DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 41J-42

DIST. 18 REGION

W.P. No. 276-85-01

CONT. No. 86-219

W. O. No.

STR. SITE No. 38S-44

HWY. No. 556

LOCATION Dam Creek Bridge

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-219

Ontario

Ministry of
Transportation and
Communications

INDEX

NOTE: For the purposes of this contract, this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-noted project.

FOUNDATION INVESTIGATION REPORT
FOR
W.P. 276-85-01 ; Site 38S-44
Dam Creek Bridge
Hwy. 556, District 18, Sault Ste. Marie
(30.3 km N. of Hwy. 17)

INTRODUCTION

This report summarizes the results of the foundation investigation required for the proposed bridge replacement and its approach embankments.

The fieldwork was conducted in two stages:

1) survey of exposed bedrock on 85 08 13-14.
2) drilling operations utilizing a diamond drill equipped with B-size and A-size casings and core barrels on 85 10 16-18.

This work consisted of 25 probes to determine elevations of exposed bedrock and 2 boreholes.

SITE DESCRIPTION

The site is located in the Twp. of Hodgins, District of Algoma, approximately 30.3 km north of Hwy. 17 at the existing crossing of Hwy. 556 over Dam Creek.

The existing bridge is supported on rock-filled cribs founded on bedrock.

The local topography is extremely variable with the existing bridge located in the deeply incised floodplain of Dam Creek.

Physiographically, the site is located in the Canadian Shield.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix, BH #26 and BH #27) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes and the probe locations (#1 to #25) and the bedrock elevations are shown on Drawing No. 78018300 - A. (Refer to Drawing No. 2 of the Contract Drawings)

At this site, bedrock is essentially at the surface (except for minor surface boulders) from 10± m upstream of Hwy. 556 C/L, to 13± m downstream of Hwy. 556 C/L. The bedrock dips to approximately 4 m below the surface (elev. 308± m) at a location 20± m upstream of Hwy. 556 C/L.

Overburden

The overburden at this site is very dense, consisting of boulders, gravel and sand.

Bedrock

The bedrock is unweathered, massive granite gneiss.

Groundwater

At the time of the field investigation, the groundwater elevations was at the creek surface (elev. 311.6 m on 85 10 17).

D. H. Dundas, P. Eng.
Sr. Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

A P P E N D I X

RECORD OF BOREHOLE No 26 METRIC

W P 276-85-01 LOCATION STA 16+713.1 o/s 17.1 m RT ℄ HWY 556 LINE 'Z' ORIGINATED BY DD

DIST 18 HWY 556 BOREHOLE TYPE B & A Core COMPILED BY DD

DATUM GEODETIC DATE 85 10 16 - 17 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
311.8	GROUND SURFACE										
0.0	Boulders, Gravel and Sand very dense		1	B RC	rec. 60%	▼					
			2	B RC	rec. 39%		311				
			3	B RC	rec. 8%		310				
			4	B RC	rec. 37%		309				
307.7			5	B RC	rec. 45%		308				
4.1	Bedrock Granite Gneiss unweathered		6	A RC	rec. 100%		307				
			7	A RC	rec. 94%		306				
305.4											
6.4	END OF BOREHOLE										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ✣ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 27 METRIC

W P 276-85-01 LOCATION STA 16+719.6 o/s 10.4 m RT ℄ HWY 556 LINE 'Z' ORIGINATED BY DD

DIST 18 HWY 556 BOREHOLE TYPE B & A Core COMPILED BY DD

DATUM GEODETIC DATE 85 10 17 - 18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
311.6	GROUND SURFACE										
0.0	Boulders, Gravel and Sand Very dense		1	B RC	rec. 42%		311				
			2	B RC	rec. 32%						
			3	B RC	rec. 23%		310				
308.2							309				
3.4	Bedrock Granite Gneiss unweathered		4	B RC	rec. 94%						
			5	A RC	rec. 100%		308				
307.2			6	A RC	rec. 100%						
4.4	END OF BOREHOLE										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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

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

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

276-85-01

WP ~~7801-83-00~~ DIST 18

HWY 556 STR SITE ~~N/A~~ 385-44

DAM CREEK BRIDGE

(30.3 Km N. of Hwy. 17)

DISTRIBUTION

O. Ramakko (3)

J.B. Macmaster

R. Girad

A. Pritchard

K. Bassi

J.H. Peer

T. Yakutchuk

K. Maluzinsky (Cover Only)

T.J. Kovich (Cover Only)

GEOCRES 41J-42

DATE NOV 19 1985

FOUNDATION INVESTIGATION REPORT
FOR
W.P. 7801-83-00; Site N/A
Dam Creek Bridge
Hwy. 556, District 18, Sault Ste. Marie
(30.3 km N. of Hwy. 17)

INTRODUCTION

This report summarizes the results of the foundation investigation required for the proposed bridge replacement and its approach embankments.

The fieldwork was conducted in two stages:

1) survey of exposed bedrock on 85 08 13-14.
2) drilling operations utilizing a diamond drill equipped with B-size and A-size casings and core barrels on 85 10 16-18.

This work consisted of 25 probes to determine elevations of exposed bedrock and 2 boreholes.

SITE DESCRIPTION

The site is located in the Twp. of Hodgins, District of Algoma, approximately 30.3 km north of Hwy. 17 at the existing crossing of Hwy. 556 over Dam Creek.

The existing bridge is supported on rock-filled cribs founded on bedrock.

The local topography is extremely variable with the existing bridge located in the deeply incised floodplain of Dam Creek.

Physiographically, the site is located in the Canadian Shield.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix, BH #26 and BH #27) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes and the probe locations (#1 to #25) and the bedrock elevations are shown on Drawing No. 78018300 - A.

At this site, bedrock is essentially at the surface (except for minor surface boulders) from 10± m upstream of Hwy. 556 C/L, to 13± m downstream of Hwy. 556 C/L. The bedrock dips to approximately 4 m below the surface (elev. 308± m) at a location 20± m upstream of Hwy. 556 C/L.

Overburden

The overburden at this site is very dense, consisting of boulders, gravel and sand.

Bedrock

The bedrock is unweathered, massive granite gneiss.

Groundwater

At the time of the field investigation, the groundwater elevations was at the creek surface (elev. 311.6 m on 85 10 17).

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct an open box concrete culvert to replace the existing timber crib/rock fill single span bridge carrying Hwy. 556 over Dam Creek.

FOUNDATION DESIGN

The proposed culvert may be supported on spread footings founded on bedrock. Please refer to Drawing No. 78018300 - A for bedrock elevations at the probe and borehole locations. For estimation purposes, bedrock may be interpolated between these points.

The following design values are recommended:

- Factored Bearing Capacity at U.L.S. = 10 000 KPa
- Bearing Capacity at S.L.S. Type II will not govern design.

EARTH PRESSURE CALCULATIONS

Backfill to structures should consist of granular material in accordance with MTC Standard Special Provision #121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2. of the O.H.B.D.C.

Alternately, rockfill may be used as backfill.

For design purposes, the physical properties of the backfill are as follows:

MATERIAL	$\emptyset$	γ
GRANULAR 'A'	35°	22.0 KN/M^3
GRANULAR 'B'	30°	21.2 KN/M^3

At this site, the foundation is considered to be 'non-yielding' and the at-rest condition applies insofar as lateral earth pressures are concerned.

SETTLEMENT CONSIDERATIONS:

Differential settlements will be negligible.

SLOPE STABILITY

Assuming the proposed grade is the same as the existing grade, no stability problems are anticipated for earthfill embankments with slopes of 2:1 or flatter, or rockfill embankments with slopes of 1.25:1.

FROST PROTECTION

Frost protection is not a concern for footings founded on sound bedrock.

DE-WATERING

Where bedrock is within 1 m of the surface de-watering in not anticipated to be a major problem. In these areas, it is expected that water entering excavations can be controlled by cofferdams and sump pumping.

Where bedrock is more than 1 m below the surface, a more elaborate de-watering scheme may be required if the footings are to be constructed in the dry. However, due to the irregular bedrock surface at this site, developing a seal for a cofferdam at this depth may be difficult. Therefore, it may be advantageous to construct a portion (i.e. at least enough to balance the hydrostratic head) of the footing by employing tremie concrete techniques. The remainder of the footing should be constructed in the dry.

RESISTANCE TO LATERAL FORCES:

For design purposes an unfactored friction coefficient of 0.7, or a factored friction coefficient of 0.53 may be assumed to apply between the bedrock and base of the footings.

To supplement the frictional resistance between the base of the footing and the bedrock surface, dowels grouted into the bedrock may be used.

Concerning the inquiry by the Northwestern Region Structural Section regarding tension resistance, rock bolts (rock anchors) may be used to provide resistance. The design of rock bolts/rock anchors depends on the type of anchor (e.g. split rod anchor, expanded shell bolt, resin-bonded rock bolt). In the past, the design of rock anchors has been carried out primarily by empirical rules. In this type of rock, the ultimate load provided by a 25 mm diameter, 2 m long anchor may range from 200 kN for expanded shell anchors (torque dependent) to over 300 kN for resin-bonded anchors. If rock bolts/rock anchors are considered it is recommended that the anchor supplier should be requested to

provide installation details. The resistance of each installed anchor should be verified by field testing to 1.5 x design resistance.

