G.I.-30 SEPT. 1976

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 31F-98

DIST. 10 REGION

W.P. No. 126-78-02

CONT. No. 82-12

W. O. No.

STR. SITE No. 29-186

HWY. No. 515

LOCATION Madawaska River Bridge

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

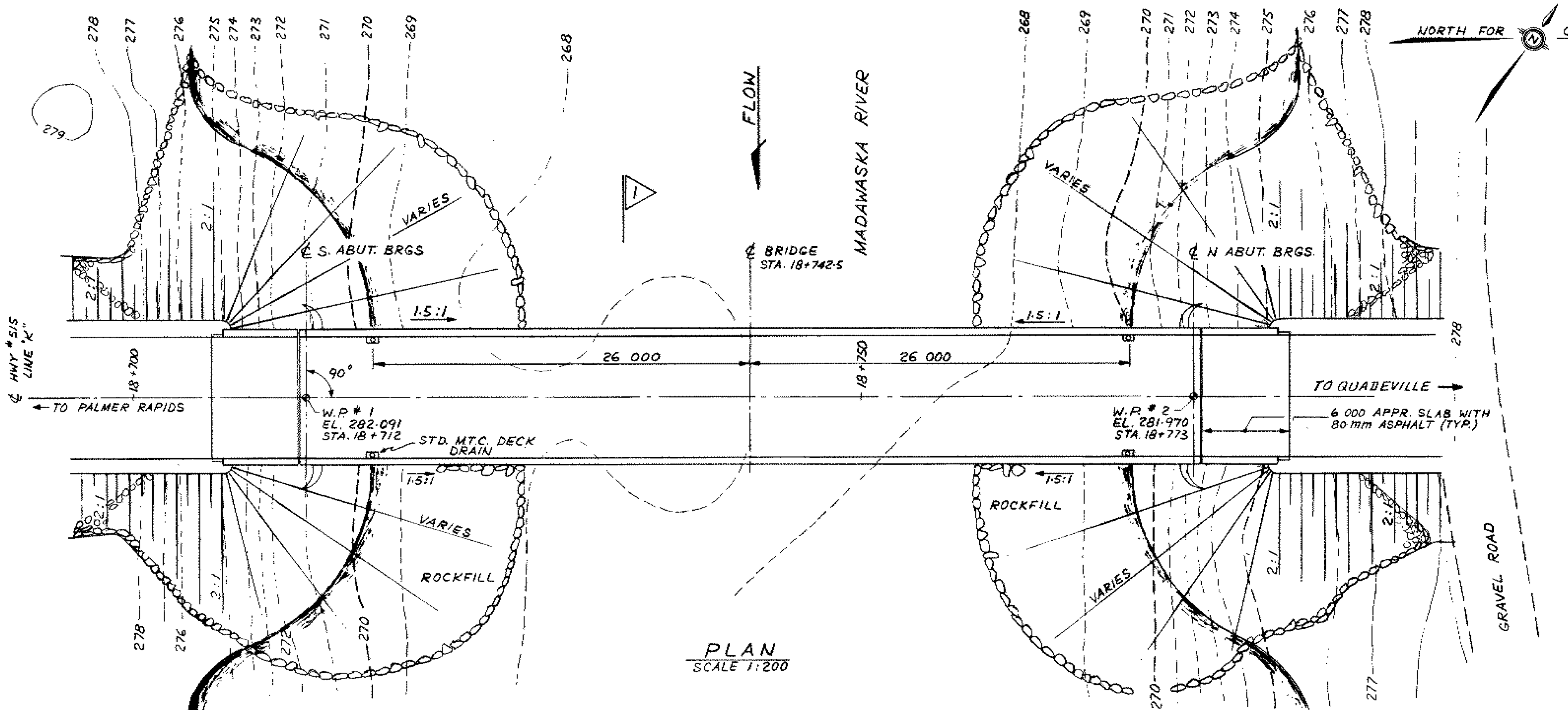
DISTRICT	10
CONT No	82-12
WP No	126 - 78 - 02

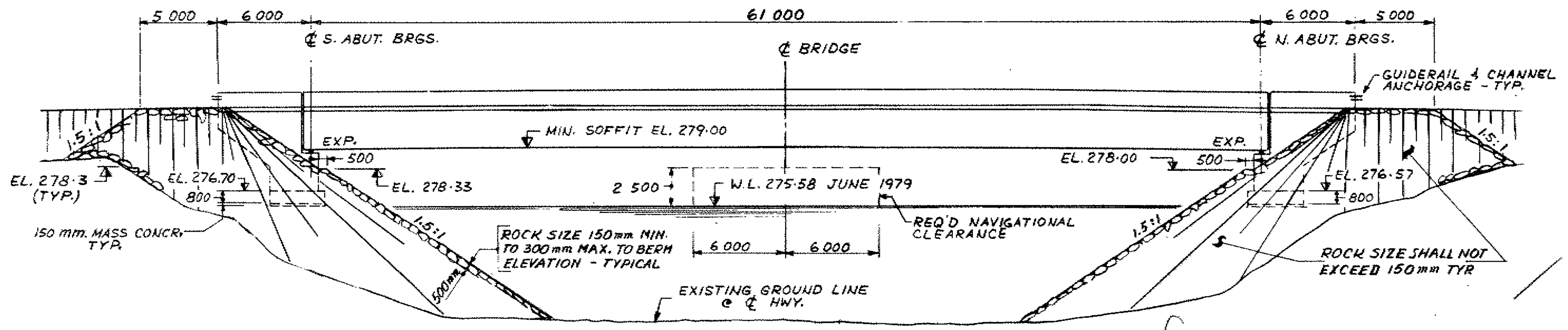
MADAWASKA RIVER BRIDGE
Approx. 5 km East of Palmer Rapids
GENERAL ARRANGEMENT

SHEET 8

METRIC

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





NOTES

CLASS OF CONCRETE

DECK & BARRIER WALLS	30 MPa
REMAINDER	20 MPa

REINFORCING STEEL GRADE

GRADE 400, COATED BARS HAVE A SUFFIX 'C'

CLEAR COVER TO REINF. STEEL

FOOTINGS & ABUTMENTS 75 mm.
DECK TOP 50 mm., DECK BTM. 40 mm.
BARRIER WALLS 50 mm.
APPROACH SLABS 50 mm.
UNLESS NOTED OTHERWISE ON DRAWINGS.

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 3 mm.

NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN THE DECK HAS BEEN PLACED.

TO ACHIEVE THE MINIMUM CLEAR COVER OF 50 mm. SPECIFIED AT TOP OF DECK, THE TOP LAYER OF REINFORCEMENT SHALL BE PLACED, PRIOR TO CONCRETING WITH A CLEAR COVER OF 65 ± 15 mm. OF TOLERANCE.

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEM

CONCRETE IN ABUTMENTS & WINGWALLS	124 m^3
CONCRETE IN DECK	123 m^3
CONCRETE IN BARRIER WALLS	37 m^3
CONCRETE IN APPROACH SLABS	26 m^3

STRUCTURAL STEEL ——— 133 TONNES

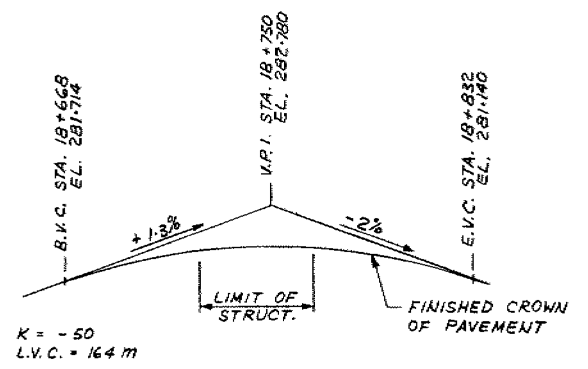
No note for subexcavation

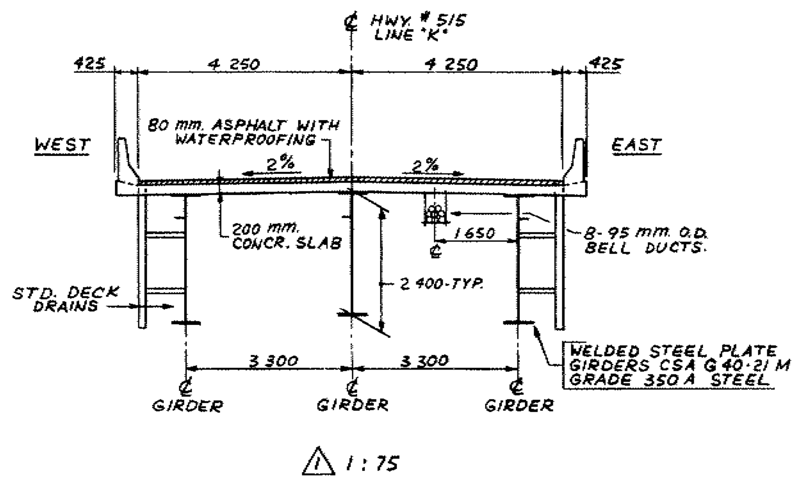
LIST OF DRAWINGS

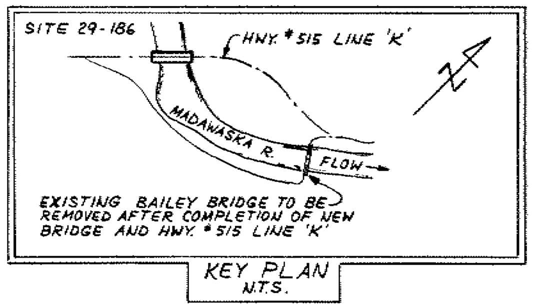
29 - 186 - 1 GENERAL ARRANGEMENT.
- 2 BOREHOLE LOCATION & SOIL STRATA.
- 3 FOUND. & ABUTS. DIMS. & REINF..
- 4 STRUCTURAL STEEL I.
- 5 " " II.
- 6 DECK DETAILS.
- 7 DECK REINFORCEMENT.
- 8 BARRIER WALL.
- 9 6 000 APPROACH SLAB.
- 10 AS CONSTRUCTED ELEV. & DIM..
- 11 STANDARD DETAILS I.

PRELOADING REQUIREMENTS

ROCKFILL TO BE PLACED TO ELEVATION 277.5 6 MONTHS PRIOR TO CONSTRUCTION OF THE ABUTMENTS (SEE GRADING DRAWINGS)

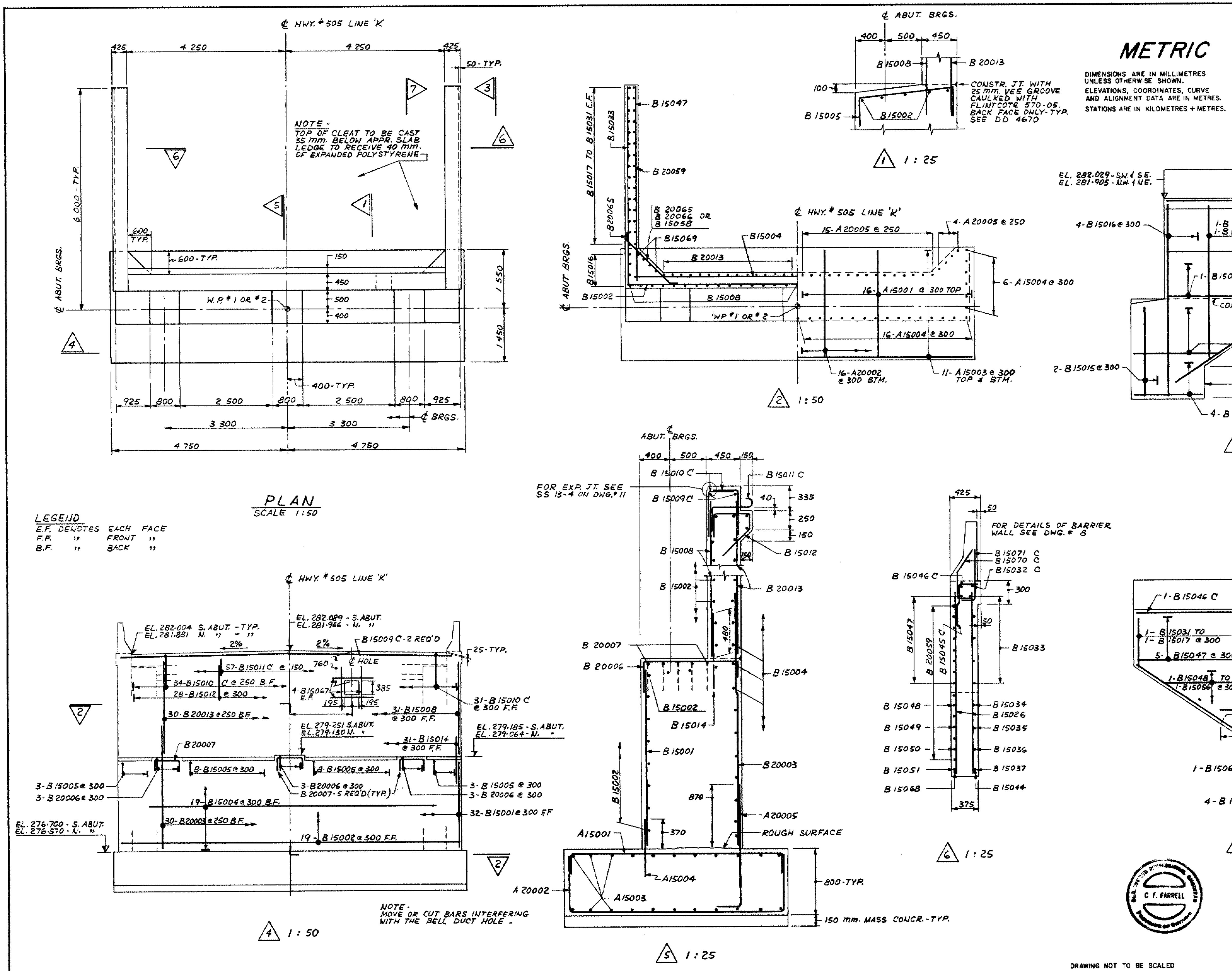






DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY		DESCRIPTION	
DESIGN C.F.F.			CHECK	LOADING OHBDC-C79	DATE AUG 80
DRAWING H.M.			CHECK J.	SITE No 29-186	DWG 1



METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
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STATIONS ARE IN KILOMETRES + METRES.

CONT No 82-12
WP No 126 - 78 - 02

MADAWASKA RIVER BRIDGE
Approx 5km East of Palmer Rapids
FOUND. & ABUTS. DIMS.& REINF.

SHEET 10

C. F. FARRELL

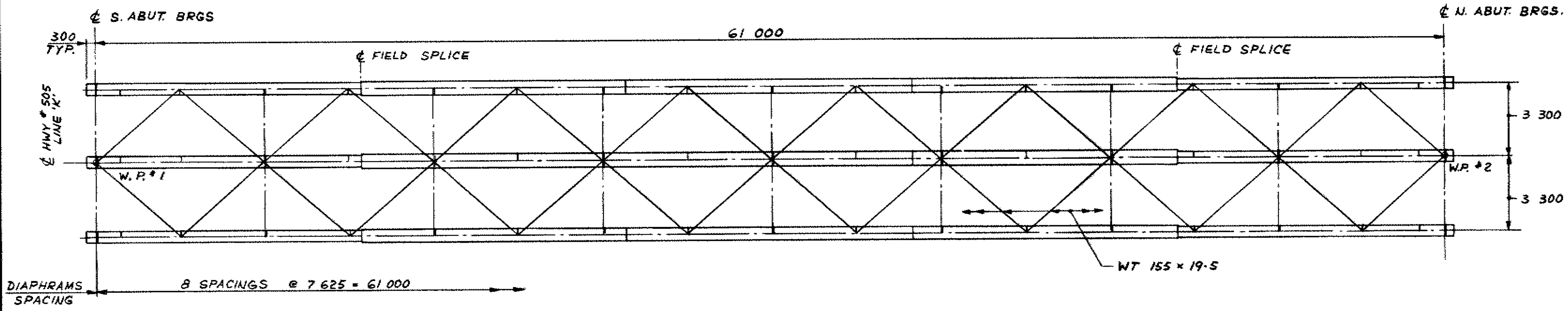
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN C.F.F.	CHECK	LOADING ONBDC-C-79	DATE AUG.80
DRAWING M.M.	CHECK J.Sz	SITE No 29-186	DWG 3

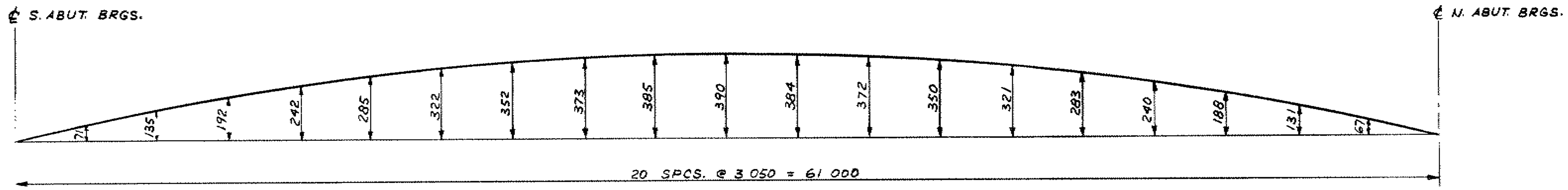
METRIC

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

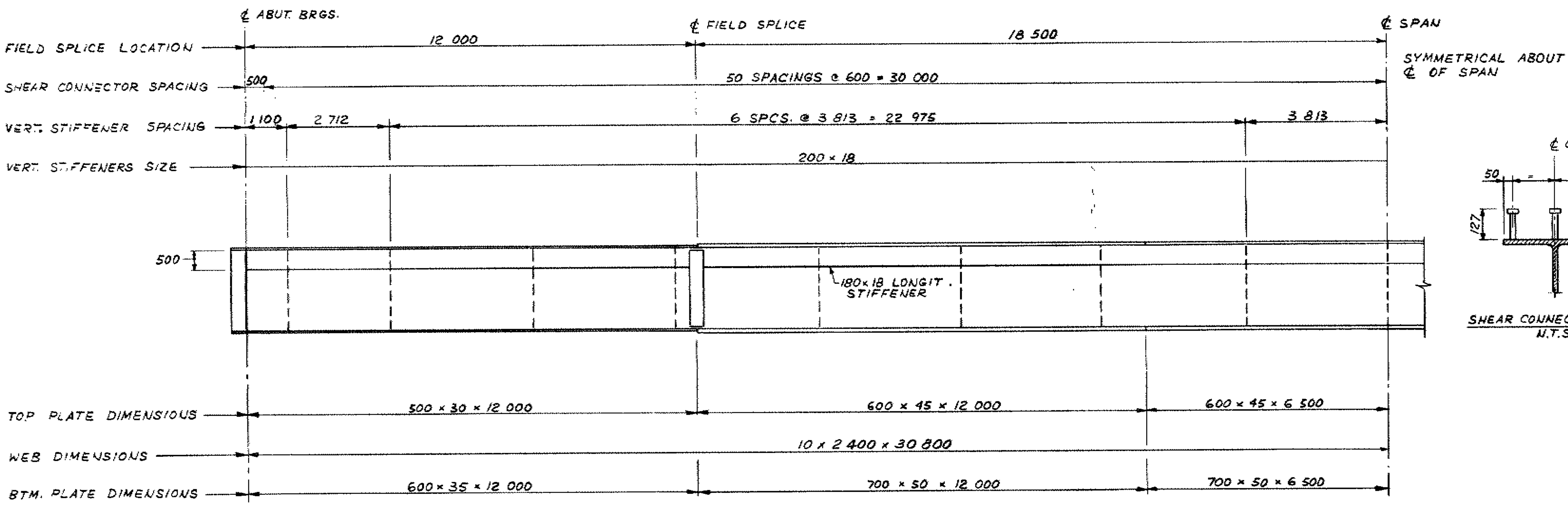
CONT No 82-12 WP No 126-78-02	
MADAWASKA RIVER BRIDGE Approx 5km East of Palmer Rapids STRUCTURAL STEEL I	SHEET 11



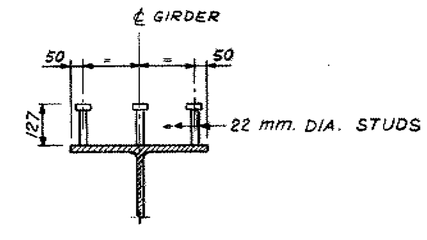
PLAN OF GIRDERS
SCALE 1:125



CAMBER DIAGRAM
N.T.S.



HALF ELEVATION OF GIRDER
SCALE 1:75



SHEAR CONNECTOR DETAIL
N.T.S.

