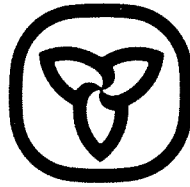


GO-T RANSIT



Ontario

GGE - 310

C N YORK SUBDIVISION
STRUCTURE AND CULVERTS

foundation investigation and design report

L.H. PARSONS - CHAIRMAN

A.F. LEACH - MANAGING DIRECTOR

PICKERING-WHITBY SECTION

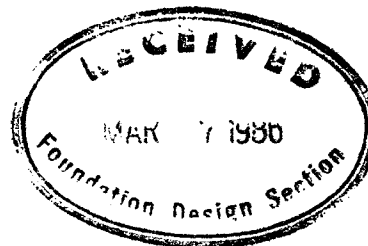
ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

GGE-310 DIST 6
HWY 40 TRANSIT STR SITE

FOUNDATION INVESTIGATION
PROPOSED GRADE SEPARATION
CNR EMBANKMENT
PICKERING, ONTARIO

DISTRIBUTION

J.B. Ashbee (3)
G.C.E. Burkhardt (1)
J. Lyle (3)
T. Kazmierowski (1)
W. Lin (1)
C. Watson (2)
T. Yakutchik (1)
CNR (1)
File Copy (1)





CONTENTS

	<u>Page #:</u>
1.0 INTRODUCTION	1
2.0 PHYSIOGRAPHY	3
3.0 SUBSURFACE CONDITIONS	4
3.1 General	4
3.2 Fill	5
3.3 Topsoil	5
3.4 Organic Silty Clay	5
3.5 Silty Clay	7
3.6 Glacial Till	7
3.7 Sand	10
3.8 Shale Bedrock	11
3.9 Groundwater Conditions	12
4.0 DISCUSSION	14
4.1 The Project	14
4.2 The Bridge & Retaining Walls	15
4.2.1 Foundations	16
4.2.2 Lateral Earth Pressures	18
4.2.3 Anchor Design	20
4.2.4 Construction	21
4.3 Culverts	22
4.3.1 Proposed Culvert at Sta. 9+850	22
4.3.2 Proposed Culvert at Sta. 9+375	27
4.3.3 Proposed Culvert at Dunbarton Creek Crossing	28
5.0 CLOSURE	36



APPENDICES

Explanation of Terms Used in Report

Procedures

Limitations of Report

ENCLOSURES

RECORD OF BOREHOLE LOG SHEETS

GRAIN SIZE DISTRIBUTION CURVES

Figs. 1 & 2

PLASTICITY CHARTS

Figs. 3 & 4

VOID RATIO - PRESSURE CURVES

Fig. 5

MEASURED UNDRAINED SHEAR STRENGTH
OF ORGANIC SOILS VS ELEVATION

Fig. 6

GRAIN SIZE DISTRIBUTION CURVES

Figs. 7 - 10
inclusive

DRAWING NO. GGE-310-A

Dwg. No. 1

DRAWING NO. GGE-310-B

Dwg. No. 2

**1.0 INTRODUCTION**

This report describes the results of a foundation investigation carried out at the site of a proposed grade separation at the C.N.R. Embankment (Mile 1.92, York Subdivision) between Whites Road and Liverpool Road in Pickering, Ontario.

The investigation was authorized by GO Transit and the investigation was conducted under the technical direction of the Foundation Design Section of the Ontario Ministry of Transportation and Communications.

In connection with the installation of the proposed new GO Commuter lines the construction of an approximately 40 m long single span bridge will be required where the new tracks will cut through the existing C.N.R. Embankment. As the new bridge will be built at a skew, the construction of retaining walls of considerable length is also required on the north-east and south-west sides of the grade separation. An earlier investigation carried out in 1983 for this project was reported under our Reference No. 83-9-16, dated November, 1983. The present investigation consisted of drilling additional and deeper boreholes for the proposed grade separation. In addition, boreholes were drilled for two proposed culverts on the east side of the proposed bridge site and one on the west at the Dunbarton Creek crossing.

... / ...



The purpose of this investigation has been to determine the subsurface conditions at the site and, based on the findings, to make recommendations pertaining to the geotechnical design of the foundations of the proposed bridge, retaining walls, the associated temporary works and the proposed culverts.

The drilling programme, which was carried out during the period of December 4, 1985 to January 15, 1986, consisted of drilling five boreholes (Boreholes 103 to 107, inclusive) to depths ranging between 9.1 and 14.3 m below the ground surface at the site of the proposed bridge and the associated retaining walls; and six boreholes (Boreholes 101, 102, 102A, 108, 109 and 110) to depths ranging between 4.1 and 11.4 m at the proposed culvert locations. The locations of the Boreholes drilled at the grade separation and the adjoining culvert site along with the stratigraphic sections, are shown on Drawings GGE-310A. The locations of Boreholes at the Dunbarton Creek site and of those at the most easterly culvert site together with accompanying stratigraphic sections, are presented on Drawing GGE-310 B. The subsurface conditions encountered are presented on the Record of Borehole Sheets.

The logs of boreholes from the previous investigation (Boreholes 1 through 9, Reference No. 83-9-16) as well as logs of Boreholes G-3, G-5, G-6 and G-7 drilled for the construction of the Go-Transit Embankment across the Dunbarton Creek Valley (Reference No. 85-12-8) have also been included.

... / ...

**2.0 PHYSIOGRAPHY**

The site is located immediately north of Frenchman Bay, on the south side of the eastbound 401 Highway. The site drainage is accomplished by the Dunbarton Creek and several other smaller water courses flowing into Frenchman Bay. Along Dunbarton Creek, swampy conditions exist indicating the presence of organic soils.

Geologically, the Pickering/Ajax area is located on a drumlinized till sheet which, following the retreat of the last Wisconsinan Glacier, was inundated by Lake Iroquois, the forerunner of the present Lake Ontario. During this lacustrine environment, stratified silt and clay deposits were laid down in the depressions between the drumlin hills. Surficially these were further modified by man-made fill deposits and in the valleys of the creeks and rivers, by recent alluvial deposits. The lacustrine deposits are underlain by a glacially deposited interlobate moraine sheet consisting of silty clay to silty sand till which, in turn, is underlain by the Paleozoic shale bedrock of the Ordovician Period.

... / ...



3.0 SUBSURFACE CONDITIONS

3.1 General

The site is intermittently covered with fill materials; the uppermost native soil stratum throughout most of the site is a 1 to 2 m thick layer of silty clay which is underlain by glacial till deposits over the shale bedrock at depths generally ranging between 5 and 9 m. There is a transition zone from the overlying till into the bedrock which contains very frequent shale fragments and rock slabs and which therefore highly resembles a weathered shale bedrock. The overlying till has variable composition ranging from silty sand to silty clay and this stratum frequently contains shale fragments. While these till deposits are generally competent materials, there are zones within the till where the material is weak. The till is also interbedded with sand and silty sand layers or lenses. In addition, deep deposits of organic soils were encountered in the vicinity of Dunbarton Creek.

Details of the subsurface conditions encountered in the boreholes are shown on the Record of Borehole Sheets and the stratigraphic sections are presented on Drawings Nos. GGE 310-A and B. The individual strata are discussed in the following paragraphs.

... / ...



3.2 Fill

Fill was encountered in the majority of the boreholes extending to depths ranging between 0.7 and 4.1 m below the ground surface. The fill, which was probably deposited at the time when the existing railway embankments were built, is generally comprised of silty clay which, at some locations, is mixed with organic soil.

3.3 Topsoil

The majority of the boreholes encountered topsoil ranging in thickness from 0.1 to 0.2 m except that at the location of Boreholes 109 and 110 where an old 0.6 m thick topsoil layer was encountered underlying fill 0.7 m below the ground surface.

3.4 Organic Silty Clay

Deep deposits of organic soils were encountered in Boreholes 101, 102 and 102A drilled near the Dunbarton Creek. These boreholes and others drilled in the area (Reference No. 85-12-8), indicate that the organic deposits extend to maximum depths ranging between 4 and 5 m and gradually taper up to near the ground surface with increasing distance from the Creek; nominal thickness of organic cover occurs at distances of about 65 m west and 20 m east and greater, away from the culvert existing under the CNR embankment. A relatively thin layer of somewhat organic silty clay was also encountered in Borehole 104, indicating the presence of sporadic pockets of organic soils elsewhere at the site.

... / ...



These materials consist of organic silts with sufficient colloidal sized particles to impart to the soil a basically cohesive character. The organic content of the soil varies from low to high and the deposit also contains zones or layers of peat. Atterberg Limit tests gave Liquid Limit values of 29 to 52% with corresponding plasticity indices of 6 to 18, indicating organic silts of low to high plasticity (OL-OH, Fig. 3). The measured moisture contents of samples of the organic silt range from 30 to 75%; moisture contents of 140 to 173% were recorded on samples from the peat zones.

'N'-values of 1 to 10 blows/0.3 m were recorded in these materials. Field vane tests gave undrained in situ shear strengths of 18 to 71 kPa and undrained (quick) triaxial tests performed in the laboratory yielded undrained shear strengths of 29 to 31 kPa. A summary of measured undrained shear strengths is presented in Figure 6. From these field and laboratory test results, together with a visual examination of the soil samples, the consistency of these organic soils is described as 'very soft' to 'stiff'.

To determine the compressibility characteristics of the material a consolidation test was carried out on a sample from the organic silty clay, and one test was carried out on the peat. The results, presented in Figure 5, indicate that both materials and especially the peat, are highly compressible. In addition, because of their organic structure, they can be expected to

... / ...



undergo very long term settlements after the completion of the primary consolidation. This is due to a phenomenon known as 'Secondary Consolidation' which continues after the dissipation of excess pore pressures has been completed.

3.5 Silty Clay

In general, below the topsoil and fill, the uppermost natural soil stratum consists of a light brown silty clay deposit. This deposit is generally 1 to 2 m thick and, in some of the borehole locations, it has a varved-like structure consisting of alternating relatively thicker seams of lean silty clay and relatively thinner heavy (fat) clay. The measured liquid and plastic limits (Reference 83-9-16) are in the range of 34 and 37% and 17 to 19%, respectively, and the measured moisture contents are 14 to 31%. The wide range of moisture contents reflects the variable shear strength of the deposit and, based on 'N'-values generally ranging between 7 and 35 blows/0.3 m, the consistency of the deposit is described as 'firm' to 'hard'.

3.6 Glacial Till

Underlying the silty clay, the predominant overburden type consists of glacial till deposits of variable composition ranging from silty clay with some sand and gravel to silty sand with some gravel and traces of clay. In general, however, the till is relatively coarse, as indicated by the grain size

... / ...



distribution curves presented in Figures 1 and 2, and 9 and 10, which show the following range of grain size distribution:

Gravel Sizes	-	2 to 38%
Sand Sizes	-	37 to 66%
Silt Sizes	-	12 to 30%
Clay Sizes	-	0 to 10%

Atterberg Limit tests (7 tests) gave the following values:

Liquid Limit	-	18 - 29%
Plastic Limit	-	10 - 14%
Plasticity Index	-	6 - 18

These results, together with a visual examination of the soil samples, show that even a small percentage of very fine (clay) sized particles (e.g. greater than 6%) imparts to the material a sufficiently high plasticity to bring its behaviour close to a cohesive soil; where the clay fraction is sufficiently high (i.e. 10% or more), the soil becomes a predominantly cohesive material. It is also believed that the disintegration of the shale fragments in these till materials leads to an increase in the amount of soil fines and degree of cohesion. Due to these, the composition of these materials varies quite considerably and in many cases leads to descriptions such as 'sandy clay till', 'silty sand till with some clay', etc.

In general, the shale content of these materials increases towards the surface of the bedrock and the material closely resembles the underlying

... / ...



shale. In many cases, based solely on a visual examination of recovered samples, the material is practically indistinguishable from a highly weathered shale. This makes the selection of the interface elevation between the till and the highly weathered bedrock somewhat subjective or even arbitrary, especially where the overburden strata include slabs of shale.

In general, these till deposits are dense to very dense where the material is basically granular, or they are hard where the till is cohesive, as evidenced by 'N'-values generally greater than 30 blows/0.3 m. There are, however, significantly weaker zones included in the till stratum, these zones being illustrated by several 'N'-values of less than 6 and in one case 1 to 2 blows/0.3 m (Borehole 106). These zones are believed to represent 're-worked' or so called 'water laid' ablation tills associated with glacio-fluvial activity and such zones were encountered at various borehole locations, and in particular at Boreholes 5 and 106. The occurrence of such 'weak pockets' in the glacial tills has been noted in the Oshawa/Pickering area bordering Lake Ontario by Dominion Soil Investigation Inc. and others. In many cases, the distribution of these zones is irregular, and therefore no accurate delineation can be made.

Where the till is coarse (i.e. silty sand) loosening and/or boiling of the material could possibly occur in excavations extending below the water table and may thus require stabilizing measures.

... / ...



3.7 Sand

Sand and silty sand layers were encountered beneath the organic soil deposits in the area of Dunbarton Creek at Borehole 101, and in several other boreholes drilled in the same area (Reference 85-12-8). At these locations the surface of the sand is 3.3 to more than 4 m below the ground surface and the deposit is 0.5 to more than 2 m thick. The grain size distribution of a sample from this area is presented on Figure 7 and from 'N'-values of generally 20 to 70 blows/0.3 m, the material is considered as 'compact' to 'very dense'.

Immediately east of the existing bridge at Boreholes 104, 2 and 106, is another area underlain by sand and silty sand layers within the till. At these borehole locations the sand was encountered at depths ranging between 5.3 and 6.7 m and is 1 to 3 m thick.

Further east, silty sand was encountered at Boreholes 7, 107, 8 and 9 closer to the ground surface immediately underlying the clay cap, i.e. at depths of 2 to 3 m below the ground surface. At these locations the thickness of the sand layers ranges from 1 to 3 m and the material is generally in the fine sand particle size range with some silt content. The grain size distribution curves for several samples are shown on Figure 8. From 'N'-values, which generally range from 30 to 50 blows/0.3 m, the sand is considered to be 'dense'.

... / ...



These soils are susceptible to boiling (i.e. unstable, quick-sand like conditions due to upward seepage gradient) in excavations extending below the water table and may need to be stabilized by dewatering methods.

3.8 Shale Bedrock

A lower transition zone from till to shale, frequently referred to as 'Till-Shale Complex' was identified at elevations ranging between 73 and 71 m at the extreme east and west ends of the project (i.e. at Boreholes 101, 102, 109 and 110) and between 77 and 74 m at the remaining borehole locations. This zone, which represents a glacial till deposit with very frequent shale fragments or slabs or an extremely weathered shale at the surface of the bedrock, generally lies between Elevations 75 and 76 m at the grade separation site.

The rock, which was cored in eight of the boreholes to depths ranging between 0.9 and 5.5 m, consists of grey to dark grey shale which is a part of the Paleozoic 'Whitby' formation of the Ordovician division. Within the upper weathered zone the measured R.Q.D. values of the rock cores are generally very low in the range 0 to 34%, which indicates a poor quality rock. From a visual examination highly weathered zones in the rock and clay seams are common. At the proposed grade separation site (Boreholes 103 through 107), these weathered zones generally extend to an average elevation of

... / ...



between 74.5 and 74 m but the zone of weathered material extends to greater depth at the location of Borehole 104. Below the upper weathered zone, the rock is relatively sound and three relatively intact core samples, which were tested in unconfined compression, gave compressive strength values of 46 to 82 MPa. It should, however, be noted that these rock samples were chosen from the intact, sound portion of the recovered cores and should be considered to be the upper limit for the strength range.

