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GEOCRES No. 30M16-33

DIST. 43 REGION

W.P. No. 273-96-00

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. 401

LOCATION Hwy 401 Toe Wall

STA 19+200 To 19+800

Hope Township

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

memorandum

Ontario

Telephone: (613) 545-4693
Fax: (613) 540-5106

To: **Tony Sangluliano,**
Foundation Engineer
Pavements and Foundations Section
Room 223, Central Building
1201 Wilson Avenue
Downsview, ON

Date: March 27, 2000

From: Planning and Design
Eastern Region, Kingston

Re: WP 273-96-00 Draft Foundations Report
Highway 401 Slope Modifications
Eastern/Central boundary to east of Hwy 28.

Attached is a copy of the final foundations report for the above noted project.. The undertaking was a foundation field investigation and recommendations for an approx. 500 m long concrete toe wall at the base of a 5 m to 10 m high 2H:1V earth cut slope.

Stuart H. Jones
Sr. Project Engineer
SHJ/shj

FOUNDATION REPORT
W.P. 273-96-00
HWY 401, TOE WALL
STA. 19+200 TO 19+800, HOPE TOWNSHIP
DISTRICT 43, BANCROFT

MINISTRY OF TRANSPORTATION ONTARIO

PROJECT NO. 11293

FOUNDATION REPORT

TO

MINISTRY OF TRANSPORTATION ONTARIO

ON

WP. 273-96-00
HWY 401, TOE WALL
STA. 19+200 TO 19+800, HOPE TOWNSHIP

DISTRICT 43, BANCROFT
MINISTRY OF TRANSPORTATION ONTARIO

Jacques, Whitford and Associates Limited
2781 Lancaster Road, Suite 200
Ottawa, ON K1B 1A7
Tel:(613)738-0708
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March 23, 2000

FOUNDATION INVESTIGATION REPORT

for

W.P. 273-96-00
Highway 401, Toe Wall
STA. 19+200 to 19+800, Hope Township
District 43, Bancroft

1.0 INTRODUCTION

This report presents the results of a geotechnical foundation investigation carried out for the slope modifications proposed for a site just west of the Highway 401/Highway 2 Interchange. An existing high cut slope on the south side of the East Bound Lanes (EBL), from Sta. 19+200 to Sta. 19+800, (Hope Township) is to be cut back to accommodate the proposed widening of Highway 401, from four to six lanes. The foundation investigation was carried out in general accordance with our proposal dated November 29, 1999, and the proposal revision dated December 10, 1999. Authorization to proceed was provided by Mr. Stuart Jones, P.Eng. of MTO.

This report has been prepared specifically and solely for the project described herein. It contains factual information obtained from this investigation pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The subject site is within the limits of MTO project WP 273-96-00 (Highway 401 from Wesleyville Road to Highway 2) and consists of the south side of Hwy 401 EBL from Sta 19+200 to 19+600 (Hope Township) and from 10+241 to 10+390 on the Hwy 401/Hwy 2 Ramp W-N/S. The site location is shown on the Key Plan provided in Appendix 1 (Drawing No. 11293-1).

Physiographically, the site lies within the area known as the Iroquois Plain. The soil deposits in this area were formed by a body of water known as Lake Iroquois and are characterized by lacustrine deposits of sand, silts and clays. Ontario Geological Survey Map P.2715 "Physiography of Southern Ontario" (Chapman and Putman) indicates that the subject site encompasses the boundary between a clay plain to the west and a till plain (drumlinized) to the east.

The subject site is within a roadway cut section. The cut heights vary from approximately 5 m to 10 m. The side slopes are approximately 2H:1V and are covered with vegetation. A plan view and cross sections are shown on Drawing No. 11293-1, provided in Appendix 1.

To the south of the subject site there is large subdivision constructed within a former borrow pit used during the initial construction of Highway 401. The former pit extends to depths similar to the highway grade and is separated from the highway by a strip of land approximately 35 m wide at the base which was not mined.

Drainage in the immediate area is currently provided by highway ditches and associated culverts.

3.0 PROCEDURE

3.1 Field Investigation

The site soil conditions were investigated through a borehole drilling investigation and laboratory testing program. The drilling was carried out using a track-mounted CME-55 drill rig on January 11, 12 and 13, 2000.

A total of twelve (12) boreholes, designated as 00-1 through 00-12, were put down during the field investigation. Boreholes 00-1 through 00-9 were put down in the ditch and along the shoulder rounding on the south side of the EBL in the area of the proposed work. Boreholes 00-10, 00-11 and 00-12 were located at the top of the slope, about 20 m from the existing asphalt edge.

The boreholes within the ditch, or base of slope, were advanced to a minimum depth of 6.7 m using hollow-stem augers. The boreholes drilled at the top of the slope were advanced through the full height of the slope. The subsurface conditions were identified in the field by our personnel while carrying out Standard Penetration Tests (SPT) (ASTM D1586) at regular intervals (760 mm at shallow depth and 1520 mm beyond a depth of 3 m) and the recovered soil samples were stored in moisture proof containers and returned to our laboratory. The subsurface conditions are described in detail in the Borehole Records presented in Appendix 2.

Standpipes were installed in seven of the boreholes.

Prior to completing the investigation, the boreholes were backfilled by replacing (and tamping in layers) the augered material.

3.2 Survey

Borehole locations were established in the field by Jacques Whitford personnel relative to the existing catch basin system. The ground surface elevations at the borehole locations were surveyed relative to the top of grate CB #100 located at Sta. 19+479.15 which has an elevation of 139.30 Geodetic (D.M. Wills Associates Limited).

3.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual classification by a geotechnical engineer. Routine testing, consisting of moisture content testing, Atterberg limit determination, and grain size distribution analysis was carried out on at least 25% of the collected samples. One representative soil sample was submitted for pH, sulphate and resistivity testing to assess the potential for corrosion of buried steel and the potential for sulphate attack on buried concrete. All soil samples will be stored for a period of one year after issuance of the final report. Unless otherwise directed, the stored samples will be disposed of after this period.

No complex testing was deemed to be necessary based on the soil conditions and nature of the proposed structure.

4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Profile

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in Appendix 2. An explanation of the symbols and terms used to describe the Borehole Records is also provided. In general, the overburden consists of a layer of granular shoulder fill over an intermittent layer of sand over glacial till.

A borehole location plan and stratagraphic sections of the soils encountered within the boreholes are provided on Drawing 11293-1.

4.1.1 Fill: Sand, trace to some silt, trace to some gravel

Granular fill was encountered at all boreholes drilled at the base of the slope which consisted of sand, trace to some silt, trace to some gravel. The fill was observed to extend to a depth of approximately 0.8 m. The moisture content of the one sample of fill tested was 6 %. SPT N-values ranged from 10 to 21, indicating a generally compact deposit.

4.1.2 Sand

A layer of sand was observed at Borehole 00-12 beneath a thin layer of topsoil and beneath the fill in Boreholes 00-1, 00-2, 00-3 and 00-9. The sand extended to a depth of as much as 4.6 m below ground surface. The sand contained trace amounts of silt and was light brown in colour. Field observations indicated that the sand was compact to dense with SPT N-values ranging from 10 to over 100. The moisture content of the five samples tested ranged from 7% to 17%. Grain size testing on six samples indicated 0% to 6% gravel, 52% to 93% sand, and 7% to 42% silt and clay sized particles. Grain size distribution curves are provided in Appendix 2.

4.1.3 Glacial Till: sand & silt, trace to some gravel, occasional cobbles & boulders

Glacial till was observed beneath a thin layer of topsoil in Boreholes 00-11 and 00-12 and beneath the above described soils, in all other boreholes. The glacial till varied from silt trace sand, trace gravel to sand and silt, some gravel. Occasional cobbles and boulders are inferred to be present in this deposit. Occasional sand or silt seams were observed within the fill. SPT N-values ranged from 18 to over 100, indicating a compact to very dense deposit. The moisture content of twenty-two samples tested ranged from 1.6 % to 18 % with an average of 7 %. Grain size analyses carried out on eleven samples of the glacial till indicated that it contained between 3% and 32% gravel, 32% and 65% sand, and 6% to 61% silt and clay sized particles. Grain size distribution curves are provided in Appendix 2. All of the boreholes terminated within the glacial till. Bedrock was not encountered.

4.2 Groundwater

Groundwater levels were measured within the standpipes at the end of the drilling investigation. The observed water levels are summarized in the table below. In addition, it is noted that running sands were encountered in Borehole 00-1 at a depth of approximately 2 m.

Location	Ground Surface Elevation (m)	Depth to Groundwater (m)	Groundwater Elevation (m)
BH 00-1	132.1	2.1	130
BH 00-2	134.1	1.3	132.8
BH 00-3	135.6	1.9	133.7
BH 00-8	141.3	6	135.1
BH 00-10	144.6	9	135.5
BH 00-11	145.4	6.5	138.8

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

The depth to groundwater as shown in the table above is influenced by the sloping topography, both the general grade along the ditch alignment (which varies by 10 m over the length of the proposed toe wall alignment) and by the offset distance within the cut section (i.e. whether the boreholes were drilled at the toe or crest of the slope).