NOTES

- ALL STRUCTURAL STEEL SHALL CONFORM TO C.S.A. STANDARD G 40.21 M GRADE 350 A.
- BOLTS SHALL BE A.S.T.M. A325 TYPE 3, 7/8 IN. DIA. BOLTS.
- STUD SHEAR CONNECTORS SHALL BE 7/8 IN. DIA. NELWELD, K.S.M. OR EQUAL.
- INACCESSIBLE SURFACES OF STEEL AT ABUTMENTS SHALL BE PAINTED WITH TWO COATS OF KOPPERS BITUMASTIC No 50 IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS.
- ALL BUTT WELDED SHOP SPLICES IN FLANGE AND WEB PLATES SHALL BE AS SHOWN. IF SLIGHT RELOCATION OR ADDITIONAL SHOP SPLICES ARE REQUIRED, THEIR LOCATIONS SHALL BE APPROVED BY THE ENGINEER.
- UNLESS NOTED OTHERWISE THE MINIMUM FILLET WELD SHALL BE AS FOLLOWS:

MATERIAL THICKNESS OF THICKER PART JOINED (mm)	MINIMUM SIZE OF FILLET WELD (mm)
TO 12 INCLUSIVE	5
OVER 12 TO 20	6
OVER 20 TO 40	8
OVER 40 TO 60	10

- GIRDERS SHALL BE CAMBERED TO THE VALUES SHOWN IN THE CAMBER DIAGRAM WITH NO GIRDER DEAD LOAD ACTING.
- ALL DIMENSIONS SHOWN ARE IN THE HORIZONTAL PLANE AND MEASURED AT 15° C.
- THE END OF GIRDERS AND BEARING STIFFENERS SHALL BE TRUE VERTICAL UNDER FULL DEAD LOAD.
- ALL BUTT WELDS IN FLANGE AND LONGITUDINAL STIFFENER SHOP SPLICES IN TENSION AREAS SHALL BE FINISHED FLUSH.
  BUTT WELDS IN FLANGE AND LONGITUDINAL STIFFENER SHOP SPLICES IN COMPRESSION AREAS SHALL BE SMOOTH.
  BUTT WELDS IN WEBS OF GIRDERS SHALL BE FLUSH FOR A DISTANCE OF 1/3 THE WEB DEPTH FROM TENSION FLANGE AND SMOOTH FOR THE REMAINDER.
- CONTACT SURFACES AT BOLTED CONNECTIONS TO BE GRITBLASTED IMMEDIATELY PRIOR TO ERECTION.

C. F. FARRELL

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN C.F.F.	CHECK [illegible]	LOADING OHBDC-C-79	DATE AUG.80
DRAWING M.M.	CHECK J.S.	SITE No 29-186	DWG 4

CONT No 82-12
WP No 126 - 78 - 02
MADAWASKA RIVER BRIDGE
Approx 5km East of Palmer Rapids
STRUCTURAL STEEL II
SHEET 12

METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
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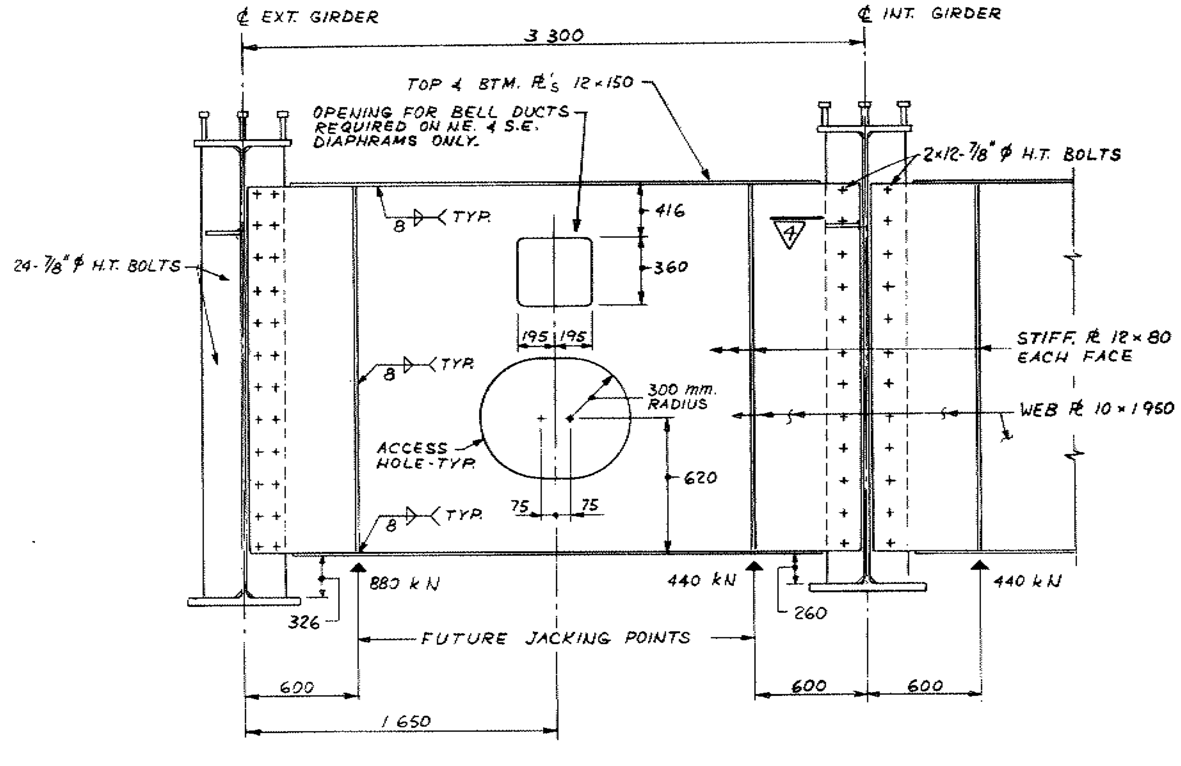
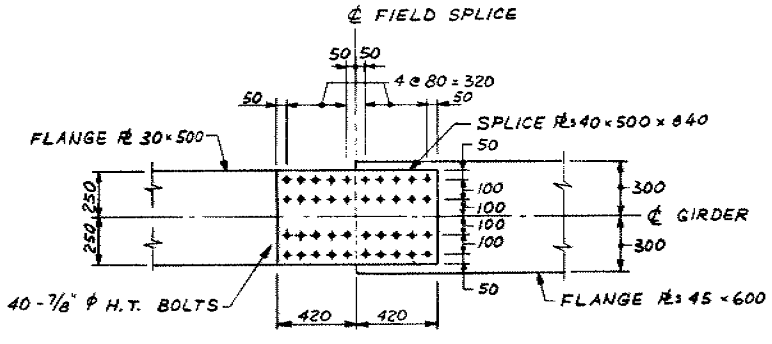
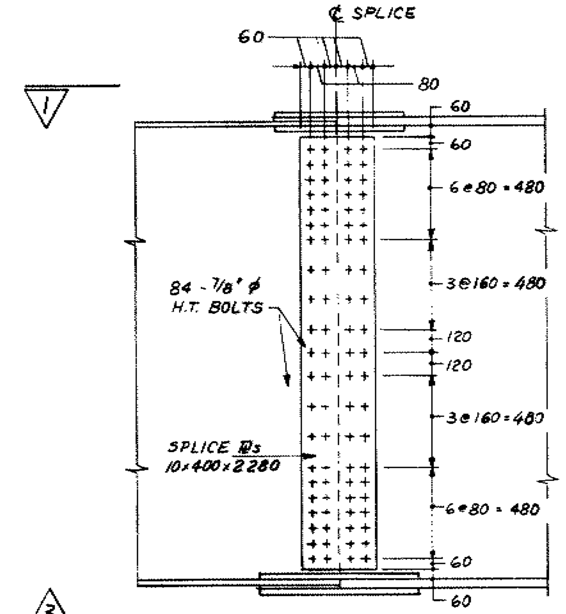
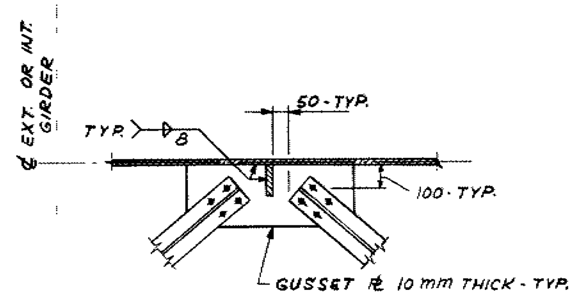


ABUT. DIAPHRAGM - TYP.
N.T.S.

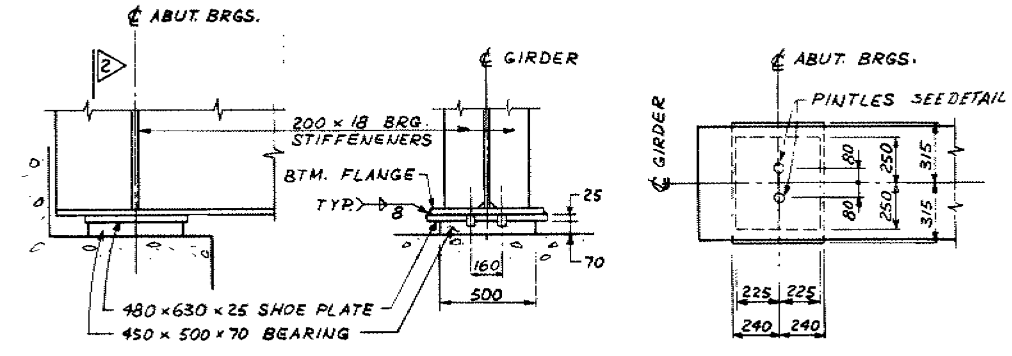




ELEVATION
SCALE - 1:20

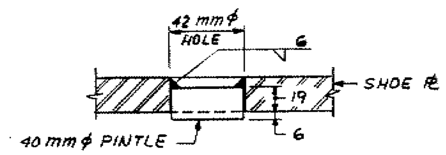


DETAIL AT GUSSET PLATE
N.T.S.

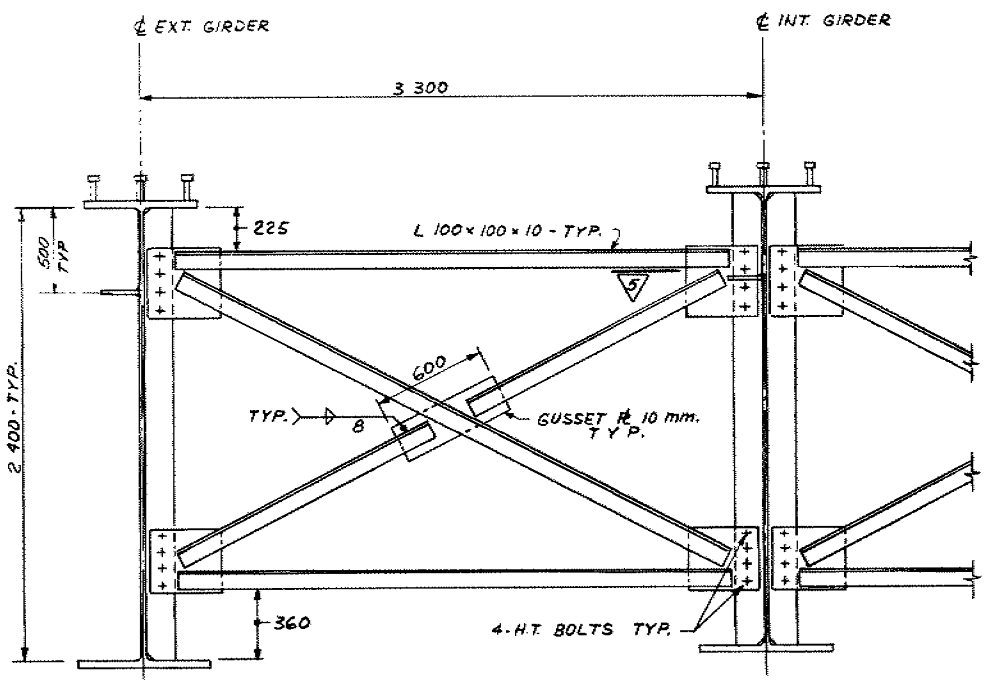


ELEVATION — 2 — PLAN

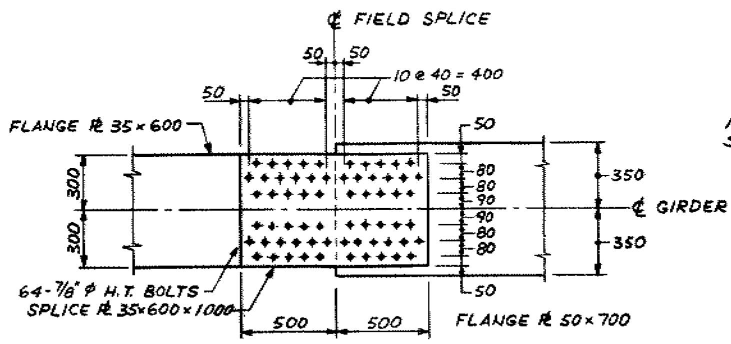
ABUTMENT BRGS. (TYP.)
SCALE 1:20



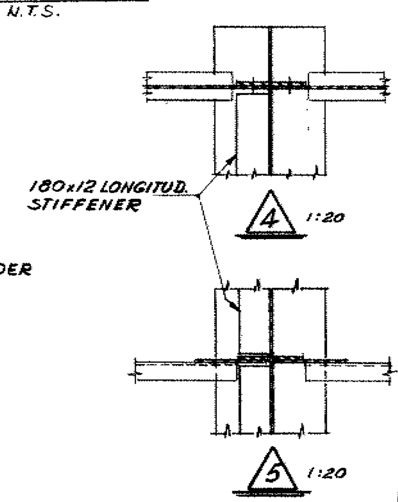
TYP. PINTLE DETAIL
N.T.S.



CROSS FRAME - TYP.
SCALE 1:20



FIELD SPLICE DETAILS
SCALE 1:20



BEARING DESIGN DATA

DESCRIPTION	S. ABUT.	N. ABUT.
TYPE	LAMINATED ELASTOMERIC	
SIZE (mm)	500 × 450 × 70	
DEAD LOAD (DL)	880 kN	
TOTAL LOAD (DL + LL)	1380 kN	
LONGITUDINAL MOVEMENTS	20 mm	

FOR SERVICEABILITY LIMIT STATES TYPE II LOADING WITH Ψ = 1.0

C. F. FARRELL

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS DATE	BY	DESCRIPTION

DESIGN C.F.F. | CHECK | LOADING OHBDC-C-79 | DATE AUG '80
DRAWING M.M. | CHECK J. Sz | SITE No 29-186 | DWG 5

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-12

Ontario
Ministry of Transportation and Communications

INDEX

Page | **Description**

NOTE: For purposes of the contract this report supercedes 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

Madawaska River Bridge

W.P. 126-78-02, Site 29-186

Hwy. 515, District 10, Bancroft

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks.

The fieldwork was carried out in two stages:

i) The initial work was carried out between 79 09 20 and 79 10 04 by Golder and Associates, consulting geotechnical engineers.

During this period, four sampled boreholes with accompanying dynamic cone penetration tests (numbers 1, 2, 5, and 6) and two additional dynamic cone penetration tests (numbers 7 and 10) were put down on land using a track mounted hollow stem auger machine. In addition, four dynamic cone penetration tests (numbers 3, 4, 8, and 9) were put down in the riverbed using a skid-mounted diamond drill rig operating from a floating drum raft.

These borings were extended to a maximum depth of 47 metres with bedrock being cored for 3 metres in one borehole.

ii) A total of six additional boreholes (BH 1A to 6A) were carried out in the area of the east and west approaches during 80 06 10 to 80 06 12. The borings were carried out beneath the river bottom by means of a diamond drill mounted on a drum floating raft and equipped with NX casing. The boreholes were advanced to depths of 2.8 to 5.9 metres below the river bottom.

DESCRIPTION OF SITE AND GEOLOGY

The site of the proposed bridge crossing is located on Secondary Highway 515, some 3.5 kilometres east of Secondary Highway 514 and about

5 kilometres downstream (east) of Palmer Rapids, Ontario. Highway 515 presently crosses the Madawaska River via a "Bailey" bridge about 0.5 kilometres downstream of the site under investigation.

In the area of the proposed crossing the Madawaska River is about 8 metres deep and some 80 metres wide. The riverbanks, along the proposed Line K crossing, rise at about a 2 horizontal to 1 vertical slope to some 3 to 4 metres above normal water level. Some undercutting of the riverbanks is evident in the general area although the river currents do not appear to be excessively fast. The ground surface adjacent to the river is relatively level.

The site is located in the Precambrian Shield section of Renfrew County. Fine and very fine sands of the Uplands and St. Samuel Series have been identified in large, widely distributed tracks over the Precambrian Shield. The origin of these deposits are in most cases deltic, having been laid down either in a lacustrine basin or in the upper reaches of the glacial Champlain Sea which extended up the St. Lawrence and Ottawa valleys. These sand deposits typically lie adjacent to present lakes or basins that are now drained by rivers and streams. The sands are typically underlain by variable thicknesses of glacial till and then by bedrock formations of crystalline limestone, gneisses, and quartzites. Locally, surficial deposits of river alluvium form terraces adjacent to major river channels.

SUBSURFACE CONDITIONS

In summary, the site is underlain by surficial deposits of sandy silt and/or fill material. These deposits are underlain by recent river alluvium on the east side of the river. The main subsoil at the site consists of a thick deposit of interlayered and interbedded sandy silt, silty sand, and fine to medium sand which at the borehole locations has been divided into an upper and lower zone separated by a layer of slightly plastic layered silt to sandy silt. These sandy deposits are in turn underlain by sands and gravels, glacial till, and then bedrock.

The detailed subsurface stratigraphy encountered in each borehole is shown on the Record of Borehole sheets and a section showing the relative borehole stratigraphy at the proposed bridge crossing is shown on Drawing No. 2. It should be noted that the soil boundaries indicated on the Record of Borehole sheets and on the drawing are inferred from non-continuous samples and auger cuttings and do not necessarily indicate an exact plane of geological change.

Surficial Deposits

Boreholes 1, 2, and 6 encountered some 120 to 150 millimetres of topsoil at ground surface. Borehole 5, put down alongside the roadway on the east side of the river also encountered topsoil but in this case within about 2.5 metres of sand and gravel to silty sand roadway fill. The topsoil was in turn underlain by thin, loose to compact deposits of sandy silt.

In boreholes 5 and 6 these deposits were underlain by up to 4 metres of very loose to loose dark brown organic silty sand with layers of organic silt and organic material (see Figure 1 for grading). This deposit is considered to represent flood-plain deposited material of alluvial origin.

Upper Silty Sands and Sands

The surficial materials are underlain in boreholes 1, 2, and 5 by a layered deposit of silty sand and fine sand. In boreholes 1 and 2 this deposit was encountered at about 1 metre below ground level and extended to depths of about 3 to 5 metres. In borehole 5 however the top of this deposit was encountered below the alluvium at a depth of about 7 metres. The results of a grading test carried out on a representative sample of the silty sand are shown on Figure 3 and indicate the fine uniform nature of this deposit. Standard penetration tests carried out in this deposit gave 'N' values ranging from 20 blows per 0.3 metres near the top of the deposit to 4 blows per 0.3 metres with depth. This upper sandy deposit is therefore considered to have a loose to compact relative density.

Layered Silt and Sandy Silt

The upper sandy strata were found to be underlain in all the boreholes by a fine, slightly cohesive layered silt and sandy silt. In boreholes 1, 2, and 5, this stratum was found to be in the order of 5 to 6 metres thick while borehole 6 was terminated within the layered silt at a depth of about 8 metres below ground surface. An Atterberg limit test carried out on a sample of the clayey portion of this layered stratum gave a liquid limit value of 18 per cent and a plasticity index value of only 3 per cent indicating an inorganic silt of slight plasticity (ML). A grading test carried out on a sample recovered from this stratum (Figure 2) shows the material to consist basically of silt sizes, with some sand and clay sizes. Standard penetration tests carried out in this layered silt and sandy silt gave 'N' values ranging from 3 to 11 blows per 0.3 metres, indicating a generally loose relative density.

Lower Sandy Silt, Silty Sand and Fine to Medium Sand

This lower sandy deposit was encountered in the boreholes at depths of 8 (boreholes 1 and 2) to 19 (borehole 5) metres below ground surface, and in boreholes 2 and 5 extended to a depth of 30 to 31 metres. This deposit consists of sandy silt, silty sand with sandy silt layers, and fine to medium sand with some silt. Grain size analyses were carried out on various types of materials within this deposit and are shown on Figure 2 for the sandy silt, on Figure 3 for the silty sand, and on Figure 4 for the fine to medium sand. Standard penetration tests carried out in this lower sandy stratum gave 'N' values in the order of 4 to 10 blows per 0.3 metres. In some cases it is felt that the soil at sampling depth may have been distributed somewhat by upward seepage forces. However, in general it is considered that the density of these lower sands is in the loose range.

Sand and Gravel

A 2 to 4 metre thick deposit of fine to coarse sand with some cobbles was encountered at depth in boreholes 2 and 5. The top of this deposit at these borehole locations was at a depth of 30 to 31 metres below ground surface level. Figure 5 shows the results of a grading test carried out on a sample of this material and indicates the coarse, well graded nature of this deposit. It should be noted that some cobble and boulder sizes were also encountered throughout this sand and gravel stratum. Standard penetration tests in this sand and gravel gave 'N' values of greater than 100 blows per 0.3 metres, indicative of a very dense state of packing. The one low 'N' value of 6 blows per 0.3 metres recorded in borehole 5 was again considered to be representative of disturbance due to upward seepage forces into the borehole casing.