3.9 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling and in the open boreholes after their completion. To enable us to monitor groundwater levels for a prolonged period of time, piezometers were installed in eight of the eleven boreholes drilled for the present investigation.

The recorded water levels shown on the Borehole Logs indicate that the water levels at the structure site (i.e. Boreholes 103 to 107 for the present investigation and Boreholes 1 to 8 of the previous investigation) were generally at about Elevation 80 m except where sand layers were penetrated. Piezometers installed in Boreholes 2, 104, 106 and 107, where sand layers were encountered, recorded water levels ranging between Elevations of 81.1 and 81.7 m, that is, about 1 to 1.5 m higher than the levels recorded in the other boreholes. From this it would appear that the sand deposits are

... / ...



generally under a slight subartesian pressure. The water levels will also be subject to seasonal fluctuations.

At the creek locations (Boreholes 101, 102, 108, 109 and 110), the water levels were generally recorded within a depth of about 0.6 and 1.5 m below the ground surface; at these locations the water level will normally be controlled by the prevailing water level in the creek. It is, however, of interest that a slight artesian condition was recorded in December in the piezometer installed in Borehole 108 and this subsequently dropped to slightly below the ground surface in January, 1986. Furthermore, a slight artesian condition was also observed in Borehole 109 at a depth of about 10 m while drilling. The piezometer installed in this borehole showed water levels below the ground surface in December but subsequently rose to 0.9 m above the ground surface in January.

... / ...



4.0 DISCUSSION

4.1 The Project

West of Liverpool Road the proposed alignment for the GO Transit track is located south of Highway 401 and north of the existing CNR embankment. About halfway between Liverpool Road and Whites Road the CNR embankment makes a bend towards the north and a steel girder bridge carries the railway over the Highway. Immediately east of the existing bridge, the new GO Transit line will cut through the CNR embankment and this will necessitate the construction of a new plate girder bridge. The new bridge will carry the existing CN tracks and at the same time new abutment walls will be constructed for future widening of the bridge for a second CN track. As the centreline of the new GO Transit corridor and the existing CN embankment meet at a skew angle of about 23° , the new bridge will span approximately 40 m at the location of the existing CN tracks and a span of 47 m will be provided for the future CN north tracks.

The grade separation will also necessitate construction of an approximately 80 m long retaining wall to the east of the new bridge abutments in order to support the north side of the existing CN embankment and an approximately 30 m long retaining wall on the west side to support the south side slope of the existing embankment.

... / ...



In addition, the project will entail the construction of three new culverts, two of which are to be located east of the new grade separation and one to the west at the Dunbarton Creek crossing.

4.2 The Bridge and Retaining Walls

A preliminary geotechnical investigation carried out at the site in 1983 showed the presence of weak zones in the overburden. In view of the anticipated heavy abutment foundation loads and because of problems which could occur in dewatering soils to facilitate construction, the use of steel H-piles driven to refusal on shale bedrock was recommended to support the bridge foundations.

As presently proposed, the method of construction of the new bridge will be by temporarily replacing sections of the embankment at the proposed abutment locations by a trestle-type steel structure supported by driven H-piles. These will allow the support of the railway tracks along an approximately 10 m opening on girders, which will permit the excavation of the existing embankment in between temporary retaining structures. Once the abutments are built, sections of the embankment in between the abutment locations will also be excavated allowing the rapid construction of the bridge deck, thus facilitating the construction with the least disruption of the existing CN traffic. As mentioned before because of the skew angle, an approximately 80 m long permanent retaining wall will have to be built on the north-east side

... / ...



of the existing embankment beyond the normal wing walls, as well as a 30 m long section on the south-west side to safely retain the present grade. Both the temporary retaining bulkheads and portions of permanent retaining walls will be tied back into the shale bedrock using rock anchors.

4.2.1 Foundations

Due to the presence of randomly distributed weak zones in the till and water bearing sand strata in several of the boreholes, it is our opinion that the use of spread footing foundations using the relatively high soil bearing pressures required for this project is not feasible at the site. The structure should therefore be supported on deep foundations resting on the competent strata underlying the weak zones.

Due to the presence of water bearing granular soils (some under subartesian pressure), the use of bored and cast-in-place concrete piles (caissons) is not considered to be an economical choice; these are likely to encounter construction difficulties in some areas and may require the installation of permanent liners. On the other hand, in many places, driven pile lengths will be short and the presence of shale fragments and slabs in the soils overlying the bedrock will cause difficult driving conditions. These will render the penetration of steel tube and especially timber piles difficult and may lead to damage in the case of timber piles. For these reasons, the use of end-bearing steel H-piles driven to the surface of the relatively sound bedrock is recommended.

... /...



To enable sufficient penetration of the piles into the competent bearing stratum through the overlying soils containing rock fragments and slabs and the highly weathered zones of the bedrock, we recommend the use of heavy sections and that the pile tips be reinforced with a cast steel shoe. Unbalanced horizontal forces carried by the foundations should be resisted by battered piles. For frost protection, the underside of the pile caps should be established at least 1.2 m below the finished grade. The estimated pile tip elevations at the borehole locations and estimated pile load carrying capacity are tabulated separately below.

Estimated Pile Tip Elevations

<u>B.H. No.</u>	<u>Probable Pile Tip Elevation (m)</u>
103	74.5
104	74.0
105	74.5
106	74.5
107	76.0
108	77.0

... / ...



Estimated Pile Capacity Using OHBDC Method(kN)

<u>Pile Type</u>	<u>Size</u>	<u>Factored Capacity at Ultimate Limit States (Qf)</u>	<u>Capacity at Serviceability Limit States - Type II (Qs)</u>
Steel H	HP310x110	1600	1150
	HP310x79	1150	830

Using the working stress method of design the safe (working) capacity can be taken as 1150 kN for HP 310 x 110 and 830 kN for HP 310 x 79 section piles. In view of the necessity to achieve adequate penetration of the pile through shale slabs embedded in the till and into the upper horizons of the bedrock stratum, it is important that a relatively heavy driving hammer (such as a D-22) be used, and it is recommended that a hammer with an energy rating of 40 000 Joules/blow be taken as a minimum for this project.

4.2.2 Lateral Earth Pressures

Assuming that compacted free-draining granular materials and adequate drainage are provided behind the abutments and retaining walls, earth pressures can be calculated in accordance with Section 6.6.1.2 of the O.H.B.D.C.

For design purposes, the following physical properties of the compacted backfill should be used:

... /...



<u>Material</u>	<u>Angle of Internal Friction, ϕ</u>	<u>Unit Weight, γ</u>
Granular 'A'	35°	22.0 kN/m ³
Granular 'B'	30°	21.2 kN/m ³

For retaining walls which can tolerate an angular rotation of up to about 1/500 the active condition applies. Rigid abutment walls and the rigid retaining walls should, however, be designed to withstand 'at-rest' earth pressures. The slope of the surface of the retained backfill should be considered in assessing the earth pressures acting on the retaining structures. Construction joints should be provided between those parts of the retaining walls which can yield and those which are rigidly restrained. Care should be taken to avoid the development of large horizontal stresses which are caused by overcompaction of the backfill behind retaining structures and therefore vibratory compaction equipment for use behind retaining structures must be restricted in size as per current M.T.C. Specifications (M.T.C. Directive B-131).

Water accumulation in the backfill behind the retaining structure should be prevented by means of properly filtered perforated drainage pipes installed at the base of the fill, or weepholes.

... / ...

**4.2.3 Anchor Design**

For shoring and for some sections of the permanent retaining walls, tiebacks anchored into the bedrock will be utilized to support lateral earth pressures. Anchor design will be provided by the M.T.C. Foundation Design Section, based on test results from the site.

For preliminary estimating purposes in anchor design, the top of suitable (i.e. relatively unweathered) bedrock can be assumed to be at the following elevations at each borehole location.

<u>Borehole No.</u>	<u>Bedrock Surface Elevation (m)</u>	<u>Surface of Relatively Unweathered Bedrock (m)</u>
103	75.0	74.0
104	73.6	72.2
105	75.2	74.2
106	74.6	74.3
107	76.1	73.9
108	77.5	76.4

... / ...



4.2.4 Construction

At the proposed grade separation site (i.e. Boreholes 103 through 108), the groundwater level at about Elevation 80 m was measured at the time of our investigation; the soils at shallow depths generally consist of cohesive materials. In general, shallow excavations for pile caps, etc. should not therefore encounter any unusual difficulties due to groundwater seepage. Seepage emanating from near the surface, the fill or the fissured zones of the soil should be moderate, and should therefore be in the range of quantity which can be intercepted and handled by means of perimeter drainage and/or pumping from open sumps. A skim coat of concrete or granular layer may have to be placed on the bearing surface to permit passage of foot traffic without disturbing the soil structure. The sides of excavations more than 1.2 m deep should be cut at 1:1 side slopes in order to comply with the safety regulations.

It should however be noted that in the section covered by Boreholes 7 and 8 and especially Borehole 107, the surface of a sand layer was found close to the existing ground surface (i.e. between Elevations 82.2 m at Borehole 107 and 81.4 m at Borehole 8). The groundwater table at the time of this investigation was found to lie between Elevations 81.1 and 80.3 m. Should the excavations extend below or very close to these elevations or should the water table be high at the time of construction, then dewatering of sand layers at or below the base of the excavation would be required.

... / ...



The extent of dewatering in these sand deposits will depend on the depth of excavation below the water level. The water level could be depressed by up to about 0.5 m by means of perimeter drains and pumping from shallow filtered sumps. To further lower the water table, wellpoints will likely be required.

In order to investigate more fully the conditions which will be experienced in open excavations, it would be prudent for the contractor to dig shallow test pits immediately before the start of the construction.

4.3 Culverts

Two culverts will be constructed on the east side of the new bridge location and one on the west side at Dunbarton Creek crossing. These culverts will connect the existing culverts under Highway 401 to the existing culverts under the CNR embankment.

4.3.1 Proposed Culvert at Sta. 9+850

Boreholes 109 and 110, put down at the site of the proposed culvert to be built between the new bridge site and Liverpool Road, contacted 0.7 m of fill, underlain by a 0.6 m layer of topsoil which is, in turn, underlain by glacial till below 1.3 m. The grain size distribution of a sample of the till taken from this location is shown on Figure 1, which indicates 8% gravel, 58% sand,

... / ...



27% silt and 7% clay size particles. Based on 'N'-values measured in this material which range between 30 and more than 100 blows/0.3 m, the till is considered to be 'dense' to 'very dense'. As shown on the Subsurface Profile, presented on Drawing GGE 310-B, the surface of the weathered bedrock lies 8 to 8.5 m below the ground surface. A slight artesian condition was encountered at Borehole 109 and this is believed to be emanating from the bedrock at a depth of about 10 m below the ground surface.

The boreholes show that the till deposit encountered below a depth of 1.3 m (or below an elevation of about 78.3 m) is, in its undisturbed state, a competent material and suitable to support normal spread footings for a box culvert structure, the base of which is designed as a raft. The factored bearing capacity of the undisturbed till at or below Elevation 78.3 m at Ultimate Limit States is 700 kPa. The bearing capacity at Serviceability Limit States Type II is 300 kPa.

A permanent earth cover of at least 1.2 m should be provided above the foundations for frost protection.

Under inclined loading conditions the bearing capacity at Ultimate Limit States should be reduced in accordance with Sub-section 6-7.3.3.5 of the O.H.B.D.C.

... / ...



For the evaluation of the sliding resistance of the foundation, the ultimate value of the angle of friction between the underside of the foundations and the dense to very dense till can be taken as 25 degrees.

Provided that free-draining granular material is used for backfill behind the walls of the culvert, and adequate drainage is provided, earth pressures can be calculated in accordance with Section 6.6.1.2 of the O.H.B.D.C. using the following soil parameters.

<u>Material</u>	<u>Angle of Internal Friction, ϕ</u>	<u>Unit Weight, γ</u>
Granular 'A'	35°	22.0 kN/m ³
Granular 'B'	30°	21.2 kN/m ³

In this instance the at-rest condition is applicable for the lateral earth pressure.

To relieve the water pressure above the creek level, it is recommended that a drainage blanket of free-draining granular material should be placed behind the wing walls, and the water collected relieved through weeping holes. We also recommend the use of seepage collars or cut-off walls around the proposed culvert to prevent erosion of the enclosing soil.

... / ...



When constructing excavations below the creek level (which is believed to be one of the controls influencing the water level at this site), dewatering measures will be required to prevent the disturbance or loosening of the foundation soils which are susceptible to boiling under a condition of upward seepage. For this purpose, gravity drainage and vigorous pumping from filtered sumps will likely be sufficient but, depending on the groundwater conditions at the time of the construction and the depth of excavation below the water table, if the excavations extend more than about 0.9 m below the water table more elaborate measures could also be necessary. Allowance should also be made to place a 15 cm thick skim coat of concrete at the base of foundation excavations within six hours of exposure to enable the construction of the formwork and the placement of reinforcing steel to be carried out without causing excessive disturbance to the underlying foundation soils.

Above the water table, temporary excavations which are more than 1.2 m deep should be cut at side slopes no steeper than 45°, or adequately supported in accordance with the Safety Regulations of the Province. Below the water table flatter side slopes of 2 horizontal in 1 vertical or adequate support will be required. Special precautions will be required in the vicinity of the existing embankment if the construction encroaches into the existing embankment to ensure adequate toe support at all times and thus prevent the failure or slippage of the embankment slopes.

... / ...



In this instance a suitable method of shoring could consist of support provided by driven steel H-piles (soldier piles) and lagging. Steel H-piles should be driven below the highly weathered upper zones of the bedrock (i.e. to about Elevation 71 m at Borehole 109). As discussed before, to enable sufficient penetration of the piles into the bedrock stratum we recommend the use of a heavy pile section and that the pile type be reinforced with a cast steel shoe.

The passive earth resistance of the overburden in front of the piles below the ground surface will depend on a variety of factors, including the allowable deflections of the temporary structure as well as the prevailing soil types and properties. To mobilize the ultimate passive resistance of the soil in front of the piles, significant deflections will be required. Assuming, however, that some deflections are acceptable, based on the results of Boreholes 109 and 110, a conservative value of angle of internal friction of 30° can be used to calculate the coefficient of passive earth resistance in the overburden soil; an angle of internal friction of 42° may be used in the weathered rock. In this instance the bulk unit weight of the soil can be taken as 20 kN/m^3 above the groundwater table. Below the groundwater table a submerged unit weight of 11.5 kN/m^3 can be used. The top 1.2 m of the soil in front of the piles will be subject to freeze and thaw cycle and therefore the passive resistance of the soil in this zone should be ignored. The weight of the soil in this zone, however, can be taken into consideration provided that this material is not removed while the shoring system is in use.

... / ...



No information is presently available regarding the composition and properties of the fill that make up the existing CNR embankment. In the absence of this information, assuming that the existing embankment fill generally consists of loose to compact basically cohesionless soils, the active earth pressure due to the embankment can be based on ϕ -value of 29 degrees and the bulk unit weight of the retained soil can be taken as 20 kN/m^3 .

The backfill around the culvert should be in accordance with the current M.T.C. Standards.

