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CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 401

LOCATION HWY 401 FROM BROCK RD.

TO COURTICE RD.

PRELIMINARY DESIGN

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE



Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 242-86-00

DIST 6

HWY 401

STR SITE

Feasibility Study of Highway 401 Widening
Brock Road to Courtice Road

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FOUNDATION INVESTIGATION REPORT
For
Feasibility Study Of
Highway 401 Widening
Brock Road to Courtice Road
W.P. 242-86-00
District 6, Toronto

INTRODUCTION

This report contains the results of a thorough literature search of subsoil information at structural project sites along the above mentioned study route. The Foundation Design Section has reviewed the preliminary foundation data collected for structures in the above mentioned project.

Highway 401 was built and opened to traffic in various stages. Construction began in 1952, and by the end of 1958, the basic four-lane divided, controlled access highway was completed. But unprecedented growth of the Metropolitan Toronto area meant that the volume of traffic on the highway rapidly exceeded its capacity.

To keep pace with rapid traffic growth, multi stage widenings of Highway 401 were completed with a 12-lane core/collector freeway system from Islington Avenue to Markham Road (Highway 48) in late 1960's.

In 1980, widening to 6 lanes was carried out from east of Markham Road to Brock Street (Highway 12) in Whitby and further from there to beyond Courtice Road.

A preliminary design report is currently in preparation recommending five linear alternatives between section 1 and section 5 and four linear alternatives between section 6 and section 8 as follows (See References 1 and 2).

Linear Alternatives, Section 1-5

- 1) 'Do Nothing' or B6 alternative
- 2) Completion of Contract WP87-87-00 & Tapering to Basic 10 lanes
- 3) Extended C-D to Westney Rd. then 10 lanes easterly
- 4) Extended C-D to Reg. Rd. 23, then 10 lanes easterly
- 5) Continuous C-D

References

- 1) Fenco Report, May 1987: "Study Design Report for Hwy 401 widening between Brock Rd to Courtice Rd"
- 2) Fenco Report, December 1987 "Presentation, Alternatives for Ultimate widening, Recommended ALTERNATIVE SELECTION".

Linear Alternatives, Section 6-8

- 1) 'Do Nothing' or B6 alternative
- 2) Basic 10 lanes or B10 alternatives
- 3) 4 lane core with transfers and 2/3 lane arterial collector
- 4) Standard C-D 3 + 3 - 3 + 3, No transfers

As discussed above, the study area is divided into 8 sections. 38 existing and new structures are included in this study within the area. Table 1 shows a chart listing the various structures, their locations, and a brief description of the work proposed and soil data available.

ROUTE DESCRIPTION AND GEOLOGY

The study route extends from the Brock Road (Durham Regional Road 1) interchange in Pickering easterly 27 km to the Courtice Road interchange in Newcastle (Drawing No. 242-8600-A). The project is located in the Regional municipality of Durham and tranverses the following area municipalities.

Town of Pickering
Town of Ajax
Town of Whitby
City of Oshawa
Town of Newcastle

The portion of the Highway 401 corridor under investigation is flanked by a mosaic of urban land uses on the periphery of area municipal core areas which includes major new residential and industrial subdivision development and interstitial rural township areas still occupied by traditional agricultural operations as well as specialty crop systems.

In addition to the new residential and industrial development, the current 'Go Transit' heavy rail expansion from Pickering to Whitby, scheduled for revenue service by 1989, is serving to perpetuate Durham's significant function as a bedroom community for Metro Toronto. It is anticipated that the 'Go Transit' rail service will ultimately be expanded to Oshawa and Bowmanville.

Topographically, the area is flat to gently undulating, generally sloping down to the creeks and rivers from the east and the west.

Physiographically, the area is located in the region referred to as the "Iroquois Plain". This is the lowland bordering Lake Ontario which was inundated in the Pleistocene time by Lake Iroquois. Subsoils in these areas generally are characterized by some glacial till plains, drumlins and silty lacustrine deposits.

SUBSURFACE CONDITIONS

The subsoil encountered at these sites can be divided into three deposits as follows:

- i) Topsoil and Fill material
- ii) Clayey silt, Silty sand to sandy silt (Lacustrine Deposits)
- iii) Cohesive heterogeneous mixture of clayey silt, sand and gravel, or granular heterogeneous mixture of silt, sand and gravel (Glacial Till)

Topsoil and Fill material were found just beneath the ground surface. Based on the laboratory results, the organic content of topsoil was found to be up to 9 percent by weight. The 'N' values as per the Standard Penetration Test indicate the topsoil is soft to very stiff. On the other hand, Fill material, generally consisting of clayey silt with layers of sand, was encountered at the borehole locations. The thickness of the fill material varied considerably over the site. The Standard Penetration Test indicated the fill material to be stiff to hard.

The lacustrine deposits of Clayey silt and Silty sand to sandy silt were found to be in the study area. The cohesive deposit of clayey silt was encountered just below topsoil in the vicinity of the creeks and river crossing. This stratum is composed of clayey silt with occasional layers or seams of sandy silt and clay. It extends to a depth ranging from 0.5 to 10.2 m below the ground surface. A surficial deposit of silty sand to sandy silt was found to cover the study area. Occasional silt and gravel layers or silt lenses were found in

various locations. The denseness of these materials based on Standard Penetration Test results was found to vary from very loose to very dense, but generally dense throughout. Often this stratum was interrupted by beds of clayey silt generally firm to very stiff in consistency. The granular deposit was explored to a maximum depth of 16.9 m.

A glacial till deposit was found immediately below the lacustrine deposit. A glacial till is generally composed of a cohesive heterogeneous mixture of clayey silt, sand and gravel or a granular heterogeneous mixture of silt, sand and gravel. Results from testing indicate the cohesive glacial till is inorganic and of low plasticity. This ground morain till was found to be a maximum depth of greater than 18.4 m. This till is usually unsorted and well graded, but zones of sand and/or silt inclusion's were found throughout.

The Standard Penetration Test gave 'N' values in the range of 31 to over 100 blows/0.3 m, generally increasing with depth. Based on these 'N' values the consistency of this cohesive stratum is estimated to be very stiff to hard, whereas the denseness of the noncohesive glacial till has a dense to very dense, generally in the very dense range.

Weathered shale bedrock underlies the glacial till in the area. Generally, bedrock was found at depths between 1.1 and 16.9 m below the ground surface.

Groundwater was encountered at depths ranging from 0.5 to 13.7 m below ground surface, except adjacent to waterways where the groundwater level would approximate the creek or river water level.

The subsurface conditions together with groundwater at respective existing structure locations are shown on the attached Foundation Data Sheets in Appendix.

As shown on Table 1, no subsoil information is available for some 13 structures. Foundation Design Section reviewed the above sites and concluded that a preliminary foundation investigation will be necessary for the following four sites, since adequate sufficient information is not available.

- i) proposed Pickering Beach Road overpass
- ii) proposed interchange at the Regional Road 23
- iii) Regional Road 23 at Hwy. 2
- iv) Bloor Street underpass

The results of the preliminary foundation investigation for the above sites will be submitted as soon as the field investigation is completed.

DISCUSSION AND RECOMMENDATIONS

At present the regional planning and design staff is involved in the preliminary design phase for Hwy. 401 widening. This report contains the geotechnical aspects of Hwy. 401 widening from west of Brock Road in Pickering to east of Courtice Road in Oshawa for various structures and culverts. Thirty-eight structure sites including fifteen creek and river crossings were reviewed for this program. It should be noted that there is a possibility of constructing high retaining walls on the south side of Hwy. 401 at the proposed new Pickering Beach Roads interchange. As well, due to a very restricted right of way there may be a need of extensive use of high retaining walls through Oshawa area also (Section 6). It should be noted that the schemes being studied for the major interchange at Regional Road 23 may require that the proposed interchange be moved to the north and the profile grade of Hwy. 401 be lowered by approximately 3.0 m.

In general, subsurface conditions over the site are uniform and competent for structure foundation and embankment loadings.

Our comments from the feasibility, design and construction of the various structures are given on the Foundation Data Sheets included in the Appendix. A data sheet is provided for each of the 38 areas; the area location is described on these sheets and is also shown on Drawing No. 242-8600-A. An explanation of information provided on the data sheet is outlined below.

1. The site number given (i.e. 1 (MT022-275), 2 (MT022-120), etc.) is a numbering system developed for the purposes of the feasibility study only. The number given in the brackets ((MT0-22-275), MT0-22-120, etc.) is a MTO site number. The actual location is shown on Drawing No. 242-8600-A.
2. The original ground elevation is based on the survey results for each of the borehole locations of the previous investigations.
3. The grades of roadway/railway given is based on the existing grades of Hwy. 401 at the respective sites.
4. Subsurface conditions are described very briefly and are based on generally not more than two borings per site from previous information.

5. Recommendations - Structure

The recommendations are discussed separately for the structural elements (abutments and piers). The options for structure foundations are given in preferential order based on geotechnical/economical considerations. Further elaboration of structure recommendations made on the data sheets are given below.

Compacted Granular 'A' Core (Engineeral Fill) - This option is for abutments only where subsurface conditions are competent. This option is not recommended for water crossings. The minimum requirements of a compacted granular 'A' Core are shown on Figure 1 in the Appendix. Furthermore, the footing for this scheme could be designed using the following parameters:

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

Spread Footings - This option is given for abutments and piers where subsurface conditions are competent. The maximum elevation and corresponding maximum design load is given. It is to be noted the spread footings should be provided with a minimum of 1.2 m of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, subject to softening upon exposure to construction or weather conditions, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a granular deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from "boiling" due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required. Two alternative dewatering schemes are shown on Figure 2 and Figure 3.

End-Bearing Piles - This founding scheme is recommended for the abutments and piers where appropriate. The recommendation gives the estimated pile tip elevation. Generally, the end-bearing piles can be designed for the factored capacity at U.L.S. and the capacity at S.L.S. Type II which is dependent on the pile section chosen. The following design parameters are recommended for the pile foundation:

<u>Pile Type</u>	<u>Factored Capacity at U.L.S. (kN)</u>	<u>Allowable Capacity at S.L.S Type II (kN)</u>
310 HP 79	1150	700
310 HP 110	1600	980

It is generally assumed steel 'H' piles will be used, however, if a certain pile section is not suitable at the specific area, this fact is mentioned in the data sheet. Pile driving would be field controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil.

NOTE: In some instances, the data sheets contain the capacities for the shallow and deep foundations on the old system. However, the final foundation investigation report will contain capacities for foundations according to the new system (O.H.B.D.C.).

6. Recommendation - Approaches

The recommendations for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current M.T.O. Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also discussed under this heading is special treatment, i.e. benching, slope protection, etc., that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

7. Other Considerations

The granular 'A' or 'B' backfill should be in accordance with Special Provision No. 121 (dated October, 1983). The following parameters are recommended for the granular backfill:

	<u>Gran. 'A'</u>	<u>Gran. 'B'</u>
Angle of Internal Friction:	$\phi = 35^\circ$	30°
Unit Weight (kN/m ³):	$\gamma = 22.8$	21.2

All foundation elements should have a minimum of 1.2 m earth cover for frost protection.

The concrete for the footings should be formed 'In The Dry'. Consequently, a dewatering scheme will be required if the concrete is poured below the prevailing water level.

8. Remarks

In this column assumptions made and geotechnical preference of schemes if appropriate, are discussed, as well as other options or considerations to be evaluated during this stage of design.

MISCELLANEOUS

The various comments outlined in this report are for feasibility study purposes based on limited field data. It will be necessary to carry out a detailed subsurface investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, groundwater studies and special in-situ field testing may be warranted.

This report was prepared by Mr. T. C. Kim, Project Foundation Engineer and reviewed by Mr. M. Devata, Chief Foundation Engineer (East).



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APPENDIX

TABLE 1

<u>SECTION</u>	<u>STRUCTURE NAME</u>	<u>STRUCTURE NO.</u>	<u>(M.T.O. SITE NO.)</u>	<u>REFERENCE</u>	<u>PROPOSED WORK</u>
1	Brock Rd Underpass	1	(22-275)	30M 14-9 WP 29-67-06	Removal of material from front of abutments to accommodate widening of Hwy 401.
1	Church St - Duffins Creek Bridge	2	(22-120)	30M 14-5 WP 269-59-2	Widening existing structure and possible major rehabilitation of original structure.
1	Miller Creek Culvert	3	(22-374)	30M 14-173 GGE-000-40	Extension of existing culvert structure to the north.
1	Westney Road Overpass	4	(22-372)	30M 14-171 EGG-000-7	Possible widening of structure on the north side of Hwy 401. The extent of work will depend on the limits set for the collector distribution.
2	Harwood Ave Underpass - NB and SB Structures	5	(22-121)	30M 14-164 WP 133-78-01	Structure replacement due to geometric and structural deficiencies.
2	Creek Crossing Just West of Pickering Beach Road	6	(N/A)	30M 14-172 GGE-313	Extension of existing culvert.
2	Proposed Pickering Beach Road Overpass	7	(N/A)	No information	Proposed new interchange. Possible extensive high retaining walls on the south side of Hwy 401 on access ramps.
3	Carruthers Creek Culvert	8	(N/A)	30M 15-78 GGE-330	Extension of existing structure.
3	Regional Rd No. 23 Underpass	9	(22-122)	No Information	Proposed future major interchange to north. Possible widening and/or new structure.
3	Regional Rd No. 23 at Hwy 2	10	(N/A)	No Information	Proposed Crossing of Hwy 2 with Regional Road 23.

TABLE 1

<u>SECTION</u>	<u>STRUCTURE NAME</u>	<u>STRUCTURE NO.</u>	<u>(M.T.O. SITE NO.)</u>	<u>REFERENCE</u>	<u>PROPOSED WORK</u>
3	Creek Crossing at approx Sta 10+500 (No Name)	11	(N/A)	30M 15-78 GGE-330	Extension of existing structure.
3	Lynde Creek Bridge	12	(22-150)	30M 15-4 WP 44-71-04	Widening existing structure.
3	Creek Crossing at approx Sta 12+325 (No Name)	13	(22-374)	30M 15-66 WP 168-81-01	Extension of existing structure.
4	Henry St Underpass	14	(22-152)	30M 15-70 EGG-000-21	Replacement likely due to geometric deficiencies and age.
4	Brock St (Hwy 12) Underpass	15	(22-151)	30M 15-72 EGG-000-22	Replacement likely due to geometric deficiencies and age.
4	Pringle Creek Culvert	16	(N/A)	30M 15-71 EGG-000-23	Extension of existing structure.
5	Creek Crossing just West of Thickson Rd	17	(N/A)	30M 15-52 WP 38-77-01	Extension of existing structure (major soil problem at this site).
5	Thickson Rd Underpass	18	(22-171)	30M 15-44 WP 38-77-01	Minor structure work required.
5	Basket Weave Bridge at Truck Inspection Station	19	(22-367)	30M 15-46 WP 38-77-01	Possible retaining walls required adjacent to Basket Weave Bridge
5	Corbett Creek Culvert	20	(N/A)	30M 15-46 Cont 82-72	Extension of existing culvert.

TABLE 1

<u>SECTION</u>	<u>STRUCTURE NAME</u>	<u>STRUCTURE NO.</u>	<u>(M.T.O. SITE NO.)</u>	<u>REFERENCE</u>	<u>PROPOSED WORK</u>
6	CPR Subway (GM Spur)	21	(22-172)	No Information	Structure replacement likely. Possible need for temporary trestle during construction.
6	Stevenson Road Underpass	22	(22-185)	30M 15-67 WP 44-71-24	New interchange design with possible twinning of existing structure or complete replacement.
6	Park Road Overpass	23	(22-173)	30M 15-7 WP 44-71-06	Widening of existing structure.
6	Cubert Street Overpass	24	(22-174)	30M 15-29 WP 44-71-07	Widening of existing structure.
6	Oshawa Creek Bridge	25	(22-175)	30M 15-33 WP 44-71-08	Widening of existing structure.
6	Simcoe St Underpass	26	(22-176)	No Information	Structure replacement.
6	Albert St Underpass	27	(22-177)	No Information	Structure replacement.
6	CNR Subway	28	(22-178)	No Information	Structure replacement. Possible need for temporary trestle during construction.
6	Possible Retaining Walls between Park Rd and Bloor St	29	(N/A)	No Information	Due to very limited right-of-way retaining walls may be required between Park Rd and Bloor St. Check foundation material at right-of-way limit.
6	Ritson Rd Overpass	30	(22-179)	30M 15-31 WP 44-71-09	Widening of existing structure.
6	Wilson Rd Overpass	31	(22-180)	30M 15-32 WP 44-71-10	Widening of existing structure.

