

GEOCRES No. 40I14-120DIST. 2 REGION W.P. No. 263-91-00CONT. No. W. O. No. STR. SITE No. HWY. No. 4LOCATION Hwy 4 & Elgin Rd 16 I.C.Proposed Retaining WallNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



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HWY 4 STR SITE
Proposed Retaining Wall
Hwy. 4 and County Road 16

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FOUNDATION INVESTIGATION REPORT

for

Proposed Retaining Wall

Hwy. 4 and County Road 16

G.W.P. 263-91-00

District 2, London

INTRODUCTION

This report summarizes the results of a foundation investigation conducted in conjunction with the proposed retaining wall replacement structure located at the southeast quadrant of Hwy. 4 and County Road 16. The deteriorated condition of the existing retaining wall and the proposed widening of Hwy. 4 has dictated the design and construction of a suitable replacement retaining wall structure.

SITE DESCRIPTION AND GEOLOGY

The site is located at the southeast quadrant of the Hwy. 4 and County Road 16 (Talbot Rd.) in the City of St. Thomas, County of Elgin. Hwy. 4 is a two lane asphaltic highway that runs in a north-south direction. Talbot Rd., a two lane roadway, intersects Hwy. 4 just north of the site.

The site is located within a natural broad valley with ridges located east and west of the site. The Hwy. 4 - Talbot Rd. intersection is situated at the toe of the eastern valley slope. Kettle Creek meanders within the valley adjacent to the site. A residential dwelling and an abandoned two (2) storey building are located at the northeast and northwest quadrants of the intersection respectively. A multi-span CNR Subway structure intersects Hwy. 4 at a skew approximately 30 metres south of Talbot Rd. The structure has a steel girder deck with concrete piers and abutments. Approach embankments consist of transverse slopes and forward slopes, the latter sloping to the existing concrete crib type retaining wall. The slope ranges in geometry from approximately 3H:1V with an almost flat bench north of the structure to approximately 2H:1V collinear with the structure itself. The slope is covered with grassland and trees beyond the structure and a gravel blanket beneath the structure.

The concrete crib wall is approximately 1.5 metres in height and extends from the most southerly pier located just east of Hwy. 4 northerly for a distance of approximately 23 metres. A second retaining wall equal in height extends beyond the pier in a southerly direction tapering for a distance of approximately 35 m.

Exposed foundations, perhaps the remnants of a structure demolition is located south of the CNR Subway west of Hwy. 4.

Physiographically, the site is located in the geological domain known as the Mount Elgin Ridges. The Mount Elgin Ridges is comprised of moraine glacial till materials consisting of heterogeneous mixtures of clayey silt, silty clays, sands, and gravels. These materials were deposited during the retreat of the Wisconsin glacialiation (approximately 12,000 years ago).

INVESTIGATION PROCEDURE

Physical and mechanical soil properties were obtained by in situ and laboratory testing. The field and laboratory investigation and testing programs are summarized below.

Field Investigation

The fieldwork for the investigation was carried out on 92 04 27 and consisted of three (3) sampled boreholes advanced to depths ranging from 6.6 m to 8.1 m below the existing ground surface. A gas powered track mounted Central Mining Equipment (CME) 55 unit was used to advance the boreholes employing conventional solid stem augering techniques.

Subsoil samples were generally retrieved at 0.7 m intervals for the surficial 4.5 metres and at 1.5 m intervals thereafter for the boreholes advanced in conjunction with the proposed retaining wall structure (BH's 1 and 2). At BH 3, positioned on the slope behind the proposed retaining wall, samples were retrieved at 1.5 m intervals.

Disturbed subsoil samples were retrieved employing a standard split spoon sampler in accordance with the Standard Penetration Test (ASTM D1585). All subsoil samples were identified in the field and then placed in sealed plastic jars to ensure the preservation of the natural moisture contents. Samples were subsequently transported to the laboratory and then classified employing both visual and laboratory methods as described below.

Groundwater levels were determined by monitoring the levels in the open boreholes throughout the duration of the field investigation. All boreholes were backfilled upon completion of the fieldwork.

The survey related to the location and elevation of the individual borehole and a profile section of the existing slope behind the retaining wall was provided by Southwestern Region Surveys and Plans.

Laboratory Analyses

As mentioned above, all subsoil samples were visually examined in the laboratory using procedures described in the MTO Soil Classification Manual. These procedures consist of estimating the particle size distribution of the material and conducting manual physical index property tests.

The visual examinations of the samples were combined with some laboratory testing on selected representative samples. Laboratory tests were carried out to define the behaviour, gradation and other physical properties of the soil and included:

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

Laboratory tests were conducted in accordance with the respective procedures outlined in the MTO Laboratory Testing Manual and as described in Chapter 3 of the MTO Soil Classification Manual.

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

SUBSURFACE CONDITIONS

General

The ground surface elevation at the site varies between approximately 206 m and 220 m which reflects the existing forward slope extending from the east abutment of the CNR Subway to the existing retaining wall. The slope is approximately 2H:1V or flatter.

Two types of fill material exist surficially at different locations at the site. In front of the existing retaining wall, a shallow thickness (approximately 0.8 m) of sand and gravel with some black organics is present. Behind the retaining wall, an irregular mixture of clayey silt to silty clay, sand and gravel with random interbeds of cinder ash exists. The thickness of the irregular mixture of clayey silt to silty clay, sand and gravel fill material investigated varied from approximately 1.5 metres just behind the retaining wall (BH 2) to approximately 4.0 metres at BH 3, suggesting that the thickness of the fill material increases up the slope.

The fill material is underlain by a native heterogeneous mixture of clayey silt to silty clay, sand and gravel. The thickness of this deposit of glacial till origin varies between 5.3 m to 6.1 m. This cohesive deposit has a very stiff to hard consistency.