4.3.2 Proposed Culvert at Sta. 9+375

Borehole 108 was drilled at the location of the proposed culvert, approximately 120 m east of the proposed bridge site, and this showed the presence of silty clay fill mixed with some topsoil to 1.5 m below the ground surface, where it is underlain by a 0.5 m thick layer of peaty topsoil.

At a depth of 2.0 m or Elevation 79.2 m, the borehole encountered a very dense silty sand till with frequent embedded shale fragments. The grain size distribution of a sample of the till is shown on Figure 2, indicating 25% gravel, 53% sand, 18% silt, and 4% clay size particles. The shale bedrock which was encountered at Elevation 77.5 m, is extremely weathered and fractured and the piezometer installed in the borehole showed the presence of a slight artesian condition.

... / ...



At the borehole location at or below Elevation 79.2 m, the bearing capacity of the undisturbed very dense till at Ultimate Limit States is 800 kPa. The bearing capacity at Serviceability Limit States Type II is 360 kPa.

The conditions are essentially similar to those encountered at the previously discussed culvert site (Section 4.3.1) and the same foundation conditions apply. To avoid repetition the reader is referred to Section 4.3.1 for our discussion. It is, however, pertinent that the grain size distribution curve shows that the till is slightly coarser and could be somewhat more pervious at this site. This would lead to increased problems due to groundwater seepage into the excavations during the construction.

4.3.3 Proposed Culvert at Dunbarton Creek Crossing

A new culvert will be constructed at Dunbarton Creek crossing at about Sta. 9+030, that is, about 200 m west of the proposed bridge structure site.

At this location, the centreline of the proposed GO Commuter corridor is about 70 m south of Highway 401 (measured from the edge of the eastbound shoulder) and about 15 m north of the existing CNR embankment centreline. The elevation of the rail tracks on the CNR embankment is about 89 m at the proposed creek crossing and the proposed elevation for the top of the new commuter line will be about 87.5 m, that is, about 1.5 m lower than the

... / ...



existing CNR embankment. In the immediate vicinity of the creek the existing ground elevation is generally about 76.5 to 77 m and therefore for the construction of the new embankment the placement of about 10 m to 11 m of fill will be required. The new fill will be integrated with the north slope of the existing CNR embankment.

Boreholes 101 and 102 put down near the creek show, below some topsoil and fill, the presence of organic soils extending to depths ranging between 3.6 and 4.3 m, that is, to Elevation 73.2 and 73.4 m, at Boreholes 101 and 102, respectively. At Borehole 102 these organic soils are underlain by a silty sand till deposit containing frequent shale fragments, while at Borehole 101 a 0.9 m thick silty sand layer is sandwiched between the glacial till and the organic soil deposits. Boreholes put down in the general area for the construction of the embankment showed that silty sand layers are frequently encountered at the site along with occasional silt layers. The surface of the weathered shale was contacted at an average elevation of 71.3 m and the groundwater table, as can be expected, lies close to the ground surface.

If the proposed culvert were to be founded on organic soils, excessive settlements will take place due to the primary and secondary consolidation of these materials under the weight of the 10 to 11 m of fill which will be placed for the embankment construction. In addition, assuming an average

... / ...



undrained shear strength of 40 kPa for the organic soils, and a bulk unit weight of 20 kN/m^3 for the embankment fill, plastic shear deformations would be likely to occur although these would depend, to some extent, on the rapidity of the fill placement. For these reasons, we recommend that the culvert be founded on the inorganic soils underlying the organic materials.

The use of driven steel piles could be considered to support the culvert, by transferring loads structurally to the underlying competent strata but it is our opinion that this would create a "hard spot" under the high portion of the embankment. There would therefore be substantial differential movements and cracks in the embankment unless the removal of all organic soils beneath the embankment itself is implemented.

From this discussion it is evident that the construction and design procedures chosen for the new embankment will have a great influence in the choice of the most suitable foundation treatment for the proposed culvert. Assuming that the organic soils under the embankment will be completely removed to expose the surface of the underlying competent inorganic soils, and the grade is then raised to foundation elevation with suitable compacted fill, a similar approach can be taken for the construction of the culvert itself. This will involve the removal and replacement of the organic soils with compacted granular fill.

... / ...



There are three main concerns with this approach (i.e. removal of the organic soils and construction of the replacement fill). These are: a) to maintain the stability of the existing embankment during construction; b) to effect an acceptable degree of compaction of the fill to be placed below the groundwater table; and c) differential settlements between the existing culvert under the existing CNR embankment and the new culvert to be constructed under the new embankment.

In order not to jeopardize the stability of the existing CNR embankment, the organic soils should be removed in narrow strips normal to the existing embankment and the width of the open trench should not exceed 4 m. Additionally, a dredging and filling technique should be used so that the open trench is backfilled immediately after its excavation.

We also recommend that the existing culvert structure be adequately supported during the excavation to prevent its shifting as a result of yielding of the weak organic soils from beneath; this assumes that the organic soils were not removed when the existing culvert was constructed. Furthermore, as the sides of the existing CNR embankment are very steep (i.e. nearly 1:1) any encroachment into the existing slope or undercutting of the toe will require adequate shoring. This could be achieved by means of steel H-soldier piles (probably with anchored tie-backs into bedrock) and lagging.

... / ...



The existing culvert could also possibly be shored by means of driven sheet piles or probably more appropriately by means of steel H-soldier piles and lagging. The shoring will likely have to be tied back by anchoring into the bedrock. The steel-H piles will have to be driven into the relatively unweathered bedrock which is at about Elevation 70 m at Borehole 101 location. As discussed before, the use of a heavy pile section is recommended and the pile tips should be reinforced with a cast steel shoe.

As also discussed before, provided some lateral deflections can be accommodated, a conservative value of $\phi = 30$ degrees can be used to calculate the coefficient of passive earth resistance within the inorganic portion of the overburden where the bulk unit weight of the inorganic soil can be taken as 20 kN/m^3 above the groundwater level and 11 kN/m^3 below. In this context we recommend that the resistance of the organic soils be ignored, however, the material may be presumed to provide a beneficial surcharge using a submerged unit weight of 5 kN/m^3 if the soil is not to be removed.

Below the water table, the removal of organic soils in narrow strips will likely be feasible only by dredging and simultaneous placement of the fill material.

... / ...



As compaction of the lower section of the fill below the water table will be difficult and, depending on the site conditions may not be feasible, a free-draining granular material should be used for fill to be placed below the existing ground surface level. In the selection of this fill, compatibility with the underlying natural soils should be carefully considered especially where the underlying soils consist of silty sand or silt deposits; otherwise the infiltration of the soil fines into the fill material will lead to post construction settlements. In this respect the use of a Granular 'A' or Granular 'B' material (M.T.C. Form 1010) is acceptable. However, a close control of the conditions in the field will be required and, depending on the soil conditions underlying the trench excavation, the use of, for instance, Granular 'B' material which has a relatively coarse grain size distribution, may not be advisable. Otherwise, the use of a separator, such as a compatible geofabric, will be necessary if a coarse fill which is not compatible with the foundation soils is used. In addition, as mentioned before, to maintain the stability of the adjacent embankment, the placement of the fill should closely follow the dredging operations, especially when excavating adjacent to, or very close to, the existing CNR embankment.

A high degree of compaction will only be possible for the upper zones of the fill. In this instance, assuming that a material such as Granular 'A' is used within at least about 1 m of the final subgrade level which is suitably

... / ...



compacted, the factored bearing capacity at Ultimate Limit States is 500 kPa. The bearing capacity at Serviceability Limit States Type II is 200 kPa. With this value, the settlements will depend on the type of material used and the degree of compaction achieved and could be of the order of 100 mm. For this reason, allowance should be made for possible greater than normal settlements.

It should, however, be pointed out that, provided a granular fill is used, the settlements should occur during the placing of the embankment fill and should be substantially complete shortly after the completion of the construction. For this reason, surcharging could also be considered to effect some of the settlements prior to construction of the new culvert. On the other hand, assuming that the organic soils were not removed when the existing CNR embankment was constructed, the new embankment fill will likely induce settlements under the north side of the existing embankment which could cause settlement of the existing culvert. This should also be taken into account in the design. The magnitude of these settlements is very difficult to estimate as the height of the fill varies with the north slope of the embankment and to a large extent will be dependent, among other factors, on the thickness of the underlying organic soils. Assuming however that the subsurface conditions under the existing embankment are similar to those encountered in the borings, these settlements could reach a value of about 0.4 m.

... / ...



A permanent earth cover of at least 1.2 m should be provided above the foundations for frost protection. Under inclined loading conditions the bearing capacity at Ultimate Limit States should be reduced in accordance with Sub-section 6-7.3.3.5 of the O.H.B.D.C.

For the evaluation of the sliding resistance of the foundation, the ultimate value of the angle of friction between the underside of the foundations and the Granular 'A' quality backfill can be taken as 26 degrees.

As discussed before, one of the main problems in the replacement of organic soils will be the adequate control of the groundwater seepage, maintaining the stability of the sides of the trenches during replacement, and the stabilization of the underlying cohesionless strata. For this purpose, it is believed that if the construction sequence is well planned and the surface water is adequately intercepted, pumping from strategically located filtered sumps or deep wells will suffice for construction. Otherwise dewatering in the form of wellpoints or pumping from within tight interlocking sheeting may be required.

... / ...



Ref: 85-11-9

Page # 36

5.0 CLOSURE

The Statement of Limitations, as quoted in the Appendix, is an integral part of this report.

DOMINION SOIL INVESTIGATION INC.

Z.S. Ozden, P.Eng.



C. Alston, P.Eng.

ZSO:bh

APPENDICES

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:

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

**FIELD WORK**

The field work was carried out during the period between December 4, 1985 and January 15, 1986, and consisted of drilling eleven boreholes to depths ranging between 4.1 and 14.3 m below the ground surface. The bedrock was cored in eight of the boreholes and the unusually cold weather experienced in December, 1985 and the early part of January, 1986, as well as the weathered and fractured nature of the rock immediately below the overburden, caused difficulties and long delays during coring. The following is a chronological summary of the drilling:

<u>B.H. No.</u>	<u>Depth of Borehole</u>	<u>Drilling Dates(s)</u>	<u>Coring by Diamond Drilling</u>	<u>Drilling Company</u>
109	11.4 m	Dec. 4 & 5, 1985	2.6 m	D.S.I.L. Drilling Inc.
110	8.5	Dec. 5, 1985	-	D.S.I.L. Drilling Inc.
108	4.9	Dec. 11, 1985	1.0 m	Eastern Soil Limited
107	12.9	Dec. 11, 12 & 13, 1985	5.5 m	Eastern Soil Limited
106	14.3	Dec. 13 & 14, 1985	5.1 m	Eastern Soil Limited
102	6.7	Dec. 24, 1985	-	D.S.I.L. Drilling Inc.
102A	4.1	Jan. 2, 1986	-	D.S.I.L. Drilling Inc.
101	7.6	Jan. 2, 3 & 4, 1986	0.9 m	D.S.I.L. Drilling Inc.
103	12.8	Jan. 4, 6, 10 & 11, 1986	5.5 m	D.S.I.L. Drilling Inc.
105	9.1	Jan. 9 & 10, 1986	3.6 m	D.S.I.L. Drilling Inc.
104	13.9	Jan. 13, 14 & 15, 1986	5.3 m	D.S.I.L. Drilling Inc.

... / ...



The boreholes were advanced using a track-mounted power auger drill equipped with hollow stem augers. Sampling in the boreholes was effected by the Standard Penetration test method and from the test results, recorded as 'N'-values or Penetration Resistances, the compactness condition or consistency of the soil strata was inferred. In eight of the boreholes the bedrock was cored using BXL size core barrels except for Boreholes 103, 106 and 109 where NXL size was used.

The field work was carried out under the supervision of technical personnel from Dominion Soil Investigation Inc. Upon completion of the field work the locations and ground surface elevations of the boreholes were provided by Morrison Hershfield Limited.

LABORATORY WORK

The samples were shipped to our laboratory where they were examined and classified. A laboratory testing programme consisting of the following tests was performed on selected soil samples:

- Water Content
- Bulk Unit Weight
- Atterberg Limits
- Grain Size Analyses
- Undrained Compression (Quick) Triaxial Tests
- Hand Vane Tests on TW samples
- Consolidation Tests

... / ...



In addition, unconfined compression tests were performed on three selected intact rock core samples.

The test results are shown on the Borehole Logs and on Figures 1 through 10 and are also discussed in the text of the report.



LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

ENCLOSURES



RECORD OF BOREHOLE No 101

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,767N; 337,042E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, BXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 02, 1986 01 03 & 1986 01 04 CHECKED BY Z.S.O.

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					
76.8	GROUND LEVEL																
0.0	0.1 m Topsoil		1	SS	3		76										
75.8	Fill - Silty Clay & Sandy Silt, soft to v.loose		2	SS	3												
1.0	Organic Silty Clay, v.soft to firm, dark grey/black.		3	SS	1		75										
73.8			4	TW	PH		74										
3.0	Sandy some gravel loose		5	SS	7		73										
73.2			6	SS	20												
3.6	Silty Sand with silty clay seams, compact, grey.		7	SS	100	13 cm	72										
72.3			8	SS	130	15 cm											
4.5	Silty Sand Till with shale fragments, v.dense, grey.		9	SS	100	10 cm	71										
71.4			10	RC BXL	83%		70										
5.4	Bedrock SHALE dark grey weathered																Advance hole to 6.7 m using tri- cone.
69.2																	R.Q.D. = 22%
7.6	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 102

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,757N; 337,062E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY R.M.
DATUM GEODETIC DATE 1985 12 24 CHECKED BY Z.S.O.

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			SHEAR STRENGTH									
							20	40	60	80	100						
77.7	GROUND LEVEL																
0.0	0.15 m Topsoil					SEAL											
	Sandy Silt with traces of gravel and clay. Compact, brown/grey (probably fill).		1	SS	19												
75.7			2	SS	19	SEAL											
2.0	Organic Silty Clay soft to firm dk. grey/black		3	SS	6												
			4	SS	4												
74.0																	
3.7	Peat		5	SS	10												
73.4	Firm to stiff, black																
4.3	Silty Sand Till with frequent shale fragments.		6	SS	49												
	Dense to v.dense dark grey		7	SS	50/												
71.2			8	SS	102												
6.5	Bedrock Shale, weathered																
6.7	End of Borehole		9	SS	50/	2 cm											



METRIC

W P GGE-310 LOCATION Co-ords. 4,853,757N; 337,062E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 02 CHECKED BY Z.S.O.

[illegible]

+³, x⁵ : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPOKI VIN SOIL EXPLUKATION

RECORD OF BOREHOLE No 103

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,854N; 337,169E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, NXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 04, 1986 01 06, 1986 01 10 & 1986 01 11 CHECKED BY Z.S.O.

