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92-90-01

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HWY. No. 401

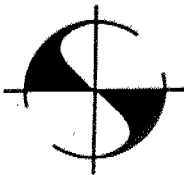
LOCATION Hwy 401 & Regional Rd 8

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



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RESEARCH . ENGINEERING . SCIENCE

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FOUNDATION INVESTIGATION REPORT

W.P. 91-90-01/92-90-01 Bridge Site 10-49

Proposed Structure Addition

Hwy. 401 and Regional Road 8

District 4, (Burlington)
Ministry of Transportation, Ontario

CONT 93-07

Strata Project No: S-91-309

Date of Report: 1991 04 22

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FOUNDATION INVESTIGATION REPORT

W.P. 91-90-01/92-90-01 Bridge Site 10-49

Proposed Structure Addition

Hwy. 401 and Regional Road 8

District 4, (Burlington)

Ministry of Transportation, Ontario

1.0 INTRODUCTION

Strata Engineering Corp. has been retained by the Foundation Design Section of the Ministry of Transportation, Ontario, under Consultant Agreement No: 4240-9190-193, to conduct a foundation investigation for a proposed inside widening of Highway 401 at Regional Road 8 (Halton Road 8). The widening is to be accomplished with a deck in the median gap between existing twin structures. The terms of reference were to investigate the subsurface conditions for the support of the deck widening and for any road protection requirements.

This report is submitted in compliance with these terms of reference.

2.0 SITE AND GEOLOGY

The site is located 5.3km west of Highway 25 in the Regional Municipality of Halton.

At this site, Highway 401 crosses Regional Road 8 on a 15° skew angle on twin overpasses, one each for the eastbound and westbound lanes. Regional Road is located in a cut some 5m to 6m deep. The clear transverse distance between the twin structures is 4.2m.

The median fill between the twin overpass structures is retained by means of vertical concrete slabs cast in line with the ballast walls of the abutments. Concrete box culverts, 1.2m by 1.2m in size, are located some 2.5m behind the abutment footing heels of the twin structures, on both the east and west sides of Regional Rd. 8. Archival drawings also show the presence of a 100mm diameter corrugated steel drain pipe situated in the abutment backfill zone at a distance of about 600mm from the backface of the existing abutment walls.

Along the median, a concrete guide rail protects the open gap between the twin structures. Inertia absorption barriers are located on either side of the guide rail.

The terrain in this area is gently undulating, and a number of gravel pits are evident within a radius of 1km of the site.

The dominant geological feature of the area is the Niagara Escarpment. The site is within an outwash plain tending east to west. The major soil types are therefore outwash sands and gravels, with some boulders and numerous cobbles. Drift thickness and bedrock topography maps indicate a bedrock depth in this area of $30 \pm m$ below prevailing ground surface.

3.0 FIELD AND LABORATORY WORK

Boreholes were drilled between 1991 01 31 and 1991 02 04 using two bombardier mounted CME 55 drill rigs, each drilling two boreholes. Each borehole was accompanied by a dynamic cone penetration resistance test. The boreholes were advanced with hollow stem augers.

Maintenance staff of the MTO Burlington District provided traffic protection assistance when the drill rigs were moved to and from the Highway 401 median.

Four boreholes were drilled along the median of the highway to depths ranging from 9.2m to 17.2m below ground surface, at locations shown on Drawing No: 91/929001-A appended. Boreholes 2 and 3 for the new abutment footings were located as close as practical to the vertical concrete slabs, within the constraints of underground structures and services.

Borehole elevations are referenced to geodetic datum.

Recovered soil samples were transported to our Don Mills laboratory where they were visually classified according to the USC system. Index property tests such as moisture contents, grain size analyses and Atterberg limits were performed on selected samples. The results are shown on the Record of Borehole Sheets as well as on Figures 1 to 4 in the Appendix.

4.0 SUBSURFACE AND GROUNDWATER CONDITIONS

4.1 General

A relatively thin road fill (gravelly sand) overlies a very dense sand and gravel deposit which is underlain by a very dense silty sand. The groundwater table was not reached in any of the boreholes.

4.2 Gravelly Sand (Road Fill)

Frozen road fill comprising brown gravelly sand with trace silt was found from the surface to a depth of approximately 1m.

The moisture content of the fill material was approximately 7 per cent. One grain size analysis is given on Figure 1 which shows the material to be well graded. The denseness of this material could not be established due to its frozen state.

4.3 Sand and Gravel

The natural soil is a brown sand and gravel with trace to some silt. It was found below the road fill in all boreholes, but was fully penetrated only in Borehole 3 where the thickness of the deposit was 13.5m. Occasional cobbles and sandy zones are present at random.

The moisture content of samples from this deposit ranged from 4 to 11 per cent, averaging 6 per cent. Grain size distribution curves are shown in envelope form on Figure 2A. A grain size curve for a sandy zone from the deposit is shown on Figure 2B. Both indicate the material is relatively well graded.

Three Atterberg limit tests were attempted on the fraction of soil finer than $425\mu\text{m}$ to check for the presence of clay. Two of the soil samples were non-plastic, whereas one sample showed some plasticity (Figure 3).

"N" values ranging from 27 blows/0.3m to over 100 blows/0.3m, and generally increasing with depth, indicate the deposit is compact to very dense.

4.4 Sand

A brown sand with some silt was found in Borehole 3 at a depth of 14.3m, the full thickness of which could not be established as the stratum was not fully penetrated.

The moisture content was approximately 5%. A grain size distribution curve for a sample from this deposit, Figure 4, shows the material to be a well graded medium sand.

