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W. O. No.

STR. SITE No. 37-1318

HWY. No. 407

LOCATION Black Creek & Jane St.

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

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FOUNDATION DESIGN SECTION

CONT. 93-86

WP 140-87-09

DIST 6

HWY 407

STR SITE 37-1318

Black Creek Culvert and Jane Street

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FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing
at
Black Creek Culvert and Jane Street
W.P. 140-87-09, Site 37-1318
Highway 407, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to replace the existing 4.8 m x 2.1 m x 26 m rigid frame concrete box culvert with a 6 m x 4 m x 61.7 m rigid frame concrete box culvert located along an alignment rotated approximately 18° southwesterly from the existing alignment. The proposed culvert will support the proposed Jane S-407 E Ramp located almost colinear to the existing Jane Street, and the proposed realigned Jane Street. The proposed realigned Jane Street is to be a two lane roadway with a future widening proposal in both directions. The profile grade of the new Jane Street is at approximate elevation 196.1 m and consequently the proposed culvert will have a cover of up to 2.5 m.

SITE DESCRIPTION AND GEOLOGY

The site is located along and immediately west of the existing Black Creek Culvert crossing at Jane Street approximately 1 km north of Steeles Avenue in the Town of Vaughan, Regional Municipality of York. The meandering Black Creek runs its course in westerly direction perpendicular to Jane Street at the site. Upstream and at the eastern boundary of the site exists a cemetery. A man-made water retention pond is located at the western limits of the site. The oval-shaped pond is approximately 35 m long, 20 m wide and 1 to 2 m deep.

The existing Jane Street is a single lane paved roadway with unpaved shoulders. The Black Creek at the site is approximately 2 m wide and 1 m deep. Water

flowing in the creek bed at the time of the investigation was approximately 0.6 m in depth. The creek bed is located at the toe of a slope approximately 3H:1V situated north of the creek on the west side of the site. The height of this slope is approximately 5 m.

The land surrounding the site is occupied by residential homes located at the crest of the slope discussed above and also east of Jane Street, north of the site. The land southwest of the site is vacant and unoccupied.

Physiographically, the site lies in the geological domain known as the Bolton Area, an area that covers approximately 1200 square kilometres located at the northwestern border of the Municipality of Metropolitan Toronto. The Bolton area has drumlins, till plains, moraines, meltwater channels and numerous other features associated with deglaciation. The area was covered with the Wisconsin glacier of the Pleistocene period that advanced into the region approximately 50,000 years ago and retreated approximately 15,000 years ago. The Black Creek, a tributary of the Humber River was formed by the advancement and retreat of the Ontario ice lobe.

The overburden deposits at the site consist of moraine tills of the Halton Till Formation underlain by glaciolacustrine sediments deposited by Lake Peel, a body of water impounded between lobes of projecting ice. The Halton Till is primarily a silt till composed of varying percentages of clay, silt, sand and gravel. The glaciolacustrine deposits generally consist of stratified silt, clayey silt and/or silty clay.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation. Bedrock topographical maps reveal that the bedrock exists at depths approximately 70-80 m below the natural ground surface at the site location.

INVESTIGATION PROCEDURES

Field Investigation

The fieldwork for the investigation was carried out between 90 02 12 to 90 02 21 and consisted of 9 sampled boreholes advanced to depths ranging from 15.7 to 36.9 m below the natural ground surface.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 4.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were obtained by monitoring the levels in the open borehole throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Construction Tests

Laboratory test results have been summarized in the subsequent section of this report entitled Subsurface Conditions, and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The ground surface elevation at the site varies from approximately 192.6 m at the existing Jane Street roadway to approximately 190.4 m located beyond the roadway. The subsoil stratigraphy at the site consists of approximately 1.5 m of brown, compact sand with traces of gravel that comprises the fill material overlying and adjacent to the existing concrete culvert. The fill material is underlain by a till deposit consisting of a heterogeneous mixture of silt to clayey silt, sand, gravel and boulders. The deposit exists surficially beyond the existing culvert west of Jane Street. The upper 1.2-1.8 m is black in colour, an indication of the organics present in the soil. The organic enriched soil is soft and weak. Underlying the organic enriched thickness, the deposit is grey and its consistency/denseness is generally hard/very dense. The behaviour of the main component varies randomly throughout the deposit from a plastic silt to a cohesive clayey silt. The thickness of the deposit is in the order of 7.6 m.

Underlying the till deposit exists a glaciolacustrine cohesive stratum consisting of a clayey silt. The deposit is generally very stiff to hard.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1408709-A.

A detailed description of the subsurface conditions encountered is given below.

Sand, trace Gravel (Fill Material)

Located as cover on the roof of the concrete box culvert and existing as backfill on the sides of the culvert, a brown sand with a trace of gravel exists. The fill material is brown, compact and moist.

Heterogeneous Mixture of Clayey Silt to Silt, Sand, Gravel and Boulders (Glacial Till)

A heterogeneous mixture of clayey silt to silt, sand, gravel and boulders underlies the fill material at the existing culvert location, and is present surficially west of the existing culvert. The deposit has a thickness of approximately 7.6 m.

The upper 1.2-1.8 m of the deposit is black and concentrated with some organics. As a result, the material is weak and highly compressible.

Below the upper organic thickness, the deposit is grey and consists of a wide range of grain sizes spanning from fine clay particle sizes to boulders.

Boulders were encountered throughout the deposit as evidenced by auger grinding and refusal witnessed during the boring operation. A grain size distribution envelope for this deposit is provided in Figure 1 in the Appendix. The envelope illustrates that clay and silt percentages range from 15 to 20% and 49 to 62% respectively.

The range of fine grained percentages reflects the varying behaviour of the fine grained portion of the till deposit. Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below.

Table 1 - Het. Mix. of Clayey Silt/Silt, Sand
Gravel and Boulders (Glacial Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	8-10	4
Liquid Limit (W _L %)	16-23	4
Plasticity Index (I _p %)	4-11	4
Unit Weight (kN/m ³)	21.6-22.9	3
SPT 'N' values (blows/0.3 m)	2->120	20

The test results reveal that the fine grained portion of the deposit ranges in behaviour from a plastic silt to a low plasticity clayey silt.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2-9 blows/0.3 m in the upper organic concentrated material and 20 blows/0.3 m to 120 blows/0.25 m in the lower thickness of the deposit. Based on this data, the organic material can be classified as soft to firm and the lower thickness has a consistency/denseness ranging from v.stiff/compact to hard/v.dense. In general the lower thickness can be considered as hard/v.dense.

