

G.I.-30 **SEPT. 1976**

REMARKS: _____

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-217



Ministry of
Transportation

Ontario

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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned projects.

EXPLANATION OF TERMS USED IN REPORT

2

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:

RQD (%)	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	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

for
Marian Creek Culvert Extension
Proposed Widening of Highway 11
W.P.60-87-00, Site 43-360
District 17, Sudbury
(North Bay Area)

INTRODUCTION

This report summarizes the information obtained from the foundation investigation carried out at the above noted site. The investigation was carried out at the request of the Northern Region Structural Section for a culvert extension required for the proposed widening of Highway 11. The field work was carried out on 93 06 05 and 93 06 06 and consisted of two (2) sampled boreholes and one (1) dynamic cone penetration test at the east side of the existing culvert site where an extension is required.

SITE DESCRIPTION

The site is located to the east of Highway 11, approximately 0.4 km south of the intersection of Highway 64 and Highway 11, in the Township of Sisk, District of Nippissing.

The immediate area is flat to moderately rolling. The existing embankment is generally grassed and the bottom of the embankment is heavily vegetated with trees. The property on which the site is located is within the MTO right-of-way. According to the Northern Ontario Engineering Geology Terrain Study published by the Ministry of Natural Resources, the site is located in a Glaciofluvial outwash plain over a Bedrock knob. The material is predominantly sand with some organics near the top.

The existing Highway 11 embankment is about $3 \pm$ m high at this location with the

watercourse accommodated by a 6.10 m x 3.55 m x 15.25 m rigid frame concrete culvert with wingwalls.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in-situ and laboratory testing. The procedures employed are discussed below.

Field

The field work for the investigation was carried out on 93 06 05 and 93 06 06 and consisted of two (2) sampled boreholes and one (1) dynamic cone penetration test.

The boreholes were advanced using conventional hollow stem augering techniques with a track mounted continuous flight auger machine. A dynamic cone penetration test was first carried out next to BH 1 location, followed by sampling in the soil mantle in BH 1. The sampling program consisted of disturbed samples taken directly from the auger in the surface soil and by split spoon sampler in accordance with Standard Penetration Test (ASTM D1586) for the subsurface strata. Standard Penetration ('N') values were recorded for assessment of the denseness of the materials encountered. Dynamic Cone Penetration test was carried out in BH 1 to refusal at El.283.7 m. Auger refusal was reached at El.283.9 m. Due to the soft nature of the ground, the machine could not be set up properly for rock coring. The machine was moved slightly away from the creek to BH 1A location. Straight augering was carried out to bedrock at El.283.4 m. A 2.7 m length of rock core was obtained in BH 1A. All subsoil samples were identified in the field and returned to the laboratory for further examination and appropriate testing.

Groundwater level was monitored in open boreholes throughout the investigation. Water level in the creek was also measured during the time of the investigation. All boreholes were backfilled upon completion of the field work.

Surveying required to ascertain borehole locations and elevations was carried out by the Northern Region Surveys and Plans Section.

Laboratory

The laboratory testing on selected soil samples consisted of the following:

- Grain Size Distribution
- Natural Moisture Content Determination
- Organic Content Determination

Laboratory results are given in the following section of this report and are illustrated on Record of Borehole sheets included in the Appendix.

SUBSURFACE CONDITIONS

General

The Record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations of the boreholes are shown in Dwg. No. 608700-A.

The subsurface stratigraphy as revealed in BH 1 typically comprises a major silty sand deposit over bedrock. The top 1.5 m of this deposit contains organics, rootlets and woodchips. Bedrock was encountered at relatively shallow depth in BH 1A (El. 283.4 m) and probably El. 283.7 m in BH 1. In order to verify bedrock, 2.7 m of rock core was taken from BH 1A. A subsurface profile is shown in Dwg. No. 608700-B.