For design purposes it may be assumed that the physical properties of the bedrock will not govern design of the dowels/rock bolts/rock anchors. That is, the bedrock is sufficiently massive, and has sufficient strength, to exceed the strength of the dowel/rock bolt/rock anchor.

Concerning the inquiry the Northwestern Region Structural Section regarding the applicability of Section 8-8.4 of the O.H.B.D.C. to the design of anchors, this Section is not responsible for that particular Section of the code. Provided that the minimum requirements specified in the foundation report are met, the provisions of that Section may be followed at the discretion of the Structural Section.

CONSTRUCTION CONSIDERATIONS

As the bedrock surface is undulating, mass concrete may be used to bring the bearing surface up to the footing level.

MISCELLANEOUS

The probe portion of the fieldwork for this project was carried out under the supervision of Mr. I. Richardson, Student Engineer. The drilling portion of the fieldwork for this project was carried out under the supervision of Mr. D. Dundas, Foundations Engineer.

The report was written by Mr. Dundas, and reviewed by Mr. M. Devata, Chief Foundations Engineer.

The drilling equipment used was owned and operated by Marathon Drilling Co. Ltd.

D. H. Dundas

D. H. Dundas, P. Eng.
Senior Foundations Engineer

M. Devata

M. Devata, P. Eng.
Chief Foundations Engineer

A P P E N D I X

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

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 and Communications
Ontario

RECORD OF BOREHOLE No 26 METRIC

W P 276-85-01 LOCATION STA 16+713.1 o/s 17.1 m RT ℄ HWY 556 LINE 'Z' ORIGINATED BY DD
DIST 18 HWY 556 BOREHOLE TYPE B & A Core COMPILED BY DD
DATUM GEODETIC DATE 85 10 16 - 17 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
311.8	GROUND SURFACE										
0.0	Boulders, Gravel and Sand very dense		1	B RC	rec. 60%	▽					
			2	B RC	rec. 39%		311				
			3	B RC	rec. 8%		310				
			4	B RC	rec. 37%		309				
			5	B RC	rec. 45%		308				
307.7											
4.1	Bedrock Granite Gneiss unweathered		6	A RC	rec. 100%		307				
			7	A RC	rec. 94%		306				
305.4											
6.4	END OF BOREHOLE										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 27 METRIC

W P 276-85-01 LOCATION STA 16+719.6 o/s 10.4 m RT ⊆ HWY 556 LINE 'Z' ORIGINATED BY DD
DIST 18 HWY 556 BOREHOLE TYPE B & A Core COMPILED BY DD
DATUM GEODETIC DATE 85 10 17 - 18 CHECKED BY DD

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
311.6	GROUND SURFACE										
0.0	Boulders, Gravel and Sand Very dense		1	B RC	rec. 42%		311				
			2	B RC	rec. 32%						
			3	B RC	rec. 23%		310				
308.2							309				
3.4	Bedrock Granite Gneiss unweathered		4	B RC	rec. 94%						
			5	A RC	rec. 100%		308				
307.2			6	A RC	rec. 100%						
4.4	END OF BOREHOLE										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04

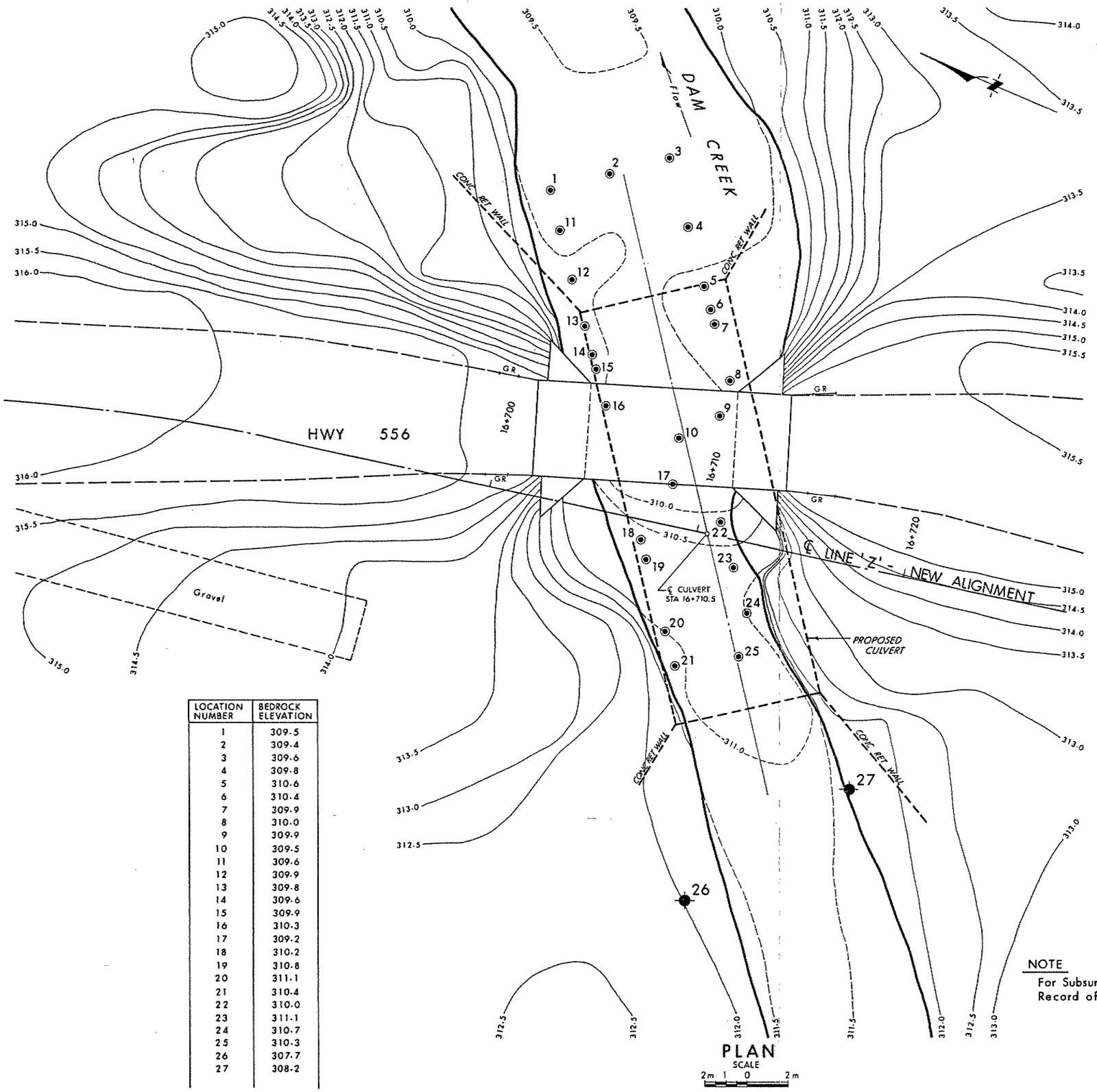
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 276-85-01

DAM CREEK

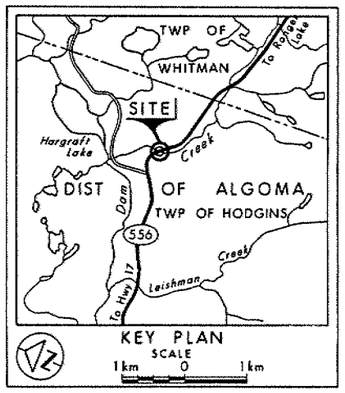
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE
2m 1 0 2m

LOCATION NUMBER	BEDROCK ELEVATION
1	309.5
2	309.4
3	309.6
4	309.8
5	310.6
6	310.4
7	309.9
8	310.0
9	309.9
10	309.5
11	309.6
12	309.9
13	309.8
14	309.6
15	309.9
16	310.3
17	309.2
18	310.2
19	310.8
20	311.1
21	310.4
22	310.0
23	311.1
24	310.7
25	310.3
26	307.7
27	308.2



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 1985 10
- Probe Hole

No	ELEVATION	STATION	OFFSET
26	311.8	16+713.1	17.1m Rt
27	311.6	16+719.6	10.4m Rt

NOTE
For Subsurface details refer to Record of Borehole Sheets

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 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION
	86 04	SO	LINE 'Z' ADDED

Geocres No 41 J-42

HWY No 556			DIST 18
SUBM'D D D	CHECKED	DATE 1985 11 13	SITE
DRAWN	CHECKED	APPROVED	DWG 2768501-A

REF No E-8055-1; 1985 01

OVERSIZE DRAWING

memorandum

Ontario

To: Mr. C. E. Pritchard
Manager, Construction Office
Northwestern Region

Date: 1986 05 07

From: Engineering Materials Office
Foundation Design Section
Central Building, Room 315

Re: W.P. 276-85-02; Site 38S-44
Dam Creek Culvert
Hwy. 556, District #18, Sault Ste. Marie

We acknowledge receipt of your memo dated April 29, 1986, in which you have discussed the problems you have experienced with foundation information provided by this office.

