DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 41J-38

DIST. _____ REGION _____

W.P. No. 187-80-01

CONT. No. 84-204

W. O. No. _____

STR. SITE No. _____

HWY. No. 554

LOCATION Hwy 554 @ Bells Falls Bridge

No of PAGES - _____

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 — METRIC

WP 187-80-01 LOCATION STA 10+926 ℄ ORIGINATED BY HJ
DIST 18 HWY 554 BOREHOLE TYPE Hollow Stem Auger COMPILED BY HJ
DATUM Geodetic DATE SEPT. 13/83 CHECKED BY M.M.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ 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
235.0	Ground Surface										
0.6	Topsoil										
	SILTY CLAY with 10mm thick layers of Silt. VERY STIFF		1	SS	21			VANE - NO FAILURE	Wp W	17.1 kN/m³	
			2	TW	PH						
			3	SS	7						
			4	TW	PH			VANE - NO FAILURE		c' = 47 kPa, φ' = 28°, 17.8 kN/m³	
			5	SS	8			VANE - NO FAILURE			
			6	TW	PH					c' = 34 kPa, φ = 31°, 18.8 kN/m³	
225.9			7	SS	41			VANE - NO FAILURE			
9.1			8	SS	54			END OF CONE TEST			0 47 50 3
			9	SS	20	▼ 13m					
221.3			10	SS	88						
13.7	WITH GRAVEL		11	SS	105/11cm						
	SILTY SAND VERY DENSE										
216.2	TRACE GRAVEL		12	SS	105/11cm						
18.8	END OF BOREHOLE										

OFFICE REPORT ON SOIL EXPLORATION

+³, ×⁵ : Numbers refer to Sensitivity

15 (20, 10) 3 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 187-80-01 LOCATION STA 101+890 ℄ ORIGINATED BY HI

DIST 18 HWY 554 BOREHOLE TYPE Hollow Stem Augers COMPILED BY HI

DATUM Geodetic DATE SEPT. 13/85 CHECKED BY MM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
23.0 0.0	GROUND SURFACE										
	silty clay with 10mm thick layers of silt very stiff		1	SS	18						
			2	TW	PH			6	⊢○⊣	17.9	
			3	SS	5			VANE NO FAILURE			
22.5 0.5			4	TW	PH			0 VANE COULD NOT PUSH	H⊙	19.3	
	silty sand dense		5	SS	42						
22.2 0.8			6	SS	36						
0.1	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

RECORD OF BOREHOLE No 3 METRIC

W P 187-80-01 LOCATION STA 10+980 Q ORIGINATED BY HI

DIST 13 HWY 554 BOREHOLE TYPE Hollow Stem Auger COMPILED BY HI

DATUM Geodetic DATE SEPT. 14/82 CHECKED BY MM.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
233.8	Ground Surface										
0.0			1	SS	17						
			2	SS	12						
	silty clay with 10 mm thick layer of silt very stiff							VANE - NO FAILURE			
			3	SS	7						
								VANE - NO FAILURE			
			4	SS	9						
			5	SS	22				NOT PLASTIC		
226.2											
225.7	silty sand		6	SS	41						
8.1	END OF BOREHOLE										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

memorandum

Ontario

To: R. Girard
Head, Geotechnical Section
Thunder Bay Region

Date: 1983 10 13

Atten: J.P. Cleaver

From: Pavement & Foundation
Design Section
Room 315, Central Building

Re: W.P. 187-80-01
District 18, Highway 554
Bells Falls Bridge
Slope Stability Station 10 + 860
to 11 + 070

Further to your request of 83 08 29, we have investigated the stability of the above mentioned cut.

Our field investigation was carried out in September, 1983 and consisted of 3 sampled boreholes advanced to depths of up to 19 m below the existing ground surface. In general subsurface conditions consist of up to 10 m of stiff to very stiff clay overlying dense to very dense deposits of sand to silty sand. Ground water was encountered at depths of up to 13 m below the ground surface.

Laboratory testing was conducted to determine the effective stress parameters of the subsoils. Testing indicated that the clay has an effective internal angle of friction of about 28^{o} and an effective cohesion intercept of 34 kPa.

The stability of the proposed cuts, up to 9 m deep, were analysed in terms of effective stress. The analysis indicates that the proposed cuts will be stable with 2:1 side slopes.

Should you have any further questions, please do not hesitate to call this office.

M. MacLean

M. MacLean, P. Eng.
Foundations Engineer

MM/mmj

memorandum

Ontario

To: Mr. M. Devata
Senior Foundations Engineer
Pavement & Foundation Design Section
3rd Floor, Central Building
Downsview

Date: 83 08 29

From: Geotechnical Section
Northwestern Region

RE: W.P. 187-80-01, DISTRICT 18, HIGHWAY 554
BELLS FALLS BRIDGE - SLOPE STABILITY

Last fall the Soils Design Report for the above project was prepared and submitted. Just last week, however, it came to our attention there could be a slope stability problem on the south side of the proposed structure at Station 10+910.

The soil erodibility of the cut material reveals as "K" value ranging from 14 to 24, so expectancy of surface erosion is slight. The moisture contents of the samples, however, were very high. On one sample the moisture content was even above the liquid limit.

In the past the District tried to lower the grade on the existing road, but the excavated material turned "quick" so they gave up and filled the hole in. The Liquidity Index calculation on sample number 114 reveals a factor of 1.17 which means there may be a chance of the cut going "quick" if the material is agitated and there may be a failure.

At the present time the slopes have been designed at the normal 2:1 slope. Would you please review our field data which is in Mr. G. A. Wrong's office. We are most anxious to have a preliminary reply by mid September as the technical review will be held then. If additional cores and shear tests are required these should as well be carried out in the very near future.

Before ending it should be noted that when we were drilling last year the party chief left one of the drill holes open over night. No water seeped into the hole and the hole itself did not slough.

James A Cleaver

JAMES A. CLEAVER
Project Soils Engineer
(For)
J. R. GIRARD
Head, Geotechnical Section

JAC/lr

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 41J-38

DIST. 18 REGION

W.P. No. 187-80-02

CONT. No. 84-204

W. O. No.

STR. SITE No. 38S-170

HWY. No. 554

LOCATION Little White River Crossing (Bells Falls Bridge)

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

Ontario

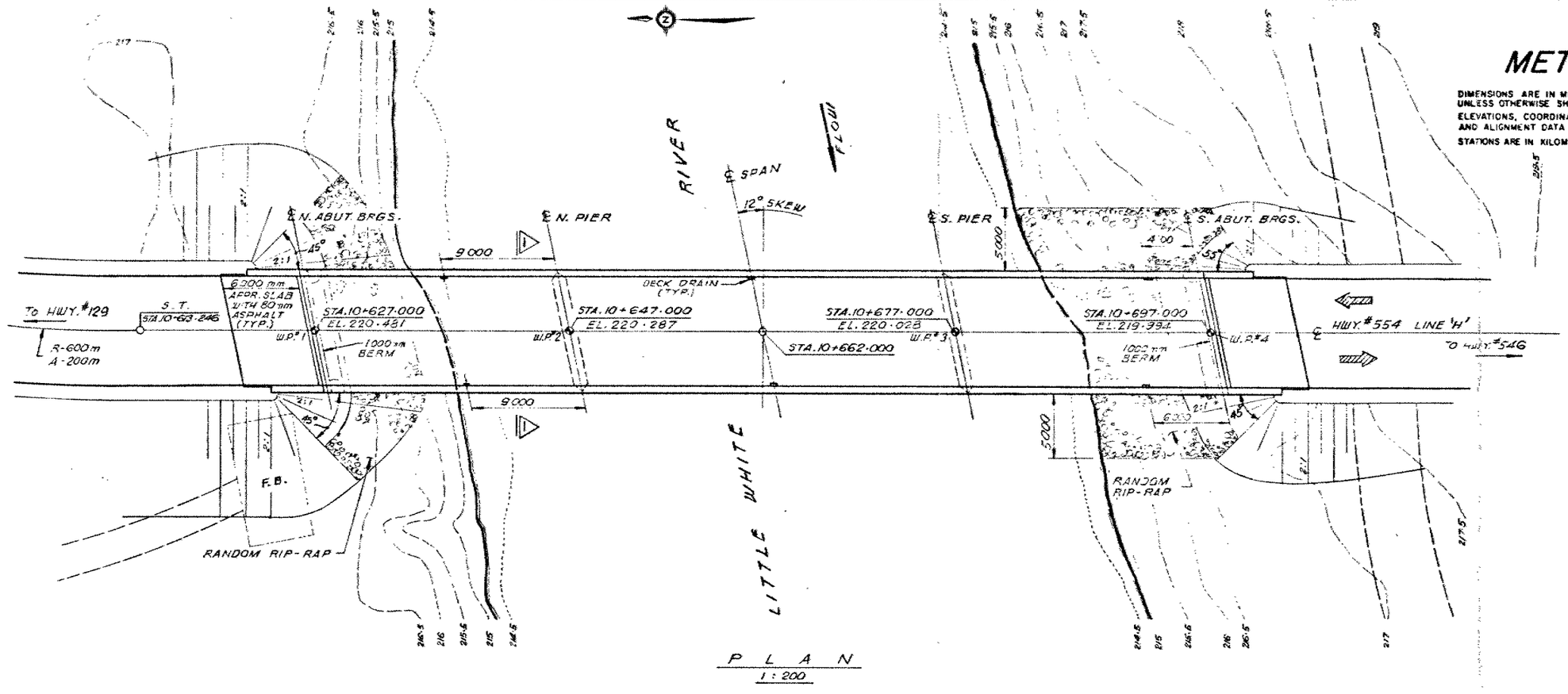
Ministry of
Transportation and
Communications

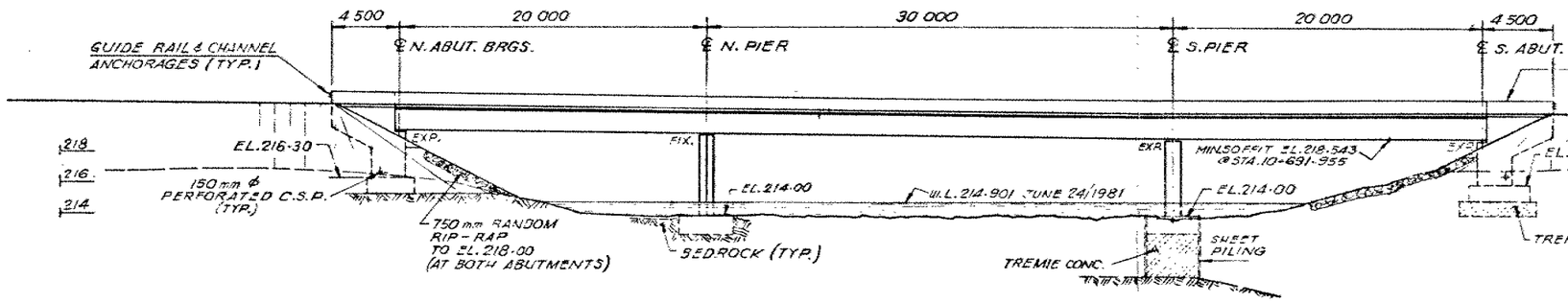
FILE No. _____ **DATE** _____

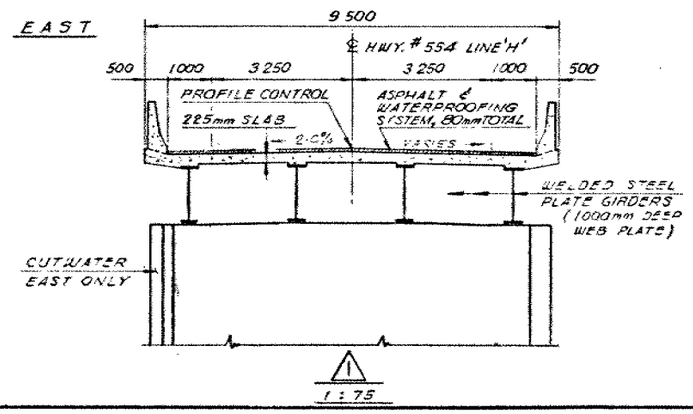
Assign to Joan C. on Jan. 8/82.