Glacial Till

Below the sand and gravel in boreholes 2 and 5 is a stratum of glacial till consisting of silty sand and gravel with some cobbles and boulders (see Figure 6). The silty sand till was found to be about 10 metres thick in borehole 2 while borehole 5 was terminated after penetrating some 6 metres into the stratum. The till is generally very dense with recorded 'N' values ranging from 76 to greater than 100 blows per 0.3 metres.

Bedrock

Bedrock was encountered and cored in BX size in borehole 2. The surface of the bedrock at this location was at a depth of 44 metres below ground surface (elevation 234.64). From visual examination of the rock core and from the recorded core recovery, the bedrock is considered to be fractured to fairly sound. The bedrock cored is a white and grey quartzite.

Groundwater

Standpipes were installed in boreholes 1, 2, and 5, details of which are shown on the Record of Borehole sheets. The stabilized groundwater level recorded on October 4, 1979 in these shallow installations was at a depth of 1.3 to 2.7 metres, i.e. elevation 275.07 to 275.95. The level of the water in the Madawaska River adjacent to the boreholes was at elevation 275.55 on the same date.

T. J. Kazmierowski, P. Eng.
Foundations Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

A P P E N D I X

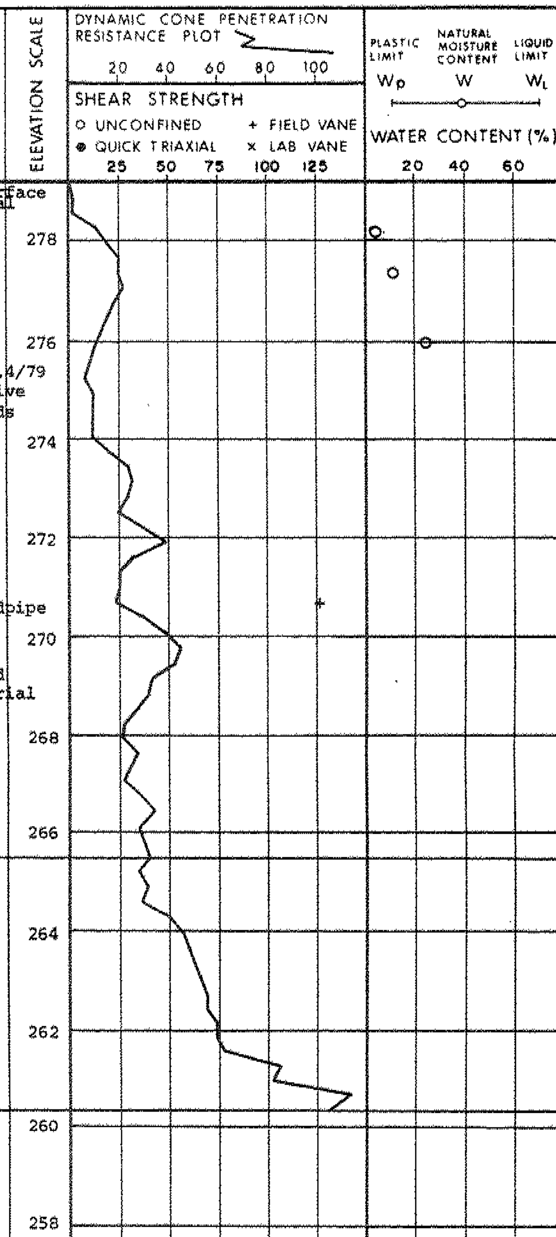
OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1

METRIC 10

W P 126-78-02 LOCATION Sta.18+660, O/S 3.1 m Lt. ORIGINATED BY DJS
DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY DN
DATUM Geodetic DATE September 21, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.15	Ground Level					
0.00	0.12 Topsoil				Surface Seal	
278.54	Sandy silt, red-brown					
0.61	Silty sand, stratified. Brown Compact	1	SS	16		
		2	SS	20		0 56 44 0
276.25		3	SS	15		
2.90	Fine sand, some silt. Brown to Grey Loose	4	SS	6	Oct. 4/79 Native Sands	
274.03		5	SS	4		
5.12	Layered clayey silt and sandy silt, some fine sand seams. Grey Very Loose	6	SS	3		
270.62		7	SS	3	Standpipe	
8.53	Sandy silt. Grey Loose	8	SS	5	Caved Material	
268.63						
10.52	Silty sand. Grey Loose	9	SS	4		
265.43		10	SS	5		
13.72	End of Borehole.					
260.25						
18.90	End of Cone Test.					



UNIT WEIGHT γ

+3, ×5 : Numbers refer to Sensitivity

15 ⟡ 5 (%) STRAIN AT FAILURE (20, 10)

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RECORD OF BOREHOLE No 2

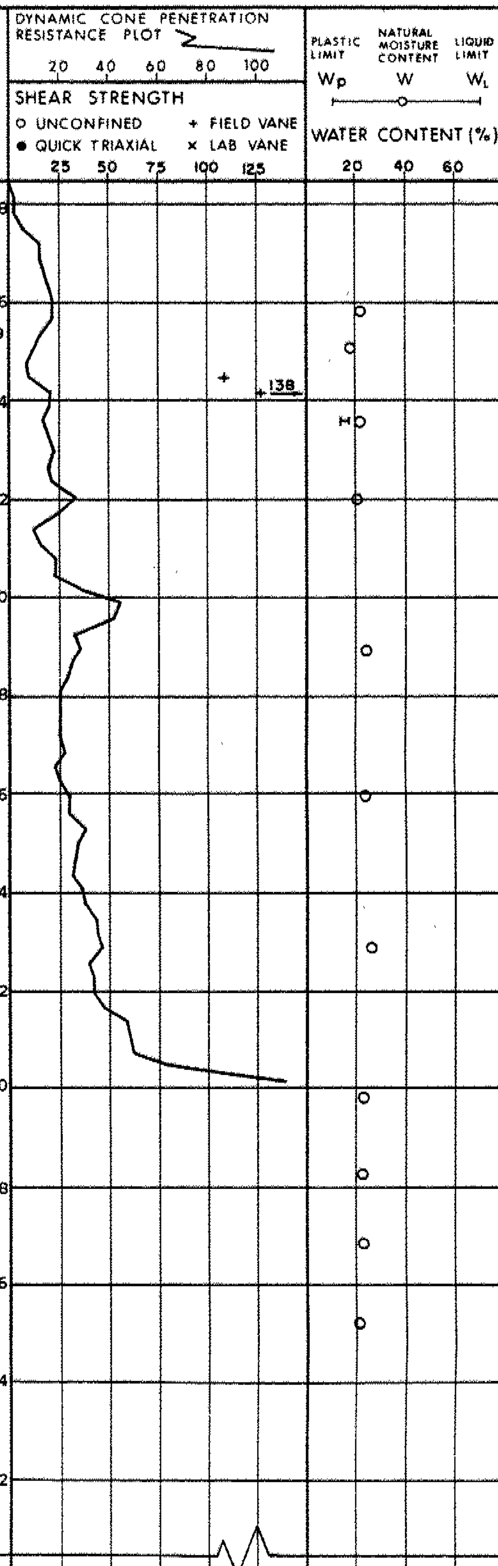
METRIC 11

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem, Wash Boring BWCa, Rock Core, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24-28, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
278.44	Ground Level					
0.00	0.12 Topsoil				Surface Seal	
277.46	Sandy silt, Light brown					
0.98 / 276.46	Silty sand, stratified. Brown Loose	1	SS	10	Native Sands	
		2	SS	16		
1.98 / 275.09	Fine sand, some silt. Brown to Grey Compact	3	SS	20	Oct.4/79	
3.35 / 270.36	Layered Silt and sandy silt, some fine sand seams. Grey Loose	4	SS	6		
		5	SS	5	Standpipe	
		6	SS	7	Caved Material	
		7	SS	4		
8.08 / 259.24	Silty sand, some sandy silt layers and seams.	8	SS	5		
		9	SS	4		
	Sandy Silt	10	SS	6		0 20 80 0
	Grey Loose	11	SS	3		
		12	SS	5		Sand in augers when plug pulled.
		13	ST	4		
		14	SS	5		0 50 50 0
19.20	Fine to medium sand. Loose	15	ST	7		
		16	ST	4		
	Compact	17	SS	14		0 90 10 0
	Grey Loose	18	SS	7		
						Unable to turn augers telescoped BW casing.
		19	SS	7		



Continued on Sheet 2

$+^3$, x^5 : Numbers refer to Sensitivity 15 ⌖ 5 (%) STRAIN AT FAILURE (20 / 10)

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2 cont

METRIC

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem, Wash Boring BWCa, Rock Core, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24-28, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION (Continued from Sheet 1)	NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	Fine to medium sand. Grey Loose				250		Rotary drill BW casing.
247.35		20	SS	21	248		
31.09	Compact Fine to coarse sand and gravel, some cobbles and boulders.				246		Boulders up to 225 mm diameter in casing.
244.67	Grey Dense	21	SS	>100			
33.77	Glacial till, silty sand and gravel, some cobbles and boulders. Grey Very Dense				244		
		~~22~~	~~SS~~	~~>100~~	242		Boulder core in casing.
		~~23~~	~~SS~~	~~>100~~	240, 238	o	
234.46					236		
43.98	Quartzite Bedrock Fairly Sound	24	RC BX	71%	234		
231.50	White and Grey Fractured	25	RC BX	21%	232		Core loss due to grinding.
46.94	End of Borehole.				230		

Chart headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; STRAT PLOT; GROUND WATER CONDITIONS; UNIT WEIGHT γ; GR SA SI CL

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

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

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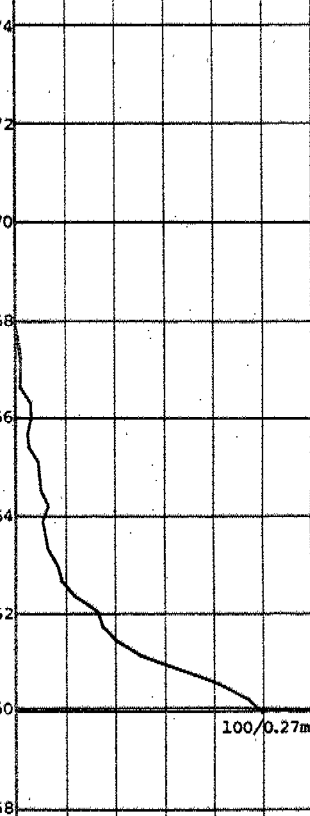
RECORD OF PENETRATION TEST No 3 METRIC

W P 126-78-02 LOCATION Sta.18+725, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE October 4, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION (SOIL PROFILE)	STRAT PLOT	NUMBER (SAMPLES)	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	WATER CONTENT (%) (PLASTIC LIMIT Wp, NATURAL MOISTURE CONTENT W, LIQUID LIMIT WL)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level										
0.00	Water						274, 272, 270				
267.93 / 7.62	Bottom of River.						268, 266, 264, 262				
260.07 / 15.48	End of Cone Test.						260, 258	100/0.27m			



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+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF PENETRATION TEST No 4 METRIC

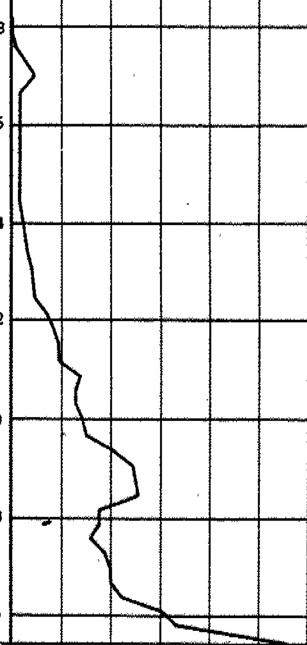
14

W P 126-78-02 LOCATION Sta.18+760, O/S 4.5 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE October 3, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION	STRAT PLOT	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	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
275.55	River Level										
0.00	Water						274				
							272				
							270				
268.23	Bottom of River						268				Drill rods sank 0.3 m under own weight.
7.32							266				
							264				
							262				
							260				
							258				
255.43							256				
20.12	End of Cone Test.						254				



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

15 -◇- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

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Ministry of Transportation and Communications, Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

METRIC 15

W P 126-78-02 LOCATION Sta.18+789, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Wash Boring BWCa, Cone Test COMPILED BY DN

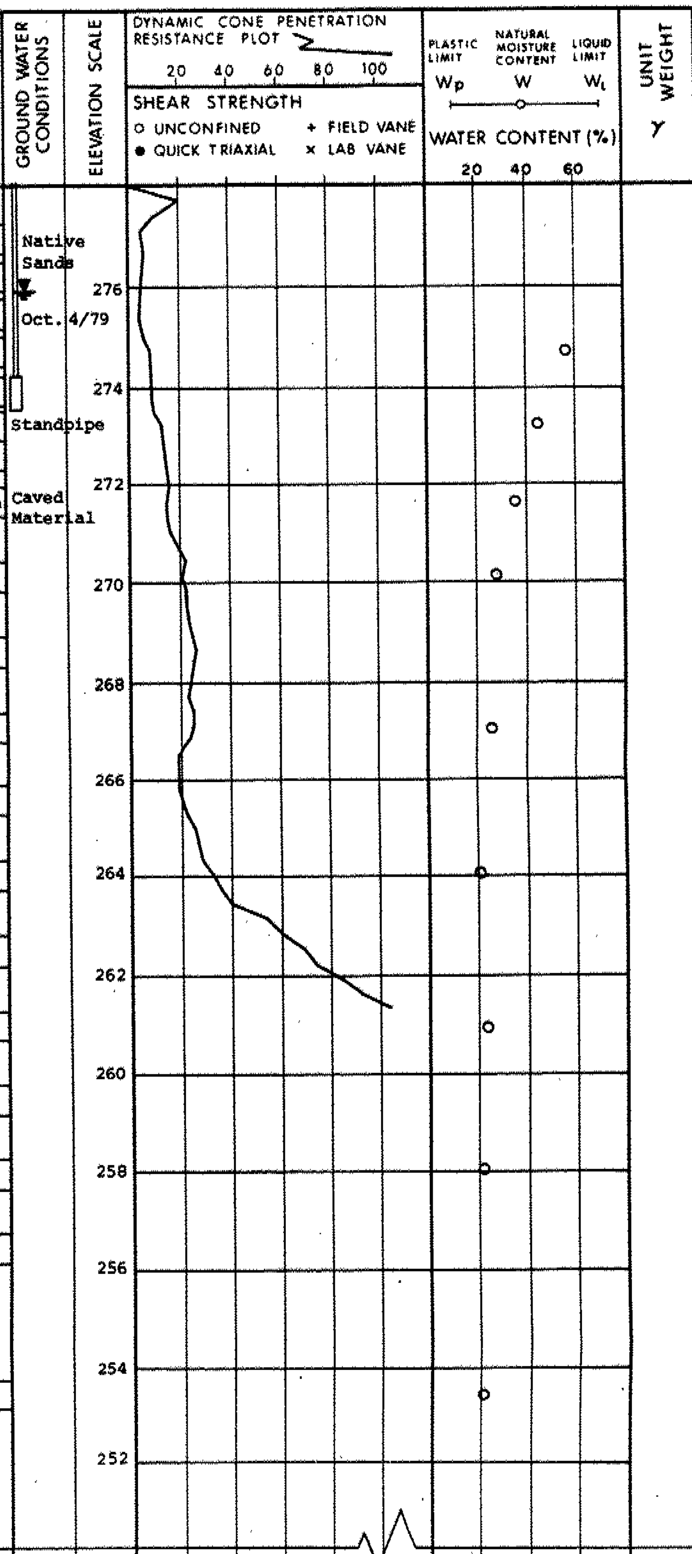
DATUM Geodetic DATE September 28 - October 4, 1979 CHECKED BY [signature]

Soil Profile

ELEV / DEPTH	DESCRIPTION
278.05	Ground Level
0.00 / 276.98	Fill, sand, gravel, silty sand, brown, loose
1.07 / 275.46	Fill, silty sand, organic material. Brown Loose
2.59 / 271.04	Alluvium, organic silty sand and silt. Dark Brown to Grey-Brown Very Loose
7.01 / 269.52	Fine sand. Grey Loose
8.53 / 263.42	Fine to medium sand, some thin silty sand seams. Loose ------- Grey Compact
14.63 / 258.54	Layered Silt and sandy silt, some fine sand seams. Grey Compact
19.51	Fine to medium sand, some silt. Grey Loose to Compact
	Continued on Sheet 2

Samples

NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	4	Native Sands	
2	SS	5		
3	SS	3	Oct. 4/79	
4	SS	1		
5	SS	1/.6m	Standpipe	
6	SS	1		
7	SS	1		Sand in augers when plug pulled.
8	SS	1/.6m	Caved Material	
9	SS	7		
10	SS	8		
11	SS	7		0 97 3 0
12	SS	8		
13	SS	12		
14	SS	11		
15	SS	15		0 5 92 3
16	SS	13		
17	SS	4		Sand in augers, unable to turn, telescoped BW casing.
18	SS	10		
19	SS	7		0 93 7 0



+3, ×5 : Numbers refer to Sensitivity   15 ◇ 5 (20, 10) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 5 cont

METRIC 16

W P 126-78-02 LOCATION Sta.18+789, O/S 4.5 m Lt. ORIGINATED BY DJS
DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Wash Boring BWCa, Cone Test COMPILED BY DN
DATUM Geodetic DATE September 28 - October 4, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION (Continued from Sheet 1)	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Fine to medium sand, some silt. Grey Loose					250			
248.03 / 30.02	Fine to coarse sand and gravel some cobbles and boulders. Very Dense / Grey Loose	20	SS	>100		248			
						246			Boulders to 175 mm diameter in casing.
		21	SS	6			o		30 66 4 0
243.91 / 34.14	Glacial till, silty sand and gravel, some cobbles and boulders Very Dense / Grey					244			
		22	SS	76			o		46 45 9 0
						242			
						240			
237.51 / 40.54	End of Borehole.					238			
						236			

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE
PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ

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

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

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OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC 17

W P 126-78-02 LOCATION Sta.18+840, C/L ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DN

DATUM Geodetic DATE October 4, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
276.41	Ground Level							
0.00 / 275.50	0.15 m Topsoil Dark Brown to Light Brown sandy silt, some organic material.						276	
0.91	Alluvium, organic silty sand and silt, some wood. Loose		1	SS	6	Oct.4/79	274	7 76 17 0
	Dark Brown Very Loose		2	SS	1			
272.14 / 4.27	Layered clayey silt and sandy silt, some fine sand seams.		3	SS	7		272	
	Grey Loose		4	SS	5		270	
268.18			5	SS	4			
8.23	End of Borehole.						268	
							266	

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION – ENGINEERING MATERIALS OFFICE – SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 7

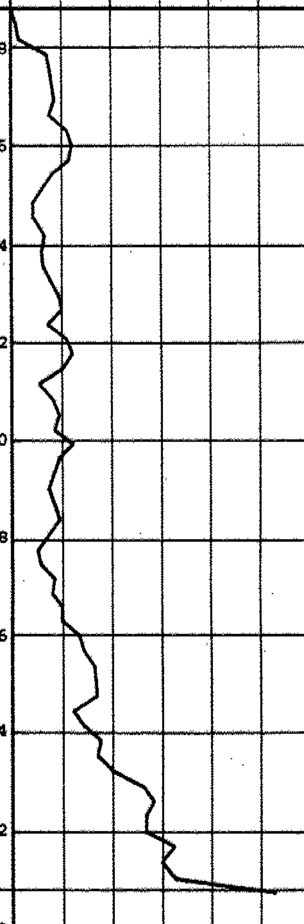
METRIC

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24, 1979 CHECKED BY [signature]

SOIL PROFILE			SAMPLES			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	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						
278.73	Ground Level										
0.00							278				
							276				
							274				
							272				
							270				
							268				
							266				
							264				
							262				
260.75 / 17.98	End of Cone Test.										
							260				



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

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

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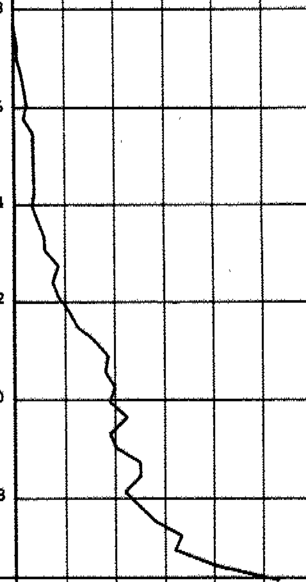
HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 8

METRIC 19

W P 126-78-02
LOCATION Sta.18+725, O/S 5.0 m Rt.
ORIGINATED BY DJS
DIST 10 HWY 515
BOREHOLE TYPE Cone Test
COMPILED BY DN
DATUM Geodetic
DATE September 25, 1979
CHECKED BY [signature]

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)	WATER CONTENT (%) (PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level										
0.00	Water						274				
							272				
							270				
267.63	Bottom of River						268				
7.92							266				
							264				
							262				
							260				
							258				
256.35											
19.20	End of Cone Test.						256				
							254				



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

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

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Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION – ENGINEERING MATERIALS OFFICE – SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 9

METRIC

W P 126-78-02 LOCATION Sta.18+760, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE October 3, 1979 CHECKED BY [signature]

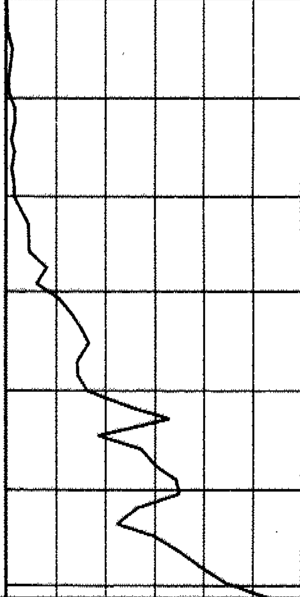
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level							
0.00	Water						274, 272, 270	
268.23 / 7.32	Bottom of River						268, 266, 264, 262, 260, 258, 256	Drill rods sank 0.3 m under own weight.
255.74 / 19.81	End of Cone Test.						254	

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100)

SHEAR STRENGTH: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; × LAB VANE

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%)

UNIT WEIGHT γ



+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 10

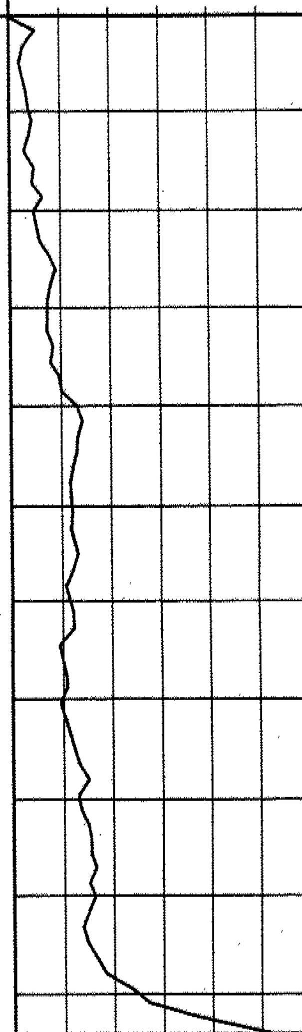
METRIC

W P 126-78-02 LOCATION Sta.18+790, O/S 5.0 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE September 28, 1979 CHECKED BY [signature]

SOIL PROFILE			SAMPLES			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)	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						
278.01	Ground Level										
0.00							276, 274, 272, 270, 268, 266, 264, 262, 260, 258				
257.29 / 20.72	End of Cone Test.						256				



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

15 -◇- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

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OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 1A

W P 126-78-02 LOCATION Sta. 18+772 o/s 5.2 m Lt. ORIGINATED BY W.T.

DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.

DATUM Geodetic DATE 1980-06-12 CHECKED BY

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4	Water Level									
0.0	Water					274				
						272				
270.5	Bottom of River									
	Fine Sand, Trace Organic Material, Trace Silt — Very Loose	1	SS	4		270				
		2	SS	2				o		0 85 15
		3	SS	3						
	Fine Sand, Trace Organic Material, Trace Silt — Loose to Compact	4	SS	5				o		0 96 4
		5	SS	6		268				
		6	SS	16				o		0 98 2
		7	SS	5						
		8	SS	22		266				
	Silt, Trace Sand	9	SS	9				o		
264.6		10	SS	8						
10.8	End of Borehole					264				

Dynamic cone penetration resistance plot scale: 20 40 60 80 100

Shear strength: o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

Plastic Limit W_p, Natural Moisture Content W, Liquid Limit W_L; Water content scale: 10 20 30

+3, ×5 : Numbers refer to Sensitivity

15 -o- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2A

METRIC 23

W P 126-78-02 LOCATION Sta. 18+777 o/s 4 m Rt. ORIGINATED BY W.T.
DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.
DATUM Geodetic DATE 1980-06-12 CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4	Water Level							
	Water							
274.2	Bottom of River					274		
1.2	Fine Sand Very Loose, Some Silt, Trace Organic Material	1	SS	2			~60	
		2	SS	1/.46 m				
		3	SS	1/.46 m			~38	0 79 21
		4	SS	1/.46 m		272		
		5	SS	1/.46 m			~35	0 80 20
270.7	Loose	6	SS	5				
4.7	End of Borehole					270		

Dynamic cone penetration resistance plot: 20 40 60 80 100. Shear strength: o Unconfined, + Field Vane, ● Quick Triaxial, x Lab Vane. Plastic limit W_p, natural moisture content W, liquid limit W_L; water content (%) 20 40 60. Unit weight γ.

$+^3$, x^5 : Numbers refer to Sensitivity   15 -○- 5 (20 above, 10 below) (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3A

METRIC 24

W P 126-78-02 LOCATION Sta. 18+764 at ₵ ORIGINATED BY W.T.

DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.

DATUM Geodetic DATE 1980-06-10 CHECKED BY

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4	Water Level					
0.0	Water				274, 272, 270, 268	
267.8 / 7.6	Silt, Trace Sand, Trace Organics, Loose to Compact	1	SS	16		
		2	SS	22		
		3	SS	14	266	0 15 80 5
		4	SS	4		
264.9		5	SS	8		
10.5	End of Borehole				264	

Chart columns: Dynamic Cone Penetration Resistance Plot (20 40 60 80 100); Shear Strength (○ Unconfined, + Field Vane, ● Quick Triaxial, × Lab Vane); Plastic Limit W_p, Natural Moisture Content W, Liquid Limit W_L; Water Content (%) 10 20 30; Unit Weight γ; Ground Water Conditions; Strat Plot.

$+^3, \times^5$: 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 4 A

METRIC 25

W P 126-78-02 LOCATION Sta. 18+723 at ℄ ORIGINATED BY W.T.

DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.

DATUM Geodetic DATE 1980-06-11 CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4 / 0.0	Water Level Water					274, 272, 270, 268			
267.8 / 7.6	Bottom of River Silt, Some Sand to Sand, Some Silt Trace Organics Loose	1	SS	5					
		2	SS	3			o		0 63 35 2
		3	SS	6		266			
		4	SS	11			o		0 17 80 3
264.9 / 10.5	End of Borehole	5	SS	8		264			

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH: o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5A

METRIC 26

W P 126-78-02 LOCATION Sta. 18+706 o/s 4.3 m Lt. ORIGINATED BY W.T.

DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.

DATUM Geodetic DATE 1980-06-11 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4	Water Level										
0.0	Water						274				
273.2	Bottom of River										
2.2	Silt, Some Sand		1	SS	9						
	Trace Organics		2	SS	11		272				
	Loose to Compact		3	SS	15						1 14 82 3
			4	SS	12						
270.4			5	SS	5						
5.0	End of Borehole						270				

Dynamic cone penetration resistance plot scale: 20 40 60 80 100. Shear strength: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE. Plastic limit W_p, natural moisture content W, liquid limit W_L. Water content scale: 10 20 30.

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

15 -◇- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6A

METRIC 27

W P 126-78-02 LOCATION Sta. 18+712 o/s 3.5 m Rt. ORIGINATED BY W.T.

DIST 10 HWY 515 BOREHOLE TYPE Diamond Drill - NX Casing COMPILED BY W.T.

DATUM Geodetic DATE 1980-06-11 CHECKED BY

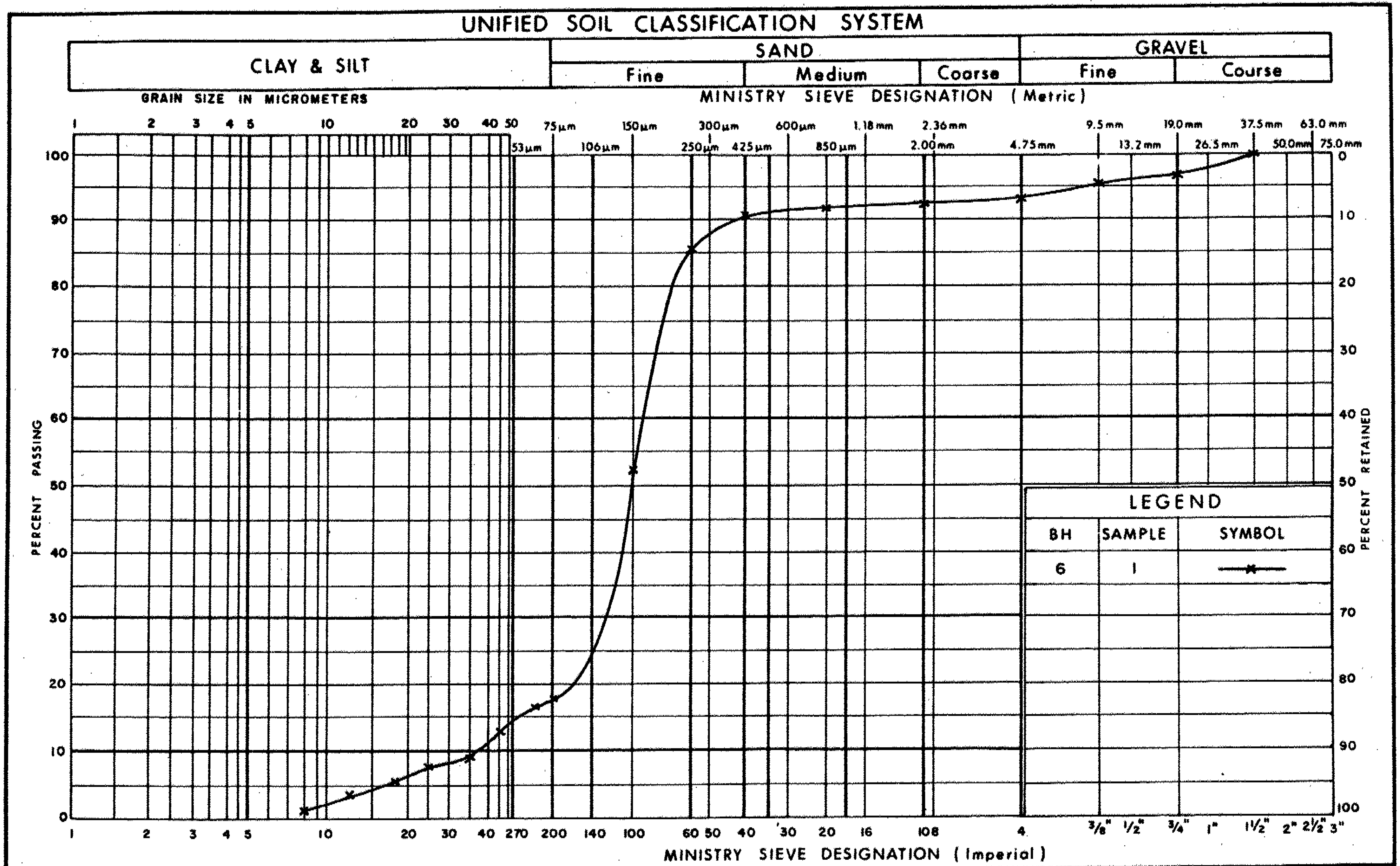
ELEV / DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.4	Water Level						
0.0	Water				274		
					272		
271.4	Bottom of River						
4.0	Silt, Some Sand to Sand, Some Silt; Very Loose to Loose	1	SS	4			
		2	SS	6	270		
		3	SS	3		~29	0 4 90 6
		4	SS	4			
		5	SS	3			
		6	SS	OW	268	~27	3 25 68 4
		7	SS	5			
		8	SS	3			
		9	SS	8	266	~25	0 47 51 2
265.5		10	SS	5			
9.9	End of Borehole				264		

+3, x5 : Numbers refer to Sensitivity

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

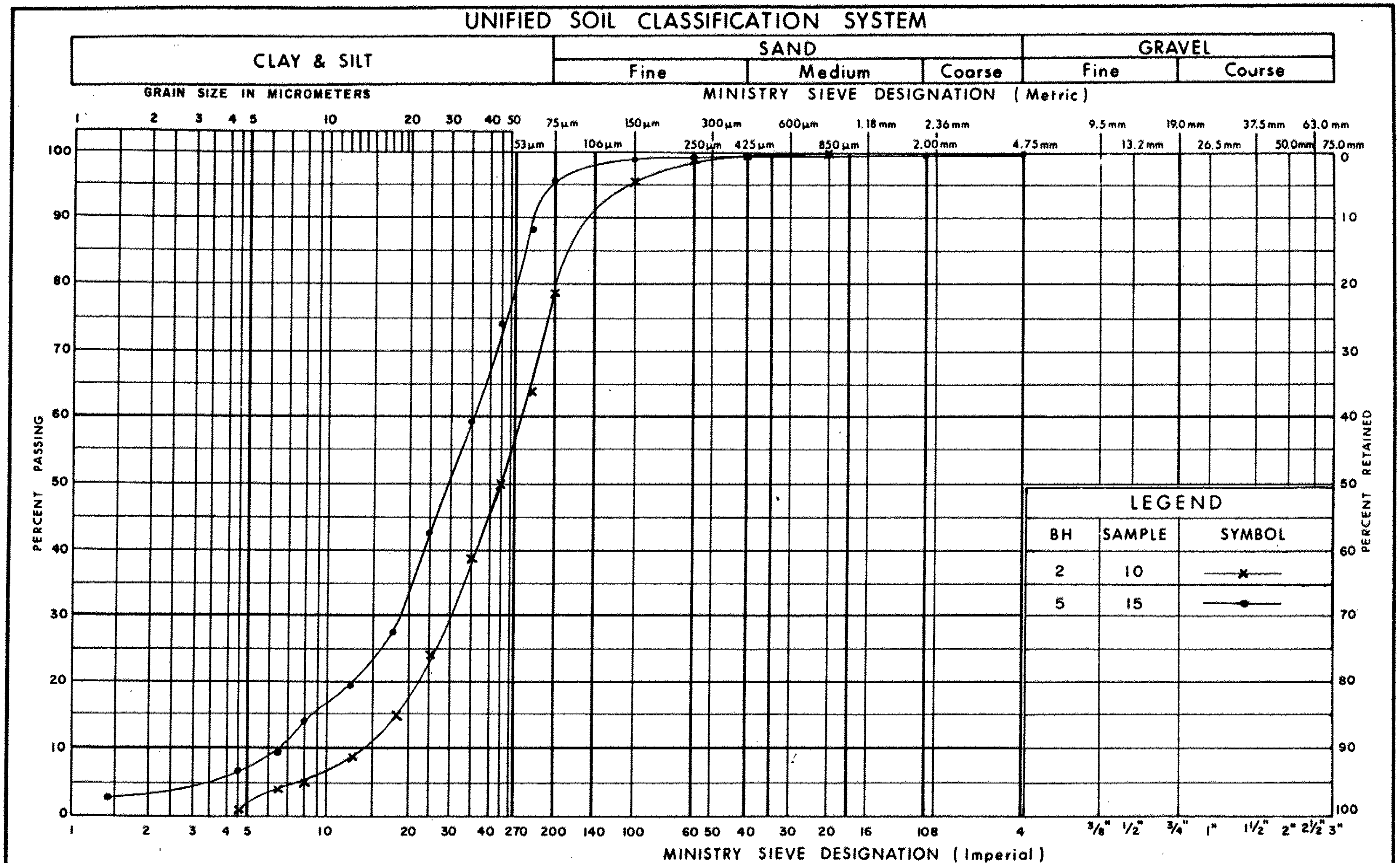
OFFICE REPORT ON SOIL EXPLORATION

78 12 M



Ministry of Transportation and Communications Ontario	**GRAIN SIZE DISTRIBUTION** ALLUVIUM; ORGANIC SILTY SAND AND SILT	FIG No 1 WP 126-78-02

