



Golder Associates Ltd.

CONSULTING ENGINEERS

REPORT TO

TOTTEN SIMS HUBICKI ASSOCIATES

FOUNDATION INVESTIGATION

PROPOSED COUNTY ROAD 21 UNDERPASS

HIGHWAY 416

GEOCRES # 31B-62

W.P. 177-89-05, SITE 16-311

DISTRICT 9 (OTTAWA), EASTERN REGION

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1. INTRODUCTION

Golder Associates Ltd. has been retained by Totten Sims Hubicki Associates, consultants to the Ministry of Transportation Ontario (MTO), to carry out a subsurface investigation at the site of a proposed underpass for County Road 21 at Highway 416 (see Key Plan, Figure 1). The purpose of this investigation was to determine the subsurface conditions at the site and, based on the factual information obtained, to provide recommendations on the geotechnical design aspects of this project, including construction considerations which could influence design decisions.

The proposed underpass structure and realigned County Road 21 are to be located some 10 to 20 metres south of the present roadway alignment at Highway 16. The underpass will consist of a two span concrete bridge structure having a total length of 102 metres and a width of about 28 metres. The approach embankments within 30 metres of the bridge will have a maximum height of about 8.5 metres above existing ground surface. The abutments for the proposed bridge are to be perched above existing ground surface.

2. SITE DESCRIPTION AND GEOLOGY

The site is located along existing Highway 16 to the east of Spencerville, Ontario. The topography across the site is relatively flat although the existing County Road 21 and Highway 16 roadways are raised between about 0.5 and 1.5 metres above the adjacent existing ground surface. The area across the underpass site presently consists of cleared land.

Geology maps suggest that this area is underlain by deposits of sensitive silty clay. Bedrock is expected to consist of Oxford formation dolostone. Drift thickness maps suggest that the overburden thickness may be about 9 to 10 metres.

3. PROCEDURE

The field work for this investigation was carried out between April 23 and 27, 1990. During this time, two boreholes were advanced at the centre pier location and at each of the two bridge abutment locations. In addition, two shallow boreholes were advanced about 30 metres from both the east and west abutments to evaluate the subgrade conditions for the approach embankments near the bridge. Two of the boreholes put down in the underpass area were advanced to bedrock and the bedrock was cored using BXL size diamond drilling equipment; the other boreholes were terminated in the glacial till at depths of 6.7 to 8.2 metres below ground surface. The boreholes advanced in the embankment area were taken to depths of between about 4.9 and 5.2 metres below existing ground surface. Standard penetration tests were carried out in the boreholes and samples of the soils encountered were recovered using drive open sampling equipment. Standpipes were sealed into most of the boreholes to determine the groundwater levels at the site. One sample of groundwater was obtained from borehole 3-3 and was sent to a laboratory for basic chemical testing to evaluate the corrosivity of the groundwater on exposed concrete and unprotected steel. The field work was supervised throughout by a member of our engineering staff.

Logs of the soil, bedrock and groundwater conditions encountered in the borings are shown on the Record of Borehole Sheets following the text of this report. The locations of the boreholes are given on the Borehole Locations and Soil Strata, Drawing 1778905-A.*

* Dwg No 2 (Sheet No 205) of the Contract Drawings

Samples of the soils encountered were taken to our laboratory for examination and classification testing. Samples of the soil were tested for moisture content, organic content, liquid and plastic limit, and grain size distribution. The results of the laboratory testing are given on the Record of Borehole sheets and on Figures 2 to 4.

The borehole locations and elevations were determined by Totten Sims Hubicki Associates personnel. The elevations are referenced to Geodetic datum.

4. SUBSURFACE CONDITIONS

4.1 General

The borehole logs indicate the approximate subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the method of boring, the frequency of sampling, the method of sampling and the uniformity of the subsurface conditions.

Subsurface conditions between the boreholes may vary significantly from conditions encountered at the boreholes.

Groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These conditions may vary seasonally or as a consequence of construction activities.

The soil and bedrock descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil and bedrock involves judgement and

Golder Associates Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The soil and rock conditions described in this report are those observed at the time of the study. Unless otherwise noted, those conditions form the basis of the recommendations in this report. The condition of the soil may be significantly altered by construction activities such as construction traffic, excavation, pile driving, etc. Excavation may expose the soils to changes due to wetting, drying, or frost.

As previously indicated, the detailed soil, bedrock and groundwater conditions determined from the boreholes are given on the Record of Borehole sheets following the text of this report. The following sections present descriptions of the soil, bedrock and groundwater conditions encountered in the boreholes.

4.2 Fill, Topsoil, Silt

Boreholes 3-1, 3-2, 3-4, 3-6, and 3-8 advanced along County Road 21 encountered roadway fills composed of brown sand or sand and gravel which was, in the case of borehole 3.4 overlain by an asphalt thickness of about 200 millimetres. The thickness of the fills ranges from about 1.1 to 1.5 metres.

Deposits of topsoil were encountered at ground surface in boreholes 3-3, 3-5 and 3-7 and beneath the roadway fill at borehole 3-6. The thickness of this deposit is about 0.2 to 0.3 metres.

A deposit of silt containing some organic material was encountered beneath the roadway fills in borehole 3-8. The thickness of the silt deposit is about 0.3 metres. The organic content and moisture content of the silt were found to be 6.7 and 34 percent, respectively.