TABLE 1

<u>SECTION</u>	<u>STRUCTURE NAME</u>	<u>STRUCTURE NO.</u>	<u>(M.T.O. SITE NO.)</u>	<u>REFERENCE</u>	<u>PROPOSED WORK</u>
6	Bloor St Underpass	32	(22-181)	No Information	Structure replacement, possibly at a new location.
6	Harmony Creek Bridge	33	(22-182)	30M 15-30 WP 44-71-11	Extension of existing barrel arch culvert.
6	Farewell Creek Bridge	34	(22-183)	30M 15-8 WP 44-71-12	Widening of existing structure.
7	Proposed New Structure for access to New GM Headquarters	35	(N/A)	No Information	Proposed new structure for access to GM HQ. (No longer Valid)
8	Robinson Creek Culvert	36	(N/A)	No Information	Extension of existing culvert.
8	Creek Crossing (just east of Courtice Rd)	37	(N/A)	No Information	Extension of existing culvert.
8	Courtice Rd Underpass	38	(21-158)	30M 15-45 WP 59-75-01	Possible widening of existing structure.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 1 (MTO 22-275) LOCATION Hwy. 401 at Brock Road Underpass
 ORIGINAL GROUND ELEV. 87.5 - 89.0 m PROPOSED HWY. 401 GRADE ELEV. 89.6 m
 Widening References: WP 29-67-06
 Cont. 73-41

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
(Depth in m) <u>Reference Boreholes</u> <u>BH 1 (North Abutment)</u> 0-2.1 Clayey Silt (Fill) 2.1-8.5 Clayey Silt (Stiff-Soft) 8.5-10.7 Glacial Till (Dense) 10.7-13.7 Weathered Shale 13.7-15.2 Sound Shale <u>BH 4 (South Abutment)</u> 0-0.5 Top Soil 0.5-2.9 Clay Silt (Very Stiff) 2.9-10.2 Glacial Till (Very Dense) 10.2-12.1 Weathered Shale 12.1-13.4 Sound Shale <u>Groundwater</u> Water level at 0.6-1.8 m below ground surface, at about elevation 86.6-87.2	<u>Abutments and Piers</u> 1. Footings founded on end-bearing Steel 'H' Section piles driven to tip elevations of 77.4 m± on the north of Hwy. 401, and 80.5 m± on the south of the highway. Designed for the maximim allowable load per pile Section (12BP73, 90 tons/pile) 2. Piers also founded on end-bearing Steel 'H' Section piles.	<u>South Approach</u> Fill heights in excess of 5.5 m will be stable with forward and side slopes of 2:1. <u>North Approach</u> Fill heights up to 8.5 m with 13.7 m safety berm at the half height of fill	1. The South abutment will be supported on Steel 'H' piles. The north abutment will be perched in the approach fill and supported on Steel 'H' piles as well. 2. If widened to the south, retaining walls will be required to protect Ramps, no serious problems. 3. If widened to the north, slope stability problem should be considered to overcome this difficulty, material should be used for north approach berm with wide dimension. 4. Additional investigation will be required.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 2 (MTO 22-120) LOCATION Hwy. 401 at Church St. - Duffins Creek Bridge

ORIGINAL GROUND ELEV. 80.0 m PROPOSED HWY. 401 GRADE ELEV. 86.0 m
References: WP 269-59-2
WP 44-71-02

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS																																
	STRUCTURE	APPROACHES																																	
(Depth in m) <u>Reference Boreholes</u> <u>BH 2 (West Abutment)</u> 0-3.4: Silty sand, some gravel, trace clay (compacted) 3.4-7.6: Sand with gravel, trace silt (V. Dense) 7.6-8.2: Sand, some silt, trace clay & gravel 8.2-8.9: Shale <u>BH 21 (East Abutment)</u> 0-2.7: Silt with sand some gravel, trace clay (V. Loose) 2.7-5.6: Sand with silt, some gravel, trace clay (V. Loose) 5.6-6.5: Sand, some silt trace gravel, (Dense to V. Dense) (Continued next page)	<u>Abutments and Piers</u> 1. Original footings formed on spread footings on bedrock (Deep excavation) 2. In 1972, these structures were widened with pile foundation ('H' 12BP74). <u>Estimated Footing Elevations</u> <table border="1"> <thead> <tr> <th>Location</th> <th>Sta.</th> <th>0.Footings</th> <th>Piles</th> </tr> </thead> <tbody> <tr> <td>W. Abut.</td> <td>92+50</td> <td>74.0±</td> <td>70.4-71.6±</td> </tr> <tr> <td>Pier 'A'</td> <td>92+70</td> <td>74.0±</td> <td>70.7-72.3±</td> </tr> <tr> <td>Pier 'B'</td> <td>92+93</td> <td>72.5±</td> <td>71.9-72.3±</td> </tr> <tr> <td>Pier 'C'</td> <td>92+16</td> <td>72.1±</td> <td>71.6-72.3±</td> </tr> <tr> <td>Pier 'D'</td> <td>93+39</td> <td>72.9±</td> <td>72.9±</td> </tr> <tr> <td>Pier 'E'</td> <td>93+62</td> <td>72.9-74.1±</td> <td>72.0-72.9±</td> </tr> <tr> <td>E. Abut.</td> <td>93+82</td> <td>73.5-74.7±</td> <td>73.5±</td> </tr> </tbody> </table> 3. Widening structures were built completely independent of the existing structures utilizing a vertical expansion joint.	Location	Sta.	0.Footings	Piles	W. Abut.	92+50	74.0±	70.4-71.6±	Pier 'A'	92+70	74.0±	70.7-72.3±	Pier 'B'	92+93	72.5±	71.9-72.3±	Pier 'C'	92+16	72.1±	71.6-72.3±	Pier 'D'	93+39	72.9±	72.9±	Pier 'E'	93+62	72.9-74.1±	72.0-72.9±	E. Abut.	93+82	73.5-74.7±	73.5±	Fills heights up to 7.5 m will be stable with forward and side slopes of 2:1.	1. New structures should be founded on the pile foundations. 2. Dewatering would be required. 3. Erosion protection should be placed along the bank of the existing stream. 4. No difficult problem is anticipated.
Location	Sta.	0.Footings	Piles																																
W. Abut.	92+50	74.0±	70.4-71.6±																																
Pier 'A'	92+70	74.0±	70.7-72.3±																																
Pier 'B'	92+93	72.5±	71.9-72.3±																																
Pier 'C'	92+16	72.1±	71.6-72.3±																																
Pier 'D'	93+39	72.9±	72.9±																																
Pier 'E'	93+62	72.9-74.1±	72.0-72.9±																																
E. Abut.	93+82	73.5-74.7±	73.5±																																

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 2 (MTO 22-120) LOCATION Hwy. 401 at Church St. - Duffins Creek Bridge
 ORIGINAL GROUND ELEV. 80.0 m PROPOSED HWY. 401 GRADE ELEV. 86.0 m

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p>6.5-6.9: Shale</p> <p><u>Groundwater</u> Water level at 0.3-2.7 m below ground surface.</p>			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 3 (MTO 22-374) LOCATION Hwy. 401 at Miller Creek Culvert
 ORIGINAL GROUND ELEV. 81.5 - 81.9 m PROPOSED HWY. 401 GRADE ELEV. 89.5 m

References: GGE-000-40
GGE-315

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH A2 (North of Hwy. 401)</u> 0-0.6: Silty Sand 0.6-3.1: Weathered Shale 3.1-6.3: Faintly Weathered Shale Bedrock <u>BH A4 (South of Hwy. 401)</u> 0-1.1: Silty Clay Till, some sand, trace of Gravel (Hard) 1.1-7.1: Weathered Shale Bedrock <u>Groundwater</u> Water level at +0.5-0 m below ground surface.	<u>Abutments and Piers</u> 1. The existing culverts are founded on spread footing on 0.3 m of well graded granular 'A' material which is placed on the shaly bedrock.	Fill heights up to 6 m will be stable with forward and side slopes of 2:1. Cuts to a depth of 1.0 m will be stable with 2:1 side slopes.	1. Extended culverts can be founded on the spread footings on the shaly bedrock. 2. The existing culvert can be extended to the north. No serious problems are anticipated. 3. Some erosion protection will be required.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 4 (MTO 22-372) LOCATION Hwy. 401 at Westney Road Overpass
 ORIGINAL GROUND ELEV. 91.9 - 92.5 m PROPOSED HWY. 401 GRADE ELEV. 92.5 m
 Reference: Contract GGE-315
 EGG-000-7

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 16 (W. Abutment)</u> 0-1.5: Sand trace to some silt Fill (compact) 1.5-4.0: Silty sand trace to some gravel, trace clay (Dense to V. Dense) 4.0-11.5: Silt to Sandy silt (V. Dense) 11.5-16.9: Silty Sand (V. Dense) 16.9-18.4: Silty to Sandy clay (Hard) <u>BH 17 (E. Abutment)</u> 0.0-1.4: Sand Fill 1.4-7.0: Silty Sand (Dense to V. Dense) 7.0-10.4: Sandy silt (V. Dense) (Continued next page)	<u>Abutments and Piers</u> 1. Spread footings founded on the very dense soils are considered to be the most suitable foundation for the bridge & retaining walls. <u>For Bridge</u> a) Factored U.L.S. : 800 kPa b) S.L.S. Type II : 500 kPa <u>For the Retaining Walls</u> a) Factored U.L.S. : 600 kPa b) S.L.S. Type II : 300 kPa	<u>Retaining Walls</u> Fill heights up to 7m will be stable with forward and side slopes of 2:1. Cuts to a depth of 7.5m will be stable with 3:1 side slopes.	1. It may be necessary to widen the existing structure to the north. 2. No serious problems are anticipated. 3. But dewatering scheme would be required.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 4 (MTO 22-372) LOCATION Hwy. 401 at Westney Road Overpass
 ORIGINAL GROUND ELEV. 91.9 - 92.5 m PROPOSED HWY. 401 GRADE ELEV. 92.5 m

Reference: Contract GGE-315

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
10.4-11.6: Silt (V. Dense) 11.6-14.9: Sand and gravel (V. Dense) 14.9-16.2: Silty Clay (Hard) 16.2-16.9: Shale Bedrock <u>Groundwater</u> Water level at 88.7 to 91.6 m.			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 5 (MTO 22-121) LOCATION Hwy. 401 at Harwood Ave. Underpass
 ORIGINAL GROUND ELEV. 109.4-109.6 m PROPOSED HWY. 401 GRADE ELEV. 104 m

Reference: Contract 80-63,
 WP 133-78-01
 and GGE-313

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 4 (S. Abutment)</u> 0-4.3: Clayey Silt (Fill) 4.3-7.3: Mixture of silt, sand and gravel (V. Dense) (Glacial Till) <u>BH 5 (N. Abutment)</u> 0-2.7: Clayey Silt (Fill) 2.7-6.3: Mixture of silt, sand and gravel (V. Dense) (Glacial Till) <u>Groundwater</u> Water level, Dry.	<u>Abutments and Piers</u> <u>South Abutment</u> a) <u>Original footings</u> were founded on spread footings. b) Widening of Harwood Ave. (S.B.) Bridge - Founded on short piles or - concrete caissons or (30 in. 250 Tons (V) 15 Tons (H)) - Spread footings (1.5 TSF) <u>North Abutment</u> 1. Founded on spread footings with an allowable design load of 3.0 TSF. 2. Footing elevations at about 105.6 m within the competent glacial till. <u>Piers</u> Founded on spread footings with a maximum allowable design load of up to 5 TSF, at an elevation of 102.7 m.	Fill Heights up to 6.1 m will be stable with forward and side slopes of 2:1. Cuts to a depth of 3 m will be stable with 2:1 side slopes.	1. The existing structures will be removed and replaced with a new structure. 2. Extreme care should be taken during construction to prevent disturbance to the existing footing foundation. 3. No serious foundation problems are anticipated. 4. Spread footing or short piles for abutments would be required. 5. About 11 m retaining walls would be required.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 6 (MTO N/A) LOCATION Hwy. 401 at Creek Crossing West of Pickering Beach Road
 ORIGINAL GROUND ELEV. 104.00 m PROPOSED HWY. 401 GRADE ELEV. 97.8m

Reference: No Information.

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
From GGE-313 (Retaining Walls) <u>Reference Boreholes</u> <u>BH 1</u> 0-0.2: Top Soil 0.2-2.6: Sand Fill (Compacted to V. Dense) 2.6-4.3: Silty Fine Sand (V. Dense) 4.3-5.0: Silty Sand (V. Dense) 5.0-7.0: Silty Fine Sand (V. Dense) 7.0-9.8: Silt (Hard) 9.8-13.0: Silty Sand (V. Dense) 13.0-13.8: Silty Clay (Hard) <u>Groundwater</u> Water level at 1.5 m below ground surface.	<u>Abutments and Piers</u> NO INFORMATION	Fill Heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. Extension of existing culver. 2. Granular 'A' core should be placed under the culvert. 3. No serious foundation problems are anticipated.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 7 (MTO N/A) LOCATION Hwy. 401 at Proposed Pickering Beach Road Overpass

ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 97.4 m
Reference: No information available.

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u>	<u>Abutments and Piers</u> NO INFORMATION	Fill Heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. A new structure is proposed to carry Hwy. 401 over Pickering Beach Road. 2. No subsoil data are available. 3. The type of problem that could be anticipated would be related to dewatering and slope stability. 4. Preliminary site investigation will be carried out to evaluate the extent and degree of anticipated problems.
<u>Groundwater</u> Water level at below ground surface.			5. Probably need permanent dewatering system.

FOUNDATION DATA SHEET

W.P. 242-86-00 FILE 8 (MTO N/A)

LOCATION Hwy. 401 at Carruthers Creek Culvert

ORIGINAL GROUND ELEV. 92.7 m

PROPOSED HWY. 401 GRADE ELEV. 90.8 m

Reference: Culvert #19
Strata Eng. Report GGE-330

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 19-1</u> (South of Hwy. 401) 0-11.5: Silty fine sand to silt (Fill) 11.5-12.5: Sand & Gravel (Dense) 12.5-14.6: Clayey Silt Till (Hard) 14.6-18.6: Weather Shale	<u>Abutments and Piers</u> 1. Culvert founded on spread footings. 2. GO-ALRT project, strata engineering recommended pile footings driving to a shaly bedrock at an elevation of about 74.5 m <u>HP 310 x 110 piles</u> U.L.S. - 3500 kN S.L.S. Type II - 1000 kN	Fill Heights up to 6 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. The existing structure can be extended to the north and south. 2. No serious foundation problems are anticipated.
<u>Groundwater</u> Water level at an elevation of about 83± m.			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 9 (MTO 22-122) LOCATION Hwy. 401 at Regional Road No. 23 UnderPass
 ORIGINAL GROUND ELEV. 86.3 m PROPOSED HWY. 401 GRADE ELEV. 86.0 m

Reference: From Culvert #21
 Strata Eng. Report
 CCE-330

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 21-1</u> (230m West of Regional Rd 23) 0-4.0 Sandy silt to silty sand and silty clay (Very Stiff) (FIII) 4.0-5.5 Silty sand and gravel (Loose) 5.5-10.0 Silt with some clay (Very Soft to Firm) 10.0-13.3 Glacial Till (Very Dense) 13.3-15.0 Shale Bedrock <u>Groundwater</u> Water level at 5.6m below ground surface at an elev. 80.7±m.	<u>Abutments and Piers</u> 1) The profile of Hwy. 401 at this location will be lowered by approx. 3.0 m. 2) New Interchange is proposed at this location. 3) 5 new Bridges are proposed. 4) Proposed culvert foundation (#21) A) Founded on end-bearing piles driven down to bedrock. B) HP310 x 110 piles U.L.S. - 3500 kN S.L.S. Type II -1000 kN	Fill Heights up to 9 m will be stable with forward and side slopes of 2:1.	1. The existing structure will be removed and replaced with a new structure. 2. Due to the proximity of the rail line, it is being proposed to realign Hwy. 401 to the north. 3. A new major interchange is proposed at this location. 4. To accomodate the proposed interchange, the profile of Hwy. 401 will be lowered by up to 3.0 m. 5. Due to no soil data available, foundation investigation is required.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 10 (MTO N/A) LOCATION Hwy. 401 at Regional Road No. 23 at Hwy. 2
ORIGINAL GROUND ELEV. _____ PROPOSED HWY 2 GRADE ELEV. _____

