

FOUNDATION INVESTIGATION REPORT

W.P. 374-89-02, SITE 16-306
RAMP W-N OVER HWY 401 & CEDAR GROVE RD
HWY. 401-416 INTERCHANGE
File DISTRICT 9, OTTAWA
GEOCRES # 31B-74 ~~F21E~~
MINISTRY OF TRANSPORTATION OF ONTARIO

SUBMITTED TO
DELCAN CORPORATION
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Report

on

Foundation Investigation

for

W.P. 374-89-02, Site 16-306
Ramp W-N Over Hwy 401 & Cedar Grove Road
Hwy. 401-416 Interchange
District 9, Ottawa

Jacques, Whitford Limited

March, 1992

Project No. 10210

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Appendix 1

Explanation of Terms Used in Report

Record of Boreholes

Figure 1 : Plasticity Chart

Figure 2 - 3 : Grain Size Distribution

Figure 4 : Plasticity Chart

Figure 5 : Abutment on Compacted Fill

Appendix 2

Drawing No. 3748902-A - Bore Hole Locations & Soil Strata

FOUNDATION INVESTIGATION REPORT

for

**WP 374-89-02 Site 16-306
Ramp W-N Over Hwy 401 & Cedar Grove Road
Hwy 401-416 Interchange
District 9, Ottawa**

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at the above noted site in the Township of Edwardsburg, Ontario. The investigation was carried out in accordance with our proposal dated December 11, 1990. Authorization to carry out the work was provided by Mr. H.R. Luck, P.Eng., of Delcan Corporation.

This report contains factual information obtained from this investigation pertaining to the subsurface conditions.



2.0 SITE DESCRIPTION AND GEOLOGY

The site is located at the existing Cedar Grove Road and Highway 401 about 1 kilometre west of the existing intersection of Highways 401 and 16. The terrain surrounding the site is generally flat and consists of pasture, grassed areas and forested areas. Along the alignment of the proposed structure, the existing ground surface generally slopes downward from north to south at less than 2% grade.

The existing Cedar Grove Road is a two-lane paved road with gravel shoulders. Cedar Grove Road at this location is in general about 0.8 m above surrounding ground. Highway 401 is a four-lane divided highway with gravel shoulders. Highway 401 at this location is in general about 1.2 m above surrounding ground, and has a median ditch about 1 m deep.

Drainage of the site adjacent to the existing Highway 401 and Cedar Grove Road is provided by culverts that are connected to highway ditches. Outside of the right-of-ways of Highway 401, the areas south and north of the highway are low-lying with surface water ponding. Johnstown Creek is located immediately south of the proposed overpass. Drainage of the creek under the existing Highway 401 is provided by box culverts.

Physiographically, the site lies in the area known as the Glengarry Till Plain. The surface consists of morainic ridges and drumlins together with intervening clay flats and swamps. Bedrock underlying the overburden consists of Ordovician dolostone of the Oxford Formation. Overburden thickness in this area is less than 10 m.

3.0 PROCEDURE

3.1 Field Investigation

Prior to the onset of the drilling investigation, the necessary utility check clearances were obtained by our site personnel.

The field work for this investigation was carried out between April 8 and April 17, 1991. A total of eight (8) boreholes, (numbered 91-1 to 91-8) were put down at the site. Boreholes 91-1 and 91-8 were put down at the approach fill locations. Boreholes 91-2 and 91-7 were put down at the abutment locations. Boreholes 91-3 to 91-6 inclusive were put down at the pier locations. In addition, a total of nine (9) cone penetration tests, (numbered 91-9 to 91-17) were performed at the pier and abutment locations to identify potential sloping bedrock profiles. The test locations and the proposed structure are indicated on Drawing No. 3748902-A provided in Appendix 2.

All boreholes were put down using a track-mounted power auger drill suitably equipped for soil and bedrock sampling. Hollow stem augers and N-sized rock coring techniques were employed during the course of the investigation to advance the boreholes.

The boreholes were put down to depths ranging from 1.9 m to 12.6 m. Boreholes 91-3 to 91-7 inclusive were terminated after coring in NQ-size 1.9 m to 3.1 m into bedrock. The remaining boreholes (91-1, 91-2 and 91-8) were terminated at depths ranging from 1.9 m to 10.8 m, upon hollow stem auger refusal.

The overburden soils encountered were sampled by means of a split tube sampler during the performance of Standard Penetration Tests (SPT) (ASTM D1586). Where cohesive soils were encountered, thin-walled (Shelby) tube samples were collected. Field vane tests were conducted at selected locations. Sampling was generally conducted on a near continuous basis (intervals of 0.76 m) at the top 4.6 m. Below this depth, sampling was conducted in intervals of about 1.5 m.

All soil samples recovered were stored in moisture-proof bags and were returned to our Ottawa laboratory together with rock cores for detailed classification and testing.

Standpipe piezometers 25 mm in diameter were installed in Boreholes 91-1 to 91-3, 91-5, 91-6 and 91-8 between depths of 1.9 m and 12.6 m. Monitoring wells 58 mm in diameter were installed in boreholes 91-4, 91-6 and 91-7 between depths of 4.3 m to 6.9 m. The monitor well in Borehole 91-6 and the piezometers in Boreholes 91-3 and 91-5 were installed and sealed within the bedrock to monitor its water level.

The piezometers and the monitoring wells were backfilled with sand within the perforated lengths. A bentonite seal was then placed in the boreholes prior to backfilling with soil cuttings to near the ground surface. A bentonite surface seal was then provided and the ground surface was mounded to prevent water infiltration. Locked steel casings were installed for the monitoring wells in Boreholes 91-4 and 91-6 to ensure long term monitoring if desired. Groundwater samples were collected from the monitor wells and were subject to chemical testing.

3.2 Survey

The borehole and cone penetration test locations and ground surface elevations were surveyed by Delcan Corporation personnel after completion of the field work. The elevations are referenced to Geodetic datum. The borehole coordinates and elevation data is summarized on Drawing 3748902-A in Appendix 2.

3.3 Laboratory Testing

To identify the properties of the soil samples collected during the field investigation, the following laboratory tests were carried out:

- Detailed visual classification,
- Natural moisture content,
- Sieve and hydrometer analyses,
- Atterberg Limits determination,
- Laboratory vanes.

Samples remaining after testing will be stored in our laboratory for a period of six months after issuance of the final report. They will then be discarded unless we are directed otherwise.

4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Conditions

The subsurface conditions observed in the boreholes are presented in detail on the Record of Boreholes provided in Appendix 1. An Explanation of Terms Used in Report is also provided in Appendix 1. The laboratory test results are summarized in the Record of Boreholes and also on Figures 1 to 4 in Appendix 1.

The ground surface elevations at the borehole locations varied from El. 83.5 m to 87.9 m at the time of the investigation. The surficial material at the boreholes consists of topsoil and/or fill, overlying sand where present, overlying silty clay, overlying a heterogeneous mixture of clay, silt, sand, gravel and boulders (glacial till) where present, underlain by dolostone bedrock. The bedrock surface was encountered between about El. 76.5 m and El. 81.7 m. The groundwater level was observed between about El. 83.1 m to 87.1 m (0.2 m above ground surface to 0.9 m below ground surface).

A brief discussion of the observed subsurface conditions is provided below. Specific details of the subsurface materials should be obtained from the Record of Boreholes.

4.1.1 Topsoil

Topsoil was encountered in all boreholes except Borehole 91-3 from ground surface. The thickness of the topsoil ranges from 100 mm to 300 mm.

4.1.2 Sand and Gravel (Fill) / Silt and Sand (Fill)

A compact sand and gravel, some silt (fill) layer was encountered from ground surface in Borehole 91-3. The thickness of the fill layer is 1.4 m. The SPT conducted in this fill layer yielded an N value of 13, indicating a denseness of compact. The moisture content of a representative sand and gravel fill sample is 7.5%. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

A loose silt and sand (fill) was encountered underlying the topsoil layer in Borehole 91-5. The thickness of the fill layer is 0.9 m. The SPT conducted in this fill layer yielded an N value of 6, indicating a denseness of loose. The moisture content of a representative silt and sand fill sample is 20%. Based on visual identification and laboratory tests, this fill can be classified as inorganic and cohesionless.

4.1.3 Sand

Sand, some silt was encountered underlying the topsoil layer in Boreholes 91-6 to 91-8 inclusive. The thickness of the sand layer ranges from 0.5 m to 1.0 m.

The SPT conducted in the sand layer yielded a typical N value of 2, indicating a denseness of very loose. The moisture content of a representative sand sample is 24%. Based on the visual identification and laboratory tests, the sand can be classified as inorganic and cohesionless.

4.1.4 Clay

Clay was encountered underlying the topsoil/fill/sand materials described above. The thickness of the clay ranges from 1.0 m to 2.8 m. The clay consists of an upper oxidized brown to grey, mottled layer underlain by a grey layer. The results of laboratory testing are provided on the Record of Boreholes, on Figures 1 and 2 in Appendix 1, and are summarized below:

| Property | Range | # Tests | Average |
|----------------------|-------|---------|---------|
| Moisture Content (%) | 24-41 | 13 | 32 |
| Grain Size | | | |
| % Gravel and Sand | 0 | 2 | 0 |
| % Silt | 33-37 | 2 | 35 |
| % Clay | 63-67 | 2 | 65 |
| Liquid Limit (%) | 51-54 | 3 | 53 |
| Plastic Limit (%) | 24-27 | 3 | 26 |
| Plasticity Index(%) | 25-30 | 3 | 27 |

Field and laboratory vane tests indicated that the clay has undrained shear strengths ranging from 75 kPa to over 200 kPa, indicating a consistency ranging from stiff to hard, and generally in the very stiff range (100 to 200 kPa). Based on visual identification and laboratory tests, the silty clay is classified as a cohesive material of high plasticity.