4.3 Sand, Sand and Gravel

Deposits of sand, sand with some silt, and sand and gravel were encountered beneath the surficial topsoil and/or roadway fills at boreholes 3-1, 3-6 and 3-7. The deposits were found to have a thickness of about 0.6 to 0.9 metres. A grain size distribution curve for a sample of fine to medium sand with some silt recovered from borehole 3-6 is given on Figure 3. Standard penetration testing carried out within these deposits gave N values of 5 to 7 blows per 0.3 metres, which reflect a loose relative density. The moisture content of the sand and sand and gravel was found to be about 19 to 22 percent.

4.4 Silty Clay

The boreholes encountered a deposit of silty clay at depths ranging from 0.2 to 1.8 metres below ground surface (elevation 86.9 to 88.4 metres). The thickness of the deposit ranges from 0.2 metres (borehole 3-7) to about 2.7 metres (borehole 3-3). Standard penetration testing carried out within this deposit gave N values ranging from 9 to 26 blows per 0.3 metres, which reflect a very stiff consistency. Atterberg limit tests carried out on samples of the silty clay gave liquid limit values of 33 and 52 and corresponding plastic limit values of 26 and 20, which indicate a clay of low to high plasticity. The results of the Atterberg limit testing are given on Figure 2. The moisture content of the silty clay was found to range from about 24 percent for the silty clay of

low plasticity to 32 percent for the higher plasticity silty clay.

4.5 Glacial Till

Deposits of glacial till were encountered beneath the silty clay at depths of 1.4 to 4.4 metres below existing ground surface (elevation 85.2 to 86.8 metres). The boreholes penetrated these glacial tills for depths ranging from 3.8 metres (borehole 3-3) to 9.3 metres (borehole 3-7).

The glacial till consists of a heterogeneous mixture of all grain sizes but may be generally described as a sandy silt and gravel with clay, cobbles and boulders. Diamond drilling techniques were required to advance boreholes 3-2, 3-4, 3-6, 3-7 and 3-8 due to the presence of cobbles and boulders in the glacial till. The results of grain size distribution tests carried out on samples of the glacial till are given on Figure 4. It should be noted that the gradation tests were carried out on 38 millimetre I.D. split barrel samples and so do not reflect the presence of cobbles and boulders within the glacial till.

Standard penetration tests carried out within the glacial till gave N values of 14 to over 100 blows per 0.3 metres, which reflect a compact to very dense relative density.

The moisture content of the glacial till is between 5 and 11 percent.

4.6 Bedrock

Bedrock was encountered and proven by coring within boreholes 3-2 and 3-7. The bedrock consists of medium to thickly bedded dolomitic limestone and was encountered at depths of 10.7 to 10.8 metres below existing ground surface (elevation 77.4 to 78.6 metres).

A measure of the quality of the bedrock recovered from the boreholes is shown on the Record of Borehole sheets as the percent recovery (REC) and Rock Quality Designation (RQD). No core loss was observed, resulting in core recovery values of 100 percent. The RQD values range from 68 to 92 percent (average of 82 percent), which reflect a good to excellent quality bedrock.

4.7 Groundwater

Groundwater levels were obtained from standpipes sealed in the completed borings and by observing the water level in the open boreholes at the completion of drilling. Details on the standpipe installations and groundwater levels (elevation and time of measurement) are given on the Record of Borehole sheets. The boreholes advanced in the proposed underpass area showed groundwater levels of between 0.4 metres above ground surface (borehole 3-3) to 1.5 metres below ground surface (borehole 3-1), (elevation 87.4 to 89.0 metres).

Groundwater samples from this site and other bridge sites along Highway 416 were submitted to Accutest Laboratories Ltd. for chemical analysis related to potential corrosion, the results of which are shown on the attached Report of Analyses No. A0-0708.

The results of the chemical analysis on the groundwater sample from this site are as follows:

ph	-	7.58
Conductivity	-	546 umhos/cm
Sulphate (SO ₄)	-	39 mg/L
Chloride (Cl)	-	5 mg/L

5. PROPOSED COUNTY ROAD 21 UNDERPASS

5.1 Bridge Foundations

The proposed two span bridge is to be supported on two perched abutments and one centre pier. It is understood that the structure will be designed with a continuous concrete box girder and will be relatively sensitive to post construction movement of the foundation; the tolerable differential movement between the abutment and pier foundation is understood to be about 15 millimetres. For standard size conventional spread footing foundations, it is understood that the required bearing capacity for the abutments and pier foundations would be about 400 and 500 kilopascals, respectively.

The east and west abutments for the proposed bridge could be founded on a pad of compacted granular material placed on the native very stiff weathered silty clay. The existing loose sand or sand and gravel overburden deposits, such as those encountered within 2.3 metres of ground surface in boreholes 3-6 and 3-7, should be removed to expose the native silty clay prior to placing the granular fill. It should be noted that the upper surface of the silty clay deposit where overlain directly by topsoil or existing roadway fills may have been affected by frost penetration and may not be suitable for bearing support following excavation; therefore, some subexcavation (about 0.3 to 0.5 metres) of the weathered silty clay may be necessary. The granular pad should be constructed in general accordance with the attached MTO Standard, Figure 5. If required, however the granular fill below the abutments could also consist of well graded crushed stone conforming to Ontario Provincial Standard Specifications (OPSS) for Granular B Type II (50 millimetre minus crushed stone). The granular fill should be compacted in maximum 200 millimetre thick lifts

to 100 percent of standard Proctor density. As shown on Figure 5, to allow adequate spread of the footing load the granular fill should extend about 1.0 metre horizontally from the sides of the abutment footings and should be sized to accommodate a slope down and outward from this point at 1 horizontal to 1 vertical or flatter.

