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W. O. No. _____

STR. SITE No. _____

HWY. No. NWMA

LOCATION Storm Sewer Tunnel at
Wesher & Rogers Rd.

No of PAGES - _____

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____



Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

REPORT
TO

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

GEOTECHNICAL INVESTIGATION
PROPOSED WESTON ROAD STORM SEWER
STA. 137+00 TO STA. 145+00
W.P. 33-76-15

DISTRICT 6

TORONTO

Distribution:

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Mississauga, Ontario

May, 1981

811-1111

GEOTECH. 30M11-185

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ABSTRACT

A geotechnical investigation was carried out by Golder Associates for the Ministry of Transportation and Communications, at the site of a proposed storm sewer on Weston Road in the Borough of York. The storm sewer is to be installed by tunnelling.

The borings revealed the presence of fill of maximum thickness of 16 ft. within the anticipated construction area. Below the fill, a stratified medium sand stratum was encountered. Groundwater was not encountered within the depths investigated.

Tunnelling in the sand above the groundwater table will present favourable conditions. Realignment towards the east in the vicinity of station 142+00 to 145+00 will avoid the presence of loose fill at tunnel obvert level. Shallower sections of the storm sewer may be constructed by open cut methods.

1.0 INTRODUCTION

As part of the proposed Northwest Metro Arterial Roadway project (NWMA), Golder Associates have been authorized by the Ministry of Transportation and Communications, to carry out a geotechnical investigation for a proposed storm sewer under the reconstructed Weston Road in the vicinity of the intersection with Rogers Road in Toronto, Ontario.

The details and requirements of the project were provided in a copy of a memorandum, dated April 14, 1981 from Mr. P. Penev of the Ministry, addressed to Mr. M. Devata of the Ministry and on preliminary drawings, numbered Sheets 12, 13, 19 and 20 by FENCO Consultants Ltd. for Station 128+00 to 152+00.

The purpose of the investigation was to determine the subsurface conditions along the proposed sewer alignment, and based on our interpretation of these conditions, to provide engineering recommendations for the geotechnical design of the proposed storm sewer.

The field investigation was carried out and this report was prepared in accordance with our proposal letter dated April 30, 1981 and Consultant's Agreement No. 4242-9081-08.

2.0 SITE AND PROJECT DESCRIPTION

The site is located in the Borough of York along Weston Road from about 300 ft. south to 500 ft. north of Rogers Road (refer to Sheet 1 - Borehole Location and Soil Strata). The surrounding land is primarily residential except for properties fronting on Weston Road which are industrial and commercial use.

The proposed 27 in. diam. storm sewer is part of the Northwest Metro Arterial Roadway (NWMA) Project which will connect Highway 400 and Weston Road. It is proposed to install

the storm sewer within the road allowance for Weston Road and this report is for the section of sewer from Station 137+00 to 145+00, about 800 ft. in length. At this time, it is proposed to install the storm sewer from Station 137+00 to 145+00 at invert levels of 15 to 25 ft. below existing grade, by tunnelling methods below the center of the road. The preliminary design alignments of the storm sewer are shown on Sheets 1 and 2 - Borehole Location and Soil Strata.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

From a review of geological references, the site is located in the Iroquois sand plain which consists of sandy deposits from glacial Lake Iroquois forming old shorelines, bars, and beaches. Gravelly beaches along the Humber River to the west were important sources of sand and gravel for many years. The site of the investigation is on the Baymouth Bar just south of Black Creek.

The sandy beach deposits are underlain by glacial tills of the Pleistocene Epoch which are underlain by grey shale of the Dundas formation at depths in excess of 100 ft.

Significant quantities of fill have been placed along Weston Road, south of the Black Creek, to meet the level of Rogers Road.

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in each of the borings is given on the accompanying Record of Borehole sheets. Stratigraphic sections showing the inferred subsurface conditions across the site are given on Sheets 1 and 2. The results of laboratory testing carried out on representative samples are given on the Record of Borehole sheets and on Figures 1 to 6 inclusive.

3.2.1 Fill

Fill materials were encountered in all boreholes from grade to depths of 5.5 to 16 ft. The fill depth varies both longitudinally and transversely along the proposed sewer alignment.

Along the existing east curb line on Weston Road, the fill depth is uniformly 7 to 8 ft. from Station 137+00 to 142+00. From Station 142+00 to 145+00 the fill depth decreases from about 7 ft. to about 3 ft. respectively.

Along the existing west curb line on Weston Road, the fill is uniformly 8 to 10 ft. from Station 137+00 to 140+00. Between Station 140+00 and 141+00 the depth of fill increases from 10 ft. to 15 ft. and remains at about 15 ft. depth up to Station 145+00.

A transverse cross-section across Weston Road at about Station 145+00 has the fill sloping from a depth of about 5 ft. under the east curb to about 16 ft. under the west curb. At about Station 142+00, the fill slopes from a depth of about 8 ft. under the east curb to about 15 ft. under the west curb (refer to Sheets 1 and 2, Borehole Location and Soil Strata).

The fill is in a generally loose state with an average 'N' value of 8 (range of 5 to 15). The fill composition over the site is chiefly a brown silt with some clay (see Figure 1). At Borehole 8 (Station 144+76 50 ft. Lt. C), from a depth of 5 to 16 ft., the fill comprised a mixture of black silty sand, gravel and fragmented claybrick (see Figure 2). A gasoline odour was noticed at a depth of about 5 ft. in Borehole 8. No gasoline odour was noticed from the remaining samples from the fill in this borehole. The average measured water content of the fill was 18.5 per cent (range of 7 to 38 per cent).

3.2.2 Stratified Sand

Beneath the fill in all boreholes, a stratified medium to fine sand was encountered to depths of 25 to 35 ft. in Boreholes 1 to 7, the maximum depth of exploration, and to 31 ft. in Borehole 8. The clay content of this stratum was measured as up to 10 per cent and the silt content 5 to 15 per cent (see Figures 3 and 4). The soil samples showed distinct horizontal stratification, typical of beach and delta deposits. Occasional thin seams and thicker zones of coarse sand and fine rounded gravel were also encountered (see Figure 5). The bottom 6 in. of Borehole 8 encountered a very stiff, brown clayey silt (see Figure 6).

The upper 5 to 9 ft. of the stratified sand deposit is in a compact state with an average 'N' value of 22 (range of 13 to 28). Below the compact upper zone of the stratum, the sand is dense with an average 'N' value of 41 (range of 19 to 68). The average water content of the stratified sand is 6 per cent (range of 2 to 18 per cent).

3.3 Groundwater Conditions

Following completion of each of the boreholes, piezometers were installed to allow monitoring of groundwater levels along the proposed sewer route. The details of piezometer installation are given on the accompanying Record of Borehole sheets.

The piezometers were monitored on May 14, 1981, more than one week after installation and all piezometers were dry to the depths installed.

The fill overlying the native stratified sand was wet near the surface and an intermittent perched groundwater level may occur. It is recommended that the piezometers be monitored prior to construction.

4.0 DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are addressed to the proposed horizontal and vertical alignments of the storm sewer as presented on the preliminary design drawings by FENCO Consultants Ltd. for W.P. 33-76-15:

Sheet 12 - Weston Rd. Plan, Sta. 128+00 to 140+00
Sheet 13 - Weston Rd. Plan, Sta. 140+00 to 152+00
Sheet 19 - Weston Rd. Profiles, Sta. 132+00 to 143+00
Sheet 20 - Weston Rd. Profiles, Sta. 143+00 to 152+00.

It is proposed to construct the 27 in. diam. storm sewer from Station 137+00 to 145+00 by tunnelling. The preliminary invert levels along this section vary from about 15 to 24 ft. below existing ground surface.

4.1 Tunnelling

Installation of the proposed storm sewer by tunnelling will require a nominal 5 ft. diameter tunnel. The native dry, dense, stratified sand represents favourable tunnelling conditions in that groundwater will not pose a problem. The dense sand is moist which imparts an apparent short term cohesion to the soil such that the unsupported tunnel roof and walls at the tunnel face will remain stable for short periods of time to allow assembly of the tunnel liner.

From Station 137+00⁺ to 142+00⁺ the proposed tunnel will have about 3 to 7 ft. of native sand cover over the tunnel obvert which is favourable.

From Station 142+00⁺ to 145+00⁺ the native sand cover over the tunnel obvert is less than 3 ft. and, near Station 145+00⁺ the tunnel may intersect the overlying loose fill (see Sheets 1 and 2). As this fill is loose and unconsolidated, caving and loss of ground should be expected. Careful tunnelling with fore-poling or hooded shields would reduce the possibility of this caving. Further, in the area of Station 145+00⁺

it is possible that fill may underlie the proposed invert level.

It is recommended that the proposed storm sewer alignment be revised to achieve a greater cover of native sand over the tunnel and to prevent caving or loss of ground. The necessary sand cover could only be achieved along the present route in plan in the vicinity of station 145+00 by dropping the invert level by up to 10 ft. (see Sheet 2). The present invert levels could be maintained by shifting the alignment eastward to take advantage of less fill overlying the native stratified sand. Realignment of the sewer centreline by some 10 to 15 ft. eastward would appear to increase the amount of sand cover over the tunnel obvert by about 3 to 5 ft.

Grouting of the annular space between the ground and the tunnel liner should be carried out immediately to minimize the extent of ground subsidence above the tunnel. The space between the temporary tunnel liner and the storm sewer should be backfilled to avoid any collapse of the tunnel opening since the temporary tunnel liner will deteriorate with time. Backfill may consist of sand or grout (cement grout or "K-crete"). However, the placement and deformation properties of grout are superior to those of sand. Alternatively the tunnel opening could be maintained for several years. In this event it is recommended that the temporary tunnel liner be protected against corrosion by a layer of asphaltic compound on the interior.

4.2 Open Cut

Shallower portions of the proposed storm sewer could be alternatively constructed by open cut. Where space permits, excavations may be made in open cut at side slopes not steeper than:

- a) 1.5 (horizontal) to 1 (vertical) through the fill;
- b) 1 (horizontal) to 1 (vertical) through the native stratified sand.

All excavations should be carried out in accordance with the Ontario Occupational Health and Safety Act.

Where space restrictions do not allow the large open cut excavations necessary for cuts up to 25 ft. deep, sheeted bracing is recommended. Figure 7 shows the estimated magnitude of the lateral earth pressures for design of the bracing. Normal Class 'B' bedding may be used with well-graded granular 'A' material compacted to at least 95 per cent of Standard Proctor dry density. Where the existing fill occurs below invert level it should be subexcavated and replaced with bedding material.

The native stratified sand is suitable as backfill and must be compacted to at least 95 per cent of Standard Proctor dry density in lifts not thicker than 12 in.

The existing fill may be used as backfill to within 4 ft. of roadway grade provided it is free of organic material and is sufficiently dry to compact.

GOLDER ASSOCIATES

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APPENDIX A

FIELD WORK

June, 1981

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FIELD WORK

The present boring program consisted of eight boreholes (numbered 1 to 8) which were put down between May 4 and 6, 1981. A bombardier-mounted CME-55 power auger (supplied by Master Soil Investigations Ltd.) was used with 4.5 in. diam. solid-stem augers for all boreholes except Borehole 7 where 7 in. diam. hollow-stem augers were used. A total of 255 ft. of sampled borings were put down to depths of about 26 to 36 ft.

Soil samples were taken at 2.5 to 5.0 ft. intervals of depth, using a standard 2 in. O.D. split-barrel sampler advanced by a 140 lb. weight falling freely over 30 in. to determine 'N' values (blows per 12 in. penetration). Details of the drilling and sampling operations are summarized on the Record of Borehole sheets.

Piezometers were sealed into each of the boreholes to allow monitoring of groundwater levels along the site.

In addition, the stratigraphy exposed by excavations for the construction of a retaining wall, was logged since it bordered on the project site (Station 145+90, 40 ft. Rt.).

The field work was supervised throughout by a member of our engineering staff who located the borings in the field, cleared the site for buried services, directed the drilling and sampling operations, and logged the boreholes.

The survey chainages and ground elevations at the boreholes were supplied by survey personnel from the Ministry of Transportation and Communications.

All soil samples were shipped to our laboratory for detailed examination. Selected representative samples were tested for grain size distribution while all samples were subjected to a water content determination. The test results are summarized on the Record of Borehole sheets and on Figure 1 to 6.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}IU$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

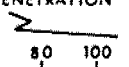
HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 α_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

RECORD OF BOREHOLE No. 1

RECORD OF BOREHOLE No. 2

W P 33-76-15 LOCATION Sta. 138 + 30 45' Rt. E ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 5, 1981 CHECKED BY PJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
405.0	Ground Level																
0.5	Pavement - 2" asphalt 4" granular						Feet										
	Fill - silt, some clay						Seal										
	Brown Loose		1	SS	5		Seal										
397.0							400 Pea Gravel										
8.0	Sand, medium to fine, stratified, trace silt and fine gravel.		2	SS	13		Dry May 14										
			3	SS	19		395										
			4	SS	37												
	Compact to Dense		5	SS	25		390										
	Grey-brown		6	SS	31												
			7	SS	30		385										
378.5			8	SS	43		380										
26.5	End of Borehole						375										

RECORD OF BOREHOLE No. 3

W P 33-76-15 LOCATION Sta. 138 + 99 66' Lt. C ORIGINATED BY MT
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MY
DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

[illegible]

RECORD OF BOREHOLE No. 4

W P 33-76-15 LOCATION Sta. 140 + 00 59' Ltd. c ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
407.1	Ground Level						Feet										
0.0	Concrete						Seal										
0.3																	
405.1	Fill - granular						405										
2.0	Fill - silt, some clay																
			1	SS	8		Dry										
	Brown Loose						May 14										
							400										
397.1																	
10.0	Sand, medium to fine, stratified, some silt, trace clay and fine gravel seams		2	SS	28		395										
			3	SS	23												
			4	SS	27		390										
	Compact to Dense		5	SS	42												
			6	SS	56		385										
	Grey-brown		7	SS	30												
							380										
375.6			8	SS	47		Seal										
							Pea										
							Gravel										
31.5	End of Borehole						375										

RECORD OF BOREHOLE No. 5

W P 33-76-15 LOCATION Sta. 14 + 18 59' Ltd. E ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH							PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%) 10 20 30										
409.7	Ground Level						Feet Seal										
406.7																	
3.0	Fill - silt, some clay						405										
			1	SS	6												
	Brown Loose						Dry May 14										
			2	SS	12		400										
394.5							395										
			3	SS	28												
15.2	Sand, medium to fine, stratified, some silt, trace clay and fine gravel seams.		4	SS	22		390										
			5	SS	32												
			6	SS	37												
	Compact to Dense		7	SS	28		385										
	Grey-brown		8	SS	38		380										
375.7			9	SS	48		Seal Pea Gravel										
34.0	End of Borehole						375										

