

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 40-74-14

DIST 4

HWY B.S.A.R.

STR SITE 1-184

C.N.R. Overhead at Park Road North
Brantford South Access Road (B.S.A.R.)

DISTRIBUTION

G.C.E. Burkhardt (3)

R.D. Gunter

F. Norman

J. Smrcka (2)

K. Bassi

B.J. Giroux

R. Hore

R. Fitzgibbon (Cover Only)

T.J. Kovich (Cover Only)

Files

FOUNDATION INVESTIGATION REPORT

For
C.N.R. Overhead at Park Rd. North
Brantford South Access Road (B.S.A.R.)
W.P. 40-74-14; Site No. 1-184
District #4 (Hamilton)

INTRODUCTION

This report contains the results of a foundation investigation carried out at the aforementioned site during the period of 82 03 31 to 82 04 05. The field work consisted of three sampled boreholes accompanied by dynamic cone penetration tests. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped either with 83 mm hollow stem augers or by conventional washboring methods using BX (60 mm I.D.) Casing.

SITE DESCRIPTION

The site is located at the crossing of C.N.R. (presently two tracks) and Park Road North in the City of Brantford. The surrounding terrain is relatively flat. Several overhead and underground utilities are located adjacent to the proposed structure site.

Physiographically the site is located in the region referred to as the Norfolk Sand Plains.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of a deep deposit (38 m) of irregularly stratified silts and silty clays interbedded with a $4.7 \pm$ m thick zone of silty sand to sandy silt at elevation $211.5 \pm$.

Dolomite type bedrock was encountered at elevation 184 ⁺. The boundaries between the different strata, together with the obtained field and laboratory tests results are shown on the Record of Borehole Sheets contained in the appendix. A stratigraphical profile is shown on Drawing No. 407414-A. A description of the different strata encountered is given below.

Irregular Layers of Silt and Silty Clay

This irregularly stratified deposit was encountered at the boring locations in two zones. The first zone was found to extend from groundlevel to elevation 211.5 ⁺ and the second segment is from elevation 206.7 ⁺ to the surface of bedrock. The material in both zones consists of irregular layers of silt and silty clay with traces of sand. The thickness of these layers was found to vary randomly from a few millimetres to over 20 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	15-27
Liquid Limit (%)	20-33
Plastic Limit (%)	14-20

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the appendix.

The consistency of the overall deposit varies randomly from firm to hard.

Silty Sand to Sandy Silt

This stratum was found to be sandwiched between the upper and lower portion of the previously described deposit. The material consists mainly of sands and silts with varying proportions. Trace of clay was also observed to be present. Grain-size distribution curves are plotted on Figure 2 of the appendix. The natural moisture content ranges from 17 to 21%. Based on the standard penetration tests 'N' values (11 to 56 blows per 0.3 m) the material appears to be in the compact to very dense state.

Bedrock

Sound, dolomite type bedrock was encountered at elevation 184.0 in Borehole #1.

Groundwater Conditions

The following groundwater levels were observed in the open boreholes:

B.H. #1	Elevation 221.4
B.H. #2	Elevation 221.3

No groundwater level was established in Borehole #3.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to build a three-span (skew-span lengths: 20 m - 23 m - 18 m) twin-structure overhead at the crossing of Park Road North and C.N. Railways. The centre span will accomodate four C.N. Tracks (the existing two plus two future tracks) while the south span will accomodate a future service track. In order to minimize the south span, it is necessary to construct a retaining wall some 12 m north of the south abutment.

The proposed profile grade of Park Road North will be approximately 9 m above the existing C.N. Railway grade of elevation 222.4.

Structure Foundations

The entire structure (abutments and piers) and the retaining wall should be supported on steel 'H' piles driven to bedrock which was found to be at elevation 184 ⁺, some 38 m below the existing ground level. These 'H' piles should be equipped with reinforced tips. For the purpose of the O.H.B.D.C. the following design values are recommended:

310 HP 110

Factored capacity at U.L.S: 1600 kN

Capacity at S.L.S. Type II: 1150 kN

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill (non-yielding foundation) a value of $K_o = 0.5$ is recommended.

The pile caps should have a minimum of 1.5 m of earth cover to provide for frost protection.

The pile caps should be formed "in the dry." Therefore, a dewatering scheme will be required if the excavation are carried below the prevailing groundwater level.

Should the piles be driven closer than 4 m from underground utilities (such as gas or oil pipelines, watermain, sewers etc...) preboring to a minimum depth of about 2 m below such utilities is recommended. Temporary track protection will be required.

Approach Embankments

No stability problems are anticipated for the 9 m high approaches, constructed with 2:1 slopes.

The fill should consist of well compacted acceptable material. Care should be taken that the fill material should not contain grain size larger than 50 mm at locations where piles have to be driven.

Immediate and longterm settlements in order of 10 to 15 cm will take place due to the weight of the superimposed embankments. To minimize future maintenance problems caused by these settlements, consideration should be given to the advanced placement of the fills prior to the structure construction.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. D. Collom, Construction Technician. The equipment used was owned and operated by Atcost Soil Drilling Inc. This report was written by Mr. P. Payer and reviewed by Mr. K.G. Selby.

P. Payer
P. Payer, P. Eng.
Foundations Engineer



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

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 40-74-14 LOCATION Sta. 8 + 739.0; o/s 12.5 m Lt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & BXL Rock Coring COMPILED BY PP
DATUM Geodetic DATE 82 03 31 and 82 04 05 & Cone Test CHECKED BY *PP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
221.7	Ground Level													GR SA SI CL
0.0	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand		1	SS	32		220							0 0 85 15
			2	SS	15									0 1 75 24
			3	SS	20									0 2 78 20
			4	TW	PH		218							0 0 61 39
	Stiff to Hard		5	SS	13									0 5 88 7
			6	SS	16									
			7	SS	15		216							0 0 60 40
			8	SS	11									
			9	SS	15									
			10	SS	18		214							0 0 90 10
			11	SS	9		212							
211.6	Silty Sand to Sandy Silt Trace of Clay Compact to V. Dense		12	SS	11									0 18 77 5
10.1			13	SS	56		210							0 22 73 5
			14	SS	26		208							0 55 41 4
206.9	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand		15	SS	9		206							
14.8	Stiff to Hard		16	SS	9		204							
			17	SS	12		202							
			18	TW	PH		200							
191.5							198							
30.2							196							
							194							
							192							

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued



RECORD OF BOREHOLE No 1 Continued

METRIC

W P 40-74-14 LOCATION Sta. 8 + 739.0; o/s 12.5 m Lt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & BXL Rock Coring & Cone COMPILED BY PP
DATUM Geodetic DATE 82 03 31 and 82 04 05 Test CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
191.5	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand Stiff to Hard Traces of Gravel		19	SS	26	190										0 0 64 36
30.2						188										
			20	SS	42	186										4 1 71 24
184.0						184										
37.7	Bedrock Dolomite Sound		21	RC BXL	REC 100%											
182.4	End of Borehole															
39.3																