We believe that the memo to O. E. Ramakko, dated 86 04 07, and your subsequent telephone conversations with D. Dundas of this office, have clarified our opinion that additional fieldwork is not required at Dam Creek. It is our understanding that you agree that no additional fieldwork will be carried out at this site unless another project requires drilling in that vicinity. However, if you insist, we will arrange for additional fieldwork.

Regarding your concerns about the foundation information for Contract 83-216 and Contract 83-221, your memo has been passed along to Ken Selby, Chief Foundations Engineer (West), who is responsible for the foundation aspects of those projects. Ken is preparing a response to your comments.

Please be assured that we take the quality of our foundation reports very seriously, and it is our intent to provide the best possible information for design and construction. Careful consideration is given to the extent of fieldwork required for each project, and these decisions are based on our experience and our assessment of site conditions. If foundation related construction problems do occur, we are most anxious to be advised, and we will attach the highest priority to resolving these problems.

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

MD:gp

cc: O.E. Ramakko
K. G. Selby

memorandum

Ontario

To: Mr. O. E. Ramakko,
Head, Structural Section,
NORTHWESTERN REGION - Thunder Bay

Date: 86 04 07

From: Engineering Materials Office,
Foundation Design Section,
Central Building, Room 315

Re: W. P. 276-85-02; Site: 38S-44
Dam Creek Culvert
Hwy. 556, District #18, Sault Ste. Marie

This office has reviewed your request for additional foundation investigations at the above-noted site.

Because of the presence of numerous builders at this site, drilling operations are extremely difficult and costly. We estimate that the cost of completing additional foundation investigations to provide bedrock elevations at your proposed borehole locations would be in the order of $10,000 to $15,000.

Due to the problems associated with drilling at this site, an alternate method of ascertaining bedrock elevations at your requested locations would be to excavate using a backhoe. However, it would seem more reasonable to carry out this type of operation during the actual construction of the culvert.

We note that the proposal shown on the General Arrangement (Dwg. #1 dated January/1986) by Northland Engineering Limited is different than the Site Plan (E-8055-1,[dated January 1985]) on which our foundation investigation was based. However, in our opinion sufficient foundation investigations have already been carried out, and the subsurface information and foundation recommendations in our foundation report dated 85 11 19, provide the required information to design and construct this culvert.

Your proposed additional boreholes have been plotted on the attached Borehole Locations and Soil Strata drawing for this project. From the existing data, we estimate the following bedrock elevations at these locations:

Location	Estimated Bedrock Elevation
proposed BH#1	308± m
proposed BH#2	309± m
proposed BH#3	309± m
proposed BH#4	308± m

....2

Re: W. P. 276-85-02; Site: 38S-44
Dam Creek Culvert
Hwy. 556, District #18, Sault Ste. Marie

In summary, its our opinion that further foundation investigations should not be carried out at this stage of the project. We suggest that the bedrock elevation can be adequately estimated for design purposes and verified during construction. Rather than spending $10,000 to $15,000 on further foundation investigations, a more practical approach may be to reserve these funds for construction of the footings.

If the present design can not be completed with the existing foundation information, other alternatives should be considered, such as;

1. Supporting the west end of the culvert and the wing walls on spread footings founded directly on the overburden. In this case construction joints would be required to accommodate anticipated differential settlements between the bedrock and overburden foundations.

2. Re-aligning the road to the east, where bedrock is visible at the surface.

3. Supporting the west end of the culvert and the wing walls on caissons socketed into the bedrock.

If there are any questions, please contact this office.

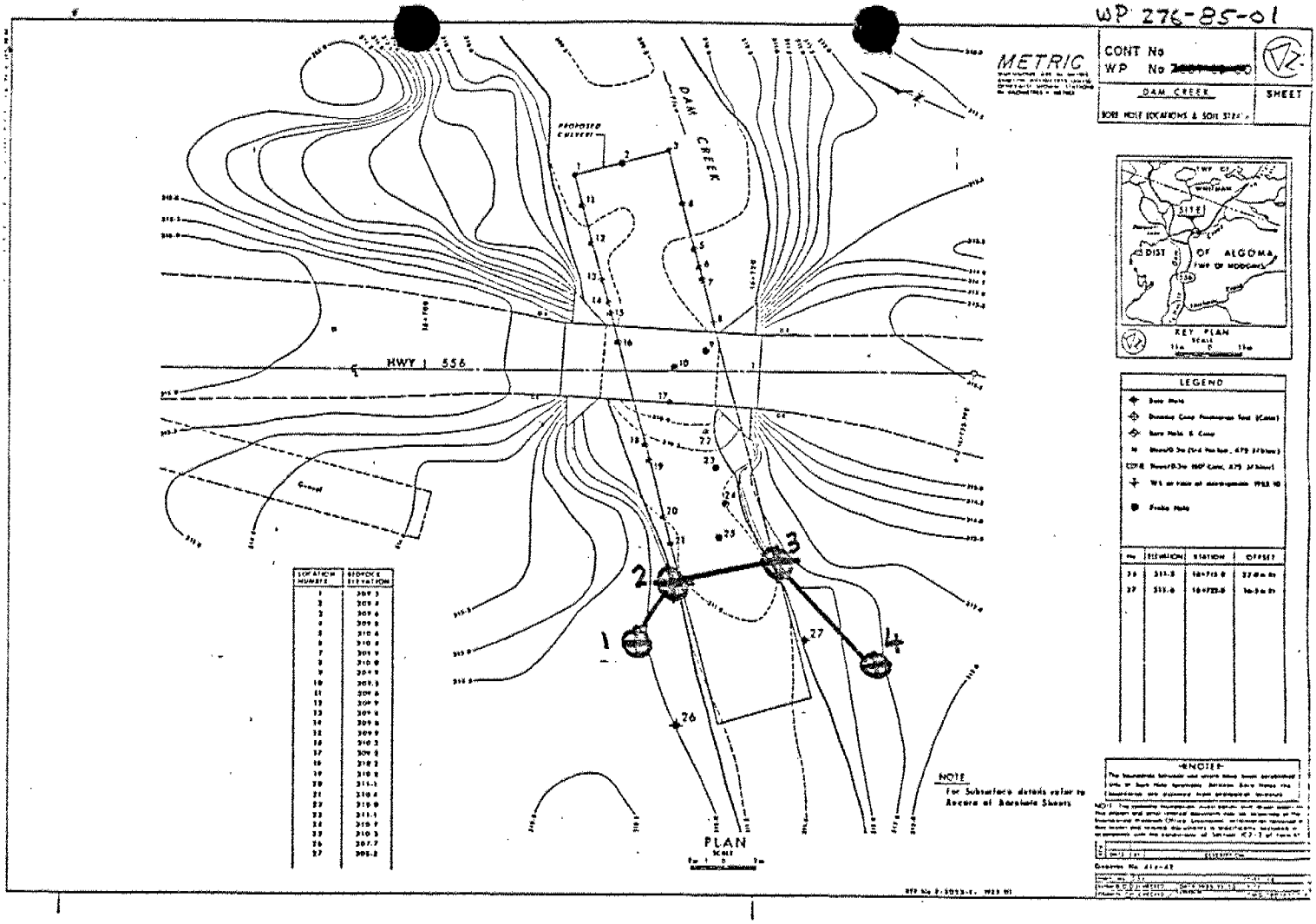
D. H. Dundas, P. Eng.,
Sr. Foundations Engineer

for M. Devata, P. Eng.,
Chief Foundations Engineer
(East)

DHD:ma

cc: K. G. Bassi,
C. E. Pritchard

WP 276-85-01


METRIC
CONT No
WP No
DAM CREEK
SHEET
BORE HOLE LOCATIONS & SOIL STRATA
PROPOSED CULVERT
DAM CREEK
HWY 1 556
Gravel
PLAN
SCALE
KEY PLAN
SCALE
SITE
DIST OF ALGOMA
LEGEND
NOTE
For Subsurface details refer to Assoro of Borehole Sheets
NOTES

M E M O R A N D U M

TO: Mr. M. Devata, Chief
Foundations Engineer (East)
3rd Floor, Central Building
Downsview, Ontario

DATE: 86 03 13

FROM: Structural Section
Northwestern Region

Re: W.P. 276-85-02 - Dam Creek Culvert - Site 38S-44

At a technical review meeting held on 86 03 11 regarding the above project, concern was expressed by the Regional Construction Office about the lack of information existing on bedrock elevations at the upstream end of the culvert. As a result they have requested additional foundation investigations to verify bedrock elevations at the locations shown on the attached print.

Should you agree to carry out this work, the information is requested by 86 05 15.

R. J. Krisciunas
Senior Structural Engineer
(for)
O. E. Ramakko
Head, Structural Section

RJK/lps
Attach.

