

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 52A-69A

DIST. 19 REGION

W.P. No. 600-72-05

CONT. No. 84-205

W. O. No.

STR. SITE No. 48C-5

HWY. No. 130

LOCATION Kaministiquia River

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

DIST. 19
CONT No
WP No 600-72-05

SHEET

METRIC

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

KAMINISTQUIA RIVER BRIDGE
1.0 km SOUTH OF HWY #11 & 17
GENERAL ARRANGEMENT

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
ABUTMENT & WINGWALLS:
FRONT FACE - 80 ± 20 mm
BACK FACE - 70 ± 20 mm
PIERS:
DECK: TOP - 70 ± 20 mm
BOTTOM - 40 ± 10 mm
BARRIER WALLS - 70 ± 20 mm
APPROACH SLABS - 70 ± 20 mm
OR AS NOTED ON DRAWINGS.

CONSTRUCTION NOTES

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

LIST OF DRAWINGS

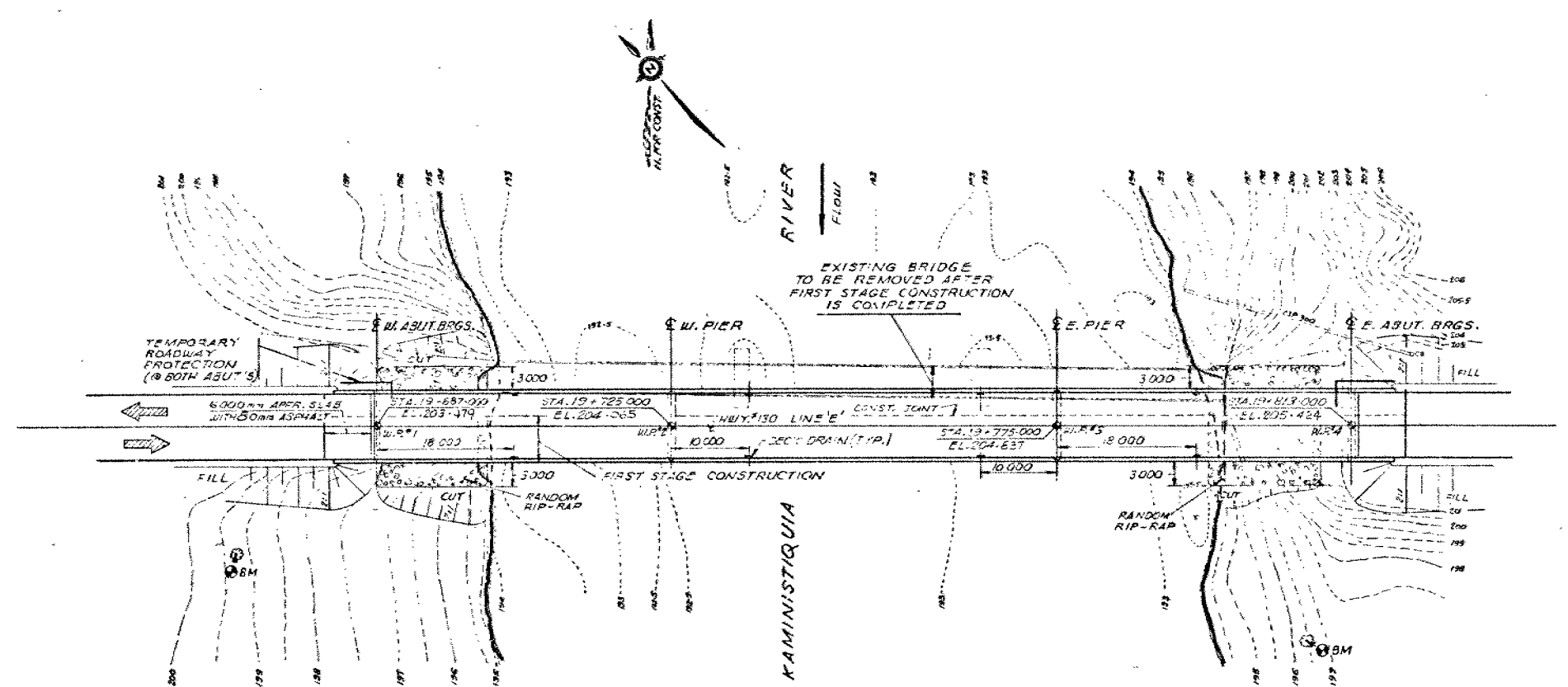
- ABC-5-1 GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATION & SOIL STRATA
- 3 FOOTING LAYOUT & DETAILS
- 4 ABUTMENTS
- 5 PIERS
- 6 BEARINGS
- 7 STRUCTURAL STEEL I
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- 9 DECK & SCREED ELEVATIONS
- 10 EXPANSION JOINT - E. ABUT.
- 11 BARRIER WALL
- 12 6000mm APPROACH SLAB
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- 15 STANDARD DETAILS
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- 18 QUANTITIES - STRUCTURE I
- 19 QUANTITIES - STRUCTURE II

BM 199.470
GEODETIC DATUM
N. & W. IN ROOT 0-4 PULPAR
16.4 RT 19+668.7

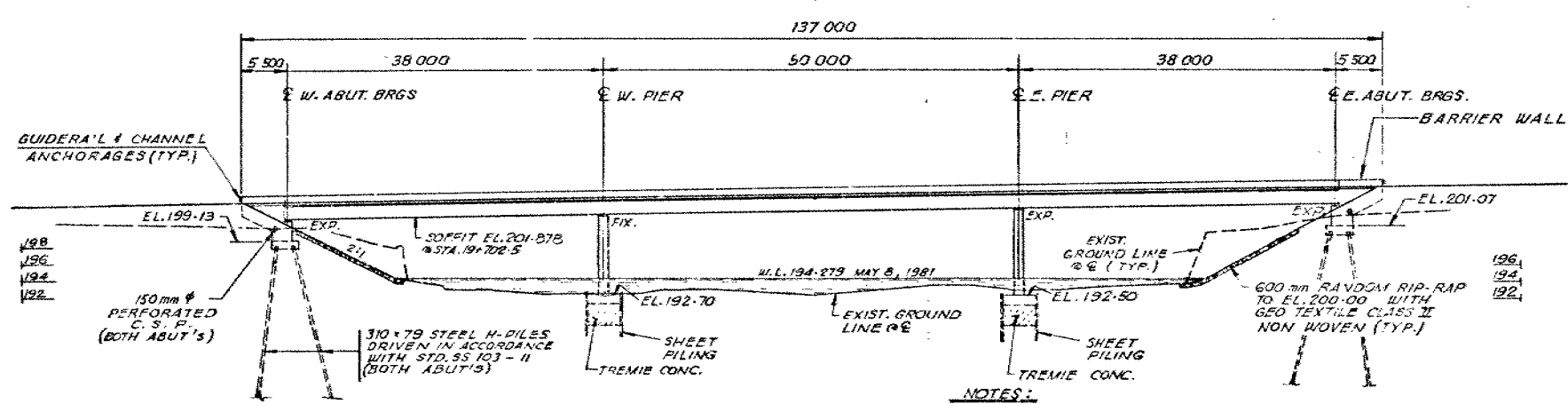


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

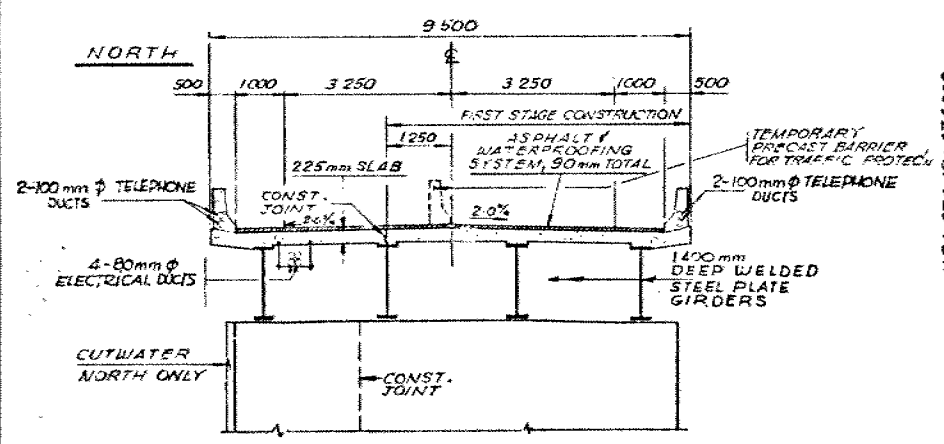


PLAN
1:400

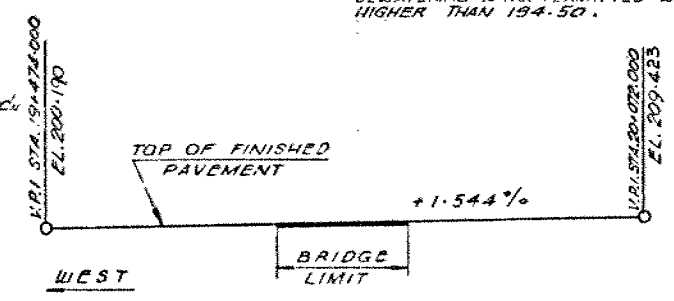


ELEVATION
1:400

NOTES:
SHEET PILES ARE NOT DESIGNED TO PENETRATE
THE COBBLES, SOULDERS OR ROCK FRAGMENTS. REMOVAL
OF COBBLES, SOULDERS AND ROCK FRAGMENTS, EXCAVATION
WITHIN THE COFFERDAM, MIGHT BE NECESSARY TO
INSTALL SHEET PILES TO REQUIRED ELEVATION.
DURING EXCAVATION OF THE WEST PIER FOOTING, WATER
ELEVATION WITHIN THE COFFERDAM SHOULD BE MAINTAINED
TO THE WATER LEVEL OF THE RIVER AT ALL TIME.
DEWATERING IS NOT PERMITTED WHEN WATER ELEVATIONS
HIGHER THAN 194.50.



TYP. DECK SECTION
1:75



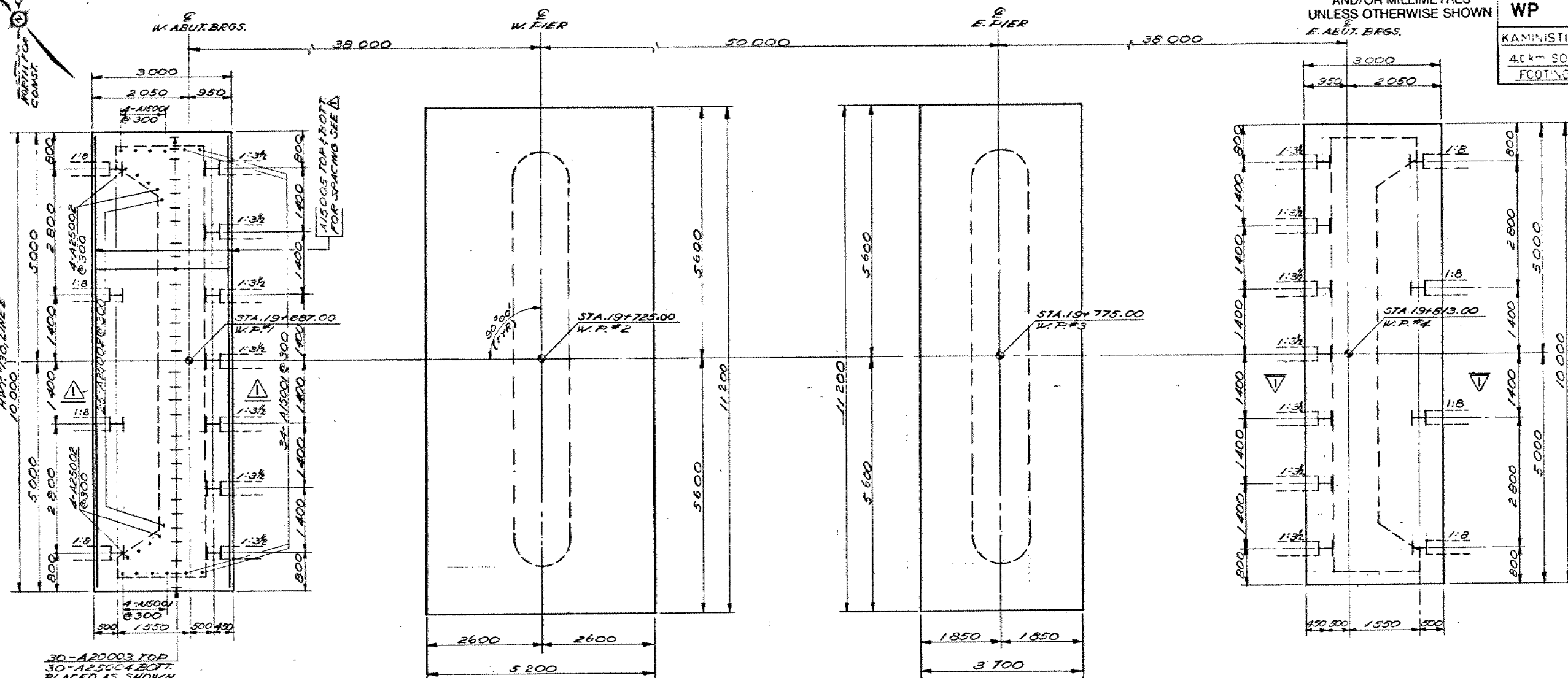
PROFILE OF HWY #10 LINE 'E'
1:75

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No 19
CONT No
WP No 600-72-05
KAMINISTIGUIA RIVER BRIDGE
4.6km SOUTH OF HWY #116 #17
FOOTING LAYOUT DETAILS

