

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40P02-041

DIST. 2 REGION

W.P. No. 75-82-02

CONT. No.

W. O. No.

STR. SITE No. 23-1127-346

HWY. No. 2

LOCATION CPR OVERHEAD

(2.9 KM WEST OF WOODSTOCK)

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 75-82-02

DIST 2

HWY 2

STR SITE 23-1127-346

CPR Overhead  
2.9 km West of Woodstock

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# FOUNDATION INVESTIGATION REPORT

For

W.P. 75-82-02; Site 23-1127-346

CPR Overhead, 2.9 km West of Woodstock

Hwy. #2, District 2, London

## INTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed overhead structure at this site.

The fieldwork was conducted during the period from 83 05 24-26 utilizing a continuous flight auger machine equipped with 82 mm I.D. hollow-stem augers.

This work consisted of 4 sampled boreholes/dynamic cone penetration tests.

## SITE DESCRIPTION

The site is located at the CPR crossing on Hwy. 2 (Governor's Road) approximately 2.9 km west of Woodstock (Lot 25, Con. 1, Lot 1, Con. 8, Twp. of Zorra, County of Oxford).

At this site, the existing Hwy. 2/CPR intersection is a level crossing over a creek valley, on a fill up to 8 m high. The creek flows through a concrete box culvert under the fill.

Physiographically the site lies in the Oxford Till Plain, an area of generally low local relief.

## SUBSURFACE CONDITIONS

### General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data, are shown on Drawing No. 758202-A.

At the proposed abutment locations, fill material, up to 2.4 m in thickness, is underlain by silty clay till.

At the proposed pier locations, fill material, up to 7.9 m in thickness, is underlain by up to 3.3 m of firm to stiff silty clay then very stiff to hard silty clay till.

#### Fill Material

The fill material at this site is reported to be extremely variable, ranging from earth fill, to rock and slag fill, to tree trunks.

At the proposed abutment locations, up to 1 m of loose to compact silty sand overlies approximately 1.5 m of firm to hard silty clay (CL) to silt (ML) containing occasional organics.

At the proposed pier locations, the fill material extends for up to approximately 7.9 m in thickness. The material is generally a heterogeneous mixture of silty clay (firm to stiff) to silty sand (loose) containing variable amounts of gravel and organics. In some cases, the cohesive and non-cohesive materials are stratified in layers approximately 1.2 m in thickness. As previously noted, it is expected that this fill consists of a wide range of materials. However, directly above the concrete box culvert that carries the creek under the fill, the material consists entirely of very loose to compact silty sand, containing traces of gravel and clay.

The physical properties of the material, at the proposed pier locations are variable.

Physical properties of the material at the proposed abutment locations, as determined from field tests and laboratory tests, are summarized below.

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (w)	10.0 - 20.5%	15.3%	N/A
Liquid Limit ( $W_L$ )	17.0 - 22.0%	19.5%	N/A
Plastic Limit ( $W_p$ )	16.5 - 21.5%	19.0%	N/A

Figure 1 illustrates a typical grain size distribution for this material.

Silty Clay (CL); with/some sand, some/trace gravel

All boreholes were terminated in this very stiff to hard low plasticity till deposit. This thickness of this deposit is variable, but estimated to be at least 17± m at the abutment locations and 13± m at the pier locations.

In the valley (i.e. beneath the proposed pier locations) a firm to stiff layer of silty clay, up to 3.3 m in thickness underlies the fill.

Physical properties of the material, as determined from field and laboratory tests, are summarized below:

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (w)	8.5 - 15.5%	10.9%	10.0%
Liquid Limit ( $W_L$ )	13.0 - 18.0%	15.5%	16.0%
Plastic Limit ( $W_p$ )	12.0 - 14.5%	13.2%	13.5%

Figure 2 illustrates a typical grain size distribution for this material.

Bedrock

The bedrock in this area is shale. Although the bedrock elevation was not proven during the field investigation, it is estimated at elev. 285 m.

Groundwater

At the time of the field investigation, the groundwater was estimated at elev. 299± m at BH #1 and #4 (i.e. at the proposed abutment locations), and at elev. 297± m at BH #2 and #3 (i.e. at the proposed pier locations).

## DISCUSSION AND RECOMMENDATIONS

It is proposed to construction an overhead structure carrying Hwy. 2 over the CPR tracks.

Two schemes have been proposed. It is recommended that the scheme which leads to the least expensive design should be adopted.

Scheme 1 proposes the construction of a fill to carry Hwy. 2 over the CPR tracks. This scheme would also require the construction of a rigid-frame structure, through which the CPR tracks would pass beneath the fill.

Scheme 2 proposes the construction of a conventional 3 span bridge to carry Hwy. 2 over the CPR tracks.

### Scheme 1 (culvert/fill)

During negotiations to obtain permission to enter CPR property, it was agreed that any work that would interfere with CPR operations should be delayed until absolutely necessary. For this reason the following recommendations for Scheme 1 are intended for estimation purposes only. If this scheme is adopted, please contact this office, as further field-work and analysis may be required.

The existing fill height at this site is up to 8 m. In order to provide the required clearance for the CPR tracks, it is estimated that an additional 8.5 m fill height would be required for Scheme 1. The construction of such as extensive fill would probably require the excavation of any soft material in the creek valley, extension of the creek culvert, and the construction of counter-balancing berms.

The culvert may be supported on steel H-piles equipped with reinforced tips and driven in accordance with MTC Standard SS 103-10 or SS 103-11. Due to the possibility of damaging the CPR tracks, it may be necessary to pre-auger before driving the piles. Note that it will also be necessary to avoid the creek culvert during pile driving. For calculation purposes, the following values are recommended:

Pile Type  
310 HP 79

Ultimate Capacity  
2670 kN per pile

For estimation purposes, it may be assumed that the recommended pile capacities will be achieved at elev. 291± m.