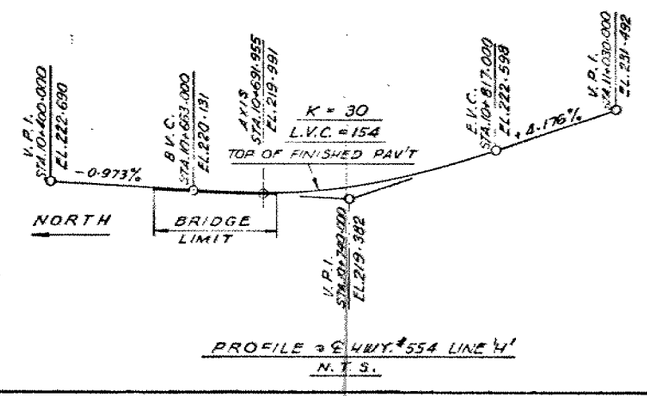
REMARKS

Paul Wilson 751-6565









METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. 18
CONT No
WP No 187-80-02

LITTLE WHITE RIVER BRIDGE
6.1 km WEST OF SEC HWY. 546
GENERAL ARRANGEMENT

SHEET

NOTES

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLASS OF CONCRETE

FOOTINGS & APPROACH SLABS	20 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25 mm
ABUTMENTS & WINGWALLS: FRONT FACE	80 ± 20 mm
BACK FACE	70 ± 20 mm
PIERS	80 ± 20 mm
DECK: TOP	70 ± 20 mm
BOTTOM	40 ± 10 mm
BARRIER WALLS	70 ± 20 mm
APPROACH SLABS	70 ± 20 mm

UNLESS OTHERWISE NOTED ON DRAWINGS.

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 3 mm.

LIST OF DRAWINGS

BM 216·723
N & W IN ROOT 0.40 TWIN SPRUCE
29·0 LT. 10·628·6

REGISTERED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO CIVIL P.Q. LAW

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN P.Q.L.	CHECK	LOADING		DATE	
DRAWING J.S.	CHECK P.Q.L.	SITE 383-170		DWG	1

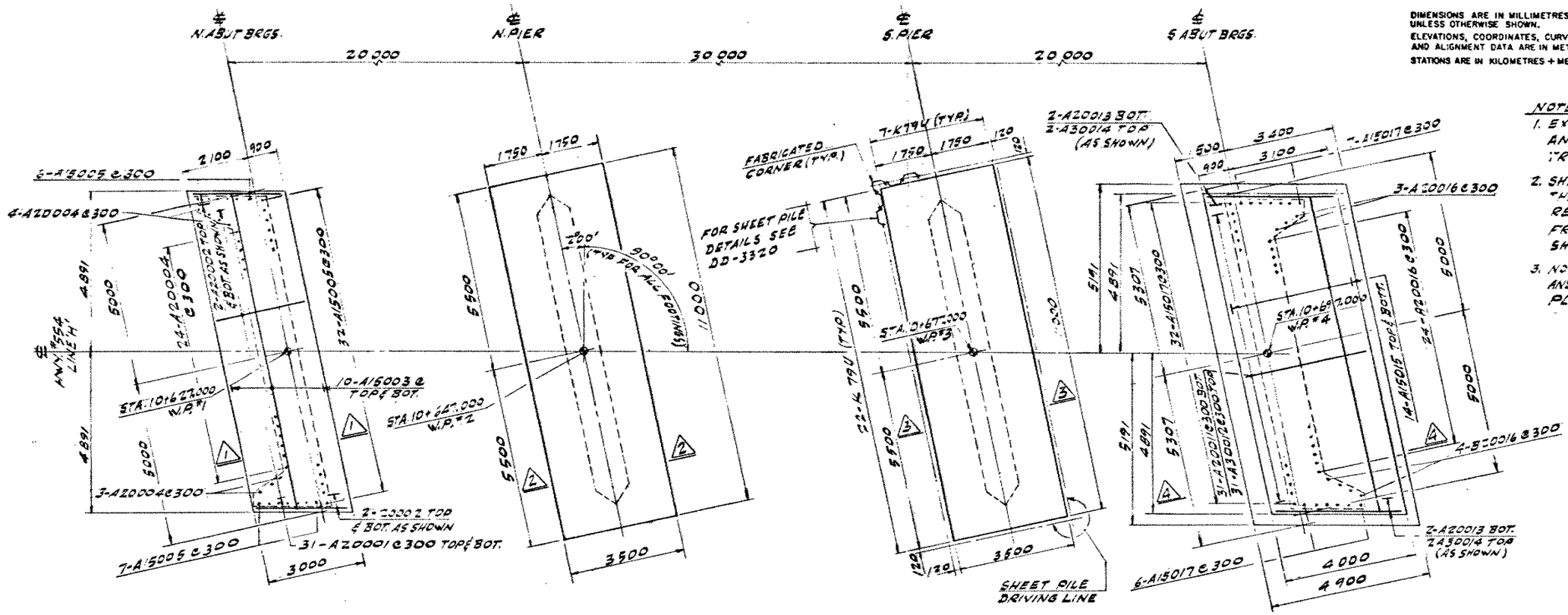
METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. 16
CONT No
WP No 197-80-02

LITTLE WHITE RIVER BRIDGE
6.1km WEST OF SEC. HWY. 546
FOOTING LAYOUT

SHEET

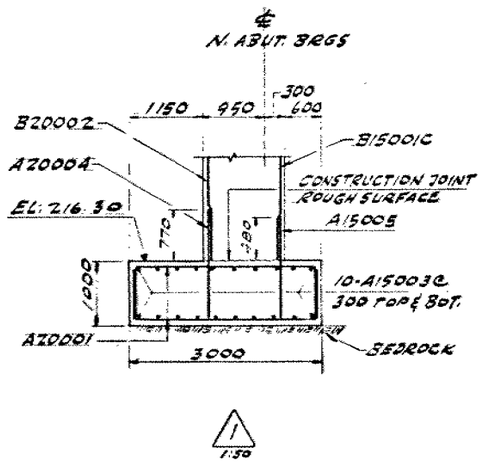


NOTES:

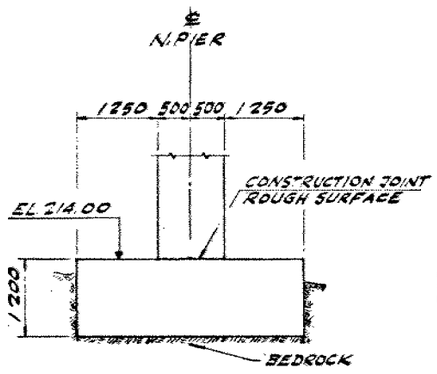
1. EXCAVATIONS FOR PIERS MUST BE CLEAR OF ANY FOREIGN MATERIAL PRIOR TO PLACING TREMIE CONCRETE.
2. SHEET PILES ARE NOT DESIGNED TO PENETRATE THE COBBLES, BOULDERS OR ROCK FRAGMENTS. REMOVAL OF COBBLES, BOULDERS AND ROCK FRAGMENTS MIGHT BE NECESSARY TO INSTALL SHEET PILES TO REQUIRED ELEVATION.
3. NORTH ABUTMENT FOOTING, NORTH PIER FOOTING AND SOUTH PIER TREMIE CONCRETE SHALL BE PLACED ON SOUND BEDROCK.

FOOTING LAYOUT
1:75

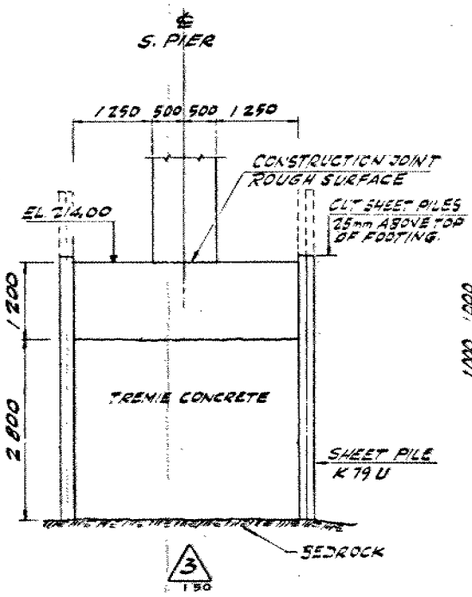
NOTE:
FOR PIER FOOTING REINFORCEMENT SEE DWG. 6



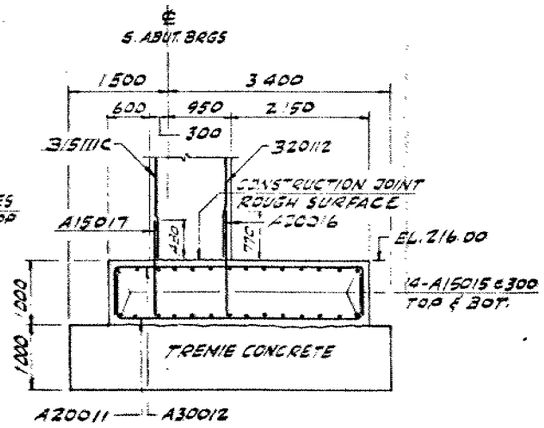
1 / 1:50



2 / 1:50



3 / 1:50



4 / 1:50

SHEET PILE DATA

LOCATION	TYPE	No.	LENGTH LEFT IN PLACE
SOUTH PIER	K79U	58	4 025
	CORNERS	4	4 025

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN ... CHECK ... LOADING CL-625-ONT-1 DATE JAN./83
DRAWING ... CHECK ... SITE ... DWG 5

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84 - 204

Ontario

Ministry of
Transportation and
Communications

INDEX

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 project.

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:

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

FOUNDATION INVESTIGATION REPORT
For
Bells Falls Bridge over Little White River
Hwy. 554, Site 38S-170
W.P. 187-80-02
District 18, Sault Ste. Marie

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation carried out by Dominion Soil Investigation Inc. at site of the proposed new Bells Falls Bridge over the Little White River (38S-170) on the proposed new alignment of Hwy. 554 in the District of Sault Ste. Marie.

The fieldwork was carried out during the period of Jan. 27 to Feb. 4, 1982, and consisted of drilling four boreholes to depths ranging from 2.6 to 7.8 m. Three additional borings were carried out during the period of Dec. 12 & 13, 1982 to depths ranging from 4.4 to 6.1 m. The locations of the boreholes are shown on Drawing No. 2 and the subsurface conditions encountered are presented on the Record of Borehole Sheets.

SITE DESCRIPTION AND GEOLOGY

The site is located in Parkinson Township approximately 15 km north of Iron Bridge in Northern Ontario. At the existing bridge site which is located about 170 m downstream from the proposed bridge site, the bedrock is exposed at the ground surface on both banks of the river and immediately downstream is the Bells Falls. At the site, rock outcrops are visible on the north shore only.

Published geological data show that the bedrock in the general area is of the Middle Precambrian age and consists of conglomerate, argillate, greywacke, quartzite and siltstones of the Gowganda or Mississagi Formations. The geological maps also indicate that the bridge site is located at the southern tip of a major fault line known as the "Flack Lake Fault."

SUMMARIZED SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are shown on the Record of Borehole Sheets and an inferred subsoil profile is presented on Drawing No. 2.

Briefly, Boreholes 3 and 4, located on the north side of the river showed the presence of rock at or near the ground surface. Boreholes 102 & 103 encountered a shallow sandy overburden underlain by quartzite bedrock at depths of 1.3 and 1.9 m below the ground surface. On the south side, in Boreholes 1, 2, and 101, the depth of overburden (dense to very dense sandy silt till) ranged from 4.2 to more than 7.8 m, and from this, it appears that the surface of the rock dips rather sharply from north to south.

The strata are briefly described in the following paragraphs.

a) Surficial Granular Deposit

Boreholes 1, 2, 4, 102 and 103 encountered a surficial granular deposit ranging from 0.1 m (Borehole 4) to 1.9 m (Borehole 103) in thickness. The grain size distribution of the gravelly sand encountered in Borehole 2 is presented in Fig. 1. As shown it consists of 37% gravel, 61% sand, and 2% silt. Based on this, and a visual examination of the samples, the gravelly sand is considered to be pervious. The penetration resistance varies from 7 to 37/0.23 m suggests that the surficial granular deposit is loose to dense. In the area of Borehole 3, the river bed was covered by boulders.

b) Glacial Till

In Boreholes 1, and 2, the surficial granular deposit is underlain by a relatively coarse textured glacial till deposit which extends to a depth of more than 7.8 m in Borehole 1, and 4.2 m below the ground surface in Borehole 2. In Borehole 101 the glacial till in the upper 1.5 m contains numerous cobbles and boulders. The grain size distribution curves of representative samples taken from the till are shown in Figures No. 2 and 3. The curves indicate 6 to 40% gravel, 34 to 55% sand, 14 to 40% silt and 3 to 8% clay size particles and an effective grain size (D_{10}) ranging between 0.02 and 0.004 mm. From this, the permeability of the material is estimated to be medium low, i.e. of the order of 10^{-4} to 2×10^{-5} cm/sec. The till also contains frequent cobbles and boulders and exhibits only very little cementation. The measured natural moisture contents range between 7.5 and 10.9%. 'N'-values or penetration indices ranged from 32 to more than 100 blows/0.3 m indicating a dense to very dense material. It should, however, be pointed out that due to the embedded gravel, cobbles and boulders in the till, some of the recorded high 'N'-values may have been caused by these obstructions.

c) Bedrock

Bedrock was encountered at or near the ground surface in Boreholes 3 and 4 and 1.3 and 1.9 m below ground surface in Boreholes 102 and 103 located at the north pier and abutment locations respectively. In Borehole 2, near the south pier location, the surface of the rock was encountered 4.2 m below the river bed (at El. 210.0 m) and in Borehole 1 and 101 which is located on the south shore, the bedrock was not encountered to a depth of 7.8 m below the ground surface (i.e. to El. 208 m). From this, it is concluded that the surface of the bedrock dips in a southerly direction at an average angle of about 6 horizontal in 1 vertical.

