

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-73

DIST. 6 REGION

W.P. No. 137-87-03

CONT. No. 90-18

W. O. No.

STR. SITE No. 37-1175

HWY. No. 400/407

LOCATION Ramp 400 S to 407 W
Bridge #11

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

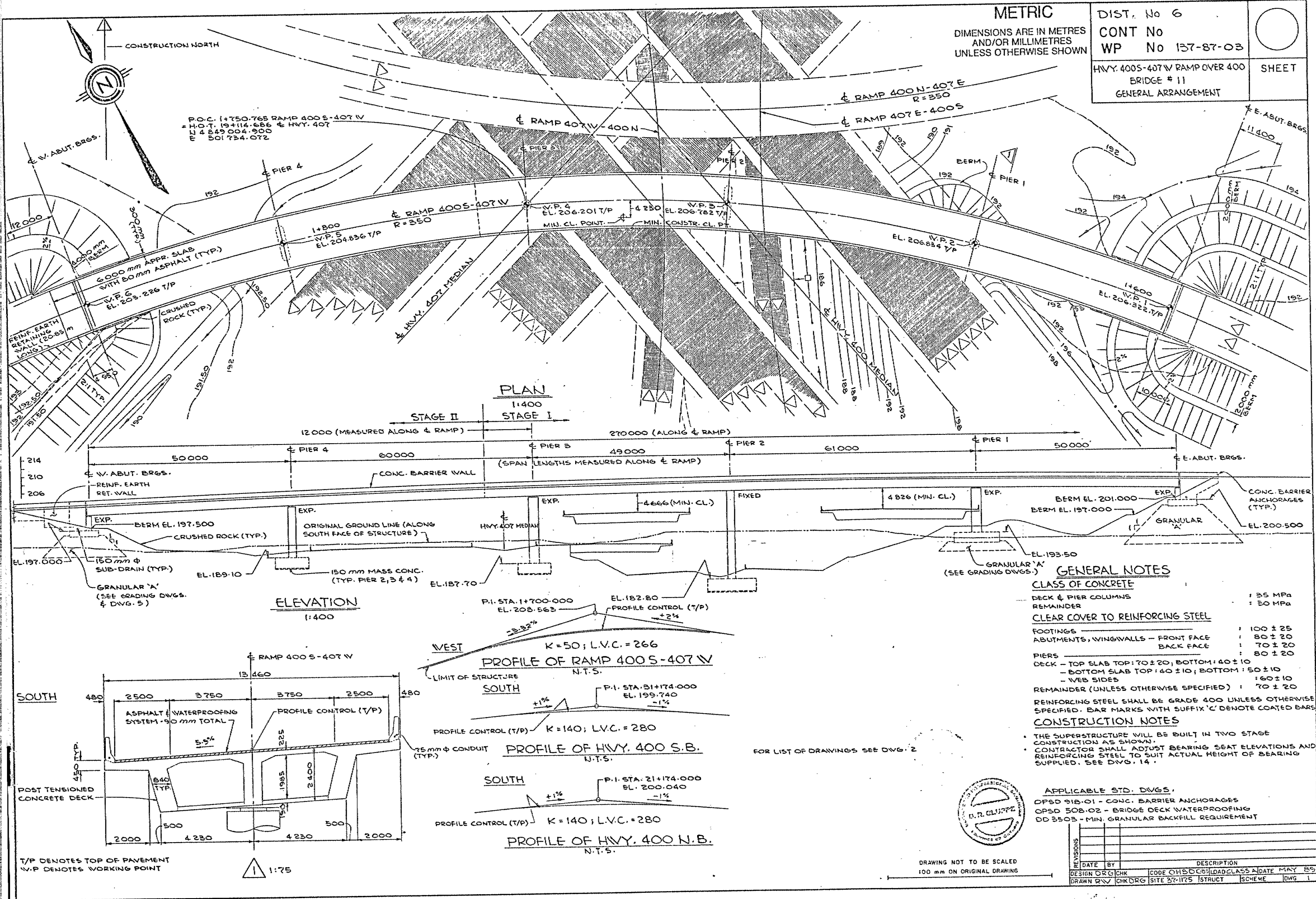
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. No 6
CONT No
WP No 137-87-03

HVY. 400S-407 W RAMP OVER 400
BRIDGE # 11
GENERAL ARRANGEMENT

SHEET



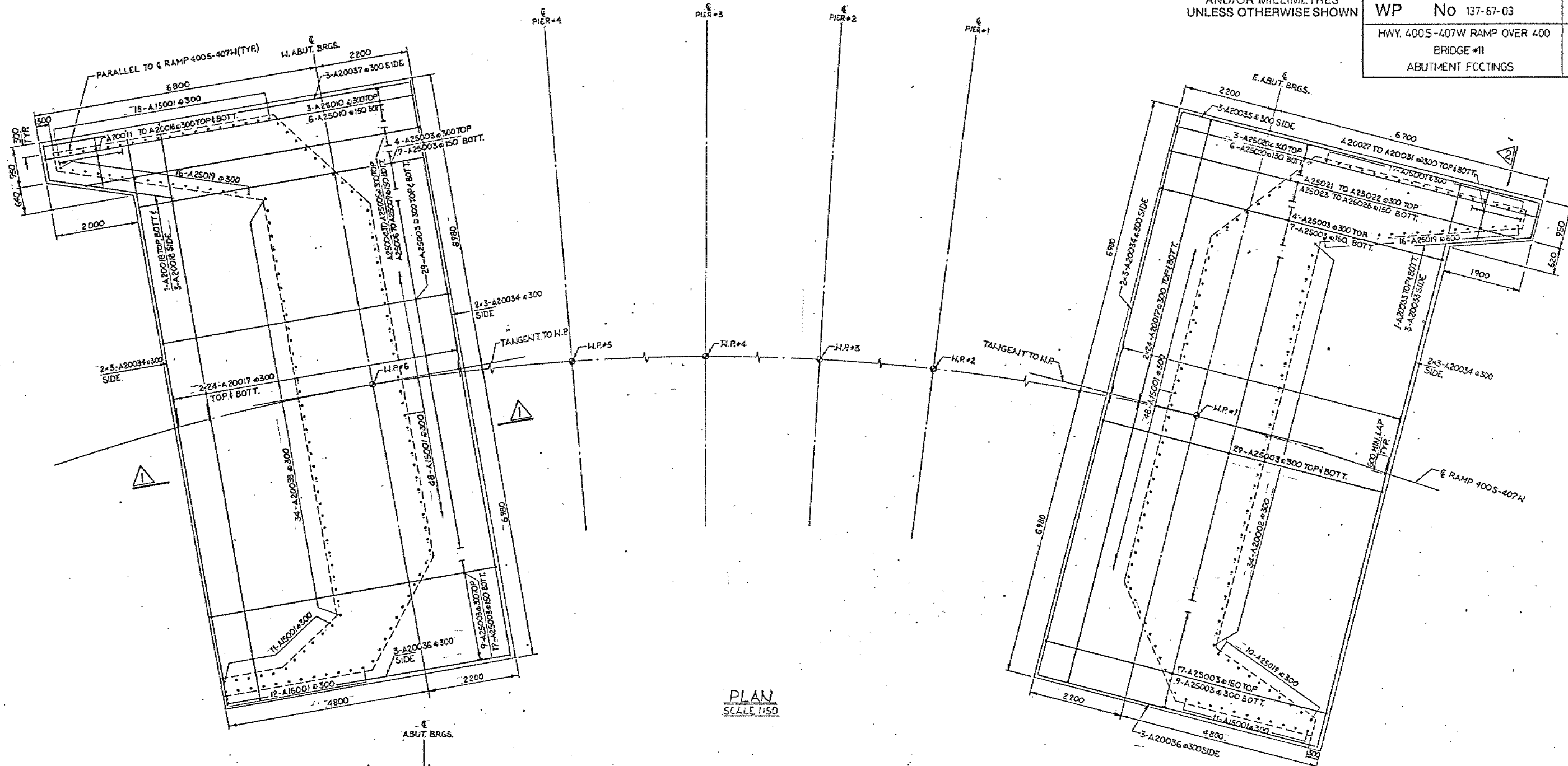
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

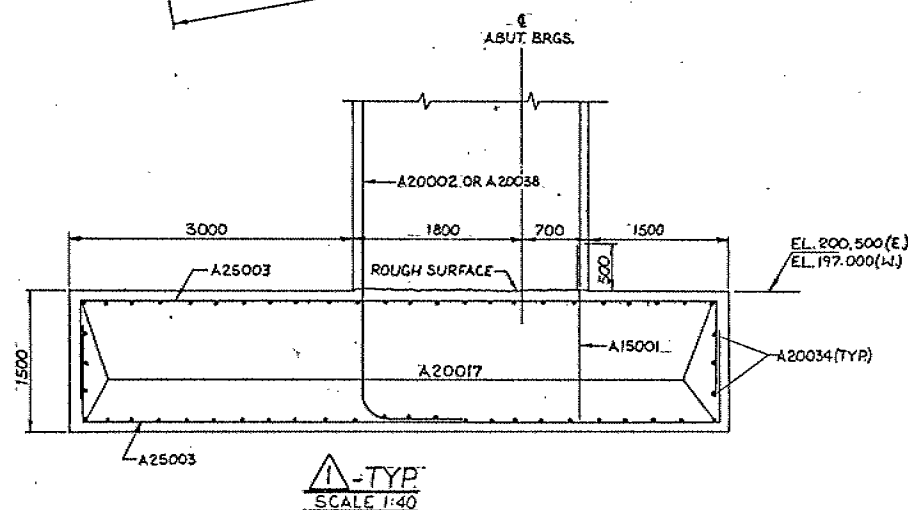
CONT No
WP No 137-67-03

HWY. 400S-407W RAMP OVER 400
BRIDGE #11
ABUTMENT FOOTINGS

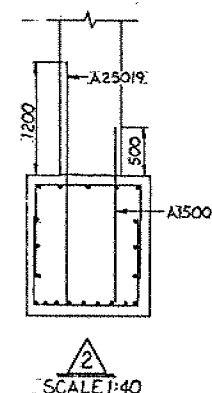
SHEET



PLAN
SCALE 1:50



TYP
SCALE 1:40



2
SCALE 1:40

NOTE:
DRWG. TO BE READ IN CONJUNCTION
WITH DRWG. 5, 8, 9, 10 & 11.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN (R) CHK			CODE (H) (L) (S) (LOAD) (CL) (SS) (2) DATE APR 69
DRAWN J.O.		CHK R.W.	SITE 37-1175 INSTRUCT SCHEME DWG. 6



Ministry of
Transportation and
Communications

FILE COPY

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 137-87-03

DIST 6

HWY 400/407 IC

STR SITE 37-1175

BRIDGE #11

CONT. 90-18

Ramp Hwy. 400 S to Hwy. 407 W

DISTRIBUTION

G. C. E. Burkhardt (3)

R.D. Gunter

A. Wittenberg

J. Smrcka (2)

K. Bassi

J.H. Peer

T. Yakutchuk

G. Szekreny

B. Steeves (Cover Only)

M. Maclean (Cover Only)

File Copy

FOUNDATION INVESTIGATION REPORT
FOR
Bridge #11
Ramp Hwy. 400 S to Hwy. 407 W
W.P. 137-87-03, Site 37-1175
Hwy. 400/407 IC, Dist. 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation for the proposed new bridge for Ramp Hwy. 400 S to Hwy. 407 W. The report is applicable to the proposed structure, the retaining walls and the approaches within 100 m of the abutments.

SITE DESCRIPTION

The site is located at the proposed Hwy. 400/407 interchange, approximately 0.9 km south of Hwy. 7.

This area is basically a glacial till plain with low local relief except for the existing Hwy. 400 embankment and ditches. The natural ground elevation is at elev. 192.5± m while the Hwy. 400 embankment is at elev. 194.5± m. The till deposits are interbedded with some continuous lacustrine layers and frequent random discontinuous silt to sand pockets. Bedrock was not encountered during the investigation but is reported to be composed of shale with limestone laminations and located below elev. 120± m.

To the east of Hwy. 400, land use is agricultural; to the west, there is a drive-in theatre and the Toronto Star property.

INVESTIGATION PROCEDURES

A foundation investigation for this site was conducted between 87 10 19 and 87 11 27. Continuous-flight auger machines equipped with 82 mm I.D. hollow-stem augers and solid-stem augers, and N and B casing were used.

The investigation for the entire interchange consisted of:

- 54 boreholes
- and
- 28 piezometer installations

The portion of the investigation directly related to the Bridge #10 site consisted of:

- 9 sampled boreholes accompanied by dynamic cone penetration tests,
and
- 2 sampled boreholes

These site specific boreholes are identified as BH #11-1 to #11-11 inclusive. They extended for depths ranging from 12.6 m to 21.8 m. All boreholes were terminated in overburden.

Survey details were provided by the Central Region Surveys and Plans Section.

The sampling program consisted of split spoon samples collected at 0.8 m to 3.0 m intervals. They provided Standard Penetration Test (N) values for assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of shear strengths of cohesive materials. These samples also provided material for identification purposes.

The laboratory testing program for representative samples consisted of:

- grain size analyses
- natural moisture content determinations
- Atterberg Limit determinations

SUBSURFACE CONDITIONS

The Record of Borehole Sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 1378703 A & B.