+3, x⁵ : Numbers refer to 20
Sensitivity 15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC

W P 40-74-14 LOCATION Sta. 8 + 758.0; o/s 2.5 m Rt. 4 Alignment (Park Rd. North) ORIGINATED BY D.C.
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (H.S.) & Cone Test COMPILED BY P.P.
DATUM Geodetic DATE 82 04 01 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
221.6	Ground Level															
0.0	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand		1	SS	13		220									0 5 80 15
			2	SS	4											
			3	SS	25											
	Firm to V. Stiff		4	TW	PH		218									Om. 0.52% 0 6 83 11
			5	SS	9											21.4 0 0 75 25
			6	SS	12											
			7	SS	12		216									0 0 55 45
			8	SS	16											
			9	SS	13											
213.5			10	SS	13		214									0 0 69 31
8.1	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



METRIC

W P 40-74-14 LOCATION Sta. 8 + 825.0; o/s 4.2 m Rt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & Cone Test COMPILED BY PP
DATUM Geodetic DATE 82 04 01 to 02 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60
								SHEAR STRENGTH							
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × LAB VANE							
221.3	Ground Level													GR SA SI CL	
0.0	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand		1	SS	42	*	220							0 4 79 17	
			2	SS	25									0 5 84 11	
			3	SS	28									0 14 80 6	
			4	TW	PR		218								
			5	SS	12										
			6	SS	13										
			7	SS	18		216							0 0 64 36	
			8	SS	22										
			9	SS	20		214								
			10	SS	9										
	Stiff to Hard		11	SS	9		212							0 11 79 10	
211.1															
10.2	Silty Sand to Sandy Silt		12	SS	37		210							0 27 65 7	
	Silty Clay		13	SS	9		208							0 0 61 39	
	Trace of Clay		14	SS	22		206							0 77 19 4	
206.4	Compact to Dense														
14.9			15	SS	15		204								
	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand						202								
	Stiff to Hard		16	SS	10		200								
							198							0 1 68 31	
							196								
			17	SS	14		194								
							192								
191.1															

30.2

Continued

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

Continued

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
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RECORD OF BOREHOLE No 3 Continued

METRIC

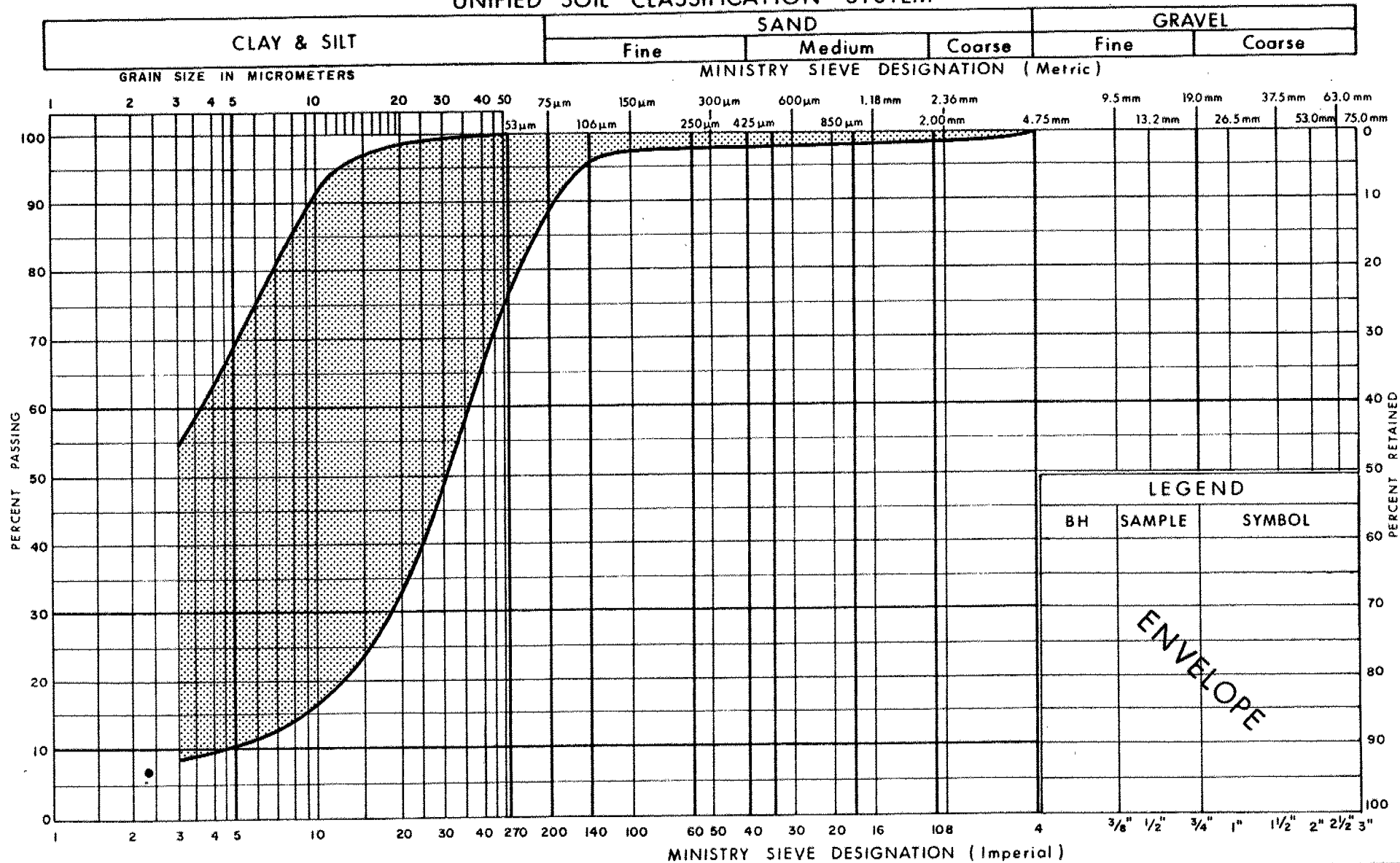
W P 40-74-14 LOCATION Sta. 8 + 825.0; o/s 4.2 m Rt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & Cone Test COMPILED BY PP
DATUM Geodetic DATE 82 04 01 to 02 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
191.1	Continued										
30.2 190.4	Silt & Silty Clay		19	SS	29						0 0 65 35
30.9	End of Borehole										
							190	Push Rods			
							188				
							186	Cone Test Below Augers			
							184				
183.7	End of Cone Test										
37.6	Refusal (Probable Bedrock)							45/13 cm Refusal			
	*Note: Water Level Not Established										