4.1.5 Heterogeneous Mixture of Silty Sand, some Clay and Gravel, occasional Boulders (Glacial Till)

A heterogeneous mixture of silty sand, some clay and gravel, occasional boulders (glacial till) was encountered underlying the silty clay in all boreholes except Borehole 91-8. Where present, the glacial till surface was encountered at elevations ranging from El. 81.7 m to El. 86.6 m (depths of 1.3 m to 3.6 m). The thickness of this material ranges from 0.1 m to 9.3 m.

The SPT conducted in the glacial till layer yielded N values ranging from 3 to 68, indicating a denseness ranging from very loose to very dense, and generally in the compact to dense range. The results of laboratory testing are provided on the Record of Boreholes, on Figures 3 and 4 in Appendix 1, and are summarized below:

| Property | Range | # Test | Average |
|----------------------|-------|--------|---------|
| Moisture Content (%) | 7-14 | 18 | 9 |
| Grain size | | | |
| % Gravel | 10-31 | 5 | 19 |
| % Sand | 26-39 | 5 | 35 |
| % Silt and Clay | 43-52 | 5 | 46 |
| % Silt | 27-30 | 2 | 28 |
| % Clay | 21-22 | 2 | 21 |
| Liquid Limit (%) | 14-15 | 3 | 15 |
| Plastic Limit (%) | 10-11 | 3 | 11 |
| Plasticity Index (%) | 3-5 | 3 | 4 |

The above grain-size distributions represent only the minus 38 mm fraction (split spoon samples) of the glacial till. Cobbles and boulders are also present in this material. If the coarser portion is to be included, the actual percentage of fines would be less than that indicated above. Based on the above tests and visual identification, this till material can be classified as generally cohesionless, with some cohesive layers.

4.1.6 Bedrock

Bedrock was encountered and proven by coring in NQ-size in Boreholes 91-3 to 91-7 inclusive. The bedrock surface at these locations was encountered between El. 77.8 m and El. 81.7 m (depths of 2.6 m to 9.6 m). The bedrock is a grey, unweathered, limy dolostone interbedded with shale occasionally. The dolostone has close to moderately close spaced horizontal fractures. The bedrock is of fair to excellent quality (RQD ranging from 53% to 100%). Core recoveries varied between 80% and 100%. The average RQD over 13.9 m of rock cored was 84%, indicating an overall rock mass quality of good.

In Boreholes 91-2 and 91-8, hollow stem auger refusal was encountered at El. 76.5 m and 81.4 m on inferred bedrock. Nine (9) cone penetration tests (numbered Boreholes 91-9 to 91-17) were conducted near the boreholes put down at the pier and abutment locations. The inferred bedrock elevations based on auger and cone penetration refusal range from El. 76.5 m to 81.6 m. Where cone penetration tests were carried out to supplement the borehole data, the results indicated that the bedrock slope is generally less than 10 degrees, except between Boreholes 91-6 and 91-15 where the bedrock slope was determined to be about 14 degrees.

4.2 Groundwater

The monitor wells /standpipes in Boreholes 91-3, 91-5 and 91-6 were sealed in the bedrock. Groundwater levels at these locations, which represent the levels within the bedrock, ranged between El. 85.4 m and El. 86.5 m, or from 0.2 m above ground surface (artesian) to 0.9 m below ground surface. In the remaining boreholes, groundwater levels recorded, which represent the levels within the overburden, ranged between El. 83.1 m and El. 87.1 m (depths from ground surface to 0.8 m).

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

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Proposed Development

The site is located at the existing Cedar Grove Road and Highway 401 approximately 1.0 km west of the intersection of the existing Highways 16 and 401 in the Township of Edwardsburg, Ontario (refer to the Key Plan provided on Drawing No. 3748902-A in Appendix 2).

The proposed bridge structure is part of the Highway 416 development from Highway 401 to Highway 43. The Highway 401 and Cedar Grove Road overpass structure is to consist of the following components:

- A two-lane five-span fly-over structure spanning over Cedar Grove Road and Highway 401.
- The structure will be supported by four (4) piers, and two (2) abutments with associated approach fills.
- Fill heights at abutment locations are to range from approximately 7.7 m to 9.8 m.

5.2 Geotechnical Assessment

The subsurface soils profile at the site consists of sand/silty clay overlying glacial till, underlain by dolostone bedrock. The bedrock profile generally slopes upward from north to south along the alignment of the proposed structure.

The abutments may be supported by driven piles end bearing on bedrock, or may be founded on spread footings perched within compacted Granular 'A' fill.

For the pier foundations, it is understood that conventional spread footing foundations will require bearing capacity in the order of 300 kPa or higher. Both the clay and the glacial till overburden at this site are not capable of withstanding this bearing capacity. The pier foundations should be supported on bedrock. Depending on the bedrock profile at the specific pier location, three alternatives may be considered, namely (i) driven piles end bearing on bedrock, (ii) cast-in-place drilled caissons socketed into bedrock, and (iii) spread footings placed on bedrock.

For Pier #4 (BH 91-3) where bedrock is relatively deep, driven piles should be the most viable alternative. For Pier #3 (BH 91-4), Pier #2 (BH 91-5) and Pier #1 (BH 91-6) where the bedrock is 2.2 m to 2.7 m from the proposed founding levels, spread footings on bedrock should be the most viable alternative. For all structure foundation locations, the alternative that proves to be the most cost effective should be selected for design.

The approach fills of up to about 9.8 m in height may be constructed using side slopes of 2 horizontal to 1 vertical for granular borrow, or side slopes of 2.5 horizontal to 1 vertical for fine-grained borrow. A 2.0 m wide berm is recommended at mid-height of the embankment. No embankment stability and settlement problems are anticipated. This report contains our detailed recommendations in the following areas:

- 1) Structure Foundations
- 2) Abutment Backfill
- 3) Approach Fills
- 4) Construction Considerations

5.3 Structure Foundations

5.3.1 Perched Abutments on Compacted Granular 'A' Fill

// Both the north and south abutments may be founded on spread footings perched within compacted Granular 'A' fills in accordance with the details shown on Figure 5 in Appendix 1. Prior to the placement of the granular fill, the following is recommended: //

- Remove all surficial organic/loosened materials within the plan limits of the granular core as shown on Figure 5.
- Proof roll the exposed surface. Soft areas revealed under proof rolling should be excavated.

ⓐ Construct granular pads using OPSS Granular 'A' material as shown on Figure 5. The Granular 'A' should be compacted in accordance with OPSS 501.

ⓐ Foot 1.8m

Spread footings placed on granular pads constructed as recommended above may be designed based on the following bearing pressures:

| | <u>Footing Elevation (m)*</u> | <u>Factored Bearing Capacity at U.L.S.</u> | <u>Bearing Capacity at S.L.S. Type II</u> |
|----------------|-----------------------------------|--|---|
| South Abutment | 88.0 or above | 800 kPa | 300 kPa |
| North Abutment | 88.8 or above | 550 kPa | 250 kPa |

* Approximate elevations of the underside of the abutment footings as indicated by Delcan Corporation.

The above bearing pressures have been calculated based on a footing width (B) of 4 m. The S.L.S. Type II bearing pressure has been calculated assuming that a total settlement of 25 mm is satisfactory.

The relatively weaker overburden conditions (specifically the sand and the clay) present at the site are reflected in the lower bearing capacities especially at the north abutment. Consideration could be given to sub-excavating the weaker overburden, and replacing with compacted Granular 'A' fill. Spread footings in this case may be designed based on the following bearing pressures:

| | <u>Subexcavation to Elevation</u> | <u>Factored Bearing Capacity at U.L.S.</u> | <u>Bearing Capacity at S.L.S. Type II</u> |
|----------------|---------------------------------------|--|---|
| South Abutment | 83.1 m | 900 kPa | 350 kPa |
| North Abutment | 85.8 m | 900 kPa | 350 kPa |

The exposed surface after subexcavation should be proof rolled with soft areas removed. The above bearing pressures have been calculated based on a footing width (B) of 4 m, and that the underside of the south and north abutment footings will be placed at or above El. 88.0 m and El. 88.8 m respectively. The S.L.S. Type II bearing pressure has been calculated assuming that a total settlement of 25 mm is satisfactory.

A minimum earth cover of 1.8 m over the footings should be provided for frost protection purposes and has been assumed in the calculations.

Sliding resistance between concrete footings and Granular 'A' should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. using an unfactored friction coefficient of 0.7.

Dewatering may be required only if subexcavation is to be carried out. Details on dewatering will be addressed in Section 5.6.1 of this report.

5.3.2 End Bearing Driven Piles

All structure foundations including abutments and piers may be supported on end-bearing steel-H piles equipped with reinforced tips (to facilitate pile penetration through the glacial till deposit) and driven to bedrock.