The bedrock was penetrated in Boreholes 2, 3, 4, 102 and 103 to depths ranging between 1.7 and 3.1 m and the percentage of recovery of the AXT size (32 mm) rock cores ranged from 42 to 100%. The R.Q.D. values ranged from 0 to 73%. The examination of the cores showed that the rock consists of a light greyish colored quartzite and an unconfined compression test performed on an intact portion of the core gave a compressive strength value of 137.7 MPa. While the core recovery and the R.Q.D. values may suggest a rock of somewhat lower quality than the actual in-situ conditions, (largely due to the size of the core barrel (AXT) used), nevertheless, an examination of the cores indicates that the rock is frequently highly fractured. Thus while in its intact form, this rock would exhibit high strength, due to its fractured condition the mass properties of the rock are likely to be only poor to fair.

GROUNDWATER CONDITIONS

Boreholes 2 and 3 were drilled from the top of the ice in the river which at the time of the fieldwork was at El. 214.7± m. In Boreholes 1 and 4, which were situated at the proposed abutment locations near the shore of the river, the groundwater levels were also recorded at El. 214.7 m (i.e. 0.7 to 1.0 m below the ground surface). In Boreholes 101, 102 and 103 the groundwater level ranged from El. 216 to 216.4.

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

APPENDIX

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 1

METRIC

W P 187-80-02 LOCATION Sta. 10+692 o/s 4.2 m Rt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Core and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 30-01-82 to 01-02-82 CHECKED BY Z.S.O.

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 (o UNCONFINED, • FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	WATER CONTENT (%) Wp W Wl (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.7	GROUND SURFACE										
0.0 / 215.2	Sand with roots & some decayed vegetation, brown.		1	SS	-						Ground Frozen
0.5	brown / grey		2	SS	70	▼	215				7 52 34 7
			3	SS	80/0.22 m		214				13 50 33 4
	Heterogeneous mixture of sand, silt & gravel, occasional cobbles. (Glacial Till) very dense		4	SS	92/0.15 m						30 53 14 3
			5	SS	91/0.22 m		213				7 55 33 5
			6	SS	120/0.22 m						10 51 33 6
	very frequent cobbles & boulders.		7	RC	REC 73%		212				Jan.30/82 Jan.31/82
			8	SS	50/0.08 m		211				
			9	SS	82/0.15 m						6 47 40 7
			10	SS	REC 96%		210				Jan.31/82 Feb. 1/82
			11	SS	230/0.08 m						
			12	SS	REC 0%						
			13	SS	REC 24%		209				
207.9			14	SS	100/0.12 m		208				4 45 24 7
7.8	END OF BOREHOLE										Hole advanced by driving N-casing to 1.5m. Pull N-casing out and drill in BW casing.

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

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

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

METRIC

W P 187-80-02 LOCATION Sta. 10+675.5 o/s 4.5 m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Core and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 27-01-82 to 29-01-82 CHECKED BY Z.S.O.

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 W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.7	ICE SURFACE										
0.0 214.2	Ice & Water										
0.5 213.9	Cobbles & Boulders	RC					214				
0.8 213.2	Gravelly Sand. compact to dense brown		1	SS	31						37 61 2 0
1.5	boulder		2	RC	REC 33%		213				
	Heterogeneous mixture of sand, silt & gravel, frequent cobbles & boulders. (Glacial Till) dense to v. dense, grey.		3	SS	80/0.22 m				a		12 46 35 7
			4	SS	67/0.15 m		212		o		12 46 34 8
			5	RC	REC 60%						Jan.28/82
			6	SS	92/0.15 m		211		e		Jan.29/82 40 34 20 6
210.0			7	SS	32/0.25 m		210				Sample No.7 no recovery.
4.7	greyish Quartzite Bedrock		8	RC	REC 57% RQD=0						
			9	RC	REC 83% RQD=0						
208.1			10	RC	REC 81% RQD 55%		209				
6.6	END OF BOREHOLE										Hole advanced by N-casing to 1.5 m. Pull out N-casing and drill BW casing.

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

$\frac{20}{15} \diamond \frac{}{10}$ S [%] STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 187-80-02 LOCATION Sta. 10+648 o/s 4.7 m Rt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Coring and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 04-02-82 CHECKED BY Z.S.D.

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.6	ICE SURFACE										
0.0 214.0	Ice & Water						214				
0.6 213.7	boulder or rock										
0.9	greyish Quartzite Bedrock		1	RC	REC 95%	RQD 53%					
			2	RC	REC 85% RQD 14%		213				
212.0			3	RC	REC 81%	RQD 30%					
2.6	END OF BOREHOLE										Advance BW casing to 0.9 m. Clean inside with bicone.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No. 4

METRIC

W P 187-80-02 LOCATION Sta. 10+634 o/s 4.0 m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Coring and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 02-02-82 to 03-02-82 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ✦ FIELD VANE ● QUICK TRIAXIAL × 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						
215.4	GROUND SURFACE										
0.0	0.12 m Sand						215				
			1	RC	-	▼					
	greyish										
	Quartzite Bedrock		2	RC	REC 85% RQD 18%		214				
			3	RC	REC 83% RQD 25%		213				
212.4											
3.0	END OF BOREHOLE										Drill BW casing. RC 1 recovered from casing. BW casing advanced to 1.2 m. Clear inside casing with tricone.

*3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 101

METRIC

W P 187-80-02 LOCATION Sta. 10+697 o/s 4.5 m Lt. ℄ Hwy. 554 - Line 'B' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering COMPILED BY S.D.

DATUM Geodetic DATE 12-12-82 to 13-12-82 CHECKED BY J.P.L.

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)	WATER CONTENT (%) (W_p — ◇ — W_l)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
216.8	GROUND LEVEL										
0.0	0.15 m Topsoil										
	very frequent cobbles					▼	216				
	greyish brown		1	SS	62/0.15m		215				
	grey		2	SS	75/0.15m						
	Heterogeneous mixture of sand, silt & gravel occasional cobbles (Glacial Till) very dense.		3	SS	50/0.07m		214				
			4	SS	82/0.15m		213				
			5	SS	50/0.02m		212				
			6	SS	82/0.15m						
210.7			7	SS	105/0.15m		211				
6.1	END OF BOREHOLE										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications (Ontario)

RECORD OF BOREHOLE No 102

METRIC

W P 187-80-02 LOCATION Sta. 10+626 o/s 5.0m lt. ℄ Hwy. 554 Line 'B' ORIGINATED BY [illegible]

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering and [illegible] COMPILED BY [illegible]

DATUM Geodetic DATE 13-12-82 CHECKED BY [illegible]

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						
216.7	GROUND LEVEL										
0.0	0.15m Topsoil					▼					
	Sand, fine traces of silt compact, brown		1	SS	18		216				
215.4											
1.3	Greyish Quartzite Bedrock		2	RC	REC. 100% RQD 72%		215				
			3	RC	REC. 100% RQD 60%		214				
							213				
212.3			4	RC	REC. 100% RQD 66%						
4.4	END OF BOREHOLE										

+3, ×5 : Numbers refer to Sensitivity

15 φ 20 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 103

METRIC

W P 187-80-02 LOCATION Sta. 10+628 o/s 4.5 m Rt. Hwy. 554 - Line 'B' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering and BXL Rock Core COMPILED BY S.D.

DATUM Geodetic DATE 13-12-82 CHECKED BY J.P.L.

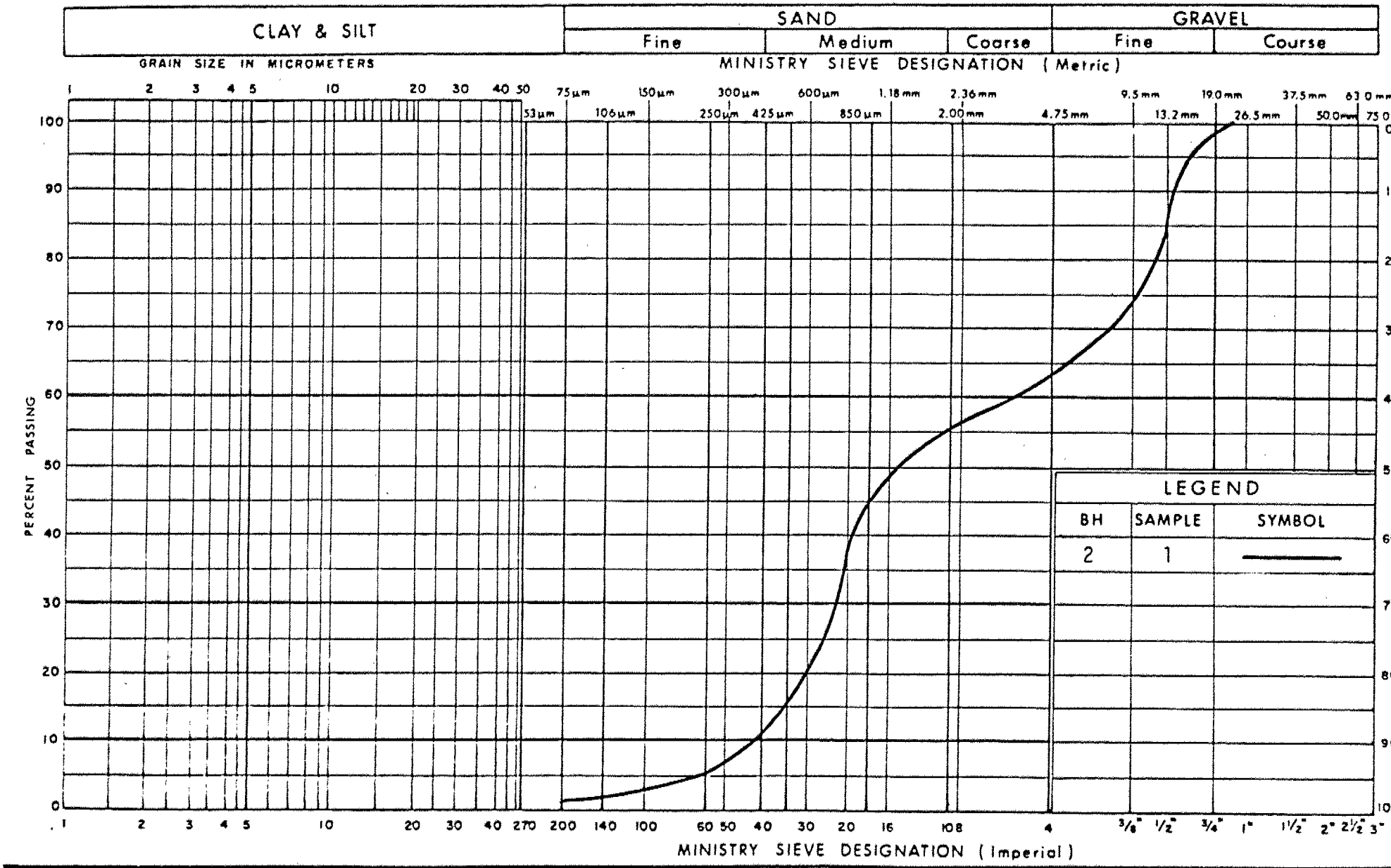
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	WATER CONTENT (%) Wp W Wl	UNIT WT. γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
216.8	GROUND SURFACE										
0.0	0.20m Topsoil										
	Sand, fine traces of silt loose, brown		1	SS	7		216				
215.5											
1.3	Sandy silt to silty sand										
214.9	dense, brown		2	SS	37/	0.23m	215				
1.9			3	RC	REC. 100% RQD 73%		214				
	Greyish Quartzite Bedrock		4	RC	REC. 100% RQD 57%		213				
			5	RC	REC. 100% RQD 61%						
212.2											
4.6	END OF BOREHOLE										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