[illegible]

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 11 (MTO N/A) LOCATION Hwy. 401 at West Branch of Lynde Creek Crossing
 ORIGINAL GROUND ELEV. 83.5m PROPOSED HWY. 401 GRADE ELEV. 81.4 m

Reference: Culvert #23
 Strata Engineering

SUBSURFACE CONDITIONS	RECOMMENDATIONS		Report GGE-330 REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 23-2</u> South of Hwy 401 0-4.0: Sand & Gravel to Sandy Silt (Fill) (Compact) 4.0-6.7: Sand and Gravel (Compact) 6.7-10.5: Silty Clay with Sand and Trace of Clay (V. Soft to Stiff) 10.5-13.3: Sand & Gravel with some Silt & Clay (V. Dense) (Glacial Till) 13.3-15.1: Shale Bedrock (top of bed-rock at elev. 70.2 m) <u>Groundwater</u> Water level at 7.5 m below ground surface. (Elev. 76 m \pm)	<u>Abutments and Piers</u> 1. Existing culvert founded on Mat footing on Granular 'A' pad at an elev. 77.1 m <u>GO-ALRT</u> 2. due to the presence of a soft to firm silty clay deposit below the culverts, organic and unsuitable material should be excavated to their full depth and back filled with Granular 'A'. 3. To preserve the structural integrity of the culvert, it was proposed that loading relieving slabs be constructed above the culvert crown, which is supported on piles down to shaly rock ('H' piles). 4. Alternatively, pipe piles was considered founded in and bearing within the glacial till stratum. 5. Pile design (HP 310 x 110) U.L.S. 3500kN S.L.S. Type II 1000kN	Fill Heights up to 2 m will be stable with forward and side slopes of 2:1. Cuts to a depth of 6 m will be stable with 2:1 side slopes.	1. Existing structure can be widened to the north. 2. The groundwater table is situated well below the proposed culvert. No dewatering problems are anticipated. 3. Roadway protection would be required due to a layer of poor subsoil condition.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 12, 13 (MTO 22-150) LOCATION Hwy. 401 at Lynde Creek Bridge & Creek Crossing at St. 12+325
 ORIGINAL GROUND ELEV. 78.0 m PROPOSED HWY. 401 GRADE ELEV. 79.6 m 79.9 m (East of Lynde Creek)

Reference: WP 44-71-04
 WP 72-11-123
 WP 168-81-01 (Cont. 82-114)

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 1</u> 0-4.7: Silt to Silty Sand with trace of Gravel and organics (Loose) 4.7-7.9: Gravelly Sand to Sandy Gravel, trace of Clay (Dense to Very Dense) 7.9-9.6 Wethered Shale Bedrock 9.6-12.7: Sound Shale Bedrock <u>Groundwater</u> Water level at 1.4 m below ground surface. (Elev. 78.6 m±)	<u>Abutments and Piers</u> <u>Abutments</u> 1. Existing abutments are founded on spread footings at the following elevations in the gravelly sand to sandy gravel. East abutment - 72.1 m West abutment - 72.1 m 2. The footing extensions were designed using an allowable bearing pressure of 3.0 t.s.f. (322kPa). 3. The extension excavation extended down to 4.6 m below the creek water. 4. A positive dewatering scheme was necessary for the foundation construction. 5. Alternative dewatering scheme would be to employ a cofferdam incorporating interlocking steel sheeting to bedrock and using conventional pumping technique.	Fill Heights up to 3.0 m will be stable with forward and side slopes of 2:1. Cuts to a depth of 7.6 m will be stable with 2:1 side slopes.	1. Widening structure can be founded on spread footing at the same elevation of existing footing. 2. In the above case, dewatering scheme will be required. 3. Alternatively, structure can be founded on piles driven to shale bedrock. 4. A construction joint should be provided between existing abutment foundation and the extension.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 14 (MTO 22-152) LOCATION Hwy. 401 at Henry St. Underpass
 ORIGINAL GROUND ELEV. 89.0 m PROPOSED HWY. 401 GRADE ELEV. 87.5 m
 Reference: WP EGG-000-21
 (B.P. Walker Report)

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 1</u> 0-4.6: Silty Clay and Sand, trace of gravel (Upper Glacial Till) V. Stiff to Hard 4.6-15.3: Gravelly Sand, Trace of Silt and Clay (Lower Glacial Till) Brown to Grey 15.3-16.8: Weathered Shale (Grey)	<u>Abutments and Piers (GO-ALRT)</u> 1. Existing abutments for GO-ALRT are founded on spread footings at an approximate elevation of 81.3 m (on the lower glacial till). 2. The footings were designed using a Factored Bearing Capacity at U.L.S. of 1000 kPa. 3. Settlement will be less than 12 mm. 4. About 4.8 m high retaining walls were proposed both sides of the underpass. 5. A positive dewatering scheme was necessary for the foundation construction.	Fill Heights up to 5.7 m will be stable with forward and side slopes of 2:1.	1. The existing structure will be removed and most likely replaced at the same location. 2. Spread footing would be most likely. 3. A positive dewatering scheme would be required depending on the footing elevations. 4. No serious problems are anticipated.
<u>Groundwater</u> Water level at 4.2m below ground surface. (Elev. 84.8m±)			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 15 (MTO 22-151) LOCATION Hwy. 401 at Brock Street (Hwy. 12) Underpass
 ORIGINAL GROUND ELEV. 86.4 m PROPOSED HWY. 401 GRADE ELEV. 83.8 m
 Reference: WP EGG-000-22
 (Geocon Report)

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS																
	STRUCTURE	APPROACHES																	
<u>Reference Boreholes</u> <u>BH 2</u> 0-3.4: Fill-Silty Clay and Sand, trace gravel and organics (Stiff to Hard) 3.4-13.7: Heterogeneous Mixture of Silty Clay, Sand and Gravel Occasional to frequent Shale fragments (Glacial Till) 13.7-15.3: Weathered Shale Bedrock <u>Groundwater</u> Water level at 3.4 to 4.4 m below ground surface at the elevation of about 82 to 83 m.	<u>Abutments and Piers (GO-ALRT Structures)</u> <u>Abutments</u> <ol style="list-style-type: none"> All surficial organic and loose materials within the limits of the proposed embankment were removed for a minimum distance of 10 m behind the abutments. H.P. 310 x 110 Steel H-piles with Standard reinforced tips were used with the pile tip elevations at about 77± and 80± for the north and south abutments, respectively. An axial bearing Capacity at U.L.S. of 1600 kN/pile and 1150 kN/pile at S.L.S. Type II was used. <u>Piers</u> <ol style="list-style-type: none"> The piers were founded on spread footings located in the glacial till deposit and designed for the following bearing capacities. <table> <tr> <td></td><td>Founding</td><td></td><td>S.L.S.</td></tr> <tr> <td></td><td>Elev.</td><td>U.L.S.</td><td>Type II</td></tr> <tr> <td>South Piers</td><td>81.5 m</td><td>1000 kPa</td><td>500 kPa</td></tr> <tr> <td>North Piers</td><td>81.5 m</td><td>1000 kPa</td><td>500 kPa</td></tr> </table>		Founding		S.L.S.		Elev.	U.L.S.	Type II	South Piers	81.5 m	1000 kPa	500 kPa	North Piers	81.5 m	1000 kPa	500 kPa	Fill Heights up to 8 m will be stable with forward and side slopes of 2:1. <hr/> REMARKS <hr/> <ol style="list-style-type: none"> Alternatively, both abutments can be founded on spread footings supported on a Granular 'A' core. For the above option, excavation to elevation 83.5 m± is required at the south abutment and to elevation 83 m± at the north abutment. The abutment footings can be founded at elevation 87.2 m± designed for a factored bearing capacity of 900 kPa at U.L.S. and a bearing capacity of 350 kPa at S.L.S. Type II. 	(continued ...) 4. Dewatering scheme will not be required, since the glacial till is cohesive. (no boiling) 5. The existing structure will be removed and replaced at the same location. 6. No serious foundation problems are anticipated.
	Founding		S.L.S.																
	Elev.	U.L.S.	Type II																
South Piers	81.5 m	1000 kPa	500 kPa																
North Piers	81.5 m	1000 kPa	500 kPa																

FOUNDATION DATA SHEET

W.P. 242-86-00 FILE 16 (MTO N/A)

LOCATION Hwy. 401 at Pringle Creek Culvert

ORIGINAL GROUND ELEV. 81.6 m (BH #4)

PROPOSED HWY. 401 GRADE ELEV. 81.8 m

Reference: WP EGG-000-23
(Golder Report)

SUBSURFACE CONDITIONS		RECOMMENDATIONS		REMARKS
		STRUCTURE	APPROACHES	
<u>Reference Boreholes</u>		<u>Abutments and Piers</u>		1. The existing culvert structure will be extended to the north and south with spread footings. 2. No serious problems.
<u>BH 4</u> (Centreline of Hwy. 401)		<u>West Abutment</u> (Sta. 24+606.7±)		
0-1.2: Fill-Sand silt and gravel (compact)		1) Remove the sanitary landfill beneath approach embankment (cut 2:1 slope).		
1.2-2.9: Fill-Silty sand, some gravel, trace clay, organic material at 2.4 m depth. (compact to Dense)		2) Founded on Steel 'H' piles driven to a tip elevation of about 74.0 m.		
		3) 310H110: Factored U.L.S. : 1600 kN S.L.S. Type II : 1150 kN		
		<u>W. Pier 1</u> (Sta. 24+646.7±)		
2.9-6.9: Gravelly Sand, some silt, trace clay (Glacial Till) V. Dense		1) Spread footings located at or below elevation 76.0 m		
6.9-8.4: Silt with clay & sand & interlayers of weathered Shale (V. Dense)		2) Factored U.L.S. : 800 kPa S.L.S. Type II : 400 kPa		
8.4-10.4: Weathered Shale Bedrock		3) Due to possible boiling, dewatering scheme would be required by means of pumping from over-size perimeter drains.		
		<u>W. Pier 2</u> (Sta. 24+706.7±)		
		1. Founded on spread footings at or below elev. 78 m.		
		2) Bearing Capacities and dewatering scheme would be the same as above.		

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 16 (MTO N/A) LOCATION Hwy. 401 at Pringle Creek Culvert
 ORIGINAL GROUND ELEV. 79.2 m (BH #3) PROPOSED HWY. 401 GRADE ELEV. 81.8 m
 Reference: WP EGG-000-23
 (Golder Report)

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 3</u> (North of Hwy. 401) 0-2.1 Interlayered organic silt and silty sand with shell fragments (V. loose to compact) 2.1-4.3 Silty Clay some sand trace gravel (Firm) 4.3-5.6 Silty Sand and gravel, trace clay (Glacial Till) (Dense) 5.6-7.2 Silt with clay & sand & interlayers of Shale (Weathered) 7.2-10.0 Weathered Shale Bedrock <u>Groundwater</u> Water level across the site ranged from 77.8 to 78.3 m.	<u>M. Pier (Sta. 24+741.7±)</u> 1. Founded on spread footings at or below elev. 78.7 m. 2. Factored U.L.S. : 1000 kPa S.L.S. Type II : 500 kPa 3. No dewatering scheme required. <u>E. Pier (Sta. 24+812.7±)</u> 1) Founded on steel 'H' piles driven to a tip elev. of about 72.0 m. 2) 310H110 : Factored U.L.S. : 1600 kPa S.L.S. Type II : 1150 kPa <u>E. Abutment (Sta. 24+254.7±)</u> 1. Founded on steel 'H' piles driven to weathered Shale (71.6 m). 2. Bearing Capacities are the same as above. 3. Approach fill is limited to a maximum height 6 m. 4. If the berm is higher than that, mid height berms are required. 5. 310H110: Bearing Capacity is same as above.		

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 17 (MTO N/A) LOCATION Hwy 401 at W Corbett Creek Crossing West of Thickson Rd.
 ORIGINAL GROUND ELEV. 83.8 m PROPOSED HWY. 401 GRADE ELEV. 88.3 m

Reference: WP 38-77-01
 Contract: 82-72

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 1</u> 0-1.8: Silty clay trace sand organics and root structure. Occasional silt inclusions firm. 1.8-10.2: Silty Clay to Clay medium plasticity. Occasional Banded structure Random Mottling of Silt inclusions. (Very soft to soft) 10.2-14.3: Silty Sand trace of clay and gravel very loose. <u>Groundwater</u> Water level at 0.5 to 0.9 m below ground surface at elevation 82.9 m.	<u>Abutments and Piers</u> <u>Scheme #1</u> Concrete culvert founded on a 1 m thick Granular 'A' pad extending a minimum of 1.5 m on either side of the culvert. - Culvert built with a camber to handle consolidation settlements. Site was preloaded 6 months prior to construction (50% of before construction). - Bottom of culvert at elevation 82.3 m. <u>Scheme #2</u> - Complete removal of the existing geometry and replacement with 3.4 m metal pipe utilizing open cut technique is not practical. Sheeted or braced excavation is required. - Tunneling techniques by hydraulically pushing could be considered.	Profile grade for ramps required fill heights of 7.6 m. - Embankments are to be constructed with light weight fill with minimum slope of 2:1. - Use of light weight fill should extend a minimum of 30 m on either side of the creek.	Existing Culvert will be extended. - At this site there is a deposit of very soft clay to a depth of 12 m which will create very serious stability & settlement problems. - Grade of 401 should not be increased in this area. - In order to reduce the settlement, it may be necessary to place any fill material a minimum of 1 year in advance of final construction.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 18 (MTO 22-171) LOCATION Hwy. 401 at Thickson Road Underpass
 ORIGINAL GROUND ELEV. 100.3 m PROPOSED HWY. 401 GRADE ELEV. 95.1 m

Reference: WP 38-77-01

Contract: 82-72

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes</u> <u>BH 1</u></p> <p>0-4.9: Fill-Clayey Silt with sand and traces of gravel organics (Firm to Stiff)</p> <p>4.9-14.0: Glacial till Het. Mix. Clayey Silt Sand and Gravel. Hard Changing to Het. Mix. Silt Sand and Gravel (V. Dense)</p> <p><u>Groundwater</u></p> <p>Water level at 3.7 to 13.7 m below ground surface.</p> <p>Elev. fluctuated between elev. 86.0 m to 94.5 m.</p>	<p><u>Abutments and Piers</u></p> <p><u>North & South Abutments:</u> (Original Recommendation)</p> <ul style="list-style-type: none"> - Spread footing design (closed type of Abut.) - N & S Abutments - West side at elev. 95.4 m - Allowable load = 535 kPa (5 t.s.f.) <p><u>South Abutments</u></p> <p>Retaining wall placed either side 5-8 m Height = 4.4 m. Found on spread footings at elev. 93.3 m to elev. 94.0 m. Footings: Factored Bearing Capacity at U.L.S. 1000 kPa. Bearing Capacity at S.L.S. Type II of 500 kPa.</p> <ul style="list-style-type: none"> - 5 cm of styrofoam placed on S. Abutment footing for frost protection. <p><u>Both Abutments</u></p> <ul style="list-style-type: none"> - 10 cm minimum earth cover above base of footings required for frost protection. <p><u>Center Pier:</u></p> <ul style="list-style-type: none"> - footing elev. at or below 93.9 m for frost protection. - allowable Bearing Capacity of 535 kPa (5 t.s.f.) 	<p>Fill heights up to 3.8 m will be stable with forward and side slopes of 2:1.</p> <p>Cuts to a depth of 3.5 m will be stable with 2:1 side slopes.</p> <ul style="list-style-type: none"> - Additional fills to be benched into existing fills. 	<ol style="list-style-type: none"> 1. Widening of 401 will be a cut situation of approximately 3.5 m. 2. No dewatering problems anticipated for excavation of footings. 3. Depending on the final scheme chosen, this structure may have to be replaced. No serious foundation problems are anticipated.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 19 (MTO 22-367) LOCATION Hwy. 401 at Basket Weave Bridge at Truck Inspection Station
 ORIGINAL GROUND ELEV. 97.9 m PROPOSED HWY. 401 GRADE ELEV. 92.8 m
Reference: WP 38-77-01

