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Dominion Soil Investigation Inc.  
104 Crockford Boulevard  
SCARBOROUGH, Ontario  
M1R 3C6

PICKERING TO OSHAWA  
ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION  
GGE 000-61 DIST 6  
GO-ALRT  
STR SITE CHAMPLAIN AVENUE

GEOCRES

DATE AUGUST, 1984

GEOTECHNICAL INVESTIGATION  
GO-ALRT CHAMPLAIN AVENUE  
SANITARY AND STORM SEWERS  
AND RETAINING WALLS  
NORTH OF HIGHWAY 401  
STA. 14+960 EASTERLY TO HOPKINS STREET  
STA. 9+130 EASTERLY TO STA. 10+000 (EAST OF THICKSON ROAD)  
WHITBY, ONTARIO  
PROJECT NO. GGE 000-61

Town of Whitby  
Regional Municipality of Durham  
District #6, Central Region

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1.0 INTRODUCTION

Dominion Soil Investigation Inc., Consulting Geotechnical Engineers, were authorized by the Ontario Ministry of Transportation and Communications to conduct a geotechnical investigation for proposed sewers under Champlain Avenue, north of Highway 401 in Whitby, Ontario (GO-ALRT Project No. GGE-000-61).

The two portions of the overall project that were investigated by Dominion Soil Investigation Inc. are easterly from Thickson Road South and westerly from Hopkins Street South. The easterly portion starts about 200 m east of Thickson Road and extends approximately 870 m further east. In this portion, sanitary sewers are proposed along the north side of Champlain Avenue. An approximately 200 m long north/south leg also connects to the proposed sewer line from the north along the west side of the Cadbury Plant.

The westerly portion of the investigation also comprises sanitary sewers from near the Hopkins Street intersection, westerly about 600 m under and along Champlain Avenue. Storm sewers are also proposed from the Hopkins Street intersection westerly about 200 m and also for approximately 40 m northerly along Hopkins Street. Also included in this portion of the project are possible retaining walls.  
.../...



Approximately 80 m of retaining walls may be located between Sta. 15+500 and 15+580 m (i.e. immediately west of Hopkins Street intersection) on the south side of Champlain Avenue. A second section of retaining walls, approximately 160 m long, may also be constructed on the south side of Champlain Avenue from Sta. 15+200 to Sta. 15+360 m.

The purpose of the investigation was to obtain geotechnical information of the substrata and groundwater conditions underlying the project area as relevant for the design and construction of the proposed sewers and to make a preliminary assessment of the subsurface conditions for the construction of the retaining walls.

The field work was carried out during the period of June 19 to June 23, 1984, and on June 28, 1984, and consisted of drilling forty boreholes to depths ranging from 3.5 m to 9.8 m. The locations of the boreholes, along with subsurface profiles, are shown on Drawing Nos. GGE00061-A through F. The subsurface conditions encountered in the borings are presented on the Record of Borehole Sheets (Enclosures 1 to 36 inclusive).

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2.0 SUMMARIZED SUBSOIL CONDITIONS

Details of the subsurface conditions encountered in the boreholes are given on the individual Record of Boreholes and conditions at each borehole location are also represented on the profiles presented on Drawing Nos. GGE00061-A to GGE00061-F, inclusive.

The subsurface conditions encountered in the boreholes can be summarized briefly as follows:

Below some fill and silty clay, the site is underlain by glacial deposits ranging from silty clay to silty sand till. Deposits and layers of sand were also encountered, especially in the areas covered by Boreholes 32, 33, 36 and 37.

The relevant index and engineering properties of the principal soil strata are briefly discussed in the following paragraphs.

2.1 Topsoil

The thickness of topsoil, where encountered, ranged between 0.05 and 0.6 m. In addition, in some of the boreholes, topsoil layers were contacted within or below the fill. In several areas the surface topsoil layer appears to be a regrowth topsoil fill.

.../...



2.2 Fill

The majority of the boreholes encountered fill extending to depths ranging between 0.3 and 3.3 m (Borehole 36) below the ground surface. In addition, material identified as probably fill was also encountered in some of the boreholes.

At some borehole locations the fill was found to consist of a granular material (i.e. shoulder fill). Fill consisting of silty clay mixed with some sand and traces of organics was also found in many of the boreholes. In several of the boreholes the fill was also found to consist of sandy silt or silty sand with some gravel (derived from indigeneous till materials). The composition of the fill was thus found to be variable, not only from borehole to borehole but occasionally within the same borehole. Thus differences in the engineering properties such as permeability characteristics of the fill can be expected even within short distances.

'N'-values recorded within these fill materials range from 3 to 56 blows/0.3 m, indicating that, in most cases, the fill has received some compaction.

.../...





### 2.3 Silty Clay

Silty clay was encountered in Boreholes 1, 5, 6, 10, 11, 22, 26, 27, 37, 39 and 40 at depths ranging between 0.5 and 3 m below the ground surface and in many of these boreholes it comprises the uppermost natural stratum below the fill and/or topsoil. The thickness of the material ranges from 0.2 (Borehole 26) to 3.3 m (Borehole 10).

In some cases the material has a layered, almost varved-like, structure whereas in other cases layers of material with a blocky and probably sensitive structure was also noted.

The following index properties were measured in the laboratory:

	<u>Range</u>	<u>Average</u>
Liquid Limit	49 - 53%	50%
Plastic Limit	20 - 22%	21%
Plasticity Index	28 - 31	29
Moisture Content	20 - 40%	36.2%

These values are characteristics of clays of medium-high plasticity.

Standard Penetration Resistances ('N'-values) recorded within the deposit are 5 to 23 blows/0.3 m and undrained shear strengths, as measured by field vane tests, range from 53 to .../...



more than 180 kPa. An undrained (quick) triaxial compression test carried out in the laboratory gave a value of 45 kPa. From these results, the consistency of the material is described as firm to very stiff.

The silty clay is a practically impervious material.

#### 2.4 Silty Clay Till

Silty clay till was encountered in thirty of the forty boreholes drilled at the site at depths ranging from approximately the ground surface to more than 6 m below the ground surface. In general the silty clay till overlies the coarser sandy silt till deposits, except in the easterly sections of the site, covered by Boreholes 1 to 11.

The grain size distribution of typical samples from this deposit is shown on Figure 1, indicating the following particle sizes:

Gravel	=	2 - 17%
Sand	=	27 - 42%
Silt	=	30 - 39%
Clay	=	17 - 27%

.../...



The following index properties were measured in the laboratory:

	<u>Range</u>	<u>Average</u>
Liquid Limit	21 - 32%	26%
Plastic Limit	11 - 15%	13%
Plasticity Index	8 - 21	13
Moisture Content	9 - 29%	15.6%

These values are characteristics of clay deposits of low to medium plasticity and the material can be expected to be practically impervious.

'N'-values recorded in this deposit generally range from 8 to more than 100 blows/0.3 m and field vane tests gave undrained shear strengths ranging from 66 to more than 180 kPa. From these values, the material is considered to be generally stiff to hard although 'N'-values as low as 2 blows/0.3 m also were recorded in some of the boreholes, indicating the presence of soft to firm zones within the deposit.

.../...



## 2.5 Sandy Silt Till

The predominant soil stratum in the majority of the boreholes is sandy silt till. The material is an unsorted, non-homogeneous mixture of sand, silt, gravel and clay size particles. It is frequently interbedded with somewhat coarser silty sand till and finer silty clay till layers or zones, in addition to silt and sand seams.

The grain size distribution of samples from the deposit is shown on Figures 2 and 3, indicating the following composition:

Gravel	=	2 - 25%
Sand	=	38 - 50%
Silt	=	26 - 39%
Clay	=	8 - 12%

The material has a coarser texture than the silty clay till described in Section 2.4 and is basically a non-cohesive (granular) deposit. However, due to some cementation between the particles, it exhibits some apparent cohesion. In some instances where the clay content is somewhat greater, the material has a higher degree of cementation and cohesion. The presence of some cobbles and boulders can be expected in the glacial till deposits. The sandy silt till is considered to be moderately impervious with an estimated

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coefficient of permeability (k) of the order of  $5 \times 10^{-5}$  to  $10^{-6}$  cm/sec. These values indicate moderate to small amounts of seepage through these materials. Heavier seepage can, however, be expected through the sand seams or layers present in the till. The measured moisture contents generally range from 6.5 to 9% with occasional lower values, but where the material is wet or interbedded with water bearing sand seams, higher moisture contents (up to 15%) were measured.

Penetration Resistances ('N'-values) recorded within the deposit are generally greater than 20 blows/0.3 m and in many cases, more than 50 blows/0.3 m indicating a generally compact to very dense material. However, in some cases 'N'-values were less than 20 blows/0.3 m and in several boreholes (e.g. Boreholes 1, 5, 18, 25 and 30) less than 10 blows/0.3 m, indicating the presence of very loose to loose zones or layers.

## 2.6 Silty Sand Till

Silty sand till was generally found interbedded with the sandy silt till but was less frequently encountered. It has a somewhat coarser texture, is generally uncemented and can be expected to be more pervious. The grain size distribution of samples from this deposit is presented in .../...



Figure 4 indicating the following particle size distribution:

Gravel	=	7 - 14%
Sand	=	49 - 60%
Silt	=	23 - 30%
Clay	=	7 - 10%

In general 'N'-values recorded within the silty sand till range from 17 to more than 100 blows/0.3 m, except where 'N'-values between 2 and 10 blows were recorded (e.g. Boreholes 1, 37 and 38).

## 2.7 Sand

Layers and deposits of sand were contacted at various borehole locations throughout the site. Frequent sand seams or lenses, in some cases water bearing, were generally found to be interbedded with the till deposits. In addition, relatively thicker sand layers were encountered in Boreholes 4, 18, 31, 36 and 37, while sand constitutes the predominant soil type at Boreholes 32 and 33.

In general the grain size distribution of the sand is in the fine sand range with a trace to some silt size particles, as shown in Figures 5 and 6. Occasional coarser layers or zones, however, were also encountered (Figure 7).

.../...



Based on the 'N'-values, which generally ranged upwards of 32 blows/0.3 m, the relative density of these deposits is described as dense to very dense with occasional loose zones (e.g. Borehole 37).

The sand deposits are expected to have a medium to high permeability. Below the water table considerable seepage could therefore be expected through these materials and they would also be unstable when excavated below the water table. Furthermore, the silty fine sands will exhibit a tendency to dilate and could easily be disturbed when unloaded in the trenches.

A potential problem could arise if the base of the excavation in a relatively impervious stratum too closely approaches the upper surface of a more pervious sand layer which is under excess hydrostatic pressure. In such a case, the base of the excavation could be disturbed by bottom heave or piping. Under these conditions, the excess hydrostatic pressure in the sand, below the excavation level, will have to be relieved. Although the possibility of such a condition existing is small, it is noted here, given the present invert levels, at the location of Borehole 18.

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2.8 Silt

Layers or pockets of silt were encountered at Boreholes 4, 12 and 40. The silt has a medium permeability.

The silt, and in some cases the silty fine sands and the relatively weaker and wet silty till (e.g. Borehole 37), could dilate, upon excavation, especially in the presence of water. If the material below the invert level has a liverish, jelly-like appearance during trenching, the disturbed, dilated soil must be removed and if this is not feasible, it must be stabilized by a suitable method to prevent the dilatation of the soil.

2.9 Groundwater Conditions

Groundwater conditions in the open boreholes were observed during the drilling and, where possible, periodically after their completion. In addition, sealed piezometers were installed in twenty-one boreholes in order to monitor the water levels over a prolonged period of time.

The final water levels recorded in the open boreholes and in the sealed piezometers are given on the individual Record of Borehole sheets. The groundwater levels recorded at the time of the investigation range from 0.6 to 6.3 m below the ground surface but were generally 1.5 to 3.0 m below the ground surface.  
.../...





### 3.0 DISCUSSION

The project entails the construction of sanitary and storm sewers along Champlain Avenue, which parallels the north side of Highway 401. As shown on Drawing Nos. GGE00061-A through F, the sections of the project investigated cover approximately 870 m of sanitary sewers east of Thickson Road, together with an approximately 200 m long north/south leg along the west side of the Cadbury Plant, which connects with the main east/west sewer line. Along this stretch 22 boreholes were drilled at approximately 50 m spacing. To the west of Hopkins Street, an approximately 600 m long section was also investigated for the proposed sanitary sewers. In this section, from Hopkins Street westerly approximately 200 m of storm sewers also will be constructed, together with an approximately 40 m long leg, northerly under Hopkins Street. Retaining walls also may be constructed between Sta. 15+500 and 15+580 m and also Sta. 15+200 and 15+360 m. For this section of the project eighteen boreholes were drilled at approximately 30 to 50 m spacing.

In general, the boreholes indicate the presence of glacial deposits ranging from silty sand and sandy silt to silty clay tills with some sand layers below some topsoil and fill, and in some boreholes, a relatively shallow deposit of silty clay. Although some weaker zones were encountered, the .../...



majority of these deposits were found to be competent (i.e. compact to very dense or stiff to hard). The groundwater levels at the time of the investigation were recorded at depths ranging between 0.3 and 6.3 m below the ground surface and were generally at a depth of 1.5 to 3.0 m.

The following sections of the report present our interpretation of the data and recommendations regarding the geotechnical aspects of the design for the proposed project. Potential construction problems are also discussed where these have a bearing on design decisions, however, the feasible construction methods express our opinion and are not intended to direct contractors how to carry out the construction. Contractors should also be aware that the data and their interpretation presented in this report may not be sufficient to assess all the factors that may have an effect upon the construction.

### 3.1 Proposed Sewers

The sanitary sewers will be 250 to 300 mm in diameter and the invert depths will generally be 3.0 to 5.5 m below the existing ground surface. The short storm sewer section near Hopkins Street will consist of 525 to 675 mm diameter pipes with invert levels 2.0 to 2.5 m below the surface of the road.

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### 3.1.1 Engineering Properties of Main Soil Types

Summarized engineering properties and the anticipated behaviour of the various soil types as relevant for the design and construction of the proposed sewers are as follows.

#### a) Fill

As discussed in Section 2.1, fill was encountered in the majority of the boreholes to depths ranging from 0.3 and 3.3 m. At many borehole locations the upper 0.6 m of the fill consisted of a granular pavement fill. In the majority of the boreholes, however, the composition of the fill was found to vary from silty clay to silty sand or a mixture of these materials including topsoil.

In open excavations above the groundwater table, the fill is expected to be stable at angles ranging between 45 and 30° to the horizontal. Below the water table, even flatter side slopes may be necessary. The rate of water flow through the fill, depending on the composition, can be expected to range from small where the fill is predominantly clay, to heavy where the material is basically granular. The reuse of these materials as backfill will depend to a great extent on the degree of contamination by organic soils and soil fines. In general, if they are not excessively contaminated, the more granular materials can be reused as backfill.  
.../...



b) Silty Clay

Eleven of the boreholes contacted clay layers generally immediately below the fill. In general, the thickness of these layers ranged from 0.3 to 1.5 m, but at the location of Boreholes 6, 10 and 11 the material was 1.9 to 3.3 m thick. The consistency of these deposits was generally firm to very stiff. Atterberg Limit tests indicated a medium-high plasticity while the recorded natural moisture contents were generally found to be about midway between the plastic and liquid limits.

In general these deposits can be expected to be practically impervious and, due to the relatively high moisture contents, unsuitable for backfilling, especially within the narrow confines of a service trench. It is expected that the material can stand unsupported for short periods of time at relatively steep angles both above and below the water table.

c) Silty Clay Till

The silty clay till encountered in a large number of boreholes is one of the predominant soil strata at the site. Where the till is hard to stiff (i.e. in the majority of the boreholes), it is expected that the material will stand unsupported for short periods of time with relatively steep side slopes both above and below the water table. The .../...

seepage of groundwater, below the water table may, in time, cause some ravelling resulting in flatter side slopes. Unstable side slopes can be expected occasionally where the soil consistency is soft to firm (i.e. 'N'-values less than 8 blows/0.3 m or undrained shear strength less than 50 kPa).

The silty clay till is a practically impervious material and will not yield any significant amounts of water even below the water table. No seepage problems are therefore anticipated within this material during the construction. As a backfill material, the silty clay till will, however, be difficult to compact in the narrow confines of a trench.

d) Silty Sand & Sandy Silt Till

Sandy silt tills, together with the slightly coarser silty sand tills comprise the predominant soil type at the site. They are well sorted and well-graded materials consisting of gravel, sand, silt and clay size particles. These materials are somewhat more pervious than the silty clay till and especially through the silty sand tills some seepage can be expected below the groundwater table. In addition, they are frequently interbedded with sand seams. The sandy silt till and, to a certain extent, the silty sand tills, exhibit some cementation and are expected to be stable at relatively steep side slopes for short periods of time, even below the .../...



groundwater table. In time, however, ravelling and instability can be expected, especially within the coarser zones of the material and where the water bearing sand seams are intercepted.

Theoretically, the well-graded sandy silt and silty sand tills can be compacted to a high density; however, owing to the high silt content, they will be sensitive to the moisture content of the material during compaction. In order to achieve satisfactory compaction, the moisture contents must be kept close to the optimum and heavy compaction equipment must be employed.

e) Sand

Sand is the predominant soil type at Boreholes 32 and 33 and layers of sand were encountered in Boreholes 4, 18, 31, 36 and 37. In addition, relatively thin sand seams also were encountered stratified within the till deposits.

The sand deposits encountered at the site are expected to have a moderate to high permeability and would therefore yield a considerable amount of water below the groundwater table. They would also be unstable when excavated below the groundwater table.

.../...



In general, they are uniformly graded fine grained materials, and especially where they have a high silt content, they will show a tendency to dilate and to be disturbed when unloaded (i.e. in the trenches).

Owing to their uniform grading and fine texture these materials, except for the coarser layers, can be expected to be somewhat difficult to handle and to compact in a trench, especially when wet.

### 3.1.2 Trenching

In general, hard digging conditions are expected only in the very dense cemented till or the hard cohesive till or where boulders were encountered. Therefore the excavation in most of the soil types encountered generally should not present unusual problems.

The sides of the excavations in the fill will be stable at 45° side slopes. Where the fill is deep and/or weak or below the water table, flatter slopes will be required (e.g. Borehole 29). Where space is limited, support will likely be necessary.

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The clays and glacial tills are expected to be stable at relatively steep side slopes, but to comply with the Safety Regulations, unsupported cuts more than 1.2 m deep should have side slopes no steeper than  $45^{\circ}$ . Steeper cuts into the dense to very dense or very stiff to hard till will require temporary support (bracing and skeleton sheeting) or protection for the workmen could be provided by trench boxes. Support must be increased (close or tight sheeting) where the till is loose or weak (e.g. Boreholes 1, 38, 39 and 40) and/or uncemented, or where saturated sand layers are encountered (e.g. Borehole 4). The proximity to the road traffic or other surcharges should also be considered when designing the support system. With an open cut excavation system, possible damage to the existing pavement and the underlying adjacent service pipes should be considered.

In the till materials, provided the trenches are excavated in short sections, the pipes are installed immediately, and the trenches backfilled as quickly as possible, it is believed that, in most cases, even below the water table, dewatering by gravity drainage and pumping from filtered sumps will suffice. At some isolated locations (e.g. Borehole 20) where the till is coarse textured and relatively more pervious (silty sand) or where larger sand seams or lenses are intercepted by the excavation (e.g. Borehole 4), .../...





substantial pumping or the use of wellpoints or deep wells or tight interlocking sheeting may be required to control seepage.

The silty clay deposits are nearly impervious, therefore, no significant amount of seepage is expected to occur through these deposits even below the water table. However, seepage through the overlying fills, where they extend below the water table, could be significant especially if the fill is made up of essentially pervious materials. Seepage through these fill deposits could also be encountered due to a perched water table created by the accumulation of surface infiltration beneath the road surface or within the backfill around the existing underground utilities.