Clayey Silt (Lacustrine)

The glacial till deposit is underlain by a glaciolacustrine deposit consisting of a grey clayey silt. The surface of this stratum is generally at an elevation ranging from 183.5 m to 182.8 m. The extent of this stratum was not determined during the investigation.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 3 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 44-48% and 47-51% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 4. A summary of the indices is provided in Table 2 below.

Table 2 - Clayey Silt (Lacustrine)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	16-20	2
Liquid Limit (W_L %)	32-35	2
Plasticity Index (I_p %)	17-18	2
Unit Weight (kN/m^3)	21.4-22.7	3
SPT 'N' values (blows/0.3 m)	7->100	8

The test results reveal that the stratum is of low plasticity and consequently can be categorized as a clayey silt.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 7 blows/0.3 m to 100 blows/0.25 m as tabulated in Table 3 indicating a firm to hard consistency. However, in general 'N' values exceed 30 blows/0.3 m and consequently this stratum has a hard consistency.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation ranged from 1 to 3 m below ground surface (Elevation 189.4 to 189.6 m), approximately equal to the stream water level.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in the report.

DISCUSSION AND RECOMMENDATIONS

A rigid frame concrete box culvert of dimensions 6 m x 4 m x 61.7 m is proposed at the Black Creek-Jane Street crossing to replace the existing 4.8 x 2.1 x 26 m concrete box culvert. The new culvert, as reflected in the aforementioned dimensions has a greater cross-sectional area to satisfy hydrological requirements at the site. In addition, the new culvert has an extended length west of existing Jane Street to accommodate a proposed two lane Jane Street roadway and the proposed Jane Street-Hwy. 407 E Ramp. The existing Jane Street is a single lane roadway and at approximate elevation 192.8. The proposed profile grade of Jane Street crossing is approximately 196.1 m and the depth of cover above the roof of the culvert is to be in the order of 2.5 m, approximately 1.5 m greater than the existing cover.

The natural Black Creek stream upstream elevation is 189.6 m whilst downstream the stream elevation is 189.1 m. The existing culvert was constructed approximately 15-20 years ago, and the structure shows no signs of structural distress.

Recommendations pertaining to the following foundation and geotechnical considerations are included in the scope of this report.

- 1) Structure Foundations
- 2) Backfill Structure
- 3) Construction Considerations

- 1) Structure Foundations

In view of the competent nature of the surficial till deposit below the organic concentrated material, the concrete box culvert can be founded on conventional spread footings within the till deposit at an elevation of 189.0 m or lower. For purposes of the O.H.B.D.C. the foundation can be designed using the capacities summarized in Table 3 below.

Table 3 - Shallow Foundation Design

Structure	Founding El. (m)	Bearing Capacity at S.L.S. Type II	Factored Capacity
		(kPa)	U.L.S. (kPa)
Concrete Box Culvert	<189	250	375

Settlement of the foundation subsoil as a result of the applied footing pressure will be elastic in nature and consequently is expected to take place during or immediately following the construction period. The magnitude of this settlement is anticipated to be within 25 mm provided the subsoil is not softened by construction or related activities. To protect the founding soil from this disturbance and from the elements of weathering, a 150 mm lean concrete working slab is recommended. All softened and/or organic material shall be removed from the founding soil and replaced with mass concrete or granular material such as Granular 'A'. Any granular material must be placed and compacted to achieve 100% of the Proctor maximum dry density as outlined in OPSS 501.08.02.

A segment of the culvert and the headwalls at the downstream is to be constructed at the location of the existing pond. The water in the pond will have to be discharged to facilitate the construction of the culvert. This can be achieved by standard pumping methods. Depressions in the pond can be backfilled with granular material or concrete as discussed above.

The footings must be protected against the scouring forces of the stream water. This can be obtained by constructing aprons and rip-rap at the culvert inlet and outlet. The design of the scour protection shall be made in conjunction with applicable hydrological parameters.

Adequate frost protection cover shall be provided for footings subject to frost penetration as for instance during winter construction.

To facilitate construction of the footings, a temporary creek diversion and dewatering scheme will be required. Methods are discussed under "Construction Considerations" in subsequent sections of this report.

2) Backfill to Structure

Material

Approach fills in the order of magnitude of 6.5 m will be required at the culvert. To prevent hydrostatic pressure build-up on the culvert walls, it is

recommended that free draining material such as Granular 'A' or Granular 'B' combined with weep holes in the walls be used. Design parameters of the soil are given in Table 4 below.

Table 4 - Backfill Properties

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m^3)	22.8	21.2
Coefficient of Active Earth Pressure (K_a)*	0.27	0.33
Coefficient of Earth Pressure at Rest (K_0)*	0.43	0.5

*Horizontal surface backfill only

For a rigid and unyielding structure, the earth pressure coefficient 'at rest' is to be used in computing lateral earth pressures.

The backfill beyond the granular wedge as illustrated on OPSD 803 series can consist of acceptable borrow material as defined in OPSS 212.05.

Stability/Settlement

In view of the competent nature of the subsoil, no deep-seated stability problems are anticipated for the proposed approach embankment fill heights of 6.5 m. In addition, internal (surficial) stability of the embankment fill can be effectively controlled by providing an adequate surface erosion protection scheme such as sodding, on the exposed slopes.

Settlements in the order of magnitude of 50 mm attributable to the elastic recompression of the native subsoil and settlement within the fills under its own weight are anticipated. It is predicted that the majority of the settlements will be realized during or immediately following the construction of the embankments.

Embankment Construction

In the construction of the embankment fills, all softened and/or organic material should be excavated for their full depth within the plan limits prior to fill placement.

The backfill should be constructed in 300 mm lifts on alternating sides of the rigid box structure so that the maximum differential in backfill heights at no time exceeds 300 mm. The backfill shall be constructed in accordance with OPSS 902 series and applicable OPSD 803 series. The backfill shall be compacted to achieve the target maximum dry density as outlined in OPSS 501.07-08.