FIG No 1

W P 187-80-02

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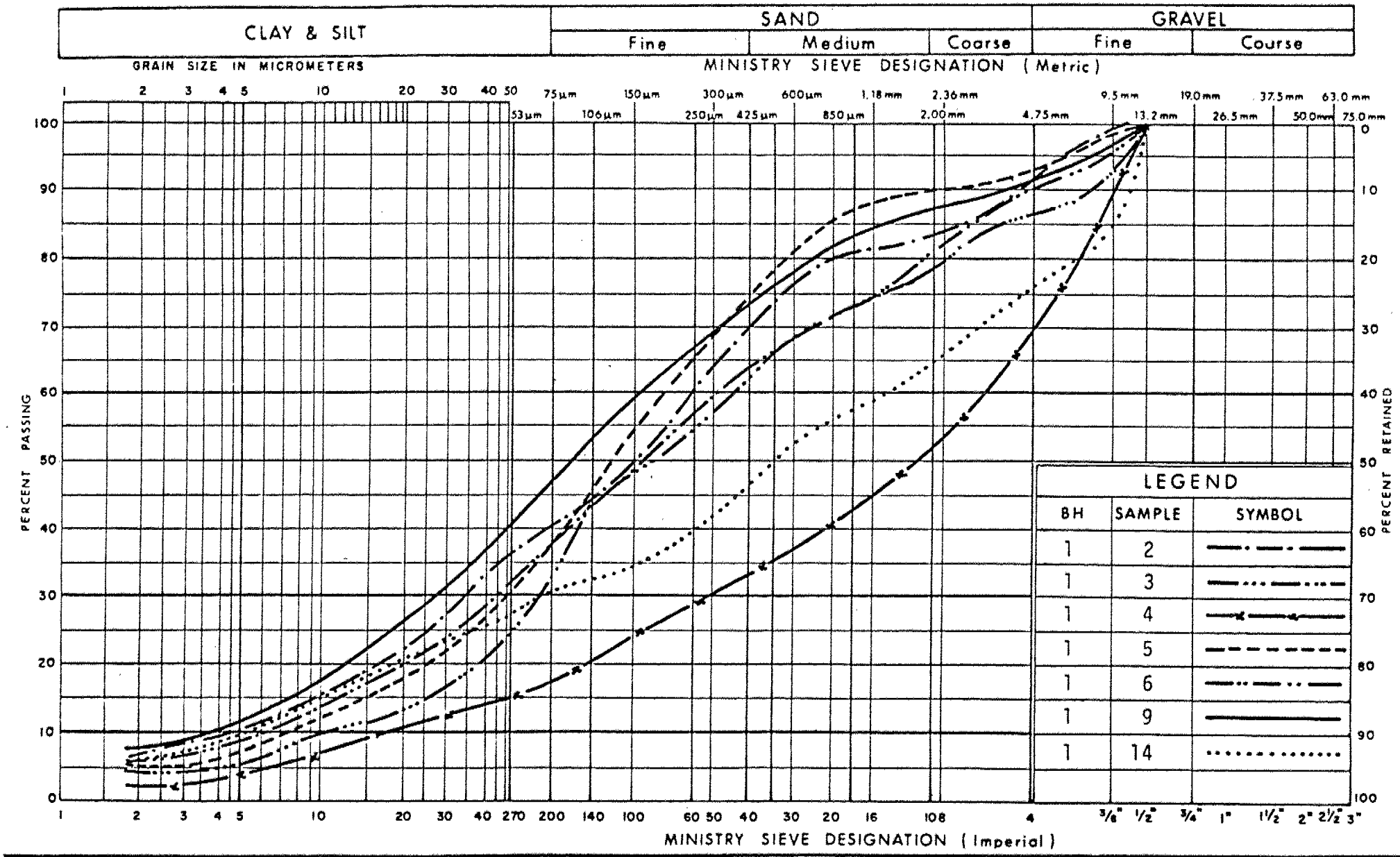
UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

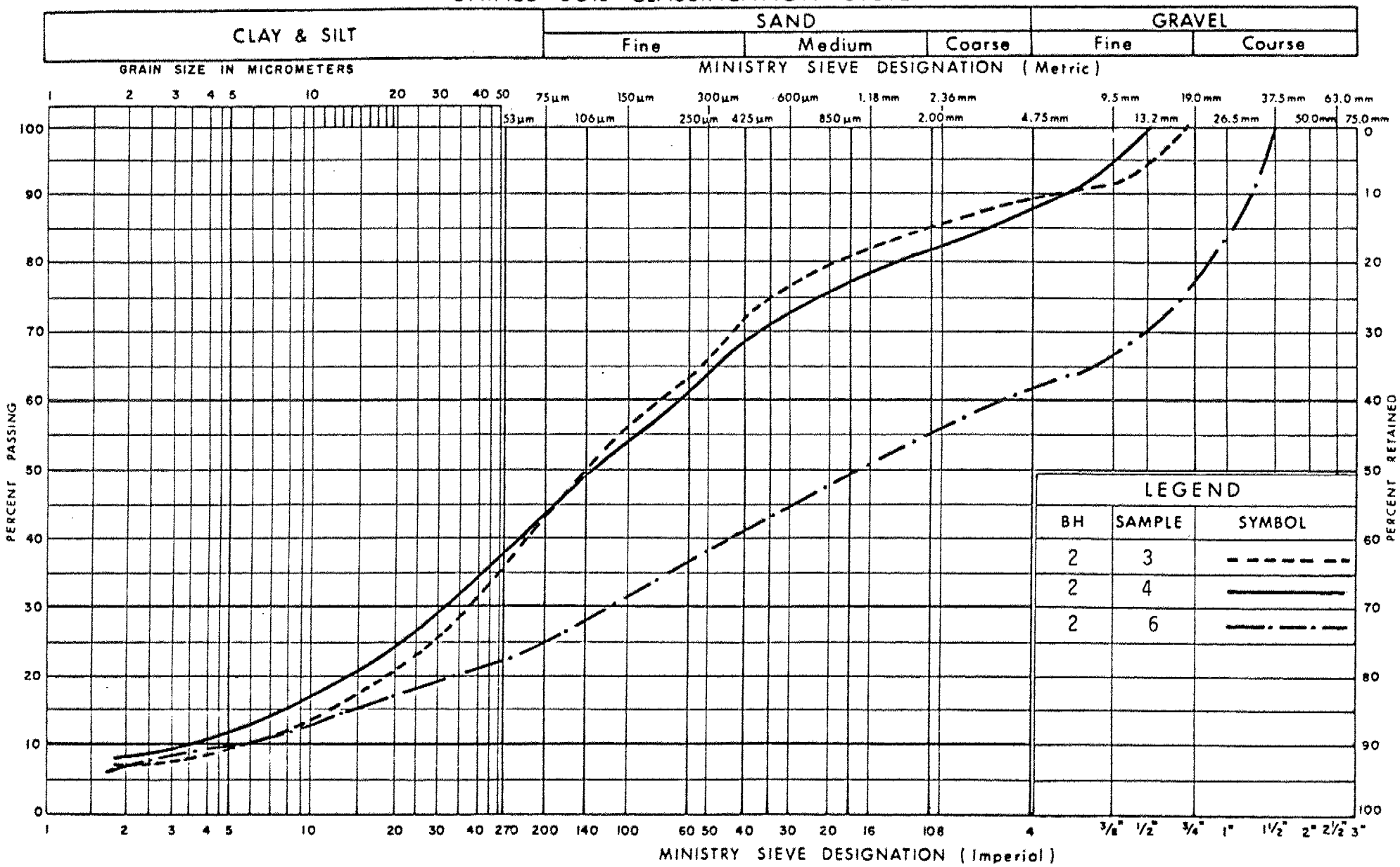
SILTY SAND TILL

FIG No 2

W P 187-80-02

15

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

FIG No 3

W P 187-80-02

16

DOMINION SOIL INVESTIGATION INC.
CONSULTING SOIL & FOUNDATION ENGINEERS
104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6 (416) 751-6565

SUPPLEMENTARY GEOTECHNICAL INVESTIGATION
BELLS FALLS BRIDGE OVER LITTLE WHITE RIVER
HIGHWAY 554-SITE 38S-170
DISTRICT OF SAULT STE. MARIE
W.P. 187-80-02

Ref. No. 82-12-1
January 1983

Prepared for:

Ministry of Transportation and Communications
Pavement and Foundation Design Section
Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Distribution:

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DOMINION SOIL INVESTIGATION INC.
CONSULTING SOIL & FOUNDATION ENGINEERS
104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6 (416) 751-6565

January 12, 1983

Ref. No. 82-12-1

Ministry of Transportation and Communications
Pavement and Foundation Design Section
Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. M. Devata, P. Eng.
Senior Foundations Engineer

Re: Supplementary Geotechnical Investigation
Bells Falls Bridge over Little White River
Highway 554-Site 38S-170
District of Sault Ste. Marie
W.P. 187-80-02

Dear Sirs:

We have now completed the above project and take pleasure in presenting our findings in this report.

The field work was carried out during the period of December 12-13, 1982 and consisted of drilling three boreholes to depths ranging from 4.4 to 6.1 m. The new boreholes were numbered in the 100-series to differentiate them from the boreholes drilled during our original investigation in January 1982. The locations of the boreholes are shown on Drawing No. 1878002-A and the subsurface conditions encountered are presented on the Record of Borehole Sheets.

Borehole 101, located at the south abutment, encountered a sandy and gravelly glacial till. Within the top 1.5 m, in this borehole, normal sampling was not possible due to the presence of continuous cobbles and boulders. Below this, the recorded 'N'-values were consistently greater than 50 blows/0.3 m indicating a very dense material. The groundwater level in this borehole was recorded at Elevation 216.0 m (i.e. 0.8 m below the ground surface).

At the north abutment, Boreholes 102 and 103 encountered a shallow sandy overburden underlain by the quartzite bedrock at depths of 1.3 and 1.9 m below the ground surface respectively (i.e. Elev. 215.4 and 214.9 m respectively). The core recovery was 100% and the R.Q.D. values ranged

.../...

from 57 to 73%.

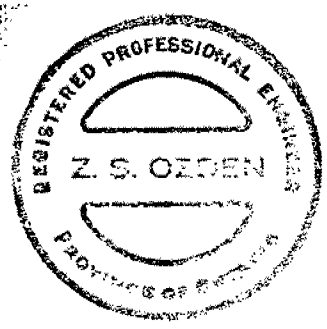
These findings show that the south abutment can be founded on the undisturbed very dense till and the north abutment on the surface of the bedrock. The suggested bearing capacities, design parameters and the anticipated construction conditions were discussed in our original report dated March 1982 (Ref. No. 82-1-11) and will not be repeated here.

We trust that this work is complete within our terms of reference. If you have any questions, however, please feel free to call us.

Yours very truly,
DOMINION SOIL INVESTIGATION INC.

Z.S. Ozden, P. Eng.

ZSO:lt



Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 101

METRIC

W P 187-80-02 LOCATION Sta. 10+697 o/s 4.5 m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering COMPILED BY S.D.

DATUM Geodetic DATE 12-12-82 to 13-12-82 CHECKED BY T.P.L.

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						
216.8	GROUND LEVEL										
0.0	0.15 m Topsoil										
	very frequent cobbles						216				
	greyish brown / grey		1	SS	62/0.15m		215				
			2	SS	75/0.15m						
	Heterogeneous mixture of sand, silt & gravel occasional cobbles (Glacial Till) very dense.		3	SS	50/0.07m		214				
			4	SS	82/0.15m		213				
			5	SS	50/0.02m						
			6	SS	82/0.15m		212				
210.7			7	SS	105/0.15m		211				
6.1	END OF BOREHOLE										

$+^3$, $\times^5$: 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 102

METRIC

W P 187-80-02 LOCATION Sta. 10+626 o/s 5.0m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering and BXL Rock Core COMPILED BY S.D.

DATUM Geodetic DATE 13-12-82 CHECKED BY I.P.L.

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 W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
216.7	GROUND LEVEL										
0.0	0.15m Topsoil										
	Sand, fine traces of silt compact, brown		1	SS	18		216				
215.4											
1.3	Greyish Quartzite Bedrock		2	RC	REC. 100% RQD 72%		215				
			3	RC	REC. 100% RQD 60%		214				
							213				
212.3			4	RC	REC. 100% RQD 66%						
4.4	END OF BOREHOLE										

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

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 103

METRIC

W P 187-80-02 LOCATION Sta. 10+628 o/s 4.5 m Rt. Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE Solid Stem Augering and BXL Rock Core COMPILED BY S.D.