Downdrag forces due to negative skin friction forces will need to be considered at the abutment locations. Downdrag forces are induced as a result of consolidation of the insitu clay caused by the embankment fill load. No downdrag forces are expected at the pier locations since fill placement is not expected. Considering the downdrag forces at the abutment locations, the following design parameters are recommended for steel H-piles at this site:

Table 1

| <u>Foundation Location</u> | <u>Reference Borehole</u> | <u>Estimated Tip Elevation (m)</u> |
|----------------------------|---------------------------|------------------------------------|
| South Abutment | 91-7 | 81.7 |
| Pier 1 | 91-6 | 81.2 |
| Pier 2 | 91-5 | 80.9 |
| Pier 3 | 91-4 | 81.1 |
| Pier 4 | 91-3 | 77.8 |
| North Abutment | 91-2 | 76.5* |

* Elevation based on auger refusal.

Table 2

| <u>Structure</u> | <u>Pile Type</u> | <u>Factored Capacity at U.L.S. (kN)</u> | <u>Capacity at S.L.S. Type II (kN)</u> |
|------------------|------------------|---|--|
| Abutments | HP 310x79 | 1000 | 790 |
| | HP 310x110 | 1450 | 1050 |
| Piers | HP 310x79 | 1150 | 890 |
| | HP 310x110 | 1600 | 1150 |

Steel H-piles should be driven to refusal with a pile hammer delivering an energy of 3.5 J/mm² to 4.5 J/mm² of steel cross-sectional area. With this energy, refusal may be taken as:

- i) 20 blows for the last 25 mm of penetration; and
- ii) a total of 50 blows for not more than 100 mm of penetration.

In cases where piles do not penetrate the glacial till stratum, the pile capacity should be controlled in the field using current MTO pile driving standards. Attempts should be made in all cases to drive the piles to the bedrock surface.

At the abutment locations, pile caps may be perched within the embankment fill provided that particle sizes within the piling areas do not exceed 75 mm. No dewatering will be required in this case.

Resistance to lateral load for battered piles should be calculated in accordance with Section 6-8.3.8 of the O.H.B.D.C.

Pile caps should be provided with 1.8 m of earth cover for frost protection. At locations where the bedrock is shallow such as Piers 1 and 3, consideration may be given to providing insulation above the pile caps in order to reduce the earth cover and thus lengthening the piles. Alternatively, drilled caissons socketed into bedrock or spread footings placed on bedrock may be utilized for support. The following sections outline our recommendations for drilled caissons and spread footings.

5.3.3 Cast-In-Place Drilled Caissons

At locations where bedrock is relatively shallow, consideration may be given to cast-in-place drilled caissons socketed into bedrock. The compressive load carrying capacity of socketed caissons can be calculated from either end bearing or from bond capacity between the concrete and the rock face within the socket. Socketed caissons may be designed based on the following parameters:

- The capacity based on end bearing alone using a factored bearing capacity at U.L.S. of 2000 kPa, or
- The capacity based on bond stress alone using a factored ultimate concrete/rock bond stress of 750 kPa.

For design based on end bearing or bond, a minimum socket length of 1 m or equal to one (1) caisson diameter, whichever is greater, is recommended. Concrete for caisson sockets should have a minimum compressive strength of 30 MPa. The base of the sockets should be well cleaned before concreting regardless whether the design is based on end bearing or bond.

The horizontal components of battered caissons can be applied to resist lateral forces. Battered caissons can be installed up to an inclination of 1 horizontal to 5 vertical.

The uplift capacity of socketed caissons may be taken as the lesser of the following:

- Capacity calculated using a factored ultimate bond stress of 750 kPa, and
- Capacity calculated from a rock mass resistance assuming a 60° failure cone and a rock mass submerged unit weight of 16.0 kN/m³. The failure cone is defined using the lower end of the caisson as the apex, and the axis of the caisson as the altitude.

5.3.4 Spread Footings on Bedrock

As an alternative to the cast-in-place drilled caissons, spread footings placed on the dolostone bedrock may be considered for support where the bedrock is relatively shallow. Spread footings founded on the bedrock may be designed using the following value:

Factored Bearing Capacity at U.L.S. 1500 kPa

The dolostone bedrock is considered to be an unyielding foundation base and hence a S.L.S. Type II bearing capacity would not be applicable.

The bedrock should be prepared if necessary such that the slope of the bearing surface is no steeper than 10%.

Dewatering will likely be required for this alternative. Details of dewatering are discussed in Section 5.6.1.

Footings placed on mass concrete placed on bedrock can be considered. This option would likely be more economical than placing the footings directly on bedrock for the following reasons:

- reduction in structural materials,
- reduction in dewatering effort since shorter construction time will be required within the excavation.

The factored bearing capacity at U.L.S. of 1500 kPa would also be applicable in this case.

5.4 Abutment Backfill

The abutments should be backfilled with free draining material such as OPSS Granular 'A' or Granular 'B', to prevent hydrostatic pressure build-up.

Computation of earth pressures should be in accordance with Section 6-6.1.2.1 of the O.H.B.D.C. For abutments that are designed to allow rotation, active earth pressure may be used for design. For rigidly tied structures, the at-rest earth pressure should be used for design, unless the stem can deflect enough (approximately 0.05 percent of the wall height) to establish the active pressure. For a horizontal backfill the following soil parameters are recommended for design:

| | Granular 'A' | Granular 'B' |
|---|-----------------|-----------------|
| Bulk unit weight, γ (kN/m ³) | 22.8 | 21.2 |
| Effective friction angle, ϕ' | 35° | 30° |
| At Ultimate Limit States | | |
| Coefficient of active earth pressure (K_a) | 0.34 | 0.41 |
| Coefficient of earth pressure at rest (K_o) | 0.51 | 0.58 |
| At Serviceability Limit States | | |
| Coefficient of active earth pressure (K_a) | 0.27 | 0.33 |
| Coefficient of earth pressure at rest (K_o) | 0.43 | 0.50 |

Compaction of the granular backfill near the walls should be carried out using hand-operated equipment to prevent overstressing the abutment walls.

5.5 Approach Fills

Fill placement of up to 9.8 metres is proposed for the approach fills within the investigated area. Side slopes of 2 horizontal to 1 vertical would be appropriate for fills constructed of granular borrow or select subgrade materials. If fine-grained borrow materials are to be used, side slopes of 2.5 horizontal to 1 vertical would be appropriate.

At the south abutment where fill height in excess of 8.0 m, it is recommended that the approach embankment be constructed with a 2.0 m wide berm at the mid height of the slope. Berm should be constructed as an integral part of the main embankment up to the berm height.

✓ All organic, fill and deleterious materials should be stripped and removed prior to fill placement within the entire fill area. Based on the boreholes (Boreholes 91-1 and 91-8), the anticipated depth of stripping varies from 200 mm to 300 mm. //

The exposed surface should be proof rolled and soft areas removed prior to fill placement. The fills should be placed and compacted in accordance with OPSS 212 and 501.

Settlement of the embankment and the underlying soil are not expected to exceed 25 mm. It is recommended to place the fill early in the construction stage, and to delay the paving, to allow any time dependent portions of these settlements to take place.

✓ To protect against surficial instability, normal slope vegetation should be established in accordance with MTO standards as soon as possible after construction. //

5.6 Construction Considerations

5.6.1 Dewatering

Dewatering is likely required in the following situations:

- Perched abutments placed on compacted Granular 'A' fill and where subexcavation of the insitu weaker soils is required.
- Installation of pile caps at the pier locations.
- Excavation to the bedrock for spread footing installation.

// Dewatering may be achieved by utilizing perimeter ditches within a gravity system in conjunction with a sump pump discharge system to drain accumulated water. Alternatively, dewatering may be achieved by carrying out the excavation from within an interlocking steel sheeting. Other dewatering alternatives may also be considered. The more economical and practically feasible dewatering alternative should be selected. It is the responsibility of the contractor to lower the groundwater below the excavation base, and to construct the structure foundations in the dry without disturbing the underlying foundation soils. //

5.6.2 Temporary Excavations

In view of the high groundwater table present at the time of the investigation, and the cohesionless nature of the fill, sand and glacial till, temporary excavations should be undertaken using slopes no steeper than 1 horizontal to 1 vertical from the bottom of the excavation. In cohesionless deposits where seepage is encountered, flatter side slopes may be required or alternatively a shoring system may be utilized.

5.6.3 Driven Piles Installation

Where cone penetration tests were carried out to supplement the borehole data, the results indicated that the bedrock within each foundation unit generally has a slope of less than 10 degrees, except at Pier 1 (Boreholes 91-6 and 91-15), where the bedrock was determined to be sloping at about 14 degrees. Rock injector points are recommended at this location.

5.6.4 Cast-In-Place Drilled Caissons Installation

The installation of cast-in-place drilled caissons socketed into bedrock at this site will likely require sleeving. Advancement through the glacial till in some locations may encounter cobbles and boulders.

The groundwater head within the bedrock was encountered at 0.2 m above (artesian) to 0.9 m below ground levels (El. 85.4 m to 86.5 m). It is expected that concrete will have to be placed by tremie method.