3) Construction Considerations

Stage Construction

To facilitate the construction of the culvert, whilst maintaining traffic, consideration may be given to staging the construction. This can be accomplished by constructing a west segment of the culvert while maintaining traffic on the existing Jane Street and then diverting traffic over this segment while constructing the east segments. Any temporary excavation slope during construction should not be steeper than 1.5H:1V for fills/cuts upto 7 m.

Alternatively a temporary shoring scheme consisting of a cantilever soldier pile lagging wall can be considered. Pertinent design parameters can be obtained from this office should this option be considered.

Temporary Diversion and Dewatering

Temporary diversion of the Black Creek will be required upstream. This can be accomplished by diverting the water using temporary steel pipe culverts adjacent to the proposed culvert and draining the water to its present course through the existing concrete culvert.

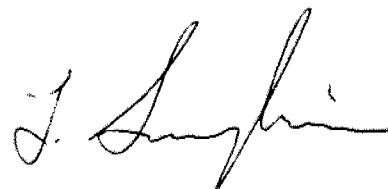
No dewatering problems are anticipated for footing construction provided that perimeter ditches and conventional sump pumping techniques are employed to drain any groundwater seepage or surface runoff that may occur. The surficial till deposit is relatively impervious and it is expected that these conventional dewatering methods will suffice.

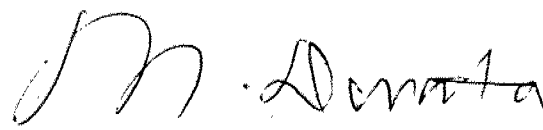
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, and B. Chung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Master Soils Investigation.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.




T. Sangiuliano, P.Eng.
Foundation Engineer


M.S. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

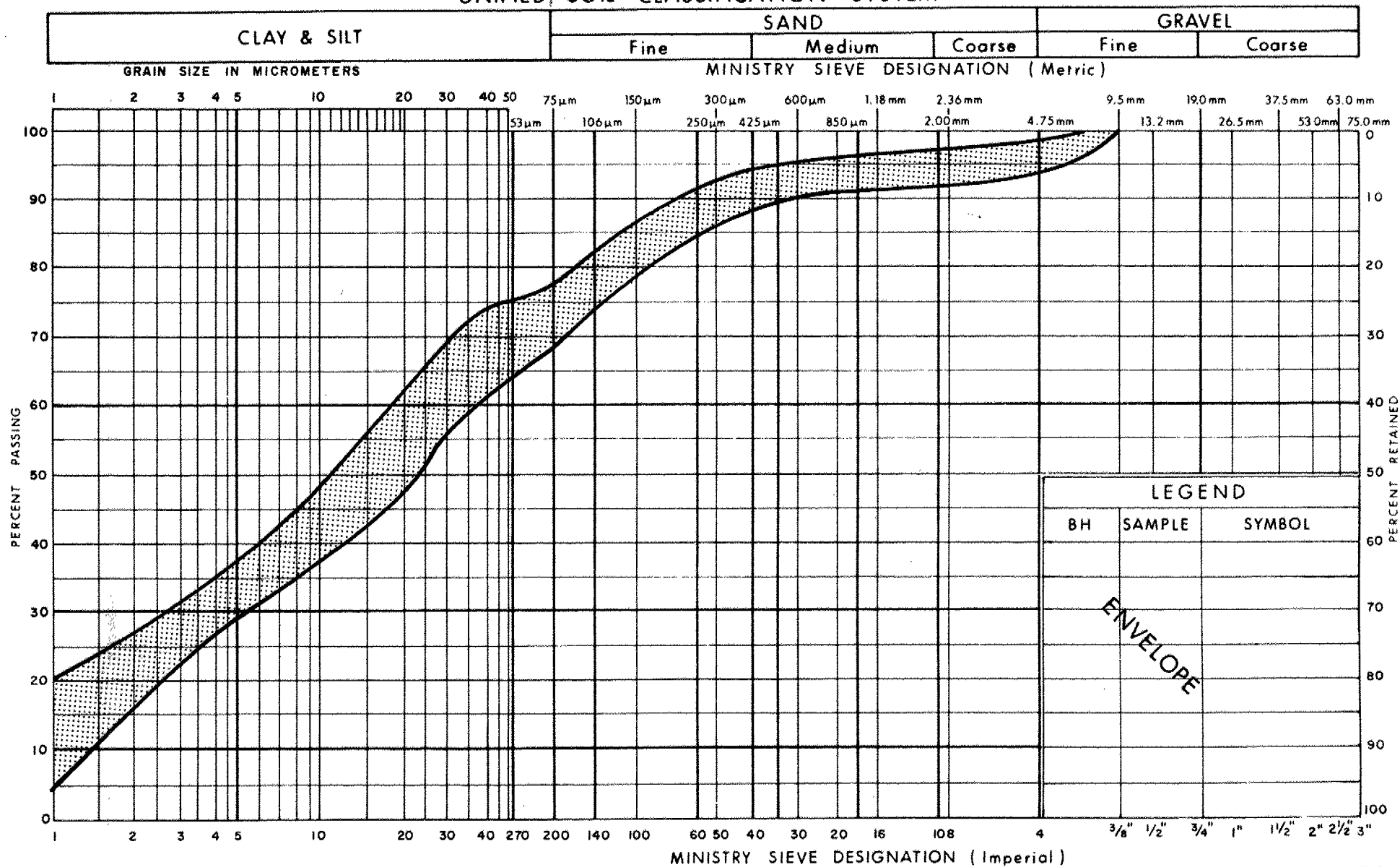
STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{I_p}$	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						

