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Ministry
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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE

FOUNDATION DESIGN SECTION

CONT 94-22

WP 121-87-05 DIST 9

HWY 416 STR SITE 3-5540

Hwy. 417E to Hwy. 416S Ramp
over
Hwy. 416S to Hwy. 417W Ramp Underpass

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GEOCRES 31G5-180 DATE JUN 12 1991

FOUNDATION INVESTIGATION REPORT
For
Hwy. 417E to Hwy. 416S Ramp
over
Hwy. 416S to Hwy. 417W Ramp Underpass
W.P. 121-87-05, Site 3-540
Hwy. 416, District 9, Ottawa

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. The structure is a component of the proposed Hwy. 416/Hwy. 417 interchange complex. The report describes the subsurface conditions at the site and includes recommendations pertaining to structure foundations and related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 0.5 km south of the existing Hwy. 417 and approximately 200 metres west of the existing Acres Road in the City of Nepean, Regional Municipality of Ottawa-Carleton. The land surrounding the site location is used primarily for cattle grazing and agricultural farmland.

Rock outcrops accentuate the site area and the terrain is generally flat. The ground surface elevation increases gently in a southerly direction. Some shallow overburden exists at various locations overlying the bedrock outcrops.

Physiographically, the site lies in the area known as the Ottawa Valley clay Plains founded in the lowlands of the St. Lawrence. The native subsoil consists of clay plains interrupted by ridges of rock or sand. Bedrock at the site is the March/Nepean Formation and consists of sandstone/dolostone. Fault scarps are also evident within the area, an illustration of the numerous normal faults that dominate the region.

The overburden was deposited during and immediately following the Wisconsinan glaciation approximately 12,000 years ago during the Pleistocene Epoch. At that time, the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the Champlain Sea flooded the

area and then gradually receded as the land rebounded with the deposition of sediments to its present level.

INVESTIGATION PROCEDURES

Soil and rock properties were obtained by in situ and laboratory testing conducted. The procedures employed are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 90 12 14 and 90 12 17 and consisted of five (5) sampled boreholes accompanied by three (3) dynamic cone penetration tests and one additional dynamic cone penetration test. The boreholes were advanced to depths ranging from 1.7 metres to 4.0 metres below the existing ground surface whislt the dynamic cone penetration tests were advanced to depths ranging from 0.15 m to 1.8 m. Four of the boreholes were advanced at proposed structure foundation locations and one borehole was advanced at the south approach to the structure. A dynamic cone penetration test was advanced at the north approach.

Track mounted CME equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. The limited sampling that was carried out in the overburden was conducted in accordance with the Standard Penetration Test (ASTM D1586).

Conventional rock coring methods were applied in retrieving rock core samples. A standard BX core barrel within BW casing was used in the coring of rock.

All samples retrieved in the overburden and all rock core 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 boreholes 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 the boreholes was provided by the Eastern Region Surveys and Plans Office.

Laboratory Analyses

To identify the behaviour and gradation of the overburden and to determine the physical index properties of the rock, some laboratory testing was performed. These tests included:

1) Atterberg Limit Tests
2) Grain Size Distributions
3) Natural Moisture Contents
4) Rock Core Logging

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

Subsurface conditions are generally uniform across the site and consists of a shallow veneer of clayey silt to silty clay with interbedded sandy silt layers and traces of gravel. The thickness of the stratum varies up to 1.8 m. The overburden overlies dolomitic sandstone bedrock which is exposed as an outcrop visible at the surface at some locations across the site.

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 and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1218705-A.

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

Clayey Silt to Silty Clay with interbedded Sandy Silt

The surficial material in the areas of the site where the bedrock is not exposed at the surface consists of a brown, cohesive clayey silt to silty clay with random interbeds of cohesionless sandy silt layers. Traces of gravel are also present within the deposit. A grain size distribution curve as determined by mechanical sieve and hydrometer analyses are shown in Figure 1. The thickness of this deposit ranges up to approximately 1.8 metres at the north approach (BH 12-5) but gradually diminishes in the northerly direction.

Atterberg Limit tests were also carried out on the fine grained portion (less than 75 micrometres) on two representative samples of this material to evaluate the plasticity of the soil. The results are plotted on the individual borehole logs and summarized on the plasticity chart in Figure 2 in the Appendix. Results reveal that the liquid limit (w_L) ranges from 32% to 44% and the plasticity index (I_P) ranges from 11% to 20%. Consequently the fine grained portion of this stratum has a low to intermediate plasticity and hence can be described as a clayey silt to silty clay.

Standard Penetration tests carried out in the surficial soil revealed 'N' values ranging from 5 blows/0.3 m to 7 blows/0.3 m. Based on these 'N' values, the soil is considered to have a firm consistency.

Bedrock

The surficial material is underlain by dolomitic sandstone bedrock of the March Formation. The bedrock surface rises gently in elevation in a southerly direction, elevations ranging from 66.5 to 68.9 m across the site. The bedrock was cored in BX size in thickness ranging from 1.2 m to 2.7 m.

The dolomitic sandstone bedrock is light grey in colour and is fine to medium grained. The bedrock is generally unweathered to only slightly weathered. The rock has very close to moderately close spaced fractures that are flat to undulating and has a roughness ranging from smooth to rough. Rock Core Descriptions obtained by rock core logging in the laboratory are attached in the Appendix.