RECORD OF BOREHOLE No. 6

W P 33-76-15 LOCATION Sta. 142 + 20 65' Rt. E ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 5, 1981 CHECKED BY FJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
407.0	Ground Level													
	Fill - silt, some clay	X					Feet							
	Loose Brown	X	1	SS	6		405							
199.0		X					Dry 400 May 14							
8.0	Sand, medium to fine, stratified, trace silt and fine gravel seams.	.	2	SS	18									
		.					395							
		.	3	SS	38									
		.					390							
	Compact to Dense	.	4	SS	43									
		.	5	SS	34									
	Grey-brown	.	6	SS	45		385							
		.	7	SS	40									
		.	8	SS	48		380							
377.5		.												
29.5	Gravelly seam	.	9	SS	45		375							
375		.					Seal							
32.0		.												
370.5		.	10	SS	41		Rea Gravel							
36.5	End of Borehole	.					370							

RECORD OF BOREHOLE No. 7

W P 33-76-15 LOCATION Sta. 143 + 20 50' Rt. E ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Hollow Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 6, 1981 CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
403.3	Ground Level																
0.0	Fill - silt, some clay						Feet										
	Loose Brown						Seal										
397.8							400										
5.5	Sand, medium to fine, stratified, trace silt and fine gravel seams.		1	SS	24		Dry May 14										
							395										
			2	SS	13												
	Compact to Dense						390										
	Grey-brown		3	SS	41												
			4	SS	50		Seal 385										2 91 7 0
391.3			5	SS	41		Pea Gravel										
22.0	Gravelly seam		6	SS	55		Seal 380										38 58 4 0
378.8																	
24.5			7	SS	60		Dry May 14 375										
			8	SS	28		Seal										
366.8			9	SS	44		Pea Gravel										
36.5	End of Borehole						365										

RECORD OF BOREHOLE No. 8

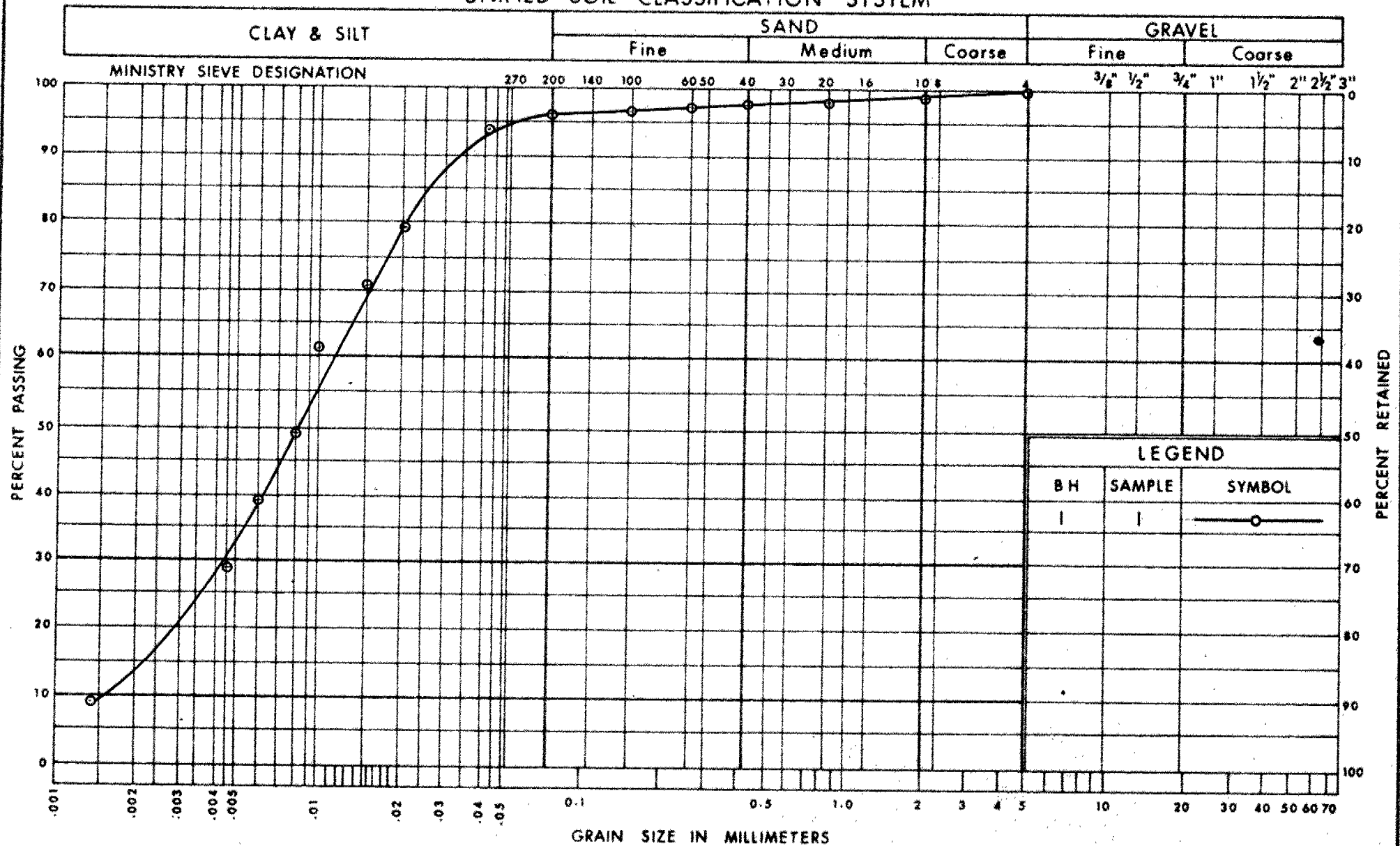
W P 33-76-15 LOCATION Sta. 144 + 76 50' Lt. Q ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY WV
 DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
395.4	Ground Level													
0.0	Pavement - 3" asphalt - granular						Feet 395 Seal							
391.4														
4.0	Fill - mixture of silt, sand and gravel, bricks, concrete.		1	SS	5		Dry May 14 390							35 32 27 6
			2	SS	5									
	Loose		3	SS	15		385							
	Brown to Black		4	SS	13									
379.4			5	SS	23		380							
16.0	Sand, medium to fine, stratified, trace silt and fine gravel seams.		6	SS	40									
			7	SS	45		375							0 90 100
	Dense													
	Grey-brown		8	SS	50		370							
	Clayey Silt very stiff Brown		9	SS	33		Seal 365 Pea Gravel							0 5 60 35
31.5	End of Borehole													
							360							

+3, x3: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



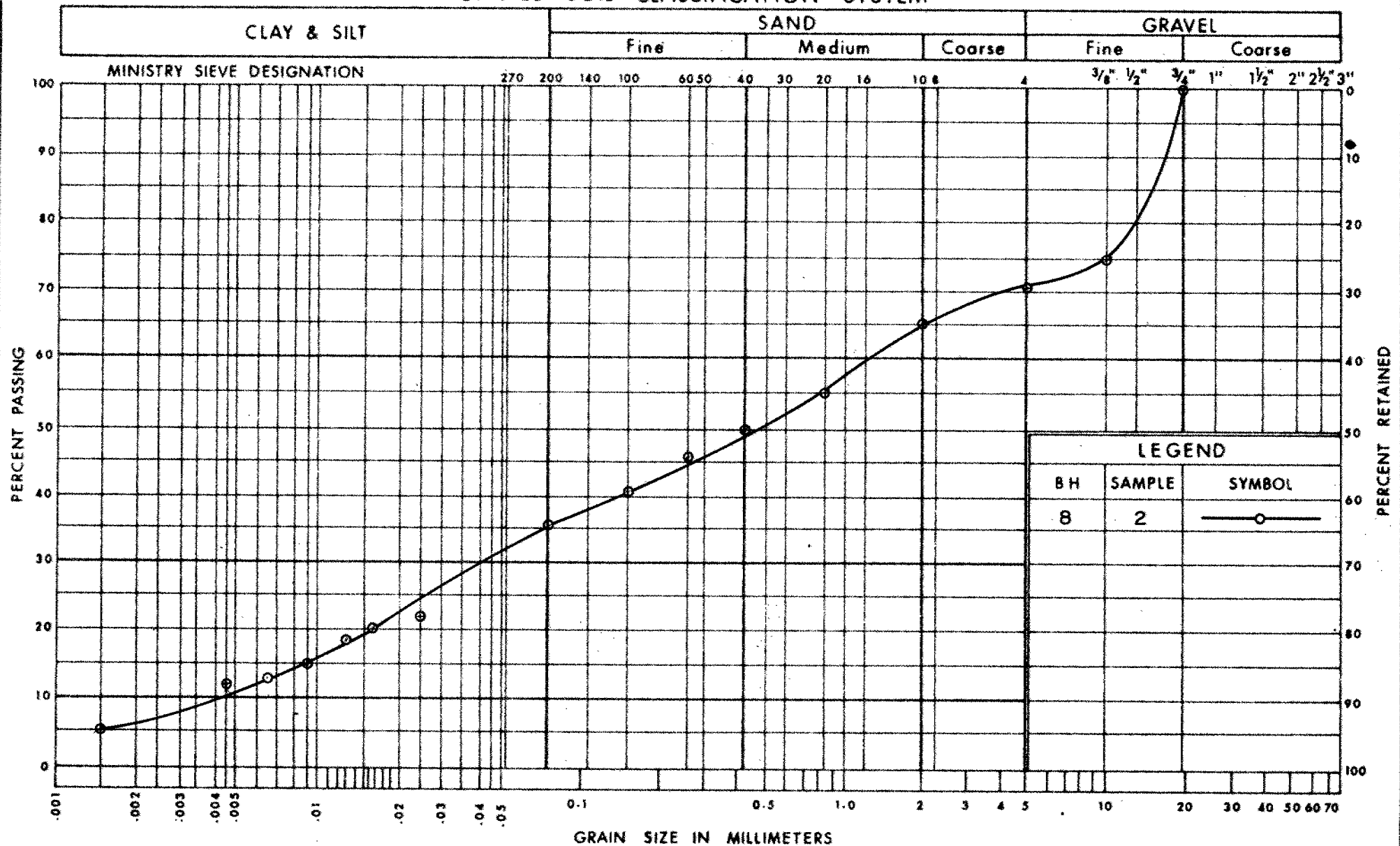
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL
SILT SOME CLAY

FIG No 1

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



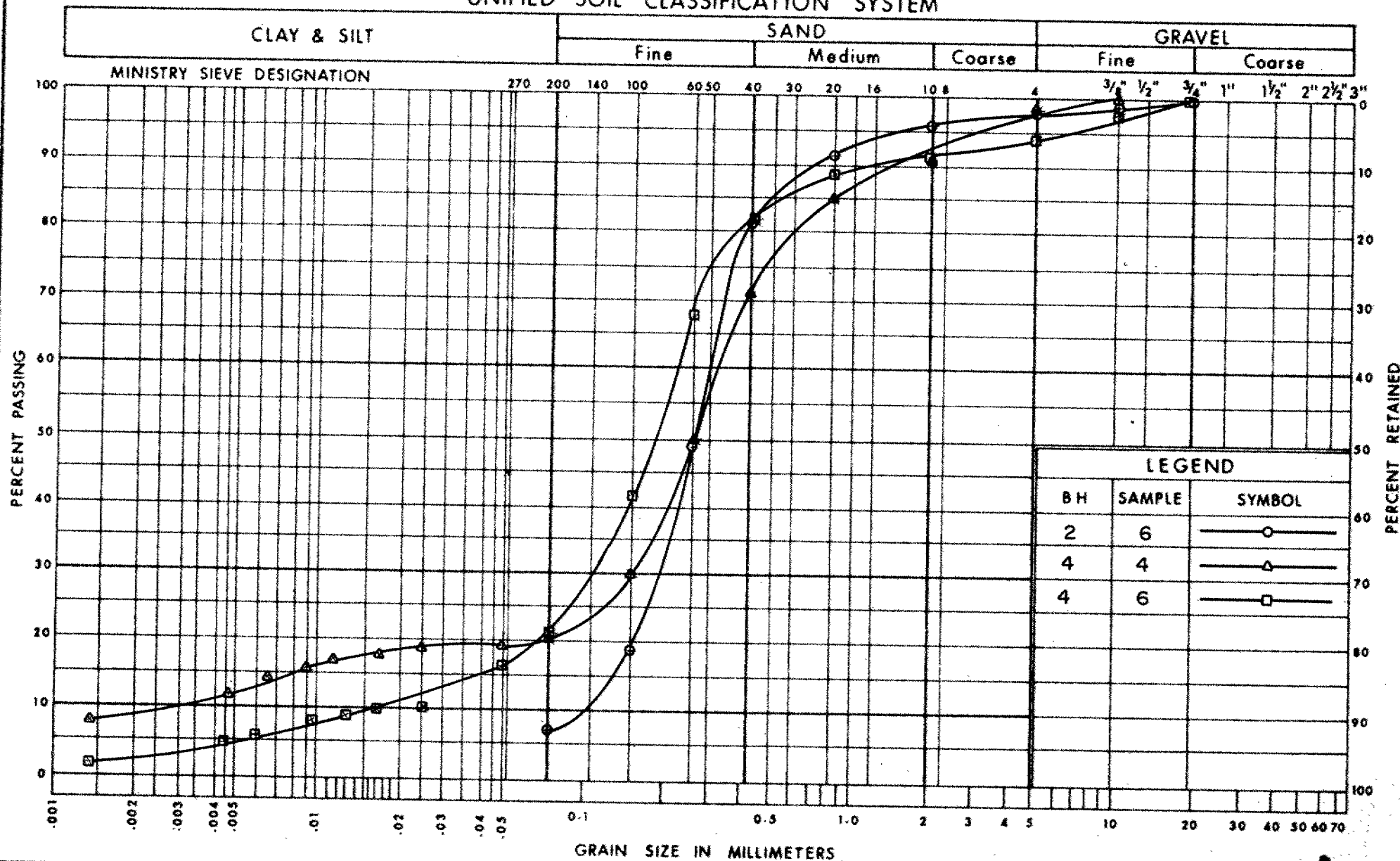
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL
MIXED