+3, x5; Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

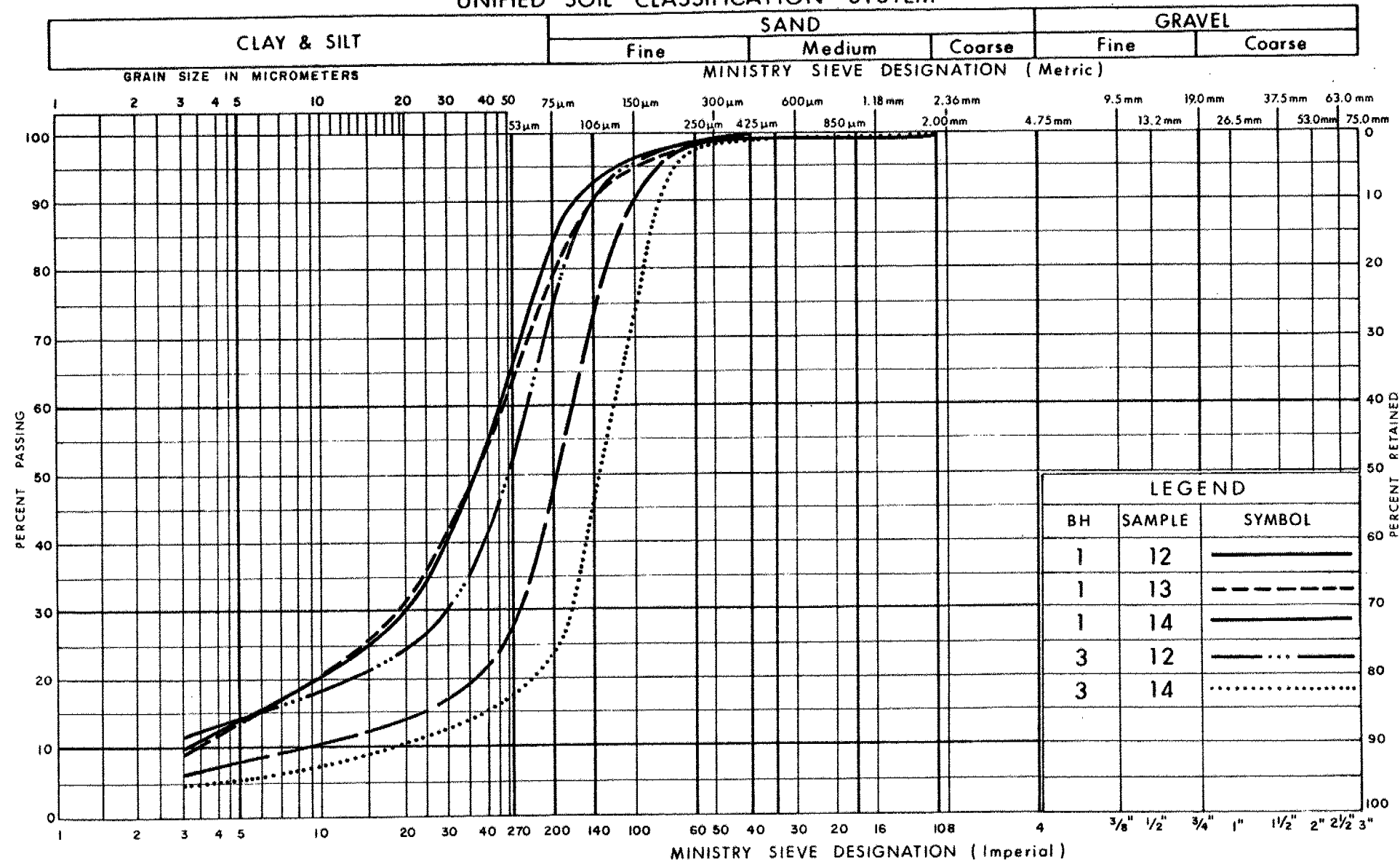
 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
IRREGULAR LAYERS OF
SILT AND SILTY CLAY, TRACES OF SAND

FIG No 1

W P 40-74-14

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT, TRACES OF CLAY

FIG No 2

W P 40-74-14

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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

MECHANICAL PROPERTIES OF SOIL

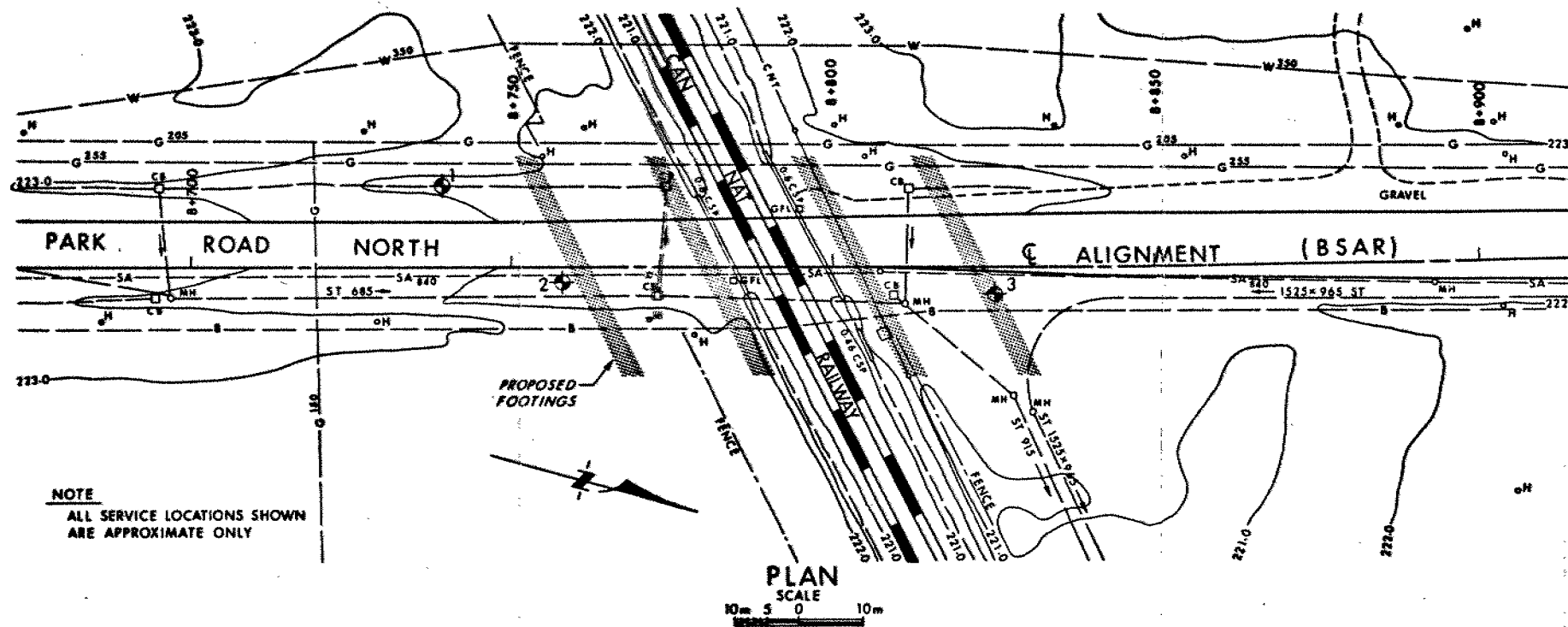
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{v0}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