The existing Hwy. 400 embankment is composed of compact sand fill extending from the road surface (elev. 194.5± m) to the surface of the native overburden (elev. 192.5± m). The upper portions of this fill are the granular sub-base for the pavement structure.

The native overburden consists of the following generalized layers, in sequence, from the surface down:

<u>Elevation (m)</u>		<u>Material</u>
<u>From</u>	<u>To</u>	
192.5	190	Clayey Silt (Glacial Till)
190	179	Silt/Clayey Silt with random silt and sand pockets (Glacial Till with Lacustrine Interbeds)
179	157	Silty Clay to Clay with thin silt seams (Lacustrine)
157	undetermined	Sandy Silt to Silty Sand (Lacustrine)

The properties of the glacial till deposits are variable across the site in both the horizontal and vertical dimensions, and the boundaries between the soil strata are transitional.

Sand (Fill)

This non-cohesive material is fill for the existing Hwy. 400 embankment. It has been described as sand, but is a typical granular sub-base material.

At the Bridge #11 site, it was encountered at BH #11-1, #11-2, #11-3 and #11-6 where it extended, from the surface, for thicknesses of 0.8 m.

Based on the results of Dynamic Cone Penetration Tests for the Bridge #11 site, the material is considered to be in a compact state.

Clayey Silt (Glacial Till)

This cohesive material has been described as clayey silt, some sand, trace gravel.

At the Bridge #11 site the material was encountered at all boreholes. At BH #11-1, #11-2, #11-3 and #11-6 it underlies sand fill. At all other boreholes it is the surface material. Thicknesses of this deposit ranged from 1.3 m to 3.5 m at the borehole locations. At BH #11-2 the upper 0.5 m of this deposit contained organics, while at BH #11-4 the upper 1.9 m contained organics.

Based on the results of Standard Penetration Tests (N = 4 to 70), for the Bridge #11 site, the material is in a firm to hard state.

Typical properties of the material, as determined by laboratory tests of representative samples from the entire interchange site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	9.0-15.5%	13.0%
Liquid Limit (w_L)	17.0-23.5%	20.8%
Plastic Limit (w_p)	10.0-12.5%	11.4%

Figure 1 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 2 illustrates a typical grain size distribution for this material, based on representative samples from the entire interchange site.

Silt/Clayey Silt (Glacial Till)

The silt/clayey silt (glacial till) deposit has been described as silt/clayey silt, some sand, trace gravel, with random silt and sand pockets and occasional boulders. The main component of this deposit varies randomly from non-plastic silt (ML), to slightly plastic silt (CL-ML), to clayey silt (CL). Within this deposit there are frequent random discontinuous pockets of silts and sands, typically 1 m thick. A semi-continuous layer of lacustrine silt to sand, varying in thickness from 0.6 m to 3.6 m was encountered at elev. 189± m, at all boreholes except BH #11-1 and #11-6.

At the Bridge #11 site, this material was encountered at all borehole locations where it extended for thicknesses varying from over 7.7 m to 11.3 m.

Based on 'N' values which ranged from 14 to over 100 for Bridge #11, the denseness of this deposit can be described as loose to very dense (for the non-cohesive zones) while the consistency is stiff to hard (for the cohesive zones). Generally, the deposit may be considered to be dense to very dense (non-cohesive component) or hard (cohesive component).

Typical properties of the basic cohesive material matrix, as determined by laboratory tests of representative samples from the entire interchange site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	6.5-23.0%	12.1%
Liquid Limit (w_L)	13.5-32.5%	19.8%
Plastic Limit (w_p)	9.0-17.5%	12.6%

Figure 3 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 4 illustrates a typical gran size distribution for this material based on representative samples from the entire interchange site.

Silty Clay to Clay (Lacustrine)

The silty clay to clay (lacustrine) deposit has been described as silty clay to clay, with thin silt seams. The thickness of this deposit was not fully explored at the Bridge #11 site, but it is in excess of 11.1 m. Within this deposit there are occasional sand pockets, generally up to 1.5 m thick. However, at BH #11-4, #11-5 and #11-6 the sand layers are more extensive.

Based on 'N' values ranging from 39 to over 100 at the Bridge #11 site, the consistency of this deposit is hard. The sand pockets are generally very dense.

Typical properties of the material, as determined by laboratory tests of representative samples from the entire site, are summarized as follows:

	<u>Range</u>	<u>Average</u>
Water Content (w)	12.0-24.0%	17.1%
Liquid Limit (w_L)	26.0-61.5%	35.6%
Plastic Limit (w_p)	11.5-21.0%	16.0%

Figure 5 illustrates a typical plasticity envelope for this material, based on representative samples from the entire interchange site.

Figure 6 illustrates a typical grain size distribution for this material, based on representative samples from the entire interchange site.

Sandy Silt to Silty Sand (Lacustrine)

This non-cohesive material has been described as sandy silt to silty sand.

Based on boreholes at other locations within the interchange site, the material underlies the silty clay to clay deposit at elevation 157± m. Its thickness was not determined. The material is in a very dense state with N values in excess of 100.

Groundwater

The groundwater was measured in open boreholes and also in piezometer installations (at various locations across the site for this project and related projects) that measured groundwater conditions in isolated zones at approximately 3 m, 6 m, 9 m, 12 m, 15 m, and 18 m below the surface. Based on these measurements, the groundwater elevation is generally between elev. 190 m and 192 m. However, the measurements of some of the piezometers over 12 m deep have required a considerable period of time to stabilize (in the order of weeks), indicating that there are zones of

very low permeability within the silt/clayey silt (glacial till) deposit and silty clay to clay (lacustrine) deposit. Although the initial readings in these zones measured groundwater at elevations ranging from 187.5 m to 189.5 m, the depth to groundwater has slowly been decreasing with time and had not completely stabilized by January 6, 1988.

There are pockets of silt and sand within the overburden which are water bearing and exhibit a tendency to flow or boil under conditions of unbalanced hydrostatic head.

DISCUSSION

The recommendations in this report apply to the structure, the retaining walls, and the approaches within 100 m of the abutments.

Bridge #11 is for Ramp Hwy. 400 S to Hwy. 407 W. A 5-span structure with related retaining walls is proposed. This structure will be at Level 4 of this 4 level interchange. The proposed deck elevation is up to 209± m, which is 16.5± m above the existing natural ground surface. Cuts for Level 1 of this interchange will be to elevation 183 ± m.

STRUCTURE FOUNDATIONS

The survey locations of Bridge #11 footings are referenced to Bridge #11 PCL chainage.

There are some uncertainties in the footing locations in the present proposal. Consequently, the recommendations for structure foundations are subject to revision when the proposal has been finalized and fully detailed.

In addition, there is a possibility of footing interference with other interchange footings. The effect of footing interference cannot be fully assessed until footing locations are finalized, but deep foundations may be required for footings that are affected.

The following interchange footings may interfere with Bridge #11 footings.

Bridge #11 Footings	Location	Possible Interference Footings
South Centre Pier	Sta. 1 + 701± and elev. 184± m	- Bridge #8 Centre Pier at Sta. 19 + 160± (Bridge #8 PCL chainage) and elev. 184± m.
West Centre Pier	Sta. 1 + 751± and elev. 191± m	- Bridge #8 West Abutment at Sta. 19 + 115± (Bridge #8 PCL chainage) and elev. 187± m. - Bridge #9 North Centre Pier at Sta. 21 + 174± (Bridge #9 PCL chainage)* and elev. 185± m.

*There is an inconsistency in station designations between the plan and profile. Bridge #9 PCL chainage may be either 21 + or 31 +.

The spread footing recommendation in this report apply only to footings in which the underside of the footing is a minimum of 3 m from a slope. Otherwise a reduction in bearing capacity may be necessary.

The abutments and related retaining structures may be founded on spread footings on compacted Granular 'A' pads constructed in accordance with the geometry illustrated in Figure 13.

The following chart indicates recommended elevations for the base of the granular pad, and O.H.B.D.C. bearing capacities for footings on compacted granular pads for each abutment and its related retaining structures. The granular pad must be a minimum of 2 m thick. If the assumed highest possible footing elevation is incorrect, these recommendations will require revision.

Footing Element	Location	Assumed Highest Footing Elev.	Recommended Base of Granular 'A' Pad	Factored Bearing Capacity at U.L.S.	Bearing Capacity at S.L.S Type II
South Abutment and Retaining Structures	Sta. 1 + 608 \pm	202 \pm m	190 m	900 kPa	350 kPa
West Abutment and Retaining Structures	Sta. 1 + 826 \pm	191 \pm m	189 m	900 kPa	350 kPa

The piers may be founded on spread footings on native overburden.

The following chart indicates recommended footing elevations and O.H.B.D.C. bearing capacities for spread footings at each pier. If the assumed highest possible footing elevation is incorrect, these recommendations will require revision.

Footing Element	Location	Assumed Highest Footing Elev.	Recommended Footing Elev.	Factored Bearing Capacity at U.L.S.	Bearing Capacity at S.L.S. Type II
South Pier	Sta. 1 + 638 _±	198 _± m	189 m	1000 kPa	*
South Centre Pier	Sta. 1 + 701 _±	184 _± m	184 m	1000 kPa	*
West Centre Pier	Sta. 1 + 751 _±	191 _± m	189 m or 187.5 m	525 kPa 1000 kPa	350 kPa *
West Pier	Sta. 1 + 806 _±	190 _± m	189 m	750 kPa	500 kPa

*The foundation is considered to be unyielding, and S.L.S. Type II will not govern design.

Consideration should also be given to the application of earth reinforcement principles for the retaining structures. Both 'Reinforced Earth', which uses metal strips within the embankment to provide lateral resistance to prefabricated concrete panels, and 'Geo-crete Products Ltd.' which applies the same concept but substitutes geo-grids for metal strips, may provide more economical alternatives than conventional cantilever walls, for retaining structures in a fill situation. Anchored walls should be considered as an alternative for retaining structures in a cut situation. The alternatives should be evaluated, and the least expensive option should be adopted.

If more details are required regarding these alternatives, this office can provide details.

Earth Pressure

Backfill to structures should consist of granular material in accordance with Ministry of Transportation Standard Special Provision #121 (83 10).

Computation of earth pressures should be in accordance with Section 6-6.1.2.1 of the O.H.B.D.C. The active condition will govern earth pressure design for the yielding condition while the at-rest condition will govern earth pressure design for the unyielding condition. The following properties for backfill are recommended for design:

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_A</u>	<u>K_0</u>
Granular 'A'	35°	22.8 kN/m ³	0.27	0.43
Granular 'B'	30°	21.2 kN/m ³	0.33	0.50

Lateral Resistance

Sliding resistance between concrete and foundation soil should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. assuming an unfactored ϕ value of 30° for noncohesive foundation soils or an unfactored adhesion value of 75 kPa for cohesive foundation soils. In view of the variable nature of the foundation soils, both the noncohesive and cohesive conditions should be considered for calculation of sliding resistance, and the worst case should be adopted in the design.

Sliding resistance of footings can be supplemented by keying into the soil, in which case the passive resistance below the frost penetration depth can be considered in the design. In this case, keys should be formed against undisturbed native overburden. Alternatively, soil anchors could be considered to resist lateral loads. If this option is considered, pre-contract soil anchor testing would be required to determine design anchor bond stresses.

The resistance to lateral load for piles should be calculated in accordance with Section 6-8.3.8 of the O.H.B.D.C. The horizontal component of battered piles may be used to resist lateral loads.

Frost Protection

A minimum earth cover of 1.2 m, or equivalent, to the base of footings or pile caps is required for frost protection.

Slope Stability

For fills above the prevailing groundwater elevation, temporary slopes will be stable at 1.5H:1V, and permanent slopes will be stable at 2H:1V, for embankments up to 9 m high.

The proposal for this interchange requires cuts in the order of 9 m deep. This cut will expose numerous random pockets and some distinct zones of fine-grained granular soils that are susceptible to disturbance when the water table is lowered. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. These measures are required to lower the groundwater table below the frost penetration depth to prevent the softening of material due to freeze-thaw cycles, and to dissipate excess pore water pressures that could contribute to surficial slope failures.

Four cut geometry-surface treatment-drainage conditions variations, for a 9 m deep cut, have been analysed utilizing Bishop's effective stress method.

- (1) An analysis assuming a 2H:1V slope (Figure 7), resulted in a factor of safety of less than unity.
- (2) An analysis assuming a 2H:1V slope treated with a 1.2 m thick granular blanket (Figure 8), resulted in a marginal but unacceptable factor of safety.
- (3) An analysis assuming a 2.5H:1V slope treated with a 0.6 m thick granular blanket and a 1.2 m deep toe drain (Figure 9), resulted in an acceptable factor of safety.
- (4) An analysis assuming a 2H:1V slope with a 1.2 m wide bench located at a depth of 4.5 m from the top of the cut, a 1.2 m deep bench drain and a 1.2 m deep toe drain, and 0.6 m thick granular blankets on both the upper and lower slopes (Figure 10), resulted in an acceptable factor of safety.