The cohesive heterogeneous mixture of clayey silt to silty clay, sand and gravel is underlain by a cohesionless heterogeneous mixture of silt, sand and gravel. This deposit is also of glacial till origin and has a denseness ranging from dense to very dense. This deposit was explored up to 1.8 metres .

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 a subsoil stratigraphical section are provided on Dwg. No. 2639100-A also included in the Appendix.

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

Sand and Gravel (Fill Material)

A cohesionless sand and gravel with some organics appears to exist in front of the existing retaining wall. The material is black in colour, an indication of the organic composition of the material. The thickness of this fill material is approximately 0.8 metres.

The sand and gravel fill material appears to be in a loose to compact state of denseness.

Irregular Mixture of Clayey Silt to Silty Clay, Sand and Gravel (Fill Material)

A cohesive irregular mixture of clayey silt to silty clay, sand and gravel with random interbeds of cohesionless cinder ash exists as fill material overlying the native soil at the site. This fill material increases in thickness from approximately 1.5 metres slightly beyond the retaining wall to approximately 4 metres further up the slope and beyond the retaining wall. The cinder ash interbeds range up to approximately 100 mm in thickness. The irregular mixture of clayey silt to silty clay, sand and gravel is brown in colour with interbeds of black cinder ash.

A grain size distribution curve as determined by hydrometer and mechanical sieve analyses on a representative sample of the irregular mixture of clayey silt to silty clay, sand and gravel is shown on Figure 1 in the Appendix. The grain size distribution curve reveals that approximately 72% of the material is finer than 75 micrometres. This indicates that the material is to be categorized according

to its behaviour as defined in the MTO Soil Classification manual.

A grain size distribution curve for the cohesionless cinder ash interbeds intermixed with the fill material is also shown on Figure 1.

An Atterberg Limit Test was carried out on the fine grained portion of the fill material (less than 425 micrometres) to define the behaviour and plasticity of the material. The test results reveal that the material has a liquid limit (W_L) of 35% and a plasticity index (I_p) of 16%. Consequently, the material has a low to intermediate plasticity and hence can be categorized as clayey silt, to silty clay.

Standard Penetration Test (SPT) "N" Values retrieved in this fill material were in the order of magnitude of 11 to 12 blows/0.3 m. Based on these "N" values, the material can be described as having a stiff consistency.

Heterogeneous Mixture of Clayey Silt to Silty Clay.
Sand and Gravel (Glacial Till)

Underlying the fill material, a native deposit consisting of a cohesive heterogeneous mixture of clayey silt to silty clay, sand and gravel exists. Although not encountered during the investigation, boulders and cobbles are inherent components of glacial till deposits and hence can exist. The thickness of the deposit ranges from 5.3 m to 6.1 m.

The upper 2.6 metres of the deposit has been oxidized and hence is brown in colour, Beneath the upper 2.6 metres of the deposit, the soil is unoxidized and hence grey in colour.

The main component of this unsorted, unstratified deposit is the clayey silt to silty clay material. This material matrix essentially binds the coarser sands and gravels within the deposit. A grain size distribution envelope for the deposit as determined by mechanical sieve and hydrometer analyses is given in Figure 2 in the Appendix.

The envelope reveals that the fine grained portion (less than 75 micrometre) contribute to more than approximately 67% of the material of this deposit.

Atterberg Limit Tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted on Figure 3. A summary of the indices is provided in Table 1 below. Bulk unit weights and natural moisture contents are also included in the table.

Table 1 - Heterogeneous Mixture of Clayey Silt to Silty Clay
Sand and Gravel (Glacial Till)

	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (W%)	9-23	3
Liquid Limit (W_L %)	20-37	3
Plastic Limit (W_p %)	12-18	3
Plasticity Index (I_p %)	8-19	3
Unit Weight (kN/m^3)	18.7-23.4	3

The test results reveal that the fine grained portion of the deposit is of low to intermediate plasticity and hence is defined as clayey silt to silty clay. Natural moisture contents are generally close to the plastic limit of the soil indicating that the soil is in a plastic to semi-solid state.

Standard Penetration Test (SPT) carried out in this deposit revealed "N" values ranging from 19 blows/0.3 m to 105 blows/0.3 m. The surficial 2 to 3 metres produced "N" values ranging from 19 blows/0.3 m to 30 blows/0.3 m indicating a very stiff to hard consistency. Stronger material exists beneath this surficial thickness and "N" values exceeded 30 blows/0.3 m indicating a hard consistency.

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

The cohesive heterogeneous mixture of clayey silt, sand and gravel is underlain

by a grey, cohesionless heterogeneous mixture of silt, sand and gravel at a depth ranging from 6.1 m to 7.6 m below the ground surface (Elevation 199.1 m). Boulders and cobbles are also characteristic components of cohesionless till deposits and although not encountered during the investigation, can exist within the deposit.

A grain size distribution curve illustrating the gradation of a representative sample of the deposit as determined by mechanical and hydrometer analysis is shown in Figure 4 in the Appendix.

Standard Penetration Tests carried out in this deposit revealed "N" values ranging from 44 blows/0.3 m to 60 blows/0.15 m indicating that the deposit is in a dense to very dense state of denseness.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes at the time of the field investigation. Groundwater levels ranged from 3.9 m to 5.0 m below the ground surface (Elevation 201.3m to 206.2 m). The higher groundwater elevation is indicative of the higher ground surface elevation further up the slope (BH 3).

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

DISCUSSION AND RECOMMENDATIONS

Due to the proposed widening of Hwy. 4, the existing concrete crib retaining wall requires relocation a short distance east of its existing location. The proposed retaining wall is to be located at the toe of an existing earth embankment slope of steepness 2H:1V or flatter beneath and adjacent to the north side of the CNR Subway. The retaining wall will extend from the existing CNR Subway concrete pier northwardly for an approximate distance of 23 m as shown on Drawing 2639100-A. The proposed structure will retain slope toe heights ranging from approximately 0.7 m to 1.2 m. The elevation of the top of the retaining wall ranges from 206.3 m to 206.1 m.