The following design values are recommended:

<u>Pile Type</u>	<u>Safe Capacity</u>
310 HP 79	890 kN per pile

and for the purposes of the O.H.B.D.C.:

<u>Pile Type</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity at S.L.S. Type II</u>
310 HP 79	1335 kN per pile	890 kN per pile

#### Scheme 2 (3-span structure)

The foundation recommendations for this scheme are finalized.

Three foundation alternatives are proposed for construction at the abutments. One foundation alternative is proposed for construction at the piers. The combination of foundation alternatives which leads to the least expensive design should be adopted.

#### General Recommendations (Applicable to All Alternatives)

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation with  $K_o = 0.43$  and  $\gamma = 22.0 \text{ kN/m}^3$  for Granular A backfill;  $K_o = 0.5$  and  $\gamma = 21.2 \text{ kN/m}^3$  for Granular C backfill.
- For frost protection, cover should be greater than 1.2 m.
- No stability problems are anticipated for embankments with 2:1 slopes or flatter for total embankment heights less than 8 m.
- For Alternative 1 - Spread Footings on Glacial Till, differential settlements should not exceed 50 mm. For all other alternatives differential settlements should not exceed 25 mm.
- Dewatering is not anticipated to be a major problem because of the impermeable nature of the foundation soil.

#### ALTERNATIVE 1 - Spread Footings on Glacial Till

The abutments may be supported on spread footings founded on the silty clay till at elev. 302.5 m.

For resistance to lateral forces, the adhesion between the base of the footings and the foundation soil = 60 kPa.

Cover the foundation soil with a 15 cm pad of mass concrete within 18 hours of exposure.

The following design values are recommended:

	West Abutment	East Abutment
- net safe bearing pressure	300 kPa	200 kPa

and for purposes of the O.H.B.D.C.:

- Factored Bearing Capacity at U.L.S.	450 kPa	300 kPa
- Bearing Capacity at S.L.S Type II	300 kPa	200 kPa

#### ALTERNATIVE 2 - Perched Footings on Compacted Fill

The abutments may be supported on perched abutments on compacted granular fill. Refer to the enclosed Figure 3 for design details.

All loose or soft material beneath the approach embankment in the vicinity of the abutment locations should be removed.

For computing sliding resistance between the base of the concrete footing and the compacted fill, the friction coefficient = 0.6.

The following design values are recommended:

- net safe bearing capacity = 340 kPa

and for the purposes of the O.H.B.D.C.:

- Factored Bearing Capacity at U.L.S. = 900 kPa
- Bearing Capacity at S.L.S. Type II = 340 kPa



ALTERNATIVE 3 - Steel H-Piles in Overburden

The entire structure (i.e. both the abutments and the piers) may be supported on steel H-piles equipped with reinforced tips and driven in accordance with MTC Standards SS 103-10 or SS 103-11. For calculation purposes the following values are recommended:

<u>Pile Type</u>	<u>Ultimate Capacity</u>
310 HP 79	2670 kN per pile

For estimation purposes, it may be assumed that the recommended pile capacities will be achieved at the following elevations:

<u>Location</u>	<u>Elevation</u>
West Abutment	300± m
West Pier	291± m
East Pier	291± m
East Abutment	295± m

If desired, the abutment footings (supported on Steel H-Piles) may be perched within the embankment fill. In this case, to facilitate pile driving, particle sizes in the fill immediately beneath the pile locations should not exceed 75 mm.

The following design values are recommended:

<u>Pile Type</u>	<u>Safe Capacity</u>
310 HP 79	890 kN per pile

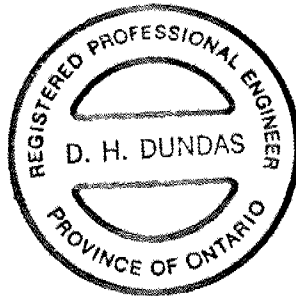
and for the purposes of the O.H.B.D.C.:

<u>Pile Type</u>	<u>Factored Capacity at U.L.S.</u>	<u>Capacity at S.L.S. Type II</u>
310 HP 79	1335 kN per pile	890 kN per pile

Note that for this alternative at the pier locations, pre-augering may be required in order to avoid damage of the CPR tracks. Also, it will be necessary to avoid the creek culvert during pile driving.

MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. C. McLorg, Student Field Technician, and Mr. D. H. Dundas, Project Foundation Engineer. The report was written by Mr. Dundas, and reviewed by Mr. K. G. Selby, Senior Foundations Engineer. The equipment used was owned and operated by Atcost Soil Drilling Inc.



*D. H. Dundas*

D. H. Dundas, P. Eng.  
Project Foundation Engineer

*K. G. Selby*

K. G. Selby, P. Eng.  
Senior Foundations Engineer

## A P P E N D I X



# RECORD OF BOREHOLE No 1

METRIC

W P 75-82-02 LOCATION Sta. 26 + 295, 7 m LT of Hwy. 2 G  
DIST 2 HWY 2 BOREHOLE TYPE Hollow-Stem Auger, Cone Test  
DATUM Geodetic DATE 83 05 24  
ORIGINATED BY CM  
COMPILED BY DD  
CHECKED BY DD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20 40 60 80 100		W <sub>p</sub>	W	W <sub>L</sub>		
305.0	Ground Surface												
0.0	(Fill) Silty Sand												
	Silty Clay (CL) to		1	SS									10 38 44 8
	Silt (ML) with/some		2	SS									12 32 46 10
302.9	sand, trace gravel &												
2.1	organics, firm to stiff		3	SS									
			4	SS									18 36 34 10
			5	SS									
			6	SS									
	stiff to hard		7	SS									
	hard		8	SS									
			9	SS									
	Silty Clay (CL)												
	with/some sand												
	some/trace gravel												
	(fill)												
291.0			10	SS									
14.0	End of Borehole												