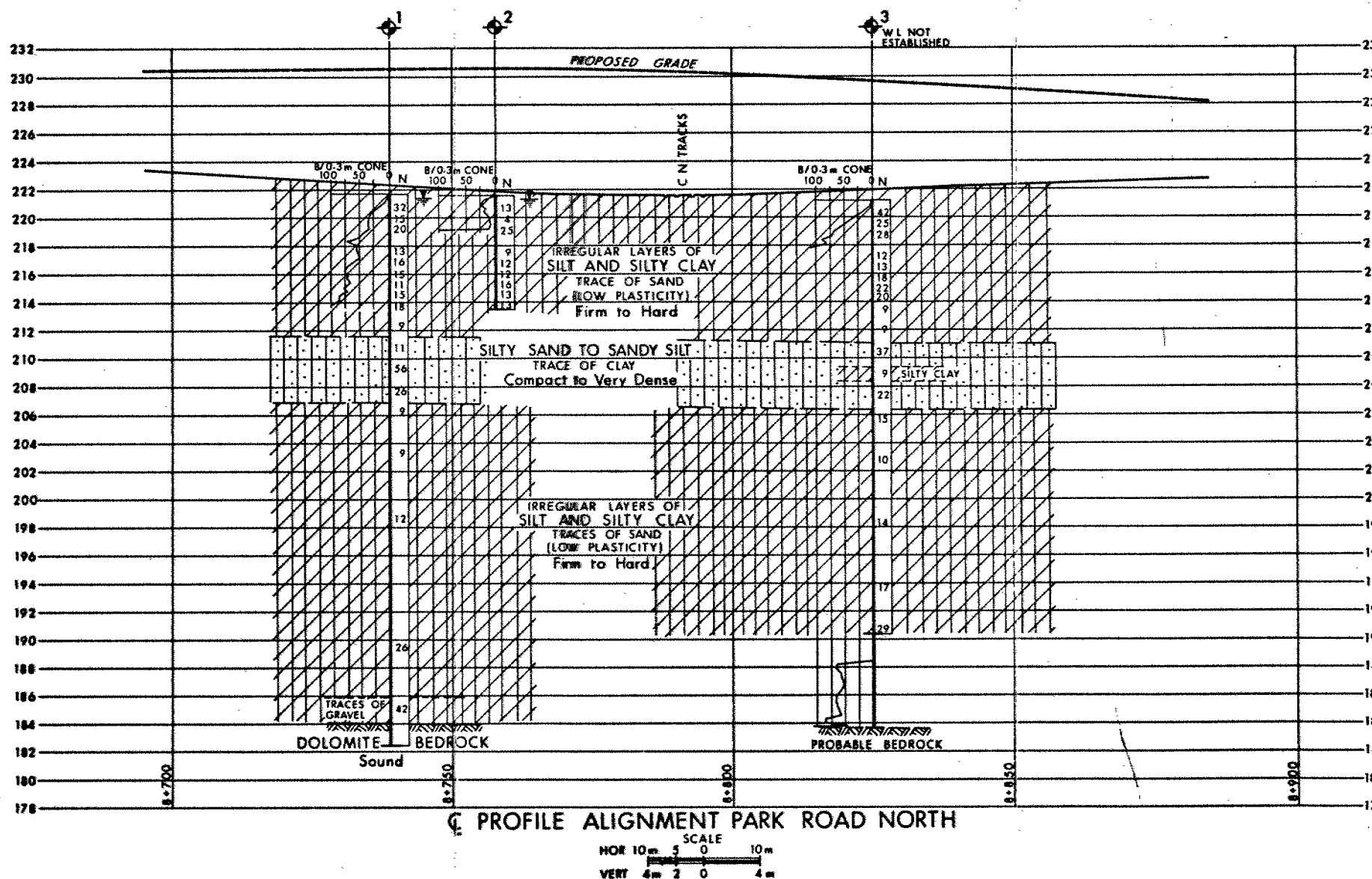
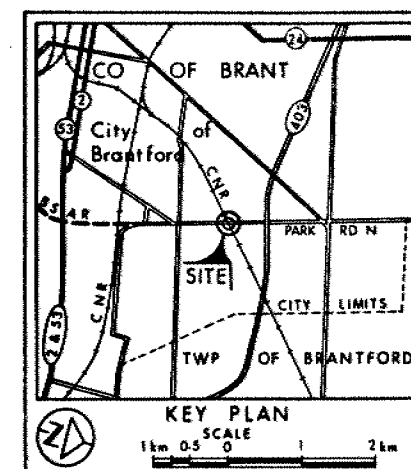
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						



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

CONT No
WP No 40-74-14

CNR OVERHEAD AT
PARK ROAD NORTH (BSAR)
BORE HOLE LOCATIONS & SOIL STRATA



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 82 04
- WL Not Established in BH 3

No	ELEVATION	STATION	OFFSET
1	221.7	8+739.0	12.5m Lt
2	221.6	8+758.0	2.5m Rt
3	221.3	8+825.0	4.2m 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.

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

Geocres No 4071-80

HWY No BSAR	DIST 4
SUBNO PP CHECKED	DATE 1982 07 06
DRAWN PP CHECKED	2778078
	SITE 1-18.4
	DWG 407414-A

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-45



Ministry of
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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.

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} .

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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_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT
for
C.N.R. Overhead at Park Rd. North
W.P. 40-74-14; Site No. 1-86-184 A&B
District #4, (Burlington)

INTRODUCTION

This report contains the results of a foundation investigation carried out at the aforementioned site during the period of 82 03 31 to 82 04 05. The field work consisted of three sampled boreholes accompanied by dynamic cone penetration tests. The borings were advanced by a continuous flight auger machine mounted on a muskeg vehicle and equipped either with 83 mm hollow stem augers or by conventional washboring methods using BX (60 mm I.D.) Casing.

SITE DESCRIPTION

The site is located at the crossing of C.N.R. and Park Road North in the City of Brantford. The surrounding terrain is relatively flat. Several overhead and underground utilities are located adjacent to the proposed structure site.

Physiographically the site is located in the region referred to as the Norfolk Sand Plains.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of a deep deposit (38 m) of irregularly stratified silts and silty clays interbedded with a $4.7 \pm$ m thick zone of silty sand to sandy silt at elevation $211.5 \pm$. Dolomite type bedrock was encountered at elevation $184 \pm$. The boundaries between the different strata, together with the obtained field and laboratory tests results are shown on the Record of Borehole Sheets contained in the

appendix. A stratigraphical profile is shown on Drawing No. 2 of the contract DWG's. A description of the different strata encountered is given below.