Rock socketed caissons should be inspected to confirm that the sockets are extended sufficiently into the bedrock, and that the base and the shaft face are adequately prepared. As such, dewatering equipment such as submersible pumps will likely be required to allow inspection.

5.7 Groundwater Chemistry

Two (2) groundwater samples were submitted to Areco Canada Inc. in Ottawa for pH, sulphate and chloride testing. The test results are summarized below:

| Borehole | pH | Sulphate (ppm) | Chloride (ppm) |
|----------|-----|----------------|----------------|
| 91-4 | 7.8 | 61 | 29 |
| 91-6 | 8.0 | 57 | 7 |

The above results indicate that the potential degree of sulphate attack on concrete and the potential degree of attack on exposed steel are both negligible.

6.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Y. Larochelle, Engineer In Training, utilizing equipment owned and operated by Marathon Drilling Limited.

The report was written by Y. Larochelle and C. Kwok, Project Engineer, and approved by G. Kack, Project Manager.

Respectfully submitted,

JACQUES, WHITFORD LIMITED



A handwritten signature in black ink, appearing to read "C. C. Kwok".

Charles C.K. Kwok, M.Sc., P.Eng.
Project Engineer



A handwritten signature in black ink, appearing to read "Gordon Kack".

Gordon J. Kack, M.E.Sc., P.Eng.
Project Manager



EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 91-1

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 859.1; E 384 898.3 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 9, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 87.9 | Ground Surface | | | | | | | | | | | | | | | | |
| 87.6 | Topsoil | | 1 | SS | 4 | Seal | | | | | | | | | | | |
| 0.3 | Clay Stiff to Very Stiff Brown/Grey | | | | | May 10, 1991 | | | | | | | | | | | |
| 86.6 | | | 2 | SS | 11 | | | | | | | | | | | | |
| 1.3 | Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) Loose to Very Dense | | 3 | SS | 41 | | | | | | | | | | | | |
| | | | 4 | SS | 44 | | | | | | | | | | | | |
| | | | 5 | SS | 32 | | | | | | | | | | | | |
| | | | 6 | SS | 17 | | | | | | | | | | | | |
| | | | 7 | SS | 8 | | | | | | | | | | | | |
| | | | 8 | SS | 68 | | | | | | | | | | | | |
| | | | 9 | SS | 50/25 | | | | | | | | | | | | |
| 79.7 | End of Borehole | | | | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-2

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 818.7; E 384 898.8 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 9, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|--------|------|----------------------------|----------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 87.3 | Ground Surface | | | | | | | | | | | | | | | |
| 87.1 | Topsoil | | | | | | | | | | | | | | | |
| 0.2 | Clay Stiff to Very Stiff Brown/Grey | | 1 | SS | 3 | Seal May 10, 1991 | | | | | | | | | | |
| 85.8 | | | 2 | SS | 8 | | | | | | | | | | | |
| 1.5 | Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) Compact to Dense Brown Grey | | 3 | SS | 43 | | | | | | | | | | | |
| | | | 4 | SS | 42 | | | | | | | | | | | |
| | | | 5 | SS | 21 | | | | | | | | | | | |
| | | | 6 | SS | 27 | | | | | | | | | | | |
| | | | 7 | SS | 30 | | | | | | | | | | | |
| | | | 8 | SS | 16 | | | | | | | | | | | |
| | | | 9 | SS | 30 | | | | | | | | | | | |
| | | | 10 | SS | 11 | | | | | | | | | | | |
| 76.5 | | | | | | Seal | | | | | | | | | | |
| | | | | | | Sand Backfill | | | | | | | | | | |
| | | | | | | Piezometer | | | | | | | | | | |
| 10.8 | End of Borehole Refusal on probable bedrock | | 11 | SS | 25/50mm | Seal | | | | | | | | | | |

+3, x⁵ : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 91-3

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 778.8; E 384 896.9 ORIGINATED BY Y.L.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock coring COMPILED BY C.K.K.
DATUM Geodetic DATE April 8, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|----------|-------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 87.4 | Ground Surface | | | | | | | | | | | | | | | | |
| 0.0 | Sand and Gravel, some Silt (Fill) Compact Brown to Black | | 1 | SS | 13 | | Seal | | | | | | | | | | |
| 86.0 | | | | | | | May 10, 1991 | | | | | | | | | | |
| 86.4 | Clay Stiff to Hard Brown/Grey | | 2 | SS | 10 | | 86 | | | | | | | | | | |
| | | | 3 | SS | 9 | | 85 | | | | | | | | | | |
| | | | | | | | Native Backfill | | | | | | | | | | |
| 83.8 | | | 4 | SS | 37 | | 84 | | | | | | | | | | |
| 3.6 | Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) Compact to Dense Grey | | 5 | SS | 16 | | 83 | | | | | | | | | | |
| | | | 6 | SS | 18 | | 82 | | | | | | | | | | |
| | | | 7 | SS | 16 | | 81 | | | | | | | | | | |
| | | | 8 | SS | 43 | | 80 | | | | | | | | | | |
| 77.8 | | | 9 | Ss | 40 | | | | | | | | | | | | |
| 9.6 | Bedrock Limy Dolostone Fair to Excellent | | 10 | NX RC | REC 80% | | Seal | | | | | | | | | | |
| | | | 11 | NX RC | REC 100% | | Sand Backfill | | | | | | | | | | |
| | | | | | | | Piezometer | | | | | | | | | | |
| 74.8 | | | | | | | Seal | | | | | | | | | | |
| 12.6 | 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 91-4

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 734.8; E 384 892.5 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
 DATUM Geodetic DATE April 12, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|----------|-------------|----------------------------|--------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 85.7 | Ground Surface | | | | | | | | | | | | | | | | |
| 0.3 | Topsoil | | | | | | May 10, 1991 | | | | | | | | | | |
| | Clay Stiff to Hard Brown/Grey | | 1 | SS | 2 | | Seal | | x | | | | | o | | | |
| | | | 2 | SS | 12 | | | | | | * | | | o | | | |
| 83.8 | | | | | | | 84 | | | | | | | | | | |
| 1.9 | Het. Mixture of Silty Sand, Brown some clay & Grey gravel, occ. boulders (Glacial Till) Loose to Compact | | 3 | SS | 26 | | Sand Backfill | | | | | | | | | | |
| | | | 4 | SS | 11 | | Piezometer | | | | | | | o | | | |
| | | | 5 | SS | 7 | | 83 | | | | | | | o | | | 10 38 30 22 |
| | | | 6 | SS | 3 | | 82 | | | | | | | o | | | |
| 81.1 | | | | | | | | | | | | | | | | | |
| 4.6 | Bedrock Dolostone Good to Excellent | | | | | | Seal | | | | | | | | | | |
| | | | 7 | NX RC | REC 98% | | 81 | | | | | | | | | | RQD = 76% |
| | | | | | | | 80 | | | | | | | | | | |
| | | | 8 | NX RC | REC 100% | | Native Backfill | | | | | | | | | | RQD = 100% |
| | | | | | | | 79 | | | | | | | | | | |
| 78.0 | | | | | | | | | | | | | | | | | |
| 7.7 | End of Borehole | | | | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-5

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 691.0; E 384 885.4 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
 DATUM Geodetic DATE April 15, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER * CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|-------|------------|------------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 86.1 | Ground Surface | | | | | | | | | | | | | | | | GR SA SI CL |
| 0.1 | Topsoil | | | | | | | | | | | | | | | | |
| | Silt and Sand (Fill) | | 1 | SS | 6 | | | | | | | | | | | | |
| | Loose | Brown | | | | | | | | | | | | | | | |
| 85.1 | | | | | | | | | | | | | | | | | |
| 1.0 | Clay | | 2 | SS | 6 | | | | | | | | | | | | |
| | Stiff to Hard | | | | | | | | | | | | | | | | |
| | | Brown/Grey | 3 | SS | 6 | | | | | | | | | | | | |
| | | Brown | | | | | | | | | | | | | | | |
| | | | 4 | SS | 13 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 82.6 | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 24 | | | | | | | | | | | | |
| 3.5 | Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | | | | | |
| | Loose to Dense Grey | | 6 | SS | 9 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 80.9 | | | 7 | SS | 50 | | | | | | | | | | | | 31 26 (43) |
| 5.2 | Bedrock Dolostone interbedded with shale Excellent | | 8 | NX RC | REC 88% | | | | | | | | | | | | RQD = 86% |
| | | | | | | | | | | | | | | | | | |
| | | | 9 | NX RC | REC 100% | | | | | | | | | | | | RQD = 90% |
| | | | | | | | | | | | | | | | | | |
| 78.0 | | | | | | | | | | | | | | | | | |
| 8.1 | End of borehole * Standpipe Damaged | | | | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-6