FIG No 2

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

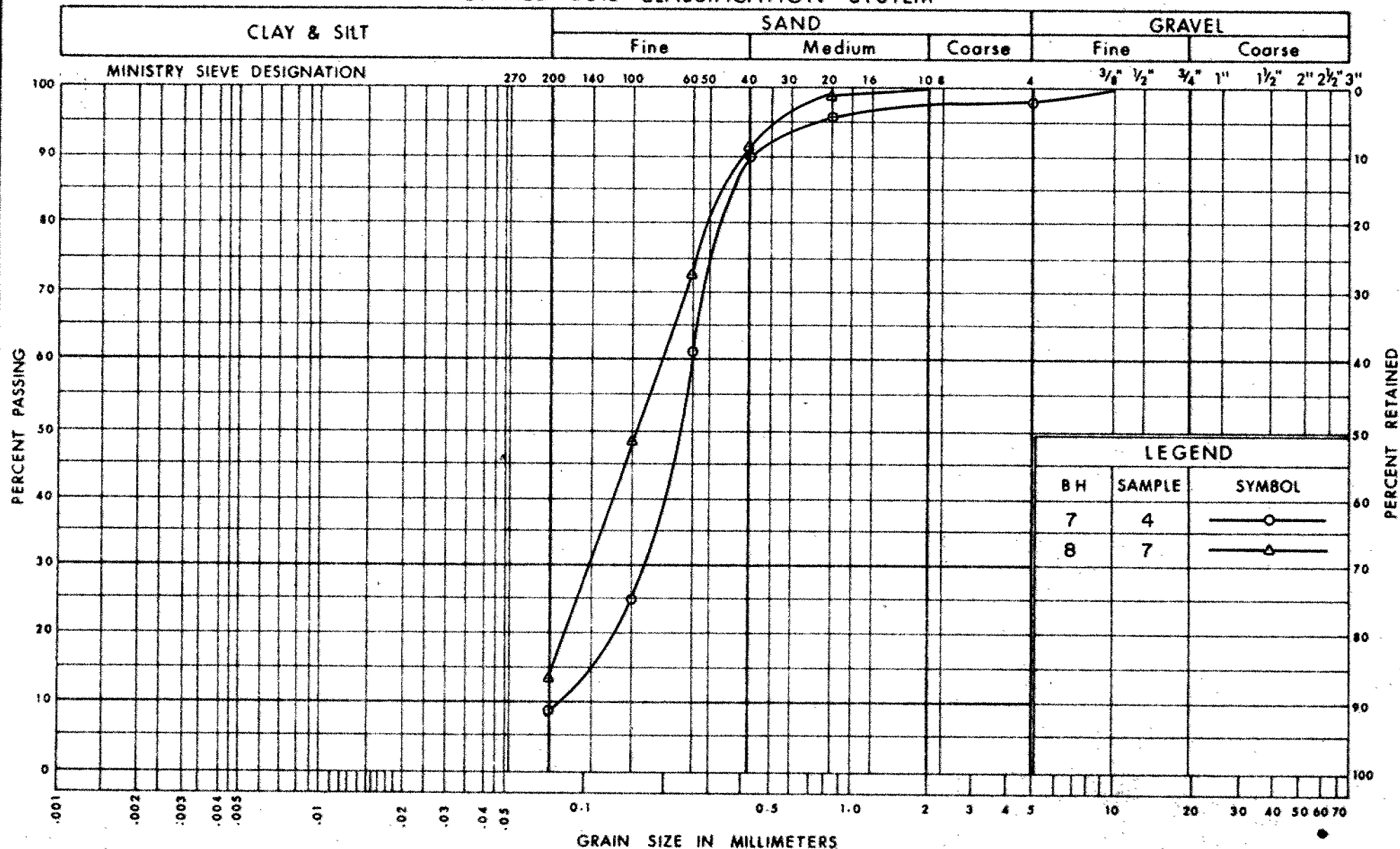
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SAND
MEDIUM TO FINE

FIG No 3

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



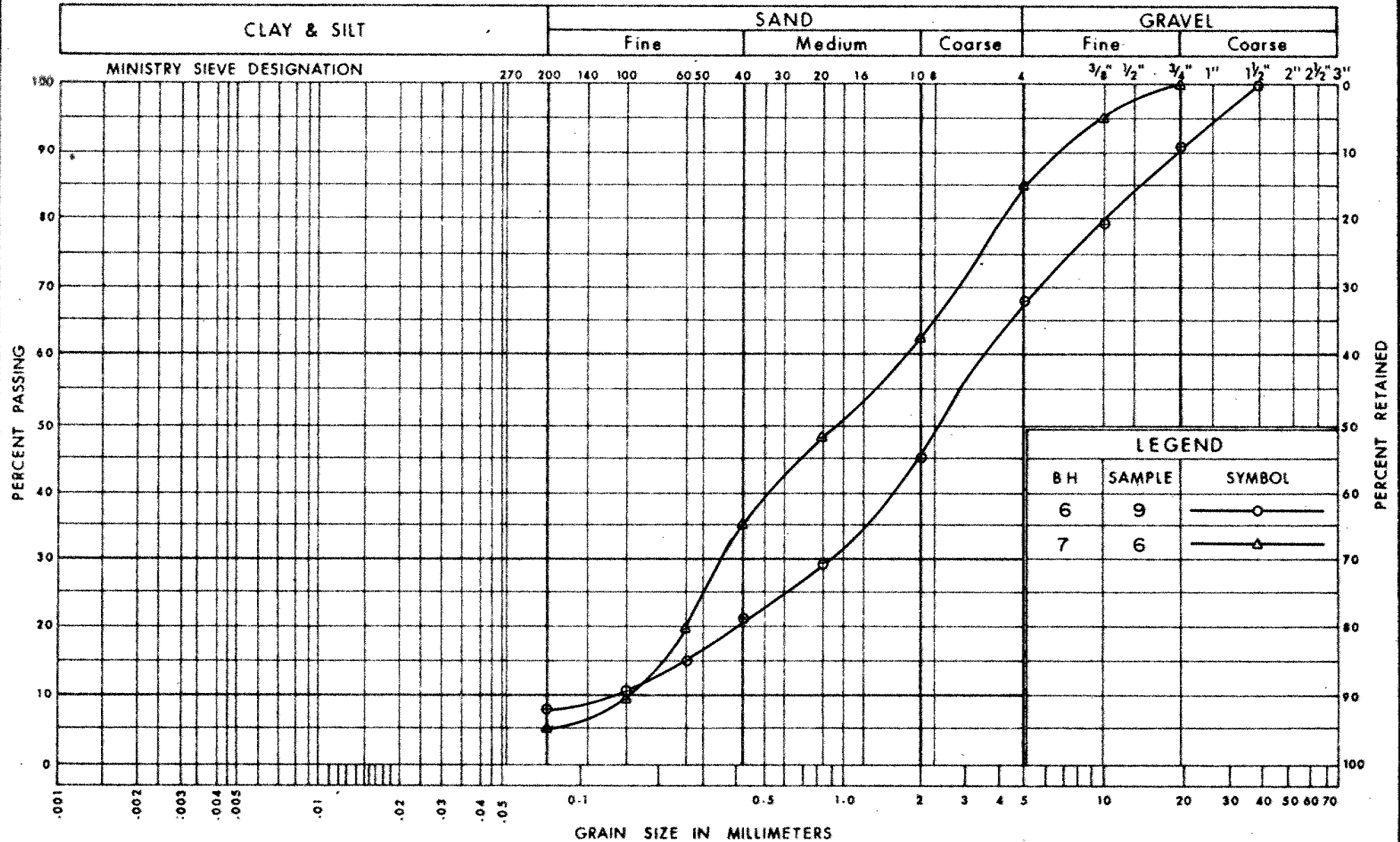
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SAND
MEDIUM TO FINE

FIG No 4

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



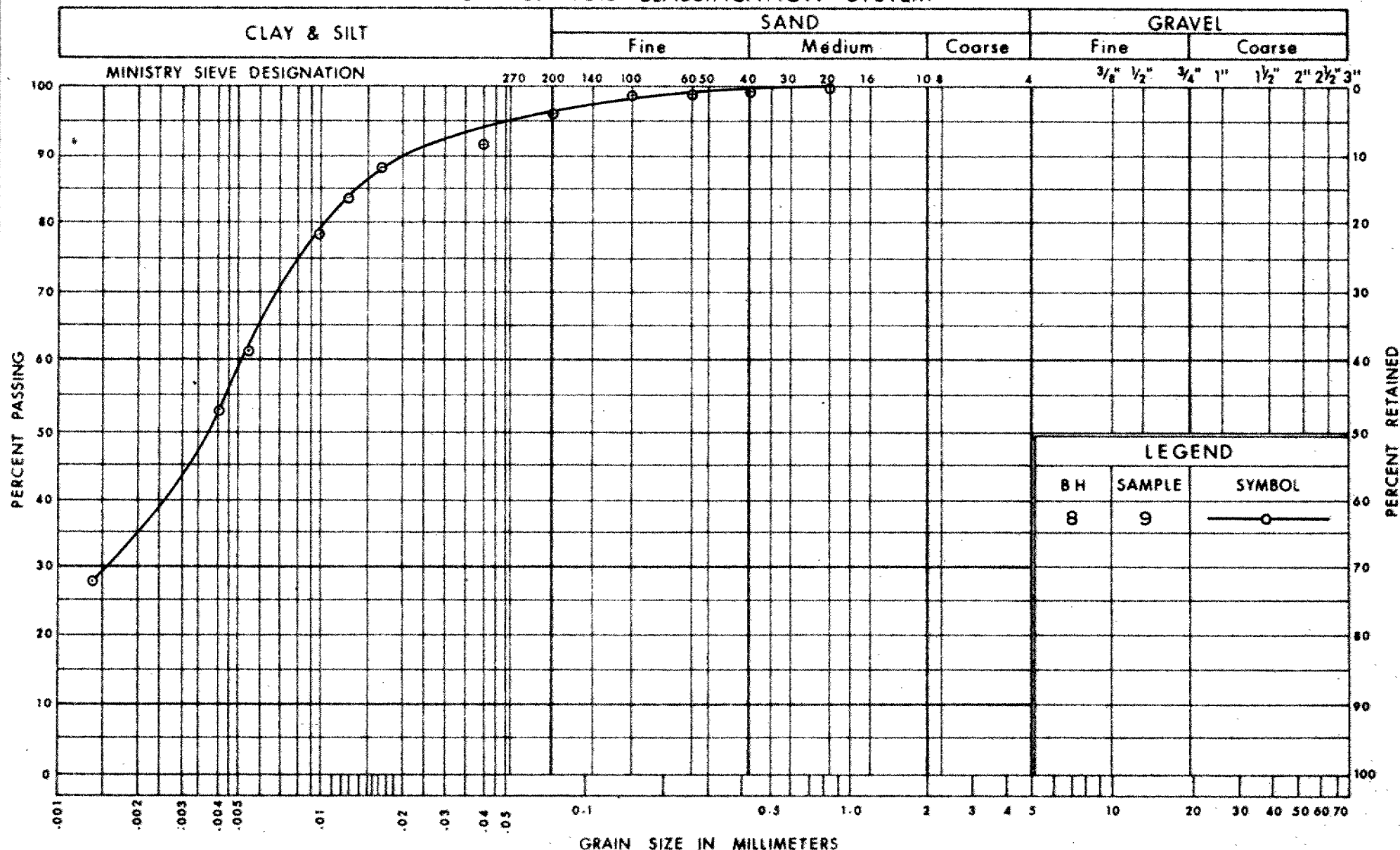
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND
SEAM

FIG No 5

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

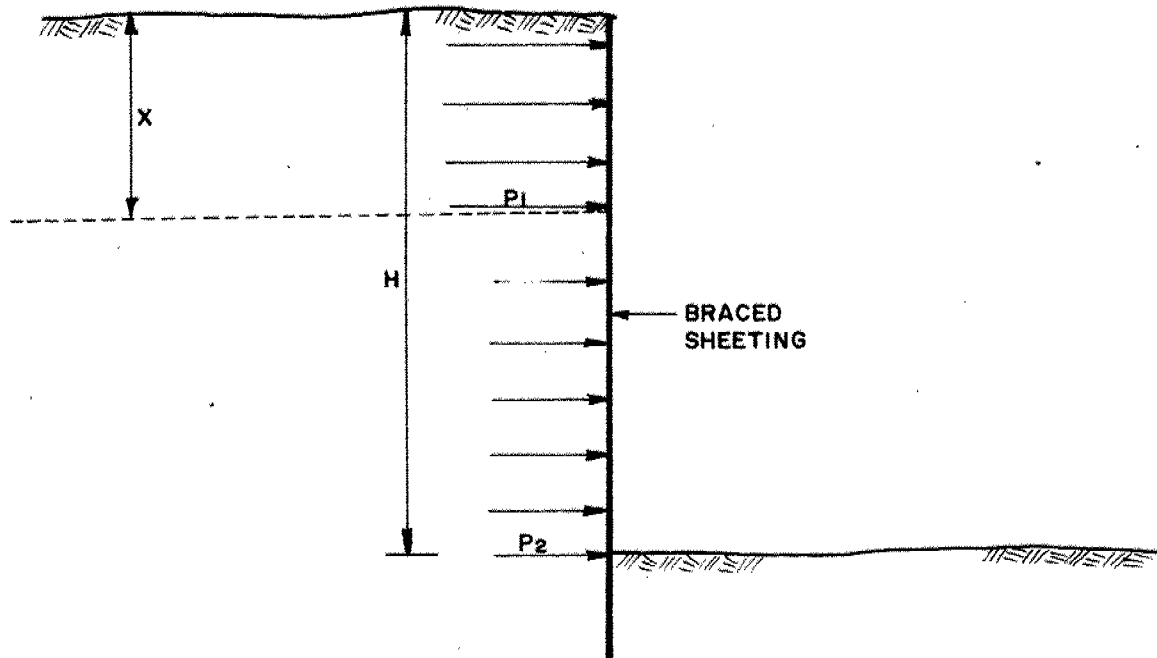
GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIG No 6

W P 33-76-15

LATERAL EARTH PRESSURE DISTRIBUTION FOR COHESIONLESS SILTS OR SANDS

FIGURE 7



$$P_1 = (0.65)(K_1)(\gamma_1)(x)$$

$$P_2 = (0.65)(K_2)(\gamma_2)(H-x)$$

WHERE

$$K_1 = 0.4$$

$$K_2 = 0.3$$

$$\gamma_1 = 110 \text{ lb./cu. ft.}$$

$$\gamma_2 = 125 \text{ lb./cu. ft.}$$

$$H = \text{TOTAL HEIGHT IN FEET}$$

$$x = \text{DEPTH OF FILL IN FEET}$$

NOTE : SURCHARGE LOADS HAVE NOT BEEN INCLUDED
AND MUST BE ADDED IF PRESENT

Date JUNE 1, 1981

Project 80-101

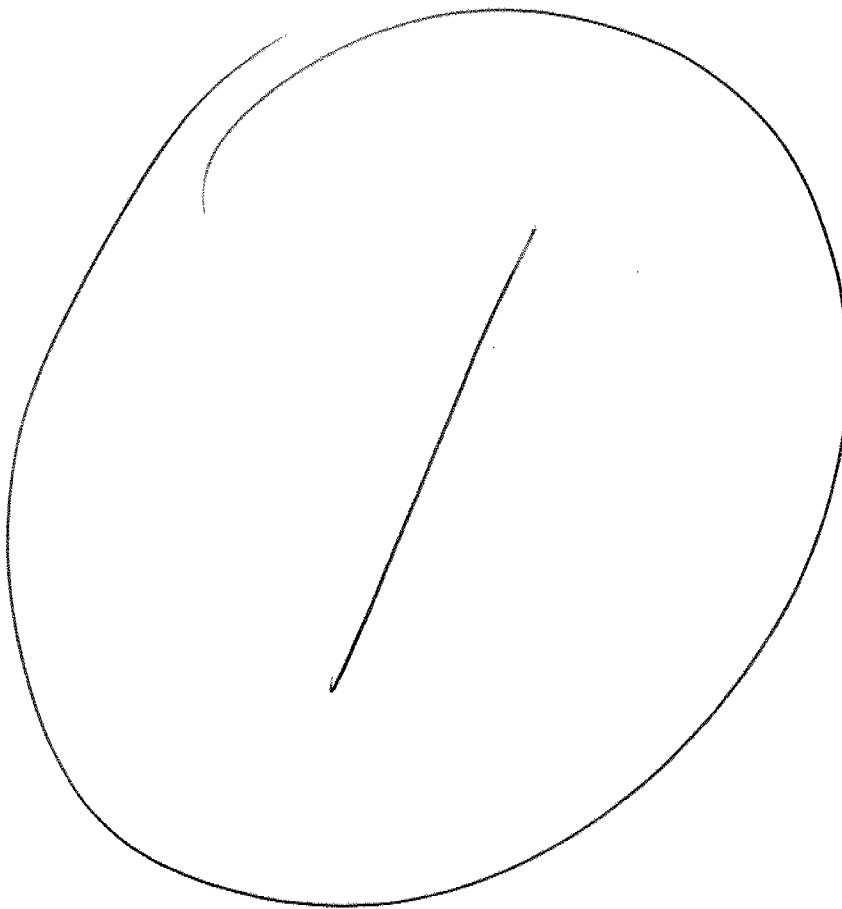
Golder Associates

Drawn M V

Chkd. _____

35MM

DRAWING



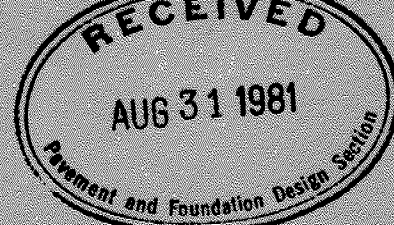
FOUNDATION INVESTIGATION REPORT

CONTRACT NO 81-96



Ontario

Ministry of
Transportation and
Communications



INDEX

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	Proposed Weston Road Storm Sewer Sta. 137 + 00 to Sta. 145 + 00 W.P. 33-76-15
	Black Creek Bridge at Weston Road Northwest Metro Arterial Road W.P. 33-76-18