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



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# RECORD OF BOREHOLE No 2

METRIC

W P 75-82-02 LOCATION Sta. 26 + 225, 9 m LT of Hwy. 2 E ORIGINATED BY CM  
DIST 2 HWY 2 BOREHOLE TYPE 'Hollow-Stem Auger, Cone Test COMPILED BY DD  
DATUM Geodetic DATE 83 05 25 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION [%]
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)		
304.5 0.0	Ground Surface													GR SA SI CL
	trace organics very loose		1	SS	3		304							
			2	SS	4									
	loose to compact		3	SS	8		302							
			4	SS	16		300							
	Silty Sand trace gravel and clay (Fill)		5	SS	11		298							
296.6 7.9			6	SS	7		296							1 43 46 10
	occ. organics firm to stiff		7	SS	13									30 24 37 9
			8	SS	30		294							
	very stiff		9	SS	60	10 cm	292							
290.5 14.0	Silty Clay (CL) with/some sand some/trace gravel (Till)		10	SS	60	8 cm								
	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 3

METRIC

W P 75-82-02 LOCATION Sta. 26 + 213, 6 m LT of Hwy. 2 G  
DIST 2 HWY 2 BOREHOLE TYPE Hollow-Stem Auger, Cone Test  
DATUM Geodetic DATE 83 05 25-26  
ORIGINATED BY CM  
COMPILED BY DD  
CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40	60	80	100					
304.5	Ground Surface																GR SA SI CL
0.0	Silty Clay (CL) to Silt (ML) Stiff		1	SS	11		304										
	Silty Sand to Sandy Silt Loose		2	SS	6		302										
	Silty Clay (CL) Firm		3	SS	7		300										
	Silty Sand to Sandy Silt Loose		4	SS	6		298										6 32 53 9
298.1	(Fill)		5	SS	10		296										17 42 31 10
6.4	occ. organics firm to stiff		6	SS	8		294										
	hard		7	SS	72		292										
	Silty Clay (CL) with/some sand some/trace gravel (Till)		8	SS	67												
			9	SS	118												
290.5			10	SS	60	15 cm											
14.0	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE RECORD ON SOIL LOGS



# RECORD OF BOREHOLE No 4

METRIC

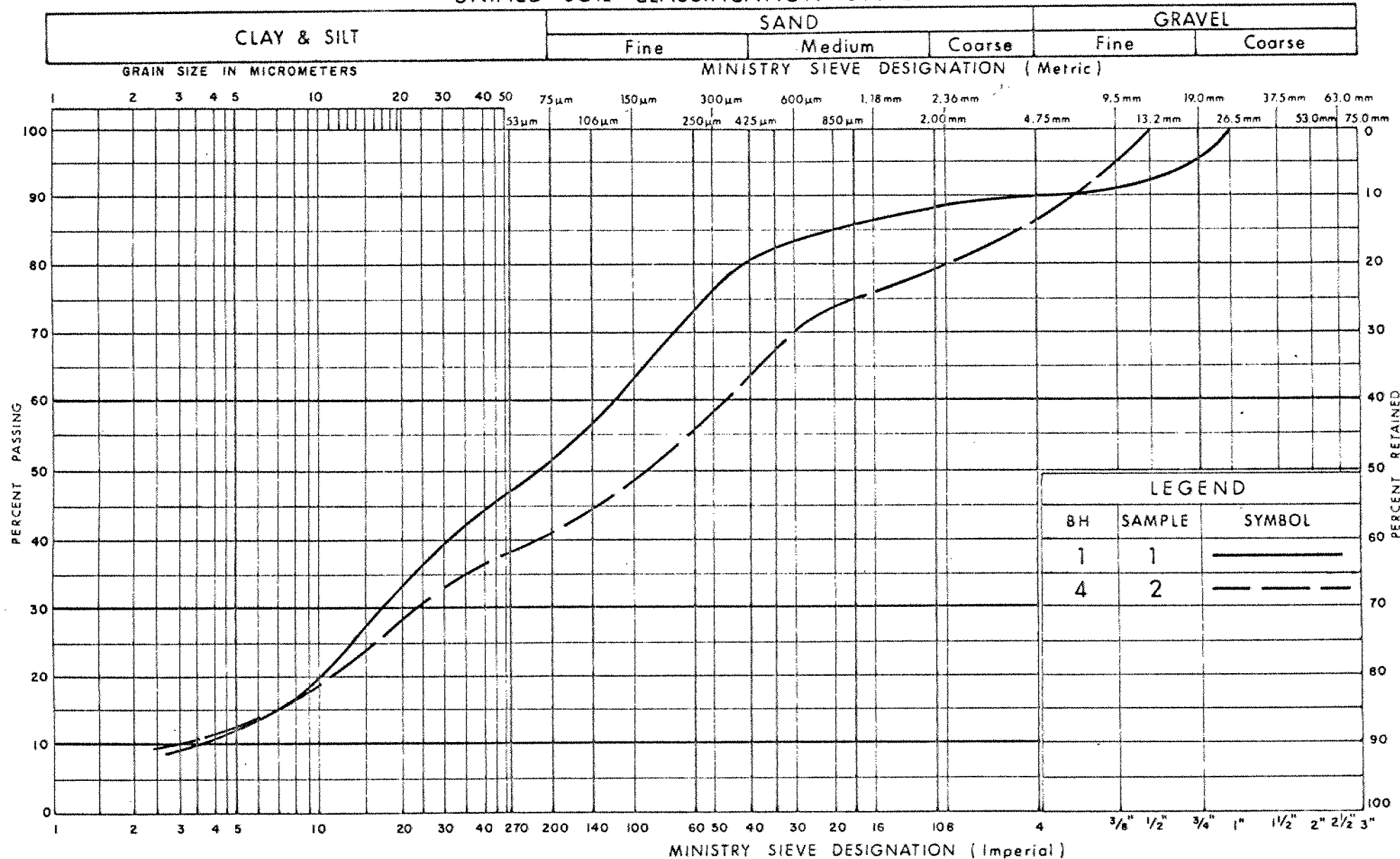
W P 75-82-02 LOCATION Sta. 26 + 160, 7 m LT. of Hwy. 2 G  
DIST 2 HWY 2 BOREHOLE TYPE Hollow-Stem Auger, Cone Test  
DATUM Geodetic DATE 83 05 26  
ORIGINATED BY CM  
COMPILED BY DD  
CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
305.5	Ground Surface																GR SA SI CL
0.0	Silty Sand Compact		1	SS	7												
	(Fill) Silty Clay (CL) to Silt (ML) occ. organics firm to hard		2	SS	37												13 45 33 9
303.1			3	SS	9												
2.4	stiff to very stiff hard		4	SS	23												
			5	SS	73												4 29 52 15
			6	SS	100												
	Silty Clay (CL) with/some sand some/trace gravel (Till)		7	SS	100	23 cm											
			8	SS	100	20 cm											
298.2			9	SS	60	14 cm											
7.3	End of Borehole																