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			20	40	60	80	100				
81.3	GROUND LEVEL														GR SA SI CL
0.0	0.2 m Topsoil Fill - Silty Clay with sand and traces of gravel. Firm to stiff brown/grey		1	SS	7	SEAL									Sampler wet @ 2.5 m while drilling.
79.7			2	SS	14										
1.6	Silty Clay firm to stiff grey/brown		3	SS	8	SEAL									
79.0															38 37 18 7
2.3	Silty Sand Till some clay. Frequent shale fragments. dense to v.dense, dark grey		4	SS	40	PIEZOMETER									
			5	SS	80										
			6	SS	53										
			7	SS	50/										
76.1															
5.2	Sandy Silt Till some shale fragments.		8	SS	55										
75.0	V.dense, grey.		9	SS	60/										
6.3	highly weathered														
74.4			10	SS	100/										
6.9															
			11	RC	80%										Auger refusal @ 6.9 m.
				BXL											R.Q.D. = 47%
72.0	weathered		12	RC	96%										R.Q.D. = 24%
				BXL											
9.3	Bedrock SHALES dark grey		13	RC	98%										R.Q.D. = 56%
				BXL											
			14	RC	96%										R.Q.D. = 89%
				BXL											
68.5															
12.8	End of Borehole														

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 104

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,913N; 337,209E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, BXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 13, 1986 01 14 & 1986 01 15 CHECKED BY Z.S.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
84.1	GROUND LEVEL												
0.0	0.1 m Topsoil		1	SS	5	SEAL							
	Fill - Silty Clay, traces of gravel firm, grey/brown.		2	SS	6	SEAL							
82.3			3	SS	10								
1.8	Organic Silty Clay stiff, dk. grey.		4	SS	13								
81.5			5	SS	15								
2.6	Silty Clay, stiff to v.stiff, grey.		6	SS	4								
80.6			7	SS	30								
3.5	soft to firm Silty Clay Till, sandy, v.stiff grey		8	SS	43								
78.8			9	SS	48								
5.3	Sand, some silt, dense, grey, wet.		10	SS	49								
	traces of gravel		11	SS	57								
76.2			12	RC	13%								
7.9	Sandy Silt Till v.dense, grey		13	BXL									
75.4			14	RC	40%								
8.7	Silty Clay Till with shale fragments, hard (inferred).		15	RC	94%								
73.6				BXL									
10.5	highly weathered			RC									
73.1				RC									
11.0	Shale Bedrock dark grey, weathered, occ. clay seams and highly weathered zones.			BXL									
70.9				RC	100%								
13.2	unweathered			BXL									
70.2													
13.9	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 105

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,873N; 337,241E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, BXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 09 & 1986 01 10 CHECKED BY Z.S.O.

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
81.2	GROUND LEVEL																GR SA SI CL
0.0	0.2 m Topsoil		1	SS	6	SEAL	81										Auger refusal @ 5.2 m. Drill BW casing to 5.3 m. Advance hole to 5.6 m using tri- cone.
	Silty Clay stiff to v.stiff brown.		2	SS	16	PIEZOMETER	80										
79.2			3	SS	16		79										
2.0	Silty Clay Till, sandy firm to stiff, brown.		4	SS	7	SEAL	78										
77.9			5	SS	15		77										
3.3	Silty Sand Till		6	SS	18		76										
	compact grey dense dk. grey shale fragments		7	SS	40		75										
76.0							74										
5.2	Till with shale slabs (inferred).		8	RC	33%		73										
75.2																	R.Q.D. = 0
6.0	extremely weathered			BXL													
74.7	weathered																
6.5																	
74.2																	
7.0	Bedrock		9	RC	82%												R.Q.D. = 39%
	SHALE			BXL													
	dark grey																
72.1			10	RC	100%												R.Q.D. = 88%
				BXL													
9.1	End of Borehole																



RECORD OF BOREHOLE No 106

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,929N; 337,260E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, NXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1985 12 13 & 1985 12 14 CHECKED BY Z.S.O.

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 k Pa											
83.7	GROUND LEVEL							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)						
								50 100					10 20 30						
0.0	Fill - Silty Clay mixed with topsoil, traces of gravel. Brown/dk. brown stiff to v.stiff		1	SS	9		SEAL	83											
			2	SS	22		SEAL												
81.9			3	SS	18			82											
1.8	Silty Clay		4	SS	19														
	Stiff to v.stiff, brown.		5	SS	14														
80.4			6	SS	10														
3.3	Silty Clay Till sandy		7	SS	2														
	Stiff, brown.		8	SS	1														
79.4			9	SS	9														
4.3	Sandy Clay Till, soft, grey, wet.		10	SS	39														
			11	SS	52/	15 cm													
78.4			12	AS	-														
5.3	Silty Sand Till		13	SS	400/	5 cm													
	V.loose to loose, grey saturated.		14	RC NXL	97%														
77.0			15	RC NXL	100%														
6.7	Silty Sand, some gravel, dense, grey, wet.		16	RC NXL	96%														
			17	RC NXL	98%														
76.0																			
7.7	Sandy Silt Till.																		
	Very dense, grey some silty sand lenses freq. shale fragments.																		
74.6																			
9.1																			
74.0	weathered																		
9.7																			
	Bedrock																		
	SHALE																		
	dark grey																		
69.4																			
14.3	End of Borehole																		



METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	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	W_p	W	W_L		
84.1	GROUND LEVEL						SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						

[illegible]

+³, x⁵ : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 108

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,974N; 337,346E ORIGINATED BY R.M.
DIST 6 HWY 60 COMMUTER BOREHOLE TYPE SOLID STEM AUGER, BXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1985 12 11 CHECKED BY Z.S.O.

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					
81.2	GROUND LEVEL																
0.0	Fill - Silty Clay mixed with topsoil, trace gravel, dark brown. Firm to stiff		1	SS	4	SEAL	81										W.L. in piezometer 0.2 m above ground level 2 days after completion.
79.7			2	SS	15		80										
1.5	Peaty topsoil. black		3	SS	79*	SEAL											W.L. 0.4 m below ground surface Jan. 14/86.
79.2																	
2.0	Silty Sand Till Very dense, grey frequent shale fragments.		4	SS	68		79										25 53 18 4
			5	SS	90/												
77.5			6	SS	100/												
			7	RC BXL	100%												
3.7	Shale bedrock Dark grey Extremely weathered and fractured, occ. clay seams		8	RC BXL	90%												R.Q.D. = 0
76.3																	R.Q.D. = 30%
4.9	End of Borehole																* Sampler driving stone ahead

+³, x⁵: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 109

METRIC

W P GGE-310 LOCATION Co-ords. 4,854,224N; 337,748E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER, NXL ROCK CORE COMPILED BY R.M.
DATUM GEODETIC DATE 1985 12 04 & 1985 12 05 CHECKED BY Z.S.O.

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	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
79.7	GROUND LEVEL																	GR SA SI CL
0.0	0.08 m Topsoil Fill - Sandy Silt mixed w/tps.tr.grav.dk.br.					SEAL	79											W.L. at 1.0 m below ground sur- face 2 weeks after com- pletion.
79.0			1	SS	20													W.L. 0.8 m above ground surface Jan. 14/86.
0.7	Sandy Silt Topsoil w/s decomp. wood bl./dk.grey, compact.																	
78.4			2	SS	43		78											
1.3	traces of organics																	
			3	SS	51													
	Silty Sand Till some clay.						77											
			4	SS	77	SEAL												
	Compact to v.dense grey					28 cm	76											
			5	SS	37													
			6	SS	30		75											
			7	SS	58													
							74											
			8	SS	90													
	frequent shale fragments						73											
			9	SS	85													
			10	SS	110		72											
71.2																		
			11	SS	75													
8.5	extremely weathered					8 cm	71											
				RC														
70.0	weathered SHALE		12	NXL	100%		70											R.Q.D. = 35%
9.7	dark grey bedrock																	
			13	RC NXL	86%		69											R.Q.D. = 60%
68.3																		
11.4	End of Borehole																	



RECORD OF BOREHOLE No 110

METRIC

W P GGE-310 LOCATION Co-ords. 4,854,202N; 337754E ORIGINATED BY R.M.
DIST 6 HWY 60 COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY R.M.
DATUM GEODETIC DATE 1985 12 05 CHECKED BY Z.S.O.

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					
79.6	GROUND LEVEL																
0.0	Fill - Silty Clay mixed with topsoil. dk. brown						79										
0.7	Sandy Silt Topsoil with some decomposed wood black/dkgrey loose		1	SS	9												
78.9																	
78.3																	
1.3	Silty Sand Till some clay, some silty fine sand and sandy silt seams. Dense to v.dense grey		2	SS	59		78										8 58 27 7
			3	SS	41		77										Sampler wet @ 2.4 m while drilling.
			4	SS	65		76										
			5	SS	43		75										
			6	SS	86												
			7	SS	50/	8 cm	74										
			8	SS	90/	28 cm	73										
	frequent shale fragments		9	SS	90/	25 cm											
			10	SS	50/	5 cm	72										
71.6																	Auger refusal at 8.5 m.
8.0	Shale bedrock - dk.grey		11	SS	100/	8 cm											
71.1	extremely weathered																
8.5	End of Borehole																

RECORD OF BOREHOLE No 1

METRIC

W P GGE 310 LOCATION CO-ORDS. 4,853,860N; 337,192E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.14 CHECKED BY L.R.

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					
81.0	GROUND LEVEL															
0.0	0.25 m Topsoil															
	Silty Clay, some sand and silt lenses Moist (Possibly Fill) to Very Brown Wet stiff mottled		1	SS	17											
78.9			2	SS	25											
2.1			3	SS	16											
	Moist Silty brown Clay stiff Till		4	SS	11											
77.0			5	SS	34											
4.0	hard, grey damp with shale fragments (transition to shale)		6	SS	68											
75.5																
5.5	Shale															
	Bedrock		7	SS	50/0.02 m											
	Dark Grey weathered		8	SS	50/0.0 m											
73.4																
7.6	End of Borehole (Refusal to auger and SS)															

+3, x5 : Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 1A

METRIC

W P GGE-310 LOCATION CO-ORDS. 4,853,862N; 337,194E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER & BXL ROCK CORE COMPILED BY F.L.
DATUM GEODETIC DATE 1983.11.02-03 CHECKED BY W. Mocho

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					
81.0	GROUND LEVEL																
	NOT SAMPLED																BH 1A: 1.5 m NE of BH 1 auger to 6.1 m depth then diamond drilling in bedrock.
74.9																	
6.1	Shale Bedrock		1	BXL	100%												
	Dark grey		2	RC BXL	100%												
73.2																	
7.8	End of Borehole																



Ministry of
Transportation and
Communications

DOMINION SOIL INVESTIGATION INC.

Ref. No. 83-9-16

RECORD OF BOREHOLE No 11

METRIC

W P GGE 310 LOCATION CO-ORDS. 4,853,861N; 337,194E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.15 CHECKED BY AdRebo

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			20	40	60	80	100	W _p	W	W _L		
81.0	GROUND LEVEL						SHEAR STRENGTH kPa					WATER CONTENT (%)				
							○ UNCONFINED + FIELD VANE									
							● QUICK TRIAXIAL x LAB VANE									
							50	100	150	200	250	10	20	30		
0.0	NOT SAMPLED					80										
						78				>+						
										>+						
77.5	Silty clay, stiff, brown		1	TW	PH										21.6	
3.5	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2

METRIC

W P GGE 310 LOCATION CO.ORDS. 4,853,922N; 337,233E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.28 CHECKED BY L.R.

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					
84.1	GROUND LEVEL																
0.0	0.15 m Topsoil																
	Fill (Silty Clay)		1	SS	15												
	Brown, Moist																
82.4	Stiff Mottled		2	SS	19												
1.7	0.10 m Topsoil		3	SS	20												
	Silty clay, varved		4	SS	28												
	structure, with																
	occasional thin sand																
80.4	layer																
	V. stiff Li.br. Moist																
3.7	Silty clay, some sand		5	SS	6												
	trace gravel, with																
	gravel pockets Moist		6	SS	6												
78.8	Firm (Gl. Till) to																
	Wet																
5.3	Silty fine sand																
	Very Dense Wet		7	SS	54												
	Dark Grey																
76.0			8	SS	80												
8.1	Sandy silt, tr. gravel		9	SS	75												
75.4	V. Dense (Gl. Till) Damp																
75.1	Till/Shale, drk. gr. v. den.		10	SS	130												
9.0	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity



20
15
10
5 (%) STRAIN AT FAILURE



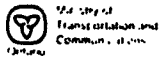
RECORD OF BOREHOLE No 3

METRIC

W P GGE 310 LOCATION CO.ORDS. 4,853,868N; 337,220E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.16 CHECKED BY L.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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							
81.2	GROUND LEVEL							SHEAR STRENGTH							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE							
								WATER CONTENT (%)							
								10 20 30							
0.0	0.10 m Topsoil						80							Groundwater encountered during drilling at 2.1 m depth.	
	Silty Clay, varved structure Very stiff to stiff		1	SS	20										
79.1	Light Brown Moist		2	SS	12										
2.1	Silty clay, some sand		3	SS	9				78						
	Stiff Brown Firm Grey Moist to wet		4	SS	7										
77.4			5	SS	90/			0.23m	76						
3.8	Sandy Silt Till frequent shale fragments		6	SS	50/			0.13m							
76.0	V. dense, dk. grey														
5.2	Bedrock Shale														
74.8	dark grey, weathered		7	SS	100/	0.13m									
6.4	End of Borehole (Refusal to Auger)														

OFFICE REPORT ON SOIL EXPLORATION



DOMINION SOIL INVESTIGATION INC.
Ref. No. 83-9-16

RECORD OF BOREHOLE No 3T										METRIC								
W P		GGE-310		LOCATION		CO.ORDS. 4,853,868N; 337,222E		ORIGINATED BY		S.D.								
DIST		6		HWY		GO COMMUTER		BOREHOLE TYPE		SOLID STEM AUGER								
DUM		GEODETIC		DATE		1983.10.15		COMPILED BY		F.L.								
DUM		GEODETIC		DATE		1983.10.15		CHECKED BY		C. Macle								
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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80	100	W _p
81.2	GROUND LEVEL																	
0.0	NOT SAMPLED						80											
78.9																		
2.3	Silty clay, some sand Firm to Stiff Moist		1	TW	PH													
77.5							78											
3.7	End of Borehole (Refusal to Vane)																	

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transport and
Communications

DOMINION SOIL INVESTIGATION INC.

Ref. No. 83-9-16

RECORD OF BOREHOLE No 4

METRIC

W P GGE-310 LOCATION CO-ORDS. 4,853,876N; 337,256E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.15 CHECKED BY Uhallo

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 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					
81.7	GROUND LEVEL																
0.0	0.15 m Topsoil																
	Silty clay, some sand		1	SS	14												
	Very Light Damp		2	SS	17												
	Stiff Brown to Moist																
79.0	Wet gravelly and sandy lense		3	SS	23												
2.7	Silty sand, some gravel		4	SS	21												
	Brown																
	Grey		5	SS	14												
77.3	Compact (Glacial Till)																
4.4	Silty clay, some sand		6	SS	24												
76.5	V.Stiff (Gl.Till) Moist																
5.2	Shale, dark grey																
	Bedrock weathered		7	SS	82/	0.15m											
74.4																	
7.3	End of Borehole (Refusal to Auger)																

+3, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W P GGE 310 LOCATION CO-ORDS. 4,853,891N; 337,285E ORIGINATED BY S.D.
DIST 6 HWY 60 COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.15 CHECKED BY L.R.