Core recoveries and Rock Quality Designations (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Recoveries ranged from 83 to 100% and RQD's ranged from 24 to 90%. In general, RQD's exceeded 50% indicating a fair to excellent rock that is medium strong.

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 the investigation were generally at or above the bedrock surface, equivalent to depths ranging from 0.3 m to 1.2 m below the ground surface. These depths correspond to elevations ranging from 67.4 m to 68.9 m.

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

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a three span structure (36.5 m-40.5 m-26.5 m) that will carry Hwy. 417E to Hwy. 416S ramp structure over the Hwy. 416S to Hwy. 417W ramp structure. The 417E-416S structure has a width of 14 metres and will facilitate two lanes of traffic. The 416S-417W ramp has a width of 11 metres and will also facilitate two lanes of traffic. The Hwy. 416S-Hwy.417W ramp intersects the 417E-416S structure at the centre span.

The proposed profile grade for the 417E-416S structure is approximately 76± metres. The existing natural ground surface elevation at the site is 69± metres. Consequently, approach fills in the order of magnitude of 7 metres will be required at the approaches to the structure.

A plan illustrating the proposed structure and profile grade is illustrated in Dwg. 1218705-A in the Appendix.

To facilitate the design and construction of the proposed structure foundations and related earthworks, the following foundation and geotechnical recommendations have been provided in the scope of this report.

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

1) Structure Foundations

In view of the presence of the bedrock at shallow depths below the existing ground surface, all foundations can be founded on coventional spread footings. Abutment foundations can be designed as "open-type" abutments supported on a well-compacted granular 'A' pad or "closed-type" abutments founded on the dolomitic sandstone bedrock. Pier foundations can be founded on the dolomitic sandstone bedrock.

The most economical and technically feasible alternative or combination thereof shall be selected.

Compacted Granular 'A' Pad

"Open-type" abutments can be founded on a well compacted granular 'A' pad as illustrated in Figure 3 in the Appendix. The granular pad shall be constructed to a minimum 1 metre edge distance from the top of the footing to the crest of the pad and with 1H:1V slopes. All footings must be protected against frost penetration and consequently a 1.8 m earth cover or equivalent frost penetration is required. It is also recommended that the shallow overburden be subexcavated prior to the granular pad placement. For purposes of the O.H.B.D.C. and for the conditions described above the bearing capacities tabulated in Table 1 below can be used in the foundation design.

Table 1 - Perched Abutment on Granular Pad

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

Settlement of the granular pad foundation 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 for pad thicknesses upto 4 metres is anticipated to be within 25 mm, provided the granular material is not loosened by construction or related activities.

The Granular 'A' material must be placed and compacted to achieve 100% of the Proctor maximum dry density as outlined in OPSS 501.08.02 (Method A). Quality control in the form of material inspection and field density measurements shall be conducted. Any softened and/or organic material present within the natural subgrade must be removed prior to the placement of the granular pad.

Reduction for the inclination of loading on the shallow foundation shall be carried out in accordance with Section 6.7.3.3.5 of the O.H.B.D.C.

The computation of the sliding resistance of the foundation shall be computed in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. An unfactored friction angle of 35° can be used between the concrete footing and the Granular 'A' material.

Spread Footings on Bedrock

Should the abutments be designed as "closed-type" abutments, abutment foundations can be founded directly on the bedrock. Pier foundations can also be founded on the bedrock. Founding elevations for the structure foundations are given in Table 2 below. For purposes of the O.H.B.D.C., it is recommended that the footing on the dolomitic sandstone bedrock be designed using a factored capacity at U.L.S. of 3000 kPa. The dolomitic sandstone bedrock is considered to be an unyielding foundation base and consequently the bearing capacity at S.L.S. Type II will not govern design.

Table 2 - Foundation Elevations

Structure	Footing Elevation (m)
N. Abutment	66.5±
N. Pier	66.5±
S. Pier	67.7±
S. Abutment	68.9±

Sliding resistance between the concrete footing and unweathered dolomitic sandstone bedrock should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. assuming an unfactored angle of friction of 30° between the concrete and the rock. If additional sliding resistance is required, consideration can be given to employing dowels or rock anchors. A horizontal capacity of 1500 kPa and a bond stress of 500 kPa between a cement grout and the bedrock at U.L.S. can be used as design parameters.

Different Settlement

Differential settlement between foundations founded on bedrock and on the Granular 'A' pad is expected to be less than 25 mm.

Reinforced Earth Abutments/Retaining Walls

Reinforced earth abutment and/or retaining walls are considered a technically feasible alternative at the site. The reinforced earth structure can be founded on the compacted Granular 'A' pad or bedrock as previously discussed. It is recommended that a non-standard special provision that specifies the materials and construction of the reinforced earth walls be included in the contract documents.

2) Approach Embankments

Approach fills in the order of magnitude of 7 metres will be required for structure approach embankments. Discussion of the lateral earth pressures on the structure, stability, settlement and construction of the approach embankments are provided below.

Lateral Earth Pressure on Structure

Free draining material such as Granular 'A' or Granular 'B' shall be used within a wedge behind the abutments and retaining walls bounded by a plane rising at 60° to the horizontal as shown in Figure 6-9.6.1 of the O.H.B.D.C. The application of granular material combined with weep holes in the abutment walls to drain any accumulation of water in the backfill will prevent hydrostatic pressure build-up. Design parameters of the soil are given in Table 3 below.