DATUM Geodetic DATE 13-12-82 CHECKED BY I.P.L.

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 W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
216.8	GROUND SURFACE										
0.0	0.20m Topsoil										
	Sand, fine										
	traces of silt										
	loose, brown		1	SS	7		216				
215.5											
1.3	Sandy silt to silty sand										
214.9	dense, brown		2	SS	37/	0.23m	215				
1.9			3	RC	REC. 100% RQD 73%						
	Greyish						214				
	Quartzite Bedrock		4	RC	REC. 100% RQD 57%						
							213				
			5	RC	REC. 100% RQD 61%						
212.2											
4.6	END OF BOREHOLE										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

OVERSIZE DRAWING

DOMINION SOIL INVESTIGATION INC.
CONSULTING SOIL & FOUNDATION ENGINEERS
104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6 (416) 751-6565

GEOTECHNICAL INVESTIGATION
BELLS FALLS BRIDGE OVER LITTLE WHITE RIVER
HIGHWAY 554, SITE 38S-170
DISTRICT OF SAULT STE. MARIE
W. P. 187-80-02

Ref. No. 82-1-11

March 1982

Prepared For:

Ministry of Transportation & Communications
Pavement & Foundation Design Section
Central Building
1201 Wilson Avenue
DOWNSVIEW, Ontario
M3M 1J8

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GEOCRES N° 41J-38

Ref. No. 82-1-11

CONTENTS

APPENDICES

ENCLOSURES

1.0 INTRODUCTION

Dominion Soil Investigation Inc. was retained by the Ontario Ministry of Transportation and Communications to carry out a geotechnical investigation at the site of the proposed new Bells Falls Bridge over the Little White River (Bridge Site 38S-170) on the proposed new alignment of Highway 554 in the District of Sault Ste. Marie.

The purpose of the investigation was to determine the subsurface conditions at the proposed structure site; to establish the engineering properties of the substrata; and to make recommendations for the geotechnical aspects of the design of foundations of the proposed bridge. Authorization to carry out the work was received from the Pavement and Foundation Design Section of the Ministry.

The field work was carried out during the period of January 27 to February 4, 1982, and consisted of drilling four boreholes to depths ranging from 2.6 and 7.8 m. The locations of the boreholes are shown on Drawing No. 1878002-A and the subsurface conditions encountered are presented on the Record of Borehole Sheets.

.../...

2.0 GEOLOGY

The site is located in Parkinson Township approximately 15 km north of Iron Bridge in Northern Ontario. At the existing bridge site which is located about 170 m downstream from the proposed bridge site, the bedrock is exposed at the ground surface on both banks of the river and immediately downstream is the Bells Falls. At the proposed bridge site, rock outcrops are visible on the north shore only.

Published geological data show that the bedrock in the general area is of the Middle Precambrian age and consists of conglomerate, argillate, greywacke, quartzite and siltstones of the Gowganda or Mississagi Formations. The geological maps also indicate that the bridge site is located at the southern tip of a major fault line known as the "Flack Lake Fault."

.../...

3.0 SUMMARIZED SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are shown on the Record of Borehole Sheets and an inferred subsoil profile is presented on Drawing No. 1878002-A.

Briefly, Boreholes 3 and 4, located on the north side of the river showed the presence of rock at or near the ground surface. On the south side, in Boreholes 2 and 1, the depth of overburden (dense to very dense sandy silt till) ranged from 4.2 to more than 7.8 m, and from this, it appears that the surface of the rock dips rather sharply from north to south.

The strata are briefly described in the following paragraphs.

a) Sand

Boreholes 1, 2 and 4, encountered 0.1 (Borehole 4) to 0.7 (Borehole 2) metres thick layer of surficial sand or gravelly sand. The grain size distribution of the gravelly sand encountered in Borehole 2 is presented in Figure 1. As shown it consists of 37% gravel, 61% sand, and 2% silt. Based on this, and a visual examination of the samples, the sand is considered to be pervious. A single penetration resistance of 31 blows/0.3 m penetration suggests that the sand is dense. In the area of Borehole 3, the river bed was covered by boulders.

.../...

b) Glacial Till

In Boreholes 1 and 2, the sand is underlain by a relatively coarse textured glacial till deposit which extends to a depth of more than 7.8 m in Borehole 1, and 4.2 m below the ground surface in Borehole 2. The grain size distribution curves of representative samples taken from the till are shown in Figures No. 2 and 3. The curves indicate 6 to 40% gravel, 34 to 55% sand, 14 to 40% silt and 3 to 8% clay size particles and an effective grain size (D_{10}) ranging between 0.02 and 0.004 mm. From this, the permeability of the material is estimated to be medium low, i.e. of the order of 10^{-4} to 2×10^{-5} cm/sec. The till also contains frequent cobbles and boulders and exhibits only very little cementation. The measured natural moisture contents range between 7.5 and 10.9%. 'N'-values or penetration indices ranged from 32 to more than 100 blows/0.3 m indicating a dense to very dense material. It should, however, be pointed out that due to the embedded gravel, cobbles and boulders in the till, some of the recorded high 'N'-values may have been caused by these obstructions.

c) Bedrock

Bedrock was encountered at or near the ground surface in Boreholes 3 and 4 located at the north pier and abutment locations respectively. In Borehole 2, near the south pier location, the surface of the rock was encountered 4.2 m below the river bed (at El. 210.0 m) and in

.../...

Borehole 1, which is located on the south shore, the bedrock was not encountered to a depth of 7.8 m below the ground surface (i.e. to El. 208 m). From this, it is concluded that the surface of the bedrock dips in a southerly direction at an average angle of about 6 horizontal in 1 vertical.

The bedrock was penetrated in Boreholes 2, 3 and 4, to depths ranging between 1.7 and 2.9 m and the percentage of recovery of the AXT size (32 mm) rock cores ranged from 42 to 95%. The R.Q.D. values ranged from 0 to 55%. The examination of the cores showed that the rock consists of a light greyish colored quartzite and an unconfined compression test performed on an intact portion of the core gave a compressive strength value of 137.7 MPa. While the core recovery and the R.Q.D. values may suggest a rock of somewhat lower quality than the actual in-situ conditions, (largely due to the size of the core barrel (AXT) used), nevertheless, an examination of the cores indicates that the rock is frequently highly fractured. Thus while in its intact form, this rock would exhibit high strength, due to its fractured condition the mass properties of the rock are likely to be only poor to fair.

.../...

4.0 GROUNDWATER CONDITIONS

Boreholes 2 and 3 were drilled from the top of the ice in the river which at the time of the field work was at Elevation 214.7± m. In Boreholes 1 and 4, which were situated at the proposed abutment locations near the shore of the river, the groundwater levels were also recorded at Elevation 214.7 m (i.e. 0.7 to 1.0 m below the ground surface). It thus appears that the water level at the site is controlled by the water level in the river.

.../...

5.0 DISCUSSION

A winding portion of Highway 554 at Bells Falls in Parkinson Township will be realigned necessitating the construction of a new bridge over the Little White River to replace an existing bailey bridge. The new structure will be located a short distance (approximately 170 m) upstream from the existing bridge and it will be an approximately 9.5 m wide structure having either a single, 42 m clear span, or three 15-25-15 m long spans.

The boreholes have shown that the surface of the quartzite bedrock is at or near the ground surface at the north pier and abutment locations, whereas at the locations of the south pier and abutment, the surface of the bedrock lies approximately 4 m to over 7.8 m below the ground surface. The overburden is a dense to very dense bouldery glacial till.

5.1 Foundations

5.1.1 Spread Footings

The south pier and abutment can be founded on shallow spread footings established in the overburden. For footings bearing on the dense to very dense glacial till below the depth of minimum frost cover (i.e. 2.1 m), the Factored Bearing Capacity at Ultimate Limit States (q_f) is 900 kPa provided that the footings are at least 1.2 m wide. The Bearing Capacity at Serviceability Limit States Type II is 400 kPa. Under inclined loading conditions, the Bearing Capacity at Ultimate Limit

.../...

State should be reduced in accordance with Clause 6.7.3.3.5 of the Ontario Highway Bridge Design Code, 1979 (OHBDC). Provided that the subsoil is not unduly disturbed during the construction, the total and differential settlements are expected to be less than 25 and 18 mm respectively.

The north pier and abutment will be founded on the bedrock. Taking into consideration the low core recovery ratios and R.Q.D. values, and the fractured nature of the rock, the Factored Bearing Capacity for spread footings bearing at least 0.3 m below the surface of the bedrock is 1,200 kPa at Ultimate Limit States. In this case, the design will not be governed by the Serviceability Limit States Type II as the settlements should be negligible. Differential settlements of up to 25 mm could, however, occur between footings placed on the bedrock and the overburden.

The till overburden is moderately susceptible to scour and therefore adequate scour protection, consisting of heavy rip-rap, should be provided for the footings placed in the overburden. It is also recommended that the footing excavations be inspected and approved at the time of the construction by a geotechnical engineer to ensure that the footings rest on undisturbed till or relatively sound bedrock.

.../...

For the evaluation of the sliding resistance of the foundations, the ultimate angle of friction between the underside of the foundations and the dense to very dense sandy till can be taken as 26^{o}. On clean sound bedrock this value can be increased to 35^{o}.

5.1.2 Spread Footing Foundations on Engineered Fill

The abutments could also be supported on shallow spread footings established on the compacted granular fill of the approach embankments.

In this case, all the topsoil, organic stained and other unsuitable materials should be removed to the surface of bedrock or competent till. The material used for embankment construction under the footings should be a well graded, clean granular earth fill (Granular 'A' quality) which at the footing level should be at least two footing widths wide and should increase at an angle of 1.5 horizontal in 1 vertical below this level. The fill should be placed in 150 mm thick lifts and each lift should be uniformly compacted to at least 100% of its Standard Proctor maximum dry density. The horizontal distance measured from the edge of the footing to the face of the embankment slope should not be less than 1.5 times width of the footing, and the footing should also have a minimum earth cover of 2.1 m.

For footings meeting the above requirements, the Factored Bearing Capacity at Ultimate Limit States (q_f) is 600 kPa. The Bearing Capacity

.../...

at Serviceability Limit States Type II is 250 kPa. With this value, the maximum total settlement should be limited to 25 mm.

5.1.3 Pile Foundations

Alternatively, for a perched abutment, end bearing steel H or tube piles could be used.

It is estimated that at the north abutment location, the piles will encounter refusal at or near the ground surface on top of the bedrock. In this case to reduce the risk of a pile (or piles) being "hung-up" on a cobble or boulder, the surface of the bedrock at the foundation location should be cleared of debris prior to placing the approach fills taking into account that some piles will be battered. Furthermore, a suitable fill should be used (i.e. free of cobbles), within the zone of the approach fill through which the piles will be driven. The piles should be fitted with hardened rock points to get a good seating on the bedrock and to avoid damage during driving.

On the south side, steel tube and H-piles can be expected to be driven to a depth of $1.5^{\pm}$ and $2.5^{\pm}$ m below the present ground surface respectively before encountering practical refusal. In view of the dense and bouldery character of the till, it is recommended that the pile tips be reinforced.

.../...

The estimated pile capacities for some common sizes of steel piles driven to a final set of about 1 blow/1 mm penetration with a hammer capable to deliver an energy of 40 to 70 thousand Joules/blow are tabulated below:

ESTIMATED PILE CAPACITY (kN)

Pile Type	Size	Factored Capacity at Ultimate Limit States (Q_f)	Capacity At Serviceability Limit States Type II (Q_s)
Steel H	HP 310 x 110	1400	980
	HP 310 x 79	1000	690
	HP 250 x 62	750	530
	HP 200 x 54	680	445
Steel Pipe	323 x 9.5	900	650
	273 x 9.3	750	530

It is recommended that the driving of the piles in the field be controlled by a recognized pile driving formula such as the Hiley formula. Unbalanced horizontal forces should be resisted by battered piles and for frost protection, the underside of the pile caps should be established at least 2.1 m below finished grade.

5.2 Lateral Earth Pressures

Assuming that free draining granular material and adequate drainage is provided behind the abutments and retaining walls (Figure 6.9.6.1 OHBDC) the unit weight of the backfill can be taken as 21 kN/m^3.

.../...