Foundation and geotechnical parameters to facilitate the design of the proposed retaining wall are contained within the purview of this report and are discussed below. Construction considerations are also described in the report.

DESIGN CONSIDERATIONS

General

The retaining wall must be designed to satisfy ultimate and serviceability limit states as described in Section 6-9 of the OHBDC. The following geotechnical related criteria must be considered.

- 1) Foundation Bearing Capacity Failure
- 2) Foundation Sliding Failure
- 3) Overturning Failure
- 4) Overall Stability

The retaining wall design must safeguard against the above mentioned failures.

- 1) Foundations Bearing Capacity

Structure foundations can be founded on conventional spread footings at or below elevation 204.5 within the native heterogeneous mixture of clayey silt to silty

clay, sand and gravel deposit. Bearing capacities of the material at the given elevation are provided in Table 2 below.

Table 2 - Spread Footing Soil Capacity

Factored Capacity at U.L.S. (kPa)	375
Bearing Capacity at S.L.S. Type II (kPa)	250

Footing Founding elevations shall be selected such that sufficient frost protection cover is provided. At the site, the frost penetration depth is 1.2 m. Therefore, the foundation must be designed with 1.2 m earth cover or equivalent frost protection.

Settlements developed as the result of the applied pressure in Table 2, at the serviceability limit state are expected to be within 25 mm magnitude and because the deformations will be recompression in nature should occur immediately during construction.

In view of the fact that horizontal pressures will be exerted against the retaining wall in addition to vertical pressures, the resultant pressure will be inclined. Bearing capacity reduction to account for inclination of loads acting on shallow foundations shall be carried out in accordance with Section 6-7.3.3.5 of the O.H.B.D.C. Bearing capacities tabulated in Table 2 must therefore be modified accordingly.

All softened and/or organic material present at the footing founding elevation shall be removed and replaced with a granular material and/or mass concrete. In addition, to preserve the founding foil during construction, it is recommended that a concrete working slab be placed in advance of the concrete footing construction.

The mutual influences of the loadings proposed at the retaining wall shallow foundation and the existing CNR Subway pier foundation, shall be reviewed to ensure that any induced loading is accounted for. Undermining of the existing

CNR Subway foundation must be avoided during the construction of the retaining wall foundation. Please contact this office should the proposed retaining wall foundation be lower than the existing CNR Subway pier foundation for recommendations for relevant excavation/shoring schemes.

2) Sliding

Angle of Friction Between Base and Soil

In the computation of the sliding resistance of the foundation, an unfactored friction angle of 30^0 can be used between the concrete footing and the native soil. Additional sliding resistance can be provided by employing shear keys in the native soil. The passive resistance developed by the shear key can be computed using an angle of internal friction of 30^0 and a natural unit weight of 20 kN/m^3 above the prevailing groundwater table.

Backfill and Drainage

Granular backfill consisting of Granular "A" or Granular "B" combined with weep holes or subdrains shall be used to prevent hydrostatic pressure build-up behind the retaining wall. The excavation cut geometry and backfill treatment is illustrated on OPSD 3504.00. As illustrated, an excavation cut shall be advanced at 1H:6V into the existing fill material and native soil at the site.

Lateral Earth Pressure on Structure

The existing fill material and native heterogeneous mixture of clayey silt to silty clay, sand and gravel will govern the earth pressures on the proposed retaining wall. Design parameters of the soil are given in Table 3 below. Earth pressures shall be computed in accordance with Section 6-6.1 of the O.H.B.D.C. It is prudent that the earth pressures account for the sloping surface behind the retaining wall? because the sloping surface has a significant influence on the earth pressure coefficient. Buoyant unit weights are to be used for any soil submerged below the groundwater table.

Table 3 - Earth Pressure Computation Parameters

<u>Soil Type</u>	Unfactored	Saturated Unit Weight (γ) (kN/m ³)
	Angle of Internal Friction (ϕ^0)	
Irregular Mixture of Clayey Silt to Silty clay, Sand, Gravel with Cinder Ash (Fill Material)	30	30
Heterogeneous Mixture of Clayey Silt to Silty Clay, Sand & Gravel (Glacial Till)	30	20

Rankine's theory of earth pressure can be used in the computation of earth pressure coefficients. For yielding retaining walls, the active Rankine state is applicable. Soil strength parameters shall be factored in accordance with Table 6-5.2 of the O.H.B.D.C.

3) Overturning

Overturning failure involves rotation of the wall about its toe. Earth pressures to be used in the analysis can be computed employing the soil parameters given in Table 3 and the drainage conditions described above.

4) Overall Stability

In view of the competent nature of the native heterogeneous mixture of clayey silt to silty clay, sand and gravel (Glacial Till) deposit at the site, there are no long term deep seated stability problems anticipated for the proposed toe retaining wall and existing embankment slope geometry. However, it is recommended that a construction sequencing scheme be executed as described under "Construction Considerations" to avoid any potential translational slope movement, particularly at the fill-native soil interface, during construction.

RETAINING WALL TYPE

Two types of retaining wall structures have been proposed:

- 1) a conventional reinforced concrete cantilever type of retaining wall
- 2) a sloped stone (Risi) wall

In our opinion from a foundation and geotechnical point of view, both structure types are acceptable provided that the design considerations described in this report are satisfied. Therefore, the most economical alternative shall be adopted.

The cost effectiveness of the application of styrofoam insulation to minimize the depth of the footing should be explored. A reduction in overall retaining wall height will definitely produce a more economical design. However, it is cautioned that the foundation must be founded on the native heterogeneous mixture of clayey silt to silty clay, sand and gravel (Glacial Till) and NOT within any fill material. Hence, it is recommended that the founding elevation be no higher than 204.5m.

