and approaches will be completed using split structure construction (no detour) with one lane of traffic being maintained at all times with traffic control signals on the approaches. Roadway protection in the immediate vicinity of the abutments will be required to facilitate construction of the new footings and abutment backfill. The soil parameters to design the roadway protection are as follows:

Within the soil above the bedrock

$\phi = 30^o$
$\Upsilon = 20.0\ kN/m^3$
Water Level @ 152.6m

Within Bedrock

Qu = 750 kPa
$\Upsilon = 22.5\ kN/m^3$

Where:

ϕ = Apparent angle of internal friction for non-cohesive soils
Qu = Unconfined Compressive Strength (kPa)
Υ = Unit Weight (kN/m^3)

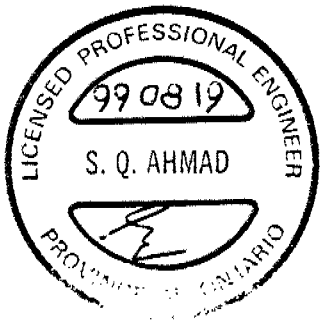
Excavation and Dewatering

For the foundation construction, excavation below the groundwater level will have to be carried out. It will be necessary to provide a dewatering scheme, to prevent boiling of the excavation bases. If boiling occurs, then the bearing resistance of the subsoil will be reduced.

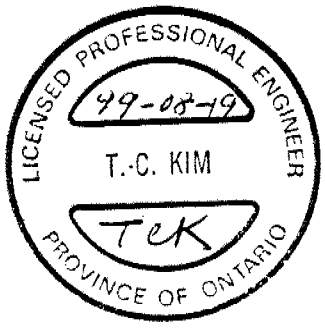
MISCELLANEOUS

The Soil information for this report is obtained from a previous foundation investigation carried out in 1965 for the existing bridge (Geocres 31K-4 dated December 15, 1965).

The report is written by K. Ahmad, Foundation Engineer, reviewed and approved by T.C. Kim, Senior Foundation Engineer.



K. Ahmad, P. Eng
Foundation Engineer



T.C. Kim, P. Eng.
Senior Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 88-88-01 (Formerly 65-F-112) LOCATION Sta 13+593.5, 7.5m Lt CL Hwy 17 ORIGINATED BY WWK

DIST 50 HWY 17 BOREHOLE TYPE WASHBORING, BX CASING COMPILED BY WWK/DT

DATUM GEODETIC DATE OCT 25 1965 CHECKED BY KGS/KA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (□ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
153.0	GROUND LEVEL										
0.2						▼	152				
			1	SS	51		151		o		27 64 8 1
	SILTY SAND with some gravel Very dense							105/ 13cm			
			2	SS	76		150		o		28 60 (12)
							149				
147.9			3	SS	81				o		10 78 (12)
5.1 / 147.5	BOULDERS						148				
5.5	Red and Blue GRANITE BEDROCK						147				
146.0											
7.0	End of Borehole										
	• WL on Oct 25 1965										

$+^3$, $\times^3$: Numbers refer to ... $\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P. 88-88-01 (Formerly 65-F-112) LOCATION Sta 13+594.7, 5m Rt CL Hwy 17 ORIGINATED BY WWK

DIST 50 HWY 17 BOREHOLE TYPE WASHBORING, BX CASING COMPILED BY WWK/DT

DATUM GEODETIC DATE OCT 25 1965 CHECKED BY KGS/KA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
153.6 GROUND LEVEL											
153.3	Black Organics Topsoil										
0.3	SILTY SAND with some gravel Dense to Very Dense		1	SS	34		153		o		
			2	SS	51		151	100/ 25cm	o		
			3	SS	90		149		o		
147.8											
5.8	Boulders										
147.2											
6.4	Red and Blue GRANITE BEDROCK						147				
145.7											
7.9	End of Borehole										

* WL on Oct 25 1965

+³, x⁵ : Numbers refer to Sensitivity

20
15-◇-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 88-88-01 (Formerly 65-F-112) LOCATION Sta 13+580, 7.2m Lt CL Hwy 17 ORIGINATED BY WWK

