

GEOCRES No. _____

DIST. 54 REGION _____W.P. No. 772-93-00

CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. 11LOCATION Goreville Rd. UnderpassNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

DRAFT

**DRAFT FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY**

Submitted To:

**DELCAN Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada**

Submitted By:

**AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada**

**January 1999
TT98801**



AGRA Earth & Environmental

ENGINEERING GLOBAL SOLUTIONS

**AGRA Earth &
Environmental Limited**

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January 28, 1999.

Ref. No.: TT98801

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: Mr. Khaled El-Dalati, P. Eng.

Dear Sir:

**Re: DRAFT FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY**

We take pleasure in enclosing six (6) Draft copies of our Geotechnical Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

Z.S. Ozden, P. Eng.,
Principal Engineer.

ZSO/dee

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1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Goreville Road over the realigned northbound and southbound lanes of proposed Highway 11 and associated interchange ramps. The site is located between South River and Trout Creek, to the east of the existing Highway 11 and Goreville Road in the Township of Laurier, Lot 4, Concession 8 in the District of Parry Sound. The proposed bridge will be an approximately 77 m long, 2-lane, two span structure.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8) to depths of 1.5 to 15.4 m, eleven dynamic cone penetration tests and four testpits. A detailed description of field procedures is given in Appendix 'A'.

The plan locations of the boreholes and cone tests, along with stratigraphic sections are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located approximately 0.3 km east of the intersection of Highway 11 and Goreville Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from south to north and from east to west, ranging from about Elevation 375 to 380 m. The area is heavily wooded with deciduous and coniferous trees.

Approximately 100 m north of the proposed bridge site, braided eskers wind across the proposed alignment of Highway 11. The topography in this area is hummocky with numerous boulders blanketing the surface.

Based on available geologic information the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss to amphibolite). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at eighteen borehole locations (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8), nineteen auger probe holes, four testpits and were inferred at the locations of eleven dynamic cone penetration tests. The locations of the boreholes and cone penetration tests are shown on the Plan and Profile Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. Cross sections of inferred subsurface stratigraphy are given on Drawing No. 1.

The ground surface at the proposed site generally drops from north to south. The ground elevation at the proposed bridge location generally ranges from about 377.5 to 377.0 m at the north side to about Elevation 376 m at the south (i.e. an elevation drop of 1 to 1.5 m within a distance of 12 m).

In general, the boreholes encountered, below a 0.2 to 0.3 m thick topsoil layer, granular deposits ranging from fine sand to gravelly sand with frequent cobbles and boulders to the full depth of the majority of the boreholes. Bedrock was encountered and cored in three boreholes (Boreholes GRD-2, 3 and 5) at depths ranging from 7.6 m (Elevation 368.0 m) to 12.2 m (Elevation 365.3 m) below existing grade. At the time of the investigation the groundwater table was recorded at depths of 9 to about 10 m below the existing grade or at Elevations generally ranging between 368.5 and 367 m.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL

The boreholes encountered 0.2 to 0.3 m of surficial topsoil. In some areas the presence of cobbles and boulders was noted within the topsoil zone. Measured natural moisture contents of samples from the topsoil ranged from 21 to 31%.

The thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 FINE SAND

Below the surficial topsoil, the boreholes drilled at the east abutment and central pier locations (i.e. except for Boreholes GRD-5, 5B, 5C, 6, 6A, 6B and 7), encountered fine sand with traces of silt. The deposit extended to depths ranging between 2.3 m or Elevation 375.4 m (Borehole GRD-1) and 4.3 m or Elevation 372.0 m (Borehole GRD-4). This is a granular (i.e. cohesionless) deposit. Grain size distribution analyses were conducted on three samples from the material and the range of particle sizes are presented as a curve envelope in Figure No. 1. The analyses indicate 1 - 3%

gravel, 84 - 89% sand and 10 - 13% silt and clay size particles. The deposit also contains some silty sand seams/lenses. Measured 'N'-values in this unit range from 3 to 22 blows/0.3 m indicating a very loose to compact condition. Measured natural moisture contents ranged from 1 to 15%, but are generally 1 to 2%.

3.3 SAND TO GRAVELLY SAND

Below the topsoil and/or surficial sand, an ice-contact stratified sand to gravelly sand deposit was encountered to the full extent of the borings or until bedrock was encountered. This is a cohesionless (granular) deposit and contains lenses of silty sand and gravel layers, and frequent cobbles and boulders. Seven grain size distribution analyses were conducted and the range of particle sizes are presented as a curve envelope in Figure No. 2. The analyses indicate 2 - 45% gravel, 51 - 96% sand and 2 - 35% silt and clay size particles. Measured 'N'-values generally range from 12 to greater than 50 blows/0.3 m, indicating compact to very dense condition, but generally compact to dense. Dynamic cone penetration results range from 11 to greater than 100 blows/0.3 m. Many of the 'N'-values were found to be unreliable due to refusal on a cobble or boulder, or the sampler pushing coarse gravel. In order to advance several of the boreholes, boulders were cored. Because of the presence of very frequent oversize particles, it was not possible to make a full or reliable assessment of the compactness condition of the deposit. Measured natural moisture contents ranged from 1 to 16%.

Due to difficult drilling conditions four testpits were excavated to Elevation 371 m, one at the proposed east abutment (Borehole GRD-3G) and pier locations (Borehole GRD-1G) and two at the proposed west abutment location (Borehole GRD-5, 5B, 5C, 6, 6A, 6B) to allow sampling below the proposed footing level. The testpits were backfilled with native sand with boulders selectively removed. The backfill is probably in a loose state.

3.4 BEDROCK

Below the overburden soils, bedrock was encountered and NQ size cores were obtained at Boreholes GRD-2, GRD-3 and GRD-5 at depths 7.6 m, 12.2 m and 8.8 m below existing ground surface (Elevations 368.0, 365.3 and 366.9 m). At boreholes GRD-2 and GRD-5 the bedrock consists of sound, pink, Precambrian granite. The rock was cored for a vertical distance of 3.0 m and a rock quality designation ranging from 69 to 100% was measured indicating the rock to be fair to excellent quality, but generally excellent. The core recovery was 100%.

At Borehole GRD-3, the bedrock consists of a black, weathered, Precambrian Amphibolite (Hornblende Schist). Coring was conducted 3.0 m into the rock (100% recovery) and a rock quality designation ranging from 0 to 34% was measured indicating the rock to be very poor to poor quality, but generally very poor.

Based on the recorded elevation of bedrock in the three boreholes and overburden depths in the remaining ones, the surface of the bedrock at the bridge site appears to slope down rather sharply from south to north (as evidenced at Boreholes GRD-1 and GRD-2) and gradually rises from west to east. It should also be pointed out that adjacent to Borehole GRD-2 (where the rock was cored) another probe was drilled within 2 m. This borehole extended to 2.1 m below the recorded (surmized) bedrock surface in Borehole GRD-2. This indicates that either the bedrock surface dips very sharply (or the rock encountered in Borehole GRD-2 was a very large boulder). From these observations and experience in the general area, the surface of the bedrock can be expected to be uneven and unpredictable.

3.5 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. The water levels in the open boreholes were checked prior to removing the augers or casing.

The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 9 to about 10 m below the ground surface (Elevation 368.5 to 367 m). These groundwater elevations were confirmed from the natural moisture content measured from collected samples. It should, however, be pointed out that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to heavy rains.

4.0 CLOSURE

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

Sincerely,

Andrew Drevininkas, P. Eng.
AD/dee

Z.S. Ozden, P. Eng.

APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes, eleven dynamic cone penetration tests and four testpits. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

The boreholes were advanced using a track-mounted power auger drilling rig (CME 75) owned and operated by Canadian Soil Drilling Inc. and a track-mounted power auger drilling rig (BOA 10M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of a soils engineer from AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit.

In addition, dynamic cone penetration tests were performed in eleven of the boreholes. This test consists of driving a 60° point, 50 mm diameter cone attached to the drill rod continuously, into the undisturbed ground with a driving energy of 475 J (63 kg hammer falling freely a distance of 76 cm) per blow. The number of blows for each 30 cm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to difficult drilling conditions, four testpits were excavated to approximate Elevations of 370 to 371 m (at Boreholes GRD- 1G, 3G, and encompassing Boreholes GRD- 5, 5B, 5C, 6, 6A, 6B). The testpits were backfilled with native sand with large boulders and cobbles selectively removed. Drilling was then carried out from the ground surface and advanced below the bottom of the sand backfill.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Goreville Road (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken by surveyors from Dearden and Stanton Limited.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also on Figure Nos. 1 and 2.

The boreholes were left open until the end of each work day to enable us to take additional water level readings. All boreholes were backfilled and grouted on November 22 and December 18, 1998.

APPENDIX B

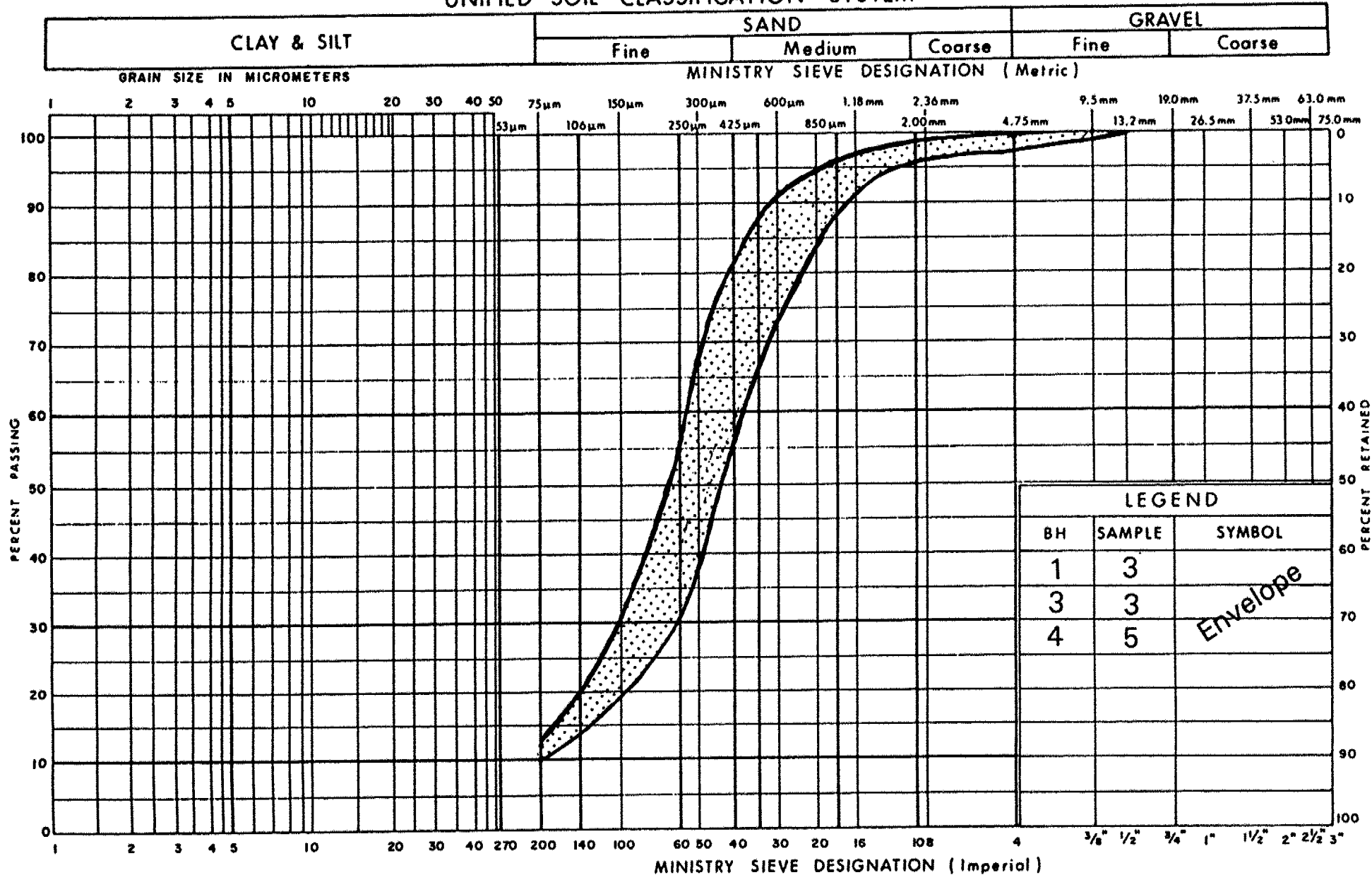
AGRA
LIMITATIONS OF REPORT

The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

Ontario

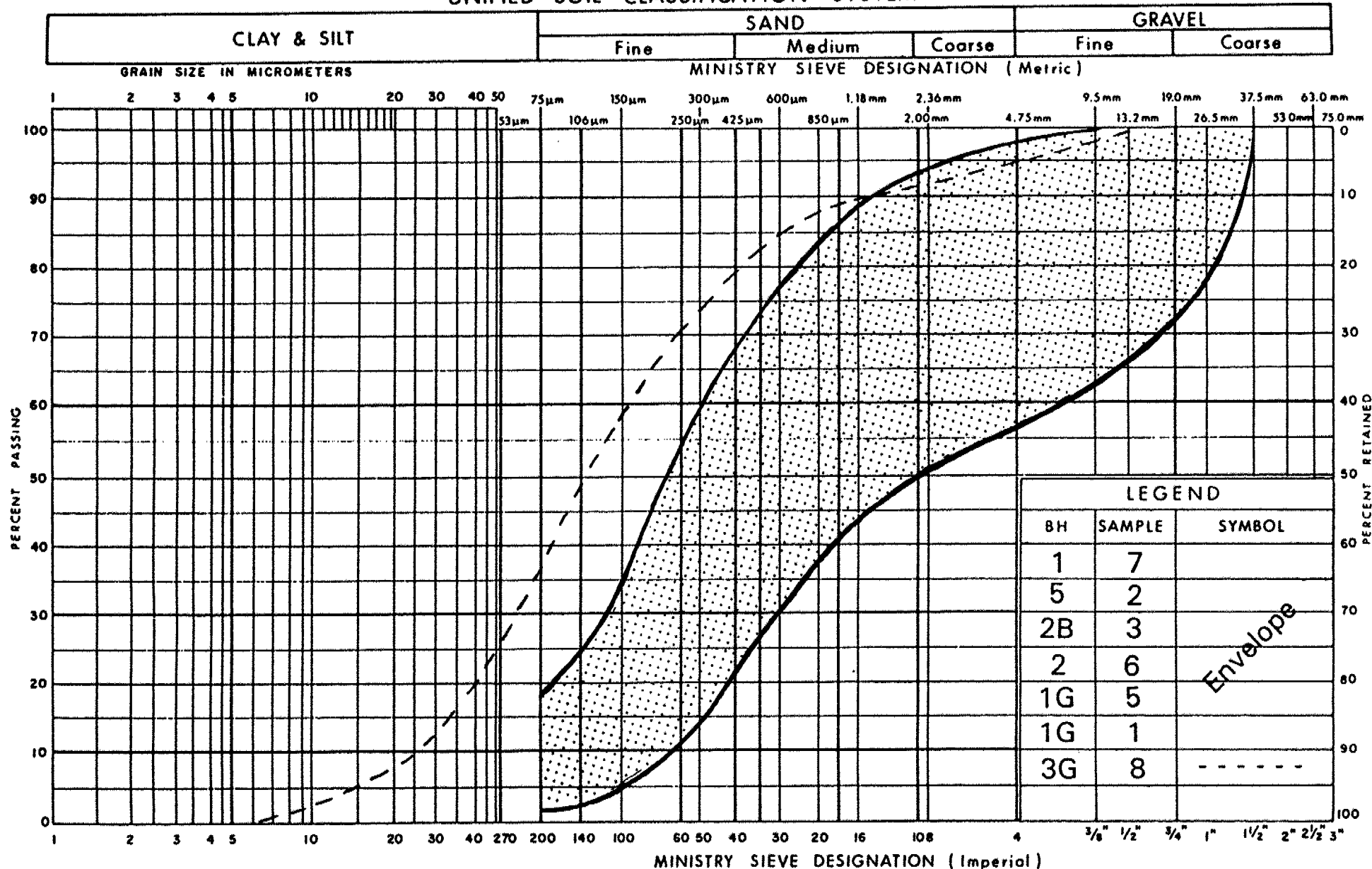
GRAIN SIZE DISTRIBUTION.
FINE SAND, TRACE SILT