Within boreholes drilled at the base of the slope, groundwater levels were observed to vary between approximately 1.3 m to 6 m below ground surface at the time of the investigation (elev. 130.0 to 135.1 m). Within the boreholes drilled at the top of the slope, Boreholes 00-10 to 00-12, groundwater levels were observed at depths ranging from 6.6 m to 9.4 m below ground surface (elev. 135.5 to 138.8 m).

5.0 CLOSURE

A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Yours very truly,

JACQUES, WHITFORD AND ASSOCIATES LIMITED

Fred J. Griffiths, Ph.D., P.Eng.
Designated Principal MTO Foundation Contact

J.G.A. Raymond Haché, M.Sc., P.Eng.
Designated Principal MTO Foundation Contact
Manager, Geotechnical Services

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Proposed Development

It is understood that the Ministry of Transportation of Ontario (MTO) plans to re-align the W-N/S Ramp and associated speed change lane at the Highway 401/Highway 2 Interchange. This work is a component of WP 273-96-00, which involves the widening of Hwy 401 from four to six lanes, from Wesleyville Road to Highway 2. In order to minimize earth cut volumes and avoid moving a fibre optic cable located at the top of the existing cut, the designers have proposed to construct a toe wall along the base of the existing cut slope.

Design Considerations:

Based on the design drawings, the limits of the proposed toe wall alignment are as follows:

Hwy 401:	19+200 to 19+600 Hope Township
Ramp W-N/S:	10+241 to 10+390

The geometry of the wall at selected stations, as identified on the design drawings prepared by D.M. Wills Associates Limited, is summarized in the table below:

Station		Offset from C.L.	Pavement Elevation (m)	Wall Height (m)
Hwy 401	19+200	17.75 RT	133.42	0.66
	19+250	17.95 RT	134.13	0.71
	19+300	19.64 RT	135.59	0.87
	19+350	20.75 RT	137	0.83
	19+400	21.05 RT	138.27	0.83
	19+450	22.19 RT	139.39	0.83
	19+500	23.99 RT	140.41	0.82
	19+550	26.22 RT	141.19	1.5
Hwy 401 19+600 = Ramp 10+241		2.50 RT	141.9	1.5
Ramp	10+250	2.50 RT	141.98	1.25
	10+300	2.50 RT	142.43	0.51
	10+350	2.50 RT	142.89	0.53
	10+390	2.50 RT	143.15	0.52

Based on the design drawings and cross sections, the existing and proposed backslopes are typically 2H:1V or flatter and the slope heights are as high as 9.5 m from the ditch invert to top of slope.

The project designer's preliminary plans for this project indicated that a concrete retaining wall was to be constructed at this site. Due to the short height of the proposed wall (generally less than 1.0 m throughout with a 100 m long section reaching 1.5 m maximum), a toe wall as per the Modified OPSD 4066.01 was selected as being most cost effective by the project designer. Therefore, a retained soil system (RSS) was not considered further and is not discussed within this report.

6.2 Geotechnical Assessment

The existing cut was subject to earlier preliminary examination as detailed in Jacques Whitford Pavement Design Report 11066 dated September 28, 1998. The slope was assessed to have only marginal stability, however the analysis was conservative owing to the paucity of soils information available at that time.

Based on the drilling investigation carried out in January 2000 the following soil parameters are appropriate for this site and have been utilized in the global stability analyses and determination of geotechnical design parameters presented within this report:

Parameter\Soil Type	Sand	Glacial Till
Unit Weight	19.5 kN/m^3	21 kN/m^3
Angle of Internal Friction	32 °	34 °

The groundwater level has a significant impact on slope stability. Based on our laboratory measurements of water content as well as the ground water levels measured in the standpipes installed at the site, it can be concluded that the groundwater level is near the Highway 401 ditch line within the western 150 m of the wall alignment.

The design of a retaining wall must satisfy four basic criteria:

1. Bearing Resistance
2. Sliding Resistance
3. Overturning Resistance
4. Global Stability

The geotechnical design parameters required by the designer in order to verify that the proposed toe wall has sufficient resistance for criteria 1 through 3, and the results of a global stability analysis are presented in the sections below.

6.3 Foundation Recommendations - Bearing Resistance

The proposed toe wall is to be adjacent to Highway 401 and is to extend from Hwy 401 Station 19+200 to 19+600 (Hope Township), and from Hwy 2 Ramp W-N/S Station 10+241 to 10+390. The total length of the toe wall proposed is 559 m. The proposed toe wall founding elevations varies along the wall profile generally as follows:

Station		Approximate Founding Elevation (Geodetic)
Hwy 401	19+200	132.0 m
	19+300	134.2 m
	19+400	136.9 m
	19+500	139.0 m
	19+600	140.5 m
Ramp W-N/S	10+250	140.6 m
	10+300	141.0 m
	10+390	141.8 m

Based on the proposed cross-section, which includes a 2.5 m wide fully paved shoulder abutting the toe wall, excavation for the toe wall will generally extend into the native till material, beyond the existing ditch.

The following design parameters may be used for spread footings founded on the native sand and/or till or on structural fill overlying the native sand and/or till:

Footing Width	Bearing Resistance	
	ULS	SLS
0.9 m	300 kPa	275 kPa
1.2 m	350 kPa	275 kPa
1.6 m	400 kPa	275 kPa

The effects of inclined loads should be accounted for in accordance with Section 6-8.4.2 of the OHBDC 3rd Edition.

The base of the toe wall should be protected from frost action by a minimum soil cover of 1.4 m. Alternatively, the toe wall could be founded on a well-drained granular pad extending down to at least 1.4 m below finished grades. The granular pad should be drained by installing a subdrain at the base of the granular layer and directing the water to a frost free outlet. Should the alternative option be selected, it is recommended that the base of the toe wall be at least 750 mm below finished grades.

6.4 Sliding Resistance and Overturning Resistance

Earth pressures exerted against the toe wall need to be calculated in order to calculate sliding resistance and overturning resistance. Computation of earth pressures should be in accordance with Section 6-7 of the OHBDC 3rd Edition.

The following unfactored soil parameters may be used for the determination of lateral earth pressures exerted against concrete toe walls constructed at this site in accordance with the Modified OPSD 4066.01:

Parameter	OPSS Granular A	Sand	Glacial Till
Bulk Unit Weight, γ (kN/m^3)	22.5	19.5	21
Effective Friction Angle, ϕ	35°	32°	34°
Active Earth Pressure Coefficient, K_a, for a 2H:1V backslope	0.4	0.48	0.43

The resultant force calculated from the active earth pressure coefficient provided in the table above acts horizontally and intersects the wall at a point equal to one third of the height of the wall from the base of the wall on a vertical plane up from the heel of the wall. The earth pressure should have a triangular distribution with the apex at the ground surface above the heel of the wall.

The properties of the sand or glacial till should be used to determine the lateral earth pressure unless the interface between the granular backfill and the sand or glacial till is flatter than 45 degrees, in which case the properties of the granular backfill may be used.

The effects of compaction should be accounted for by applying a compaction surcharge as shown in Figure 6-7.4.3 of the OHBDC 3rd Edition.

Drainage should be provide behind the proposed toe wall to prevent hydrostatic pressure build-up. Drainage should be provided by installing a 100 mm diameter subdrain wrapped in geotextile. The subdrain should be installed as per OPSD 3504.00 and should provide positive drainage to a frost-free outlet. In addition, weep holes through the wall should be provided at regularly spaced intervals.

Sliding resistance between the concrete and the native soils or structural fill should be calculated in accordance with Section 6-8.4.3 of the OHBDC 3rd Edition using an unfactored friction coefficient of 0.58.

6.5 Global Stability

The cross section at 19+300 represents the greatest height of slope while the cross section at Station 19+550 represents the greatest wall height. These cross-sections have therefore been judged to represent the worst cases for this site.

The stability of the highway cut slope and toe wall at these locations were analyzed utilizing a computer analysis program called G SLOPE, produced by Mitre Software Corporation. The program uses the Bishop's Modified Method of analysis. Potential slope failure surfaces were considered, together with the soil parameters listed in Section 6.2 above. An embankment sideslope above the toe wall of 2H:1V was utilized in the analysis.

The analyses yielded safety factors above 1.3 which is considered an appropriate minimum factor of safety for static loading in the finished condition. Seismic loading conditions were modeled with a peak horizontal ground acceleration of 0.08 g which is equivalent to a probability of exceedance of 10% in 50 years. The seismic analysis yielded safety factors above 1.1 which is also considered appropriate for a roadway cut slope.

The stability of the cut slope was also examined for the construction period. The worst case will occur when the excavation for the toe wall and granular backfill has been completed but not yet backfilled. Based on the design cross-sections, this case has been modeled using a 1.5H to 1V temporary construction slope extending to a depth of 1.4 m below the finished grade. The analysis yielded safety factors above 1.2 which is considered appropriate for a temporary roadway cut slope, however, restrictions for the construction of the toe wall in order to minimize the duration and hence the risk at this critical stage are provided in Section 6.6.