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					
83.9	GROUND LEVEL																
0.0	0.08 m Topsoil																
	Fill (silty clay, loam some sand and gravel)																
	Stiff Brown, Moist Black, to Mottled Wet		1	SS	12		82										
			2	SS	8		80										
79.8																	
4.1	moist brown																
78.7	stiff Silty Clay		3	SS	14												
5.2	firm, grey Till		4	SS	4		78										2 58 30 10
	wet, sandy																
77.2			5	SS	4												
6.7	Silty sand, shale fragments		6	SS	38												22 66 12 0
	Dense Dark Moist to Grey		7	SS	53		76										
75.0	Very Dense (Glacial Till)																
8.9	Shale bedrock		8	SS	100/	0.13m											
74.5	dark grey, weathered																
9.4	End of Borehole (Refusal to Auger)																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



DOMINION SOIL INVESTIGATION INC.

Ref. No. 83-9-16

RECORD OF BOREHOLE No 5T

METRIC

W P GGE-310 LOCATION CO-ORDS. 4,853,891N; 337,283E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.15 CHECKED BY U. M. L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 50 100 150 200 250	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
83.9	GROUND LEVEL										
0.0	NOT SAMPLED						82				
							80				
79.3								2.5			
4.6	Silty clay, some sand Stiff (Glacial Till) Moist Brown		1	TW	PH		78	2.7 2.2		20.8	
77.8											
6.1	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 6

METRIC

W P 8GE-310 LOCATION CO.ORDS. 4,853,935N; 337,279E ORIGINATED BY S.D.
DIST 6 HWY 60 COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER AND BXL ROCK CORE COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.28 and 1983.11.01 CHECKED BY W. M. M.

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					
83.8	GROUND LEVEL																
0.0	0.2 m Topsoil Fill, brown silty clay Very stiff																
82.6	0.07 m Topsoil		1	SS	22												
1.2	Silty Clay, varved structure		2	SS	22		82										
81.4	Very Light Brown Stiff Damp																
2.4	Silty clay, sandy, trace gravel		3	SS	9												
80.1	Stiff Light Brown Wet (Glacial Till)						80										
3.7	Sandy silt, trace gravel Saturated		4	SS	14												
	Compact Brown Boulders Dense Grey and Cobbles		5	SS	4	0.15m											
	(Glacial Till) Moist to Damp		6	SS	35		78										
	Very Dense		7	SS	46												
75.3			8	SS	107		76										
8.5	Shale, dark grey bedrock		9	SS	100%	0.08m											
73.0	weathered						74										
10.8			10	RC BXL	100%		72										
70.1			11	RC BXL	100%												
13.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P GGE 310 LOCATION CO-ORDS. 4,853,953N; 337,335E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.29 CHECKED BY L.R.

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		
84.3	GROUND LEVEL																			
0.0	0.15 m Topsoil					PIEZOMETER SEAL	84													
	Silty clay, some sand		1	SS	15															
	Stiff Light Damp to Brown		2	SS	30															
	Very Moist		3	SS	13			82												
81.4	Stiff																			
2.9	Silty fine sand		4	SS	37															
	Dense Moist Wet																			
	Brown		5	SS	36		80													
79.1			6	SS	75	0.15 m														
5.2	Sandy Silt Till frequent shale frag- ments		7	SS	96	0.25 m	78													
77.0	v.dense, dk. grey																			
7.3	Shale, dk.grey highly weathered bedrock		8	SS	80	0.15 m														
			9	SS	65	0.15 m	76													
74.6			10	SS	94	0.20 m														
9.7	End of Borehole (Refusal to Auger & SS)																			



Ministry of
Energy, Mines and
Technical Services

DOMINION SOIL INVESTIGATION INC.

Ref. No. 83-9-16

RECORD OF BOREHOLE No 9

METRIC

W P GGE-310 LOCATION CO-ORDS. 4,853,971N; 337,360E ORIGINATED BY S.D.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER AND BXL ROCK CORE COMPILED BY F.L.
DATUM GEODETIC DATE 1983.10.29 and 1983.10.31 CHECKED BY Ullaces

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					
81.9	GROUND LEVEL																
0.0	0.10 m Topsoil																
	Silty Clay, some sand		1	SS	24												
80.4	Very Brown Damp Stiff to Moist																
1.5	Silty fine sand, with shale fragments		2	SS	33		80										
79.3	Dense to Compact		3	SS	27												
2.6	Sandy silt, trace gravel		4	SS	45												
	Dense Grey Damp Very to Moist		5	SS	50/	0.10m	78										
77.0	Dense (Glacial Till)																
4.9	Shale, dark grey		6	SS	90/	0.23m											
	Bedrock weathered		7	RC	100%												
75.7			8	BXL	50%		76										
6.2	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No G-3

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,732N; 337,028E ORIGINATED BY D.R.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY D.R.
DATUM GEODETIC DATE 1986 01 12 CHECKED BY Z.S.O.

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					
78.8	GROUND LEVEL																
0.0	0.15 m Topsoil Fill - Sandy Silt so. clay and topsoil loose		1	SS	9	SEAL	78										
78.1																	
0.7	Fill - Sandy Silt tr. clay & gravel v.loose to compact brown		2	SS	4		78										
			3	SS	11	SEAL	77										
77.0																	
1.8	Organic Silty Clay firm to stiff dk.grey/black occ. decayed wood & peat lenses.		4	SS	10		77										
			5	SS	5		76										
			6	SS	4		76										
			7	SS	4		75										
74.4																	
4.4	Silt compact to dense brown grey		8	SS	21		74										
73.2			9	SS	54		74										
5.6	Sandy Silt Till v.dense, grey.						73										
72.1			10	SS	85												
6.7	End of Borehole																Auger refusal at 6.7 m.

RECORD OF BOREHOLE No G-5

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,744N; 337,046E ORIGINATED BY R.M.
DIST 6 HWY 60 COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 09 CHECKED BY Z.S.O.

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					
78.2	GROUND LEVEL																
0.0	Fill - Silty Clay, some sand & gravel brown, firm.		1	SS	6		78										
77.2			2	SS	10												
1.0	Fill - Sandy Silt, some gravel, brown, loose to dense.		3	SS	33		77										
76.2			4	SS	10												
2.0	Silty Clay traces of sand, gravel and organic soil firm to stiff br/grey dk grey		5	SS	8		76										
			6	SS	9		75										
73.9	frequent silt seams		7	TW	HP		74										
4.3	Organic Silty Clay firm to stiff dark grey/black.		8	SS	9		73										
72.7																	
5.5	Silty Sand Till dense to v.dense, grey wet.		9	SS	60/	15cm	72										
72.0			10	SS	28												
6.2	Silty Sand compact to v.dense grey, saturated.		11	SS	70/	13cm	71										
70.7																	
7.5	End of Borehole																Auger refusal at 7.5 m probably on bedrock.

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (% STRAIN AT FAILURE
10



RECORD OF BOREHOLE No G-6

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,757N; 337,036E ORIGINATED BY D.R.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY D.R.
DATUM GEODETIC DATE 1986 01 12 CHECKED BY Z.S.O.

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	WATER CONTENT (%)	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						
76.8	GROUND LEVEL																	
0.0	0.3 m Topsoil		1	SS	2													
	Organic Silty Clay soft, dk.grey/black, occasional grey silty clay and black peat seams.		2	SS	2		76											
			3	SS	2		75									45%		
			4	SS	3		74		+							53%		
73.5	some sand		5	SS	3		73											
3.3	Silty Sand traces of gravel compact to dense grey,wet		6	SS	39		72											
			7	SS	40													
			8	SS	27													
71.2	some shale fragments		9	SS	86/	13 cm												
5.6	End of Borehole																	

RECORD OF BOREHOLE No G-7

METRIC

W P GGE-310 LOCATION Co-ords. 4,853,776N; 337,057E ORIGINATED BY R.M.
DIST 6 HWY GO COMMUTER BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY R.M.
DATUM GEODETIC DATE 1986 01 08 CHECKED BY Z.S.O.

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			20	40	60	80	100					
76.7	GROUND LEVEL															
0.0	0.3 m Topsoil		1	SS	3											
	dk.br/gr.		2	SS	1											
	dk.grey		3	SS	2											
	Organic Silty Clay, very soft, occ. peat layers.		4	TW	—											
			5	SS	1											
	Silty Clay layer firm to stiff sandy, tr. shale fragments		6	SS	12											
72.9																
3.8	Fine Sand		7	SS	9											
72.4	loose, dk.grey, wet															
4.3	Shale - weathered		8	SS	50/											
72.0	dk. grey															
4.7	End of Borehole															

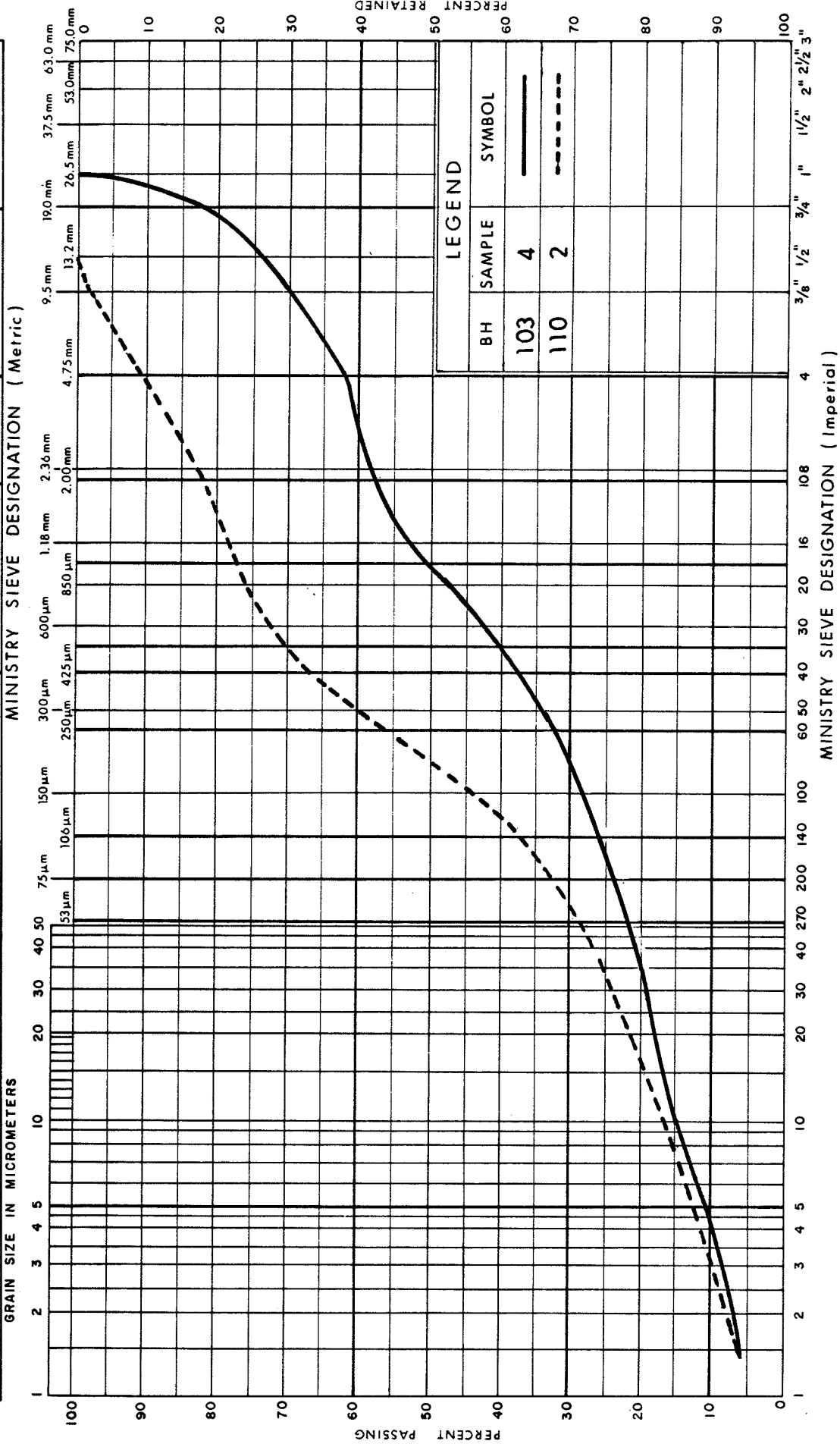
Auger refusal
at 4.7 m.

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	
GRAIN SIZE IN MICROMETERS		MINISTRY SIEVE DESIGNATION (Metric)					