METRIC

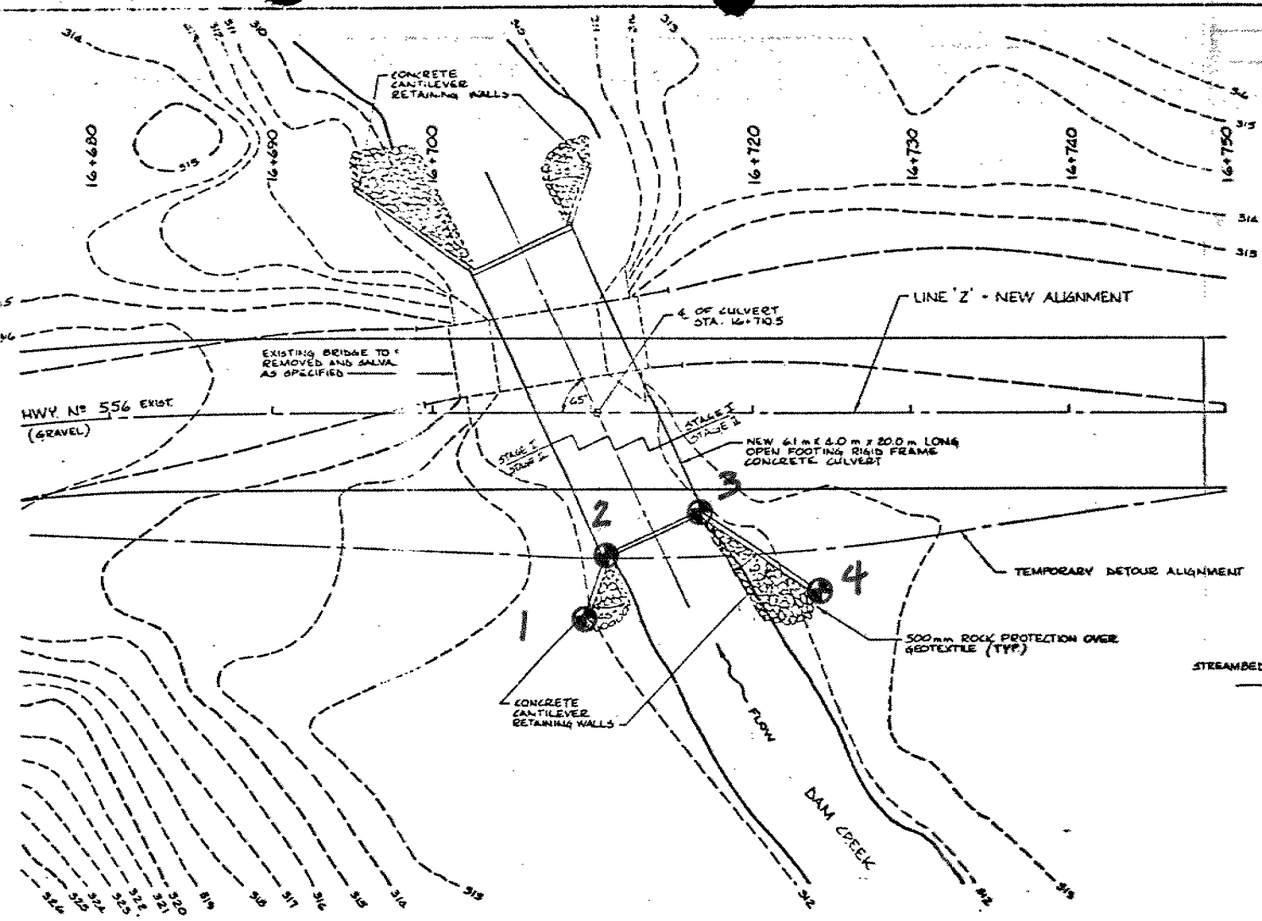
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

northland engineering limited
Consulting Engineers and Planners
NORTH BAY — SUDBURY — TIMMINS

CONT No
WP No 276-85-02

DAM CREEK CULVERT
HWY 556 STA 16+710.5
GENERAL ARRANGEMENT

SHEET 8



PLAN
SCALE 1:200

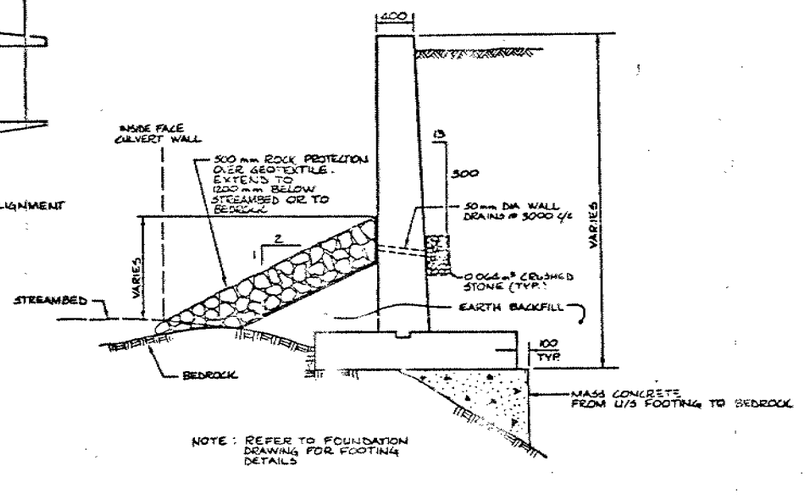
SUGGESTED CONSTRUCTION SEQUENCE

CONSTRUCT CULVERT IN TWO STAGES AS SHOWN AND IN THE FOLLOWING SEQUENCE

- CONSTRUCT AND DIVERT TRAFFIC ONTO TEMPORARY DETOUR ROAD
- CONSTRUCT STAGE I OF CULVERT INCLUDING RETAINING WALLS & SIDE
- BACKFILL AND DIVERT TRAFFIC OVER STAGE I
- REMOVE TEMPORARY DETOUR ROAD
- CONSTRUCT STAGE II OF CULVERT INCLUDING RETAINING WALLS W SIDE
- BACKFILL STAGE II AND COMPLETE BALANCE OF PROJECT

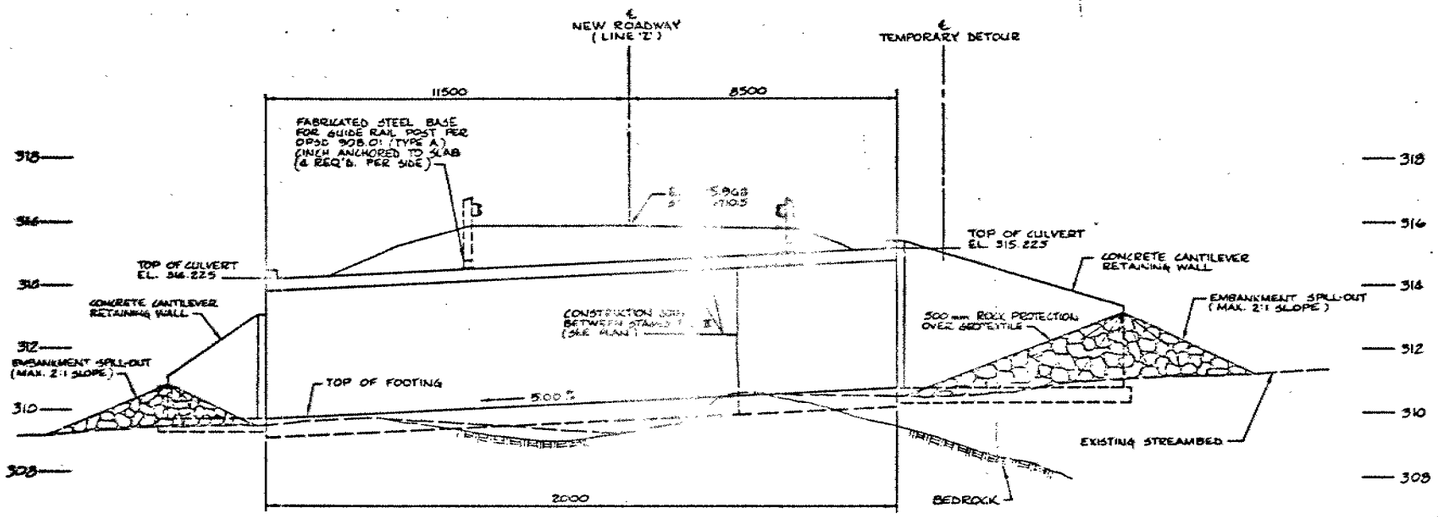
GENERAL NOTES

- CLASS OF CONCRETE FOOTINGS, TREMIE & MASS CONCRETE 20 MPa REMAINDER 30 MPa
- CLEAR COVER TO REINFORCING STEEL TO = 20 mm EXCEPT AS NOTED
- ALL EXPOSED CORNERS TO BE CHAMFERED 20 mm
- NO CONCRETE SHALL BE PLACED FOR ANY FOOTING UNTIL THE DEPTH OF THE EXCAVATION AND CHARACTER OF THE FOUNDATION MATERIAL HAVE BEEN APPROVED BY THE ENGINEER.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 300 mm
- REINFORCING STEEL SHALL BE GRADE 400
- STEEL FOR EACH STAGE OF CULVERT CONSTRUCTION AND FOR EACH RETAINING WALL SHALL BE BUNDLED SEPARATELY AND MARKED FOR LOCATION
- WALL DRAIN OPENINGS TO BE FORMED USING NON-METALLIC MATERIAL VERTICAL LOCATION OF WALL DRAINS SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER
- I.F. DENOTES INSIDE FACE
- O.F. DENOTES OUTSIDE FACE
- E.F. DENOTES EACH FACE