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 6 (about 300 m West)</u> 0-30.5 Met. mixture clayey silt, sand and gravel (Hard) changing to Met. mixture of silt, sand and gravel V. Dense (Glacial Till)	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE For Reference: See the recommendations for the Thickson Road Underpass	Fill heights up will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. Possible retaining walls required adjacent to Basket Weave Bridge. 2. Depending on the final scheme chosen, this structure may be removed. 3. No serious foundation problems are anticipated.
<u>Groundwater</u> Water level at 5.8 m below ground surface. (Elev. 92.1 m)			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 20 (MTO 22-171) LOCATION Hwy. 401 at Corbett Creek Culvert
 ORIGINAL GROUND ELEV. 82.1 m PROPOSED South East Service Rd GRADE ELEV. 86.0 m

Reference: Contract 82-72

—SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH 1</u> 0-0.5: Topsoil 0.5-5.8: Silty Sand some Gravel, trace of Clay. (Compact) 5.8-10.8: Clayey Silt with Sand and Gravel Very Stiff to hard (Glacial Till) <u>Groundwater</u> Water level at Creek level 82.0 m.	<u>Abutments and Piers</u> <u>Box Culvert:</u> - Mat foundation founded on a 0.3 m Granular 'A' pad - rigid concrete box culvert 3 x 4.9 m A temporary earth dyke or stream diversion was required Excavations below the water table require a positive dewatering system.	Fill heights up 3.4 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. Extension of existing culvert. 2. Some positive dewatering system will be required. 3. But No major problems anticipated.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 21 (MTO 22-172) LOCATION Hwy. 401 at C.P.R. Subway (G.M. Spur)
ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 106.7 m

References:

[illegible]

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 22 (MTO 22-185) LOCATION Hwy. 401 at Stevenson Road Underpass
 ORIGINAL GROUND ELEV. 105.6 m PROPOSED HWY. 401 GRADE ELEV. 108.6 m

Reference: WP 44-71-24

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #1 (For Retaining Walls)</u> 0-5.0 Met. mixture clayey silt, sand and gravel Hard or Dense to Very Dense (Glacial Till)	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE FOR STRUCTURE. THERE IS SOME INFORMATION AVAILABLE FOR A PROPOSED RETAINING WALL THAT WAS NEVER BUILT. <u>Retaining Walls</u> 1) Proposed to be founded on Spread footing within the deposit of stiff to very stiff glacial till. 2) Proposed footing elevations between 104.6 and 105.5 m. 3) Maximum allowable load is 214 kPa (2 t.s.f.). 4) Temporary road protection is required by soldier piles and timber logging.	Fill heights up to 6 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will most likely be replaced. 2. No serious foundation problems are anticipated. 3. Temporary road protection will be required (Soldier piles & Timber logging). 4. No significant dewatering scheme will be required.
<u>Groundwater</u> Water level at 3.7 to 5.8 m below ground surface. (Elev. 100.3 to 103.4 m).			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 23 (MTO 22-173) LOCATION Hwy. 401 at Park Road OverPass
 ORIGINAL GROUND ELEV. 107.9 m - 106.1 m PROPOSED HWY. 401 GRADE ELEV. 111.3 m

References: WP 44-71-06
 (Contract 77-133)
 WO 72-11140

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #4</u> (North Extension) 0-6.6: Hetrogeneous Mixture of Sand, Silt, Gravel & Clay (Compact to very Dense) (Glacial Till) 6.6-9.3: Sand & Gravel (Very Dense) <u>BH #3</u> (South Extension) 0-4.3: Hetrogeneous Mixture of Silt Sand, Gravel & Clay (Dense to Very Dense)(Glacial Till, Brown - Grey) 4.3-15.4: Hetrogeneous Mixture of Clayey Silt, Sand & Gravel (Very Stiff to Hard *Reworked zone between elev. 4.3 m to 12.2 (Glacial Till) (Continued next page)	<u>Abutments and Piers</u> <u>Original Structure:</u> Foundation on Spread Footings at elev. 104.7 m. <u>South Extensions:</u> Founded on Spread Footing at elev. 104.7 m. - allowable bearing pressure of 320 kPa (3 t.s.p). <u>North Abutment Extension:</u> was anticipated that they would settle 13 mm elastic in nature. Spread Footings. - construction joint recommended between North extension & original bridge.	Fill heights up to 5.2 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes. New fill embankments are to be keyed into existing embankment slopes.	1. These structures will likely be replaced. 2. No serious foundation problems are anticipated. 3. No dewatering problems are expected during excavation.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 23 (MTO 22-173) LOCATION Hwy. 401 at Park Road OverPass
ORIGINAL GROUND ELEV. 106.4 m PROPOSED HWY. 401 GRADE ELEV. 111.3 m

[illegible]

FOUNDATION DATA SHEET

W.P. 242-86-00

FILE 24 (MTO 22-174)

LOCATION Hwy. 401 at Cubert St. Overpass

ORIGINAL GROUND ELEV. 105.1 m

PROPOSED HWY. 40 | GRADE ELEV. 110.2 m

References: WP 44-71-07

Contract: 77-133

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes</u> <u>BH #1</u></p> <p>0-1.5: Clayey Silt with some Sand and Gravel. (Fill Material) Stiff.</p> <p>1.5-13.6: Heterogeneous Mixture of Clayey Silt to Silty Clay, Sand & Gravel. Hard. (Glacial Till)</p> <p><u>Groundwater</u></p> <p>Water level at 1.1 to 2.0 m below ground surface.</p> <p>At elev. 103.2 to 104.0 m.</p>	<p><u>Abutments and Piers</u></p> <p><u>Original Structure:</u></p> <p>Single Span, rigid frame, Foundation-Spread Footings at elev. 103.5 (west abutment) & 103.4 (east abutment).</p> <p><u>Extensions:</u></p> <ul style="list-style-type: none"> - both are founded on Spread Footings at the same elevations as the original abutment footings. - allowable bearing stress up to 375 kPa (3.5 t.s.f.) - construction joint recommended between extensions & original structure. - footing extensions were expected to settle 13 mm - elastic in nature. 	<p>Fill heights up to 5.2 m will be stable with forward and side slopes of 2:1.</p> <p>Cuts to a depth of will be stable with 2:1 side slopes.</p> <p>New fill embankments are to be keyed into existing embankment slopes.</p>	<p>1. This structure is likely to be replaced.</p> <p>2. No serious foundation problems are anticipated.</p> <p>3. No major problems are anticipated for excavation of footings.</p>

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 25 (MTO 22-175) LOCATION Hwy. 401 at Oshawa Creek Bridge
 ORIGINAL GROUND ELEV. 99.1 m (BH #7) PROPOSED HWY. 401 GRADE ELEV. 98.5 m
88.4 m (Creek Bottom) References: WP 44-71-08 (Cont. 77-133)
WO 73-11022

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #7</u> 0-1.7: Gravelly Sand (Fill) Compact. 1.7-5.5: Silt with Sand, traces of Gravel (Fill). Loose to Dense. 5.5-9.1: Sand with Silt traces of gravel & organics; Loose to Dense. (Dark Grey) 9.1-11.3: Silt with Sand, traces of gravel Grey. Very Dense (Glacial Till) <u>Groundwater</u> Water level at 0 to 8.2 m below ground surface. (Elev. 89.8 m at north) (Elev. 89.3 m at south)	<u>Abutments and Piers</u> <u>Abutments:</u> - Spread Footings. Original structure founded at 91.0 m. Extension to be founded at 90.7 m. - Design load of 535 kPa (5 t.s.f.) was used. - Vertical expansion joints between original structure & extensions is required. - 1.2 m of cover above the undersides of the footings is required for frost protection. <u>Piers</u> - Footing extensions to be founded at same elevation of existing footings, 88.3 m. - Spread footings. - Allowable bearing capacity of 535 kPa (5 t.s.f.) - During excavating of the footing extensions, extreme care must be taken to avoid boiling of the material near the existing footing. A dewatering scheme employing sheet piling driven 1.8 m into the till maybe used for the pier footing excavation to avoid boiling.	Fill heights up to 7.6 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. Widening of existing structure. 2. Erosion control should be provided by rip-rap or similar manner. 3. Artesian water conditions were encountered at elevation 83.2 m.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 26 (MTO 22-176) LOCATION Hwy. 401 at Simcoe Street Underpass

ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 95.5 m

References:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u>	<u>Abutments and Piers</u>		
0-	NO INFORMATION AVAILABLE.	Fill heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be replaced. 2. Due to silt deposits and a high water table deep cuts will require a special treatment to prevent soil erosion. 3. Otherwise, no serious foundation problems are anticipated.
<u>Groundwater</u>			
Water level at below ground surface.			

FOUNDATION DATA SHEET

W. P. 242-86-00

SILE 27 (MTO 22-177)

LOCATION Hwy. 401 at Albert Street Underpass

ORIGINAL GROUND ELEV.

PROPOSED HWY. 401 GRADE ELEV. 95.7 m

References:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> 0-	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE.	Fill heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be replaced. 2. Due to silt deposits and a high water table, cuts will require a special treatment to prevent soil erosion. 3. Otherwise, no serious foundation problems are anticipated.
<u>Groundwater</u> Water level at below ground surface.			

FOUNDATION DATA SHEET

W.P. 242-86-00

511E 28 (MTO 22-178)

LOCATION Hwy. 401 at CNR Subway

ORIGINAL GROUND ELEV. _____

PROPOSED HWY. 401

GRADE ELEV. 95.8 m

References:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> 0-	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE.	Fill heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be replaced. 2. Due to silt deposits and a high water table, deep cuts will require a special treatment to prevent soil erosion. 3. Otherwise, no serious foundation problems are anticipated. 4. Possible need for temporary trestle during construction.
<u>Groundwater</u> Water level at below ground surface.			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 29 (MTO N/A) LOCATION Hwy. 401 at Possible retaining Walls Between Park Rd. & Bloor St

ORIGINAL GROUND ELEV. Varied PROPOSED HWY. 401 GRADE ELEV. Varied
References:

[illegible]

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 30 (MTO 22-179) LOCATION Hwy. 401 at Ritson Road Overpass
 ORIGINAL GROUND ELEV. 97.5 m to 101.8 m PROPOSED HWY. 401 GRADE ELEV. 103.3 m
 References: WP 44-71-09 (Cont. 77-133)
WO 73-11051

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #2</u> 0-8.7: Het. Mixture of Sandy Silt to Silty Sand, gravel & clay. Very Dense. (Glacial Till) Brown - Grey 8.7-10.7: Silty Clay, traces of Sand. Grey. (Hard) 10.7-15.7: Sand, traces of silt and gravel. Very Dense. <u>Groundwater</u> Water level at 0.5 m to 0.6 m below ground surface. at elevations 97.8 and 98.1 m.	<u>Abutments and Piers</u> <u>Original Structure:</u> <ul style="list-style-type: none"> - Rigid frame structure supported on spread footings founded at elevation 96.8 m. <u>Abutment Extensions:</u> <ul style="list-style-type: none"> - Supported on spread footings at elev. 96.8 m. - Allowable bearing pressure: 428 kPa (4 t.s.f.) - Settlements of 13 mm can be expected during construction. Settlements are assured to be elastic and occur immediately. - Construction joint between existing footings & new footings was required to account for differential settlement. 	Fill heights up to 5.8 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes. <u>Approach Embankments:</u> <ul style="list-style-type: none"> - widened approximately 6.1 m on both sides. - new fill to be keyed into existing fills by benching. - compacted fill may settle under its own weight 0.5% of the total height. 	1. This structure will most likely be replaced. 2. No serious foundation problems are anticipated. 3. Groundwater seepage can be anticipated during excavation for footings, however it can be handled using ordinary pumping methods.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 31 (MTO 22-180) LOCATION Hwy. 401 at Wilson Road Overpass
 ORIGINAL GROUND ELEV. 89.9 m PROPOSED HWY. 401 GRADE ELEV. 94.8 m
 References: WP 44-71-10 (Cont. 77-133)
 WO 73-11052

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #3</u> 0-1.8: Fill material. Clayey Silt, some Sand and Gravel, traces of organics, Brown - Grey Firm to Stiff 1.8-9.8: Het. Mix. of Sand, Silt and gravel. (with occ. zones of Clayey silt, Sand and Gravel). Grey. (Loose to Very Dense) (Glacial Till) 9.8-11.1: Sand with some Silt and traces of Gravel. Grey. (Very Dense). <u>Groundwater</u> Water level at 0.9 m to 1.8 m below ground surface. at elev. 88.1 -89.0 m.	<u>Abutments and Piers</u> <u>Original Structure:</u> - Rigid frame structure supported on spread footings founded at elevation 87.9 m. <u>Abutment Extensions:</u> - Founded on spread footings at elev. 87.9 m. - Allowable bearing pressure: 375 kPa (3.5 t.s.f.) - Settlement of 13 mm can be expected. This settlement is assumed to be elastic in nature and will occur during construction. - In order to accomodate any differential settlement between existing footings and the extensions, an expansion joint should be constructed between these two elements.	Fill heights up to 5.5 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes. <u>Approach Embankments:</u> - new fills to be benched into existing fills. - no long term settliment anticipated. - compacted fill may settle $\frac{1}{2}\%$ of its heightt due to its own weight.	1. This structure will most likely be replaced. 2. No serious foundation problems are anticipated. 3. Groundwater seepage into footing excavatons can be expected but handled by ordinary pumping methods.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 32 (MTO 22-181) LOCATION Hwy. 401 at Bloor Street Underpass

ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 84.6 m

References:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> 0-	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE.	Fill heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be replaced. 2. No data is available for this site. Therefore, foundation investigation will be required for the possible new location for Bloor Street underpass.
<u>Groundwater</u> Water level at below ground surface:			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 33 (MTO 22-182) LOCATION Hwy. 401 at Harmony Creek Bridge (barrel each culvert)
 ORIGINAL GROUND ELEV. 78.2 m (Creek level) PROPOSED HWY. 401 GRADE ELEV. 82.7 m
 References: WP 44-71-11 (Cont. 77-133)
WO 73-11004

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #1</u> 0-2.4: Clayey Silt with Sand, traces of Gravel. (Stiff to very Stiff) 2.4-7.6: Sand and Gravel with some Silt and Clay. Very Dense. (Glacial Till) Boulder at 7.6 m 7.6-9.0: Shale Bedrock Sound <u>Groundwater</u> Water level at Creek Level - Sub-Artesian pressure encountered at BH #1. Water level rose 1.0 m above creek level.	<u>Abutments and Piers</u> <u>Existing Structure:</u> - Concrete arch culvert. <u>Extension:</u> spread footings or pile foundations. <u>Spread Footings</u> - Founded on spread footings at elev. 75.0 m. - maximum bearing capacity: 428 kPa (4 t.s.f.). - Footings contained within a sheet pile cofferdam driven to elev. 74.1 m to provide against possible blowout due to artesian water at elev. 74.1 m. <u>Pile Foundations</u> Alternatively founded on pile foundations.	Fill heights up to 3.0 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will most likely be replaced. 2. No serious foundation problems are anticipated.

FOUNDATION DATA SHEET

W. P. 242-86-00

FILE 34 (MTO 22-183)

LOCATION Hwy. 401 at Farewell Creek Bridge

ORIGINAL GROUND ELEV. 77.0 m

PROPOSED HWY. 40 | GRADE ELEV. 81.1 m

References: WP 44-71-12

WO 72-11128

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<p><u>Reference Boreholes</u></p> <p><u>BH #2</u></p> <p>0-3.0: Silty Sand, trace to some Gravel</p> <p>3.0-4.3: Clayey Silt, some Sand & occasional Gravel. Very Stiff.</p> <p>4.3-6.1: Clayey Silt, some Sand & occasional Gravel. Very Dense. Compact.</p> <p>6.1-7.6: Shale Bedrock sound.</p> <p><u>Groundwater</u></p> <p>Water level at 0.3 m to 2.7 m below ground surface.</p> <p>Creek level at 76.7 m.</p>	<p><u>Abutments and Piers</u></p> <p><u>Original Structure:</u></p> <ul style="list-style-type: none"> - Single span Rigid Frame structure founded on spread footings at elev. 75.4 m. <p><u>Abutment Extensions:</u></p> <ul style="list-style-type: none"> - founded on end-bearing piles driven to bedrock (12BP74 steel 'H' piles, designed for 95 tons/pile). - abutment elevations at 75.4 m (N. side) & 76.4 m (S. side). <p><u>Dewatering:</u></p> <ul style="list-style-type: none"> - footing excavations extend up to 1.5 m below ground water. Possible boiling condition may occur. A positive dewatering system was used, consisting of interlocking sheet piles, used to form a cofferdam. 	<p>Fill heights up to 3.7 m will be stable with forward and side slopes of 2:1.</p> <p>Cuts to a depth of will be stable with 2:1 side slopes.</p> <p><u>Approach Embankments</u></p> <ul style="list-style-type: none"> - new fills are to be benched into existing fills. - soils beneath the embankment will settle approximately 25 to 40 mm. 	<ol style="list-style-type: none"> 1. This structure will most likely be replaced. 2. No serious foundation problems is anticipated. 3. Due to possible boiling condition, a positive dewatering system should be used, consisting of interlocking sheet piles, used to form a cofferdam.

