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G.I.-30 SEPT. 1976

GEOCRES No. 30M5-165

DIST. 4 REGION

W.P. No. 411-85-04

CONT. No.

W. O. No.

STR. SITE No. 10-228

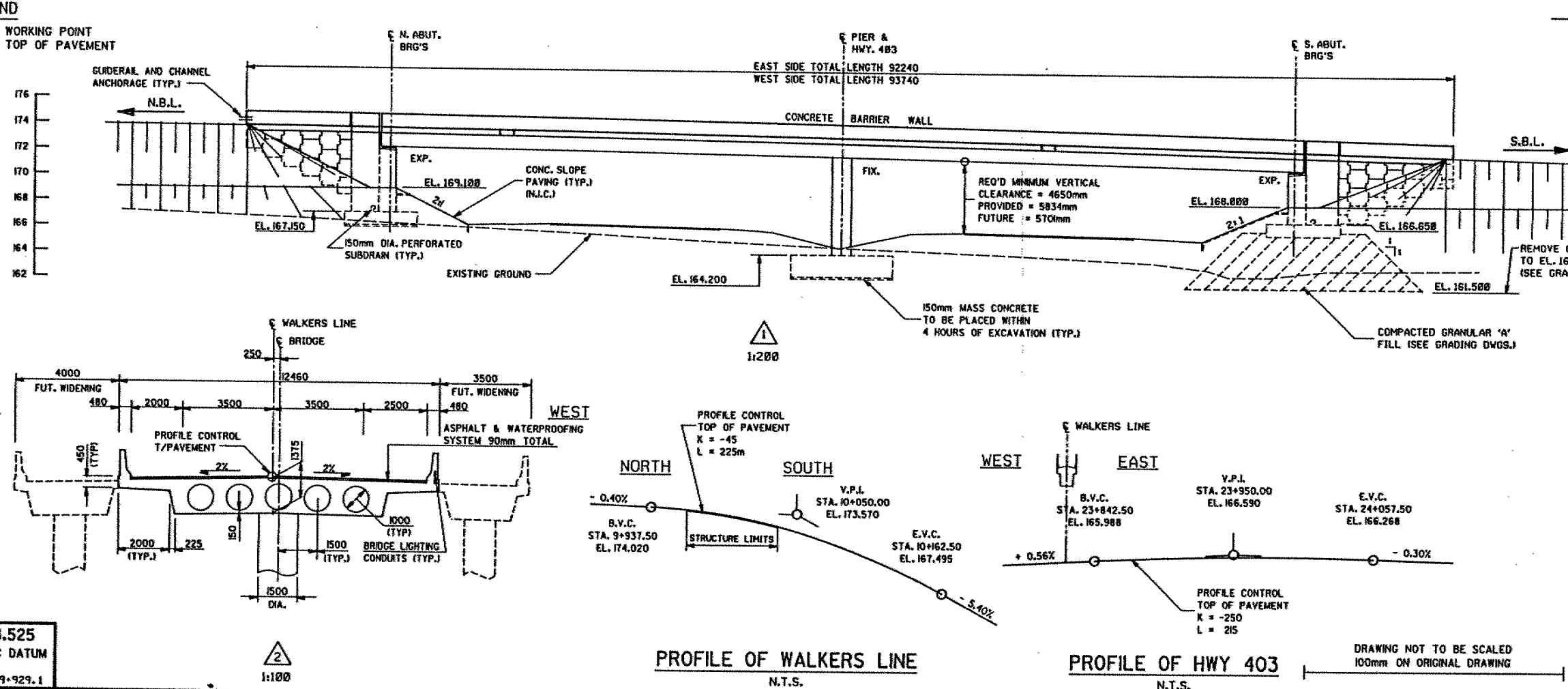
HWY. No. 403


LOCATION HWY 403 & WALKERS LINE
UNDERPASS

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



DISTRICT 4 CONT No WP No 411-85-04	
WALKERS LINE UNDERPASS HWY. 403 GENERAL ARRANGEMENT	SHEET

GENERAL NOTES

1. CLASS OF CONCRETE
 - DECK AND PIERS 35MPa
 - REMAINDER 30MPa
2. CLEAR COVER TO REINFORCING STEEL
 - FOOTINGS 100 ± 25mm
 - ABUTMENTS & WINGWALLS
 - FRONT FACE 80 ± 20mm
 - BACK FACE 70 ± 20mm
 - PIERS 80 ± 20mm
 - DECK
 - TOP 70 ± 20mm
 - BOTTOM 50 ± 10mm
 - SIDES 50 ± 10mm
 - REMAINDER 70 ± 20mm

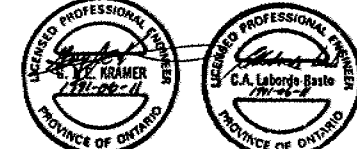
UNLESS OTHERWISE SPECIFIED
3. REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400
UNLESS OTHERWISE SPECIFIED. BAR MARKS
WITH SUFFIX 'C' DENOTE COATED BARS.
4. CONSTRUCTION NOTE

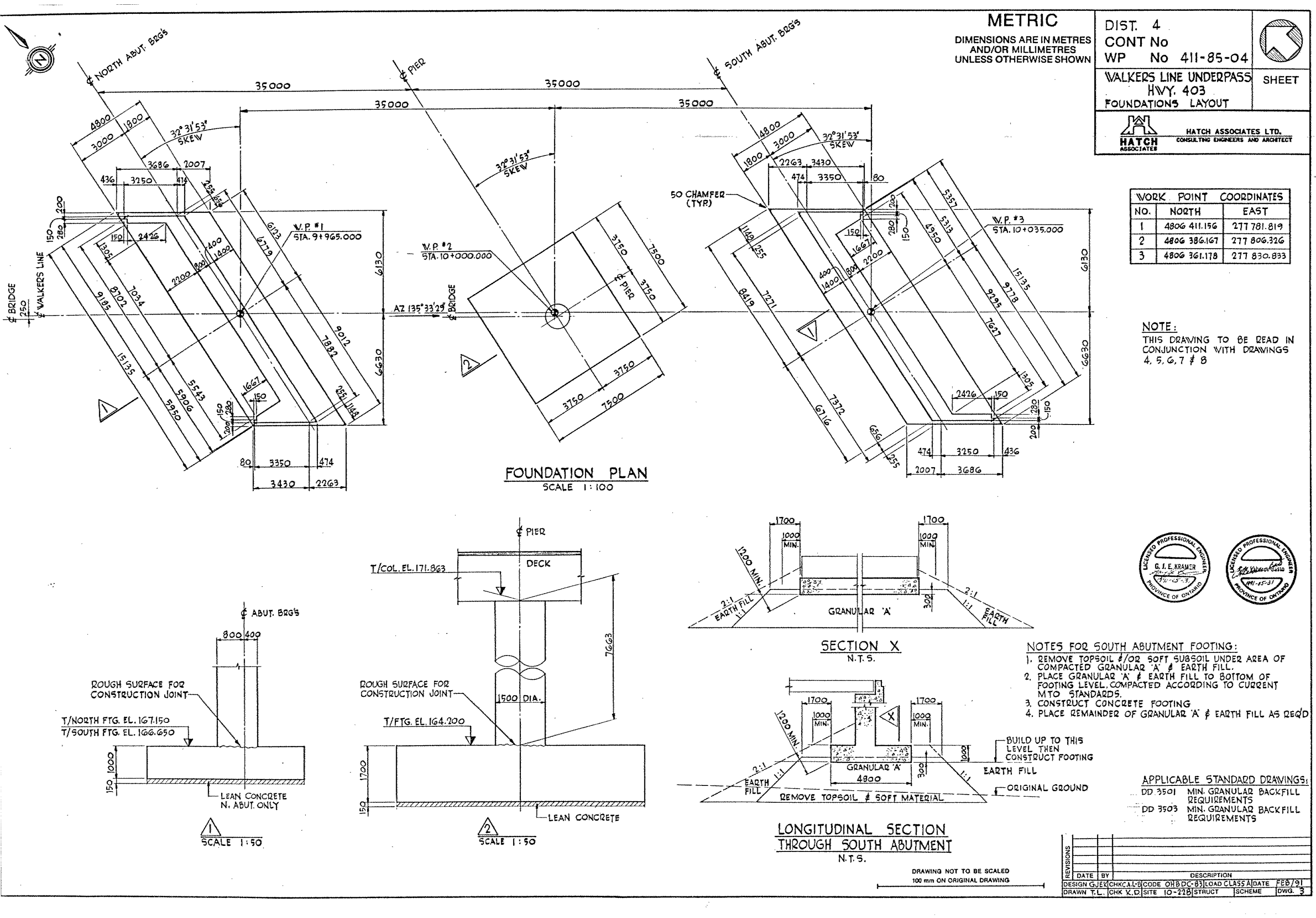
IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM
THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN
DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT
ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE
ACTUAL HEIGHTS.