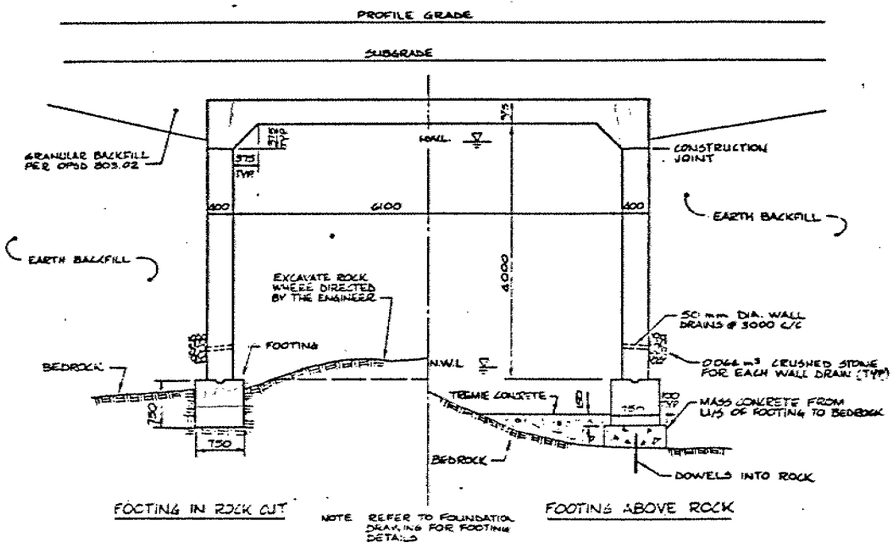


NOTE : REFER TO FOUNDATION DRAWING FOR FOOTING DETAILS

TYPICAL RETAINING WALL SECTION



PROFILE OF CULVERT @ ℄
SCALE 1:100



NOTE REFER TO FOUNDATION DRAWING FOR FOOTING DETAILS

TYPICAL CULVERT SECTION
SCALE 1:50

BM ELEV. 314.61
GEODETIC DATUM
N & W IN ROOT OF BIRCH
15.5 LT STA. 16+73.1

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS

NO.	DATE	BY	DESCRIPTION

DESIGNED | DRAWN | LEADING | CHECKED | DATE JAN 86

memorandum

Ontario

To: O. E. Ramakko
Head, Structural Section
Northwestern Region

Date: 86 02 26

Attn: R. J. Krisciunas

From: Foundation Design Section
Rm. 315, Central Building

Re: WP 276-85-01, Site 38S-44
Dam Creek Culvert
Hwy 556, District 18, Sault Ste. Marie

This Section has reviewed the preliminary drawings and your memo, concerning the above-noted project. Our comments are as follows:

1. We note that the WP has been changed from WP 7801-83-00 to WP 276-85-01, Site 385-55.

2. In our opinion the walls for the open-footing culvert are similar to bridge abatments. Please refer to Section 6-9.6.2 of the O.H.B.D.C. which specifies that free-draining backfill is required in the wedge behind the wall.

3. The wall drain on the Typical Retaining Wall Section on Dwg. 1 appears to be flowing up.

4. The rock protection/geotextile treatment shown in front of the wall on the Typical Retaining Wall Section is not required as erosion protection for footings on bedrock. If this treatment is required for some other purpose, the need for geotextile can be eliminated if the earth fill is replaced with rock fill.

5. Regarding the temporary detour construction notes on Dwg. 5, we anticipate some difficulty in diverting the creek temporarily in order to construct the CSP culvert in the dry, because of boulders and sands in the creek bottom.

6. The temporary 1:1 slopes shown on Dwg. 5 are steeper than those recommended in the Foundation Report. The integrity of these slopes will depend on the length of time they must be maintained at 1:1.

7. We are concerned that the bedding and backfill for the temporary pipe culvert may wash out if an upstream clay seal is not provided.

8. Regarding your concerns about sliding of the footing, we wish to draw to your attention that this problem was discussed with your office by our M. Devata and A. Radkowski of the Structural Office, in their telephone conversation with O. Ramakko in July, 1985. At that time, it was suggested that a bridge, with abutments supported on rock fill, would be a more appropriate solution at this crossing than an open footing culvert, because of the problems associated with long footings in bedrock.

As a solution to the sliding problem of the culvert design, it is suggested that you consider:

1. complete dewatering of the footing
2. underwater blasting
3. bolting through the tremie concrete.

or 4. installing the rock bolts under water.

If there are any questions, please contact this office.

D. H. Dundas

D. H. Dundas, P. Eng.
Sr. Foundations Eng.

DHD:gp

memorandum

Ontario

To: Mr. M. S. Devata
Chief Foundations Engineer
3rd Floor, Central Building
Downsview, Ontario

Date: 86 02 05

From: Structural Section
Northwestern Region

Att: Mr. D. Dundas
Senior Foundations Engineer

Re: Dam Creek Culvert, WP 276-85-01, Site 38S-44

We are submitting one set of drawings for the subject structure and ask you to review foundation design details. Of specific concern are the footings for the upstream retaining walls where we are faced with deep, sloping bedrock (Drawing 2). The potential for sliding of the concrete fill is obvious.

It is our opinion that the safest means of preventing sliding of the footing would be via a bench in the bedrock as superimposed on the drawing. The problem is that this would have to be carried out in the dry, a condition which the foundation investigation suggests may not be possible to obtain. The option of installing rock dowels as proposed by the Consultant is not considered to be as effective and would also require dewatering.

Your earliest review and response to this matter and the remaining foundation design would be greatly appreciated.

R. J. Krisciunas
Sr. Structural Engineer
(for)
O. E. Ramakko
Head, Structural Section

RJK:lps
Encl.

memorandum

Ontario

To: Mr. M. Devata
Chief Foundation Engineer
Foundation Design Section
Central Building, Room 315

Date: 85 11 20

File No.: 3162-2-4-113

Attn: Mr. D. Dundas

From: Soils & Aggregates Section
Engineering Materials Office
Central Building, Room 311

Re: Borehole Core Descriptions
Upstream Dam Creek Bridge
Hwy. 556, East of Sault Ste. Marie
W.P. 7801-83-00

As requested by your section, core from two (2) boreholes was logged, and descriptions are appended. Depth to top of bedrock and depth to top of sound rock in each borehole are tabulated below:

BOREHOLE NUMBER	DEPTH TO BEDROCK (in metres below ground surface)	DEPTH TO SOUND ROCK (in metres below ground surface)
1	4.08	4.08
2	3.47	3.47

Bedrock is granite gneiss of Precambrian Age.

If you have any questions, please contact me.

E.R. Magni,
Geologist.

ERM/jlo
Attachment

7540-1318 (10/78)

DESCRIPTION OF ROCK CORE - W.P. 7801-83-00

BOREHOLE NUMBER	DEPTH (m)	% CR*	% RQD*	CORE DESCRIPTION	
				DEPTH (m)	DESCRIPTION
1	0 - 0.38	60	0	0 - 4.08	Boulders
	- 1.34	37	26		
	- 2.56	10	0	4.08 - 6.40	Granite gneiss, alternating black and pink, unweathered, closely spaced joints becoming widely spaced joints at 4.34
	- 3.12	50	0		
	- 4.27	42	16		
	- 4.69	100	76		
	- 6.40	97	92		
2	0 - 0.91	36	0	0 - 3.47	Boulders
	- 1.71	29	0		
	- 3.23	23	17	3.47 - 4.42	Granite gneiss, alternating black and pink, unweathered, closely spaced joints
	- 3.66	94	29		
	- 4.11	94	83		
	- 4.42	67	58		

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

memorandum

Ontario

To: Mr. O. Ramakko
Head, Structural Section
Northwestern Region

Date: 85 06 18

From: Foundation Design Section
Room 315, Central Building

Re: W.P. 7801-83-00
Dam Creek Bridge
Hwy 556, 30.3km N. of Hwy 17
District 18-Sault Ste. Marie

This Section received your request for foundation investigations at the two proposed alignments for this project on 85 03 28.

During our telephone conversation of 85 04 25, we discussed our concerns regarding the relatively high costs involved in carrying out full-scale foundation investigations at both sites, in view of the apparent proximity of the bedrock to the surface, the presence of surface boulders and the ineffectiveness of drilling equipment under such conditions. We wished to bring this to your attention, as a consultant would probably have to be retained to carry out the investigations, and we estimated that the cost would be in the order of $30,000.

During our site visit of 85 05 09, it was determined that bedrock is at or near the surface at the proposed footing locations at both sites. The groundwater level is considered to be essentially the same as the creek water level.

Mr. Devata discussed the site conditions and required fieldwork with you in the telephone conversation of 85 05 10. At this time, you were advised the culvert could be founded on bedrock at either of the proposed alignments. It was agreed that, as both alignments are feasible from a foundation viewpoint, the final alignment could be selected, and subsequently the bedrock elevations at that chosen site could be verified by using a backhoe to expose the bedrock surface.

The following foundation recommendations are intended to be sufficient to permit route selection and preliminary design to proceed.

FOUNDATION DESIGN:

The proposed culvert may be supported on spread footings founded on sound bedrock.