UNIFIED SOIL CLASSIFICATION SYSTEM

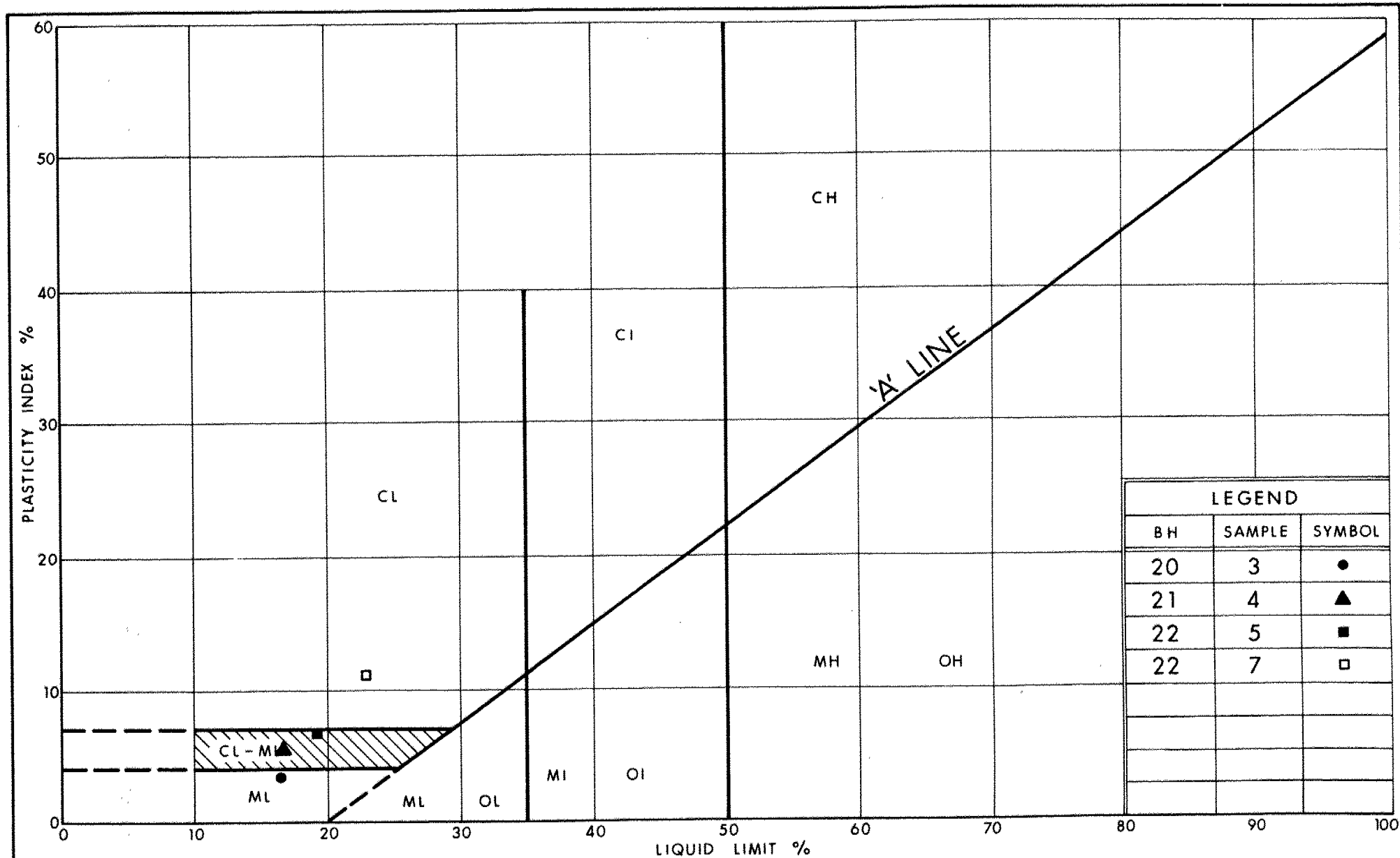


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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT/SILT, SAND, GRAVEL & BOULDERS
(GLACIAL TILL)

FIG No 1

W P 140-87-09



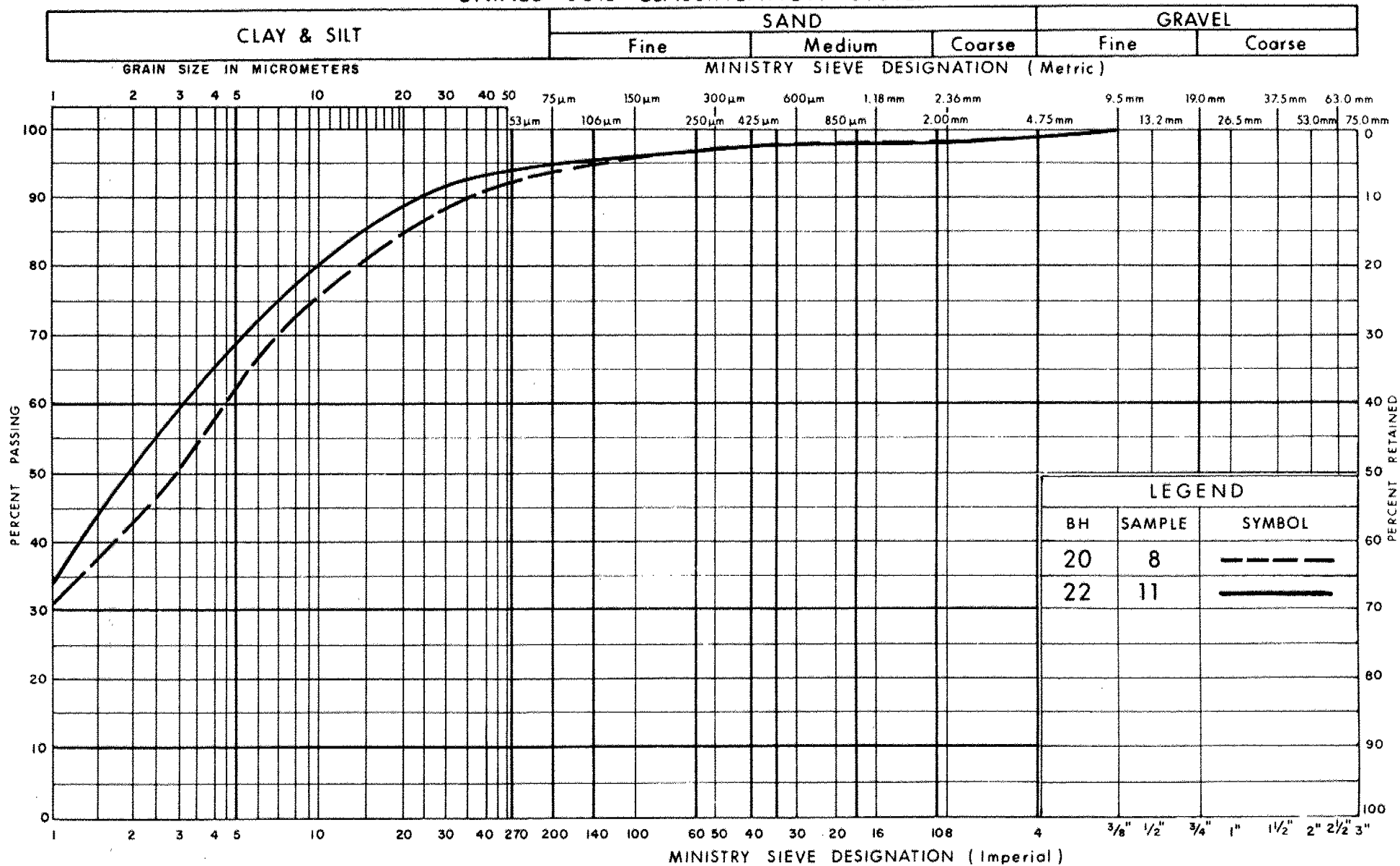
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Ontario