Irregular Layers of Silt and Silty Clay

This irregularly stratified deposit was encountered at the boring locations in two zones. The first zone was found to extend from ground level to elevation $211.5 \pm$ and the second segment is from elevation $206.7 \pm$ to the surface of bedrock. The material in both zones consists of irregular layers of silt and silty clay with traces of sand. The thickness of these layers was found to vary randomly from a few millimetres to over 20 cm.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>
Natural Moisture Content (%)	15-27
Liquid Limit (%)	20-33
Plastic Limit (%)	14-20

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the appendix.

The consistency of the overall deposit varies randomly from firm to hard.

Silty Sand to Sandy Silt

This stratum was found to be sandwiched between the upper and lower portion of the previously described deposit. The material consists mainly of sands and silts with varying proportions. Trace of clay was also observed to be present. Grain-size distribution curves are plotted on Figure 2 of the appendix. The natural moisture content ranges from 17 to 21%. Based on the standard penetration tests 'N' values (11 to 56 blows per 0.3 m) the material appears to be in the compact to very dense state.

Bedrock

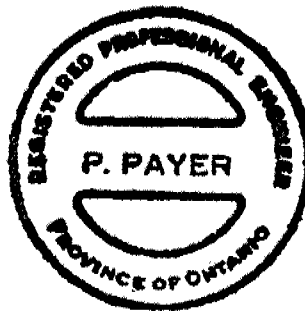
Sound, dolomite type bedrock was encountered at elevation 184.9 in Borehole # 1.

Groundwater Conditions

The following groundwater levels were observed in the open boreholes:

B.H. #1	Elevation 221.4
B.H. #2	Elevation 221.3

No groundwater level was established in Borehole #3.



P. Payer

P. Payer, P.Eng.

Senior Foundations Engineer

K. G. Selby

K.G. Selby, P.Eng.

Chief Foundations Engineer
(West)

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 40-74-14 LOCATION Sta. 8 + 739.0; o/s 12.5 m Lt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (BS) & BXL Rock Coring COMPILED BY PP
DATUM Geodetic DATE 82 03 31 and 82 04 05 & Cone Test CHECKED BY *CP*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100		W _p	W	W _L		
221.7	Ground Level												
0.0	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand		1	SS	32								0 0 85 15
			2	SS	15								0 1 75 24
			3	SS	20								0 2 78 20
			4	TW	PH								0 0 61 39
	Stiff to Hard		5	SS	13								0 5 88 7
			6	SS	16								
			7	SS	15								0 0 60 40
			8	SS	11								
			9	SS	15								
			10	SS	18								0 0 90 10
			11	SS	9								
211.6													
10.1	Silty Sand to Sandy Silt Trace of Clay Compact to V. Dense		12	SS	11								0 18 77 5
			13	SS	56								0 22 73 5
			14	SS	26								0 55 41 4
206.9													
14.8	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand		15	SS	9								
	Stiff to Hard		16	SS	9								
			17	SS	12								
			18	TW	PH								
191.5													
30.2													

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 1 Continued

METRIC

W P 40-74-14 LOCATION Sta. 8 + 739.0; o/s 12.5 m Lt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
 DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & BXL Rock Coring & Cone COMPILED BY PP
 DATUM Canadian DATE 82 03 31 and 82 04 05 Test CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
191.5 30.2	Continued																
	Irregular Layers of Silt, Silty Clay (Low Plasticity) Trace of Sand		19	SS	26		190										0 0 64 36
	Stiff to Hard						188										
	Traces of Gravel		20	SS	42		186										4 1 71 24
184.0 37.7	Bedrock Dolomite Sound		21	RC BXL	REC 100%		184										
182.4 39.3	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 40-74-14 LOCATION Sta. 8 + 758.0; o/s 2.5 m Rt. Alignment (Park Rd. North) ORIGINATED BY D.C.
 DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (H.S.) & Cone Test COMPILED BY P.P.
 DATUM Geodetic DATE 82 04 01 CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
221.6	Ground Level																
0.0	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand Firm to V. Stiff		1	SS	13											0 5 80 15	
			2	SS	4												
			3	SS	25												0m 0.52 0 6 83 11
			4	TW	PH												21.4 0 0 75 25
			5	SS	9												
			6	SS	12												0 0 55 45
			7	SS	12												
			8	SS	16												
			9	SS	13												
			10	SS	13												0 0 69 31
213.5	End of Borehole																
8.1																	

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC

W P 40-74-14 LOCATION Sta. 8 + 825.0; o/s 4.2 m Rt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PF
DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (HS) & Cone Test COMPILED BY PF
DATUM Geodetic DATE 82 04 01 to 02 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
221.3	Ground Level													
0.0	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand		1	SS	42		220							0 4 79 17
			2	SS	25									0 5 84 11
			3	SS	28									0 14 80 6
			4	TH	PH		218							
			5	SS	12									
			6	SS	13									
			7	SS	18		216							0 0 64 36
			8	SS	22									
			9	SS	20									
			10	SS	9		214							
	Stiff to Hard		11	SS	9		212							0 11 79 10
211.1														
10.2	Silty Sand to Sandy Silt		12	SS	37		210							0 27 65 7
	Silty Clay		13	SS	9									0 0 61 39
	Trace of Clay		14	SS	22		208							0 77 19 4
206.4	Compact to Dense													
14.9			15	SS	15		206							
	Irregular Layers of Silt and Silty Clay (Low Plasticity) Trace of Sand						204							
	Stiff to Hard		16	SS	10		202							
							200							
			17	SS	14		198							0 1 68 31
							196							
			18	SS	17		194							
							192							
191.1														

30.2

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 3 Continued

METRIC

W P 40-74-14 LOCATION Sta. 8 + 825.0; o/s 4.2 m Rt. E Alignment (Park Rd. N.) ORIGINATED BY DC & PP
 DIST 4 HWY B.S.A.R. BOREHOLE TYPE Cont. Flight Auger (BS) & Cone Test COMPILED BY PP
 DATUM Geodetic DATE 82 04 01 to 02 CHECKED BY PP