The sand deposits are pervious and will yield high flows. Below the water table they will be unstable and must therefore be stabilized by proper dewatering. If the excavation extends only a short distance below the water table (not more than 0.3 m), then it likely will be possible to dewater and stabilize the sand by pumping from filtered sumps extending some distance below the base of the excavation. Where the excavations extend deeper below the water table, the soil will have to be stabilized by wellpoints or where the aquifer is of limited extent, by deep .../...



wells. Alternatively, the excavation could be carried out inside tight interlocking sheeting and the sand could be dewatered by pumping from filtered sumps inside the sheeting. In this instance the sheeting must be driven into an impervious stratum, or a sufficient distance below the bottom of the excavation where an impervious stratum is not present. As a rule of thumb, a distance equal to at least the height of water table above the bottom of the trench, should be sufficiently deep.

At the location of Boreholes 32 and 33, where sand was encountered, the water table at the time of the investigation was found to be at approximately the invert levels. Therefore, depending on the position of the water table at the time of the construction, dewatering by pumping from filtered sumps will likely suffice. At the location of Borehole 36, on the other hand, the use of tight interlocking sheeting or deep wells may be necessary.

The silt, and in some cases the silty fine sands and the relatively weaker and wet silty till (e.g. Boreholes 1 and 37), could dilate, upon excavation, especially in the presence of water, and if the pipes are laid on the disturbed dilated subgrade, significant post-construction settlements could occur. If the material below the invert level has a .../...



liverish, jelly-like appearance during trenching, the disturbed, dilated soil must be removed and if this is not feasible, it must be stabilized by a suitable method (e.g. vacuum wellpoints) to prevent the dilatation of the soil. The stabilized material will stand at  $45^{\circ}$  side slopes. To be effective, the header pipe of the wellpoint system should not be more than 4 m above the invert of the trench.

We recommend that the trenches be opened up in short sections and backfilled as soon as possible. In our experience where only minimal dilatation has occurred, satisfactory results have been obtained by carrying out the excavations in short sections, using geofabric in conjunction with a thick layer of crushed stone bedding and backfilling the trench immediately.

For earth pressure calculations on temporary sheetings, the earth pressure distribution given in Figure 10 can be used. As mentioned before, however, careful consideration must be given to support the existing road and any surcharges or live loads due to the traffic must be taken into account in the design of the trench support system.

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### 3.1.3 Bedding

All major soil deposits (except the fill and organic soils) encountered in the boreholes will provide adequate support for the sewers and therefore normal Class B type bedding (M.T.C. Standards DD-823) will be acceptable.

The recommended minimum thickness of bedding material beneath the pipe is 150 mm. The bedding material should also be placed around the pipe and to a level at least 300 mm above the crown of the pipe and preferably more. Where the subgrade is weak, loose (e.g. B.H. 1) or very silty and dilatant, the thickness of the bedding below the pipe should be increased to 300 mm. All organic materials (i.e. topsoil, etc.) and fill should be removed below the invert of the pipes and replaced by well-graded and compacted imported granular fill (e.g. Borehole 29). We recommend that the conditions within the trench be carefully observed for weak spots to the west of Borehole 37 and for the presence of fill materials to the west of Borehole 39 where the existing sewer line will be approached.

Where the pipes are to be laid on predominantly bouldery overburden, boulders and cobbles over 150 mm diameter should be removed to a depth of 450 mm below the invert and replaced by well compacted granular bedding material.

.../...



We recommend that the bedding material consist of well graded Granular 'A' material. The use of clear crushed stone bedding is not recommended, especially where the subgrade is silty or fine sand or uncemented silty till, as the fines from the subgrade could infiltrate into the large voids of the bedding material causing settlement of the pipe after construction.

Where the base is wet, the use of clear crushed stone bedding may help expedite the operations. In this case the use of clear crushed stone would be feasible if a suitable geofabric, such as Terrafix 270R (or equivalent), is used as a separator. The geofabric should be placed to entirely separate the subgrade and the sides of the trench from the bedding material. Furthermore the infiltration of fines from the backfill material into the clear crushed stone is also possible. Therefore, since this may cause the post-construction settlement of the paved road surface, the surface of the crushed stone also may need to be covered with the geofabric.

The anticipated trench base conditions at each borehole location are summarized in tabular form in the Appendix.

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#### 3.1.4 Backfilling

The degree of compaction of the backfill in the trenches beneath the paved roads and other areas where future settlements are of concern, should be at least 95% of the Standard Proctor maximum dry density.

The granular road fill materials underlying the existing pavements and shoulder areas will be excellent materials for trench backfill provided these granular soils are not excessively contaminated during stripping and subsequent handling, particularly with organic matter.

The predominantly clay fills, especially where contaminated with organic soils, topsoil, etc., are considered to be unsuitable for backfilling in the trenches.

The silty clays (Section 2.3) have poor compaction characteristics. Heavy sheepsfoot compactors will be required and, especially when the material is wet of optimum, it will be very difficult to achieve a high degree of compaction. Based on experience, the optimum moisture content for these materials is generally within 3% of the plastic limits. Reference to the laboratory test results (i.e. Atterberg limit and moisture content values) shows that the measured moisture contents are generally about 10% to 12% .../...



above the plastic limits (i.e. generally too wet for a high degree of compaction).

The silts (Section 2.8) too exhibit poor compaction characteristics (i.e. difficult to handle and to compact), especially when wet. These soil types are therefore considered to be undesirable materials for trench backfill where good compaction is required.

The silty clay tills (Section 2.4) are relatively well-graded and, in most cases, the measured moisture contents were conducive to good compaction (i.e. close to the optimum). These materials, however, will require heavy compactors and thin lifts, together with careful supervision and selection of the materials. When too wet, it will not be possible to achieve a high degree of compaction and when too dry, experience has shown that they may excavate in blocks or chunks. In such a case, unless very thin lifts are used, post-construction settlements will occur, even though a high degree of compaction has been achieved. This is believed to occur over a period of time, as water percolates downwards in the trench, the voids are filled-in, causing settlements.

.../...



The sandy silt and silty sand tills (Section 2.5 and 2.6) are well graded and therefore can be compacted to a high density. Due to the high silt content, however, these materials are sensitive to the moisture content of the soil during compaction. Experience indicates that high densities can only be obtained at moisture contents close to the optimum. For proper compaction, relatively thin lifts of the material, close to optimum moisture content and heavy compactors will be required. It is believed that studded pad-type compactors are best suited to compact these materials. It is expected that these conditions will be difficult to satisfy within the narrow confines of a trench, especially below the water table. In a wet condition, the till will be unsuitable for compaction. For these reasons, if narrow trenches are considered, the use of imported material for backfill under the road base may prove to be more practical.

The fine sand and silty sand deposits (Section 2.7) can be used for backfill in the trenches, but due to their uniform grading they will be somewhat difficult to handle and compact in a trench, especially when wet.

Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc., should not be used for backfilling.

.../...





In summary therefore, it is our opinion that the existing clean granular fill, sand deposits, sandy silt to silty sand glacial tills and possibly the silty clay glacial tills could be used for backfilling in the trenches, if the contractor is able to achieve the required degree of compaction. To determine this we recommend that short test sections be carried out at the beginning of the contract.

In all cases, the achievement of a uniform degree of compaction is equally as important as the degree of compaction. Furthermore, to minimize the effects of differential frost heave, the use of the indigenous materials for backfilling, where possible, could be encouraged within the depth of frost penetration (i.e. to approximately 1.5 m below the road surface).

### 3.2 Retaining Walls

Consideration is being given to employing gravity wall structures to support two sections of Champlain Avenue. The first is an approximately 80 m long section of Champlain Avenue, westerly from the Hopkins Street intersection (area covered by Boreholes 24, 25, 26 and 27) while the second is an approximately 160 m long section further west (area covered by Boreholes 30 through 35). We understand that the retaining toe-walls will be generally 1.0 to 2.5 m in height .../...



and the ground behind them will be sloped at an angle of 2 horizontal in 1 vertical for a vertical distance of 1 to 2.5 m.

### 3.2.1 Foundations

Boreholes 24 to 27, inclusive, contacted fill and materials identified as probably fill to depths ranging between 1.5 and 2.5 m below the ground surface. Below the fill, the boreholes showed the presence of stiff to very stiff silty clay and silty clay till and very loose to very dense sandy silt till and silty sand till deposits. The groundwater table at the time of the investigation was recorded at 1.8 to 2.7 m below the ground surface. The subsurface conditions along this section, therefore, present a complex picture.

The proposed foundation elevations for this section of the wall range from 88.1 m on the east end of the wall to 87.4 m on the west end. The existing road surface elevation is 91<sup>+</sup> m.

Based on the field test results, the following tentative soil bearing values are proposed for the design of foundations at each borehole location.

.../...



B.H. No.	Existing Ground Elevation @ B.H. Location (m)	Proposed Foundation Elevation (m)*	<u>Recommended Soil Bearing Capacity</u>	
			<u>Ultimate Limit States (kPa)</u>	<u>Serviceability Limit States Type II (kPa)</u>
24	91.3	88.1	320	180
25	91.1	87.9	240	120
26	90.8	87.7	300	150
27	90.7	87.4	320	180

\* From Drawing No. 83138-WF033

At the westerly toe-wall location, Boreholes 30 to 35, inclusive, indicate the presence of up to 2.5 m of fill underlain by generally sandy silt till at Boreholes 30, 31, 34 and 35 and fine sand at Boreholes 32 and 33. The water table was recorded at 2.0 to 6.3 m below the ground surface. Along this section, the proposed foundation elevation ranges from 86.2 metres at the east end, to 85.0 m at the west. The existing road grade generally ranges from 91 to 92 m. Based on the field test results, the following tentative soil bearing values are proposed at each borehole location.

.../...



B.H. No.	Existing Ground Elevation @ B.H. Location (m)	Proposed Foundation Elevation (m)*	Recommended Soil Bearing Capacity	
			Ultimate Limit States (kPa)	Serviceability Limit States Type II (kPa)
30	90.8	86.2	800	400
31	90.7	85.8	800	400
32	91.6	85.5	600	250
33	92.7	85.3	600	250
34	91.7	85.2	800	400
35	91.9	85.0	800	400

\*From Drawing No. 83138-WF032

Maximum total and differential settlements corresponding to the recommended tentative bearing pressures for Serviceability Limit States - Type II are expected to be of the order of 25 and 18 mm or less, respectively except possibly at the location of Borehole 25 where, depending on the size of the footing, up to 35 mm of total settlement could occur.

.../...



Under inclined loading conditions, the bearing capacity at the Ultimate Limit State should be reduced in accordance with Clause 6.7.3.3.5 of the Ontario Highway Bridge Design Code, 1979 (O.H.B.D.C.).

The footings should have a minimum 1.2 m of permanent earth cover for frost protection.

It should be pointed out, however, that these tentative values must be reviewed once the design concept is finalized. It will probably be necessary to drill additional and deeper boreholes as the conditions were found to be variable and, in some cases, the boreholes did not extend to a sufficient depth below the proposed foundation levels (e.g. Boreholes 25 and 35).

### 3.2.2 Lateral Earth Pressures

Lateral earth pressures will depend on the final design concept. It is our opinion that for the proposed toe-walls the properties of the existing soils also may need to be taken into account, in addition to the backfill material. The magnitude and distribution of the lateral earth pressures may depend also on the construction methods (i.e. construction slopes, width of the backfill area, etc.). The boreholes show that the existing soils vary from granular to clay fills .../...



(in some cases contaminated with organic soil), stiff to very stiff silty clays or silty clay tills, to loose and very dense till and sand deposits. Thus the retained soils will consist of a wide range of materials with variable consistencies and relative densities. Therefore, the conditions will have to be examined closely when the concept is finalized and a detailed investigation is conducted.

Tentatively, however, for preliminary design purposes, the design can be carried out assuming a granular backfill material having an angle of friction ( $\phi$ ) of  $30^{\circ}$ . When determining the active earth pressures from this value, the inclined ground behind the wall must be taken into account (i.e. 2 horizontal in 1 vertical slope). Live loads from the existing road must also be added in accordance with the Ontario Bridge Design Code.

The over-compaction of the backfill could lead to the development of large horizontal pressures behind the retaining walls. Vibratory compaction equipment for use behind the walls therefore must be restricted in size, as per current M.T.C. Specifications.

Provisions must be made to prevent water accumulation behind the wall.

.../...



For preliminary evaluation of the sliding resistance of the foundations, the ultimate value of the angle of friction between the underside of the foundation and the undisturbed subgrade can be assumed to be as follows for various soil types encountered in the boreholes:

Very Stiff Silty Clay	= 20°
Very Stiff Silty Clay Till	= 21°
Dense to Very Dense Sandy Silt Till (or Silty Sand Till)	= 24°
Dense to Very Dense Fine Sand	= 23°

In addition, where the subgrade is cohesive (e.g. Boreholes 24, 25, 26 and 27), sliding resistance should be checked by the shear resistance of the soil. Based on the present information, a conservative value of 60 kPa is suggested for the undrained shear strength of the soil. To this an appropriate safety factor (e.g. 1.75) should be applied.

### 3.2.3 Construction

The excavations must be adequately supported in accordance with the Safety Regulations of the Province and the stability of the road should be preserved during the construction.

As the excavations, in most cases, can be expected to extend below the groundwater table, dewatering will be required. Where the excavations are in the silty clay or cemented till .../...



deposits, groundwater seepage should be moderate and can be handled by pumping from sumps (filtered where necessary).

It may be necessary to pour a concrete 'mud mat' to minimize the disturbance of the subgrade.

Where the excavations extend below the water table within the sand deposits (e.g. Boreholes 32 and 33), other dewatering methods such as wellpoints, will be required to stabilize the soil and to preserve the bearing capacity of the subgrade.

.../...



4.0 CLOSURE

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

DOMINION SOIL INVESTIGATION INC.

*Z. S. Ozden*

Z.S. Ozden, P.Eng.

ZSO:bh



*R. N. Rutka*

R.N. Rutka, P.Eng.

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 (RQD), FOR MODIFIED RECOVERY, IS:

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

**JOINTING AND BEDDING:**

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

ABBREVIATIONS AND SYMBOLSFIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	l	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
$E$	kPa	MODULUS OF LINEAR DEFORMATION
$G$	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	l	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	$e$	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	$n$	1, %	POROSITY	$I_D$	l	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	$w$	1, %	WATER CONTENT	$D$	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	l	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	$h$	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	$q$	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	$v$	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	l	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	$i$	l	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL						

PROCEDURES

The field work was performed during the period of June 19 - 23 and on June 28, 1984, and consisted of drilling forty boreholes at the locations shown on Drawing Nos. GGE00061-A to F.

The test holes were advanced to depths ranging between 3.5 and 9.8 m using two power auger drill rigs equipped for soil sampling with both standard solid stem and hollow stem augers. Sampling in the boreholes was accomplished by the Standard Penetration test method and the test results, recorded as Penetration Resistances or 'N'-values, were used to infer the relative density or the consistency of the soil strata. In addition, where the consistency permitted, the undrained shear strength of the cohesive substrata was measured in-situ by means of field vane tests. A relatively undisturbed soil sample was also retrieved by a thin-walled (Shelby) tube sampler. Sealed piezometers were installed in approximately every second borehole to enable us to monitor the groundwater conditions over a longer period of time.

.../...

Ref. No. 84-6-7

The drilling rigs used are owned and operated by D.S.I.L. Drilling Inc., and the field work was carried out under the supervision of the engineering staff of Dominion Soil Investigaton Inc., who located the borings in the field, directed the drilling and sampling operations and logged the borings.

The following benchmarks were used to determine the ground surface elevations at the borehole locations:

Benchmark No. 1: Top of concrete box culvert at 3.4 m left of Sta. 0+617.4 (near Borehole 6), Elevation 86.034 m.

Benchmark No. 2: Top of concrete box culvert (near Borehole 10), Elevation 88.186 m.

The elevations of these benchmarks were obtained from a Plan supplied to us by DSL Lea Transportation Consultants.

Benchmark No. 3: Filed 'X' on northwest corner catch-basin rim, 21.4 m left of Sta. 25+537.6 m Elevation 90.770 m.

Benchmark No. 4: Southeast corner of concrete base of hydro transformer, 37.7 m left of Sta. 25+330.9 m, Elevation 91.250 m.

The elevations of these two benchmarks were provided to us, over the telephone, by DSL Lea Consultants.

.../...

Ref. No. 84-6-7

After the completion of each borehole the soil samples were shipped to our laboratory where they were further identified and classified. A laboratory testing program consisting of Atterberg limit, bulk unit weight, undrained (quick) triaxial compression tests and grain size analyses was performed on selected samples. The test results are shown on the Record of Borehole sheets. The grain size distribution curves are given on Figures 1 to 7, inclusive, and the Plasticity Charts are presented on Figures 8 and 9.

BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>3</sub>	ε <sub>f</sub>	GROUP SYMB.
No.	m	per cent	per cent	G	S	F		-2μ										
1	2	1.7	33.5															
	3	2.5	11.4	13.0	10.0	3.0												
	4	3.5	12.8															
	5	4.0	8.1															
	6	4.8	8.0															
2	2	1.7	11.7					11	44	45	9							
	3	2.5	8.1															
	5	4.0	9.9	24.3	9.9	14.4		3	42	55	25							
5	4	3.3	26.7															
	5	4.0	19.1															
	6	4.8	14.3															
6	4	3.3	29.5															
7	2	1.7	14.5															
8	1	0.9	15.2															
	2	1.7	7.2															
	3	2.5	6.5					25	41	34	8							

SUMMARY OF LABORATORY TESTS



BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>s</sub>	E <sub>f</sub>	GROUP SYMB.
								G	S	F	-2μ							
								No.	m	per cent					per cent			
10	3	2.5	22.4															
	4	3.3	22.1															
	5	4.0	38.9	52.6	21.5	31.1												
	6	4.8	33.5							17.6			45	117	2.4			
	7	5.8	17.0															
11	4	3.3	27.0															
	5	4.0	28.8															
	6	4.8	37.4	48.9	20.1	28.8												
	7	5.8	26.9															
13	1	0.9	18.1															
	2	1.7	7.6															
	3	2.3	7.5					14	49	37	7							
	4	3.3	7.4															
15	1	0.9	19.5	29.0	15.0	14.0		2	40	58	27							
	2	1.7	20.8															
	3	2.5	7.3															
16	1	0.9	11.1															
	2	1.7	8.7					15	38	47	12							

## SUMMARY OF LABORATORY TESTS



BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>s</sub>	ε <sub>f</sub>		GROUP SYMB.		
No.	m	per cent						G	S	F	-2μ	kn/m <sup>3</sup>									
								per cent													
16	3	2.4	7.3																		
	4	3.3	6.9																		
	5	4.0	7.4																		
	6	4.8	7.5																		
17	1	0.9	14.8																		
	2	1.7	11.0	23.3	11.9	11.4															
	3	2.5	10.5									22.4									
	4	3.3	8.6					12	43	45	10	22.3									
18	2	1.7	15.1																		
	3	2.5	11.3																		
	5	4.0	7.3																		
	6	4.8	7.7					7	60	33	10										
20	1	0.9	13.2																		
	2	1.7	8.9																		
	3	2.5	6.6									23.5									
21	1	0.9	14.0																		
	2	1.7	12.5	25.0	12.0	13.0						21.2									
	3	2.5	6.8					2	48	50	11										

## SUMMARY OF LABORATORY TESTS

BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>s</sub>	ε <sub>f</sub>		GROUP SYMB.		
No.	m	per cent						G	S	F	-2μ										
								per cent													
21	4	3.3	6.2																		
	5	4.0	6.9																		
24	3	2.5	19.3	29.0	14.0	15.0															
	4	3.3	10.4																		
25	6		22.7	25.8	14.6	11.2															
28	4	3.4	21.9																		
29	5	4.0	14.5	32.0	15.0	17.0															
30	3	2.5	14.1																		
32	4	3.3	5.5					0	79	21											
	5	4.0	8.2																		
	6	4.8	14.3																		
	7	5.8	19.2																		
	8	6.3	22.0					0	80	20	2										
33	4	3.3	4.0					0	96	4											
	6	4.8	3.3																		

## SUMMARY OF LABORATORY TESTS

BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>s</sub>	ε <sub>f</sub>	GROUP SYMB.
No.	m	per cent	per cent	G	S	F		-2μ	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	
33	7	5.8	2.0															
	8	6.3	14.7															
34	1	0.9	9.9															
	2	1.7	10.2															
	3	2.5	8.8					5	50	45	12							
	4	3.3	7.5															
	5	4.0	6.1															
	6	4.6	4.8															
36	5	4.0	12.5															
	6	4.8	13.5															
	7	5.6	11.0					19	73	8								
37	5	4.0	32.3	49.6	21.8	27.8												
38	4	3.3	17.4															
	5	4.0	16.8															
	6	4.8	9.2															
	7	5.6	9.6															

SUMMARY OF LABORATORY TESTS

BH	SA	DEPTH	w	w <sub>L</sub>	w <sub>p</sub>	I <sub>p</sub>	I <sub>L</sub>	GRADATION				γ	γ <sub>d</sub>	e	c	G <sub>s</sub>	ε <sub>f</sub>		GROUP SYMB.	
No.	m	per cent	per cent	per cent	per cent	G		S	F	-2μ										
						per cent														
39	3	2.5	40.4																	
	4	3.3	17.9																	
	5	4.0	18.5	20.9	12.4	8.5	17	27	56	17										
	7	5.6	9.6																	
40	2	1.7	28.5																	
	3	2.5	30.3																	
	4	3.3	19.2	32.3	11.0	21.3														
	5	4.0	8.8	21.4	12.5	8.9														
	6	4.8	7.8																	
	7	5.6	15.5																	

SUMMARY OF LABORATORY TESTS



SUMMARY OF ANTICIPATED EXCAVATION BASE  
CONDITIONS AT EACH BOREHOLE LOCATION

<u>Borehole No.</u>	<u>Approx. Invert Elevation (m)</u>	<u>Water Table (m)</u>	<u>Soil Type at Invert</u>	<u>Anticipated Conditions</u>
1	83.8	85.7	loose sandy silt till	dewatering required
2	84.0	86.8	hard silty clay till	stable
3	84.2	86.6	hard silty clay till	stable
4	84.4	86.1	hard silty clay till	stable base; probable side instability; possible basal here due to sand layer below invert
5	84.6	85.3	stiff silty clay	stable
6	84.7	84.7	topsoil to Elev. 84.6 m stiff silty clay below	topsoil to be removed stable silty clay below; near creek
7	84.8	85.5	V. stiff silty clay till	stable
8	84.9	85.8	V. dense sandy silt till	temporarily stable
9	85.1	85.8	compact to V. dense sandy silt till	temporarily stable
10	85.3	86.5 (perched)	stiff to V. stiff silty clay	stable; near creek
11	85.8	86.4 (perched)	stiff to V. stiff silty clay	stable
12	87.3	90.3	dense to V. dense sandy silt till	temporarily stable
13	89.3	92.6	dense to V. dense sandy silt till	temporarily stable
14	90.3	91.7	V. dense sandy silt till	temporarily stable
15	90.7	94.6	V. dense sandy silt till	temporarily stable
16	90.9	95.0	V. dense sandy silt till	temporarily stable

.../...

Borehole No.	Approx. Invert Elevation (m)	Water Table (m)	Soil Type at Invert	Anticipated Conditions
17	91.1	95.1	dense sandy silt till	temporarily stable
18	91.3	94.5	V. dense sandy silt till	temporarily stable; possible basal here or boiling due to sand layers below invert
19	91.1	94.7	V. dense sandy silt till	temporarily stable
20	91.2	94.7	V. dense sandy silt till	temporarily stable; seepage from sides and possible need for dewatering
21	91.3	93.8	V. dense sandy silt till	temporarily stable
22	91.4	94.8	V. dense silty sand till	temporarily stable
23	90.4 (storm sewer)	91.4	hard silty clay till	stable
24	88.4 (sanitary sewer)	89.5	stiff to V. stiff clay till	stable
25	87.9 (sanitary sewer)	89.1	V. stiff silty clay	stable
26	87.7 (sanitary sewer)	88.7	V. stiff silty clay till	stable
27	87.2 (sanitary sewer)	88.0	stiff to V. stiff clay till	stable
28	87.0 (sanitary sewer)	89.4	firm to stiff silty clay	stable; possible weak layers
29	86.8 (sanitary sewer)	87.2	stiff silty clay till	stable
30	86.6	87.8	V. dense sandy silt till	temporarily stable
31	86.5	88.7	V. dense sandy silt till	temporarily stable; seepage from upper sand layers
32	86.5	86.5	V. dense fine sand	dewatering required

<u>Borehole No.</u>	<u>Approx. Invert Elevation (m)</u>	<u>Water Table (m)</u>	<u>Soil Type at Invert</u>	<u>Anticipated Conditions</u>
33	86.4	86.4	V. dense fine sand	dewatering required
34	86.3	87.9	V. dense sandy silt till	temporarily stable
35	86.0	89.5	V. dense sandy silt till	temporarily stable
36	85.9 84.3	85.5	compact to dense sand	dewatering required
37	82.7	83.3	compact sandy silt till	dewatering may be required
38	81.0	82.7	V. loose to compact silty sand till with some clay content	weak material may have to be sub-excavated and dewatering may be required
39	80.3	81.4	firm to stiff silty clay till	dewatering may be required
40	79.6	81.0	firm to stiff silty clay till	dewatering may be required

### 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 practise 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 details stated in the 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 given 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, e.g. 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 conclusion as to how the subsurface conditions may affect their work.



E N C L O S U R E S

RECORD OF BOREHOLE No 1

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,138N; 353,575E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.28 CHECKED BY Z.S.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
86.3	Ground Level												
0.0	FILL - Silty Clay some sand and topsoil.					86							
85.1			1	SS	13								
1.2	Silty clay, firm	Brown Grey	2	SS	5	85							
84.2													
2.1	Sandy silt till, some clay content, grey, loose, wet		3	SS	5	84	+						
83.1	Silty clay layers												
3.2	Some clay content wet loose		4	SS	9	83	+						
	Silty sand compact till, Grey moist		5	SS	30	82							
81.9													
4.4	Sandy silt till, dense, grey, moist		6	SS	45								
81.3													
5.0	END OF BOREHOLE												

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 2

METRIC

W P GGE 000-61 LOCATION CO-ORDS 4,859,111N; 353,549 E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)
								20 40 60 80 100										
90.0	Ground Level																	
0.0	0.15 m Sand Fill																	
	Silty clay, sandy, traces of gravel and organics, brown (probably fill)		1	SS	20		89											
88.6																		
1.4	moist to wet, compact		2	SS	11		88						9			11 44 36 9		
	very dense Sandy silt moist till. Brown		3	SS	50/	0.15 m							o					
86.9							87											
3.1	Silty sand till, v. dense		4	SS	50/													
86.5	brown, moist to wet				0.15 m													
3.5	Silty clay till.						86						9			3 42 30 25		
	Hard Grey		5	SS	40													
			6	SS	50/	0.15m	85											
			7	SS	50/	0.10m												
			8	SS	50/	0.15m	84											
			9	SS	65/	0.15m	83											
			10	SS	50/	0.12m	82											
81.5			11	SS	77/	0.15m												
8.5	END OF BOREHOLE																	

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 ◇ 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 3

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,096N; 353,503E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
89.6	Ground Level																
0.0	Fill - Sand, some gravel, traces of silt.																
89.0																	
0.6	Sandy silt till with some silt and sand seams. V.dense, brown, damp.		1	SS	50/	0.12m	89										
			2	SS	50/	0.10m	88										
87.5																	
2.1	Silty clay till. Hard, grey, damp.		3	SS	84		87										
86.8																	
2.8	Silty sand till with some sand seams. V.dense, grey, moist		4	SS	50/	0.15m											
85.9							86										
3.7	Silty clay till.  Hard Grey		5	SS	50/	0.12m											
			6	SS	66/	0.15m	85										
			7	SS	70/	0.15m	84										
			8	SS	50/	0.10m											
			9	SS	70/	0.15m	83										
			10	SS	50/	0.12m	82										
80.8							81										
			11	SS	50/	0.12m											
8.8	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup> : Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 4

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,080N; 353,460E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
89.0	Ground Level																
0.0	Fill - Sand, some gravel and traces of silt.																
88.4																	
0.6	Sandy silt till with fine sand layers, occasional silt and sand seams, compact, brown.		1	SS	25	SEAL	88										
			2	SS	24												
	moist Silty fine sand wet		3	SS	25		87										
	moist v.dense		4	SS	69	SEAL	86										
85.3																	
3.7	Some silt lenses		5	SS	57		85										
	Silty clay till.																
	Hard Grey		6	SS	40		84										
83.7																	
5.3	Fine sand, v.dense																
83.4	grey, wet.		7	SS	92/	0.28 m											
5.6	Silt, v.dense, grey, moist.																
83.0																	
6.0	Silty clay till.						83										
82.5	Sandy, hard, grey.		8	SS	77												
6.5	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 5

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,064N; 353,406E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
87.9	Ground Level															
0.0	Fill - Sandy silt traces of gravel.															
			1	SS	40	87										
	brown															
	mixed with some clay brn/grey		2	SS	25	86										
85.5																
2.4	Organic silty clay (topsoil). bl./dk grey		3	SS	20											
85.1																
2.8	Silty clay, layered. Stiff, brown.		4	SS	14	85										
84.2																
3.7	Silty sand till, wet. Silty clay till. Stiff, brown.		5	SS	12	84										
83.3																
4.6	Sandy silt till, some clay, loose, wet.		6	SS	7	83										
82.6																
5.3	Silty clay till. Firm to stiff, grey.		7	SS	7	82										
81.4																
6.5	END OF BOREHOLE															

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



## METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,049N; 353,361E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

[illegible]

**+<sup>3</sup>, x<sup>5</sup> : Numbers refer to Sensitivity**

15-20 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8&9

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,017N; 353,262E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										20 40 60		
							20 40 60 80 100													

87.2	Ground Level						8									
0.0	Fill - Fine sand, some gravel and traces of silt.						87									
86.6						SEAL										
0.6	Silty clay till. V.stiff, brown.		1	SS	20		86					o				
85.8																
1.4	moist loose to compact Some silty sand & silty clay till seams. dense damp v.dense		2	SS	25	SEAL	85					o				
			3	SS	50/0.10m							o				
			4	SS	50/0.15m		84									
83.7	Sandy silt till. Brown		5	SS	62/0.15m											25 41 26 8
3.5	END OF BOREHOLE							CO-ORDS 4,859,001N; 353,216E SOLID STEM AUGER								
87.6	Ground Level						9									
0.0	Fill - Sand, some gravel and traces of silt.						87									
87.0																
0.6	Silty clay till. Stiff, brown		1	SS	15		86									
86.1																
1.5	Some silty clay till & silty sand till seams; compact, wet, brown.		2	SS	11		85									
	Sandy silt till. Compact to v.dense, grey - damp to moist.		3	SS	57											
	Some clay content.		4	SS	29		84									
			5	SS	43											
83.0																
4.6	END OF BOREHOLE															

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10





RECORD OF BOREHOLE No 10

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,979N; 353,147E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
88.5	Ground Level																
0.0	Fill - Fine sand with traces of gravel & silt, brown.		1	SS	8	SEAL	88										
87.1																	
1.4	Organic silty clay (topsoil).		2	SS	13		87										
86.5																	
2.0	Silty clay some silt seams.  Firm to v.stiff.  brown grey		3	SS	9	PIEZOMETER	86										
			4	SS	18	SEAL	85										
			5	SS	7												
							84										
83.2			6	TW	-												
5.3	Silty clay till. Firm to stiff, grey		7	SS	4		83										
82.0																	
6.5	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 11

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,971N; 353,121E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 100 200								
89.4	Ground Level															
0.0	Fill - Sand some gravel traces of silt.						89									
88.8						SEAL										
0.6	Fill - Silty clay, traces of sand and gravel. Brown		1	SS	17											
88.0							88									
1.4	Fill - Organic silty clay (topsoil). Black		2	SS	14											
87.3																
2.1	Silty clay with some silt and topsoil (probably fill).		3	SS	6		87									
86.7																
2.7	Silty clay. Stiff, brown.		4	SS	13	SEAL	86									
85.7																
3.7	Silty clay till. V.stiff, brown.		5	SS	20											
84.9							85									
4.5	Silty clay. Stiff, grey.		6	SS	9											
84.1							84									
5.3	Silty clay till. Firm, grey.		7	SS	4											
83.3																
6.1	END OF BOREHOLE															

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 12

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,955N; 353,073E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETTIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
91.4	Ground Level																GR SA SI CL
0.0	Fill - Fine sand with traces of gravel and silt.						91										
90.8																	
0.6	Silty clay till. Hard, brown.		1	SS	33		90										
90.2																	
1.2	Silt V.dense, brown		2	SS	65												
89.3																	
2.1	Sandy silt till. Brown, damp.		3	SS	90		89										
			4	SS	50	0.12 m	88										
	v.dense dense		5	SS	43		87										
86.5																	
4.9	Silty clay till.		6	SS	92		86										
85.9	Hard, grey.																
5.5	END OF BOREHOLE																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 13

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4.858.941N: 353.017E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
93.5	Ground Level																
0.0	Fill - Sand, some gravel, traces of silt.																
93.0																	
0.5	Silty clay till. Stiff, brown.		1	SS	13	SEAL	93										
92.1																	
1.4	Sandy silt till with silty sand till layers, moist to damp.		2	SS	62		92										
	v.dense		3	SS	55	0.15m	91										
	dense																
			4	SS	45		90										
	brown grey																
	v.dense		5	SS	59												
			6	SS	50	0.15m	89										
87.8	Some clay content, damp to dry		7	SS	50	0.07m	88										
5.7	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

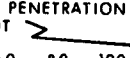



20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 14

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,932N; 352,977E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE							
94.6	Ground Level							20	40	60	80	100						
0.0	Fill - Sand, some gravel, traces of silt																	
94.1																		
0.5	Silty clay till. Brown		1	SS	23		94											
	v. stiff sandy hard		2	SS	40		93											
92.5																		
2.1			3	SS	80		92											
			4	SS	50/	0.15 m	91											
	brown grey		5	SS	50/	0.15 m	90											
	Sandy silt till, some silty sand till layers v. dense. Damp to moist.		6	SS	82		89											
88.7	Silt & silty clay seams.		7	SS	94/	0.28 m												
5.9	END OF BOREHOLE																	

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 15

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,923N; 352,924E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETTIC DATE 1984.06.20 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	'N' VALUES			20	40	60	80	100		
95.7	Ground Level							SHEAR STRENGTH						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%)						
								PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>						
								20 40 60						
0.0	0.08 m Topsoil													
	Silty clay till. Stiff to v.stiff, brown		1	SS	24		95							2 40 31 27
			2	SS	15	SEAL	94							
93.6														
2.1			3	SS	52	PIEZOMETER	93							
			4	SS	50/	0.15 m								
	cobble					SEAL	92							
	silty sand till		5	SS	50/	0.07 m								
	brown grey													
	Sandy silt till with silty sand till layers, v.dense.		6	SS	50/	0.10 m	91							
			7	SS	50/	0.10 m	90							
	Possible sand seam & 6.0 m.		8	SS	50/	0.05 m								
88.8	Some clay content.		9	SS	100/	0.10 m	89							
6.9	END OF BOREHOLE													

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 - 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 16

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,913N; 352,876E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
96.5	Ground Level																
0.0	0.05 m Topsoil																
	Silty clay till.																
	V.stiff, brown.		1	SS	23												
95.0																	
1.5																	
	dense		2	SS	32												
	v.dense																
	Sandy silt till, occ.		3	SS	52												
	thin sand seams.																
			4	SS	102												
			5	SS	50/	0.07 m											
			6	SS	39												
			7	SS	50/	0.10 m											
			8	SS	60/	0.15 m											
			9	SS	50/	0.10 m											
88.6			10	SS	50/	0.07 m											
7.9	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 17

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,904N; 352,834E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
96.3	Ground Level																
0.0	0.08 m Topsoil																
	Silty clay till. V.stiff, brown.		1	SS	26												
			2	SS	20												
			3	SS	24												
93.4																22.4	
2.9			4	SS	61											22.3	12 43 35 10
			5	SS	35												
			6	SS	39												
			7	SS	50												
89.3			8	SS	108												
7.0	END OF BOREHOLE																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10





RECORD OF BOREHOLE No 18

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,927N; 352,774E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
95.6	Ground Level																
0.0	0.08 m Topsoil																
	Silty clay till.																
	Soft, brown, wet.		1	SS	2												
94.1						SEAL											
1.5	V. loose wet some sand seams.		2	SS	3												
	Some clay content moist compact																
			3	SS	17												
			4	SS	50/ 0.10m												
			5	SS	107												
						PIEZOMETER											
			6	SS	95/ 0.25m												
90.4						SEAL											
5.2	Fine sand, some silt.		7	SS	78												
	V. dense, grey, wet																
89.6																	
6.0	Sand, some gravel.		8	SS	80/ 0.15m												
	V. dense, grey, wet.																
88.9																	
6.7	Silty clay till.		9	SS	65/ 0.15m												
88.4	Hard, grey.																
7.2	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>; Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 19

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,966N; 352,877E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
96.1	Ground Level																
0.0	Fill - Silty clay mixed with some topsoil, brown to dark brown.		1	SS	11		96										
94.8							95										
1.3	Silty clay till, sandy stiff, brown.		2	SS	13												
94.0	Moist to wet.						94										
2.1	Sandy silt till, v.dense.		3	SS	96												
			4	SS	50/	0.12 m	93										
			5	SS	50/	0.10 m	92										
			6	SS	50/	0.10 m	91										
			7	SS	60/	0.10 m	90										
			8	SS	50/	0.12 m											
89.2	some clay content		9	SS	100/	0.10 m											
6.9	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 20

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,014N; 352,861E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
96.2	Ground Level																
0.0	Silty clay till. V.stiff, brown.		1	SS	17	SEAL	96										
	sandy		2	SS	23	PIEZOMETER	95										
94.1							94										
2.1	Sandy silt till. V.dense, brown.		3	SS	96	SEAL	93										
			4	SS	50/												
92.5					0.07m												
3.7	possible sand layer		5	SS	50/	0.12m	92										
	Silty sand till with occasional sand seams & sandy silt brown till seams. grey		6	SS	100/	0.15m	91										
			7	SS	50/	0.12m											
90.4							90										
5.8	Sandy silt till, some silty sand and silty clay till seams. V.dense, grey.		8	SS	55/	0.15m											
89.2			9	SS	50/	0.15m											
7.0	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

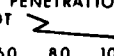
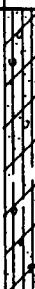

20  
15-5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 21

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,062N; 352,846E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT  γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)				
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    x LAB VANE					W <sub>p</sub>	W	W <sub>L</sub>		
96.2	Ground Level																
0.0	Silty clay till. V.stiff, brown.		1	SS	24		96										
			2	SS	28		95										
94.1	Sandy silt till with silty sand till layers v.dense.  damp brown grey moist  cobble		3	SS	52/ 0.15m		94										
2.1			4	SS	50/ 0.10m		93										
			5	SS	50/ 0.12m		92										
			6	SS	60/ 0.10m		91										
			7	SS	50/ 0.10m		90										
89.3			8	SS	110/ 0.15m												
6.9	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 22

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,859,109N; 352,831E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
96.6	Ground Level																
0.0	Topsoil																
96.1																	
0.5	Silty clay. V.stiff, brown.		1	SS	22		96										
95.1						SEAL											
1.5	Silty clay till with silty clay layers. Brown v.stiff		2	SS	27		95										
93.9	hard boulder		3	SS	50/		94										
2.7	Sandy silt till. V.dense, brown.		4	SS	104		93										
			5	SS	50/		92										
						0.10m											
						0.12m											
						0.10m											
91.4	silty sand till seams		6	SS	50/		91										
5.2	Silty sand till, v.dense. moist brown grey wet Some sand & silty sand seams.		7	SS	50/		90										
89.6			8	SS	61												
7.0	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

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



# RECORD OF BOREHOLE No 25

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,543N; 351,743E ORIGINATED BY R.M.  
 DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
 DATUM GEODETIC DATE 1984.06.19 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
91.1	Ground Level																
0.0	0.15 m Topsoil Silty sand, traces of gravel, brown, moist (probably fill).		1	SS	9	SEAL	91										
89.6							90										
1.5	Sandy silt till. Compact, brown		2	SS	21		89										
88.5			3	SS	15												
2.6	Silty clay till.  Brown		4	SS	18	SEAL	88										
			5	SS	23		87										
	V. stiff stiff		6	SS	9												
85.9	Occasional weak clay seams.						86										
5.2	Some clay.		7	SS	4												
	Sandy silt till. V. loose, grey.		8	SS	5		85										
84.4																	
6.7	END OF BOREHOLE																

+3, x5: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 26

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,531N; 351,714E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
90.8	Ground Level																
0.0	0.15 m Topsoil																
89.9	Fill - Silty sand, traces of gravel, brown.						90										
0.9	fine sand		1	SS	32												
	Fill - Sandy silt, traces of gravel, brown.		2	SS	23		89										
88.5																	
2.3	Silty clay, brown.		3	SS	11												
88.3																	
2.5	Silty clay till. Brown		4	SS	21		88				>+						
	v. stiff stiff																
	Occasional sand pockets		5	SS	15		87										
86.5																	
4.3	END OF BOREHOLE																

Sampler wet  
@ 4 m.