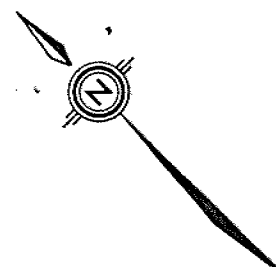
1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS AND SOIL STRATA
3. FOOTINGS AND PIER LAYOUT
4. FOOTINGS AND PIER REINFORCEMENT
5. NORTH ABUTMENT - LAYOUT AND DETAILS
6. SOUTH ABUTMENT - LAYOUT AND DETAILS
7. NORTH ABUTMENT REINFORCEMENT
8. SOUTH ABUTMENT REINFORCEMENT
9. REINFORCED EARTH WALLS
10. REINFORCED EARTH WALL DETAILS - SHEET 1
11. REINFORCED EARTH WALL DETAILS - SHEET 2
12. DECK LAYOUT AND BEARING DATA
13. LONGITUDINAL STRESSING
14. TRANSVERSE STRESSING
15. DECK REINFORCEMENT
16. DECK REINFORCEMENT DETAILS
17. JOINT ANCHORAGE AND ARMOURING
18. BARRIER WALL
19. BARRIER WALL ON REINFORCED EARTH WALL
20. 6000mm APPROACH SLAB
21. DETAILS OF CONCRETE SLOPE PAVING
22. ELECTRICAL EMBEDDED WORK
23. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
24. STANDARDS
25. QUANTITIES - STRUCTURE I
26. QUANTITIES - STRUCTURE II
27. QUANTITIES - STRUCTURE III

DD3501 - MINIMUM GRANULAR BACKFILL REQUIREMENTS
DD3503 - MINIMUM GRANULAR BACKFILL REQUIREMENTS



REVISIONS						
DATE		BY		DESCRIPTION		
DESIGN		CHK	GALB	CODE	070PG-83	LOAD CLASS A
DRAWN		CHK	RD	SITE	10-220	STRUCT
						SCHEME
						DWG. 1





METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

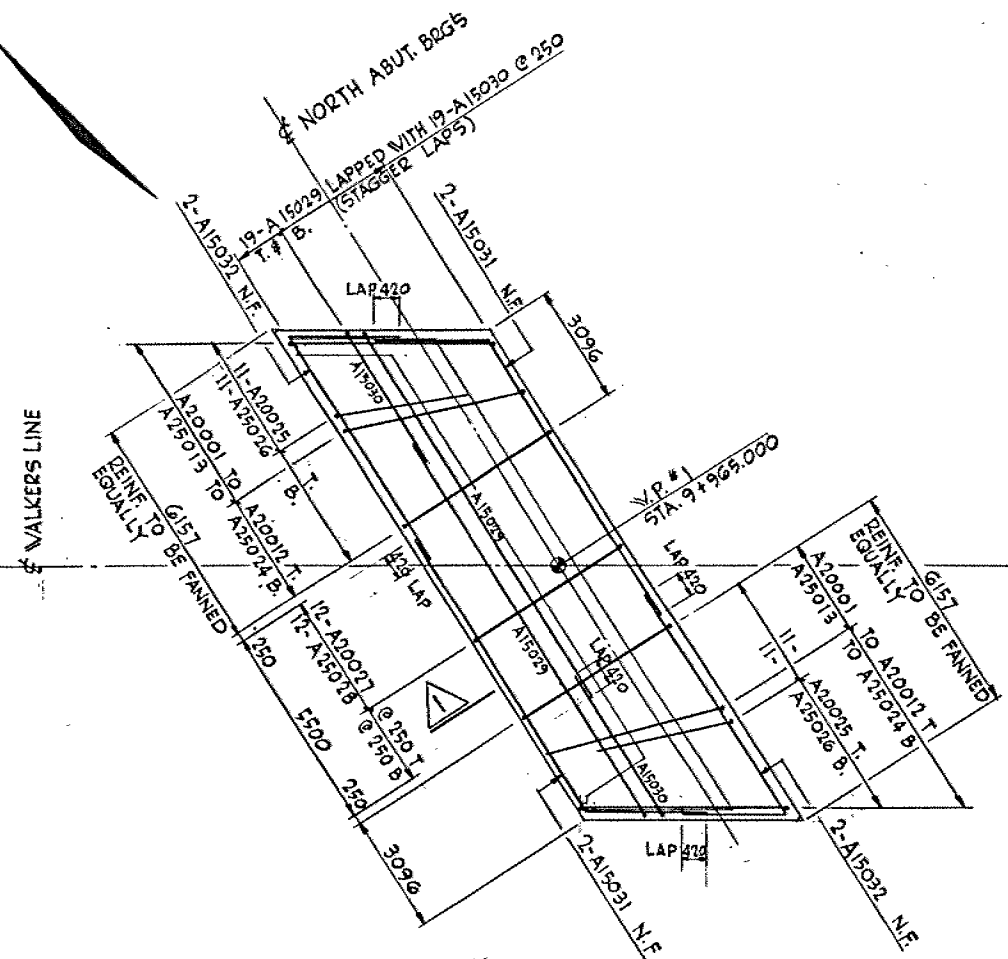
DIST. 4
CONT No
WP No 411-85-04



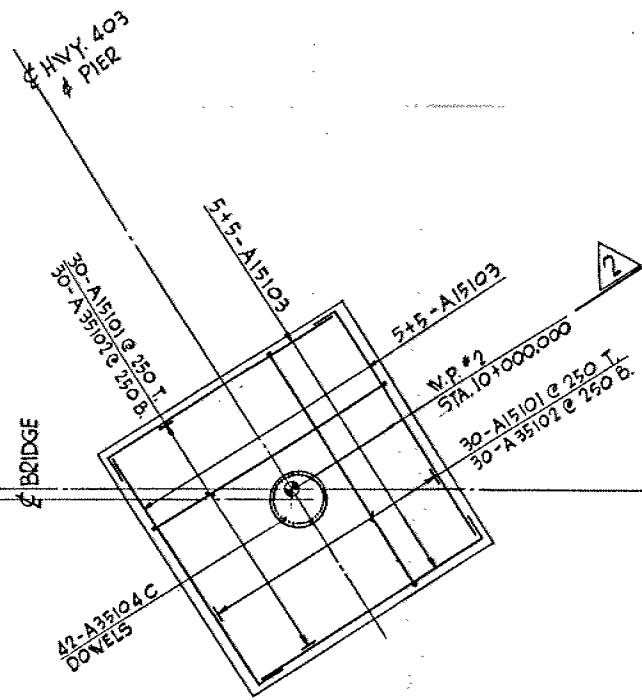
WALKERS LINE UNDERPASS
HWY. 403
FOUNDATION REINFORCEMENT



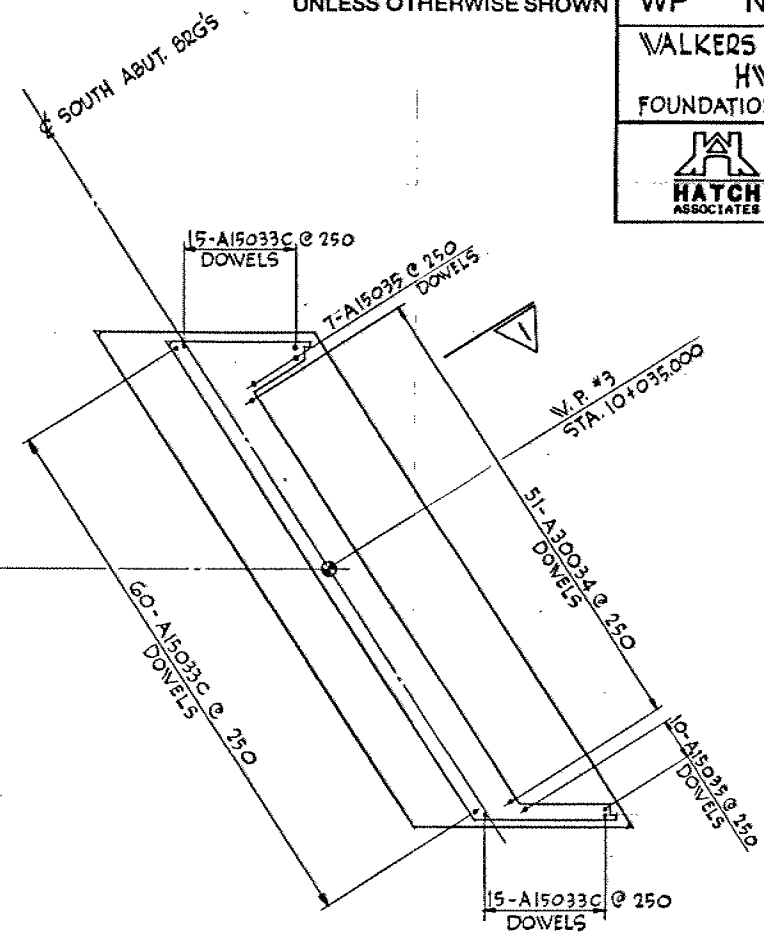
HATCH ASSOCIATES LTD.
CONSULTING ENGINEERS AND ARCHITECT



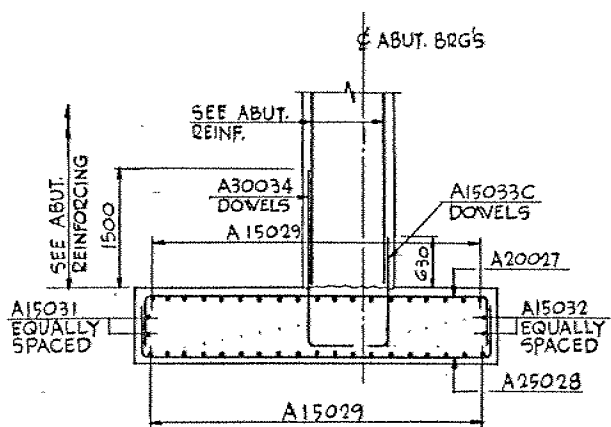
NOTE:
THIS PLAN SHOWING FOUNDATION
REINFORCEMENT ONLY.
FOR DOVELS TO ABUTMENT WALL
SEE SOUTH ABUTMENT THIS DRAWING