Provided that the granular fill is properly compacted and has a thickness of about 2 metres, the Serviceability Limit State and Ultimate Limit State bearing pressures can be taken as 350 and 800 kilopascals, respectively. The settlement of the footing should be less than about 25 millimetres if the granular material is properly compacted and placed on an undisturbed subgrade.

The centre pier footings could be founded on or within the native weathered silty clay or on the compact to very dense glacial till (at or below elevation 87 metres) and could be proportioned using Serviceability Limit State and Ultimate Limit State bearing pressures of 300 and 600 kilopascals, respectively. The total settlement of the piers should be about 25 millimetres.

For snow cleared or covered areas, the footings should be provided with at least 1.8 metres of earth cover for frost protection purposes. In protected areas where snow is allowed to accumulate this frost protection cover could be reduced to 1.5 metres. The centre pier excavations should be back filled with non frost susceptible sand or sand and gravel meeting OPSS Granular B Type I or II.

5.2 Abutment Wall Backfill and Earth Pressures

The abutments should be backfilled with compacted non frost susceptible, free draining backfill such as that meeting OPSS Granular B Type I or II. The granular fill should extend at least 1.5 metres beyond the inside face of the abutments. The granular backfill should be compacted in thin lifts to at least 95 percent of standard Proctor density. If lateral movement at the top of the abutment of about 0.05 percent of the retained height is expected to occur, "active" earth pressure coefficients (K_a) should be used in determining the horizontal load on the abutments. If the wall movement is expected to be less, then "at rest" pressure coefficients (K_o) should be used.

Assuming that a well graded sand and gravel backfill material meeting OPSS Granular B Type I material is used behind the abutments, a material unit weight of 21.2 kilonewtons per cubic metre could be used together with the following earth pressure coefficients in determining the lateral earth load on the abutments

Earth Pressure Coefficient

At Ultimate Limit State (ULS)

"at rest" condition	0.55
"active" condition	0.38

At Serviceability Limit State (SLS)

"at rest" condition	0.47
"active" condition	0.31

Earth pressure parameters for other materials could be provided if necessary. For sliding resistance a coefficient of friction of 0.55 in the Ultimate Limit State may be used

between the concrete abutment footing and the crushed stone granular pad.

To reduce compaction induced stress on the abutment walls, the granular fill near the abutments should be compacted with walk behind compaction equipment.

Highway live loads should be considered on the abutments unless approach slabs are used.

5.3 Approach Embankment Stability and Settlement

The approach embankments will have a height of about 8 metres above existing ground surface. Since the silty clay soils at this site have a stiff to very stiff consistency, no short term or long term stability problems are expected for the embankments within 30 metres of the abutments. Embankment fill should meet the requirements of OPSS 212 for borrow material, and should be placed and compacted in accordance with OPSS 206. If sandy earth borrow, rock borrow, or select subgrade material is used, embankment side slopes may be constructed at 2 horizontal to 1 vertical. If silty or clayey earth borrow is used, embankment side slopes should be 2.5 horizontal to 1 vertical or flatter.

Prior to placing the embankment fill materials, all topsoil and surficial organic materials should be removed from the embankment area. Some minor post construction settlement of the north embankment fills could occur if the topsoil and silt deposits are left in place beneath the existing roadway fills.

5.4 Corrosion of Buried Structures

As previously indicated, the sulphate content of the groundwater was found to be 39 milligrams per litre. According to CSA CAN 3-A23.1-M90, the measured level of sulphate should not be corrosive to concrete where normal Portland Type 10 cement is used.

5.5 Construction Considerations

The excavations for the engineered fill in the abutment areas and for the centre pier will be carried out through existing roadway fills, topsoil, silt, native sand and sand and gravel, and silty clay. No unusual excavation problems are expected in excavating these materials in open cut above the groundwater if 1 horizontal to 1 vertical side slopes are used. Below the groundwater level, groundwater inflow from the sandy fills or native sand or sand and gravel deposits could cause sloughing and/or undermining of the excavation side slope. As such, it may be necessary to use flatter side slopes and/or to control groundwater inflow by placing a sand and gravel drainage blanket on the sides of the excavation. Groundwater inflow should be controlled by pumping from filtered sumps in the excavation.

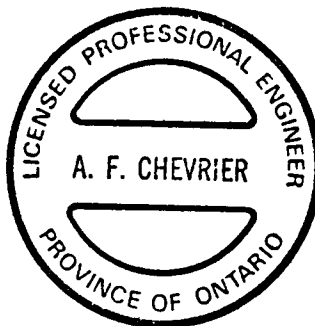
Prior to placing granular fill for the abutment footings and placing concrete in the pier footing areas, the exposed subgrade should be inspected by geotechnical personnel to ensure that a suitable subgrade has been reached and properly prepared. A 50 millimetre thick mud mat of lean concrete should be placed over the sensitive silty clay subgrade in the pier footing areas to ensure that the silty clay is not disturbed due to ponding water or during reinforcing steel placement in the footing.

We trust that this report contains sufficient information for your purposes. Should you have any questions, please call us.