RECORD OF BOREHOLE No 27 & 28

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,523N; 351,683E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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 kPa					
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
								100 200						

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 29

METRIC

W P GGE 020-61 LOCATION CO-ORDS. 4,858,498N; 351,587E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
90.5	Ground Level																
0.0	0.25 m Topsoil					SEAL	90										
	Fill - Silty sand and sandy silt, traces of gravel. Brown		1	SS	33												
			2	SS	20		89										
88.4																	
2.1	Fill - Sandy silt and clay, wet.		3	SS	3		88										
87.5																	
3.0	Silty clay till; organic stained (probably fill).		4	SS	7	SEAL	87				+						
86.8																	
3.7	Silty clay till. Stiff, brown.		5	SS	10		86										
86.1																	
4.4	Sandy silt till. Compact, brown.		6	SS	24		85										
84.7	Silty sand till layers. Grey, dense.		7	SS	33												
5.8	END OF BOREHOLE																

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 30

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,488N; 351,547E ORIGINATED BY R.M.  
 DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
 DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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					
90.8	Ground Level																
0.0	0.15 m Topsoil																
	Fill - Sandy silt, some gravel. Brown		1	SS	56		90										
89.3																	
1.5	Fill - Silty clay, organic, some sand pockets, dk.grey/black		2	SS	9		89										
88.6																	
2.2			3	SS	9		88										
	loose																
	compact		4	SS	28		87										
	v.dense																
	brown grey		5	SS	100/	0.28m											
	Sandy silt till, some clay content, occasional silt seams.		6	SS	50/	0.07m	86										
85.4																	
5.4	END OF BOREHOLE		7	SS	50/	0.02m											

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

GEOTECH REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 31

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,475N; 351,520E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
90.7														
0.0	0.6 m Topsoil					SEAL								
	Silty fine sand, compact, brown, moist (possible fill).		1	SS	20		90							
89.2														
1.5	Silty fine sand.		2	SS	17		89							
88.6	Compact, brown, wet.													
2.1			3	SS	34		88							
						SEAL								
			4	SS	33									
	dense v.dense						87							
			5	SS	95									
	Sandy silt till, some clay content, occasional thin sand seams.		6	SS	60/		86							
			7	SS	120		85							
84.6														
6.1	END OF BOREHOLE													

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

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

RECORD OF BOREHOLE No 32

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,473N; 351,481E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.20-21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
91.6	Ground Level													
0.0	0.45 m Topsoil Fill - Silty clay mixed with some topsoil.					SEAL	91							
90.3			1	SS	17									
1.3	Silty clay till. Stiff to v.stiff, brown.		2	SS	17		90							
89.1			3	SS	45	SEAL	89							
2.5	dense damp v.dense		4	SS	83		88							0 79 21
	Fine sand with traces of silt, occ. thin silty fine sand seams.		5	SS	82		87							
	Brown		6	SS	100		86							Sampler wet @ 4.8 m.
	moist wet		7	SS	60		85							0 80 18 2
	Some silt.		8	SS	58									
			9	SS	100	0.25m								
			10	SS	70	0.15m	84							June 20 Augers 1. @ 8.4m over night. Soil backed-up in the augers by 1.5 m.
83.2														
8.4	END OF BOREHOLE													



RECORD OF BOREHOLE No 33

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,460N; 351,455E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELFV DEPTH	DESCRIPTION	STAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
92.7	Ground Level													
0.0	0.3 m Topsoil						92							
92.0	Fill - Sandy silt some gravel.													
0.7	Fill - Silty clay traces of organics.		1	SS	12									
91.3	Brown													
1.4	Fill - Silty clay some sand, traces of or- ganics.		2	SS	5		91							
90.2	Brown													
2.5	loose						90							
	compact													
	dense		4	SS	32									
							89							
	v.dense		5	SS	88									
	Fine sand, with traces of silt, occ. gravel.		6	SS	55/0.15 m		88							
			7	SS	98/0.25 m		87							
	damp													
	moist		8	SS	90/									
							86							
	wet				0.28 m									
			9	SS	90									
84.6			10	SS	72		85							
8.1	END OF BUREHOLE													

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 34

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,461N; 351,423E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
91.7	0.15 m Topsoil															
91.1	Sandy silt, tr. gravel															
0.6																
	higher sand content		1	SS	56							o				
			2	SS	75							o				
			3	SS	70							o				5 50 33 12
	Sandy silt till, v.dense.		4	SS	65							o				
			5	SS	60							o				
			6	SS	50	0.07 m						o				Hard augering below 4 m.
			7	SS	50	0.10 m										
			8	SS	70	0.10 m										Sample 8: No recovery.
84.0			9	SS	75	0.07 m										
7.7	END OF BOREHOLE															

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

RECORD OF BOREHOLE No 35

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,448N; 351,395E ORIGINATED BY S.D.  
DIST 6 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY F.L.  
DATE 1M GEODETIC DATE 1984.06.23 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	'N' VALUES			20	40	60	80	100		
91.9	Ground Level													
0.0	0.3 m Topsoil													
	compact v. dense		1	SS	29	SEAL	91							
			2	SS	84		90							
	Sandy silt till.		3	SS	65	PIEZOMETER	89							
			4	SS	90	0.23m	88							
	boulder		5	SS	100	0.10m	87							
			6	SS	60	0.12m	86							
	brown grey		7	SS	100	0.12m	85							
			8	SS	50	0.07m								
84.9														
7.0	END OF BOREHOLE													

Refusal to  
augering  
@ 3.6 m due  
to a boulder  
Borehole  
relocated  
1 m south.

Sample 8:  
No recovery  
due to large  
gravel.

Refusal to  
augering @  
7.0 m prob-  
ably on a  
boulder.





RECORD OF BOREHOLE No 36

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,447N; 351,345E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
89.9	Ground Level																
0.0	0.15 m Topsoil																AS = Auger Sample
	Fill - Silty sand with traces of gravel. Occasional sandy silt and organic lenses, brown.		1	SS	30		89										
88.5																	
1.4	Fill - Silty clay with traces of sand and gravel, occ. organic lenses, brown.		2	SS	15		88										
			3	SS	20												
86.9							87										
3.0	Fill - Silty sand.		4	SS	25												
86.6	Silty sand till.																
3.3	Sand, some gravel, traces of silt.		5	SS	30		86						o				
	compact dense	moist wet	6	SS	35		85						o				19 73 8
			7	SS	38		84						o				
83.4			8	SS	70												
6.5	Sandy silt till. V.dense, grey.						83										
82.3			9	AS	-												
7.6	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 10 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 37

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,440N; 351,295E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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 kPa					
87.8	Ground Level							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	20 40 60					
0.0	0.15 m Topsoil Fill - Silty sand traces of silt, clay and organic pockets. Brown		1	SS	34	SEAL	87							
86.4	cobble													
1.4	Fill - Silty clay, some sand, gravel and organic pockets. Brown		2	SS	11		86							
			3	SS	15		85							
84.8						SEAL								
3.0	organic stained		4	SS	12		84							
	Silty clay, stiff, brown.		5	SS	12									
83.4														
4.4	Sandy silt till. Compact	moist brown grey wet	6	SS	26	PIEZOMETER	83							
			7	SS	15		82							
	traces of clay frequent silty sand till layers		8	SS	26		81							
	Some thin silty sand, silt and silty clay seams.		9	SS	16									
80.3														
7.5	Silty sand, some gravel with silty sand till layers. Loose, grey, wet.		10	SS	10		80							
			11	SS	6		79							Sample 10: No recovery
			12	SS	6									
78.0														
9.8	END OF BOREHOLE													

Sample 10:  
No recovery

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

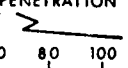









20  
15 5 (%) STRAIN AT FAILURE  
10



RECORD OF BOREHOLE No 38

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,432N; 351,248E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH					WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE						
								100	200								
85.9	Ground Level																
0.0	0.2 m Topsoil																
	Fill - Silty sand with some sandy silt and silty clay pockets, traces of gravel and organic soil, brown.		1	SS	22		85										
			2	SS	34												
83.8							84										
2.1	Fill - Silty clay some organic seams. Brown		3	SS	11												
																	
82.7							83										
3.2	Silty clay till, some sandy silt till seams. Firm to v.stiff, brown		4	SS	7							○					
			5	SS	16		82					○					
81.5																	
4.4	Some clay content.		6	SS	2		81					○					
	Silty sand till with sandy silt till layers.	wet v.loose	7	SS	30							○					
	Grey	compact wet					80										
		v.dense	8	SS	78/	0.28 m											
	more silty																
78.7			9	SS	60/	0.15 m	79										
7.2	END OF BOREHOLE																

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 39

METRIC

W P GGE 000-61 LOCATION CO-ORDS. 4,858,428N; 351,205E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.22 CHECKED BY Z.S.O.

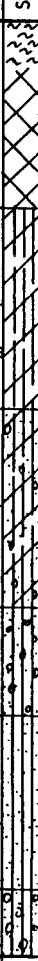
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
84.2	Ground Level																
0.0	0.3 m Topsoil Fill - Fine sand some silt; some silty clay and silt lenses. Brown		1	SS	12	SEAL	84										
82.8							83										
1.4	Fill - Sandy silt. Brown		2	SS	10												
82.2							82										
2.0	Silty clay. Firm to stiff, brown.		3	SS	7	SEAL											
81.3							81										
2.9	Silty clay till with sandy silt till and occasional fine sand and clay seams.  brown/grey grey  firm to stiff stiff to hard		4	SS	9												
			5	SS	6		80										17 27 39 17
			6	SS	8												
			7	SS	33		79										Sample 6: Recovery on second attempt with sand trap.
			8	SS	13		78										
77.2			9	SS	34												
7.0	END OF BOREHOLE																



RECORD OF BOREHOLE No 40

METRIC

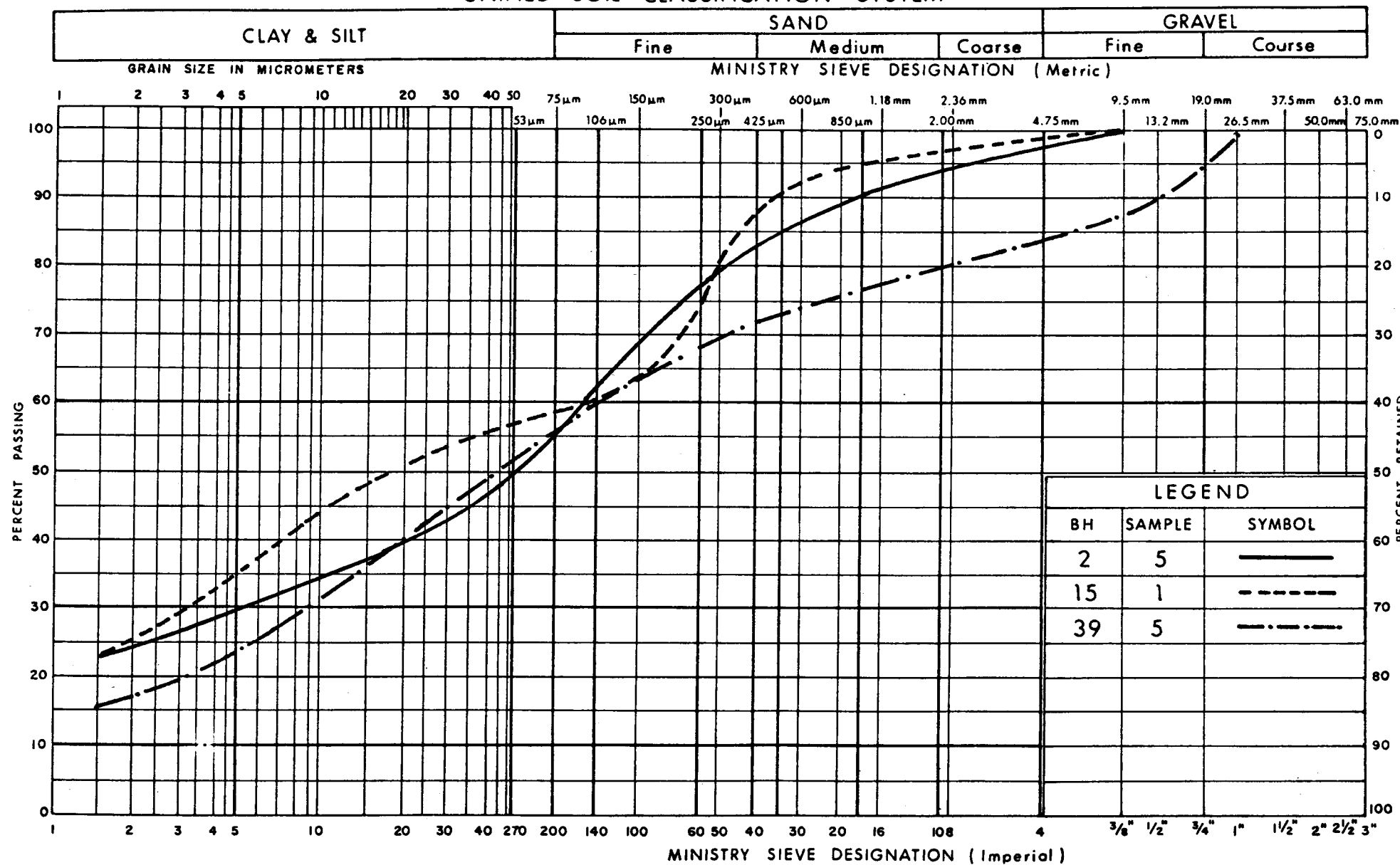
W P GGE 000-61 LOCATION CO-ORDS. 4.858.424N: 351.168E ORIGINATED BY R.M.  
DIST 6 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY F.L.  
DATUM GEODETIC DATE 1984.06.21 CHECKED BY Z.S.O.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
83.3	Ground Level							20 40 60 80 100								
0.0	0.3 m Topsoil					0.12m	83									
	Fill - Silty sand and silty clay, traces of organic pockets, brown		1	SS	22		82									
81.9																
1.4	Silty clay, firm to stiff, brown.	2	SS	7												
	layered structure	3	SS	12	81											
80.4																
7.9	Silty clay till, occasional fine sand and clay seams.	4	SS	7	80											
	Firm to stiff. brown grey	5	SS	9												
78.9																
4.4	Sandy silt till, some clay, compact, grey, wet.	6	SS	15	79											
78.1																
5.2	Sandy silt, trace of clay, some gravel.	7	SS	8	78											
	Dark grey/black loose compact to v.dense coarser	8	SS	68	77											
76.8																
6.5	Sandy silt till, v.dense, grey.	9	SS	100/												
76.3																
7.0	END OF BOREHOLE															

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



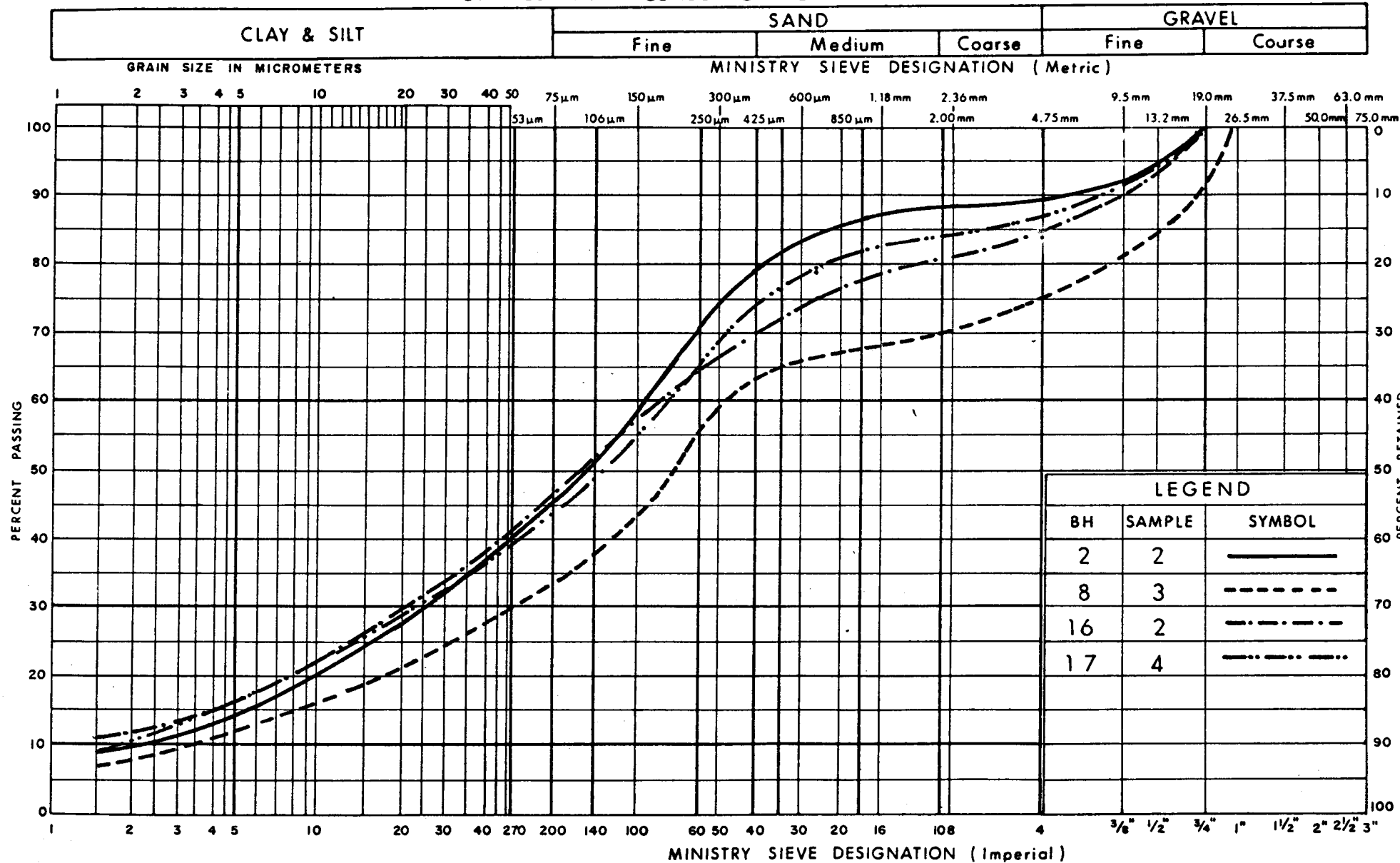
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY TILL