PLASTICITY CHART HET MIXTURE OF CLAYEY SILT/SILT, SAND, GRAVEL & BOULDERS (GLACIAL TILL)

FIG No 2

W P 140-87-09

UNIFIED SOIL CLASSIFICATION SYSTEM

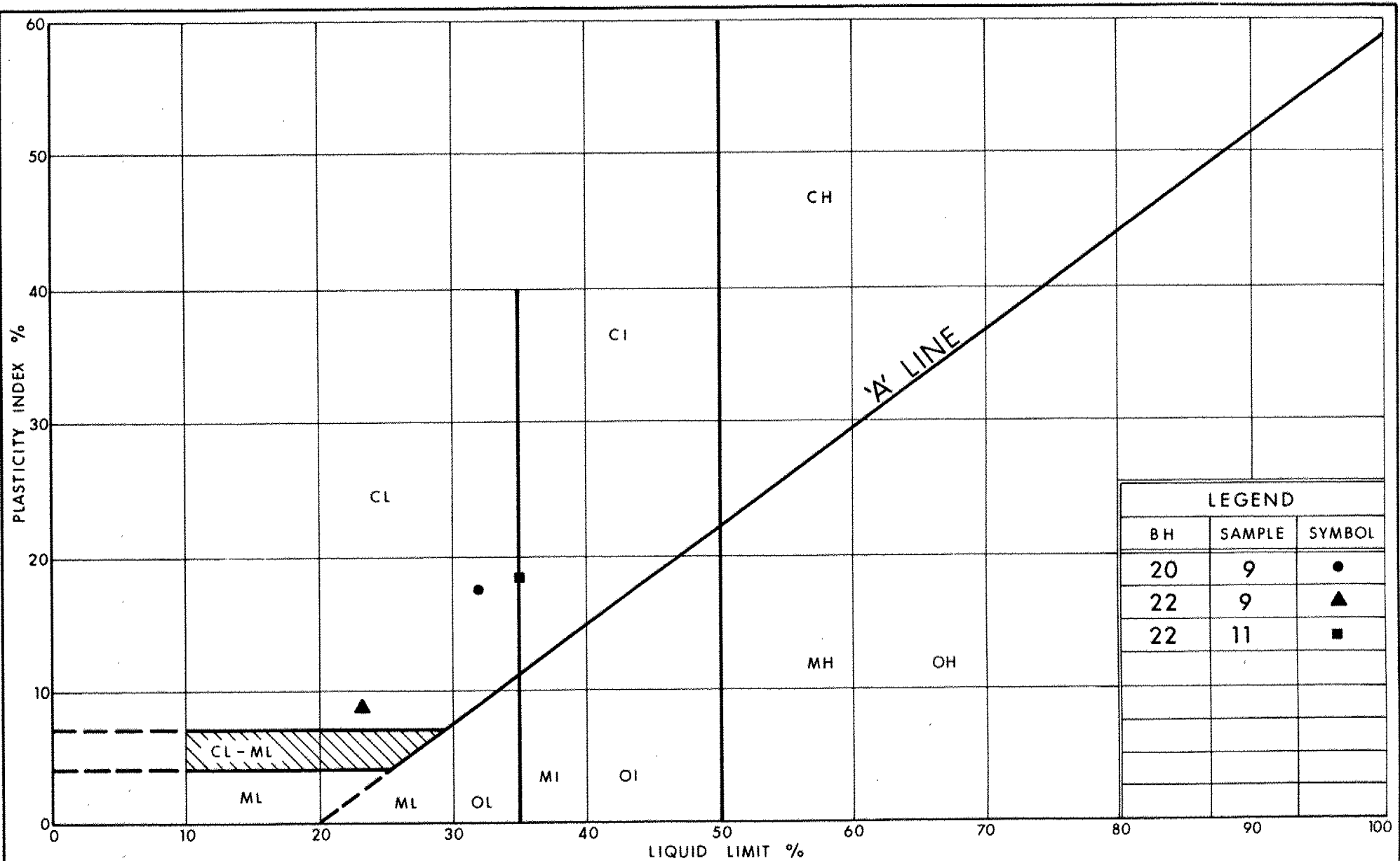


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
(LACUSTRINE)

FIG No 3

W P 140-87-09



LEGEND		
BH	SAMPLE	SYMBOL
20	9	•
22	9	▲
22	11	■



Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT (LACUSTRINE)

FIG No 4

W P 140-87-09

RECORD OF BOREHOLE No 20

1 OF 1

METRIC

W.P. 140-87-09 LOCATION Co-ords: N 4 849 024.5 ; E 302 993.7 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 22 CHECKED BY TS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60
190.4	Ground Surface														
0.0	Same Organics Black, Loose ----- Grey		1	SS	6										
			2	SS	100	/20cm									
			3	SS	100	/23cm									
			4	SS	*										
			5	SS	51										
			6	SS	77										
	Het. mixture of Silt, Sand, Gravel and Boulders (Glacial Till) Grey, Very Dense		7	SS	60										
182.8			8	SS	77										
7.6			9	SS	100	/25cm									
	Clayey Silt (Locustrine) Grey, Hard		10	SS	70										
			11	SS	91										
177.8															
12.6	End of Borehole * Sampler Bouncing (Probable Boulder)														

RECORD OF BOREHOLE No 21

1 OF 1

METRIC

W.P. 140-87-09 LOCATION Co-ords: N 4 849 036 : E 303 008.7 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 21 CHECKED BY TS