Following are the specific descriptions of the materials encountered in the investigation:

Silty Sand, Trace Gravel

This non-cohesive material is the major deposit in the area. It is generally described as silty sand, trace gravel. The top 1.5 m of this layer contains organics, rootlets and woodchips. The Standard Penetration Resistance 'N' values ranged from 0 to 8 blows/0.3 m, indicating a very loose to loose state of denseness. A high blowcount (20 blows/0 cm) was recorded at the bottom of the BH 1. This was due to sampler being driven on boulder/bedrock surface and does not represent the denseness of the material.

Laboratory tests carried out on a representative sample near the surface indicated a natural moisture content of 42%, organic content of 3.6% and grain size distribution of 0% gravel, 70% sand and 30% silt and clay. Tests carried out on a representative sample at depth indicated a natural moisture content of 20.5% and grain size distribution of 11% gravel, 82% sand and 7% silt and clay.

Bedrock

Bedrock was cored in BH 1A from El. 283.4 m. The rock cores obtained were used for rock quality determination and classification. Detailed description of the rock are attached in the Appendix. Bedrock is a slightly weathered to unweathered Biotite-Hornblende Gneiss of the Grenville Province. Core recoveries are 100% and Rock Quality Designations are 90-100%. The rock is considered strong.

Groundwater

During the time of the investigation, the water level in the creek was at El. 287.5 m. Unstabilized ground water level was measured in the boreholes to be between El. 287.0 and EL. 287.3 m approximately.

Groundwater levels are subject to seasonal fluctuations and hence may vary from the elevations given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer, using the equipment owned and operated by Master Soil Investigation Ltd. Bedrock was classified by MTO petrographer D. Williams.

The project was carried out by D. Kwok under the general supervision of B. Iyer, Senior Foundation Engineer. The report was prepared by D. Kwok, reviewed by B. Iyer, and approved by M. Devata, Chief Foundation Engineer.



P. Payer
P. Payer, P. Eng.
Senior Foundation Engineer



D. Dundas
D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 60-87-00 LOCATION Sta 14+193.4, o/s 13.0m RT CL Hwy 11 ORIGINATED BY DK
 DIST 13 17 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 93 06 05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
287.7	Ground Surface																
0.0			1	AS	-												
	with organics some rootlets and woodchips		2	SS	2											0 70 28 2	
			3	SS	0												
	Silty Sand, trace gravel Greenish Grey, Very Loose to Loose		4	SS	8											11 82 5 2	
			5	SS	5												
283.9			6	SS	0	0.0cm											
3.8 283.7	End of Borehole					**											
4.0	End of Cone Test										120/	23cm					
	• 93 06 05																
	** Spoon sampler bouncing on probable bedrock																

RECORD OF BOREHOLE No 1A

1 OF 1

METRIC

W.P. 60-87-00 LOCATION Sto 14+197.5, o/s 12.3m RT CL Hwy 11 ORIGINATED BY DK
 DIST 18 17 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Rock Core COMPILED BY DT
 DATUM Geodetic DATE 93 06 06 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
288.2	Ground Surface						288										
0.0							287										
	Probable Silty Sand						286										
							285										
							284										
283.4							283										
4.8			1	RC	REC 100%		282										
	Biotite Hornblende Gneiss Bedrock		2	RC	REC 100%		281										
280.7																	
7.5	End of Borehole																
	• 93 06 06																