Based on these analyses, cut slopes deeper than 4.5 m, should be constructed in accordance with the treatments described in either #3 or #4. These alternatives are illustrated in Figure 11. For cuts less than 4.5 m deep, the slope treatment should consist of a 2H:1V slope treated with a 0.6 m thick granular blanket and a 1.2 m deep toe drain. This recommended cut slope treatment is illustrated in Figure 12. The granular blanket should consist of free-draining material such as Ministry of Transportation Granular 'A'. Alternatively, Granular 'B' with appropriate gradation limits would be suitable. If Granular 'B' is proposed, typical gradations of the material should be submitted to this office for assessment. The drain trenches should be lined with a suitable geotextile filter fabric, such as Class 1 non-woven geotextile with EOS of 75 to 150 um. The perforated pipes should be 150 mm minimum diameter and should be surrounded by a minimum of 150 mm of granular backfill. The drains should be connected to an appropriate permanent drainage system. In addition all slopes should be provided with an interceptor ditch at the top of the slope.

Normal slope vegetation should be established as soon as possible after completion of the cut in order to control surficial erosion.

Settlement

Total and differential settlements will be negligible for structure foundations and embankments constructed in accordance with the recommendations provided.

Dewatering

As the groundwater elevation is at 190 m to 191 m, both a temporary (during construction) dewatering scheme and a permanent drainage system will be required.

The temporary dewatering scheme should lower the prevailing groundwater table a minimum of 1 m below excavations and should be designed to prevent disturbance of the foundation soil or cut slopes. The dewatering scheme should also take into consideration the presence of silt and sand pockets within the overburden. These materials are susceptible to disturbance under conditions of unbalanced hydrostatic head.

Although the dewatering of some shallow excavations may be possible by an oversized perimeter ditch/sump pumping system, the deep cut will probably require a larger scale scheme, such as excavating a pilot trench, to facilitate dewatering while the required cut geometry is constructed. A typical design would involve construction of a pilot trench prior to the excavation of the proposed cut geometry. The pilot trench would be excavated below the prevailing cut excavation level and would be located, in plan, at the central portion of the proposed cut.

The slope drainage system should be connected to an appropriate permanent drainage system.

Consideration should be given to establishing the existing groundwater conditions in the area surrounding the site, and the effects of both temporary dewatering and permanent drainage, particularly in those areas where there is a potential for claims.

Construction Considerations

The bearing surfaces of spread footing excavations should be protected by a 15 cm pad of mass concrete within 4 hours of exposure.

MISCELLANEOUS

The field work for this project was carried out under the supervision of D. Dundas, Senior Foundations Engineer, T. Sangiuliano, Foundations Engineer, K. Zasitko, Foundation Field Technician, and M. Schnarr, Engineering Student.

The equipment used was owned and operated by Dominion Soil Investigation Inc., Malone's Soil Samples and Master Soil Investigation Ltd.

The report was written by D. Dundas, and reviewed by M. Devata, Chief Foundations Engineer (East).



D. H. Dundas

D. H. Dundas, P. Eng.

Sr. Foundations Engineer

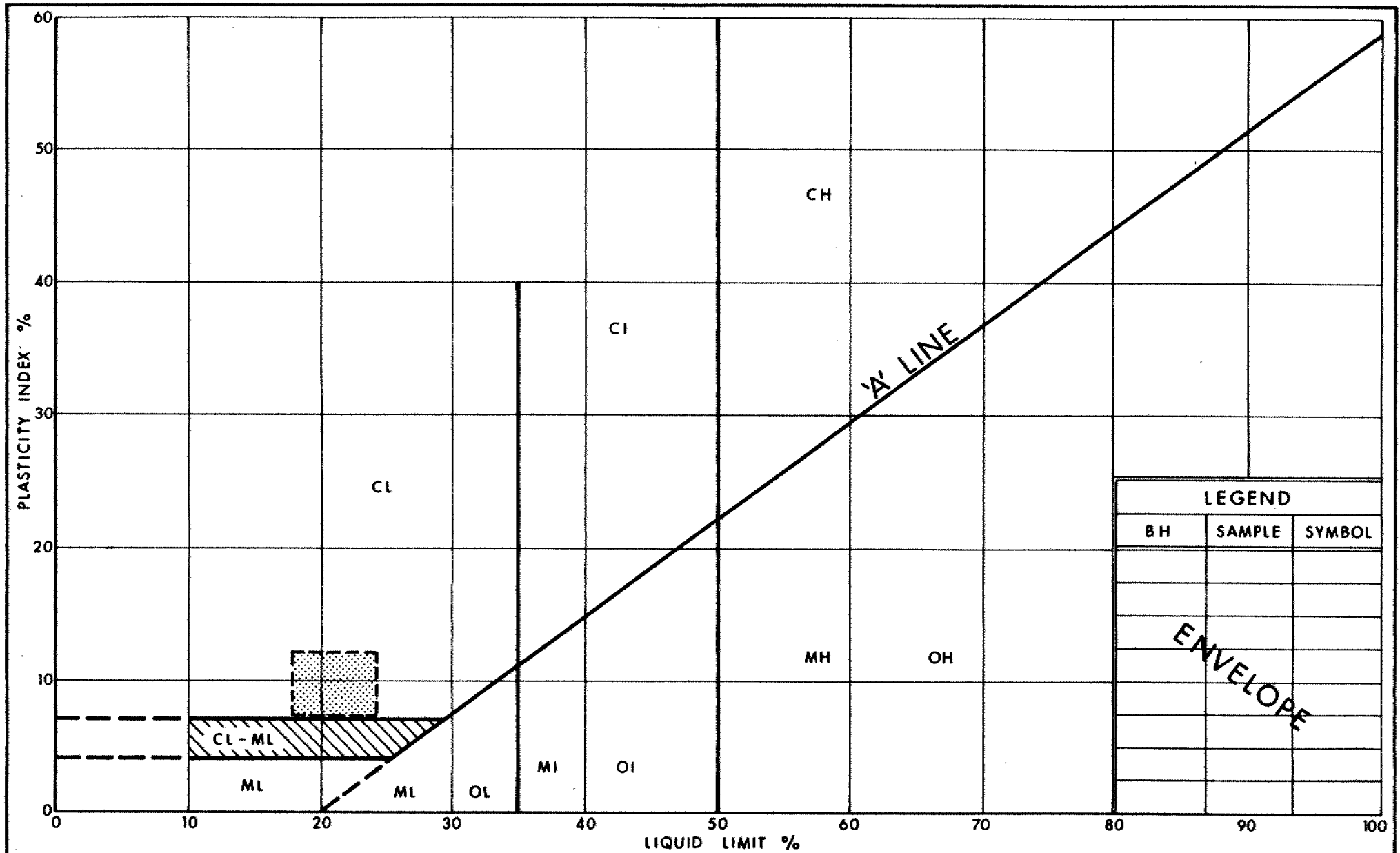
M. S. Devata

M. S. Devata, P. Eng.

Chief Foundations Engineer

(East)

APPENDIX



Ministry of
Transportation

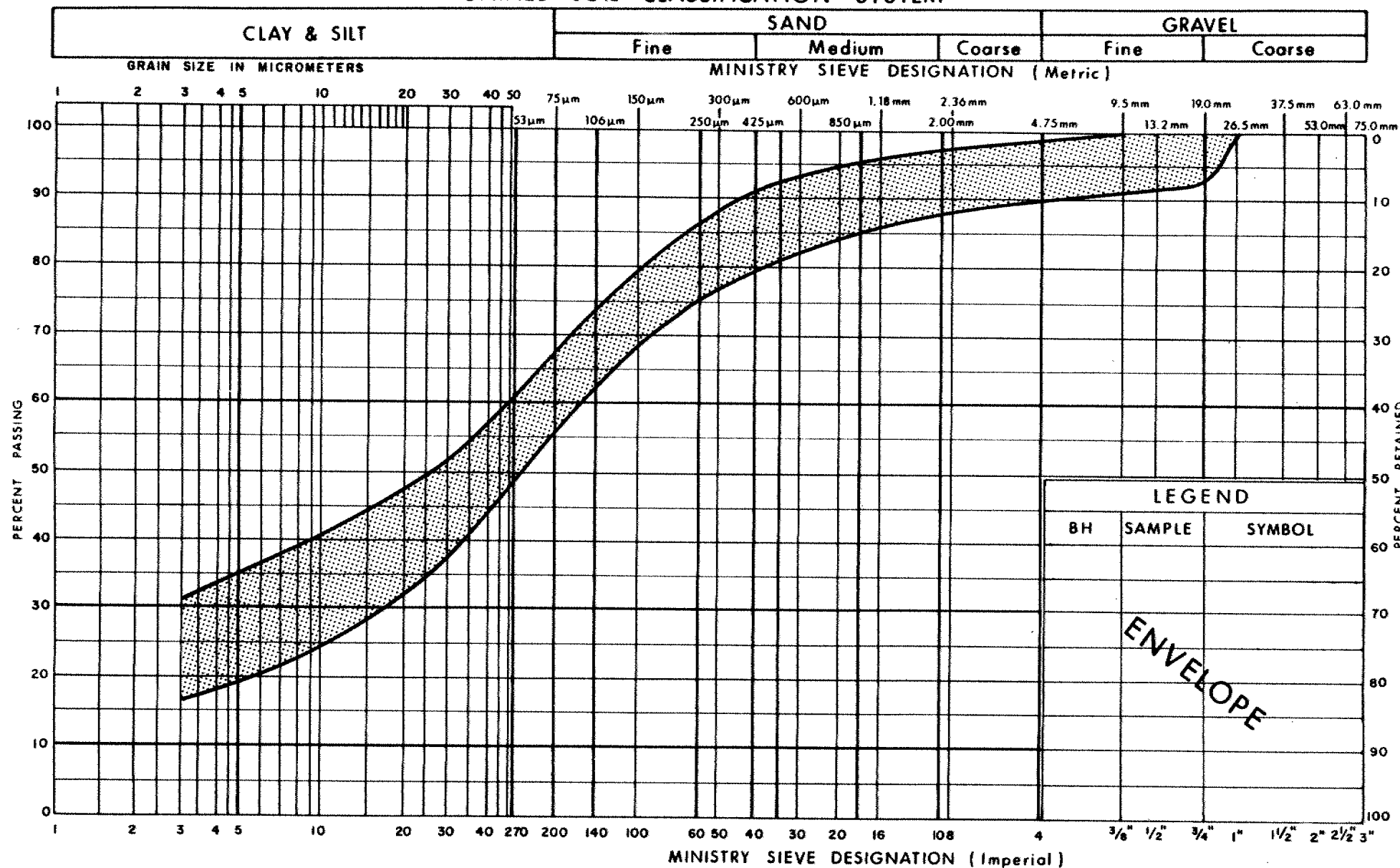
Ontario

PLASTICITY CHART CLAYEY SILT (Glacial Till)

FIG No 1

W P 137-87-03

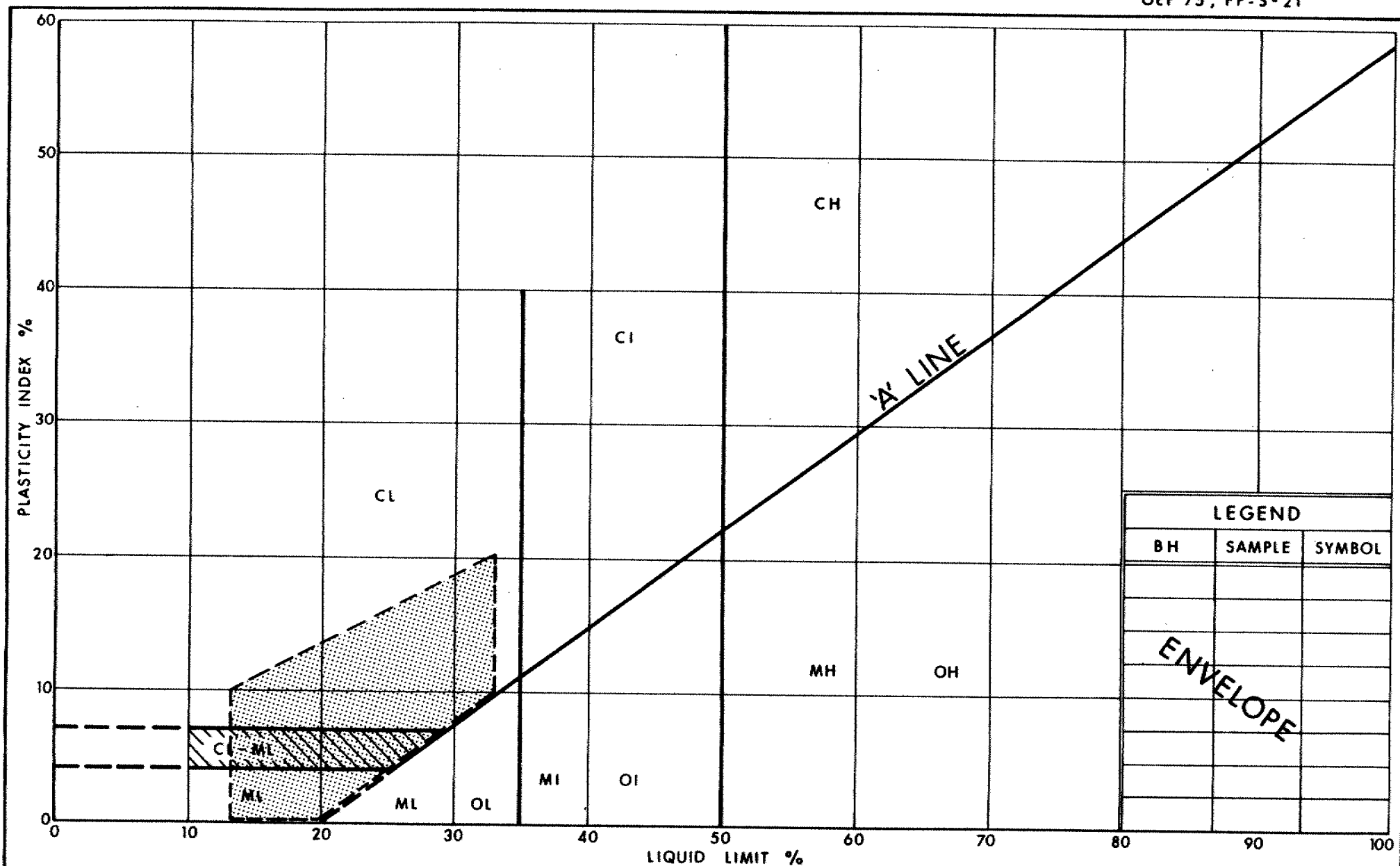
UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of
Transportation