CONSTRUCTION CONSIDERATIONS

- 1) Excavation at Toe of Slope

Construction Sequencing Scheme

To avoid any potential translational slope movements during construction, it is recommended that excavation at the toe of the existing slope be controlled by staging the excavation and hence limiting the extent of exposed cut at the toe. It is recommended that the excavation be carried out in three (3) stages:

Stage 1 - Excavate and construct most southerly section of wall at a 5 metre

maximum length. This restricted length ensures the stability of the slope at the existing bridge locations.

Stage 2 - Excavate and construct most northerly section of wall at a 10 metre maximum length.

Stage 3 - Excavate and construct central section of wall with 10 metre maximum length sections.

Temporary Shoring Wall

Alternatively, a temporary soldier pile and timber lagging cantilever type shoring wall can be designed to facilitate the construction of the retaining wall. Soil parameters tabulated in Table 3 can be employed to design the cantilever shoring wall.

Should this option be considered, recommended installation procedures can be given by this office.

Dewatering

No dewatering problems are anticipated during the excavation and construction of the structure foundations in view of the impervious nature of the existing irregular mixture of clayey silt to silty clay, sand and gravel (Fill Material) and the native heterogeneous mixture of clayey silt to silty clay, sand and gravel (Glacial Till). Conventional sump pump techniques will suffice in discharging any surface runoff or localized seepage from the excavation.

Backfill Construction

The granular backfill behind the retaining wall shall be placed and compacted in accordance with OPSS 501 series. In view of the limited space available behind the retaining wall, compaction with hand equipment is undoubtedly the most

practicable method of backfill placement.

Other

As mentioned previously in this report, construction activities must be properly coordinated to avoid damaging and/or undermining the existing CNR Subway pier foundations located at the southern end of the proposed retaining wall. In addition, excavation procedures shall appropriately consider the presence of underground utilities in front of the wall.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer utilizing equipment owned and operated by K & S Drilling Ltd.

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



A handwritten signature in black ink, appearing to read "T. Sangiuliano".

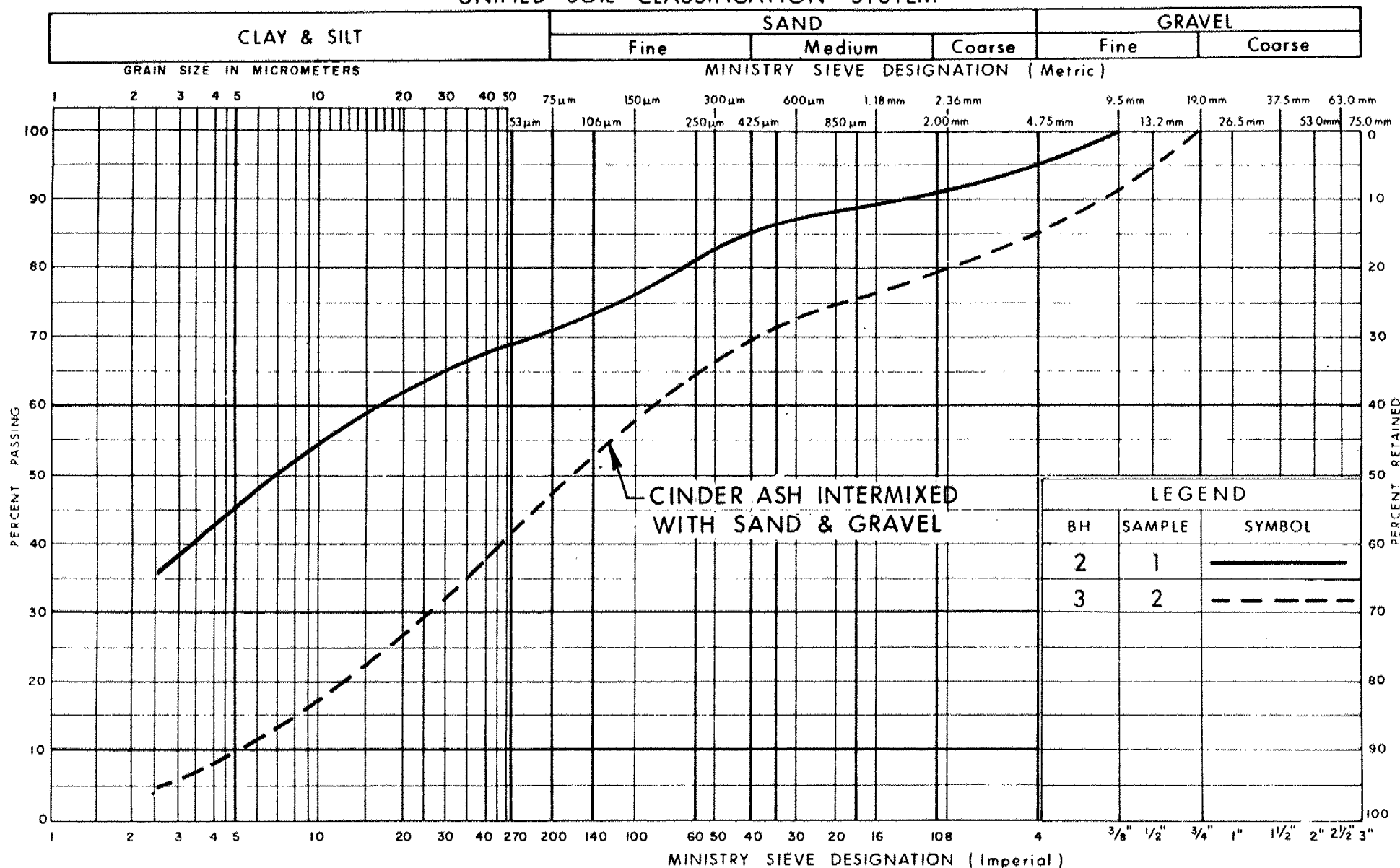
T. Sangiuliano, P. Eng.
Foundation Engineer

A handwritten signature in black ink, appearing to read "M. Devata".