78 12 M



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GRAIN SIZE DISTRIBUTION

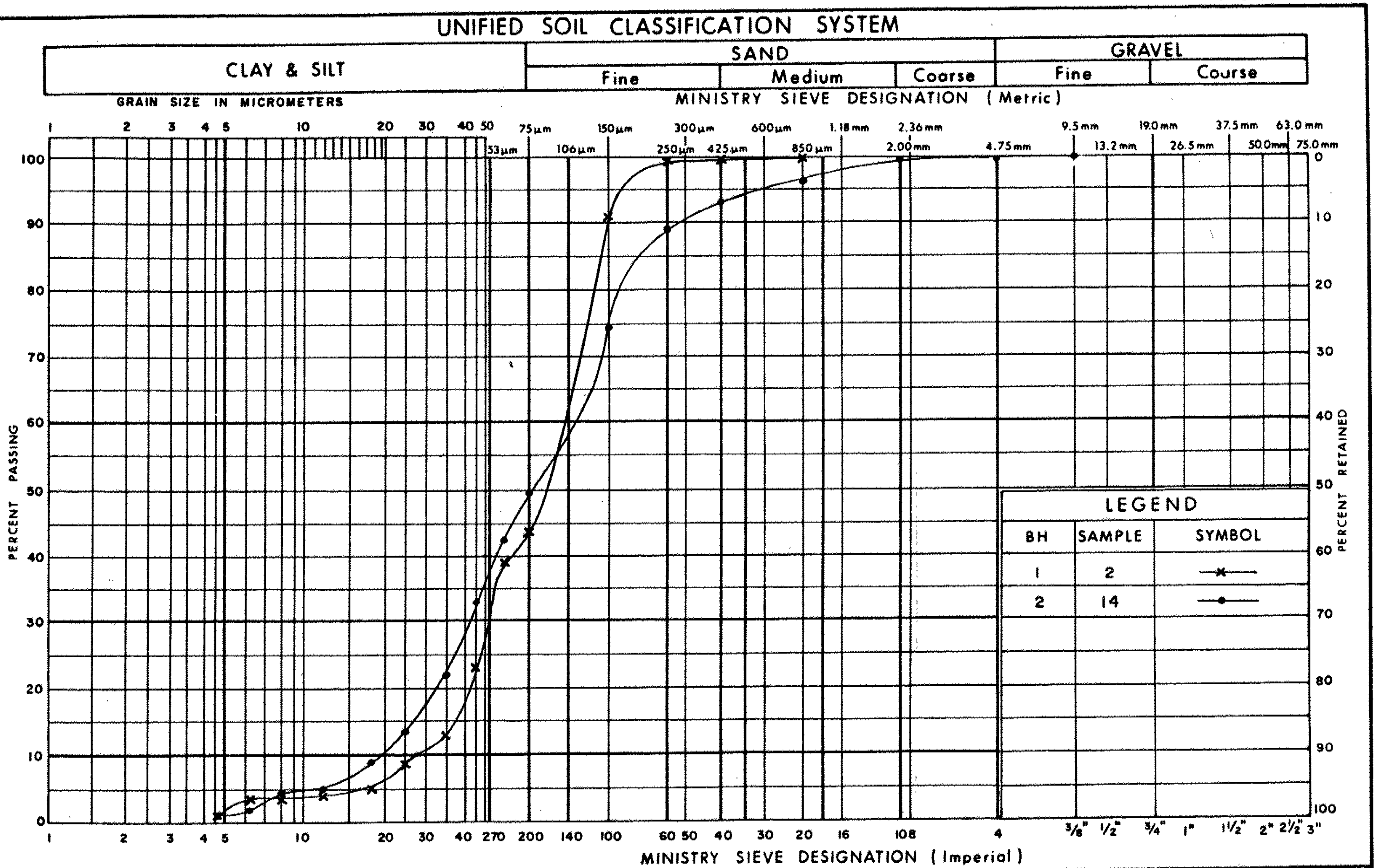
SANDY SILT

TRACE CLAY

FIG No 2

W P 126-78-02

78 12 M



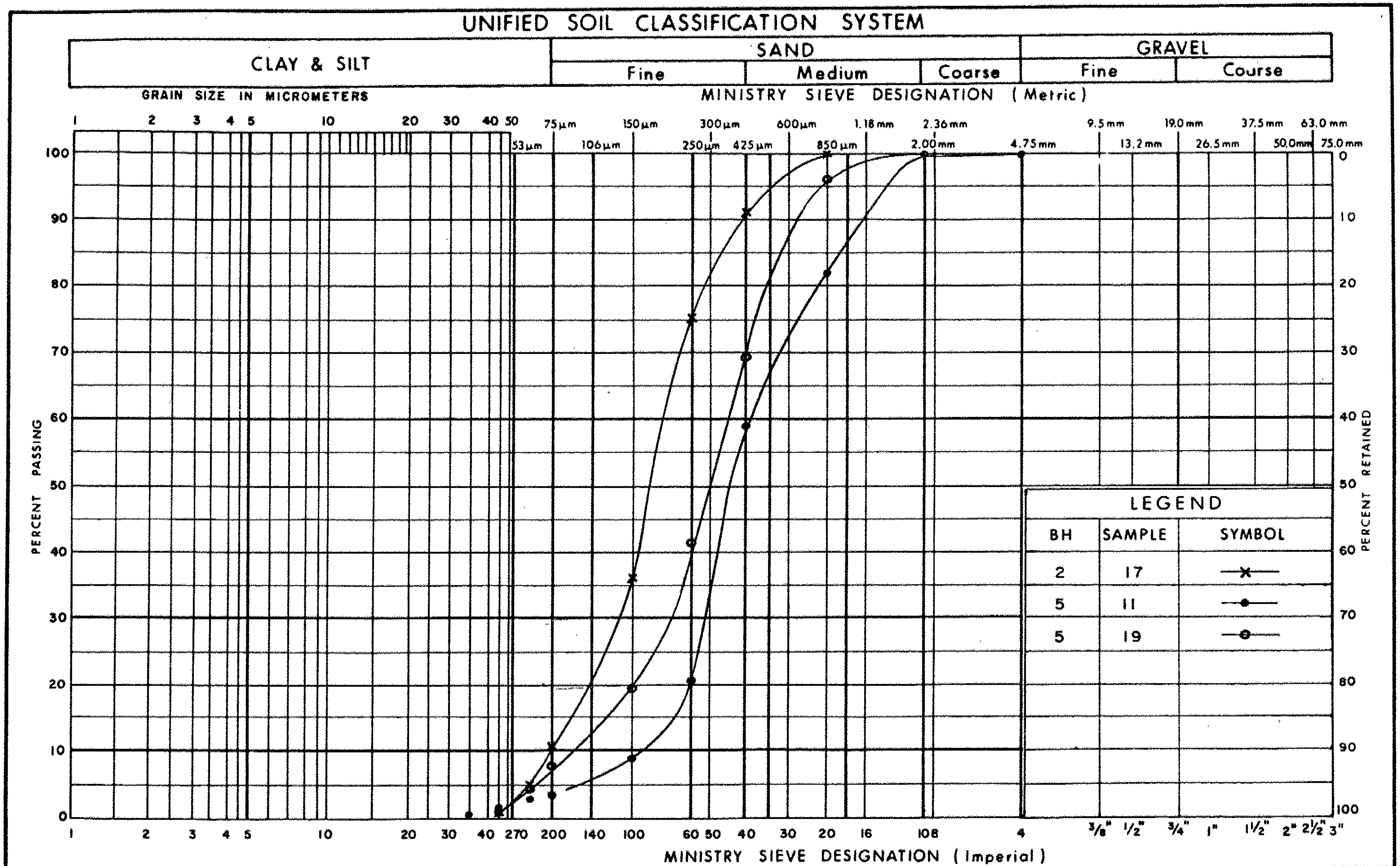
GRAIN SIZE DISTRIBUTION
SILTY SAND

Ministry of Transportation and Communications
Ontario

FIG No 3

W P 126-78-02

78 12 M



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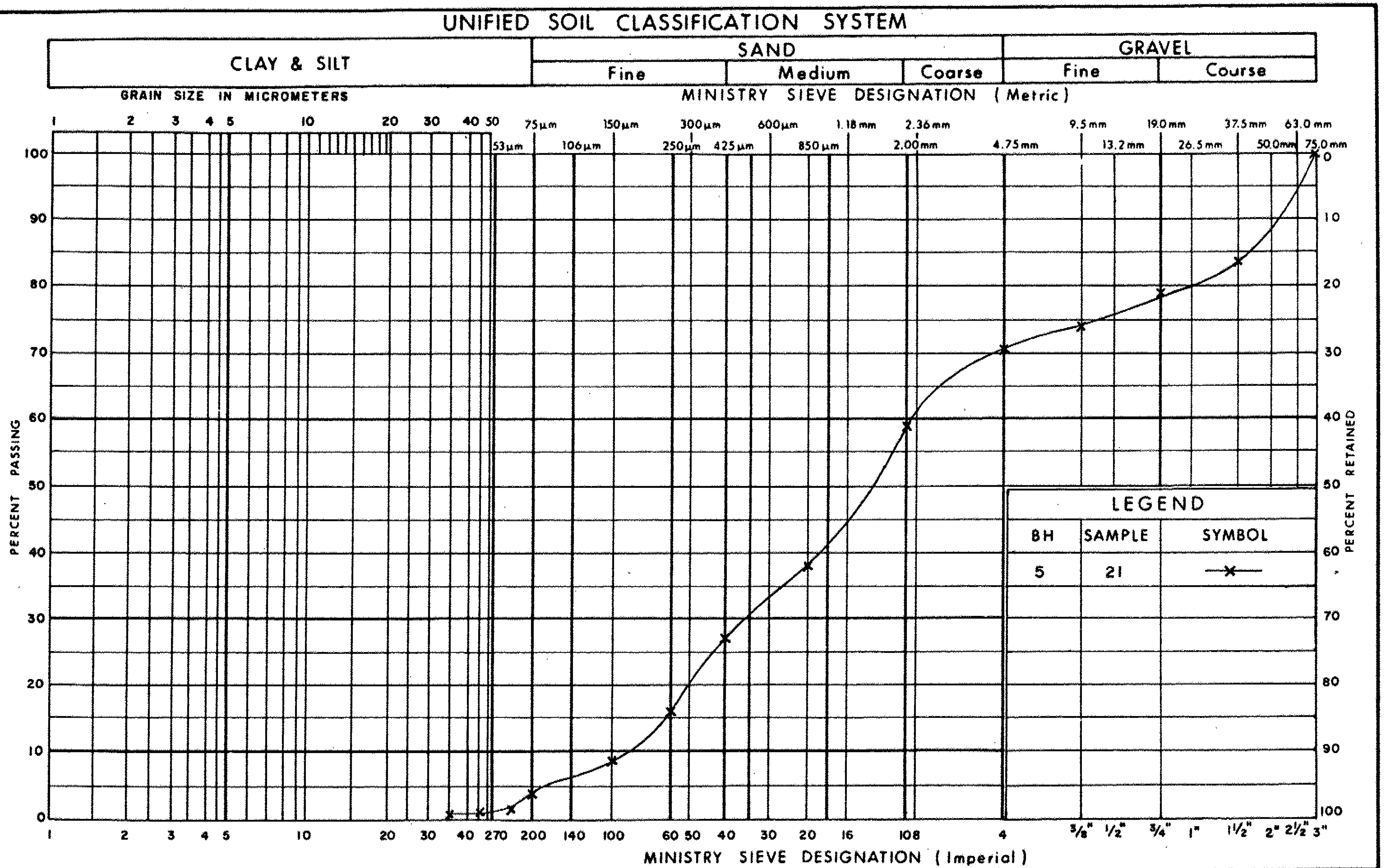
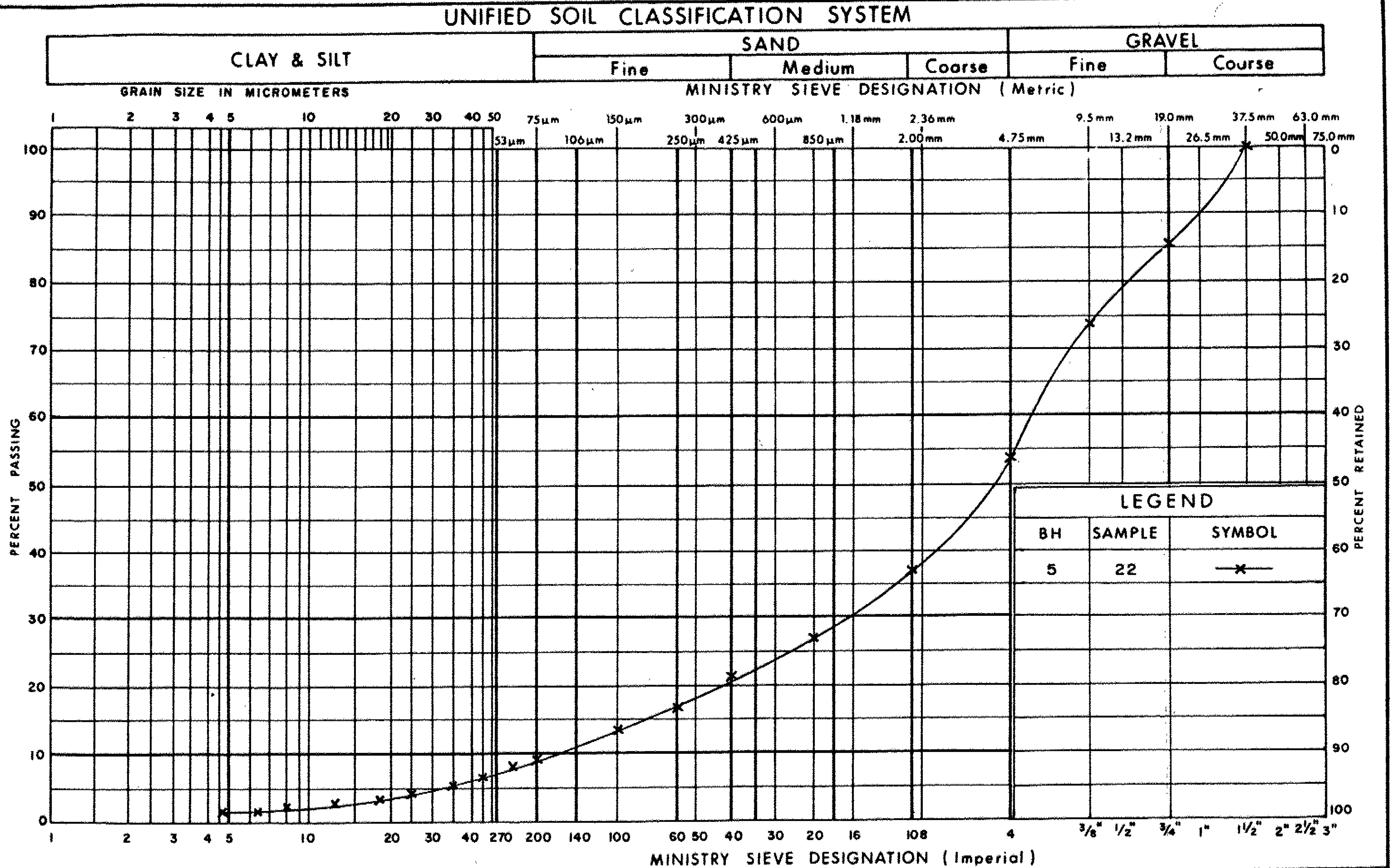
GRAIN SIZE DISTRIBUTION
FINE TO MEDIUM SAND
TRACE TO SOME SILT

FIG No 4
W P 126-78-02



Ministry of Transportation and Communications Ontario	**GRAIN SIZE DISTRIBUTION** FINE TO COARSE SAND AND GRAVEL SOME COBBLES AND BOULDERS	FIG No 5 W P 126-78-02

78 12 M



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

GLACIAL TILL : SILTY SAND AND GRAVEL SOME COBBLES AND BOULDERS

FIG No 6

W P 126-78-02

Golder Associates
CONSULTING GEOTECHNICAL ENGINEERS

31F - 98
GEOCRES No.

REPORT

TO

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS

GEOTECHNICAL INVESTIGATION

MADAWASKA RIVER BRIDGE
SECONDARY HIGHWAY 515
W.P. 126-78-02 SITE 29-186

PALMER RAPIDS ONTARIO

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ABSTRACT

The results of an investigation to determine the subsurface conditions at the site of a proposed bridge crossing of the Madawaska River by Highway 515, some 5 kilometres downstream of Palmer Rapids, Ontario, are reported herein. Geotechnical recommendations are given in the report for the foundation design of the proposed bridge structure and approach embankment.

The borings revealed that the site is covered by surficial deposits of sandy silt and/or fill material, underlain on the east side of the river by recent river alluvium. The main subsoil at the site consists of up to 31 metres of interlayered and interbedded sandy silt, silty sand, and fine to medium sand which has been divided into an upper and lower zone by a layer of clayey to sandy silt. These deposits are in turn underlain by about 14 metres of sands and gravels and glacial till, followed by quartzite bedrock. The stabilized groundwater level was at a depth of about 2 to 3 metres; that is, at about the level of the adjacent Madawaska River.

It is recommended that the piers and abutments of the proposed structure be founded on end-bearing piles driven to final set within the dense sand and gravel or glacial till. Steel piles of either H or pipe section would be suitable pile types. Preliminary design values of 890 kN per pile are given based on assumed pile size, set, and driving energy criteria. Low capacity timber "friction" piles could also be used for lightly loaded portions of the structure if required.

There should be no overall stability problem with the proposed approach embankments using 2 horizontal to 1 vertical side slopes. Some settlement of the loose granular subsoil may be expected during construction of the embankments. Nominal rip rap protection should be provided to the existing riverbanks to at least 1 metre above flood level.

1. INTRODUCTION

Golder Associates, Consulting Geotechnical Engineers, have been retained by the Ministry of Transportation and Communications, Ontario to carry out a geotechnical investigation at the site of the proposed crossing of the Madawaska River by Secondary Highway 515 near Palmer Rapids, Ontario. Preliminary details of the proposed project and data from borings at a bridge site some 5 kilometres upstream of the site to be investigated were provided to us by Mr. M.S. Devata, P.Eng., Supervisory Engineer, Soil Mechanics Section, Ministry of Transportation and Communications, Downsview, Ontario. The proposed scope of the investigation was outlined in our proposal letter of September 7, 1979 to Mr. M.S. Devata.

The purpose of the investigation was to determine the general subsurface conditions across the site by means of sampled borings, and based on our assessment and interpretation of the factual data obtained to provide engineering recommendations regarding the geotechnical aspects of the design of the proposed works, including any special construction considerations which could influence design decisions.

It should be noted, because of the extremely deep overburden deposits at the site and necessary budget restraints, that the full boring program was not completed as outlined in the proposal. The interpretations and recommendations given in this report are therefore of necessity based on data obtained from a limited number of widely spaced boreholes. Consequently, the report may not reflect undetected stratigraphic variations which may occur between boreholes.

This report is presented in two parts. Part A details the factual results of the borings while Part B gives our interpretation of the factual data, together with recommendations for the geotechnical design of the proposed works.

2. DESCRIPTION OF SITE AND GEOLOGY

The site of the proposed bridge crossing is located on Secondary Highway 515, some 3.5 kilometres east of Secondary Highway 514 and about 5 kilometres downstream (east) of Palmer Rapids, Ontario. The site is designated as 29-186 and is within District 10-Bancroft. Highway 515 presently crosses the Madawaska River via a "Bailey" bridge about 0.5 kilometres downstream of the site under investigation.

In the area of the proposed crossing the Madawaska River is about 8 metres deep and some 80 metres wide. The riverbanks along the proposed Line K crossing rise at about a 2 horizontal to 1 vertical slope to some 3 to 4 metres above normal water level. Some undercutting of the riverbanks is evident in the general area although the river currents do not appear to be excessively fast. The ground surface adjacent to the river is relatively level.

The site is located in the Precambrian Shield section of Renfrew County. Fine and very fine sands of the Uplands and St. Samuel Series have been identified in large, widely distributed tracts over the Precambrian Shield. The origin of these deposits are in most cases deltaic, having been laid down either in a lacustrine basin or in the upper reaches of the glaical Champlain Sea which extended up the St. Lawrence and Ottawa valleys. These sand deposits typically lie adjacent to present lakes or basins that are now drained by rivers and streams. The sands are typically underlain by variable thicknesses of glacial till and then by bedrock formations of crystalline limestones, gneisses, and quartzites. Locally, surficial deposits of river alluvium form terraces adjacent to major river channels.

PART A

SUBSURFACE CONDITIONS

3. SUBSURFACE CONDITIONS

3.1 Subsoil

The detailed subsurface stratigraphy encountered in each borehole is shown on the Record of Borehole sheets and a section showing the relative borehole stratigraphy at the proposed bridge crossing is shown on Drawing 1267802-A. It should be noted that the soil boundaries indicated on the Record of Borehole sheets and on the drawing are inferred from non-continuous samples and from observation of resistance to auger advance and auger cuttings and do not necessarily indicate an exact plane of geological change.

3.1.1 Summarized Stratigraphy

In summary, the site is underlain by surficial deposits of sandy silt and/or fill material. These deposits are underlain by recent river alluvium on the east side of the river (boreholes 5 and 6). The main subsoil at the site consists of a thick deposit of interlayered and interbedded sandy silt, silty sand, and fine to medium sand which at the borehole locations has been divided into an upper and lower zone separated by a layer of slightly cohesive layered clayey to sandy silt. These sandy deposits are in turn underlain by sands and gravels, glacial till, and then bedrock.

3.1.2 Surficial Deposits

Boreholes 1, 2, and 6 encountered some 120 to 150 millimetres of topsoil at ground surface. Borehole 5, put down alongside the roadway on the east side of the river also encountered topsoil but in this case within about 2.5 metres of sand and gravel to silty sand roadway fill. The topsoil in boreholes 1, 2, and 6 was in turn underlain by thin, loose to compact deposits of sandy silt.

In boreholes 5 and 6 these deposits were underlain by up to 4 metres of very loose to loose dark brown organic silty sand with layers of organic silt and organic material (see Figure 1 for grading). This deposit is considered to represent flood-plain deposited material of alluvial origin.

3.1.3 Upper Silty Sands and Sands

The surficial materials are underlain in boreholes 1, 2, and 5 by a layered deposit of silty sand and fine sand. In boreholes 1 and 2 this deposit was encountered at about 1 metre below ground level and extended to depths of about 3 to 5 metres. In borehole 5 however the top of this deposit was encountered below the alluvium at a depth of about 7 metres. The results of a grading test carried out on a representative sample of the silty sand are shown on Figure 3 and indicate the fine uniform nature of this deposit. Standard penetration tests carried out in this deposit gave 'N' values ranging from 20 blows per 0.3 metres near the top of the deposit to 4 blows per 0.3 metres with depth. This upper sandy deposit is therefore considered to have a loose to compact relative density.

3.1.4 Layered ~~Clayey Silt~~ silty clay and Sandy Silt

The upper sandy strata were found to be underlain in all the boreholes by a fine, slightly cohesive layered ~~clayey silt~~ silty clay and sandy silt. In boreholes 1, 2, and 5, this stratum was found to be in the order of 5 to 6 metres thick while borehole 6 was terminated within the layered clayey silt at a depth of about 8 metres below ground surface. An Atterberg limit test carried out on a sample of the clayey portion of this layered stratum gave a liquid limit value of 18 per cent and a plasticity index value of only 3 per cent. A grading test carried out on a sample recovered from this stratum (Figure 2) shows the material to consist basically of silt sizes, with some sand and clay sizes. Standard penetration tests carried out in this layered clayey silt and sandy silt gave 'N' values ranging from 3 to 11 blows per 0.3 metres, indicating a generally loose relative density.

Indicates ML - material silt of slight plasticity

3.1.5 Lower Sandy Silt, Silty Sand and Fine to Medium Sand

This lower sandy deposit was encountered in the borings at depths of 8 (boreholes 1 and 2) to 19 (borehole 5) metres below ground surface, and in boreholes 2 and 5 extended to a depth of 30 to 31 metres. This deposit consists of sandy silt, silty sand with sandy silt layers, and fine to medium sand with some silt. Grain size analyses were carried out on the various types of materials within this deposit and are shown on Figure 2 for the sandy silt, on Figure 3 for the silty sand, and on Figure 4 for the fine to medium sand. Standard penetration tests carried out in this lower sandy stratum gave 'N' values in the order of 4 to 10 blows per 0.3 metres. In some cases it is felt that the soil at sampling depth may have been disturbed somewhat by upward seepage forces. However, in general it is considered that the density of these lower sands is in the loose range.

3.1.6 Sand and Gravel

A 2 to 4 metre thick deposit of fine to coarse sand with some cobbles was encountered at depth in boreholes 2 and 5. The top of this deposit at these borehole locations was at a depth of 30 to 31 metres below ground surface level. Figure 5 shows the results of a grading test carried out on a sample of this material and indicates the coarse, well graded nature of this deposit. It should be noted that some cobble and boulder sizes were also encountered throughout this sand and gravel stratum. Standard penetration tests in this sand and gravel gave 'N' values of greater than 100 blows per 0.3 metres, indicative of a very dense state of packing. The one low 'N' value of 6 blows per 0.3 metres recorded in borehole 5 was again considered to be representative of disturbance due to upward seepage forces into the borehole casing.

3.1.7 Glacial Till

Below the sand and gravel in boreholes 2 and 5 is a stratum of glacial till consisting of silty sand and gravel with some cobbles and boulders (see Figure 6). The silty sand till was found to be about 10 metres thick in borehole 2 while borehole 5 was terminated after penetrating some 6 metres into the stratum. The till is generally very dense with recorded 'N' values ranging from 76 to greater than 100 blows per 0.3 metres.

3.2 Bedrock

Bedrock was encountered and cored in BX size in borehole 2. The surface of the bedrock at this location was at a depth of 44 metres below ground surface (elevation 234.64). From visual examination of the rock core and from the recorded core recovery, the bedrock is considered to be fractured to fairly sound. The bedrock cored is a white and grey quartzite.

No recovery or RQD ratios

3.3 Groundwater

Standpipes were installed in boreholes 1, 2, and 5, details of which are shown on the Record of Borehole sheets. The stabilized groundwater level recorded on October 4, 1979 in these shallow installations was at a depth of 1.3 to 2.7 metres, i.e. elevation 275.07 to 275.95. The level of the water in the Madawaska River adjacent to the boreholes was at elevation 275.55 on the same date.

PART B

DISCUSSION AND RECOMMENDATIONS

4. DESCRIPTION OF PROJECT

This section of the report presents our interpretation of the factual geotechnical data obtained during this investigation. It is stressed that the information in this section of the report is provided for the guidance of the design engineers and is based on our present understanding of the project. It is recommended that the final design of the bridge structure be discussed with the geotechnical engineer to ascertain that the recommendations given in this report are applicable to the actual design requirements and that the general intent of the geotechnical report has been met.

It is our understanding at this time that the proposed bridge is to be a three span, 95 metre long structure supported by two abutments on land and two piers within the river channel. The bridge will be in the order of 9.5 metres wide to carry two traffic lanes. The approach embankments to the structure are to be constructed using earth fill and will be in the order of 2 to 4 metres in height. Side and front slopes of 2 horizontal to 1 vertical will probably be adopted for this earth fill.