FIG No 1

W P 772-93-00

Ref No. TT98801

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

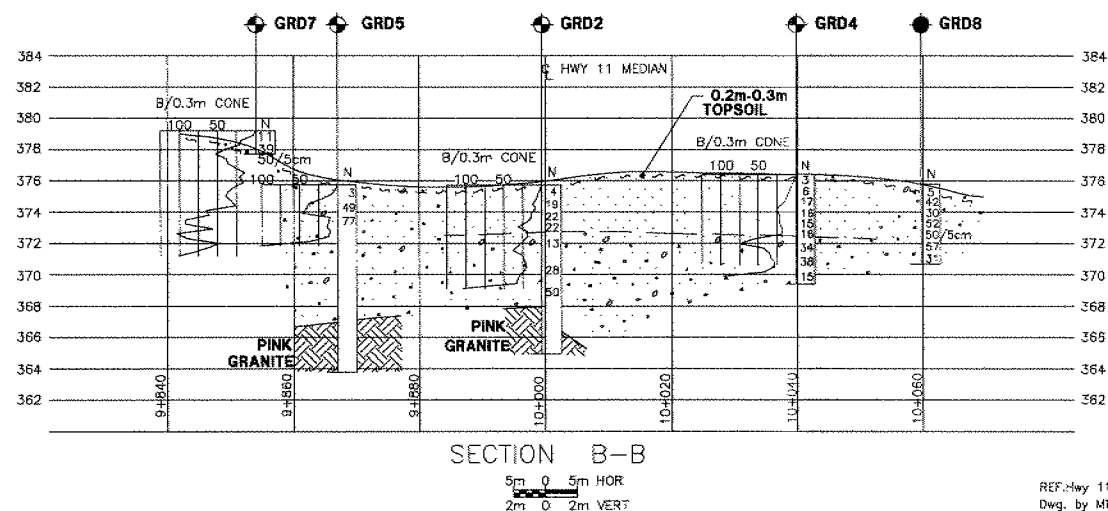
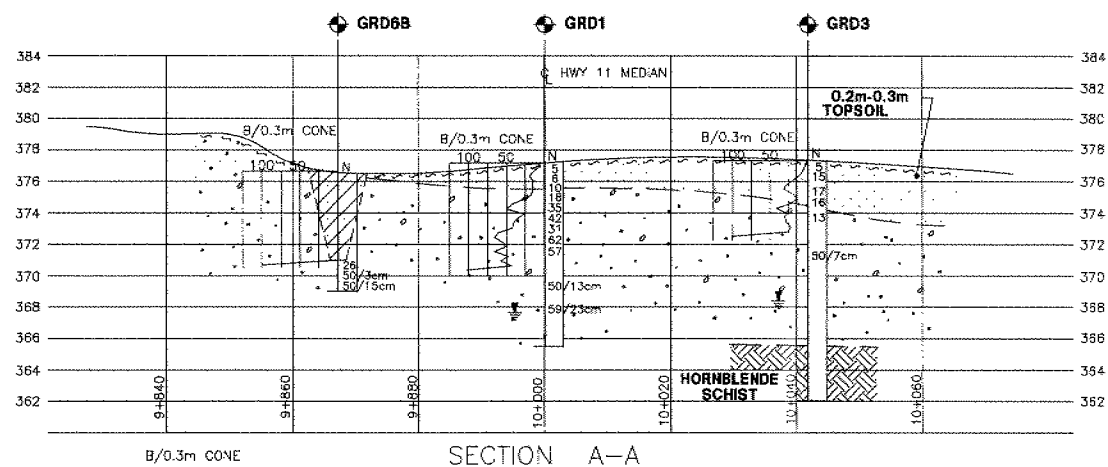
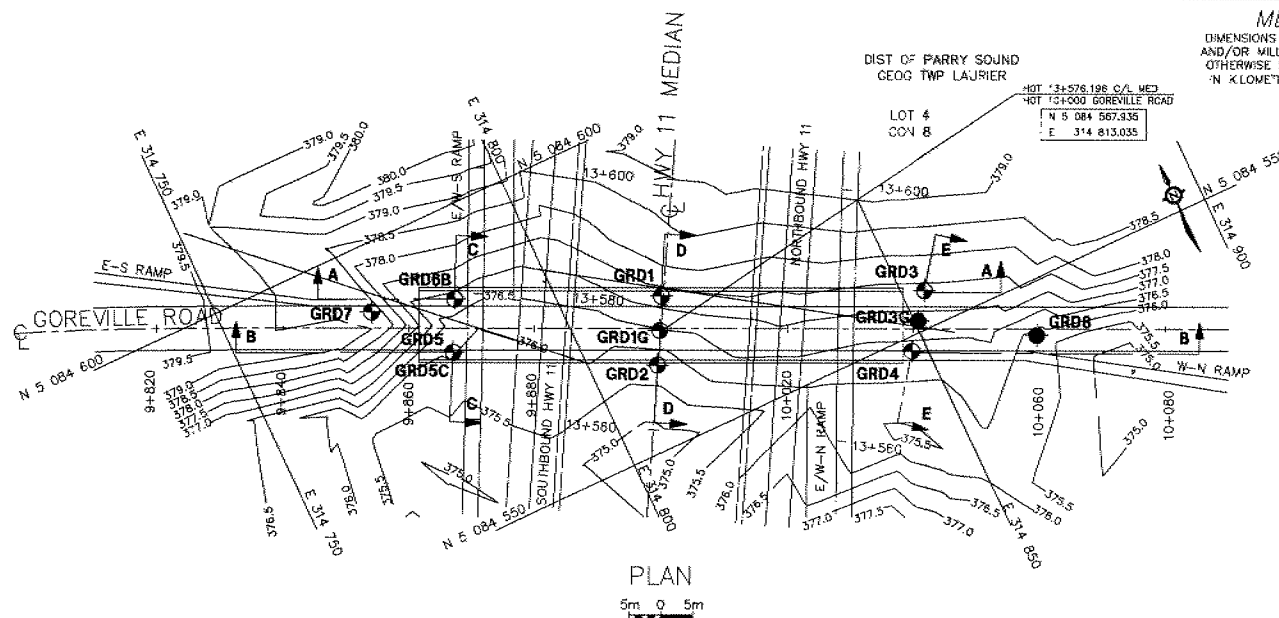
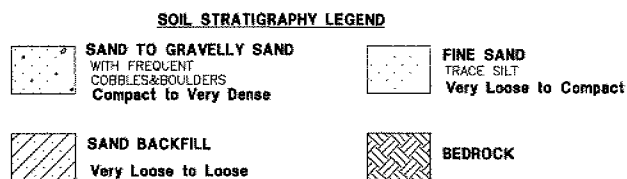
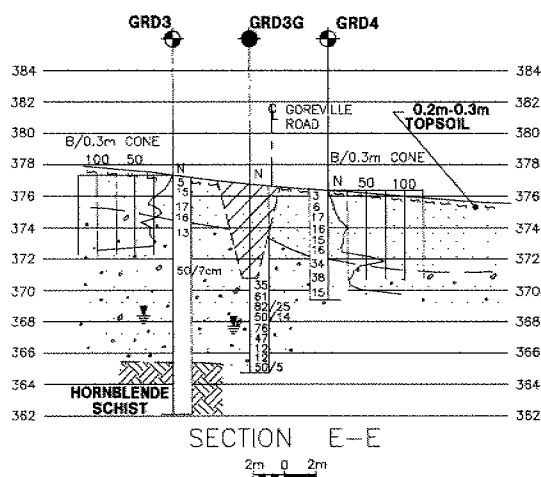
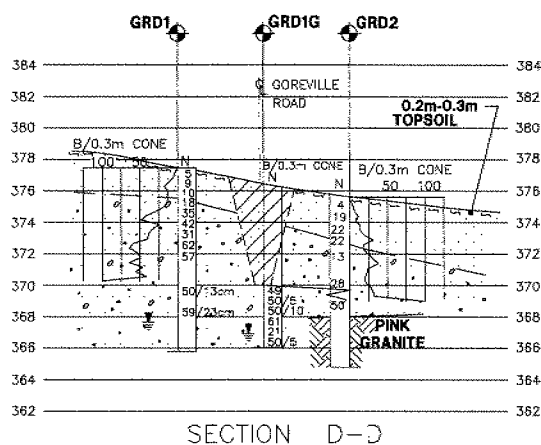
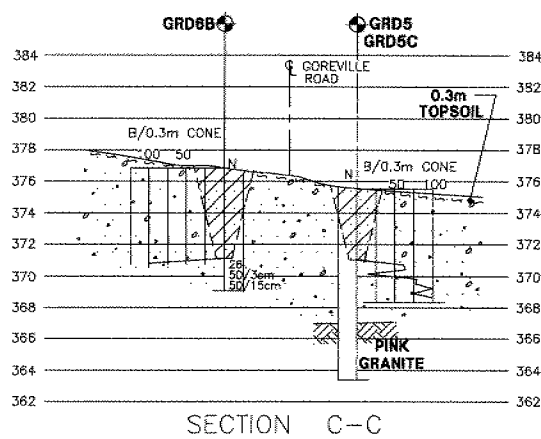
GRAIN SIZE DISTRIBUTION SAND TO GRAVELLY SAND

FIG No 2

W P 772-93-00

Ref No. TT98801

ENCLOSURES

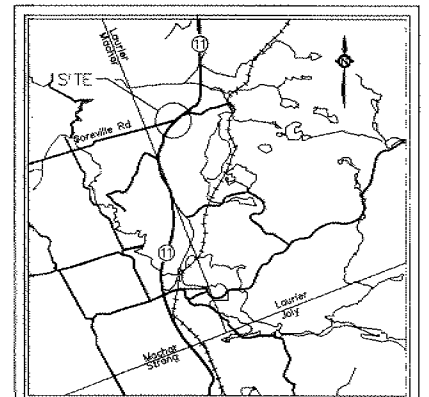


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES.

CONT. No. -
W.P. No. 772-93-00

GORVILLE ROAD UNDERPASS
BORE HOLE LOCATIONS & SOIL STRATA

AGRA Earth & Environmental Ltd.



KEY PLAN

1 km 0 1 km

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CON Blows/0.3m (60" Cone, 475 J/blow)
- WL at time of investigation Dec 98

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|-------|-----------|-----------------------|---------|
| GRD1 | 377.7 | 5 084 573 | 314 815 |
| GRD1G | 376.1 | 5 084 568 | 314 813 |
| GRD2 | 375.6 | 5 084 563 | 314 810 |
| GRD3 | 377.5 | 5 084 556 | 314 854 |
| GRD3G | 376.8 | 5 084 552 | 314 851 |
| GRD4 | 376.3 | 5 084 548 | 314 848 |
| GRD5 | 375.7 | 5 084 579 | 314 782 |
| GRD5C | 377.0 | 5 084 586 | 314 785 |
| GRD7 | 379.3 | 5 084 590 | 314 773 |
| GRD8 | 375.8 | 5 084 542 | 314 867 |

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 GC 2.01 of OPS Gen.Cond.

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

| | |
|--|------------|
| HWY No 11 | DIST 54 |
| SUBMIT TO CHECKED ZC DATE Jan 27, 1999 | SPE 44-376 |
| DRAWN MA CHECKED | DWG 1 |

REF: Hwy 11 Bridge Site Plan
Dwg. by MTO, Oct. 1998

ENCL. No.: 1

[illegible]

ENCL. No.: 2

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | MATERIAL DESCRIPTION | | ELEV. m | DEPTH m | WATER DATA | REMARKS | |
|---------------------|--------|---------|-------------|----------------------|--------------------|---------|------|-------------|--------|----------------------|--|------------|------------|---------------|---|--|
| PL % | w % | LL % | WT kN/m3 | Field Vane kPa | Lab Comp kPa | No. | TYPE | N- Value | SYMBOL | | | | | | | |
| SURFACE EL. 377.7 m | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | INFERRED FINE SAND | dry | 377 | 1 | Borehole drilled 1.5m east of GRD1. *spoon bouncing on cobble | |
| | | | | | | | | | | | | | 376 | 2 | | |
| | | | | | | | | | | | AUGER to 6.1m | dry | 375 | 3 | | |
| | | | | | | | | | | | INFERRED GRAVELLY SAND | | 374 | 4 | | |
| | | | | | | | | | | | | | 373 | 5 | | |
| | | | | | | | | | | | | | 372 | 6 | | |
| 5 | | | | | | 1 | SS | 50/10* | | | brown SAND to GRAVELLY SAND with frequent cobbles & boulders | dry | 371 | 7 | N=50/10 50 blows for 10cm penetration | |
| 5 | | | | | | 2 | SS | 40 | | | | | 370 | 8 | | |
| 1 | | | | | | 3 | SS | 75* | | | | | 369 | 9 | | |
| | | | | | | 4 | SS | 50/13* | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | |
| 2 | | | | | | 5 | SS | 63 | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 5 | | | | | | 6 | SS | 40 | | | grey,brown | moist | 368 | | | |
| | | | | | | | | | | | End of Borehole Auger refusal @9.8m on boulder. No growndwater in hole on completion. | | | | | |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD1B

ENCL. No.: 3

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------|---------------|---------------------|---------|------|-------------|--------|--|------------|------------|---------------|--|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | |
| % | % | % | WT kN/m3 | Field Vane | Lab Compr kPa | | | | | | | | | |
| SURFACE EL. 376.1 m | | | | | | | | | | | | | | |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand. | 376 | | | Gr Sa Si&Cl % |
| | | | | | | | | | | | 375 | 1 | | |
| | | | | | | | | | | | 374 | 2 | | |
| | | | | | | | | | | AUGER to 6.1m | 373 | 3 | | |
| | | | | | | | | | | dry | 372 | 4 | | |
| | | | | | | | | | | | 371 | 5 | | |
| 2 | | | | | | 111 | 1 | SS | 49 | | 370 | 6 | | 45 51 (4) |
| | | | | | | 81 | | | | | | | | |
| | | | | | | 106 | 2 | SS | 50/5* | dense to v.dense | 369 | 7 | | |
| 3 | | | | | | 100/15 | 3 | SS | 50/10* | | 368 | 8 | | |
| 9 | | | | | | | 4 | SS | 61 | brown/grey SAND | 367 | 9 | | |
| 15 | | | | | | | 5 | SS | 21 | GRAVELLY SAND to with frequent cobbles & boulders | 366 | 10 | | 16 68 (16) |
| | | | | | | | 6 | SS | 50/5* | compact | | | | |
| | | | | | | | | | | End of Borehole Auger refusal @10.1m on boulder. Groundwater in Holst Augers @9.0m and hole caved @6.1m on completion. Move hole 2.0m east, auger refusal @7.8m. Move hole 2.0m west, Auger refusal @6.2m. DCPT conducted 1.0m south of GRD1G. | | | | N=50/5 50 blows for 5 cm penetration *spoon bouncing on cobble |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD1G

ENCL. No.: 4

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|--------|---------|---------------------|-----------------------|------------------------------|---------|------|-------------|-----|--------|---|------------|------------|---------------|---|
| PL % | w % | LL % | UNIT WT kN/m3 | UNDR Field Vane | STRNG Lab Compr kPa | No. | TYPE | N- Value | | | | | | | |
| | | | | | | 2 | 1 | SS | 4 | | v.loose 0.2m TOPSOIL brown FINE SAND trace silt | | 375 | | Gr Sa Si&Cl % |
| | | | | | | 5 | | | | | compact | | | 1 | |
| | | | | | | 7 | 2 | SS | 19 | | | | | | |
| | | | | | | 12 | | | | | gravelly | | | 2 | |
| | | | | | | 14 | 3 | SS | 22 | | | | 374 | | |
| | | | | | | 14 | | | | | | | | | |
| | | | | | | 19 | 4 | SS | 22 | | | | | | |
| | | | | | | 30 | | | | | | | | | |
| | | | | | | 18 | | | | | | | 373 | | |
| | | | | | | 18 | 5 | SS | 13 | | boulder | | | 3 | |
| | | | | | | 24 | | | | | | | | | |
| | | | | | | 30 | | | | | | | | | |
| | | | | | | 37 | | | | | brown SAND to GRAVELLY SAND with frequent cobbles & boulders | | 372 | | Auger refusal on boulder @3.0m. Advance by washboring method. |
| | | | | | | 24 | | | | | boulder | | | 4 | |
| | | | | | | 23 | | | | | | | | | |
| | | | | | | 20 | 6 | SS | 28 | | compact | | | 5 | 6 84 (10) |
| | | | | | | 21 | | | | | | | 371 | | |
| | | | | | | 27 | | | | | | | | | |
| | | | | | | 30 | | | | | | | | | |
| | | | | | | 32 | | | | | | | | | |
| | | | | | | 100/25 | 7 | SS | 50* | | dense boulder | | 370 | | *'N'-value unreliable driving a stone |
| | | | | | | | | | | | | | 369 | | |
| | | | | | | | 8 | RC | | | | | | | |
| | | | | | | | 9 | RC | | | | | | | |
| | | | | | | | 10 | RC | | | | | | | |
| | | | | | | | | | | | | | 368 | | RC8: REC=100% RQD=100% |
| | | | | | | | | | | | | | 367 | | RC9: REC=100% RQD=88% |
| | | | | | | | | | | | | | 366 | | RC10: REC=100% RQD=100% |
| | | | | | | | | | | | | | 365 | | |
| | | | | | | | | | | | End of Borehole No growndwater in hole and hole caved @3.0m on completion. Move hole 2.0m east, auger refusal @9.7m. Move hole 2.0m west, auger refusal @4.1m. DCPT conducted 2.0m south of GRD2. | | | | N=100/25 100 blows for 25 cm penetration |

Vertical Scale: 1:100

AGRA

Checked: RM

SHEET 1 OF 1BH No. GRD2



LOG OF BOREHOLE GRD2B

ENCL. No.: 5

| | |
|--|----------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: November 23rd, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|--|---|----|-------------------|-------|-------|---------|------|---------|--------|---|------------|------------|---------------|---|
| PL | W | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Field | Lab | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 375.6 m | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Gr Sa Si&Cl % |
| | | | | | | | | | | | 375 | 1 | | |
| | | | | | | | | | | | 374 | 2 | | Borehole drilled 1.5m west of GRD2. |
| 3 | | | | | | 1 | SS | 14 | | compact brown SAND, trace Silt dry | 373 | 3 | | |
| 2 | | | | | | 2 | SS | 35* | | | | | | |
| 2 | | | | | | 3 | SS | 27* | | compact brown SAND to GRAVELLY SAND with frequent cobbles & boulders damp | 372 | 4 | | 2 96 (2) |
| 7 | | | | | | 4 | SS | 19 | | | 371 | 5 | | |
| End of Borehole Refusal @5.2m on boulder. No groundwater in hole on completion. | | | | | | | | | | | | | | |


Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No GRD2B

ENCL. No.: 6

| LABORATORY DATA | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS | | | | |
|-----------------|--------|---------|---------------------------------|----------------------------|-------------|--------------|---------------------|-------|--|----------------------|----------------------------------|------------|---------------|---------|----|----|--|------|
| PL % | w % | LL % | UNIT WT kN/m ³ | UNDR STRNG Field Lab | No. | TYPE | N- Value | | | | | | | | | | | |
| | | | | | Vane kPa | Compr kPa | SURFACE EL. 377.5 m | | | | | | | | | | | |
| 31 | | | | | 3 | 1 | SS | 5 |  | v.loose | 0.2m TOPSOIL | 377 | | | Gr | Sa | Si&Cl | |
| | | | | | 6 | | | | | | | | | | | % | % | % |
| 2 | | | | | 10 | 2 | SS | 15 | | | | | 1 | | | | | |
| | | | | | 19 | | | | | | | | | | | | | |
| 1 | | | | | 27 | | | | | | | | 376 | | | 1 | 89 | (10) |
| | | | | | 31 | 3 | SS | 17 | | | brown SAND | | 2 | | | | | |
| | | | | | 19 | | | | | | frequent layers of Silty Sand | | | | | | | |
| 2 | | | | | 14 | | | | | | | | | | | | | |
| | | | | | 22 | 4 | SS | 16 | | | compact | dry | 375 | | | | | |
| | | | | | 40 | | | | | | | | 3 | | | | | |
| 2 | | | | | 28 | 5 | SS | 13 | | | | 374 | | | | | Auger refusal @3.6m. Advance by washboring method. | |
| | | | | | 29 | | | | | boulder | brown SAND to GRAVELLY SAND | | 4 | | | | | |
| | | | | | 28 | | | | | | | | | | | | | |
| | | | | | 22 | | | | | boulder | with frequent cobbles & boulders | | 5 | | | | | |
| | | | | | 25 | | | | | | | | | | | | | |
| | | | | | 100 | | | | | boulder | compact | 373 | | | | | | |
| | | | | | 100/20 | | | | | | | | | | | | | |
| | | | | | | 6 | SS | 50/7* | | | | | 6 | | | | *spoon bouncing on boulder | |
| | | | | | | | | | | | | | | | | | | |
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SHEET 1 OF 1 BH No. GRD3

ENCL. No.: 7

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 23rd, 1998 |

[illegible]