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



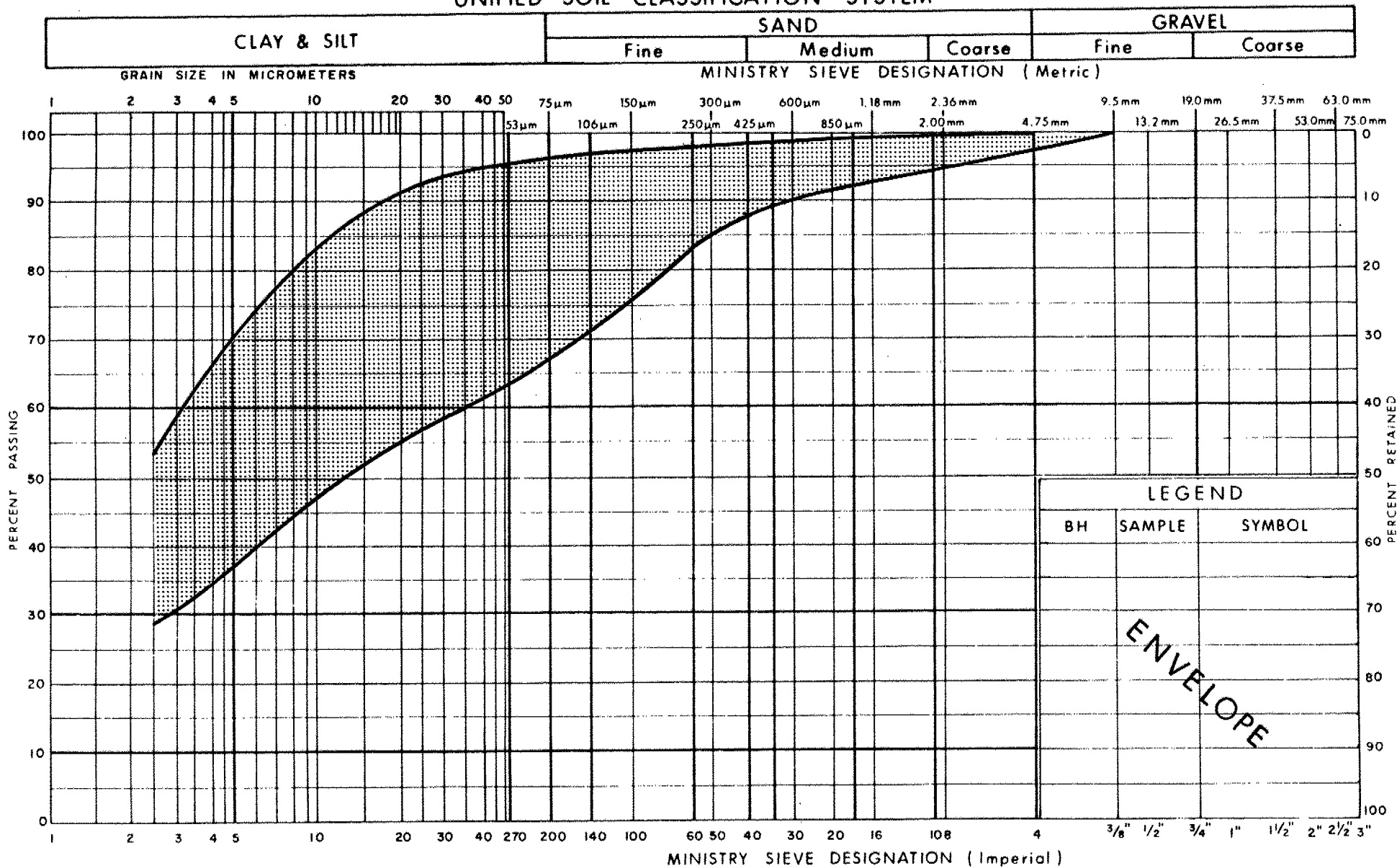
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GRAIN SIZE DISTRIBUTION
IRREGULAR MIXTURE OF CLAYEY SILT TO SILTY CLAY, SAND
& GRAVEL WITH INTERBEDS OF CINDER ASH (FILL MATERIAL)