"N" values of 67 and 84 blows/0.3m indicate the stratum is very dense.

4.5 Groundwater Conditions

The groundwater table was not reached in any borehole. The deepest borehole was 17m.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 General

It is proposed to widen Highway 401 from 4 to 6 lanes between Highway 25 and Guelph Line by the construction of two additional lanes in the existing median. The construction of the additional lanes will require the closing of the gap between twin overpasses carrying Highway 401 across Regional Rd. 8.

Archival drawings indicate the existing twin structures are supported on 1.5m wide spread footings placed at a depth of 1.2m below the profile grade of Regional Road 8 (at about elevation $256.3 \pm m$). The wing walls are shown to be supported on separate spread footings 1.2m wide.

The present bridges show some signs of deterioration. There is a hairline crack visible from below on the base of the deck slab of the WBL bridge parallel to the direction of traffic flow. There is also similar cracking on the east abutment wall of the same bridge continuous with the crack in the deck slab. Corrosion of the reinforcement of the deck slab is evident from the rust stains on the bottom surface of the slab. The abutment seat on the north end of the west abutment wall of the EBL bridge shows some cracking consistent with some settlement of the infill vertical concrete slab at this location. The vertical concrete slabs do not appear to have a foundation.

The construction of the additional lanes will entail closing the gap between the twin bridge abutments. This will require the removal of the existing concrete vertical slabs. Road protection will be required if the new abutments are placed on footings to match the existing footings.

The site investigation shows the presence of nominal road fill material (gravelly sand) overlying an extensive compact to very dense sand and gravel deposit, above a very dense sand stratum. The groundwater table was not reached in any of the boreholes.

5.2 Structure Foundations

5.2.1 Spread Footings

Spread footings, 1.5m in width and placed at elevation $256.2 \pm m$ in the very dense sand and gravel deposit, may be designed for the following factored bearing capacities:

Factored Capacity at ULS	1200kPa
Capacity at SLS Type II	500kPa

At the SLS Type II capacity, the total settlement of the new footings is likely to be elastic in nature and not in excess of 6-8mm.

Resistance to sliding may be computed using an unfactored effective angle of internal friction of 35° between concrete and the sand and gravel stratum.

Assume the unit weight of the sand and gravel to be 22.0kN/m^3 .

5.2.2 Deep Foundations

Excavations to install the shallow spread foundations will have to (1) provide for protection of Highway 401 and (2) contend with the presence of the concrete box culverts. Hence, a deep foundation alternative may be worth considering.

1. Caissons

The preferred alternative to spread footings is a caisson supported foundation scheme, which would eliminate the need for road protection, since the caissons could be augered from the existing median level.

The caissons may be placed between the heels of the existing abutment footings and the concrete box culverts in the available horizontal space (about 2.5m) between the two.

Caissons, with their base located at about elevation 256.2m, may be designed for the following factored load capacities (the 265kN loading was provided as an option to consider):

Caisson Dia. (mm)	ULS Factored Capacity (kN)	SLS Type II Capacity (kN)	Estimated Diff. Settlement (mm)
508	1250	750	15 - 20
508	1250	265	10 - 12
600	1800	750	15 - 20
600	1800	265	8 - 10
750	2800	1100	15 - 20
750	2800	265	6 - 8
1200	7000	2500	18 - 22
1200	7000	265	4 - 6

The differential settlement estimates given above are elastic in nature and will occur almost immediately upon application of the design load. They ignore axial compressive strain of the caisson. Natural soil conditions are never the same everywhere and construction practices may cause undesirable disturbance of the soil. Hence, actual differential settlements may differ from these estimated values. A heavy steel liner should be used to advance the caissons. The level of unsupported excavation below the liner should not exceed 150mm during installation.

Only full scale caisson load tests can provide greater confidence in the calculated settlement estimates.

In order to avoid disturbing the foundation soil below the existing footings, the caisson spacing and location in plan should be such that a minimum distance of 1.0m is maintained between the exterior wall of the caisson liner and the existing abutment footing heels. To avoid subsoil overstressing (and increased elastic settlements), the minimum spacing between caissons should be at least 2.0 times the diameter of the larger adjacent caisson.

2. Steel H Piles

Steel H piles may be considered as an alternative to caissons, but are not recommended due to the danger that pile driving, especially close to the existing footing heels, could cause dilation of the very dense sand and gravel and consequent settlement of the existing footings.

Steel H piles (eg HP 310x110), equipped with driving shoes, and driven with an energy not less than 40kJ to toe elevations of about 254.0m may be designed for the following load capacities:

Axial Factored Capacity at ULS	1200kN
Axial Capacity at SLS Type II	950kN

5.3 Earth Pressures

Earth pressures should be computed as per subsection 6-6.1.2.2 of the OHBD Code. A yielding foundation condition may be assumed. The granular A or B backfill should be in accordance with special provision No.109F03 (latest revision). The following parameters are recommended for granular backfill.

	Gran "A"	Gran "B"
Angle of internal friction ϕ'	35.0°	30.0°
Unit weight (kN/m ³) γ	22.8	21.2

Surcharge effects should be computed as per Clause 6-6.1.2.4 of the OHBD Code.

5.4 Construction Considerations

The spread footing option will require roadway protection by means of a shoring system placed inside the excavation adjacent to the travelled highway. The very dense nature of the sand and gravel stratum precludes driven interlocking steel sheet piling as a viable option. Therefore, soldier piles and timber lagging may be the most practical alternative for excavation shoring. Soldier piles would need to be augered down at least 1m into natural soil and concreted in place. The depth of soldier pile toe embedment below the base of the excavation will depend on the shoring design used (whether cantilever, braced or tied back).