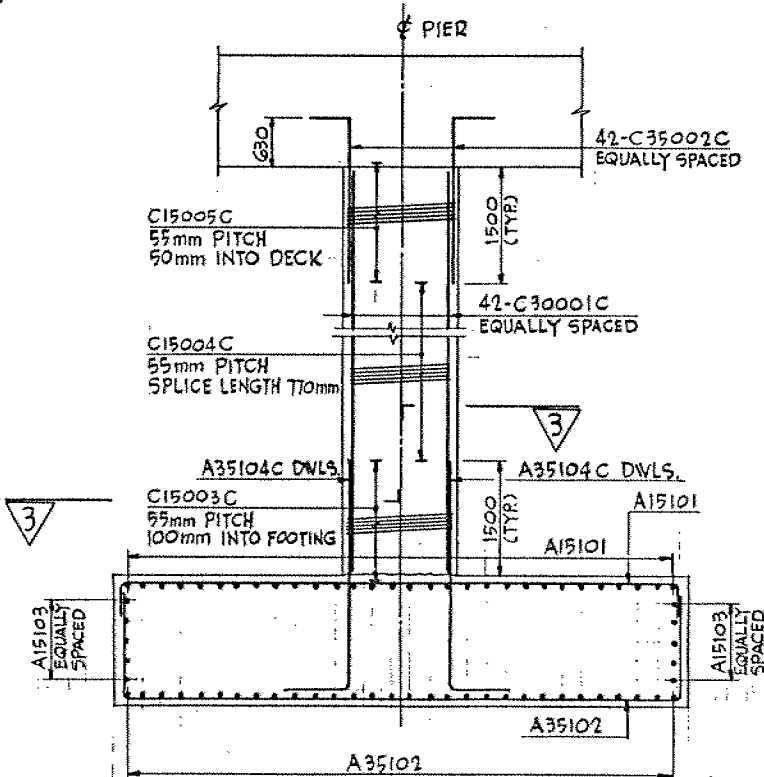
FOUNDATION PLAN
SCALE 1:100



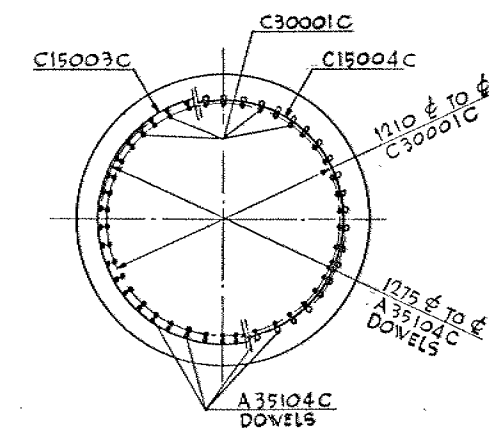
NOTE:
THIS PLAN SHOWING DOVELS TO
ABUTMENT WALL ONLY
FOR FOUNDATION REINFORCEMENT
SEE NORTH ABUTMENT THIS DRAWING



SCALE 1:50



SCALE 1:50



SCALE 1:20

STANDARD DRAWINGS:
DD-3922 SUPPORTS FOR BOTTOM
REINFORCING STEEL

APPLICABLE STANDARD DRAWING:
DD 3922 SUPPORT FOR BOTTOM
REINFORCING STEEL



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	G.J.E.	CHK K.A.L.	CODE 048DC-83 [LOAD CLASS A] DATE FEB. 91
DRAWN	T.L.	CHK K.D.	SITE 10-228 STRUCT SCHEME DWG. 4



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FILE
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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 411-85-04 DIST 4
HWY 403 STR SITE 10-228

Hwy. 403 - Walkers Line Underpass

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FOUNDATION INVESTIGATION REPORT
For
Bridge Structure
Hwy. 403 - Walkers Line Underpass
W.P. 411-85-04, Site No. 10-228
District 4, Burlington

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where a single two span structure is proposed to carry the existing Walkers Line over the proposed Hwy. 403.

The fieldwork was carried out between 90 04 05 and 90 04 17. Seven boreholes (BH 1 to BH 7) were advanced and sampled as part of this project by means of hollow stem augers with a conventional diamond drill (NW casing and NQ core barrel) adopted for rock sampling purposes. These boreholes extended down to depths of 10.9 and 27.1 m below the existing ground surface.

This report contains factual information obtained from this investigation pertaining to structure foundations, approach embankments and related earthworks for the bridge structure as shown on Dwg. No. 4118504-A.

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Hwy. 403 where it crosses the existing Walkers Line in the City of Burlington, Regional Municipality of Halton. The proposed structure is located approximately 1.5 km north of the existing Hwy. 5. The topography in the area is generally flat to gently undulating with ground surface sloping to the southeast. Land use in the vicinity of the site is primarily agricultural and dairy farming.

Physiographically, the site is located in the "Peel Plain" region (Ref. Chapman and Putnam, 1984) which is characterized by a glacial till containing large amount of paleozoic shale. Underlying the glacial deposit are the red Queenston shale from which the till's reddish colour is derived.

SUBSURFACE CONDITIONS

The subsoil conditions encountered across the site were generally uniform. The overburden consists of a heterogeneous mixture of clayey silt, Sand and Gravel (cohesive glacial till) underlain by shale and siltstone bedrock. The maximum thickness of this deposit was found to be about 21.9 m at BH 5. A layer of sandy silt (non-cohesive glacial till) was encountered at four borehole locations (BH's 1, 2, 5 and 6) within the cohesive till deposit. The maximum thickness of this layer was found to be about 4.5 m at BH 1.

The upper portion of the shale was found to be weathered down to approximate El. 142.9 m with a maximum thickness of about 3.0 m at BH 1.

Thin layers of road fill materials and clayey silt topsoils were encountered at all seven borehole locations with the maximum thickness of about 2.1 m at BH 2.

The boundaries between the various soil types, in situ and laboratory test results are shown on the attached Record of Borehole sheets in the Appendix. The locations and elevations of the boreholes, along with a profile and sections showing soil stratigraphy based on borehole data, are shown on Dwg. No. 4118504-A.

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

Fill Material

Five boreholes encountered some 1.4 m of fill material whose composition ranged from a brown reworked clayey silt to sand and gravel. Through visual observation, it is apparent that the fill material can be classified as a clayey silt to sand and gravel.

Topsoil

Topsoil was encountered at four borehole locations. The thickness of this layer is about 1.7 m at BH 6 and 0.6 m at BH 3. Two Atterberg Limit test and a Grain Size Distribution analyses were carried out on these materials as shown on

Figures 1 and 2. Through the Atterberg Limit test and visual observation, the material can be classified as a clayey silt.

Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)

This stratum encountered underneath the fill material or topsoil. This deposit consists of a heterogeneous mixture of clayey silt of low plasticity with varying amounts of sand and gravel. The thickness of this layer was found to be the maximum 21.9 m at BH 5 and the mainimum 8.4 m at BH 6.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 3 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>	<u>Average (%)</u>
Natural Moisture Content (w)	6.0-37.5	11.1
Liquid Limit (w_L)	17.5-31.5	23.7
Plastic Limit (w_p)	12.0-16.5	14.0
Plasticity Index (I_p)	4.0-15.0	9.6

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of clayey silt, sand and gravel with low plasticity (CL or CL-ML).

Grain Size Distribution tests were carried out on this cohesive glacial till material. Figure 4 in the Appendix shows the results. An increasing frequency of fragments of weathered shale was encountered within the lower portion of this till.

In this stratum, the 'N' value ranges from 11 to over 100 blows/0.3 m indicating the consistency of this deposit described as stiff to hard.

Heterogeneous Mixture of Sandy Silt, Gravel and Clay (Glacial Till)

This deposit was encountered within the cohesive glacial till in four (4) borehole locations. The thickness of this layer ranges from 0.8 m at BH 6 to 4.5 m at BH #1.

Atterberg Limit tests were performed on this material and the results are plotted on Figure 5 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>	<u>Average (%)</u>
Natural Moisture Content (w)	6.0-7.5	6.8
Liquid Limit (w _L)	14.0-16.5	15.0
Plastic Limit (w _p)	12.5	12.5
Plasticity Index (I _p)	1.5-4.0	2.5

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of sandy silt, gravel and clay (ML).

Grain Size Distribution tests were carried out on this material. Figure 6 in the Appendix shows the results. This layer is basically non-plastic. In this stratum, the 'N' values are over 100 blows/0.3 m indicating a state of compaction described as very dense.

Bedrock

In each of the borings, split spoon samples of the weathered portion of the bedrock were recovered before augering was terminated. Sound bedrock was proven in two boreholes by obtaining up to 3.0 m of NQ rock cores. The top of the bedrock ranged from El. 144.0 to 145.9 m which are corresponded to 23.8 m and 17.7 m below the existing ground surface. The upper 0.6 m to 3.0 m is in a highly weathered state, with layers of broken shale and red clayey silt.

The bedrock is a red shale with green siltstone (approximately 80% shale, 20% siltstone) of the Queenston formation. Detailed description of the rock are attached in the Appendix entitled "Rock Core Description".

The Core Recovery (CR) and Rock Quality Designation (RQD) values were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core Recoveries (RC) range between 69 and 100 percent and Rock Quality Designation (RQD) values range from 0 to 23 percent. Based on these results, the rock can be classified as weak to very weak and slightly weathered.

GROUNDWATER CONDITIONS

Groundwater level was encountered in six boreholes during the site investigation. BH 4 was dry during the site investigation. Groundwater in open boreholes was found to be approximate elevation between 145.6 m at BH 1 and 164.2 m at BH 7 which correspond to depths of 18.0 m and 4.2 m below the existing ground surface. Upon completion of rock coring, the induced drill water remained perched within the borehole, indicating a low permeability both for the till and shale strata.

DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the bridge structure and related approaches.

It is proposed to construct underpass structure that will carry the existing Walkers Line over the proposed Hwy. 403 eastbound and westbound lanes. The proposed structure is a single two span bridge. A proposed Walkers Line profile grade, ranging from 173.0 m at south abutment to 174.0 m at north abutment with a proposed Hwy. 403 profile grade of about 166.0 m, will necessitate minimum approach fill in the order of 9.0 m at south abutment and 7.0 m at north abutment above the existing ground surface.

Recommendations pertaining to the foundations of the new structure and related earth works are summarized as follows.