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 652.6; E 384 876.9 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
 DATUM Geodetic DATE April 16, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER * CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|----------|-------------|------------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 85.2 | Ground Surface | | | | | | | | | | | | | | | | |
| 85.0 | Topsoil | | | | | | | | | | | | | | | | |
| 0.2 | Sand, some silt | Brown | 1 | SS | 2 | | May 10, 1991 | | | | | | | | | | |
| 84.5 | Very Loose | | | | | | Seal | | | | | | | | | | |
| 0.7 | Clay Stiff to Very Stiff | | 2 | SS | 8 | | Native Backfill | | | | | | | | | | |
| | Brown/Grey | | | | | | 84 | | | | | | | | | | |
| | | | 3 | TW | PH | | Seal | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 11 | | 83 | | | | | | | | | | |
| | | | | | | | Sand Backfill | | | | | | | | | | |
| | | | | | | | Seal | | | | | | | | | | |
| 81.7 | Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | 5 | SS | 15 | | Native Backfill | | | | | | | | | | |
| 3.5 | | | | | | | | | | | | | | | | | |
| 81.2 | | | 6 | SS | 40/75 | | Seal | | | | | | | | | | |
| 4.0 | Dense | Grey | | | | | | | | | | | | | | | |
| | Bedrock Dolostone with large particles of sparry calcite Good to Excellent | | 7 | NX RC | REC 100% | | 81 | | | | | | | | | | RDQ = 87% |
| | | | | | | | Sand Backfill | | | | | | | | | | |
| | | | 8 | NX RC | REC 92% | | 80 | | | | | | | | | | RDQ = 80% |
| | | | | | | | Piezometer | | | | | | | | | | |
| | | | | | | | 79 | | | | | | | | | | |
| 78.2 | | | 9 | NX RC | REC 93% | | Seal | | | | | | | | | | RDQ = 93% |
| 7.0 | End of borehole | | | | | | | | | | | | | | | | |
| | * Artesian head 0.2 m above ground surface encountered on May 10, 1991 | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 91-7

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 623.4; E 384 869.5 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, N-Casing, Rock Coring COMPILED BY C.K.K.
 DATUM Geodetic DATE April 16, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|----------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 84.3 | Ground Surface | | | | | | | | | | | | | | | | |
| 84.0 | Topsoil | | | | | | | | | | | | | | | | |
| 0.3 | Sand, some Silt Very Loose | Brown | 1 | SS | 2 | | Seal | | | | | | | | | | |
| 83.1 | | | 2 | SS | 2 | | | | | | | | | | | | |
| 1.2 | Clay Stiff to Very Stiff Grey | | 3 | SS | 4 | | | | | | | | | | | | |
| 81.8 | | | 4 | SS | 48 | | | | | | | | | | | | |
| 2.5 | Het Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | 5 | NX RC | REC 99% | | | | | | | | | | | | |
| 2.6 | | | | | | | | | | | | | | | | | |
| | Bedrock Limy Dolostone Good to Excellent | | 6 | NX RC | REC 95% | | | | | | | | | | | | |
| 79.8 | | | | | | | | | | | | | | | | | |
| 4.5 | End of borehole | | | | | | | | | | | | | | | | |

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 91-8

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 588.1; E 384 859.4 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY C.K.K.
 DATUM Geodetic DATE April 17, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|--------|------|----------------------------|-----------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | | | | | |
| 83.5 | Ground Surface | | | | | | | | | | | | |
| 83.3 | Topsoil | | | | | | | | | | | | |
| 0.2 | Sand, some Silt Very Loose Reddish-Brown | | 1 | SS | 2 | | | | | | | | |
| 82.3 | | | 2 | SS | 1 | | | | | | | | |
| 1.2 | Clay Stiff to Very Stiff | | | | | | | | | | | | |
| 81.6 | Grey | | 3 | TW | PH | | | | | | | | |
| 1.9 | End of borehole Refusal on probable bedrock | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-9

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 778.2; E 384 903.1 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 12, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 40 80 120 160 200 | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|---------------------------------|----------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | | |
| 86.9 | Ground Surface | | | | | | | | | | | | |
| 86.7 | Probable Topsoil | | | | | | | | | | | | |
| 0.2 | Probable Clay | | | | | | | | | | | | |
| 85.1 | | | | | | | | | | | | | |
| 1.8 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | |
| 77.8 | | | | | | | | | | | | | |
| 9.1 | End of Cone Test | | | | | | | 80/28 cm | | | | | |

RECORD OF BOREHOLE No 91-10

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 779.2; E 384 894.1
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test
 DATUM Geodetic DATE April 12, 1991
 ORIGINATED BY Y.L.
 COMPILED BY C.K.K.
 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 40 80 120 160 200 | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|------|------------|----------------------------|-----------------|---|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | | | | | | |
| 87.5 | Ground Surface | | | | | | | | | | | | |
| 0.0 | Probable Sand and Gravel Trace Silt (Fill) | | | | | | | | | | | | |
| 86.5 | | | | | | | | | | | | | |
| 1.0 | Probable Clay | | | | | | | | | | | | |
| 85.8 | | | | | | | | | | | | | |
| 1.7 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | |
| 77.1 | | | | | | | | | | | | | |
| 10.4 | End of Cone Test | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-11

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 733.9; E 384 896.3 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 12, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|----------------------------|-----------------|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | | | | | | |
| 85.8 | Ground Surface | | | | | | | | | | | |
| 85.5 | Probable Topsoil | | | | | | | | | | | |
| 0.3 | Probable Clay | | | | | | | | | | | |
| 84.4 | | | | | | | | | | | | |
| 1.4 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | |
| 81.1 | | | | | | | | | | | | |
| 4.7 | End of Cone Test | | | | | | 65/15 cm | | | | | |

RECORD OF BOREHOLE No 91-12

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 735.6; E 384 887.1 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 12, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|------|-------------------------|-----------------|--|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | | | | | | |
| 86.2 | Ground Surface | | | | | | | | | | | |
| 85.9 | Probable Topsoil | | | | | | | | | | | |
| 0.3 | Probable Clay | | | | | | | | | | | |
| 85.0 | | | | | | | | | | | | |
| 1.2 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | |
| 81.0 | | | | | | | | | | | | |
| 5.2 | End of Cone Test | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-13

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 691.5; E 384 882.5 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 16, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|---|------------|---------|------|------------|-------------------------|-----------------|--|----|---------------------------------|-------------------------------|--------------------------------|------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | | | | | |
| 86.4 | Ground Surface | | | | | | | | | | | | | |
| 86.3 | Probable Topsoil | | | | | | | | | | | | | |
| 85.5 | 0.1 Probable Silt and Sand (Fill) | | | | | | | | | | | | | |
| 83.0 | 0.9 Probable Clay | | | | | | | | | | | | | |
| 81.1 | 3.4 Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | | |
| 5.3 | End of Cone Test | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-14

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 652.0; E 384 881.1 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 16, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 40 80 120 160 200 | | | | | |
| 84.8 | Ground Surface | | | | | | | | | | | | | |
| 84.6 | Probable Topsoil | | | | | | | | | | | | | |
| 0.2 | Probable | | | | | | | | | | | | | |
| 84.2 | Sand, some Silt | | | | | | | | | | | | | |
| 0.6 | Probable Clay | | | | | | | | | | | | | |
| 82.2 | | | | | | | | | | | | | | |
| 2.0 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | | |
| 81.6 | | | | | | | | | | | | | | |
| 3.2 | End of Cone Test | | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-15

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 653.3; E 384 873.1 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE April 16, 1991 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|--------------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 40 80 120 160 200 | | | | | |
| 85.7 | Ground Surface | | | | | | | | | | | | | |
| 85.5 | Probable Topsoil | | | | | | | | | | | | | |
| 0.2 | Probable Sand, some Silt | | | | | | | | | | | | | |
| 84.8 | | | | | | | | | | | | | | |
| 0.9 | Probable Clay | | | | | | | | | | | | | |
| 82.8 | | | | | | | | | | | | | | |
| 2.9 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | | |
| 80.3 | | | | | | | | | | | | | | |
| 5.5 | End of Cone Test | | | | | | | 85/25 cm | | | | | | |

RECORD OF BOREHOLE No 91-16

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 623.5; E 384 871.9 ORIGINATED BY Y.L.
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test COMPILED BY C.K.K.
 DATUM Geodetic DATE Aprif 17, 1991 CHECKED BY G.J.K.