DIST 50 HWY 17 BOREHOLE TYPE WASHBORING BX CASING COMPILED BY WWK/DT

DATUM GEODETIC DATE OCT 26 1965 CHECKED BY KGS/KA

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
153.0	Ground Surface						
152.7	Black Org Topsoil						
0.3	Silty Sand with some gravel Dense to Very Dense		1	SS	43	▼*	152
							151
			2	SS	82		150
							149
148.8							
148.5	Boulders						
4.5	Red And Blue Granite Bedrock						148
147.0							
6.0	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

100/ 18cm

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

*WL on Oct 26 1965

+3, ×5 : Numbers refer to 20 15-0-5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 88-88-01 (Formerly 65-F-112) LOCATION Sta 13+580, 7.2m Rt CL Hwy 17 ORIGINATED BY WWK

DIST 50 HWY 17 BOREHOLE TYPE WASHBORING, BX CASING COMPILED BY WWK,DT

DATUM Geodetic DATE OCT 27 1965 CHECKED BY KGS/KA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
153.0	Ground Level										
152.7	Black Organic Topsoil										
0.3			1	SS	45		152		o		39 51 (10)
	Silty Sand with some gravel Dense to Very Dense						151				
			2	SS	53		150		o		28 85 (12)
			3	SS	65		149		o		10 78 (12)
148.6											
4.4	Boulders						148				
147.9											
5.1	Red and Blue Granite Bedrock						147				
146.4											
6.6	End of Borehole										

*WL on Oct 25 1965

+3, ×3 : Numbers refer to 20 (%) STRAIN AT FAILURE

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

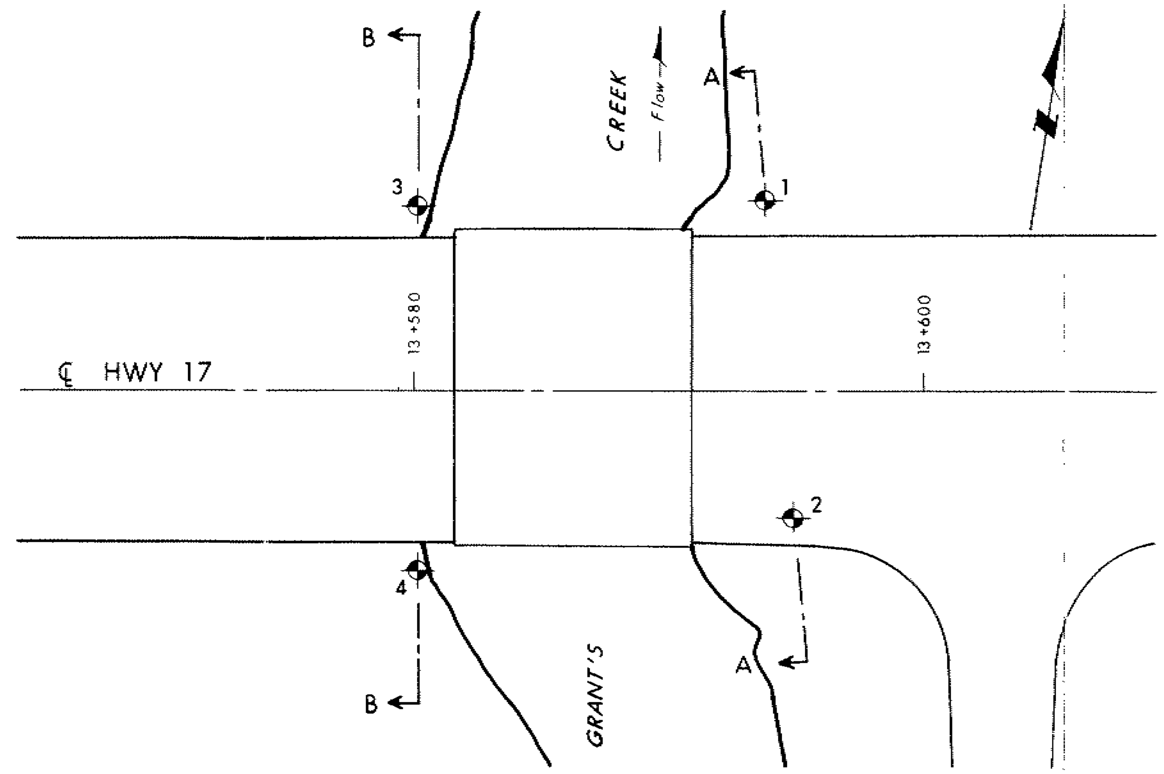
MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 88-88-01