4.1 Bridge Foundations

The proposed bridge abutment and pier locations have been indicated to be underlain by up to 31 metres of loose to compact interlayered sands and silts followed by up to 13 metres of relatively dense sand, gravel, and glacial till. It is considered that the loose to compact sands and silts have insufficient capacity to adequately support, using spread footing design, the relatively large loads imposed by the bridge structure. This is particularly evident at the pier locations where the river bottom material is indicated to be very loose (i.e. dynamic cone test values of less than 10 blows per 0.3 metres) for the top 3 to 4 metres at least. For these reasons it is recommended that a piled foundation be employed to carry the structural bridge loads. It is considered that a driven end bearing pile would be the most suitable pile type at this site. However, as outlined later, should lower capacity piles be required to support parts of the structure, consideration could be given to the use of relatively short, displacement type piles, developing the majority of their capacity from "friction" along the pile shaft.

4.1.1 End Bearing Piles

Steel piles, either H or pipe section, would be a suitable pile type for support of the bridge abutments. For design purposes, the allowable load for a 305 millimetre H pile section or 305 millimetre diameter concrete filled pipe pile driven to a final set of about 20 blows per 25 millimetres with a hammer developing a minimum of about 48 kJ of energy per blow may be taken as 890 kN per pile. Based on the results of boreholes 2 and 5 it is considered that the H-piles would probably encounter the required set and thus the allowable load at about 35 to 40 metres (elevation 243 to 238) below ground level in the dense glacial till. The pipe piles, being displacement piles, could encounter the required set at a somewhat shallower depth within the sand and gravel.

Either H or pipe section piles may also be used at the pier locations. However, the H piles, having a limited cross-sectional area, may tend to "whip" and deflect due to the long unsupported underwater lengths. As for the abutment piles, an allowable load of 890 kN per pile may be used for either a 305 millimetre H pile or 305 millimetre diameter concrete filled pipe pile. Although no deep boreholes were completed at the proposed pier locations it may be expected that the pier piles will encounter the recommended set values at about the same elevation as the abutment piles; that is about elevation 243 to 238 or some 25 to 30 metres below riverbottom level.

4.1.2 Friction Piles

Low capacity friction type piles could also be used for lighter loaded sections of the structure if required. Because of the loose nature of the subsoils at this site, displacement piles driven to an embedment of about 12 metres would probably only develop allowable capacities in the order of 178 kN per pile. At this relatively low allowable value it is considered that treated timber piles would be the suitable choice. For preliminary design purposes, a 12 metre long, 305 millimetre diameter timber pile driven to a set of 1 blow for 50 millimetres with a hammer developing about 20 kJ of energy per blow should have an allowable load of about 178 kN. This figure may be taken for preliminary design but it is recommended that at least one pile loading test be carried out on a representative timber pile to confirm the allowable working load prior to final design.

Probably less for abutment piles than pier piles.

4.1.3 General Comments on Piled Foundations

It should be noted that some cobble and boulder size material was encountered in the sand and gravel and glacial till strata. Consequently, some difficulty may be encountered in driving the piles at depth. It is therefore recommended that the pile tips be tapered and/or built up or that a rock point be fabricated onto the tip. This will aid in not only strengthening the pile tip but will also help ensure that the piles do not encounter the recommended set prematurely on cobbles and boulders.

It is anticipated that a closed steel sheet pile cofferdam will be constructed at each pier location in order to construct the pier pile caps. In order to limit the potential for "piping" of the fine subsoils at the base of the pile cap excavation, it is recommended that the sheet piling be driven to at least 5 to 6 metres below the base of the excavation. If it is planned to dewater these cofferdams, the sheet piling will have to be designed to resist the pressures associated with an 8 metre depth of water. As well, dewatering could result in an unbalanced hydrostatic pressure at the base of the excavation possibly resulting in basal instability. Consequently, the basal stability would have to be checked and/or improved prior to dewatering by either driving the sheeting to a deeper embedment or by reducing the hydrostatic pressure in the underlying strata.

4.2 Abutments

It is anticipated that the abutment pile cap will be founded within the approach embankment fills. For frost protection purposes, the pile caps should be provided with at least 1.5 metres of earth cover. If retaining type abutments are used, it is recommended that the backfill behind the abutments consist of free-draining, non-frost susceptible granular material compacted in horizontal lifts. This non-frost susceptible backfill should extend at least 1.5 metres horizontally from the back face of the abutment walls to prevent the formation of hydrostatic or ice pressure buildup. With full effective drainage of this backfill, the abutments may be designed using a coefficient of earth pressure at rest, Ko, of 0.4 and a total unit weight of 21.2 kN/m^3. If some movement of the top of the abutment wall can be tolerated, an active earth pressure coefficient, Ka, = 0.3 may be used in design.

4.3 Approach Embankments

As presently planned the approach embankments will have a maximum height of about 4 metres and should be stable with respect to deep seated instability at the proposed 2 horizontal to 1 vertical side slopes. However, it should be noted that, dependent on the embankment fill type, some minor surficial sloughing may occur with 2 to 1 side slopes. The embankment slopes should be seeded and/or mulched to minimize surface water erosion and gullying.

Prior to construction, all surficial organic material should be stripped from the embankment area. The embankment fill, to consist of acceptable granular material, should be placed in relatively thin even lifts and compacted to 95 per cent of maximum standard Proctor dry density value.

The approach embankments will experience some minor settlement due to compression of the loose granular subsoil. This settlement could be in the order of 50 to 75 millimetres where the loose alluvium material underlies the east approach embankment. However, most of this settlement should take place during and immediately following the construction period.

4.4 Riverbank Protection

Some erosion of the riverbanks is presently taking place in the area of the proposed alignment. The existing riverbanks should be trimmed back to an even slope of not greater than 2 horizontal to 1 vertical and a minimum thickness of 0.6 metres of rockfill placed on this trimmed slope. The rockfill blanket should extend up the slope to at least 1 metre above flood level and should also extend a minimum of 10 metres upstream and downstream of the final alignment.

GOLDER ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
R. A. J. MONTGOMERY
PROVINCE OF ONTARIO

R.A. Montgomery, P.Eng.

RAM:rb
791-2219

APPENDIX A

INVESTIGATION PROCEDURES

INVESTIGATION PROCEDURES

The field work for this investigation was carried out between September 20 and October 4, 1979. During this period, four sampled boreholes with accompanying dynamic cone penetration tests (numbers 1, 2, 5, and 6) and two additional dynamic cone penetration tests (numbers 7 and 10) were put down on land using a track mounted hollow stem auger machine. In addition, four dynamic cone penetration tests (numbers 3, 4, 8, and 9) were put down in the riverbed using a skid-mounted diamond drill rig operating from a floating drum raft. Both drill rigs and the drum raft were supplied and operated by the F.E. Johnston Drilling Co. Ltd. of Ottawa.

Boreholes 1 and 6 were terminated at relatively shallow depths of 14 and 8 metres respectively while boreholes 2 and 5 were extended to depths of 47 and 41 metres to reach more competent subsoils. With depth in boreholes 2 and 5, the fine sands tended to "blow" into the hollow stem augers once the plug was removed, necessitating the conversion to a wash boring operation within the auger stem. In both boreholes, wash boring within BW casing had to be carried out below a depth of about 24 to 25 metres in order to successfully complete the borings. Standard penetration tests (N values) were carried out and samples of the subsoils encountered were recovered at 0.76 to 1.52 metre intervals of depth (at depth in boreholes 2 and 5, sampling interval was extended to 3.05 metre) using conventional 51 millimetre OD split spoon (ss) sampling equipment. A few in situ vane shear tests were carried out in the cohesive clayey silt stratum to give an indication of the shear strength profile for this material. The underlying bedrock was cored in BX size for about 3 metres in borehole 2. Standpipes were sealed into boreholes 1, 2, and 5 on completion in order to determine the stabilized groundwater conditions at the site at the time of the investigation. The dynamic cone penetration tests were carried out prior to putting down the borings by driving uncased AW-size

45 millimetre OD flush-coupled drilling rods using a constant driving energy supplied by a 63.5 kilogram hammer dropping 0.76 metres. A 51 millimetre 60° steel cone was fitted to the bottom of the drill rods prior to driving. By recording the number of blows to advance the cone each 0.3 metres, a continuous plot of resistance to driving was obtained.

Details of the drilling and sampling operations carried out in each of the boreholes and cone tests are given on the Record of Borehole and Record of Penetration Test sheets following the text of this report. The field work was supervised throughout by a member of our engineering staff who directed the drilling, sampling, and in situ testing operations, logged the boreholes, and packaged the samples. The samples recovered from the boreholes were sealed in watertight jars and returned to our laboratory in Ottawa for detailed examination and classification testing. The results of the laboratory testing are given on the Record of Borehole sheets and on Figures 1 to 6.

The locations of the borings and cone tests are given on the Record of Borehole sheets and are shown on Drawing 1267802-A, located in the pocket following the text of this report. The test hole locations were set out in the field by us with reference to staking set out by the Ministry. The elevations of the ground surface at the borehole locations were also determined by us with reference to a bench mark set by the Ministry. This bench mark, consisting of a nail and washer in the southeast root of a 0.20 metre cedar tree, 28.0 metres right of Station 18+687.5, was given to us as elevation 279.313 (metres), referred to Geodetic datum.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

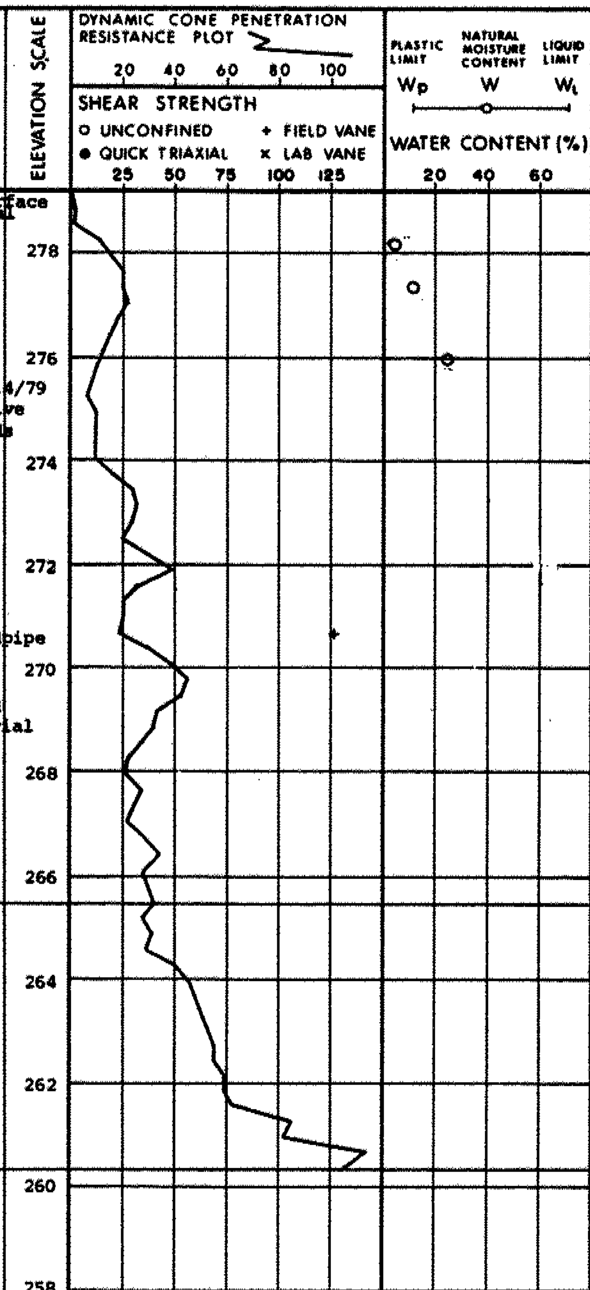
METRIC

W P 126-78-02 LOCATION Sta.18+660, O/S 3.1 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 21, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.15	Ground Level						
0.00	0.12 Topsoil					Surface Seal	
278.54	Sandy silt, red-brown						
0.61	Silty sand, stratified. Brown Compact		1	SS	16		
			2	SS	20		0 56 44 0
276.25			3	SS	15		
2.90	Fine sand, some silt. Brown to Grey Loose		4	SS	6	Oct.4/79 Native Sands	
274.03			5	SS	4		
5.12	Layered clayey silt and sandy silt, some fine sand seams. Grey Very Loose		6	SS	3		
270.62			7	SS	3	Standpipe	
8.53	Sandy silt. Grey Loose		8	SS	5	Caved Material	
268.63							
10.52	Silty sand. Grey Loose		9	SS	4		
265.43			10	SS	5		
13.72	End of Borehole.						
260.25							
18.90	End of Cone Test.						



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

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

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RECORD OF BOREHOLE No 2

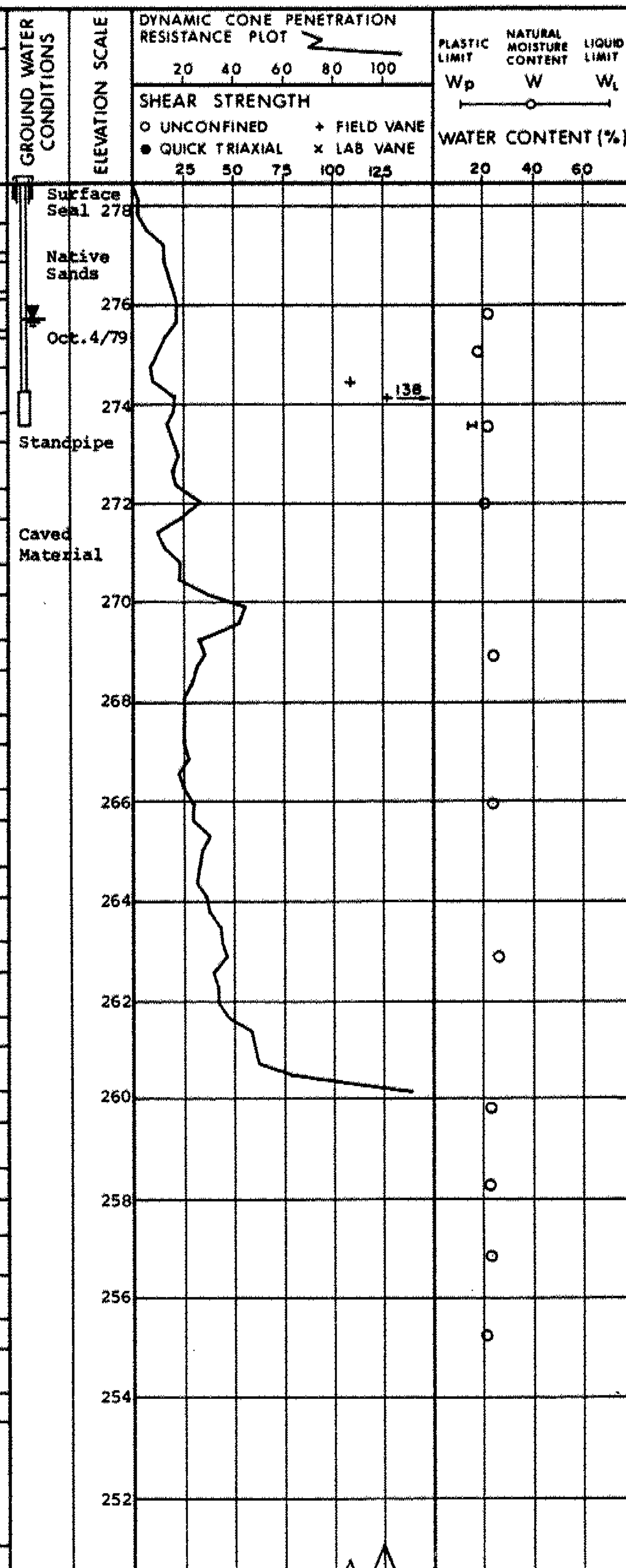
METRIC

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem, Wash Boring BWCa, Rock Core, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24-28, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
278.44	Ground Level						
0.00	0.12 Topsoil					Surface Seal	
277.46	Sandy silt, Light brown						
0.98 / 276.46	Silty sand, stratified. Brown Loose		1	SS	10	Native Sands	
			2	SS	16		
1.98 / 275.09	Fine sand, some silt. Brown to Grey Compact		3	SS	20	Oct.4/79	
3.35	Layered clayey silt and sandy silt, some fine sand seams. Grey Loose		4	SS	6		
			5	SS	5	Standpipe	
			6	SS	7	Caved Material	
270.36			7	SS	4		
8.08	Silty sand, some sandy silt layers and seams.		8	SS	5		
			9	SS	4		
	Sandy Silt		10	SS	6		0 20 80 0
	Grey Loose		11	SS	3		
			12	SS	5		Sand in augers when plug pulled.
			13	ST	4		
259.24			14	SS	5		0 50 50 0
19.20	Fine to medium sand. Loose		15	ST	7		
			16	ST	4		
	Compact		17	SS	14		0 90 10 0
	Grey Loose		18	SS	7		
							Unable to turn augers telescoped BW casing.
			19	SS	7		



Continued on Sheet 2

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

15 -◇- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

RECORD OF BOREHOLE No 2 cont

METRIC

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem, Wash Boring BWCa, Rock Core, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24-28, 1979 CHECKED BY [signature]

ELEV DEPTH	DESCRIPTION (Continued from Sheet 1)	NUMBER	TYPE	'N' VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Fine to medium sand. Grey Loose				Rotary drill BW casing.
247.35		20	SS	21	
31.09	Compact. Fine to coarse sand and gravel, some cobbles and boulders.				Boulders up to 225 mm diameter in casing.
244.67	Grey Dense	21	SS	>100	
33.77	Glacial till, silty sand and gravel, some cobbles and boulders. Grey Very Dense				
		~~22~~	~~SS~~	~~>100~~	Boulder core in casing.
		~~23~~	~~SS~~	~~>100~~	
234.46					
43.98	Quartzite Bedrock. Fairly Sound	24	RC BX	71%	
	White and Grey. Fractured	25	RC BX	21%	Core loss due to grinding.
231.50					
46.94	End of Borehole.				

Elevation scale: 250, 248, 246, 244, 242, 240, 238, 236, 234, 232, 230

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60
UNIT WEIGHT γ

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

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

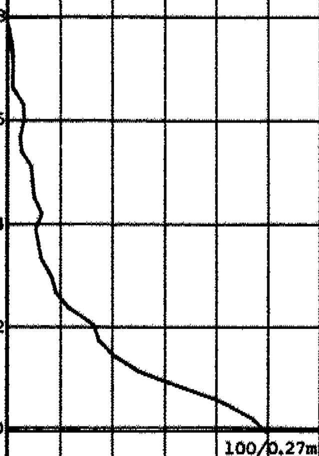
RECORD OF PENETRATION TEST No 3 METRIC

W P 126-78-02 LOCATION Sta.18+725, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE October 4, 1979 CHECKED BY [signature]

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 (O 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
275.55	River Level										
0.00	Water						274				
							272				
							270				
267.93	Bottom of River.						268				
7.62							266				
							264				
							262				
260.07							260	100/0.27m			
15.48	End of Cone Test.						258				



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

15 -$\diamond$- 5 (%) STRAIN AT FAILURE (20 above, 10 below)

RECORD OF PENETRATION TEST No 4 METRIC

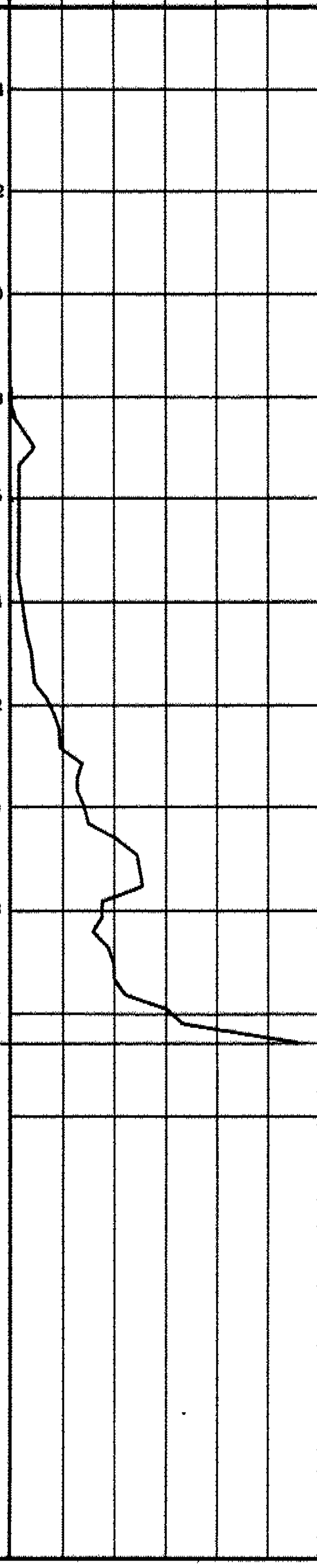
W P 126-78-02 | LOCATION Sta.18+760, O/S 4.5 m Rt. | ORIGINATED BY DJS

DIST 10 HWY 515 | BOREHOLE TYPE Cone Test | COMPILED BY DN

DATUM Geodetic | DATE October 3, 1979 | CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level							
0.00	Water						274, 272, 270	
268.23 / 7.32	Bottom of River						268, 266, 264, 262, 260, 258, 256	Drill rods sank 0.3 m under own weight.
255.43 / 20.12	End of Cone Test.						254	