NOTE: For purposes of the contract these reports supercede all other foundation reports prepared by or for the Ministry in connection with the above mentioned projects.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON A SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSITY: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CUU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_0 COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_0 INITIAL VOIDS RATIO
 e_{max} • IN LOOSEST STATE
 e_{min} • IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{w_L - w_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w_p}{w_L - w_s}$
 A_c ACTIVITY = $\frac{I_p}{w_L - w_s}$ Fraction
 O_m ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(undisturbed)}{S_u(remoulded)}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS
NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

GEOTECHNICAL INVESTIGATION

For

Proposed Weston Road Storm Sewer
Sta. 137 + 00 to Sta. 145 + 00
W.P. 33-76-15

INTRODUCTION

As part of the proposed Northwest Metro Arterial Roadway project (NWMA), Golder Associates have been retained by the Ministry of Transportation and Communications, to carry out a geotechnical investigation for a proposed storm sewer under the reconstructed Weston Road in the vicinity of the intersection with Rogers Road in Toronto, Ontario.

The purpose of the investigation was to determine the subsurface conditions along the proposed sewer alignment, and based on our interpretation of these conditions, to provide engineering recommendations for the geotechnical design of the proposed storm sewer.

The present boring program consisted of eight boreholes which were put down between May 4 and 6, 1981. A bombardier-mounted CME-55 power auger (supplied by Mater Soil Investigations Ltd) was used with a 4.5 in. diam. solid-stem augers for all boreholes except Borehole 7 where 7 in. diam. hollow-stem augers were used. A total of 255 ft. of sampled borings were put down to depths of about 26 to 36 ft.

In addition, the stratigraphy exposed by excavations for the construction of a retaining wall, was logged since it bordered on the project site (Station 145 + 90, 40 ft. Rt.).

SITE AND PROJECT DESCRIPTION

The site is located in the Borough of York along Weston Road from about 300 ft. south to 500 ft. north of Rogers Road. The surrounding land is primarily residential except for properties fronting on Weston Road which are industrial and commercial use.

The proposed 27 in. diam. storm sewer is part of the Northwest Metro Arterial Roadway (NWMA) Project which will connect Highway 400 and Weston Road. It is proposed to install the storm sewer within the road allowance for Weston Road and this report is for the section of sewer from Station 137 + 00 to 145 + 00, about 800 ft. in length. At this time, it is proposed to install the storm sewer from Station 137 + 00 to 145 + 00 at invert levels of 15 to 25 ft. below existing grade, by tunnelling methods below the center of the road. The preliminary design alignments of the storm sewer are shown on Drawing No. 2 .

SUBSURFACE CONDITIONS

Site Geology

From a review of geological references, the site is located in the Iroquois sand plain which consists of sandy deposits from glacial Lake Iroquois forming old shorelines, bars, and beaches. Gravelly beaches along the Humber River to the west were important sources of sand and gravel for many years. The site of the investigation is on the Baymouth Bar just south of Black Creek.

The sandy beach deposits are underlain by glacial tills of the Pleistocene Epoch which are underlain by grey shale of the Dundas formation at depths in excess of 100 ft.

Significant quantities of fill have been placed along Weston Road, south of the Black Creek, to meet the level of Rogers Road.

Soil Stratigraphy

The detailed stratigraphy encountered in each of the borings is given on the accompanying Record of Borehole sheets. Stratigraphic sections showing the inferred subsurface conditions across the site are given on Drawing 2 and 2A. The results of laboratory testing carried out on representative samples are given on the Record of Borehole sheets and on Figure 1 to 6 inclusive.

Fill

Fill materials were encountered in all boreholes from grade to depths of 5.5 to 16 ft. The fill depth varies both longitudinally and transversely along the proposed sewer alignment.

Along the existing east curb line on Weston Road, the fill depth is uniformly 7 to 8 ft. from Station 137 + 00 to 142 + 00. From Station 142 + 00 to 145 + 00 the fill depth decreases from about 7 ft. to about 3 ft. respectively.

Along the existing west curb line on Weston Road, the fill is uniformly 8 to 10 ft. from Station 137 + 00 to 140 + 00. Between Station 140 + 00 to 141 + 00 the depth of fill increases from 10 ft. to 15 ft. and remains at about 15 ft. depth up to Station 145 + 00.

A transverse cross-section across Weston Road at about Station 145 + 00 has the fill sloping from a depth of about 5 ft. under the east curb to about 16 ft. under the west curb. At about Station 142 + 00, the fill slopes from a depth of about 8 ft. under the east curb to about 15 ft. under the west curb (refer to Drawing 2A and 2B).

The fill is in a generally loose state with an average 'N' value of 8 (range of 5 to 15). The fill composition over the site is chiefly a brown silt with some clay (see Figure 1). At Borehole 8 (Station 144 + 76 50 ft. Lt. ϕ), from a depth of 5 ft. to 16 ft, the fill comprised a mixture of black silty sand, gravel and fragmented claybrick (see Figure 2). A gasoline odour was noticed at a depth of about 5 ft. in Borehole 8. No gasoline odour was noticed from the remaining samples from the fill in this borehole. The average measured water content of the fill was 18.5% (range of 7 to 38%).

Stratified Sand

Beneath the fill in all boreholes, a stratified medium to fine sand was encountered to depths of 25 to 35 ft. in Boreholes 1 to 7, the maximum

depth of exploration, and to 31 ft. in Borehole 8. The clay content of this stratum was measured as up to 10% and the silt content 5 to 15% (see Figures 3 and 4). The soil samples showed distinct horizontal stratification, typical of beach and delta deposits. Occasional thin seams and thicker zones of coarse sand and fine rounded gravel were also encountered (see Figure 5). The bottom 6 in. of Borehole 8 encountered a very stiff, brown clayey silt (see Figure 6).

The upper 5 to 9 ft. of the stratified sand deposit is in a compact state with an average 'N' value of 22 (range of 13 to 28). Below the compact upper zone of the stratum, the sand is dense with an average 'N' value of 41 (range of 19 to 68). The average water content of the stratified sand is 6% (range of 2 to 18%).

Groundwater Conditions

Following completion of each of the boreholes, piezometers were installed to allow monitoring of groundwater levels along the proposed sewer route. The details of piezometer installation are given on the accompanying Record of Borehole sheets.

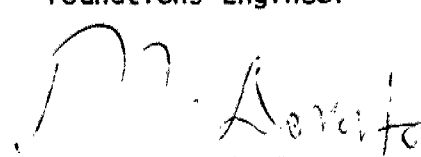
The piezometers were monitored on May 14, 1981, more than one week after installation and all piezometers were dry to the depths installed.

The fill overlying the native stratified sand was wet near the surface and an intermittent perched groundwater level may occur.



T. Kazmierowski, P. Eng.

Foundtions Engineer



M. Devata, P. Eng.

Senior Foundations Engineer

RECORD OF BOREHOLE No. 1

7

W P 33-76-15 LOCATION Sta. 137 + 30 32' Rt. C ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 5, 1981 CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
404.8	Ground Level																
0.0	Fill - granular																
0.8	Fill - silt, some clay																
	Loose Brown		1	SS	6											1 3 82 14	
397.8																	
7.0	Sand, medium to fine, stratified, trace, silt and fine gravel.		2	SS	22												
	Compact to Dense		3	SS	39												
			4	SS	31												
	Grey-brown		5	SS	19												
			6	SS	31												
			7	SS	30												
378.3			8	SS	68												
26.5	End of Borehole																

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 2

8

W P 33-76-15 LOCATION Sta. 138 + 30 45' Rt. E
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger
DATUM Geodetic DATE May 5, 1981
ORIGINATED BY MT
COMPILED BY MV
CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
405.0	Ground Level																
0.5	Pavement - 2" asphalt 4" granular						Feet										
	Fill - silt, some clay						Seal										
							Seal										
	Brown Loose		1	SS	5		400										
397.0							Pea Gravel										
8.0	Sand, medium to fine, stratified, trace silt and fine gravel.		2	SS	13		Dry May 14										
			3	SS	19		395										
			4	SS	37												
	Compact to Dense		5	SS	25		390										
	Grey-brown		6	SS	31												
			7	SS	30		385										
378.5			8	SS	43		380										
26.5	End of Borehole						375										

+3, x⁵; Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

W P 33-76-15 LOCATION Sta. 138 + 99 66' Lt. C ORIGINATED BY MT
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
DATUM Geodetic DATE May '4, 1981 CHECKED BY FJH

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 4

10

W P 33-76-15 LOCATION Sta. 140 + 00 59' Ltd. C ORIGINATED BY MT
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
407.1	Ground Level																
0.0	Concrete						Feet										
0.3							Seal										
405.1	Fill - granular																
2.0	Fill - silt, some clay																
	Brown Loose		1	SS	8		Dry May 14										
397.1							400										
10.0	Sand, medium to fine, stratified, some silt, trace clay and fine gravel seams		2	SS	28												
	Compact to Dense		3	SS	23												
			4	SS	27												8 71 13 8
	Grey-brown		5	SS	42												
			6	SS	56												8 72 15 3
			7	SS	30												
							380										
375.6			8	SS	47		Seal Pea Gravel										
31.5	End of Borehole						375										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 5

11

W P 33-76-15 LOCATION Sta. 14 + 18 59' Ltd. G ORIGINATED BY MT
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
409.7	Ground Level																
0.0	Pavement - 2" Asphalt, granular till.						Feet Seal										
406.7																	
3.0	Fill - silt, some clay		1	SS	6		405										
	Brown Loose		2	SS	12		400										
394.5			3	SS	28		395										
15.2	Sand, medium to fine, stratified, some silt, trace clay and fine gravel seams.		4	SS	22		390										
	Compact to Dense		5	SS	32		385										
	Grey-brown		6	SS	37		380										
			7	SS	28												
			8	SS	38												
375.7			9	SS	48		Seal Rea Gravel										
34.0	End of Borehole						375										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No. 6

12

W P 33-76-15 LOCATION Sta. 142 + 20 65' Rt. E ORIGINATED BY MT
 DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
 DATUM Geodetic DATE May 5, 1981 CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80					
407.0	Fill - silt, some clay															
	Loose Brown															
399.0	8.0 Sand, medium to fine, stratified, trace silt and fine gravel seams.		1	SS	6											
	Compact to Dense															
	Grey-brown															
377.5	29.5 Gravelly seam		9	SS	45											
375																
370.5	32.0															
370.5	37.5															
36.5	End of Borehole															

+³, x⁵: Numbers refer to Sensitivity

20
15-20.5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. 7

13

W P 33-76-15 LOCATION Sta. 143 + 20 50' Rt. E
DIST 6 HWY Weston Rd. BOREHOLE TYPE Hollow Stem Auger
DATUM Geodetic DATE May 6, 1981
ORIGINATED BY MT
COMPILED BY MV
CHECKED BY FJH

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 Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
403.3	Ground Level							○ UNCONFINED + FIELD VANE		10	20	30		GR SA SI CL
0.0	Fill - silt, some clay						Feet							
	Loose Brown						Seal							
							400							
397.8			1	SS	24		Dry							
	Sand, medium to fine, stratified, trace silt and fine gravel seams.						May 14							
							395							
			2	SS	13									
	Compact to Dense						390							
	Grey-brown		3	SS	41									
			4	SS	50		Seal							
							385							
			5	SS	41		Pea							
391.3							Gravel							
22.0	Gravelly seam		6	SS	55		Seal							
378.8							380							
24.5			7	SS	60									
							Dry							
							May 14							
							375							
			8	SS	28									
							Seal							
366.8			9	SS	44		Pea							
							Gravel							
36.5	End of Borehole						365							

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

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No. 8

14

W P 33-76-15 LOCATION Sta. 144 + 76 50' Lt. E ORIGINATED BY MT
DIST 6 HWY Weston Rd. BOREHOLE TYPE Solid Stem Auger COMPILED BY MV
DATUM Geodetic DATE May 4, 1981 CHECKED BY FJH