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD3B

LOG OF BOREHOLE GRD3G

ENCL. No.: 8

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: SolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 17th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|---|----|-------------------|------|-------|---------|------|--------|--------|--|------------|------------|---------------|---|
| PL | W | LL | UNIT | UNDR | STRNG | No. | TYPE | Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| | | | | | | | | | | SURFACE EL. 376.8 m | | | | |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand. | 376 | 1 | | Gr Sa Si Cl % |
| | | | | | | | | | | | 375 | 2 | | |
| | | | | | | | | | | AUGER to 6.1m | 374 | 3 | | |
| | | | | | | | | | | | 373 | 4 | | |
| | | | | | | | | | | | 372 | 5 | | |
| | | | | | | | | | | | 371 | 6 | | |
| 6 | | | | | | 2 | SS | 35 | | | 370 | 7 | | |
| 5 | | | | | | 3 | SS | 61 | | brown | 369 | 8 | | * spoon bouncing on cobble/bedrock |
| 6 | | | | | | 4 | SS | 82/25* | | | 368 | 9 | | |
| 9 | | | | | | 5 | SS | 50/14* | | dense to v. dense | 367 | 10 | | |
| 15 | | | | | | 6 | SS | 76 | | | 366 | 11 | | 5 60 35 0 |
| 8 | | | | | | 7 | SS | 47 | | | 365 | 12 | | |
| 16 | | | | | | 8 | SS | 12 | | silty | | | | |
| 8 | | | | | | 9 | SS | 12 | | compact | | | | |
| 16 | | | | | | 10 | SS | 50/5* | | | | | | N=82/25 82 blows for 25 cm penetration |
| | | | | | | | | | | End of Borehole Auger refusal @12.0m on probable Bedrock. Groundwater in HolSt Augers @9.0m and hole caved @7.5m on completion. Move hole 2.0m east, auger refusal @3.3m. Move hole @2.0m west, Auger refusal @5.1m. | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No GRD3G

ENCL. No.: 9

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 21st, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | | | MATERIAL DESCRIPTION | | | ELEV. | DEPTH | WATER DATA | REMARKS | |
|-----------------|---|----|-------------------|-------------|--------------|---------|------|----------------|-------|------------------|---|----------------------|--|-----|-------|-------|---------------------------------|---------|-------|
| PL | w | LL | WT | Field | Lab | No. | TYPE | N _i | Value | SYMBOL | | | | m | m | | | | |
| % | % | % | kN/m ³ | Vane kPa | Compr kPa | | | | | | | | | | | | | | |
| | | | | | | 8 | 1 | SS | 3 | v.loose | 0.3m TOPSOIL | | | 376 | | | Gr | Sa | Si&Cl |
| | | | | | | 11 | | | | ----- | red to brown SAND, | | | | | | % | | |
| | | | | | | 14 | | | | loose | trace Silt, Gravel, Cobbles | damp | | | 1 | | | | |
| | | | | | | 21 | 2 | SS | 6 | | | | | 375 | | | | | |
| | | | | | | 25 | | | | | | | | | | | | | |
| | | | | | | 21 | 3 | SS | 17 | | | damp | | | 2 | | | | |
| | | | | | | 21 | | | | | brown FINE SAND | dry | | 374 | | | | | |
| | | | | | | 14 | | | | | trace silt | | | | | | | | |
| | | | | | | 23 | 4 | SS | 16 | gravelly compact | occ. Gravel layers | | | | | | | | |
| | | | | | | 25 | | | | | | | | | | | | | |
| | | | | | | 25 | 5 | SS | 15 | | | | | 373 | | | 1 | 89 (10) | |
| | | | | | | 24 | | | | | | | | | | | | | |
| | | | | | | 21 | | | | | | | | | | | | | |
| | | | | | | 22 | 6 | SS | 16 | | | | | 372 | | | | | |
| | | | | | | 59 | | | | | | | | | | | | | |
| | | | | | | 78 | 7 | SS | 34 | dense | brown SAND | | | 371 | | | BH drilled 2.0m south of GRD4B. | | |
| | | | | | | 46 | | | | | to GRAVELLY SAND | | | | | | | | |
| | | | | | | 38 | | | | | with frequent cobbles & boulders | | | | | | | | |
| | | | | | | 36 | 8 | SS | 38 | | | | | | | | | | |
| | | | | | | 31 | | | | | | | | | | | | | |
| | | | | | | 33 | | | | | | | | | | | | | |
| | | | | | | 46 | 9 | SS | 15 | compact | some Silt | | | 370 | | | | | |
| | | | | | | 100/17 | | | | | | | | | | | | | |
| | | | | | | | | | | | Refusal @7.0m on boulder | | | | | | N=100/17 | | |
| | | | | | | | | | | | End of Borehole and DCPT | | | | | | 100 blows for 17 cm penetration | | |
| | | | | | | | | | | | No groundwater in hole. | | | | | | | | |
| | | | | | | | | | | | DCPT conducted 1.5m north of GRD4. | | | | | | | | |
| | | | | | | | | | | | Move hole 2.0m east, auger refusal @5.5m. | | | | | | | | |
| | | | | | | | | | | | Move hole 2.0m west, auger refusal @5.2m. | | | | | | | | |

LOG OF BOREHOLE GRD4B

ENCL. No.: 10

| | |
|--|---------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: December 9th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|---|----|-------------------|-------|-------|---------|------|---------|--------|--|------------|------------|---------------|--|
| PL | W | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | kPa | kPa | | | | | | | | | | |
| | | | | | | | | | | SURFACE EL. 376.3 m | | | | |
| | | | | | | | | | | AUGER to 4.6m | 376 | | | Borehole drilled 2.0m north of GRD4. |
| | | | | | | | | | | | 375 | 1 | | |
| | | | | | | | | | | | 374 | 2 | | |
| | | | | | | | | | | | 373 | 3 | | |
| | | | | | | | | | | | 372 | 4 | | |
| 2 | | | | | | 1 | SS | 50* | | | | 5 | | *spoon bouncing on cobble |
| 2 | | | | | | 2 | SS | 40 | | dense | | 371 | | |
| 8 | | | | | | 3 | SS | 22 | | sand compact | | 370 | | |
| 2 | | | | | | 4 | SS | 50/13* | | | | 369 | | |
| 10 | | | | | | 5 | SS | 48 | | dense | | 368 | | |
| 9 | | | | | | 6 | SS | 30 | | | | | | |
| | | | | | | | | | | | | | | N=50/13 50 blows for 13 cm penetration |
| | | | | | | | | | | End of Borehole No groundwater in hole. | | | | |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No **GRD4B**

LOG OF BOREHOLE GRD5

ENCL. No.: 11

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 22nd, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS | | | | | |
|---------------------|------|-------|------|-------|-------|---------|------|-------------|-----|--------|----------------------|--------------|------------|---------------|---------|----|----|-------|--------------------------|-----|
| PL | W | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | | | | | | | |
| % | % | % | WT | Field | Lab | | | | | | | | | | | | | | | |
| kN/m ³ | Vane | Compr | kPa | kPa | | | | | | | | | | | | | | | | |
| SURFACE EL. 375.7 m | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | 3 | 1 | SS | 3 | | v.loose | 0.3m TOPSOIL | | | | Gr | Sa | Si&Cl | | |
| | | | | | | 8 | | | | | | | | | | | % | | | |
| 2 | | | | | | 23 | | | | | | | | 375 | 1 | | | | | |
| | | | | | | 39 | 2 | SS | 49 | | | | | | | | | | | |
| | | | | | | 42 | | | | | | | | | | | | | | |
| 3 | | | | | | 47 | 3 | SS | 77* | | | dense | | | 374 | 2 | | 39 | 56 | (5) |
| | | | | | | 12 | | | | | | | | | | | | | | |
| | | | | | | 13 | | | | | | | | | | | | | | |
| | | | | | | 16 | | | | | | | | | | | | | | |
| | | | | | | 11 | | | | | | | | | | | | | | |
| | | | | | | 14 | | | | | | | | | | | | | | |
| | | | | | | 38 | | | | | | | | | | | | | | |
| | | | | | | 100/28 | | | | | compact | | | 372 | 4 | | | | **N'-value unreliable | |
| | | | | | | | | | | | | | | | | | | | | |
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Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD5

LOG OF BOREHOLE GRD5B

ENCL. No.: 12

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------------|---------------|--------------|---------|------|---------|--|--------|----------------------|------------|------------|---------------|--|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | | |
| % | % | % | WT kN/m ³ | Field Vane | Lab Compr | | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | | |
| SURFACE EL. 375.7 m | | | | | | | | | | | | | | | |
| | | | | | | | | | | | AUGER to 1.5m | 375 | 1 | | Borehole drilled 2.0m north of GRD5. |
| 2 | | | | | | 1 | SS | 37 | | | | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD5B

LOG OF BOREHOLE GRD5C

ENCL. No.: 13

| | |
|--|----------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|---|----|-------------------|-------|------|---------|------|---------|--------|---|------------|------------|---------------|--|
| PL | W | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Comp | | | | | | | | | |
| | | | | kPa | kPa | | | | | SURFACE EL. 375.7 m | | | | |
| | | | | | | 63 | | | | Excavated to 4.6m and backfilled with sand. | 375 | 1 | | |
| | | | | | | 17 | | | | | 374 | 2 | | |
| | | | | | | 80 | | | | AUGER to 4.6m | 373 | 3 | | |
| | | | | | | 78 | | | | | 372 | 4 | | |
| | | | | | | 100 | | | | | 371 | 5 | | |
| | | | | | | 75 | | | | Start of DCPT @4.6m. | 370 | 6 | | |
| | | | | | | 100/10 | | | | Auger refusal @4.6m on boulder. | 369 | | | 100/10 : 100 blows for 10 cm penetration |
| | | | | | | 100/5 | | | | compact to dense | | | | |
| | | | | | | | | | | End of DCPT | | | | |
| | | | | | | | | | | No groundwater in testpit. | | | | |
| | | | | | | | | | | Move hole 2.0m east, auger refusal @4.6m. | | | | |
| | | | | | | | | | | Move hole 2.0m west, auger refusal @4.6m. | | | | |
| | | | | | | | | | | Move hole 2.0m north, auger refusal @4.6m. | | | | |
| | | | | | | | | | | Move hole 2.0m south, auger refusal @4.6m. | | | | |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. **GRD5C**

LOG OF BOREHOLE GRD6

ENCL. No.: 14

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 24th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------------|--------------|---------|------|---------|--------|----------------------|--|------------|---------------|--|
| PL | w | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane kPa | Compr kPa | | | | | | | | | |
| SURFACE EL. 377.0 m | | | | | | | | | | | | | | |
| 2 | | | | | | 2 | 1 | SS | 5 | loose | 0.3m TOPSOIL | 377 | | |
| 4 | | | | | | 6 | | | | ***** | brown | | | |
| 16 | | | | | | 25 | 2 | SS | 44 | | GRAVELLY SAND | | | |
| | | | | | | 48 | | | | compact | with frequent cobbles & boulders | 376 | 1 | |
| 3 | | | | | | 36 | | | | to dense | occ.moist Silty Sand layers | | | |
| | | | | | | 39 | 3 | SS | 50/13* | | | | | |
| | | | | | | 28 | | | | | End of Borehole | 375 | 2 | |
| | | | | | | 54 | | | | | Auger refusal @1.8m on boulder. | | | *sampler refusal on boulder |
| | | | | | | 100/15 | | | | | End of DCPT @2.6m | | | |
| | | | | | | | | | | | No groundwater in hole. | | | |
| | | | | | | | | | | | BH drilled 1.0m south of GRD6A. | | | |
| | | | | | | | | | | | Move hole 2.0m east, auger refusal @2.1m. | | | |
| | | | | | | | | | | | Move hole 2.0m west, auger refusal @3.0m. | | | |
| | | | | | | | | | | | Move hole 2.0m east & 2.0m south, auger refusal @2.7m. | | | |
| | | | | | | | | | | | Move hole 2.0m west & 2.0m south, auger refusal @2.4m. | | | |
| | | | | | | | | | | | DCPT conducted 1.0m south of GRD6. | | | |
| | | | | | | | | | | | | | | N=50/13 50 blows for 13 cm penetration |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD6

LOG OF BOREHOLE GRD6A

ENCL. No.: 15

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------------|-------|-------|---------|------|-------------|--|---|----------------------|------------|------------|---------------|--|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | | |
| % | % | % | WT kN/m ³ | Field | Lab | | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | | |
| SURFACE EL. 377.0 m | | | | | | | | | | | | | | | |
| | | | | | | | | | | 0.2m TOPSOIL | | 377 | | | Borehole drilled 1.0m north of GRD6. |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand | | 376 | 1 | | |
| | | | | | | | | | | | | 375 | 2 | | |
| | | | | | | | | | | | dry | 374 | 3 | | |
| | | | | | | | | | | AUGER to 7.5m | | 373 | 4 | | |
| | | | | | | | | | | | | 372 | 5 | | |
| | | | | | | | | | | | | 371 | 6 | | |
| | | | | | | | | | | brown GRAVELLY SAND with frequent cobbles & boulders | | 370 | 7 | | *sampler refusal on boulder |
| | | | | | | | | | | v.dense | | 369 | 8 | | |
| | | | | | | | | | | | dry | | | | |
| | | | | | | | | | | | | 368 | 9 | | |
| | | | | | | | | | | End of Borehole Auger refusal @9.2m on boulder. No groundwater and hole caved @4.0m. | | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No GRD6A

LOG OF BOREHOLE GRD6B

ENCL. No.: 16

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------|-------|-------|---------|------|-------------|--------|---|------------|------------|---------------|---|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | |
| % | % | % | WT | Field | Lab | | | | | | | | | |
| | | | kN/m3 | Vane | Compr | | | | | | | | | |
| | | | kPa | kPa | kPa | | | | | | | | | |
| SURFACE EL. 377.0 m | | | | | | | | | | | 377 | | | |
| | | | | | | | | | | 0.2m TOPSOIL | | | | Borehole drilled 1.0m east of GRD6. |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand | | | | |
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Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD6B

ENCL. No.: 17

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Auger |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 24th, 1998 |

[illegible]

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD7

LOG OF BOREHOLE GRD8

ENCL. No.: 18

| | |
|--|----------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: SolSt Auger |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: December 18th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------------|--------------|---------|------|-------|--------|--|------------|------------|---------------|---|
| PL | W | LL | WT | Field | Lab | No. | TYPE | Value | | | | | | |
| % | % | % | kN/m ³ | Vane kPa | Compr kPa | | | | | | | | | |
| SURFACE EL. 375.8 m | | | | | | | | | | | | | | |
| 33 | | | | | | 1 | SS | 5 | + | loose | | | | |
| 4 | | | | | | 2 | SS | 42 | + | | | | | |
| 3 | | | | | | 3 | SS | 30 | + | | | | | |
| 4 | | | | | | 4 | SS | 52 | + | dense | | | | |
| 3 | | | | | | 5 | SS | 50/5* | + | | | | | |
| 2 | | | | | | 6 | SS | 57 | + | | | | | |
| 9 | | | | | | 7 | SS | 31 | + | | | | | |
| | | | | | | | | | | 0.2 m TOPSOIL | | | | |
| | | | | | | | | | | brown GRAVELLY SAND with frequent cobbles & boulders | | | | |
| | | | | | | | | | | dry | | | | |
| | | | | | | | | | | | 375 | 1 | | |
| | | | | | | | | | | | 374 | 2 | | |
| | | | | | | | | | | | 373 | 3 | | |
| | | | | | | | | | | | 372 | 4 | | |
| | | | | | | | | | | | 371 | 5 | | |
| | | | | | | | | | | End of Borehole No groundwater and hole caved @ on completion. | | | | |
| | | | | | | | | | | | | | | *sampler refusal on cobble N=50/5 50 blows for 5 cm penetration |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD8

DRAFT

**DRAFT FOUNDATION DESIGN REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY**

Submitted To:

**DELCAN Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada**

Submitted By:

**AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada**

**January 1999
TT98801**



AGRA Earth & Environmental

ENGINEERING GLOBAL SOLUTIONS

**AGRA Earth &
Environmental Limited**
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

January 27, 1999.

Ref. No.: TT98801

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: Mr. Khaled El-Dalati, P. Eng.

Dear Sir:

**Re: DRAFT FOUNDATION DESIGN REPORT
FOR
PROPOSED GOREVILLE ROAD UNDERPASS
W.P. 772-93-00
HIGHWAY 11, DISTRICT 54
SUDBURY**

We take pleasure in enclosing six (6) Draft copies of our Geotechnical Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

Z.S. Ozden, P. Eng.,
Principal Engineer.

ZSO/dee

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APPENDICES

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FIGURES

GRAIN SIZE DISTRIBUTION CURVES

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ENCLOSURES

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1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Goreville Road over the realigned northbound and southbound lanes of proposed Highway 11 and associated interchange ramps. The site is located between South River and Trout Creek, to the east of the existing Highway 11 and Goreville Road in the Township of Laurier, Lot 4, Concession 8 in the District of Parry Sound. The proposed bridge will be an approximately 77 m long, 2-lane, two span structure.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8) to depths of 1.5 to 15.4 m, eleven dynamic cone penetration tests and four testpits. A detailed description of field procedures is given in Appendix 'A'.

The plan locations of the boreholes and cone tests, along with stratigraphic sections are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located approximately 0.3 km east of the intersection of Highway 11 and Goreville Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from south to north and from east to west, ranging from about Elevation 375 to 380 m. The area is heavily wooded with deciduous and coniferous trees.

Approximately 100 m north of the proposed bridge site, braided eskers wind across the proposed alignment of Highway 11. The topography in this area is hummocky with numerous boulders blanketing the surface.

Based on available geologic information the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss to amphibolite). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at eighteen borehole locations (Borehole Nos. GRD-1, 1B, 1G, 2, 2B, 3, 3B, 3G, 4, 4B, 5, 5B, 5C, 6, 6A, 6B, 7, 8), nineteen auger probe holes, four testpits and were inferred at the locations of eleven dynamic cone penetration tests. The locations of the boreholes and cone penetration tests are shown on the Plan and Profile Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. Cross sections of inferred subsurface stratigraphy are given on Drawing No. 1.

The ground surface at the proposed site generally drops from north to south. The ground elevation at the proposed bridge location generally ranges from about 377.5 to 377.0 m at the north side to about Elevation 376 m at the south (i.e. an elevation drop of 1 to 1.5 m within a distance of 12 m).

In general, the boreholes encountered, below a 0.2 to 0.3 m thick topsoil layer, granular deposits ranging from fine sand to gravelly sand with frequent cobbles and boulders to the full depth of the majority of the boreholes. Bedrock was encountered and cored in three boreholes (Boreholes GRD-2, 3 and 5) at depths ranging from 7.6 m (Elevation 368.0 m) to 12.2 m (Elevation 365.3 m) below existing grade. At the time of the investigation the groundwater table was recorded at depths of 9 to about 10 m below the existing grade or at Elevations generally ranging between 368.5 and 367 m.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 18. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL

The boreholes encountered 0.2 to 0.3 m of surficial topsoil. In some areas the presence of cobbles and boulders was noted within the topsoil zone. Measured natural moisture contents of samples from the topsoil ranged from 21 to 31%.

The thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 FINE SAND

Below the surficial topsoil, the boreholes drilled at the east abutment and central pier locations (i.e. except for Boreholes GRD-5, 5B, 5C, 6, 6A, 6B and 7), encountered fine sand with traces of silt. The deposit extended to depths ranging between 2.3 m or Elevation 375.4 m (Borehole GRD-1) and 4.3 m or Elevation 372.0 m (Borehole GRD-4). This is a granular (i.e. cohesionless) deposit. Grain size distribution analyses were conducted on three samples from the material and the range of particle sizes are presented as a curve envelope in Figure No. 1. The analyses indicate 1 - 3%

gravel, 84 - 89% sand and 10 - 13% silt and clay size particles. The deposit also contains some silty sand seams/lenses. Measured 'N'-values in this unit range from 3 to 22 blows/0.3 m indicating a very loose to compact condition. Measured natural moisture contents ranged from 1 to 15%, but are generally 1 to 2%.

3.3 SAND TO GRAVELLY SAND

Below the topsoil and/or surficial sand, an ice-contact stratified sand to gravelly sand deposit was encountered to the full extent of the borings or until bedrock was encountered. This is a cohesionless (granular) deposit and contains lenses of silty sand and gravel layers, and frequent cobbles and boulders. Seven grain size distribution analyses were conducted and the range of particle sizes are presented as a curve envelope in Figure No. 2. The analyses indicate 2 - 45% gravel, 51 - 96% sand and 2 - 35% silt and clay size particles. Measured 'N'-values generally range from 12 to greater than 50 blows/0.3 m, indicating compact to very dense condition, but generally compact to dense. Dynamic cone penetration results range from 11 to greater than 100 blows/0.3 m. Many of the 'N'-values were found to be unreliable due to refusal on a cobble or boulder, or the sampler pushing coarse gravel. In order to advance several of the boreholes, boulders were cored. Because of the presence of very frequent oversize particles, it was not possible to make a full or reliable assessment of the compactness condition of the deposit. Measured natural moisture contents ranged from 1 to 16%.

Due to difficult drilling conditions four testpits were excavated to Elevation 371 m, one at the proposed east abutment (Borehole GRD-3G) and pier locations (Borehole GRD-1G) and two at the proposed west abutment location (Borehole GRD-5, 5B, 5C, 6, 6A, 6B) to allow sampling below the proposed footing level. The testpits were backfilled with native sand with boulders selectively removed. The backfill is probably in a loose state.

3.4 BEDROCK

Below the overburden soils, bedrock was encountered and NQ size cores were obtained at Boreholes GRD-2, GRD-3 and GRD-5 at depths 7.6 m, 12.2 m and 8.8 m below existing ground surface (Elevations 368.0, 365.3 and 366.9 m). At boreholes GRD-2 and GRD-5 the bedrock consists of sound, pink, Precambrian granite. The rock was cored for a vertical distance of 3.0 m and a rock quality designation ranging from 69 to 100% was measured indicating the rock to be fair to excellent quality, but generally excellent. The core recovery was 100%.

At Borehole GRD-3, the bedrock consists of a black, weathered, Precambrian Amphibolite (Hornblende Schist). Coring was conducted 3.0 m into the rock (100% recovery) and a rock quality designation ranging from 0 to 34% was measured indicating the rock to be very poor to poor quality, but generally very poor.

Based on the recorded elevation of bedrock in the three boreholes and overburden depths in the remaining ones, the surface of the bedrock at the bridge site appears to slope down rather sharply from south to north (as evidenced at Boreholes GRD-1 and GRD-2) and gradually rises from west to east. It should also be pointed out that adjacent to Borehole GRD-2 (where the rock was cored) another probe was drilled within 2 m. This borehole extended to 2.1 m below the recorded (surmized) bedrock surface in Borehole GRD-2. This indicates that either the bedrock surface dips very sharply (or the rock encountered in Borehole GRD-2 was a very large boulder). From these observations and experience in the general area, the surface of the bedrock can be expected to be uneven and unpredictable.

3.5 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. The water levels in the open boreholes were checked prior to removing the augers or casing.

The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 9 to about 10 m below the ground surface (Elevation 368.5 to 367 m). These groundwater elevations were confirmed from the natural moisture content measured from collected samples. It should, however, be pointed out that the groundwater at the site would fluctuate seasonally and can be expected to be somewhat higher during the spring months and in response to heavy rains.

4.0 DISCUSSION AND RECOMMENDATIONS

The proposed Highway 11 realignment will consist of a four lane divided highway with an approximately 28 m wide median. The proposed bridge will carry Goreville Road over the proposed realigned northbound and southbound lanes of Highway 11 and the associated interchange ramps. It will be an approximately 77 m long, 2-lane, (12 m wide), two span structure. The grade at the bridge site drops from north to south. In general the existing ground elevation is generally 377.5 to 377 m on the north side of the bridge location and about 376 m on the south, while the grade at the borehole locations ranges from 379.3 to 375.6 m. The proposed grade of Highway 11 at the bridge site is approximately Elevation 372 m. The existing grades under the proposed bridge will therefore be lowered to build the highway, while the existing grades at the west and east abutments will be raised by about 2 to 5 m, respectively. The grade at the pier location will be cut by about 2.6 to 4.7 m below existing grade. The proposed bridge elevation over the highway is approximately 380.7 m.

The boreholes have shown beneath a veneer of surficial topsoil the presence of fine sand extending to depths ranging between 2.3 and 4.3 m below the ground surface at the east abutment and central pier locations. Beneath the fine sand at these locations and topsoil at the west abutment, the site is underlain by a major deposit of sand to gravelly sand with frequent cobbles and boulders. In three of the boreholes, Precambrian bedrock was contacted at 7.6 to 12.2 m below the ground surface or at Elevations ranging from 368.0 to 365.3 m while in the remaining boreholes the boreholes were terminated in the overburden. The recorded 'N'-values in the surficial sand generally show a loose to compact condition. The compactness condition of the sand to gravelly sand was difficult to assess due to the presence of frequent oversize particles (i.e. many of the test results were considered to be unreliable due to the influence of cobbles and boulders). Based on the available Standard Penetration and Dynamic Cone Penetration test results, however, the material is surmized to be generally compact to dense. The boreholes show that the groundwater table at the time of our investigation was about 9 to 10 m below existing grade.

4.1 FOUNDATIONS

Based on the proposed preliminary bridge configuration, if spread footing foundations are to be utilized, the bottom of footing elevations will likely be about 371.5 m at the west abutment location and 370 m at the east abutment and the central pier location. As discussed before, owing to the presence of very frequent oversized particles (i.e. coarse gravel, cobbles and boulders) the compactness condition of the granular overburden soils could not be fully assessed with the available conventional drilling and field testing equipment. Available 'N'-values, which were judged to be more reliable, and dynamic cone penetration resistances show variable compactness conditions. Based on the overall data, however, it is our opinion that the undisturbed overburden at or below the proposed footing elevations has sufficient bearing resistance for the use of normal footing foundations but settlements may be unpredictable.

The use of deep foundations is considered to be impractical, due to the presence of cobbles and boulders.

4.1.1 Spread Footing Foundations

In view of the above mentioned considerations it is recommended that normal spread footing foundations be used after the improvement of the compactness condition of the overburden to a sufficient depth below the founding level. In-situ soil improvement methods such as vibro-compaction to densify the soil will likely be impractical due to the presence of cobbles and boulders as well as being expensive. Methods such as dynamic compaction and grouting can be considered but are unlikely to be economically viable. It is therefore recommended that normal spread footings be used after the improvement of the overburden immediately beneath the footings by removing the soil to a sufficient depth and recompacting it.

For this purpose the following approach is recommended. The soil beneath the proposed footing should be removed to a depth of not less than 2.0 m below the bottom elevation of the footing within an area at least 2.0 m beyond the perimeter of the proposed footing (for example for a footing measuring 12.0 x 5.0 m in plan, the size of the excavation at the bottom would be $5 + 2 + 2 = 9$ m by $12 + 2 + 2 = 16$ m in plan). The sides of the excavation would be sloped not steeper than 1H:1V (flatter if necessary) and therefore at the proposed founding level, the size of the excavation would be 13 m by 20 m or greater. The on-site excavated sand to gravelly sand (see Figure No. 2) can be re-used provided that oversize materials (i.e. cobbles and boulders) with a nominal diameter of greater than 100 mm are selectively removed and that moisture contents are adjusted (i.e. measured native contents show that above the water table the material is considerably dry of the optimum). As mentioned before, the sides of excavations above the water table should not be sloped steeper than 1H:1V but may require flatter side slopes, especially since vibrations induced during compaction may create instability. If excavations extend below the water table or come close to it dewatering will be required, as is discussed later.

When the excavation reaches the required depth, the subgrade should be evaluated and approved by the Geotechnical Engineer. After its approval, the exposed subgrade at the base of the excavation may need to be compacted, if requested by the Geotechnical Engineer, to achieve a density of not less than about 98% of the material's Standard Proctor Maximum Dry Density (SPMDD). The fill used to raise the grade inside the excavation can be on-site excavated soils (after removing the oversize materials, as discussed before) or other approved compactable granular fill such as Granular 'A' materials or similar. It should be placed in layers not exceeding 200 mm in thickness and should be uniformly compacted to not less than 100% of its SPMDD.

A factored bearing resistance at U.L.S. of 750 kPa and a bearing resistance at S.L.S. equal to 300 kPa can be assigned to soil prepared in this manner. The serviceability condition is based on the premise that total and differential settlements will not exceed 25 mm and 20 mm, respectively.

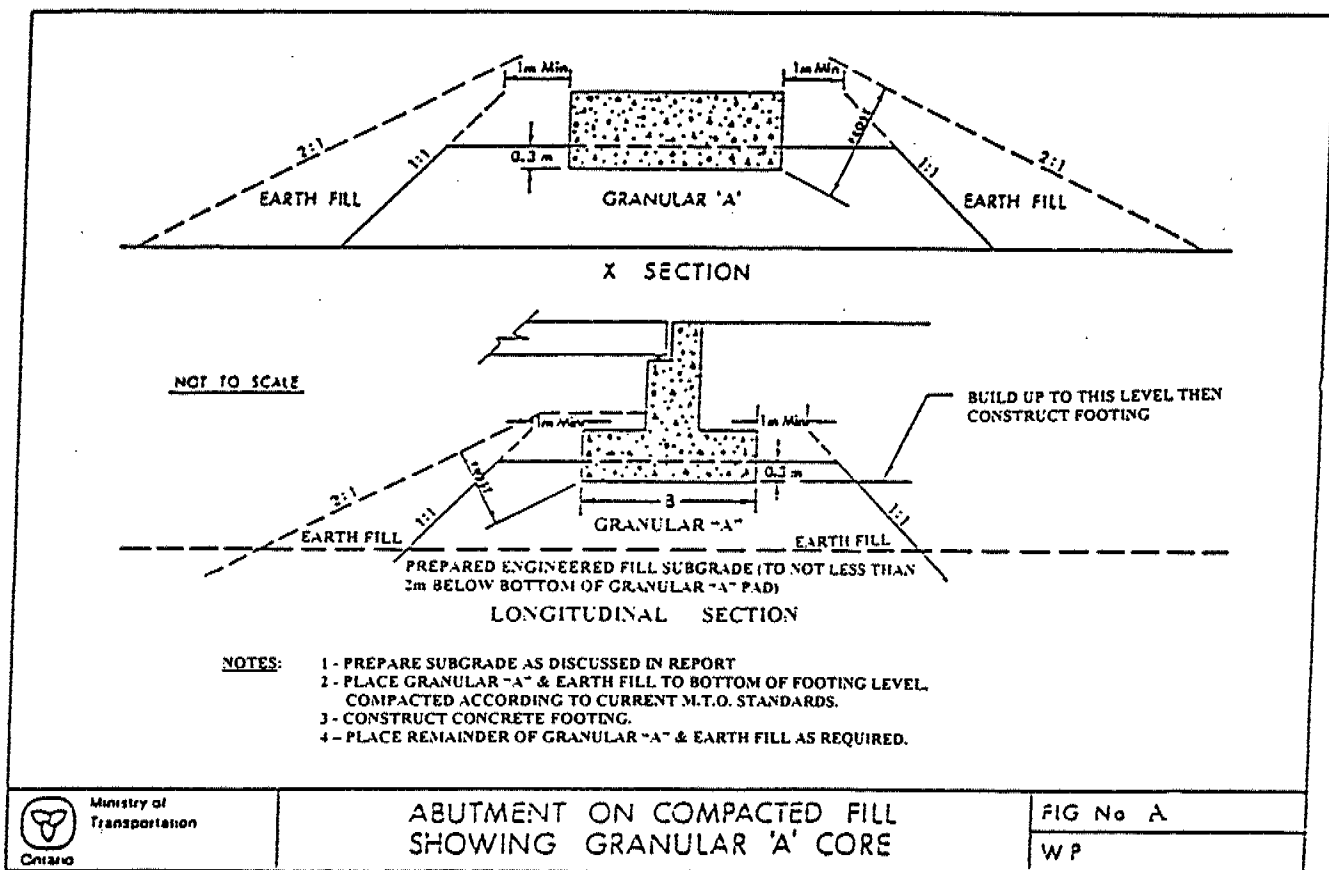
For frost protection, the footings should have a permanent earth cover of not less than 1.9 m.

Rock was encountered in Borehole GRD-2 at Elevation 368.0 m. If bedrock or boulders are encountered within the excavations (extended to 2.0 m below the footing base elevation), they should be removed to at least 0.1 m below the proposed excavation depth and replaced with compacted granular material. Allowance may need to be made for this purpose.

A potential problem with this approach would be the position of the water table. If water is encountered at or near the bottom of the excavation then dewatering will be required. Dewatering will need to be capable of drawing the water level to no less than 0.8 m below the bottom of the excavation. When preparing the dewatering scheme, the presence of cobbles and boulders and of the bedrock should be considered. If the water table is not properly lowered, the granular soil at bottom of the excavation can lose its load carrying capability (in addition to the instability of the side slopes) especially since there may be a requirement to compact the exposed subgrade from the surface. If this happens and the engineered fill is placed on disturbed and loosened subgrade

(and sides), excessive settlements can occur after the application of the structural loads. For this reason, we recommend that the contractor investigate the position of the water table before starting the excavation to assess required dewatering. The proposed dewatering scheme should be reviewed by the Geotechnical Engineer. As discussed before, water levels at the time of our investigation was generally recorded between elevations 368.5 and 367 m and was generally somewhat higher at the proposed pier location. To reduce the probability of encountering problems due to the groundwater table, we recommend that the proposed footing elevations be raised by at least 1 m, if at all possible, especially at the east abutment and (central) pier locations.

The recommended resistance values at U.L.S. and S.L.S. can be increased to 850 kPa and 350 kPa, respectively, if abutments (perched) are founded on engineered fill consisting of Granular 'A' type material (as per MTO standards) placed on top of the subgrade prepared as discussed above. In this case the thickness of the Granular 'A' pad (compacted in thin layers to at least 100% of the material's SPMDD) supporting the spread footing foundations should be at least 1.2 m. The construction of the Granular 'A' pad and of the earth fill should meet the minimum requirements as per Ontario Ministry of Transportation, as shown in Figure A below.



In any event as mentioned before, for frost protection, the footings should have a permanent earth cover if at least 1.9 m.

Under inclined loading conditions the Bearing Resistance at U.L.S. should be reduced in accordance with Clause 6-8.4.2 of O.H.B.D.C., 3rd Edition.

The unfactored horizontal resistance against sliding between concrete and approved compacted granular fill surface can be calculated using a friction angle of 29 degrees. This value can be increased to 35 degrees for Granular 'A' type material.

4.2 LATERAL EARTH PRESSURES

Backfill behind abutments and retaining walls should consist of non-frost susceptible, free draining granular materials in accordance with the Ontario Ministry of Transportation Standards.

Free-draining backfill materials and the provision of drain pipes and weep holes, etc., should prevent hydrostatic pressure build-up. Computation of earth pressures should be in accordance with O.H.B.D.C. For design purposes, the following physical properties can be used.

Compacted Granular 'A'

Angle of Internal Friction (ϕ) = 35° (unfactored)

Unit Weight = 22 kN/m^3

Coefficient of Lateral Earth Pressures:

$$K_a = 0.27$$

$$K_b = 0.35$$

$$K_o = 0.43$$

$$K^* = 0.45$$

Compacted Granular 'B'

Angle of Internal Friction (ϕ) = 30° (unfactored)

Unit Weight = 21 kN/m^3

Coefficient of Lateral Earth Pressures:

$$K_a = 0.33$$

$$K_b = 0.41$$

$$K_o = 0.50$$

$$K^* = 0.57$$

NOTE: K_b is the backfill earth pressure coefficient for an unrestrained structure including compaction effects.

K' is the earth pressure coefficient for a soil loading a fully restrained structure and includes compaction effects.

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained or movements can be allowed such that the active state of earth pressure can develop. The effect of compaction should also be taken into account in the selection of the appropriate earth pressure coefficients.

Vibratory equipment for use behind abutments and retaining walls should be restricted in size as per current MTO practice.

As an alternative to conventional retaining walls, MTO's Retained Soil System may be used. The following should be included in the Contract Documents:

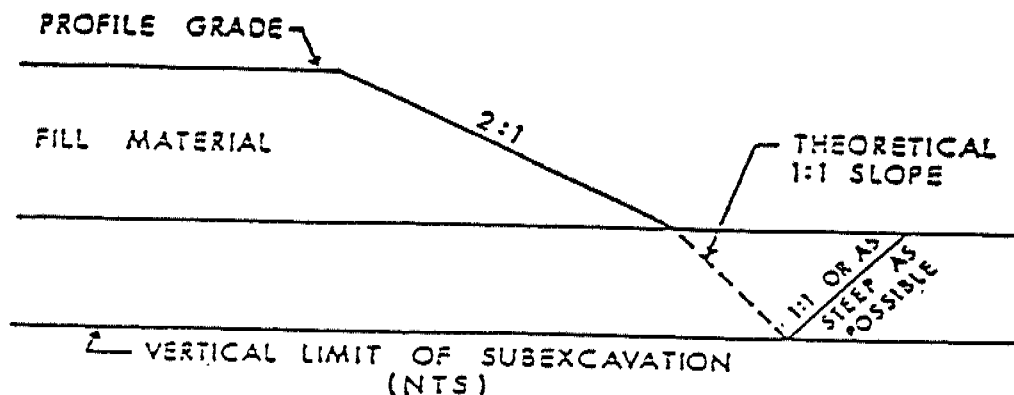
- identify longitudinal extent in plan of the Retained Soil System.
- identify in plan transverse space constraints (top of wall and bottom of wall)
- identify elevation of top of wall and bottom of wall
- include NSSP for Retained Soil Systems in Contract Documents

The Retained Soil System should be of high performance and moderate to high appearance.

4.3 CONSTRUCTION COMMENTS

As the proposed bridge deck level is about Elevation 380.7 m, and the existing grade elevations at the immediate approaches are approximately 379.3 to 376.0 m, up to about 1 to 5 m high embankments will have to be built. Based on the borehole results, the strength of the foundation materials is such that deep-seated failures are not anticipated, provided all organic soils, weak or otherwise unsuitable materials are removed as per MTO Standards before placing the fill.