ROCK CORE DESCRIPTION **WP 60-87-00**

Page 1 of 1

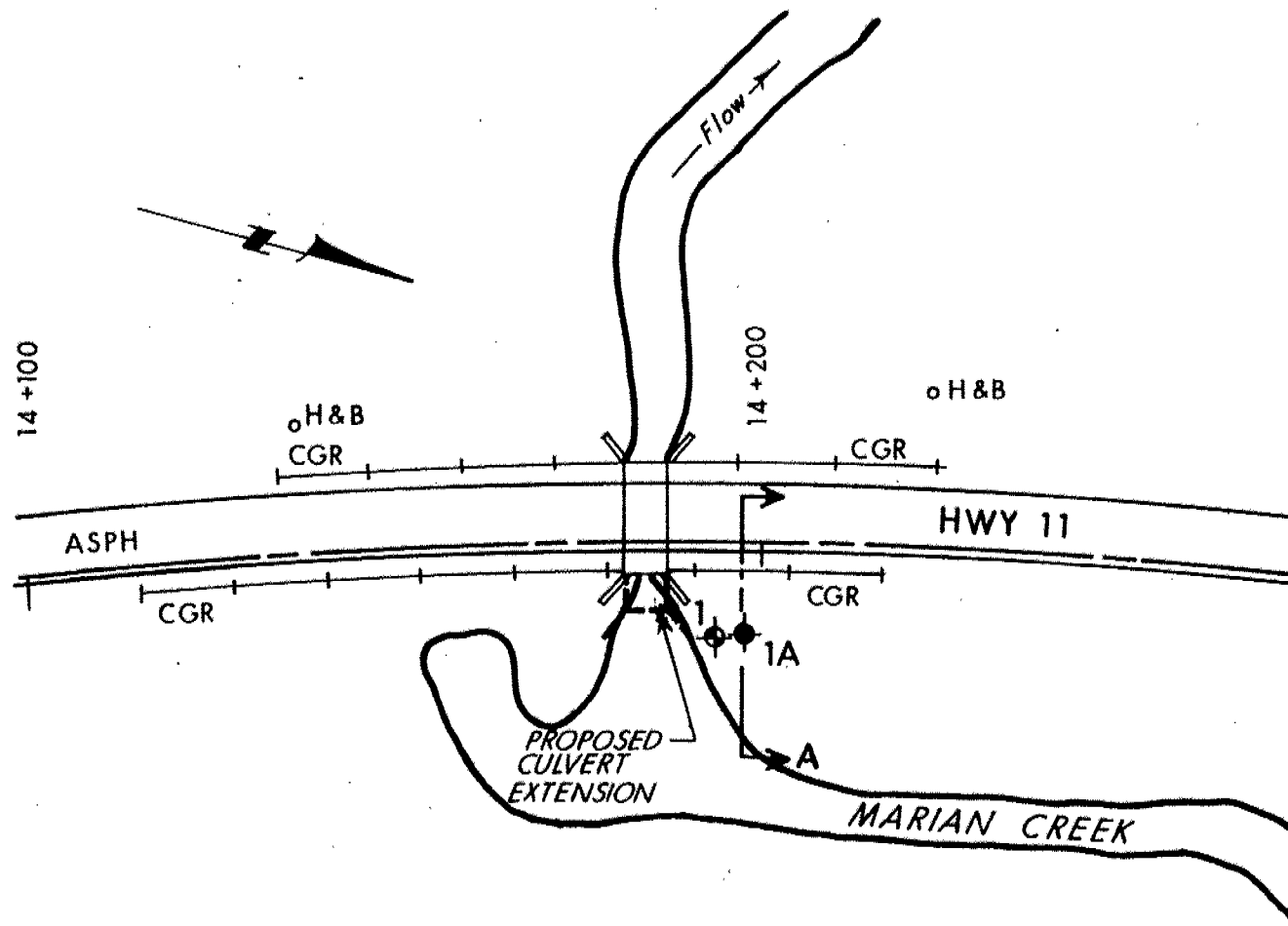
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1A	1	4.75-6.02	100	90	4.75-7.52	BIOTITE-HORNBLLENDE GNEISS, greenish black to very light grey to moderate orange pink; medium to coarse grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, dipping, undulating to planar, smooth.
	2	6.02-7.52	100	100		

*CR = CORE RECOVERY

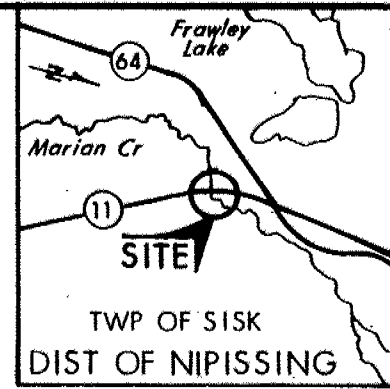
*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%