SHEET



FOOTING LAYOUT

1:50

LIST OF STEEL H-PILES							REMARKS
LOCATION	TYPE	NO. REQD.	LENGTH	FILE DESIGN DATA	FILE CONST. DATA		
W. ABUTMENT	HP310x79	11	6700mm	630 kN/PILE	1000 kN/PILE	2070 kN/PILE	WITH DRIVING SHOES
E. ABUTMENT	HP310x79	11	7700mm	630 kN/PILE	1000 kN/PILE	2070 kN/PILE	DO

NOTES:

- PILE LENGTH SHOWN IS THEORETICAL LENGTH BELOW CUT OFF ELEVATION. PILES TO BE DRIVEN IN ACCORDANCE WITH STD. S5103-11.
- PILE SPACING MEASURED AT UNDERSIDE OF FOOTING.
- FOR PIER FOOTING REINFORCEMENT SEE DWG. 5
- DRIVING SHOES SHALL BE INSTALLED ON ALL PILES IN ACCORDANCE WITH STD. DD-3301.
- PILES TO BE DRIVEN BELOW ELEV. 192.00 FOR WEST ABUTMENT AND ELEV. 193.00 FOR E. ABUTMENT.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE	BY
DESIGN		CHECK	LOADING		
DRAWING		CHECK	SITE No.		

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84 - 205



Ministry of
Transportation and
Communications

INDEX

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2	Abbreviations and Symbols
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NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT
For

3

Highway 130 Over
Kaministikwia River
W.P. 600-72-05, Site 48C-5
Hwy. 130, District 19, Thunder Bay

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation carried out by Dominion Soil Investigation at the site mentioned above.

The fieldwork was carried out in three phases. The first phase being carried out between 81-10-06 and 81-10-15. Five boreholes were advanced by either hollow stem continuous flight augers, or wash boring. An additional borehole was completed on 81-11-09 & 10 and was advanced by means of hollow stem continuous flight augers. A test pit was dug on 81-12-11.

SITE DESCRIPTION

Hwy. 130 crosses the Kaministikwia River about 15 km west of Thunder Bay. In the general area of the site, the river meanders and there is a discontinued ox-bow about 1 km east of the site. The river at the site is about 90 m wide with banks generally in the order of 8 m high and side slopes ranging from 2 horizontal in 1 vertical to 4:1 or flatter. At times of flood, the Kaministikwia River rises substantially in elevation and observations made at Point de Meuron, some 6 km downstream, indicate a rise of more than 3 m in river level under regional flood conditions; stream velocities in excess of 1.5 m/s have also been reported at such times.

No bedrock outcrops are visible in the immediate vicinity of the site. Visual observations indicate that the river bed is overlain by rounded boulders of substantial (of the order of 0.5 m) size. There are small rapids both upstream and downstream of the bridge.

Visual observations made of the existing bridge indicate that one of its piers has tilted upstream. From a discussion with the regional staff, however, we undertsand that this condition became apparent immediately after the construction of the structure and that it did not deteriorate since.

SUBSURFACE CONDITIONS

General

The foundation investigation indicates that reasonably uniform subsurface conditions are present at the site. The surficial deposits are predominantly sand and gravel fill or sand with cobbles and boulders. Underlying the surficial deposits is a hard silty clay 1.4 to 13.2 m thick. A very dense stratum of sandy silt underlies the silty clay.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile and two sections showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2 of the contract drawings.

The various soil types encountered are briefly described in the following paragraphs.

Surficial Deposits

The boreholes which were located on shore (Boreholes 1, 4, 5 and 6) encountered a 3.8 to 6.7 m thick fill, consisting of predominantly sand and gravel with some silty clay or silty sand zones. Standard Penetration Test 'N' values in the fill range from 4 to 28 blows/0.3 m, indicating a moderate to high degree of compaction.

On the east bank of the river, a shallow, 1.8 to 2.3 m thick, stratum of sand was encountered and identified as possible fill material. The relative density of this stratum was inferred to be very loose to dense but generally loose, indicated by Standard Penetration Test 'N' values ranging from 4 to 33.

Boreholes drilled on the river bed encountered a 0.6 to 0.8 m thick sand, gravel and boulder deposit. The size of the boulders in the river range up to 0.5 m.

Silty Clay

Below the above described surficial deposits the boreholes encountered a silty clay of low plasticity with bands of slightly plastic silt. The surface of this stratum was found between El. 195.8 and 192.7 m.

The stratum consists predominantly of silt and clay size particles, and a trace of sand. Interbedded in the stratum are occasional sand seams. Grain Size Distribution curves of samples from the deposit are shown on Figures 1 and 2, indicating that the deposit consists of 0 - 3% fine sand, 45 - 95% silt, and 5 - 55% clay size particles.

Atterberg Limit tests were carried out on several representative samples of the silty clay and silt bands of the deposit. The major portion of the stratum is a silty clay of low plasticity and the results of the Atterberg tests performed on this material are shown on the plasticity chart, presented as Fig. 4. The tests indicate that the liquid limit ranges from 26 to 35%, the plastic limit between 15 and 23% with a corresponding plasticity index of 10 to 13. Based on this, the material is classified as clay of low plasticity (CL). Tests on the silt bands gave liquid limits ranging between 2 and 5.5 (see Fig. 5). These indicate a silt of slight plasticity (ML). The natural moisture contents of the samples ranged from 10 to about 25%, but most of the values were between 10 and 20%. The bulk unit weight of the deposit was measured to be 22.5 kN/m^3 .

Standard Penetration tests carried out in the silty clay deposit yielded 'N' values ranging from 18 to over 100 blows/0.3 m. 'N' values less than 50 were recorded only in the upper 1 m zone of the deposit. From these tests, it is inferred that the consistency of the stratum is very stiff to hard, generally hard.

Sandy Silt

Below the silty clay, between El. 190.8 and 189.0 a sandy silt deposit was encountered in the western half of the site. This material is susceptible to 'boiling', if excavations are carried out below the water table.

The results of grain size distribution tests completed on samples from the stratum are shown on Fig. 3, indicating a material consisting of 22 to 55% fine sand, 45 to 72% silt and 0 to 5% clay. The stratum also contains some embedded and occasional layers of fine sand.

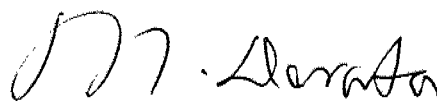
Standard Penetration resistances ranged between 54 and over 100 blows/0.3 m indicating that the deposit is very dense.

Groundwater

Groundwater levels measured in the boreholes drilled in the approach embankments, approximated the prevailing river level, which at the time of the investigation fluctuated between about El. 194.3 and 193.8 m. It is expected that the water level in the river banks will be controlled by the river with some time lag. It was noted during the fieldwork that the river level can change quickly and substantially. A high river water level, at this location has been shown as 196.8 m. Allowance should be made to sudden rises and fluctuations in the river level.



H. Sturm, P. Eng.
Project Foundations Engineer



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

APPENDIX



RECORD OF BOREHOLE No.1

METRIC

8

W P 600-72-05 LOCATION Sta. 12+611.8 o/s 3.0 m Lt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 15-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
201.0	Ground Surface								10	20	30		GR SA SI CL		
0.0	Sand & Gravel, some silt, occasional clay lumps, FILL compact.		1	AS	-		200								
			2	SS	18										
			3	SS	14										
			4	SS	18										
194.7			5	SS	18		195								
6.3	dark grey SILTY CLAY of low plasticity to SILT v. stiff of hard slight plasticity.		6	SS	86										
			7	SS	50/0	14 m								0 0 75 25	
			8	SS	50/0	12 m									
			9	SS	60/0	15 m									
190.8			10	SS	50/0	10 m	190								
10.2	very dense, black SILT & FINE SAND, occasional layers of sand.		11	SS	50/0	12 m									
			12	SS	93									0 55 45 0	
			13	SS	50/0	12 m									
			14	SS	58										
182.4			15	SS	50/0	12 m	185								
18.6	END OF BOREHOLE														

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 2

METRIC

9

W P 600-72-05 LOCATION Sta. 12+651.6 o/s 20 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 09 to 10-11-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
193.3	River Bed													
192.7	Sand & Gravel, boulders													
0.6	hard, black SILTY CLAY of low plasticity to SILT of slight plasticity		1	SS	44									0 0 45 55
			2	SS	52									0 2 73 25
			3	SS	100/0	.25 m								
			4	SS	50/0	0.12 m	190							0 0 85 15
189.0			5	SS	100/0	.25 m								
4.3	very dense, black SANDY SILT		6	SS	70									
			7	SS	90									
	some embedded fine gravel.		8	SS	60									0 22 72 5
	thick sand seams		9	SS	54		185							
183.7			10	SS	83									
9.6	END OF BOREHOLE													

NOTE: River water level fluctuated between 193.8 & 194.3m at time of investigation.

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 3

METRIC 10

W P 600-72-05 LOCATION Sta. 12+682.6 o/s 16.0 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. and tricone COMPILED BY C.A.
DATUM Geodetic DATE 13 to 14-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.5	River Bed																
0.0	Brown sand, many cobbles & boulders																
192.7																	
0.8	hard		1	SS	50/0.05 m									o			0 3 82 15
	dark grey to black		2	SS	50/0.12 m									o			0 0 62 38
	SILTY CLAY		3	SS	50/0.12 m									o			0 0 89 11
	of		4	SS	50/0.12 m									o			
	low plasticity		5	SS	50/0.12 m									o			
	to		6	SS	50/0.12 m									o			
	SILT																
	of																
	slight plasticity		7	SS	97									o			0 0 83 17
	occasional sand seams, boulders.																
185.7			8	SS	50/0.07 m									o			
7.8	END OF BOREHOLE																
	NOTE: River level fluctuated between 193.8 and 194.3 m at time of investigation.																Hole advanced by augering to 1.2 m and by tricone to the remaining depth.

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 4

METRIC

11

W P 600-72-05 LOCATION Sta. 12+718.8 o/s 2.4 m Lt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 08 to 14-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _p	W	W _L	WATER CONTENT (%)				
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					TO 20 30				
201.4	Ground Surface																
0.0	Sand & Gravel FILL loose.		1	SS	8	Dry Cave	200										
			2	SS	5												
197.6			3	SS	5												
3.8	loose, brown & grey SILTY FINE to MEDIUM SAND, trace gravel, (possible fill)		4	SS	24												
195.8			5	SS	100/0.22 m												
5.6	hard SILTY CLAY of low sandy plasticity to SILT of slight dark grey plasticity, black		6	SS	50/0.10 m			195									5 26 50 19
			7	SS	50/0.10 m												
			8	SS	50/0.10 m												
			9	SS	50/0.12 m												
	occasional sand layers.		10	SS	50/0.12 m			190									0 0 95 5
			11	SS	50/0.15 m												
			12	SS	50/0.15 m												
			13	SS	50/0.15 m			185									
182.6			14	SS	92												
18.8	END OF BOREHOLE																
NOTE: Water level not established at time of investigation.																	