Graphical representations of the G SLOPE computer output which show slope height, geometry, retaining structure, subsurface and groundwater conditions, and soil parameters are presented in Appendix 3 for cross-sections at Stations 19+300 and 19+550.

6.6 General Construction Recommendations

Site Grading and Preparation

Site preparation should be carried out in accordance with the requirements of *SP 902S01 Excavation and Backfilling - Structures.*

All organic soils, and other deleterious materials must be removed from beneath the proposed toe wall foundations. Where deleterious materials are encountered, the material should be excavated, wasted and replaced with structural fill. The lateral extent of such excavation should include all deleterious material within an imaginary line drawn at an angle of 1 horizontal to 1 vertical, downward and away from the vertical edges of the base of the wall, to the competent native soil.

Stripping of deleterious materials should be inspected by geotechnical personnel to ensure that all unsuitable materials are removed prior to placement of structural fill. Structural fill should consist of OPSS Granular A or Granular B, Type I or II, placed in lifts no greater than 300 mm thick and compacted to at least 98 % standard Proctor maximum dry density.

Excavation and Backfill

All excavation and backfilling should be carried out in accordance with the requirements of *SP 902S01 Excavation and Backfilling - Structures.*

It should be noted that some difficulty may be encountered during excavation due to the soil density and the presence of cobbles and boulders in the glacial till.

Side slopes for open cut excavations should conform to Occupational Health and Safety Act and Regulations for Construction Projects. The soils to be excavated for the proposed toe wall should be considered as a Type 2 to 3 soil. In general, temporary excavations within a Type 3 soil should be made with slopes no steeper than one horizontal to one vertical from the base of the excavation, however, given the height of the slope and the results of the stability analyses, it is recommended that the excavation slopes should be no steeper than 1.5H:1V from the base of the excavation.

In order to minimize the risk of slope instabilities during construction, the width of excavation carried out at the toe of the slope at any one time should be restricted to no greater than 6 m. In addition, the duration excavations are left open should be limited to one week.

It is noted that there may be insufficient room at some locations to achieve the recommended excavation backslope. In those locations, it is anticipated that the contractor will need to utilize temporary shoring during construction of the toe wall. The soil parameters provided in Section 6.4 as well as the table below may be used for shoring design. It is the contractor's responsibility to select an earth pressure envelope appropriate to the shoring system selected.

Parameter	OPSS Granular A	Sand	Glacial Till
Passive Earth Pressure Coefficient, K_p, for a horizontal foreslope	3.7	3.3	3.5

A depth of frost treatment, *f*, of 1.4 m should be used at this site.

Dewatering and Protection of Founding Level

Permanent drainage should be provide behind the proposed toe wall to prevent hydrostatic pressure build-up. Drainage should be provided by installing a 100 mm diameter subdrain wrapped in geotextile. The subdrain should be installed as per OPSD 3504.00 and should provide positive drainage to a frost-free outlet. In addition, weep holes through the wall should be provided at regularly spaced intervals.

The proposed founding elevations for the toe wall are below the ditch level. Dewatering will likely be required during construction. Throughout the eastern portion of the toe wall alignment, sump pumps will likely be sufficient, however, within the western portion of the alignment where excavations are expected to extend below the groundwater table within a sand deposit, excavations may require dewatering from outside the excavation in order to maintain basal stability. The native soils are susceptible to disturbance due to basal instability - running sands were encountered in Borehole 00-1. The tender documents should include a NSSP to alert the Contractor to these facts and to the fact that foundations must be constructed in the dry.

A layer of free draining granular material such as clean crushed stone should be placed immediately beneath the toe wall for levelling and support purposes. This will also serve to protect the base from disturbance and softening prior to toe wall construction.

Erosion Protection & Sediment Control

The contractor should provide silt fences and erosion control blankets, as required, throughout the duration of the construction to prevent silt/sediments from running off the site. The sand soils are considered moderately erodible. Vegetation should be re-established on the cut slopes as quickly as possible in order to avoid erosion.

Cement Type and Corrosion Protection

Two representative soil samples were submitted to Accutest Laboratories in Nepean, Ontario for analysis of pH, resistivity and water soluble sulphate, in order to determine cement type and reinforcing steel protection requirements. The results are presented in the table below.

Location	Borehole	Sample	pH	Resistivity	Soluble Sulphate
19+400	0	SS-3	8.6	24 ohm·m	24
19+500	0	SS-3	8.5	41 ohm·m	54 µg/g

The soluble sulphate results indicate that a Type 10 Portland cement would be suitable for use in concrete mixtures at this site. The pH and resistivity results should be considered by the structural designer when designing corrosion protection systems.

7.0 CLOSURE

The recommendations made in this report are in accordance with our present understanding of the project. We request that we be permitted to review our recommendations when the drawings and specifications are complete.

A soil investigation is a limited sampling of a site. The conclusions given herein are based on information gathered at the specific borehole locations. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information and its effects on the above conclusions.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Yours very truly,

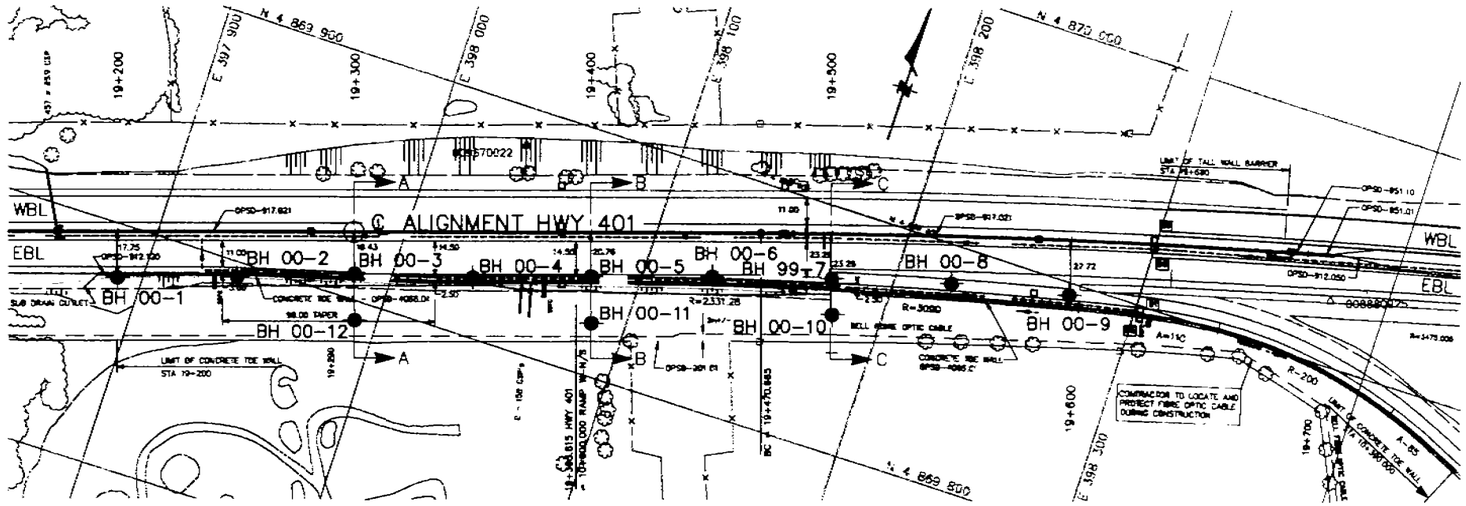
JACQUES, WHITFORD AND ASSOCIATES LIMITED

Fred Griffiths, Ph.D., P.Eng.
Designated Principal MTO Foundation Contact

J.G.A. Raymond Haché, M.Sc., P.Eng.
Designated Principal MTO Foundation Contact
Manager, Geotechnical Services

P:\2000\10000\11293\Report\Final Report.wpd

APPENDIX 1



PLAN

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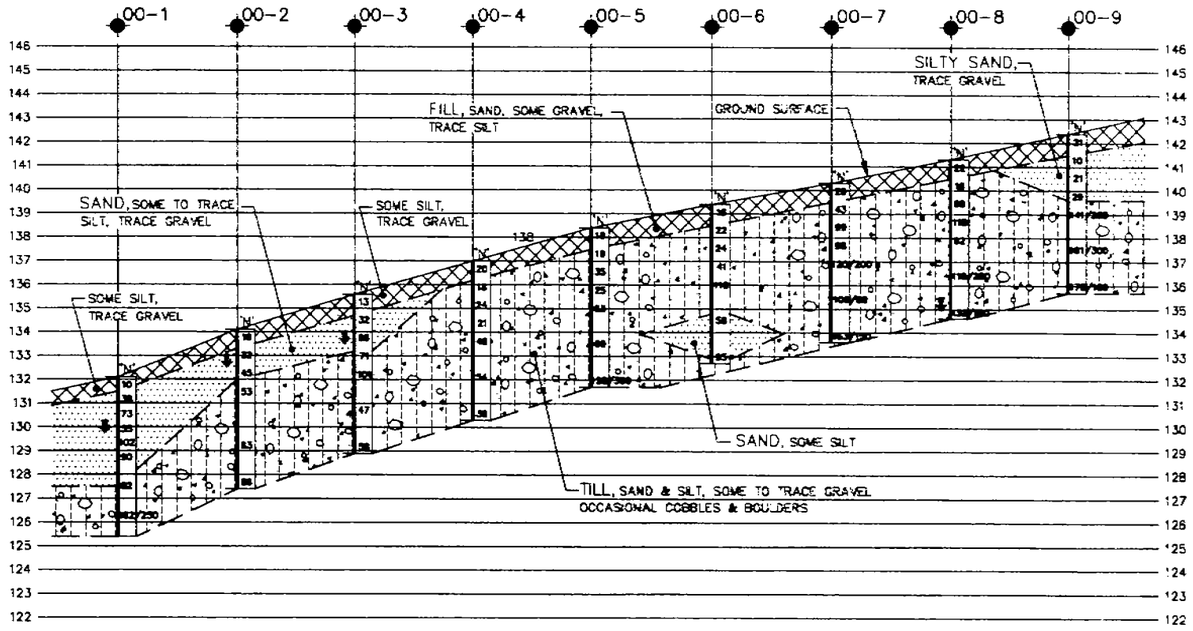
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PROFILE ALONG ℄ ALIGNMENT HWY 401