For the design of an internally braced system, use a rectangular distribution of earth pressure with a base width of $0.65\gamma Hk_s$, where H is the internal braced height. The granular B earth pressure and unit weight values given in section 5.3 above may be used in design.

Roadway protection, if required, should be of such length parallel to the highway that the angle, measured with the horizontal, from the end of the protection scheme to the new footings is 30° or less.

Excavated material may be re-used as general backfill to the new abutments.

6.0 CLOSURE

The field work for this investigation was carried out by Ms. Andrea C. Abel and Mr. Zareh Dervichian.

Drilling equipment and crew was provided by Master Soil Investigation Ltd. of Weston, Ontario.

Mr. Jim McLean of the MTO Burlington District kindly provided traffic protection services for this investigation.

Respectfully Submitted:
STRATA ENGINEERING CORP.



A.C. Abel, M.Sc.
Project Engineer



C. Mirza, P.Eng.
Senior Principal



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S-91-309

APPENDIX

Explanation of Terms Used in Report

Record of Boreholes 1 to 4

Figures 1 to 4

Drawing 91/929001-A

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

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 = $\frac{c_u}{\tau_r}$

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						

RECORD OF BOREHOLE No1

METRIC

W P 91-90-01 & 92-90-01 LOCATION Nr 4 818 111.0 ; E 267 858.8 ORIGINATED BY A.A.
 DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.
 DATUM Geodetic DATE 1991 01 31 CHECKED BY A.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
263.3	Ground Surface													
0.0	Gravelly Sand tr. Silt (Road Fill)					*	263	augered						
262.6	Frozen Brown						262							
0.7	Frozen		1	SS	-		261							
	Sand and Gravel		2	SS	27		260							64 34 (2)
	Tr Silt Compact		3	SS	68		259							
	Very Dense		4	SS	100		258							56 42 (2)
	Brown		5	SS	79		257							
			6	SS	104		256							38 58 (4)
	Occ. Cobbles		7	SS	87		255							46 51 (3)
			8	SS	87		254							29 68 (3)
			9	SS	53		253							
			10	SS	91									
252.2	End of Borehole													
11.1	Borehole dry upon completion													

OFFICE REPORT ON SOIL EXPLORATION

METRIC

W P 91-90-01 & 92-90-01 LOCATION N: 4 818 120.0; E: 267 864.0 ORIGINATED BY A.A.
DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.
DATUM Geodetic DATE 1991 01 31 & 1991 02 01 CHECKED BY A.A.

[illegible]

+3, x5 : Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC

W P 91-90-01 & 92-90-01 LOCATION N: 4 818 144.6; E: 267 880.0 ORIGINATED BY Z.D.
 DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.
 DATUM Geodetic DATE 1991 02 04 CHECKED BY A.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
262.5	Ground Surface												
0.0	Gravelly Sand tr.Silt (Road Fill)		1	SS	-	*	262	augered					19 76 (5)
261.7	Frozen Brown												
0.8	Frozen												
	Sand and Gravel some Silt		2	SS	43		261						26 58 (16)
	Dense						260	120/25cm					
	tr. Silt		3	SS	117		259						44 50 (6)
	Occ. Cobbles		4	SS	83/15cm		258						
							257						
	Very Dense		5	SS	140/25cm		256						
							255						
			6	SS	56		254						54 44 (2)
							253						
	Brown		7	SS	100/15cm		252						
							251						
							250						39 40 (21)
	Some Silt						249						
			9	SS	97		248						47 37 (16)
248.2	Sand some Silt												
14.3	Cont. on Sheet 2												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 cont'd

METRIC

W P 91-90-01 & 92-90-01 LOCATION N: 4 818 144.6; E: 267 880.0 ORIGINATED BY Z.D.
DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.
DATUM Geodetic DATE 1991 02 04 CHECKED BY A.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa								
247.5	Cont. from Sheet 1																GR SA SI CL
15.0	Sand some Silt well graded Very Dense Brown		10	SS	67		247										0 80 (20)
245.3			11	SS	84		246										
17.2	End of Borehole Borehole dry upon Completion																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