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			SHEAR STRENGTH kPa											
190.6	Ground Surface							20	40	60	80	100							
0.0	Some Organics Black, Firm Grey		1	SS	9		188												
			2	SS	95														
	Het. mixture of Silt/Clayey Silt Sand, Gravel and Boulders (Glacial Till)		3	SS	29														
			4	SS	42														
	Grey, Very Dense/Hard		5	SS	78														
186.3																			
4.3	End of Borehole Auger Refusal (Probable Boulder) •Sampler Bouncing																		

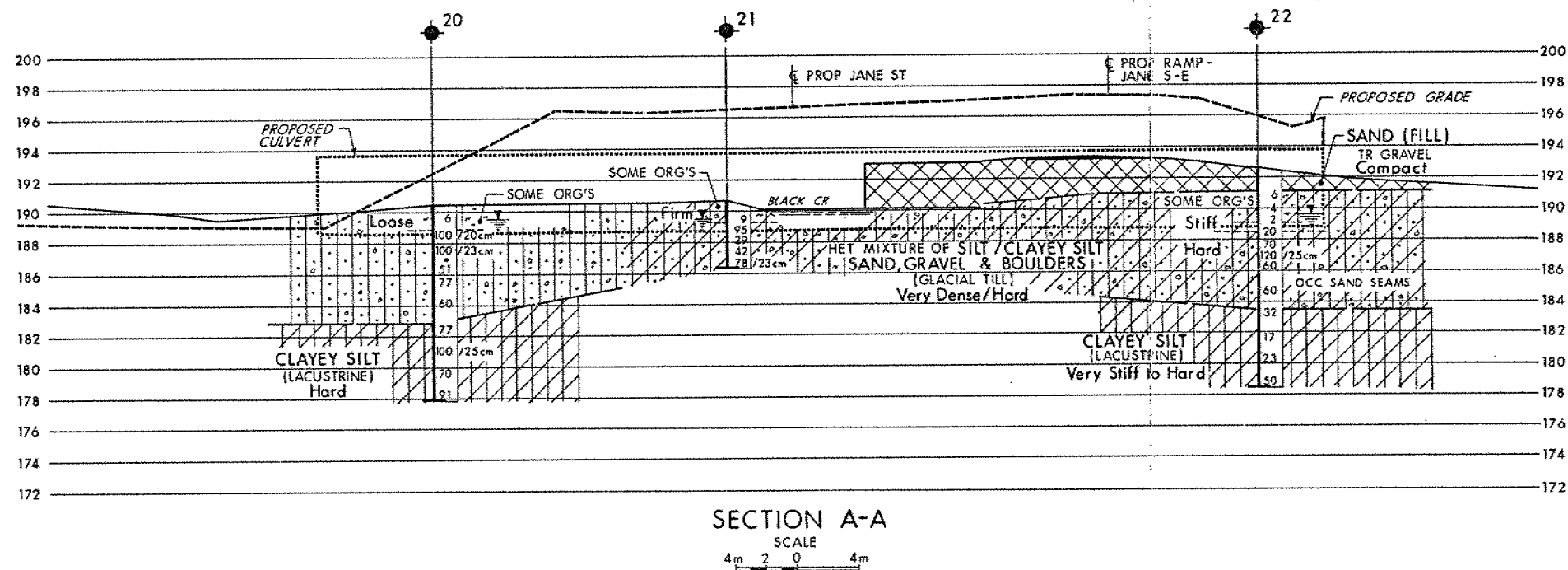
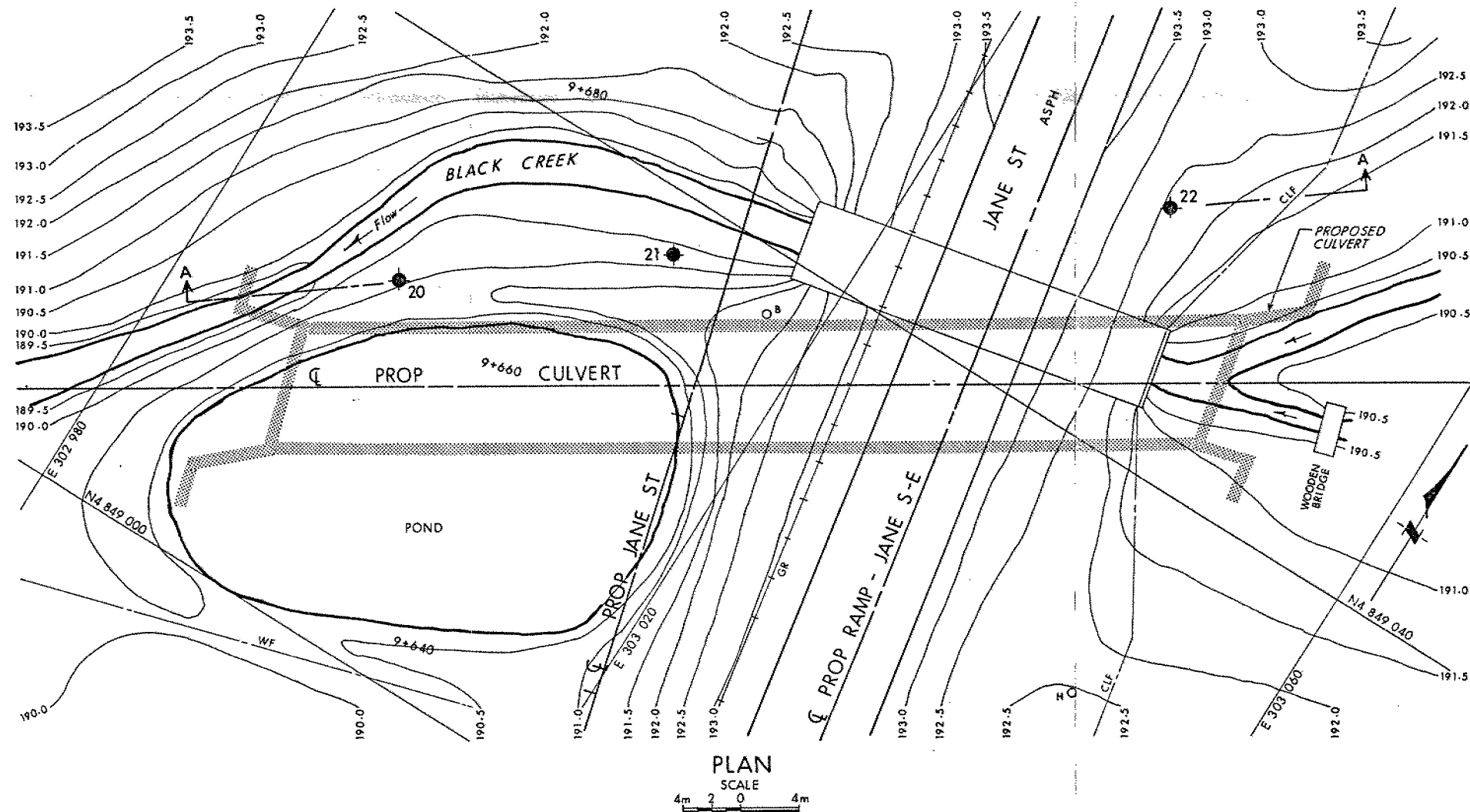
RECORD OF BOREHOLE No 22