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) — SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE — PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L — WATER CONTENT (%) — UNIT WEIGHT γ



+3, ×5 : Numbers refer to Sensitivity   20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

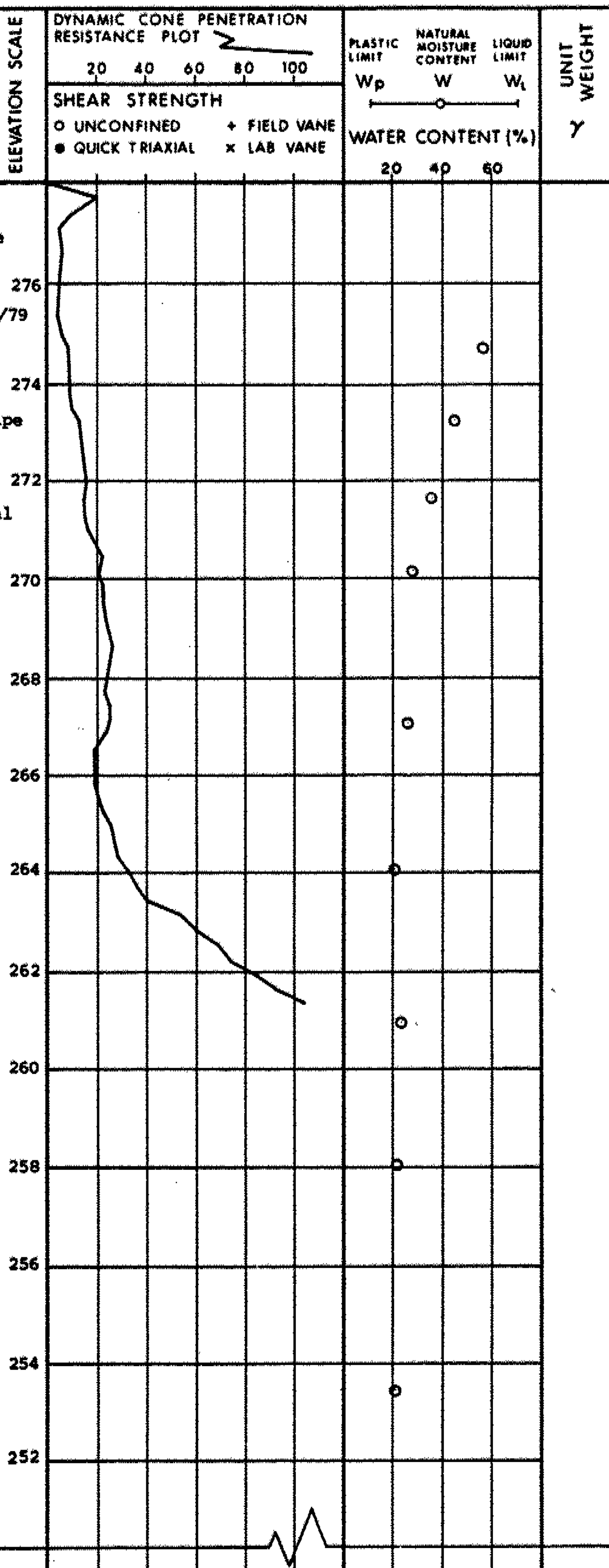
METRIC

W P 126-78-02 LOCATION Sta.18+789, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Wash Boring BWCa, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 28 - October 4, 1979 CHECKED BY [signature]

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
278.05	Ground Level					
0.00 / 276.98	Fill, sand, gravel, silty sand, brown, loose					
1.07	Fill, silty sand, organic material.	1	SS	4	Native Sands	
275.46	Brown Loose	2	SS	5		
2.59	Alluvium, organic silty sand and silt.	3	SS	3	Oct. 4/79	
		4	SS	1		
	Dark Brown to Grey-Brown Very Loose	5	SS	1/.6m		
		6	SS	1	Standpipe	
		7	SS	1		Sand in augers when plug pulled
271.04		8	SS	1/.6m	Caved Material	
7.01	Fine sand.					
269.52	Grey Loose	9	SS	7		
8.53	Fine to medium sand, some thin silty sand seams.	10	SS	8		
	Loose	11	SS	7		0 97 3 0
		12	SS	8		
263.42	Grey Compact	13	SS	12		
14.63	Layered clayey silt and sandy silt, some fine sand seams.	14	SS	11		
	Grey Compact	15	SS	15		0 5 92 3
258.54		16	SS	13		
19.51	Fine to medium sand, some silt.	17	SS	4		Sand in augers, unable to turn, telescoped BW casing.
	Grey Loose to Compact	18	SS	10		
		19	SS	7		0 93 7 0
	Continued on Sheet 2					



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

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

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RECORD OF BOREHOLE No 5 cont

METRIC

W P 126-78-02 LOCATION Sta.18+789, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger, Wash Boring BWCa, Cone Test COMPILED BY DN

DATUM Geodetic DATE September 28 - October 4, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION (Continued from Sheet 1)	NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.03	Fine to medium sand, some silt. Grey Loose				250		
30.02	Fine to coarse sand and gravel some cobbles and boulders. Grey Very Dense / Loose	20	SS	>100	248 / 246		Boulders to 175 mm diameter in casing.
243.91		21	SS	6	244	o	30 66 4 0
34.14 / 237.51	Glacial till, silty sand and gravel, some cobbles and boulders Grey Very Dense	22	SS	76	242 / 240 / 238	o	46 45 9 0
40.54	End of Borehole.				236		

Column headings: 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 (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE); PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+3, ×5 : Numbers refer to Sensitivity   20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

METRIC

W P 126-78-02 LOCATION Sta.18+840, C/L ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DN

DATUM Geodetic DATE October 4, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
276.41	Ground Level								
0.00 / 275.50	0.15 m Topsoil Dark Brown to Light Brown sandy silt, some organic material.						276		
0.91	Alluvium, organic silty sand and silt, some wood. Loose		1	SS	6	Oct.4/79		~38	7 76 17 0
							274		
272.14	Dark Brown Very Loose		2	SS	1			~45	
4.27	Layered clayey silt and sandy silt, some fine sand seams.		3	SS	7		272	~21	
	Grey Loose		4	SS	5		270		
268.18			5	SS	4				
8.23	End of Borehole.						268		
							266		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE
PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ

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

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

GA 791-2219

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 7

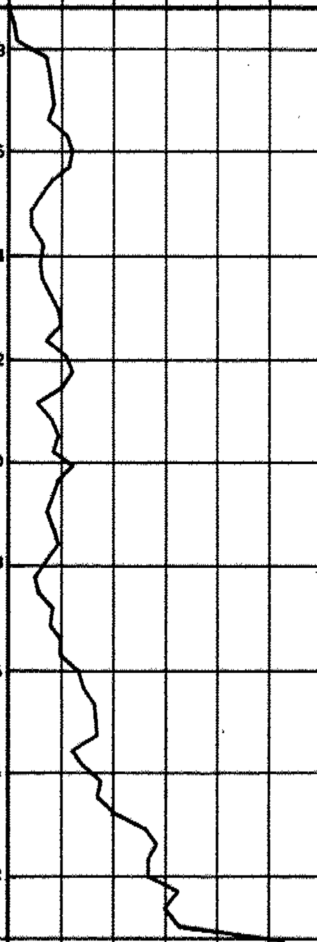
METRIC

W P 126-78-02 LOCATION Sta.18+695, O/S 4.5 m Lt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE September 24, 1979 CHECKED BY [signature]

SOIL PROFILE			SAMPLES			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	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						
278.73	Ground Level										
0.00							278				
							276				
							274				
							272				
							270				
							268				
							266				
							264				
							262				
260.75 / 17.98	End of Cone Test.						260				



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

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

GA 791-2219

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 8

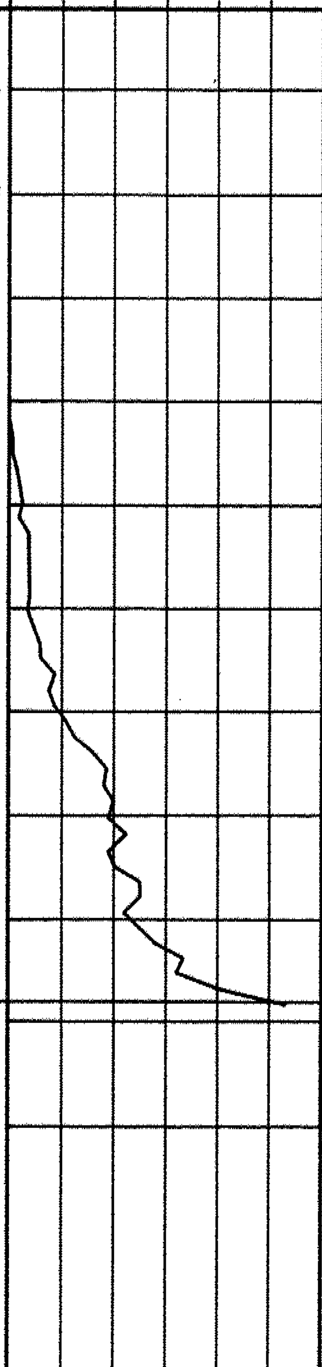
METRIC

W P 126-78-02 LOCATION Sta.18+725, O/S 5.0 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE September 25, 1979 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION (SOIL PROFILE)	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, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	WATER CONTENT (%) (PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level										
0.00	Water										
							274				
							272				
							270				
267.63 / 7.92	Bottom of River						268				
							266				
							264				
							262				
							260				
							258				
256.35 / 19.20	End of Cone Test.						256				
							254				



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

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

GA 791-2219

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF PENETRATION TEST No 9

METRIC

W P 126-78-02	LOCATION Sta.18+760, O/S 4.5 m Lt.	ORIGINATED BY DJS
DIST 10 HWY 515	BOREHOLE TYPE Cone Test	COMPILED BY DN
DATUM Geodetic	DATE October 3, 1979	CHECKED BY ERM

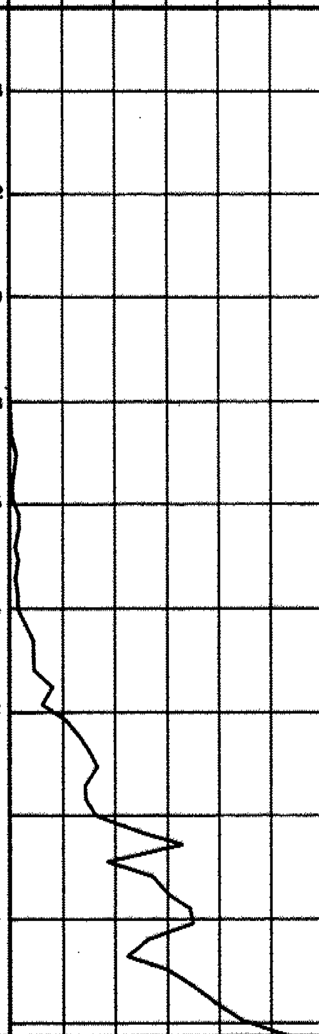
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
275.55	River Level							
0.00	Water							
							274	
							272	
							270	
268.23	Bottom of River							
7.32							268	Drill rods sank 0.3 m under own weight.
							266	
							264	
							262	
							260	
							258	
255.74							256	
19.81	End of Cone Test.							
							254	

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE

PLASTIC LIMIT W_p — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%)

UNIT WEIGHT γ



+3, x5 : Numbers refer to Sensitivity

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

GA 791-2219

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF PENETRATION TEST No 10

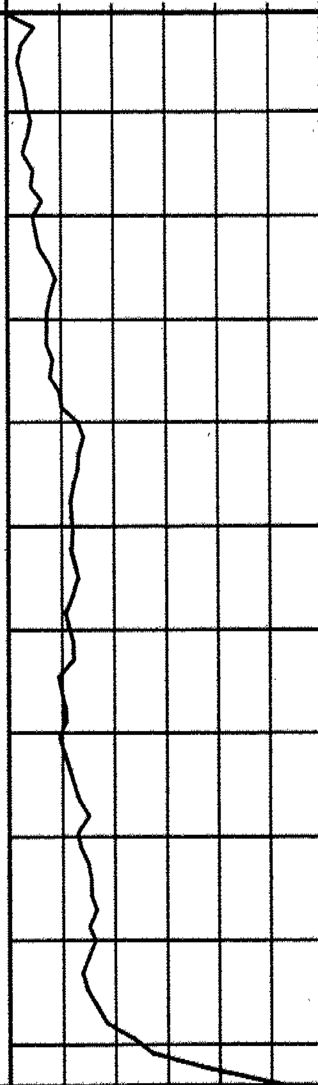
METRIC

W P 126-78-02 LOCATION Sta.18+790, O/S 5.0 m Rt. ORIGINATED BY DJS

DIST 10 HWY 515 BOREHOLE TYPE Cone Test COMPILED BY DN

DATUM Geodetic DATE September 28, 1979 CHECKED BY [signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x 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						
278.01	Ground Level										
0.00							276, 274, 272, 270, 268, 266, 264, 262, 260, 258				
257.29 / 20.72	End of Cone Test.						256				

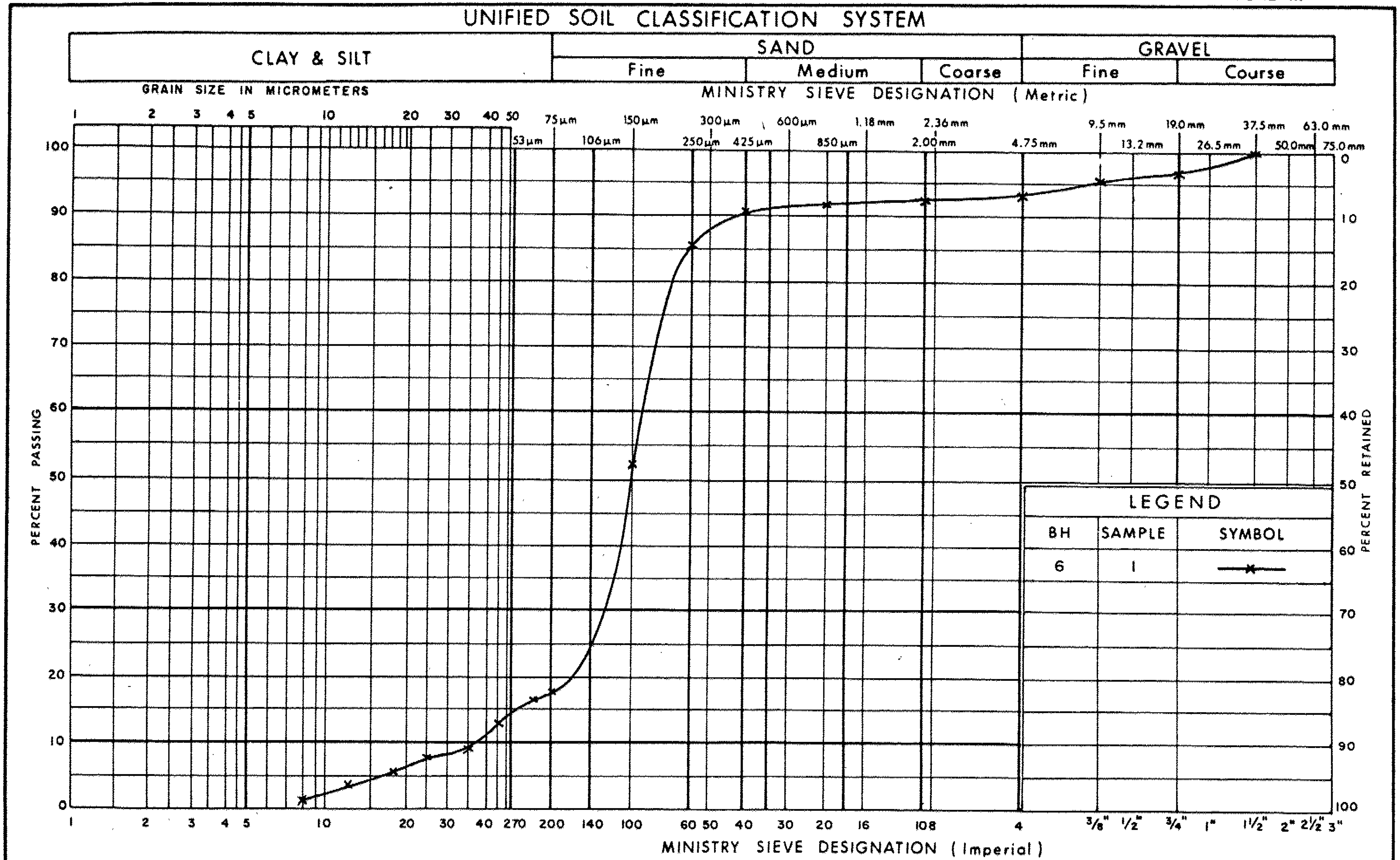


$+^3$, x^5 : Numbers refer to Sensitivity

15 ⊕ 5 (%) STRAIN AT FAILURE (20 above, 10 below)

GA 701-2219

78 12 M



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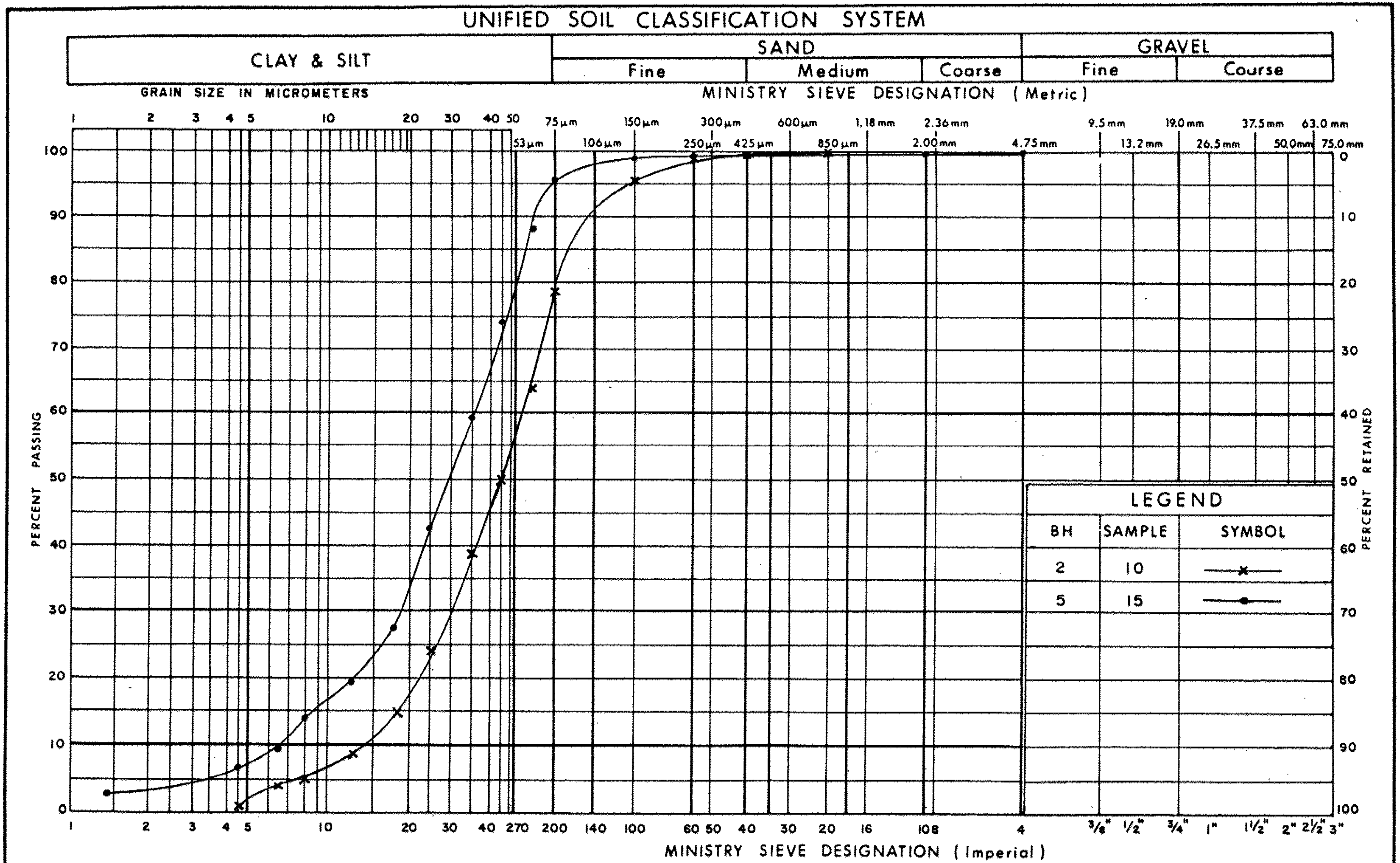
GRAIN SIZE DISTRIBUTION