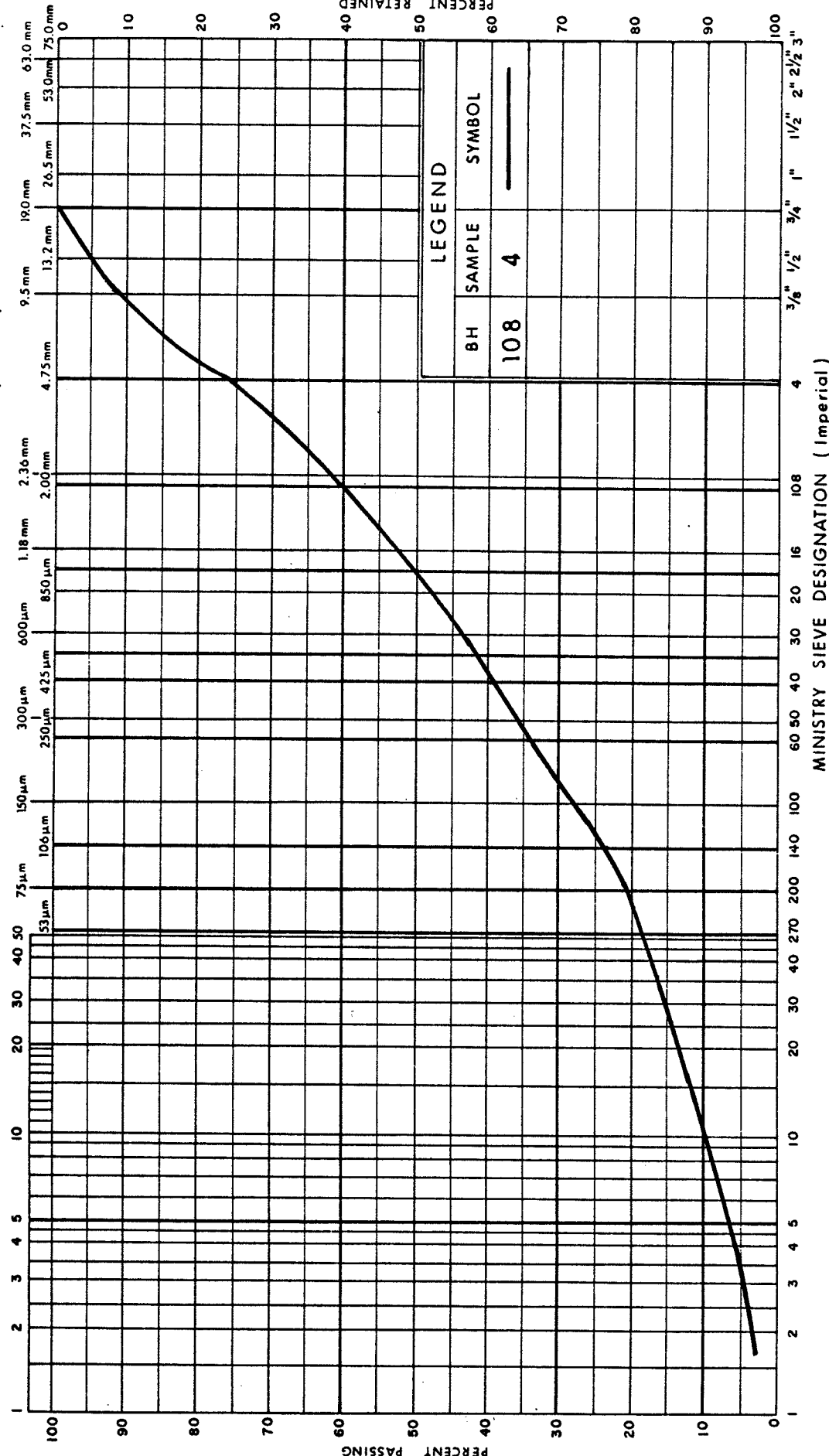


UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH	SAMPLE	SYMBOL
108	4	—

GRAIN SIZE DISTRIBUTION SILTY SAND TILL

Ministry of
Transportation and
Communications



FIG No 2

W P GGE - 310

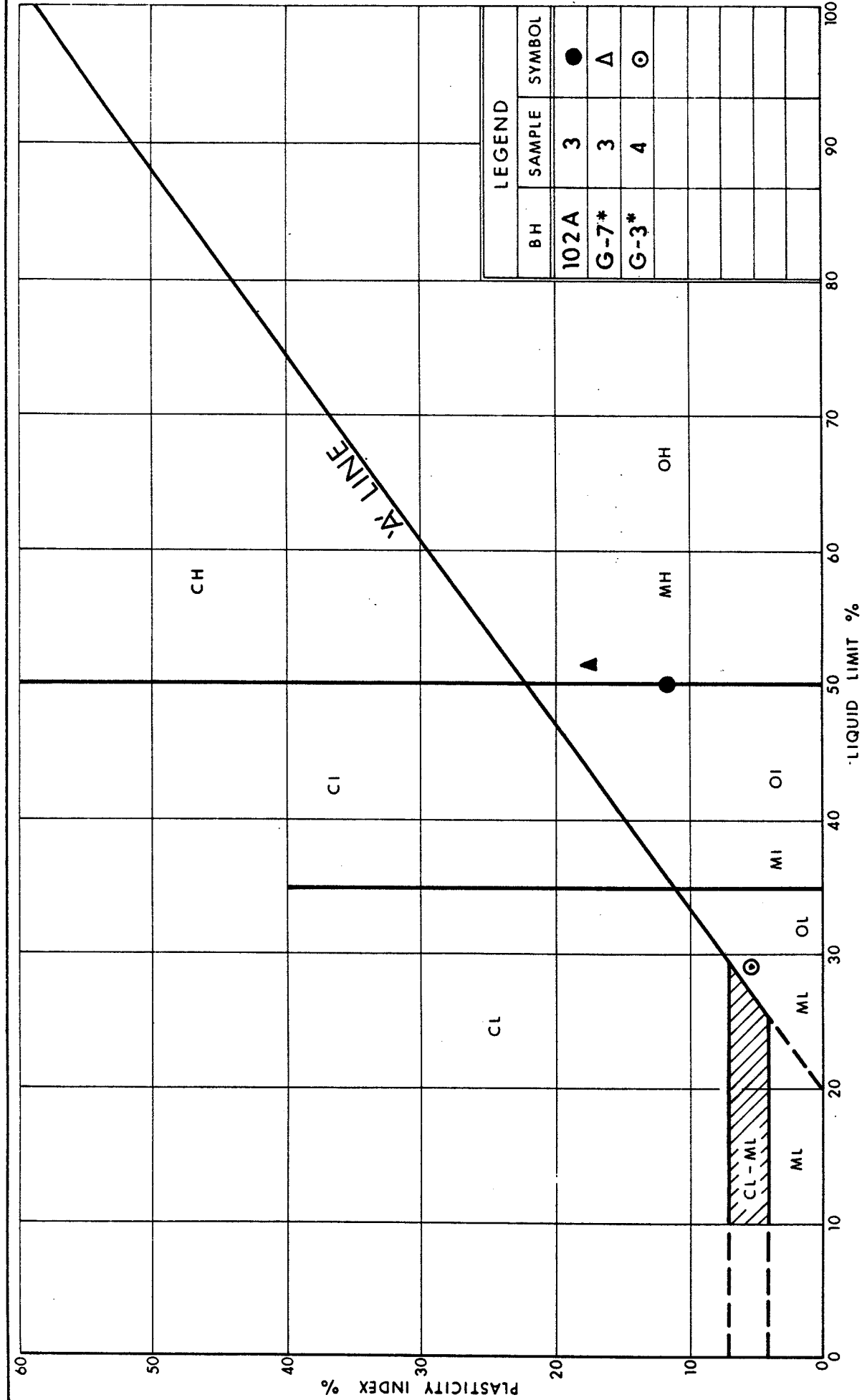


FIG No 3

W P GGE-310

*REF. No. 85-12-8

PLASTICITY CHART ORGANIC SILTY CLAY

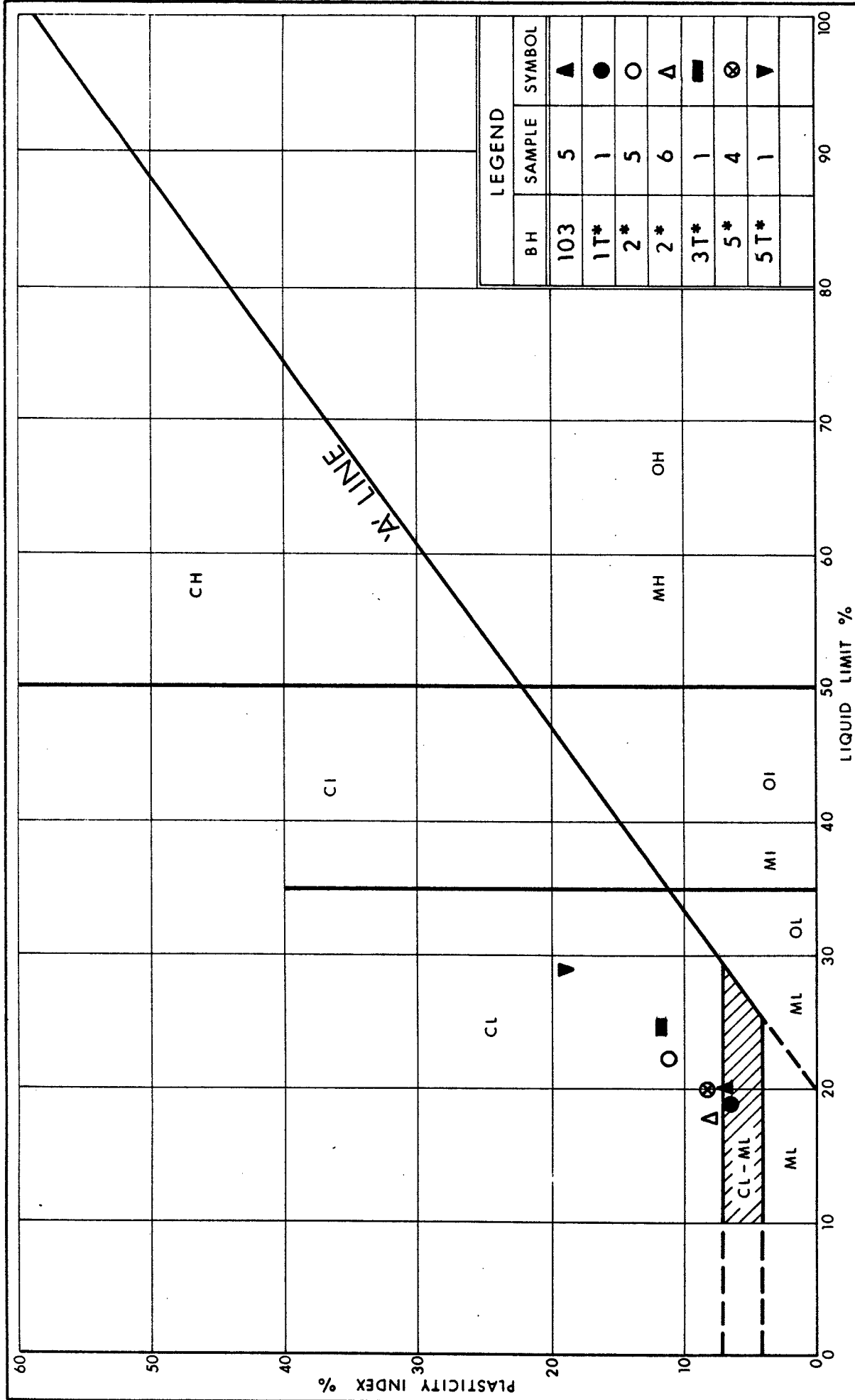


FIG No 4

PLASTICITY CHART
SILTY SAND TILL
some clay

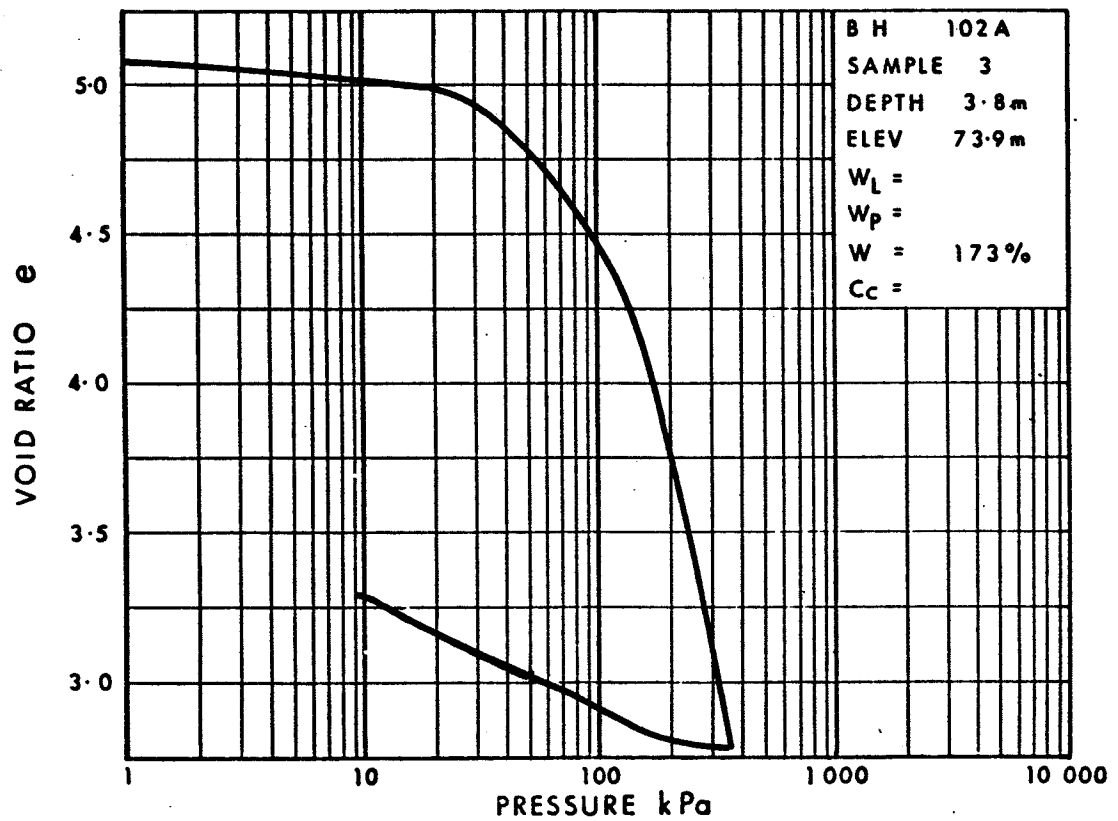
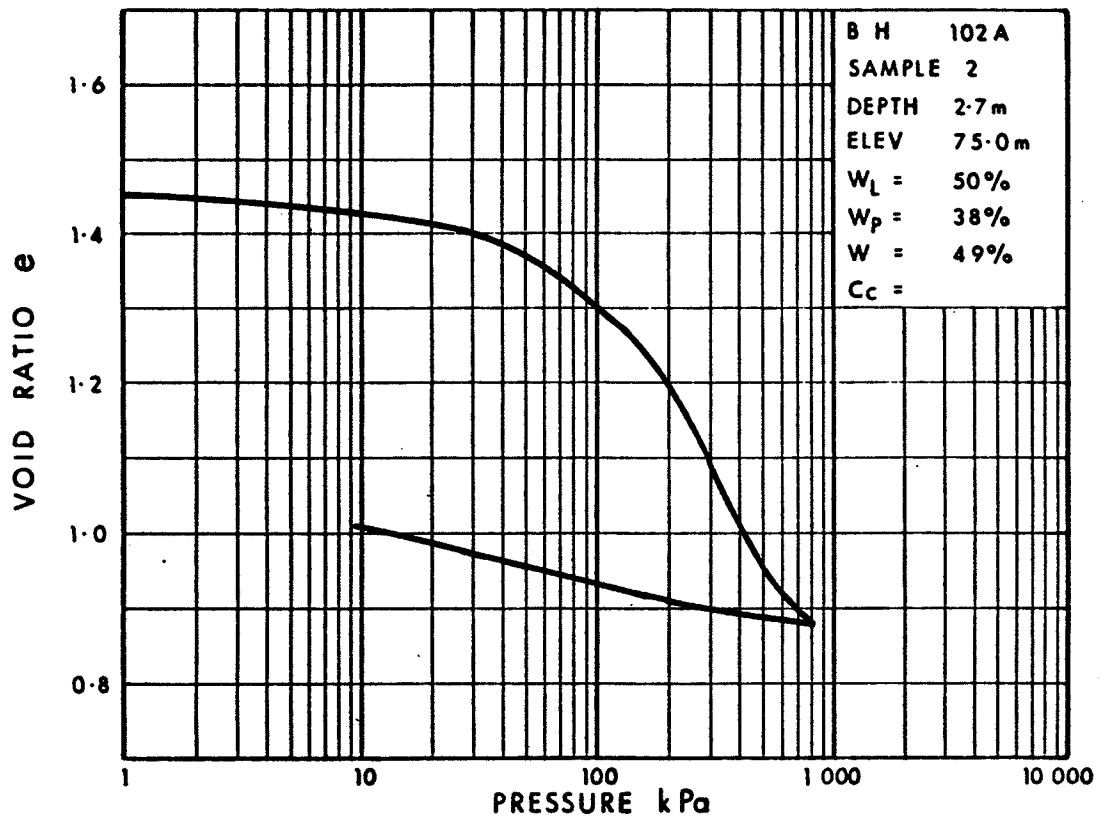
Ministry of
Transportation and
Communications