SHEET

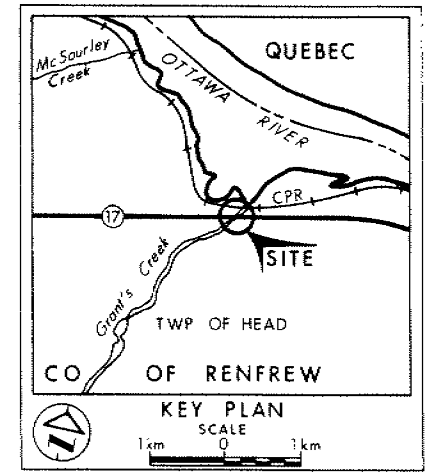
GRANT'S CREEK
BORE HOLE LOCATIONS & SOIL STRATA



PLAN
SCALE 3m 0 3m

F. Edwin
143.2m

(1) Leave Cofferdam
(2) monitor settlement

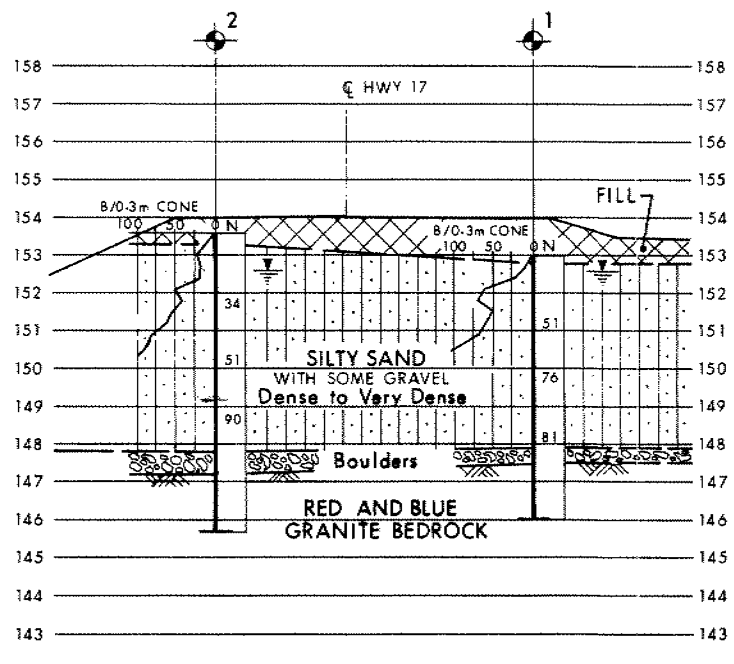


KEY PLAN
SCALE 1km 0 1km

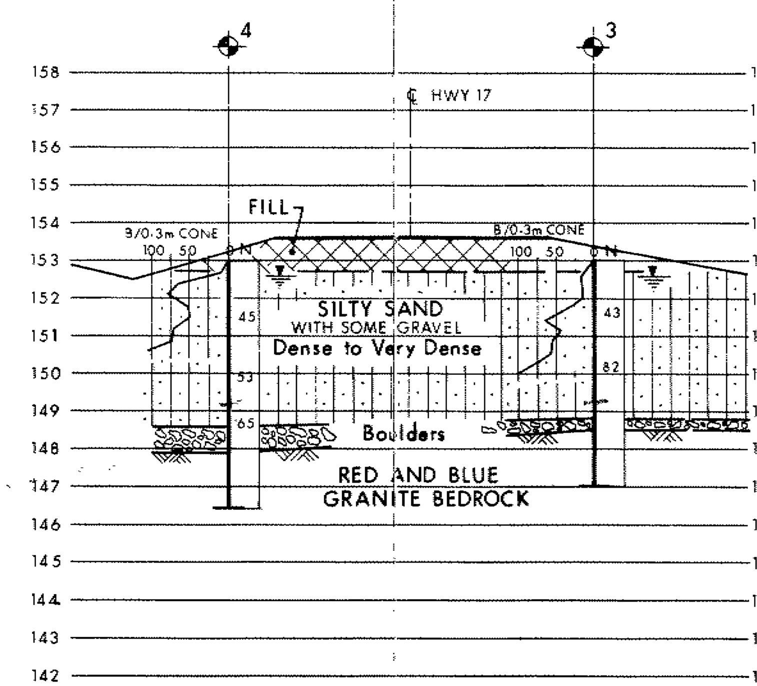
LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N — Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Oct 1965