+3, x5: Numbers refer to  
Sensitivity

20  
15 + 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



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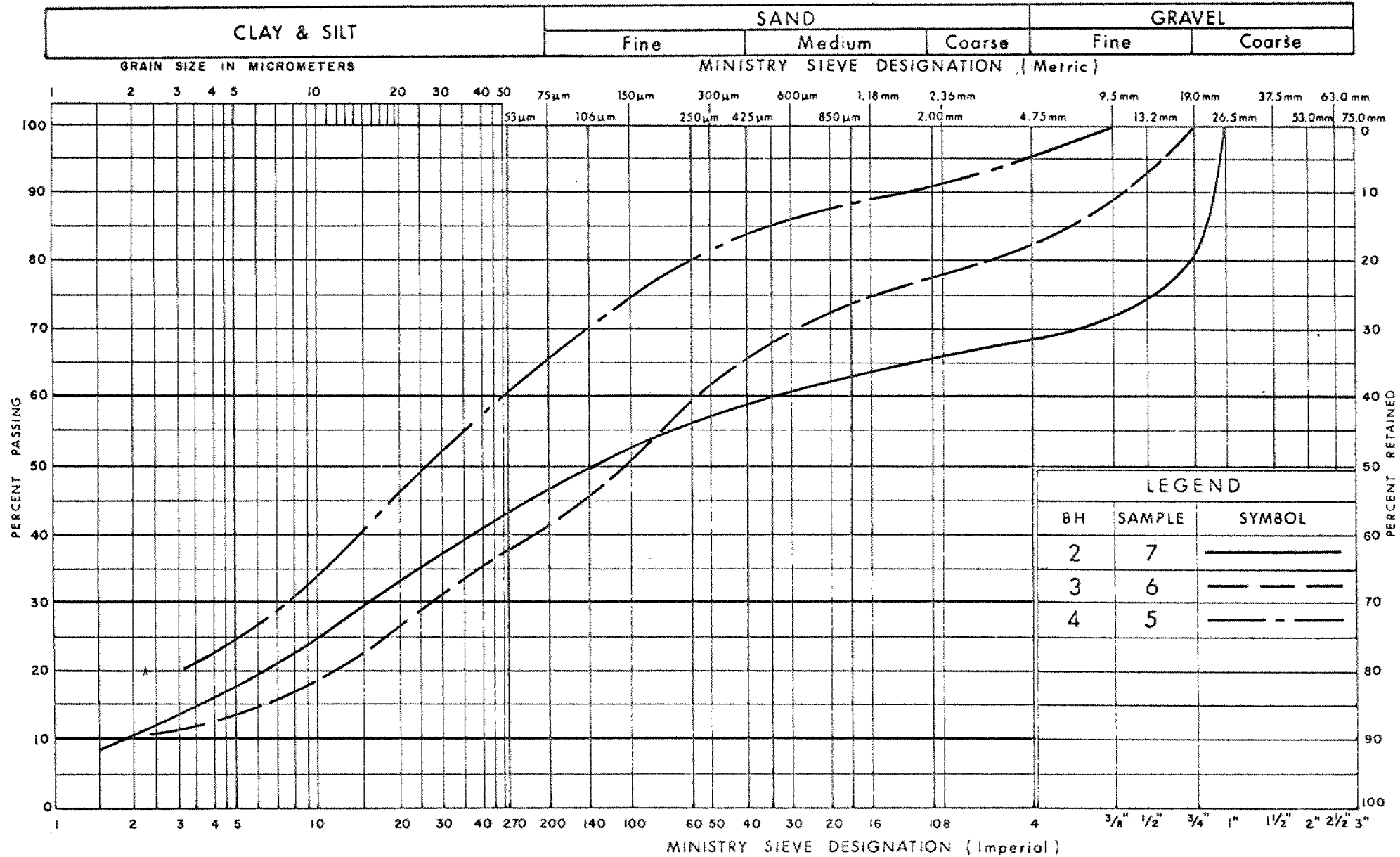
GRAIN SIZE DISTRIBUTION  
FILL  
SILTY CLAY, WITH SAND, SOME GRAVEL