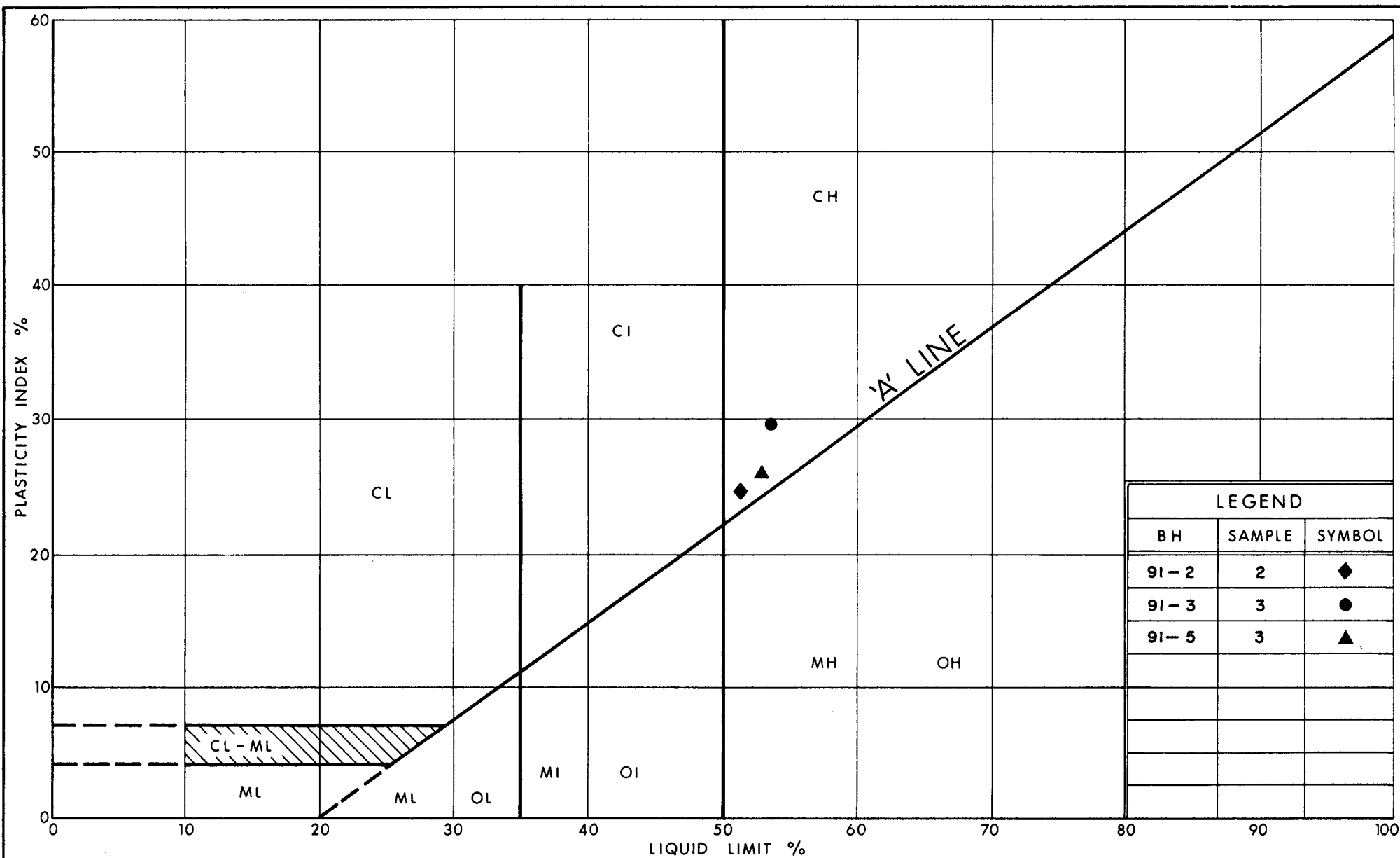
| SOIL PROFILE | | | SAMPLES | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|----------------------------|-----------------|---|-----------------|---|-------------------|--|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | 'N' VALUES | 20 40 60 80 100 | Wp W Wl | WATER CONTENT (%) | | | |
| 84.2 | Ground Surface | | | | | | | | | | | | |
| 83.9 | Probable Topsoil | | | | | | | | | | | | |
| 0.3 | Probable Sand, some Silt | | | | | | | | | | | | |
| 83.0 | | | | | | | | | | | | | |
| 1.2 | Probable Clay | | | | | | | | | | | | |
| 82.1 | | | | | | | | | | | | | |
| 2.1 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | |
| 81.6 | | | | | | | | | | | | | |
| 2.6 | End of Cone Test | | | | | | | | | | | | |

RECORD OF BOREHOLE No 91-17

METRIC

W P 374-89-02 LOCATION Co-ords: N 4 956 624.5; E 384 863.9
 DIST 9 HWY 416 BOREHOLE TYPE Cone Test
 DATUM Geodetic DATE April 17, 1991
 ORIGINATED BY Y.L.
 COMPILED BY C.K.K.
 CHECKED BY G.J.K.

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 40 80 120 160 200 | | | | | |
| 84.3 | Ground Surface | | | | | | | | | | | | | |
| 84.0 | Probable Topsoil | | | | | | | | | | | | | |
| 0.3 83.4 | Probable Sand, some Silt | | | | | | | | | | | | | |
| 0.9 | Probable Clay | | | | | | | | | | | | | |
| 2.0 | Probable Het. Mixture of Silty Sand, some clay & gravel, occ. boulders (Glacial Till) | | | | | | | | | | | | | |
| 2.9 | End of Cone Test | | | | | | | | | | | | | |