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. 5

METRIC

12

W P 600-72-05 LOCATION Sta. 12+612.0 o/s 1.6 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 09-10-81 CHECKED BY C.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	W _p	W		
201.1	Ground Surface		1	AS	-	Dry Cave						
0.0	Sand & Gravel FILL loose to compact.		2	SS	11							
			3	SS	8							
			4	SS	12							
			5	SS	5							
			6	SS	17							
			7	SS	10							
			8	SS	21							
194.4			9	SS	28							
6.7	hard, grey.	10	SS	38								
193.0	SILTY CLAY	11	SS	100								
8.1	END OF BOREHOLE											

NOTE: Water level not established at time of investigation.

⁺₃, ⁺₅: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 6

METRIC 13

W P 600-72-05 LOCATION Sta. 12+721.2 o/s 4.3 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Washbore & Diamond Drilling (BX Casing) COMPILED BY C.A.
DATUM Geodetic DATE 06 to 07-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
201.1	Ground Surface																GR SA SI CL
9.0	brown Silty Clay, Silty Sand & Gravel. FILL v. loose to compact		1	SS	10		200										
			2	SS	18												
			3	SS	12												
			4	SS	4												
196.7			5	SS	10												
4.4	brown fine to medium SAND v. loose-- some gravel, dense trace silt		6	SS	4		195										
			7	SS	5												
194.4			8	SS	33												
6.7	v. dense, dark grey SILT		9	SS	120												
193.3	some fine sand		10	SS	50/60												
7.8	END OF BOREHOLE																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 \pm 5 (%) STRAIN AT FAILURE
10

CLIENT: MINISTRY OF TRANSPORTATION & COMMUNICATIONS
PROJECT: KAMINISTIKWIA RIVER - HWY. 130
LOCATION: STA. 12+706 o/s 30 m LT.

ELEVATION/m.	DEPTH/m.	No. 1			
		SOIL DESCRIPTION	SYMBOL	GROUND WATER	SAMPLES
		GROUND SURFACE			
196.5	0	brown well graded SAND and GRAVEL occasional cobbles and boulders.			
195.0	1.5				
194.8	1.7	dark, Peat and organic Silt			
		dark grey Fine Sandy SILT some boulders (up to 0.5 m dia.)			
193.8	2.7				
		dark grey hard SILTY CLAY with bands of slightly plastic SILT.			
193.3	3.2				
		END OF TEST PIT			

DATE: December 11, 1981

BACKHOE: John Deere
(JD-410)
1/4 cu.yard bucket

WIDTH OF TEST PIT: 0.8 m

Wet Below 1.3 m.

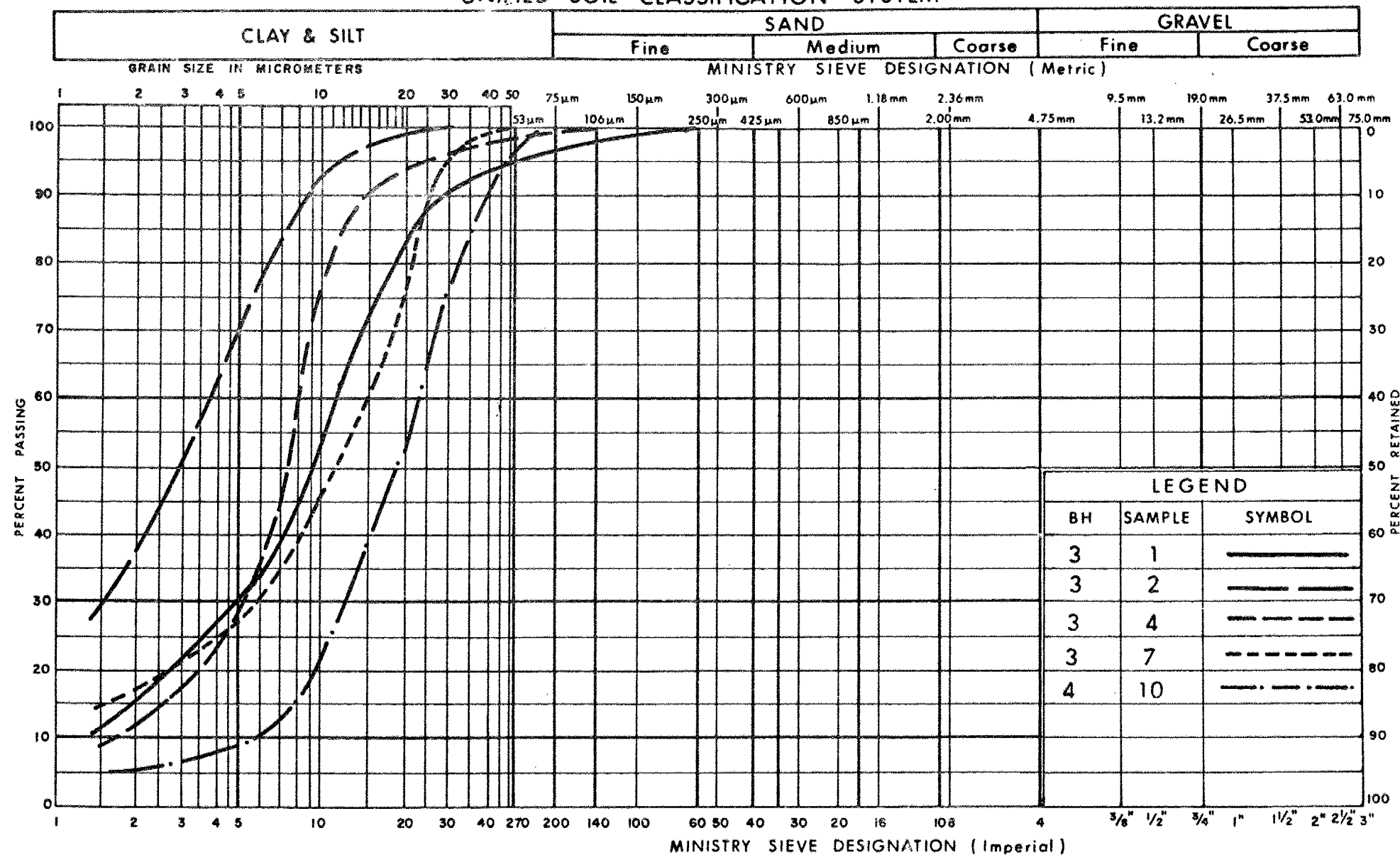
Slight seepage from sandy silt layer.

194.0 (river level)

Test pit dry and stable 1 hour after
completion. Slight seepage from
sandy silt layer continues.

Digging very hard below 2.7 m.
Backhoe unable to dig deeper than 3.2 m.

UNIFIED SOIL CLASSIFICATION SYSTEM



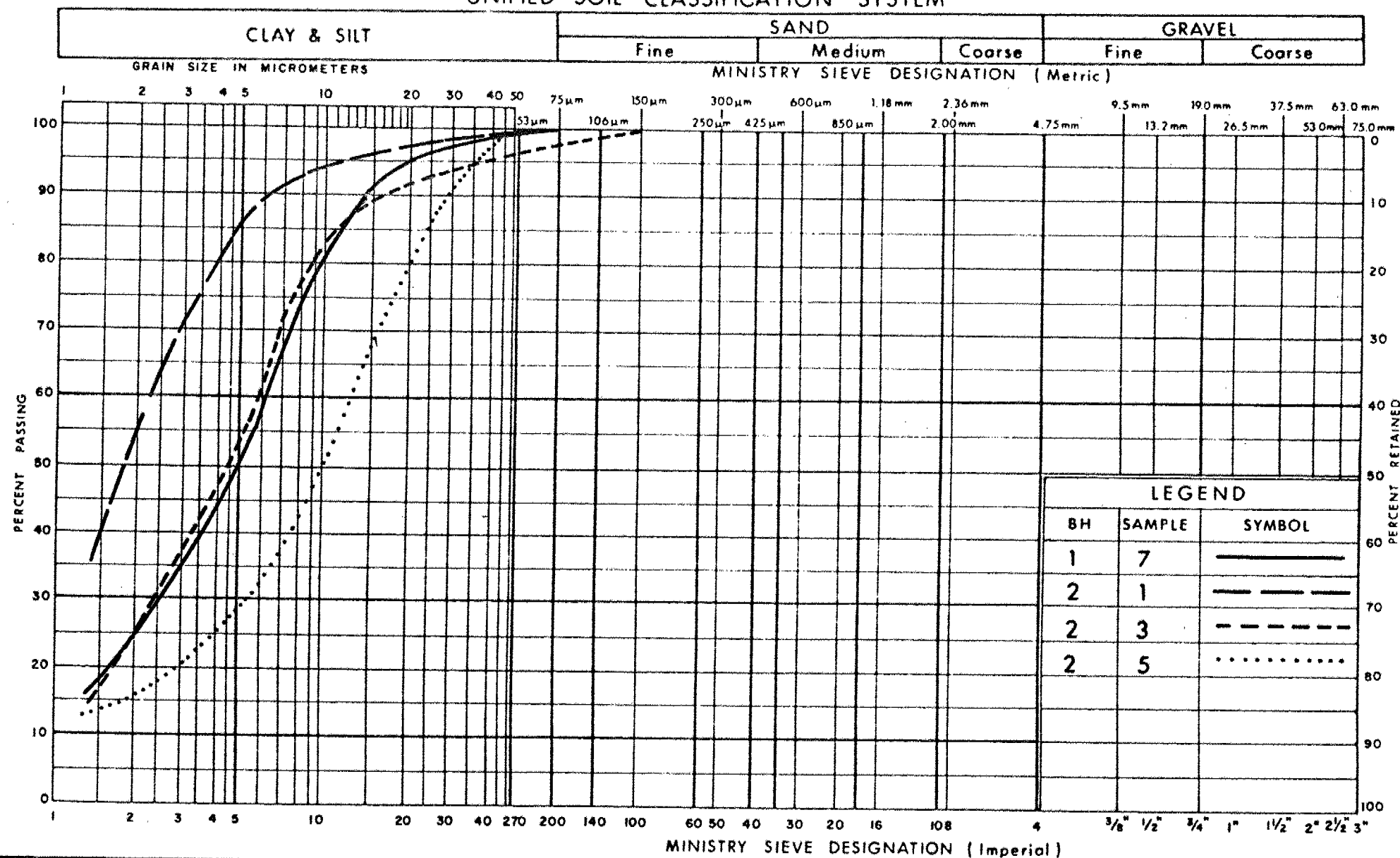
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
OF LOW PLASTICITY