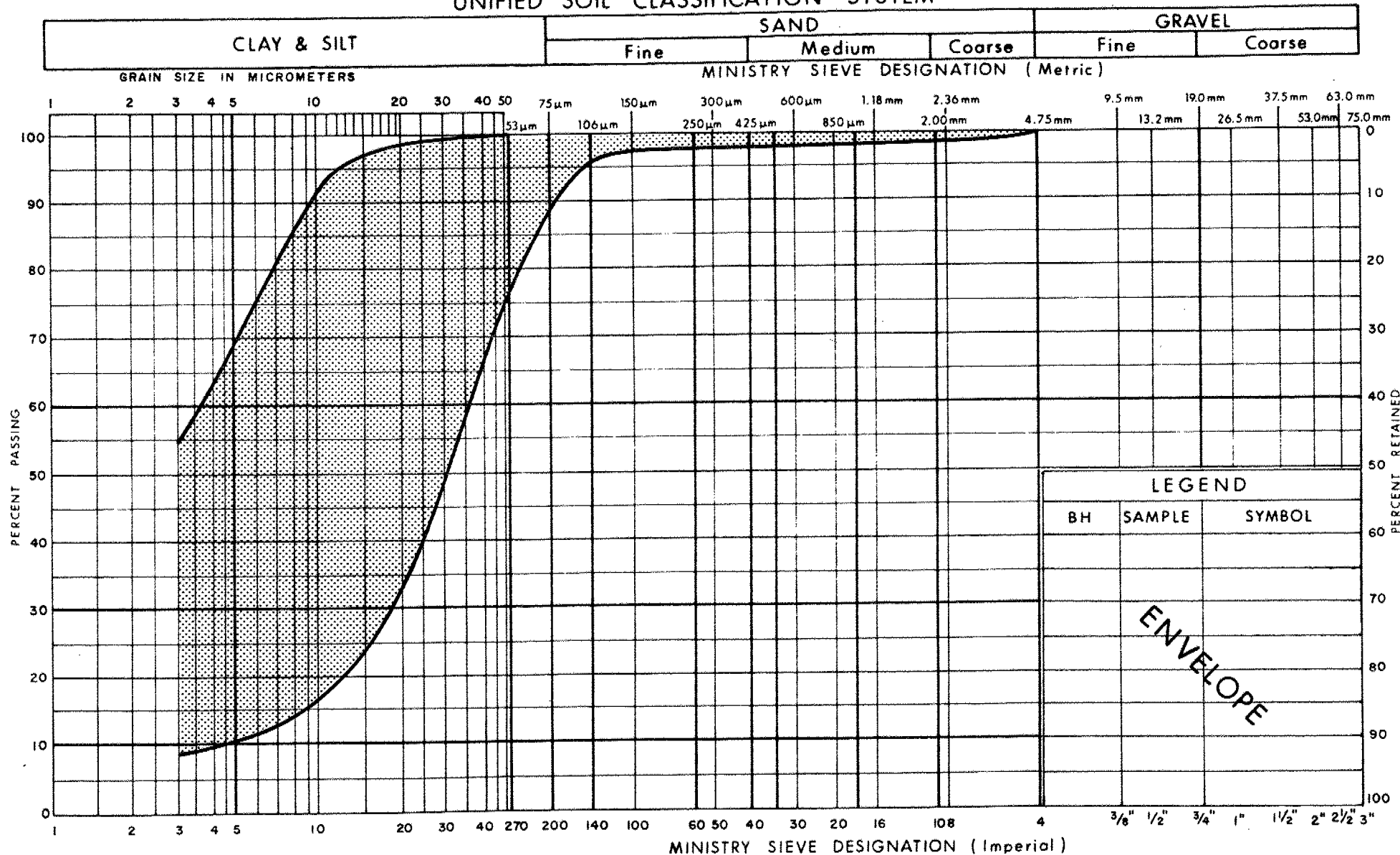
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40					
191.1	Continued												
30.2	Silt & Silty Clay		19	SS	29								0 0 65 35
190.6													
30.9	End of Borehole												

+3, x5: Numbers refer to Sensitivity

20
15
10

(%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



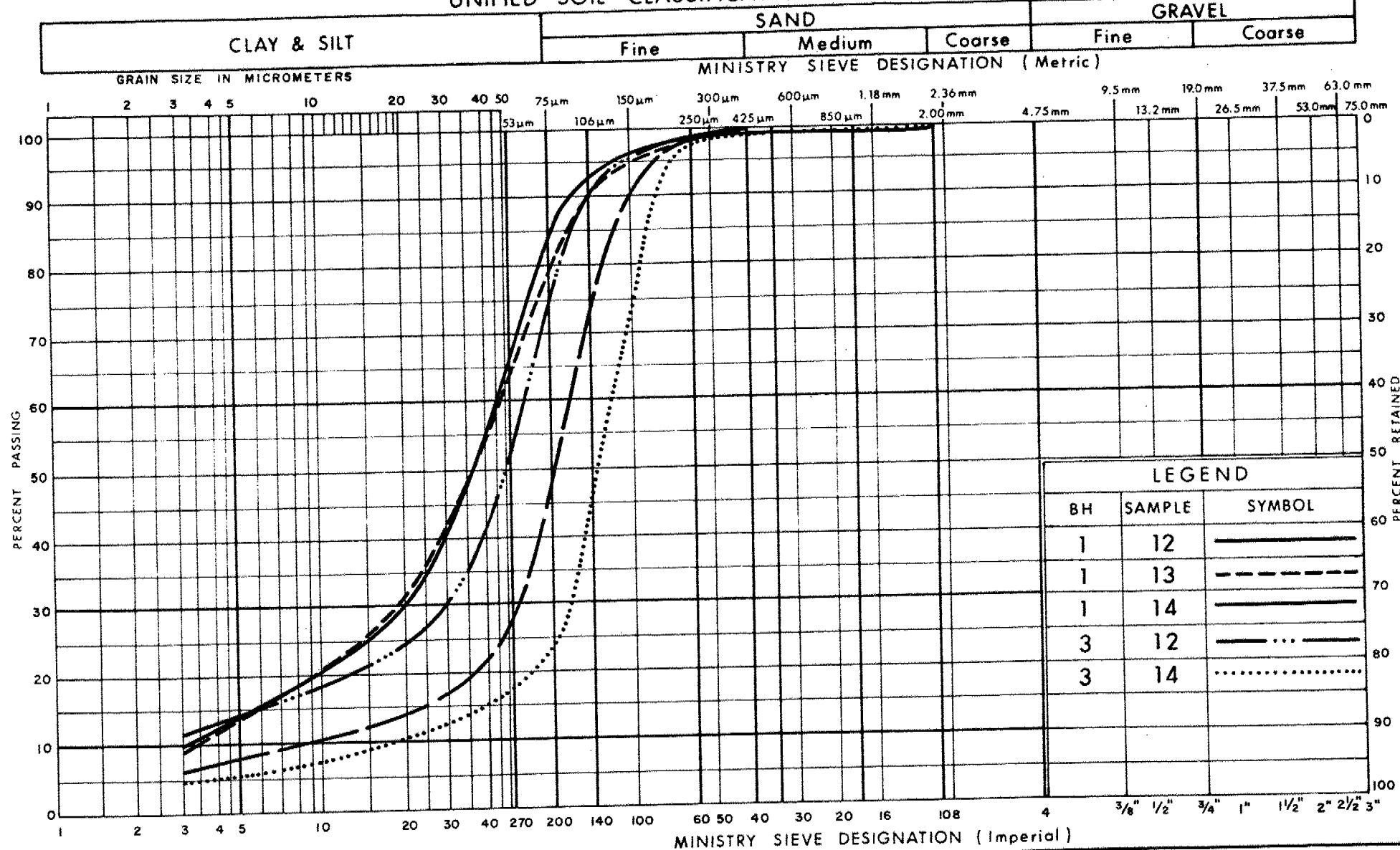
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
IRREGULAR LAYERS OF
SILT AND SILTY CLAY, TRACES OF SAND