Yours truly,
GOLDER ASSOCIATES LTD.



A.F. Chevrier, P. Eng.



R.A. Montgomery, P. Eng.



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Att.

Golder Associates

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

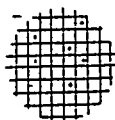
PHYSICAL PROPERTIES OF SOIL

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

← 94 Boulder
indicate in the
Borehole log.

SS 3
Fig # 2 indicate
clay $d_w > 50$

R.H.
3-1

**ACCUTEST**

LABORATORIES LTD.

146 Colonnade Rd., Suite 202, Nepean, Ontario K2E 7Y3 (613) 727-5692

LAB REPORT NO.: A0-0708

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REPORT OF ANALYSESClient: Golder AssociatesDate: May 8, 1990Project: 891-2582P. O. 15001

Report 891-2582-2 BH 2-5
Report 891-2582-3 BH 3-3
Report 891-2582-1 BH 1-5

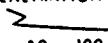





Parameter	Units	Sample	Sample	Sample	Sample	Sample
		6' - 8'	10' -12'	± 12'		
Fe	mg/L					
Mn	mg/L					
Hardness	mg/L CaCO ₃					
Alkalinity	mg/L CaCO ₃					
pH		7.06	7.58	7.80		
Conductivity	umhos /cm	3020	546	483		
F	mg/L					
Na	mg/L					
N-NO ₃	mg/L					
N-NO ₂	mg/L					
N-NH ₃	mg/L					
SO ₄	mg/L	25	39	12		
CL	mg/L	812	5	48		
Phenols	mg/L					
Turbidity	NTU					
Colour	Pt/Co Units					
Ca	mg/L					
Mg	mg/L					
Tannin & Lignin	mg/L					
Total Nitrogen	mg/L					
K	mg/L					

ANALYST: 

RECORD OF BOREHOLE No 3-1

METRIC

W P 177-89-05 LOCATION Sta. 9+896.4 0.4m Rt ORIGINATED BY M.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.
 DATUM Geodetic DATE April 27, 1990 CHECKED BY A.C.

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		
89.6	Ground Surface													
0.0	Fill - sand, some gravel and silt, scattered trace organic material						89							
88.5	Brown		1	SS	17									
1.1	Sand, fine to medium, some silt						88							
87.8	Compact Brown													
1.8			2	SS	5									
	Silty clay (weathered crust)						87							
			3	SS	26									
	Very stiff						86							
	Grey Brown		4	SS	18									
85.2			5	SS	11									
4.4	Sandy silt, some gravel and clay (glacial till)						85							
84.7	Compact Grey		6	SS	>100									
4.9	End of Borehole						84							

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3-2

METRIC

W P 177-89-05 LOCATION Sta. 9+933.9 12.3m Lt ORIGINATED BY P.H.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.
DATUM Geodetic DATE April 23 and 24, 1990 CHECKED BY A.C.

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
													○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE		
89.4	Ground Surface																	
0.0	Fill - sand and gravel trace silt						89											
11.3	Compact Brown		1	SS	17													
1.1	Silty clay (weathered crust)		2	SS	11													
			3	SS	12													
			4	SS	10													
85.7	Very stiff Grey brown																	
3.7	Sandy silt and gravel, trace clay, occasional cobble (glacial till)		5	SS	31													
			6	SS	16													
			7	SS	18													
			8	SS	31													
82.7	Compact to dense Grey																	
6.7	Sandy silt and gravel, trace to some clay, some cobbles and boulders (glacial till)		9	RC BXL														
			10	SS	55													
			11	SS	88													
			12	SS	74													
78.6	Very dense Grey																	
10.8	Dolomitic limestone bedrock, fresh to faintly weathered, medium to thickly bedded, some sandy layers		13	RC BXL	REC=100% RQD=68%													
77.3																		
12.1	End of Borehole						77											
	* REC: Recovery RQD: Rock Quality Designation																	

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3-4

METRIC

W P 177-A9-05 LOCATION Sta. 9 + 984.9 10.8 Lt. ORIGINATED BY M.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core COMPILED BY A.C.
 DATUM Geodetic DATE April 27, 1990 CHECKED BY A.C.

OFFICE REPORT ON SOIL EXPLORATION

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					
89.2	Ground Surface																
0.0	Asphalt																
0.2	Fill - sand and gravel, trace silt		1	SS	36												
0.7	Dense Brown																
1.5	Silty clay (weathered crust)		2	SS	9												
	Very stiff to stiff Grey brown		3	SS	17												
85.9			4	SS	41												
3.3	Sandy silt and gravel, trace to some clay, some cobbles and boulders (glacial till)		5	SS	10												
			6	SS	39												
			7	SS	16												
			8	SS	72												
	Compact to very dense Grey		9	RC BXL	-												
81.1			10	SS	79												
8.1	End of Borehole																

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

RECORD OF BOREHOLE No 3-5

METRIC

W P 177-AQ-05 LOCATION Sta. 9 + 967.0 15.0 Rt. ORIGINATED BY M.H.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY A.C.
 DATUM Geodetic DATE April 27, 1990 CHECKED BY A.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
88.7	Ground Surface																
0.0 or 4	Topsoil																
0.3	Silty clay, trace shells (weathered crust)		1	SS	9												
	Very stiff		2	SS	15												
86.0	Gray brown		3	SS	28												
2.7	Sandy silt and gravel, trace to some clay, some cobbles and boulders (glacial till)		4	SS	>100												
			5	SS	27												
			6	SS	23												
			7	SS	17												
	Compact to very dense		8	SS	>100												
80.9			9	SS	12 for 0 mm												
7.8	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