At the existing alignment, the bedrock surface is estimated to be within 0.5m of the creek invert. (refer to Plan E-8055-1 for creek invert elevations)

At the Line 'Y' alignment, the bedrock surface is estimated to be within 1.0m of the creek invert. (refer to Plan E-8056-1 for creek invert elevations)

....2

The following design values are recommended:

O.H.B.D.C. Method

- Factored Bearing Capacity at U.L.S. = 10,000 kPa
- Bearing Capacity at S.L.S. Type II will not govern design.

EARTH PRESSURE CALCULATIONS:

Backfill to structures should consist of granular material in accordance with MTC Standard Special Provision #121 (83 10). Computation of earth pressures should be in accordance with Section 6.6.1.2. of the O.H.B.D.C.
Alternatively, rockfill may be used as backfill.

For design purposes, the physical properties of the backfill are as follows:

MATERIAL	ϕ	γ
GRANULAR 'A'	35°	22.0 kN/m^3
GRANULAR 'B'	30°	21.2 kN/m^3

At this site, the foundation is considered to be 'non-yielding' and the at-rest condition applies insofar as lateral earth pressures are concerned.

SETTLEMENT CONSIDERATIONS:

Differential settlements will be negligible.

SLOPE STABILITY:

No stability problems are anticipated for earth embankments with slopes of 2:1 or flatter, or rock embankments with slopes of 1.25:1.

FROST PROTECTION:

Frost protection is not a concern for footings founded on sound bedrock.

DE-WATERING:

De-watering is not anticipated to be a major problem. It is expected that groundwater entering excavations can be controlled by cofferdams and sump pumping.

RESISTANCE TO LATERAL FORCES:

For design purposes an unfactored friction coefficient of 0.7, or a factored friction coefficient of 0.53 may be assumed to apply between the bedrock and base of the footings.

To supplement the frictional resistance between the base of the footing and the bedrock surface, dowels may be used.

....3

If this option is required, please refer to this Section for design details for dowels.

CONSTRUCTION CONSIDERATIONS:

As the bedrock surface is probably undulating at both sites, mass concrete can be used to bring the bearing surface up to the footing level.

If there are any questions, please contact this office.

D. H. Dundas

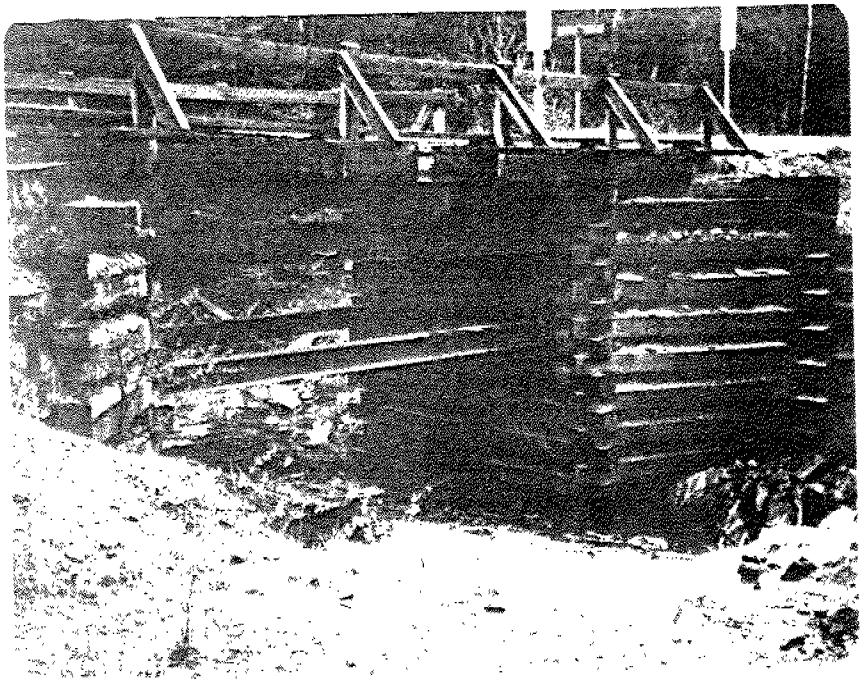
D.H. Dundas, P.Eng.
Foundations Engineer

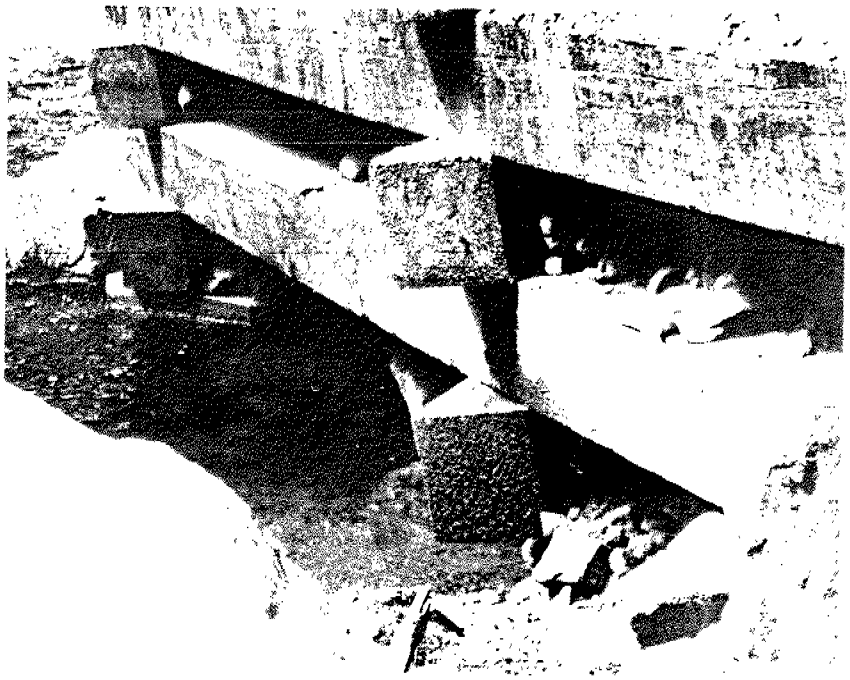
DHD/mr

MAY/79

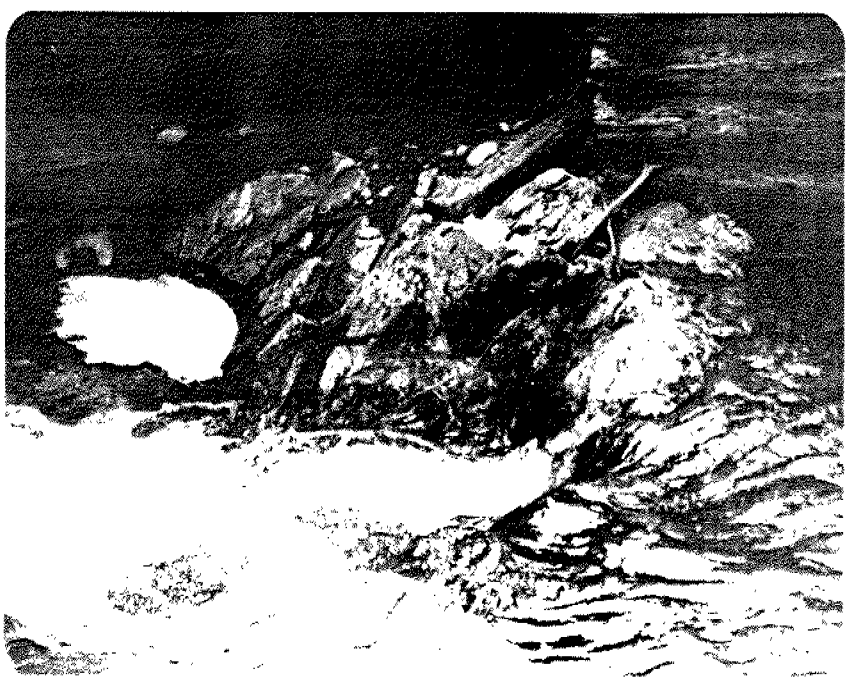
DAM CREEK

SITE # 38S-44





Fill washed out from base of cribs

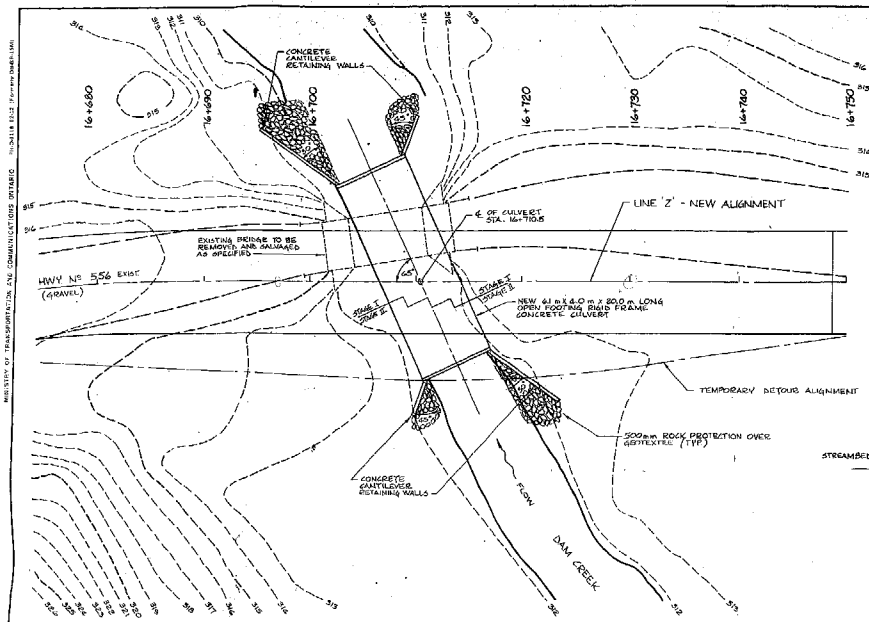


Fill Erosion from base of rock filled cribs

Sand 13/14/15.