FIG No 1

W P 263 - 91 - 00

UNIFIED SOIL CLASSIFICATION SYSTEM



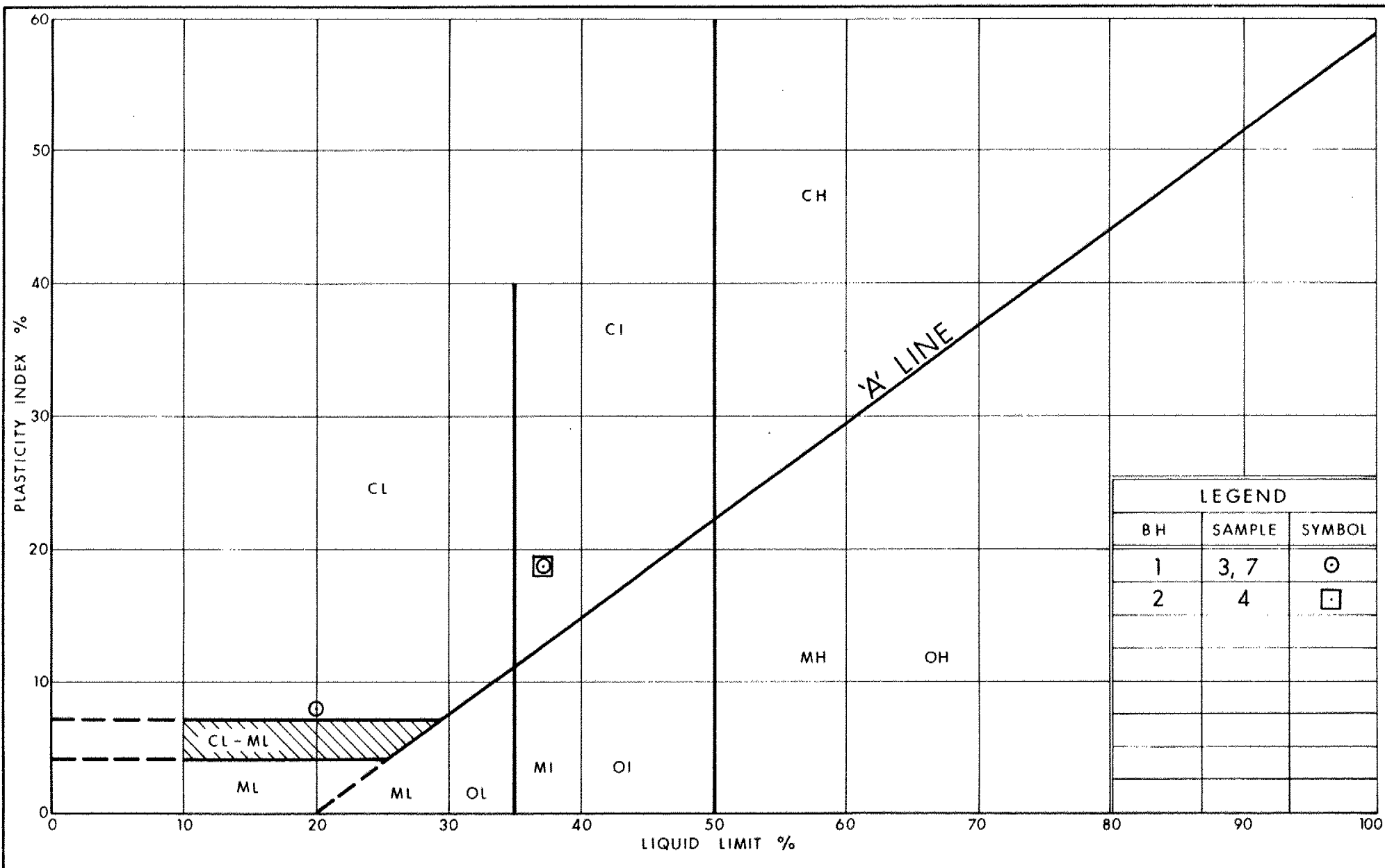
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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT TO SILTY CLAY,
SAND & GRAVEL (Glacial Till)

FIG No 2

W P 263-91-00



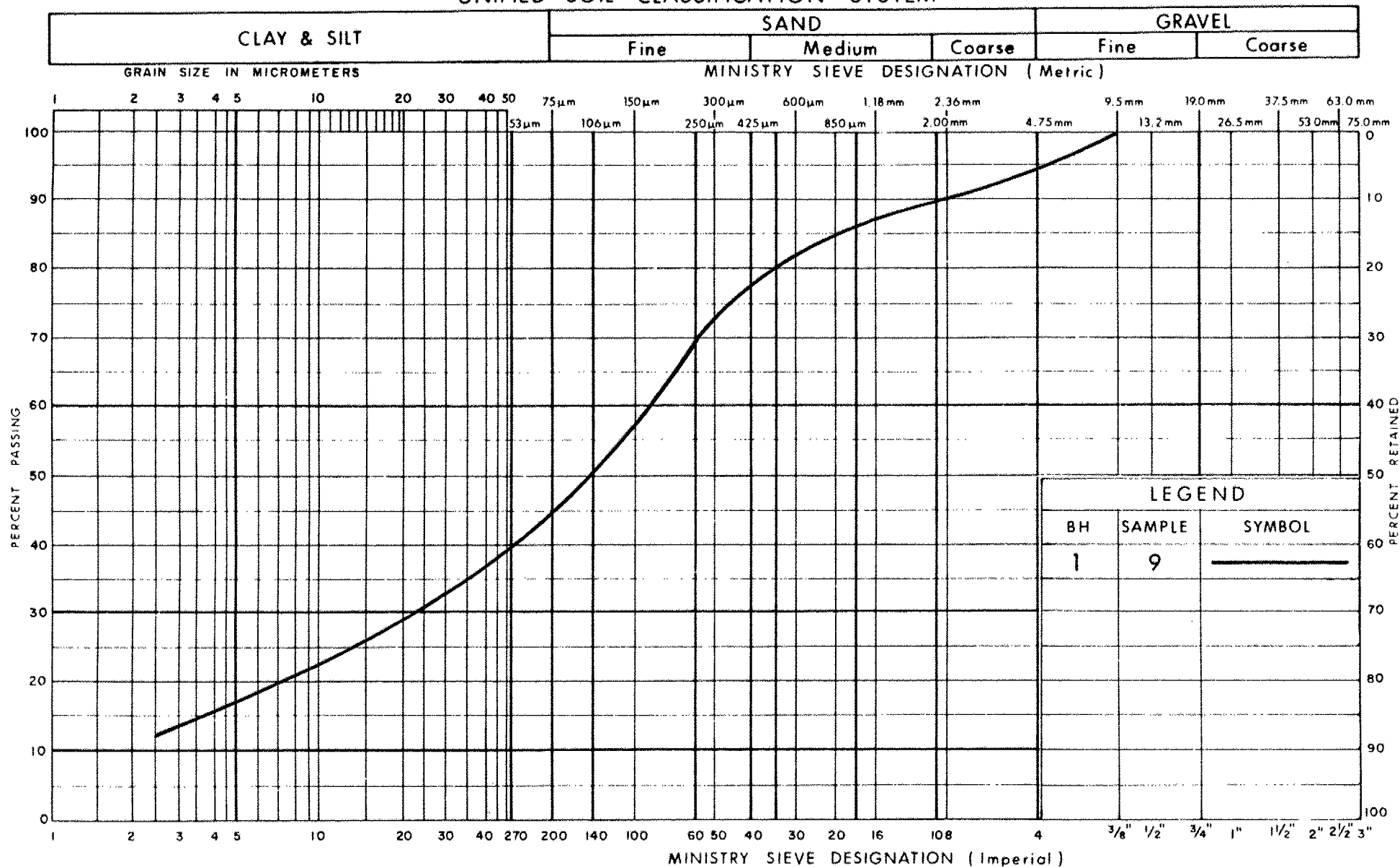
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Ontario

PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT TO SILTY CLAY,
SAND & GRAVEL (Glacial Till)

FIG No 3

W P 263-91-00

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
SILT, SAND & GRAVEL (Glacial Till)

FIG No 4

W P 263-91-00

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 63.5 kg, 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 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^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 263-91-00 LOCATION Ste. 22+365.4; O/S 5 m Rt C/L Hwy 4 ORIGINATED BY TS
DIST 2 HWY 4 BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 92 04 27 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
205.2	Ground Surface																
0.0	Sand and Gravel, some Organics (Fill Material)		1	AS	-												
204.4	Black, Loose to Compact																
0.8	Heterogeneous Mixture of Clayey Silt to Silty Clay, Sand and Gravel (Glacial Till)		2	SS	24		204									18.7	2 14 49 35
	Very Stiff		3	SS	21												
	Hard		4	SS	21												
	Brown		5	SS	29		202										
	Grey		6	SS	60												
			7	SS	56		200									23.4	2 31 41 26
199.1																	
6.1	Heterogeneous Mixture of Silt, Sand and Gravel (Glacial Till)		8	SS	44		198										
	Grey, Dense to Very Dense																
197.3			9	SS	60	/15cm											5 51 34 10
7.9	End of Borehole																
	* 92 04 27																

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 253-91-00 LOCATION Sto. 22+379.4; O/S 10.4 m Rt C/L Hwy 4 ORIGINATED BY TS
DIST 2 HWY 4 BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 92 04 27 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
206.7	Ground Surface													
0.0	Irregular Mixture of Clayey Silt to Silty Clay, Sand and Gravel (Fill Material) Brown		1	AS	-		206							5 23 40 32
205.2														
1.5	Heterogeneous Mixture of Clayey Silt to Silty Clay, Sand and Gravel (Glacial Till) Very Stiff to Hard Brown Gray		2	SS	30									
			3	SS	19		204							
			4	SS	23									
			5	SS	26									
			6	SS	35		202							
			7	SS	105									
							200							
199.1														
7.6	Het. Mixt. of Silt, Sand and Gravel		8	SS	60									
198.6	(Glacial Till), Very Dense													
8.1	End of Borehole • 92 04 27													