FIG No 1

W P 600-72-05

UNIFIED SOIL CLASSIFICATION SYSTEM



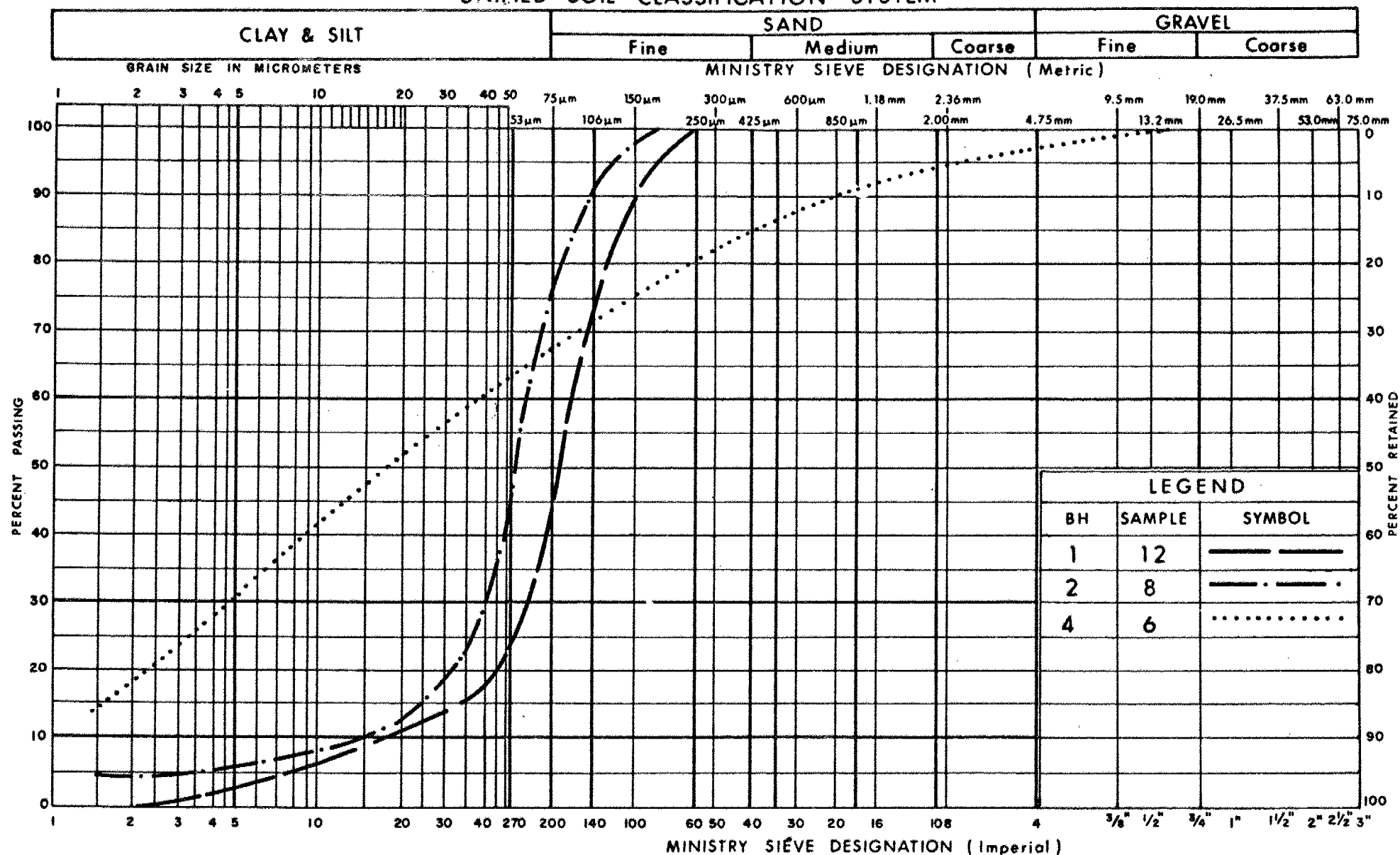
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
OF LOW PLASTICITY

FIG No. 2

W P 600-72-05

UNIFIED SOIL CLASSIFICATION SYSTEM

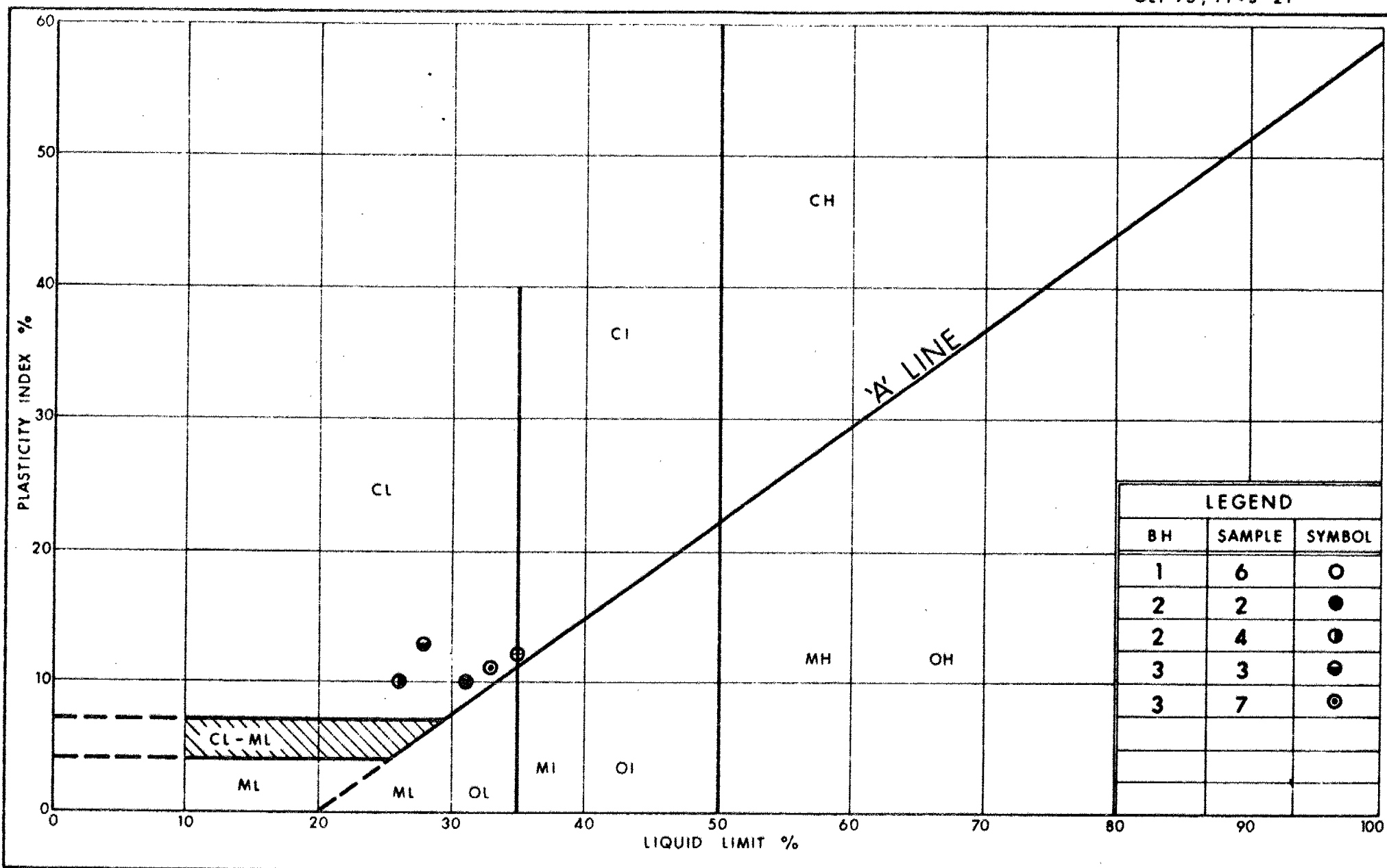


Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SANDY SILT

FIG No 3

W P 600-72-05

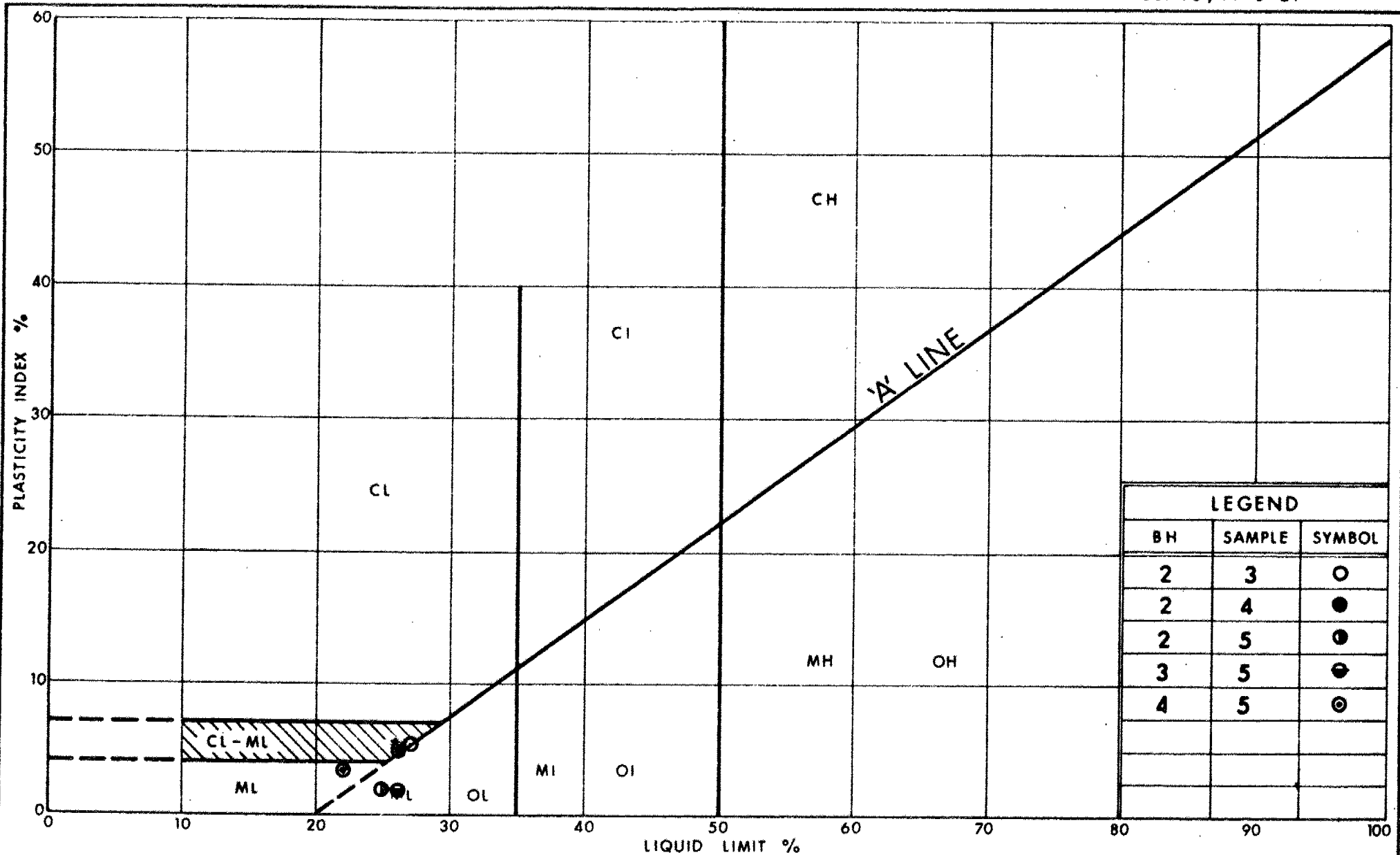


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Communications

PLASTICITY CHART SILTY CLAY of low plasticity.

FIG No. 4

W P 600-72-05



Ontario

 Ministry of
Transportation and
Communications

PLASTICITY CHART

SILT

slightly plastic.

FIG No 5

W P 600-72-05



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GEOTECHNICAL INVESTIGATION

BRIDGE OVER KAMINISTIKWIA RIVER

HIGHWAY 130, SITE NO. 48C-5, DISTRICT 19

W.P. 600-72-05

Ref. No. 81-9-T8

November 1981

Prepared For:

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GEOGRES N° 52A-69A

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1.0 INTRODUCTION

This report describes the results of a Geotechnical Investigation carried out at the site (Site No. 48C-5) of a crossing of the Kaministikwia River by Highway No. 130 in the Township of Paipoonge, District of Thunder Bay, Ontario. The investigation was requested by the Ontario Ministry of Transportation & Communications, and authorization to carry out this work was received from the Ministry in a Memorandum of Agreement (Agreement No. 4242-9081-97) dated September 25th, 1981.

The purpose of this investigation has been to establish the soil profile and groundwater conditions at the site, to establish the engineering properties of the various soil strata encountered, and to make recommendations pertaining to the design of foundations for a bridge to replace the existing structure.

.../...



2.0 DESCRIPTION OF SITE

Highway 130 crosses the Kaministiquia River about 15 km west of Thunder Bay. In the general area of the site, the river meanders and there is a discontinued ox-bow about 1 km east of the site. The river at the site is about 90 m wide and the banks are generally of the order of 8 m high with side slopes ranging from 2 horizontal in 1 vertical to 4:1 or flatter. At times of flood, the Kam River rises substantially in elevation and observations made at Point de Meuron, some 6 km downstream, indicate a rise of more than 3 m in river level under regional flood conditions; stream velocities in excess of 1.5 m/s have also been reported at such times.