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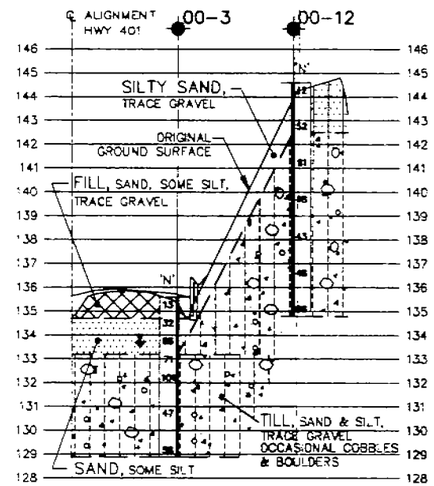

SECTION A–A

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SECTION B–B

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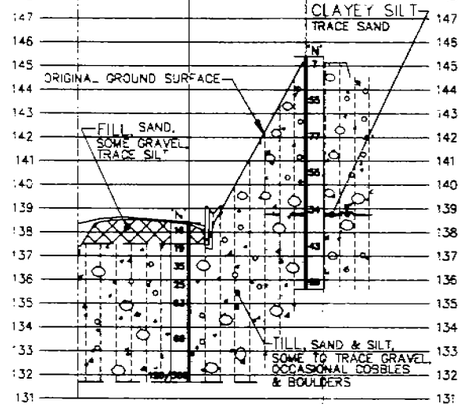
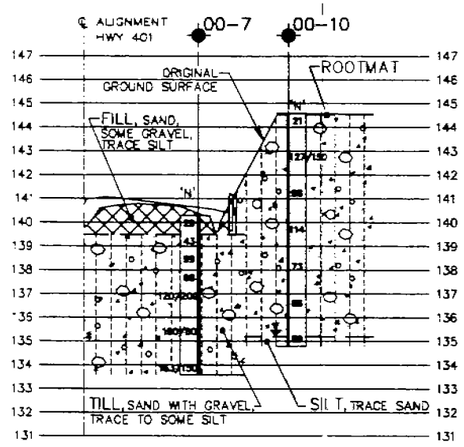




SECTION C–C

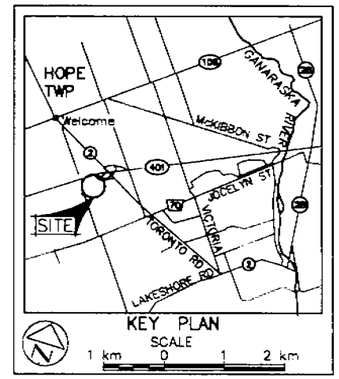
SCALE 10 0 10 HOR, 2.5 0 2.5 VERT

PLATE No –
DRAWING No 11293-1
CONT No
WP No 273-96-00

HWY 401
STA 19+200 TO STA 19+600
Survey – Revised –
BORE HOLE LOCATIONS

SHEET 1

JACQUES, WHITFORD AND ASSOCIATES LIMITED



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 00 01
- WL in Piezometer
- Piezometer

No	ELEVATION	COORDINATES NORTH	EAST
00-1	132.1	4 869 778.3	397 890.0
00-2	134.1	4 869 793.8	397 937.6
00-3	135.6	4 869 810.6	397 984.7
00-4	137.0	4 869 824.7	398 032.7
00-5	138.4	4 869 840.5	398 080.1
00-6	139.4	4 869 855.9	398 127.7
00-7	140.3	4 869 870.6	398 175.5
00-8	141.3	4 869 888.0	398 223.2
00-9	142.4	4 869 894.9	398 271.7
00-10	144.6	4 869 856.2	398 180.1
00-11	145.4	4 869 821.8	398 086.1
00-12	144.6	4 869 792.0	397 990.7

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

HWY No 401			DIST 43
SUBMTD FG	CHECKED	DATE 2000-03-23	SITE
DRAWN GSB	CHECKED	APPROVED	DWG 11293-1

11293-1

APPENDIX 2

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	>75 mm
Seam	-	2 mm to 75 mm
Parting	-	< 2 mm
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	*Very Thick*	*Very Wide*
600-2000	*Thick*	*Wide*
200-600	*Medium*	*Moderate*
60-200	*Thin*	*Close*
20-60	*Very Thin*	*Very Close*
<20	*Laminated*	*Extremely Close*
<6	*Thinly Laminated*	

Strength Classification	Uniaxial Compressive Strength (MPa)
Very Low	1-25
Low	25-50
Medium	50-100
High	100-200
Very High	>200

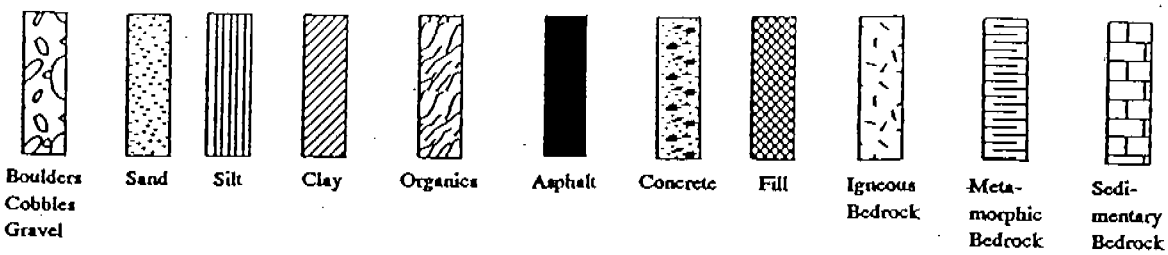
Terminology describing weathering:

Slight - Weathering limited to the surface of major discontinuities. Typically iron stained.

Moderate	-	Weathering extends throughout rock mass. Rock is not friable.
High	-	Weathering extends throughout rock mass. Rock is friable.

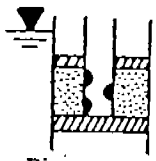
STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT

Borehole or Standpipe



Piezometer

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits.

N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

OTHER TESTS

S	Sieve analysis
G_s	Specific gravity of soil particles
k	Permeability (cm/sec)
⊤ ↓	Single packer permeability test; test interval from depth shown to bottom of borehole
⊤ ⊥	Double packer permeability test; test interval as indicated
○ ↓	Falling head permeability test using casing
▽ ↓	Falling head permeability test using well point or piezometer
H	Hydrometer analysis
γ	Unit weight
C	Consolidation
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct shear
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$; the index corrected to a reference diameter of 50 mm)

RECORD OF BOREHOLE No BH 00-1 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+200, 19.2 RT Ditch ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 11.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
132.1							132				
0.0 / 131.5	Light brown to brown sand, some silt, trace gravel: FILL		1	SS	10						
0.6	Light brown SAND, some silt, trace gravel		2	SS	38		131				
	- moist		3	SS	73				○		
			4	SS	55	▽	130				0 93 7
	- running sand		5	SS	102						
129.0							129				
3.1	Grey SAND, some silt		6	SS	90				○		0 90 10
127.4			7	SS	82		128				
4.6	Grey silt, trace sand, trace gravel: TILL						127				
	- occasional cobbles and boulders		8	SS	162/250		126				
125.4											
6.7	End of Borehole										
	- standpipe installed										

3 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-2 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+250 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 11.01.00 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
134.1											
0.0 / 133.4	Brown sand, some gravel, trace silt: FILL		1	SS	16		134				
0.8 / 132.0	Light brown SAND, trace gravel, trace silt		2	SS	32	▽	133		○		
			3	SS	45		132				1 88 11
2.1 / 127.4	Brownish grey to grey sandy silt, trace gravel: TILL - occasional cobbles and boulders		4	SS	53		131		○		7 32 61
			5	SS	63		130				3 49 48
			6	SS	86		129				
6.7	End of Borehole						128		○		