Structure Foundations

South Abutment

In consideration of the weak nature of the subsoil at this location, existing fill material, topsoil and weak cohesive glacial till should be excavated down to El. 161.5 m and the excavation can be backfilled with compacted Granular 'A' as high as possible as shown on Figure 7.

For the purposes of the O.H.B.D.C. the following values are recommended:

Factored Bearing Capacity at U.L.S. 900 kPa
Bearing Capacity at S.L.S. Type II 350 kPa

Alternatively, the closed-type of abutment can be supported on spread footings within very stiff to hard glacial till for the following recommended values:

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
700	450	at or below 161.5

North Abutment

At this location, existing fill material, topsoil and weak cohesive glacial till should be also excavated down to El. 166.5 m and the excavation can be backfilled with compacted Granular 'A' as high as possible as shown on Figure 7.

For the purpose of the O.H.B.D.C. the following values are recommended:

Factored Bearing Capacity at U.L.S. 900 kPa
Bearing Capacity at S.L.S. Type II 350 kPa

Alternatively, the closed-type of abutment can be supported on spread footings within very stiff to hard glacial till for the following recommended values:

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
530	340	at or below 166.0
420	270	at or below 164.0

Pier

In consideration of the competent nature of subsoils, spread footings can be founded on native glacial till with the following design parameters.

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
485	310	at or below 163.0

A footing width of 2.5 m with an embedded depth of 1.2 m was used in the calculation of the above capacities. The magnitude of the differential settlement of the footings is anticipated to be within 25 mm, provided the subsoil is not disturbed by construction activities.

Other Considerations

Sliding Resistance

Sliding resistance may be computed by assuming a coefficient of friction of 0.57 for cohesive till and 0.7 for Granular 'A' material to apply between the underside of footings and the founding soil.

Lateral Earth Pressures on Structures

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up.

Design parameters of the soil are given below for purpose of the O.H.B.C.D.

	Granular 'A'	Granular 'B'
Angle of Internal Friction, ϕ	35°	30°
Unit Weight (kN/m ³), γ	22.8	21.2
Coefficient of Active Earth Pressure (Ka)	0.27	0.33
Coefficient of Earth Pressure at Rest (Ko)	0.43	0.50

The earth pressure coefficient at rest is to be used in design of the abutment walls are rigid and unyielding. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

Dewatering

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till. However, if localized seepage or surface water to accumulate in excavations, it can be controlled by perimeter ditches and pumping from corner sumps.

Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection.

Approaches and Excavations

The base of all footing excavations should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed glacial till from disturbing and softening within 4 hours of exposure. All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill.

No stability problems are anticipated toward north abutment for permanent embankment constructed to a 2H:1V geometry. Due to the high fill height (9.0 m), toward south abutment, it is recommended that the approach embankment should be constructed with a 2.0 m wide berm to the midheight of the slope, incorporating side slopes with 2H:1V. Berm should be constructed as an integral part of the main embankment up to the berm height.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Sr. Foundation Engineer, John Petruzzello, Senior Technician and Frank Reynolds, Technician for Northwestern Region. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soil Investigation Co. Ltd., Toronto.

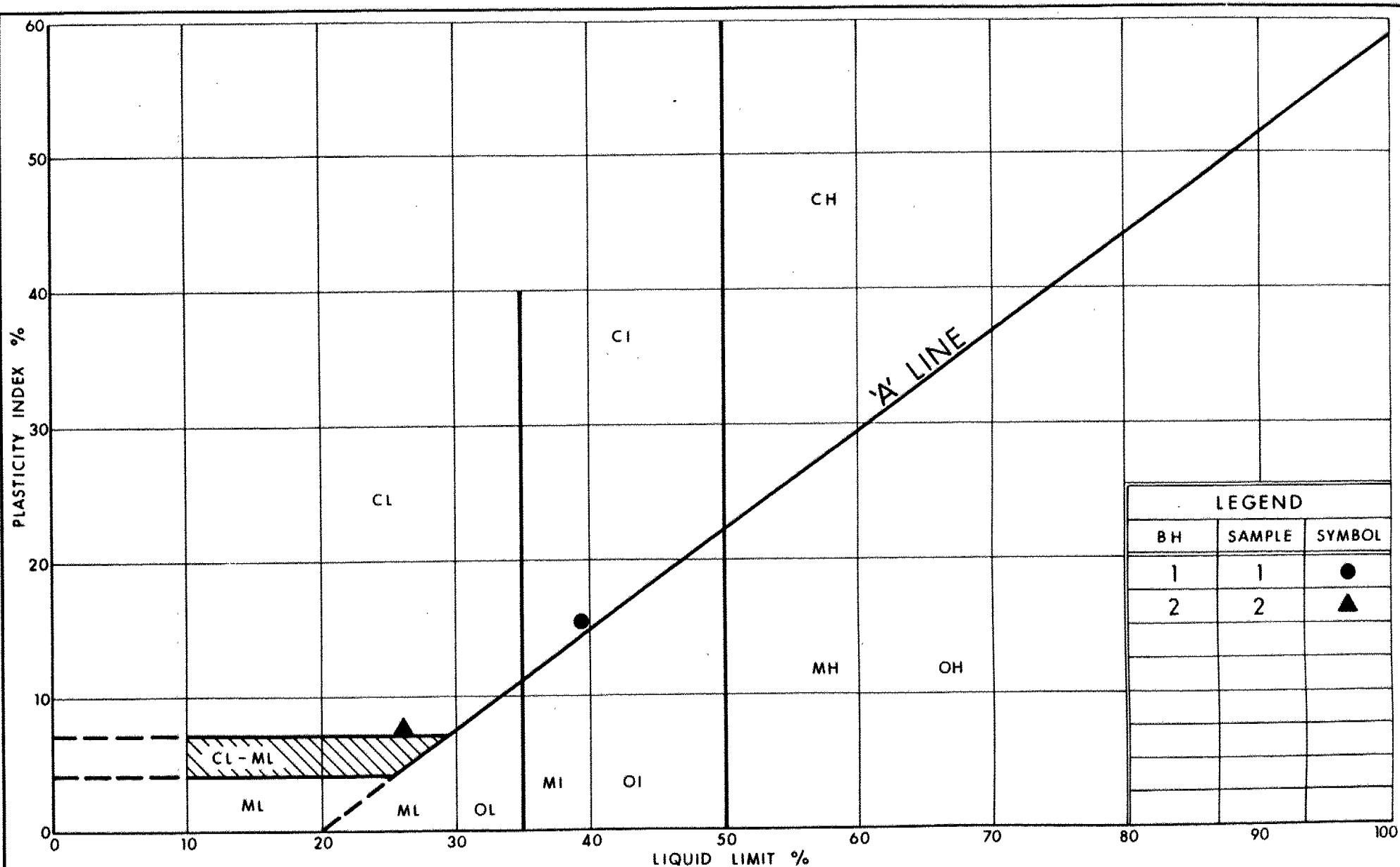
This report was written by Tae C. Kim reviewed by P. Payer, Sr. Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



Tae C. Kim
Tae C. Kim, P.Eng.
Sr. Foundation Engineer

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

APPENDIX



LEGEND		
BH	SAMPLE	SYMBOL
1	1	●
2	2	▲



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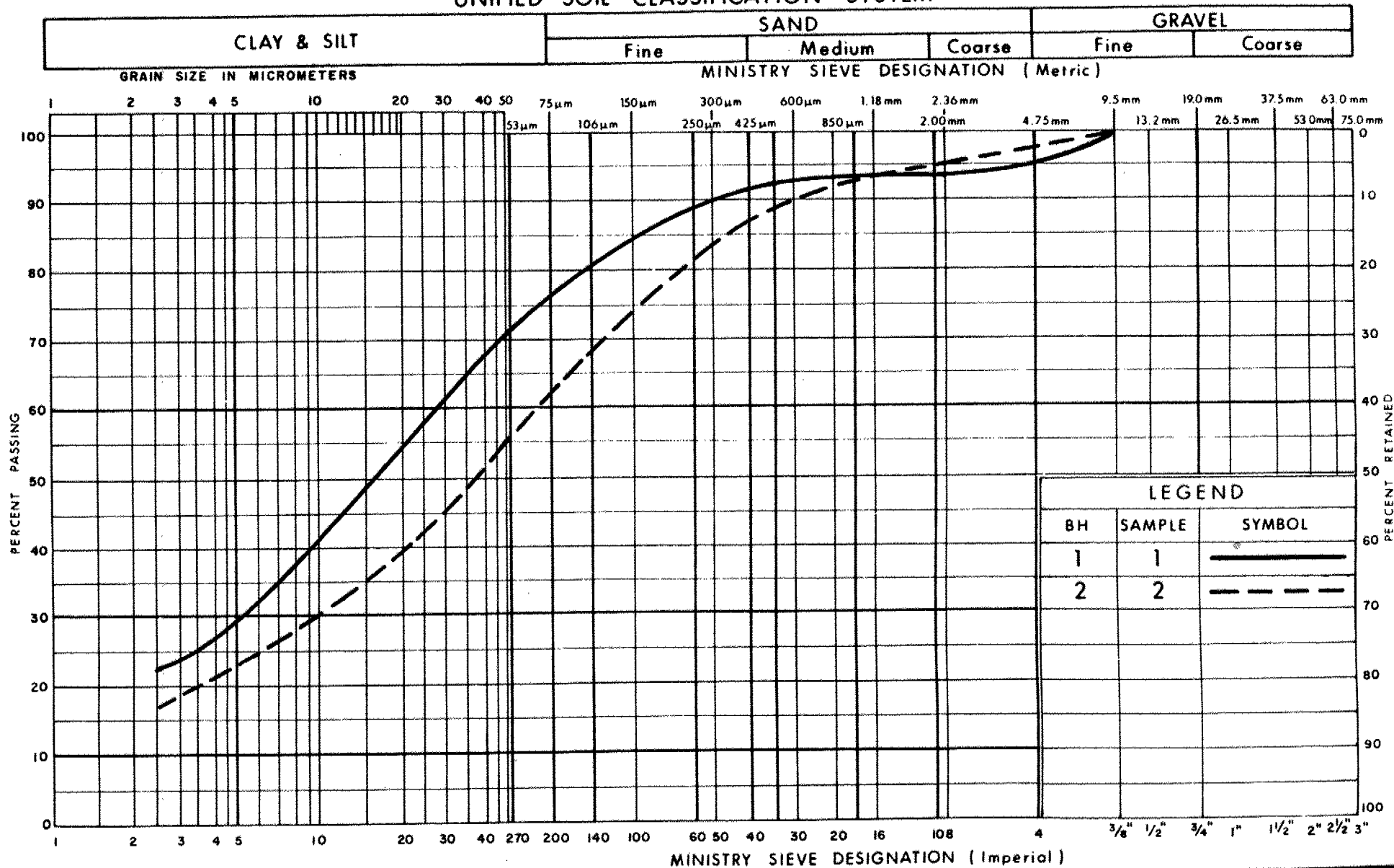
Ontario