1 OF 1

METRIC

W.P. 140-87-09 LOCATION Co-ords: N 4 849 056.9 ; E 303 036 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90.02.22 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
192.6	Ground Surface																
0.0	Sand, Tr. Gravel Brown, Compact (Fill)																
191.1																	
1.5	Some Organics		1	SS	6												
			2	SS	4												
	Black		3	SS	2												
	Grey Stiff		4	SS	20												
	Hard		5	SS	70												
			6	SS	120	/25cm											
	Het. mixture of Clayey Silt, Sand, Gravel and Boulders (Glacial Till)		7	SS	60												
	Occasional Sand Seams																
	Grey, Hard		8	SS	60												
183.5																	
9.1			9	SS	32												
	Clayey Silt (Locustrine)																
	Grey, Very Stiff to Hard		10	SS	17												
			11	SS	23												
178.4																	
			12	SS	50												
14.2	End of Borehole																



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

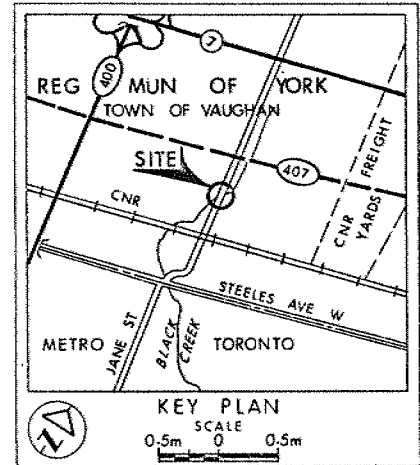
CONT No
WP No 140-87-09

BLACK CREEK CULVERT

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 90 02

No	ELEVATION	CO-ORDINATES NORTH	EAST
20	190.4	4 849 024.5	302 993.7
21	190.6	4 849 036.0	303 008.7
22	192.6	4 849 056.9	303 036.0

NOTE

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

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

REV	DATE	BY	DESCRIPTION
1			

Geocres No 30M13-102

HWY No 407	DIST 6
SUBMD T5 CHECKED	DATE 90 05 02
DRAWN DT CHECKED	APPROVED
	SITE
	DWG 1408709-A

MEMORANDUM

(416) 235-3731

To: V.F. Boehnke,
Head, Structural Section
4th Floor, Atrium Tower
1201 Wilson Avenue, Downsview

Attn: L. Mikhailovsky, P. Eng.
Senior Structural Engineer

1991 07 23

From: Foundation Design Section
Room 315, Central Building, Downsview, Ontario
Central Region, MTO

Re: Final Design Review
Black Creek Structures
W.P. 140-87-08, Site: 37-1319
W.P. 140-87-09, Site: 37-1318
Highway 407, District 6, Toronto

Further to your request dated June 27, 1991 we have reviewed the drawings of final design for the above mentioned projects. The drawings were marked as preliminary but we understand that they are final drawings. The drawings DWG 1,2,3 (Sheets 72, 72, 76, 77, 78, 79, 80 and 81) produced by Fenco Engineers Inc. dated Oct. 1990 have been reviewed by this office and are found to be in conformance with our design requirements. However, it is expected that grading of approach slope will be maintained at 2H:1V and a special provision for dewatering will be incorporated in the contract package.

Should you have any further questions, please advise.


(KEN AHMAD)

for

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

For

Murty Devata, P. Eng.
Chief Foundation Engineer

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1990 03 21

Atten: W. Garland
Inter. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Proposed Crossing at Black Creek Culvert
and Jane Street
W.P. 140-87-09, Site 37-1318
Highway 407, District 6, Toronto

This memorandum summarizes the results of a foundation investigation conducted at the aforementioned site and provides preliminary comments pertaining to the structure foundations and related earthworks. These comments have been submitted in advance of the final report to assist in expediting the design so that conformance to project scheduling can be met. The final report will be submitted in the near future.

Proposed Structure

It is proposed to replace the existing 4.8 m X 2.1 m X 26 m rigid frame concrete box culvert with a 6 m X 4 m X 61.7 m rigid frame concrete box culvert located along an alignment rotated approximately 18° southwesterly from the existing alignment. The proposed culvert will support the proposed Jane S-407E ramp and the proposed realigned Jane Street. The profile grade of the new Jane Street is at approximate elevation 196.1 m and consequently the proposed culvert will have a cover of up to 2.5 metres

Subsurface Conditions

The ground surface elevation at the site varies from approximately 192.6 m at the existing Jane Street roadway to approximately 190.4 located beyond the roadway. The subsoil stratigraphy consists of approximately 1.5 metres of brown, compact sand with traces of gravel that comprises the fill material overlying and adjacent to the existing concrete culvert. The fill material is underlain by a till deposit consisting of a heterogeneous mixture of silt to clayey silt, sand, gravel and boulders. Apart from the surficial soft, black organic material approximately 1.2 to 1.8 metre in thickness, this deposit is generally hard or very dense. The thickness of the deposit is in the order of 7.6 metres. The till deposit is underlain by a cohesive glaciolacustrine clayey silt stratum that is generally very stiff to hard.

Groundwater levels obtained at the time of the investigation revealed levels generally at the elevation of the water in the creek. This corresponds to depths ranging from 1 to 3 metres below the natural ground surface (El. 189.4 to 189.6 m).