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 35 (MTO N/A) LOCATION Hwy. 401 at Proposed G.M. Headquarters Access

ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 93.9 m
References:

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> 0-	<u>Abutments and Piers</u> NO LONGER VALID. NO INFORMATION AVAILABLE.	Fill heights up to will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. There was a requirement to provide access from Hwy 401 to a new G.M. HQ. just east of Oshawa. 2. This proposal is no longer valid, therefore no foundation data is required.
<u>Groundwater</u> Water level at below ground surface.			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 36 (MTO N/A) LOCATION Hwy. 401 at Robinson Creek
ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 95.4 m
References: _____

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
Reference Boreholes 0-	Abutments and Piers NO INFORMATION AVAILABLE.	Fill heights up to 10 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be extended. 2. No serious foundation problems are anticipated.
Groundwater Water level at below ground surface.			

FOUNDATION DATA SHEET

W.P. 242-86-00 SITE 37 (MTO N/A) LOCATION Hwy. 401 at Creek Crossing West of Courtice Road
ORIGINAL GROUND ELEV. _____ PROPOSED HWY. 401 GRADE ELEV. 98.6 m
References:

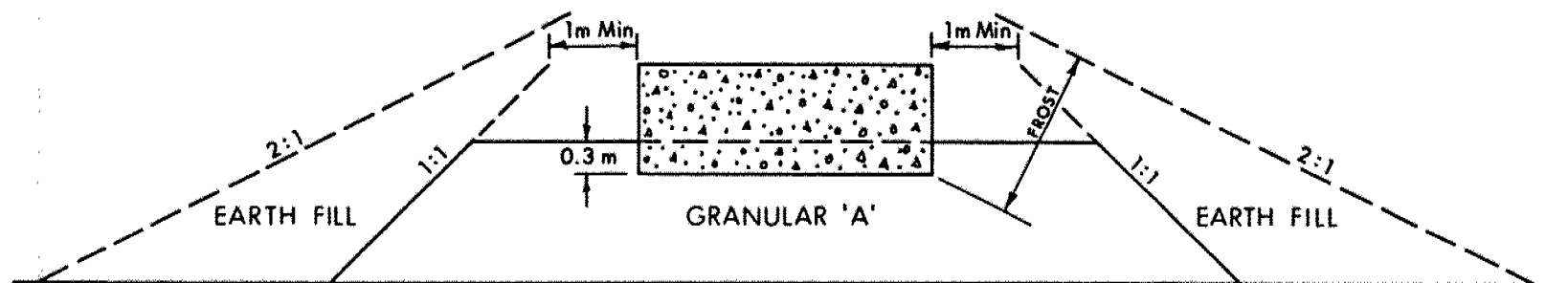
SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> 0-	<u>Abutments and Piers</u> NO INFORMATION AVAILABLE.	Fill heights up to 12.0 m will be stable with forward and side slopes of 2:1. Cuts to a depth of will be stable with 2:1 side slopes.	1. This structure will be extended. 2. No serious foundation problems are anticipated. 3. Embankment slope stability should be considered.
<u>Groundwater</u> Water level at below ground surface.			

FOUNDATION DATA SHEET

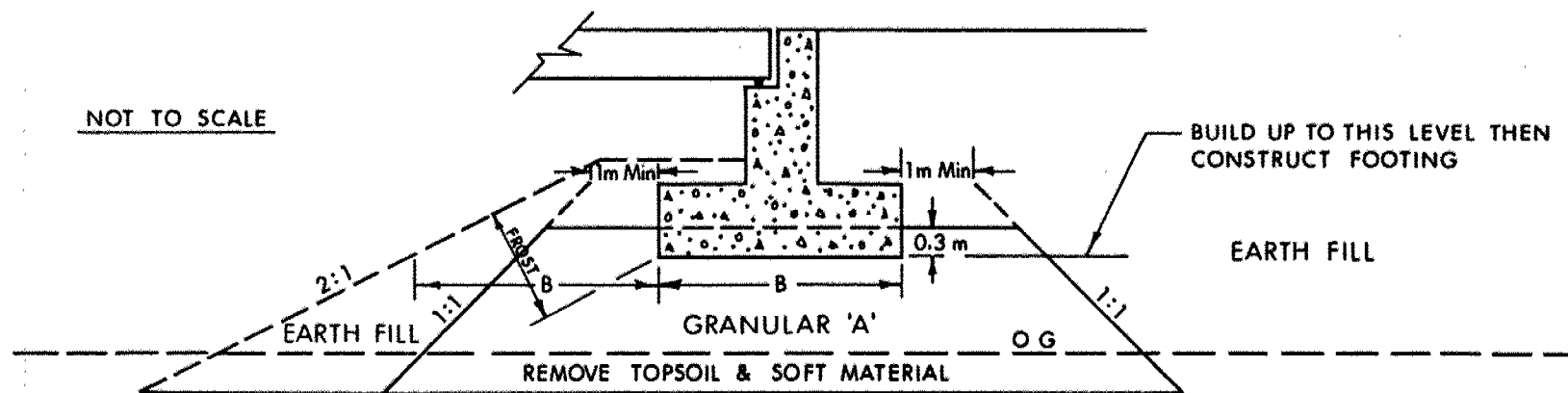
W.P. 242-86-00 SITE 38 (MTO 22-158) LOCATION Hwy. 401 at Courtice Road Overpass
 ORIGINAL GROUND ELEV. 93.9 m PROPOSED HWY. 401 GRADE ELEV. 99.8 m

References: WP 59-75-01
 Cont. 80-55

SUBSURFACE CONDITIONS	RECOMMENDATIONS		REMARKS
	STRUCTURE	APPROACHES	
<u>Reference Boreholes</u> <u>BH #1</u> 0-0.5: Fill 0.5-7.9: Heterogeneous Mixture of Silt, Sand with some Gravel and Clay. Stiff to Hard. (Glacial Till)	<u>Abutments and Piers</u> <u>Original Structure:</u> <ul style="list-style-type: none"> - Single span rigid frame structure supported on spread footings founded at elevation 91.9 m. - Retaining walls at each corner of structure to retain approach fills. Retaining walls are also founded on spread footings. <u>Abutment Extension:</u> <ul style="list-style-type: none"> - Existing wing wall footings used as abutment extension footings (South side). - Founded at elev. 91.9 m (Spread Footing). - Allowable bearing pressure < 320 kPa (3 t.s.f.) <u>New Wing Walls:</u> <ul style="list-style-type: none"> - New wing wall footings founded on spread footings at elev. 91.9 m. - Construction joint is required between new footing and existing footing to account for differential settlement. - Allowable bearing pressure = 320 kPa (3 t.s.f.) 	<u>Approach Embankments:</u> <ol style="list-style-type: none"> 1. Fill heights up to 2.7 m will be stable with forward and side slope of 2:1. 2. New fills to be keyed into existing fills by benching. 	<ol style="list-style-type: none"> 1. No major dewatering problems are anticipated. 2. Depending on the final treatment, this structure may require replacement. 3. No serious foundation problems are anticipated.
<u>Groundwater</u> Water level at 0.9 m to 1.4 m below ground surface. (Elev. 92.5 m-93.0 m)			



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 C STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

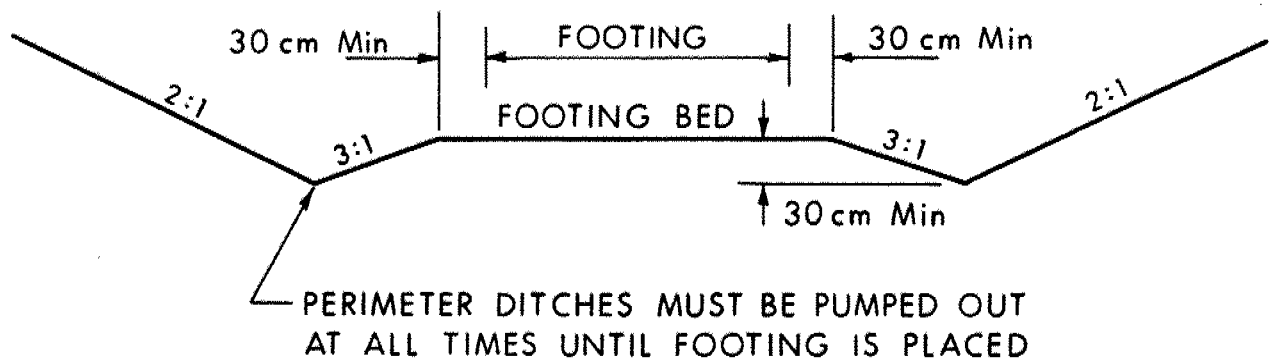


Ministry of
Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

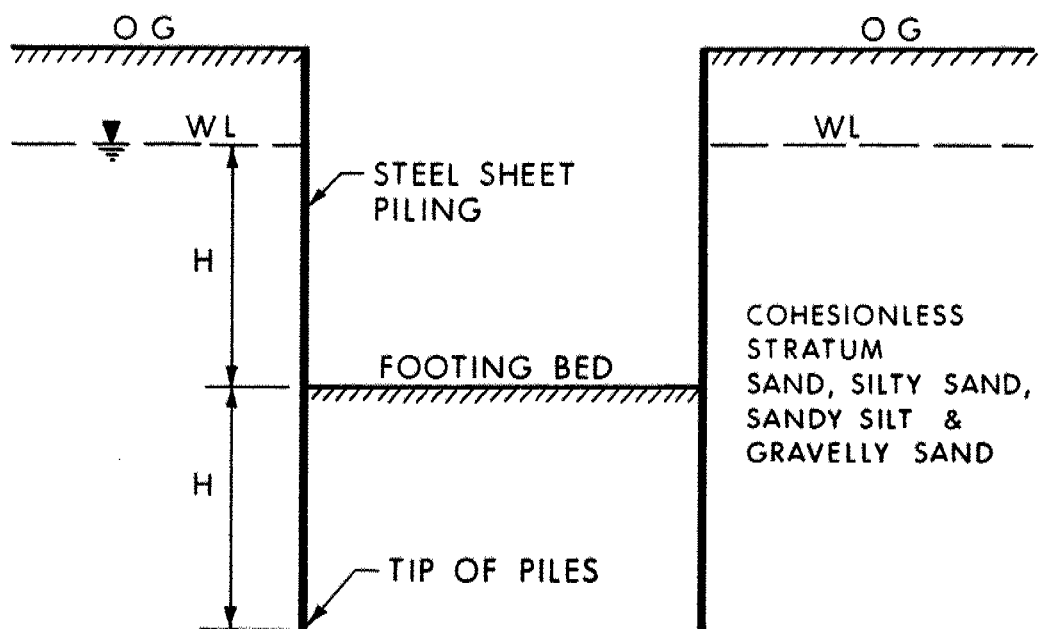
FIG No 1

W P 242-86-00



OVERSIZE EXCAVATION WITH PERIMETER DRAINS

FIG No 2



STEEL SHEET PILING

FIG No 3

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

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
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

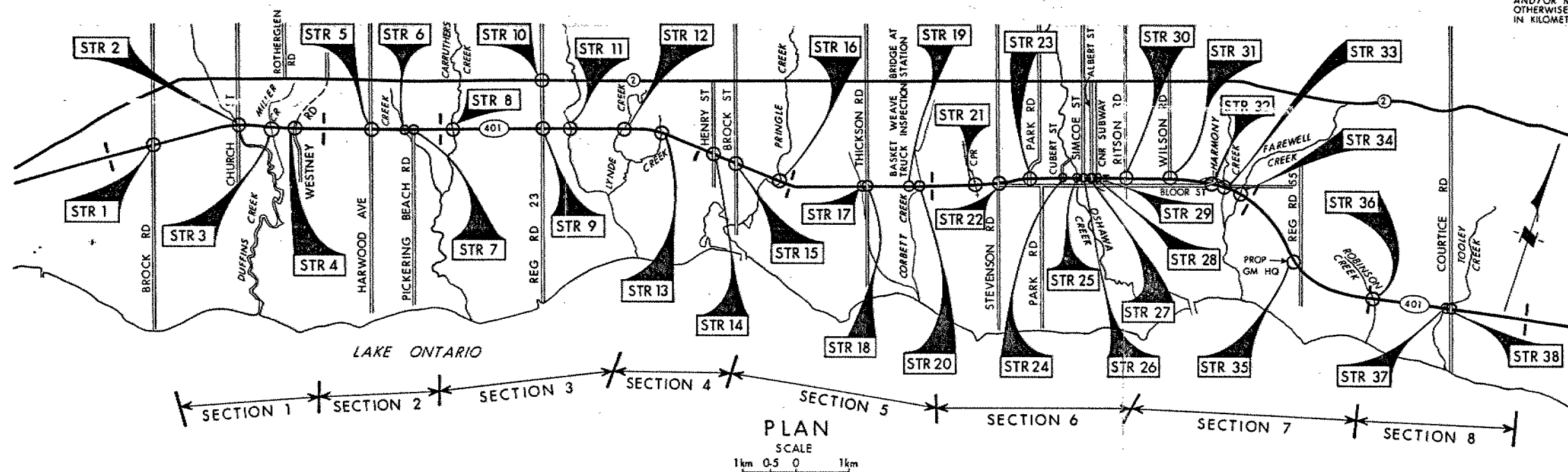
ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT 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 = $\frac{w_L - w_p}{I_p}$	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						

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

CONT No
WP No 242-86-00

HWY 401
BROCK RD TO COURTICE RD
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



EXISTING AND PROPOSED STRUCTURE SITES

- | | |
|--|--|
| ① Brock Road Underpass | ②① Corbett Creek Culvert |
| ② Church St - Duffins Creek Bridge | ②① CPR Subway (GM Spur) |
| ③ Miller Creek Culvert | ②② Stevenson Road Underpass |
| ④ Westney Road Overpass | ②③ Park Road Overpass |
| ⑤ Harwood Ave Underpass - NB and SB Structures | ②④ Cubert Street Overpass |
| ⑥ Creek Crossing Just West of Pickering Beach Road | ②⑤ Oshawa Creek Bridge |
| ⑦ Proposed Pickering Beach Road Overpass | ②⑥ Simcoe Street Underpass |
| ⑧ Carruthers Creek Culvert | ②⑦ Albert Street Underpass |
| ⑨ Regional Road No 23 Underpass | ②⑧ CNR Subway |
| ⑩ Regional Road No 23 at Hwy 2 | ②⑨ Possible Retaining Walls Between Park Road and Bloor Street |
| ⑪ Creek Crossing at Approx Sta 10+500 (No Name) | ③① Wilson Road Overpass |
| ⑫ Lynde Creek Bridge | ③② Bloor Street Underpass |
| ⑬ Creek Crossing at Approx Sta 12+325 (No Name) | ③③ Harmony Creek Bridge |
| ⑭ Henry Street Underpass | ③④ Farewell Creek Bridge |
| ⑮ Brock Street (Hwy 12) Underpass | ③⑤ Proposed New Structure for Access to New GM Headquarters |
| ⑯ Pringle Creek Culvert | ③⑥ Robinson Creek Culvert |
| ⑰ Creek Crossing just West of Thickson Road | ③⑦ Creek Crossing (just East of Courtice Road) |
| ⑱ Thickson Road Underpass | ③⑧ Courtice Road Underpass |
| ⑲ Basket Weave Bridge at Truck Inspection Station | |

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

No	ELEVATION		

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 30M15-80

HWY No 401	DIST 6
SUBMITTAL CHECKED	DATE 86 03 15
DRAWN BY	APPROVED
	DWG 2428600-A

FILE



Ministry
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~~Robert J. Smith~~

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

LPN

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 242-86-00 (A)

DIST 6

HWY 401

STR SITE

Feasibility Study of Highway 401 Widening
Brock Road to Courtice Road

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SUPPLEMENTARY FOUNDATION INVESTIGATION REPORT
For
Feasibility Study of
Highway 401 Widening, Brock Road to Courtice Road
W.P. 242-86-00 (A)
District 6, Toronto

INTRODUCTION

A request, dated July 9, 1987, to review the feasibility of Highway 401 widening between Brock Road to Courtice Road for 38 structure sites was received from the Central Region Structural Section (Mr. D. Bye).