FIG No 1

W P GGE000-61

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

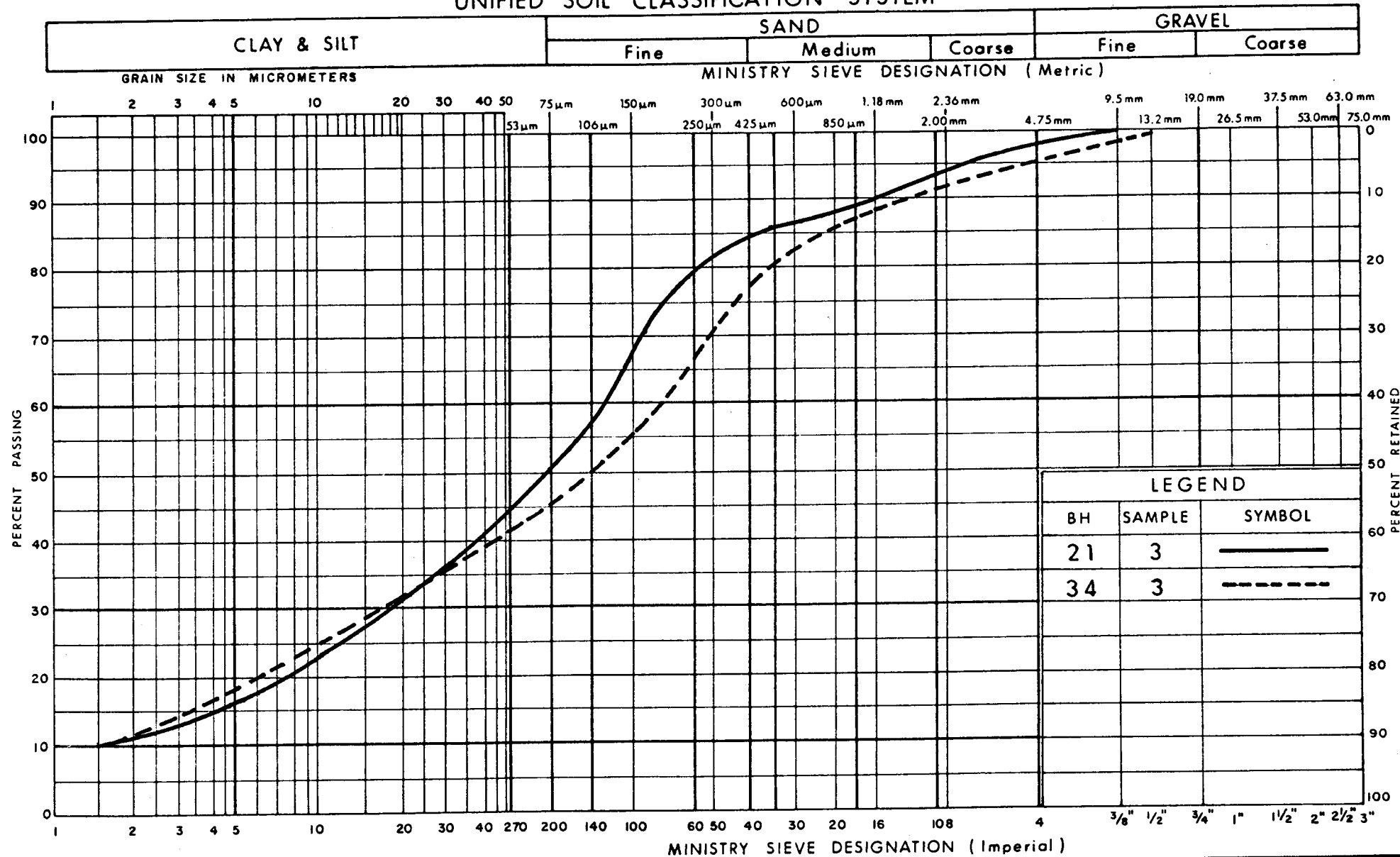
 Ministry of  
Transportation and  
Communications

## GRAIN SIZE DISTRIBUTION SANDY SILT TILL

FIG No 2

WP GGE000-61

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

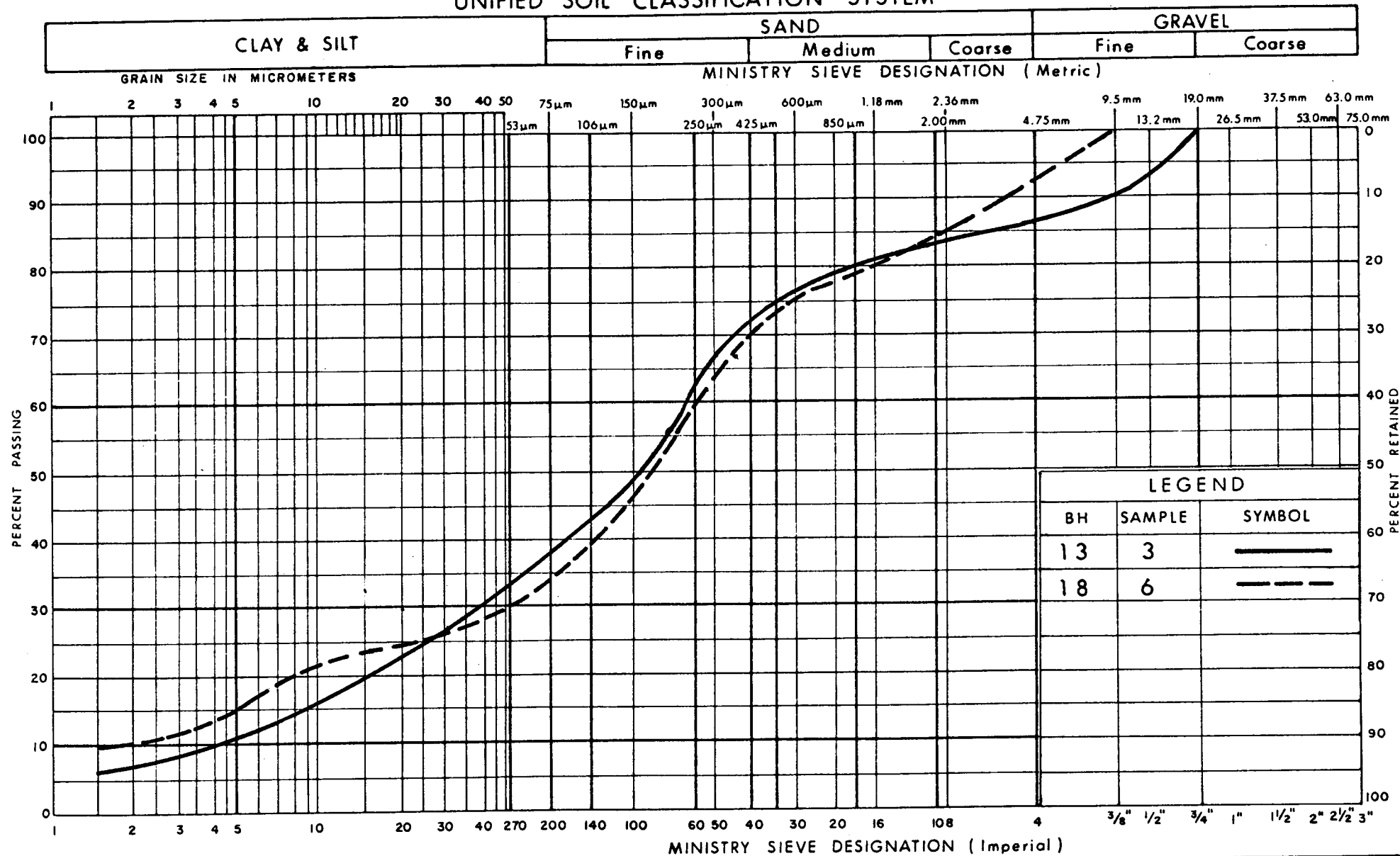
GRAIN SIZE DISTRIBUTION  
SANDY SILT TILL

FIG No 3

W P GGE000-61



## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

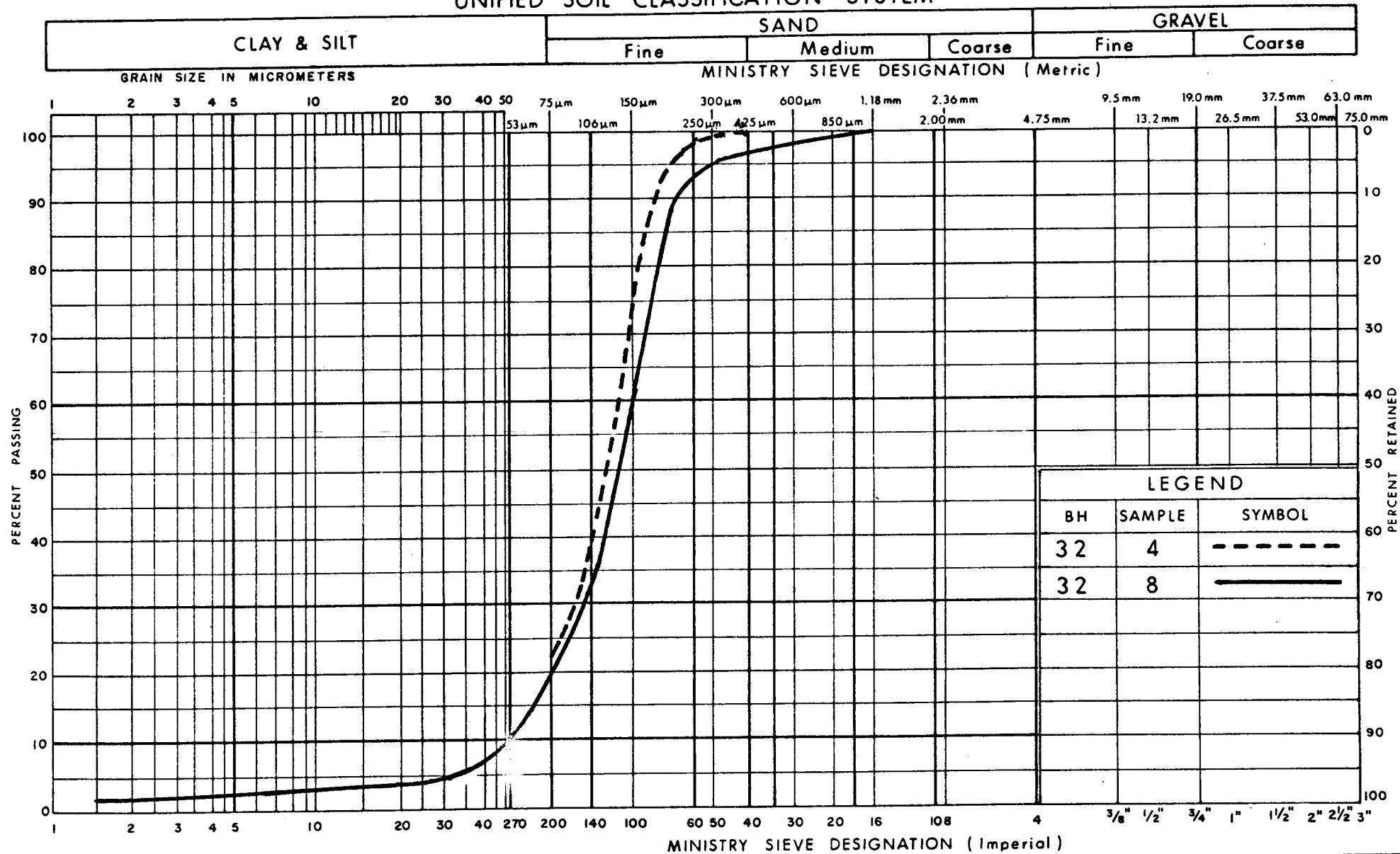
# GRAIN SIZE DISTRIBUTION

## SILTY SAND TILL

FIG No 4

W P GGE 000- 61

## UNIFIED SOIL CLASSIFICATION SYSTEM



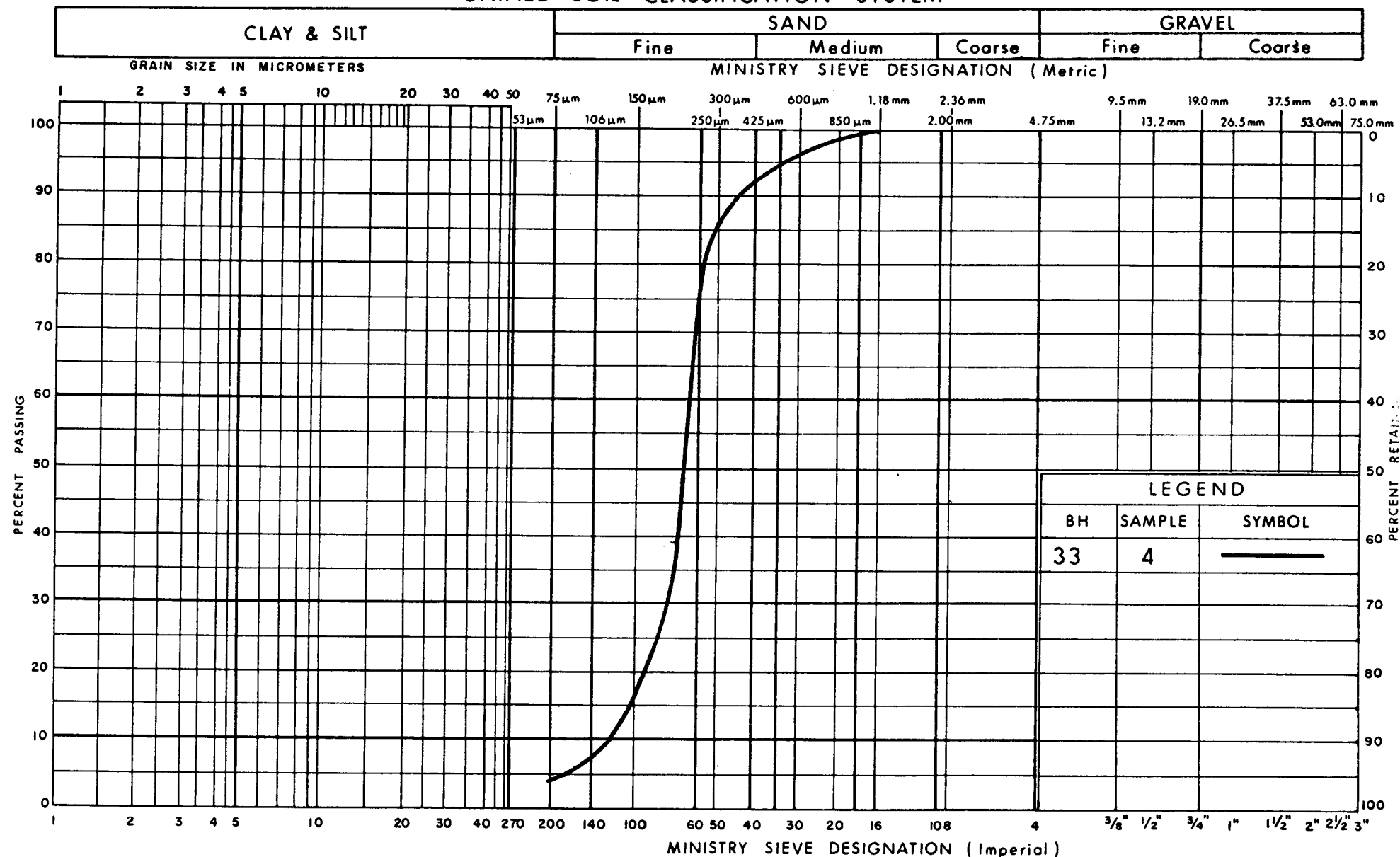
Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
FINE SAND, some Silt

FIG No 5

W P GGE 000-61

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of  
Transportation and  
Communications