Logged by: DAW, Soils and Aggregates Section



PLAN
SCALE
10m 0 10m



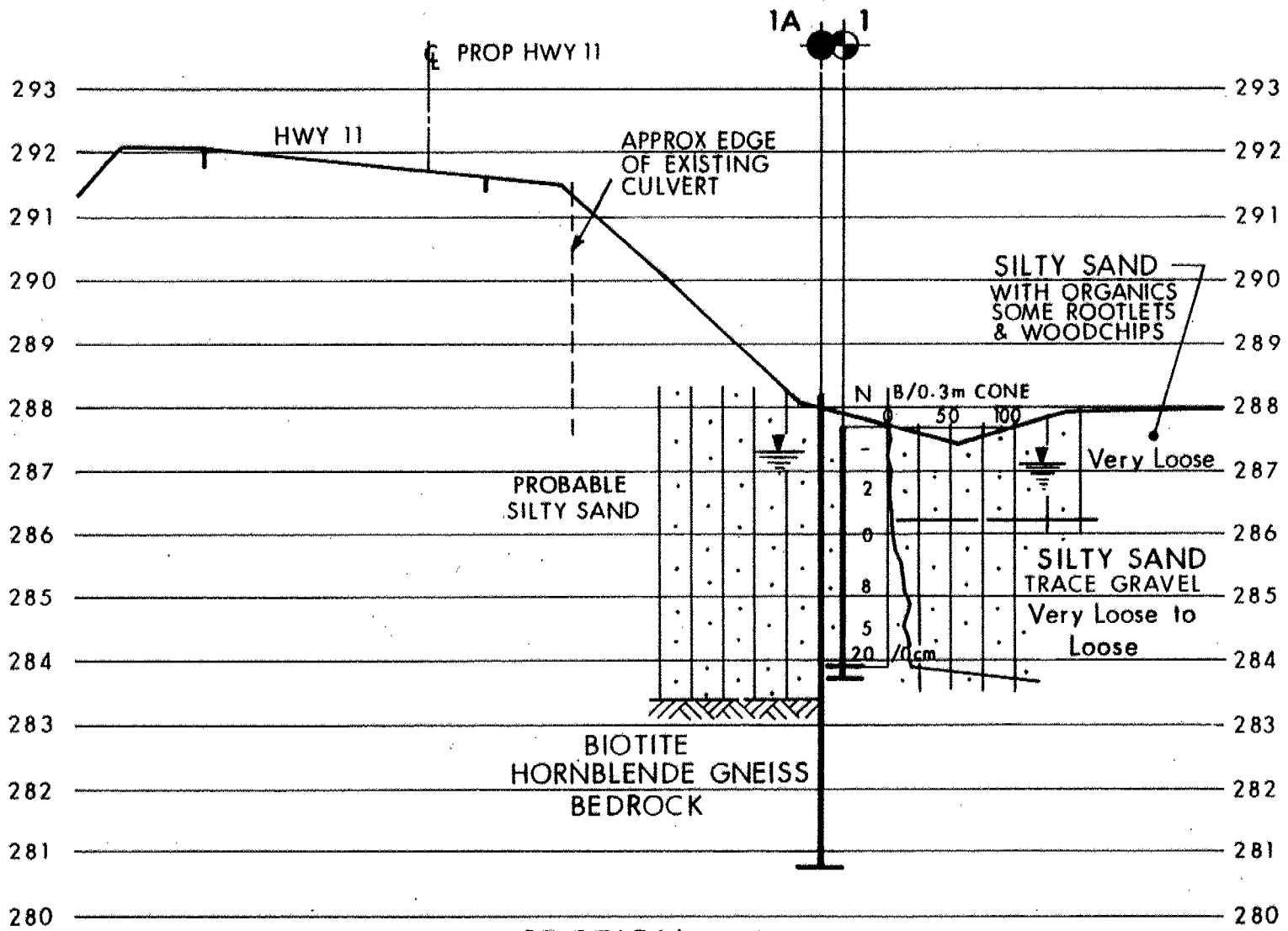
KEY PLAN
SCALE
0.5km 0 0.5km

LEGEND

- Bore Hole
- ⊙ Bore Hole & Cone

Note :
For subsurface information refer
to Dwg 608700-B

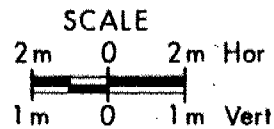
Geocres No 31L-62
WP 60-87-00
Dist 17, SITE 43-360
Dwg No 608700-A



SECTION A-A

Note :

For Plan refer to 608700-A .