Based on the above request, a Foundation Investigation report for the Feasibility Study of Highway 401 widening was submitted on March 28, 1988 (See Report No. WP 242-86-00, March 28, 1988). The subsurface conditions together with groundwater at respective existing structure locations were summarized in the above report based on the existing available information. Foundation Design Section concluded that a preliminary foundation investigation would be necessary for the following four sites, since adequate subsoil information was not available.

- proposed Pickering Beach Road Overpass (Site #7)
- proposed interchange at the Regional Road 23 (Site #9)
- Regional Road 23 at Highway 2 (Site #10)
- Bloor Street and Harmony Road Underpass (Site #32)

This report summarizes the information obtained from a foundation investigation carried out at the above-mentioned sites during the period of August 11 to August 29, 1988. Various span structures are proposed at each location. However, it should be noted that the schemes being studied for the major interchange at Regional Road 23 may require that the proposed new interchange be moved to the north and the profile grade of Highway 401 be lowered by approximately 3.0 metres.

Thirteen boreholes (BH #7-1 and BH #7-2, BH #9-1 to BH #9-5, BH #10-1 and BH #10-2 and BH #32-1 to BH #32-4) were advanced and sampled as part of this project by means of solid or hollow stem augers and using a conventional diamond drill with washboring techniques (NX Casing and NX Rock core barrel) adopted for soil and rock sampling purposes at the above four sites. These boreholes extended down to depth of 7.7 metres at BH #9-2 and 14.2 metres at BH #7-2 below the existing ground surface.

This report contains factual information together with discussion and recommendations pertaining to the subsurface conditions, structure foundations, approach embankments and cuts, and related earthworks for the sites as shown on Drawing No. 2428600-B.

SITE DESCRIPTION AND GEOLOGY

The proposed structure sites extend from the Pickering Beach Road overpass in Pickering to the Harmony Road in Oshawa (Drawing No. 2428600-B). The sites are located in the Regional municipality of Durham and tranverses the following area municipalities.

Town of Pickering

Town of Ajax

Town of Whitby

City of Oshawa

The topography of the areas is generally flat to gently undulating with the land in the immediate vicinity being used for farming purposes. Residential development exists north of the Highway 401 in the vicinity of Pickering Beach Road, and Bloor street and Harmony Road areas.

Physiographically, the area is located in the region referred to as the "Iroquois Plain". This is the lowland bordering Lake Ontario which was inundated in the Pleistocene time by Lake Iroquois. Subsoils in these areas generally are characterized by a mozaic of till plains, drumlins, and areas of silty lacustrine deposits.

SUBSURFACE CONDITIONS

The subsoil encountered at these four sites can be divided into four deposits as follows:

- i) Topsoil and Fill Material
- ii) Cohesive heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)
- iii) Granular heterogeneous mixture of Silt, Sand and Gravel (Glacial Till)
- iv) Bedrock (Shale)

The maximum thickness of these deposits vary with the location and depths. A detailed description of the subsurface conditions encountered is given below.

Topsoil and Fill Material

Topsoil and fill material were found just beneath the ground surface. Fill material, generally consisting of sand or clayey silt with layers of sand, was encountered at the 9 borehole locations out of 13 boreholes. The thickness of this layer varies from 1.4 metres to 2.1 metres as shown Record of Boreholes. The Standard Penetration Tests indicated that the fill material to be firm to hard. The thickness of the topsoil varies from 0.5 metres at Boreholes #7-1 and #7-2 to 2.1 metres at Borehole #9-2. The 'N' values as per the Standard Penetration Test indicate this material is firm to very stiff.

Cohesive Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)

A cohesive glacial till deposit was found immediately below the topsoil and fill material. This material consists of a cohesive heterogeneous mixture of clayey silt, sand and gravel ranging in thickness between 1.6 metres at BH #9-1 and 10.9 metres at BH #10-1. The material changes in colour from brown to grey at various elevation between 78.3 metres at BH #32-1 and 95.4 metres at BH #7-2.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 1 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>
Natural Moisture Content (w)	5-26.5
Liquid Limit (w_L)	15-39.0
Plastic Limit (w_p)	10-20.5
Plasticity Index (I_p)	3-18.5

From the plasticity chart (see Figure 1), it is evident that the deposit can be classified as an inorganic clayey silt to silt with low plasticity (CL or CL-ML).

Grain size distribution tests were carried out on these materials. Figure 2 in the Appendix shows the result in an envelope form.

Standard Penetration Test 'N' values between 7 and over 100 blows/0.3 m indicated that the soil can be interpreted as being firm to hard.

Granular Heterogeneous mixture of Silt, Sand and Gravel (Glacial Till)

A granular heterogeneous mixture of silt, sand and gravel (glacial till) was encountered between the cohesive glacial till material at seven borehole locations (BH #7-2, #9-1, #9-4, #9-5, #32-2, #32-3, and #32-4). The thickness of this layer ranges from 1.4 metres at BH #9-4 to 5.0 metres at BH #32-4. All samples recovered from the investigation has a grey colour.

Grain size distribution analyses indicate that this layer can be classified as silty sand with gravel and trace of clay. Gradation limits for these particular soils are presented in an envelope form on Figure 3. This layer is basically non-plastic.

In this stratum, the 'N' values ranged from 9 to over 100 blows/0.3 m indicating a state of compaction described as loose to very dense.

Bedrock

The glacial till deposit is directly underlain by weathered shale bedrock and the bedrock was proven at three borehole locations by obtaining up to 1.5 metres of rock core samples. Bedrock is shale of the Whitby Formation. The bedrock consists mainly of a very fine grained and thickly bedded shale. Detailed descriptions of the rock are attached in the Appendix entitled "Description of Rock Core". However, it should be noted that the upper 0.3 m of bedrock is slightly weathered and unweathered shale was encountered below this level.

Core recoveries and Rock Quality Designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on these results, the rock can be classified as medium strong to weak rock.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes except two boreholes in the vicinity of the proposed interchange at the Regional Road 23 (BH #9-2 and BH #9-5). At these locations, a piezometer was installed at each borehole to measure the water level variation with seasons.

At the proposed Pickering Beach Road overpass, groundwater level in the boreholes was found to be 94.0 metres at BH #7-2 which correspond to a depth of 3.5 metres below the existing ground surface.

In the vicinity of the proposed new interchange at the Regional Road 23, the observations indicate that the water level in the open boreholes under the existing Highway 401 WB was found to be between elevation 79.6 metres at BH #9-3 and elevation 82.3 metres at BH #9-1, which corresponds to depths of from 3.2 to 4.6 metres below existing ground surface. At the proposed new Highway 401 location, groundwater level in the piezometer (BH #9-2) varies as follows:

<u>G.L. (m)</u>	<u>1988 (Elevation, m)</u>		<u>1989</u>
	<u>Nov. 2</u>	<u>Dec. 2</u>	<u>Jan. 19</u>
85.5	84.34 (1.14)	84.42 (1.08)	84.34 (1.16)

Further north at the proposed ramps to and from Highway 401, the water level in open borehole (BH #9-4) was found to be higher at an elevation of 86.7 metres which corresponds to a depth of 1.7 metres below the existing ground surface, while groundwater level in a piezometer (BH #9-5) varies as follows:

<u>G.L. (m)</u>	<u>1988 (Elevation, m)</u>		<u>1989</u>
	<u>Nov. 2</u>	<u>Dec. 2</u>	<u>Jan. 19</u>
89.3	88.23	88.24	88.07

At the location of proposed Regional Road 23 over the Highway 2, groundwater level in the open borehole was found to range between 90.0 and 90.2 metres which corresponds to depths of 2.6 metres to 2.8 metres below the existing ground surface.

In the vicinity of Highway 401 and Bloor Street/Harmony Road underpass, the water level in the open borehole was found to range between 77.1 metres at BH #32-4 and 82.5 metres at BH #32-1 which corresponds to depths of 4.6 metres to 1.3 metres below the existing ground surface.

DISCUSSION AND RECOMMENDATIONS

As discussed in our previous report, at present the regional planning and design staff is involved in the preliminary design phase for Highway 401 widening from Brock Road in Pickering to Courtice Road in Oshawa. The subsurface conditions together with groundwater at respective existing structure locations were presented in the above mentioned report. Based on our review, a preliminary foundation investigation was carried out at the four sites during the period of August 11 to August 29, 1988.

This report summarizes the results of the subsurface investigation and the recommendations applying to the bridge structures and related approaches at the following four sites:

- proposed Pickering Beach Road overpass (Site #7)
- proposed interchange at the Regional Road 23 (Site #9)
- Regional Road 23 at Highway 2 (Site #10)
- Bloor Street and Harmony Road underpass (Site #32)

Structure Foundations

Only preliminary recommendations are discussed here for each structure location. Detailed recommendations will be provided for each structure at a later date.

Spread Footings

In consideration of the competent nature of the subsoils and the anticipated fill heights, a perched-type abutment, founded on spread footings as high as possible within the approach fills on a zone composed of well compacted Granular 'A' core, are proposed for three locations except at Highway 401/Bloor Street area as per the current MTO Standard (see Figure 4). All surficial softened and/or organic material within the planned limits of the granular core must be subexcavated prior to placement of granular 'A' core. For spread footings founded on a Granular 'A' core, the following design parameters can be used:

	Factored Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)
Spread Footings	900	350

Alternatively, a closed type of abutment can be designed at various footing elevation with different design parameters. The maximum height footing elevation and corresponding maximum design load should be calculated at the design stage. However, it should be noted that the spread footings be provided with a minimum of 1.2 metres of earth cover for frost protection purposes. In addition, where the spread footing is to be founded on a cohesive deposit, it would be necessary to protect the base of the footing excavation from softening by placing a working slab of lean concrete immediately upon completion of the footing excavation. Also, where the footing is located in a granular deposit and the water table is at or above the footing founding level, it will be necessary to prevent the base of the footing from "boiling" due to an unbalanced excess hydrostatic head. In this case a dewatering scheme would be required as discussed in our previous report.

Pile Foundation

This founding scheme is recommended for the abutments and piers at Bloor Street. The recommendation should give the estimated pile tip elevations. However, at this stage detailed recommendation will not be provided in the report. Generally, the end-bearing piles can be designed for the Factored Capacity at U.L.S. and the Capacity at S.L.S. Type II which is dependent on the pile section chosen. If Steel 'H' pile is used, the following design parameters are recommended for the pile foundation:

<u>Pile Type</u>	Factored Capacity at U.L.S. (kN)	Allowable Capacity at S.L.S. Type II (kN)
HP 310 X 79	1150	700
HP 310 X 110	1600	980

Pile driving would be field controlled by the Hiley Formula unless it is being driven to the bedrock surface or in clayey subsoil. Pile caps can be perched

within the embankment fill provided that particle sizes in the fill immediately beneath the pile locations does not exceed 75 mm.

Grade Revision of Highway 401 at Regional Road 23

As mentioned earlier, the schemes being studied for the major interchange at Regional Road 23 may require that the proposed new interchange be moved toward the north and the profile grade of Highway 401 be lowered by approximately 3.0 metres from existing elevation of approximately 86.0 metres to proposed elevation of about 83.0 metres.

In the vicinity of the proposed new interchange location, a piezometer was installed at BH #9-2 location in order to measure the seasonal variation of groundwater. As discussed in the section of groundwater conditions, the observations indicate that water level in piezometer has remained almost constant with an average of approximately 84.4 metres which corresponds to depths of about 1.1 metres below the existing ground surface.

However, it should be noted that the groundwater level is about 1.4 metres higher than the newly proposed profile of an elevation 83.0 metres. Some permanent dewatering scheme would be required for the proposed cuts at this location, such as gravity drainage channel.

Further monitoring of groundwater level would be required to establish the seasonal variation of water level.

Approaches

The recommendations for fill slopes, cut slopes and berm requirements, are based on the proposed preliminary grades assuming fills are constructed of acceptable earth borrow according to current MTO Specifications. Any changes in profile grade would require a reassessment of these recommendations. Also discussed under this heading is special treatment, i.e. benching, slope protection, etc... that is anticipated at this location. No excessive settlements of embankments at the proposed fill heights are anticipated at this stage.

Other Considerations

The granular 'A' or 'B' backfill should be in accordance with Special Provision No. 109F03 (dated March, 1988). The following parameters are recommended for the granular backfill:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction	$\phi = 35^\circ$	30°
Unit Weight (kN/m^3)	$\gamma = 22.8$	21.2

All foundation elements should have a minimum of 1.2 m earth cover for frost protection.

The concrete for the footings should be formed 'In The Dry'. Consequently, a dewatering scheme will be required if the concrete is poured below the prevailing water level.

MISCELLANEOUS

The various comments outlined in this report are for preliminary study purposes based on limited field data. It will be necessary to carry out a detailed subsurface investigation at each of the structure sites when the design details and geometries are finalized and approved. In some areas, groundwater studies and special in situ field testing may be warranted.

The fieldwork for this investigation was carried out during the period of 88 08 11 to 88 08 29 under the supervision of Ken Zasitko, Technician. The equipment was owned and operated by Malones Soil Samples Toronto.

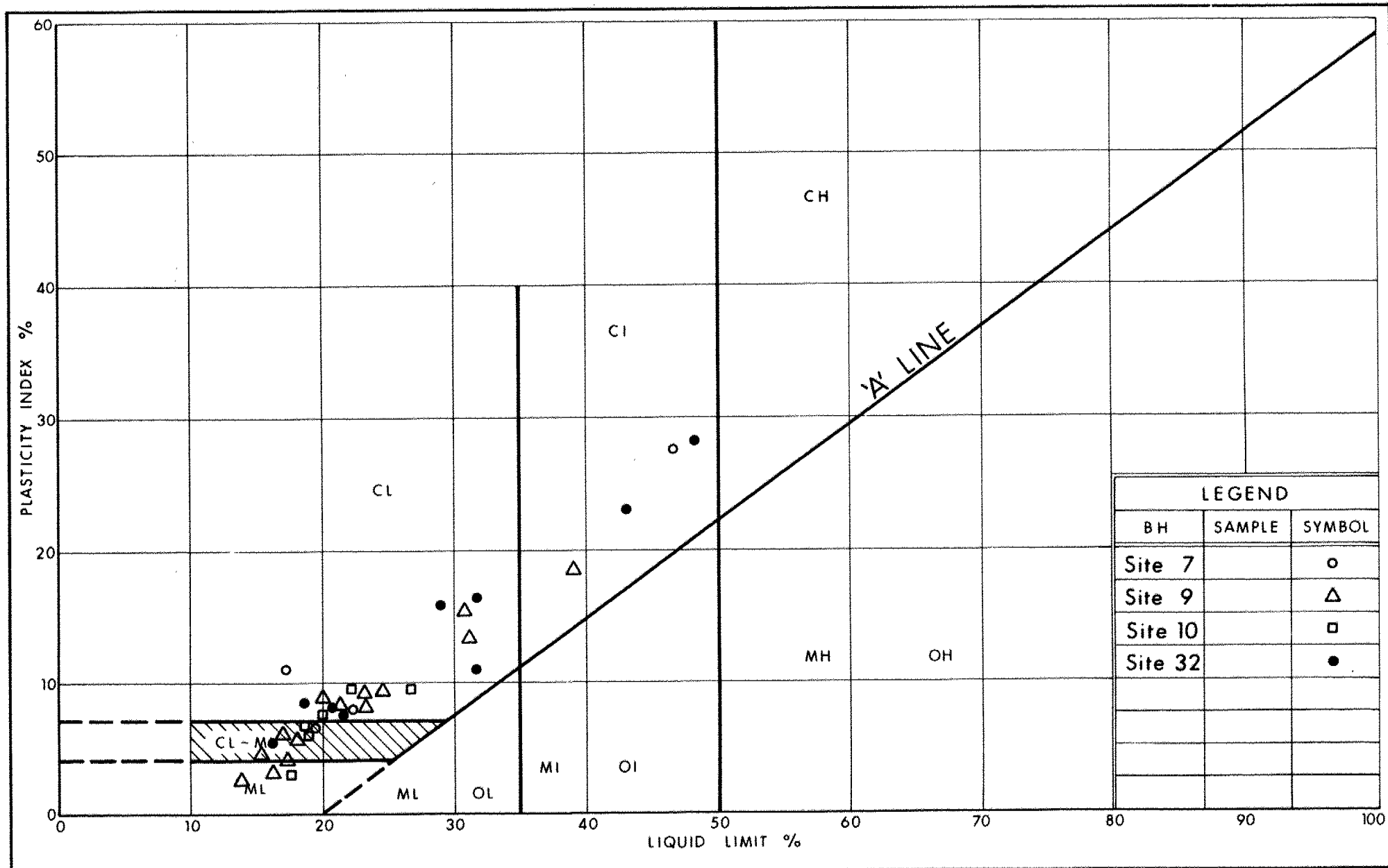
This report was written by T.C. Kim, Foundation Design Engineer and reviewed by Murty Devata, Chief Foundation Engineer.