Table 3 - Backfill Properties

	Granular 'A'	Granular 'B'
Angle of Internal Friction (Ø) (unfactored)	35°	30°
Unit Weight (kN/m^3)	22.8	21.2
*Coefficient of Active Earth Pressure (Ka)		
- S.L.S.	0.27	0.33
- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure at Rest (Ko)		
- S.L.S.	0.43	0.5
- U.L.S.	0.5	0.58

*These earth pressure coefficients apply to horizontal backfill surfaces only. The appropriate consideration shall be given to account for sloping backfill.

Stability/Settlement

No deep-seated or surficial stability problems are anticipated for the proposed embankment fill heights both in the forward and transverse direction for slopes constructed at 2H:1V. The exposed slopes should be protected from erosional forces by providing an effective erosion control protection scheme.

Settlements in the order of magnitude of 35 mm are expected at the approaches due to settlement within the fills under its own weight. It is predicted that the majority of the settlements will be realized during or immediately following the construction of the embankment.

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.

Embankment fills shall be placed and compacted as specified in OPSS 206.07.07 and OPSS 501 series.

Heavy compaction equipment should not be used behind the abutment/retaining walls within a lateral distance equal to the current height of fill above the wall footing in order to avoid imposing damage or deflection to the wall during the fill placement.

3) Construction Considerations

The footing base shall be scaled of any loose surficial overburden or any loosened rock prior to the placement of the concrete footing. In addition, it is recommended that a concrete working slab be provided immediately following excavation to protect the bearing surface of the bedrock at the footing location from the effects of weathering and other disturbances.

No dewatering problems are anticipated during foundation construction. Any localized seepage and/or surface runoff can be readily discharged employing conventional sump pumping techniques.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano and M. Michalek, Foundation Engineers, and F. Tannous, Engineer Trainee, utilizing equipment owned and operated by Johnston Drilling Ltd. and Marathon Drilling Ltd. Logging of rock core in the laboratory was carried out by D. Williams, Petrographer.

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

LICENSED PROFESSIONAL ENGINEER
A. J. Sangiuliano
PROVINCE OF ONTARIO

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 (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