3 ✓3. Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

MTO 11293.GPJ ON_MOT.GDT 21/03/00

RECORD OF BOREHOLE No BH 00-3 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+300, 17.5 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
135.6											
0.0	Brown sand, some silt, trace gravel: FILL		1	SS	13		135		○		
134.7											
0.9	Light brown SAND, some silt		2	SS	32						
			3	SS	66	▽	134		○		1 81 18 -
133.1	- moist										
2.4	Grey sand and silt, trace gravel: TILL		4	SS	71		133				
	- occasional cobbles and boulders		5	SS	101		132		○		
	- sand seams		6	SS	47		131		○		8 50 42 -
							130				
126.9			7	SS	58		129		○		
6.7	End of Borehole										
	- standpipe installed										

3 / 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-4 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+350, 18.6 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
137.0											
0.0 / 136.2	Brown sand, some gravel, trace silt: FILL		1	SS	20						
0.8 / 135.5	Brown sand, brownish grey sandy silt: TILL		2	SS	18		136				
1.5	Grey sandy silt, trace gravel: TILL		3	SS	24		135				
			4	SS	21		134		○		6 48 46
			5	SS	48		133				
	- occasional cobbles and boulders		6	SS	54		132				
130.3			7	SS	39		131				
6.7	End of Borehole										

3 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-5 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+400, 18.3 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
138.4											
0.0	Brown sand, some gravel, trace silt: FILL		1	SS	16		138				
137.5											
0.9	Grey sand and silt, some gravel: TILL		2	SS	19		137				
			3	SS	35						
			4	SS	25		136		○		8 49 43
			5	SS	63		135				
							134				
			6	SS	69				○		9 49 42
							133				
131.7	- occasional cobbles and boulders		7	SS	126/ 300		132				
6.7	End of Borehole - standpipe installed										

MTO 11293.GPJ ON_MOT.GDT 21/03/00

3 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-6 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+450, 18.3 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
139.4											
0.0	Brown sand, some gravel, trace silt: FILL		1	SS	16		139				
138.6											
0.9	Brownish grey silty sand, trace gravel: TILL		2	SS	22		138				
			3	SS	24				○		8 50 42
			4	SS	41		137				
			5	SS	110		136		○		
134.8											
4.6	Fine, brown SAND, some silt		6	SS	56		135		○		
132.9							134				
6.5	Grey sandy silt some gravel: TILL		7	SS	95		133				
132.7											
6.7	End of Borehole										

MTO 11293.GPJ ON_MOT.GDT 21/03/00

3 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-7 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+500, 19.0 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH 140.3	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
0.0 / 139.6	Brown sand, some gravel, trace silt: FILL		1	SS	20		140				
0.8	Grey sandy silt, trace gravel: TILL		2	SS	43		139				
			3	SS	99						
	- occasional cobbles and boulders		4	SS	98		138				
	- sand layer		5	SS	120/ 200		137				
			6	SS	100/ 80		136				
							135				
133.6			7	SS	163/ 150		134				
6.7	End of Borehole - standpipe installed										

MTO_11293.GPJ_ON_MOT.GDT 21/03/00

Numbers refer to Sensitivity

STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-8 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+550, 20.0N RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 10 20 30				GR SA SI CL
141.3													
0.0	Brown sand, some gravel, trace silt: FILL		1	SS	22		141						
140.6													
0.8	Light brown fine sandy silt, trace gravel: TILL		2	SS	16		140						
			3	SS	60								11 50 39
			4	SS	118		139						
	- sand seam		5	SS	92		138						
							137						
	- occasional cobbles and boulders		6	SS	119/ 280								
						▽	136						
134.6	- moist to wet		7	SS	132/ 180		135						
6.7	End of Borehole												

MTO 11293.GPJ ON_MOT.GDT 21/03/00

3, c 3 Numbers refer to Sensitivity 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-9 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+600, 23.1 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 12.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
142.4											
0.0	Brown sand, some gravel, trace silt: FILL		1	SS	21		142				
141.5											
0.9	Brown SILTY SAND, trace gravel		2	SS	10						
			3	SS	21		141		○		3 60 37
139.6			4	SS	29		140				
2.8	Brown, fine sandy silt, trace gravel: TILL - occasional cobbles and boulders		5	SS	141/ 280		139				
			6	SS	161/ 300		138				
							137				
			7	SS	170/ 180		136				
135.7											
6.7	End of Borehole - standpipe installed										

MTO 11293.GPJ ON_MOT.GDT 21/03/00

3 × 3 Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-10 1 OF 1 METRIC

W.P. 273-99-00 LOCATION Highway 401, Slope Modifications, Station 19+500, 34.0 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 13.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
144.6											
144.5 0.1	ROOTMAT (75 mm)										
	Brown sand with gravel, trace to some silt: TILL		1	SS	21		144		○		
			2	SS	127/150		143				
	- occasional cobbles and boulders						142				
			3	SS	98		141		○		32 61 7 -
			4	SS	114		140		○		
			5	SS	73		139		○		
			6	SS	66		138		○		
135.2						▽	137		○		
9.4 134.9	Brown SILT, trace sand		7	SS	89		136				
9.8	End of Borehole						135		○		
	- standpipe installed										

$^{3}_{3}$ × Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-11 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station 19+400, 38.0 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 13.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
145.4											
145.0	TOPSOIL (150 mm)										
0.2	Brown sand, trace gravel, trace silt: TILL		1	SS	7		145				
							144				
			2	SS	55						
							143				
			3	SS	77		142				29 65 6 -
	- occasional cobbles and boulders										
			4	SS	55		141				
							140				
138.8			5	SS	34	▽	139				
138.8	Grey CLAYEY SILT, trace sand										
6.7	Grey sandy silt, trace gravel: TILL						138				
			6	SS	43						
							137				
135.6	- occasional cobbles and boulders		7	SS	99		136				
9.8	End of Borehole										
	- standpipe installed										

$^{3}\times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 00-12 1 OF 1 METRIC

W.P. 273-96-00 LOCATION Highway 401, Slope Modifications, Station Station 19+300, 37.0 RT C/L ORIGINATED BY DF

DIST 43 HWY 401 BOREHOLE TYPE Hollow stem augers COMPILED BY JAZ

DATUM Geodetic DATE 13.01.00 CHECKED BY FG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
144.6											
144.6	TOPSOIL (175 mm)										
0.2	Brown SILTY SAND, trace gravel		1	SS	12		144				
			2	SS	52		143		○		6 52 42
142.5											
2.1	Brown sand and silt, trace gravel: TILL						142				
			3	SS	81				○		16 43 41 -
							141				
			4	SS	48		140		○		
							139				
	- occasional cobbles and boulders		5	SS	43				○		
							138				
			6	SS	48		137		○		
							136				
			7	SS	96						
134.9							135				
9.8	End of Borehole										

3, 3, 3: Numbers refer to Sensitivity

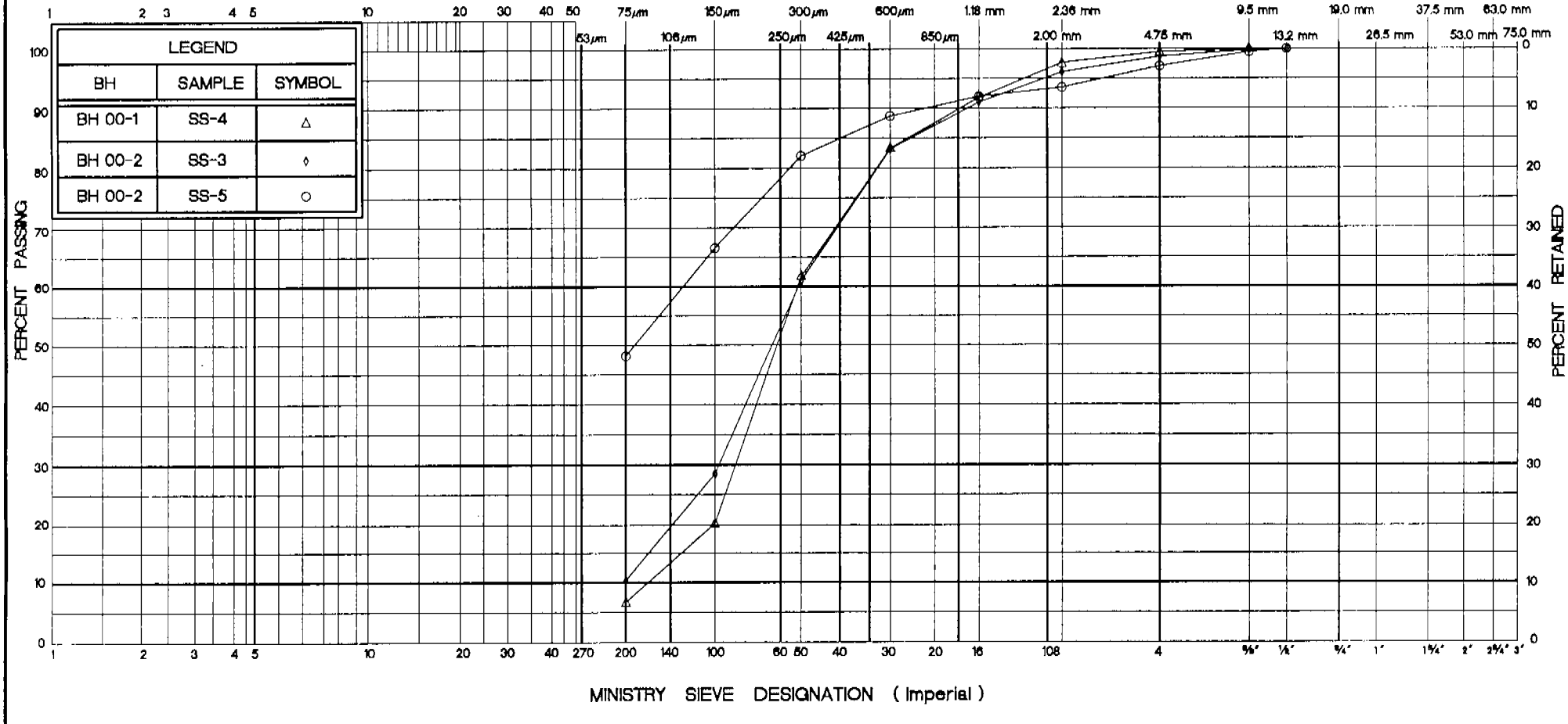
3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
HIGHWAY 401 TOE WALL, STA 19+200 TO 19+800,
HOPE TOWNSHIP