ALLUVIUM; ORGANIC SILTY SAND AND SILT

FIG No 1

WP 126-78-02

78 12 M



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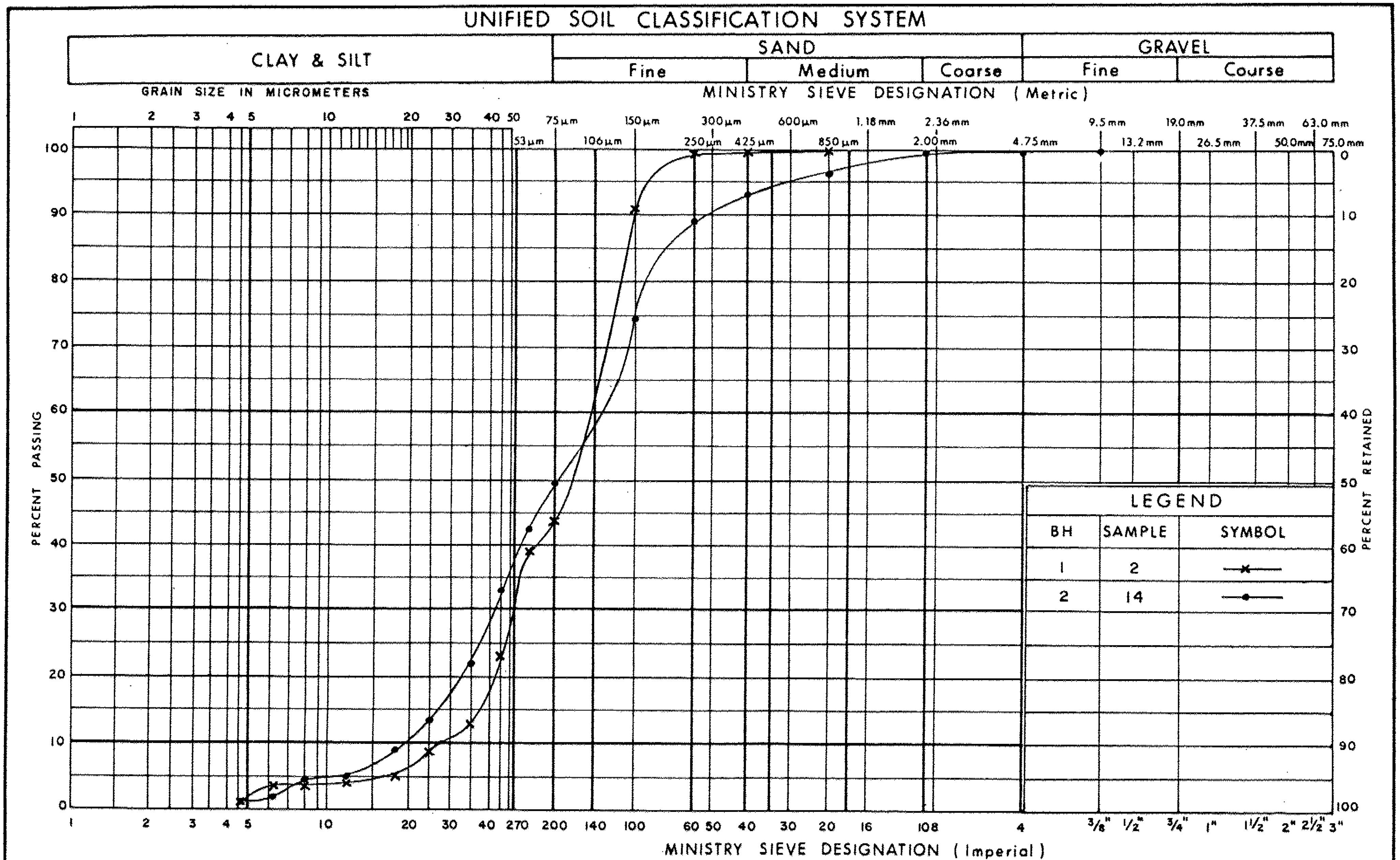
GRAIN SIZE DISTRIBUTION
SANDY SILT
TRACE CLAY

FIG No 2

W P 126-78-02

78 12 M



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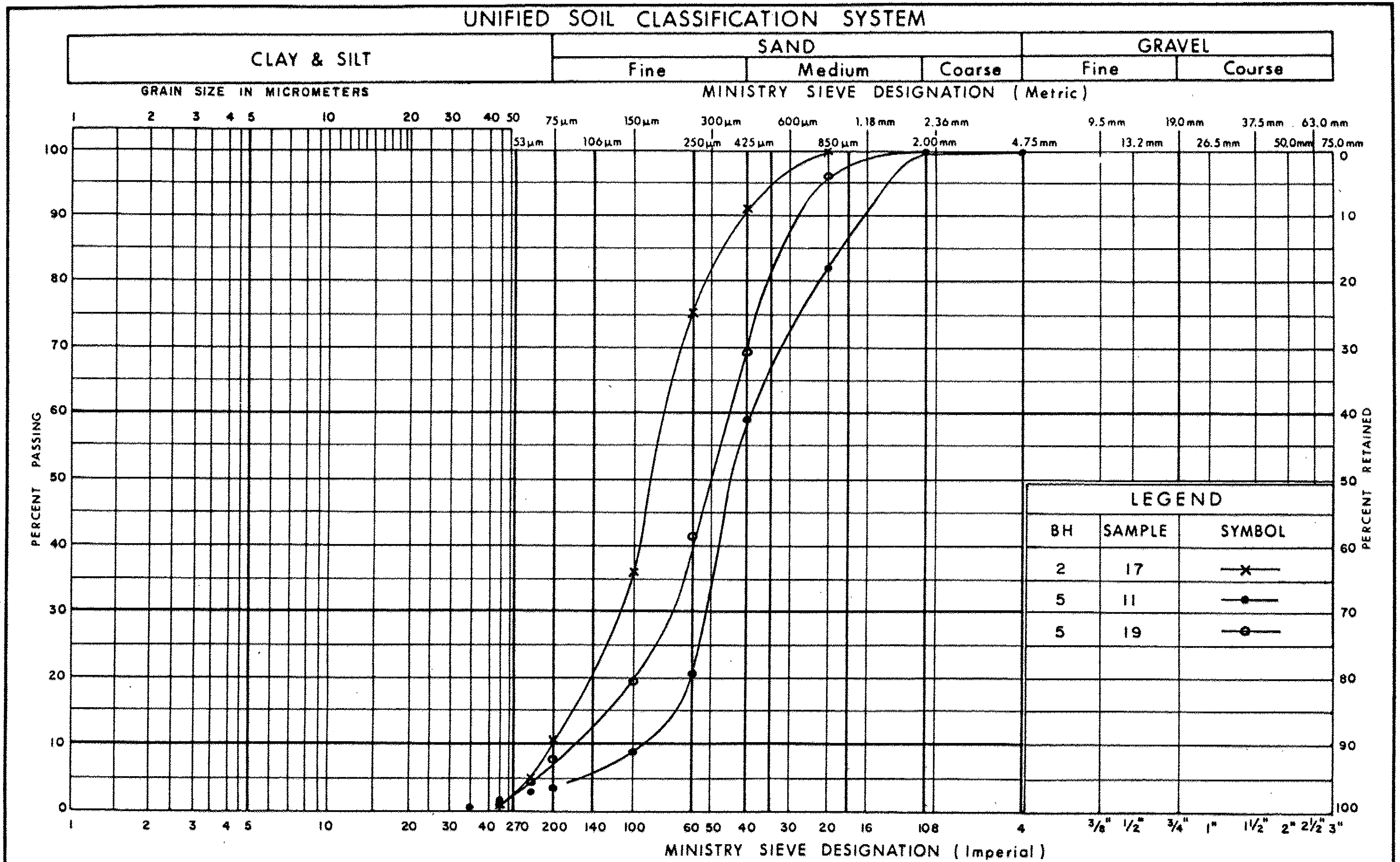
GRAIN SIZE DISTRIBUTION
SILTY SAND

FIG No 3

W P 126-78-02

78 12 M



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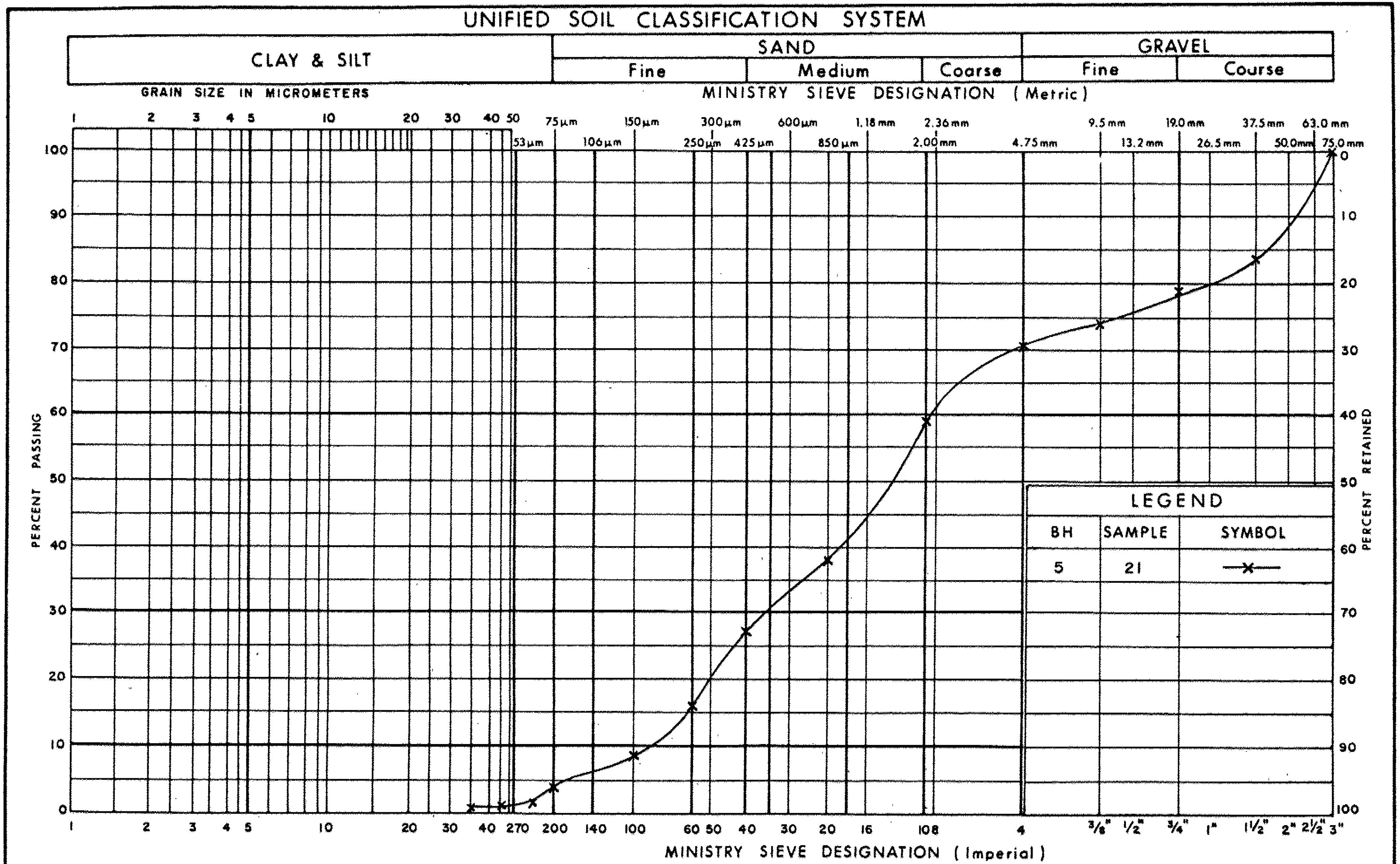
GRAIN SIZE DISTRIBUTION
FINE TO MEDIUM SAND
TRACE TO SOME SILT

FIG No 4

W P 126-78-02

78 12 M



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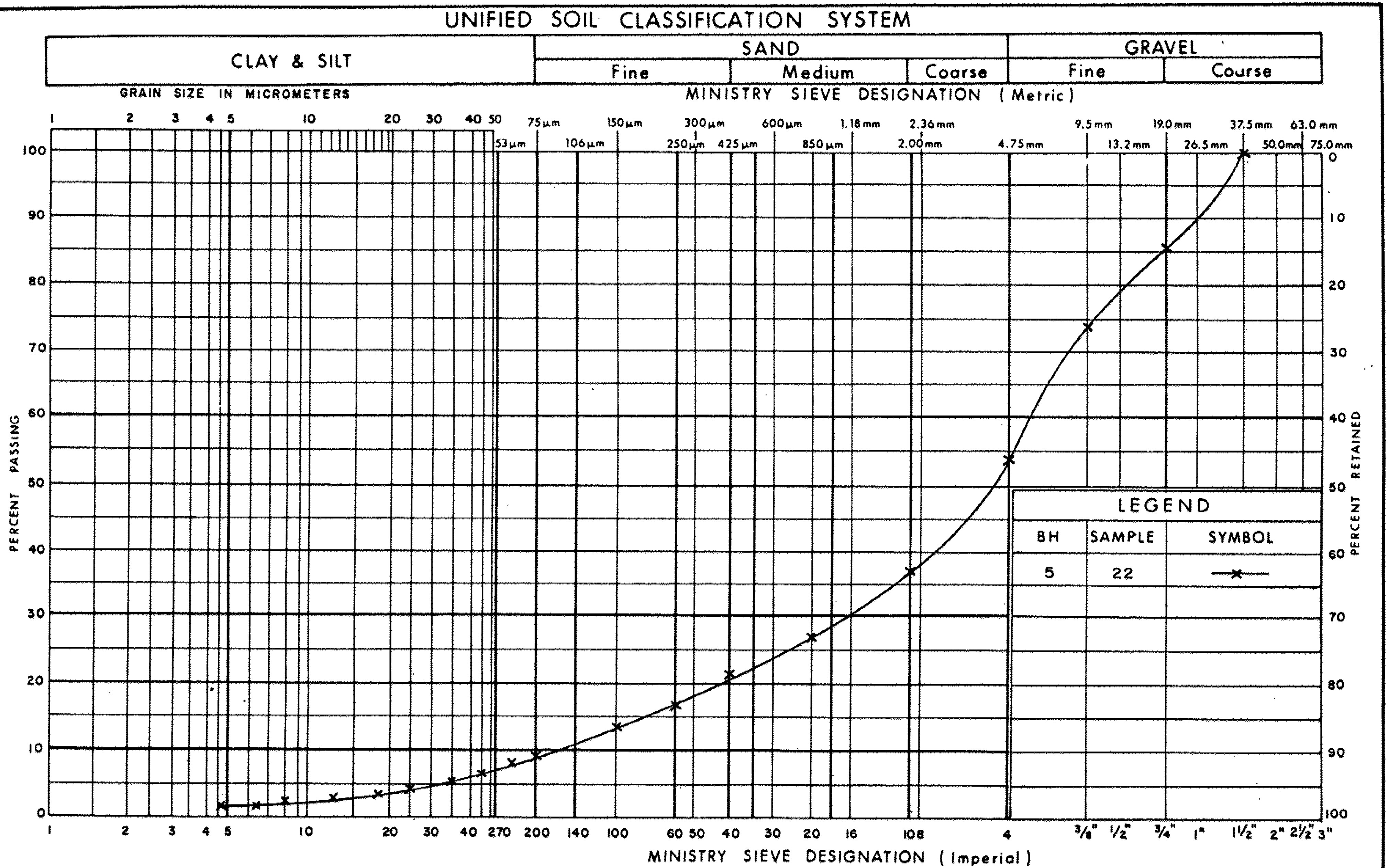
GRAIN SIZE DISTRIBUTION
FINE TO COARSE SAND AND GRAVEL
SOME COBBLES AND BOULDERS

FIG No 5

W P 126-78-02



LEGEND		
BH	SAMPLE	SYMBOL
5	22	—×—

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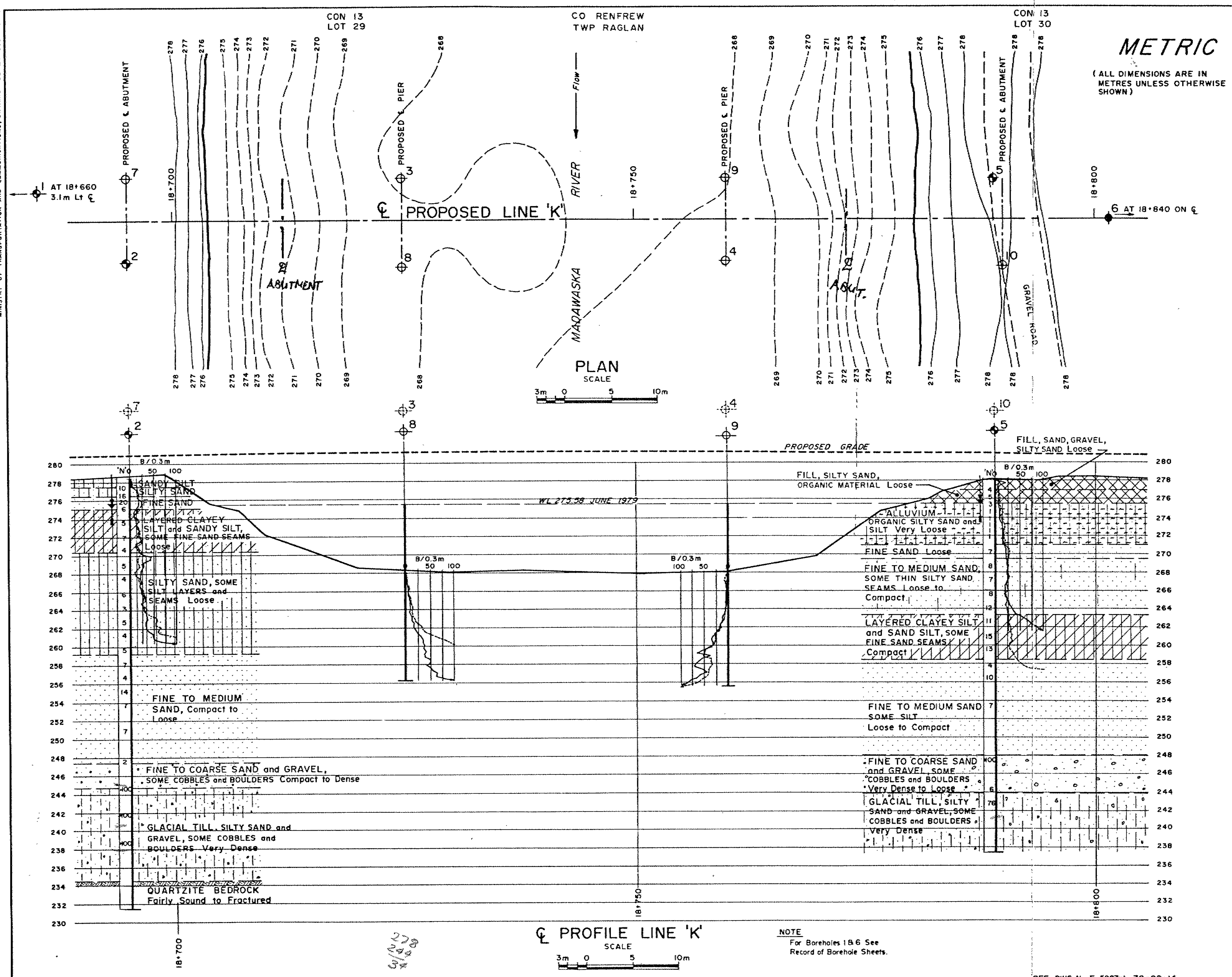
GRAIN SIZE DISTRIBUTION

GLACIAL TILL: SILTY SAND AND GRAVEL
SOME COBBLES AND BOULDERS

FIG No 6

W P 126-78-02



NOTE
For Boreholes 1 & 6 See Record of Borehole Sheets.

REF: DWG No E-5287-1, 79-09-14

METRIC

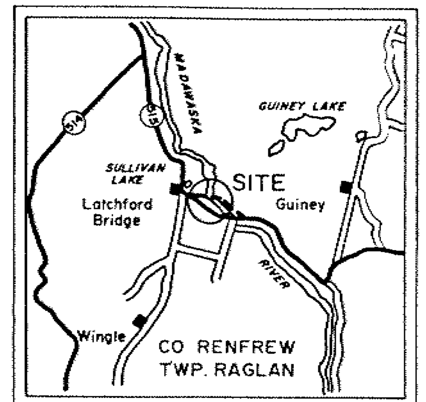
(ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN)

CONT No
WP No 126-78-02

LATCHFORD BRIDGE
HWY 515 OVER MADAWASKA BRIDGE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET
OF

GOLDER ASSOCIATES
CONSULTING GEOTECHNICAL & MINING ENGINEERS



KEY PLAN
SCALE
0 1 2 Kilometres

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 79-09 & 79-10
- Piezometer

No	ELEVATION	STATION	OFFSET
1	279.15	18+660	3.1m Lt
2	278.44	18+695	4.5m Rt
3	275.55	18+725	4.5m Lt
4	275.55	18+760	4.5m Rt
5	278.05	18+789	4.5m Lt
6	276.41	18+840	℄
7	278.73	18+695	4.5m Lt
8	275.55	18+725	5.0m Rt
9	275.55	18+760	4.5m Lt
10	278.01	18+790	5.0m Rt

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

REVISIONS

DATE	BY	DESCRIPTION

Geocres No 31F-98

HWY No 515			DIST 10
SUBM'D	CHECKED	DATE Nov 27, 1979	SITE 29-186
DRAWN DN	CHECKED	APPROVED	DWG 1267802-A