No	ELEVATION	STATION	OFFSET
1	153.0	13+593.5	7.5m Lt
2	153.6	13+594.7	5.0m Rt
3	153.0	13+580.0	7.2m Lt
4	153.0	13+580.0	7.2m Rt



SECTION A-A
SCALE 3m 0 3m Hor; 2m 0 2m Vert



SECTION B-B
SCALE 3m 0 3m Hor; 2m 0 2m Vert

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen Cond

REV.	DATE	BY	DESCRIPTION

Geocres No 31K-4

REF General Arrangement 88-88-01 (P1)

HWY No 17			DIST 54
SUBM'D KA	CHECKED	DATE 1999 08 26	SITE 29-004
DRAWN DT	CHECKED	APPROVED	DWG 888801-A

cc: GEN. FILES

DEPARTMENT OF HIGHWAYS ONTARIO

23-69-02

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie

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

Date: December 15, 1965

Our File Ref.

In reply to DEC 22 1965

Subject:

FOUNDATION INVESTIGATION REPORT
For
Widening of Existing Bridge on Grant's Creek and Hwy. #17, County of Renfrew, Twp. of Head, Lot 32, Con.'B', Dist. #13 (North Bay).

W.J. 65-F-112 -- W.P. 344-61

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

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements.

Should you require additional information, please do not hesitate to contact our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
H. McArthur
G. Martens
E. R. Saint
A. Watt

Foundations Office
Gen. Files

FILE

1965 DEC 16 PM 4:50

no W.P card

DOWN NBAR 11 DEC 16/65 4.46P

A RUTKA M & T ENGR

ATTN A STERMAC

RE: W.P. 344-61 GRANT'S CREEK HWY 17

WHEN MIGHT WE EXPECT THE FOUNDATION REPORTFOR THE ABOVE PROJECT?

COULD YOU EXPEDITE ITS DISTRIBUTION AS WE WISH TO STUDY IT PRIOR

TO COMPLETING OUR SOILS DESIGN REPORT.

K L HOWE FOR E R SAINT REG MAT ENGR M & T

BA

TELETYPE

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7. MISCELLANEOUS.

FOUNDATION INVESTIGATION REPORT

For

Widening of Existing Bridge on Grant's Creek and Hwy. #17, County of Renfrew, Twp. of Head, Lot 32, Con.'B', Dist. #13 (North Bay).

W.J. 65-F-112 -- W.P. 344-61

1. INTRODUCTION:

A request to carry out a foundation investigation for the widening of the existing bridge on Grant's Creek and Hwy. #17, was received from Regional Bridge Location Engineer, Mr. J. C. McAllister, dated September 23, 1965.

It is proposed to widen the existing bridge on Grant's Creek and Hwy. #17 on both sides, by approximately 8'-0". The site is located in the County of Renfrew, Twp. of Head, Lot 32, Con. 'B', approximately 4 miles west of the station of Stonecliffe. At this location the chainage of Hwy. #17 is from 714/44 to 714/78.

In order to determine the soil properties and decide on the type of foundations, an investigation was carried out by this Section. Results and discussion of the field and laboratory work, as well as recommendations for the future design work, are contained in the following paragraphs of this report.

2. DESCRIPTION OF SITE:

The site of the existing bridge is located in the County of Renfrew, Twp. of Head, Lot 32, Con. 'B', approximately 4 miles west of the station of Stonecliffe. The surrounding area is generally flat terrain.

The existing beam type bridge, which was erected in 1932, on 5'-1"

cont'd. /2 ...

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

wide spread footings at approximate El. 495.0 (bottom of footings), is still in good condition. No visible damage can be observed.

3. FIELD AND LABORATORY WORK:

In order to obtain sufficient information on the type and properties of the subsoil, four sampled boreholes and four dynamic cone penetration tests were carried out at this site. Split-spoon samples were taken at various depth intervals. Samples recovered in the split-spoon sampler were used to determine the following physical properties:

1. Natural Moisture Contents.
2. Grain Size Distribution.

Results of these laboratory tests are summarized in Appendix I of this report.