FIG No 1

W P 75 - 82 - 02



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

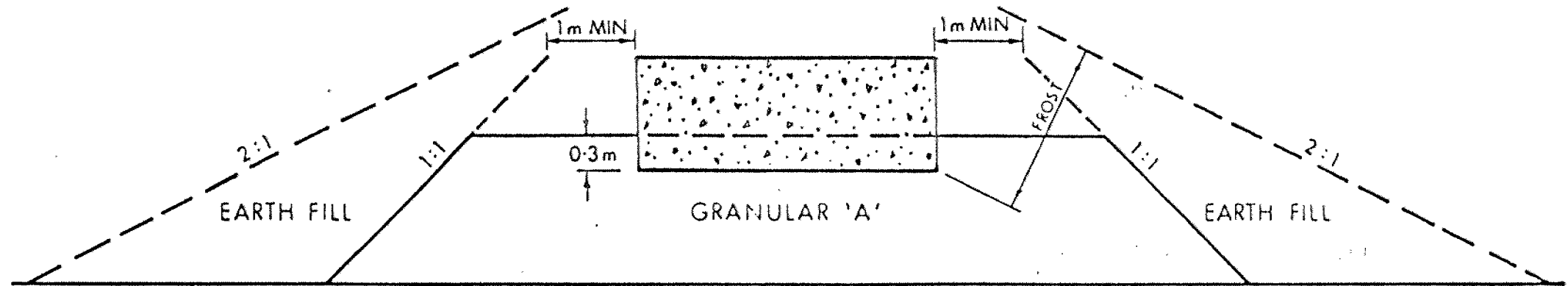
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GRAIN SIZE DISTRIBUTION  
SILTY CLAY (Till)  
WITH / SOME SAND, SOME / TRACE GRAVEL

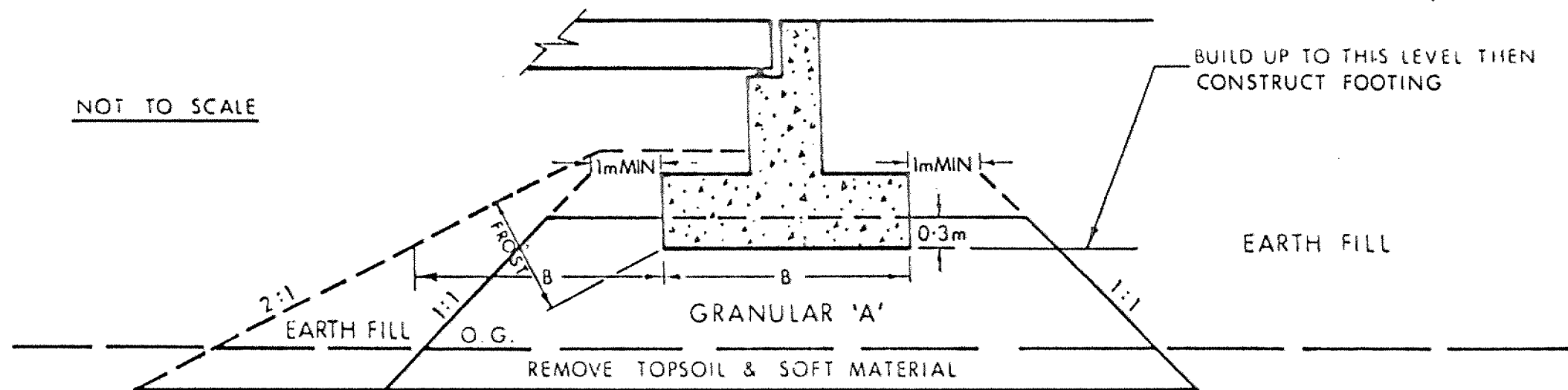
FIG No 2

W P 75-82-02

# ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION



LONGITUDINAL SECTION

## NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED

FIG. 3

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kn/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kn/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kn/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kn/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kn/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