Based on the borings, the average thickness of the unsuitable soils (i.e. organic topsoil and the weak zones of the underlying soil) can be expected to be about 0.3 to 0.4 m. All organic and other unsuitable soils should be removed within an envelope given by an imaginary slope not steeper than 1:1 from the toe of the proposed embankment as depicted by the sketch below. After stripping, the exposed subgrade should be inspected, approved and properly compacted from the surface under the supervision of qualified personnel.



REMOVAL OF UNSUITABLE SOILS FROM BENEATH APPROACH FILLS

Provided that all organic and otherwise unsuitable materials are removed and the subgrade is properly compacted from the surface as detailed above, the settlement of the foundation materials (i.e. not including the settlement of the embankment material under its own weight) should not exceed 25 mm and should be substantially completed within three weeks of placing the embankment fill to its full height. Such settlements are considered acceptable and will not necessitate preloading or surcharging.

Water level measurements in the boreholes indicate water levels between Elevations 367 and 368.5 m. Potential problems, depending on the groundwater table level at the time of construction and depth of excavations to prepare the engineered fill to support footings, due to groundwater, were discussed in Section 4.1.1 of this report and will not be repeated here. No problems due to groundwater are anticipated for excavations extending to or above Elevation 371± m. Any surface water seepage, if necessary, can easily be handled by gravity drainage and pumping from open sumps.

Allowance should be made to place an approximately 150 mm thick layer of lean concrete on the bearing surface to receive the foundations within four hours of preparation and acceptance of the bearing soil. It should be pointed out that if the foundation soil is disturbed, excessive settlements can occur after structural loads are applied.

All foundation excavations and bearing surfaces should be inspected and approved by the Geotechnical Engineer. We recommend that following construction of the footing, backfill be placed to a height of at least 1.2 m above the footing to prevent disturbance and frost penetration.

5.0 CLOSURE

We recommend that once the details of the structure are finalized, our recommendations should be reviewed for their specific applicability.

The Limitations of Report, as quoted in Appendix B, is an intergral part of this report.

Sincerely,

Andrew Drevininkas, P. Eng.

Z.S. Ozden, P. Eng.

AD/dee

APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 11 to 22, December 9 to 10, and December 16 to 18, 1998, and consisted of drilling and sampling eighteen boreholes, eleven dynamic cone penetration tests and four testpits. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

The boreholes were advanced using a track-mounted power auger drilling rig (CME 75) owned and operated by Canadian Soil Drilling Inc. and a track-mounted power auger drilling rig (BOA 10M) owned and operated by Groundworks Drilling Inc., under the full-time supervision of a soils engineer from AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit.

In addition, dynamic cone penetration tests were performed in eleven of the boreholes. This test consists of driving a 60° point, 50 mm diameter cone attached to the drill rod continuously, into the undisturbed ground with a driving energy of 475 J (63 kg hammer falling freely a distance of 76 cm) per blow. The number of blows for each 30 cm of penetration is recorded and this provides an indication of the relative changes in the soil density with depth.

Due to difficult drilling conditions, four testpits were excavated to approximate Elevations of 370 to 371 m (at Boreholes GRD- 1G, 3G, and encompassing Boreholes GRD- 5, 5B, 5C, 6, 6A, 6B). The testpits were backfilled with native sand with large boulders and cobbles selectively removed. Drilling was then carried out from the ground surface and advanced below the bottom of the sand backfill.

The borehole locations were established in the field by our engineering staff, in relation to the already staked out centre-line of Goreville Road (by Dearden and Stanton Limited). The borehole geodetic elevations and co-ordinates were later taken by surveyors from Dearden and Stanton Limited.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Borehole Log Sheets and also on Figure Nos. 1 and 2.

The boreholes were left open until the end of each work day to enable us to take additional water level readings. All boreholes were backfilled and grouted on November 22 and December 18, 1998.

APPENDIX B

AGRA
LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

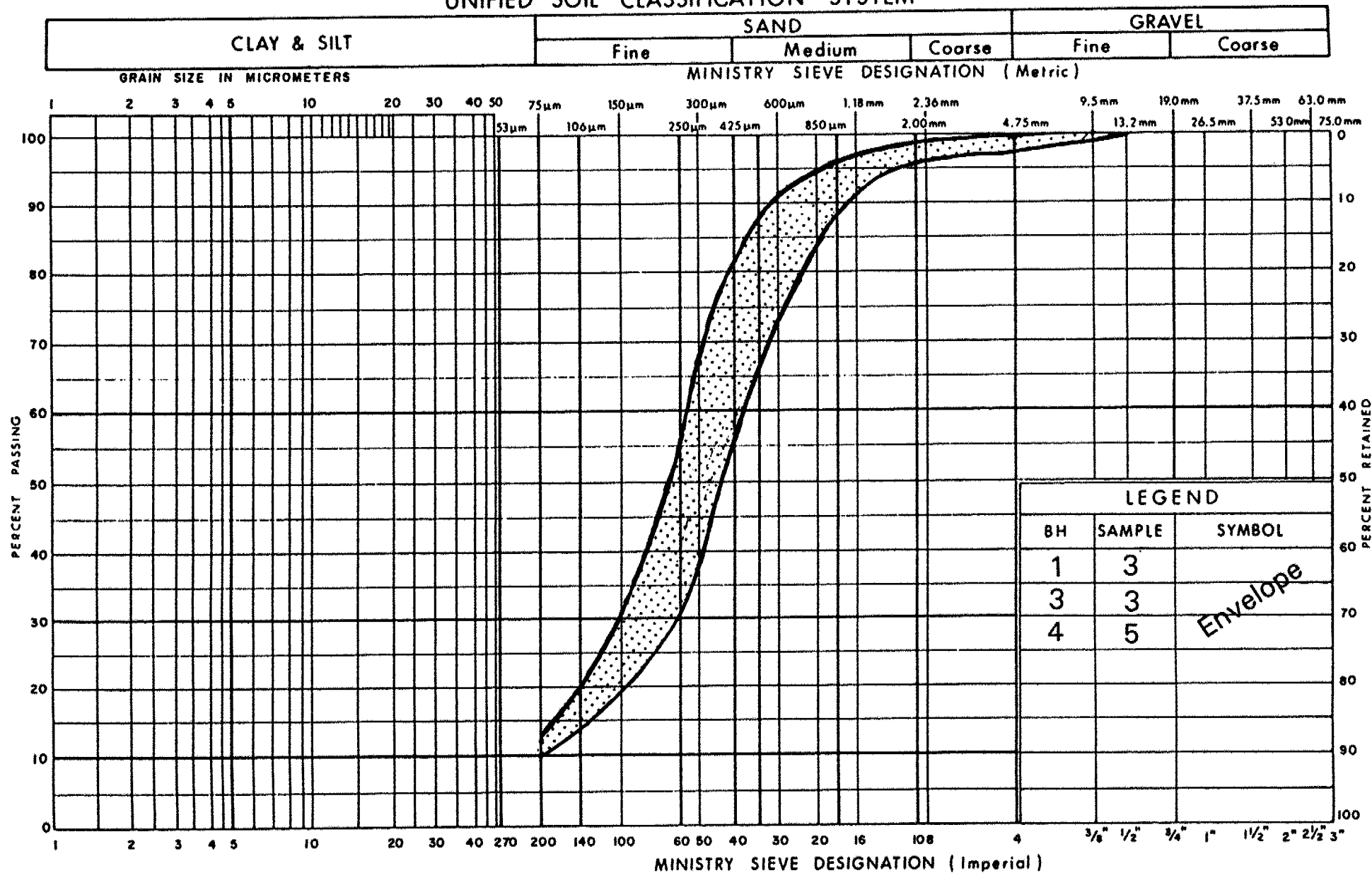
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final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

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

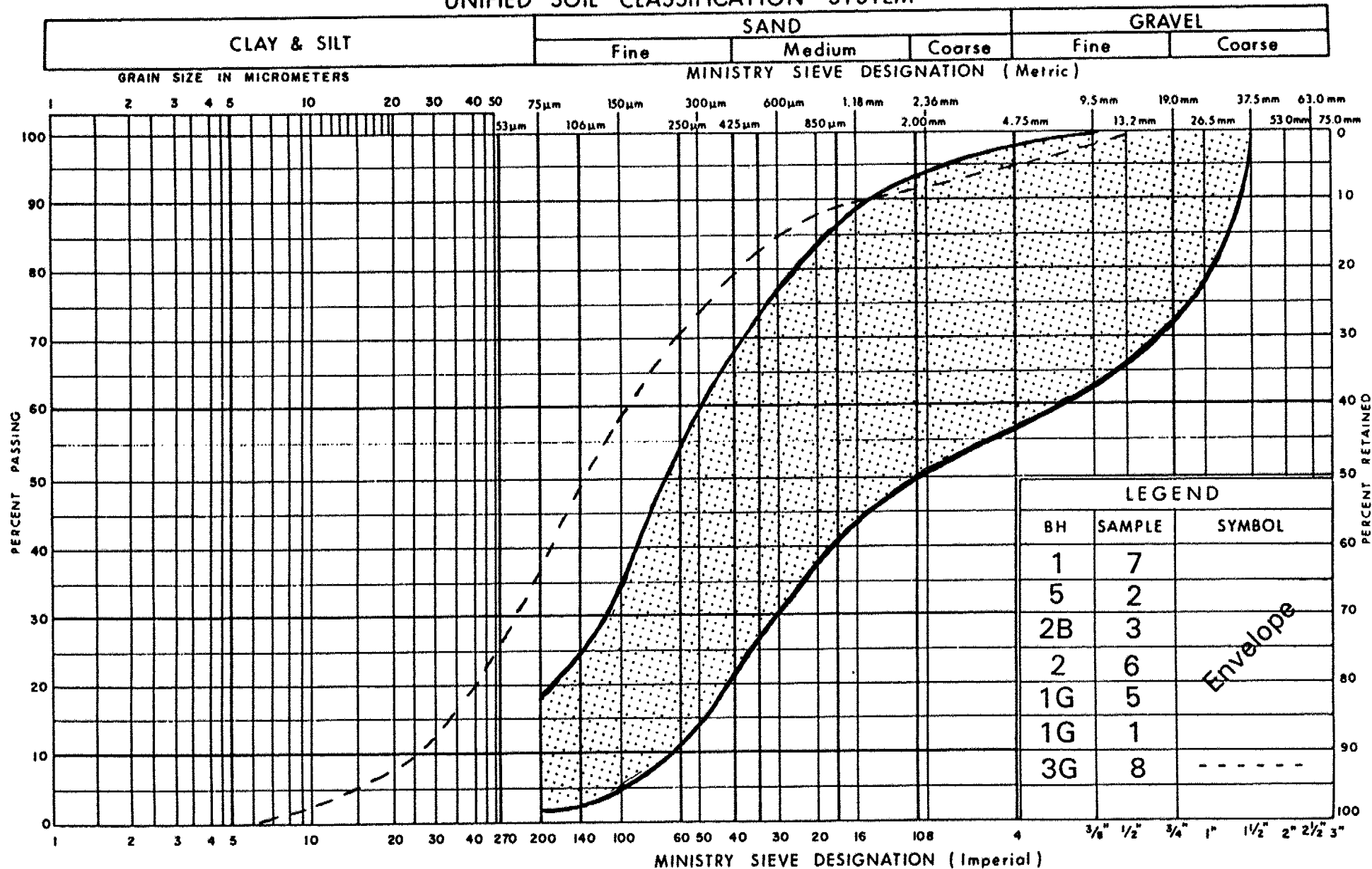
GRAIN SIZE DISTRIBUTION
FINE SAND, TRACE SILT

FIG No 1

W P 772-93-00

Ref No. TT98801

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

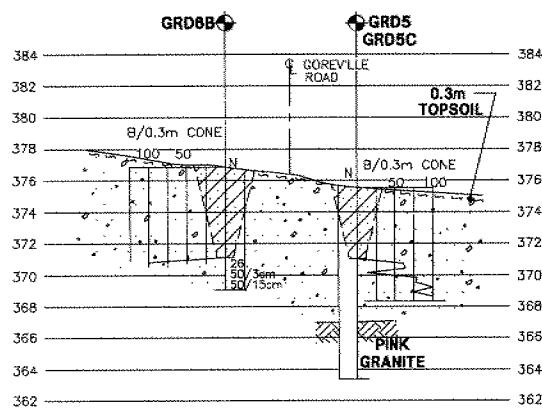
GRAIN SIZE DISTRIBUTION SAND TO GRAVELLY SAND

FIG No 2

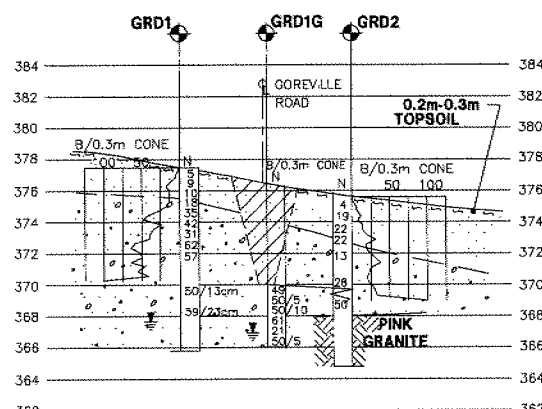
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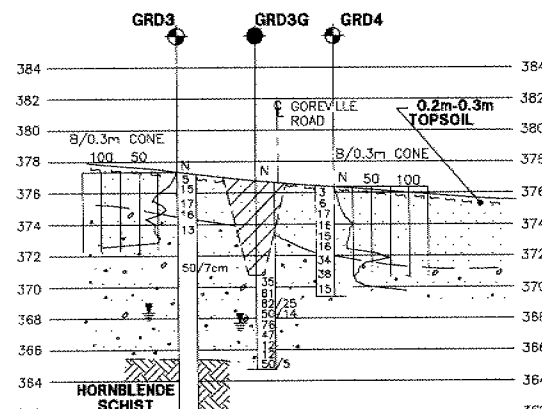
ENCLOSURES



SECTION C-C

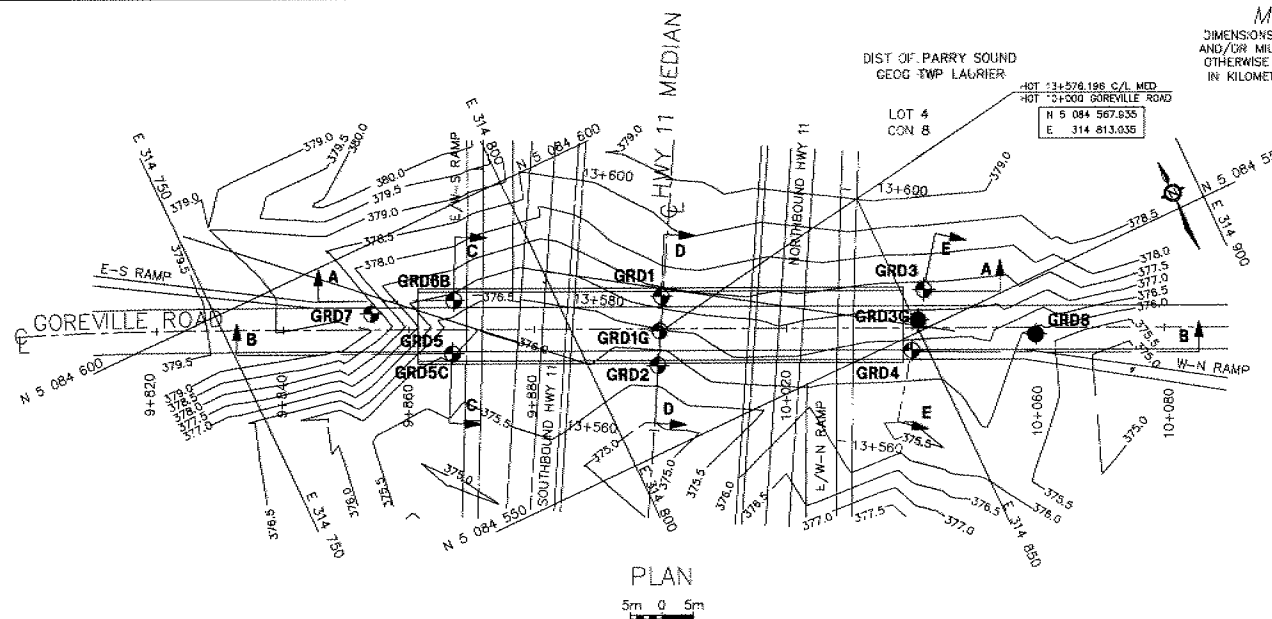
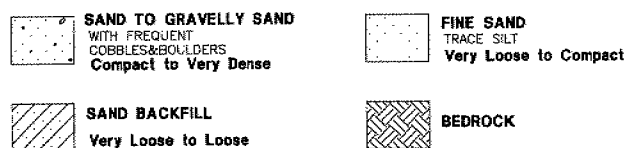


SECTION D-D

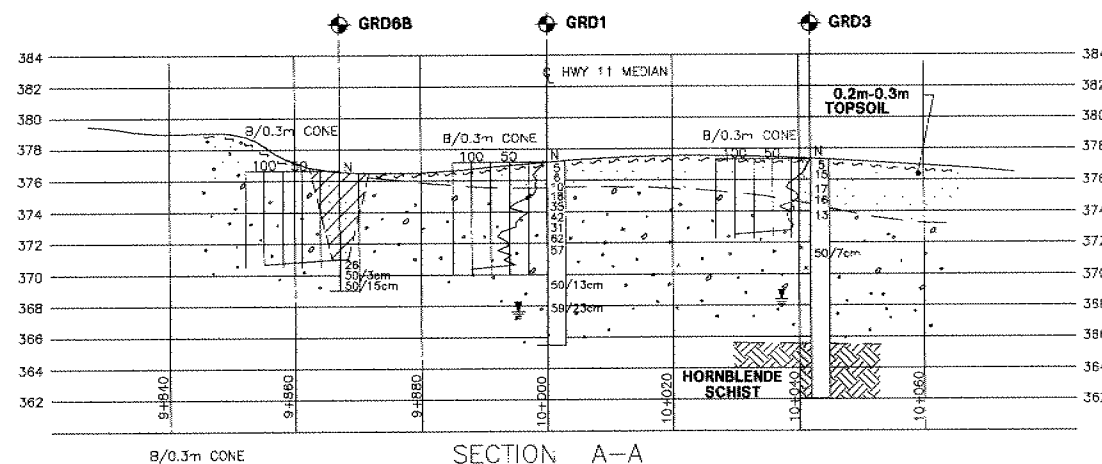


SECTION E-E

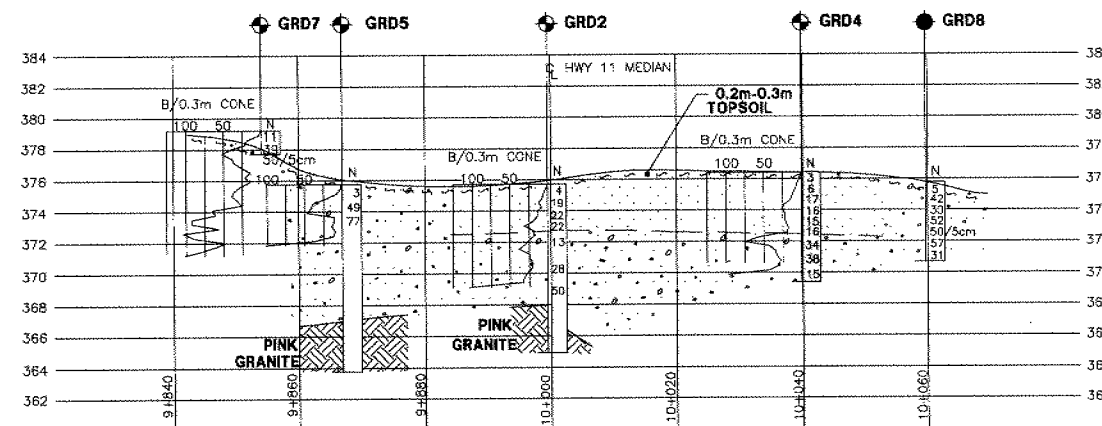
SOIL STRATIGRAPHY LEGEND



PLAN



SECTION A-A



SECTION B-B

5m 0 5m HOR
2m 0 2m VERT

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

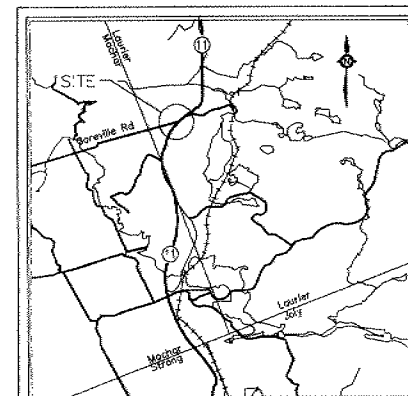
CONT. No. -
W.P. No. 772-93-00

GOREVILLE ROAD UNDERPASS
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

AGRA Earth & Environmental Ltd.