4. SOIL TYPES AND SOIL CONDITIONS:

Subsoil at the site consists of from 14 to 19 feet of silty sand with some gravel, followed by a 1-to 2-foot thick layer of boulders, followed by granite bedrock.

The silty sand layer has a dense to very dense relative density with 'N' values ranging from 34 to 82 blows per foot. Mechanical analyses performed in the laboratory, indicate the following grain size distribution: Gravel, 20%; Sand, 70%; Silt, 10%. The average moisture content is about 17%.

Ground water level in the borings was observed to be at El. 500.5 which was slightly higher than the prevailing creek level.

cont'd. /3 ...

5. DISCUSSION AND RECOMMENDATIONS:

It is proposed to widen the existing bridge at this site by about 8 feet on each side. As described in the preceding paragraphs, subsoil consists of dense to very dense silty sand containing some gravel. The existing bridge is in good condition and is supported by spread footings founded at approximate elevation 495.0. It is recommended that the proposed widenings be supported also on spread footings founded at El. 495.0, in which case, a safe load of up to 3.0 t.s.f. may be assumed for design purposes. The new portions should be separated from the existing bridge by means of vertical expansion joints.

Since excavations below the ground water level will have to be carried out, it will be necessary to provide a dewatering scheme which will prevent 'boiling' of the excavation bases. If 'boiling' does occur, not only will the bearing capacity of the subsoil be reduced, but serious damage to the adjacent existing bridge will occur. In order to dewater the excavations satisfactorily, it is recommended that a scheme which incorporates steel sheet piling be used. Sheeting should be driven to a depth below the excavation bottom equal to the height of the prevailing ground water level above it.

No stability problems for the widening of the approaches are anticipated provided standard 2:1 slopes are constructed.

6. SUMMARY:

A foundation investigation at the site of a proposed widening of Grant's Creek bridge on Hwy. #17 at Stonecliffe, is reported.

Subsoil at the site consists of a deposit of dense to very dense silty sand underlain by a thin layer of boulders, followed by granite bedrock.

cont'd. /4 ...

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

It is recommended to found the proposed widenings on spread footings as is the case for the existing bridge. A dewatering scheme utilising steel sheet piling is also recommended.

No stability problems are anticipated for the proposed approach widening.

7. MISCELLANEOUS:

The field work for this project was carried out during the period October 25 - 27, 1965, under the supervision of Mr. W. W. Kulmatickas, Project Foundation Engineer. Equipment used was owned and operated by Johnston Drilling Co., Ltd.

This report was prepared by Mr. W. W. Kulmatickas and Mr. K. G. Selby.

December 1965

APPENDIX I.

FORM OB-MT-126 (FORMERLY OB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 65-F-112 LOCATION Hwy 17 & Grant Creek Ch 714/83 25'-0" Lt. ORIGINATED BY W.W.K.
W.P. 344-61 BORING DATE Oct. 25, 1965. COMPILED BY W.W.K.
DATUM 502.0 BOREHOLE TYPE Washboring BX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT
502.0	Groundlevel				
0.5	Silty sand with some gravel. Very dense.		1	SS	51
			2	SS	76
585.3			3	SS	81
584.0	Boulders				
18.0	Red and Blue Granite Bedrock.				
479.0					
23.0	End of borehole.				

ELEV. SCALE: 500, 490, 480, 470

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

For 5"

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % — 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

Observed in Casing.
WL El 500.6
Gr27%
Sa64%
Si 8%
Cl 1%
Gr28%
Sa60%
Si12%
Gr10%
Sa78%
Si12%

FORM DS-MT-126 (FORMERLY DS-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 65-F-112
W.P. 344-61
DATUM 504.0

LOCATION Hwy 17 & Grant Creek Ch 714/87 18'-0" Rt.
BORING DATE Oct. 26, 1965.
BOREHOLE TYPE Washboring BX Casing.

ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY K.G.S.

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
504.0	Groundlevel					
503.0	Black org. topsoil.					
	Silty sand with some gravel. Dense to very dense.		1	SS	34	500
			2	SS	51	
			3	SS	90	490
485.0						
483.0	Boulders					
21.0	Red and Blue Granite Bedrock.					480
478.0						
26.0	End of borehole.					470

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
w_P w w_L
WATER CONTENT %
10 20 30

BULK DENSITY γ P.C.F.