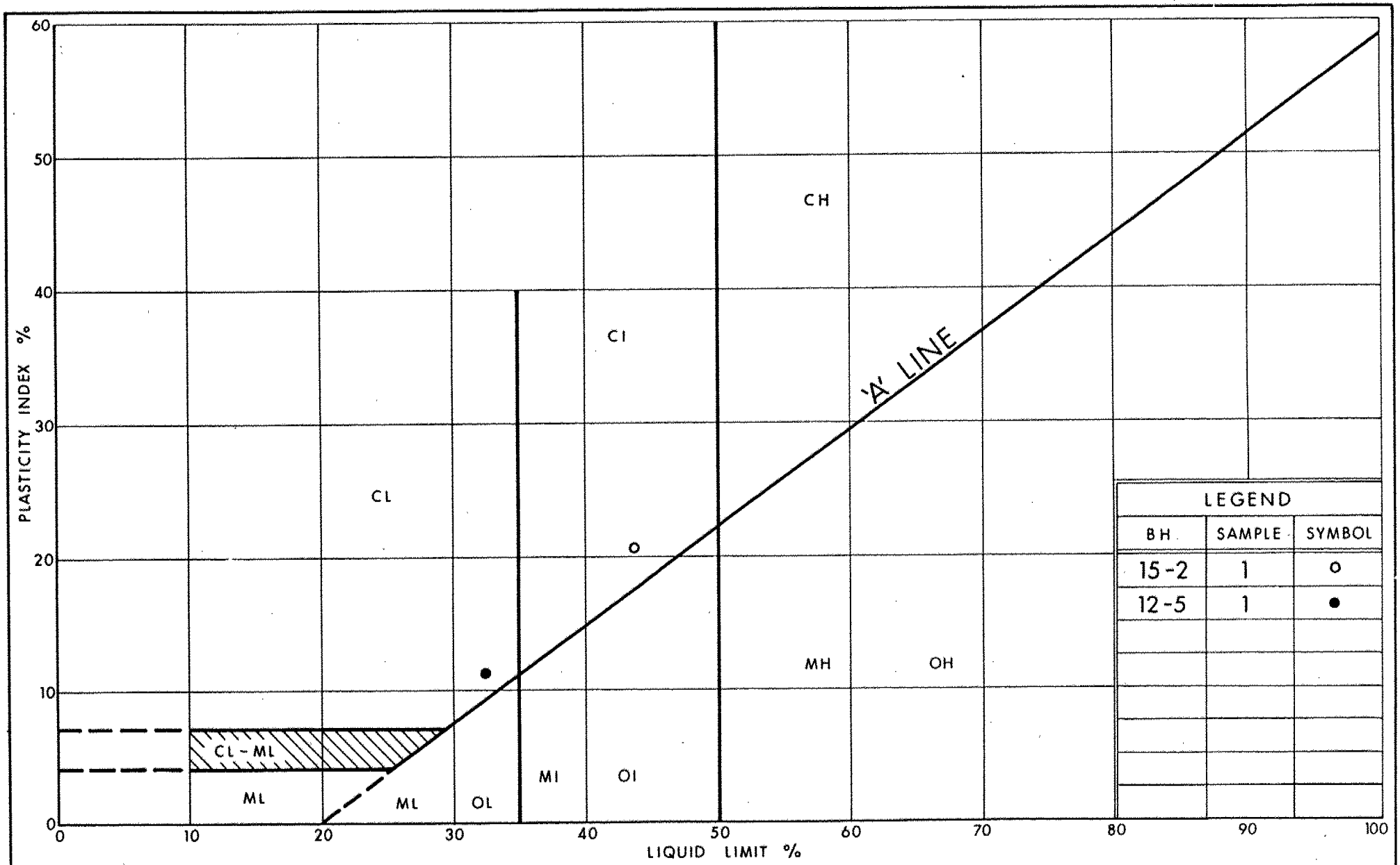
ROCK CORE DESCRIPTION
WP 121-87-05

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	2 3	1.17-2.69 2.69-4.22	97 97	90 87	1.17-4.22	**DOLOMITIC SANDSTONE** (calcareous), medium light grey to light grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, undulating, smooth to rough.
2	2	1.22-2.90	94	24	1.22-2.90	**DOLOMITIC SANDSTONE** (calcareous), medium light grey to light grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures very close to moderately close spaced, flat to near vertical, undulating, smooth to rough.
3	1	0.15-1.83	100	57	0.15-1.83	**DOLOMITIC SANDSTONE** (calcareous), medium light grey to light grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating, smooth to rough.
4	1	0.46-1.68	83	71	0.46-1.68	**DOLOMITIC SANDSTONE** (calcareous), medium light grey to light grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to dipping, undulating, smooth to rough.

*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



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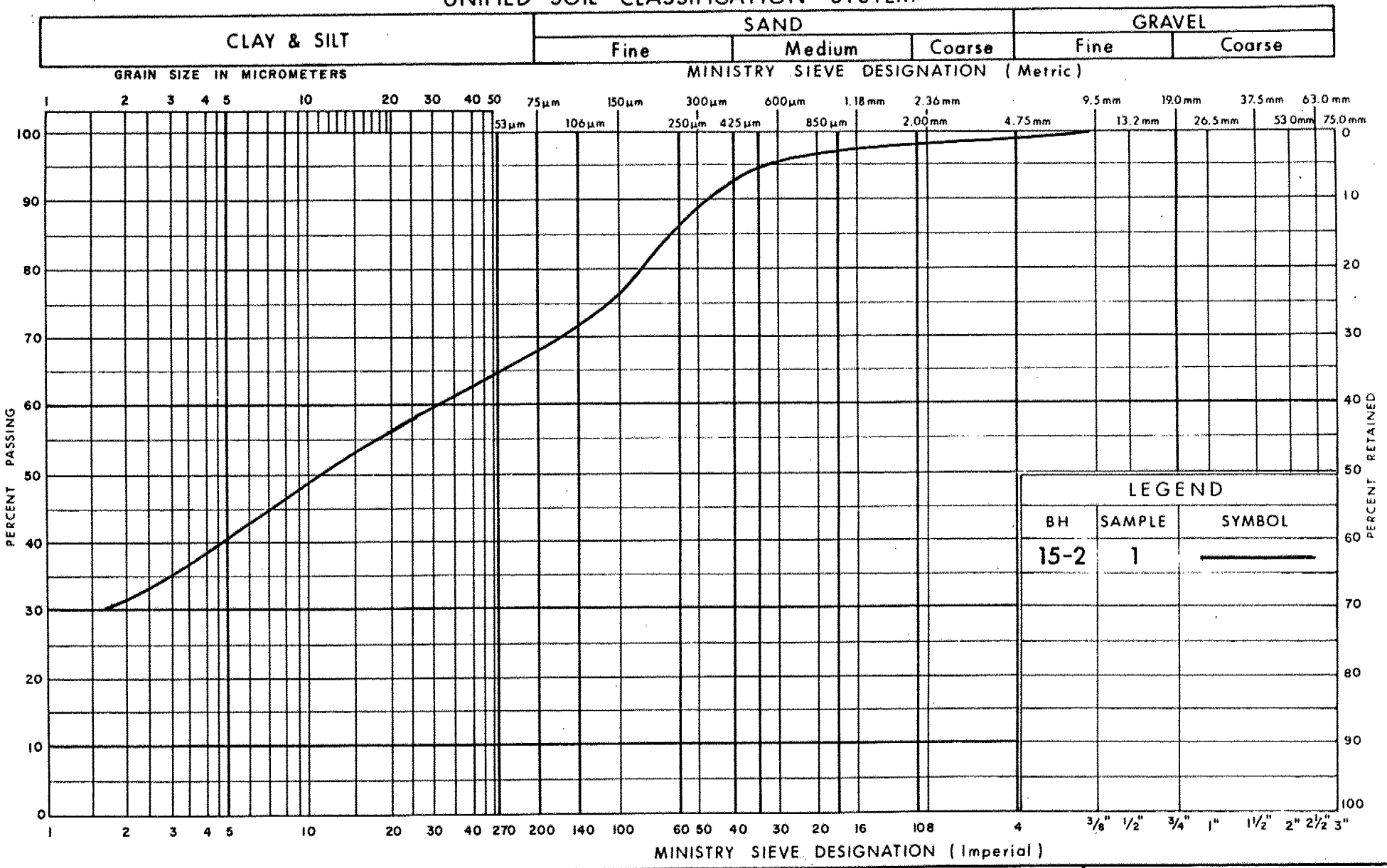
PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
WITH INTERBEDDED SEAMS OF SANDY SILT