Tae C. Kim
Tae C. Kim, P.Eng.
Foundation Design Engineer

Murty Devata
Murty Devata, P.Eng.
Chief Foundation Engineer

APPENDIX



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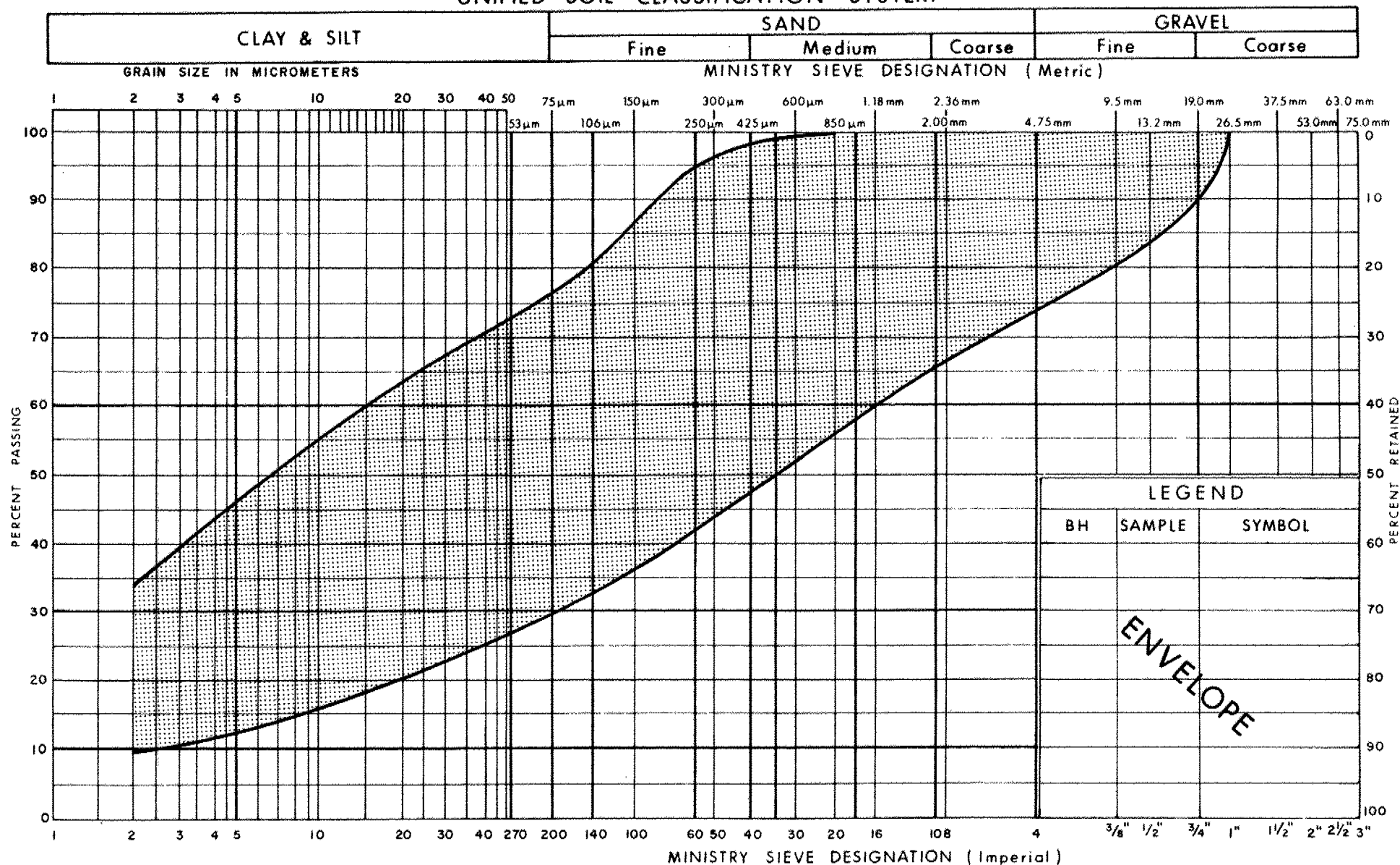
Ontario

PLASTICITY CHART COHESIVE HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 1

W P 242-86-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

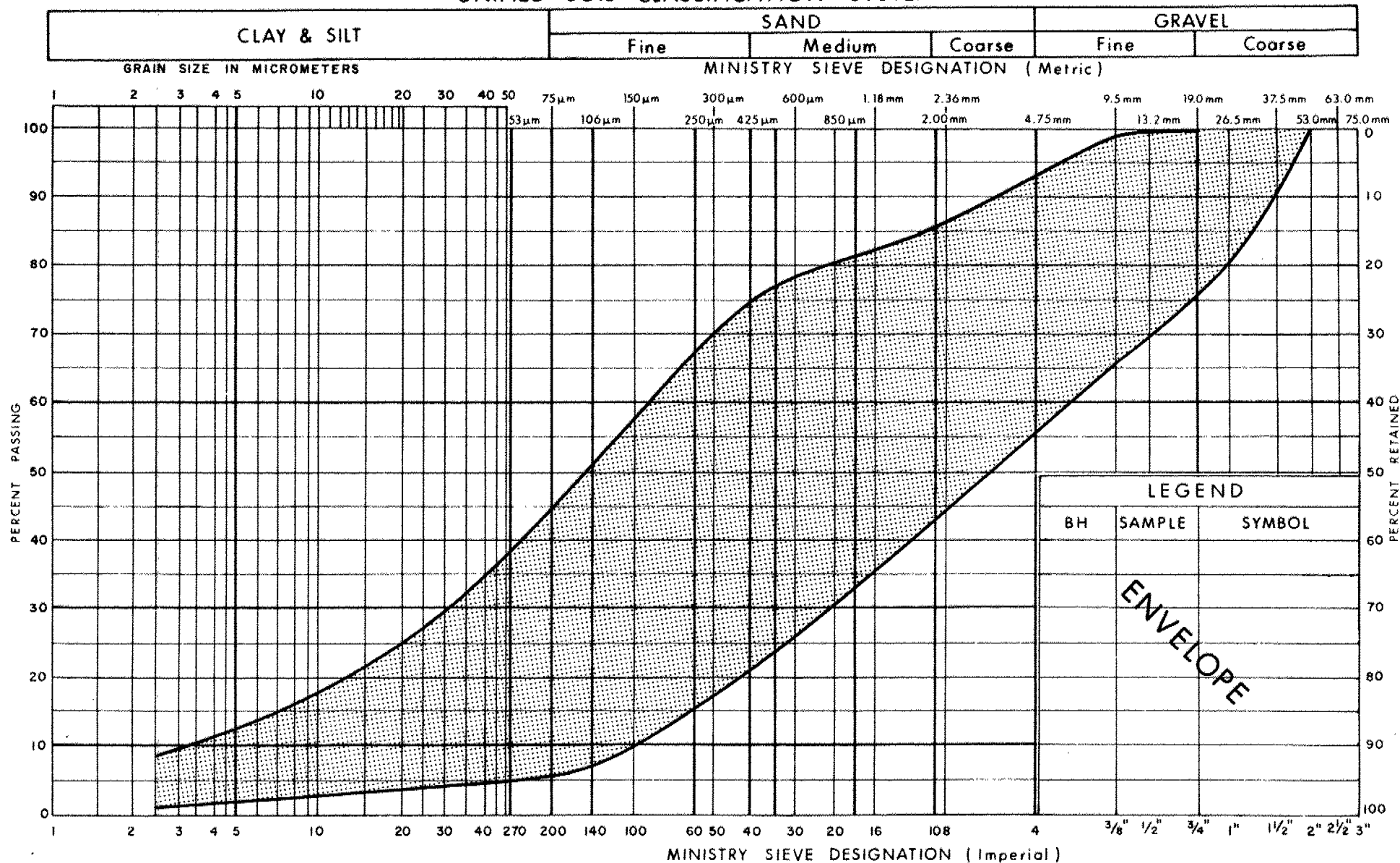
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GRAIN SIZE DISTRIBUTION
 COHESIVE HET MIXTURE OF
 CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 2

W P 242-86-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

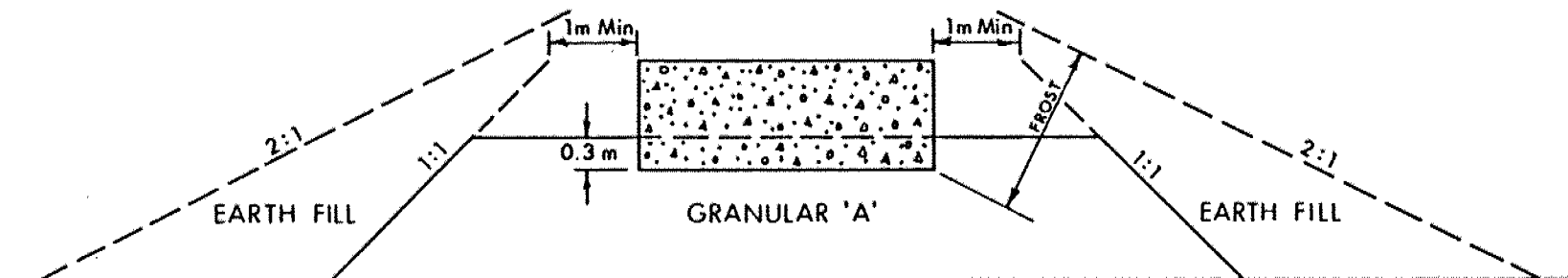
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GRAIN SIZE DISTRIBUTION

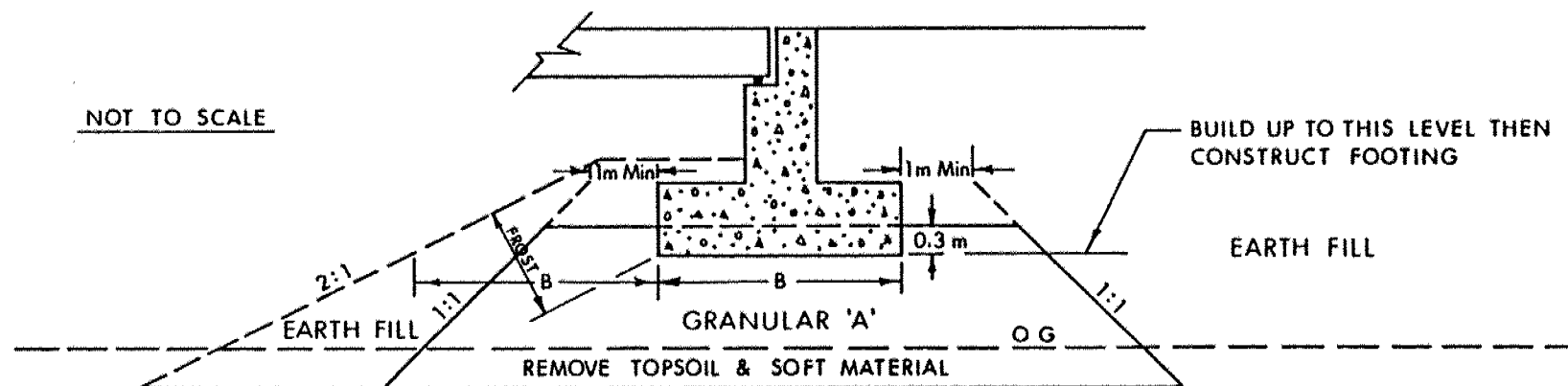
GRANULAR HET MIXTURE OF SILT, SAND & GRAVEL (Glacial Till)

FIG No 3

W P 242-86-00



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 C STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



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ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 4

W P 242-86-00

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

MECHANICAL PROPERTIES OF SOIL

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

DESCRIPTION OF ROCK CORE - WP 242-86-00

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
9-4	10.77-12.09	90	10	10.77-12.09	SHALE , dark grey to greyish black; very fine grained, thickly bedded, very thinly laminated, slightly calcareous; medium strong to weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal bedding joints, smooth to irregular, planar, closed to slightly open, clean.
10-2	10.97-12.50	100	0	10.97-12.50	SHALE , light brownish grey to medium dark grey; very fine grained, thickly bedded, very thinly laminated, slightly calcareous; medium strong to weak rock; slightly weathered; very close spaced fractures: horizontal bedding joints, smooth to irregular, planar, closed to slightly open, clean.
32-1	10.67-12.19	88	0	10.67-12.19	SHALE , light brownish grey to medium dark grey; very fine grained, thickly bedded, very thinly laminated, slightly calcareous; medium strong to weak rock; slightly weathered; very close spaced fractures: horizontal bedding joints, smooth to irregular, planar, closed to slightly open, clean.

NOTE: Depths are approximated in zones of poor core recovery.

*CR = CORE RECOVERY

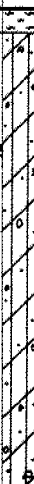
*RQD = ROCK QUALITY DESIGNATION

1../1

RECORD OF BOREHOLE No 7-1

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 857 112.0; E 344 008.9 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 25 CHECKED BY TCK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100						
95.1	Ground Level												
94.6	Topsoil				*								
0.5	Cohesive Het. Mixture of Clayey Silt - Brown Grey Sand and Gravel Occasional Sand Layers Stiff to Hard (Glacial Till)		1	SS	13								6 29 41 24
			2	SS	24								
			3	SS	61								
			4	SS	100								
			5	SS	120	25 cm							2 33 41 24
			6	SS	60	10 cm							
			7	SS	120	25 cm							
			8	SS	130	23 cm							
85.6	End of Borehole												
9.5	* Water Not Encountered During Drilling												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

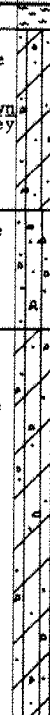
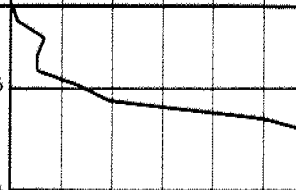
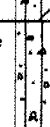
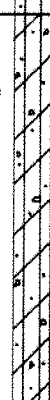
20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7-2

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 857 164.3; E 343 964.5 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers, Solid Stem Augers & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 24, 25 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W W _L	WATER CONTENT (%)				
97.6	Ground Level													
97.1	Topsoil													
0.5	Cohesive Het. Mixture of Clayey Silt Sand and Gravel <i>Brown Grey</i> Very Stiff to Hard (Glacial Till)		1	SS	20	23 cm							13 51 25 11	
			2	SS	41									
			3	SS	95									
			4	SS	91									
93.6	Granular Het. Mixture of Silt, Sand and Gravel Very Dense (Glacial Till)		5	SS	107	28 cm							6 68 18 8	
4.0			6	SS	120									
91.3	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel Occasional Silty Clay Layers Hard (Glacial Till)		7	SS	54	25 cm							0 3 20 77	
6.3			8	SS	56									
			9	SS	115									
			10	SS	120									
			11	SS	122									
			12	SS	122									
83.4	End of Borehole													
14.2														

RECORD OF BOREHOLE No 9-1

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 857 812.9; E 346 050.1 ORIGINATED BY KZ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger & Cone Test COMPILED BY KZ
DATUM Geodetic DATE 88 08 23 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W WL	WATER CONTENT (%)				
86.9	Ground Level													GR SA SI CL
0.0	Clayey Silt Some Sand (Fill)	Brown Gray	1	SS	25		86							1 24 47 28
84.8			2	SS	12									
2.1	Clayey Silt to Silt (Organic Topsoil)	3	SS	13										
		4	SS	7										
82.9														
4.0	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)	5	SS	7			82							1 29 44 26
81.3														
5.6	Granular Het. Mixture of Silt, Sand, and Gravel Compact to Very Dense (Glacial Till)	6	SS	18			80							6 51 39 4
		7	SS	76										
		8	SS	59			78							
76.8														
10.1	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel Hard (Glacial Till)	9	SS	116	23 cm	76								
74.1														
12.8	Bedrock						74							
73.1	Shale		10	SS	200	8 cm								
13.8	End of Borehole													