REMARKS

WL El 500.5 Observed in Casing.

For 10'

FORM 08-MT-126 (FORMERLY 08-ML-126)
65-1931

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 65-F-112 LOCATION Hwy 17 & Grant Creek Ch 714/38 25'-0" Lt. ORIGINATED BY W.W.K.
W.P. 344-61 BORING DATE Oct. 26, 1965. COMPILED BY W.W.K.
DATUM 502.0 BOREHOLE TYPE Washboring BX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
502.0	Groundlevel					
501.0	Black org. topsoil.					
	Silty sand with some gravel. Dense to very dense.		1	SS	43	
			2	SS	82	
488.3						490
487.3	Boulders.					
14.7	Red and Blue Granite Bedrock					
482.3						480
19.7	End of borehole.					470

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

For 7"

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

WL El 500.6
Observed in Casing.

FORM DB-MT-126 (FORMERLY DB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 65-F-112 LOCATION Hwy 17 & Grant Creek Ch 714+38 25'-0" Rt. ORIGINATED BY W.W.K.
W.P. 344-61 BORING DATE Oct. 27, 1965. COMPILED BY W.W.K.
DATUM 502.0 BOREHOLE TYPE Washboring EX Casing. CHECKED BY K.G.S.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT
502.0	Groundlevel				
501.0	Black org. topsoil.				
1.0	Silty sand with some gravel. Dense to very dense.		1	SS	45
			2	SS	53
			3	SS	65
486.3					
485.3	Boulders				
16.7	Red and Blue Granite Bedrock				
480.3					
21.7	End of borehole.				

ELEV. SCALE: 500, 490, 480, 470

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

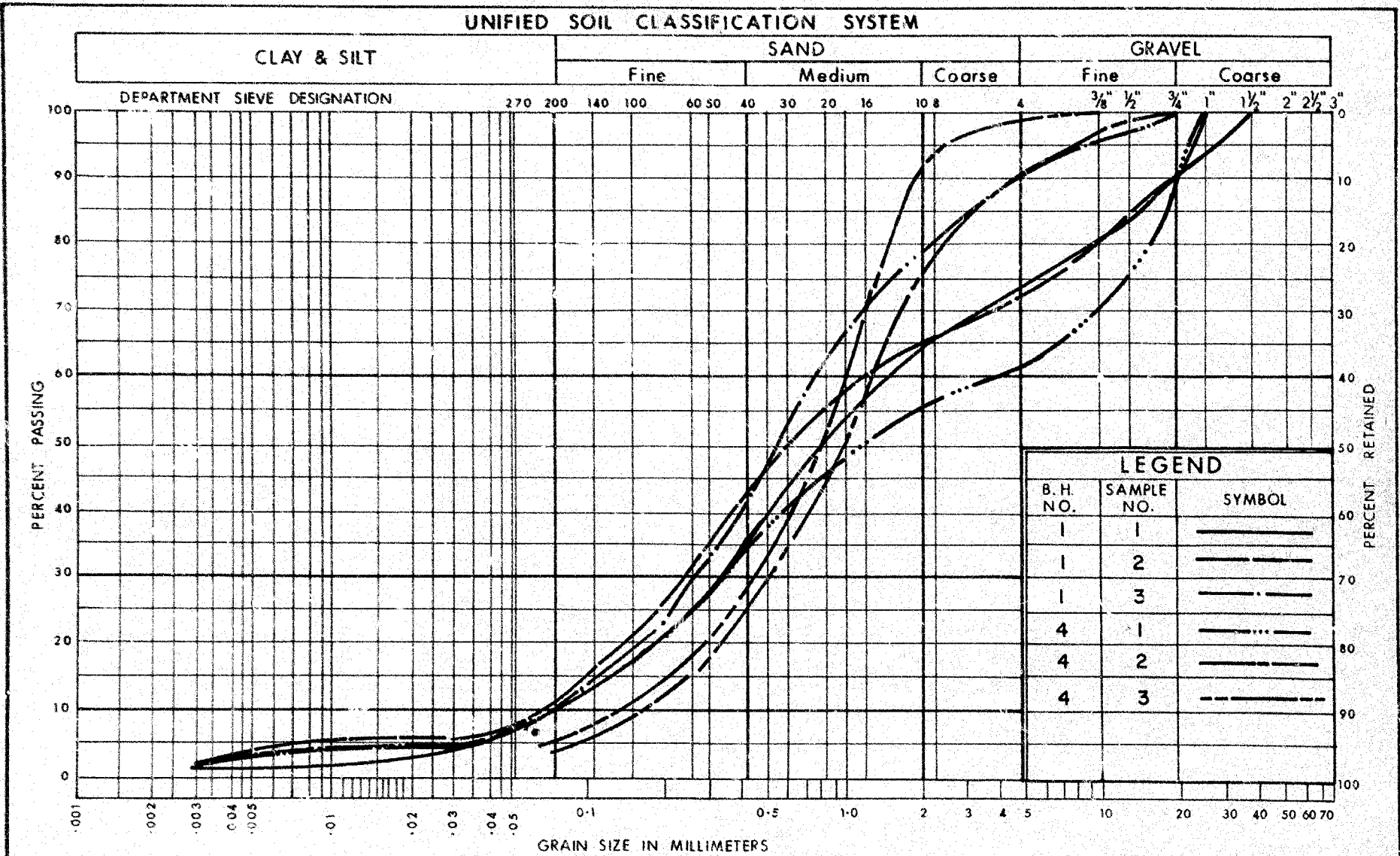
LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