PLASTICITY CHART CLAYEY SILT (TOPSOIL)

FIG No 1

W P 411-85-04

UNIFIED SOIL CLASSIFICATION SYSTEM

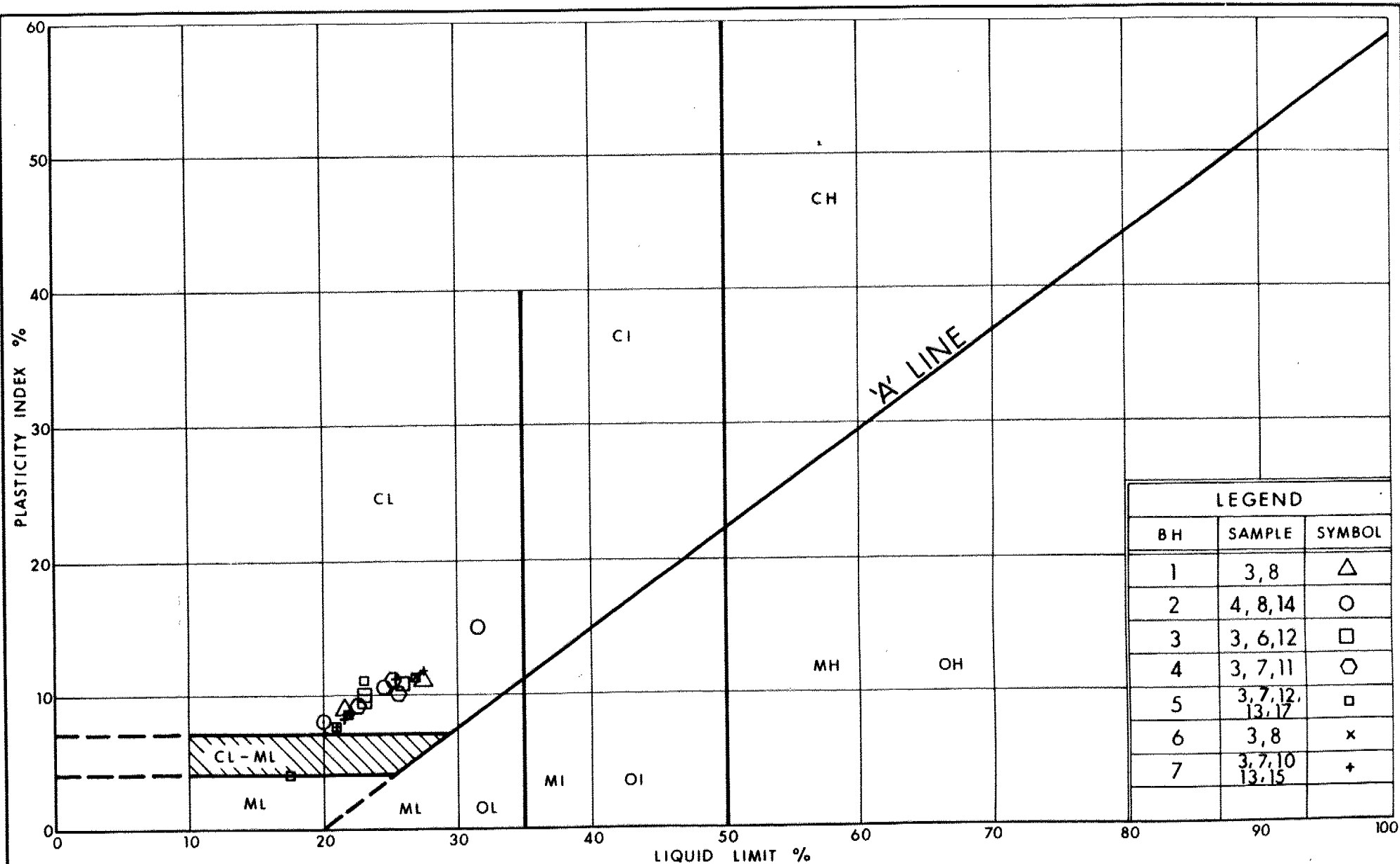


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GRAIN SIZE DISTRIBUTION CLAYEY SILT (TOPSOIL)

FIG No 2

W P 411-85-04



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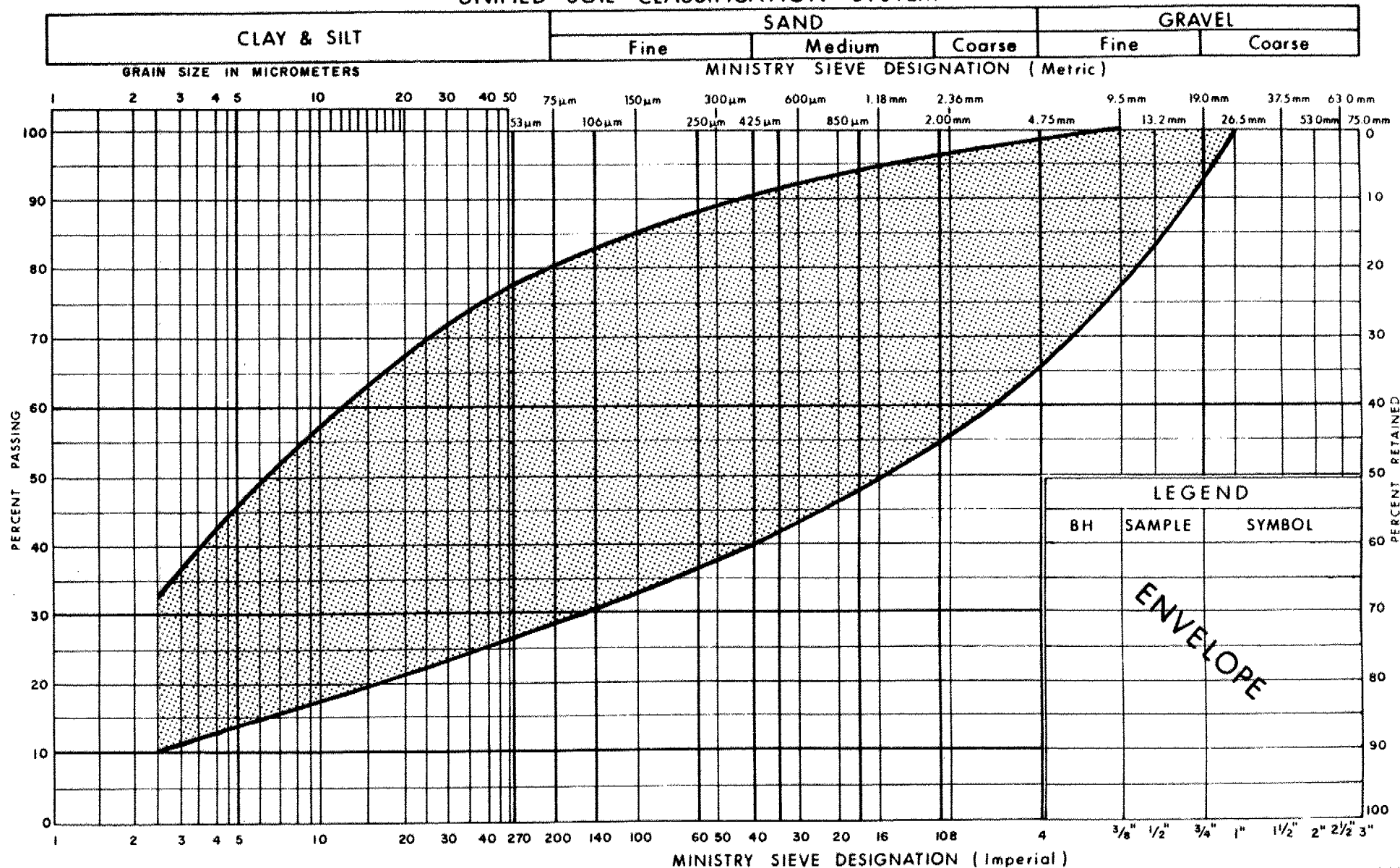
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PLASTICITY CHART
HETEROGENEOUS MIXTURE OF
CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 411-85-04