For retaining walls, the lateral earth pressure can be calculated using the active earth pressure and the following equivalent fluid pressures:

At Ultimate Limit States = 8 kPa/m

At Serviceability Limit States Type II = 6.5 kPa/m

The rigid abutment walls should, however, be designed to withstand the at-rest earth pressures, provided that the backfill is not heavily compacted (in which case much higher earth pressures could occur). For the at-rest earth pressure condition, the following equivalent fluid pressures can be used:

At Ultimate Limit States = 10 kPa/m

At Serviceability Limit States Type II = 8.5 kPa/m

When using these values, it is assumed that the slope of the backfill behind the retaining structure is approximately level. Water accumulation in the backfill behind the retaining structures should be prevented by means of perforated pipes or weep holes.

5.3 Approach Fills

There are no stability problems foreseen and therefore the design of the approach fills will not be limited by the strength of the foundation materials underlying the site.

.../...

The maximum safe side slopes for the embankment will be governed by the material used for construction (e.g. 2 horizontal in 1 vertical for earth fills and 1.5 horizontal in 1 vertical for rock fill). In case of pile supported perched abutments, rock fill should not be used in that part of the embankment through which piles will be driven. Only negligible settlements are expected to occur under the embankments.

The slopes of the embankments should be adequately protected against surface erosion and the end slopes should also be protected by rip-rap against river scour.

5.4 Construction

The permeability of the bouldery till is estimated to be medium to low and therefore some seepage into the footing excavations can be expected through the till. The overlying sand and gravelly sand has a much higher permeability and groundwater seepage from this stratum could be considerable. The sides of the excavations in the till below the water table will be stable at steep side slopes but as the material appears to possess only little cementation the stand up time of the till at these angles is expected to be short and ravelling and sloughing can be expected to occur with the passage of time. The sides of the excavations should therefore be supported by braced close sheeting. To preserve the bearing capacity of the subsoil, it is important that the excavations be properly dewatered and that the subsurface is not unduly disturbed

.../...

during the construction. It is expected that gravity drainage and pumping from filtered sumps will sufficiently dewater the excavation.

To reduce potential problems due to groundwater seepage, however, it would be advantageous to keep the excavations as shallow as possible.

It is anticipated that the removal of the bedrock will require blasting. In the selection of the charges for blasting, care should be given not to cause too much overbreak and damage to the rock below the foundation level.

The construction of the piers could be carried out inside an earth or sheet pile cofferdam. The availability of impervious soil to form the cofferdams could present some problems. The on-site excavated till could be used with reasonably satisfactory results but the surficial sand and gravelly sand materials should first be removed to the surface of the rock or till before placing the earth fill.

6.0 STATEMENT OF LIMITATION

The Statement of Limitation, as quoted in Appendix 'B', is an integral part of this report.

DOMINION SOIL INVESTIGATION INC.

Z. S. Ozden, P. Eng.

I. P. Lieszkowszky, P. Eng.

ZSO/IPL:jd

REGISTERED PROFESSIONAL ENGINEER Z. S. OZDEN PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER CIVIL I. P. LIESZKOWSZKY PROVINCE OF ONTARIO

APPENDICES

APPENDIX 'A'

PROCEDURES

The field work was carried out during the period of January 27 and February 4, 1982. During this period a total of four boreholes were drilled at the positions shown on the Borehole Location Plan, Drawing 1878002-A. The boreholes were advanced to depths ranging between 2.6 and 7.8 m using a conventional diamond drilling unit adapted for soil sampling. Within the overburden, the boreholes were cased with 'N'-size (89 mm O.D.) and BX size (73 mm O.D.) casings and the boreholes were extended by washboring methods and coring through the boulders. Sampling in the overburden was effected by the Standard Penetration Test method and from the test results, recorded as 'N'-values or penetration indices, the relative density of the strata was inferred. The bedrock was cored using AXT size core barrel.

The drilling equipment was owned and operated by Geocon Ltd., and the field work was carried out under the supervision of the technical personnel from Dominion Soil Investigation Inc. Upon the completion of the field work the soil and rock samples were shipped to our laboratory where they were examined by an engineer and laboratory testing consisting of moisture content, sieve and hydrometer analyses was carried out on selected soil samples. Percentage of recovery and R.Q.D. values of rock cores were established and an unconfined compression test was performed on a representative core sample of the rock.

The ground surface elevations at the borehole locations were determined with respect with a local benchmark indicated on the Borehole Location Plan, Drawing 1878002-A. It is understood that this benchmark has a geodetic elevation of 216.723 m.

APPENDIX 'B'
STATEMENT OF LIMITATION

The conclusions and recommendations in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation.

We recommend that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known, in our analysis certain assumptions had to be made. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis.

In cases where these recommendations are not followed, the company's responsibility is limited to report accurately the information encountered in the testholes.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of boreholes may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

ENCLOSURES

Ministry of Transportation and Communications Ontario

Ref. No. 82-1-11

Encl. 1

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 1

METRIC

W P 187-80-02 LOCATION Sta. 10+692 o/s 4.2 m Rt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Core and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 30-01-82 to 01-02-82 CHECKED BY Z.S.D.

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
215.7	GROUND SURFACE										
0.0 / 215.2	Sand with roots & some decayed vegetation, brown.		1	SS	-						Ground Frozen
0.5	brown / grey		2	SS	70	▼	215		○		7 52 34 7
			3	SS	80/0.22 m		214		○		13 50 33 4
	Heterogeneous mixture of sand, silt & gravel, occasional cobbles. (Glacial Till) very dense		4	SS	92/0.15 m				○		30 53 14 3
			5	SS	91/0.22 m		213		○		7 55 33 5
			6	SS	120/0.22 m				○		10 51 33 6
	very frequent cobbles & boulders.		7	RC	REC 73%		212				Jan.30/82 Jan.31/82
			8	SS	50/0.08 m		211		○		
			9	SS	82/0.15 m				○		6 47 40 7
			10	SS	REC 96%		210				Jan.31/82 Feb. 1/82
			11	SS	23/0.08 m				○		
			12	SS	REC 0%						
			13	SS	REC 24%		209				
207.9			14	SS	100/0.12 m		208		○		24 45 24 7
7.8	END OF BOREHOLE										Hole advanced by driving N-casing to 1.5m. Pull N-casing out and drill in BW casing.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications Ontario

Ref. No. 82-1-11

Encl. 2

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

METRIC

W P 187-80-02 LOCATION Sta. 10+675.5 o/s 4.5 m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Core and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 27-01-82 to 29-01-82 CHECKED BY Z.S.O.

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
214.7	ICE SURFACE										
0.0 / 214.2	Ice & Water										
0.5 / 213.9	Cobbles & Boulders						214				
0.8 / 213.2	Gravelly Sand, compact to dense brown		1	SS	31						37 61 2 0
1.5	boulder		2	RC	REC 33%		213				
	Heterogeneous mixture of sand, silt & gravel frequent cobbles & boulders. (Glacial Till) dense to v. dense, grey.		3	SS	80/0.22 m				○		12 46 35 7
			4	SS	67/0.15 m		212		○		12 46 34 8
			5	RC	REC 60%						Jan.28/82 Jan.29/82
			6	SS	92/0.15 m		211		○		40 34 20 6
210.0			7	SS	32/0.25 m						Sample No.7 no recovery.
4.7	greyish Quartzite Bedrock		8	RC	REC 57% RQD=0		210				
			9	RC	REC 83% RQD=0						
208.1			10	RC	REC 81% RQD 55%		209				
6.6	END OF BOREHOLE										Hole advanced by N-casing to 1.5 m. Pull out N-casing and drill BW casing.

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

15 $\frac{20}{10}$ 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

Ref. No. 82-1-11

ENCL. 3

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

METRIC

W P 187-80-02 LOCATION Sta. 10+648 o/s 4.7 m Rt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Coring and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 04-02-82 CHECKED BY Z.S.O.

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
214.6	ICE SURFACE										
0.0 / 214.0	Ice & Water						214				
0.6 / 213.7	boulder or rock										
0.9	greyish Quartzite Bedrock		1	RC	REC 95%	RQD 53%					
			2	RC	REC 85% RQD 14%		213				
212.0			3	RC	REC 81%	RQD 30%					
2.6	END OF BOREHOLE										Advance BW casing to 0.9 m. Clean inside with bicone.

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

$\overset{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
$\underset{10}{}$

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications Ontario

Ref. No. 82-1-11

Encl. 4

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No. 4

METRIC

W P 187-80-02 LOCATION Sta. 10+634 o/s 4.0 m Lt. ℄ Hwy. 554 - Line 'H' ORIGINATED BY S.D.

DIST 18 HWY 554 BOREHOLE TYPE AXT Rock Coring and Washboring COMPILED BY S.D.

DATUM Geodetic DATE 02-02-82 to 03-02-82 CHECKED BY Z.S.O.

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 W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
215.4	GROUND SURFACE										
0.0	0.12 m Sand						215				
			1	RC	-	▼					
	greyish										
	Quartzite Bedrock		2	RC	REC 42% RQD 18%		214				
			3	RC	REC 83% RQD 25%		213				
212.4											
3.0	END OF BOREHOLE										Drill BW casing. RC 1 recovered from casing. BW casing advanced to 1.2 m. Clear inside casing with tricone.

OFFICE REPORT ON SOIL EXPLORATION

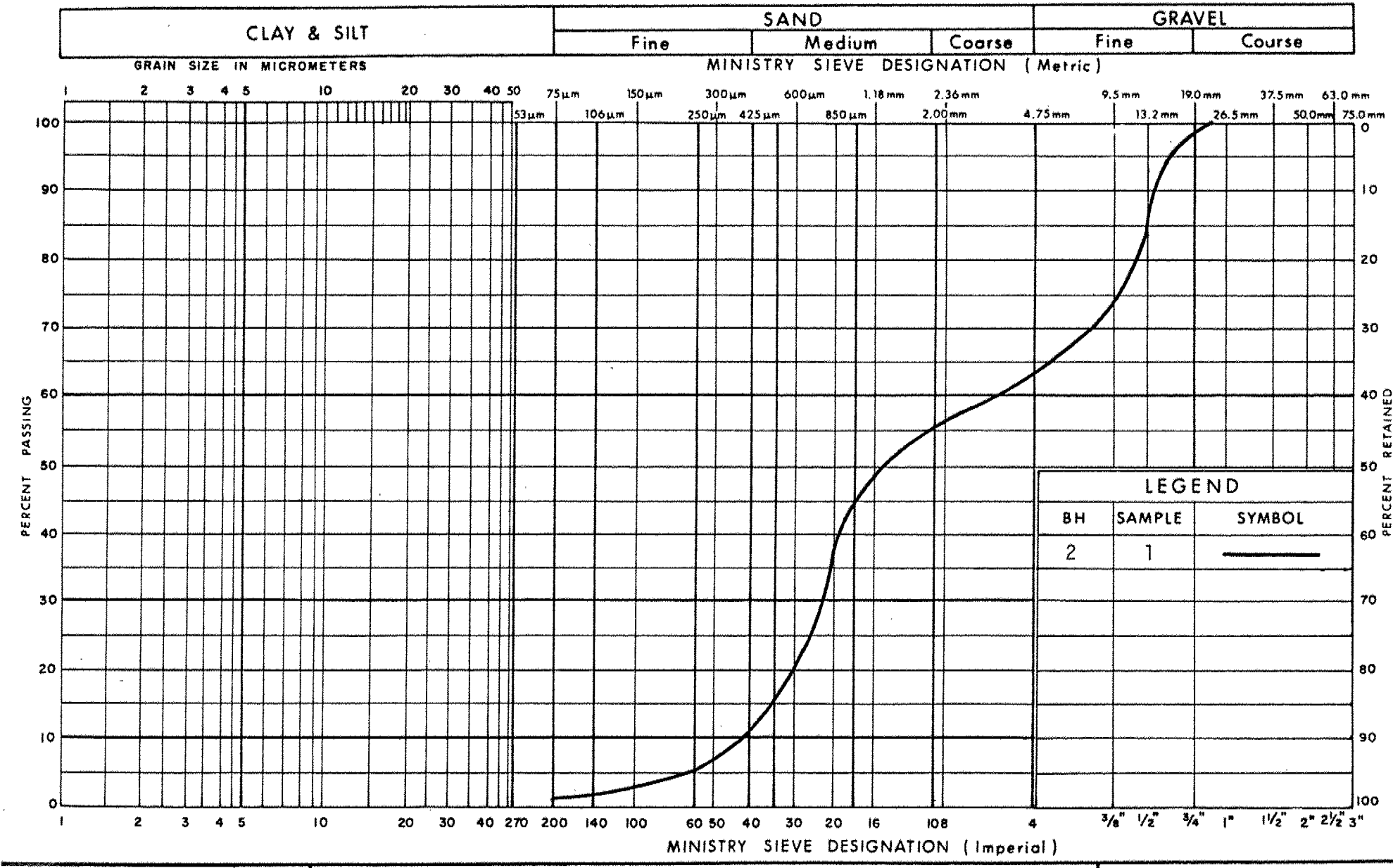
$+^3$, $\times^5$: Numbers refer to Sensitivity