Dwg No 608700-B



Ministry
of
Transportation

FILE

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 60-87-00

DIST 13 / 7

HWY 11

STR SITE 43-³⁶⁰~~240~~

Marian Creek Culvert Extension
Proposed Widening of Highway 11

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FOUNDATION INVESTIGATION REPORT

for

Marian Creek Culvert Extension
Proposed Widening of Highway 11

W.P.60-87-00, Site ~~43-2400~~ 43-360

~~District 13, North Bay~~

DISTRICT 17, SUDBURY (NORTH BAY AREA)

INTRODUCTION

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Groundwater level was monitored in open boreholes throughout the investigation. Water level in the creek was also measured during the time of the investigation. All boreholes were backfilled upon completion of the field work.

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Groundwater levels are subject to seasonal fluctuations and hence may vary from the elevations given in this report.

DISCUSSION and RECOMMENDATIONS

General

Due to the proposed widening of Highway 11, an extension of the existing culvert at Marian Creek on the east side of the highway is required. The centreline of the highway will be shifted 2.5 m to the east. The required culvert extension is about 5 m long and it is proposed to maintain the same size of opening for the extension (i.e. 6.10 m X 3.55 m). Wingwalls will also be provided at the end of the extension. The approach fills will be approximately $3.0 \pm$ m in height.

Foundation

It is proposed to maintain the same size of culvert opening and use the same type of culvert for the extension. The details of the existing foundation is not known. However, based on the size of the existing culvert, it is envisaged that the founding elevation is approximately EL. 286 to 287 m. According to the investigation results, the subsoils at or below the envisaged footing founding elevation typically comprises very loose to loose silty sand. The material contains organics, rootlets and woodchips down to El. $286.2 \pm$ m.

It is recommended to construct the culvert and wingwalls on conventional shallow foundation such as footings. Subexcavation should be carried out to about El. $286 \pm$ m. This would in effect remove all the surficial organics. The excavation should be backfilled with granular material and compacted in 'dry' to form a working mat as well as bearing surface for the placement of the structure. Creek diversion and advance dewatering is required for this purpose. Dewatering may be in the form of pilot trenches with sump pumping to draw the water level down to at least 0.5 m below the bottom of the excavation.

The factored bearing capacity at U.L.S. recommended as per the O.H.B.D.C. is 200 kPa. From serviceability considerations, a design capacity of 100 kPa may be used. This corresponds to an estimated settlement of up to 50 mm due to the compression of the loose wet sand material, but majority of the settlement will occur on completion of culvert construction and placement of fill above it. The design of the structure should include features such as articulated joints to accommodate a settlement of up to 50 mm at the location where the new and existing culvert joins. It is not known at this point of time which type of culvert would be adopted. However, the above recommendations are applicable to both open footing and box culverts.

Construction Considerations

Depth of excavation required will be up to $2.0 \pm$ m. Temporary excavation may be carried out at a gradient of 2H:1V. Where excavation comes close to the existing culvert, shoring will be required to prevent undermining of the existing foundation. Backfill to the culvert should consist of granular material. Reference is made to OPSD 803.2 standards for details. Culvert inlet and outlet treatments should comply with MTO Standards.

Frost Protection

The minimum earth cover required for frost protection is 2.0 m or equivalent insulation, unless the culvert is structurally designed to accommodate frost action.

Earth Pressure

Backfill to culvert walls should consist of granular material in accordance with MTO Standard Special Provision No. 109F03.