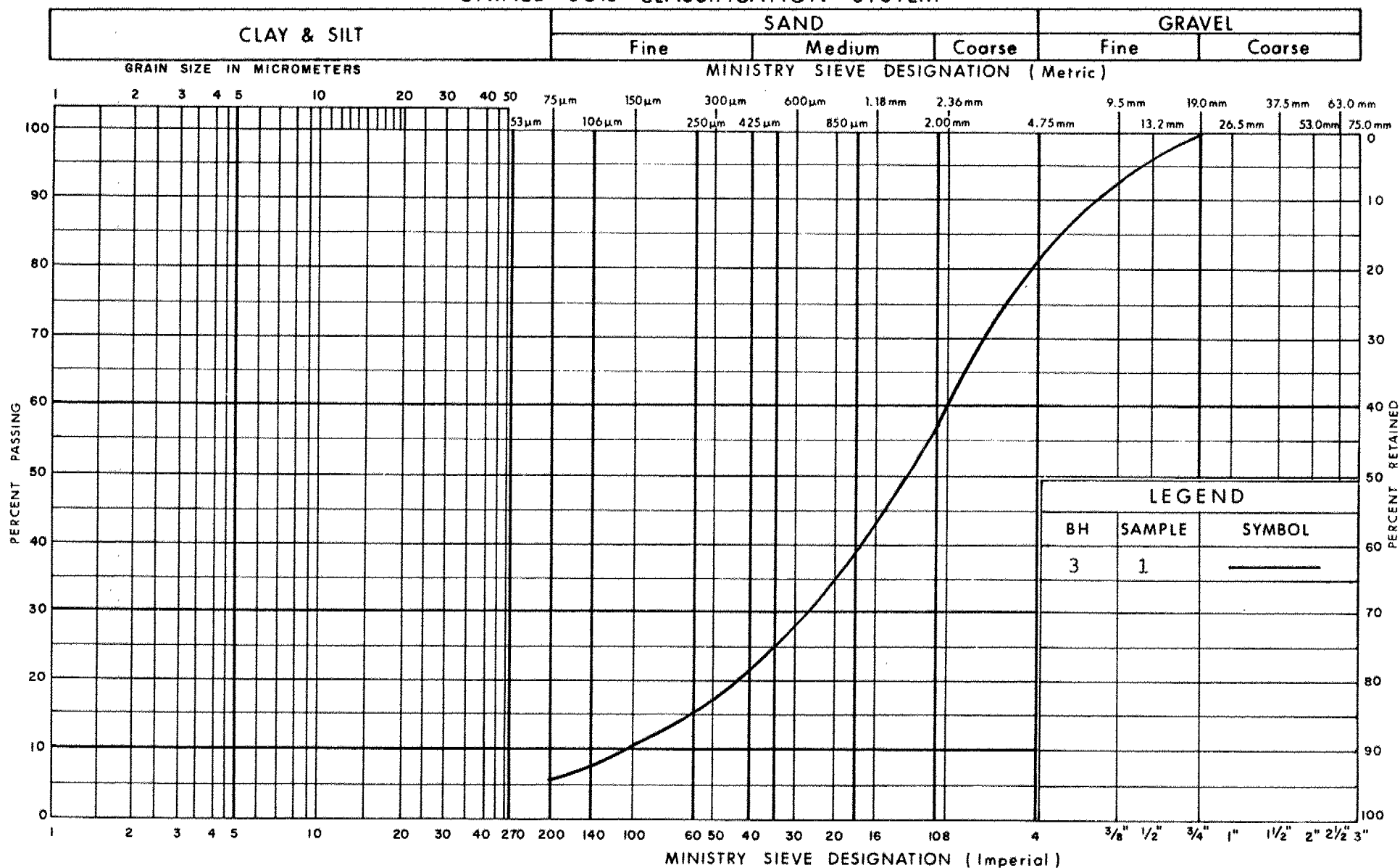
METRIC

W P 91-90-01 & 92-90-01 LOCATION N: 4 818 159.0; E: 267 886.0 ORIGINATED BY Z.D.
 DIST 4 HWY 401 BOREHOLE TYPE Hollow Stem Auger, Dynamic Cone Test COMPILED BY A.K.
 DATUM Geodetic DATE 1991 02 01 CHECKED BY A.A.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL x LAB VANE							
262.0	Ground Surface														GR SA SI CL
0.0	Gravelly Sand tr.Silt (Road Fill)		1	SS	-	*		augered							
261.3	Frozen Brown														
0.7	Frozen														
	Cobbles		2	SS	100/6cm										No Recovery
	Sand and Gravel some Silt														
	Very Dense		3	SS	118										
	Occ. Cobbles														
			4	SS	66										58 33 (9)
	Sandy Zone Dense		5	SS	33										7 90 (3)
	Very Dense		6	SS	53										
252.8			7	SS	100/8cm										64 22 (14)
9.2	End of Borehole * Borehole dry upon Completion														

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Gravelly Sand trace Silt
(Road Fill)