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

78 12 M

Ref. No. 82-1-11

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

FIG No 1

W P 187-80-02

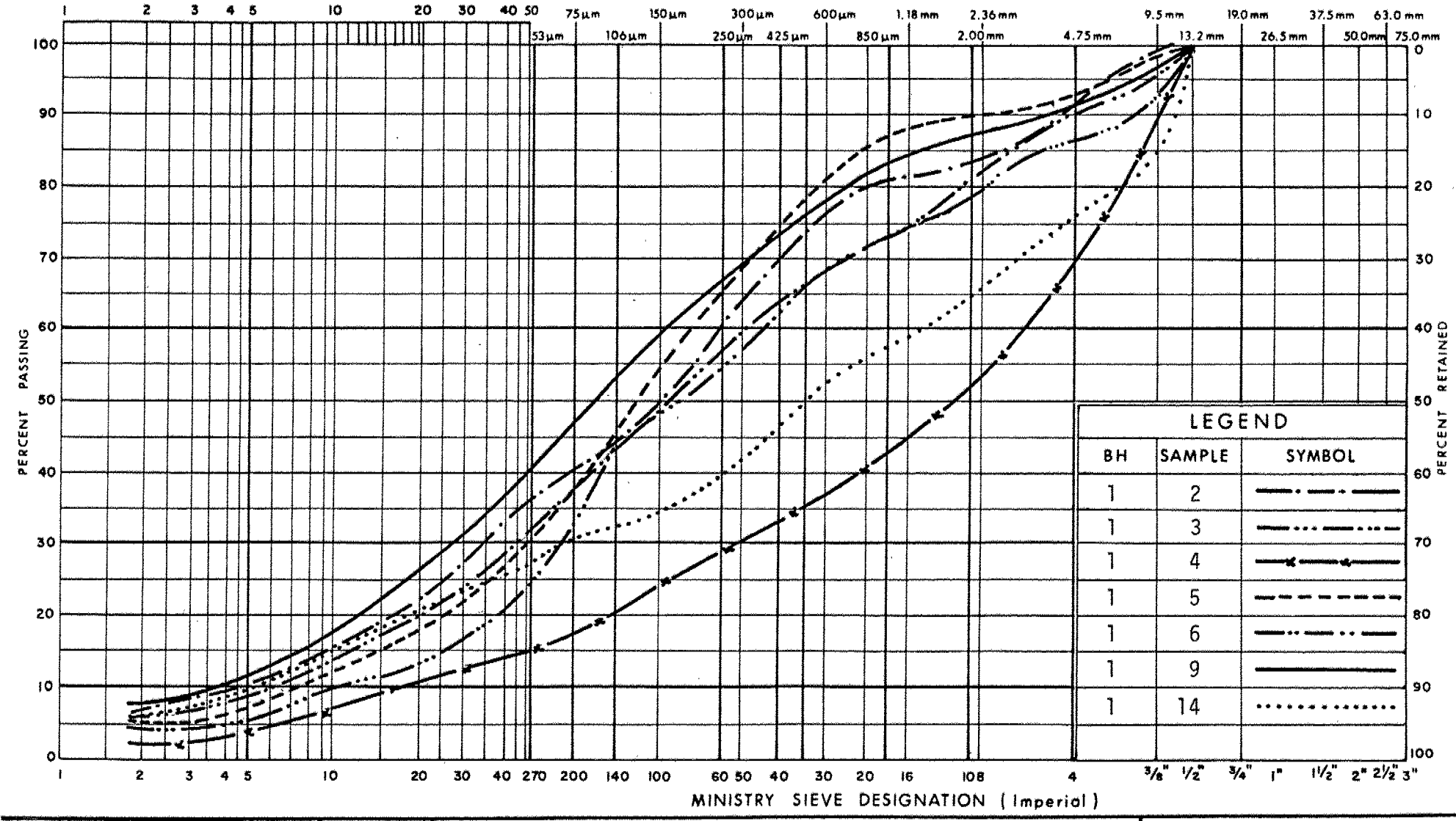
Encl. 5

78 12 M

Ref. No. 82-1-11

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Course



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

FIG No 2

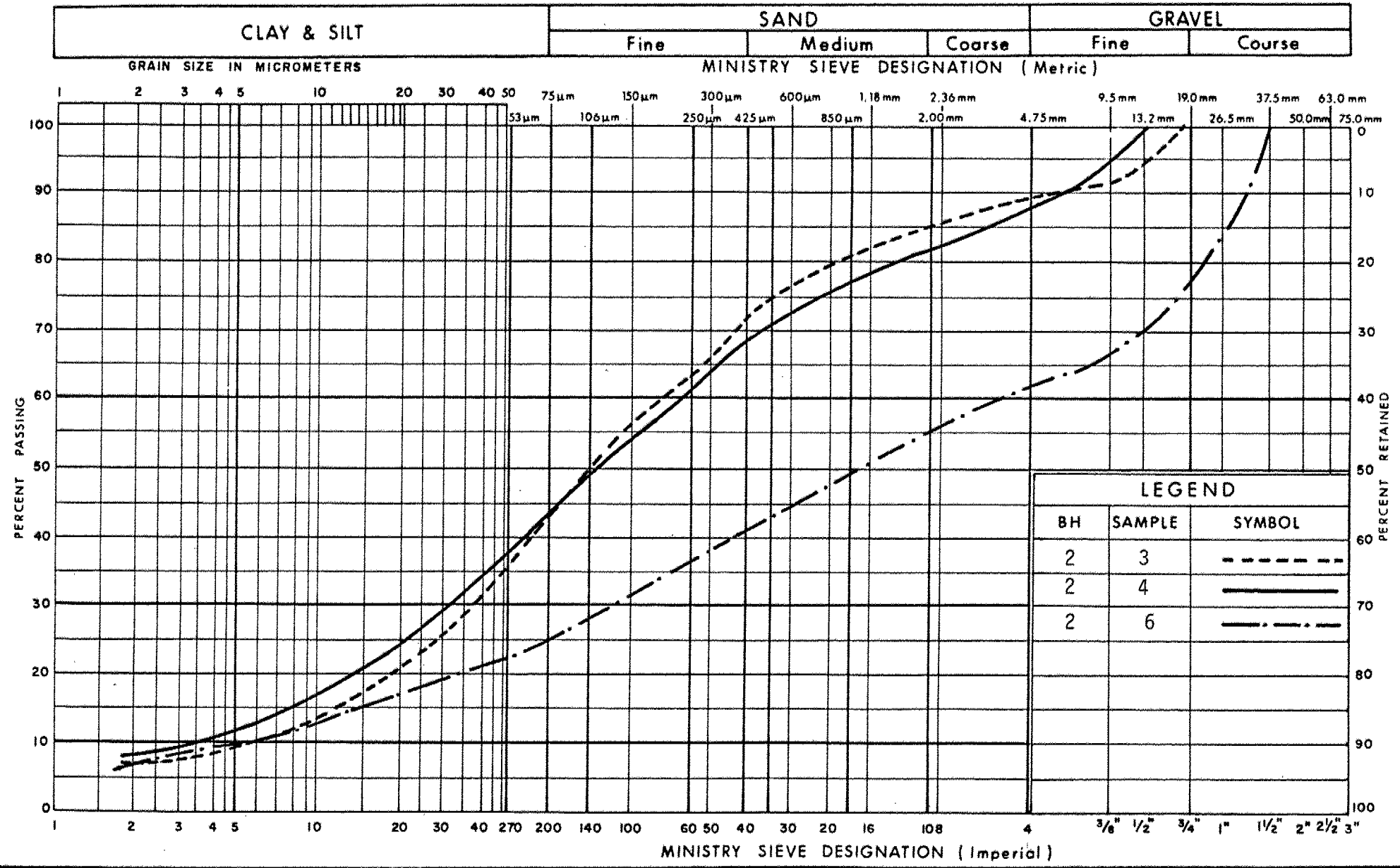
W P 187-80-02

Encl. 6

78 12 M

Ref. No. 82-1-11

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

FIG No 3

W P 187-80-02

Encl. 7

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO 08-MT-3048N 6-78

METRIC

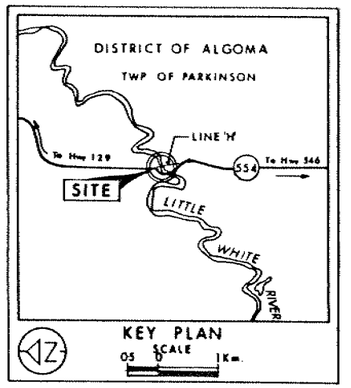
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

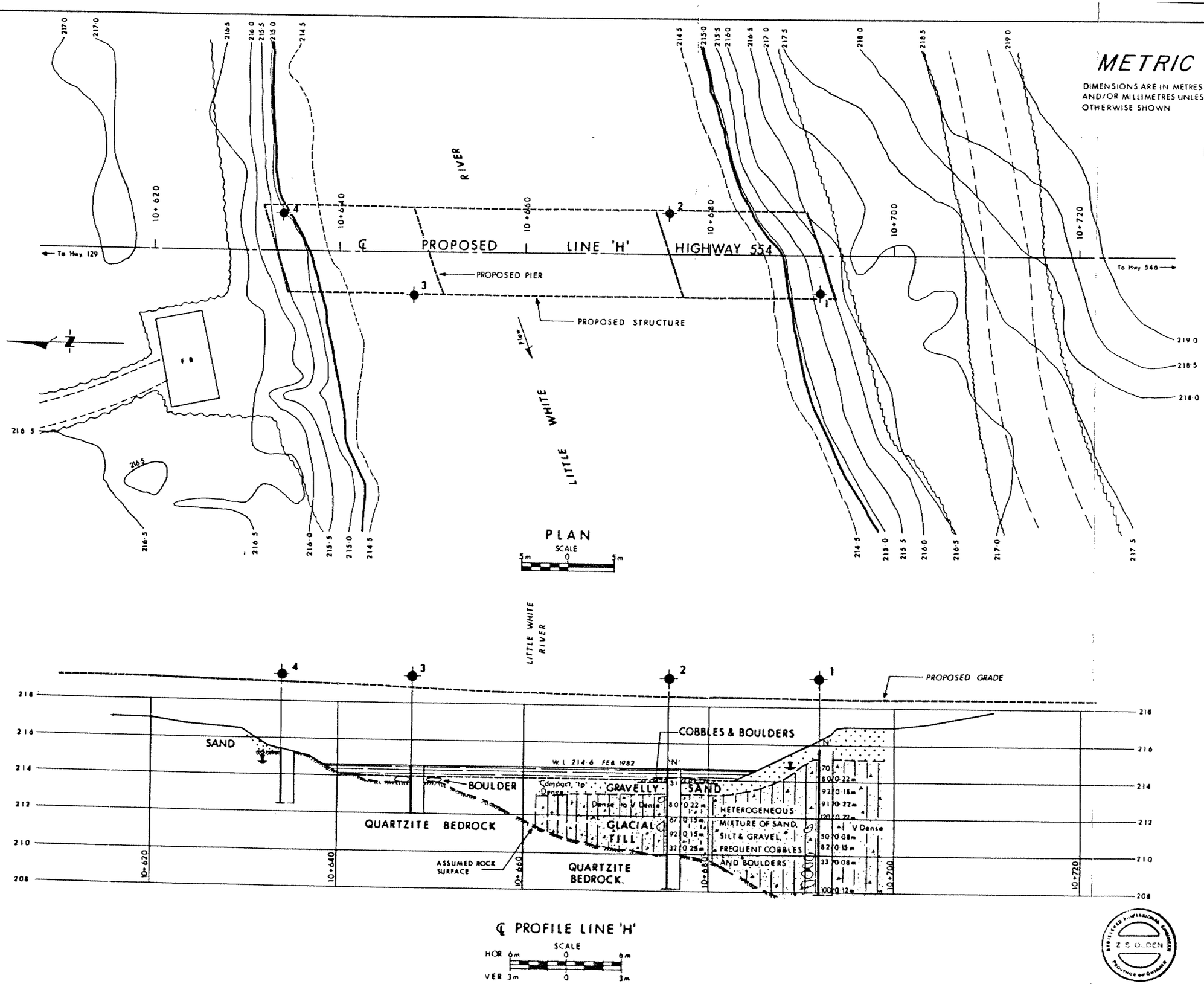
CONT No
WP No 187-80-02

SHEET

BELLS FALLS BRIDGE OVER LITTLE WHITE RIVER
BORE HOLE LOCATIONS & SOIL STRATA

DOMINION SOIL INVESTIGATION INC.