METRIC

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x⁵: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 3-8

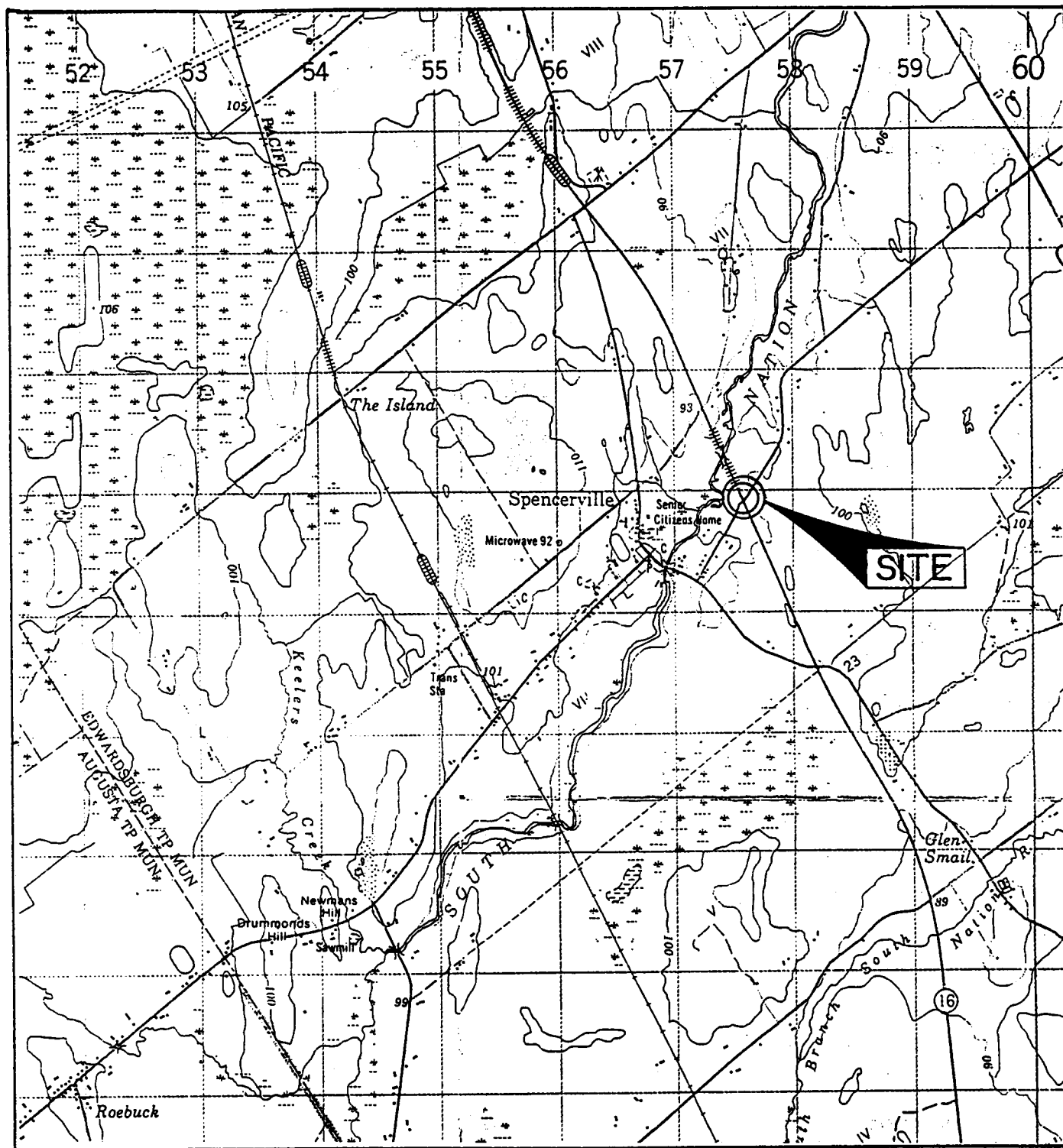
METRIC

W P 177-90-05 LOCATION Sta. 10 + 058.3 5.0 Rt. ORIGINATED BY M.H.
 DIST 0 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Wash Boring - RW Casing COMPILED BY A.C.
 DATUM Geodetic DATE April 26, 1990 CHECKED BY A.C.

OFFICE REPORT ON SOIL EXPLORATION

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										SHEAR STRENGTH kPa			WATER CONTENT (%)		
																		O UNOBTAINED * FIELD VANE • QUICK TRIAXIAL x LAB VANE					
80.0	Ground Surface																						
0.0	Fill - sand and gravel																						
0.7	Fill - sand, some silt and gravel		1	SS	7		88																
0.7	Loose silt, trace organic matter																						
1.0	Very loose dark grey silty clay (weathered crust)		2	SS	5		87																
2.2	Very stiff grey brown sandy silt and gravel, trace to some clay, some cobbles and boulders (glacial till)		3	SS	44																		
			4	SS	33		86																
			5	SS	36		85																
	Compact to dense Grey		6	SS	19		84																
83.8																							
5.2	End of Borehole						83																
	* Water level not established																						