No bedrock outcrops are visible in the immediate vicinity of the site. Visual observations indicate that the river bed is overlain by rounded boulders of substantial (of the order of 0.5 m) size. There are small rapids both upstream and downstream of the bridge.

Visual observations made of the existing bridge indicate that one of its piers has tilted upstream. From a discussion with the regional staff of M.T.C., however, we understand that this condition became apparent immediately after the construction of the structure and that it did not deteriorate since.

.../...



3.0 SUMMARIZED SUBSURFACE CONDITIONS

The subsurface conditions at the site were investigated at seven locations, and the location of the boreholes and a test pit are shown on Drawing No. 6007205-A.

The stratigraphy encountered in the boreholes and the test pit are given in detail on the attached Record of Borehole sheets and are also graphically presented on the profile and sections of the above drawing.

The borings indicate reasonably uniform subsurface condition at the site, consisting of:

1. Surficial deposits (predominantly fill and sand);
2. Hard, SILTY CLAY of low plasticity with bands of slightly plastic SILT; and
3. Very dense, fine sandy SILT.

The above soil deposits and their properties are described briefly in the following paragraphs.

3.1 Surficial Deposits

The boreholes which were located on shore (Boreholes 1, 4, 5 and 6) encountered a 3.8 to 6.7 m thick fill, consisting of predominantly sand and gravel with some silty clay or silty sand zones. Standard Penetration Resistances ('N'-values) in the fill range from 4 to 28 blows/0.3 m, indicating a very loose to compact, but generally compact, deposit.

.../...



Boreholes 4 and 6, located on the east bank of the river, encountered a shallow, 1.8 to 2.3 m thick, stratum of sand which was identified as a possible fill material. The relative density of this stratum was inferred to be very loose ($N = 4$) to dense ($N = 33$) but generally loose.

Boreholes 2 and 3, which were drilled from the river bed encountered a 0.6 to 0.8 m thick sand, gravel and boulder deposit. The size of the boulders in the river range up to 0.5 m.

3.2 Silty Clay

Below the above described surficial deposits the boreholes encountered a silty clay of low plasticity with bands of slightly plastic silt. The surface of this stratum was encountered between El. 195.8 and 192.7 m.

The stratum consists predominantly of silt and clay size particles, and a trace of sand. Interbedded in the stratum are also occasional sand seams or thin layers. Grading curves of the deposit are shown on Figures 1 and 2, indicating that the deposit consists of 0 - 3% fine sand, 45 - 95% silt, and 5 - 55% clay size particles.

Atterberg Limit tests were carried out on several representative samples of the clayey and silty bands of the deposit. The major portion of the stratum is a silty clay of low plasticity and the results of the Atterberg

.../...



tests performed on this material are shown on the plasticity chart, presented as Figure 4. The tests indicate that the liquid limit ranges from 26 to 35%, the plastic limit between 15 and 23% with a corresponding plasticity index of 10 to 13. Based on this, the material is classified as clay of low plasticity (CL). Tests on the silty bands gave liquid limits ranging between 22 and 27%, and plasticity indices between 2 and 5.5 (see Figure 5). These indicate a silt of slight plasticity (ML). The natural moisture contents of the samples ranged from 10 to about 25%, but most of the values were between 10 and 20%. The measured consistency limits and natural moisture contents are plotted on the Borehole Logs. The bulk unit weight of the deposit was measured to be 22.5 kN/m^3 .

Standard Penetration tests carried out in the ^{silty clay} silt gave penetration indices ranging from 18 to over 100 blows/0.3 m. Penetration indices less than 50 were recorded only in the upper approximately 1 m zone of the deposit. From these tests, it is inferred that the consistency of the deposit is very stiff to hard, but generally hard.

It is estimated that the permeability of the deposit is low, less than 10^{-6} cm/sec , and based on its grading characteristics it is believed to be moderately susceptible to frost and scour.

.../...



3.3 Sandy Silt

Below the silty clay, between El. 190.8 and 189.0 m, Boreholes 1 and 2 encountered a coarser textured silt deposit which extended to the remaining depth of these boreholes.

The grading characteristics of the stratum are shown on Figure 3, indicating a material consisting of 22 to 55% fine sand, 45 to 72% silt and 0 to 5% clay. The stratum also contains some embedded gravel and occasional layers of fine sand.

Standard Penetration resistances ranged between 54 and over 100 blows/0.3 m indicating that the deposit is very dense.

3.4 Groundwater

Groundwater levels measured in the boreholes drilled in the approach embankments, approximated the prevailing river level, which at the time of the investigation fluctuated between about El. 194.3 and 193.8 m. It is expected that the water level in the river banks will, with some time lag, be controlled by the river level. It has been noted during the field work that the river level can rise and drop quickly and substantially. In a report prepared for the Lakehead Region Conservation Authority, by James F. MacLaren Limited, the high water level, at this location was shown as 196.8 m. In the design of the project and the planning of the construction, allowance should be made to sudden rises and fluctuations in the river level.

.../...



4.0 DISCUSSION

4.1 General

The existing bridge is a three-span structure with nearly equal, 30 m long, spans. The southern pier (Sta. 12+680 \pm) is out of plumb and is tipped towards the upstream side, a condition which was noticed immediately after the construction of the existing structure and apparently has not deteriorated since. The proposed bridge replacement will take place over the present alignment of the structure and will consist of a three-span structure with two 30 m outside spans and a 45 m interior span. There are no major changes proposed in the vertical alignment of the bridge and there will be only a slight shift in the horizontal alignment towards downstream.

4.2 Summarized Subsurface Conditions

The existing approach embankments to the bridge have been constructed of granular soils which are in a generally loose condition. The surface of the underlying native soils lies between El. 195.8 and 192.7 m. It is a hard clayey silt of low plasticity with bands of slightly plastic silt, the lower zone of which is interbedded with occasional sand seams. At the north abutment and pier locations (Boreholes 1 and 2) the silty clay is underlain by very dense fine sandy silt.

The groundwater level at the bridge site appears to be controlled by the prevailing river level. At the time of the investigation, this varied between El. 193.8 and 194.3 m.

.../...



4.3 Foundation Design

The hard silty clay deposit which underlies the site can, in its undisturbed state, support heavy loads without excessive deformation. It is, however, susceptible to scour and frost, and the foundation design may, therefore, be governed by other considerations, such as scour and frost protection, construction problems, etc.

4.3.1 Pier Foundations

At the pier locations, the embedment of the foundation will depend on the requirement to provide sufficient protection against scour and frost penetration to the footings. Although a full evaluation of the depth of maximum scour is beyond the scope of this report, in our opinion, the foundations should be embedded at least 2.5 m in the river bed, that is, between El. 191 and 190 m. The soil deposits encountered at and below this elevation are consistently hard or very dense, and the factored bearing capacity of the soil, at ultimate limit state, is 1100 kPa. In order to limit the settlements to a maximum of 25 mm, the bearing capacity at serviceability limit states, Type II is 700 kPa.

4.3.2 Abutment Foundations

At the abutment locations the foundations may be taken to the hard silty clay and constructed using conventional spread footings in accordance with the recommendations given in Section 4.3.1.

.../...

Alternatively, a perched abutment could be constructed at a higher level and the foundations placed either on compacted fill or supported on end-bearing piles.

Pre-cast concrete, steel tube, or steel-H piles could be considered as possible alternatives for a pile supported structure. It is anticipated that displacement piles (i.e. pre-cast concrete or tube piles) will encounter practical refusal after penetrating the dense deposit to a depth of about 0.9 to 1.5 m. Steel-H piles are expected to penetrate the stratum about twice this amount. The estimated capacity of 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 is tabulated below. *for abutments only.*

ESTIMATED PILE CAPACITIES (kN)

Type	Size	At Ultimate Limit States	At Serviceability Limit States Type II
Steel-H	310 x 110	1400	980
	310 x 79	1000	690
	310 x 62	750	530
Steel Pipe	323 x 9.5	910	650
	273 x 9.3	750	530
Precast Concrete	355 x 355	1500	1100

It is recommended that the underside of the pile caps be established at least 2.5 m below finished grade to provide protection against

.../...



frost action. Unbalanced horizontal forces should be resisted by battered piles.

In view of the very hard consistency of the bearing stratum, and the need to achieve adequate penetration into the stratum to develop the carrying capacity, it is suggested that, in order to prevent damage to the piles, their tips be reinforced. It is further recommended, that the piles be redriven after 24 hours, and should relaxation of the piles be noted, then the capacity of the piles be confirmed by a load test.

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

In this case, all existing fill and surficial granular deposits should be removed to the surface of the hard silty clay. The material used for embankment construction should be well graded granular material (Granular ^A quality) which should be placed in 150 mm thick layers to the underside of the footings and each layer compacted to not less than 100% of its Standard Proctor maximum dry density. This fill should extend from the toe of the endslope of the embankment to a distance equal at least three times the height of the embankment (measured from the surface of the silty clay to the underside of the footing) plus two times the width of the footing.

.../...



The horizontal distance measured from the edge of the footing to the face of the slope should be not less than the width of the footing, and the footing should also have a minimum earth cover of 2.5 m.

For footings meeting the above requirements, the factored bearing capacity of the fill at ultimate limit state can be taken as 300 kPa; and at serviceability limit state, Type II, the bearing capacity is 190 kPa, (maximum settlement = 25 mm).

4.4 Scour Protection

The silty clay deposit which underlies the river bed is considered to be moderately susceptible to erosion. Reference to the topographic plan of the site prepared by the Ministry suggests that between the existing piers, some erosion has occurred. A possible indication of the depth of scour at the site could be obtained during construction when the depth of the existing pier footings can be determined by exposing the underside of these footings. A report prepared by the Ministry of Natural Resources after the 1977 flood indicates that speeds of more than 1.5 m/s were estimated in this stretch of the river at that time. Protection measures should be designed to resist such erosive forces.

4.5 Approach Embankments

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

.../...



The maximum safe side slopes of the embankment will be governed by the material used for construction, (e.g. 2 horizontal in 1 vertical for earth fills and 1.5:1 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 erosion by rip-rap or other suitable means. The protection should extend at least to the high water level mark. Erosion protection is particularly important if the abutments are supported on spread footings resting in the fill.

4.6 Construction

In order to construct the pier foundations in the dry, it will be necessary to install a water-tight enclosure to the foundation excavations. This may be done using a steel sheet pile cofferdam; however, the sheet piling would have to be of sufficient section to withstand heavy driving, also the tips would require reinforcing. The driving of the sheeting may have to be assisted by water jetting or vibratory driving equipment. Alternatively, an earthen cofferdam consisting of impervious (clayey) soils may be constructed around the foundation excavation. In order to construct the earth cofferdam, it will be necessary to remove all the permeable granular river bed materials and expose the silty clay soil

.../...



prior to commencing earthwork construction. The observations made in test pit (see Log of Test Pit) suggest that the rate of flow through the silty clay deposit will be slow and the amount of water seepage could be handled by sump pumps operated from inside the excavation.

To protect the clayey or silty subgrade, it is recommended that once the final excavation level has been reached, and the subgrade has been checked and approved, a 75 mm thick skim coat of weak concrete be placed as a working mat.

At the proposed abutment locations, excavations constructed in accordance with the requirements of the construction safety act will be adequate.

5.0 STATEMENT OF LIMITATION

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

DOMINION SOIL INVESTIGATION INC.

D. M. ...

per C. Alston, P. Eng.

I. P. Lieszkowsky

I. P. Lieszkowsky, P. Eng.

CA:IPL/jd



APPENDICES

A P P E N D I X 'A'
METHOD OF INVESTIGATION

The work in the field was carried out in three phases. During the interim of October 6 to 15, 1981, Boreholes 1, 3, 4, 5 and 6 were drilled and Borehole No. 2 was drilled on November 9 and 10, 1981. On December 11, 1981, a test pit was dug on the south bank of the river.