FIG No 11293-1

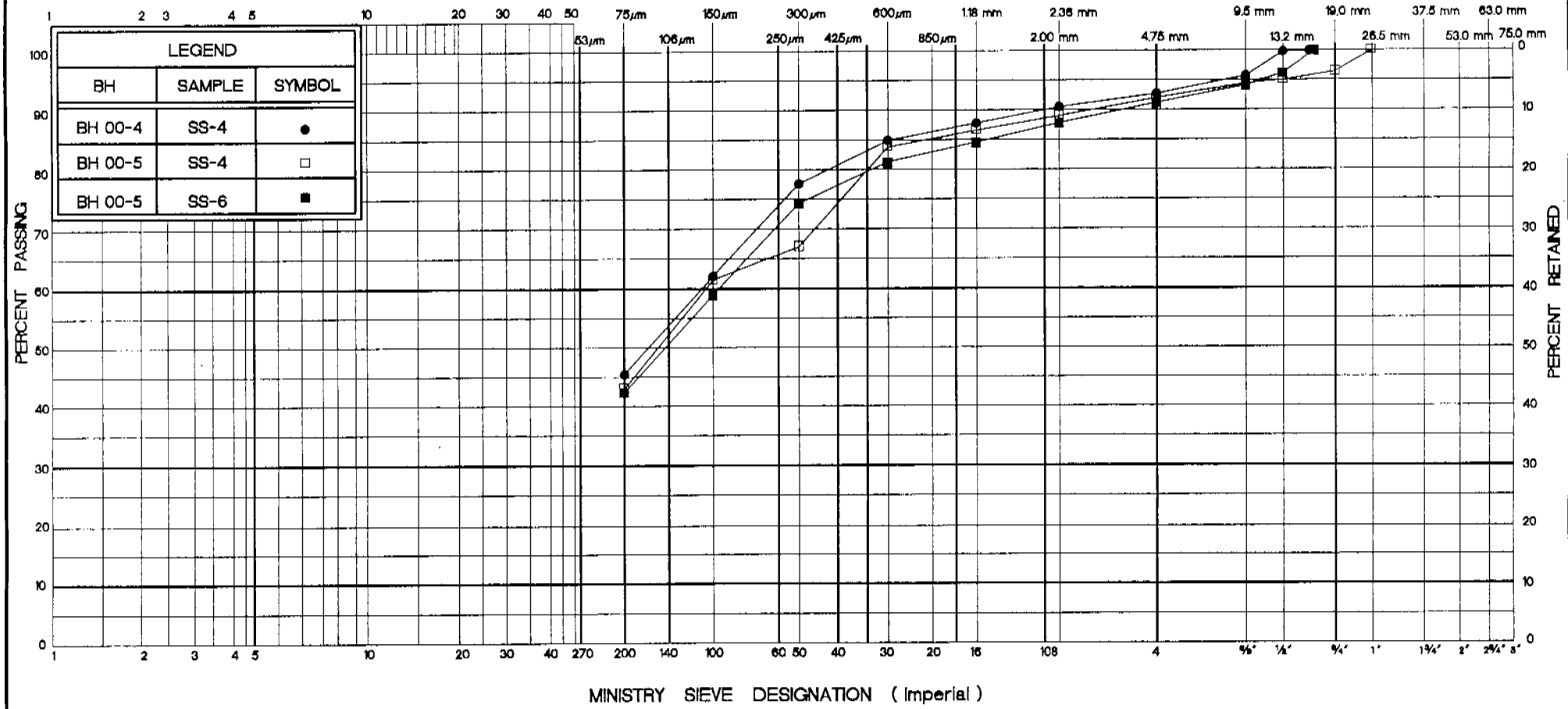
W P 273-96-00

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION HIGHWAY 401 TOE WALL, STA 19+200 TO 19+800, HOPE TOWNSHIP

FIG No 11293-2

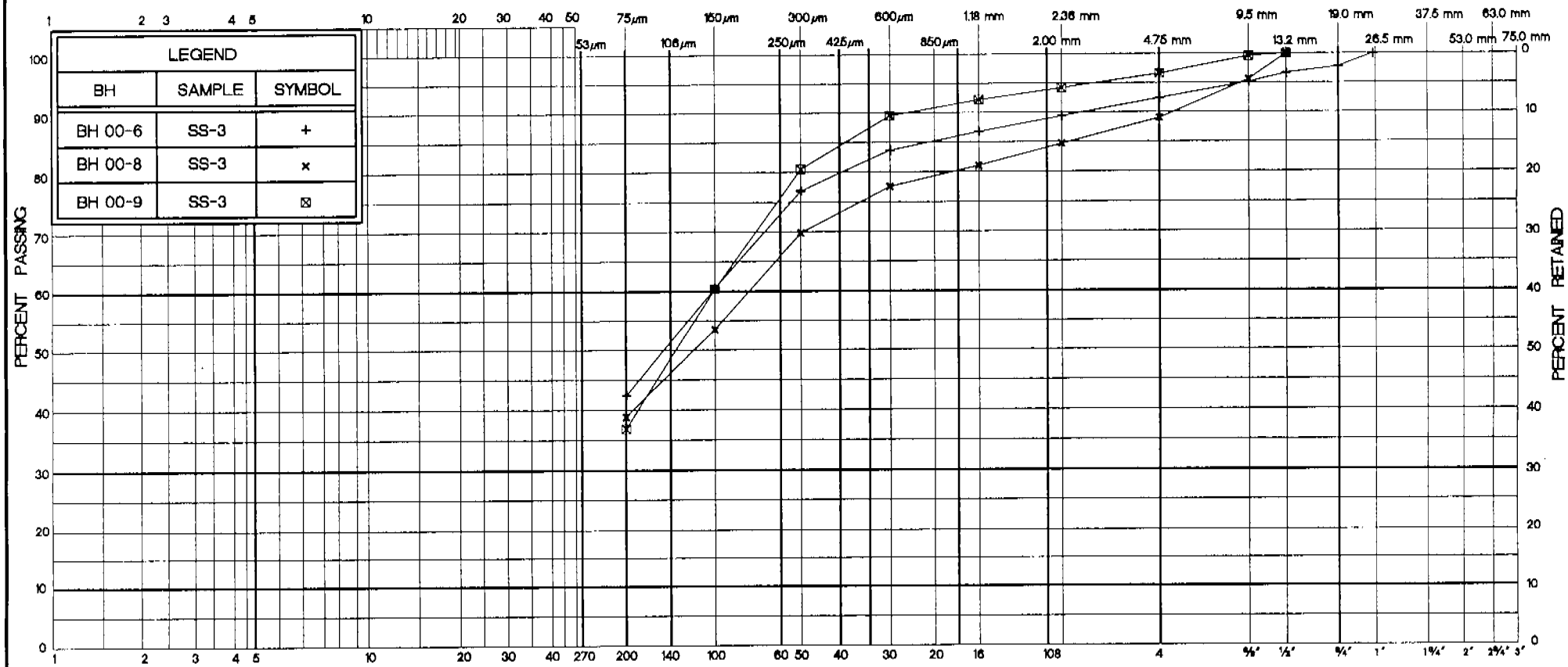
W P 273-96-00

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



MINISTRY SIEVE DESIGNATION (Imperial)

Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
HIGHWAY 401 TOE WALL, STA 19+200 TO 19+800, HOPE TOWNSHIP