RECORD OF BOREHOLE No 9-2

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 858 028.4; E 346 308.7 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger and Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 26 CHECKED BY TCK

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	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
85.5	Ground Level											
0.0	Clayey Silt Trace of Sand Dk. Brown		1	SS	12							
83.4	(Organic Topsoil) Brown		2	SS	4							
2.1	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel		3	SS	13							12 35 37 16
	Stiff to Hard Brown Grey		4	SS	24							2 57 26 15
	(Glacial Till)		5	SS	95							41 42 13 4
79.4			6	SS	140							
6.1	Bedrock											
77.8	Shale		7	SS	100							
7.7	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9-3

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 857 972.0; E 346 532.5 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 23, 24 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100					
82.8	Ground Level												
0.0	Clayey Silt Some Sand (Topsoil)		1	SS	11								
81.4			2	SS	30								
1.4			3	SS	22								
	Brown Grey Cohesive Het. Mixture of Clayey Silt, Sand and Gravel		4	SS	17								
			5	SS	19								
	Very Stiff to Hard (Glacial Till)		6	SS	46								
			7	SS	20								
74.4			8	SS	100	13 cm							
74.1	Bedrock - Shale												
8.7	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9-4

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 858 248.4; E 346 257.1 ORIGINATED BY KZ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers, Rock Coring, Cone Test COMPILED BY KZ
DATUM Geodetic DATE 88 08 29 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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					
88.4	Ground Level												
0.0	Clayey Silt Some Sand (Fill)		1	SS	11		88						
87.0			2	SS	23								
1.4	Cohesive Het. Mixture of Clayey Silt Sand and Gravel Very Stiff to Hard Brown Grey (Glacial Till)		3	SS	32		86						16 31 37 16
			4	SS	29								
			5	SS	32		84						17 43 32 8
82.8	Granular Het. Mixture of Silt, Sand and Gravel Very Dense (Glacial Till)		6	SS	60	10 cm	82						13 42 38 7
81.4			7	SS	60	8 cm							12 53 27 8
7.0	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel Hard (Glacial Till)		8	SS	102	23 cm	80						
			9	SS	100	10 cm	78						
77.7	Bedrock Shale		10	RC	REC 90%								RQD = 10%
76.3													
12.1	End of Borehole												

RECORD OF BOREHOLE No 9-5

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 858 306.5; E 346 217.3 ORIGINATED BY KZ
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers and Cone Test COMPILED BY KZ
DATUM Geodetic DATE 88 08 26 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl		
89.3	Ground Level												
0.0	Clayey Silt Some Sand (Fill)		1	SS	30		88						
87.9			2	SS	40								
1.4	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel		3	SS	48								
			4	SS	20								
85.3	Very Stiff to Hard (Glacial Till)												
4.0	Granular Het. Mixture of Silt, Sand and Gravel		5	SS	23								
83.7	Compact (Glacial Till)		6	SS	145								
5.6	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel		7	SS	120								
	Hard (Glacial Till)		8	SS	106								
79.7													
9.6	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10-1

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 858 774.9; E 346 029.3 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 18, 19 CHECKED BY TCK

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				
92.6	Ground Level															
0.0	Clayey Silt, Some Sand (Fill)		1	SS	8		92									
91.2			2	SS	34											
1.4			3	SS	43											
			4	SS	72											
			5	SS	70											
			6	SS	42											
			7	SS	27											
			8	SS	61											
			9	SS	100											
80.3			10	SS	150	3 cm	82									
12.3	End of Borehole															
	Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10-2

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 858 797.0; E 345 996.4 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, Rock Coring, Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 22 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

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				
93.0	Ground Level															
0.0	Sand															
91.6	Trace Gravel (Fill)		1	SS	12		92									
1.4			2	SS	28											
			3	SS	83											
			4	SS	95											
			5	SS	57											
			6	SS	120											
			7	SS	63											
			8	SS	74											
			9	SS	100											
82.0			10	RC	REC 100%		82									
11.0	Bedrock Shale															
80.5																
12.5	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 32-2

METRIC

W P 242-86-00 LOCATION Co-ords, N 4 860 822.8; E 358 713.1 ORIGINATED BY KZ
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers & Cone Test COMPILED BY KZ
DATUM Geodetic DATE 88 08 17 CHECKED BY TCK

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L			
86.0	Ground Level													GR SA SI CL
0.0	Clayey Silt Trace Sand (Fill)		1	SS	21									
84.6			2	SS	26									
1.4	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel <u>Brown</u> Occ. Silty <u>Grey</u> Clay Layers Occ. Cobbles & Boulders		3	SS	16									0 3 63 34
			4	SS	12									54 25 14 7
	Stiff to Very Stiff (Glacial Till)		5	SS	8									
80.4			6	SS	9									16 51 24 9
5.6	Granular Het. Mixture of Silt, Sand and Gravel Loose to Dense (Glacial Till)		7	SS	35									28 40 25 7
77.4			8	SS	150	20 cm								
8.6	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel Hard (Glacial Till)		9	SS	135	15 cm								
74.7			10	SS	200	8 cm								
11.3	Bedrock Shale													
73.7														
12.3	End of Borehole													

RECORD OF BOREHOLE No 32-3

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 860 816.1; E 358 899.3 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 16, 17 CHECKED BY TCK

SOIL PROFILE		STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
82.5	Ground Level												
0.0	Clayey Silt Trace Sand (Fill)		1	SS	7								
81.1			2	SS	28								
1.4			3	SS	24								
	Cohesive Het. Mixture of Clayey Silt, Sand and Gravel		4	SS	35								
	Occ. Cobbles and Boulders		5	SS	41								
	Very Stiff to Hard (Glacial Till)		6	SS	39								
76.2			7	SS	52								
6.3			8	SS	75								
	Granular Het. Mixture of Silt, Sand and Gravel		9	SS	200								
	Occ. Cobbles and Boulders												
	Dense to Very Dense (Glacial Till)												
71.5													
11.0	End of Borehole												
	Probable Bedrock												

OFFICE REPORT ON SOIL EXPLORATION

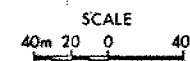
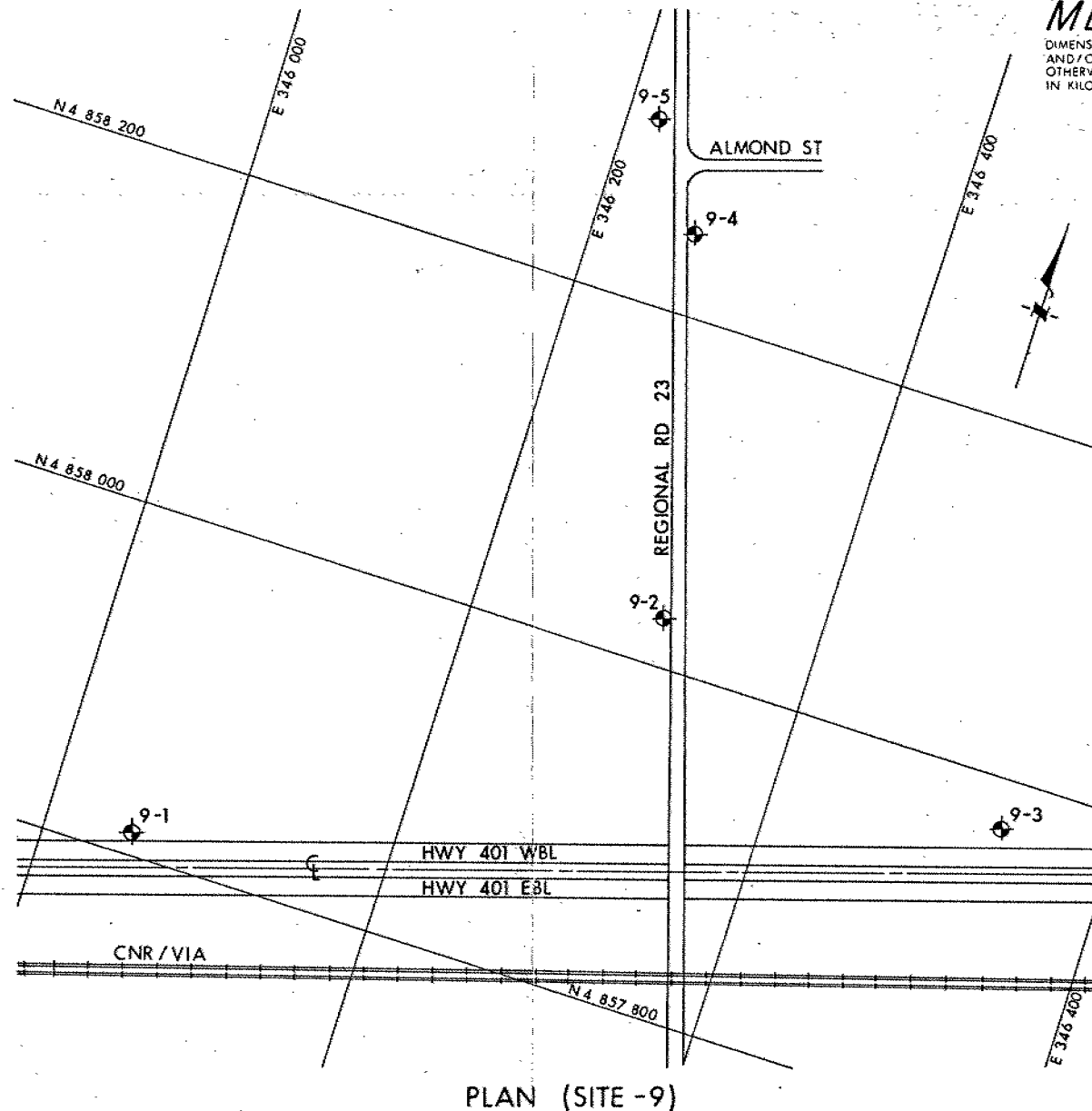
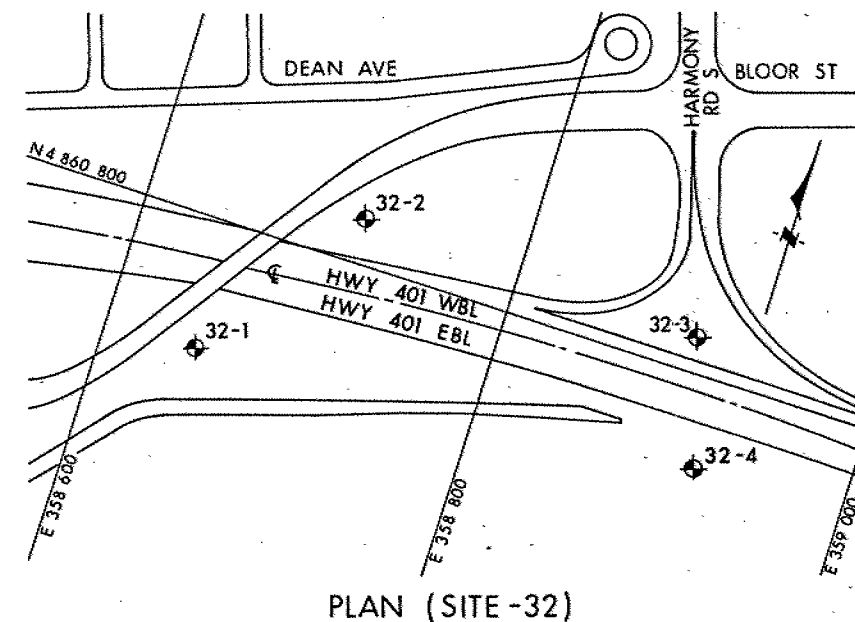
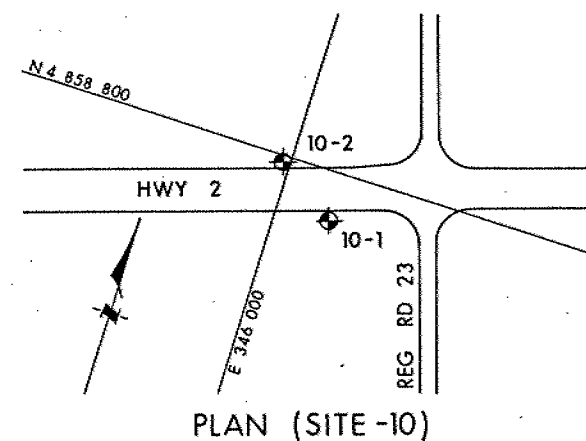
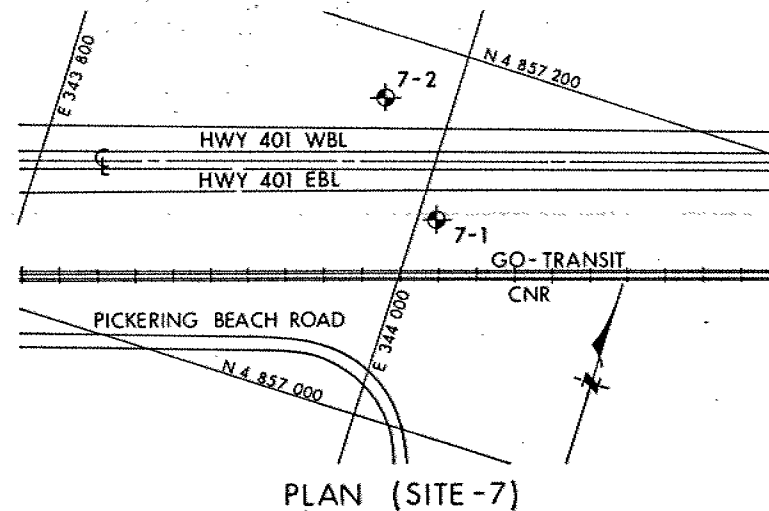
RECORD OF BOREHOLE No 32-4

METRIC

W P 242-86-00 LOCATION Co-ords. N 4 860 750.8; E 358 919.1 ORIGINATED BY KZ
 DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers & Cone Test COMPILED BY KZ
 DATUM Geodetic DATE 88 08 15 CHECKED BY TCK

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
81.7	Ground Level												
0.0	Clayey Silt Trace Sand (Topsoil)		1	SS	18								
80.3			2	SS	14								
1.4			3	SS	20								
	Brown Grey Cohesive Het. Mixture of Clayey Silt, Sand and Gravel Stiff to Hard (Glacial Till)		4	SS	42								
			5	SS	48								
76.1			6	SS	81								
5.6	Granular Het. Mixture of Silt, Sand and Gravel Compact to Very Dense (Glacial Till)		7	SS	41								
			8	SS	15								
71.1			9	SS	200	5 cm							
10.6	End of Borehole Probable Bedrock												

OFFICE REPORT ON SOIL EXPLORATION



NOTE:
For Subsurface details refer to
Record of Borehole sheets

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

CONT No
WP No 242-86-00

HWY 401 WIDENING
BROCK RD TO COURTICE RD
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

HWY 401
BROCK RD TO COURTICE RD

KEY PLAN
SCALE

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (5rd Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 88 08

No	ELEVATION	CO-ORDINATES NORTH	EAST
7-1	95.1	4 857 112.0	344 008.9
7-2	97.6	4 857 164.3	343 964.5
9-1	86.9	4 857 812.9	346 050.1
9-2	85.5	4 858 028.4	346 308.7
9-3	82.8	4 857 972.0	346 532.5
9-4	88.4	4 858 248.4	346 257.1
9-5	89.3	4 858 306.5	346 217.3
10-1	92.6	4 858 774.9	346 029.3
10-2	93.0	4 858 797.0	345 996.4
32-1	83.8	4 860 731.9	358 649.9
32-2	86.0	4 860 822.8	358 713.1
32-3	82.5	4 860 816.1	358 899.3
32-4	81.7	4 860 750.8	358 919.1

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 30M15-80

HWY No 401	DIST 6
SUBMD TCK CHECKED	DATE 89 02 13
DRAWN DT CHECKED	APPROVED
	DWG 2428600-B

<u>SECTION</u>	<u>STRUCTURE NAME</u>	<u>MTC SITE NO</u>	<u>PRELM. DES. REPORT IDENTIFICATION NO</u>	<u>PROPOSED WORK</u>
8	Robinson Creek Culvert	N/A		Extension of existing culvert
8	Creek Crossing (Just east of Courtice Rd)	N/A		Extension of existing culvert
8	Courtice Rd Overpass	21-158	8.S5	Possible widening of existing structure