**METRIC**

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

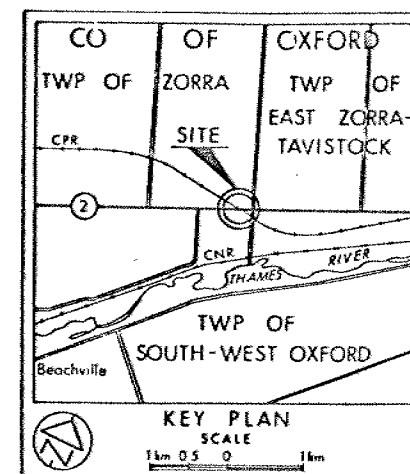
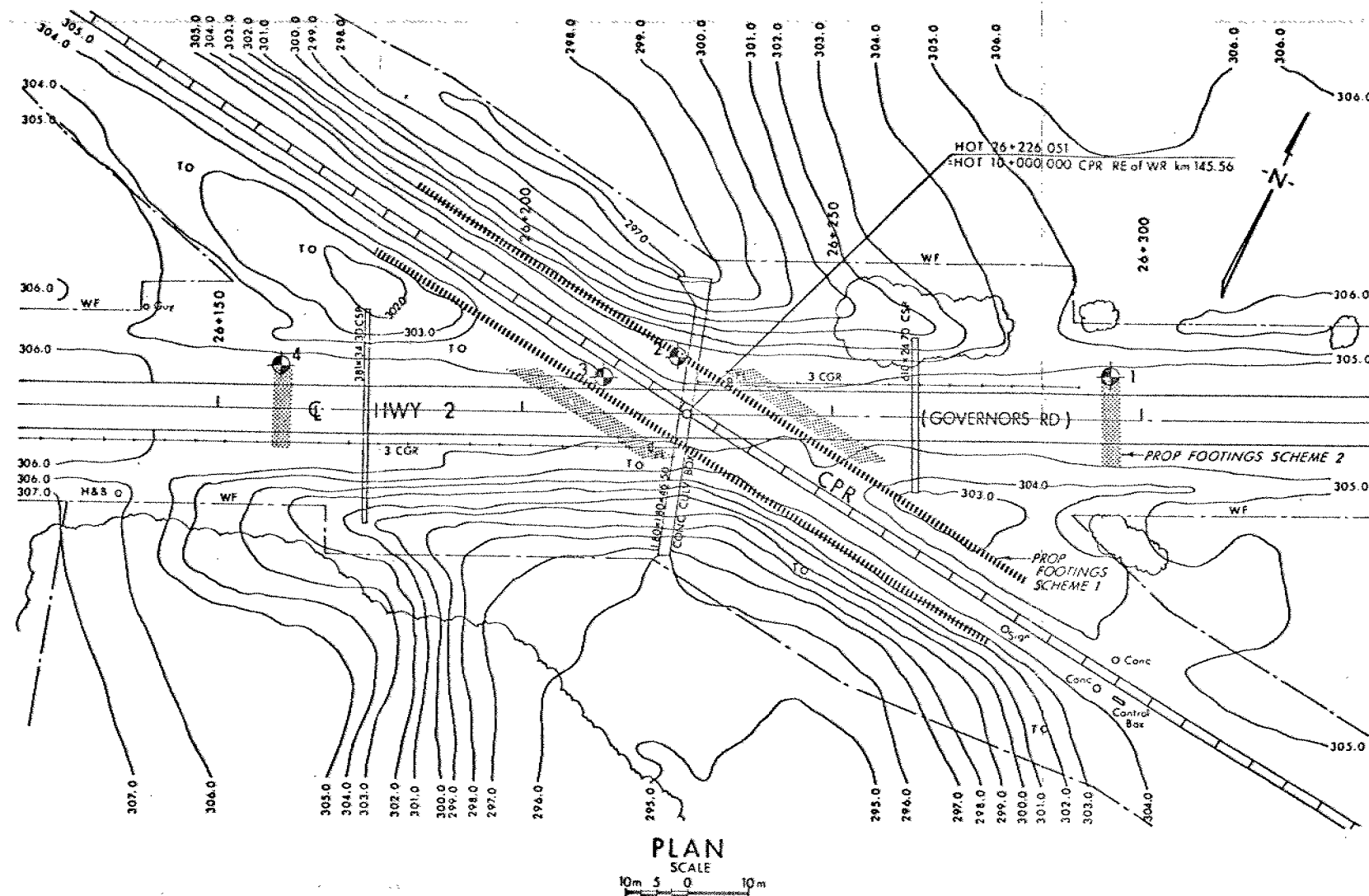
CONT No  
WP No 75-82-02

CANADIAN PACIFIC RAILWAYS

BORE HOLE LOCATIONS & SOIL STRATA



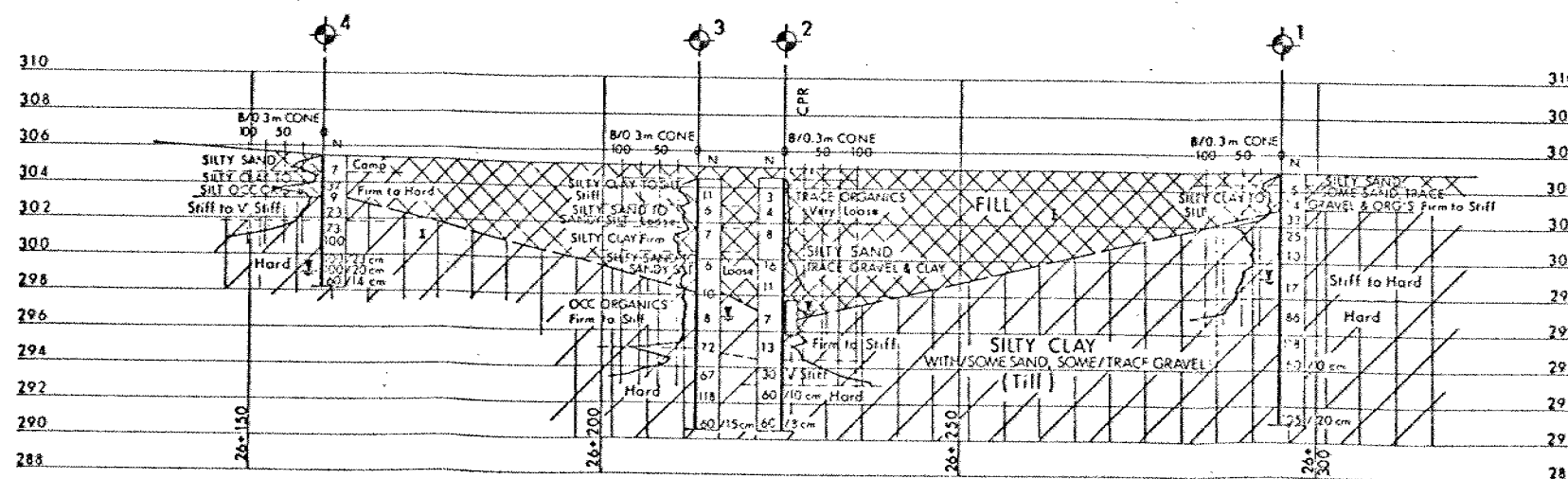
SHEET



**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 83.05

No	ELEVATION	STATION	OFFSET
1	305.0	26+295	7.0 m LT
2	304.5	26+225	9.0 m LT
3	304.5	26+213	8.0 m LT
4	305.5	26+160	7.0 m LT