W P GGE - 310

REF. No. 83-9-16

VOID RATIO - PRESSURE CURVES



W P GGE-310

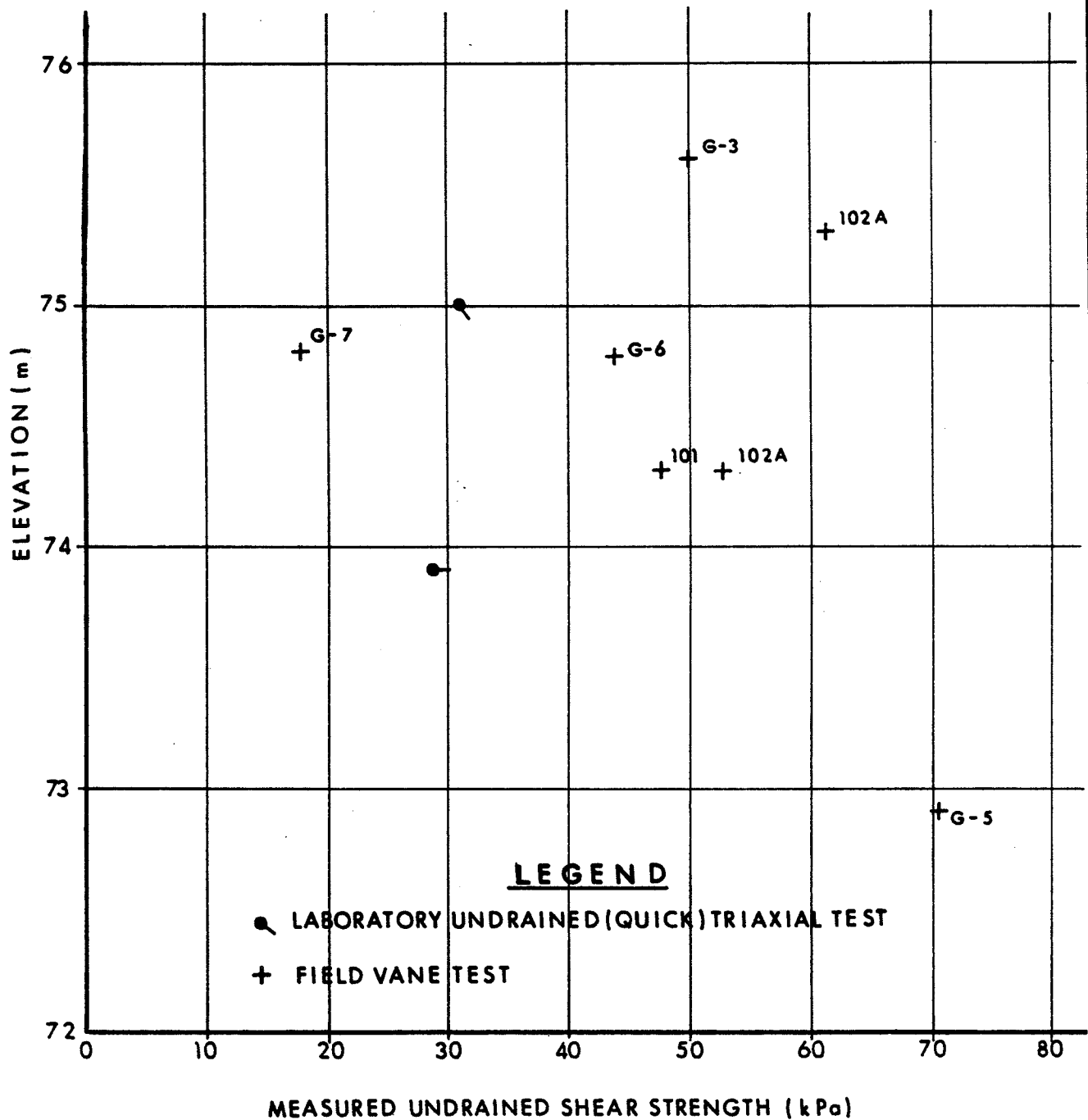


FIG. 6 MEASURED UNDRAINED SHEAR STRENGTH OF ORGANIC SOILS V. S. ELEVATION

WP. GGE-310

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine 3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"

Coarse

Fine

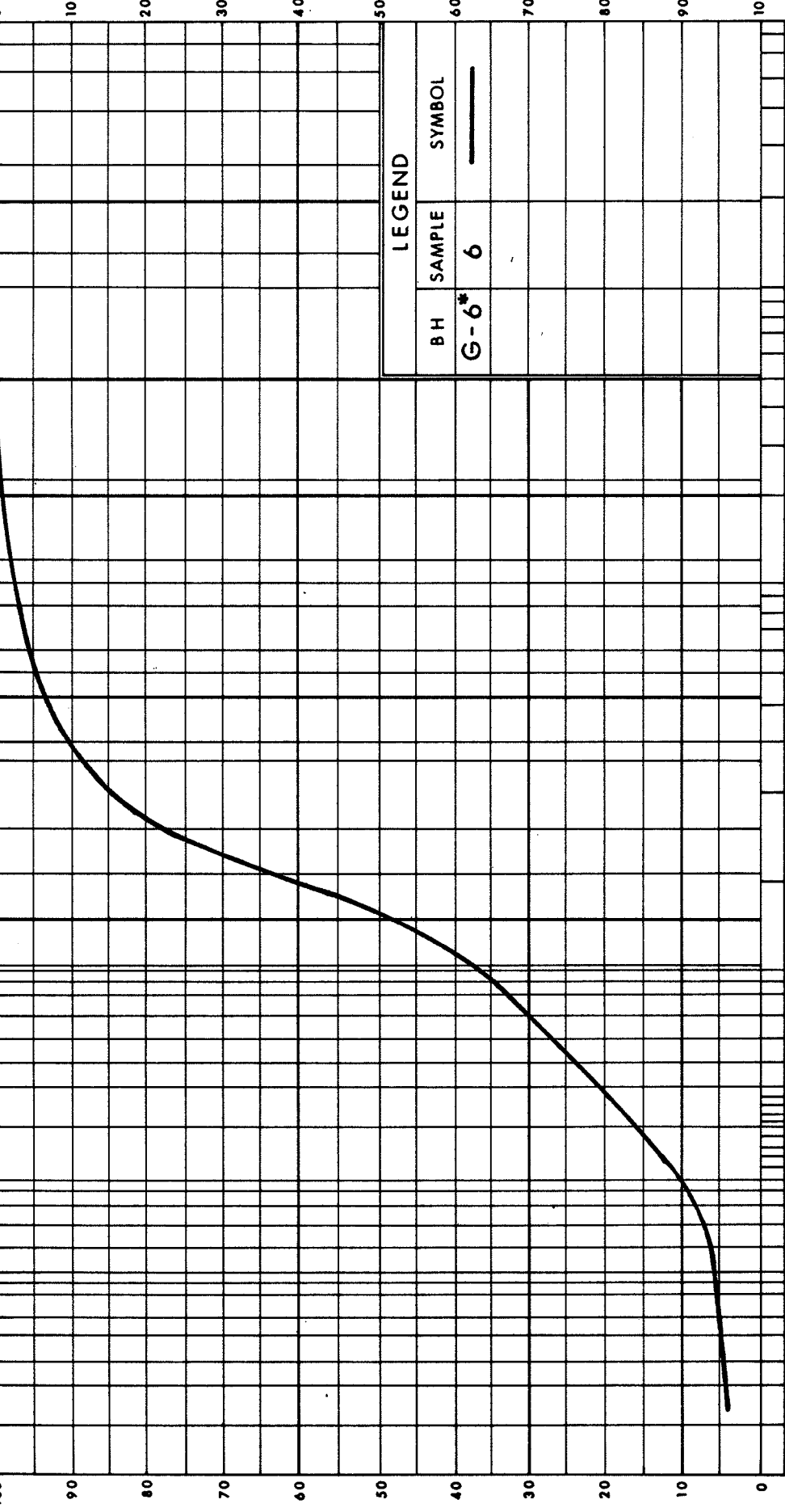
Medium

Coarse

MINISTRY SIEVE DESIGNATION

100 90 80 70 60 50 40 30 20 10 0

270 200 140 100 60 50 40 30 20 16 10.6 4



PERCENT PASSING

PERCENT RETAINED

LEGEND

BH SAMPLE SYMBOL

G-6*

6

Ministry of
Transportation and
Communications



ENGINEERING SERVICES BRANCH

GRAIN SIZE DISTRIBUTION SILTY SAND

FIG No 7

WP GGE-310

*REF.No. 85-12-8

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

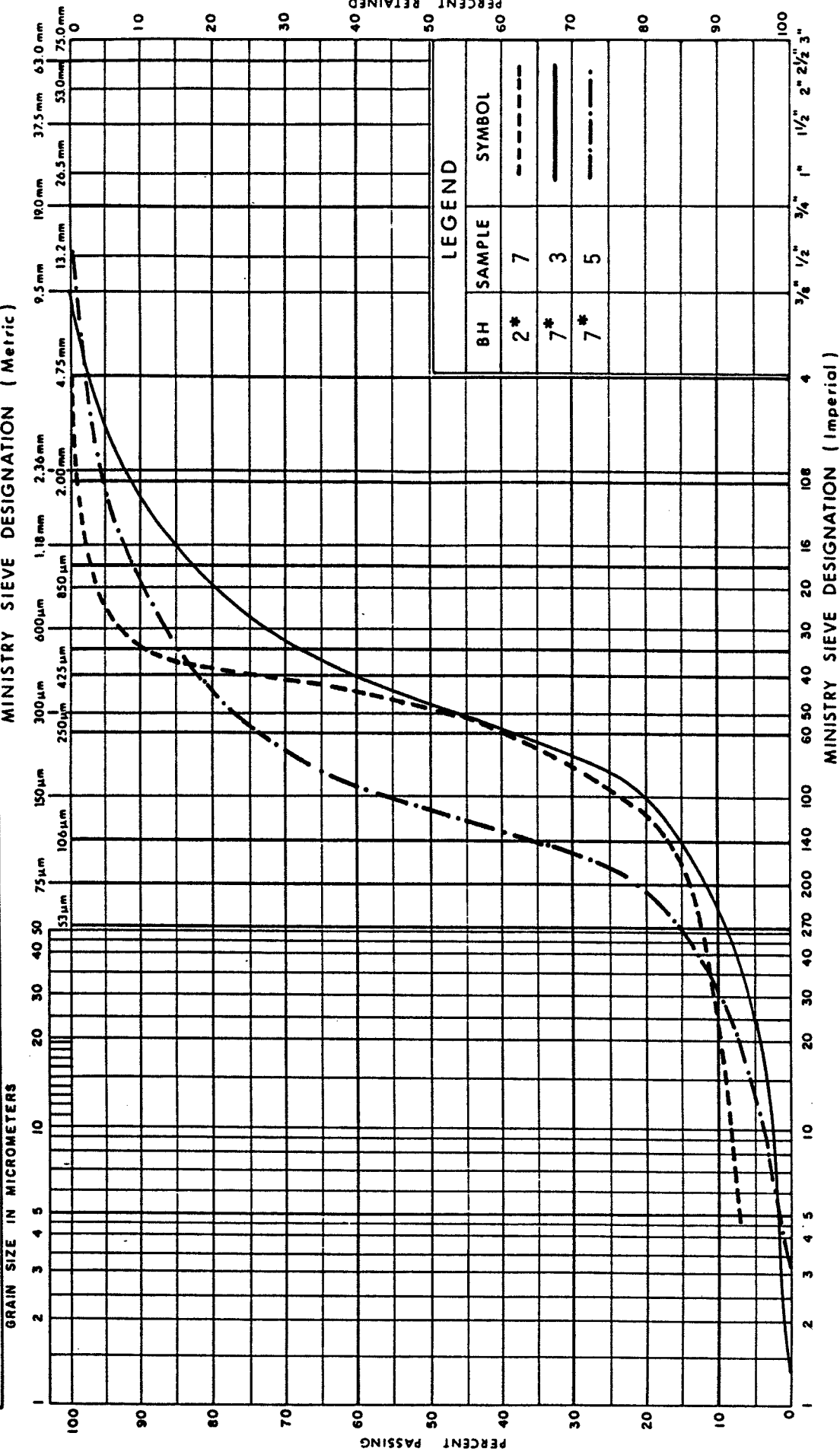


FIG No 8

W P GGE-310

REF. No. 83-9-16

GRAIN SIZE DISTRIBUTION

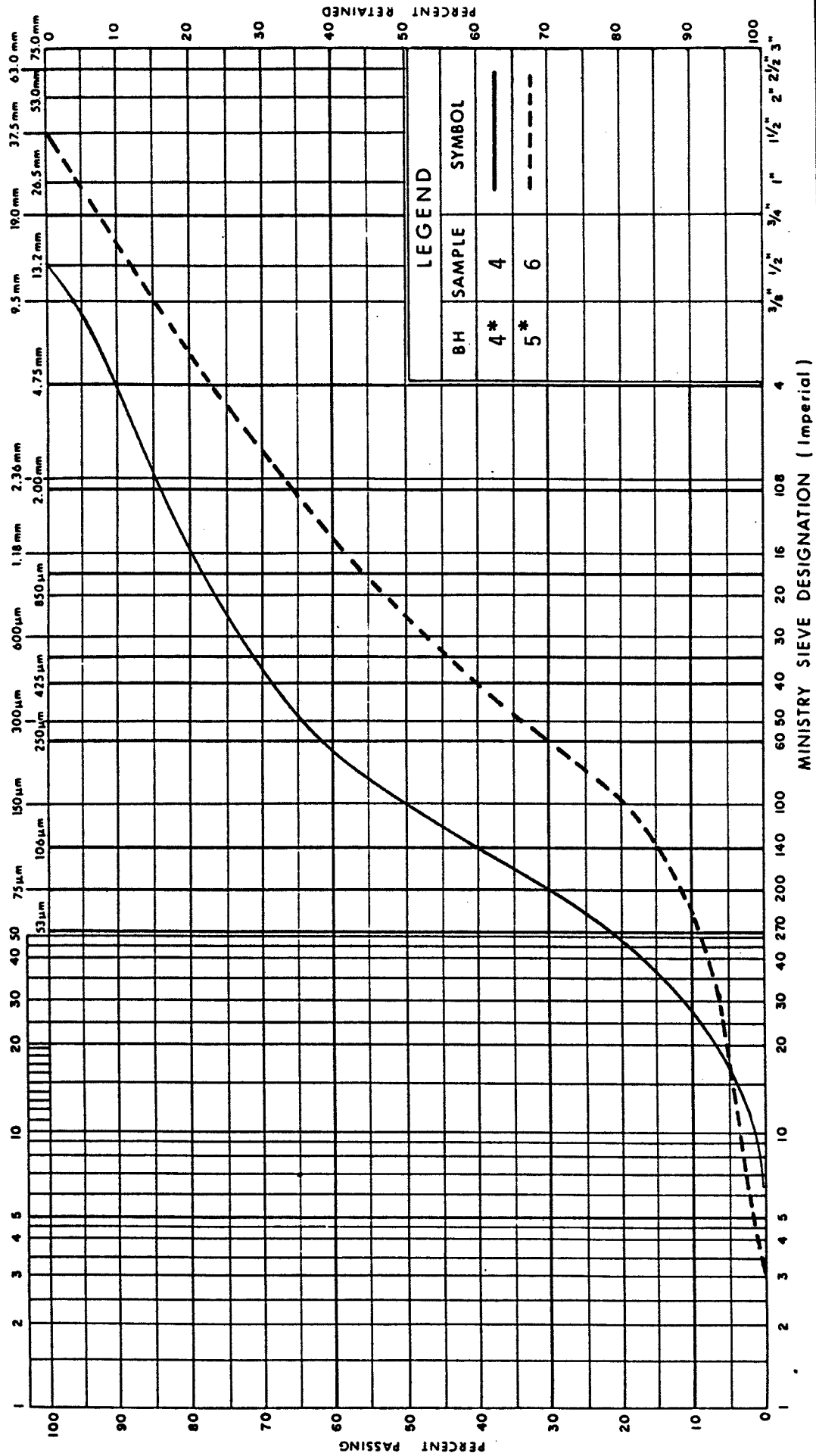
SILTY FINE SAND WITH
TRACES OF COARSE SAND