RECORD OF BOREHOLE No 3

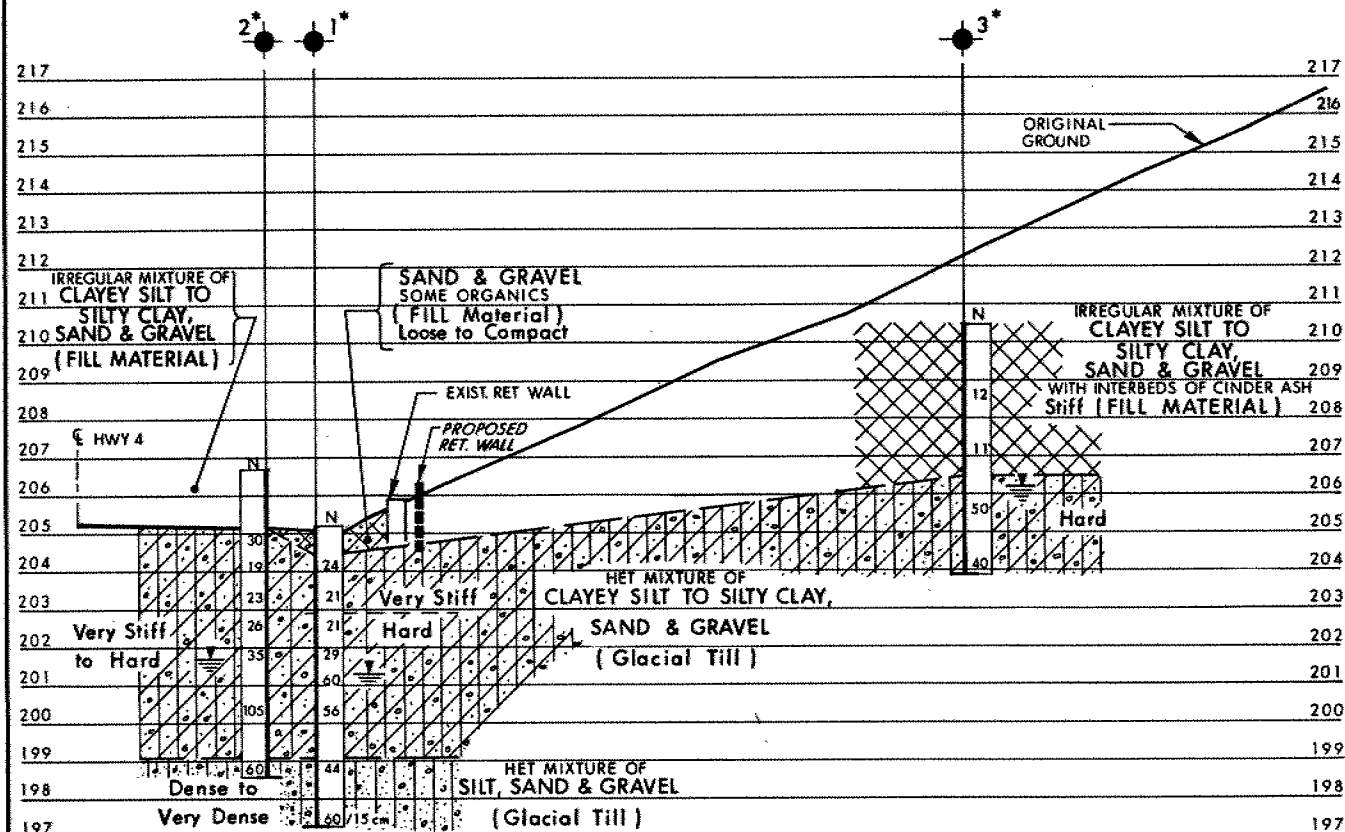
1 OF 1

METRIC

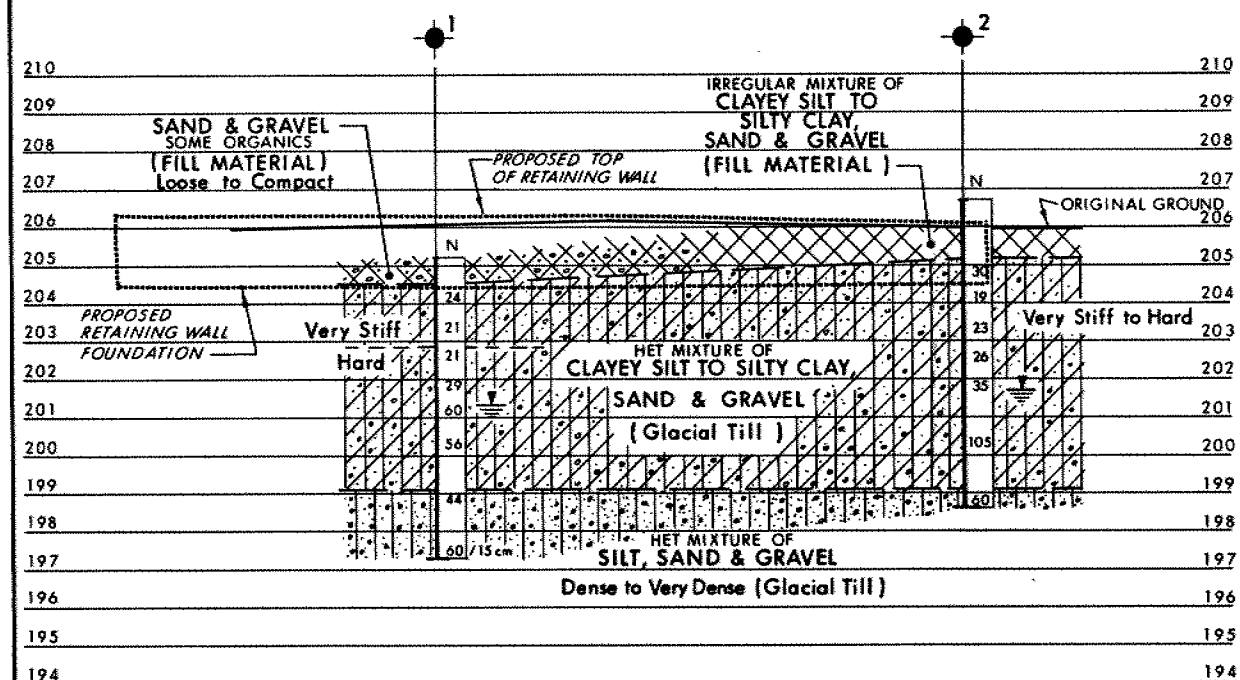
W.P. 263-91-00 LOCATION Sto. 22+371.9; O/S 26.7 m Rt C/L Hwy 4 ORIGINATED BY TS
DIST 2 HWY 4 BOREHOLE TYPE SS Auger COMPILED BY TS
DATUM Geodetic DATE 92 04 27 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
210.5	Ground Surface															
0.0	Irregular Mixture of Clayey Silt to Silty Clay, Sand and Gravel with interbeds of Cinder Ash (Fill Material) Brown, Stiff		1	SS	12											
			2	SS	11											
206.5	Heterogeneous Mixture of Clayey Silt to Silty Clay, Sand and Gravel (Glacial Till) Brown, Hard		3	SS	50											
4.0			4	SS	40											
203.9	End of Borehole															
6.6	* 92 04 27															

* BH's projected on Section A-A



SECTION A-A



SECTION ALONG PROPOSED RETAINING WALL

SCALE
2m 1 0 2m

METRIC

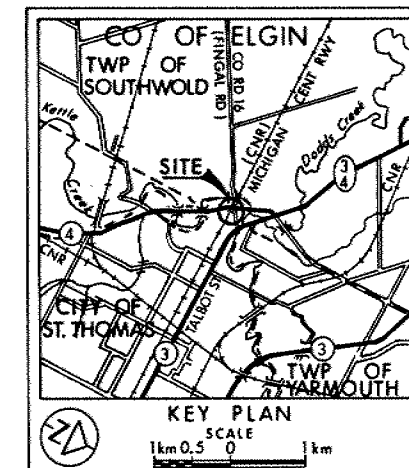
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 263-91-00

PROPOSED RETAINING WALL
S-E QUADRANT HWY 4 and CO RD 16
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Srd Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1992 04

No	ELEVATION	STATION	OFFSET of HWY 4
1	205.2	22+365.4	5.0m RT
2	206.7	22+379.4	10.4m RT
3	210.5	22+371.9	26.7m RT

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

REV.	DATE	BY	DESCRIPTION
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Geocres No 40114-120	
HWY No 4	DIST 2
SUBM'D T.S.	CHECKED T.S. DATE 1992 09 29 SITE
DRAWN R.S.	CHECKED T.S. APPROVED DWG 2639100-A