FIG No 11293-3

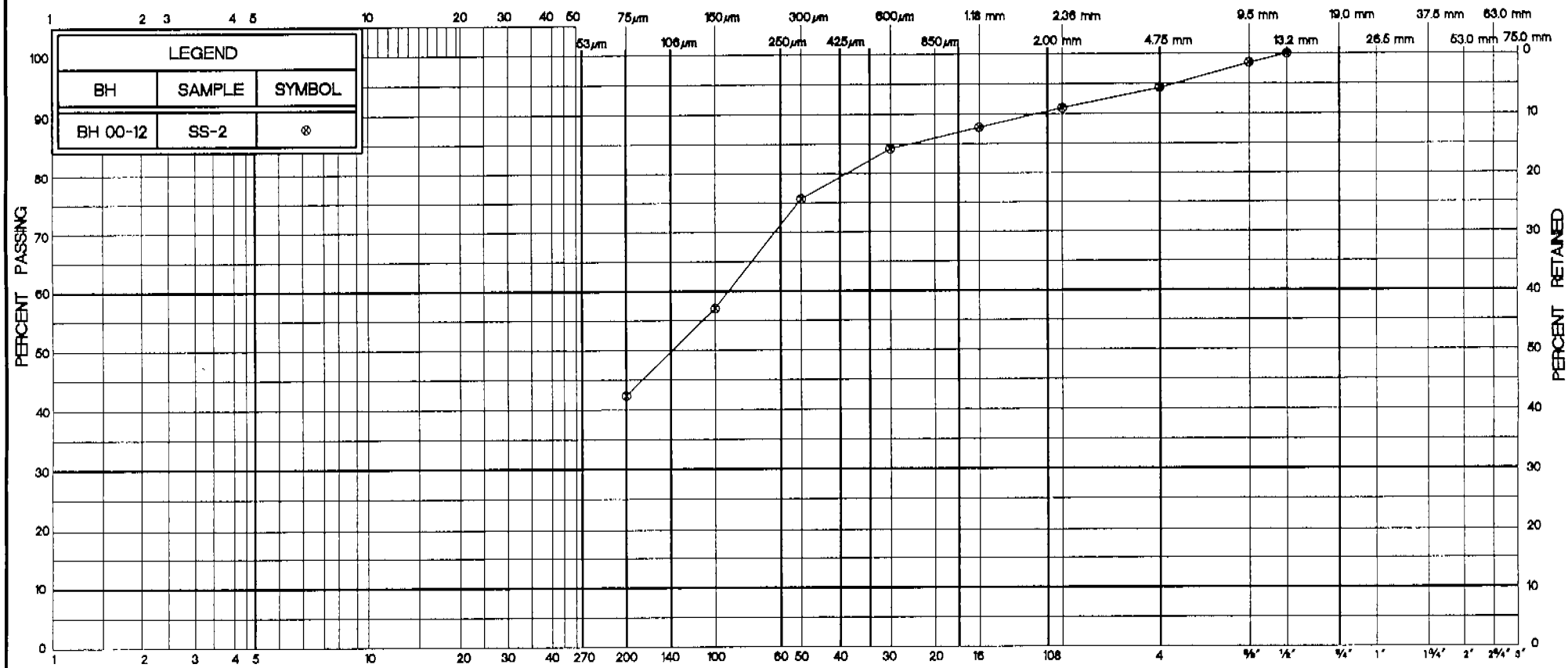
W P 273-96-00

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



Ministry of Transportation Ontario

GRAIN SIZE DISTRIBUTION
HIGHWAY 401 TOE WALL, STA 19+200 TO 19+800, HOPE TOWNSHIP

FIG No 11293-4

W P 273-96-00

APPENDIX 3

Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Toe Wall	24	15000	45	1	0
Granular Fill	22.5	0	35	1	0
Sand	19.5	0	32	1	0
Till	21	0	34	1	0

F^0_s = 1.906

Jacques Whitford Ltd. - Ottawa

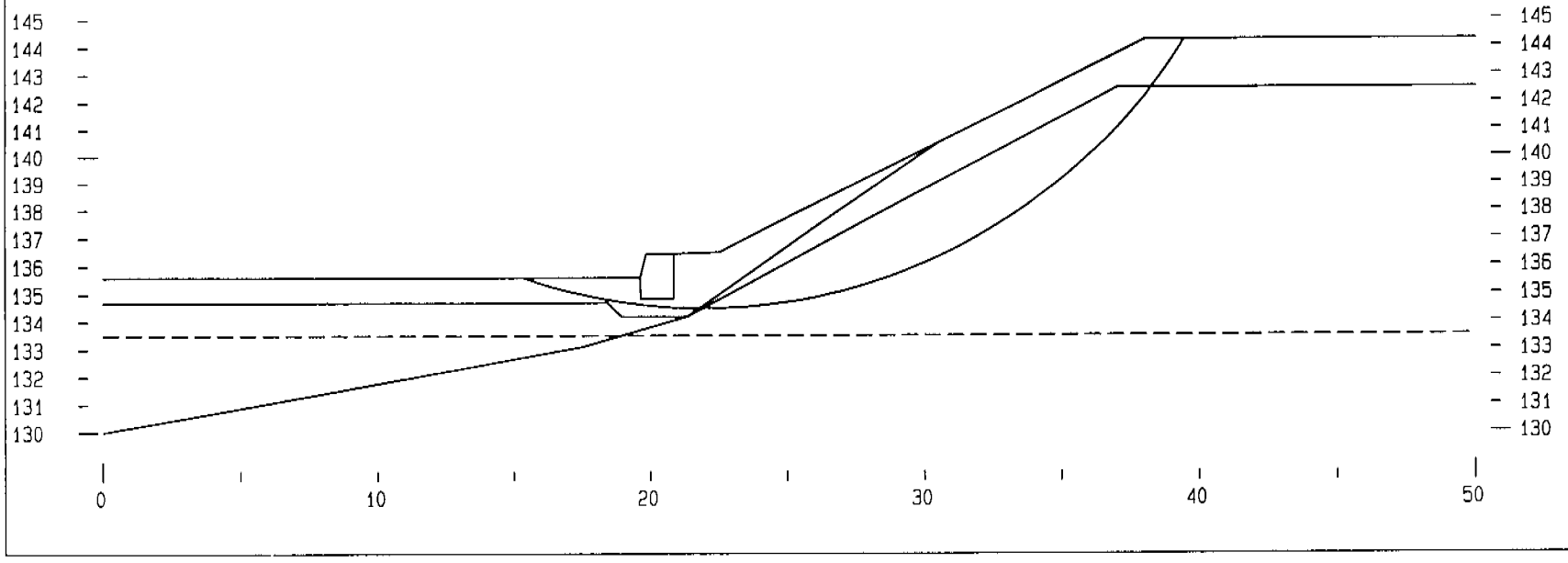
11293

W.P. 273-96-00

March 21, 2000

Station 19+300

19300_1.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Toe Wall	24	15000	45	1	0
Granular Fill	22.5	0	35	1	0
Sand	19.5	0	32	1	0
Till	21	0	34	1	0

Seismic coefficient = .08

F = 1.566

Jacques Whitford Ltd. - Ottawa

11293

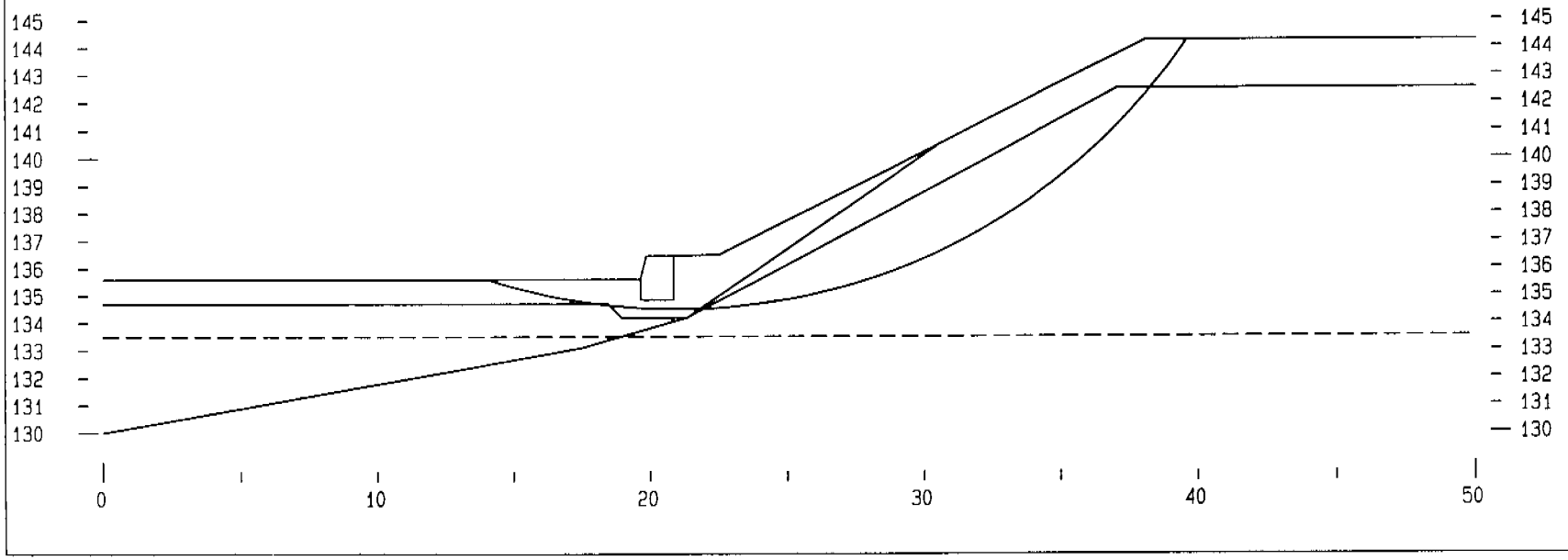
W.P. 273-96-00

March 21, 2000

Station 19+300

Earthquake Loading

19300_2.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Sand	19.5	0	32	1	0
Till	21	0	34	1	0