A variety of drilling rigs, ranging from a skid-mounted diamond drill to trailer mounted and self propelled power auger machines, were used to advance the boreholes depending on the availability of the equipment and the accessibility of the borehole locations. It was particularly difficult to gain access to the proposed pier locations. First, attempts were made to drill boreholes at the pier locations, with a light, skid-mounted, diamond drill machine operated from a raft. The swift current and bouldery bottom of the river, however, prevented the floating of the raft into position. In view of this, a self propelled power auger machine was used to enter the river and to drill the boreholes in the river bed, however, due to local depressions in the river bed and the deeper waters surrounding the immediate area of the existing bridge, the boreholes had to be offset some distance from the proposed pier locations.

Generally, the boreholes were advanced by augering using continuous flight hollow-stem augers. Exception to this was only with Borehole No. 6,

.../...



which was drilled with a standard diamond drill machine using washboring techniques. Soil samples were recovered at 0.75 and 1.5 m intervals, using a Standard 50 mm outside diameter split spoon sampler. Standard Penetration tests were carried out during sampling. The depth of the boreholes ranged between 7.8 and 18.8 m. A dynamic cone penetration test was carried out adjacent to Borehole No. 5.

The test pit was dug on December 11, 1981, with a rubber-tire mounted John-Deere backhoe (Model: JD-410) equipped with a $\frac{1}{4}$ cubic yard bucket. The test pit was dug to a depth of 3.2 m below which, due to the hard consistency of the subsoil, further digging was not possible.

The field work was supervised throughout by a member of our engineering staff, who located the borings in the field, directed the drilling and sampling operations, logged the borings and also obtained the ground surface elevations. The boreholes in the field were located with the aid of a site plan provided by M.T.C. (Plan No. E-8001-1). Ground surface elevations at the borehole locations were referred to the geodetic datum using local benchmarks shown on the above M.T.C. drawing.

Following field identification, all samples obtained from the boreholes were sealed in air-tight jars and were returned to our laboratory for further detailed examination and testing. The laboratory testing program

.../...



consisted of sieve and hydrometer analyses to determine the grain size distribution of the various strata, and the measurement of the natural moisture content and consistency limits of selective representative soil samples. The test results are plotted on the Record of Boreholes, and are also presented in the form of Grain Size Distribution Curves and Plasticity Chart on Figures 1 to 4 inclusive.

.../...

A P P E N D I X '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 conclusion as to how the subsurface conditions may affect their work.

ENCLOSURES

RECORD OF BOREHOLE No. 1

METRIC

W P 600-72-05 LOCATION Sta. 12+511.8 o/s 3.0 m Lt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 15-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
201.0	Ground Surface																
0.0	Sand & Gravel, some silt, occasional clay lumps, FILL compact.		1	AS	-		200										
			2	SS	18												
			3	SS	14												
			4	SS	18												
194.7			5	SS	18		195										
6.3	dark grey SILTY CLAY of low plasticity to SILT v. stiff of hard slight plasticity.		6	SS	86												
			7	SS	50/0	14 m											0 0 75 25
			8	SS	50/0	12 m											
			9	SS	50/0	15 m											
190.8			10	SS	50/0	10 m	190										
10.2	very dense, black SILT & FINE SAND, occasional layers of sand.		11	SS	50/0	12 m											
			12	SS	93												0 55 45 0
			13	SS	50/0	12 m											
			14	SS	58		185										
182.4			15	SS	50/0	12 m											
18.6	END OF BOREHOLE																

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. 2

METRIC

W P 600-72-05 LOCATION Sta. 12+651.6 o/s 20 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 09 to 10-11-81 CHECKED BY C.A.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT	PLOT NUMBER	TYPE	VALUES		20	40	60	80	100					
193.3	River Bed															
0.0 192.7	Sand & Gravel, boulders															
0.6	hard, black SILTY CLAY of low plasticity to SILT of slight plasticity		1	SS	44											0 0 45 55
			2	SS	52											
			3	SS	100/10	0.25 m										0 2 73 25
			4	SS	50/10	0.12 m										
189.0			5	SS	100/10	0.25 m										0 0 85 15
4.3	very dense, black SANDY SILT		6	SS	70											
			7	SS	90											
	some embedded fine gravel.		8	SS	60											0 22 72 5
	thick sand seams		9	SS	54											
183.7			10	SS	83											
9.6	END OF BOREHOLE															

NOTE: River water
level fluctuated
between 193.8 & 194.3m
at time of investiga-
tion.

+3, x5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. 3

METRIC

W P 600-72-05 LOCATION Sta. 12+682.6 o/s 16.0 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. and tricone COMPILED BY C.A.
DATUM Geodetic DATE 13 to 14-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.5	River Bed																GR SA 51 CL
0.0	brown sand, many cobbles																
192.7	& boulders																
0.8	hard		1	SS	50/0	0.05 m								o			0 3 82 15
	dark grey to black		2	SS	50/0	0.12 m								o			0 0 62 38
	SILTY CLAY		3	SS	50/0	0.12 m								o			
	of		4	SS	50/0	0.12 m	190							o			0 0 89 11
	low plasticity		5	SS	50/0	0.12 m								o			
	to		6	SS	50/0	0.12 m								o			
	SILT		7	SS	97									o			0 0 83 17
	of																
	slight plasticity																
	occasional sand seams,																
	boulders.		8	SS	50/0	0.07 m								o			
185.7	END OF BOREHOLE																Hole advanced by augering to 1.2 m and by tricone to the remaining depth.
7.8																	
	NOTE: River level fluctuated between 193.8 and 194.3 m at time of investigation.																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. 4

METRIC

W P 600-72-05 LOCATION Sta. 12+718.8 o/s 2.4 m Lt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 08 to 14-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
201.4	Ground Surface																GR SA SI CL
0.0	Sand & Gravel FILL loose.		1	SS	8	Dry Cave	200										
			2	SS	5												
197.6			3	SS	5												
3.8	loose, brown & grey SILTY FINE to MEDIUM SAND, trace gravel, (possible fill)		4	SS	24		195										
5.6	hard SILTY CLAY of low sandy plasticity to SILT of slight dark grey plasticity black		5	SS	100/0.22 m												5 26 50 19
			6	SS	50/0.10 m												
			7	SS	50/0.10 m												
			8	SS	50/0.10 m												
			9	SS	50/0.12 m		190										
			10	SS	50/0.12 m												0 0 95 5
			11	SS	50/0.15 m												
			12	SS	50/0.15 m												
			13	SS	50/0.15 m		185										
182.6			14	SS	92												
18.8	END OF BOREHOLE																
NOTE: Water level not established at time of investigation.																	

+3, x5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 5

METRIC

W P 600-72-05 LOCATION Sta. 12+612.0 o/s 1.6 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Hollow Stem Auger, 80 mm i.d. COMPILED BY C.A.
DATUM Geodetic DATE 09-10-81 CHECKED BY C.A.

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 x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
201.1	Ground Surface											
0.0	Sand & Gravel FILL loose to compact.		1	AS	-							
			2	SS	11							
			3	SS	8							
			4	SS	12							
			5	SS	5							
			6	SS	17							
			7	SS	10							
			8	SS	21							
194.4			9	SS	28							
6.7	hard, grey SILTY CLAY		10	SS	38							
193.0			11	SS	100							
8.1	END OF BOREHOLE											

NOTE: Water level not established at time of investigation.

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 6

METRIC

W P 600-72-05 LOCATION Sta. 12+721.2 o/s 4.3 m Rt. ORIGINATED BY N.L.
DIST 19 HWY 130 BOREHOLE TYPE Washbore & Diamond Drilling (BX Casing) COMPILED BY C.A.
DATUM Geodetic DATE 06 to 07-10-81 CHECKED BY C.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
201.1	Ground Surface							20	40	60	80	100	10	20	30			
196.7	② brown Silty Clay, Silty Sand & Gravel. FILL v. loose to compact	⊗	1	SS	10		200											
		⊗	2	SS	18													
		⊗	3	SS	12													
		⊗	4	SS	4													
		⊗	5	SS	10													
194.4	4.4 brown fine to medium SAND v. loose - some gravel, dense trace silt	⊙	6	SS	4		195											
		⊙	7	SS	5													
		⊙	8	SS	33													
193.3	6.7 v. dense, dark grey SILT some fine sand	⊙	9	SS	120													
		⊙	10	SS	50/60	07 m												
7.8	END OF BOREHOLE																	

+3, x⁵: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

TEST PIT No. 1

CLIENT: MINISTRY OF TRANSPORTATION & COMMUNICATIONS
PROJECT: KAMINISTIKWIA RIVER - HWY. 130
LOCATION: STA. 12+706 o/s 30 m LT.

ELEVATION /m.	No. 1				
	EL. 196.5 m				
	DEPTH /m.	SOIL DESCRIPTION GROUND SURFACE	SYMBOL	GROUND WATER	SAMPLES TESTS
196.5	0	brown well graded SAND and GRAVEL occasional cobbles and boulders.			
195.0	1.5	dark, Peat and organic Silt			
194.8	1.7	dark grey Fine Sandy SILT some boulders (up to 0.5 m dia.)			
193.8	2.7	dark grey hard SILTY CLAY with bands of slightly plastic SILT.			
193.3	3.2	END OF TEST PIT			

DATE: December 11, 1981

BACKHOE: John Deere
(JD-410)
1/2 cu.yard bucket

WIDTH OF TEST PIT: 0.8 m

Wet Below 1.3 m.

Slight seepage from sandy silt layer.

194.0 (river level)

Test pit dry and stable 1 hour after
completion. Slight seepage from
sandy silt layer continues.

Digging very hard below 2.7 m.
Backhoe unable to dig deeper than 3.2 m.

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

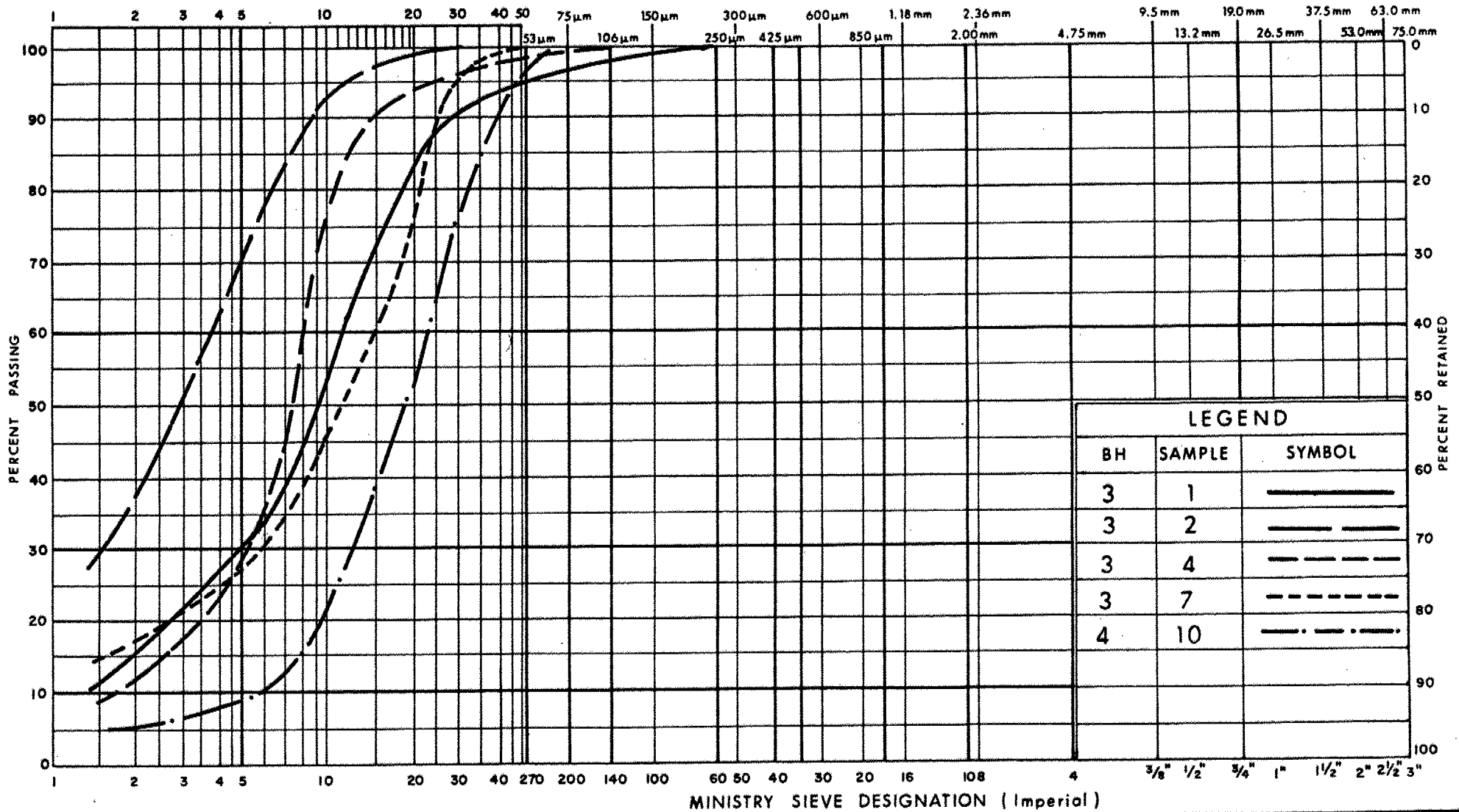
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH	SAMPLE	SYMBOL
3	1	—————
3	2	—————
3	4	-----
3	7	-----
4	10	-----