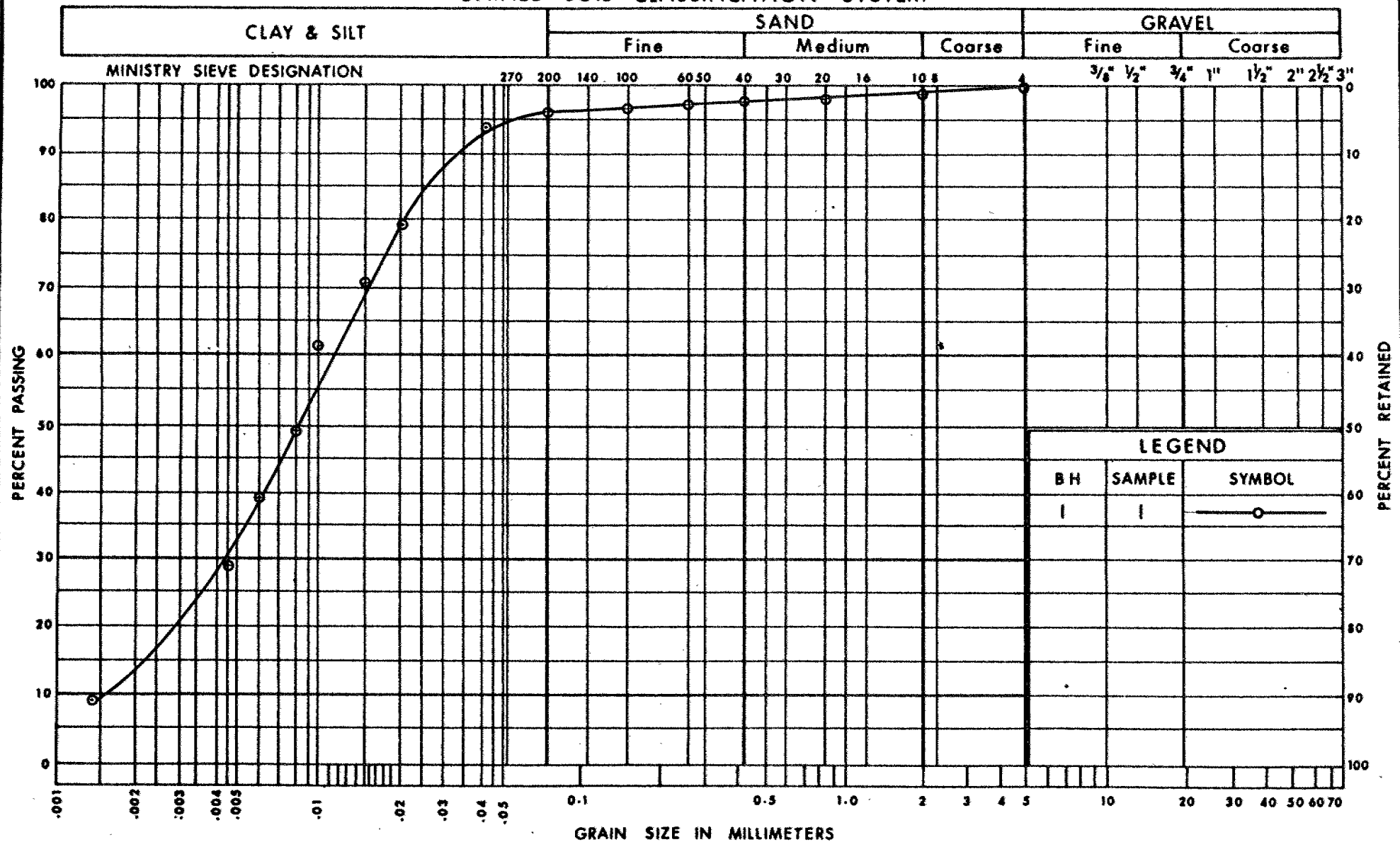
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH Feet	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
395.4	Ground Level															
0.0	Pavement - 3" asphalt - granular															
391.4																
4.0	Fill - mixture of silt, sand and gravel, bricks, concrete.		1	SS	5											
			2	SS	5											
	Loose		3	SS	15											
	Brown to Black		4	SS	13											
379.4			5	SS	23											
16.0	Sand, medium to fine, stratified, trace silt and fine gravel seams.		6	SS	40											
			7	SS	45											
	Dense															
	Grey-brown		8	SS	50											
	Clayey Silt very stiff Brown		9	SS	33											
31.5	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



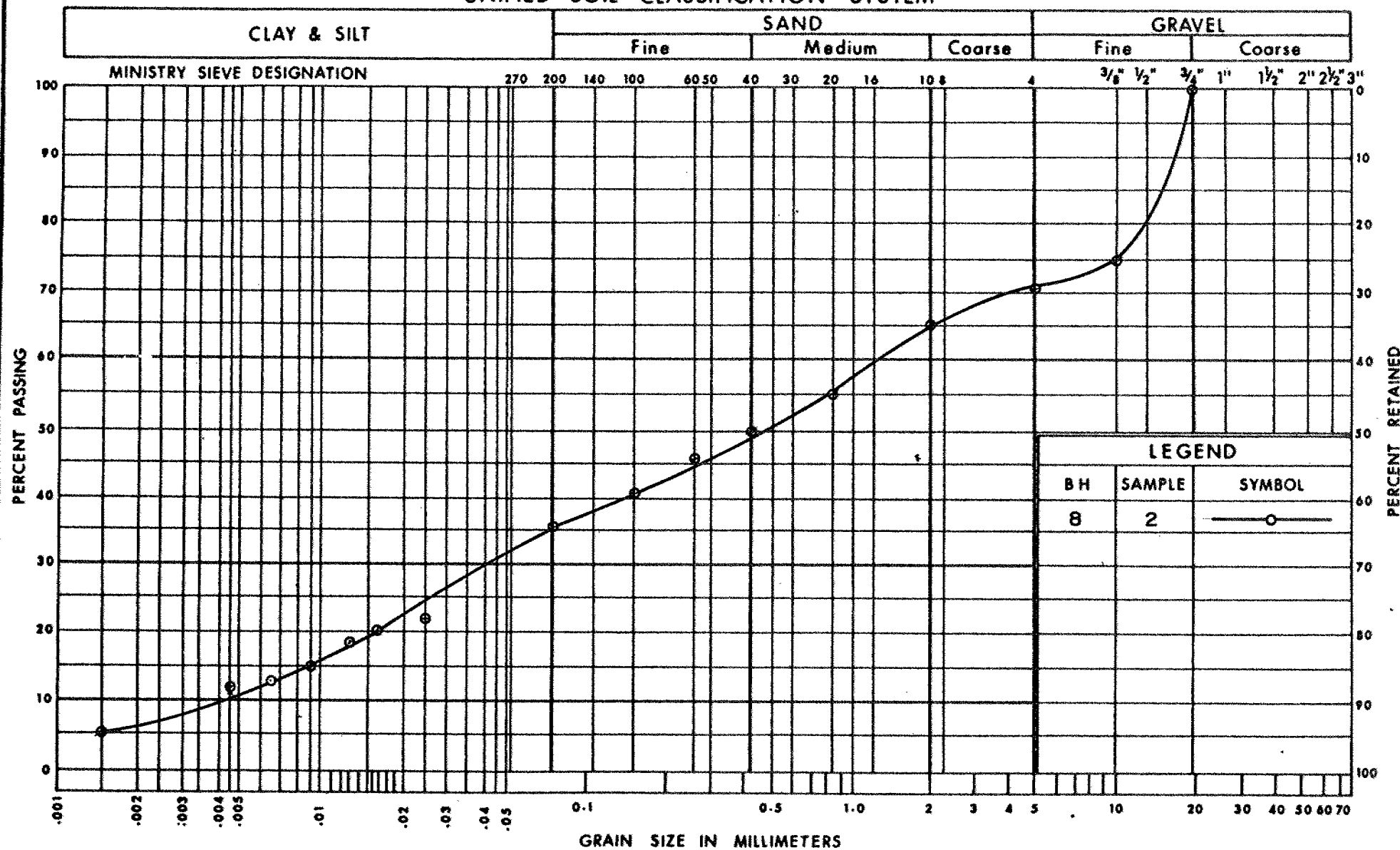
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL
SILT SOME CLAY

FIG No 1

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



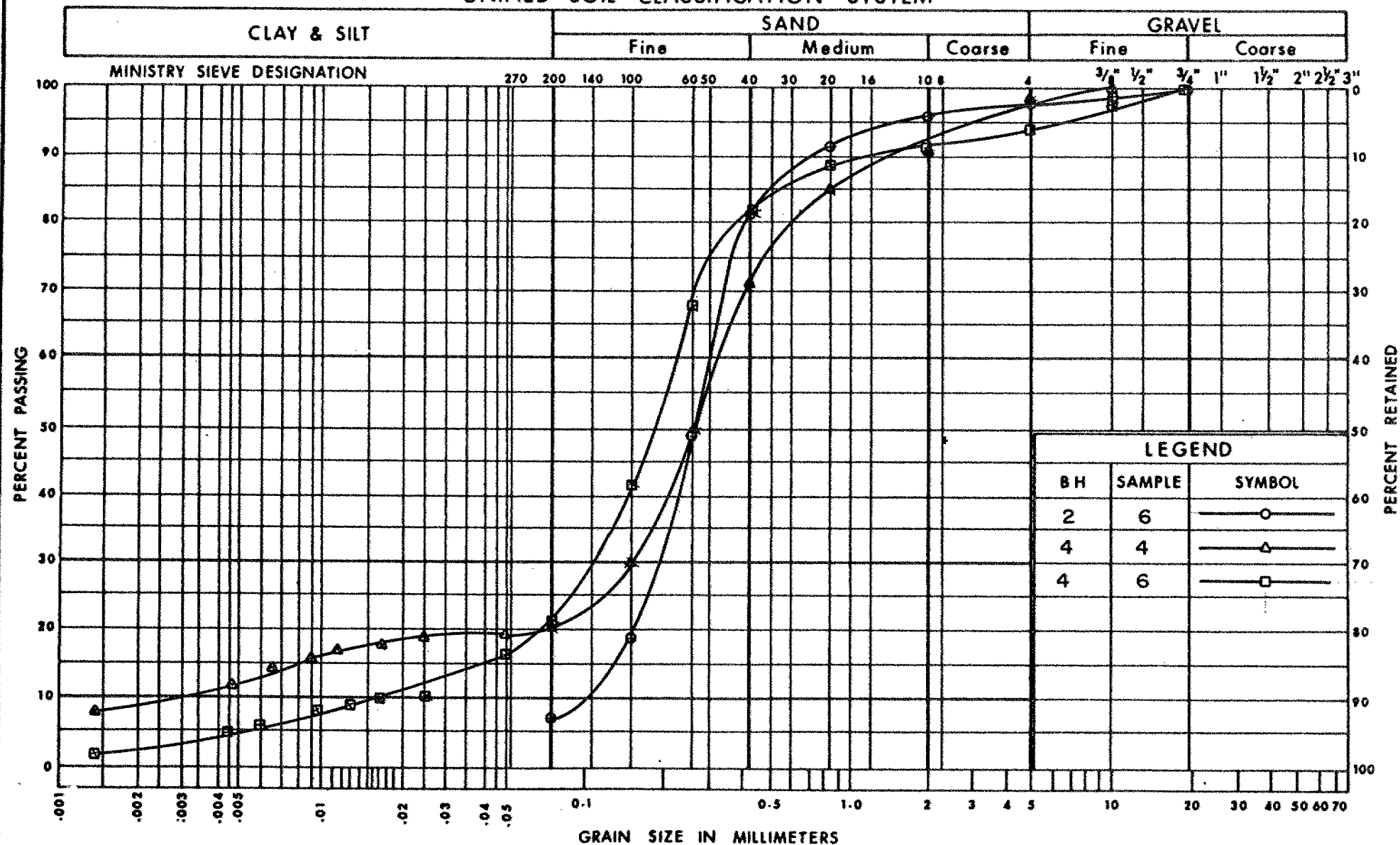
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
FILL
MIXED

FIG No 2

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



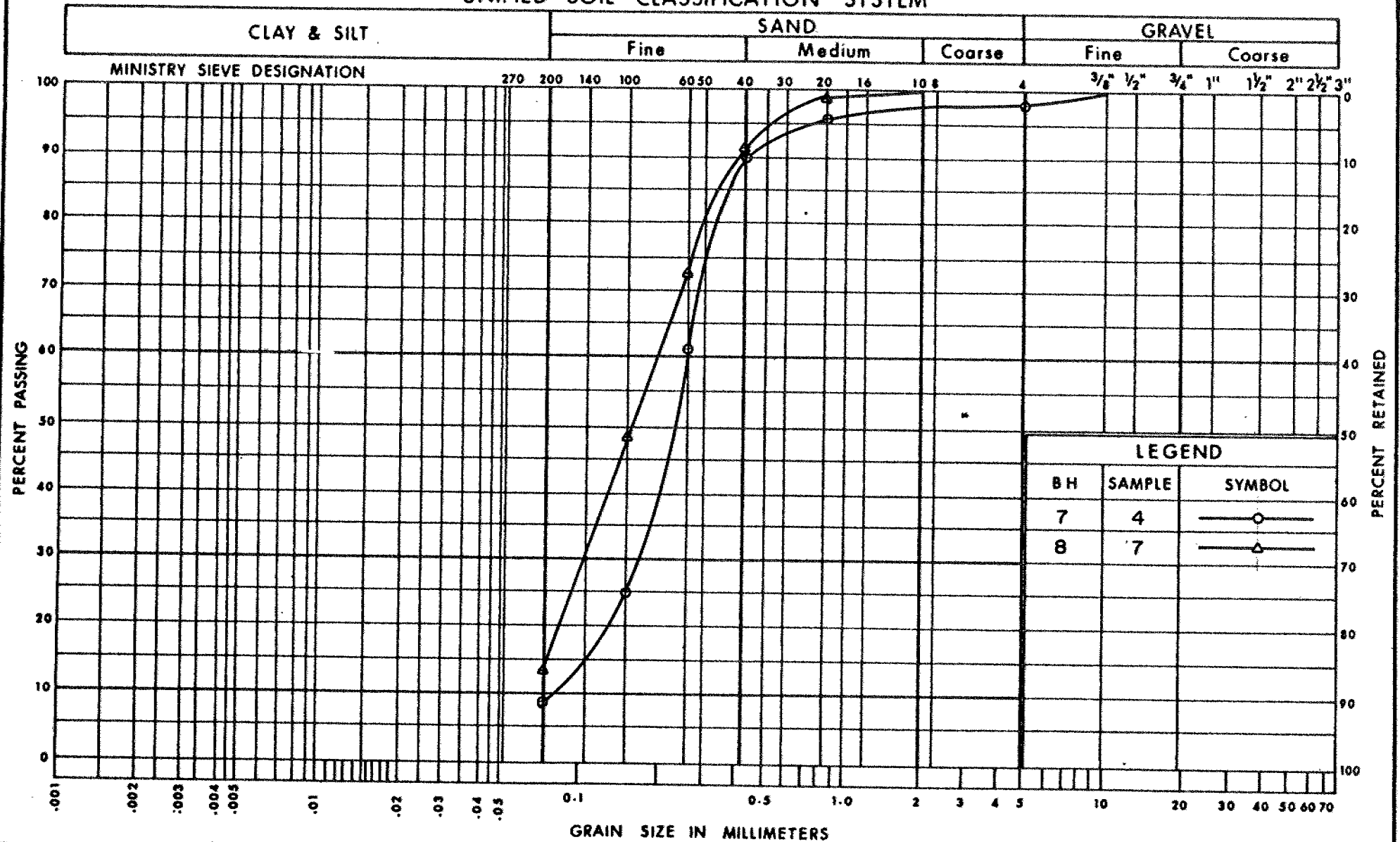
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SAND
MEDIUM TO FINE