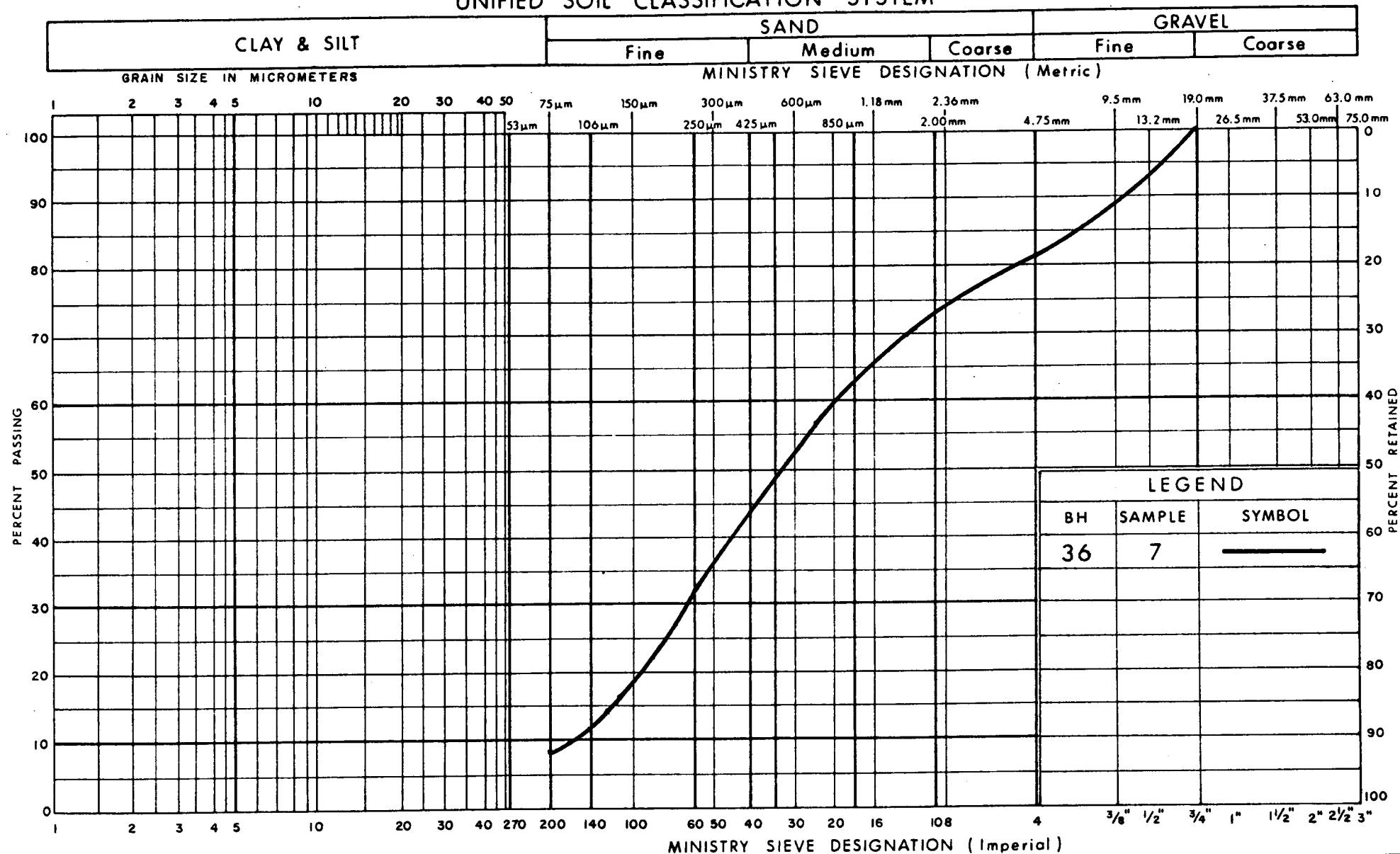
# GRAIN SIZE DISTRIBUTION

## FINE SAND

FIG No 6

W P GGE000-61

## UNIFIED SOIL CLASSIFICATION SYSTEM

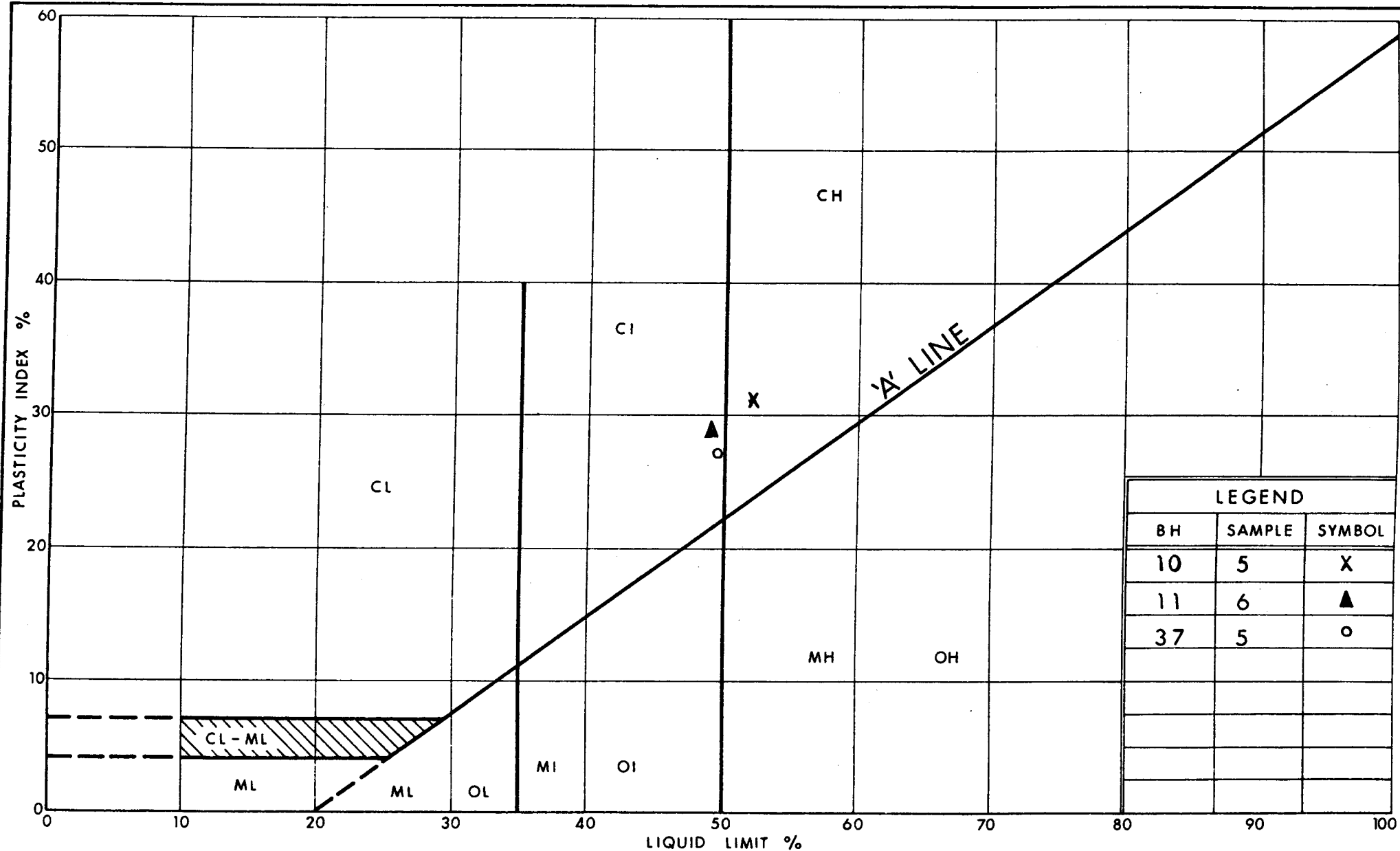


Ministry of  
Transportation and  
Communications

**GRAIN SIZE DISTRIBUTION**  
**SAND, with some gravel & traces of silt.**

FIG No 7

W P GGE000-61



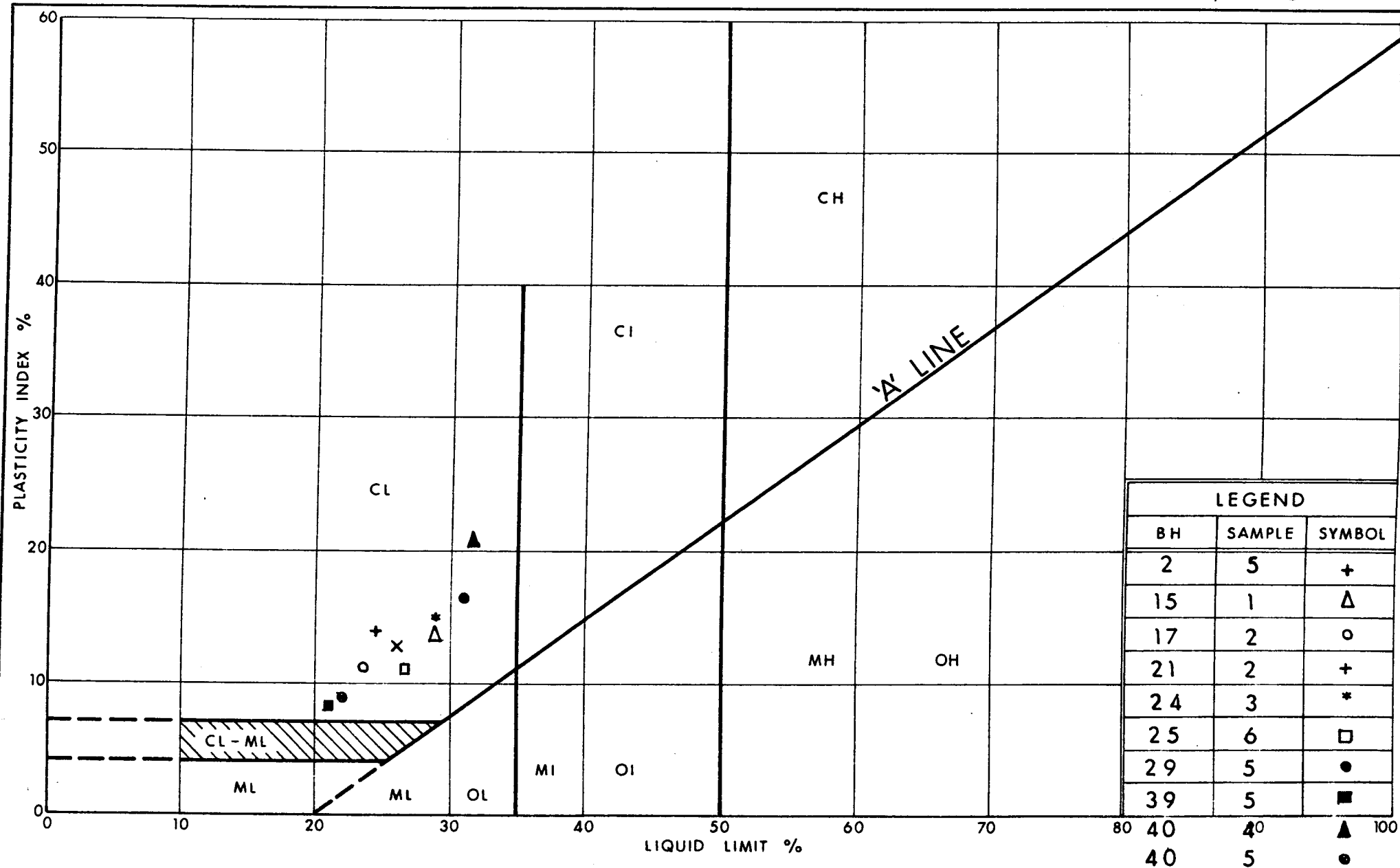
Ministry of  
Transportation and  
Communications

Ontario

## PLASTICITY CHART SILTY CLAY

FIG No 8

W P GGE 000- 61



Ministry of  
Transportation and  
Communications

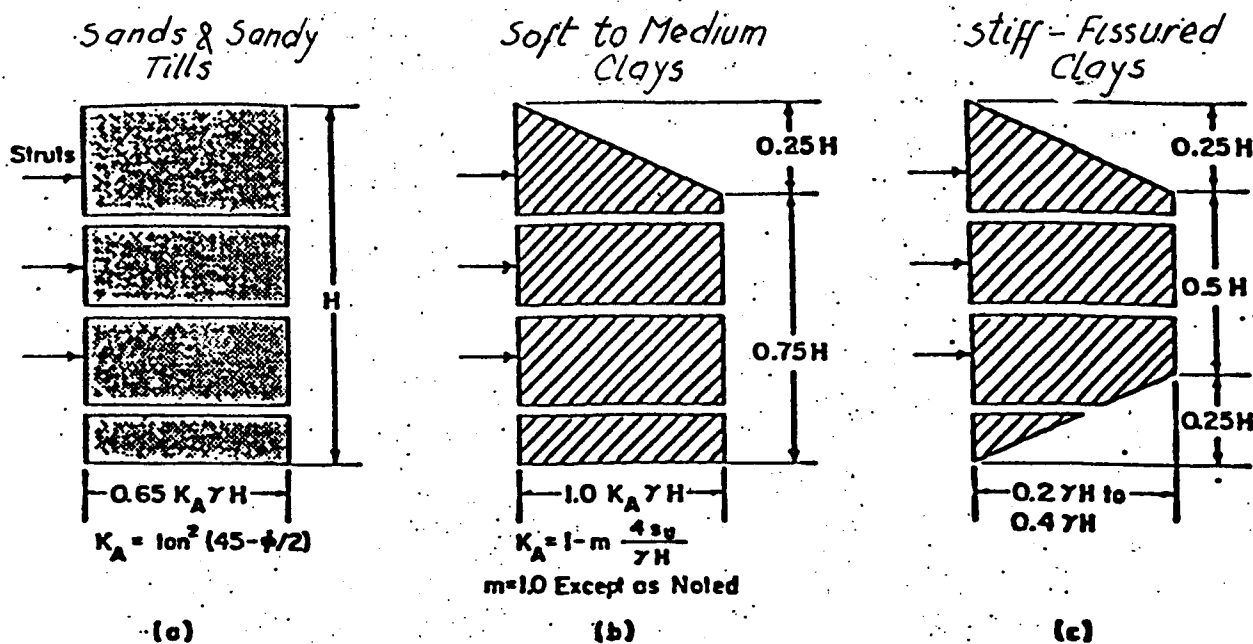
# PLASTICITY CHART SILTY CLAY TILL

FIG No 9

W P G G E 000 - 61

Our Ref. No. 84-6-7

Prep. By F.L.



where

$K_A = 0.3$  for Sands & Sandy Tills.

$S_u =$

$\gamma = 20 \text{ kN/m}^3$

$\gamma = 20.5 \text{ kN/m}^3$  for Sands

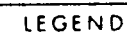
$\gamma = 19 \text{ kN/m}^3$

$\gamma = 22.5 \text{ kN/m}^3$  for Sandy Tills

FIG. 10

EARTH PRESSURE ON BRACED CUTS

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



- | No | ELEVATION | CO-ORDINATES |         |
|----|-----------|--------------|---------|
|    |           | NORTH        | EAST    |
| 1  | 87 3      | 4,859,138    | 353,575 |
| 2  | 90 0      | 4,859,111    | 353,549 |
| 3  | 89 6      | 4,859,096    | 353,503 |
| 4  | 89 0      | 4,859,080    | 353,460 |
| 5  | 87 9      | 4,859,064    | 353,406 |
| 6  | 87 3      | 4,859,049    | 353,361 |
| 7  | 87 0      | 4,859,037    | 353,309 |

NOTE

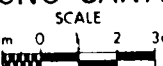
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office. Downview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102.2 of Form 100.

GO-ALRT REF









\* DURHAM REGION



GO-ALRT/CHAMPLAIN AVE SANITARY SEWER  
BOREHOLE LOCATION AND SOIL STRATA

CONTRACT NO	DWG NO GGE00061 - A	REV	SHEET
-------------	------------------------	-----	-------



### LEGEND

- |   |            |   |                 |   |      |
|---|------------|---|-----------------|---|------|
|  | FILL       |  | SILTY CLAY TILL |  | SAND |
|  | TOPSOIL    |  | SANDY SILT TILL |  | SILT |
|  | SILTY CLAY |  | SILTY SAND TILL |   |      |

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: FL 1284 08 07	DESIGNED BY:		DOMINION SOIL INVESTIGATION INC	 Ministry of Transportation and Communications	DURHAM REGION			
				CHK'D BY: ZSO	APPROVED BY:				GO-ALRT/CHAMPLAIN AVE SANITARY SEWER			
				SCALE: FULL SIZE ONLY AS SHOWN					BOREHOLE LOCATION AND SOIL STRATA			
								PROJECT MANAGER	CONTRACT NO.	DWG NO. GGE00061- A	REV	SHEET



METRIC

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

SEE DWG 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 1984.06
- | PIEZOMETER

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
8	87.2	4,859,017	353,262
9	87.6	4,859,001	353,216
10	88.5	4,858,979	353,147
11	89.4	4,858,971	353,121
12	91.4	4,858,955	353,073
13	93.5	4,858,941	353,017

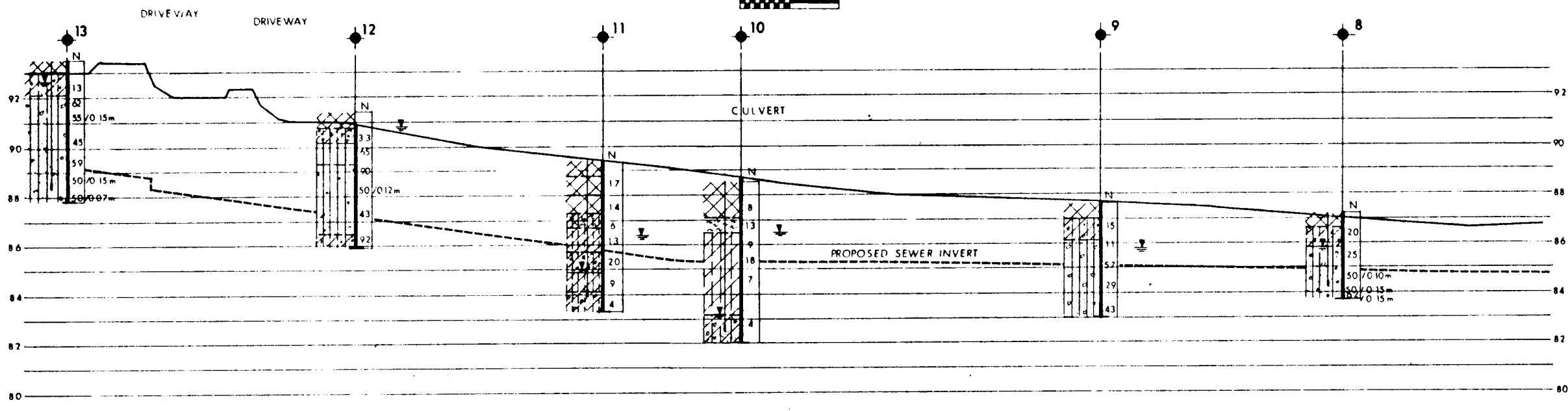
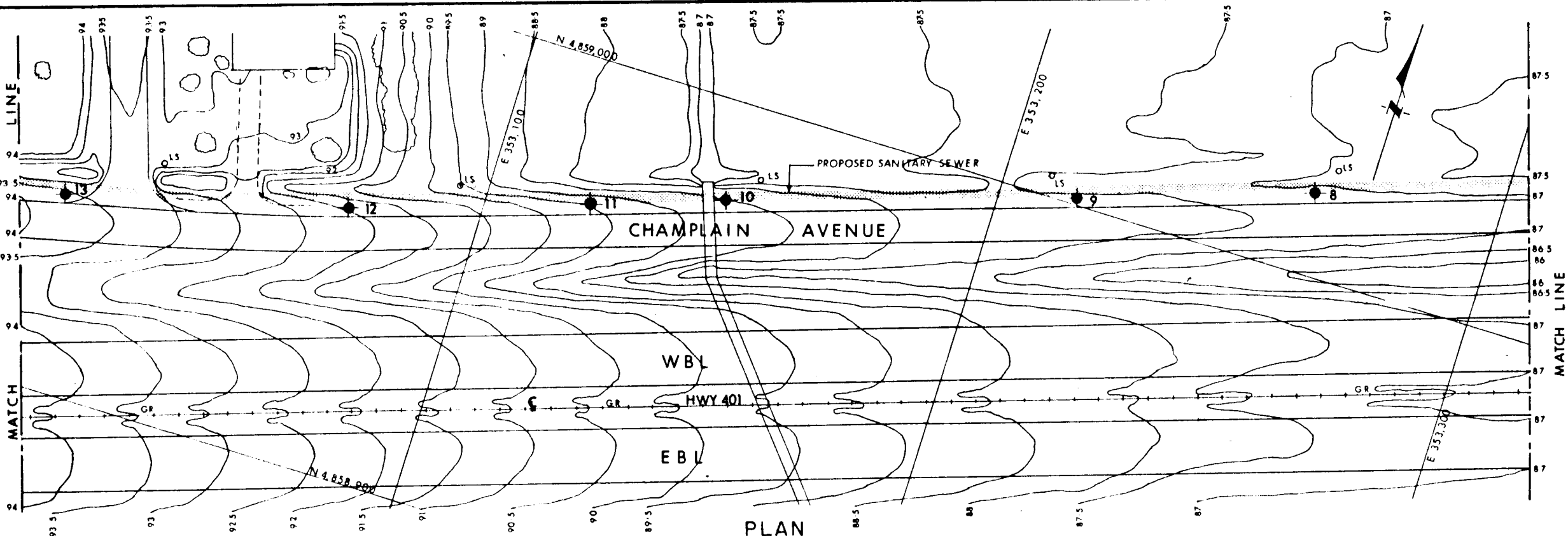
Geocres No.

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.