Ontario

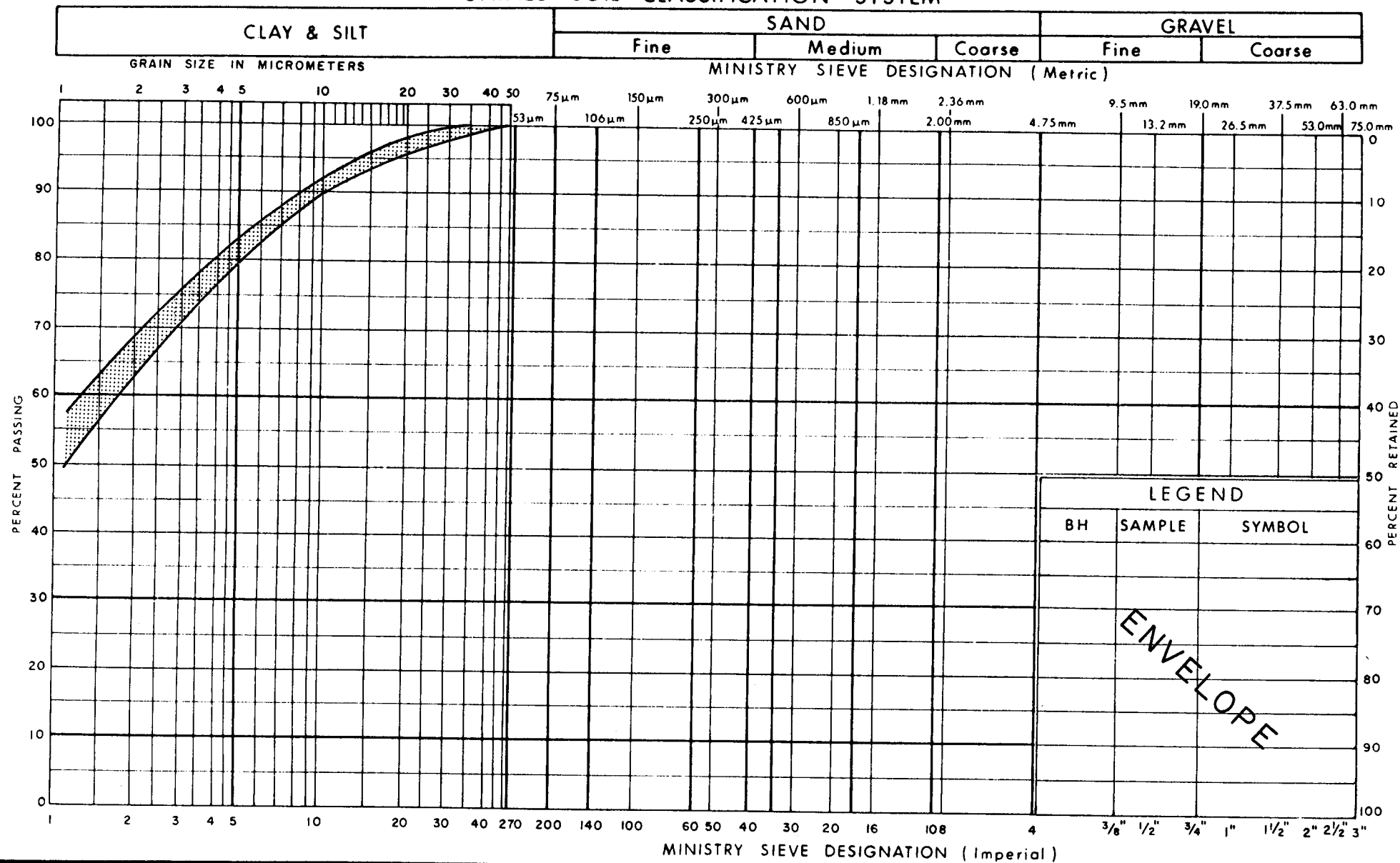
Ministry of
Transportation

PLASTICITY CHART CLAY

FIG No 1

W P 374 - 89 - 02

UNIFIED SOIL CLASSIFICATION SYSTEM



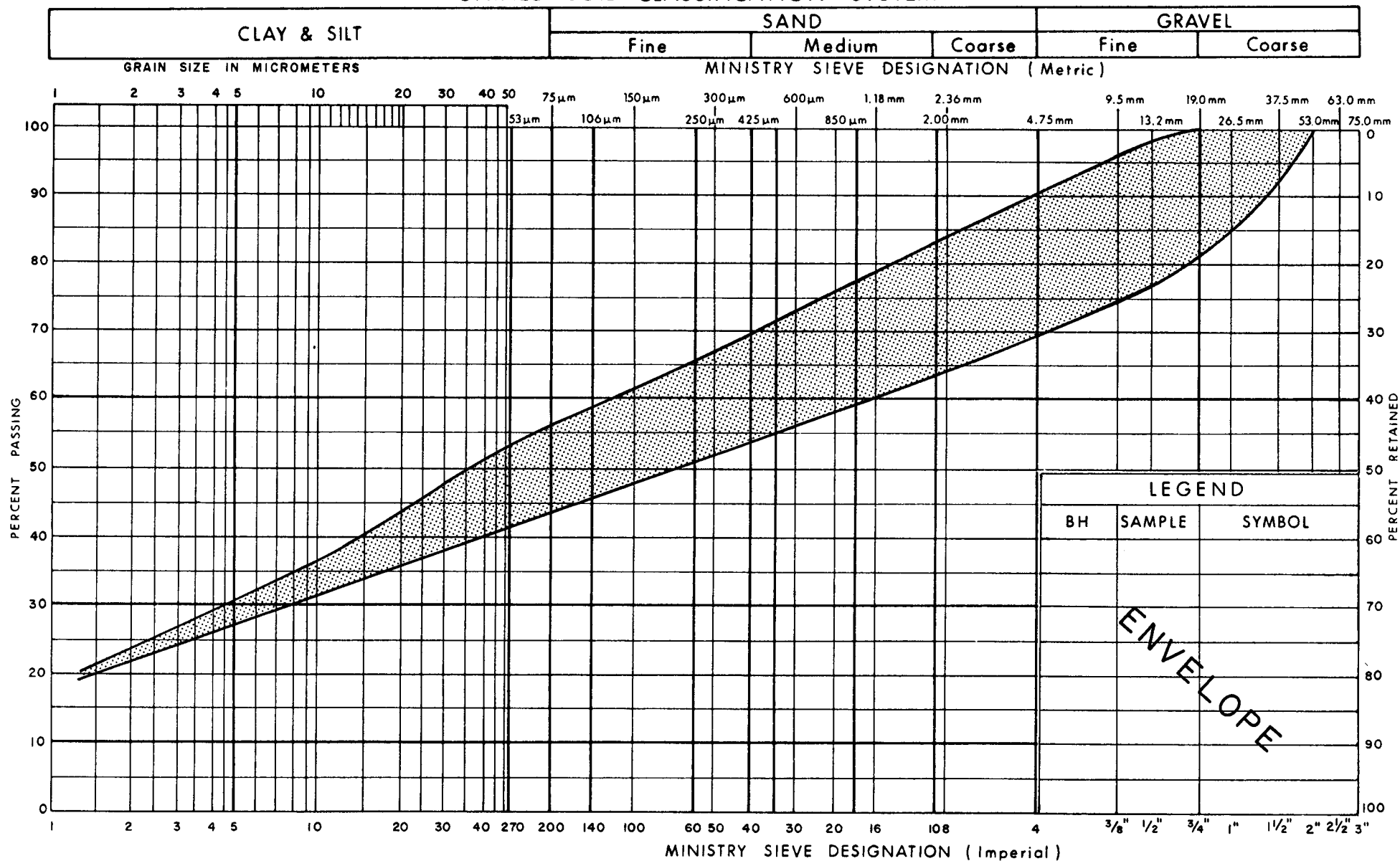
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION CLAY

FIG No 2

W P 374 - 89 - 02

UNIFIED SOIL CLASSIFICATION SYSTEM

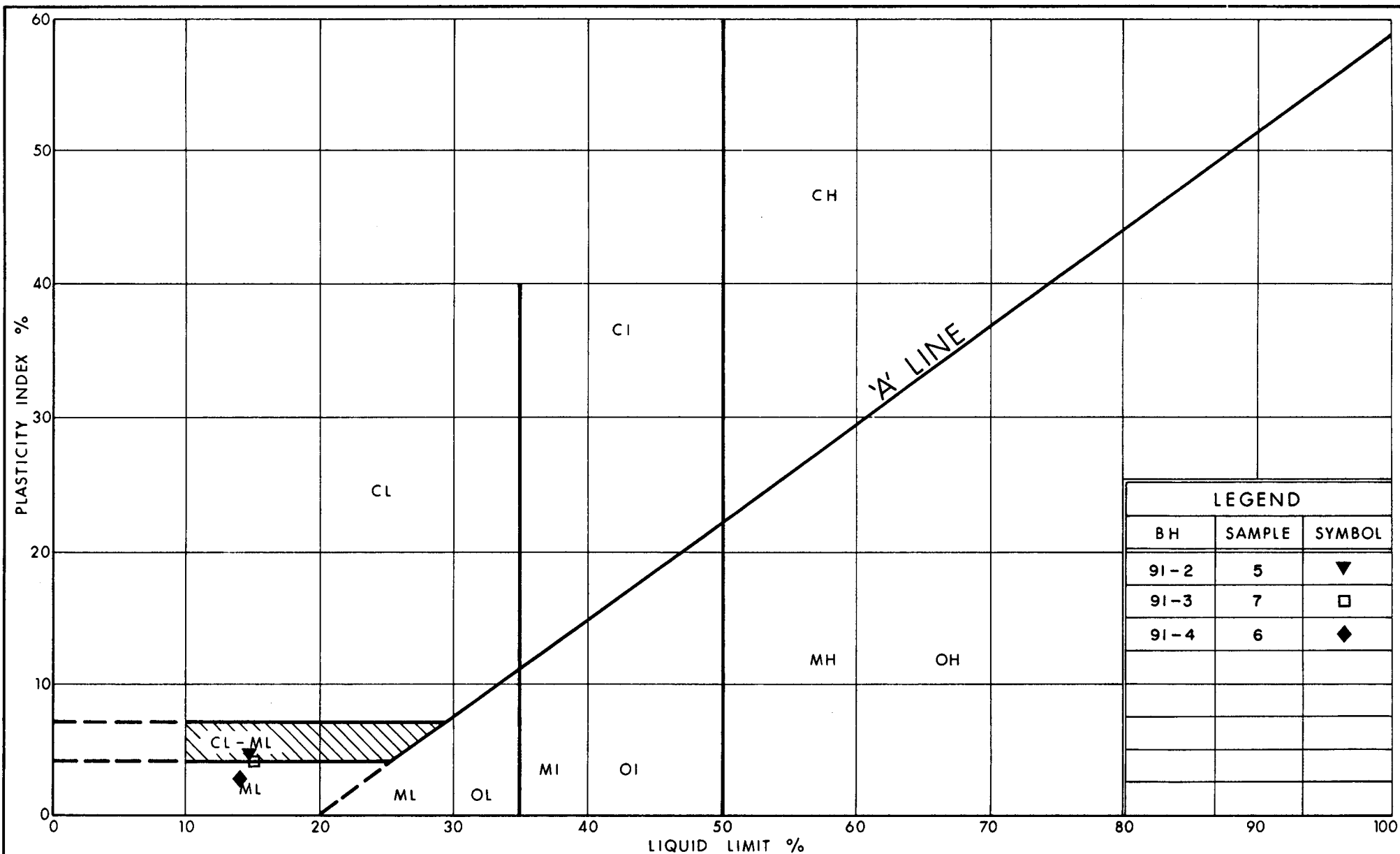


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILTY SAND,
SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 3

W P 374-89-02

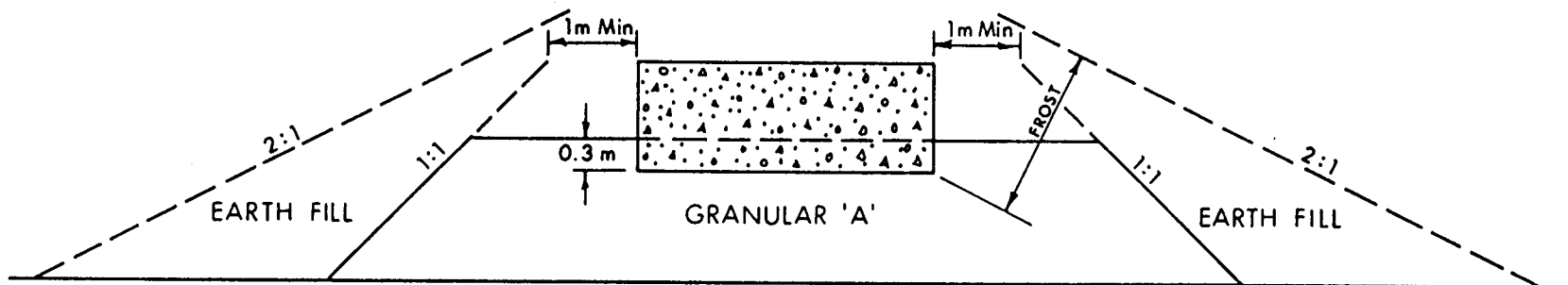


Ministry of
Transportation
Ontario

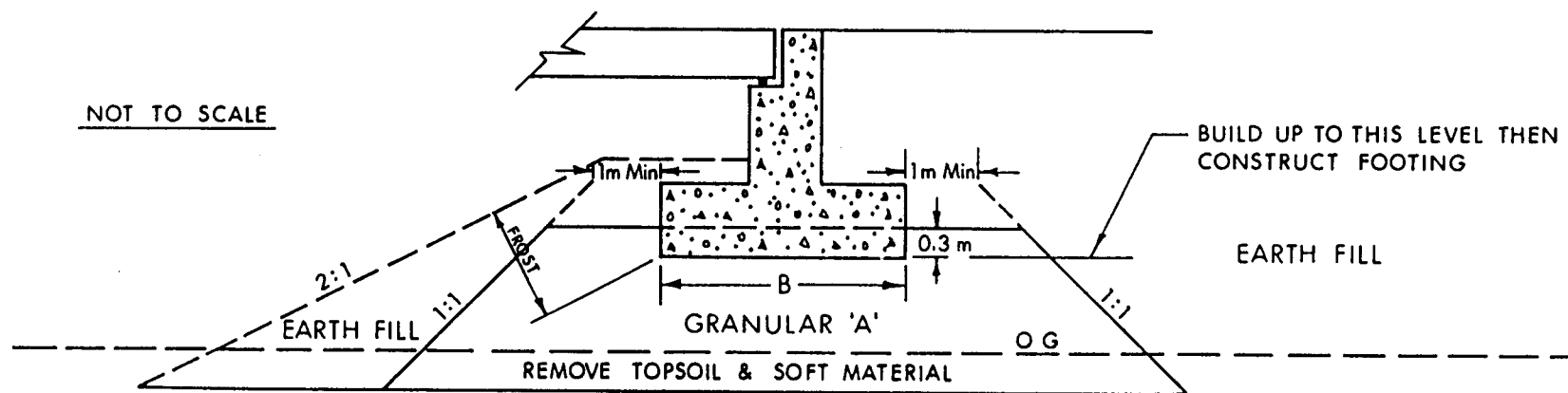
PLASTICITY CHART
HET MIXTURE OF SILTY SAND,
SOME CLAY & GRAVEL, OCCASIONAL BOULDERS (Glacial Till)