GRAIN SIZE DISTRIBUTION
SILTY CLAY
OF LOW PLASTICITY

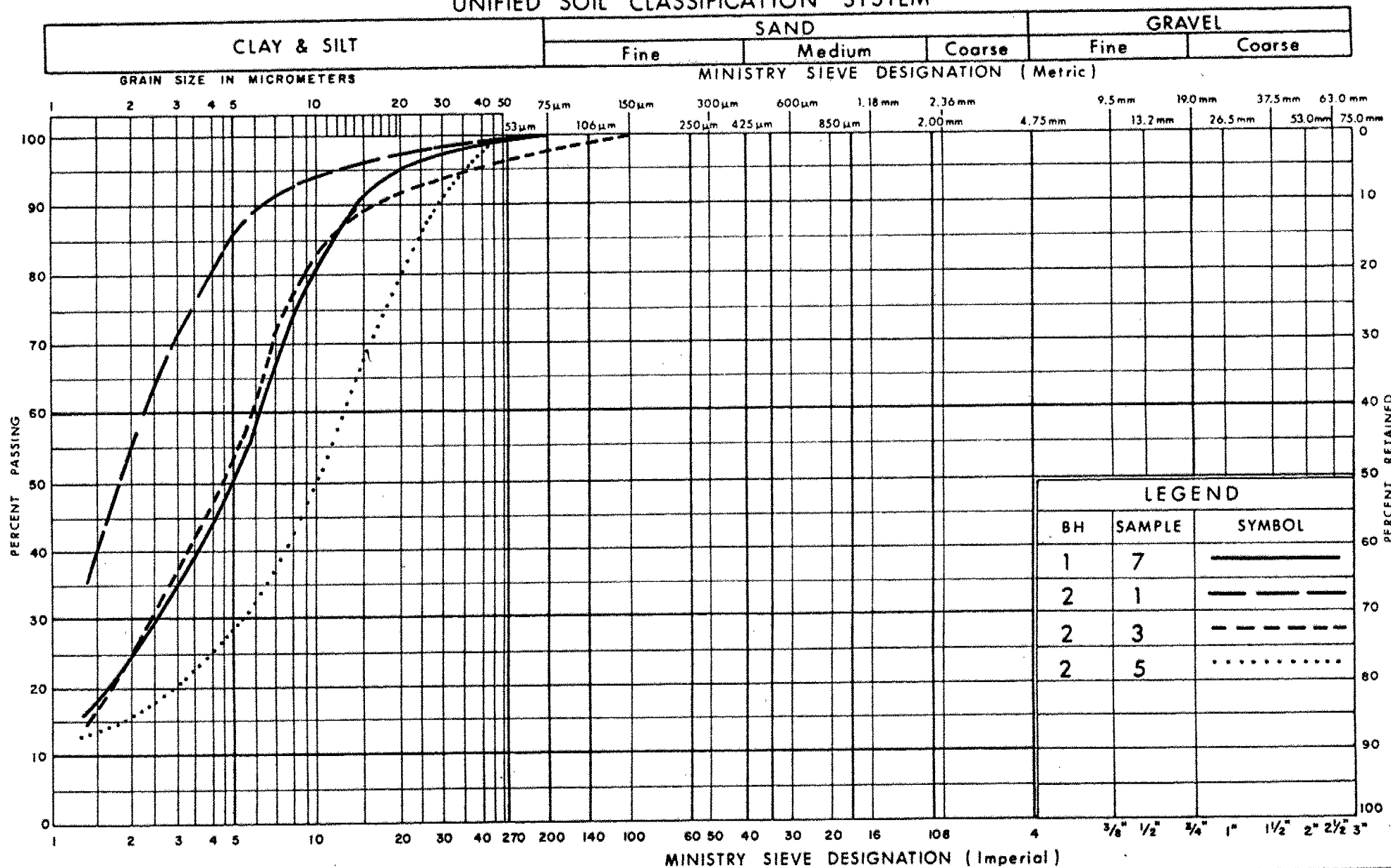
FIG No 1

W P 600-72-05



Ministry of
Transportation and
Communications

UNIFIED SOIL CLASSIFICATION SYSTEM



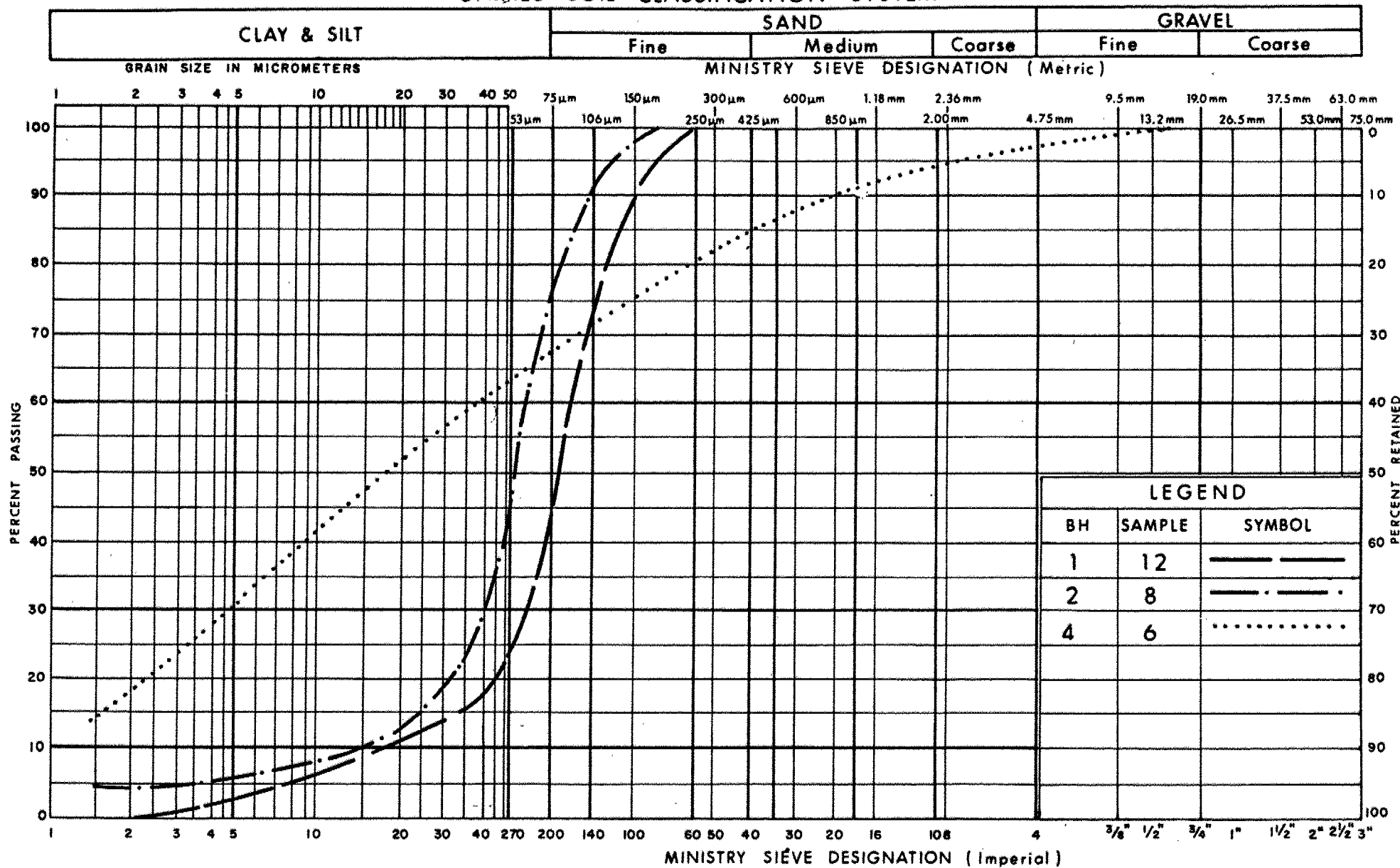
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY
OF LOW PLASTICITY