Discussion and Recommendations

The following foundation/geotechnical items are hereby discussed.

- 1) Structure Foundations
- 2) Approach Embankments
- 3) Construction Considerations

Structure Foundations

In view of the competent nature of the surficial till deposit below the organic concentrated material, the concrete box culvert can be founded on conventional spread footings within the till deposit at an elevation of 189.0 m or lower. For purposes of the O.H.B.D.C., the foundation can be designed using the capacities summarized in Table 3 below:

Table 3 - Shallow Foundation Design

Structure	Founding El.m)	Bearing Capacity at S.L.S. Type II (kPa)	Factored Capacity at U.L.S. (kPa)
Concrete Box Culvert	<189	250	375

Settlement of the foundation subsoil as a result of the applied footing pressure will be elastic in nature and consequently is expected to take place during or immediately following the construction period. The magnitude of this settlement is anticipated to be within 25 mm provided the subsoil is not softened by construction or related activities. To protect the founding soil from this disturbance and from the elements of weathering, a concrete working slab is recommended.

The footings must be protected against the scouring forces of the stream water. This can be obtained by constructing aprons and rip-rap at the culvert inlet and outlet. The design of the scour protection shall be made in conjunction with applicable hydrological parameters.

Approach Embankments

In view of the competent nature of the subsoil, no deep-seated stability problems are anticipated for the proposed approach embankment fill heights of 6.5 metres. In addition, internal (surficial) stability of the embankment fill can be effectively controlled by providing an adequate surface erosion protection scheme such as sodding the exposed slopes.

Settlements in the order of magnitude of 50 mm attributable to the elastic recompression of the native subsoil and settlement within the fills under its own weight are anticipated. It is predicted that the majority of the settlements will be realized during or immediately following the construction of the embankment.

Construction Considerations

Stage Construction

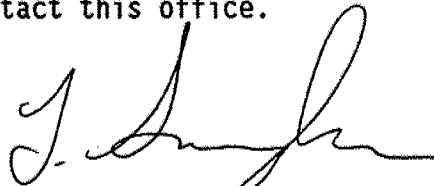
To facilitate the construction of the culvert, whilst maintaining traffic, consideration may be given to staging the construction. In the staging, any temporary excavation slope shall not be steeper than 1.5H:1V for fills/cuts up to 7 metres. Alternatively, a temporary shoring scheme consisting of a cantilever soldier pile lagging wall can be considered.

Temporary Diversion and Dewatering

Temporary diversion of the Black Creek will be required upstream. This can be accomplished by diverting the water using temporary steel pipe culverts adjacent to the proposed culvert and draining the water through the existing concrete culvert.

No dewatering problems are anticipated for footing construction provided that perimeter ditches and conventional sump pumping techniques are employed to drain any groundwater seepage or surface runoff that may occur.

If you have queries regarding the above comments or require additional information, please do not hesitate to contact this office.



T. Sangiuliano, P. Eng.
Foundation Engineer

for

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

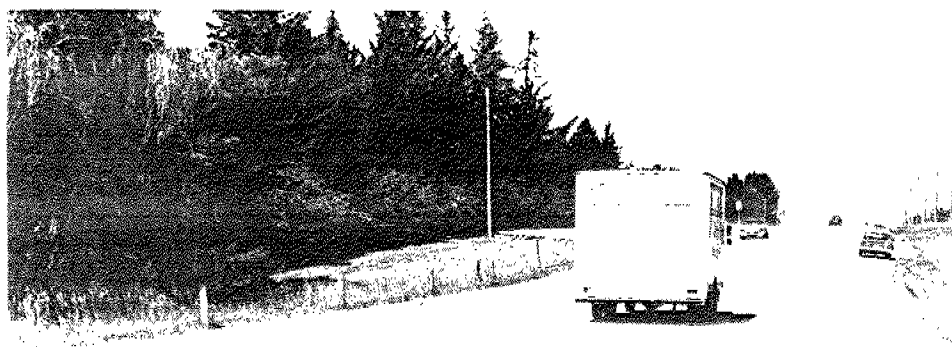
TS/mmj



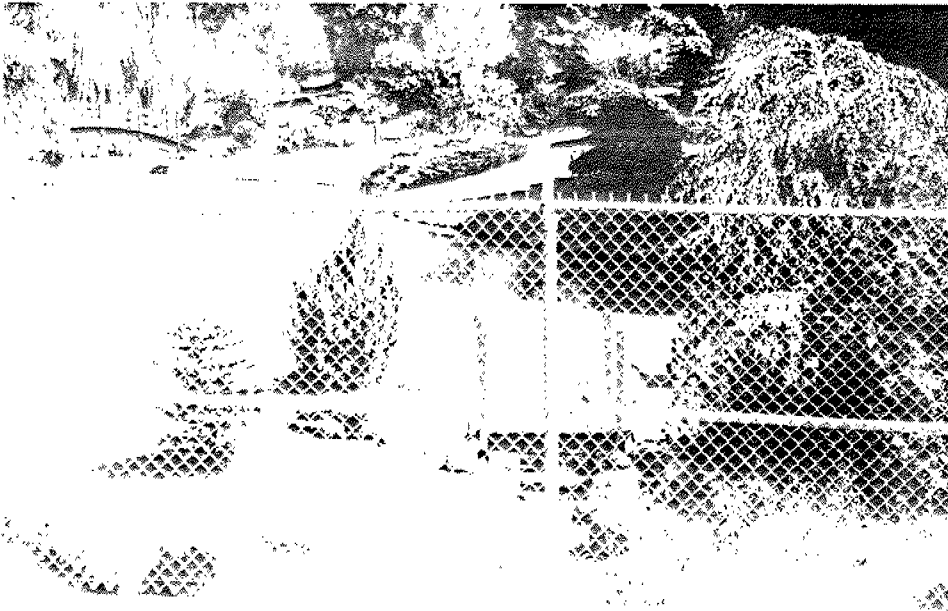
<==
Looking East
(at outlet)

File: 37-1318
Date: 18 SEP 1989

Stream : Black Creek
Photos by: L. Mikhailovsky



<==
Looking North Along
Jane Street



<==
Looking U/S

File: 37-1318 Stream : Black Creek
Date: 18 SEP 1989 Photos by: L. Mikhailovsky



<==
Looking South Along
Jane Street