Computation of earth pressures should be in accordance with Section 6.7 of the O.H.B.D.C. The at-rest condition will govern earth pressure design for unyielding condition. For design purposes, the following properties for backfill are recommended:

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_0</u>
Granular A	35°	22.8 kN/m ³	0.43
Granular B	30°	21.2 kN/m ³	0.50

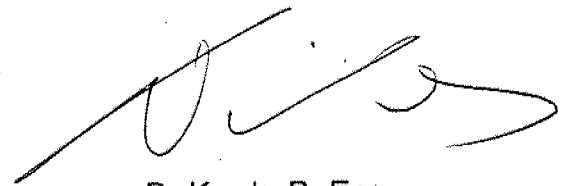
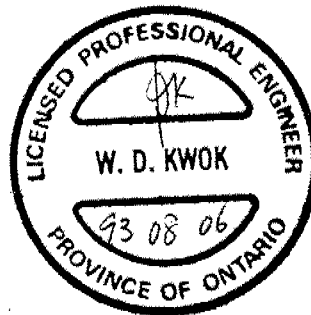
Embankment Slopes

Approach embankment slopes will be about 3.0 m high. Surficial organics should be removed prior to filling. Embankment slopes should be constructed at 2H:1V in the approach areas. Regular slope vegetation should be established as soon as possible after the fill operation to control surface erosion, as per OPSD-218.01.

MISCELLANEOUS

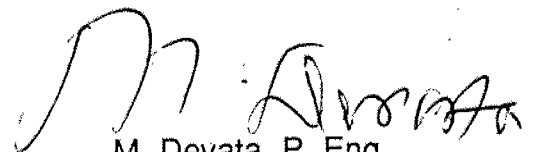
The field work for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer, using the equipment owned and operated by Master Soil Investigation Ltd. Bedrock was classified by MTO petrographer D. Williams.

The project was carried out by D. Kwok under the general supervision of B. Iyer, Senior Foundation Engineer. The report was prepared by D. Kwok, reviewed by B. Iyer, and approved by M. Devata, Chief Foundation Engineer.



D. Kwok, P. Eng.

Project Foundation Engineer



M. Devata, P. Eng.

Chief Foundation Engineer

APPENDIX

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 (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	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

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_r	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

1 OF 1

METRIC

[illegible]

RECORD OF BOREHOLE No 1A

1 OF 1

METRIC

W.P. 60-87-00 LOCATION Sta 14+197.5, e/s 12.3m RT CL Hwy 11 ORIGINATED BY DK
 DIST 16 17 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Rock Core COMPILED BY DT
 DATUM Geodetic DATE 93 06 06 CHECKED BY BI

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _P	W			W _L		
288.2	Ground Surface																		
0.0	Probable Silty Sand					288													
						287													
						286													
						285													
						284													
283.4	Biotite Hornblende Gneiss Bedrock		1	RC	REC 100%	283													
4.8						282													
						281													
280.7	End of Borehole																		
7.5	• 93 06 06																		