UNIFIED SOIL CLASSIFICATION SYSTEM

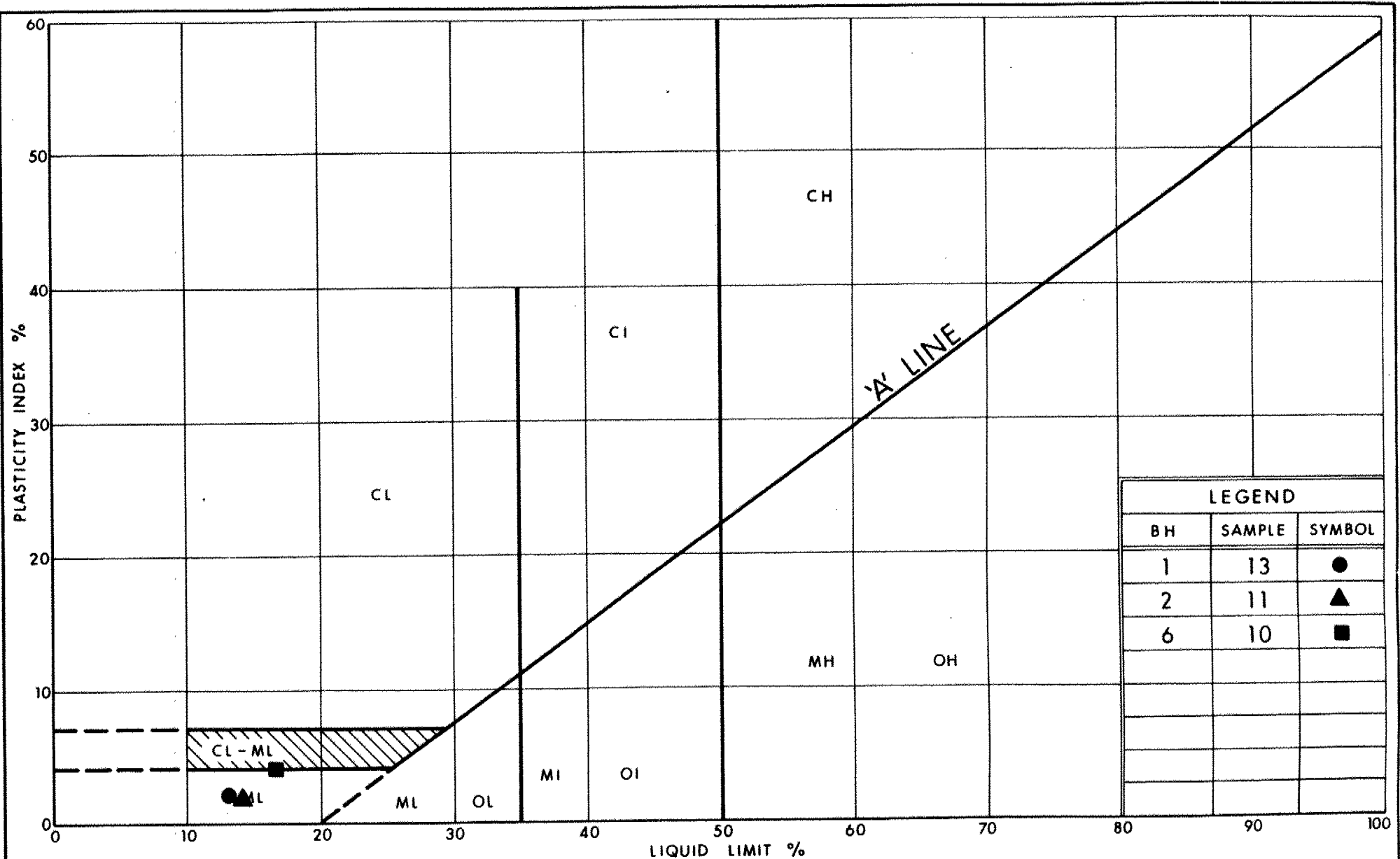


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GRAIN SIZE DISTRIBUTION
 HETEROGENEOUS MIXTURE OF
 CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 4

W P 411-85-04



Ontario

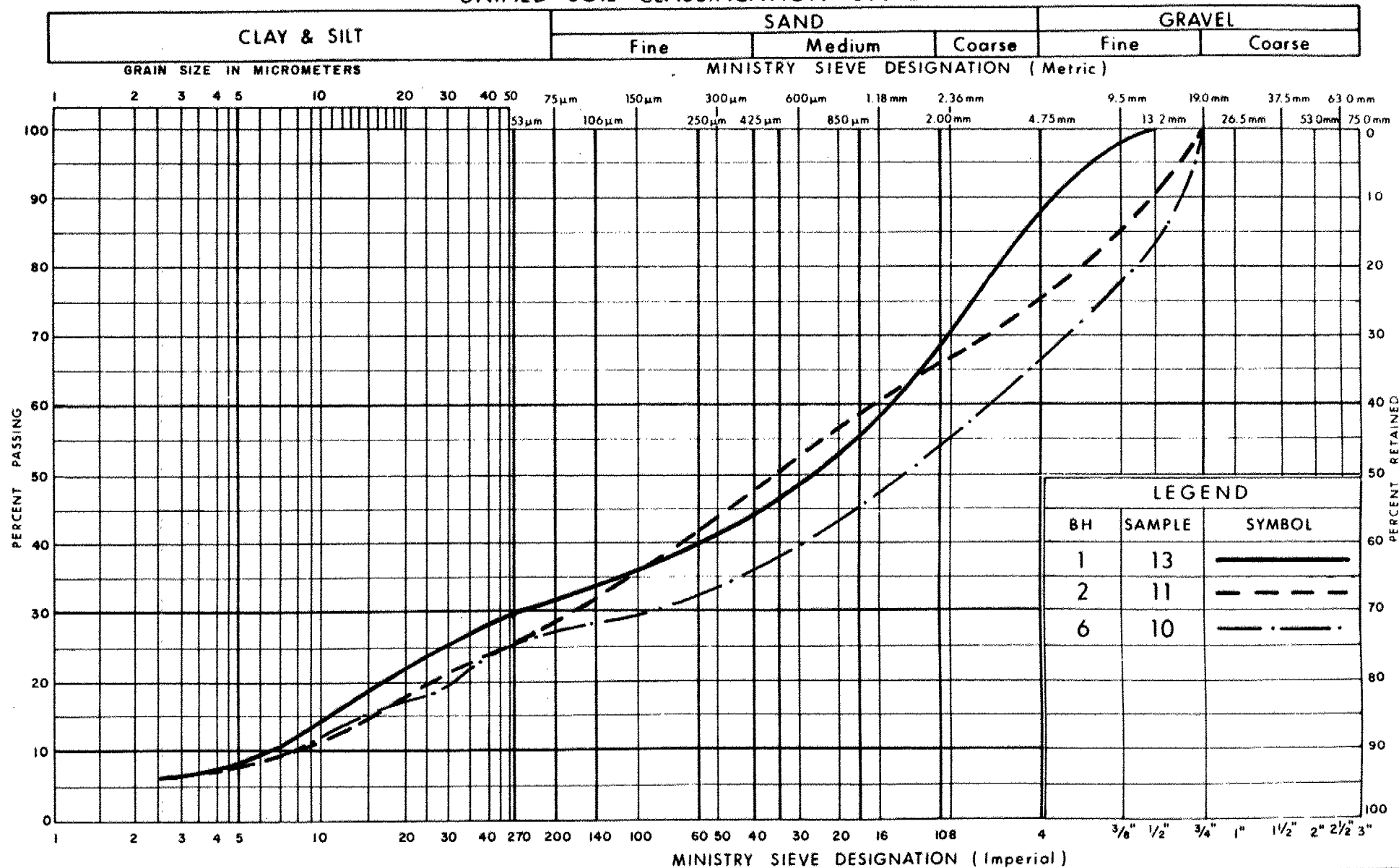
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PLASTICITY CHART
HETEROGENEOUS MIXTURE OF
SANDY SILT, GRAVEL & CLAY (Glacial Till)

FIG No 5

W P 411-85-04

UNIFIED SOIL CLASSIFICATION SYSTEM

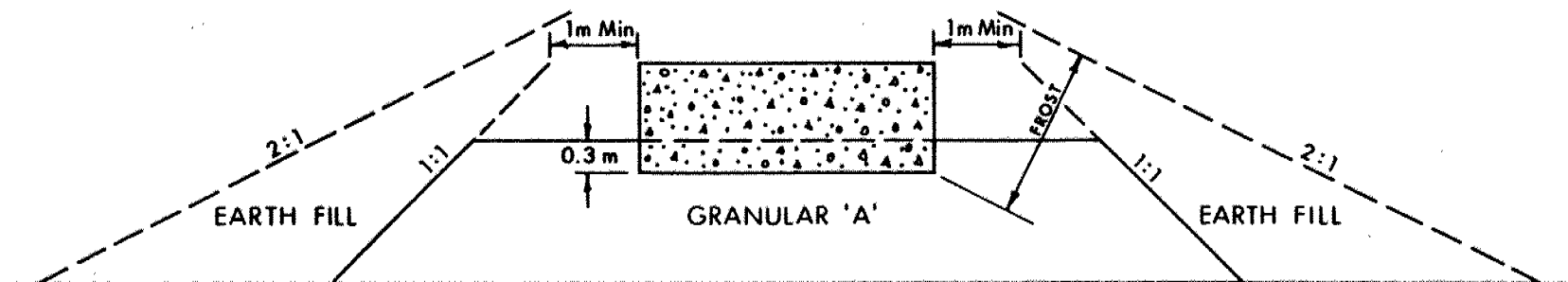


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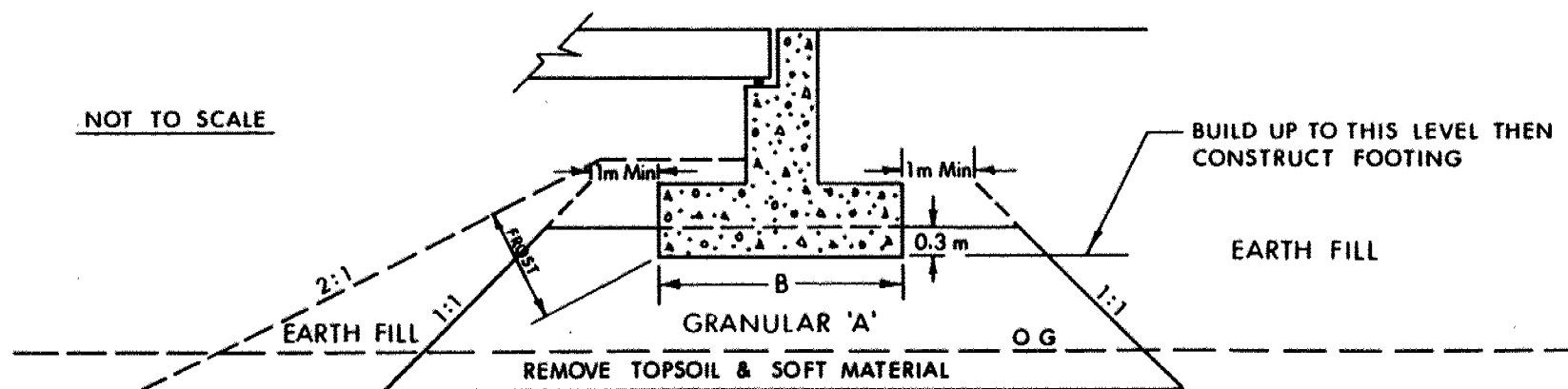
GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF
SANDY SILT, GRAVEL & CLAY (Glacial Till)