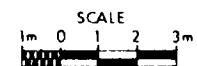
GO-ALRT REF



LEGEND

- FILL
- TOPSOIL
- SILTY CLAY
- SILTY CLAY TILL
- SANDY SILT TILL
- SILT

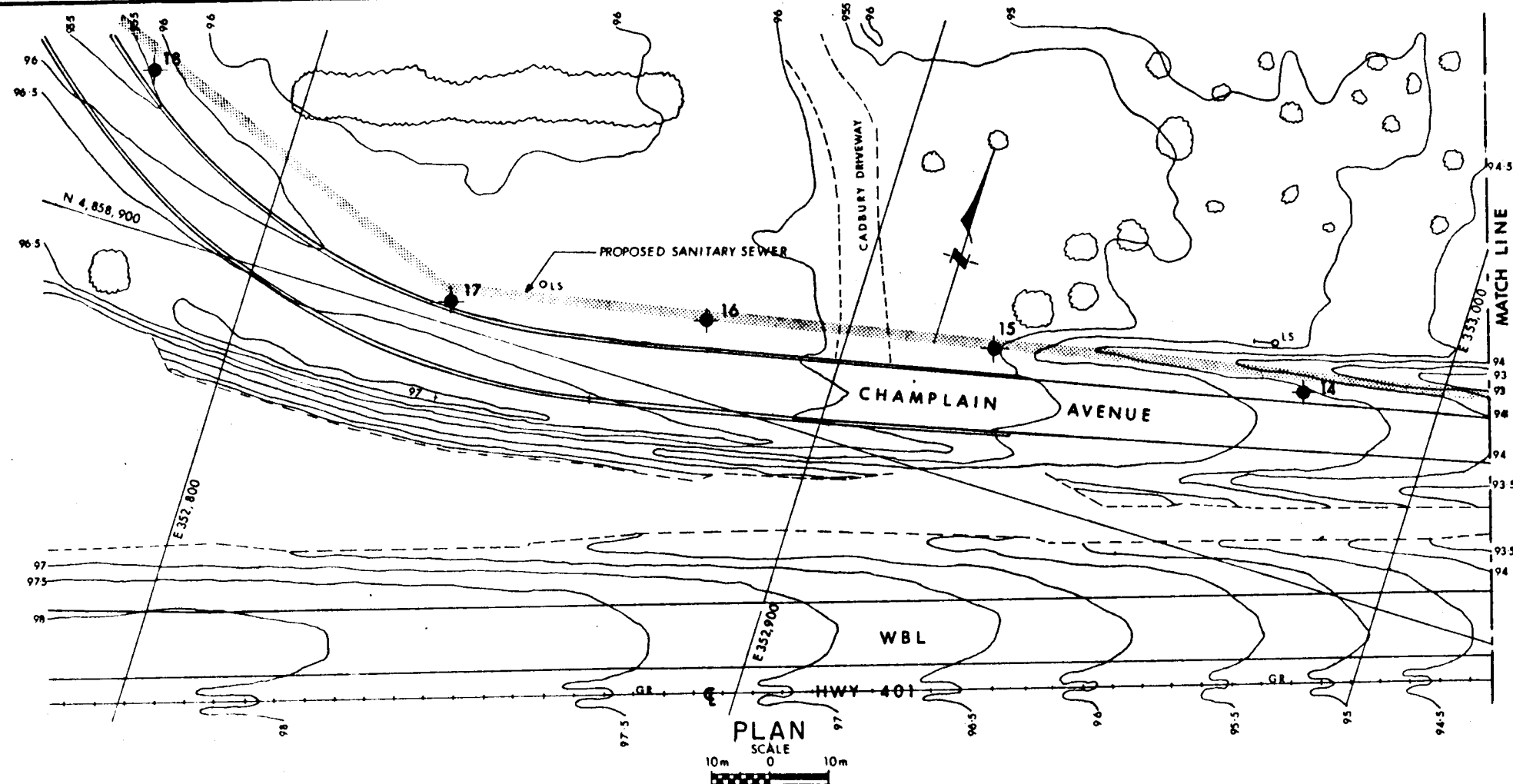
PROFILE ALONG SANITARY SEWER



REFERENCE DRAWINGS		REVISIONS		DRAWN BY: F.L. 1984.08.07 CHK'D BY: ZSO SCALE: FULL SIZE ONLY AS SHOWN		DESIGNED BY: APPROVED BY: 		DOMINION SOIL INVESTIGATION INC. 		DURHAM REGION GO-ALRT/CHAMPLAIN AVE SANITARY SEWER BOREHOLE LOCATION AND SOIL STRATA	
						PROJECT MANAGER		CONTRACT NO.		DWG NO. GGE00061-8	
								REV		SHEET	

**METRIC**

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



SEE DWG 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 1984 06
- PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
14	94.6	4,858,932	352,977
15	95.7	4,858,923	352,924
16	96.5	4,858,913	352,876
17	96.3	4,858,904	352,834
18	95.6	4,858,927	352,774

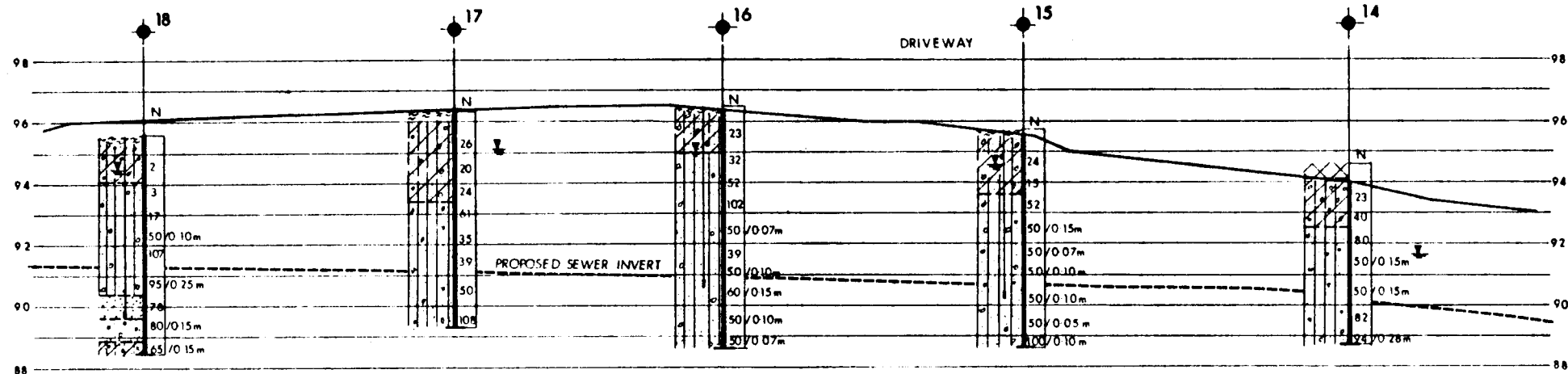
Geocres No

**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



**LEGEND**

- FILL
- TOPSOIL
- SILTY CLAY TILL
- SANDY SILT TILL
- SAND
- SAND, some Gravel

**PROFILE ALONG SANITARY SEWER**

SCALE  
1m 0 1 2 3m

**REFERENCE DRAWINGS**

**REVISIONS**

DRAWN BY:  
FL  
1984 08 07  
CHK'D BY:  
ZSO

DESIGNED BY:  
APPROVED BY:  
SCALE: FULL SIZE ONLY  
AS SHOWN



DOMINION SOIL  
INVESTIGATION INC



**DURHAM REGION**

GO ALRT/CHAMPLAIN AVE SANITARY SEWER  
BOREHOLE LOCATION AND SOIL STRATA

CONTRACT NO DWG NO REV SHEET  
GGE00061-C

PROJECT MANAGER

**METRIC**

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

SEE DWG A

KEY PLAN  
SCALE

**LEGEND**

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Sid Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- ↓ W.L. at time of investigation, 1984 06
- | PIEZOMETER

No	ELEVATION	CO-ORDINATES NORTH	EAST
19	96.1	4,858,966	352,877
20	96.2	4,859,014	352,861
21	96.2	4,859,062	352,846
22	96.6	4,859,109	352,831

Geocres No

**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

**DURHAM REGION**

GO-ALRT/CHAMPLAIN AVE SANITARY SEWER  
BOREHOLE LOCATION AND SOIL STRATA

CONTRACT NO	DWG NO	REV	SHEET
	GGE00061-D		

PROJECT MANAGER

DOMINION SOIL  
INVESTIGATION INC



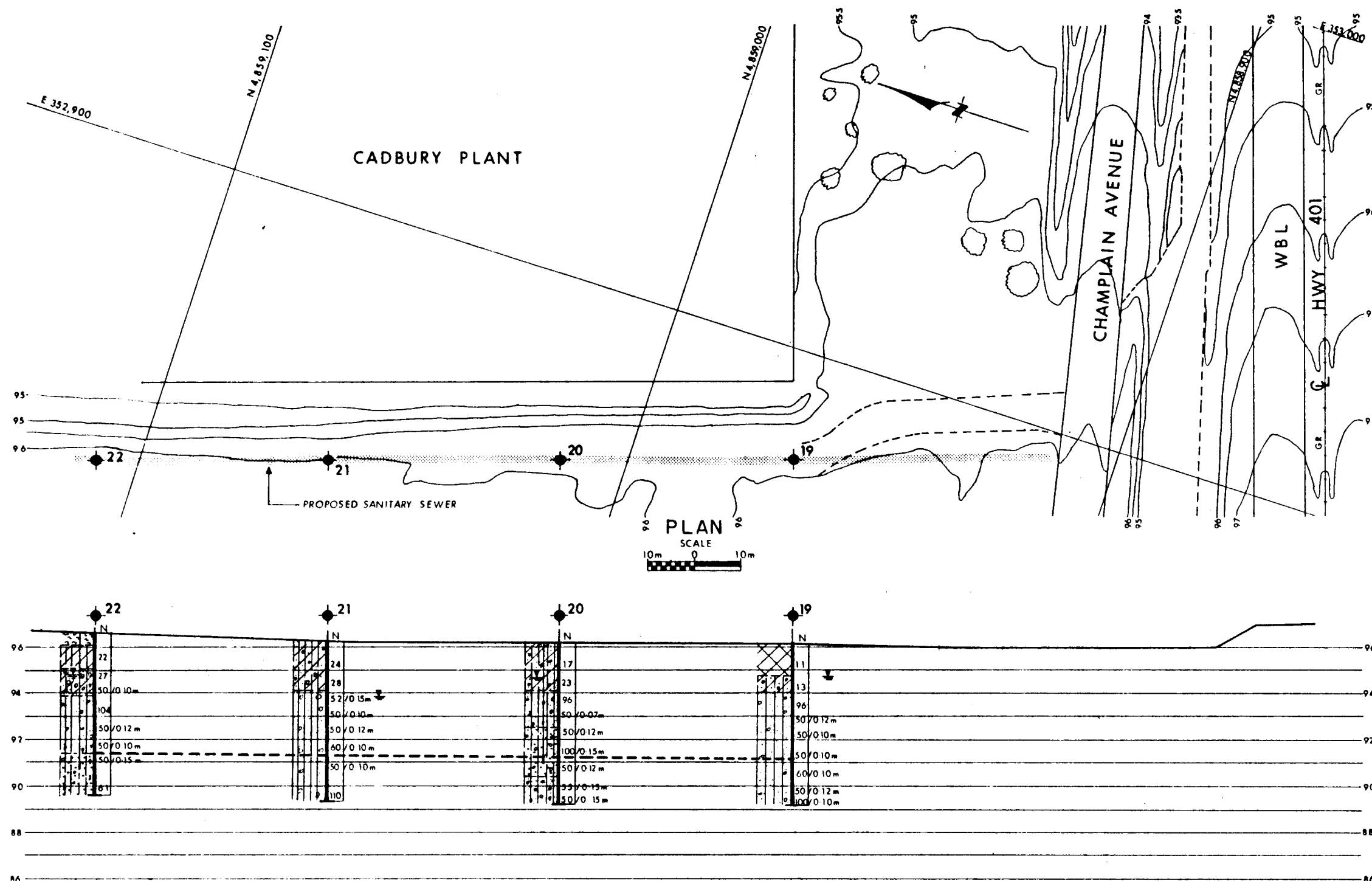
DRAWN BY: FL  
1984 08 07  
CHK'D BY: ZSO  
DESIGNED BY:  
APPROVED BY:  
SCALE: FULL SIZE ONLY  
AS SHOWN

**PROFILE ALONG SANITARY SEWER**

SCALE  
1m 0 1 2 3m

**LEGEND**

- FILL
- TOPSOIL
- SILTY CLAY
- SILTY CLAY TILL
- SANDY SILT TILL
- SILTY SAND TILL



CADBURY PLANT

CHAMPLAIN AVENUE

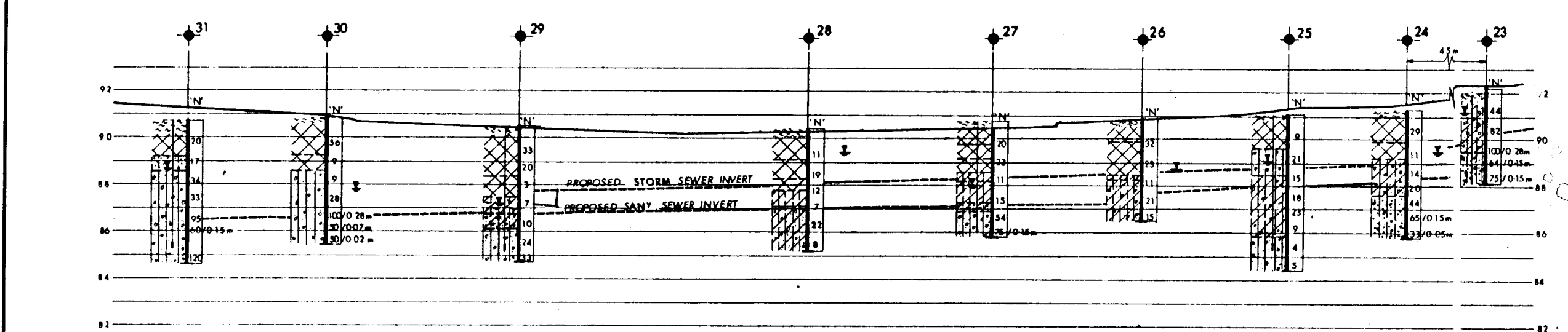
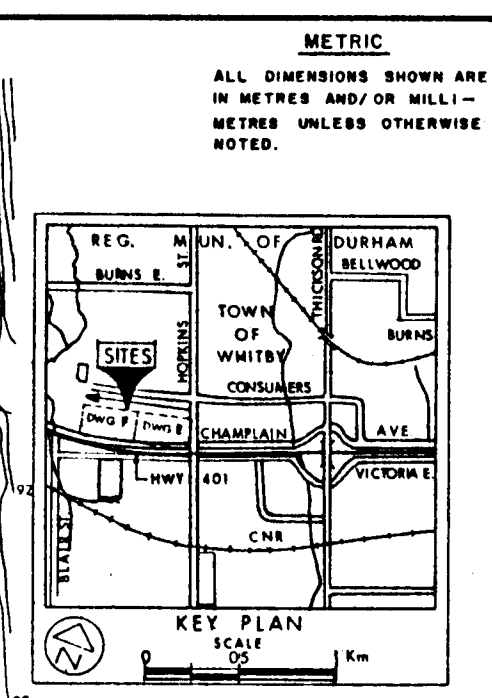
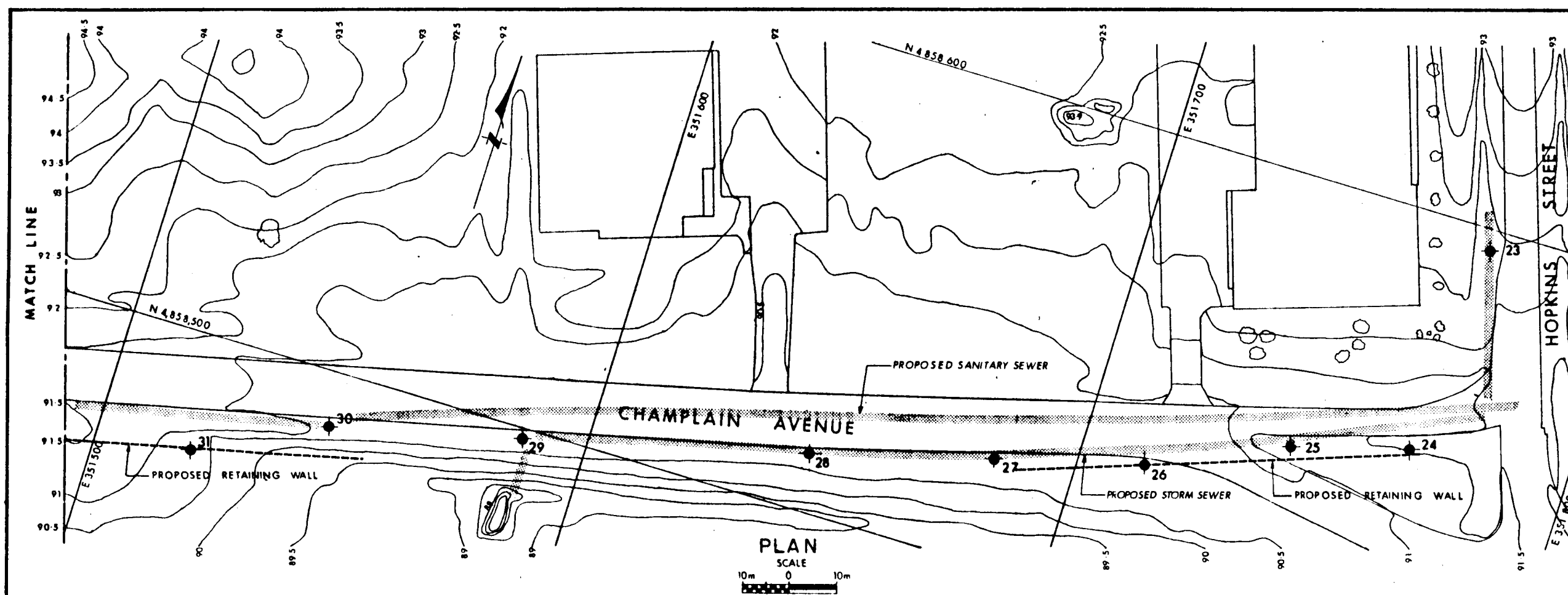
WBL

HWY 401

PLAN

SCALE  
10m 0 10m

PROPOSED SANITARY SEWER



**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
- PIEZOMETER

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
23	92.2	4,858,595	351,771
24	91.3	4,858,550	351,767
25	91.1	4,858,543	351,743
26	90.8	4,858,531	351,714
27	90.7	4,858,523	351,683
28	90.4	4,858,512	351,646
29	90.5	4,858,498	351,587
30	90.8	4,858,488	351,547
31	90.7	4,858,475	351,520