KEY PLAN

1 km 0 1 km

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/0.3m (Std Pen Test, 475 J/slow)
- CONE Blows/0.3m (60' Cone, 475 J/blow)
- WL at time of investigation Dec 98

| No | ELEVATION | CO-ORDINATES | |
|-------|-----------|--------------|---------|
| | | NORTH | EAST |
| GRD1 | 377.7 | 5 084 573 | 314 815 |
| GRD1G | 376.1 | 5 084 568 | 314 813 |
| GRD2 | 375.6 | 5 084 563 | 314 810 |
| GRD3 | 377.5 | 5 084 556 | 314 854 |
| GRD3G | 376.8 | 5 084 552 | 314 851 |
| GRD4 | 376.3 | 5 084 548 | 314 848 |
| GRD5 | 375.7 | 5 084 579 | 314 762 |
| GRD5C | 377.0 | 5 084 586 | 314 785 |
| GRD7 | 379.3 | 5 084 590 | 314 773 |
| GRD8 | 375.8 | 5 084 542 | 314 867 |

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 GC 2.01 of OPS Gen.Cond.

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

REF: Hwy 11 Bridge Site Plan
Dwg. by MTO; Oct. 1998

| | |
|-------------------|-------------|
| HWY No 11 | DIST 54 |
| SUBM 3 Z0 | CHECKED 20 |
| DATE Jan 27, 1999 | SITE 44-376 |
| DRAWN MA | CHECKED |
| | DWG 1 |

ENCL. No.: 1

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 11th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS | |
|---|--------|---------|---------------------|------------------------------|------------------------------|---------|------|-------------|--------|--|--|------------|------------|---------------|--|---|
| PL % | w % | LL % | UNIT WT kN/m3 | UNDR Field Vane kPa | STRNG Lab Compr kPa | No. | TYPE | N- Value | | | | | | | | |
| SURFACE EL. 377.7 m | | | | | | | | | | | | | | | | |
| 21 | | | | | | 4 | 1 | SS | 5 | loose | 0.3m TOPSOIL brown FINE SAND trace Silt | dry | 377- | 1 | Gr Sa Si&Cl % 3 84 (13) | |
| 2 | | | | | | 6 | | | | | | | | | | |
| | | | | | | 12 | 2 | SS | 9 | | | | | | | |
| 3 | | | | | | 13 | | | | compact | | | 376- | 2 | | |
| | | | | | | 16 | 3 | SS | 10 | | | | | | | |
| 1 | | | | | | 26 | | | | | | | | | | |
| | | | | | | 40 | 4 | SS | 18 | compact | | dry | 375- | 3 | | |
| | | | | | | 47 | | | | | | | | | | |
| | | | | | | 24 | | | | | | | | | | |
| | | | | | | 33 | 5 | SS | 35 | dense | | | 374- | 4 | | |
| 1 | | | | | | 37 | | | | | | | | | | |
| | | | | | | 38 | 6 | SS | 42 | | | | | | | |
| | | | | | | 56 | | | | GRAVELLY SAND with frequent cobbles & boulders | | | 373- | 5 | 24 73 (3) | |
| 2 | | | | | | 61 | | | | | | | | | | |
| | | | | | | 50 | 7 | SS | 31 | | | | | | | |
| | | | | | | 48 | | | | v.dense | | | 372- | 6 | | |
| 1 | | | | | | 62 | 8 | SS | 62 | | | | | | | |
| | | | | | | 45 | | | | | | | | | | |
| 1 | | | | | | 54 | | | | boulder | | | 371- | 7 | Auger refusal on boulder @6.9m. Advance by washboring method. | |
| | | | | | | 40 | 9 | SS | 57 | | | | | | | |
| | | | | | | 100/20 | | | | | | | | | | |
| | | | | | | | | | | | | | 370- | 8 | | |
| | | | | | | | | | | | | | 369- | 9 | | |
| | | | | | | | 10 | SS | 50/13* | | | | 368- | 10 | *spoon bouncing on cobble **No recovery spoon bouncing on cobble | |
| | | | | | | | | | | | | | 367- | 11 | | |
| | | | | | | | | | | | | | 366- | 12 | Casing shoe worn out at 12m, withdrew casing, hole caved. | |
| End of Borehole Groundwater in casing @10.0m and hole caved @6.0m on completion. Move hole 2.0m east, auger refusal @2.7m. Move hole 2.0m west, auger refusal @2.3m. | | | | | | | | | | | | | | | | N=50/13 50 blows for 13cm penetration |

LOG OF BOREHOLE GRD1B

ENCL. No.: 2

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DEL CAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------|-------|---------|------|---------|--------|---|------------|------------|---------------|--|
| PL | w | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | kPa | kPa | | | | | | | | | | |
| SURFACE EL. 377.7 m | | | | | | | | | | | | | | |
| | | | | | | | | | | INFERRED FINE SAND | 377 | 1 | | Borehole drilled 1.5m east of GRD1. |
| | | | | | | | | | | dry | 376 | 2 | | |
| | | | | | | | | | | AUGER to 6.1m | 375 | 3 | | *spoon bouncing on cobble |
| | | | | | | | | | | INFERRED GRAVELLY SAND | 374 | 4 | | |
| | | | | | | | | | | | 373 | 5 | | |
| | | | | | | | | | | | 372 | 6 | | |
| 5 | | | | | | 1 | SS | 50/10* | | brown SAND to GRAVELLY SAND with frequent cobbles & boulders | 371 | 7 | | N=50/10 50 blows for 10cm penetration |
| 5 | | | | | | 2 | SS | 40 | | | 370 | 8 | | |
| 1 | | | | | | 3 | SS | 75* | | | 369 | 9 | | |
| | | | | | | 4 | SS | 50/13* | | | 368 | | | |
| 1 | | | | | | 5 | SS | 63 | | | | | | |
| 2 | | | | | | 6 | SS | 40 | | | | | | |
| 5 | | | | | | | | | | grey, brown | | | | |
| | | | | | | | | | | End of Borehole Auger refusal @9.8m on boulder. No groundwater in hole on completion. | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD1B

ENCL. No.: 3

| | | | |
|---------------|---------------------|----------------------|---------------------|
| REF. No.: | TT98801 | <i>DRILLING DATA</i> | |
| CLIENT: | DELCAN | | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: | HolSt Augering |
| LOCATION | TROUT CREEK,ONTARIO | Diameter: | 150 mm |
| DATUM: | Geodetic | Date: | December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|--------|---------|-------|-------|-------|---------|------|-------------|--------|---|------------|------------|---------------|--|
| PL % | w % | LL % | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | |
| | | | WT | Field | Lab | | | | | | | | | |
| | | | kN/m3 | Vane | Compr | | | | | | | | | |
| SURFACE EL. 376.1 m | | | | | | | | | | | | | | |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand. | 376 | | | Gr Sa Si&Cl % |
| | | | | | | | | | | | 375 | 1 | | |
| | | | | | | | | | | | 374 | 2 | | |
| | | | | | | | | | | AUGER to 6.1m | 373 | 3 | dry | |
| | | | | | | | | | | | 372 | 4 | | |
| | | | | | | | | | | | 371 | 5 | | |
| | | | | | | | | | | | 370 | 6 | | 45 51 (4) |
| 2 | | | | | | 111 | 1 | SS | 49 | | | | | |
| | | | | | | 81 | | | | | | | | |
| | | | | | | 106 | 2 | SS | 50/5* | | | | | |
| | | | | | | 100/15 | | | | dense to v.dense | 369 | 7 | dry | |
| | | | | | | | 3 | SS | 50/10* | | | | | |
| 3 | | | | | | | | | | | | | | |
| | | | | | | | 4 | SS | 61 | | | | | |
| 9 | | | | | | | | | | brown/grey SAND to GRAVELLY SAND with frequent cobbles & boulders | 368 | 8 | moist | |
| | | | | | | | | | | | 367 | 9 | wet | 16 68 (16) |
| 15 | | | | | | | 5 | SS | 21 | compact | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | 6 | SS | 50/5* | | | | | |
| | | | | | | | | | | End of Borehole Auger refusal @10.1m on boulder. Groundwater in HolSt Augers @9.0m and hole caved @6.1m on completion. Move hole 2.0m east, auger refusal @7.8m. Move hole 2.0m west, Auger refusal @6.2m. DCPT conducted 1.0m south of GRD1G. | 366 | 10 | | N=50/5 50 blows for 5 cm penetration *spoon bouncing on cobble |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD1G

ENCL. No.: 4

[illegible]

Vertical Scale: 1:100



Checked: **RM**

ENCL. No.: 5

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 23rd, 1998 |

| LABORATORY DATA | | | | | | | SAMPLES | | | MATERIAL DESCRIPTION | | | ELEV. | DEPTH | WATER DATA | REMARKS | | |
|---|---|----|-------------------|-------|-------|------|---------|-------|-----|----------------------|---------|--------|---------|--|------------|---------|---|---|
| PL | w | LL | WT | Field | Lab | UNIT | UNDR | STRNG | No. | TYPE | N-Value | SYMBOL | m | m | | | | |
| % | % | % | kN/m ³ | Vane | Compr | kPa | kPa | | | | | | | | | | | |
| SURFACE EL. 375.6 m | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | 1 | SS | 14 | | compact | brown SAND, trace Silt | dry | 375 | 1 | Borehole drilled 1.5m west of GRD2. |
| 2 | | | | | | | | | 2 | SS | 35* | | compact | brown SAND to GRAVELLY SAND with frequent cobbles & boulders | dry | 374 | 2 | |
| 2 | | | | | | | | | 3 | SS | 27* | | | | | 373 | 3 | |
| 7 | | | | | | | | | 4 | SS | 19 | | | | | 372 | 4 | |
| | | | | | | | | | | | | | | | | 371 | 5 | 2 96 (2) |
| End of Borehole Refusal @5.2m on boulder. No groundwater in hole on completion. | | | | | | | | | | | | | | | | | | *spoon bouncing 'N'-value unreliable |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No GRD2B

ENCL. No.: 6

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 19th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | MATERIAL DESCRIPTION | | | | ELEV. | DEPTH | WATER DATA | REMARKS |
|---------------------|---|----|------|-------|-------|---------|------|---------|----------------------|---------|--|-----|-------|-------|------------|--|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | SYMBOL | | | | m | m | | |
| % | % | % | WT | Field | Lab | | | | | | | | | | | |
| SURFACE EL. 377.5 m | | | | | | | | | | | | | | | | |
| 31 | | | | | | 3 | 1 | SS | 5 | v.loose | 0.2m TOPSOIL | | 377 | | | Gr Sa Si&Cl % |
| | | | | | | 6 | | | | | | | | | | |
| 2 | | | | | | 10 | 2 | SS | 15 | | | | | 1 | | |
| | | | | | | 19 | | | | | | | | | | |
| | | | | | | 27 | | | | | | | | | | |
| 1 | | | | | | 31 | 3 | SS | 17 | | brown SAND | | 376 | | | 1 89 (10) |
| | | | | | | 19 | | | | | | | | 2 | | |
| 2 | | | | | | 14 | | | | compact | frequent layers of Silty Sand | | | | | |
| | | | | | | 22 | 4 | SS | 16 | | | dry | 375 | | | |
| | | | | | | 40 | | | | | | | | 3 | | |
| 2 | | | | | | 28 | 5 | SS | 13 | | brown SAND | | 374 | | | Auger refusal @3.6m. Advance by washboring method. |
| | | | | | | 29 | | | | | | dry | | | | |
| | | | | | | 28 | | | | boulder | to GRAVELLY SAND | | | 4 | | |
| | | | | | | 22 | | | | | with frequent cobbles & boulders compact | | 373 | | | |
| | | | | | | 25 | | | | boulder | | | | 5 | | |
| | | | | | | 100 | | | | boulder | | | | | | |
| | | | | | | 100/20 | | | | boulder | | | 372 | | | *spoon bouncing on boulder |
| | | | | | | | 6 | SS | 50/7* | | INFERRED SAND | | 371 | | | |
| | | | | | | | | | | | to GRAVELLY SAND | | | | | |
| | | | | | | | | | | boulder | with frequent cobbles & boulders | | 370 | | | |
| | | | | | | | | | | | | | | 8 | | N=50/7 50 blows for 7cm penetration |
| | | | | | | | | | | boulder | | | 369 | | | |
| | | | | | | | | | | boulder | | | | | | |
| | | | | | | | | | | boulder | | | 368 | | | |
| | | | | | | | | | | boulder | | | | 10 | | |
| | | | | | | | | | | boulder | | | 367 | | | |
| | | | | | | | | | | boulder | | | | 11 | | |
| | | | | | | | | | | boulder | | | 366 | | | |
| | | | | | | | | | | | | | | 12 | | |
| | | | | | | | 7 | RC | | | | | 365 | | | RC8: REC=100% RQD=34% |
| | | | | | | | | | | | | | | | | |
| | | | | | | | 8 | RC | | | black HORNBLENDE SCHIST BEDROCK (AMPHIBOLITE) closely jointed | | 364 | | | RC9: REC=100% RQD=0% |
| | | | | | | | 9 | RC | | | | | | 14 | | |
| | | | | | | | | | | | | | 363 | | | RC10: REC=100% RQD=12% RC11: REC=100% RQD=0% |
| | | | | | | | 10 | RC | | | | | | 15 | | |
| | | | | | | | | | | | End of Borehole DCPT conducted 2.0m south of GRD3. Groundwater in casing @9.0m and hole caved @5.0m on completion. Move hole 2.0m east, auger refusal @4.5m. Move hole 2.0m west, auger refusal @3.6m. | | | | | |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD3

LOG OF BOREHOLE GRD3B

ENCL. No.: 7

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 23rd, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------|-------|-------|---------|------|---------|--------|---|------------|------------|---------------|--|
| PL | W | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m3 | Field | Lab | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 377.5 m | | | | | | | | | | | | | | |
| | | | | | | | | | | AUGER to 4.6m | 377 | 1 | | Borehole drilled 3.0m south of GRD3. |
| | | | | | | | | | | | 376 | 2 | | |
| | | | | | | | | | | | 375 | 3 | | |
| | | | | | | | | | | | 374 | 4 | | *spoon bouncing |
| | | | | | | | | | | | 373 | 5 | | 'N'-value unreliable |
| 3 | | | | | | 1 | SS | 53 | | dense sandy | 372 | 6 | | |
| 3 | | | | | | 2 | SS | 31 | | | 371 | 7 | | |
| 11 | | | | | | 3 | SS | 25 | | silty compact to dense | 370 | 8 | | |
| 1 | | | | | | 4 | SS | 50/13* | | brown SAND to GRAVELLY SAND with frequent cobbles & boulders | 369 | 9 | | |
| 1 | | | | | | 5 | SS | 50/7* | | dry | 368 | 10 | | |
| | | | | | | | | | | End of Borehole Auger refusal @7.8m on boulder. No groundwater in hole on completion. DCPT conducted Dec.17/98. | 367 | 11 | | |
| | | | | | | | | | | | 366 | | | |
| | | | | | | | | | | End of DCPT @11.6m. On possible Bedrock | | | | N=50/13 50 blows for 13 cm penetration |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No GRD3B

LOG OF BOREHOLE GRD3G

ENCL. No.: 8

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: SolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 17th, 1998 |

| LABORATORY DATA | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---|--------|---------|---------------------|----------------------|---------------------|-----|------|-------------|--------|--|------------|------------|---------------|---------|
| PL % | w % | LL % | UNIT WT kN/m3 | Field Vane kPa | Lab Compr kPa | No. | TYPE | N- Value | | | | | | |
| STRNG | | | | | | | | | | | | | | |
| SURFACE EL. 376.8 m | | | | | | | | | | | | | | |
| 6 | | | | | | 1 | GS | | | Excavated to 6.0m and backfilled with sand. | 376 | 1 | Gr Sa Si Cl % | |
| | | | | | | | | | | AUGER to 6.1m | 375 | 2 | | |
| | | | | | | | | | | | 374 | 3 | | |
| | | | | | | | | | | | 373 | 4 | | |
| | | | | | | | | | | | 372 | 5 | | |
| | | | | | | | | | | | 371 | 6 | | |
| 6 | | | | | | 2 | SS | 35 | | | | 370 | 7 | |
| 5 | | | | | | 3 | SS | 61 | | | brown | | 8 | |
| 6 | | | | | | 4 | SS | 82/25* | | | damp | | 9 | |
| 9 | | | | | | 5 | SS | 50/14* | | | brown/grey | | 10 | |
| 15 | | | | | | 6 | SS | 76 | | SAND to GRAVELLY SAND with frequent cobbles & boulders | | 11 | | |
| 8 | | | | | | 7 | SS | 47 | | | | 12 | | |
| 16 | | | | | | 8 | SS | 12 | | | | | | |
| 8 | | | | | | 9 | SS | 12 | | | | | | |
| 16 | | | | | | 10 | SS | 50/5* | | | | | | |
| | | | | | | | | | | End of Borehole Auger refusal @12.0m on probable Bedrock. Groundwater in HolSt Augers @9.0m and hole caved @7.5m on completion. Move hole 2.0m east, auger refusal @3.3m. Move hole @2.0m west, Auger refusal @5.1m. | | | | |
| * spoon bouncing on cobble/bedrock | | | | | | | | | | | | | | |
| N=82/25 82 blows for 25 cm penetration | | | | | | | | | | | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD3G