FIG No 6

W P 411-85-04



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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ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 7

W P 411-85-04

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 1" 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_f	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						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 352.2 E 277 833.7 ORIGINATED BY F.L.R.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NG Core COMPILED BY J.L.
DATUM Geodetic DATE April 9 and 11, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	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	20 40 60 80 100	w _p	w	w _L		
163.6	GROUND SURFACE													
0.0														
162.2	Clayey Silt (Topsoil)		1	SS	5									4 20 57 19
1.4			2	SS	12									5 22 49 24
			3	SS	38									
			4	SS	47									
			5	SS	46									
			6	SS	26									
			7	SS	32									
			8	SS	101									4 32 46 18
			9	SS	131									
			10	SS	125									
			11	SS	84									
150.4			12	SS	110									
13.2			13	SS	120	/8cm								12 57 24 7
			14	SS	123	/25cm								
145.9			15	SS	120	/13cm								15 18 59 8
17.7			16	SS	120	/5cm								
			17	RC	REC 100%									RQD 0%
			18	RC	REC 69%									RQD 0%
140.8														
22.8	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 353.3 E 277 833.7 ORIGINATED BY G.P.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
DATUM Geodetic DATE April 5 and 6, 1990 CHECKED BY T.K.

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
163.9	GROUND SURFACE													
0.0														
162.8	Sand and Gravel (Fill)		1	SS	8									
1.1														
161.8	Clayey Silt (Topsoil)		2	SS	11									3 36 47 14
2.1			3	SS	38									
			4	SS	40									7 21 38 34
	Brown Reddish Brown		5	SS	37									
			6	SS	27									
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel w/ Occasional Sand and Gravel Layers		7	SS	34									
	Hard (Glacial Till)		8	SS	59									18 5 56 21
			9	SS	76									
	Sand and Gravel Layer		10	SS	116	/27cm								
152.2			11	SS	100	/10cm								24 47 22 7
11.7	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		12	SS	100	/13cm								
149.3			13	SS	100	/15cm								
14.6	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Hard (Glacial Till)		14	SS	200	/13cm								22 32 34 12
147.0														
16.9	End of Borehole													

RECORD OF BOREHOLE No 3

1 OF 1 METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 381.1 E 277 805.2 ORIGINATED BY T.K.
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
 DATUM Geodetic DATE April 9, 1990 CHECKED BY T.K.

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			SHEAR STRENGTH kPa							WATER CONTENT (%)
165.2	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30					
0.0	Clayey Silt		1	SS	6		164								
163.2	(Fill)		2	SS	13		182								
2.0	(Topsoil)		3	SS	40										2 24 50 24
	Brown		4	SS	27										
	Reddish Brown		5	SS	21										
			6	SS	17										
			7	SS	29										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		8	SS	43										
	Very Stiff to Hard		9	SS	55										
	(Glacial Till)		10	SS	163										
			11	SS	120		/23cm								
			12	SS	150		/23cm								10 28 42 20
149.5			13	SS	112										
15.7	End of Borehole														
	* Borehole dry down to 11.1 m below ground surface while drilling charged with water later														

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 410.3 E 277 776.5 ORIGINATED BY F.L.R.
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
 DATUM Geodetic DATE April 12 and 17, 1990 CHECKED BY T.K.

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
167.5	GROUND SURFACE													
166.7	Clayey Silt (Fill)					DRY								
0.8			1	SS	20									
			2	SS	26									
			3	SS	40									
			4	SS	48									
			5	SS	46									
			6	SS	26									
			7	SS	15									
			8	SS	24									
			9	SS	39									
			10	SS	33									
			11	SS	84									
			12	SS	120	/15cm								
			13	SS	95									
148.9			14	SS	104	/13cm								
18.6	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 419.5 E 277 778.7 ORIGINATED BY F.L.R.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.
DATUM Geodetic DATE April 5 and 6, 1990 CHECKED BY T.K.

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	20 40 60 80 100					
167.7	GROUND SURFACE													
167.2	Sand and Gravel (Fill)													
0.5			1	SS	16									
			2	SS	32									
			3	SS	29									
			4	SS	28									
			5	SS	24									
			6	SS	24									
			7	SS	11									
			8	SS	15									
			9	SS	31									
			10	SS	40									
			11	SS	94									
			12	SS	124	/30cm								
			13	SS	100	/13cm								
			14	SS	68									
			15	SS	89									
			16	SS	120	/13cm								
			17	SS	120	/8cm								
			18	SS	120	/8cm								
143.9			19	SS	200	/10cm								
23.8			20	RC	REC 88%									
			21	RC	REC 91%									
140.6														
27.1	End of Borehole													

RECORD OF BOREHOLE No 6

1 OF 1 METRIC

W.P. 411-85-04 LOCATION Co-ord: N 4 806 338.7 E 277 856.5 ORIGINATED BY G.P.
 DIST 4 HWY 403 BOREHOLE TYPE H.S. Auger COMPILED BY J.L.
 DATUM Geodetic DATE April 5, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC UNIT W _p	NATURAL MOISTURE CONTENT W	LIQUID UNIT 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					
162.9	GROUND SURFACE																
0.0	Clayey Silt (Topsoil)		1	SS	6		162										
161.2			2	SS	33												
1.7	Brown Reddish Brown		3	SS	63		160										7 24 47 22
			4	SS	43												
			5	SS	38												
			6	SS	52		158										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		7	SS	44												
	Hard		8	SS	100	/11cm	156										13 27 47 13
	(Glacial Till)		9	SS	100	/15cm	154										
152.8			10	SS	100	/9cm											34 39 21 6
10.1 152.0	Heterogeneous Mixture of Sandy Silt Gravel and Clay, V. Dense (Glacial Till)																
10.9	End of Borehole																

ROCK CORE DESCRIPTION

WP 411-85-04

Page 1 of 1

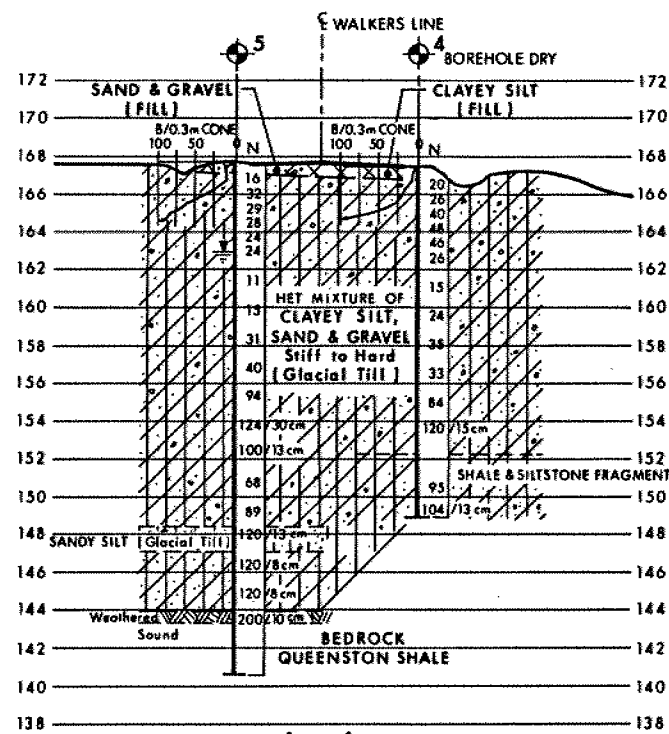
CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	17	19.86-21.46	100	0	19.86-22.84	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (8%); very fine grained; weak to very weak rock; unweathered to slightly weathered; very close to extremely close spaced fractures.
	18	21.46-22.84	69	0		
5	20	24.38-25.91	88	8	24.38-27.13	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (19%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
	21	25.91-27.13	91	23		

*CR = CORE RECOVERY

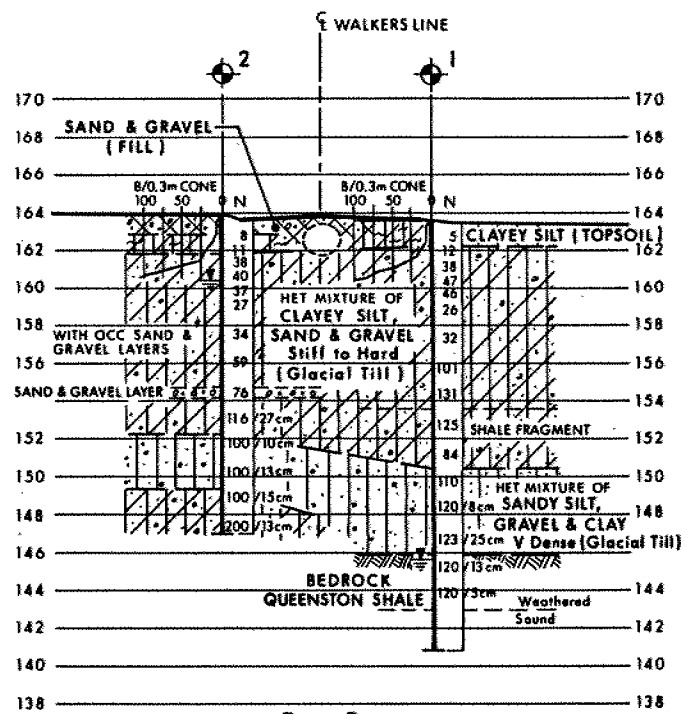
*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