FIG No 1

W P 91-90-01 & 92-90-01

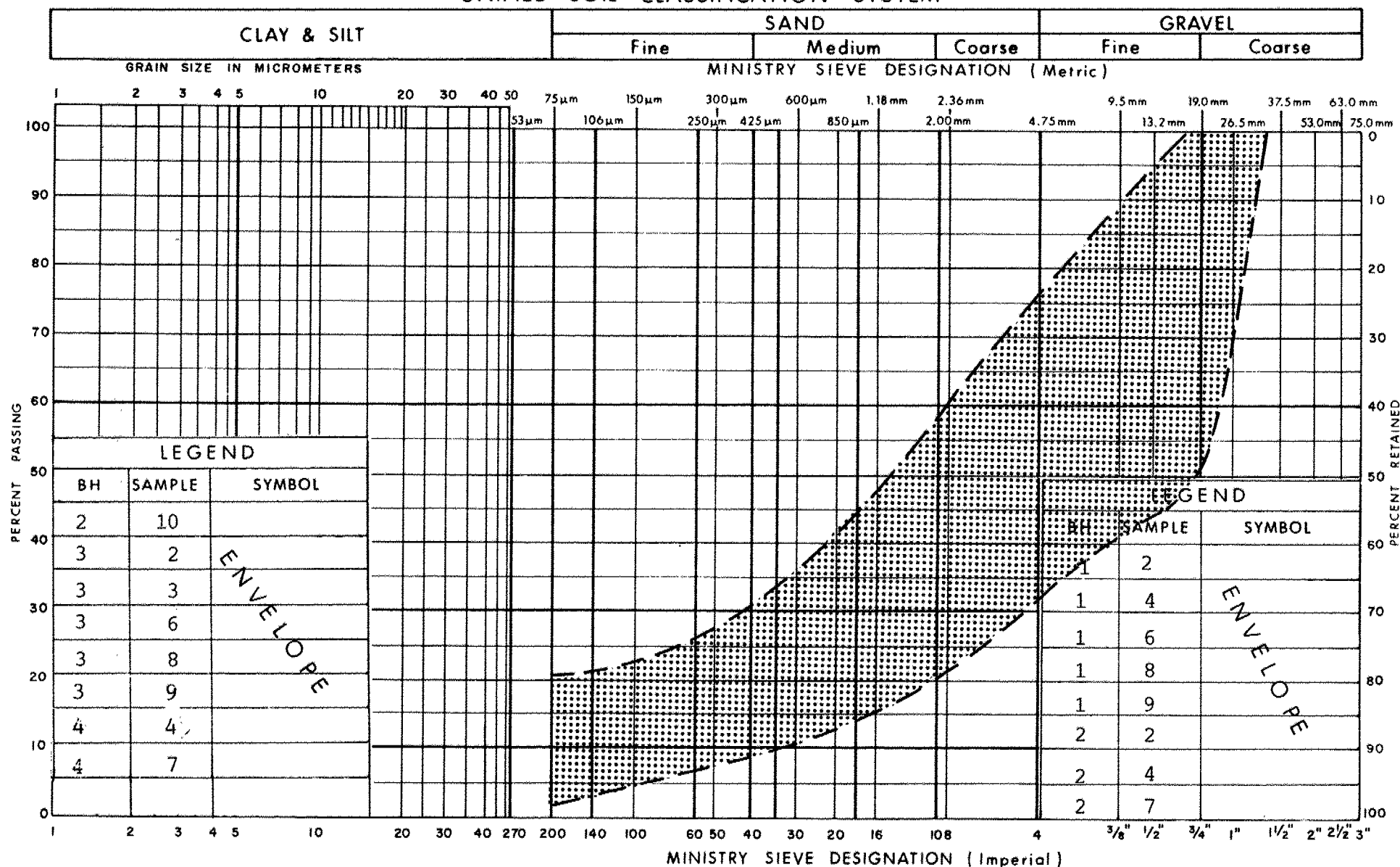
Hwy. 401/ Regional Rd. 8



Ontario

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Sand and Gravel, trace to some Silt