ENCL. No.: 9

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 21st, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS | | |
|---------------------|---|----|-------------|-------|-------|---------|------|-------------|--------|----------------------|------------------------------------|------------|---------------|---------|-------------|------------------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | | | |
| % | % | % | WT kN/m3 | Field | Lab | | | | | | | | | | Vane kPa | Compr kPa |
| SURFACE EL. 376.3 m | | | | | | | | | | | | | | | | |
| 21 | | | | | | 8 | 1 | SS | 3 | v.loose | 0.3m TOPSOIL | 376 | | Gr | Sa | Si&Cl |
| 11 | | | | | | 11 | | | | ----- | red to brown SAND, | | | % | | |
| 1 | | | | | | 14 | 2 | SS | 6 | loose | trace Silt, Gravel, Cobbles | damp | 1 | | | |
| 1 | | | | | | 21 | | | | | | | | | | |
| 15 | | | | | | 25 | | | | | | 375 | | | | |
| | | | | | | 21 | 3 | SS | 17 | | | damp | 2 | | | |
| | | | | | | 21 | | | | | | | | | | |
| | | | | | | 14 | 4 | SS | 16 | gravelly | brown | dry | 374 | | | |
| | | | | | | 23 | | | | compact | FINE SAND | | | | | |
| | | | | | | 25 | | | | | trace silt | | | | | |
| 1 | | | | | | 25 | 5 | SS | 15 | | occ. Gravel layers | | 3 | 1 | 89 | (10) |
| 4 | | | | | | 24 | | | | | | | | | | |
| 2 | | | | | | 21 | 6 | SS | 16 | | | | 4 | | | |
| | | | | | | 22 | | | | | | | | | | |
| | | | | | | 59 | | | | | | 372 | | | | |
| 1 | | | | | | 78 | 7 | SS | 34 | dense | brown | | 5 | | | |
| | | | | | | 46 | | | | | SAND | | | | | |
| | | | | | | 38 | | | | | to | | | | | |
| | | | | | | 36 | 8 | SS | 38 | | GRAVELLY SAND | | 371 | | | BH drilled 2.0m |
| | | | | | | 31 | | | | | with frequent cobbles & boulders | | 6 | | | south of GRD4B. |
| 14 | | | | | | 33 | 9 | SS | 15 | compact | some Silt | | | | | |
| 1 | | | | | | 46 | | | | | | 370 | | | | |
| | | | | | | 100/17 | | | | | | | 7 | | | N=100/17 |
| | | | | | | | | | | | Refusal @7.0m on boulder | | | | | 100 blows for 17 |
| | | | | | | | | | | | End of Borehole and DCPT | | | | | cm penetration |
| | | | | | | | | | | | No groundwater in hole. | | | | | |
| | | | | | | | | | | | DCPT conducted 1.5m north of | | | | | |
| | | | | | | | | | | | GRD4. | | | | | |
| | | | | | | | | | | | Move hole 2.0m east, auger refusal | | | | | |
| | | | | | | | | | | | @5.5m. | | | | | |
| | | | | | | | | | | | Move hole 2.0m west, auger refusal | | | | | |
| | | | | | | | | | | | @5.2m. | | | | | |

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. **GRD4**

ENCL. No.: 10

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 9th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. | DEPTH | WATER DATA | REMARKS |
|-------------------|---|----|------|-------|-------|---------|------|---------|---------------------|----------------------|-------|-------|------------|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | m | m | | |
| % | % | % | WT | Field | Lab | | | | | | Vane | Compr | | |
| kN/m ³ | | | | | | kPa | | kPa | SURFACE EL. 376.3 m | | | | | |
| | | | | | | | | | | | | | | |
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Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No GRD4B

ENCL. No.: 11

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 22nd, 1998 |

[illegible]

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. **GRD5**

LOG OF BOREHOLE GRD5B

ENCL. No.: 12

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------|-------|---------|------|---------|--------|---|--|------------|------------|---------------|--|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | | |
| % | % | % | kN/m ³ | Field | Lab | | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | | |
| SURFACE EL. 375.7 m | | | | | | | | | | | | | | | |
| | | | | | | | | | | AUGER to 1.5m | | 375 | 1 | | Borehole drilled 2.0m north of GRD5. |
| 2 | | | | | | 1 | SS | 37 | | | | 374 | 2 | | |
| 2 | | | | | | 2 | SS | 30 | | | | 373 | 3 | | |
| 4 | | | | | | 3 | SS | 50/7* | | dense | | 372 | 4 | | *N'-value unreliable |
| | | | | | | 4 | SS | 110 | | v.dense | | 371 | | | |
| | | | | | | | | | | End of Borehole Auger refusal @4.7m on boulder. No groundwater in hole. | | | | | N=50/7 50 blows for 7 cm penetration |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No GRD5B

ENCL. No.: 13

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 10th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | MATERIAL DESCRIPTION | | ELEV. | DEPTH | WATER DATA | REMARKS |
|-----------------|---|----|-------|------|-------|---------|------|-------------|--------|---|--|-------|-------|---------------|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | SYMBOL | | | m | m | | |
| % | % | % | kN/m³ | Vane | Comp | kPa | kPa | | | | | | | | |
| | | | | | | | | | | SURFACE EL. 375.7 m | | | | | |
| | | | | | | | | | | Excavated to 4.6m and backfilled with sand. | | 375 | 1 | | |
| | | | | | | | | | | AUGER to 4.6m | | 374 | 2 | | |
| | | | | | | | | | | | | 373 | 3 | | |
| | | | | | | | | | | | | 372 | 4 | | |
| | | | | | | | | | | Start of DCPT @4.6m. Auger refusal @4.6m on boulder. | | 371 | 5 | | |
| | | | | | | | | | | compact to dense | | 370 | 6 | | |
| | | | | | | | | | | End of DCPT No groundwater in testpit. Move hole 2.0m east, auger refusal @4.6m. Move hole 2.0m west, auger refusal @4.6m. Move hole 2.0m north, auger refusal @4.6m. Move hole 2.0m south, auger refusal @4.6m. | | 369 | | | |
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Vertical Scale: 1:100



AGRA

Checked: **RM**

SHEET 1 OF 1 BH No **GRD5C**

ENCL. No.: 14

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 24th, 1998 |

| LABORATORY DATA | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|--------|---------|---------------------------------|------------|---------|-----|------|-------------|--------|----------------------|------------|------------|---------------|---------|
| PL % | w % | LL % | UNIT WT kN/m ³ | UNDR STRNG | | No. | TYPE | N- Value | | | | | | |
| | | | | Field | Lab | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
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Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD6

LOG OF BOREHOLE GRD6A

ENCL. No.: 15

| | |
|--|----------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------|-------|---------|------|----|-------|--------|---|------------|------------|---------------|---------|
| PL | w | LL | WT | Field | Lab | No. | TYPE | N- | Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | | |
| | | | kPa | kPa | | | | | | | | | | | |
| SURFACE EL. 377.0 m | | | | | | | | | | | | 377 | | | |
| | | | | | | | | | | | 0.2m TOPSOIL | | | | |
| | | | | | | | | | | | Excavated to 6.0m and backfilled with sand | 376 | 1 | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | 375 | 2 | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | dry | 374 | 3 | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | AUGER to 7.5m | 373 | 4 | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | 372 | 5 | | |
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| | | | | | | | | | | | | 371 | 6 | | |
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| | | | | | | | | | | | brown GRAVELLY SAND with frequent cobbles & boulders | 370 | 7 | | |
| | | | | | | | | | | | v.dense | | | | |
| | | | | | | | | | | | | 369 | 8 | | |
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| | | | | | | | | | | | | 368 | 9 | | |
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| | | | | | | | | | | | End of Borehole Auger refusal @9.2m on boulder. No groundwater and hole caved @4.0m. | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD6A

LOG OF BOREHOLE GRD6B

ENCL. No.: 16

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 16th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|---|----|-------------------|-------|------|---------|------|---------|--------|---|------------|------------|---------------|--|
| PL | w | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Comp | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 377.0 m | | | | | | | | | | | | | | |
| | | | | | | | | | | 0.2m TOPSOIL | 377 | | | Borehole drilled 1.0m east of GRD6. |
| | | | | | | | | | | Excavated to 6.0m and backfilled with sand | 376 | 1 | | |
| | | | | | | | | | | | 375 | 2 | | |
| | | | | | | | | | | | 374 | 3 | | |
| | | | | | | | | | | AUGER to 6.1m | 373 | 4 | | |
| | | | | | | | | | | | 372 | 5 | | |
| | | | | | | | | | | | 371 | 6 | | |
| | | | | | | | | | | | 370 | 7 | | |
| | | | | | | | | | | | | | | *sampler refusal on boulder N=50/3 50 blows for 3 cm penetration |
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Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD6B

ENCL. No.: 17

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Auger |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 24th, 1998 |

[illegible]

Vertical Scale: 1:100



Checked: **RM**

SHEET 1 OF 1 BH No. GRD7

LOG OF BOREHOLE GRD8

ENCL. No.: 18

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: SolSt Auger |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: December 18th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|--|---|----|-------------------------|-------|-------|---------|------|-------------|--------|--|------------|------------|---------------|---|
| PL | W | LL | UNIT | UNDR | STRNG | | | | | | | | | |
| % | % | % | WT kN/m ³ | Field | Lab | No. | TYPE | N- Value | | | | | | |
| | | | | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 375.8 m | | | | | | | | | | | | | | |
| 33 | | | | | | 1 | SS | 5 | loose | 0.2 m TOPSOIL | 375 | 1 | | |
| 4 | | | | | | 2 | SS | 42 | | | | | | |
| 3 | | | | | | 3 | SS | 30 | | | | | | |
| 4 | | | | | | 4 | SS | 52 | dense | brown GRAVELLY SAND with frequent cobbles & boulders | 374 | 2 | | |
| 3 | | | | | | 5 | SS | 50/5* | | dry | 373 | 3 | | *sampler refusal on cobble N=50/5 50 blows for 5 cm penetration |
| 2 | | | | | | 6 | SS | 57 | | | 372 | 4 | | |
| 9 | | | | | | 7 | SS | 31 | | | 371 | 5 | | |
| | | | | | | | | | | | | | | |
| End of Borehole No groundwater and hole caved @ on completion. | | | | | | | | | | | | | | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 1 BH No. GRD8

GEOCRES No. _____

DIST. 54 REGION _____W.P. No. 772-93-01

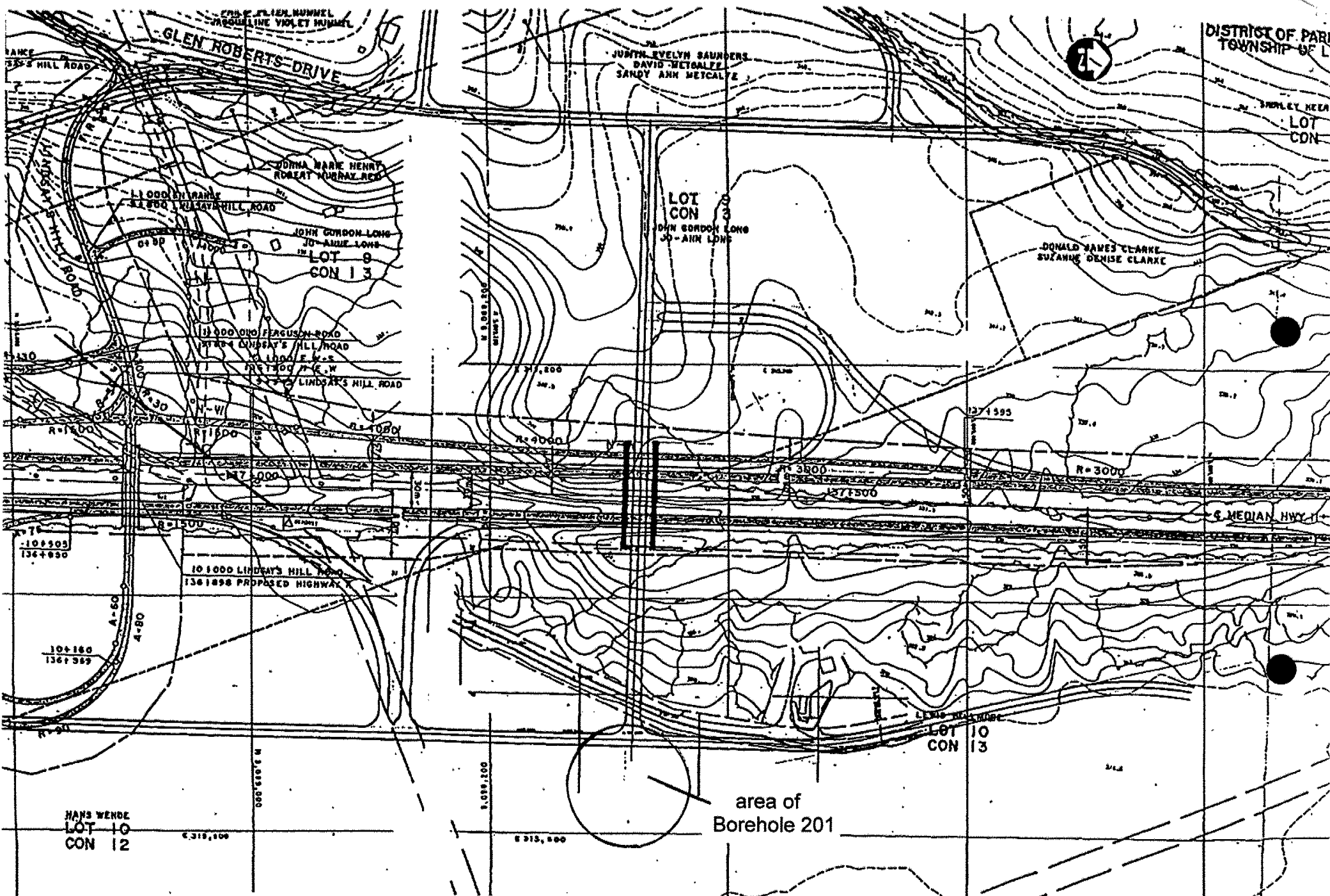
CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. 11LOCATION Lindsay Hill BridgeNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS: _____



LINDSAY'S HILL ROAD INTERCHANGE
ALTERNATIVE 2(j) Modified
Underpass With Access Ramps
(Flyover With "Buck-Saw Access" Further South)

RECORD OF BOREHOLE No 201

1 OF 1

METRIC

W.P. 772-93-00 LOCATION ORIGINATED BY AD
 DIST 54 HWY 11 BOREHOLE TYPE Hollow Stem COMPILED BY AD
 DATUM Assumed DATE 8 July 1999 CHECKED BY ZSO

| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|------------|---------|------|------------|-------------------------|-----------------|--|----|---------------------|------------------------------|--------------------|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 | 40 | | | | | |
| 100.0 | | | | | | | | | | | | | | |
| 0.0 | black PEAT wet | | 1 | SS | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 97.4 | | | 2 | SS | 1 | | | | | | | | | |
| 2.6 | brown SAND fine to medium compact, wet | | 3 | SS | 13 | | | | | | | | | |
| 96.0 | | | | | | | | | | | | | | |
| 4.0 | brown SILTY SAND compact, wet | | 4 | SS | 13 | | | | | | | | | |
| 94.4 | | | | | | | | | | | | | | |
| 5.6 | | | 5 | SS | 3 | | | | | | | | | |
| | SAND layer | | | | | | | | | | | | | |
| | grey SILTY CLAY firm | | 6 | SS | 1 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 7 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 8 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 9 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 10 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 11 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 12 | SS | 0* | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 81.7 | | | | | | | | | | | | | | |
| 18.3 | END OF BOREHOLE | | | | | | | | | | | | | |
| | Water Level in Open Bore: on completion: 0.15m | | | | | | | | | | | | | |

+³ X³ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

SS7 to 12: drill rods sank under own weight

RECORD OF BOREHOLE No 202

1 OF 1

METRIC

W.P. 772-93-00 LOCATION Between CNR & Black Creek ORIGINATED BY MA
 DIST 54 HWY 11 BOREHOLE TYPE Wash boring COMPILED BY AD
 DATUM Assumed DATE 24 August 1999 CHECKED BY AD

| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|-------------------------|-----------------|--|--|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | | | |
| 100.0 | | | | | | | | 20 40 60 80 100 | | | | | | |
| 0.0 | 0.15m TOPSOIL | | | | | | | | | | | | | |
| 99.4 | brown SAND trace Silt, damp, loose | | 1 | SS | 7 | | | | | | | | | |
| 0.6 | grey, varved SILTY CLAY to CLAYEY SILT | | 2 | SS | 11 | | | | | | | | | |
| | stiff to very stiff | | 3 | SS | 12 | | | | | | | | | |
| | | | 4 | TW | - | | | | | | | | | |
| | soft | | 5 | SS | 3 | | | | | | | | | |
| | firm | | 6 | SS | 4 | | | | | | | | | |
| | | | 7 | SS | 3 | | | | | | | | | |
| | stiff | | 8 | TW | - | | | | | | | | | |
| | | | 9 | SS | 3 | | | | | | | | | |
| | firm | | 10 | SS | 6 | | | | | | | | | |
| | soft | | | | | | | | | | | | | |
| 91.9 | | | | | | | | | | | | | | |
| 8.1 | grey SILT with frequent clay & sand seams compact, wet | | 11 | SS | 12 | | | | | | | | | |
| | | | 12 | SS | 12 | | | | | | | | | |
| 90.3 | | | | | | | | | | | | | | |
| 9.7 | grey SILTY SAND with occasional clay seams wet | | 13 | SS | 13 | | | | | | | | | |
| | | | 14 | SS | 5 | | | | | | | | | |
| | | | 15 | SS | 10 | | | | | | | | | |
| | loose | | 16 | SS | 8 | | | | | | | | | |
| | compact | | 17 | SS | 12 | | | | | | | | | |
| 87.3 | | | 18 | SS | 50/3 | | | | | | | | | |
| 12.7 | END of BOREHOLE | | | | | | | | | | | | | |
| | CASING REFUSAL ON PROBABLE BOULDER | | | | | | | | | | | | | |
| | Water Level on completion: 1.8m | | | | | | | | | | | | | |

+ 3 X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



AGRA Earth & Environmental

ENGINEERING GLOBAL SOLUTIONS

**AGRA Earth &
Environmental Limited**

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February 23, 1999
Ref. No.: TT98801

Ministry of Transportation
Foundation Design Section
Central Building
1201 Wilson Avenue
Dowdview, Ontario, M3M 1J8
Canada

Attention: Mr. D. Dundas, P. Eng.
Mr. T. Sangiuliano, P. Eng.