FIG No 1
W P 121-87-05

UNIFIED SOIL CLASSIFICATION SYSTEM



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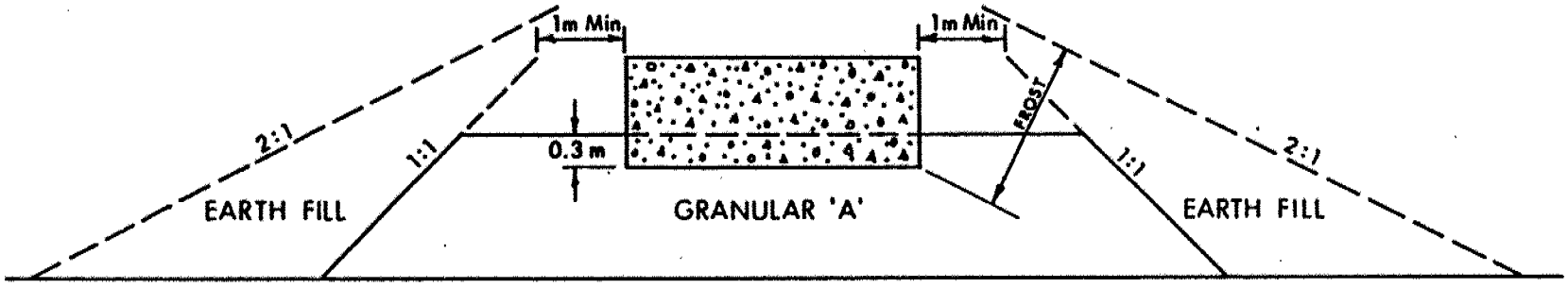
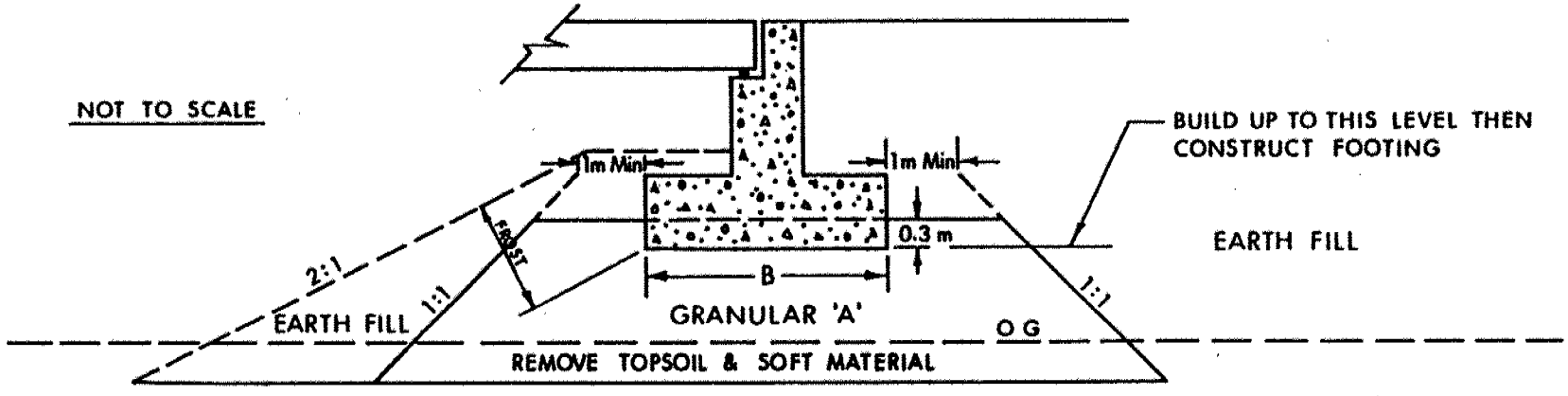
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
WITH INTERBEDDED SEAMS OF SANDY SILT

FIG No 2

W P 121-87-05



X SECTION



LONGITUDINAL SECTION

NOTES:

1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.

2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T O STANDARDS.

3 - CONSTRUCT CONCRETE FOOTING.

4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

Ministry of Transportation Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 3 W P 121-87-05

RECORD OF BOREHOLE No 15-1 1 OF 1 METRIC

W.P. 121-87-05 LOCATION N 5 022 370 E 358 403 ORIGINATED BY MM

DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, Rock Coring COMPILED BY TS

DATUM Geodetic DATE 90 12 15 CHECKED BY TS

ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
67.7	Ground Surface										
0.0 / 66.5	Clayey Silt with interbedded Sandy Silt Brown, Firm		1	SS	120	/25cm	67				
1.2	Bedrock, Dolomitic Sandstone Grey, Medium Strong Unweathered		2	RC	REC 96%			100/ 25cm			RQD = 90 %
63.7			3	RC	REC 87%		65				RQD = 97 %
4.0	End of Borehole • 90 12 15										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 15-2 1 OF 1 METRIC