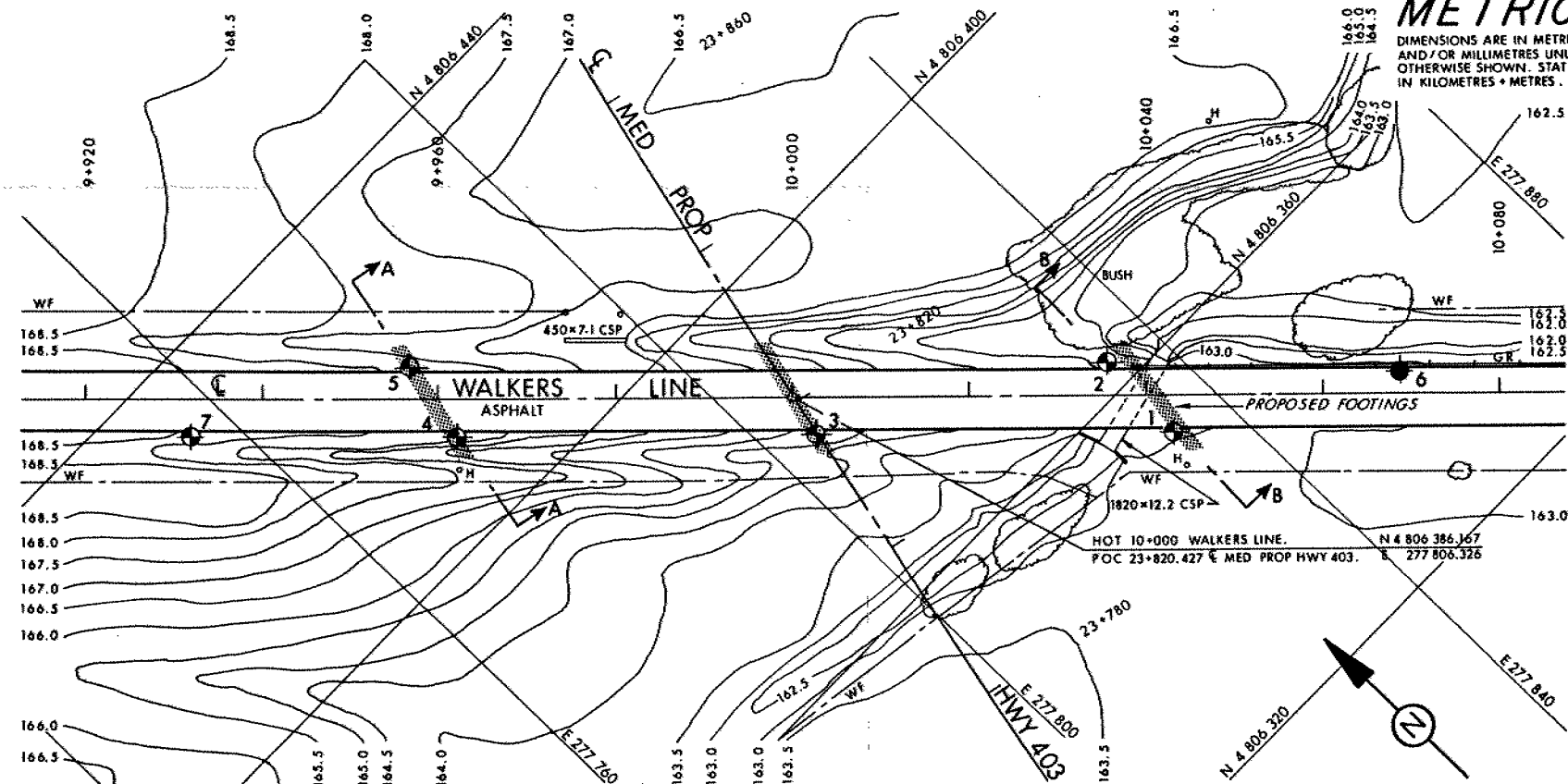


A - A



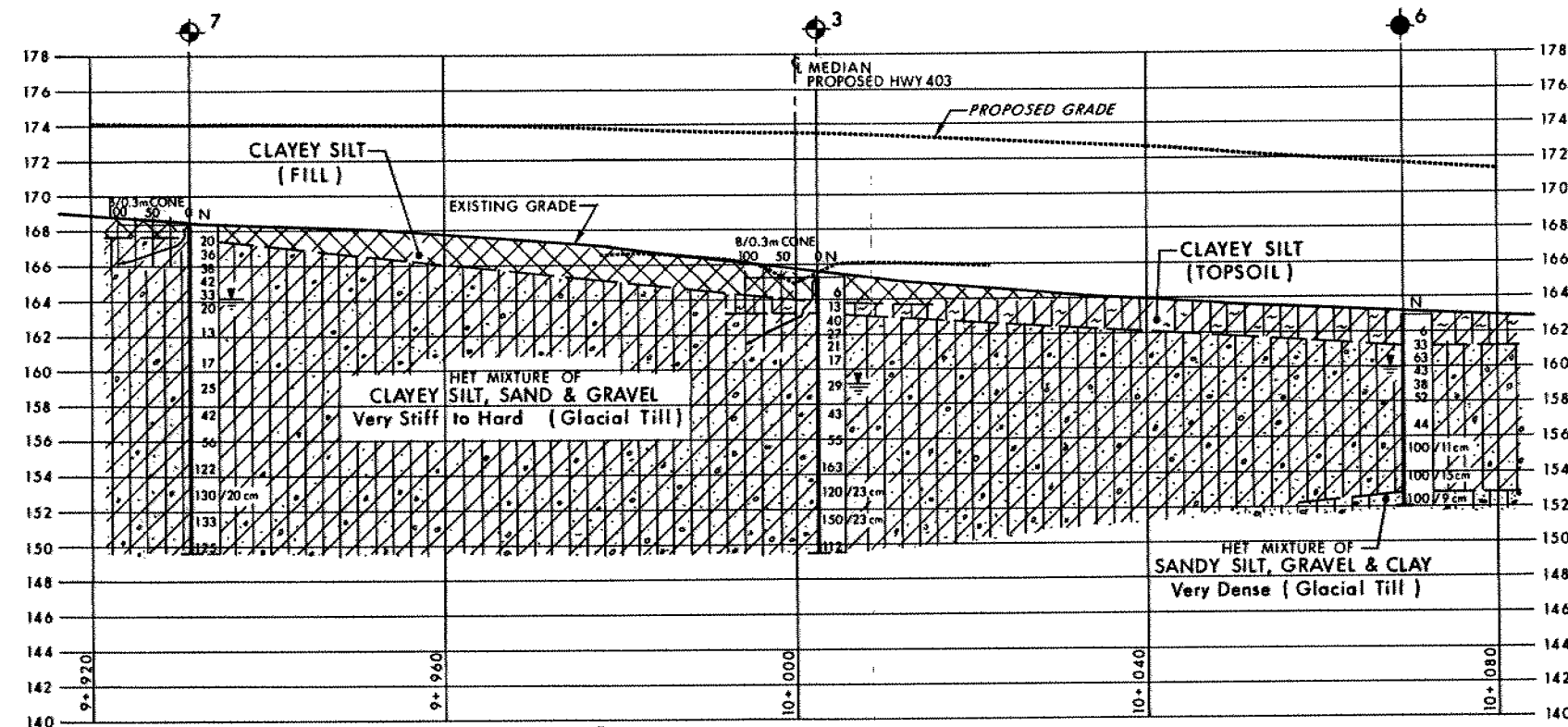
B - B
SECTIONS

SCALE
4m 2 0 4m



PLAN

SCALE
8m 4 0 8m



PROFILE - WALKERS LINE

SCALE
8m 4 0 8m HOR
4m 2 0 4m VERT

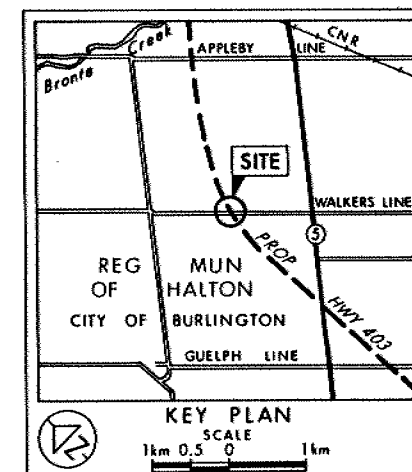
CONT No
WP No 411-85-04

WALKERS LINE

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)
- Wt at time of investigation 1990 04

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	163.6	4 806 352.2	277 833.7
2	163.9	4 806 363.3	277 833.7
3	165.2	4 806 381.1	277 805.2
4	167.5	4 806 410.3	277 776.5
5	167.7	4 806 419.5	277 778.7
6	162.9	4 806 338.7	277 856.5
7	168.4	4 806 431.7	277 755.3

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	90 10 26	DATE	90 10 26
2	90 10 26	DATE	90 10 26
3	90 10 26	DATE	90 10 26
4	90 10 26	DATE	90 10 26

Geocres No 30M5-165

HWY No 403	DIST 4
SUBMD TK	SITE 10-228
DRAWN RS	DWG 4118504-A