ROCK CORE DESCRIPTION **WP 60-87-00**

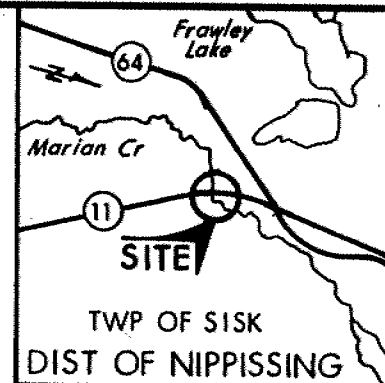
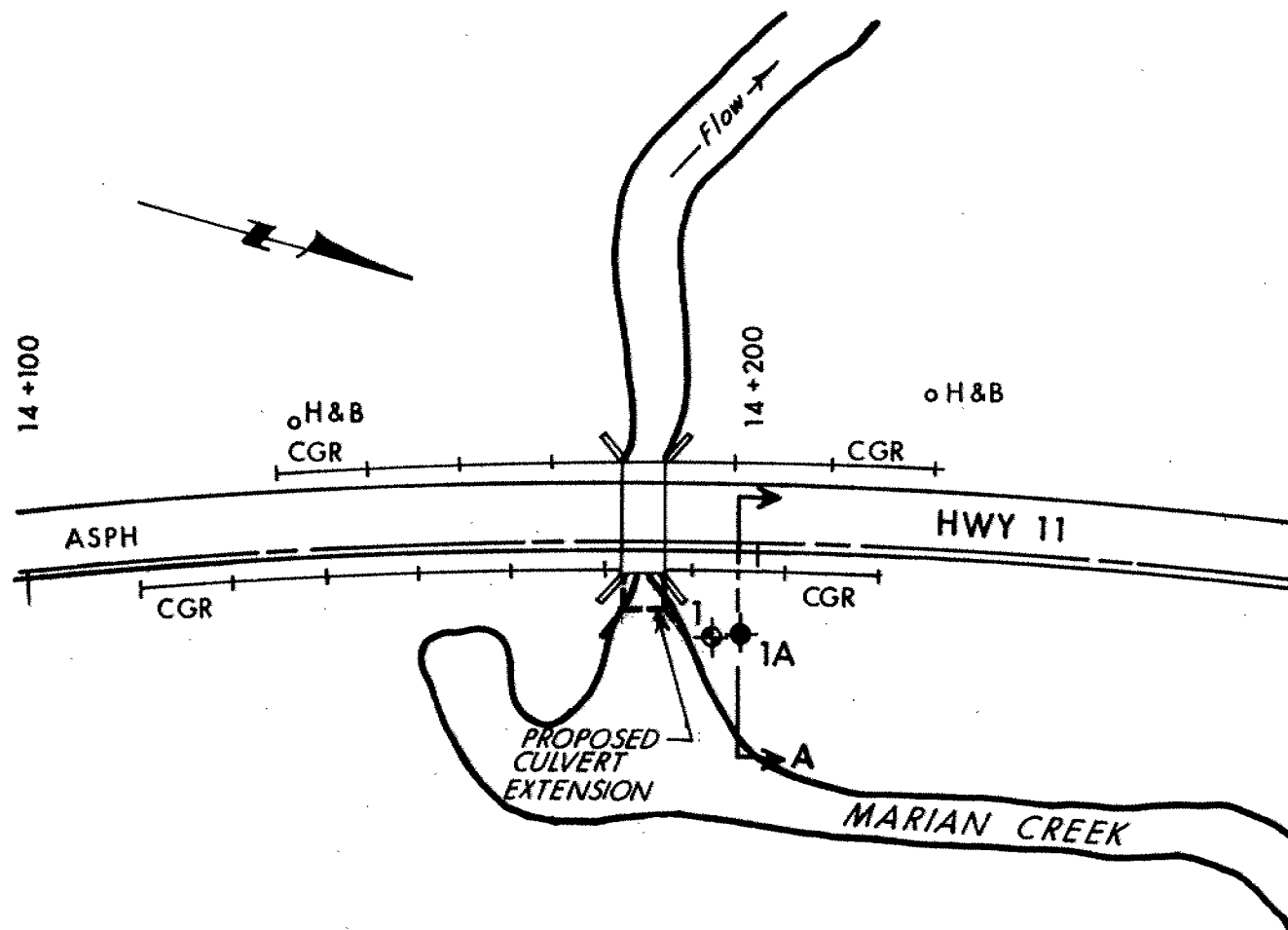
Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1A	1	4.75-6.02	100	90	4.75-7.52	BIOTITE-HORNBLLENDE GNEISS, greenish black to very light grey to moderate orange pink; medium to coarse grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, dipping, undulating to planar, smooth.
	2	6.02-7.52	100	100		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
 Logged by: DAW, Soils and Aggregates Section