 GRAIN SIZE DISTRIBUTION
CLAYEY SILT (Glacial Till)

FIG No 2

W P 137-87-03



Ministry of
Transportation

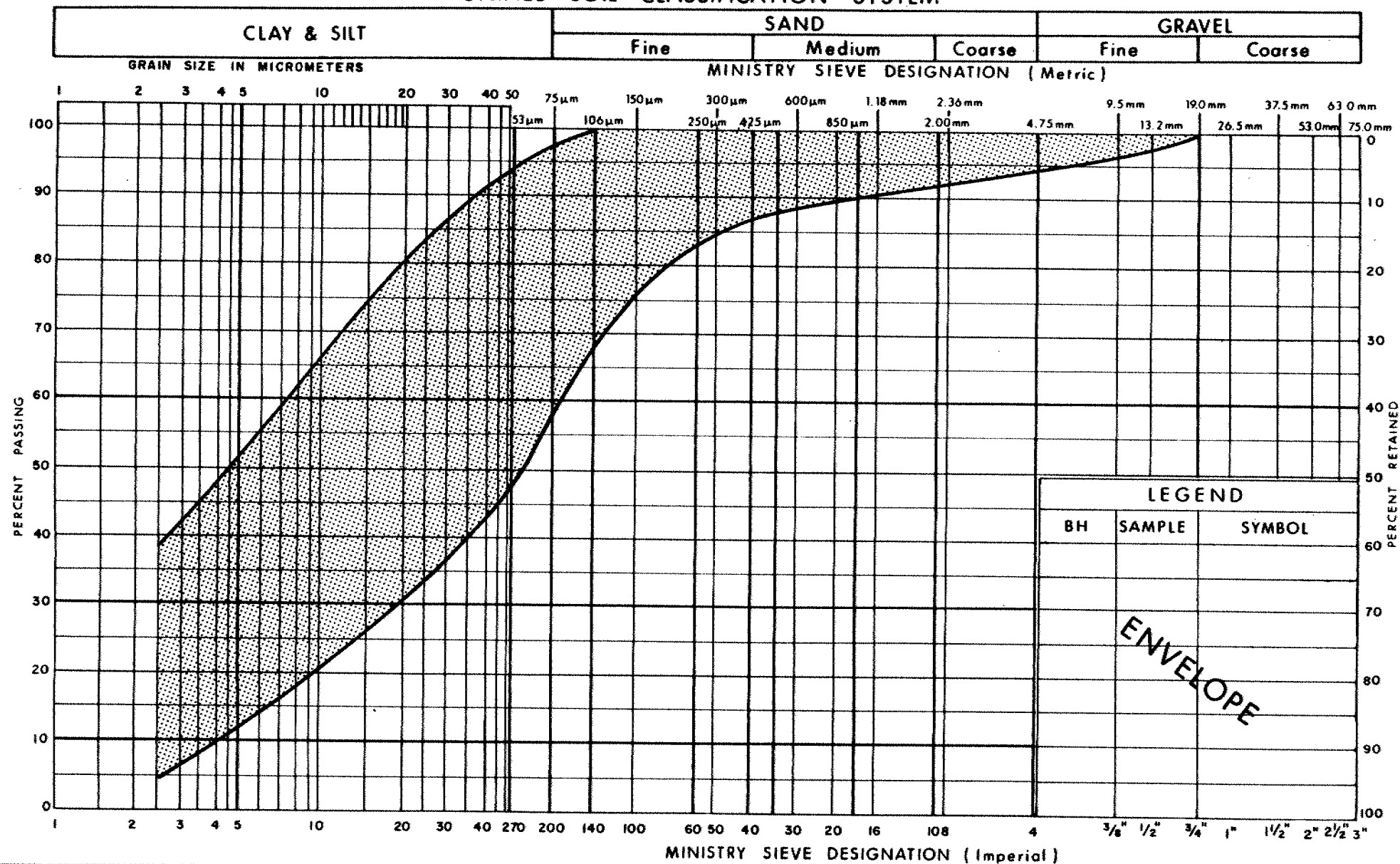
Ontario

PLASTICITY CHART SILT / CLAYEY SILT (Glacial Till)

FIG No 3

W P 137-87-03

UNIFIED SOIL CLASSIFICATION SYSTEM

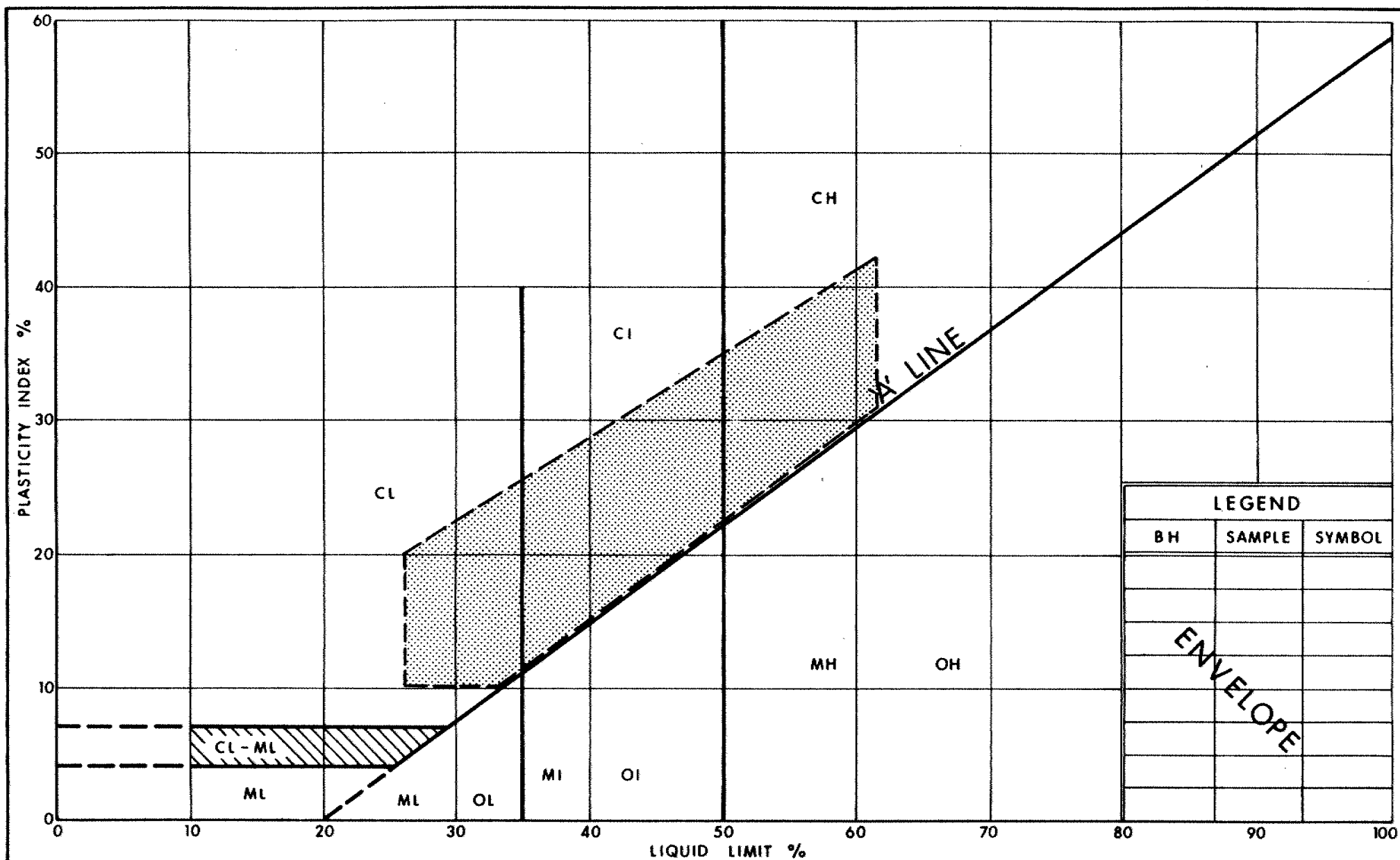


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT/CLAYEY SILT (Glacial Till)

FIG No 4

W P 137-87-03



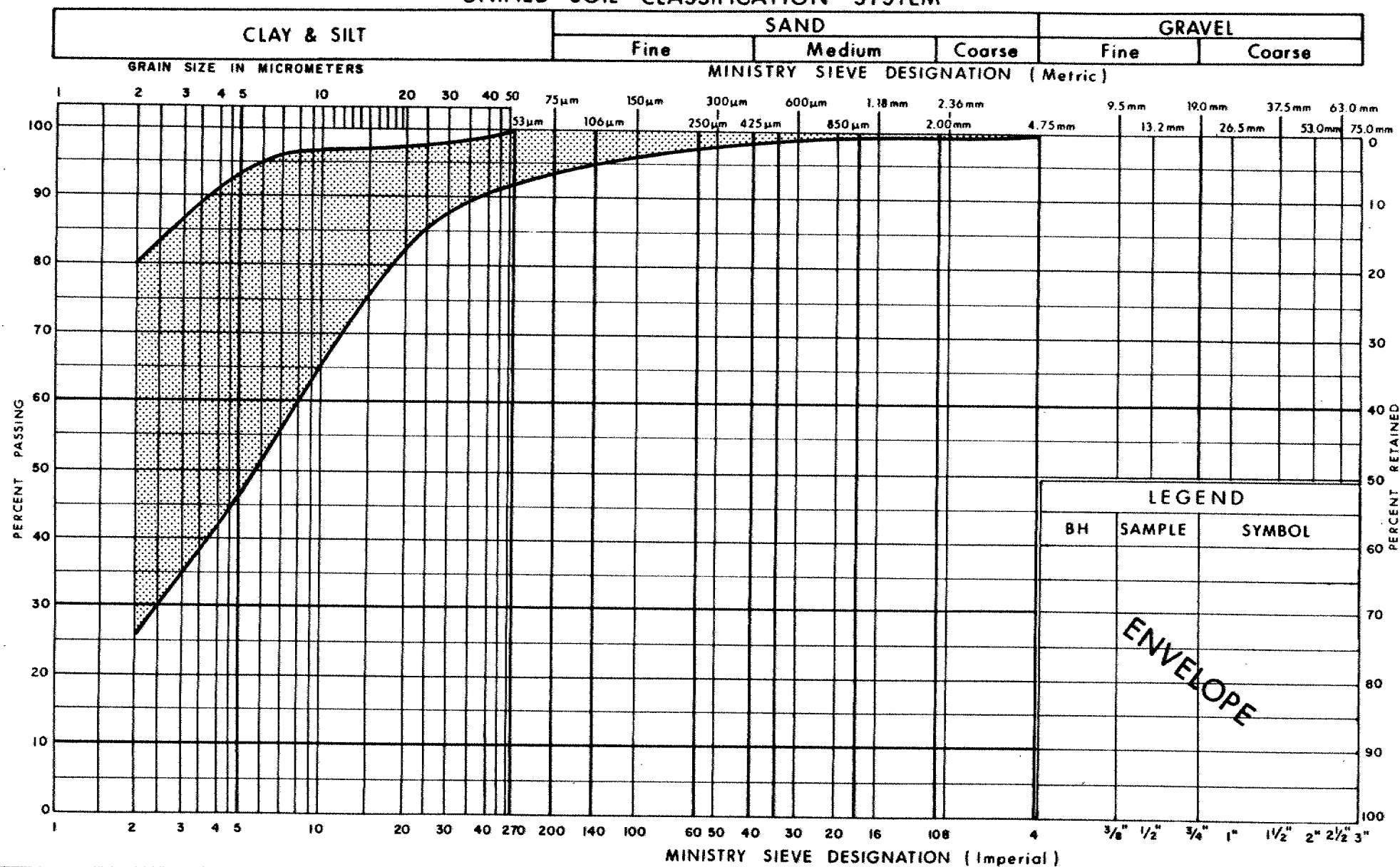
Ministry of
Transportation

PLASTICITY CHART SILTY CLAY TO CLAY (LACUSTRINE)