Ontario

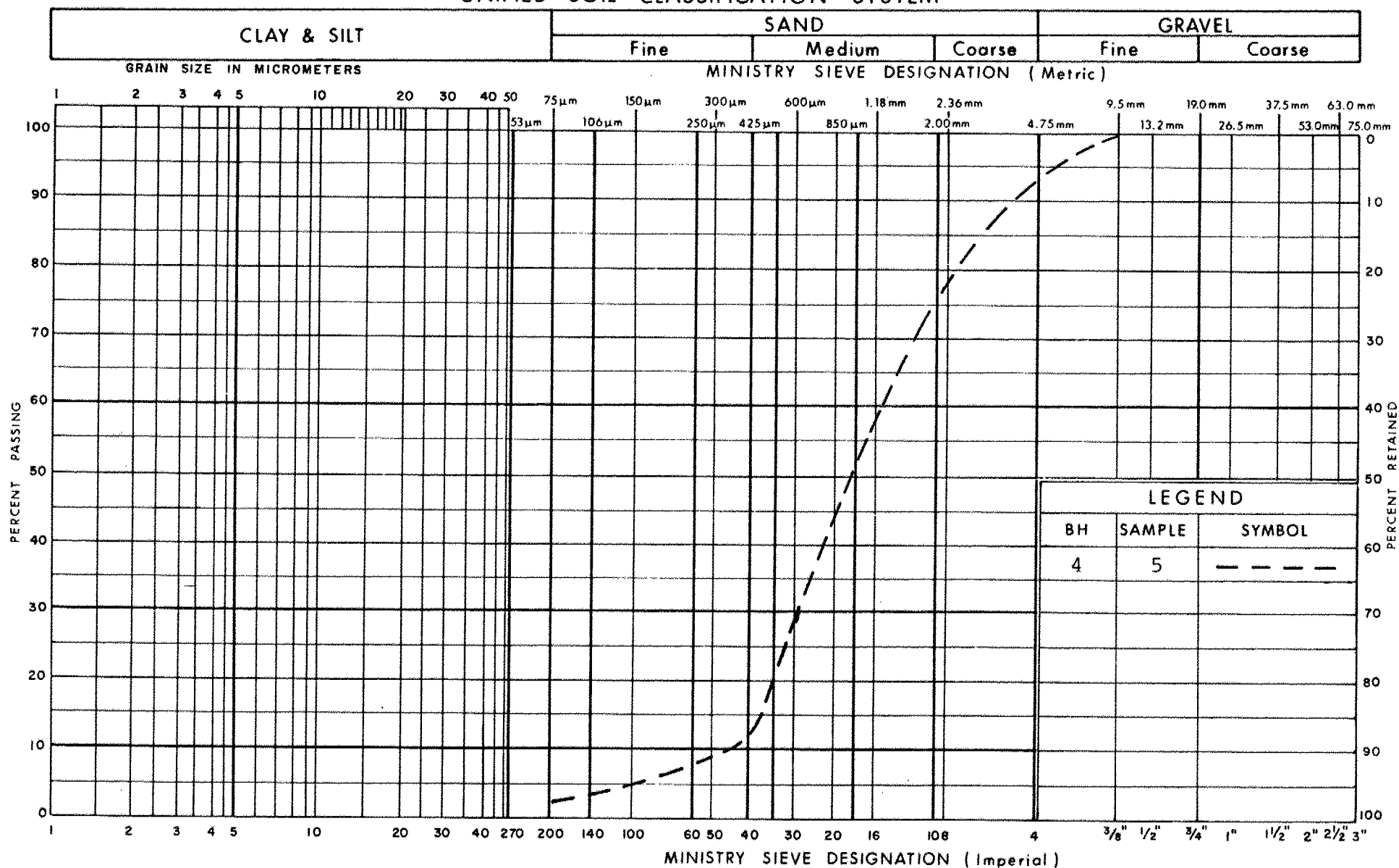
Ministry of
Transportation

FIG No 2A

W P 91-90-01 & 92-90-01

Hwy. 401/Regional Rd. 8

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

Ontario

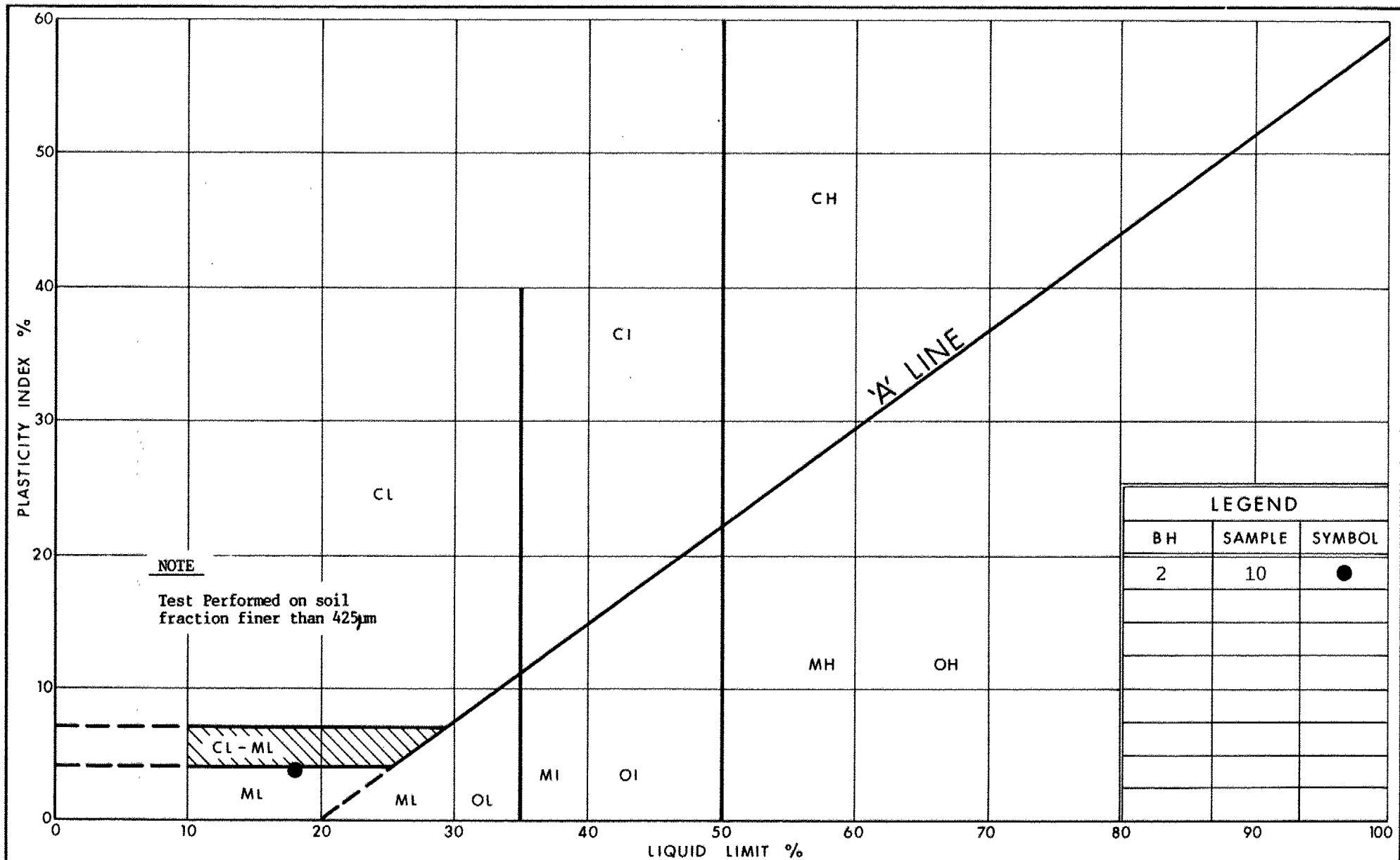
GRAIN SIZE DISTRIBUTION

Sandy Zone (in Sand and Gravel Deposit)