**PROFILE HWY 2**

SCALE  
10m 5 0 10m Horiz  
4m 2 0 4m Vert

**NOTE**

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

DATE	BY	DESCRIPTION
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Geocres No 40P2-41

HWY No 2	DIST 2
SUBMITTED	CHECKED
DATE 83 06 27	SITE 23-1127-145
DRAWN 30	CHECKED
	DWG 758202-A

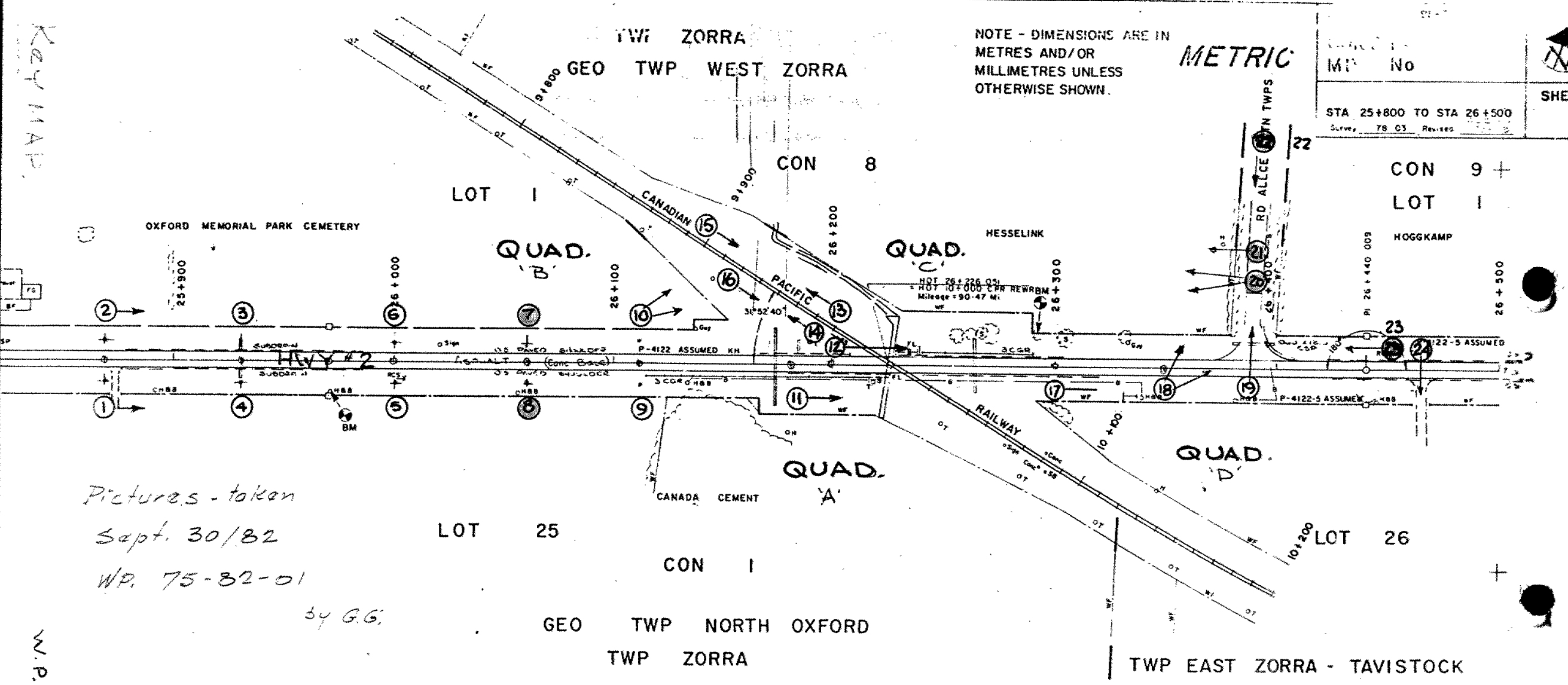
KEY MAP.

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

METRIC

No	
STA 25+800 TO STA 26+500	Survey 78 03 Revised

SHEET

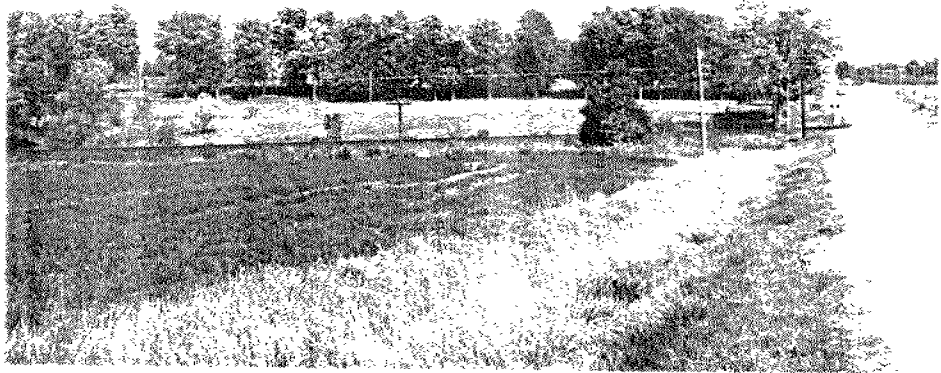


Pictures - taken  
Sept. 30/82  
W.P. 75-82-01  
by G.G.