Observed in Casing.
WL El 500.6
Gr 39%
Sa 51%
Si 10%
Gr 11%
Sa 85%
Si) 4%
Cl)
Gr 2%
Sa 93%
Si) 5%
Cl)

FORM OB MT-17
REV. APR. 1965
65-413



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

GRAIN SIZE DISTRIBUTION

W.P. No. 344-61
JOB No. 65-F-112

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
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
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

65-F-112

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

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

From: Bridge Division,
Downsview, Ontario.

Date: September 23, 1965.

Our File Ref.

In reply to

Subject: W.P. 344-61 Grants Creek Widening, Hwy. No. 17, District No. 13. STONECLIFFE STATION

It is presently proposed to widen the above structure by approximately 8' on both sides.

Drawings of the existing structure built in 1932 show that spread footings were used on compact gravel. Although there is no evidence to doubt that the structure was built as shown, we would like to have one test hole put down adjacent to either footing. Attached are prints of site plan E 4144-1 for this crossing and a print of plan B 1757 for the existing structure.

A request for an investigation at a proposed O. N. R. overhead at North Bay was sent you on the 22nd September 1965. I would suggest that both these jobs could be done together.

JCMcA/ag

J. C. McAllister,
for S. McCombie,
Bridge Planning Engineer.

DEC. 15. 1966 COMPLETION DATE

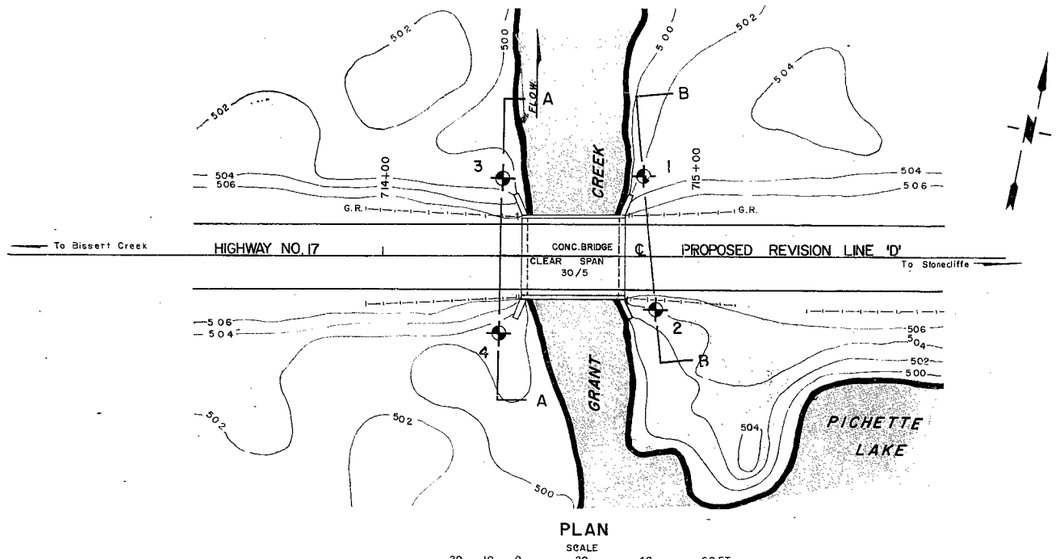
#65-F-112

W.P. #344-61

Hwy #17

GRANT

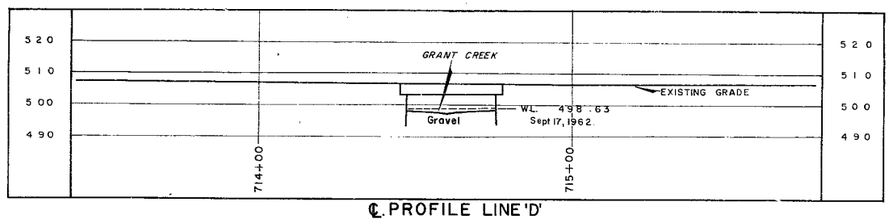
CREEK



PLAN

SCALE

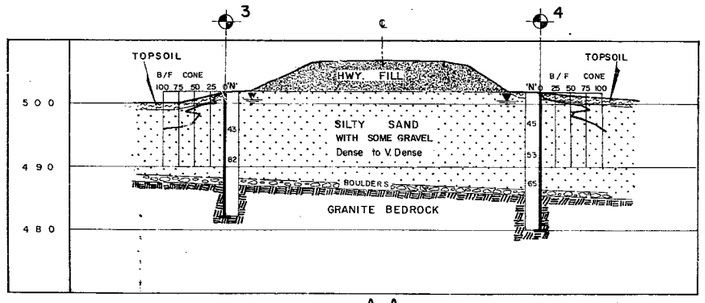
20 10 0 20 40 60 FT.



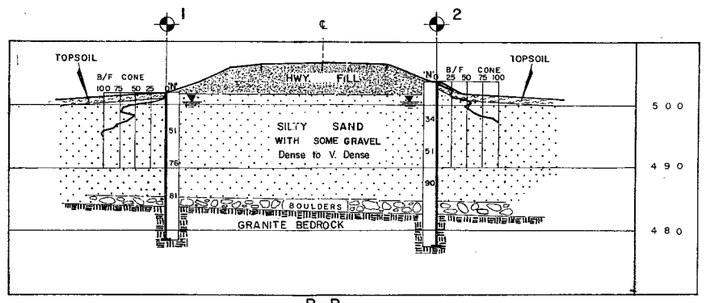
℄ PROFILE LINE 'D'

SCALE

20 10 0 20 40 60 FT.



A–A

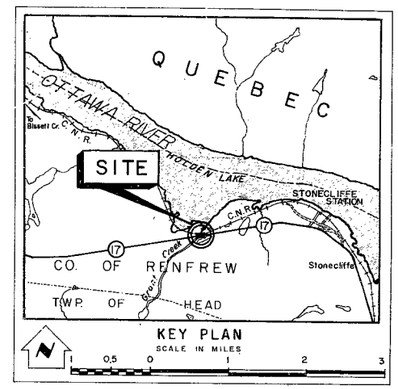


B–B

SECTIONS

SCALE

10 5 0 10 20 30 FT.



LEGEND

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

NO.	ELEVATION	STATION	OFFSET
1	502.0	714+83	25' LT.
2	504.0	714+87	18' RT.
3	502.0	714+36	25' LT.
4	502.0	714+38	25' RT.

— 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.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS – ONTARIO

MATERIALS & TESTING DIVISION – FOUNDATION SECTION

GRANT CREEK

KING'S HIGHWAY NO. 17 LINE 'D' REVISION DIST. NO. 13

CO. RENFREW

TWP. HEAD LOT 32 CON. B

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D W.K.	CHECKED .	W.P. NO. 344-61	M.B.T. DRAWING NO. 65-F-112A
DRAWN J.N.	CHECKED ///	JOB NO. 65-F-112	
DATE 10 DEC. 1965	SITE NO.		BRIDGE DRAWING NO.
APPROVED (PRINCIPAL FOUNDATION ENGINEER)	CONT NO.		

REF NO E-4144-1