FIG No. 2

W P 600-72-05

UNIFIED SOIL CLASSIFICATION SYSTEM

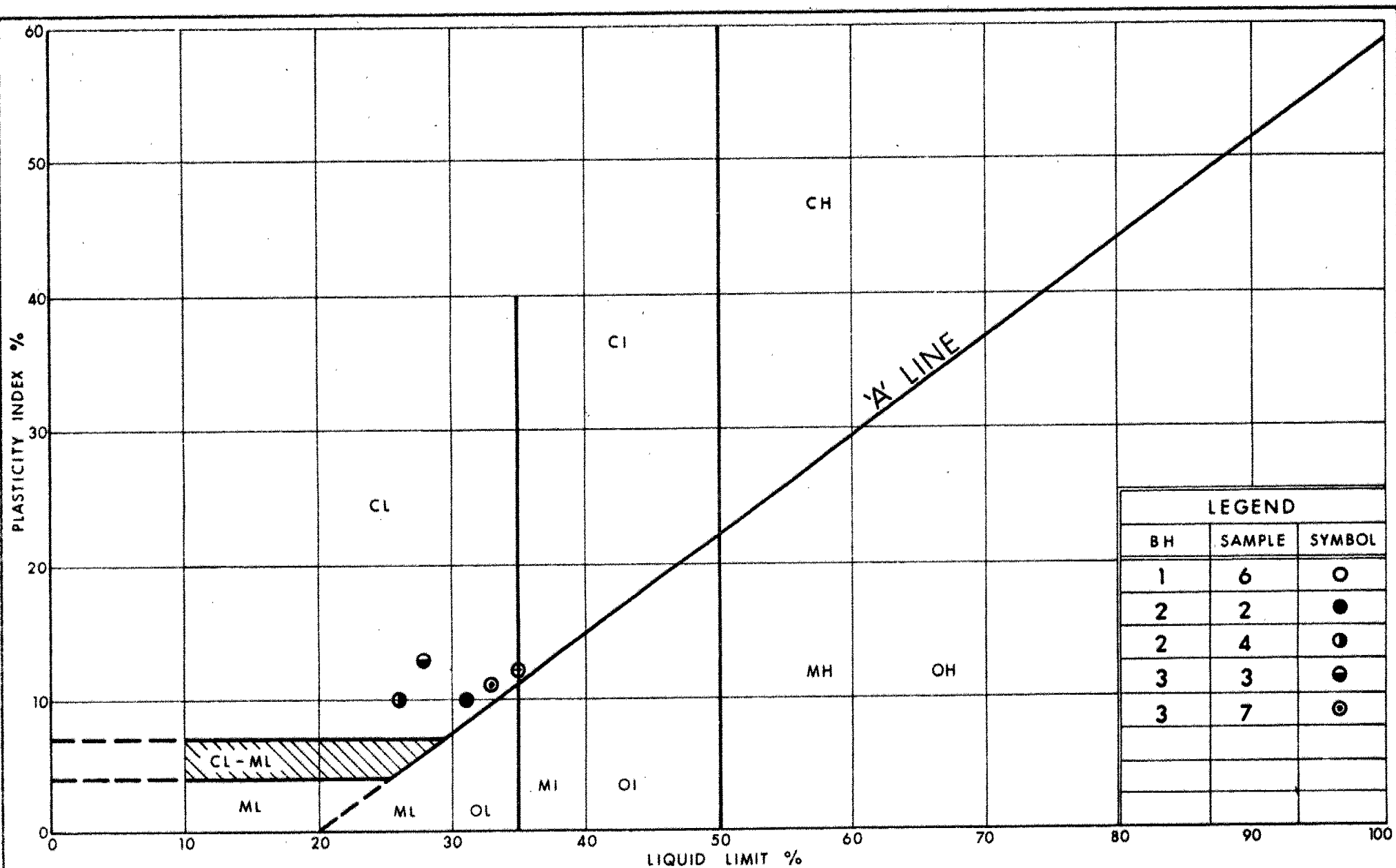


**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION SANDY SILT

FIG No. 3

W P 600-72-05



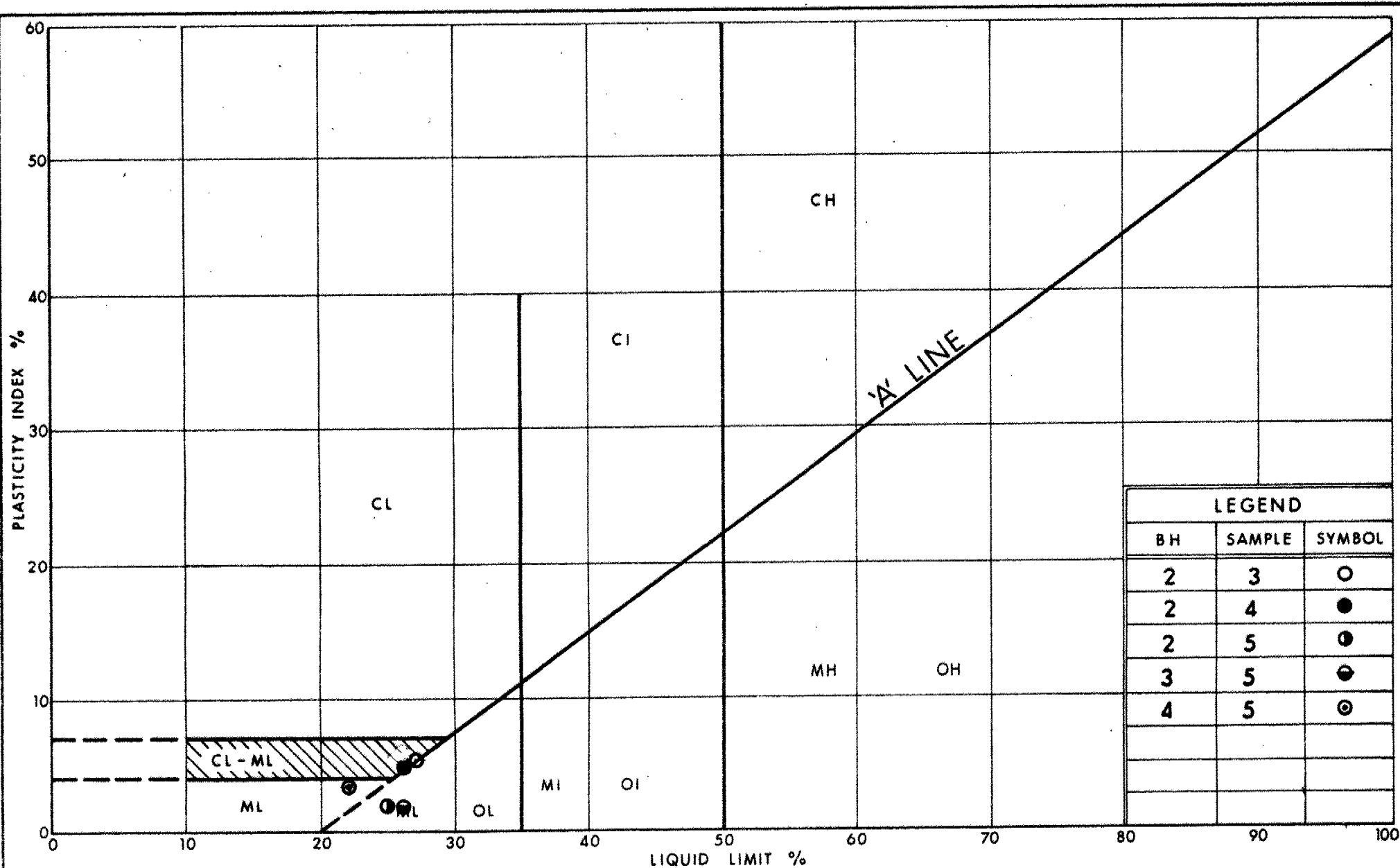
Ontario

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Communications

PLASTICITY CHART
SILTY CLAY
of low plasticity.

FIG No. 4

W P 600-72-05



Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART
SILT
slightly plastic.

FIG No 5

W P 600-72-05

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'_{v0}	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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

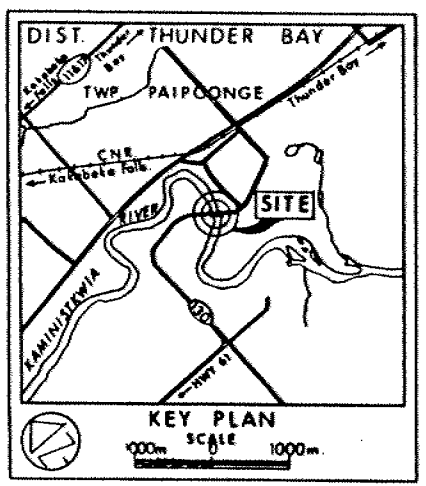


METRIC

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

NOTE: FOR TEST PIT DETAILS
SEE LOG OF TEST PIT.

DOMINION SOIL INVESTIGATION



- 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)
 - WL at time of investigation 1981 10
 - Test Pit

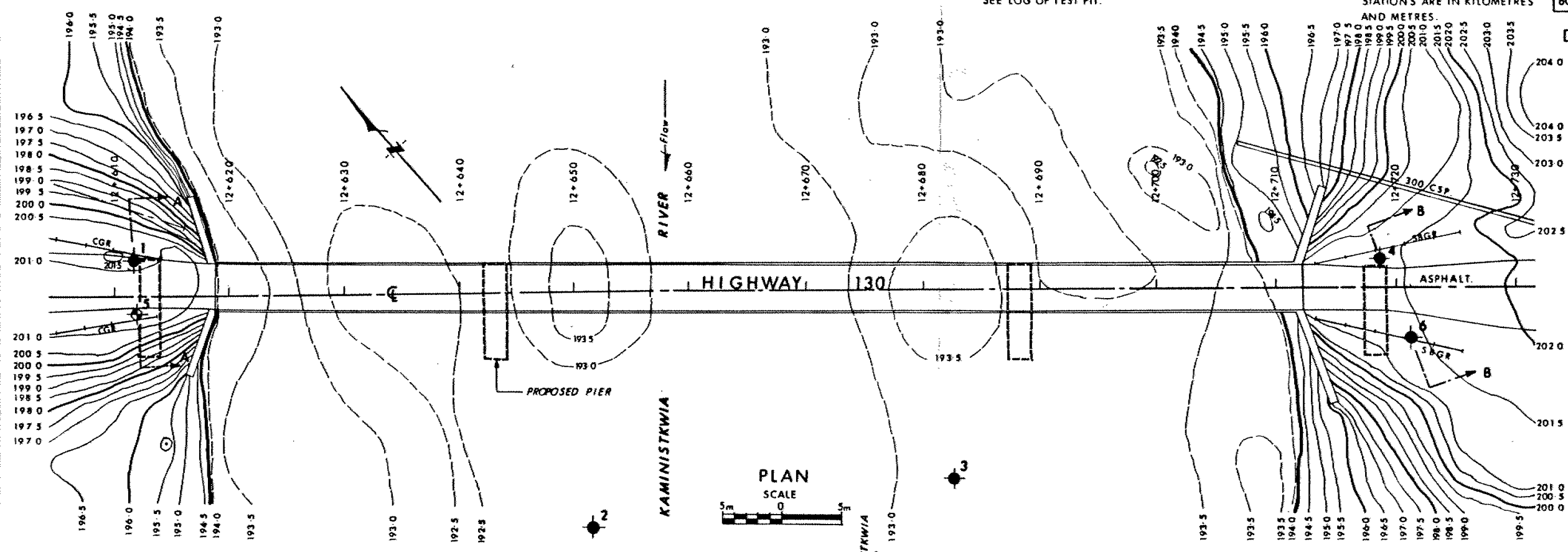
No	ELEVATION	STATION	OFFSET
1	201.0	12+611.8	3.0 Li
2	193.3	12+651.6	20.0 Ri
3	193.5	12+682.6	16.0 Ri
4	201.4	12+718.8	2.4 Li
5	201.1	12+612.0	1.6 Ri
6	201.1	12+721.2	4.3 Ri
TP.1	196.5	12+706.0	30.0 Li



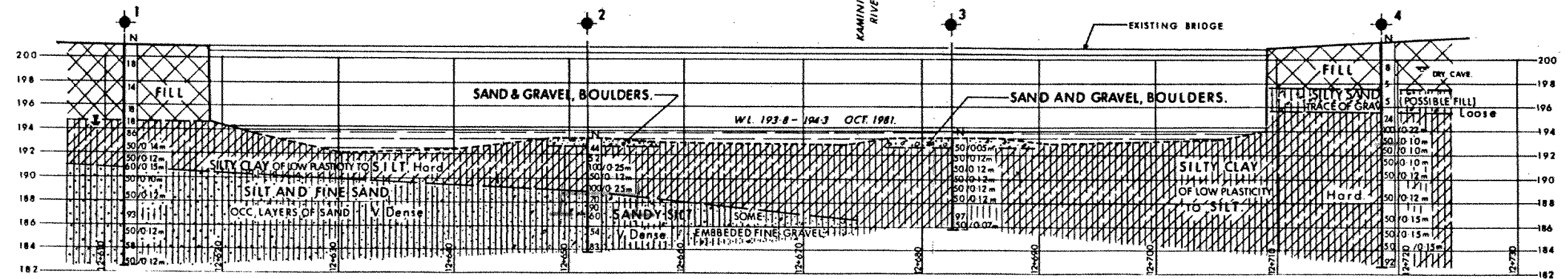
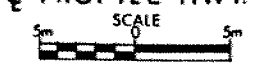
NOTE
The boundaries between soil strata have been established
only at Bore Hole locations. Between Bore Holes the
boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No	HWY No 130	DIST 19
SUBMITTAL	CHECKED/A	DATE 1981 12 10
DRAWN/F	CHECKED/A	SITE 48C-5
		DWG 6007205-A

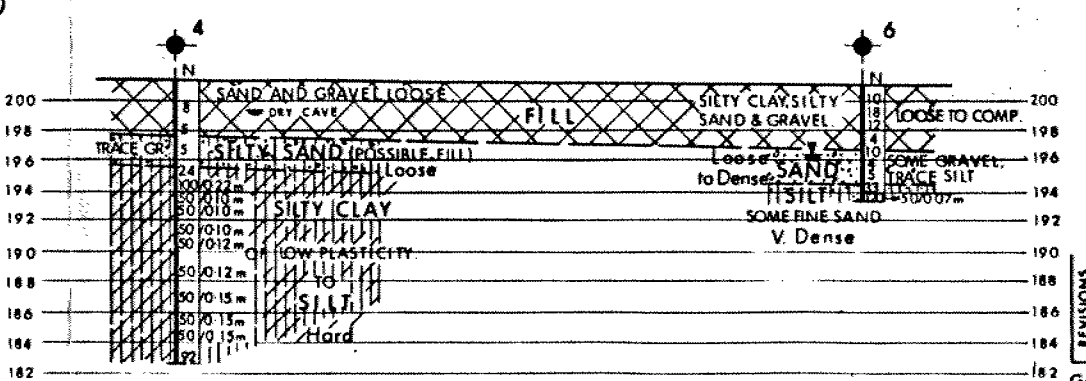


PROFILE HWY 130



A-A

SECTIONS



B-B