KEY PLAN

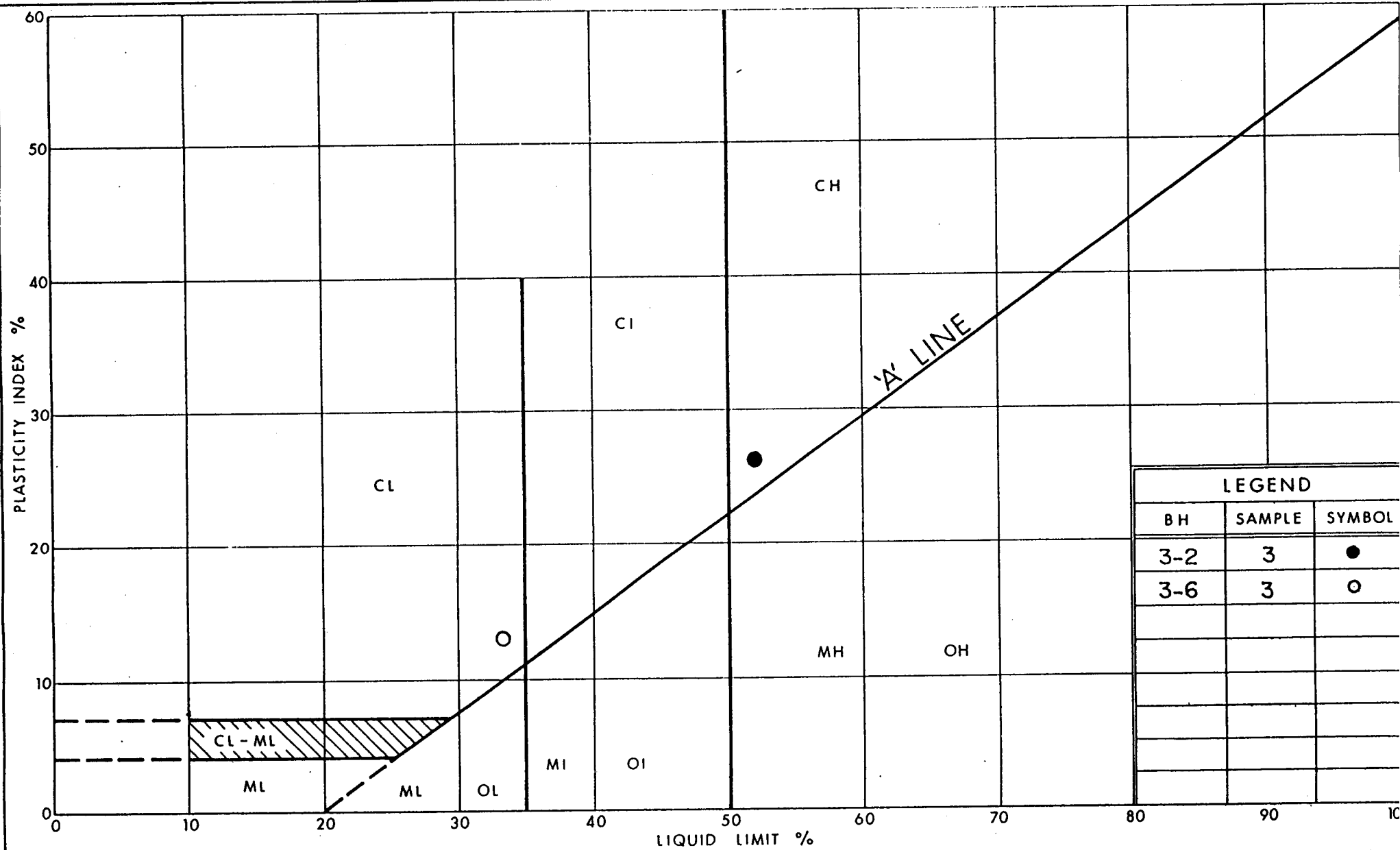
FIGURE I
WP 177-89-05SCALE
1:50,000

SPECIAL NOTE
THIS DRAWING IS TO BE READ IN CONJUNCTION
WITH ACCOMPANYING REPORT

Date AUG. 20, 1990
Project 891-2582-3

Golder Associates

Drawn JC
Chkd. *[Signature]*



LEGEND		
BH	SAMPLE	SYMBOL
3-2	3	●