FIG No 3

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



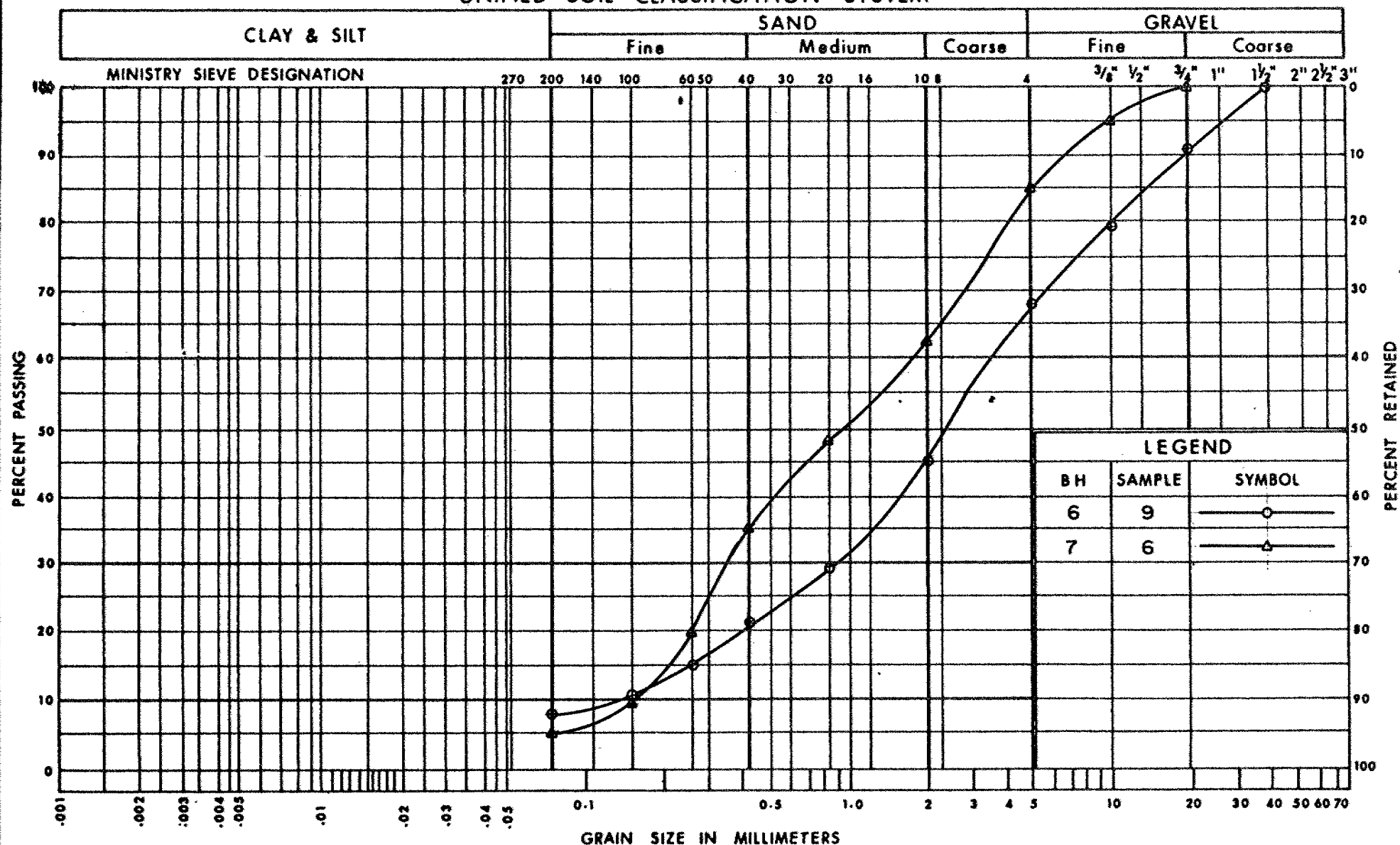
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SAND
MEDIUM TO FINE

FIG No 4

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



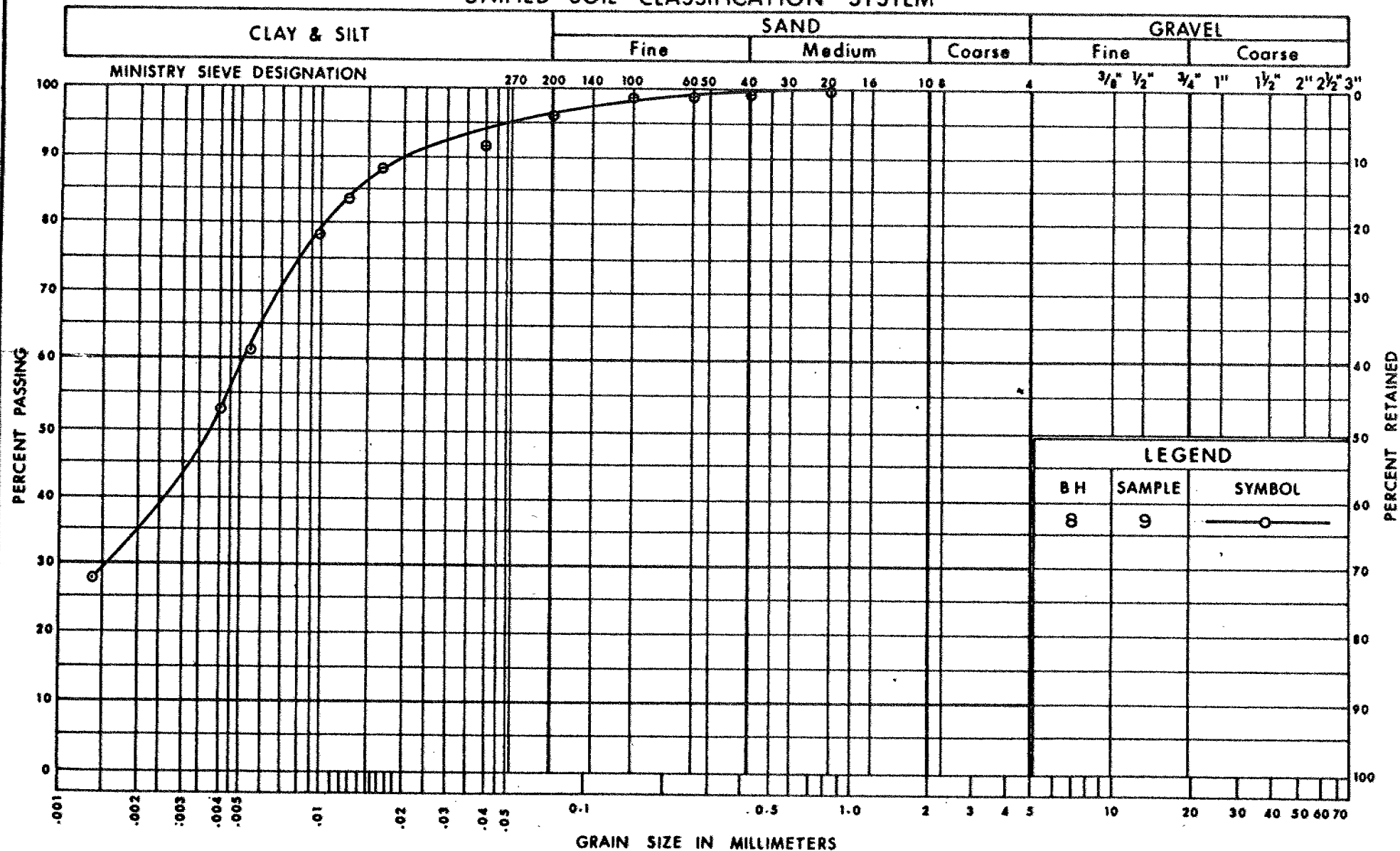
Ministry of
Transportation and
Communications
Ontario

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND
SEAM

FIG No 5

W P 33-76-15

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIG No 6

W P 33 - 76 - 15

FOUNDATION INVESTIGATION REPORT

For

Black Creek Bridge at Weston Road
W.P. 33-76-18, Site 37-519
Northwest Metro Arterial Road
District 6, Toronto

INTRODUCTION

As part of the proposed Northwest Metro Arterial Roadway project (NWMA), Golder Associates have been retained by the Ministry of Transportation and Communications, to undertake a subsurface investigation for a proposed bridge/culvert and hydraulic transition structure to carry the reconstructed Weston Road over the existing Black Creek in Toronto, Ontario.

The purpose of the investigation was to determine the subsurface conditions at the site, and based on our interpretation of these conditions, to provide engineering recommendations for the geotechnical design of the proposed structure.

The present drilling programme consists of three boreholes numbered 201 to 203, inclusive which were put down between October 24 and 27, 1979, using a bombardier mounted CME 55 power auger operated by Eastern Soil Investigations Ltd. Boreholes 202 and 203 were put down using 4-1/2 in. diameter solid stem augers, while Borehole 201 was advanced with 7 in. diameter hollow stem augers. No undue difficulties were encountered during the drilling, except in the water bearing sand stratum found at depth in Borehole 201. The sub-artesian water conditions in this stratum caused the sand to "blow" inside the augers, requiring they be washed out with a chopping bit prior to sampling. In all, a total of approximately 174.5 ft. of sampled borings were put down during the present investigation.

PREVIOUS INVESTIGATIONS

Two previous investigations were carried out in the vicinity of the present project as part of a study for adjacent structures of the

NWMA. The investigations comprised preliminary borings undertaken by the Ministry followed by a more detailed programme carried out by Golder Associates. The factual borehole and laboratory data obtained from both of these previous investigations are summarized in Golder Associates' report 781308 and were considered in the preparation of this report. In particular, the data obtained from Borehole 1 (which was put down during the preliminary Ministry study) is directly applicable to the present project since the borehole is located at the northwest corner of the proposed structure.

SITE AND PROJECT DESCRIPTION

The site is located in a fully urban area in the Borough of York, near the intersection of Weston Road and Humber Boulevard.

The surrounding land use is primarily residential except for some small commercial buildings on the north side of Weston Road. Railway lines for both the CN and CP cross the Black Creek valley immediately north of the project. An existing structure with a 33 ft. wide hydraulic opening carries Weston Road over the Black Creek. The creek flows in an open "natural" channel to the north (upstream) of the existing structure and a 40 ft. wide concrete lined channel is flared slightly at the bridge to accommodate the difference between the bridge opening and downstream channel width.

The proposed structure will form part of the Northwest Metro Arterial Roadway system, and will have a 36 to 40 ft. wide opening to increase hydraulic capacity. Upstream of the structure the flow from the existing open channel will be directed beneath the bridge by a transition structure having flared vertical wing walls, and an 8 ft. drop section. Downstream of the bridge, a transition to the existing lined channel will be constructed. At this time, it is proposed to retain the east wall of the existing lined channel and reconstruct the west wall to obtain the required channel width.

SUBSURFACE CONDITIONS

Site Geology

From a review of selected geological references, the site falls within the physiographic region known as the South Slope of the Oakridges Interlobate Moraine. This area is characteristically underlain by glacial tills of the Pleistocene Epoch, with some interstadial deposits of sand. Shale bedrock of the Dundas formation underlies the area at considerable depth.

Recent accumulations of alluvium and fill may be expected within the Black Creek valley and in the vicinity of the existing road and bridge structures.

Soil Stratigraphy

The detailed stratigraphy encountered in each of the borings is given on the accompanying Record of Borehole sheets. A stratigraphic section showing the inferred subsurface conditions across the site is given on Drawing 2. It should be noted that the boundaries shown between the various strata are based on non-continuous sampling and typically represent a transition between the soil types rather than an exact plane of geologic change.

In summary, the site is underlain by fill and recent alluvial materials beneath which a till-like, competent clayey silt stratum is encountered. A relatively thin deposit of interstadial dense sand overlying hard glacial till was found at depth beneath the clayey silt.

Fill Materials: Fill materials were encountered in all boreholes from grade to depths of 7 to 15 ft. Two main types of fill material were encountered.

On the south side of Weston Road, essentially granular fill was encountered from grade to a depth of 7 ft. The material is relatively "clean" and generally comprises fine-medium sand with some silt and

gravel and a trace of clay. Occasional pieces of building rubble such as brick fragments were also noted in some samples. The fill is generally compact with 'N' values ranging from 10 to 22 blows/ft.

Fill materials of an essentially random composition were encountered beneath the granular fill in Borehole 202 to a depth of 15 ft. and from grade to 7 ft. and 10 ft. depths in Boreholes 1 and 203 respectively. In Boreholes 202 and 203, the fill consisted of silty fine sand with varying amounts of gravel and clay, and contained some organic matter and building rubble throughout. 'N' values of 5 to 74 blows/ft. were recorded during sampling. It is suspected that the higher values are the result of coarse gravel or brick fragments, and the fill is actually in a loose state throughout. In Borehole 1, the fill material is reported to consist of firm/loose clayey silt and silty sand.

Recent Alluvium: Underlying the fill materials on the east side of Black Creek, alluvial material, probably deposited by the Black Creek, was encountered to depths of 18 to 22 ft. below grade, respectively. This stratum consists of loose to compact fine-medium sands, with a trace to some clay, silt and gravel. The material is grey to brown in colour and has occasional dark grey to black zones of organic staining. Faint laminated and cross bedded structures were noted in some of the samples.

Upper Sandy Silt: In Borehole 203 only, a layer of dense sandy silt was sampled from 20 to 21.5 ft. However, based on the rate of advance of the augers, and the appearance of the auger cuttings brought to the ground surface, it is thought that this stratum extends from about 18 to 23 ft. depth. A standard penetration resistance value of 38 blows/ft. was recorded during sampling, suggesting that the material is in a dense state. No layering or other depositional structures were noted in the sample obtained.

Upper Clayey Silt: This stratum was found at depths of 7, 19, 22 and 23 ft. in Boreholes 1, 201, 202 and 203 respectively. This stratum was not fully penetrated by Boreholes 202 and 203 (terminated at a depth of about 41 ft. below grade) but was found to extend to depths

of 64 and 43 ft. in Boreholes 1 and 201 respectively.

The material contains a trace to some sand and gravel and is well graded and till-like (see Figure 3 for gradation analyses). Occasional thin seams of sand were noted throughout, and in particular, a zone of silty fine sand to sandy silt was noted in the 25 to 26.5 ft. sample from Boreholes 1 and 202. The soil also exhibited a faintly laminated structure in some samples.

The material is generally stiff to very hard, except in the upper portion of Borehole 1, where it reportedly has a firm consistency. Laboratory testing by the Ministry indicates an undrained shear strength of about 600 lb/sq. ft. in the firm zone, while field vane tests in this zone indicate an undrained shear strength in excess of 2000 lb/sq. ft.

The liquid limit of the material varies between about 20 and 26 percent and the plasticity index is about 7 to 10. The measured water content of the soil is approximately 25 percent in the firm zone of Borehole 1 and is generally between 12 and 16 percent in other areas. Based on the relatively low natural water content and liquidity indices, it is anticipated that this stratum will be of very low compressibility.

Middle Silt Stratum: A deposit of very stiff to hard silt containing a trace to some clay and occasional sand seams was encountered between depths of about 43 and 65 ft. in Borehole 201 (see Figure 4 for gradation analysis). The upper portions of this stratum have the highest clay content and are slightly cohesive while below approximately 50 ft. depth, the silt is essentially non-cohesive. The natural water content is generally between 15 and 22 percent.

Lower Sand Stratum: In Boreholes 1 and 201, a sand stratum was encountered from about 64 to 68 ft. and 65.5 to 80 ft. depths respectively. In Borehole 201, the soil graded with depth from a silty fine to a fine-medium sand with a trace of silt (see Figure 2 for gradation analysis).