KEY PLAN
SCALE
0.5km 0 0.5km

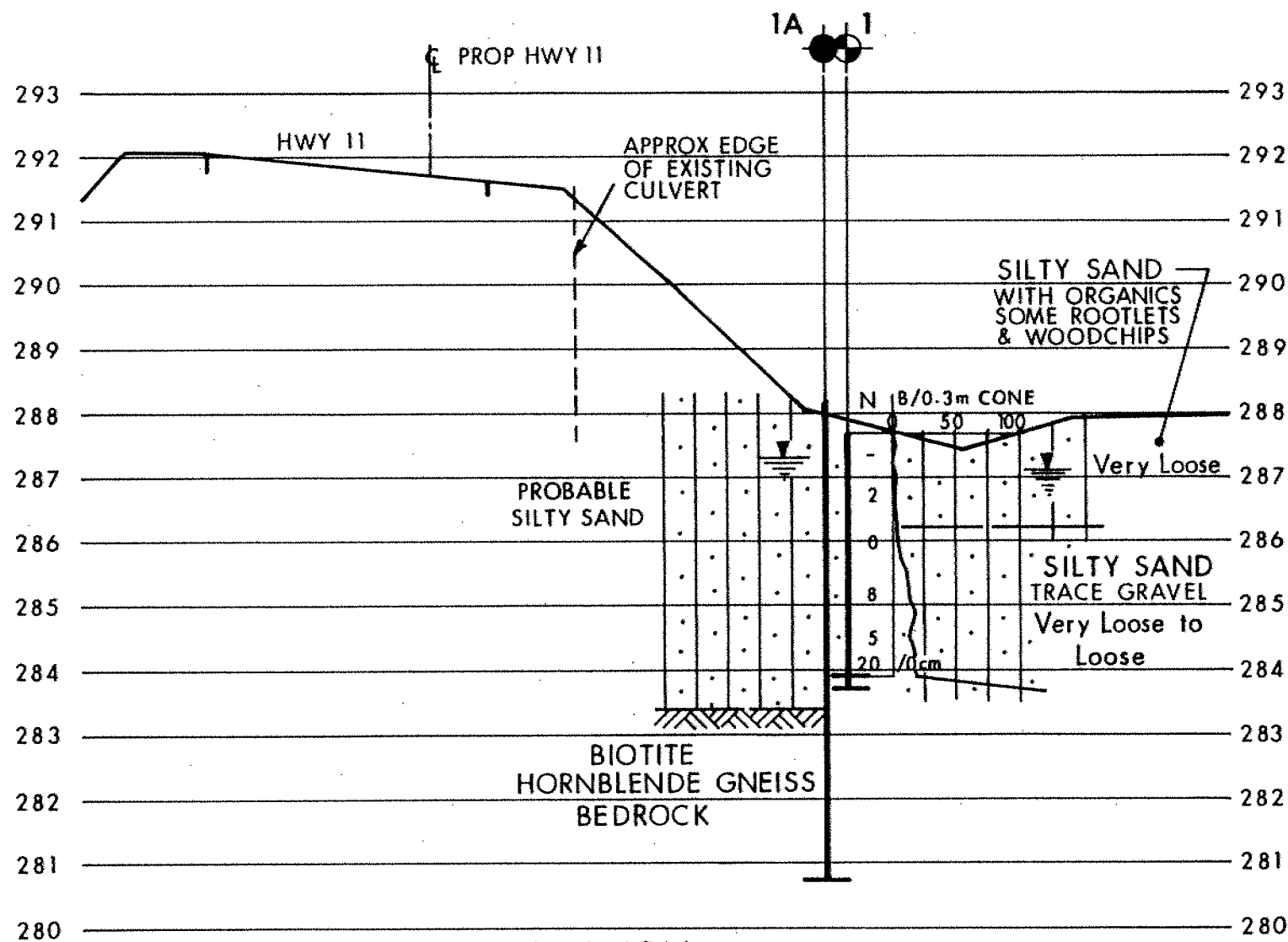
LEGEND

- Bore Hole
- ⊕ Bore Hole & Cone

PLAN
SCALE
10m 0 10m

Note :
For subsurface information refer
to Dwg 608700-B

Geocres No 31L-62
WP 60-87-00
Dist 1817, site 43-360
Dwg No 608700-A



Note :

For Plan refer to 608700-A

Dwg No 608700-B