FIG No 1

W P 40-74-14

UNIFIED SOIL CLASSIFICATION SYSTEM



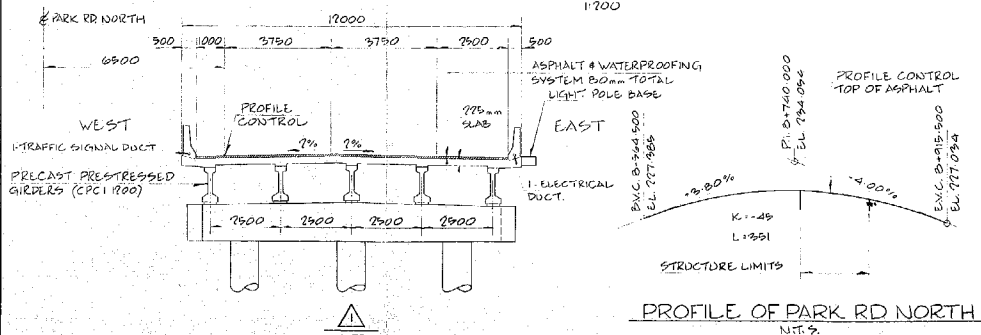
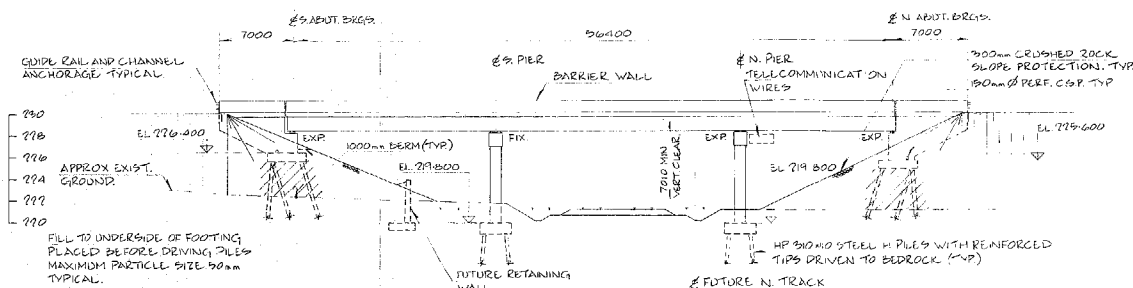
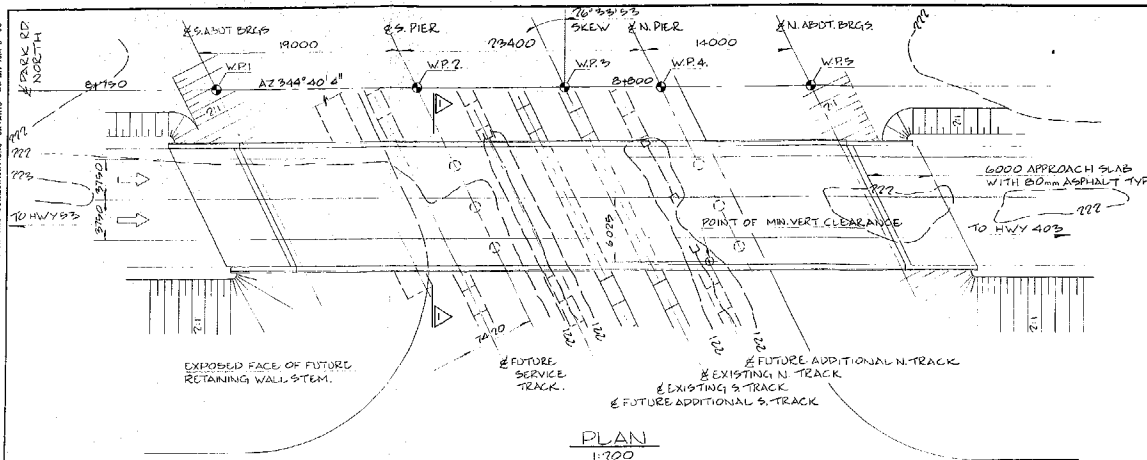
Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT, TRACES OF CLAY

FIG No 2

W P 40-74-14



METRIC

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

DISTRICT 4
CONT No
WP No 40-74-14



SHEET

C.N.R. O'HEAD AT PARK RD. NORTH
(NORTHBOUND STRUCTURE)
GENERAL ARRANGEMENT.


Consulting Engineers & Planners

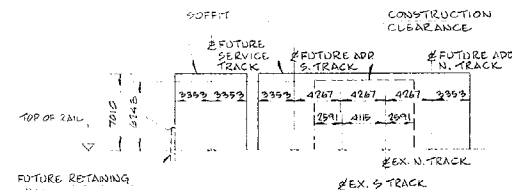
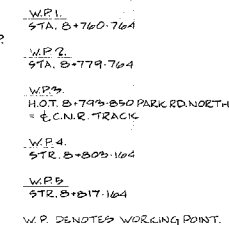
NOTES

CLASS OF CONCRETE	
PRECAST PRESTRESSED GIRDERS	35 MPa
DECK, BARRIER WALLS, ABUTMENTS,	
COLUMNS, AND COLUMN CAPS	30 MPa
REMAINDER	20 MPa

CLEAR COVER TO REINFORCING STEEL	
FOOTINGS	100 ± 25 mm
PRECAST PRESTRESSED GIRDERS	40 ± 10 mm
DECK TOP	70 ± 20 mm
BOTTOM	40 ± 10 mm
ELSEWHERE, UNLESS NOTED	70 ± 20 mm

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

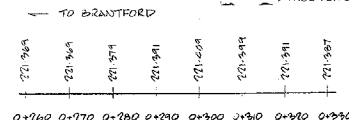
CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE BEARING
SEATS DEAD LEVEL TO THE SPECIFIED
ELEVATIONS TO A TOLERANCE OF ± 3 mm