DAM CREEK
38S-34-44
Sec Hwy 556

June 80



PLAN
SCALE 1:200

SUGGESTED CONSTRUCTION SEQUENCE

CONSTRUCT CULVERT IN TWO STAGES AS SHOWN AND IN THE FOLLOWING SEQUENCE :

- CONSTRUCT AND DIVERT TRAFFIC ONTO TEMPORARY DETOUR ROAD
- CONSTRUCT STAGE I OF CULVERT INCLUDING RETAINING WALLS E. SIDE
- BACKFILL AND DIVERT TRAFFIC OVER STAGE I
- REMOVE TEMPORARY DETOUR ROAD
- CONSTRUCT STAGE II OF CULVERT INCLUDING RETAINING WALLS W. SIDE
- BACKFILL STAGE II AND COMPLETE BALANCE OF PROJECT

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

northland engineering limited
Consulting Engineers and Planners
NORTH BAY — SUDBURY — TIMMINS

CONT No
WP No

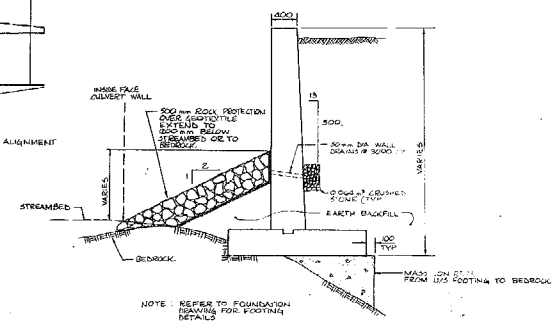
DAM CREEK CULVERT
HWY. 556 STA. 16+710.5

GENERAL ARRANGEMENT

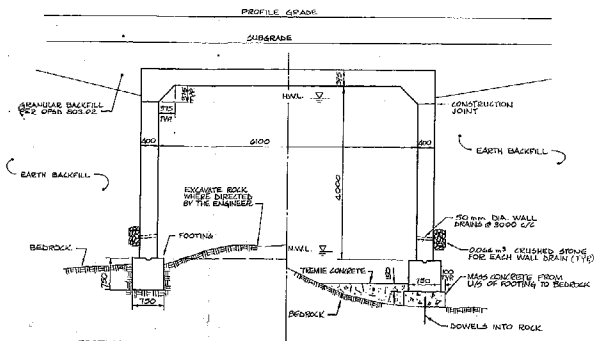
SHEET

GENERAL NOTES

- CLASS OF CONCRETE FOOTINGS, TREMIE & MASS CONCRETE 20 MPa REMAINDER 35 MPa
- CLEAR COVER TO REINFORCING STEEL 70 ± 20 mm EXCEPT AS NOTED
- ALL EXPOSED CORNERS TO BE CHAMFERED 20 mm
- NO CONCRETE SHALL BE PLACED FOR ANY FOOTING UNTIL THE DEPTH OF THE EXCAVATION AND CHARACTER OF THE FOUNDATION MATERIAL HAVE BEEN APPROVED BY THE ENGINEER.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS KEEPING THE HEIGHT OF BACKFILL APPROXIMATELY THE SAME AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 500 mm
- REINFORCING STEEL SHALL BE GRADE 400
- STEEL FOR EACH STAGE OF CULVERT CONSTRUCTION AND TYPE EACH RETAINING WALL SHALL BE BUNDLED SEPARATELY AND MARKED FOR LOCATION
- WALL DRAIN OPENINGS TO BE FORMED USING NON-METALIC MATERIAL. VERTICAL LOCATION OF WALL DRAINS SHALL BE DETERMINED IN THE FIELD BY THE ENGINEER.
- I.F. DENOTES INSIDE FACE
- O.F. DENOTES OUTSIDE FACE
- E.F. DENOTES EACH FACE

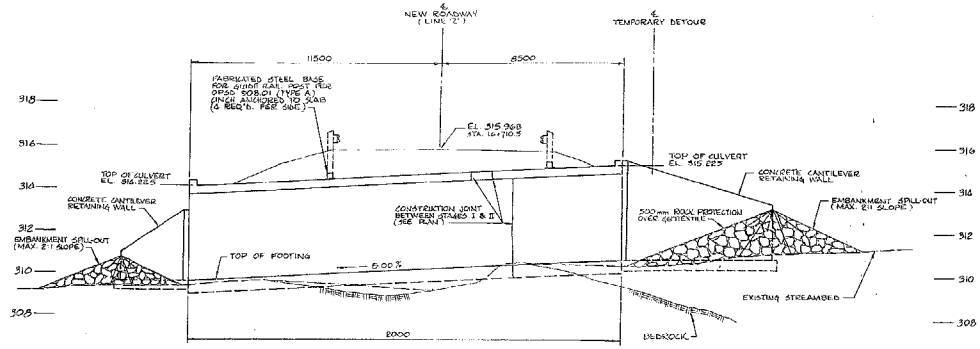


TYPICAL RETAINING WALL SECTION
N.T.S.



NOTE: REFER TO FOUNDATION DRAWING FOR FOOTING DETAILS

TYPICAL CULVERT SECTION
SCALE 1:50



PROFILE OF CULVERT @ ℄
SCALE 1:100

BM	E.L.EV. 311.61
GEODETIC DATUM	
N.B.W. IN ROOT 0.06 BIRCH 15.9 LT. STA. 16+751.1	

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWINGS

REVISIONS			
NO	DATE	BY	DESCRIPTION

DESIGN N.W.L.	CHECK	LOADING	CHECK
DRAWING W.R.	CHECK	SITE No 385-66	DWG 1

DATE JAN/86

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

northland engineering limited
Consulting Engineers and Planners
NORTH BAY — SUDBURY — TIMMINS

CONT No
WP No

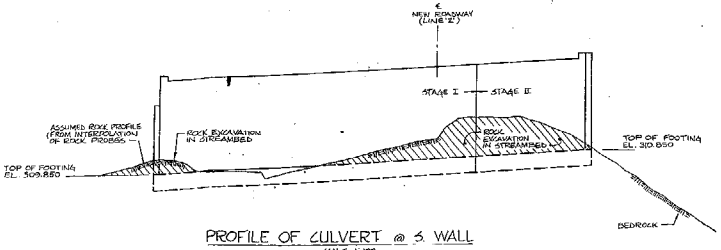
DAM CREEK CULVERT
HWY. Nº 556 STA. 16+710.5

FOUNDATIONS

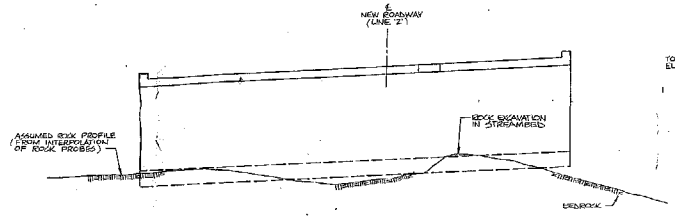
SHEET

GENERAL NOTES:

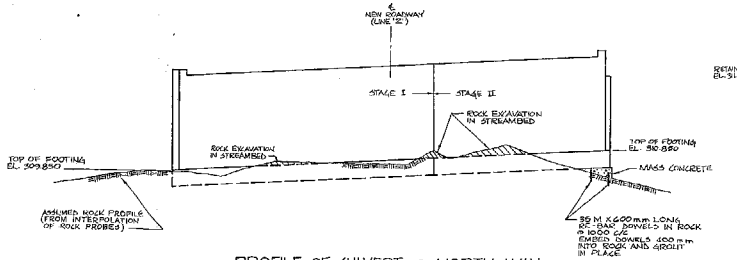
- REFER TO GENERAL ARRANGEMENT DRAWING!
- FOOTINGS TO BE SET 150mm INTO SOUND BEDROCK EXCEPT WHERE FOOTINGS ARE SHOWN TO BEAR ON MASS CONCRETE
- ROCK SURFACES IN OVEREXCAVATED AREAS SHALL BE SUBJECT TO APPROVAL BY THE ENGINEER.
- THE OVEREXCAVATION SHALL BE REPLACED WITH FOOTING CONCRETE



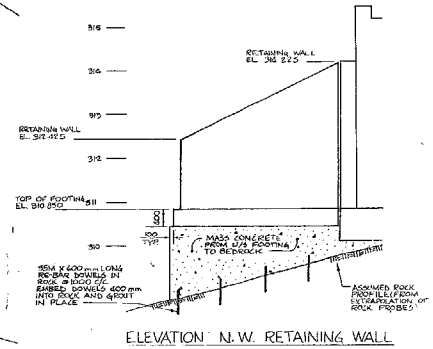
PROFILE OF CULVERT @ S. WALL
SCALE 1:100