W.P. 121-87-05 LOCATION N 5 022 345 E 358 415 ORIGINATED BY MM
DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, Rock Coring COMPILED BY TS
DATUM Geodetic DATE 90 12 16 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
67.7	Ground Surface							20 40 60 80 100	10 20 30		
0.0 66.5	Silty Clay with interbedded Sandy Silt Brown, Firm		1	SS	5	▼	67				
1.2 64.8	Bedrock, Dolomitic Sandstone Grey, Medium Strong Unweathered		2	RC	REC 94%		65				RQD = 24%
2.9	End of Borehole • 90-12-17										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 15-3 1 OF 1 METRIC

W.P. 121-87-05 LOCATION N 5 022 305 E 358 406 ORIGINATED BY TS

DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, Rock Coring COMPILED BY TS

DATUM Geodetic DATE 90 12 17 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
67.9	Ground Surface										
0.5	Bedrock, Dolomitic Sandstone Grey, Medium Strong Unweathered		1	RC	REC 100%	▼					RQD = 38%
66.1											
1.8	End of Borehole										
	* 90 12 17										
	** Clayey Silt with interbedded sandy silt										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 15-4 1 OF 1 METRIC

W.P. 121-87-05 LOCATION N 5 022 270 E 358 421 ORIGINATED BY TS

DIST 9 HWY 416 BOREHOLE TYPE HS Auger, BW Casing, Rock Coring COMPILED BY TS

DATUM Geodetic DATE 90 12 17 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
69.4	Ground Surface										
68.9	Clayey Silt, Brown					▼ *					
0.5 / 67.7	Bedrock, Dolomitic Sandstone Grey, Medium Strong Unweathered		1	RC	REC 85%						RQD = 71%
1.7	End of Borehole										
	* 90 12 17										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15-5 1 OF 1 METRIC

W.P. 121-87-05 LOCATION N 5 022 220 E 358 422 ORIGINATED BY TS

DIST 9 HWY 416 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY TS

DATUM Geodetic DATE 90 12 17 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 10 20 30	γ kN/m^3	GR SA SI CL
70.5 / 70.3	Ground Surface										
0.2	End of Borehole (Probable Bedrock)							120/15cm			

+^{3}, ×^{5} : Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 12-5 1 OF 1 METRIC

W.P. 121-87-04 LOCATION N 5 022 406 E 358 416 ORIGINATED BY MM

DIST 9 HWY 416 BOREHOLE TYPE HS Auger COMPILED BY TS

DATUM Geodetic DATE 90 12 14 CHECKED BY TS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
67.4	Ground Surface										
0.0	Clayey Silt with interbedded seams of Sandy Silt		1	SS	4	DRY	67				
65.6	Brown, Firm		2	SS	100	/15cm					
1.8	End of Borehole Auger Refusal (Probable Boulder)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