FIG No 2B

W P 91-90-01 & 92-90-01

Hwy. 401/ Regional Rd. 8



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PLASTICITY CHART

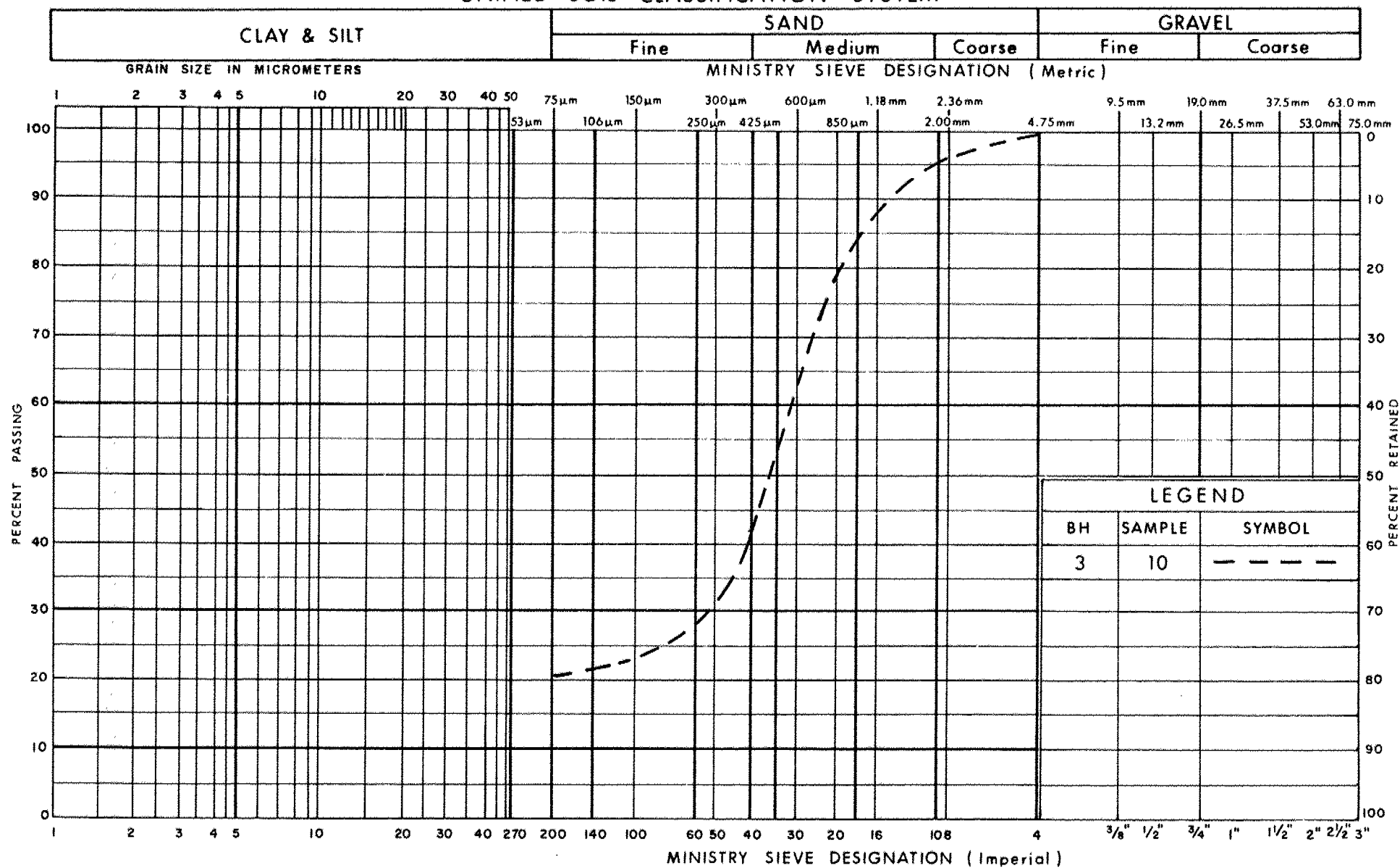
Silt

FIG No 3

W P 91-90-01 & 92-90-01

Hwy. 401/ Regional Rd. 8

UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of
Transportation

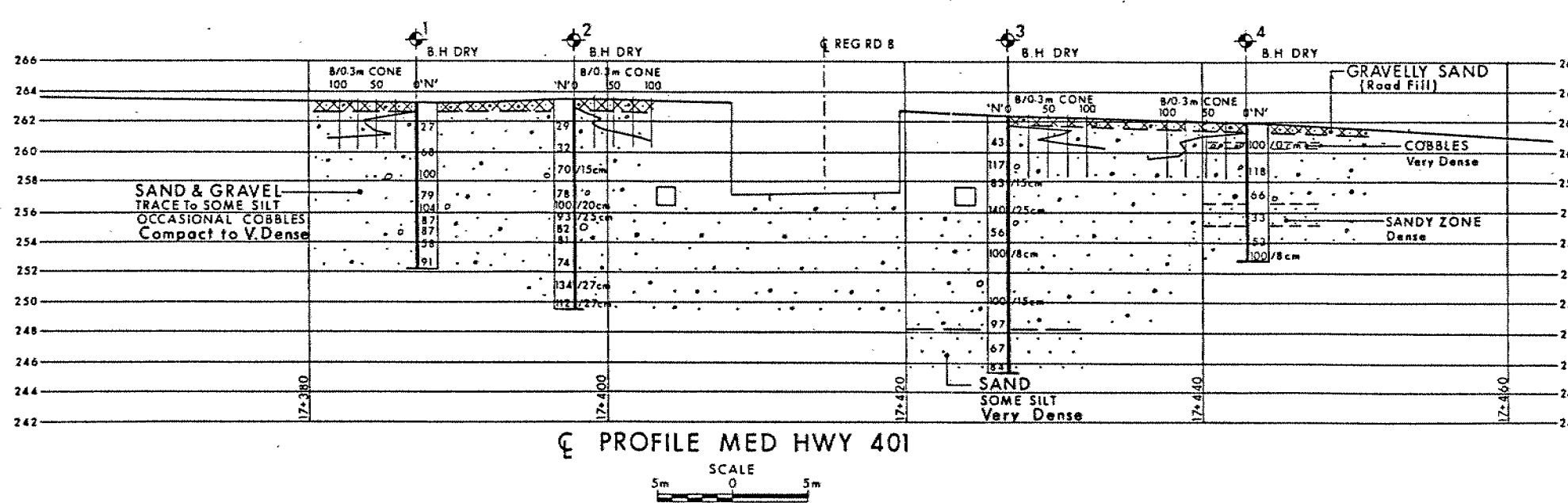
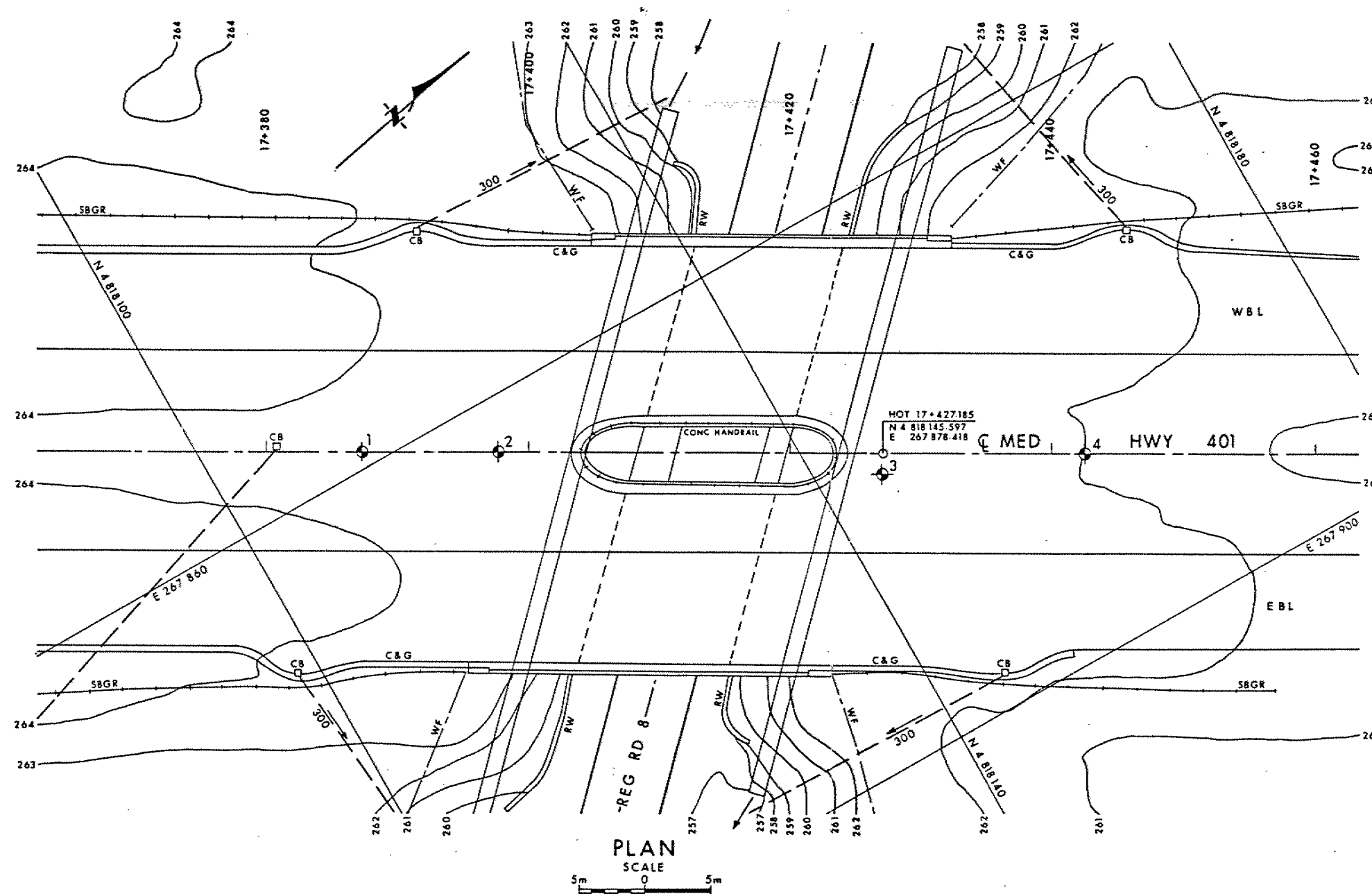
GRAIN SIZE DISTRIBUTION

 Sand some Silt
well graded

FIG No 4

W P 91-90-01 & 92-90-01

Hwy. 401/ Regional Rd. 8



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

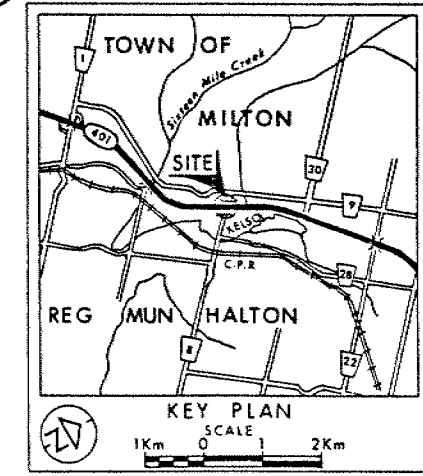
CONT No
WP No 91&92-90-01

REG RD 8 OVERPASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

STRATA ENGINEERING CORP.



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
Jan 1991 And Feb 1991

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	263.3	4 818 111.0	267 858.8
2	263.5	4 818 120.0	267 864.0
3	262.5	4 818 144.6	267 880.0
4	262.0	4 818 159.0	267 886.0

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.

REV	DATE	BY	DESCRIPTION
1			

Geocres No 30M12-215

HWY No 401	DIST 4
SUBMD A.A. [CHECKED] DATE Feb 27 1991	SITE 10-49
DRAWN A.K. [CHECKED] DATE	DWG 91&92-90-01-1

Site 10-49 Perpendicular To Halton Rd #8