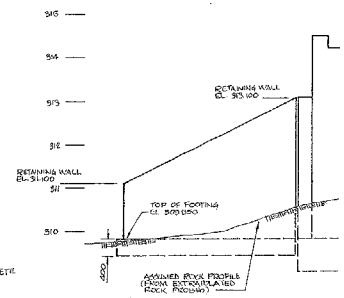
PROFILE OF CULVERT @ ℄
SCALE 1:100



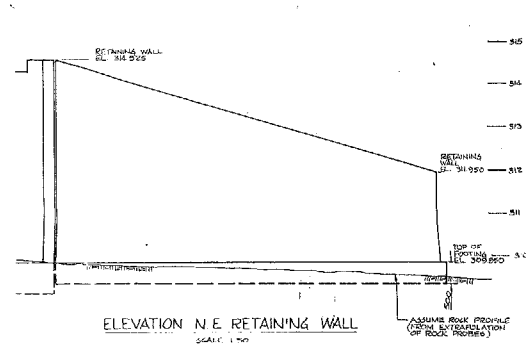
PROFILE OF CULVERT @ NORTH WALL
SCALE 1:100



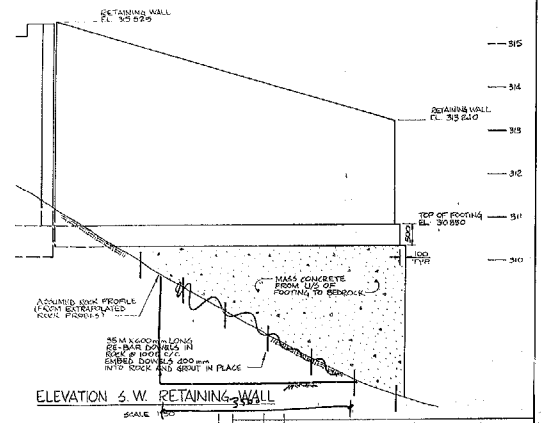
ELEVATION N.W. RETAINING WALL
SCALE 1:50



ELEVATION S.E. RETAINING WALL
SCALE 1:50



ELEVATION N.E. RETAINING WALL
SCALE 1:50

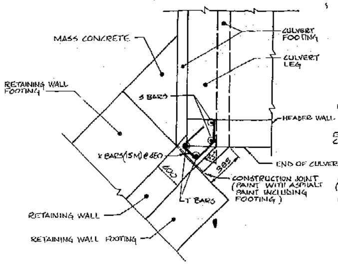


ELEVATION S.W. RETAINING WALL
SCALE 1:50

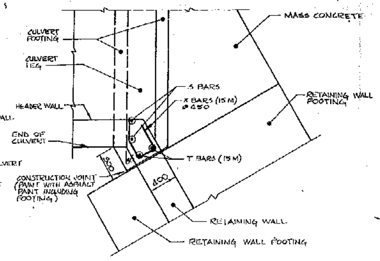
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN	MWL	CHECK	LOADING OHBDC '83 C1
DRAWING	WP	CHECK	SITE No 353-44

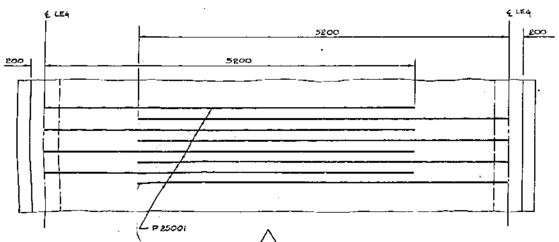
DATE JAN '86
DWG 2



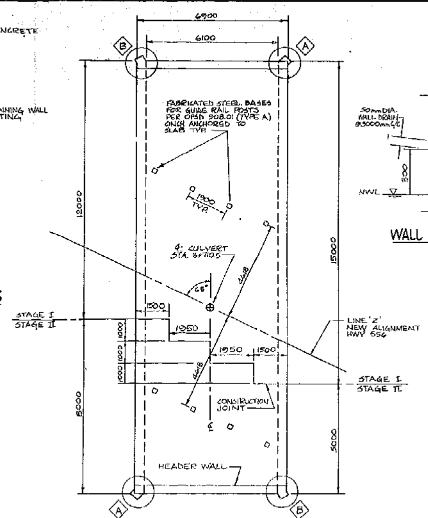
A DETAIL - S.E. & N.W. CORNERS
SCALE 1:30



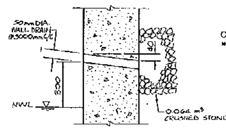
B DETAIL - S.W. & N.E. CORNERS
SCALE 1:30



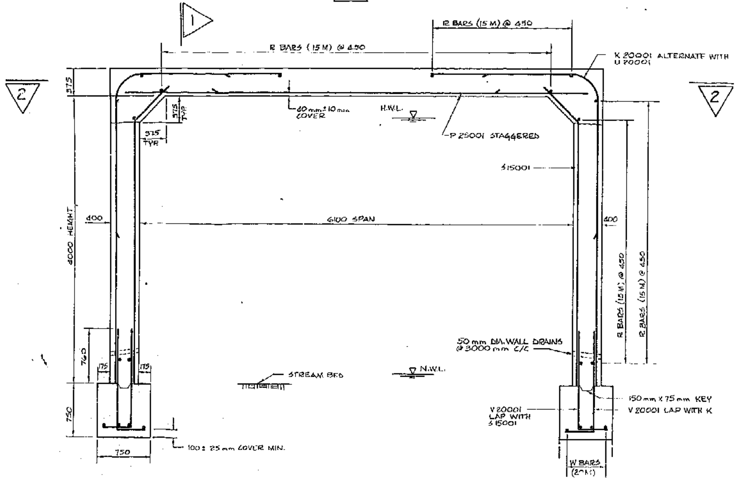
2



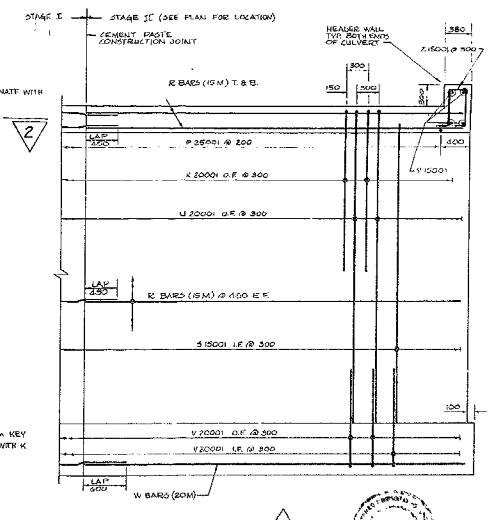
CULVERT PLAN
SCALE 1:100



WALL DRAIN DETAIL
N.T.S.



TYPICAL CULVERT SECTION
SCALE 1:30



1

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

northland engineering limited
Consulting Engineers and Planners
NORTH BAY — SUDBURY — TIMMINS

CONT No
WP No

DAM CREEK CULVERT
HWY. No 556 STA. 16+710.5
CULVERT DETAILS

SHEET

GENERAL NOTES
- REFER TO GENERAL ARRANGEMENT DRAWING

QUANTITIES			
ITEM	LEGS & SLAB	FOOTINGS	TOTAL
MASS OF REINF. STEEL tonnes	8.35	1.58	9.93
VOLUME OF CONCRETE cubic metres	120.6	22.3	142.9

REINFORCING STEEL DETAILS

MARK	No REQD	C/C	LENGTH	DETAILS	REMARKS
P 25001	97	200	5200	STRAIGHT	BOTTOM OF TOP SLAB STAGGERED
K 20001	132	300	4390	1950, *1850, R=375	K BARS ALTERNATE WITH U BARS
U 20001	136	300	5660	1150, *3920, R=375	
S 15001	136	300	4385	*3700, 45°, 685	INSIDE FACE OF LEGS
R 15001 R 15002 R 15003	59 59 59	450 450 450	12550 3150 4930	STRAIGHT	LONGITUDINAL STEEL (LAP 450) @ 450 TOP SLAB & LEGS
V 20001	272	300	1845	*1410, 435	FOOTING DOWELS
W 20001 W 20002 W 20003	3 8 3	- - -	12650 3600 5080	STRAIGHT	LONGITUDINAL IN FOOTINGS (LAP 600)
Y 15001	8	-	6760	STRAIGHT	HEADER WALLS
Z 15001	48	300	1610	240, *535, 150, 150	HEADER WALLS
T 15001 T 15002 T 15003	2 3 2	- - -	3500 4600 3175	STRAIGHT	N.W. CORNER OF CULVERT N.E. & S.W. CORNERS OF CULVERT S.E. CORNER OF CULVERT
X 15001 X 15002	16 22	450 450	1315 1265	X15001 (135°), X15002 (150°)	N.W. & S.E. CORNERS OF CULVERT N.E. & S.W. CORNERS OF CULVERT

* VERTICAL DIMENSIONS

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN N.W.C.	CHECK	LOADING OHBDC '83	DATE JAN./84
DRAWING W.P.	CHECK	SITE No 385-44	DWG 3