3-6	3	○



Ministry of
Transportation

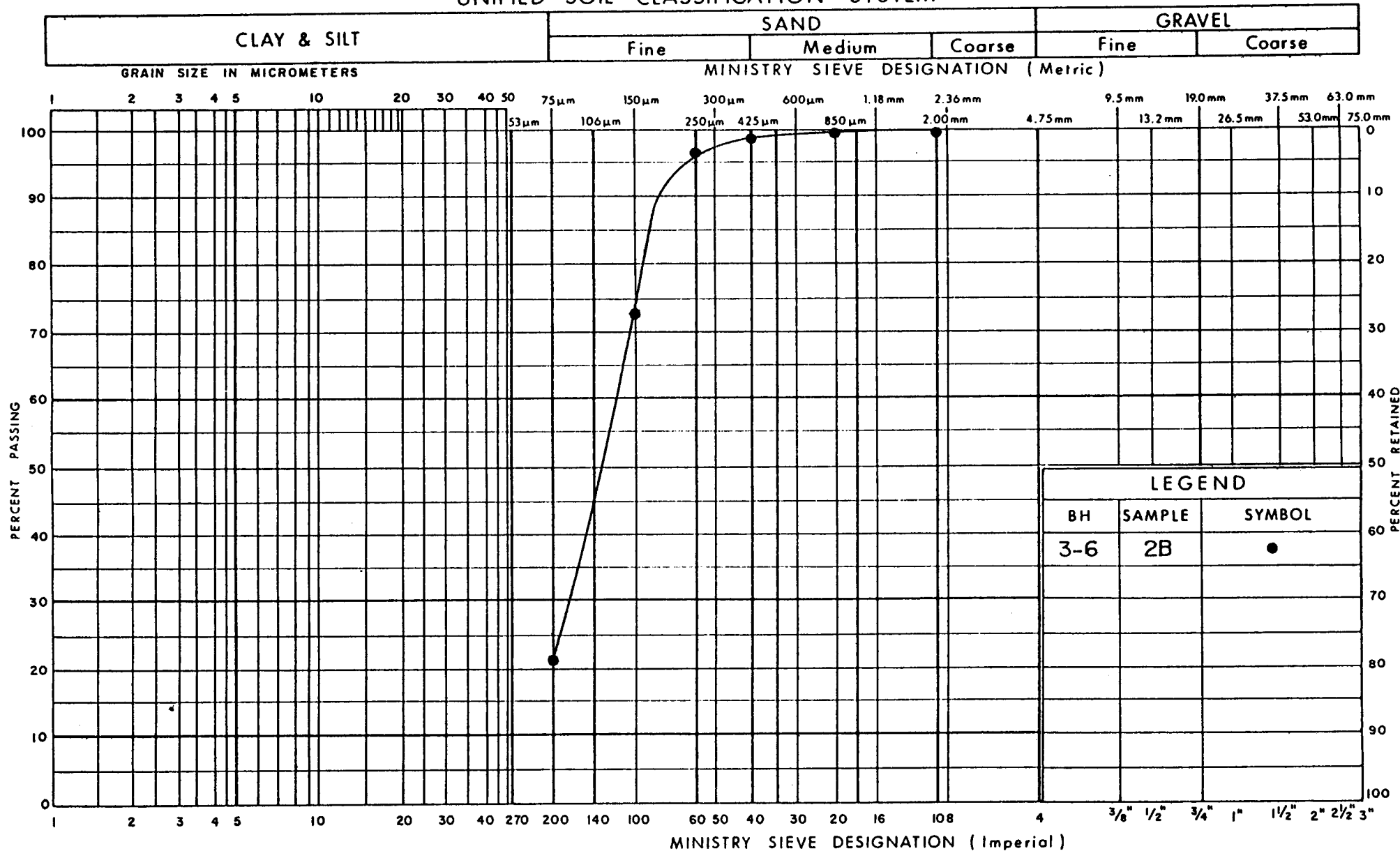
Ontario

PLASTICITY CHART SILTY CLAY

FIG No 2

W P 177-89-05

UNIFIED SOIL CLASSIFICATION SYSTEM



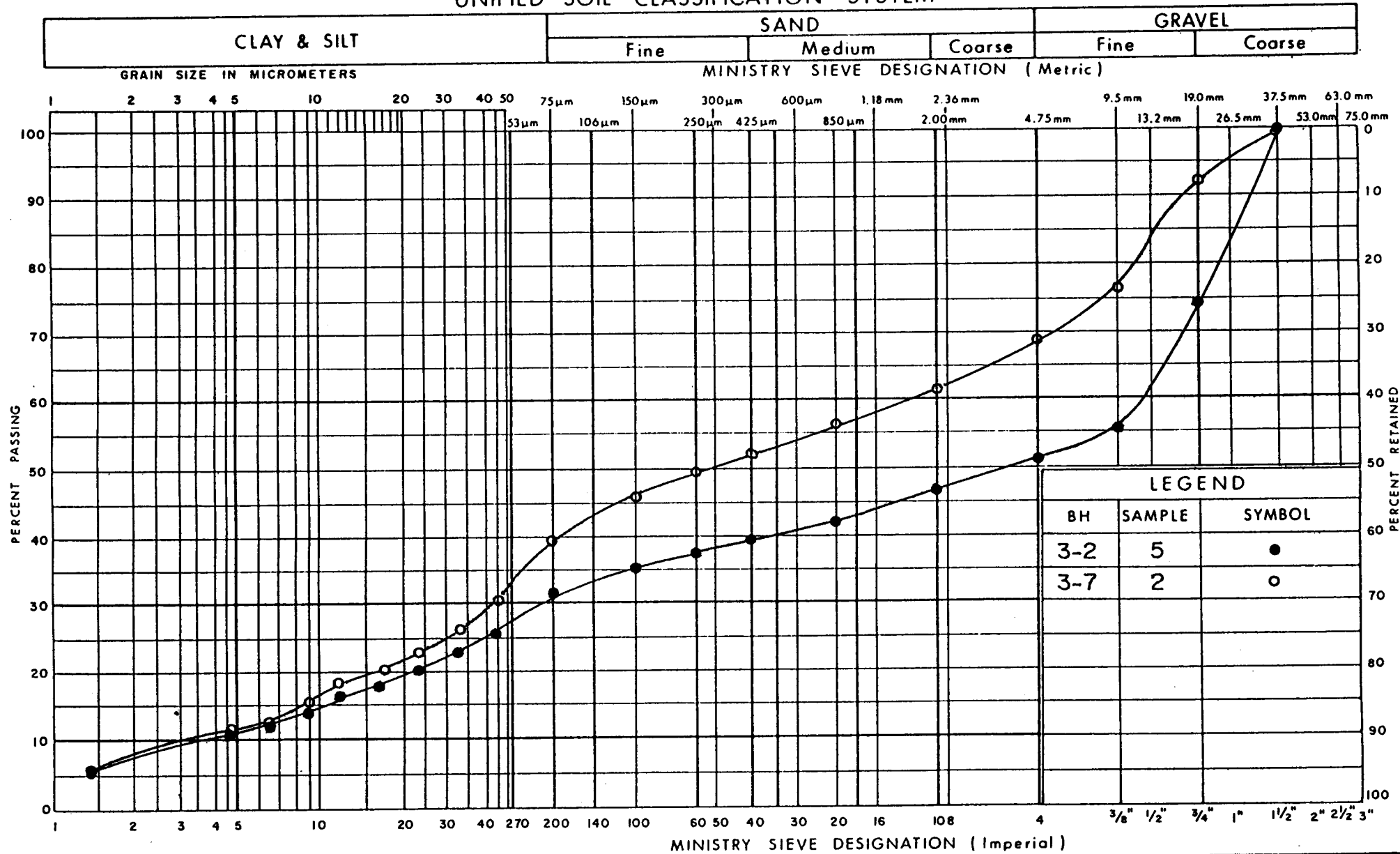
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, some silt