FIG No 5

W P 137-87-03

UNIFIED SOIL CLASSIFICATION SYSTEM



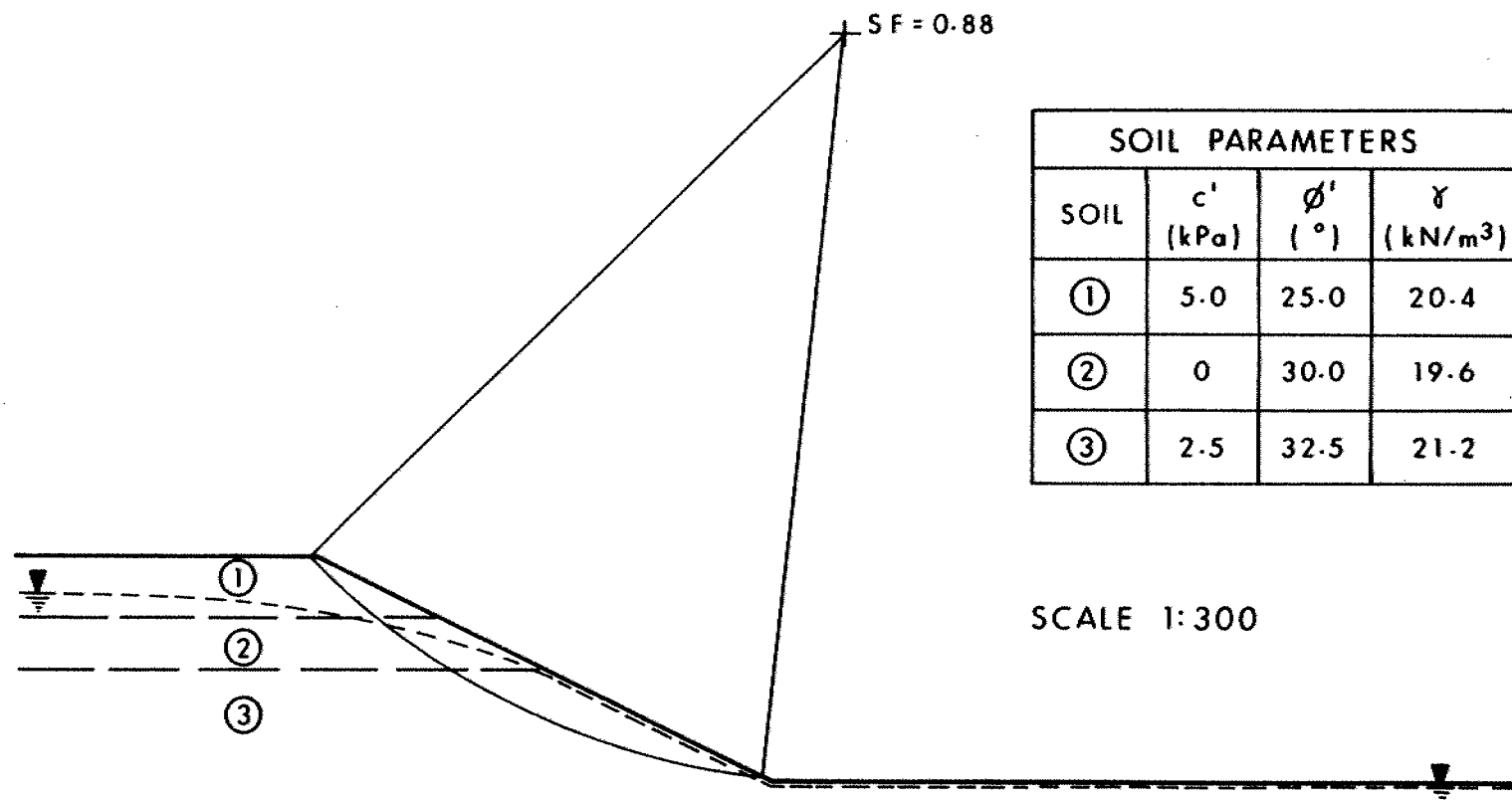
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

SILTY CLAY TO CLAY (LACUSTRINE)

FIG No 6

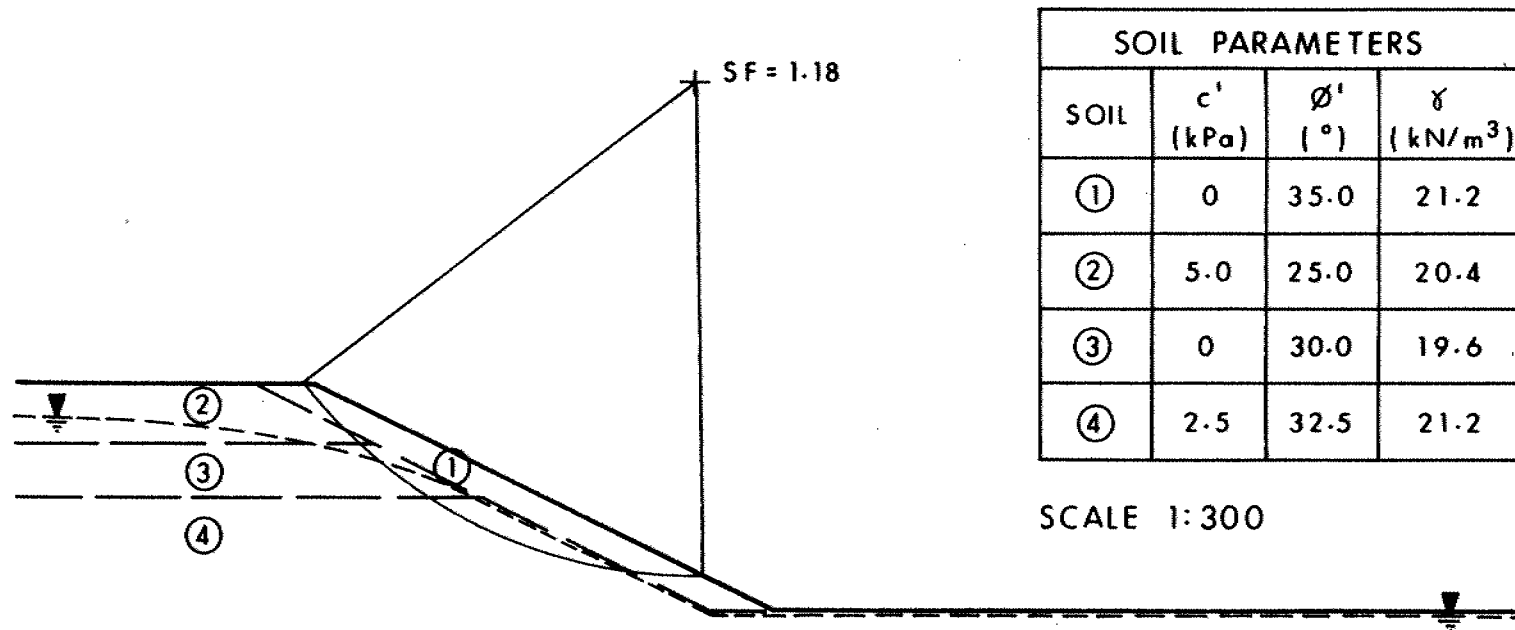
W P 137-87-03



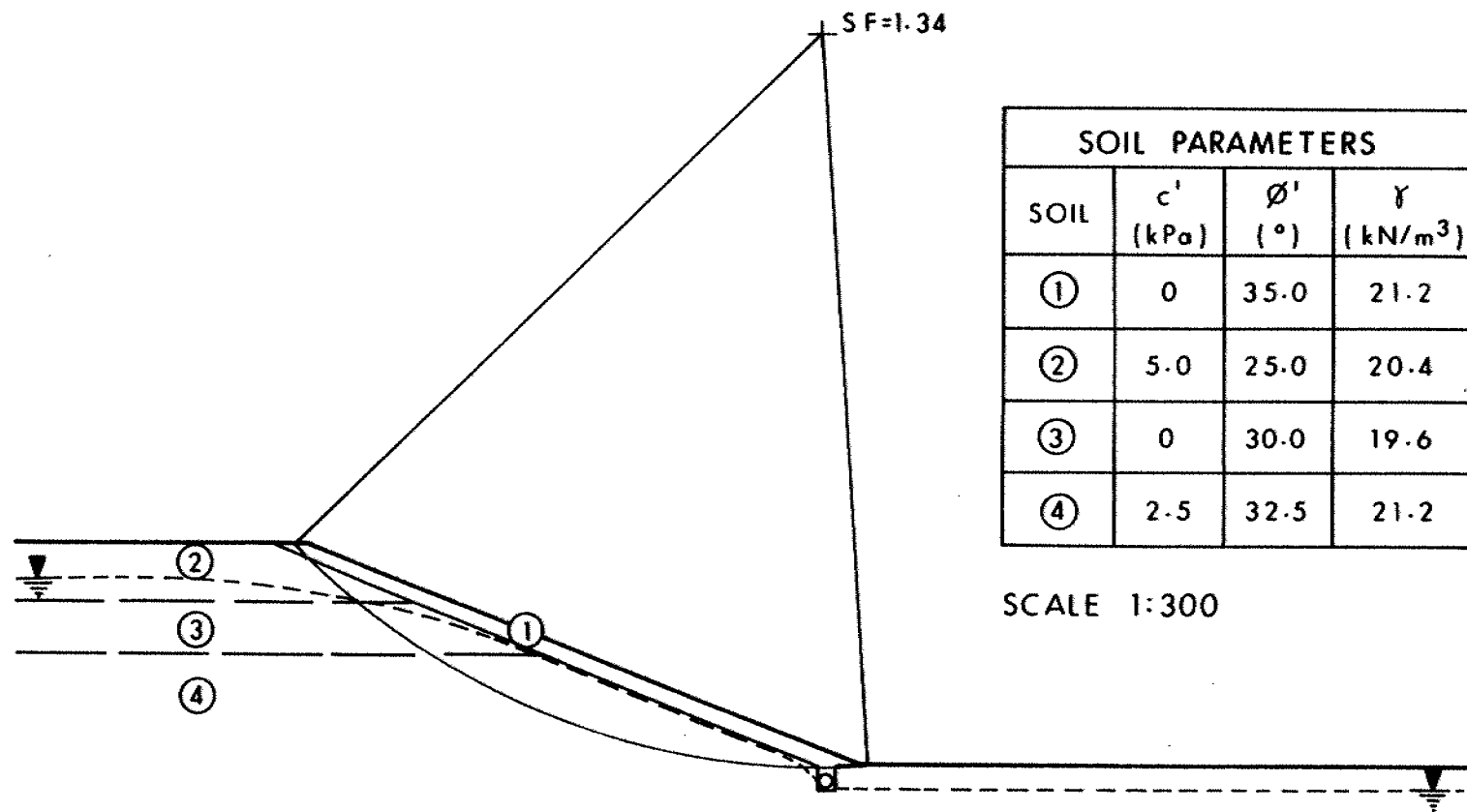
EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)

Fig 7

WP 137-87-03



EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)
WITH 1.2m THICK GRANULAR BLANKET

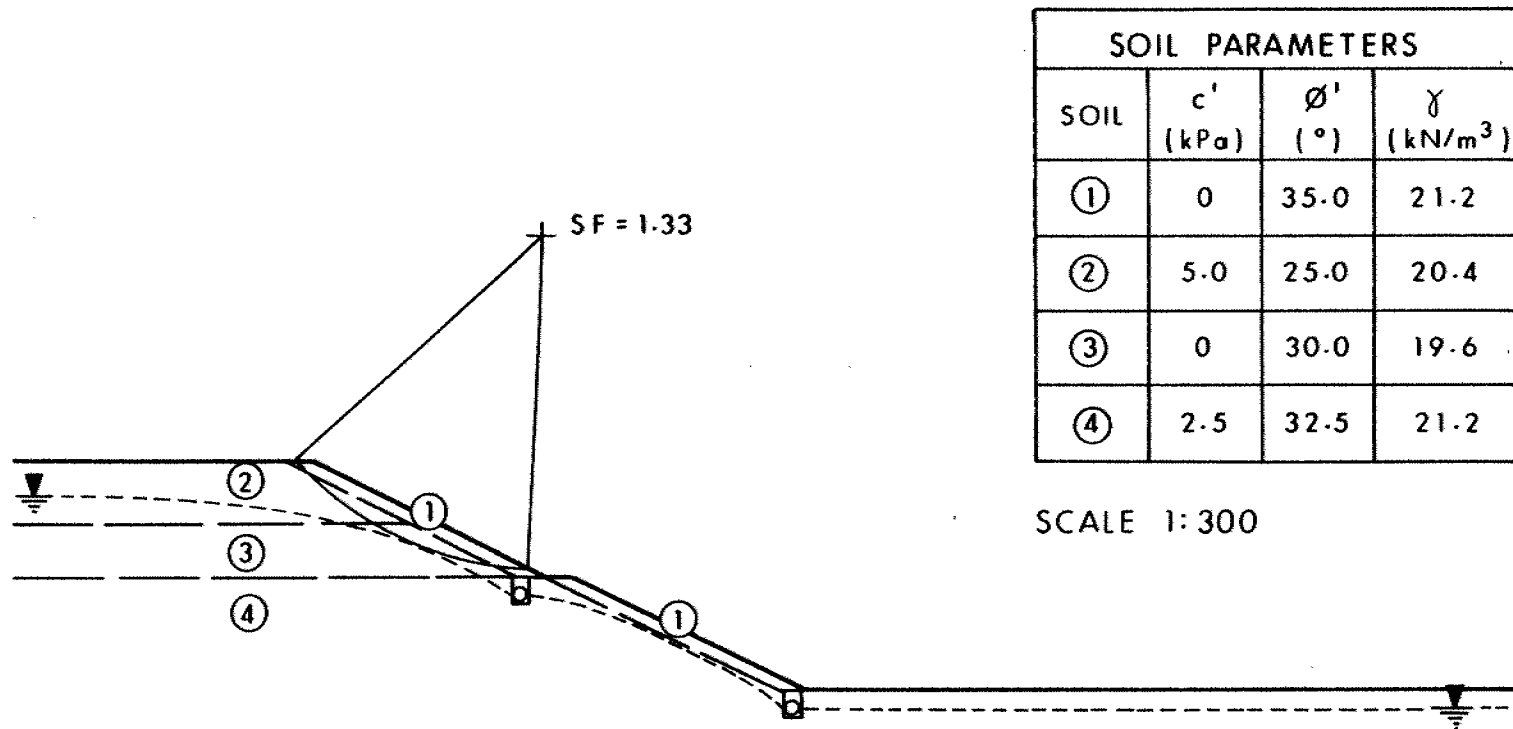


EFFECTIVE STRESS ANALYSIS (2.5H:1V SLOPE)