FIG No 4

W P 374 - 89 - 02



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL & /OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T O STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



Ontario

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Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 5

W P 374 - 89 - 02



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

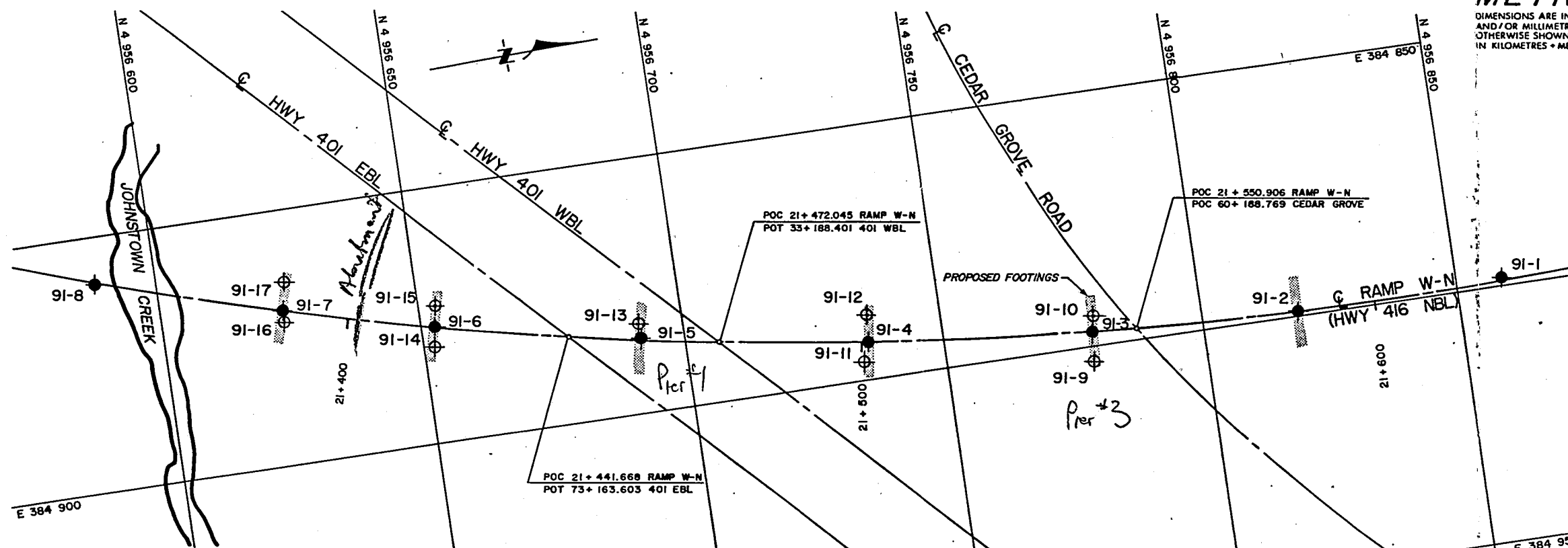
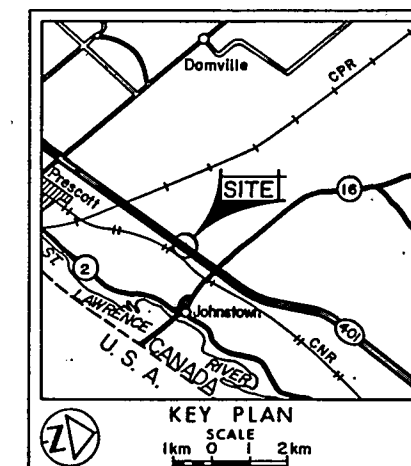
CONT No
WP No 374-89-02



RAMP W-N OVER HWY 401
& CEDAR GROVE RD
BORE HOLE LOCATIONS & SOIL STRATA

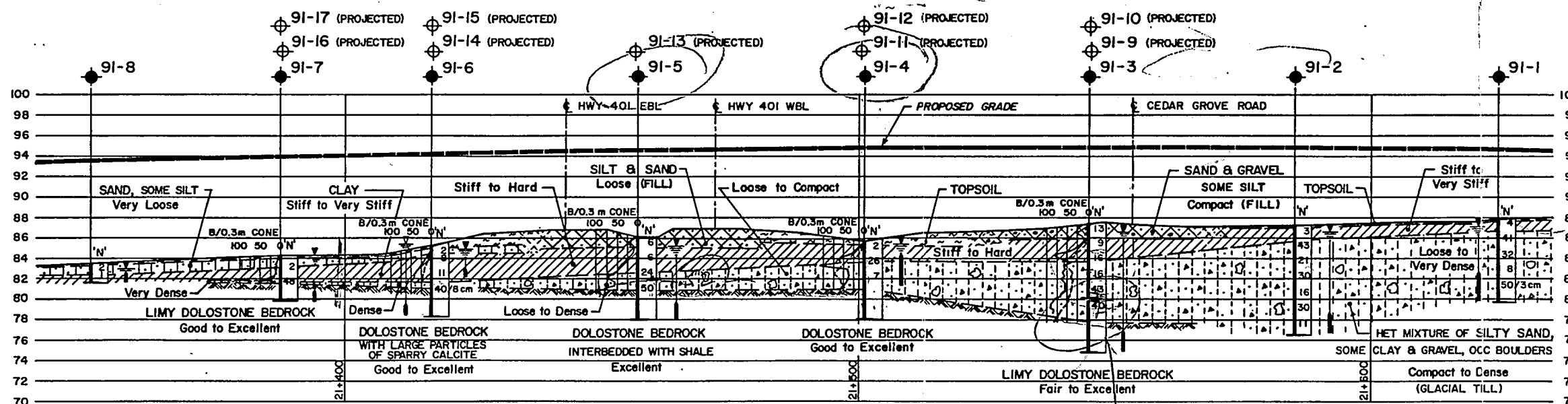
SHEET

JACQUES, WHITFORD LIMITED



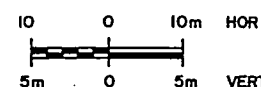
PLAN

SCALE



PROFILE PROPOSED RAMP W-N

SCALE



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 91 04'
- WL in Piezometer
- Piezometer

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|-------|-----------|-----------------------|-----------|
| 91-1 | 87.9 | 4 956 859.1 | 384 898.3 |
| 91-2 | 87.3 | 4 956 818.7 | 384 898.8 |
| 91-3 | 87.4 | 4 956 778.8 | 384 896.9 |
| 91-4 | 85.7 | 4 956 734.8 | 384 892.5 |
| 91-5 | 86.1 | 4 956 691.0 | 384 885.4 |
| 91-6 | 85.2 | 4 956 652.6 | 384 876.9 |
| 91-7 | 84.3 | 4 956 623.4 | 384 869.5 |
| 91-8 | 83.5 | 4 956 588.1 | 384 859.4 |
| 91-9 | 86.9 | 4 956 778.2 | 384 903.1 |
| 91-10 | 87.5 | 4 956 779.2 | 384 894.1 |
| 91-11 | 85.8 | 4 956 733.9 | 384 896.3 |
| 91-12 | 86.2 | 4 956 735.6 | 384 887.1 |
| 91-13 | 86.4 | 4 956 691.5 | 384 882.5 |
| 91-14 | 84.8 | 4 956 652.0 | 384 881.1 |
| 91-15 | 85.7 | 4 956 653.3 | 384 873.1 |
| 91-16 | 84.2 | 4 956 623.5 | 384 871.9 |
| 91-17 | 84.3 | 4 956 624.5 | 384 863.9 |

NOTE

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

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

| REV | DATE | BY | DESCRIPTION |
|-----|------|----|-------------|
| | | | |

Geocres No 31B-74

| | |
|--|------------------------|
| HWY No 416 | DIST 9 |
| SUBM'D CKK CHECKED 2/2/91 DATE JUNE 14, 1991 | SITE 16-306 |
| DRAWN GBB CHECKED | APPROVED DWG 3748902-A |

wrong information