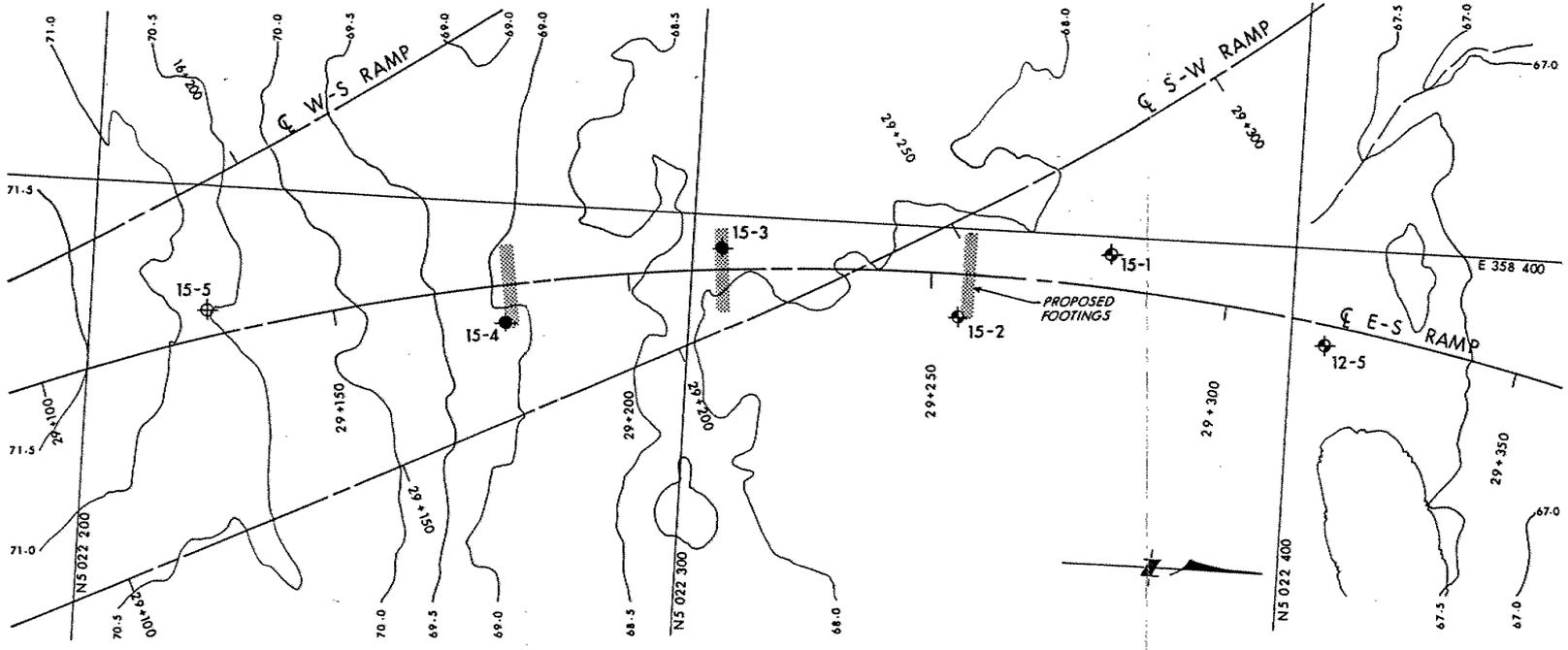
SHEAR STRENGTH kPa: 20 40 60 80 100

WATER CONTENT (%): 10 20 30

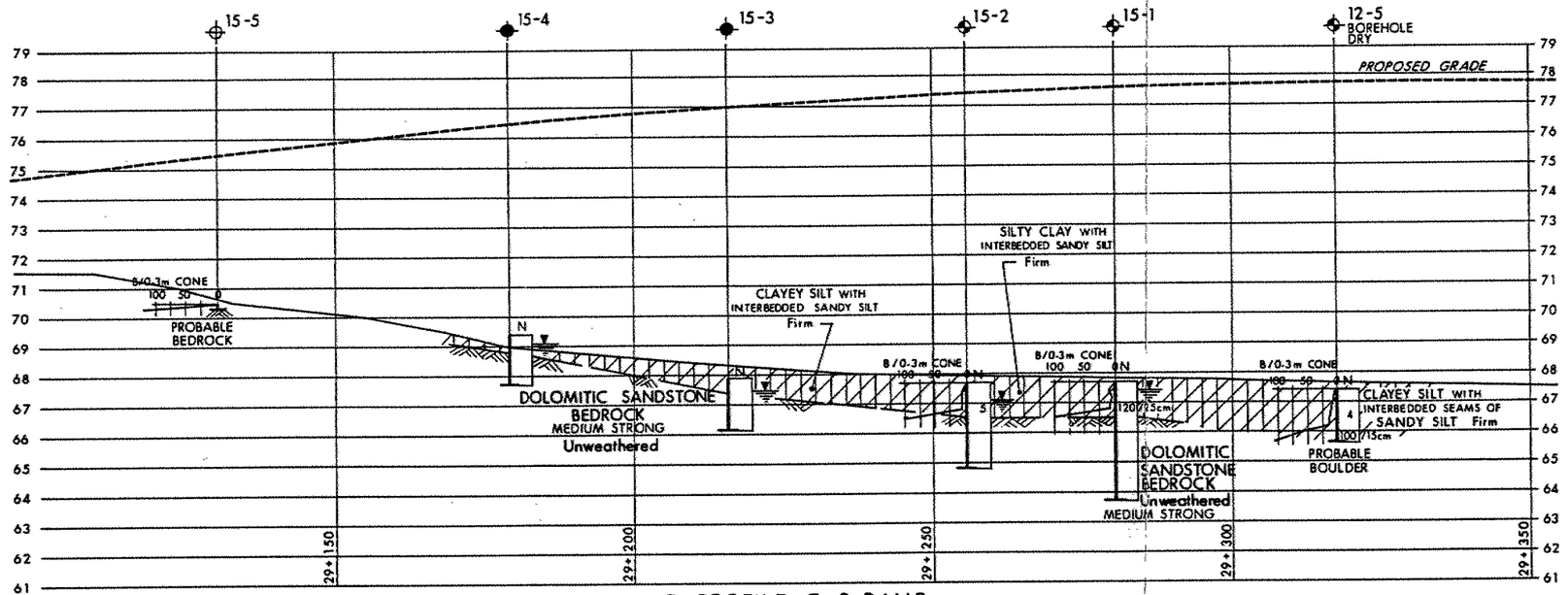
+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10



PLAN
SCALE
10m 5 0 10m



℄ PROFILE E-S RAMP
SCALE
10m 0 10m Hor
2m 0 2m Vert

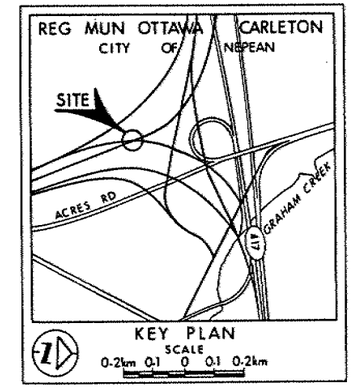
METRIC

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

CONT No
WP No 121-87-05

E-S RAMP OVER S-W RAMP
(STRUCTURE-15)
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 12

No	ELEVATION	CO-ORDINATES NORTH	EAST
15-1	67·7	5 022 370·0	358 403·0
15-2	67·7	5 022 345·0	358 415·0
15-3	67·9	5 022 305·0	358 406·0
15-4	69·4	5 022 270·0	358 421·0
15-5	70·5	5 022 220·0	358 422·0
121-87-04 12-5	67·4	5 022 406·0	358 416·0