WITH 0.6m THICK GRANULAR BLANKET AND TOE DRAIN

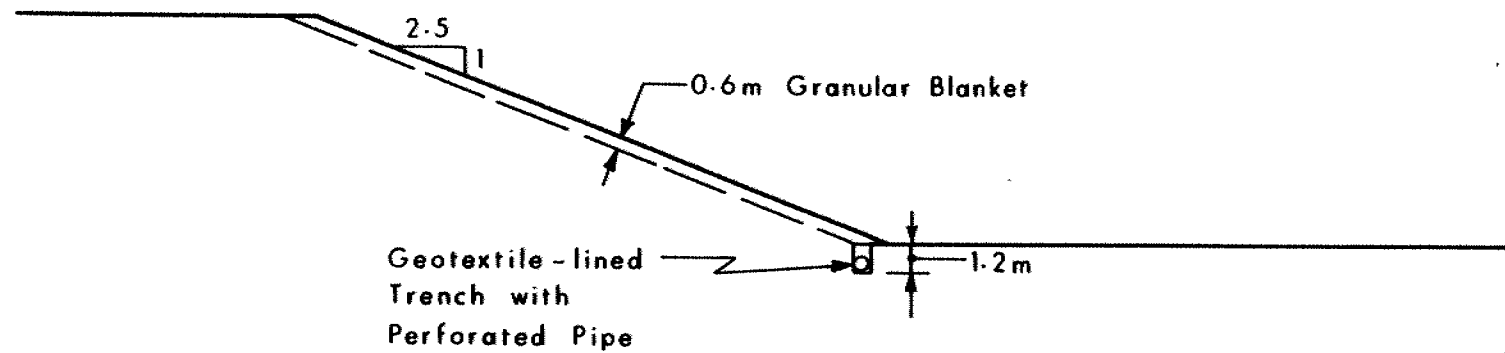
Fig 9

WP 137-87-03

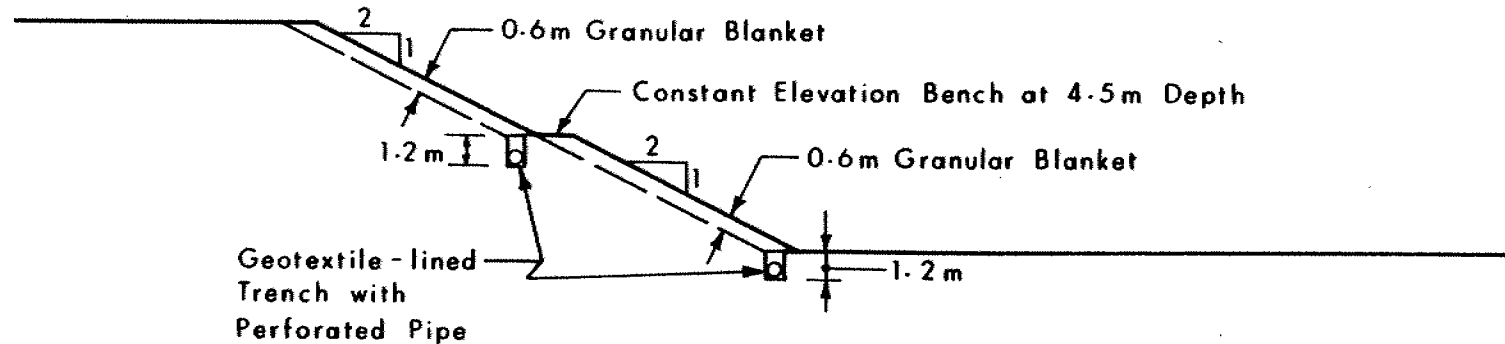


EFFECTIVE STRESS ANALYSIS (2H:1V SLOPE)
WITH 0.6m THICK GRANULAR BLANKET AND BENCH AND TOE DRAINS

Alternative No 1



Alternative No 2

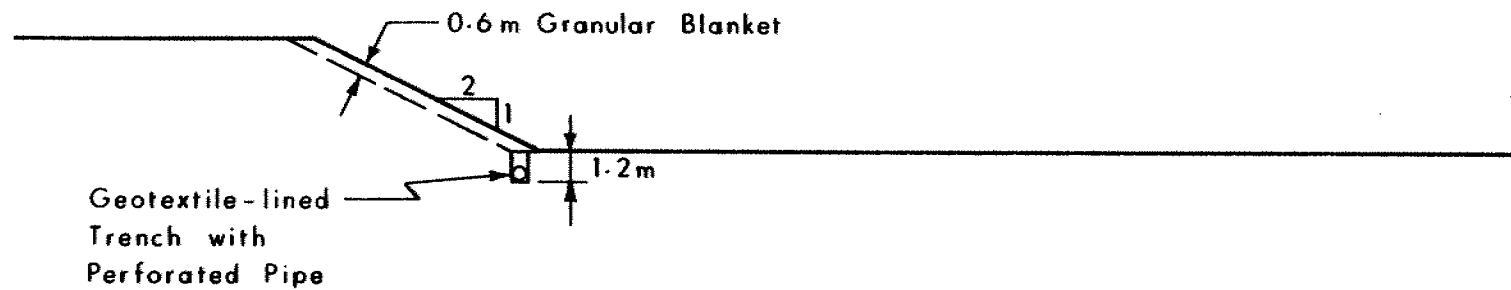


SCALE 1:300

RECOMMENDED CUT SLOPE TREATMENT FOR CUTS OVER 4.5m DEEP

Fig 11

WP 137-87-03

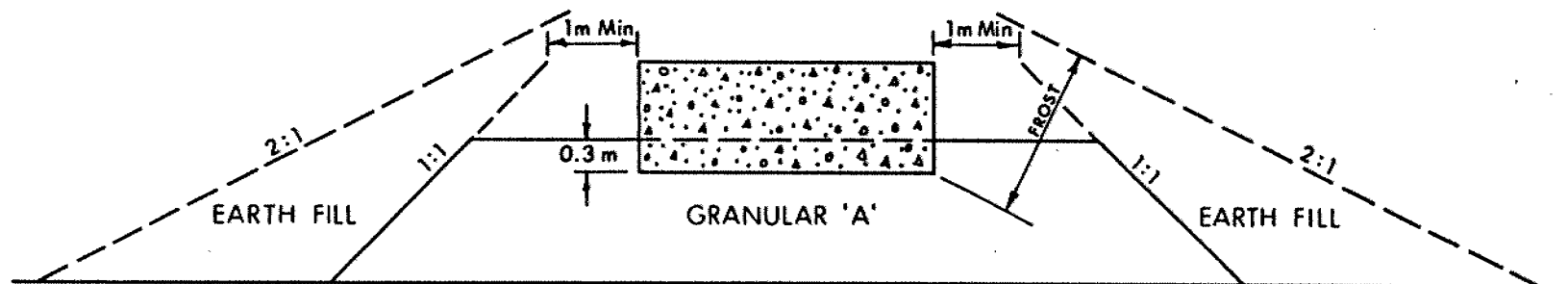


SCALE 1:300

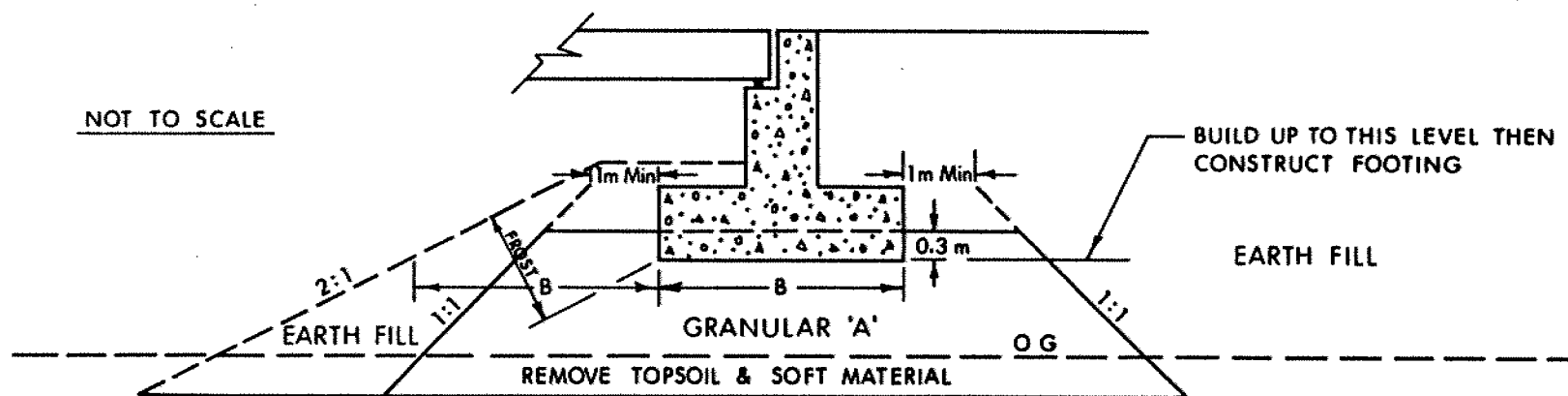
RECOMMENDED CUT SLOPE TREATMENT FOR CUTS UNDER 4.5 m DEEP

Fig 12

WP 137-87-03



X 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 C 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 13

WP 137-87-03

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

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



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-1

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 036.0; E 301 646.0 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 1987 11 16 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
192.8	Ground Surface											
0.0	Sand											
192.0	Compact (Fill)											
0.8	Clayey Silt		1	SS	9							
	Some Sand		2	SS	15							
	Trace Gravel		3	SS	16							
190.1	Stiff to Very Stiff (Glacial Till)		4	SS	37							
2.7			5	SS	32							
			6	SS	17							
	Silt/Clayey Silt		7	SS	14							
	Some Sand		8	SS	22							
	Trace Gravel		9	SS	23							
	Random Silt and Sand Pockets		10	SS	14							
	Occ. Boulders		11	SS	54							
	Compact to Very Dense Stiff to Hard (Glacial Till)		12	SS	50							
180.2												
12.6	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-2

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 026.5; E 301 659.0 ORIGINATED BY TS
DIST 6 HWY. 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 16 - 17 CHECKED BY MS

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	SHEAR STRENGTH						
191.8	Ground Surface														GR SA SI CL
0.0	Sand														
191.0	Compact (Fill)														
0.8	With Organics		1	SS	4										0 13 82 5
	Clayey Silt														
	Some Sand Trace Gravel		2	SS	18										0 2 90 8
189.7	Firm to Very Stiff														
	(Glacial Till)		3	SS	23										1 11 69 15
2.1	Silt														
	Compact		4	SS	20										
	(Lacustrine)		5	SS	22										
			6	SS	14										
			7	SS	34										
			8	SS	81										
	Silt/Clayey Silt														
	Some Sand		9	SS	79										0 67 32 1
	Trace Gravel														2 25 53 20
	Random Silt and														
	Sand Pockets														
	Occ. Boulders		10	SS	82										1 22 60 17
	Compact to Very Dense														
	Stiff to Hard		11	SS	76										0 0 32 68
	(Glacial Till)														
			12	SS	48										0 3 82 15
178.7															
13.1	Sand and Gravel		13	SS	80										
			14	SS	75										1 7 (92)
	Sand and Gravel		15	SS	100	25 cm									
	Silty Clay to Clay														
	With Thin Silt Seams		16	SS	110										
	Hard														
	(Lacustrine)														
171.5			17	SS	110										
20.3	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-3