℄ PROFILE LINE 'H'

SCALE
HOR 6m 0 6m
VER 3m 0 3m

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 198202

No	ELEVATION	STATION	OFFSET
1	215·7	10+692	4·20Rt.
2	214·7	10+675·5	4·50Lt.
3	214·6	10+648	4·70Rt.
4	215·4	10+634	4·00Lt.

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

REF No 6-8004-1 1981 04

Z S OLDEN
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No

HWY No 554 LINE 'H'			DIST 18
SUBMD S.O.	CHECKED Z.O.	DATE 1982 02 26	SITE 385-170
DRAWN F.L.	CHECKED Z.O.	APPD	DWG 1878002-A

memorandum

Ontario

To: Mr. A. Radkowski
Design Engineer
N & NW Regions
Structural Office
3501 Dufferin St., 4th Floor

Date: 83 02 25

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Little White River Bridge
W.P. 187-80-02, Site 38S-170
District 18, Sault Ste. Marie

We have reviewed final bridge drawings Nos. 1 and 3 for the above-mentioned site and provide the following comments:

(1) In our memo of 82 10 28, we noted that additional field borings were required. We feel that the three additional boreholes satisfy this requirement.

(2) Also in the memo, we stated that due to the presence of boulders and cobbles in the glacial till, it would not be possible to drive sheet piling for the unwatering scheme. We believe that your note No. 2 on Drawing 3 satisfies the requirement.

(3) In the memo, we suggested bracing the north pier footing to resist lateral forces and note that the design complies with this recommendation.

(4) We question the need for the tremie concrete beneath the south pier footing. We believe that the footing can be founded on the glacial till at elevation 215.0. This would reduce both the amount of excavation, and the uplift pressure at the base of the excavation.

Brian Ruck

Brian Ruck
Trainee Engineer

For: M. Devata, P. Eng.
Senior Foundations Engineer

BR:syc

memorandum

Ontario

To: Mr. W.W. Kulmatickas
Head, Structural Section
Northwestern (Thunder Bay) Region

Date: 83 02 04

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Supplementary Foundation Investigation
Bells Falls Bridge Over Little White River
Hwy. 544, Site 38S-170
District #18 (Sault Ste. Marie)
W.P. 187-80-02

At the above-mentioned location a subsurface investigation was carried out by Dominion Soil Investigation Inc., and the report was submitted to you on 82 06 03. Since then, we have reviewed the preliminary bridge drawing #38S-170-P1 and submitted our comments to Mr. A. Radkowski in a memo dated 82 10 28 which are still applicable. As indicated in our memo, additional field investigation was warranted due to the change in structural geometry subsequent to completion of the original foundation investigation.

We have recently requested Dominion Soil Investigation Inc., to carry out a supplementary geotechnical investigation in the area of the revised abutment footing locations. Attached please find the results of the supplementary investigation and the revised drawing showing the additional borehole information (B.H. #101, 102 & 103). These findings show that the north abutment can be founded on the surface of the bedrock and the south abutment within the dense glacial till stratum. The bearing capacity, design parameters and other pertinent recommendations were discussed in the original foundation report. This additinal information and the revised drawing should be appended to the original report.

M. Devata, P. Eng.
Senior Foundations Engineer

MD:syc

Att.

cc: R. Girard
D. Thomas (2)
W.A. Stewart (2)
K. Bassi
B.J. Giroux
R. Hore

K. Maluzinsky (Cover Only)
T.J. Kovich (Cover Only)

DOMINION SOIL INVESTIGATION INC.
CONSULTING SOIL & FOUNDATION ENGINEERS
104 CROCKFORD BLVD., SCARBOROUGH, ONTARIO, CANADA, M1R 3C6 (416) 751-6565

January 12, 1983

Ref. No. 82-12-1

Ministry of Transportation and Communications
Pavement and Foundation Design Section
Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. M. Devata, P. Eng.
Senior Foundations Engineer

Re: Supplementary Geotechnical Investigation
Bells Falls Bridge over Little White River
Highway 554-Site 38S-170
District of Sault Ste. Marie
W.P. 187-80-02

Dear Sirs:

We have now completed the above project and take pleasure in presenting our findings in this report.

The field work was carried out during the period of December 12-13, 1982 and consisted of drilling three boreholes to depths ranging from 4.4 to 6.1 m. The new boreholes were numbered in the 100-series to differentiate them from the boreholes drilled during our original investigation in January 1982. The locations of the boreholes are shown on Drawing No. 1878002-A and the subsurface conditions encountered are presented on the Record of Borehole Sheets.

Borehole 101, located at the south abutment, encountered a sandy and gravelly glacial till. Within the top 1.5 m, in this borehole, normal sampling was not possible due to the presence of continuous cobbles and boulders. Below this, the recorded 'N'-values were consistently greater than 50 blows/0.3 m indicating a very dense material. The groundwater level in this borehole was recorded at Elevation 216.0 m (i.e. 0.8 m below the ground surface).

At the north abutment, Boreholes 102 and 103 encountered a shallow sandy overburden underlain by the quartzite bedrock at depths of 1.3 and 1.9 m below the ground surface respectively (i.e. Elev. 215.4 and 214.9 m respectively). The core recovery was 100% and the R.Q.D. values ranged

.../...

from 57 to 73%.

These findings show that the south abutment can be founded on the undisturbed very dense till and the north abutment on the surface of the bedrock. The suggested bearing capacities, design parameters and the anticipated construction conditions were discussed in our original report dated March 1982 (Ref. No. 82-1-11) and will not be repeated here.

We trust that this work is complete within our terms of reference. If you have any questions, however, please feel free to call us.

Yours very truly,
DOMINION SOIL INVESTIGATION INC.

Z.S. Ozden, P. Eng.

ZSO:lt

memorandum

Ontario

To: Mr. A. Radkowski
Design Engineer
N. & N.W. Regions
Structural Office
3501 Dufferin St., 4th Floor

Date: 82 10 28

From: Pavement & Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Little White River Bridge
W.P. 187-80-02, Site 38S-170
District 18, Sault Ste. Marie

We have reviewed the preliminary general arrangement drawing #38S-170-P1 for the above-mentioned structural site and provide the following comments:

1) As a result of lengthening the end spans from 15 metres to 20 metres, the original foundation investigation no longer encompasses the abutment footing locations, hence we feel additional fieldwork is warranted. In addition, a twin span structure is also now being considered. We will delay any further investigation until this Section has been informed of the final structure geometry.

2) Due to the presence of frequent cobbles and boulders within the granular till at the south pier location, it will not be possible to drive sheet piling for the unwatering scheme. Alternative measures, such as preexcavation prior to sheet pile tremie box installation, will be required.

3) The north pier footing should be keyed or dowelled into bedrock to insure adequate lateral resistance. In addition, lowering of the footing will reduce horizontal ice forces againsting the footing.

Tom Kazmierowski, P. Eng.
Foundations Engineer

TK:syc

METRIC

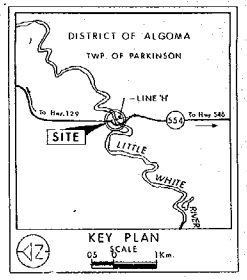
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.

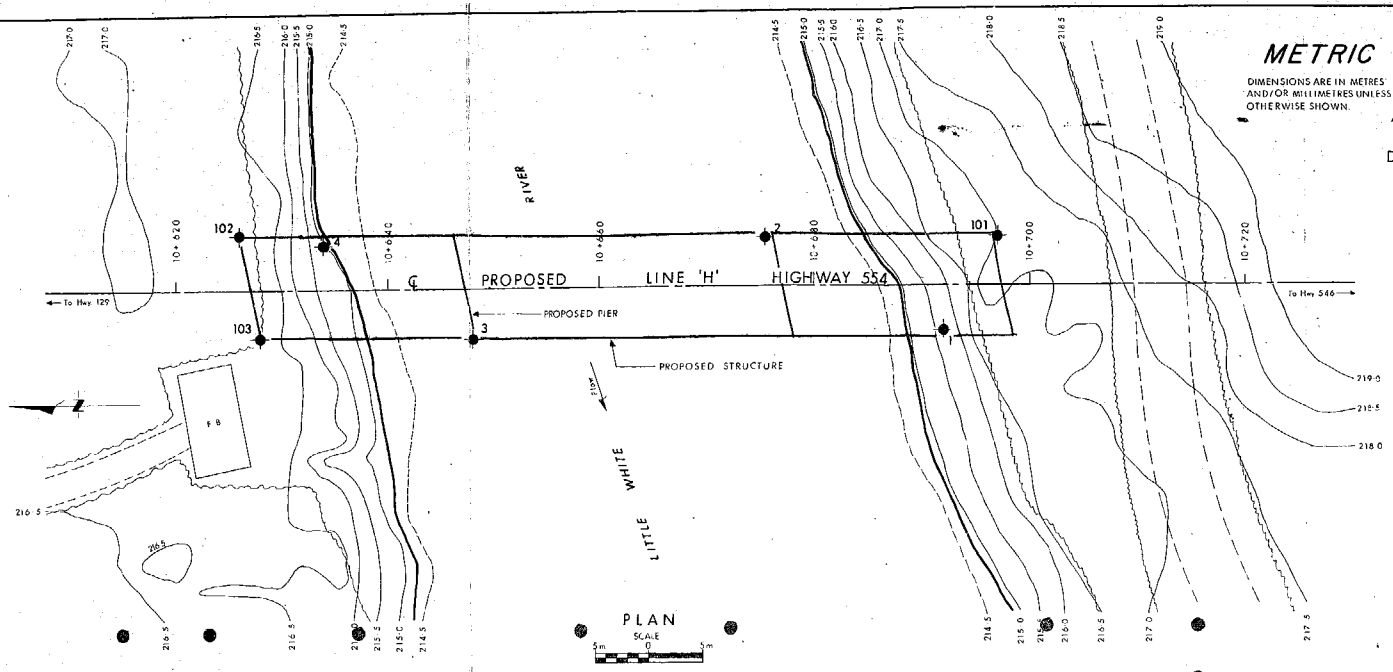
CONT No
WP No 187-80-02

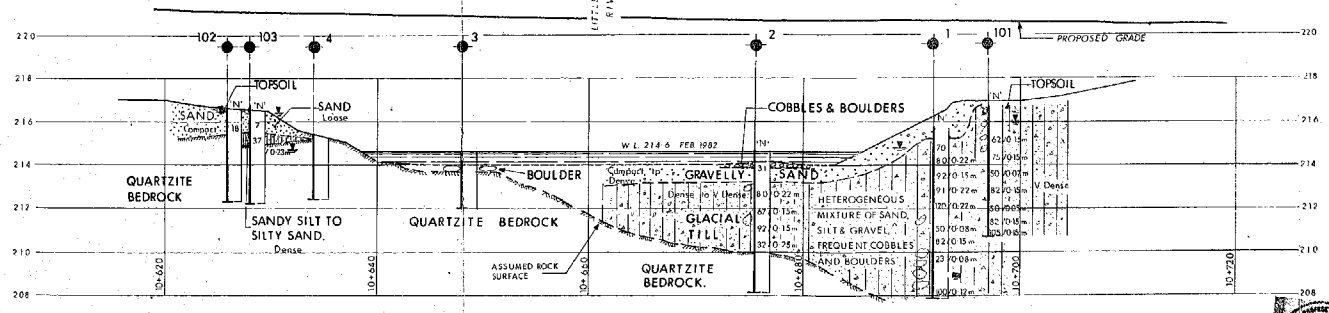
BELLS FALLS BRIDGE OVER LITTLE WHITE RIVER
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

DOMINION SOIL INVESTIGATION INC.







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HOR. 6m 0 6m
VER. 3m 0 3m

LEGEND

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2	214·7	10+675·5	4·50Lt.
3	214·6	10+648	4·70Rt.
4	215·4	10+634	4·00Lt.
101	216·8	10+697	4·50Lt.
102	216·7	10+626	5·00Lt.
103	216·8	10+628	4·50Rt.

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

REVISIONS		
82 12 16	FL	BOREHOLES 101, 102 & 103 ADDED
DATE	BY	DESCRIPTION

Geocres No.

HWY No. 554 LINE 'H'		DIST 16
SUBMD S.O.	CHECKED Z.Q.	DATE 1982 02 26 SITE 385-170
DRAWN F.L.	CHECKED Z.Q.	DWG 1878002-A

REF No. E-8004-1 1981 04