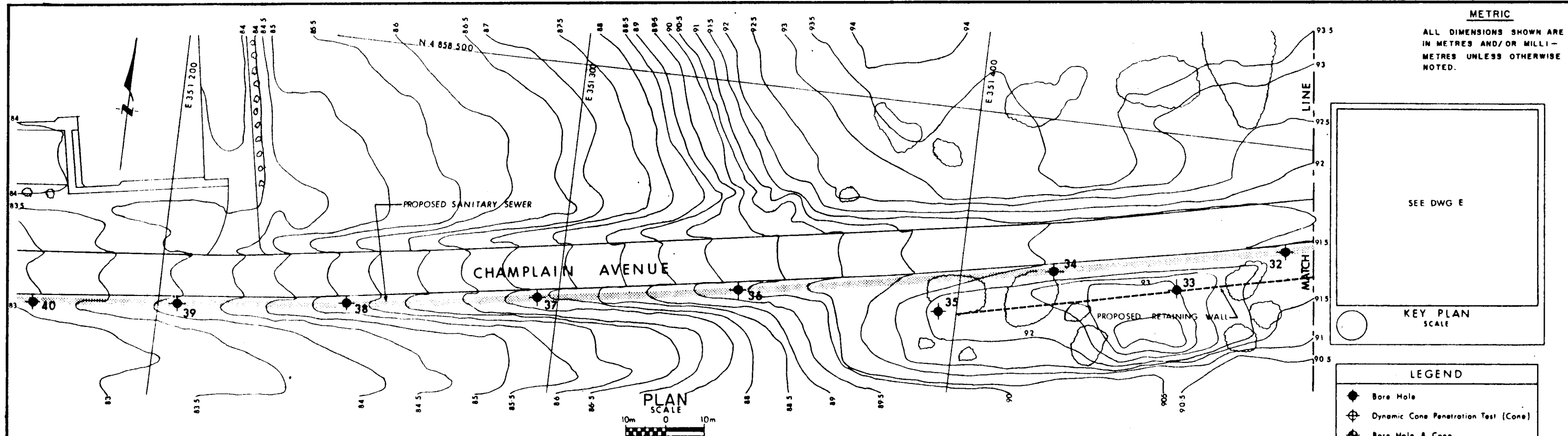
Geocres No

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

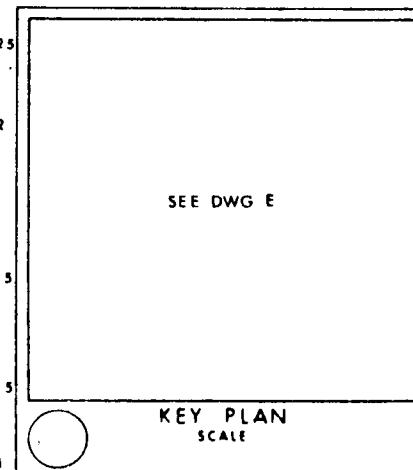
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically included in accordance with the conditions of Section 102-2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

GO-ALRT REF

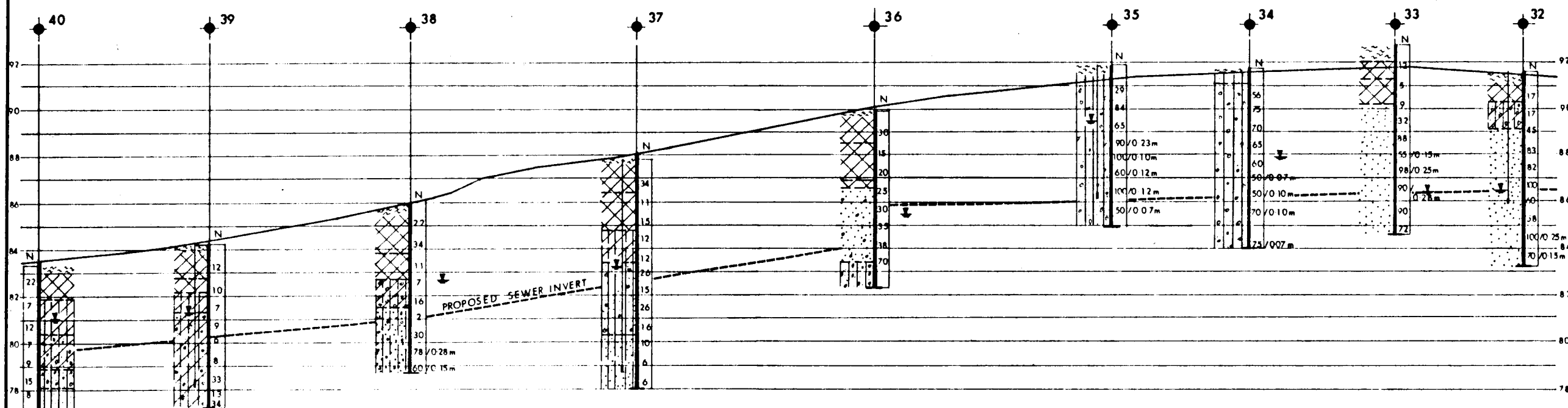
REFERENCE DRAWINGS		REVISIONS		DRAWN BY: FL 1984 08 07	DESIGNED BY:	DOMINION SOIL INVESTIGATION INC	 Ministry of Transportation and Communications	DURHAM REGION			
				CHK'D BY: ZSO	APPROVED BY:			ALRT/CHAMPLAIN AVE SANITARY & STORM SEWERS			
				SCALE: FULL SIZE ONLY AS SHOWN				BOREHOLE LOCATION AND SOIL STRATA			
								CONTRACT NO	DWG NO GGE00061-E	REV	SHEET



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



- LEGEND
- Bore Hole
  - ⊕ Dynamic Cone Penetration Test (Cone)
  - ⊕ Bore Hole & Cone
  - N Blows/0.3m (Std Pen Test, 475 J/blow)
  - CON Blows/0.3m (60° Cone, 475 J/blow)
  - W.L. at time of investigation 1984 06
  - PIEZOMETER



No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
32	91.6	4,858,473	351,481
33	92.7	4,858,460	351,455
34	91.7	4,858,461	351,423
35	91.9	4,858,448	351,395
36	89.9	4,858,447	351,345
37	87.8	4,858,440	351,295
38	85.9	4,858,432	351,248
39	84.2	4,858,428	351,205
40	83.3	4,858,424	351,168

- LEGEND
- FILL
  - SILTY CLAY TILL
  - SAND
  - TOPSOIL
  - SANDY SILT TILL
  - SANDY SILT
  - SILTY CLAY
  - SILTY SAND TILL
  - SILTY SAND
  - SAND some gravel

Geocres No. **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. Unreviewed 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

REFERENCE DRAWINGS		REVISIONS		DRAWN BY: FL 1984 08 07	DESIGNED BY:	DOMINION SOIL INVESTIGATION INC	GO-ALRT Ministry of Transportation and Communications	DURHAM REGION		
				CHK'D BY: ZSO	APPROVED BY:			GO-ALRT/CHAMPLAIN AVE. SANITARY SEWER BOREHOLE LOCATION AND SOIL STRATA		
				SCALE: FULL SIZE ONLY AS SHOWN						
						PROJECT MANAGER	CONTRACT NO	DWG NO GGE00061-F	REV	SHEET

# REGORD OF MEETING

Project No. 1138003

Title Whitby to Oshawa

Page 1 of 3

Client GO-ALRT

Date of Meeting 31 May 1984

Time

8:30 PM

M.M. DILLON LTD.  
TORONTO OFFICE

Location MTC Foundation Section, Downsview.

## In Attendance

Name

Firm

M. Devata ]

L. Politano ]

R. Radolli ]

T. Miles ]

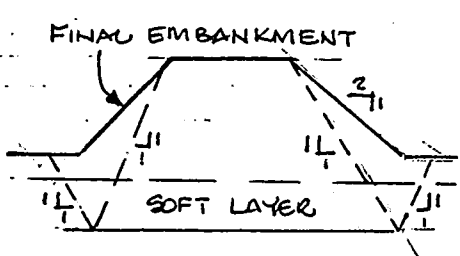
E. Lisinski ]

MTC

MM Dillon

DS-Lea Associates Ltd.



Item	Description	Action by
	Purpose of meeting - To review outstanding matters relating to soils & foundations for GO-ALRT Contract GGE 334.	
1	<p>The matter of the east embankment for the Hwy. 401 Structure was reviewed. The consultants had prepared cost estimates for using light weight slag or excavating &amp; disposing of the soft underlying material, and the latter had proved the lesser in cost. However, no special provisions had been made for protecting the 401 lanes near the excavation, and this was the main point of the meeting. After discussion it was decided that the following course would be adopted:</p> <p>a) A 1:1 plane would be struck at the edges of the embankment top, and where this intercepted the sound stratum below the soft material, would define the extremities of the excavation. The side slopes of the excavation could be 1:1.</p> 	

Recorded by

Distribution

# RECORD OF MEETING

Project No. \_\_\_\_\_

Page 2 of 3

Item	Description	Action by
	b) All unsuitable material would be removed in strips of 3-4 m width. In this way there would be no hazard to Hwy. 401.	
	c) Back filling to above water level would be in Granular B, and then in common fill. The percolation would likely be slow, so it might be possible to mechanically compact the granular material.	
	d) Each excavated "strip" would be back filled as soon as possible after excavation, and before proceeding with the next strip.	
	The Consultants will review the layout of the embankment relative to the Hwy. 401 lanes, and confirm the above procedure will keep the excavation sufficiently far from the W.B. lanes to be acceptable, and also review their cost estimates.	DS-Lea
	2. The toe wall construction along the guideway between Hwy. 401 and Hopkins was reviewed. These are small walls, ranging up to 2 m in height, and the consultant was considering using the MTC standard mass concrete wall. M. Devata suggested that it might be more economical to use gabions or reinforced earth with steeper slopes, or a combination of these methods. The MTC has had good experience with a newly developed grass that requires no cutting, and is suitable for steeper slopes.	
	DS-Lea is to provide M. Devata with the critical section and a copy of the soils profile, and a request for the Foundation Section to advise them on the best way to proceed.	DS-Lea MTC
	3. There is now some urgency in carrying out the soil investigations for the sewers on Champlain west of Hopkins & east of Thickson, if the consultant is to maintain his work program. R. Radolli will arrange for the	MMD

Recorded by \_\_\_\_\_

Distribution \_\_\_\_\_

# RECORD OF MEETING

Project No.

Page 3 of 3

Item	Description	Action by
	appropriate director to be given to the Foundation Section	MMD
	There being no further business the meeting terminated at approx. 5:00 pm.	

Recorded by

## Distribution

--- All present.  
J. Lyle - MM Dillon  
C. Lumley - GO-ALRT



ADM 9A



# RECORD OF MEETING

Project No. 83138/3/330 Title GO-ALRT

Page 1 of

Client GO-ALRT

Date of Meeting 20 June 1984 Time

Location M.T.C. Foundations Office

In Attendance  
Name

Firm

Mr. M. Devata

M.T.C.

Mr. L. Politano

Mr. T. Miles

DS-Lea

Item	Description	Action by
1.	<p>Purpose of Meeting: To review the findings of the Foundations Office regarding the east approach fill to the 401 structure, and retaining walls along Champlain.</p> <p>Regarding the Highway 401 east approach, the differences between the soil profile and foundation report were reviewed.</p> <p>It was decided that the water levels in the foundation report should be used for determining the height of granular backfill, and assume it followed the existing ground profile. It would be assumed that the soft material extended to Sta. 24+990.</p> <p>The procedure in excavating would be to work in strips, remote from Highway 401 and working towards 401.</p> <p>If the cost of using light weight slag and a soil transfer are similar, the Foundation Office prefers the use of slag - the uncertainties of the extent of the soft material, unforeseen construction problems are the basis of this view.</p>	

Recorded by

Distribution



DS-LEA ASSOCIATES LTD.  
Consulting Engineers and Planners  
Vancouver • Winnipeg • Toronto • Ottawa

ADM 9

## Project No.

Page of

## Distribution

All Present  
Mr. J. Lyle, M.M. Dillon Ltd.



**DS-LEA ASSOCIATES LTD.**  
Consulting Engineers and Planners  
Vancouver • Winnipeg • Toronto • Ottawa

ADN 9A



Ontario

Ministry of  
Transportation and  
Communications

Tel: (416) 248-3282

Foundation Design Section  
Engineering Materials Office  
1201 Wilson Avenue  
Room 315, Central Building  
Downsview, Ontario  
M3M 1J8

1984 06 20

D.S. Lea Associates Ltd.  
Consulting Engineers and Planners  
1240 Ellesmere Road  
Scarborough, Ontario  
M1P 2Y4

Attention: S.A. Miles, P.Eng.

RE: GO-ALRT, Proposed Champlain Ave. Toe Walls

Dear Sir,

As per discussions with you at the meeting held at this office on 84 05 31, we understand that a toe wall is proposed to retain the south side of Champlain Ave. between Sta. 25 + 200 and 25 + 330, and between Sta. 25 + 500 and 25 + 585. The maximum design height of the wall is 1.75 m and 0.95 m for the first and second section respectively.

We have considered alternatives to the toe wall and suggest the following:

- (1) Gabion Walls can be used along the entire length of the sections previously noted. The gabion baskets should be imbedded a minimum depth of 500 mm.
- (2a) Earth reinforcing concept can be used for slopes in the order of 1.4:1 to 1.7:1. The typical treatment indicated on the attached drawing can be applied. Pertinent features of the scheme include the following:
  - . Granular 'A' cover to be benched into natural slope,
  - . Granular 'A' to be compacted in 250 mm lifts,
  - . Compaction equipment is not permitted to travel directly on the Tensar SS-1 grid,
  - . Ditch should be sodded.

Further details can be supplied by this office if this scheme is adopted.

- (2b) For slopes between 1.7:1 and 1.9:1, the treatment shown on the attached drawing can be implemented. The only difference is, however, that there is no need for the Tensar SS-1 in the granular cover provided that it is properly compacted. A surface mesh should still be included.

If clarification is required for any of the above points, do not hesitate to call the undersigned.

Yours truly,



L. Politano  
Project Foundations Engineer

for

M. Devata, P. Eng.  
Chief Foundations Engineer  
(East)

LP/MD/mmj

Attach.

c.c. - E. Lisinski  
R. Radolli  
C. Lumley

Cont 83-39

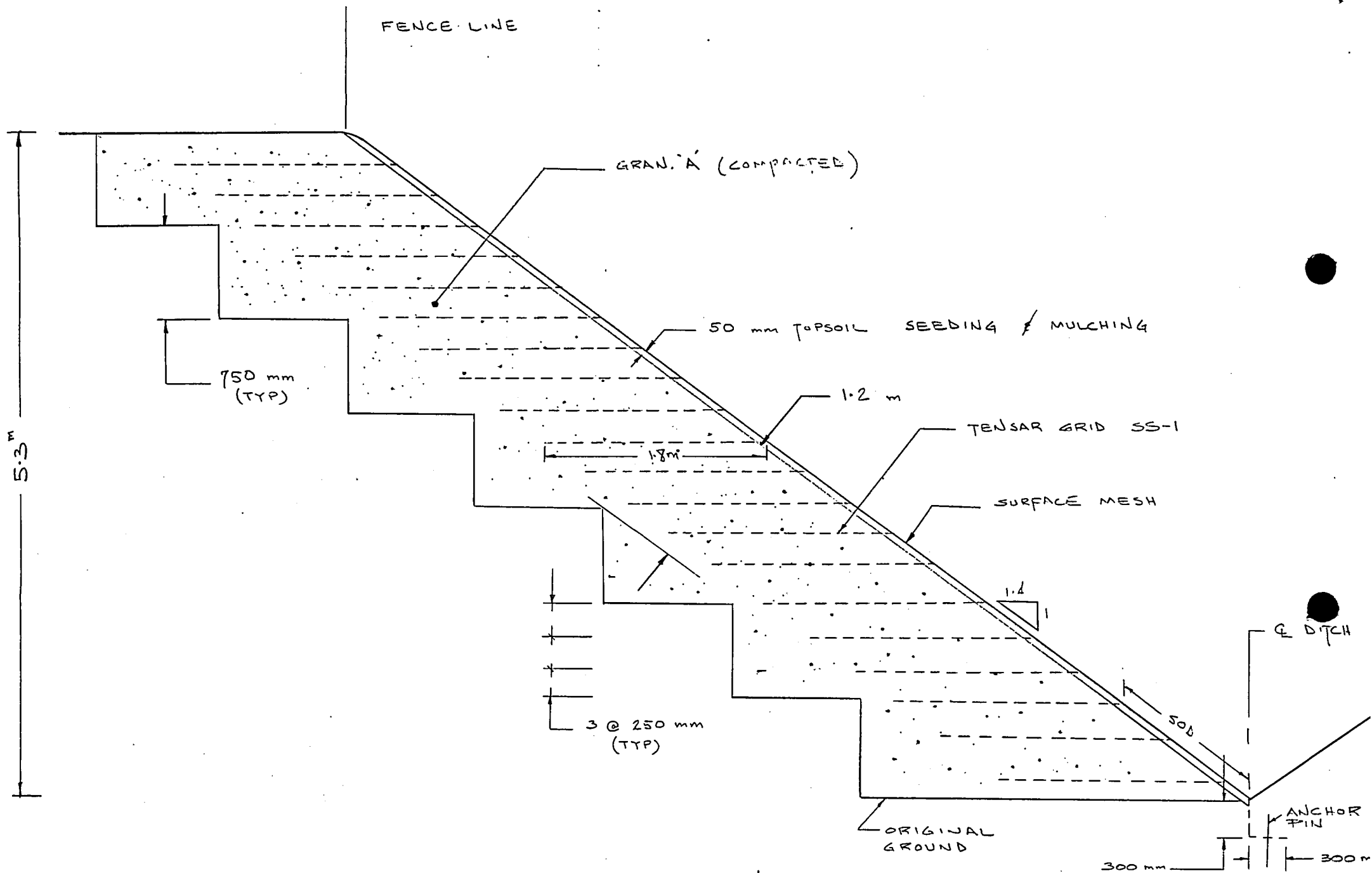
contract Prices obtained from D. O'GRADY

Proj Super : 457-9289

supply place

SS-1	_____	\$ 2.40 m <sup>2</sup>
CE-III	_____	2.40 m <sup>2</sup>
GRAN 'A'	_____	\$ 6.27 t

} info. supplied  
to D.S. Lea





**DS-LEA ASSOCIATES LTD.**

Consulting Engineers and Planners  
Vancouver • Winnipeg • Toronto • Ottawa

6 June 1984

Our Ref. 83138/3/330

Mr. M. Devata  
Ministry of Transportation  
and Communications  
Foundation Section  
1201 Wilson Avenue  
Downsview, Ontario  
M3M 1J8



Dear Mr. Devata:

re: GO-ALRT - Hwy. 401 to  
Thickson Rd., Whitby

Further to our meeting on Thursday 31 May 1984, we submit herewith two copies each of Drawings No. 83138-WF039, WF040 and WF041.

Drawings No. 83138-WF039 and 040 relate to the east embankment for the Hwy. 401 structure.

In the course of our meeting, we discussed excavating the area of soft material in strips. In reviewing this in more detail, it did not appear practical. What we are now suggesting is that we excavate the area with 1:1.5 side slopes, backfill with granular to above the expected water line, and then, excavate to 1:1 slopes (in short lengths if necessary) along the face abutting the Hwy. 401 lanes. We would appreciate you confirming that this appears acceptable to you.

The borehole locations are shown on Drawing WF039. The soils profile, a copy of which is enclosed, suggests the soft material might extend as far as Sta. 25+200. It may be advisable to take additional borings to better define the extent of the soft material.

Preliminary estimates indicate that the cost of excavating and of using lightweight slag are comparable, but depend on the extent of the poor material. If the costs prove to be similar, it would be our preference to remove the poor material, and deal with an embankment whose behavior is more predictable. We would appreciate your view on this.

Mr. M. Devata

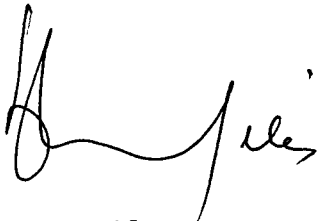
6 June 1984 - page 2

Drawing 83138-WF041 is a section through the guideway west of Hopkins St. You will note that between Sta. 25+200 and Sta. 25+360 the side slope in the cut section varies from 2:1 to 1.4:1. We would appreciate your advice on what treatment might allow the use of these slopes, or whether a retaining structure should be incorporated to maintain 2:1 slopes.

Your early response to these matters would be appreciated.

Yours very truly

DS-LEA ASSOCIATES LTD.

A handwritten signature in black ink, appearing to read 'S.A. Miles', with a stylized flourish at the end.

S.A. Miles, P.Eng.  
Project Manager

:ecf

cc: Mr. R. Radolli