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

Geocres No 31G5-180

HWY No 416			DIST 9
SUBM'D TS	CHECKED	DATE 91 05 31	SITE 3-540
DRAWN DT	CHECKED	APPROVED	DWG 1218705-A

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

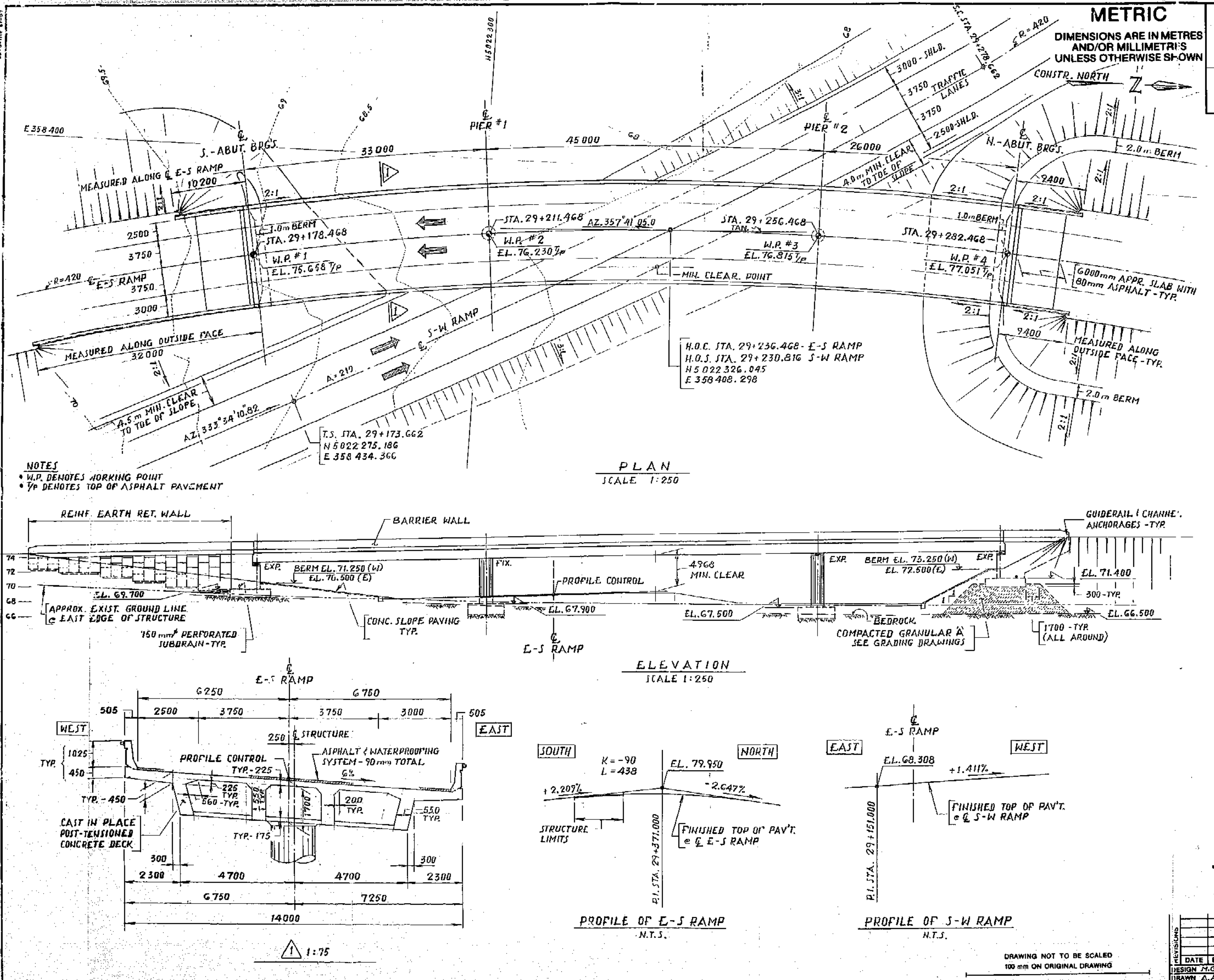
DIST. 9

CONT No

WP No 121-87-05

STRUCTURE Nº 15
E-S RAMP OVER S-W RAMP
HWY. 416/417 INTERCH.
GENERAL ARRANGEMENT

SHEET



GEODETIC DATUM
B.M. ELEV. 69.303
N&W in root of 0.90 elm
8.44 Rt. 29+137.6 S-E Ramp

GENERAL NOTES

CLASS OF CONCRETE

DECK & PIER COLUMNS	35 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25
ABUTMENTS & WINGWALLS — FRONT FACE	80 ± 20
ABUTMENTS & WINGWALLS — BACK FACE	70 ± 20
PIER	80 ± 20
DECK: TOP SLAB, TOP	70 ± 20
TOP SLAB, BOT.	40 ± 10
BOT. SLAB, TOP	40 ± 10
BOT. SLAB, BOT.	50 ± 10
WEBS	60 ± 10
REMAINDER	70 ± 20

UNLESS OTHERWISE NOTED.

REINFORCING STEEL

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

CONSTRUCTION NOTES

THE CONTRACTOR SHALL ESTABLISH THE BEA[illegible] SEAT ELEVATIONS BY DEDUCTING [illegible] THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

APPLICABLE STANDARD DRAWINGS

• OPSD - 3501.00 GRANULAR BACKFILL REQUIREMENTS

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS — DATE | BY | DESCRIPTION

DESIGN M.G. CHK | CODE OHBDC-'83 LOAD CLASS | DATE SEPT.
DRAWN A.A. CHK | SITE 3-540 | STRUCT | SCHEME | DWG. [illegible]