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 039.5; E 301 662.0 ORIGINATED BY TS
DIST 6 HWY. 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 23 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
193.4	Ground Surface													
0.0	Sand													
192.6	Compact (Fill)													
0.8	Clayey Silt		1	SS	17		192							
	Some Sand		2	SS	16									
	Trace Gravel		3	SS	18									
	Stiff to Very Stiff (Glacial Till)		4	SS	29		190							
190.0			5	SS	48									
3.4	Silt		6	SS	42									
	Compact to Dense (Lacustrine)		7	SS	44		188							
			8	SS	77									6 14 63 17
	Silt/Clayey Silt		9	SS	72		186							
	Some Sand		10	SS	62									
	Trace Gravel		11	SS	60		184							
	Random Silt and Sand Pockets													
	Occ. Boulders						182							1 31 50 18
180.9	Dense to Very Dense/ Hard (Glacial Till)		12	SS	75									1 74 24 1
12.5			13	SS	92		180							
	Sand													
	Silty Clay to Clay With Thin Silt Seams													
	Hard (Lacustrine)		14	SS	110		178							
177.7														
15.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (% STRAIN AT FAILURE

RECORD OF BOREHOLE No 11-4

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 026.0; E 301 686.5 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 24 - 26 CHECKED BY MS

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					
193.1	Ground Surface													
0.0	Clayey Silt Some Sand Trace Gravel With Organics Stiff (Glacial Till)		1	SS	9	*	192							2 24 42 32
190.1			2	SS	16		190							4 39 56 1
3.0			3	SS	41									
	Sandy Silt to Silt Compact to Very Dense (Lacustrine)		4	SS	47		188							
			5	SS	52									
			6	SS	50									0 2 85 13
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense/ Very Stiff to Hard (Glacial Till)		7	SS	94		186							
			8	SS	100									
			9	SS	85		184							2 22 57 19
182.4			10	SS	110									
10.7			11	SS	70		182							0 15 75 10
	Silt to Sand Very Dense		12	SS	60		180							0 55 44 1
			13	SS	80									0 77 22 1
			14	SS	64		178							
			15	SS	14		176							1 50 44 5
	Silt to Sand Compact to Very Dense		16	SS	110									
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		17	SS	90	28 cm	174							
171.3			18	SS	80		172							
21.8	End of Borehole													
	* Groundwater Elevation Not Determined													

RECORD OF BOREHOLE No 11-5

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 007.0; E 301 735.5 ORIGINATED BY MS
DIST 6 HWY. 400/407 BOREHOLE TYPE H-S Auger COMPILED BY MS
DATUM Geodetic DATE 87 11 24 - 26 CHECKED BY MS

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							WATER CONTENT (%)	GR SA SI CL			
								SHEAR STRENGTH											
								○ UNCONFINED	+ FIELD VANE										
								● QUICK TRIAXIAL	x LAB VANE										
192.0	Ground Surface																		
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	24		190												
189.0			2	SS	34		188							0 22 73 5					
3.0	Silt Dense (Lacustrine)		3	SS	100		186							0 10 71 19					
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)		4	SS	60	10 cm	184							1 27 59 13					
			5	SS	90	8 cm	182												
			6	SS	90	15 cm	180												
181.0	Boulder		7	SS	120	0 cm	178							1 92 5 2					
11.0			8	SS	60	10 cm	176							1 92 6 1					
			9	SS	100	20 cm	174												
	Sand Very Dense		10	SS	100														
	Silty Clay to Clay		11	SS	100														
173.4	*																		
18.6	End of Borehole																		
	* With Thin Silt Seams Hard (Lacustrine)																		

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 11-6

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 848 982.0; E 301 777.5 ORIGINATED BY KZ
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY KZ
DATUM Geodetic DATE 1987 11 04 - 06 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%) 20 40 60					
194.6	Ground Surface													
0.0	Sand, Compact (Fill)						194							
193.1	Clayey Silt Some Sand Trace Gravel Stiff to Hard (Glacial Till)		1	SS	7		192							
1.5			2	SS	16									
			3	SS	47									
189.6	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)		4	SS	92	30 cm	190							4 38 45 13
5.0			5	SS	85		188							0 8 87 5
			6	SS	112	25 cm	186							1 18 65 16
			7	SS	105		184							
			8	SS	60	12 cm	182							
181.8			9	SS	59		180							
12.8			10	SS	43									
	Sand		11	SS	55		180							28 65 6 1
			12	SS	129	28 cm	178							9 84 5 2
			13	SS	123	28 cm	176							
			14	SS	114									
174.4	Silty Clay to Clay *		15	SS	165	20 cm								1 27 48 24
20.2	End of Borehole													
	* With Thin Silt Seams Hard (Lacustrine)													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-7

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 848 945.5; E 301 823.0 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 11 09 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH						WATER CONTENT (%) 20 40 60	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE							
192.1	Ground Surface															
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	19											
			2	SS	26											
189.4			3	SS	21											
2.7	Silt Very Dense (Lacustrine)		4	SS	66											
			5	SS	110	28 cm									2 13 76 9	
			6	SS	74											
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Very Dense/Hard (Glacial Till)		7	SS	103									1 21 62 16		
			8	SS	100	28 cm										
			9	SS	120	23 cm										
			10	SS	115	25 cm									0 3 96 1	
			11	SS	100										0 12 61 27	
180.2	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		12	SS	39											
11.9			13	SS	100	23 cm										
			14	SS	108	30 cm									6 25 49 20	
176.6	End of Borehole															
15.5																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11-8

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 848 928.5; E 301 848.5 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 09 CHECKED BY MS

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
								SHEAR STRENGTH							WATER CONTENT (%)		
							○ UNCONFINED	+ FIELD VANE									
							● QUICK TRIAXIAL	x LAB VANE									
192.4	Ground Surface													GR SA SI CL			
0.0	Clayey Silt Some Sand Trace Gravel Hard (Glacial Till)		1	SS	33												
			2	SS	70												
189.7			3	SS	34												
2.7	Silt to Sand Dense to Very Dense (Lacustrine)		4	SS	44									10 33 48 9			
			5	SS	33												
			6	SS	55										1 15 77 7		
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets		7	SS	41												
			8	SS	26										2 25 52 21		
			9	SS	100	23 cm									1 51 44 4		
	Silty Sand to Sandy Silt																
			10	SS	90	28 cm									3 58 33 6 0 39 52 9		
	Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)																
			11	SS	108										1 25 57 17		
180.2																	
12.2	Sand and Gravel		12	SS	97												
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)																
			13	SS	101	28 cm											
176.9			14	SS	98	23 cm											
15.5	End of Borehole																



Ministry of
Transportation and
Communications
Ontario

RECORD OF BOREHOLE No 11-9

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 848 919.5; E 301 839.0 ORIGINATED BY DD
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, H-S Auger COMPILED BY DD
DATUM Geodetic DATE 87 11 09 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
192.2	Ground Surface													
0.0	Clayey Silt Some Sand Trace Gravel Stiff to Hard (Glacial Till)		1	SS	44		192							
			2	SS	15		190							
189.5			3	SS	26									
2.7	Sandy Silt Compact to Very Dense (Lacustrine)		4	SS	26		188			CH				12 35 42 11
			5	SS	74					CH				2 16 76 6
			6	SS	84		186							
			7	SS	54		184							
			8	SS	66		182							
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense Very Stiff to Hard (Glacial Till)		9	SS	103/25 cm		180							1 20 64 15
			10	SS	110									
			11	SS	105/28 cm		178							
			12	SS	105									
178.2			13	SS	123/25 cm									6 32 51 11
14.0	Silty Clay to Clay *													
176.8			14	SS	100/13 cm									
15.4	End of Borehole													
	* With Thin Silt Seams Hard (Lacustrine)													

+3, x5: Numbers refer to Sensitivity 20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications

RECORD OF BOREHOLE No 11-10

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 848 913.0; E 301 853.0 ORIGINATED BY MS
DIST 6 HWY 400/407 BOREHOLE TYPE H-S Auger, Tricone COMPILED BY MS
DATUM Geodetic DATE 87 10 27 CHECKED BY MS

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									
								SHEAR STRENGTH									
192.0	Ground Surface														GR SA SI CL		
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff to Hard (Glacial Till)		1	SS	33												
			2	SS	37												
189.3			3	SS	22		190										
2.7			4	SS	31												
	Silt Very Dense (Lacustrine)		5	SS	53		188										
			6	SS	40												
			7	SS	42		186								2 22 62 14		
			8	SS	38												
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Dense to Very Dense/ Hard (Glacial Till)		9	SS	110	25 cm	184								3 35 52 10		
			10	SS	127	28 cm	182										
			11	SS	68												
180.1							180								3 79 17 1		
11.9	Sand		12	SS	110	30 cm											
	Silty Clay to Clay With Thin Silt Seams Hard (Lacustrine)		13	SS	110	15 cm	178										
176.6			14	SS	110	18 cm											
15.4	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

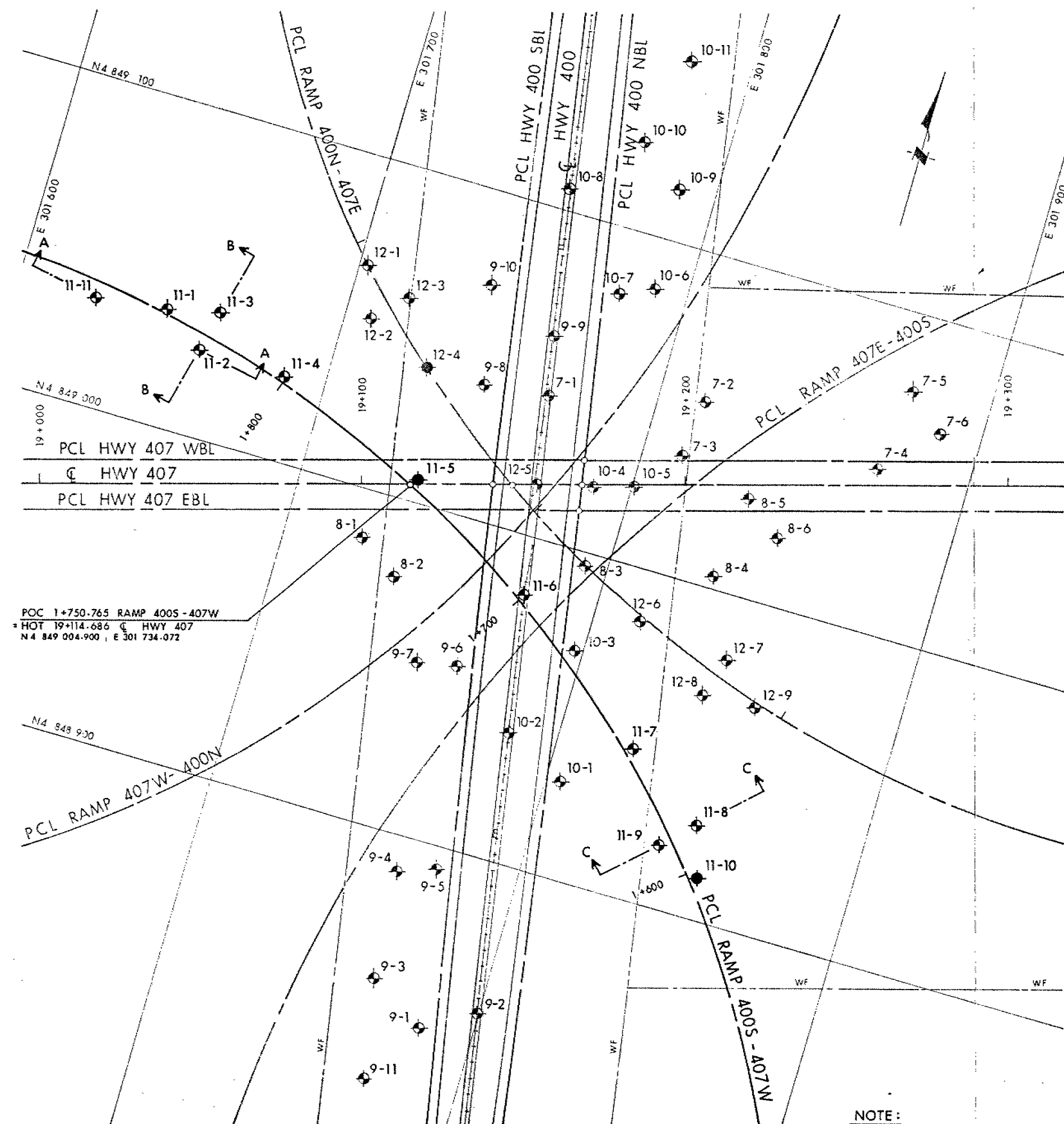
RECORD OF BOREHOLE No 11-11

METRIC

W P 137-87-03 LOCATION Co-ords. N 4 849 033.0; E 301 623.5 ORIGINATED BY TS
DIST 6 HWY 400/407 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY TS
DATUM Geodetic DATE 87 11 18 CHECKED BY MS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
192.9	Ground Surface							○ UNCONFINED + FIELD VANE						
0.0	Clayey Silt Some Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	29		192							
			2	SS	29									
190.6			3	SS	31		190							
2.3	Silt, Dense (lacustrine)		4	SS	50									
			5	SS	25									
			6	SS	54									
			7	SS	42		188							
			8	SS	43									
	Silt/Clayey Silt Some Sand Trace Gravel Random Silt and Sand Pockets Occ. Boulders Compact to Very Dense Very Stiff to Hard (Glacial Till)		9	SS	48		186							
			10	SS	52									
			11	SS	80		184							
180.3			12	SS	100	182								
12.6	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION



PLAN

SCALE

20m 10 0 10 20m

NOTE :

For Profile, Sections and
Subsoil Stratigraphy
refer to Dwg No 1378703-B

METRIC

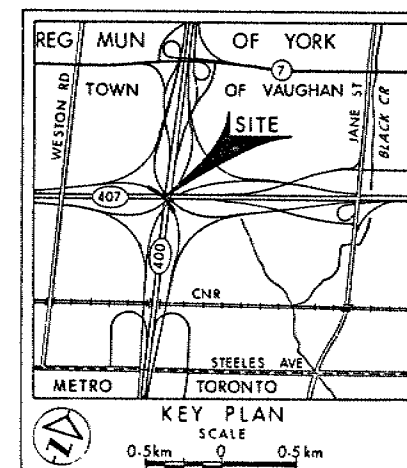
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 137-87-03





RAMP HWY 400S TO HWY 407W
(BRIDGE - 11)
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 |

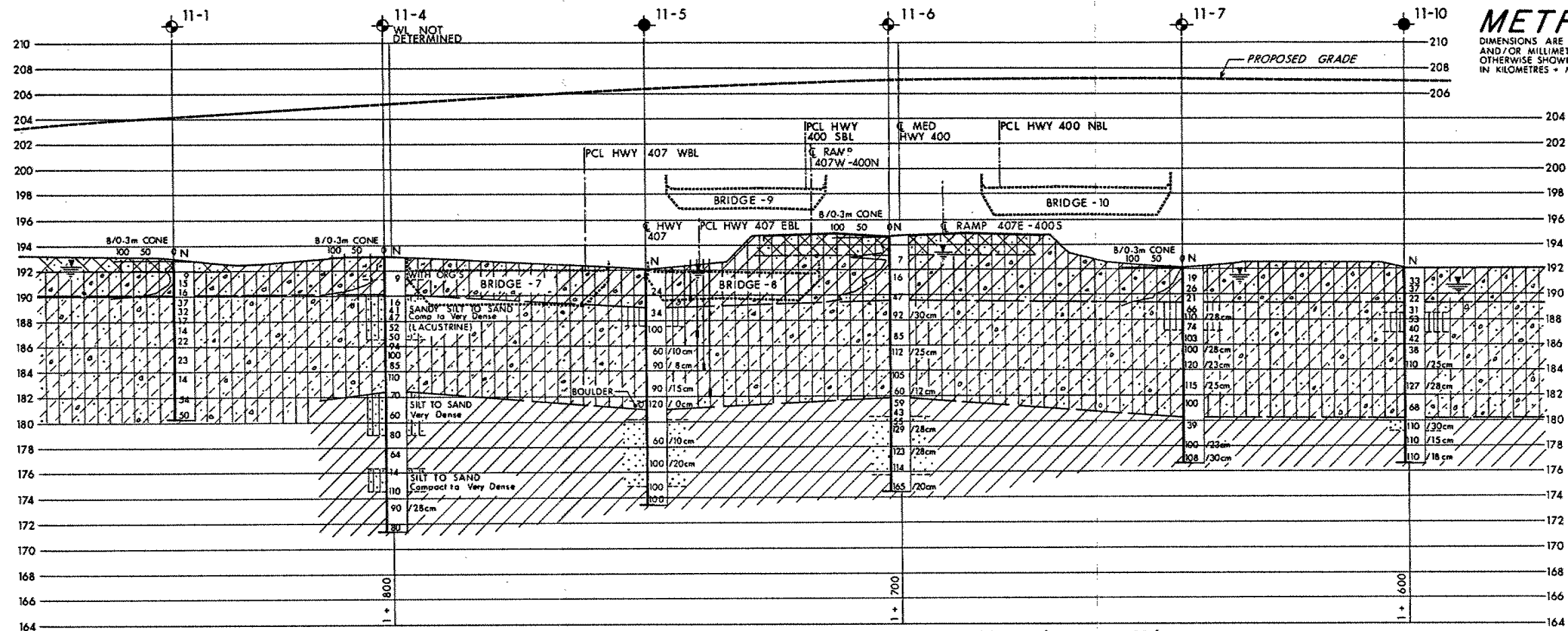
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
7-1	194.6	4 849 043.3	301 767.3
7-2	192.6	4 849 055.0	301 814.5
7-3	192.6	4 849 037.0	301 812.0
7-4	192.3	4 849 050.0	301 871.5
7-5	192.3	4 849 076.0	301 875.5
7-6	192.3	4 849 066.0	301 887.5
8-1	192.8	4 848 985.0	301 724.0
8-2	192.2	4 848 976.0	301 737.0
8-3	194.6	4 848 995.7	301 793.0
8-4	192.6	4 849 004.0	301 832.0
8-5	192.5	4 849 030.0	301 836.0
8-6	192.4	4 849 021.0	301 848.0
9-1	194.3	4 848 844.3	301 782.9
9-2	194.3	4 848 853.7	301 799.0
9-3	191.6	4 848 855.5	301 765.5
9-4	191.8	4 848 889.0	301 763.0
9-5	194.4	4 848 893.0	301 774.5
9-6	194.6	4 848 955.0	301 763.1
9-7	191.9	4 848 952.5	301 751.0
9-8	194.6	4 849 040.7	301 747.0
9-9	194.6	4 849 061.7	301 764.0
9-10	194.6	4 849 071.3	301 740.9
9-11	191.5	4 848 825.0	301 771.0
10-1	194.0	4 848 929.9	301 804.4
10-2	194.5	4 848 939.9	301 784.6
10-3	194.6	4 848 969.8	301 797.3
10-4	194.6	4 849 020.0	301 788.6
10-5	192.6	4 849 023.5	301 800.5
10-6	192.8	4 849 084.0	301 789.5
10-7	194.5	4 849 079.7	301 779.2
10-8	194.4	4 849 106.9	301 755.8
10-9	192.1	4 849 116.0	301 788.0
10-10	194.3	4 849 127.0	301 773.5
10-11	191.8	4 849 155.0	301 780.5
11-1	192.8	4 849 036.0	301 646.0
11-2	191.8	4 849 026.5	301 659.0
11-3	193.4	4 849 039.5	301 662.0
11-4	193.1	4 849 026.0	301 686.5
11-5	192.0	4 849 007.0	301 735.5
11-6	194.6	4 848 982.0	301 777.5
11-7	192.1	4 848 945.5	301 823.0
11-8	192.4	4 848 928.5	301 848.5
11-9	192.2	4 848 919.5	301 839.0
11-10	192.0	4 848 913.0	301 853.0
11-11	192.9	4 849 033.0	301 623.5
12-1	193.3	4 849 066.5	301 702.5
12-2	193.4	4 849 051.0	301 708.0
12-3	193.5	4 849 060.0	301 717.5
12-4	192.2	4 849 041.0	301 728.5
12-5	194.6	4 849 016.0	301 771.8
12-6	192.4	4 848 984.0	301 814.0
12-7	192.4	4 848 980.0	301 843.5
12-8	192.7	4 848 967.5	301 839.0
12-9	192.3	4 848 968.5	301 856.0

NOTE

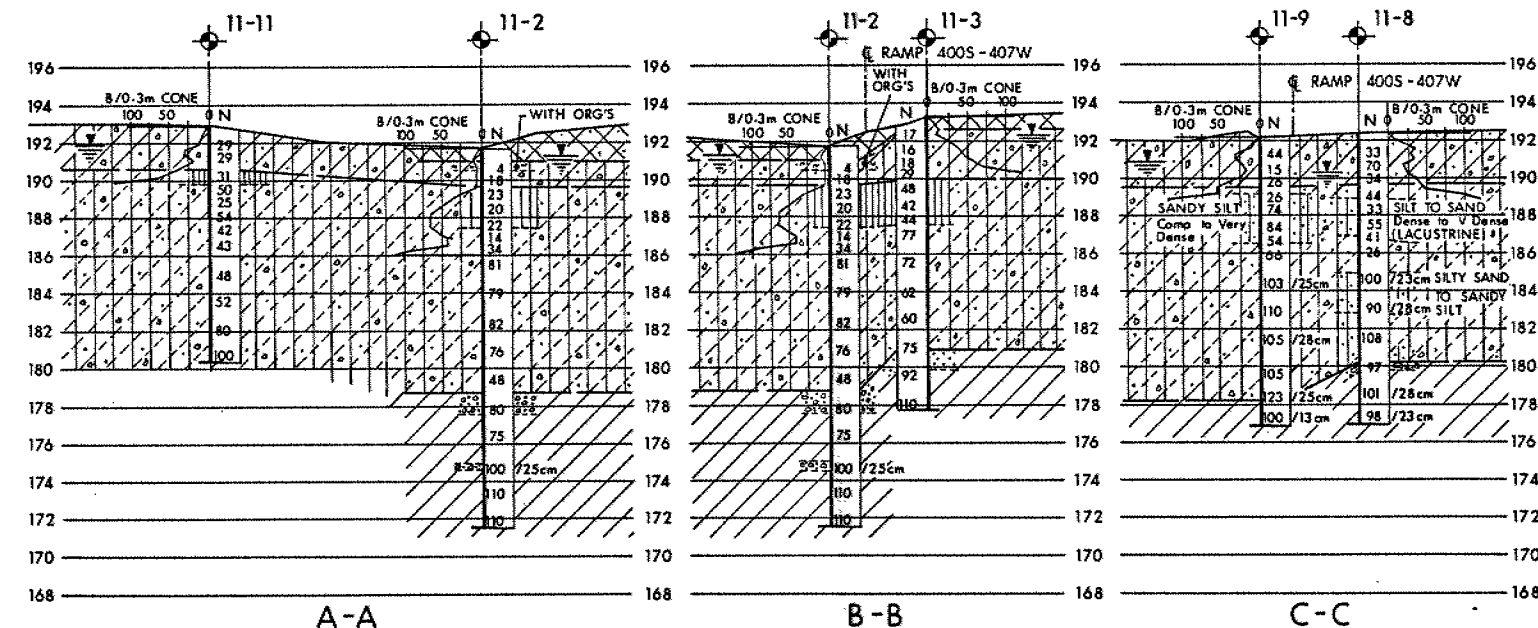
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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 02-2 of Form 100.

REV				
DATE	BY	DESCRIPTION		
Geocres No 30M13-73				
HWY No 400 & 407			DIST 0	
SUBMD DD	CHECKED	DATE 1988 02 22	SITE 37 - 1175	
DRAWN DT	CHECKED	APPROVED	DWG1378703-A	



PROFILE CONTROL LINE RAMP HWY 400S TO HWY 407W (BRIDGE-11)



SECTIONS

SCALE
10m 5 0 10m Hor
4m 2 0 4m Vert

SOIL STRATIGRAPHY LEGEND

	SAND (FILL) Compact		SILT Compact to Very Dense (LACUSTRINE)
	CLAYEY SILT SOME SAND, TRACE GRAVEL Firm to Hard (GLACIAL TILL)		SAND Very Dense (LACUSTRINE)
	SILT / CLAYEY SILT SOME SAND, TRACE GRAVEL RANDOM SILT & SAND POCKETS OCCASIONAL BOULDERS Compact to Very Dense/ Stiff to Hard (GLACIAL TILL)		SAND & GRAVEL (LACUSTRINE)
	SILTY CLAY TO CLAY WITH THIN SILT SEAMS Very Stiff to Hard (LACUSTRINE)		

CONT No
WP No 137-87-03

RAMP HWY 400S TO HWY 407W
(BRIDGE - 11)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

SEE DWG 1378703-A

KEY PLAN
SCALE

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)
- WL at time of investigation
87 10 and 87 11
- WL in Piezometer
- Piezometer

No	ELEVATION	CO-ORDINATES NORTH	EAST
11-1	192.8	4 849 036.0	301 646.0
11-2	191.8	4 849 026.5	301 659.0
11-3	193.4	4 849 039.5	301 662.0
11-4	193.1	4 849 026.0	301 686.5
11-5	192.0	4 849 007.0	301 735.5
11-6	194.6	4 848 982.0	301 777.5
11-7	192.1	4 848 945.5	301 823.0
11-8	192.4	4 848 928.5	301 848.5
11-9	192.2	4 848 919.5	301 839.0
11-10	192.0	4 848 913.0	301 853.0
11-11	192.9	4 849 033.0	301 623.5

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.

Note:

For Plan Refer to
Dwg No 1378703-A

REV.	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			
61			
62			
63			
64			
65			
66			
67			
68			
69			
70			
71			
72			
73			
74			
75			
76			
77			
78			
79			
80			
81			
82			
83			
84			
85			
86			
87			
88			
89			
90			
91			
92			
93			
94			
95			
96			
97			
98			
99			
100			

Geocres No 30M13-73

HWY No. 400 & 407	DIST 6
SUBWD DD CHECKED	DATE 88 02 24
DRAWN DT CHECKED	DATE 88 02 24
	SITE 37-1175
	DWG 1378703-B