The sand is compact to dense with 'N' values of 26 to 40 blows/ft. recorded during sampling. It is anticipated that the material is actually in a very dense state, but was loosened during sampling by

upward groundwater movement and/or the washboring procedure.

Glacial Till: Glacial till was found from 68 and 80 ft. depths to the base of Boreholes 1 and 201 respectively. It was not penetrated in any of the borings for this investigation.

The till generally comprises clayey silt, with some sand and gravel throughout (see Figure 5 for gradation analysis). It has a hard consistency with 'N' values of 30 to 39 blows/ft. and a low plasticity with liquid and plastic limits of 11 and 20 percent respectively. Natural water content of the strata is uniformly low at 12 and 13 percent.

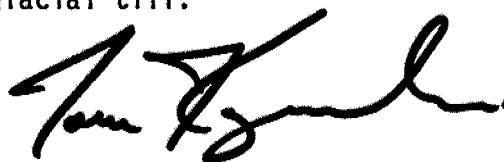
Groundwater Conditions

Following completion of each of the boreholes, standpipes were installed to allow monitoring of groundwater levels across the site.

The water level in the standpipe installed in Borehole 203, with its tip in the clayey silt to sandy silt stratum, was at about 14 ft. depth after five days. The standpipe in Borehole 202, with its tip at about 15 ft. depth in the alluvial materials, was dry after five days. A water level at about 1.5 ft. below grade was recorded in the standpipe installed in the lower sand stratum in Borehole 201.

It is expected that the water level in the upper pervious deposits of fill, alluvium and sandy silt will generally coincide with the water level in the adjacent Black Creek.

Although not penetrated in this investigation, previous borings to the east of the site indicate that a sand stratum with artesian water conditions is found below the glacial till.



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



M. Devata, P. Eng.
Senior Foundations Engineer



MINISTRY OF
TRANSPORTATION
CANADA

RECORD OF BOREHOLE No 1 (ORIGINATED BY M.T.C.)

W.P. 33-76-18 LOCATION Co-ords. N 472 572 E 1 005 221 ORIGINATED BY S.L.
DIST 0 HWY N.W.M.A. BOREHOLE TYPE Hollow Stem Auger COMPILED BY S.L.
DATUM Geodetic DATE March 23, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES			20	40	60	80	100					
0-0.6	GROUND LEVEL																
0.0	Fill: Clayey Silt And Silty Sand		1	SS	9		340										
0.6			2	SS	6												
7.0	Clayey Silt: Some Sand And A Trace Of Gravel. Very Stiff		3	SS	6												2 16 50 32
			4	SS	5												
			5	TW	PH		330									124.0	
			6	SS	39												
			7	SS	33												3 28 52 17
			8	SS	39												
	Sandy Silt Trace Of Clay		9	SS	41		320										0 41 50 9
			10	SS	45												
			11	SS	37												
			12	SS	38		310										
			13	SS	26												
	Silt: Some Sand & Clay		14	SS	26		300										0 22 63 15
			15	SS	31												
	Stiff		16	SS	26		290										
			17	TW	PH												
280.6			18	SS	26		280									127.5	
276.6	Sand: Fine To Medium Compact		19	SS	26												
273.1	Glacial Till		20	SS	17												
71.5	End Of Borehole																

* 1, * 5: Numbers refer to
Sensitivity

20
10
15
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 201

28

W P 33-76-18 LOCATION STA. 152+08.42' LT. (15,872,405 N., 1,005,252 E.) ORIGINATED BY W.W.
DIST 6 HWY NWMA BOREHOLE TYPE HOLLOW STEM AUGER & CONE TEST COMPILED BY M.H.W.
DATUM GEODETIC DATE OCTOBER 24-26, 1979 CHECKED BY *PA*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	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								
349.9	GROUND SURFACE												
0.0	Fill, fine to medium sand, some silt and gravel, brick fragments		1	SS	22								
342.9	Compact to loose Brown		2	SS	10								
7.0	Sand, fine to medium, some silt, trace clay and organic matter (Recent alluvium)		3	SS	8								
	Loose Brown		4	SS	4								
	Grey		5	SS	4								
330.9													
19.0			6	SS	45								
	Clayey Silt, trace to some sand and gravel, faintly laminated (Till- Like)		7	SS	37								
	Hard Grey		8	SS	27								7 32 44 17
			9	SS	35								
306.9			10	SS	52								
43.0													
	Silt, trace to some clay, trace fine sand in layers		11	SS	37								
	Hard Grey		12	SS	27								0 5 86 9
			13	TW	PH								
			14	CS	PH								
284.4													
65.5	Silty fine sand Dense Grey		15	SS	40								
	Clayey silt till		16	SS	40								
	Sand, fine to medium, trace to some silt		17	SS	30								1 87 9 3
	Dense Grey												
269.9			18	SS	30								
80.0	Clayey Silt, trace to some sand and gravel (Glacial Till)		19	SS	32								7 34 43 16
	Hard Grey												
258.4			20	SS	39								
91.5	END OF BOREHOLE												

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 202

29

W P 33-76-18 LOCATION STA. 152+72.57' LT. (15,872,396 N, 1,005,183 E.) ORIGINATED BY W.W.
DIST 6 HWY NWMA BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY MHW
DATUM GEODETIC DATE OCTOBER 26, 1979 CHECKED BY R.E.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (FEET)	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH				WATER CONTENT (%)				
349.6	GROUND SURFACE							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE				
0.0	Fill, fine to medium sand, some gravel, some silt Compact Brown		1	SS	21											
342.6			2	SS	17											
7.0	Fill, fine silty sand, trace gravel, trace organic matter Loose Grey brown		3	SS	5											
334.6			4	SS	7											
15.0	Sand, fine to medium, trace to some gravel, trace clay, trace organic matter (Recent alluv.) Compact Brown to grey		5	SS	22											
327.6			6	SS	29											
22.0	Silty fine sand ----- Dense Grey ----- Clayey Silt, trace to some sand and gravel, faintly laminated, occasional thin seams of fine sand (Till- Like) Hard Grey		7	SS	92											
			8	SS	54											
			9	SS	90											
308.1			10	SS	65											
41.5	END OF BOREHOLE															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 203

30

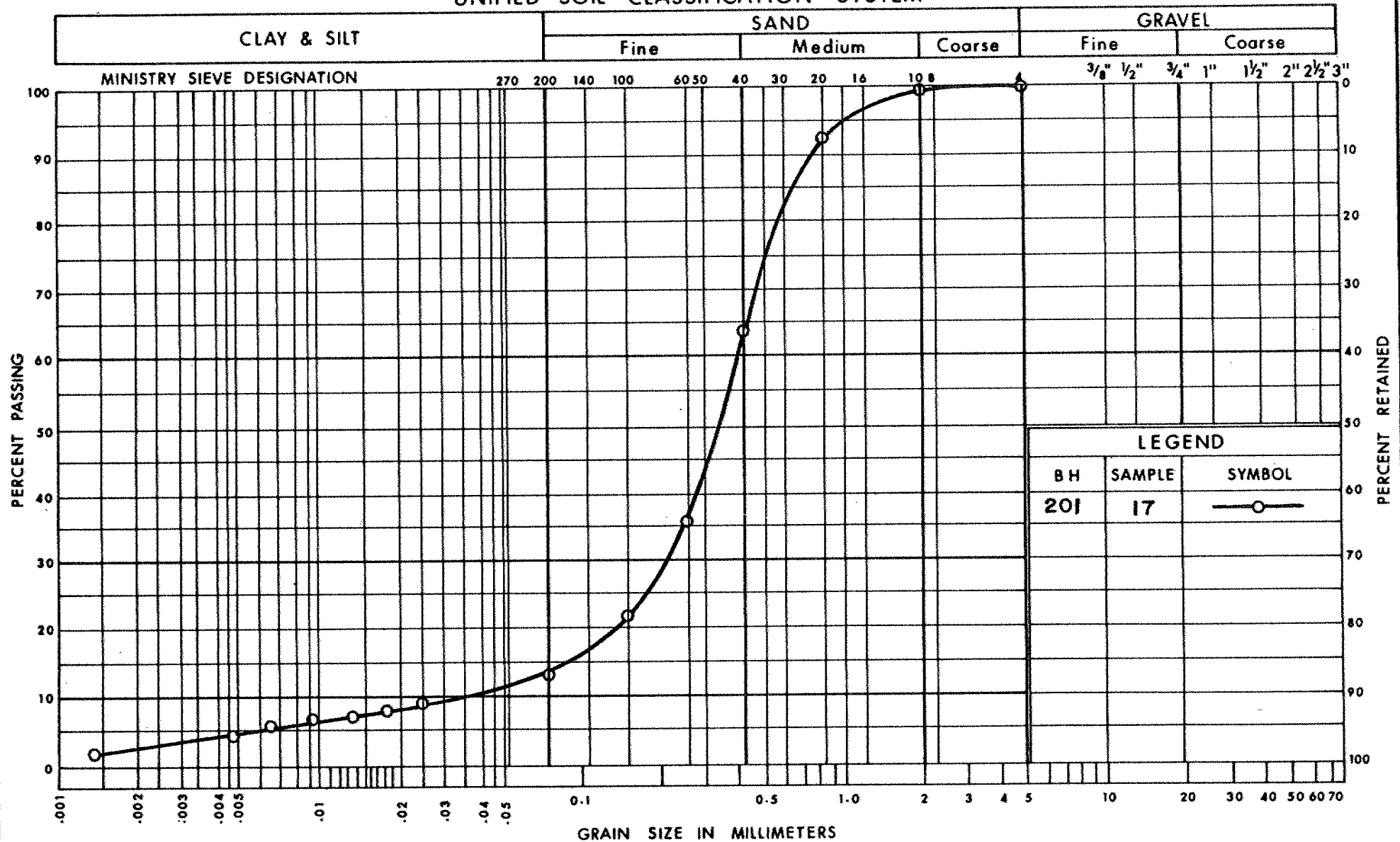
W P 33-76-18 LOCATION STA.151+90.97 RT. (15,872,535 N., 1,005,308 E.) ORIGINATED BY W.W.
DIST 6 HWY NWMA BOREHOLE TYPE SOLID STEM AUGER & CONE TEST COMPILED BY MHW
DATUM GEODETIC DATE OCTOBER 27, 1979 CHECKED BY WWS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE (FEET)	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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N° VALUES							
349.2	GROUND SURFACE		1	SS	39							
0.0	Fill, fine silty sand, trace to some gravel, some debris trace organic matter and brick fragments		2	SS	74							
			3	SS	31							
339.2	Compact to dense Brown		4	SS	37							
10.0	Sand, fine to medium, some silt, trace of gravel & organic matter (Recent alluvium)		5	SS	14							
	Loose to compact		6	SS	7							
331.2	Grey brown		7	SS	38							
18.0	Sandy silt		8	SS	58							
326.2	Dense Grey		9	SS	30							
23.0	Clayey Silt, trace to some sand & gravel (Till-Like)		10	SS	57							
	Hard Grey		11	SS	24							
307.7												
41.5	END OF BOREHOLE											

*3, *5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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Communications

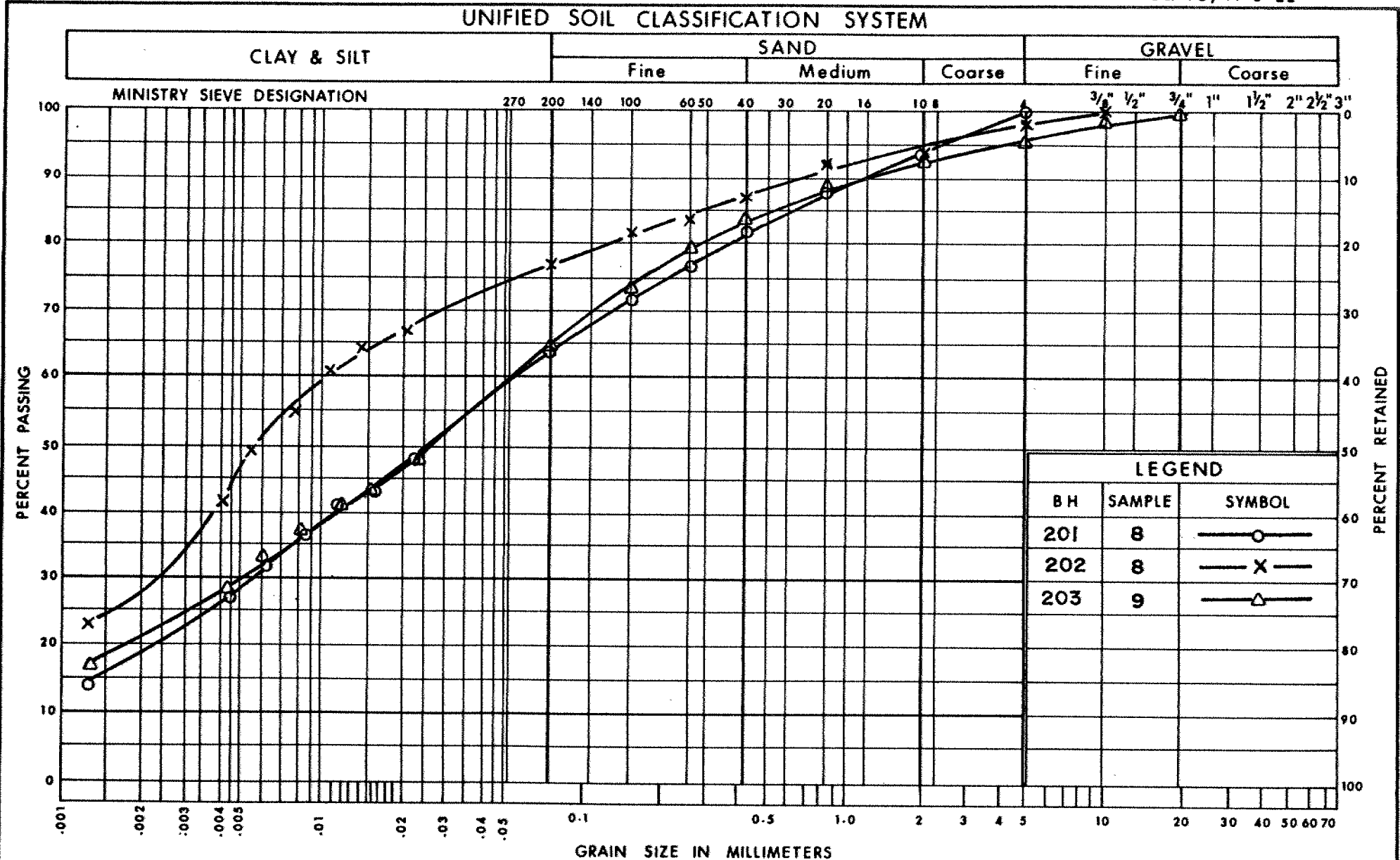
ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION

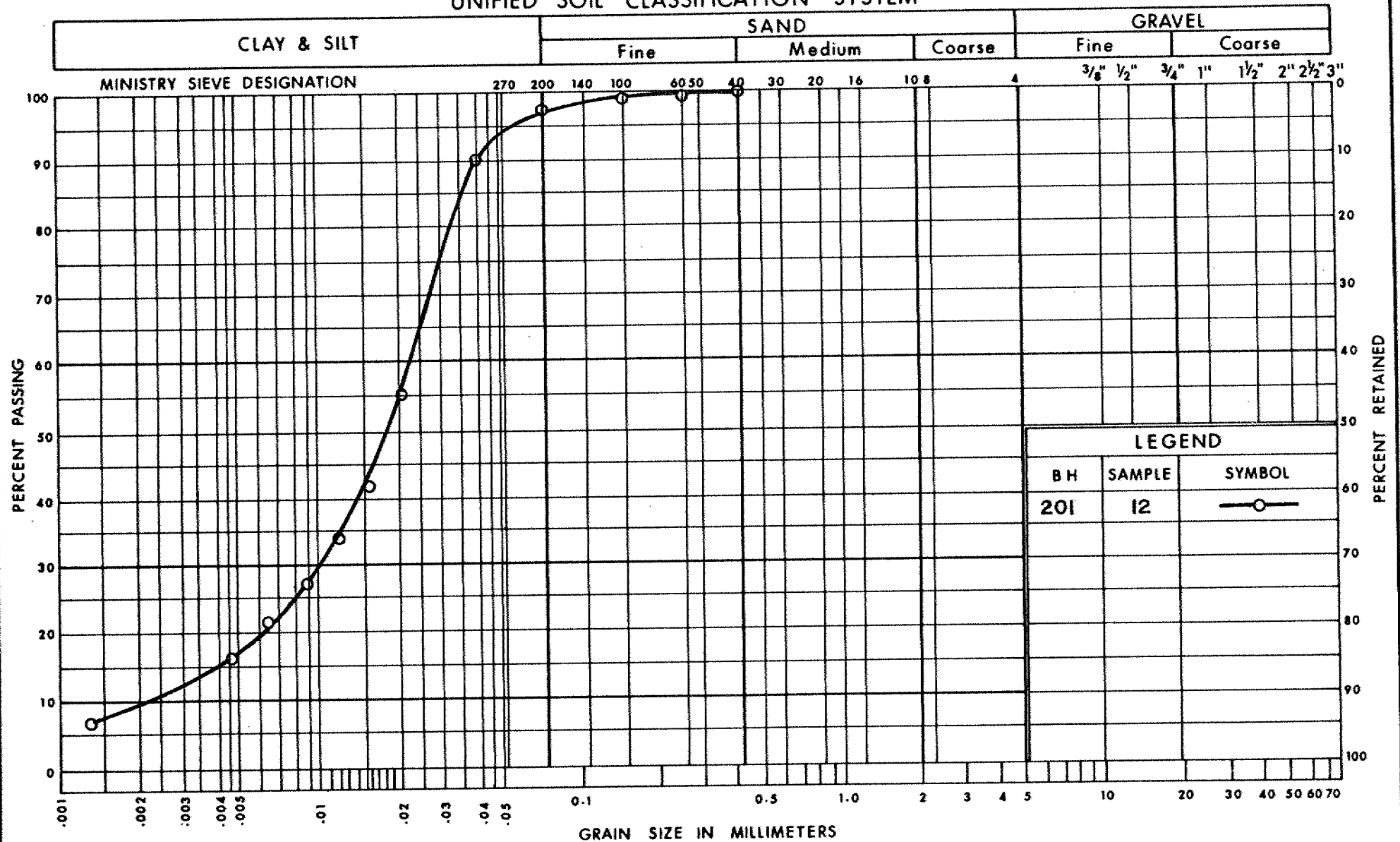
SAND, fine to medium

FIG No 2

W P 33-76-18



UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION SILT



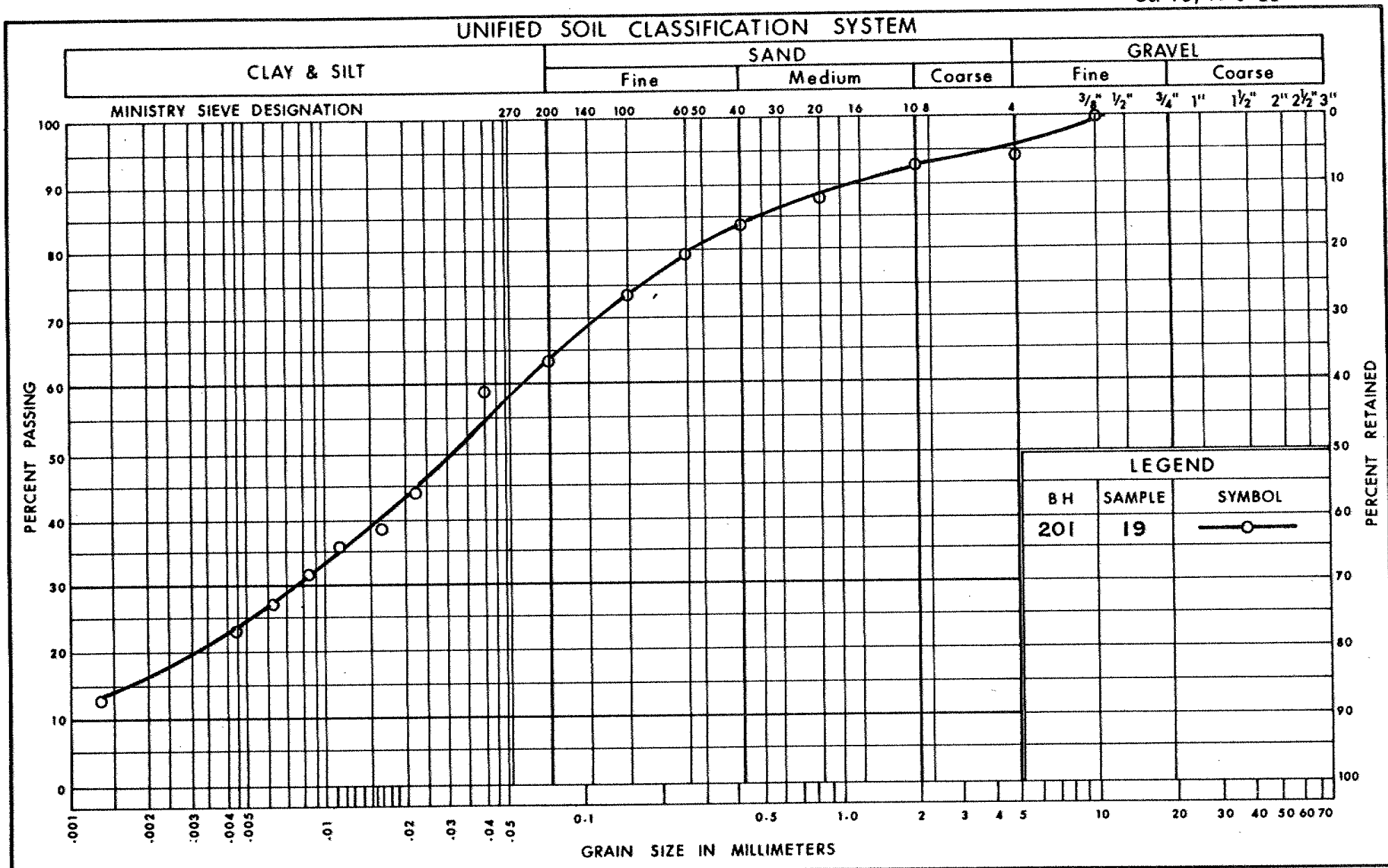
Ministry of
Transportation and
Communications

Ontario

ENGINEERING SERVICES BRANCH

FIG No 4

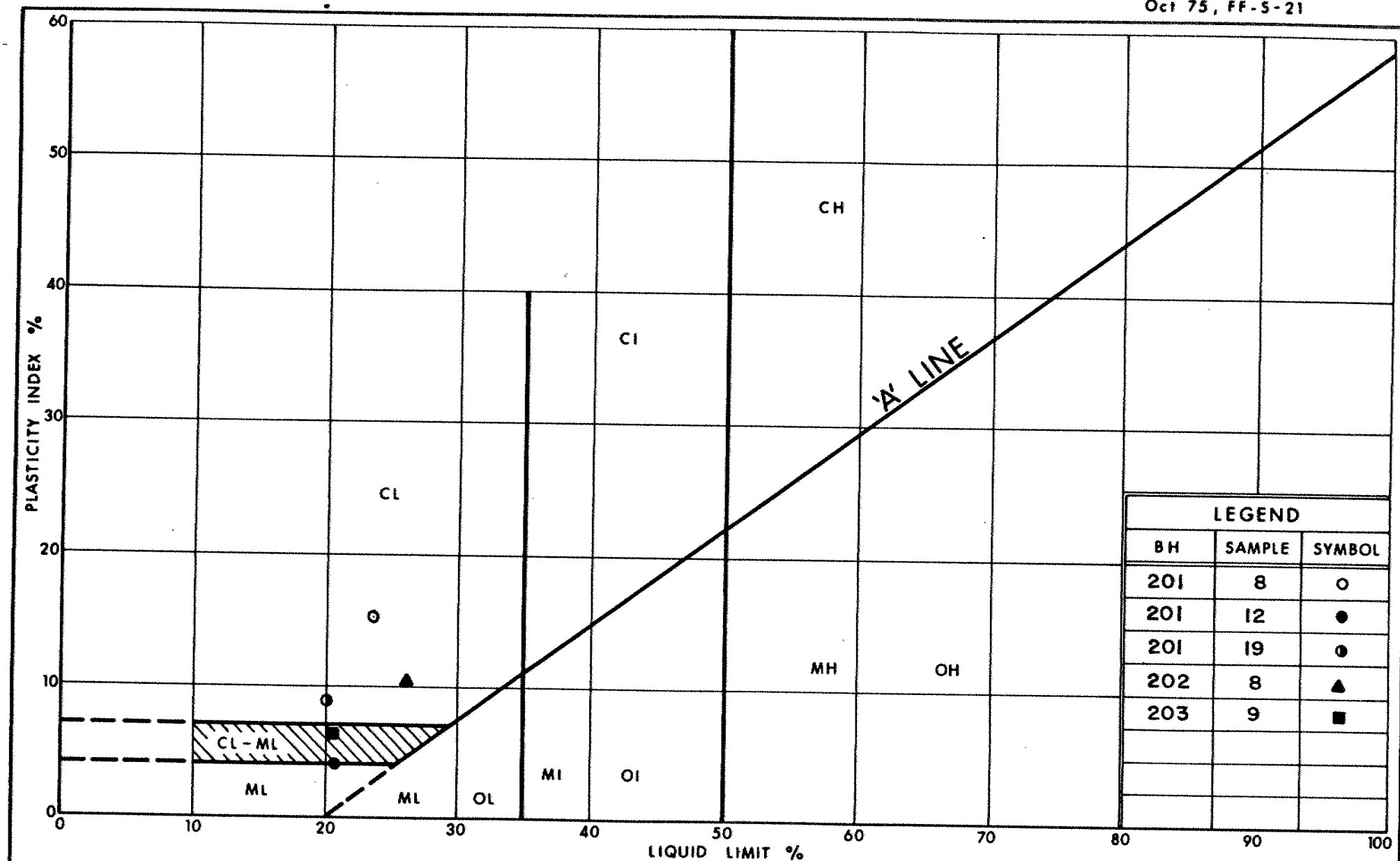
W P 33 - 76 - 18



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ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION LOWER CLAYEY SILT (GLACIAL TILL)

FIG No 5
W P 33-76-18



Ministry of
Transportation and
Communications
Ontario
ENGINEERING SERVICES BRANCH

PLASTICITY CHART

FIG No 6
W P 33-76-18



Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

May 8, 1981

Ministry of Transportation and
Communications
Pavement and Foundation Design Section
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8



ATTENTION: Mr. M. Devata, P. Eng.

RE: GEOTECHNICAL INVESTIGATION
PROPOSED STORM SEWER
WESTON ROAD AND ROGERS ROAD
TORONTO, ONTARIO
W.P. 33-76-15

Dear Sirs:

This letter presents our preliminary findings of the field work carried out for the above project. Our final report on the geotechnical investigation will be submitted within two weeks.

The attached working figures of the site plan and cross-sections show the locations and extent of the subsurface exploration program.

SUBSURFACE CONDITIONS

In summary, the site is underlain by 3 to 16 feet of loose fill which rests on compact to dense, stratified medium sand. Groundwater was not encountered to the full depth of exploration.

The fill consists of brown to black, moist silty fine sand intermixed with gravel and occasional building debris (brick, concrete and the like). The upper few feet of the fill is wet and a perched groundwater level is likely. The lower portion of the fill is relatively dry. The depth of fill is generally 8 to 10 feet along both curb lines from

station 137+00⁺ to 140+00⁺. From station 140+00⁺ to 145+00⁺, the depth of fill along the east curb line varies from 10 to 3 feet respectively. Along the west curb line from station 140+00⁺ to 145+00⁺, the fill depth varies from 10 to 16 feet respectively. The depth of fill in this section generally increases from east to west.

Beneath the fill, the medium sand is stratified and has occasional thin seams of fine gravel. The upper few feet of this sand stratum is in a compact state and then it is dense to very dense to a depth of up to 36 feet below ground surface. The sand samples were dry. Piezometers installed in the boreholes and monitored a day or two later were also dry.

DISCUSSION

Installation of the proposed storm sewer by tunnelling will require a minimum 5 foot diameter tunnel. The attached cross-sections show the design sewer invert and the sub-surface conditions. It appears that the tunnel will pass through the native stratified sand from station 137+00⁺ to 142+00⁺, above the groundwater level, and with about 3 to 7 feet of sand cover over the tunnel obvert. This represents favourable tunnelling conditions. From station 142+00⁺ to 145+00⁺ the sand cover over the tunnel obvert is less than 3 feet and, near station 145+00⁺ the tunnel may intersect the overlying loose fill. As this fill is loose and unconsolidated, it probably contains void areas and zones of high permeability, and caving and loss of ground should be expected. Careful tunnelling, including forepoling methods would reduce the possibility of this caving.

In the area of station 145+00⁺, it is also possible that fill may underlie the invert level. Preference should be given to open cut operations in this north end of the project.

Alternatively, the proposed sewer alignment could be realigned to the east to take advantage of less fill overlying the native stratified sand, or the design invert level could be dropped to achieve greater cover of native sand over the tunnel.

May 8, 1981

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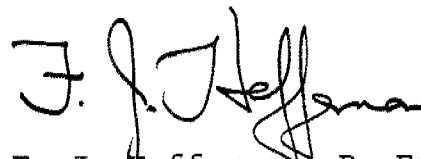
We trust that this preliminary summary of our findings is sufficient for your present requirements. The final report will be submitted in about two weeks.

Yours truly,

GOLDER ASSOCIATES



Michael Tanos, P. Eng.



F. J. Heffernan, P. Eng.

MT/FJH/cg
811-1111

Att: Site Plan
Cross-sections