Ministry of
Transportation and
Communications



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND			GRAVEL	
GRAIN SIZE IN MICROMETERS		Fine	Medium	Coarse	Fine	Coarse
MINISTRY SIEVE DESIGNATION (Metric)		MINISTRY SIEVE DESIGNATION (Imperial)				



Ministry of
Transportation and
Communications
Ontario

GRAIN SIZE DISTRIBUTION

SILTY SAND, SOME GRAVEL
(GLACIAL TILL)

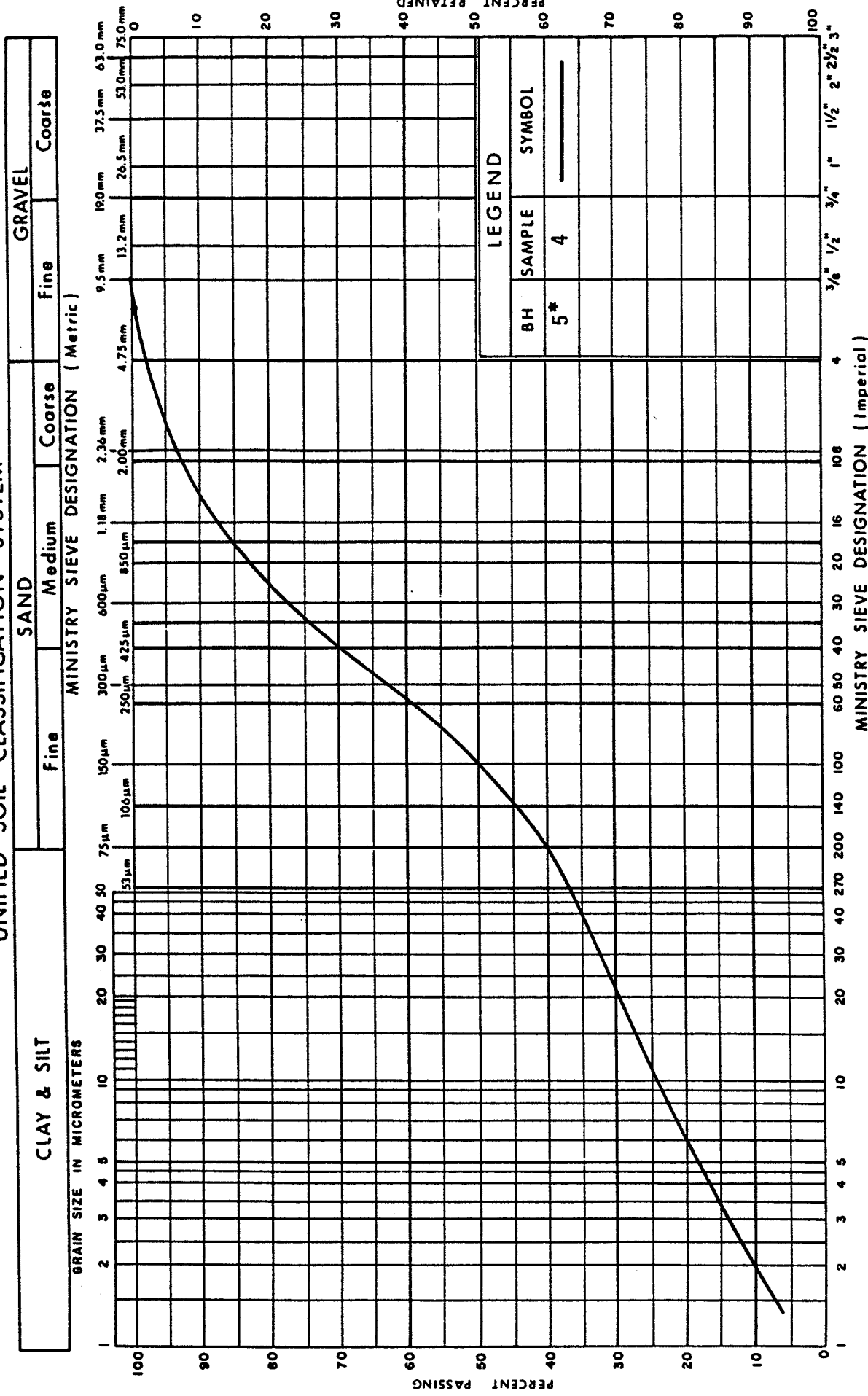
FIG No 9

W P GGE - 310

* REF. No. 83-9-16

3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"

UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation and
Communications

Ontario

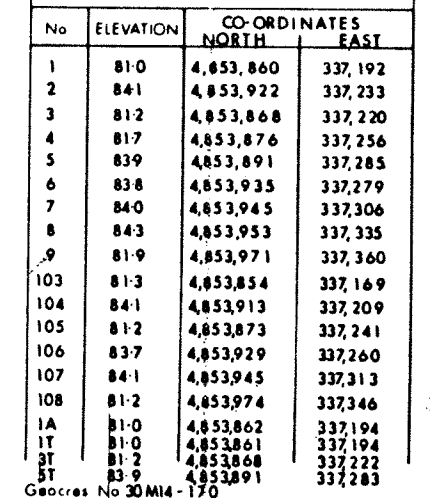
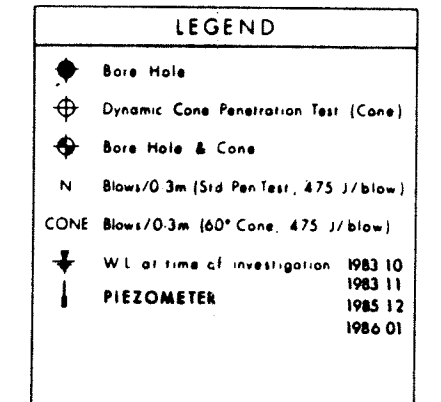
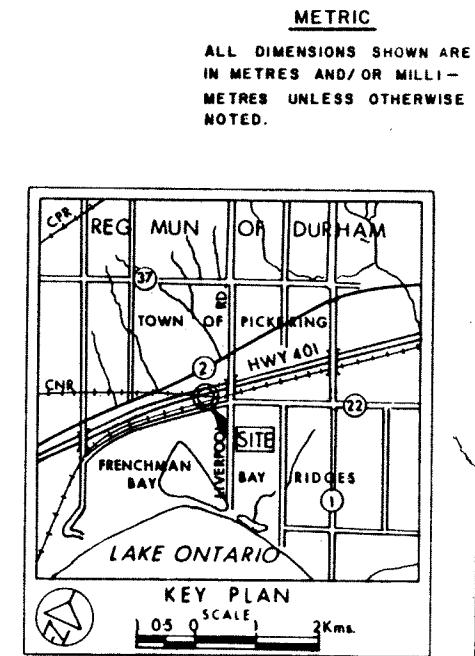
GRAIN SIZE DISTRIBUTION

**SILTY CLAY, SANDY, TRACE GRAVEL
(GLACIAL TILL)**

FIG No 10

WP GGE-310

REF. No. 83-9-16



=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. Downstream information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 10.

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: F.L.	DESIGNED BY:	GGE-310	DOMINION SOIL INVESTIGATION INC.	PROJECT MANAGER	GO-ALERT REF			
				CHK'D BY: <i>F.L.</i>	APPROVED BY:				PROPOSED CROSSING AT CN RAIL YORK SUBDIVISION AND GO COMMUTER.			
				SCALE: FULL SIZE ONLY AS SHOWN					CONTRACT NO	DWG NO GGE-310-A	REV	SHEET

METRIC

ALL DIMENSIONS SHOWN ARE
IN METRES AND/OR MILLI-
METRES UNLESS OTHERWISE
NOTED.

SEE DWG No GGE-310-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)
- W/L at time of investigation 1985 12 1986 01
- ARTESIAN WATER
- PIEZOMETER
- ARTESIAN WATER ENCOUNTERED WHILE DRILLING

No	ELEVATION	CO-ORDINATES NORTH	EAST
101	76.8	4,853,767	337,042
102	77.7	4,853,757	337,062
109	79.7	4,854,224	337,748
110	79.6	4,854,202	337,754
102A	77.7	4,853,757	337,062
G-3	78.8	4,853,732	337,028
G-5	78.2	4,853,744	337,046
G-6	76.8	4,853,757	337,036
G-7	76.7	4,853,776	337,057

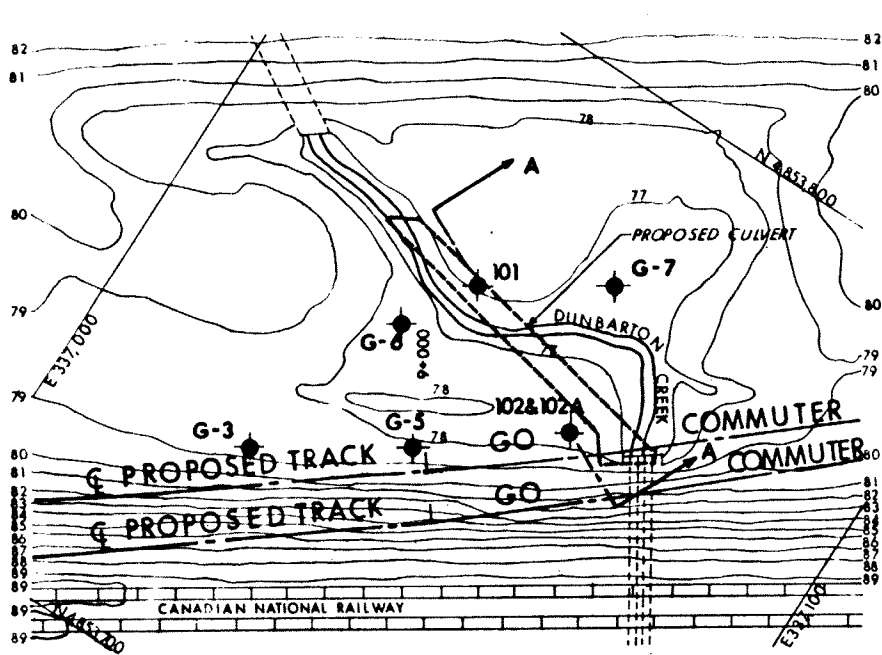
Geocres No 30M14-170

NOTE

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

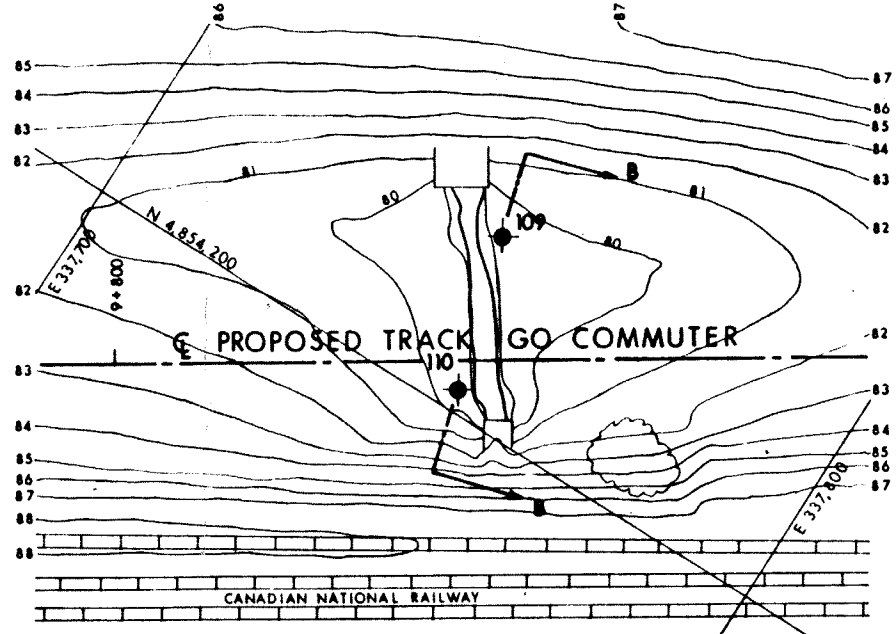
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

GO-ALRT REF

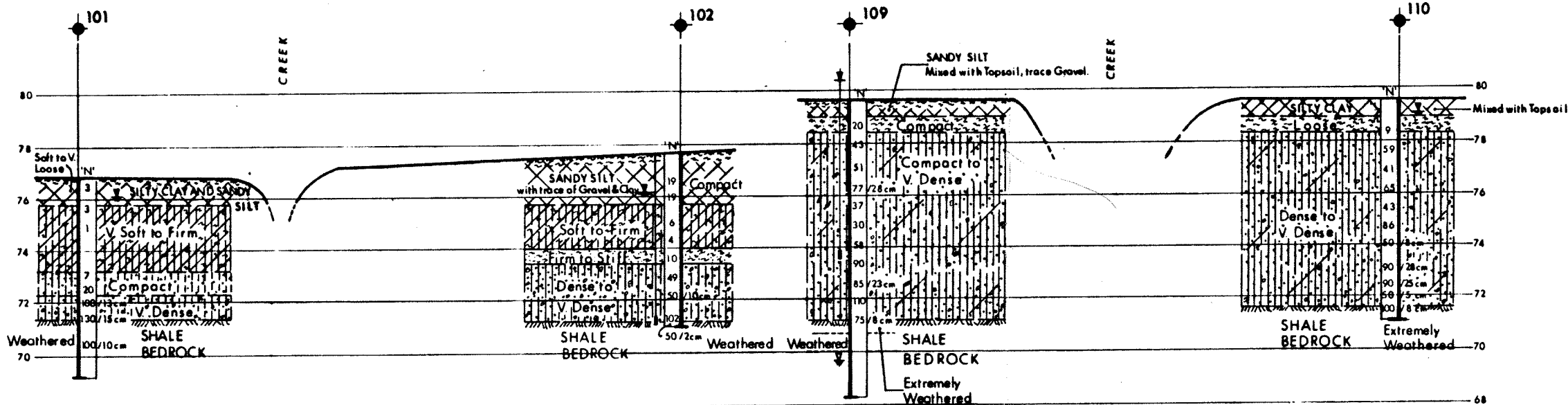


DUNBARTON CREEK CULVERT AT STA. 9+030

PLAN
SCALE
10m 0 10m



CULVERT AT STA. 9+850



A-A

SECTIONS
SCALE
3m 0 3m

B-B

LEGEND

- FILL
- PEAT
- SILTY SAND, with Silty Clay seams.
- SILTY SANDTILL, with some Clay.
- TOPSOIL
- ORGANIC SILTY CLAY
- SILTY SANDTILL, with Shale fragments.
- SHALE BEDROCK

REFERENCE DRAWINGS				REVISIONS		DRAWN BY: F.L.	DESIGNED BY:	GGE - 310	DOMINION SOIL INVESTIGATION INC.	PROJECT MANAGER	PROPOSED CULVERTS AT DUNBARTON CREEK AND STA. 9+850			
						CHK'D BY: <i>[Signature]</i>	APPROVED BY:				CONTRACT NO	DWG NO GGE - 310- B	REV	SHEET
						SCALE: FULL SIZE ONLY AS SHOWN								