FIG No 3

W P 177-89-05

UNIFIED SOIL CLASSIFICATION SYSTEM

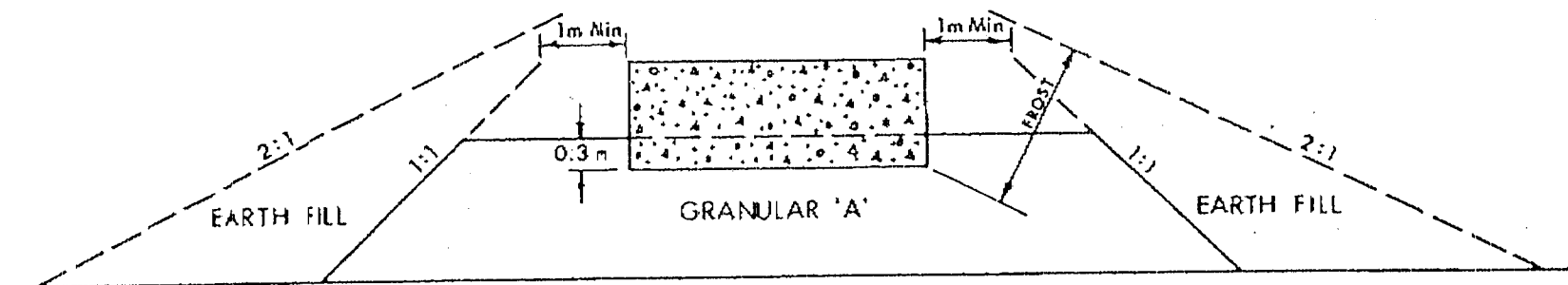


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Transportation

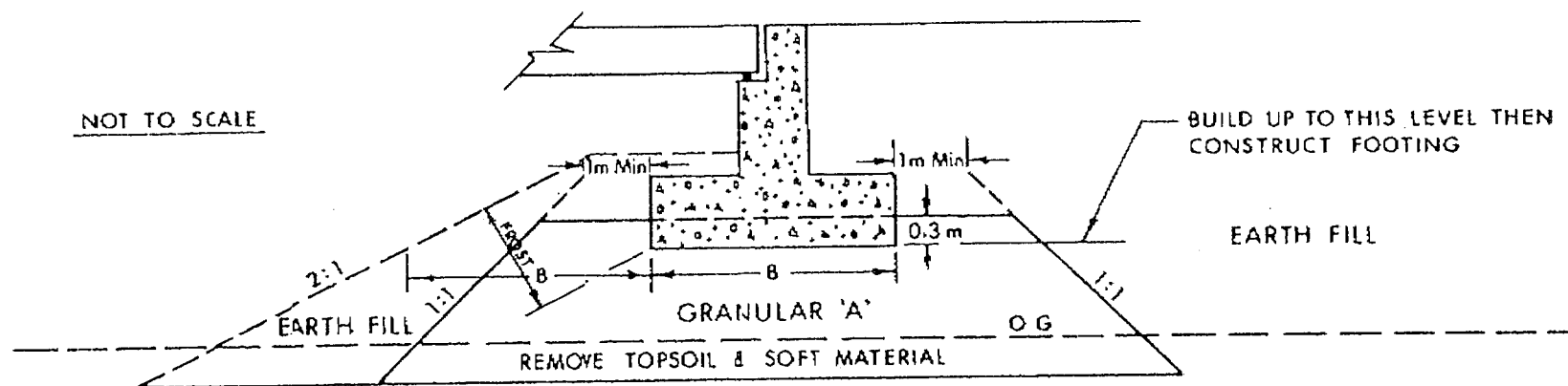
GRAIN SIZE DISTRIBUTION
GLACIAL TILL

FIG No 4

W P 177-89-05



X SECTION



LONGITUDINAL SECTION

NOTES:

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



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Ontario

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 5

W P 177-89-05