MIN. REQ'D RAILWAY CLEARANCE

PERPENDICULAR TO TRACKS
NTS

2 PARK RD. NORTH
STRUCTURE LIMITS

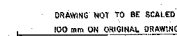


B.M. 224.964

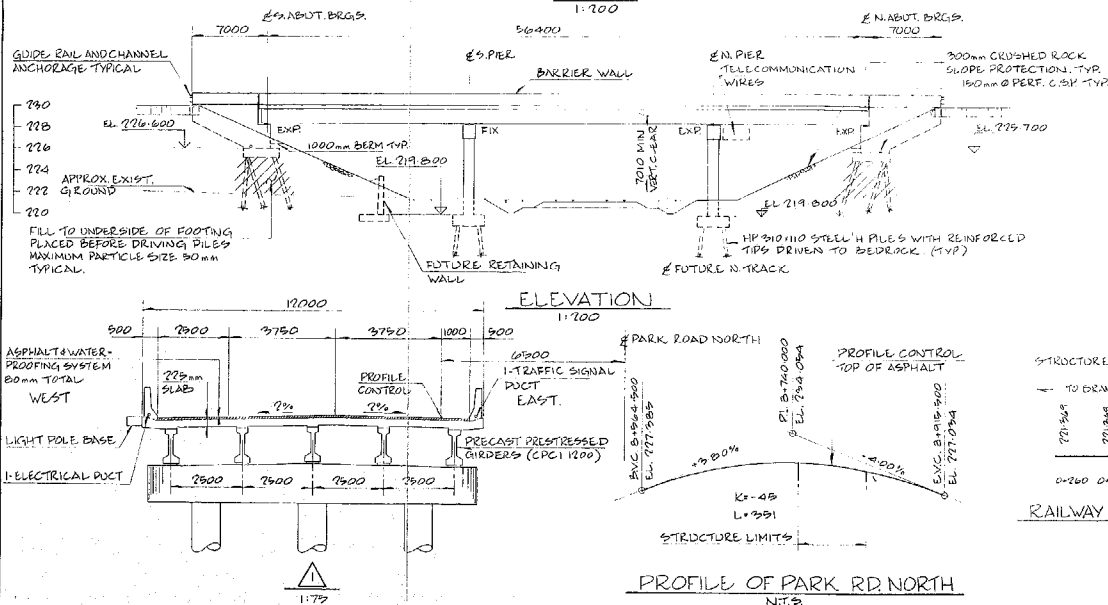
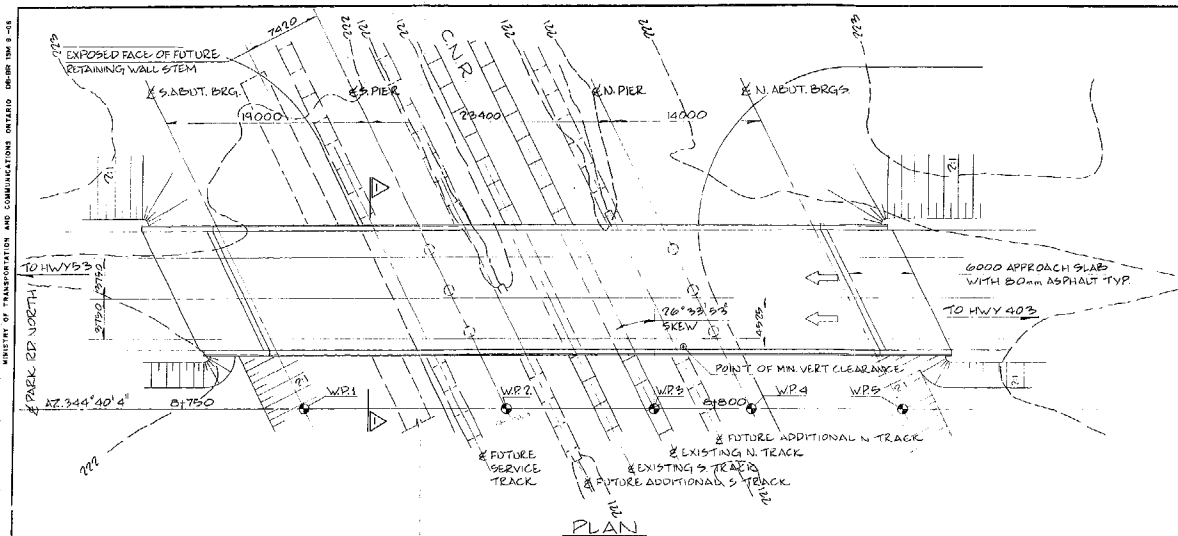
M.T.C. PRECISE B.M. 157-68

RAILWAY PROFILE-NORTH TRACK NORTH RAIL

MILE 21.33 PUNDAS SUBDIVISION
NTS



REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN GEL	CHECK	LOADING ON DRUM - 17	
DESIGN GEL	CHECK	DATE AUG 20	



METRIC

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

DISTRICT 4
CONT No
WP No 40-74-14
C.N.R. O'HEAD AT PARK RD. NORTH
(SOUTHBOUND STRUCTURE)
GENERAL ARRANGEMENT.



SHEET

 Consulting Engineers & Planners

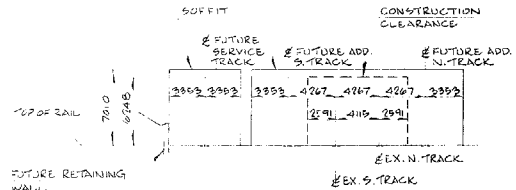
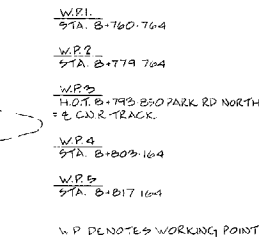
NOTES

CLASS OF CONCRETE
PRECAST PRESTRESSED GIRDERS --- 35MPa
DECK, BARRIER WALLS, ABUTMENTS,
COLUMNS AND COLUMN CAP. --- 30MPa
REMAINDER --- 20MPa

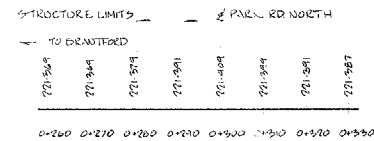
CLEAR COVER TO REINFORCING STEEL	
FOOTINGS	100 ± 25 mm
PRECAST PRESTRESSED GIRDERS	40 ± 10 mm
DECK TOP	70 ± 20 mm
BOTTOM	40 ± 10 mm
ELSEWHERE, UNLESS NOTED	70 ± 20 mm

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

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



MIN. REQD RAILWAY CLEARANCE.
PERPENDICULAR TO TRACKS
NTS.



RAILWAY PROFILE - NORTH TRACK, NORTH RAIL
MILE 21.33 DUNDAS SUBDIVISION
N.T.S.

B.M. 224-964
M.T.C. PRECISE B.M. 157-68

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS					
	DATE	BY	DESCRIPTION		
	DESIGN GEL	CHECK	LOADING 04B0C-179	DATE	AUG 82
	DRAWING MAN.	CHECK	SITE PLAN - 180A	DATE	B