W.P. 75-82-01

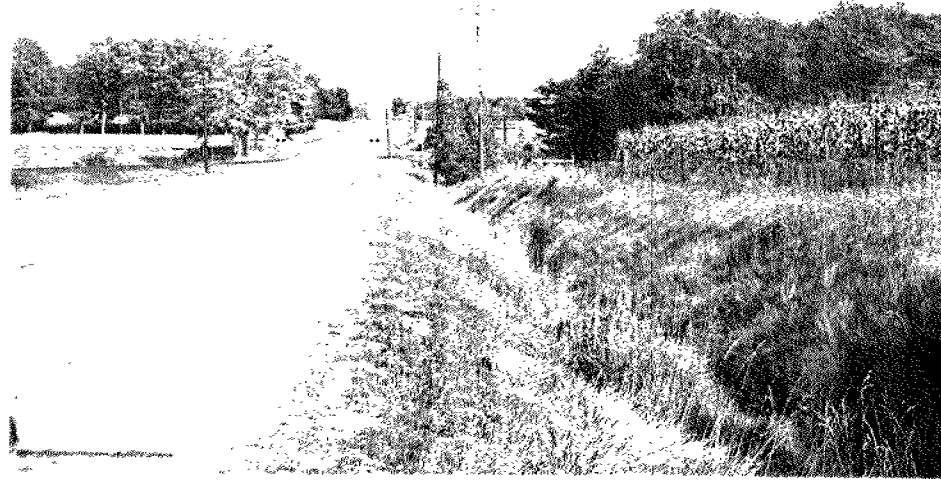
QUANTITIES

Sta	Sta
EC	
SI	
ED	
ME	
MBE	
EF	
RC	
SH	
RD	
MBR	
RF	
306	
Sta	Sta



⑦

Sta. 26+060

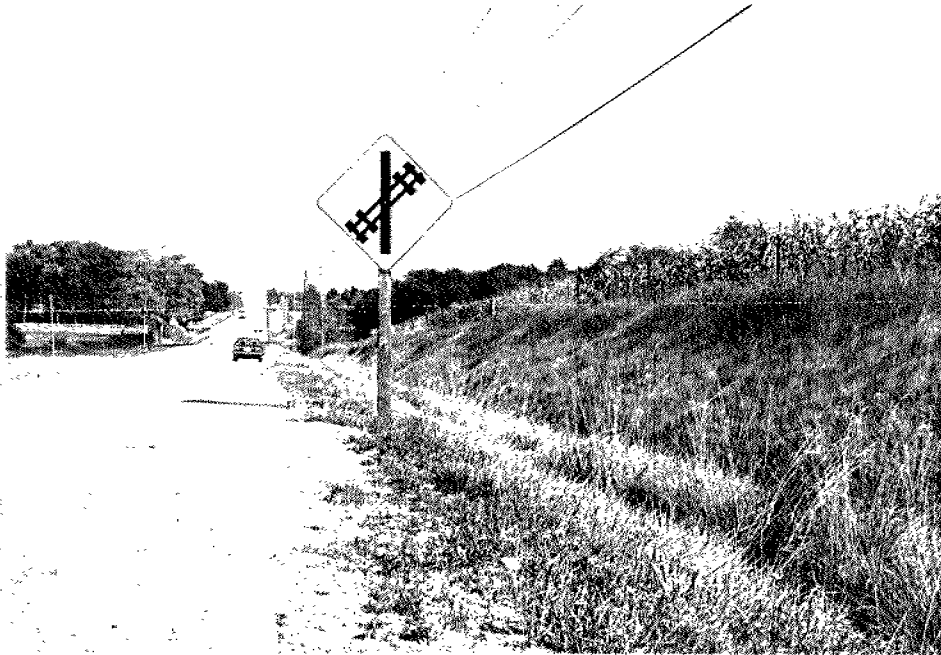


⑧



⑥

Sta. 26+00

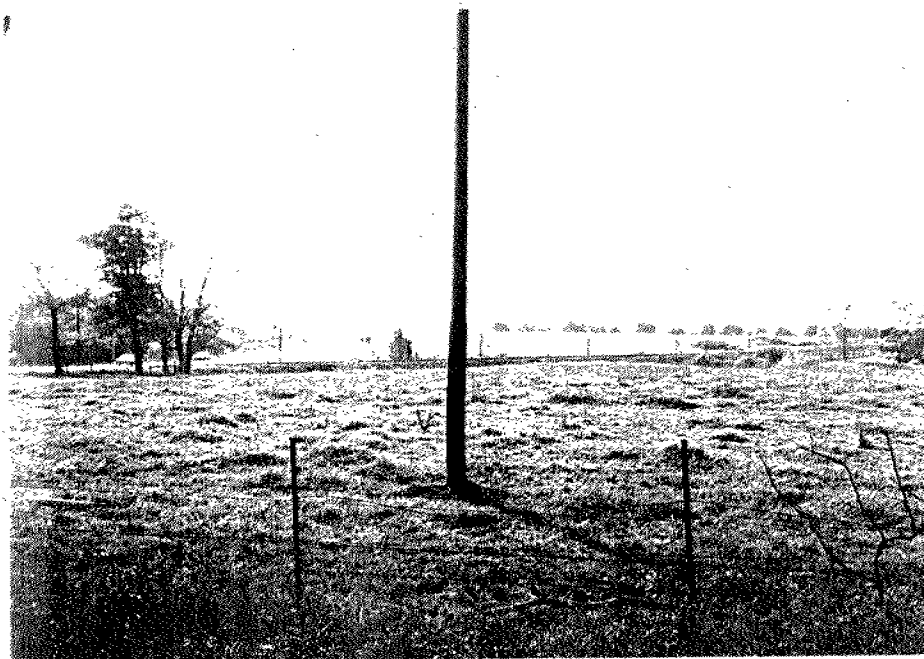


⑤



(20)

LOOKING WEST From Side Road.



(21)

WEST