Jacques Whitford Ltd. - Ottawa

11293

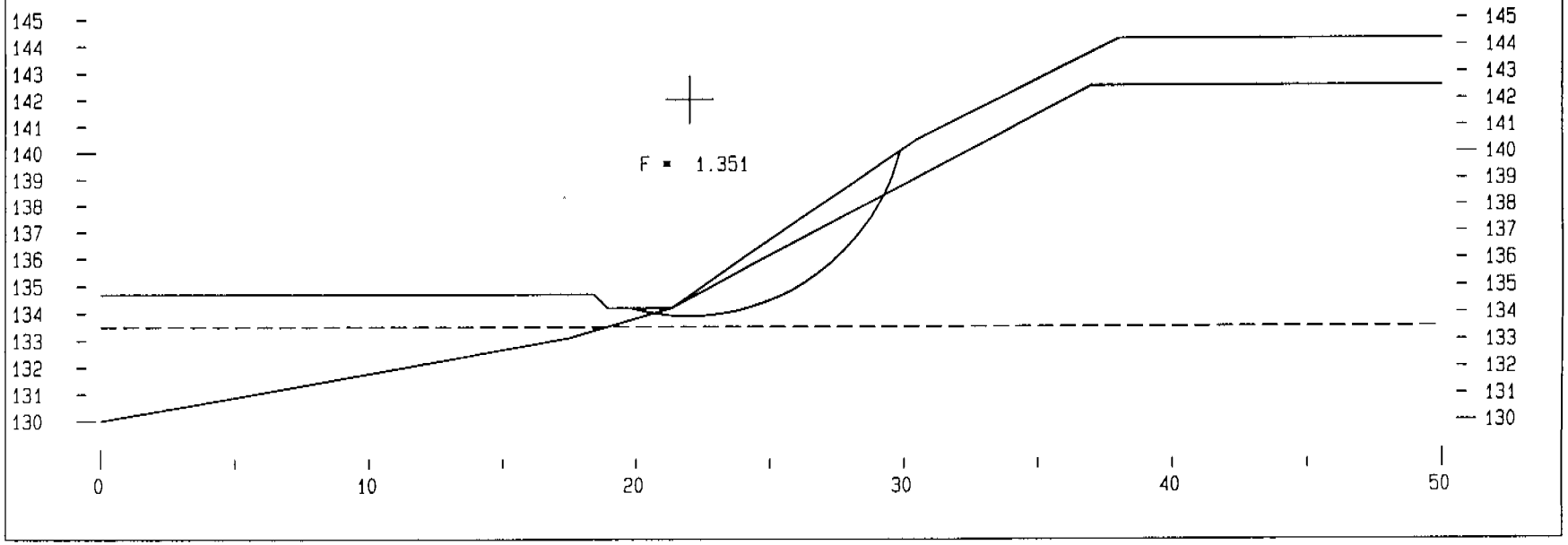
W.P. 273-96-00

March 21, 2000

Station 19+300

Construction Stage

19300_3.GSL



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Toe Wall	24	15000	45	1	0
Granular Fill	22.5	0	35	1	0
Till	21	0	34	1	0

Jacques Whitford Ltd. - Ottawa

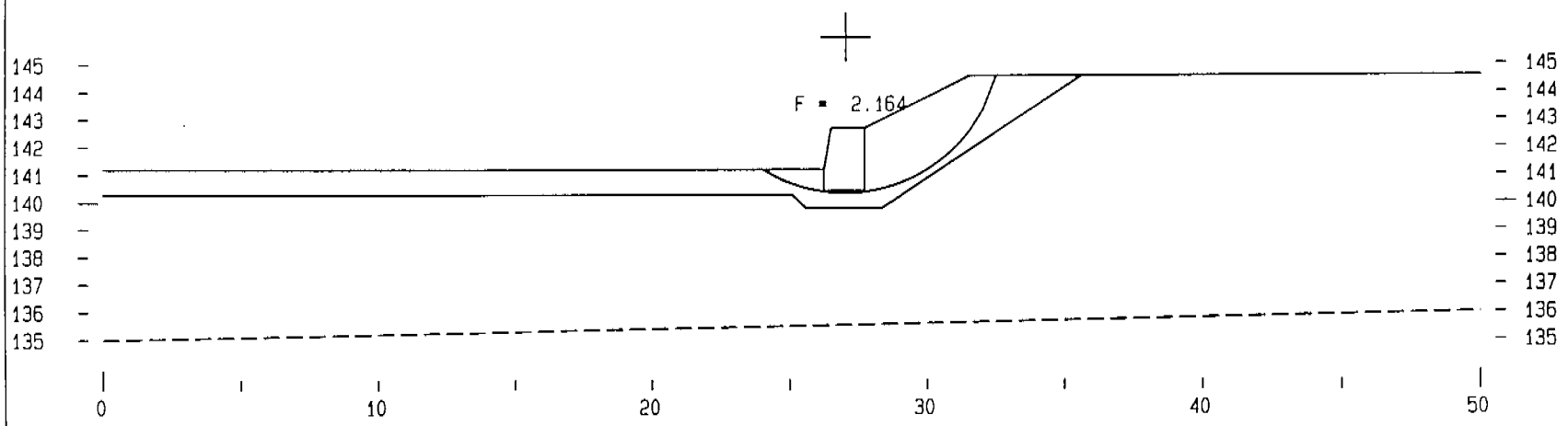
11293

W.P. 273-96-00

March 21, 2000

Station 19+550

19550_1.GSL



Material	Unit Wt	C	Phi	Piezo	Ru
	kN/m3	kPa	deg	Surf.	
Toe Wall	24	15000	45	1	0
Granular Fill	22.5	0	35	1	0
Till	21	0	34	1	0

Seismic coefficient = .08

Jacques Whitford Ltd. - Ottawa

11293

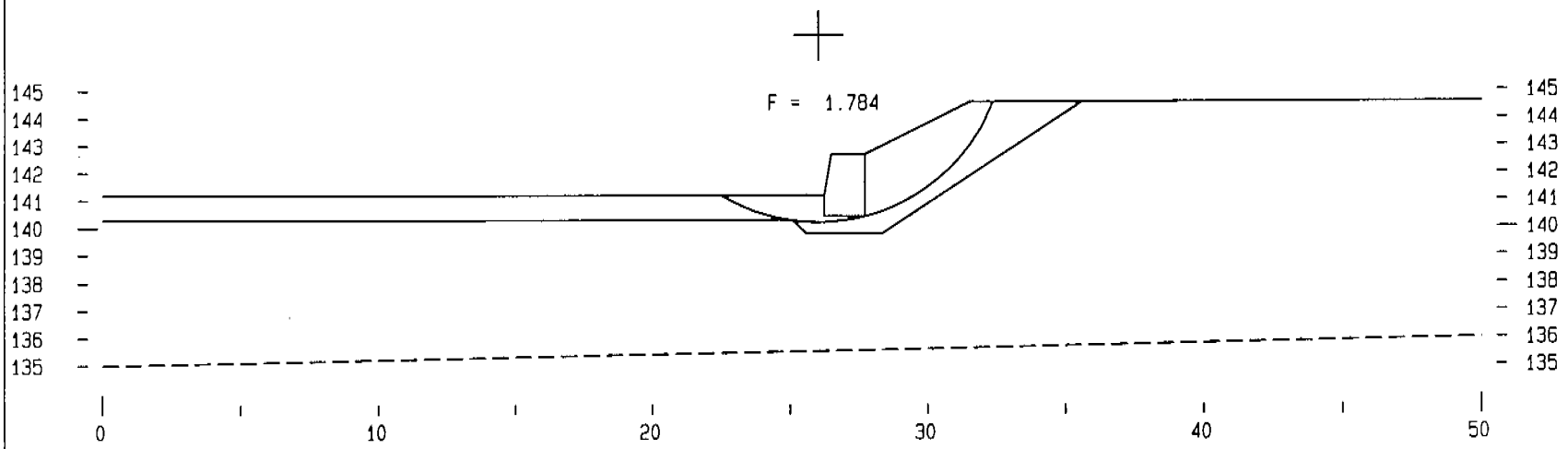
W.P. 273-96-00

March 21, 2000

Station 19+550

Earthquake Loading

19550_2.GSL



Material	Unit Wt kN/m3	C kPa	Phi deg	Piezo Surf.	Ru
Till	21	0	34	1	0

Jacques Whitford Ltd. - Ottawa

11293

W.P. 273-96-00

March 21, 2000

Station 19+550

Construction

19550_4.GSL