Dear Sirs:

Re: PROPOSED LINDSAY HILL/HIGHWAY 11 BRIDGE
FOUR LANING OF HIGHWAY 11, BETWEEN TROUT CREEK
AND SOUTH RIVER
DISTRICT 54, SUDBURY REGION, ONTARIO

Under the cover of this letter we are forwarding to you a preliminary draft report for the above captioned project, to enable you to become familiar with the subsurface conditions at the site and our method of approach, prior to our meeting.

Please let me know if you require any other information.

Sincerely,

Z.S. Ozden, P. Eng.

ZSO/dee
Encl.

1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, was retained by DELCAN Corporation to conduct a foundation investigation at the site of a proposed bridge that will carry Lindsay Hill Road over the proposed realigned northbound and southbound lanes of Highway 11. The site is located between South River and Trout Creek, along the existing Highway 11, in Laurier Township Lot 9, Concession 12, in the Parry Sound District. The proposed bridge will be a two-lane, two span structure. The west and east spans will be approximately 33.5 m and 36 m long, while the bridge width will be about 12 m.

The purpose of the investigation has been to obtain information about the subsurface conditions at the site of the proposed bridge and approach embankments by means of exploratory boreholes, and based on the findings, to provide recommendations for the geotechnical design of the foundations of the proposed structure and approach fills.

The field work for the investigation was carried out during the period of November 3 to 14, December 19 to 21, 1998, and January 6 to 17, 1999, and consisted of drilling and sampling seven boreholes (Borehole Nos. LH1 to LH7, inclusive) to depths ranging from 14.6 to 27.6 m, and performing two dynamic cone penetration tests (within about 1.5 m of the locations of Borehole Nos. LH1 and LH2). Bedrock was cored at two locations and it was proven by diamond drilling methods in NQ size. A detailed description of field procedures is given in Appendix A.

The plan locations of the boreholes, along with stratigraphic section are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testings, are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 7, inclusive.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located at the intersection of Highway 11 and Lindsay Hill Road, between the Villages of Trout Creek and South River. The ground elevation in the general area rises from east to west, ranging from about Elevation 314.4 m to 316.9 m. The site is generally heavily wooded and the area to the east of the proposed bridge is swampy.

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Based on available geologic information* the site is underlain by glaciolacustrine sediments. These deposits are commonly confined by bedrock uplands and the sediments are subdivided into: 1) nearshore and deltaic sand and minor gravel and, 2) offshore silt and clay. Sections within deltaic deposits exhibit planar, ripple- and cross laminated sand and fine gravel usually flat-lying to gently dipping to the south and southwest.

The glaciolacustrine fine grained deposits, primarily grey silt and red clay rhythmites, occur sporadically in depressions in the glaciolacustrine basin area. The rhythmic sequences commonly grade upwards to a greyish-red, massive, blocky silt-clay. These fine grained sediments are occasionally folded and faulted. A thin unit of planar to ripple-laminated sand and fine gravel generally caps the fine grained sequences. The silts and clays represent distal and quiescent lake conditions during the main Algonquin and early post-Algonquin phases.

The glaciolacustrine sediments were deposited on top of the existing Precambrian bedrock, ranging from granite to gneiss to amphibolite.

3.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at the location of seven boreholes (Borehole Nos. LH1 to LH7, inclusive). Dynamic cone penetration tests were also performed within 1.5 m of Borehole Nos. LH1 and LH2. The locations of the boreholes are shown on Drawing No. 1 and are also indicated on the individual Borehole Log Sheets. A cross section of inferred subsurface stratigraphy is given in Drawing No. 1.

Details of the subsurface conditions encountered in these boreholes are presented on the Borehole Log Sheets, Enclosure Nos. 1 to 7. The following paragraphs are only meant to complement and summarize these data.

3.1 TOPSOIL/PEAT

Topsoil was encountered at Borehole Nos. LH1, LH3, LH5 and LH6 extending to depths ranging from 0.2 to 0.3 m below ground surface. The top 0.6 m of Borehole Nos. LH2 and LH4, and the soil to a depth of about 1.0 m in Borehole No. LH1 were organically stained. Measured natural moisture contents of the samples from the topsoil layer ranged from 27 to 115%.

Peat was encountered in Borehole No. LH7, extending to 1.7 m below the existing grade. The measured moisture content of a sample from the peat layer was 175%.

*Kor, P.S.G. and Delorme, R.J. 1980. Quaternary Geology of the South River Area; Ontario Geological Survey, Preliminary Map P.3160, Scale 1:50 000

In our experience the thickness of topsoil and other organic soils frequently varies in between and beyond the borehole locations.

3.2 UPPER FINE SAND

Underlying the surficial organic soils (i.e. topsoil or peat), all seven boreholes encountered a fine sand deposit, extending to an average depth of about 4.9 m (average Elevation 310.5 m) below the existing ground surface (i.e. to 4.0 to 4.5 m in Borehole Nos. LH1-LH4 to 5.2 to 6.6 m in Borehole Nos. LH5 to LH7).

The grain-size distribution of samples from the deposit is given in Figure No. 1. These indicate 0-1% gravel, 86-97% sand (mostly fine) and 0-8% soil fines (i.e. silt & clay size particles).

Standard penetration tests carried out in this upper sand deposit yielded 'N'-values generally ranging from 4 to 26 blows/0.3 m, with occasional lower values (0, 2, 3 blows/0.3m) near the surface, indicating a generally loose to compact condition. The results of dynamic cone penetration tests carried out near Borehole Nos. LH1 and LH2 ranged from 9 to 33 blows/0.3 m.

The measured natural moisture contents range from 10 to 26%, but are generally 14 to 24%, indicating a wet state.

3.3 SILTY CLAY/CLAYEY SILT

Underlying the fine sand, Borehole Nos. LH3 (west approach location), LH1 (central pier location) and Borehole Nos. LH5, LH6 and LH7 (east abutment and approach) contacted a stratified deposit consisting of thin clay, silty clay, clayey silt, silt and sandy silt with occasional silty sand & sand seams. The deposit was contacted at depths ranging from about 4.4 m below the ground surface or Elevation 310.1 m (BH LH3) on the west side to 6.6 m or Elevation 307.8 m (BH LH7) on the east. Its thickness ranges from about 2.2 m at Borehole No. LH3 (west approach) to more than about 13.5 m at Borehole No. LH7 (east approach) and as such the deposit in general appears to be thickening from west to east.

The grain-size distribution of samples from the deposit is presented in Figure No. 2. The analyses results indicate 0-2% sand, 54-76% silt and 22-44% clay size particles.

Atterberg limits tests performed in the laboratory on samples from these materials (after discarding any obvious silt seams) gave the following index values.

| | |
|------------------|----------|
| Liquid Limit | = 30-43% |
| Plastic Limit | = 18-24% |
| Plasticity Index | = 9-19% |

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These values are characteristic of clayey soils of low to intermediate (but generally low) plasticity (Figure No. 6). A somewhat unusual feature of these findings is that with most soils, the measured clay size percentages would normally be associated with higher plasticity index values than indicated above. Another unusual observation is that the samples of the material obtained from the boreholes showed a much higher degree of dilatancy than would be expected from soils containing a relatively high percentage of clay size particles as measured. This rather unusual property could perhaps be caused by clay size particles being rather inactive.

The grain-size distribution of samples from the more silty zones (two samples) is given in Figure No. 3. These show 7% sand, 87-88% silt and 5-6% clay size particles. The following index values were obtained in the laboratory (three samples) as shown in Figure No. 7.

| | |
|------------------|----------|
| Liquid Limit | = 20-25% |
| Plastic Limit | = 15-20% |
| Plasticity Index | = 4-5% |

The measured natural moisture contents of samples from the silty clay/clayey silt deposit range from 22 to 39% and as such they are generally close to or higher than the measured liquid limit values. Such results are generally indicative of weak and compressible soils.

The bulk unit weights of several suitable soil samples were measured in the laboratory and the results ranged from 17.8 to 20.5 kN/m³.

Standard Penetration tests carried out in the silty clay/clayey silt deposit yielded 'N'-values generally in the range of 0 to 8 blows/0.3 m with higher values (13, 16, 17 and 23 blows/0.3 m) near the bottom of the deposit in Borehole Nos. LH6 and LH7. Dynamic cone penetration tests carried out adjacent to Borehole No. LH1 gave blow counts ranging from 32 to 138 blows/0.3 m. These high results are inconsistent with the low 'N'-values in the same boreholes (which ranged from 4 to 5 blows/0.3 m) and the undrained in-situ shear strength values of 15 to 20 kPa (as measured by field vane tests).

Field vane tests conducted in the boreholes gave undrained in-situ shear strengths of 15 to 49 kPa. A quick triaxial compression test on a sample from a thin walled (Shelby) tube sample obtained from a depth of about 8.0 m in Borehole No. LH6 gave a value of 25 kPa. These results indicate a soft to stiff consistency. The results of all the field vane and of the quick triaxial compression tests are summarized in Figure No. 13.

The results of consolidation tests performed on four samples from the deposit are given in Figure Nos. 9, 10, 11 and 12.

3.4 SILT

Borehole Nos. LH2, LH4 and LH5 contacted, immediately underlying the upper fine sand deposit (at depths ranging between 4.0 and 5.2 m below the ground surface), a deposit of silt to sandy silt. This deposit is transition from the overlying upper fine sand to the underlying silty clay/clayey silt (Borehole No. LH5) or the lower sand (Borehole Nos. LH2 and LH4). A similar transition zone was also encountered in Borehole Nos. LH1 and LH5 immediately underlying silty clay/clayey silt at depths of 7.0 and 10.2 m, respectively.

The silt deposit contains some thin silty clay and occasional silty sand and silt seams. The grain-size distribution of three samples from the deposit is presented in Figure No. 4 and these indicate 7-15% sand, 79-85% silt and 6-8% clay size particles.

Atterberg limits tests were performed in the laboratory, on six samples which gave the following values (Figure No. 8):

| | |
|------------------|----------|
| Liquid Limit | = 18-21% |
| Plastic Limit | = 15-19% |
| Plasticity Index | = 2-3% |

The measured natural moisture contents generally range from 18 to 28%, indicating a wet condition.

Standard Penetration tests performed in this unit gave 'N'-values of 6 to 26 blows/0.3 m. From these values the compactness condition of the deposit is considered loose to compact, but generally compact.

3.5 LOWER SAND

Underlying the silt or silty clay/clayey silt deposits all the boreholes, except for Borehole No. LH7, showed the presence of a lower sand deposit.

In Borehole Nos. LH4 and LH3 (most westerly boreholes) the surface of this deposit was contacted at about Elevation 310 m (i.e. about 7 m below the ground surface) and generally dips to about Elevation 300.5 m in Borehole No. LH6 (at about 14 m below grade). Borehole No. LH7 (located further east) was terminated at Elevation 294± m within the silty clay/clayey silt deposit without encountering this sand deposit.

Borehole Nos. LH3 and LH5 were terminated in this deposit. Borehole Nos. LH1 and LH4 were also terminated in this deposit upon encountering refusal while in Borehole Nos. LH2 and LH5 the surface of the bedrock underlying the deposit was proven by rock coring (Elevations 295.8 m and 290.0 m, respectively).

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The grain-size distribution of ten samples from the deposit is given in Figure No. 5 and the results show 42% gravel, 52-85% sand, 2-14% soil fines (i.e. silt & clay). The presence of cobbles and boulders was also inferred while drilling, especially towards the bottom of the stratum.

Measured 'N'-values in the deposit generally range from 10 to 35 blows/0.3 m with occasional lower (5, 6, 7 and 9 blows/0.3 m) and higher (43 to in excess of 50 blows/0.3 m) values, mainly near the surface and close to the bottom of the deposit, respectively, indicating a generally compact to dense condition, changing to dense to very dense at increased depths. The results of the dynamic core penetration tests carried out in the deposit adjacent to Borehole Nos. LH 1 and LH2, range from 23 to in excess of 100 blows/0.3 m.

The measured moisture contents ranged from 8 to 21%, indicating a wet state.

3.6 BEDROCK & POSSIBLE BEDROCK

Bedrock was encountered and cored in Borehole Nos. LH2 and LH5 at depths of 20.0 m (Elevation 295.8 m) and 24.5 m (Elevation 290.0 m) below the existing ground surface, respectively. At both boreholes, the bedrock consists of pink Precambrian granite. The granite was cored to a depth of 3.0 m and the percentage of core recovery was 95 to 97%. A rock quality designation (R.Q.D.) value of between 70 and 96% was measured. Based on these and a visual examination of the rock cores, the rock is considered to be fair to excellent quality, but generally good to excellent.

'Possible bedrock' was contacted (refusal on the augers) at the bottom of Borehole No. LH4, at a depth of about 14.7 m (Elevation 302.2 m) below the ground surface.

Refusal to normal washboring was encountered in Borehole No. LH1 at 19.2 m to washboring and the borehole was further advanced to 20.7 m (Elevation 294.2 m) by rock coring methods. The core indicated the presence of frequent cobbles in the overburden within this zone. Further attempts to advance the boring by coring (three attempts) were unsuccessful and therefore the presence of the bedrock at the location could not be proven by rock coring.

3.7 GROUNDWATER CONDITIONS

Groundwater levels in the open boreholes were observed during the drilling and at the completion of each borehole. In addition, piezometers were installed in all seven boreholes, to enable us to monitor the groundwater levels over a prolonged period of time without interference from surface water.

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The recorded values, shown on the individual Borehole Log Sheets, indicate that the water levels at the time of the investigation ranged from 2.6 m below ground surface on the west approach (Borehole No. LH4) to ground surface east of the west abutment (Borehole Nos. LH1 and LH5 to LH7). These depths correspond to an average elevation of 314.4 m.

Based on these values together with the moisture contents of the samples, it can be assumed that the groundwater level at the time of our investigation was generally about 1 m below the ground surface along the west approach and at or very close to the ground surface east of the west abutment location. The groundwater at the site would fluctuate seasonally and can be expected to be higher during the spring months and in response to heavy rains.

4.0 DISCUSSION AND RECOMMENDATIONS

The existing Highway 11 will be realigned and widened from the existing two lanes. The widened road will consist of a four lane divided highway with a 30 m wide median. The proposed bridge will carry Lindsay Hill Road over the proposed realigned northbound and southbound lanes of Highway 11. The proposed bridge will be an approximately 70 m long, 2-lane, two span structure. The proposed elevation for the bridge is approximately 332 m while the grade at the borehole locations range from 314.5 to 315.8 m. The proposed grade of Highway 11 at the bridge site is approximately at Elevation 324 m and therefore the grade for the highway will be raised by about 8 to 9 m from the existing grades. The grades at the west and east abutments at the bridge will be raised by about 16 m. Based on the preliminary information given to us by DELCAN, an integral abutment structure is being considered for the proposed bridge.

The boreholes have shown beneath a surficial organic layer the presence of a generally loose to compact fine sand to an average depth of about 4.9 m below ground surface. This is in turn underlain by loose to compact silt and/or a soft to firm silty clay/clayey silt deposit with an increasing thickness from about 2 m near the west embankment (Borehole No. LH3) to a dominant layer covering the remaining depth of the borehole (i.e. to more than 20 m below the ground surface) on the proposed east approach (Borehole No. LH7). This cohesive deposit or the silt are, in turn, underlain by a second (lower) sand deposit (at all the borehole locations, except for Borehole No. LH7) with occasional cobbles and boulders, the frequency of which appears to increase with increasing depth. The 'N'-values indicate that the sand is generally compact changing to dense to very dense towards the bottom. Beneath the lower sand deposit 'possible bedrock' was contacted in Borehole No. LH4 at the west approach embankment location. Precambrian granite bedrock was encountered and cored at the location of the east and west abutments at Borehole Nos. LH2 and LH5 at 20.0 and 24.5 m, respectively. Borehole No. LH1, drilled at the central pier location, encountered refusal on a boulder at 19.2 m below the ground surface. The borehole was cored through cobbles and boulders to 20.7 m without encountering the bedrock. The boreholes show that the

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groundwater table lies at or close to the ground surface.

4.1 FOUNDATIONS

Owing to the presence of loose to compact sand and silt and weak (i.e. generally soft to stiff) and compressible silty clay/clayey silt, the use of normal shallow foundations is considered impractical and therefore we recommend that the structure be supported on deep foundations, extending to the bedrock or the very dense sand overburden immediately above the bedrock.

A low displacement type of pile, such as a steel H-pile, would be better suited for the prevailing subsurface conditions. We recommend that a steel H-pile with a heavy section, such as HP310X110, with reinforced tips as per MTO specifications, be used.

Induced stresses due to the weight of the fill placed for the approach embankments and to raise the grade for Highway 11 construction at the (central) pier will cause settlement of the underlying soils, which will then transfer the loads by negative skin friction to the piles, thus causing down-drag. In order to reduce potential problems due to down-drag and settlements, the fill to raise the grade should be placed as early as possible prior to driving the piles.

Assuming that the fills to raise the grade will be placed at least three months prior to constructing the piles at the west abutment and the central pier areas and at least six months prior to constructing the piles at the east abutment, the following axial resistances are recommended.

TABLE I

| LOCATION | PILE SIZE | RECOMMENDED FACTORED AXIAL RESISTANCE AT U.L.S. | RECOMMENDED RESISTANCE AT S.L.S. |
|-------------------------------------|-----------|---|--|
| Borehole No. LH2 (West Abutment) | HP310X110 | 1500kN | 1000kN |
| Borehole No. LH1 (Central Pier) | HP310X110 | 1400kN | 900kN |
| Borehole No. LH5 (East Abutment) | HP310X110 | 1400kN | 900kN |

The serviceability condition is based on the premise that the maximum total and differential settlements will not exceed 25 mm and 20 mm, respectively.

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The piles would preferably be driven to bedrock, the surface elevation of which was established at Elevation 295.9 m at Borehole No. LH2 at the west abutment location and at Elevation 290.0 m at Borehole No. LH5 at the east abutment location, while at the central pier location Borehole No. LH1 could not be extended to the bedrock due to the presence of cobbles and boulders. This borehole was terminated within the overburden at about Elevation 294 m. Boreholes indicate that it may not be practical to extend all the piles to the surface of the bedrock and that some may terminate in the overburden immediately above the bedrock in the very dense sand or even at higher elevations due to cobble and boulders. Estimated probable tip elevations are given in Table II. Also summarized in the same table are the highest acceptable pile tip elevations in the event of practical refusal in the overburden.

TABLE II

| LOCATION/ BOREHOLE NO. | ESTIMATED PROBABLE PILE TIP ELEVATION | MINIMUM ACCEPTABLE PILE TIP ELEVATION |
|-----------------------------------|---|--|
| West Abutment Borehole No. LH2 | 296.0 m (bedrock) | 296.5 m (overburden) |
| Central Pier Borehole No. LH1 | 294.0 m | 296.0 m (overburden) |
| East Abutment Borehole No. LH5 | 291.5 m - 290.0 m (overburden-bedrock) | 292.5 m (overburden) |

As mentioned before, the presence of cobbles and boulders may cause practical refusal at elevations above those shown (due to cobbles and boulders) in which case additional piles may need to be driven, requiring modifications to the original design. It is also possible that due to the undulations in the surface of the bedrock, which are not uncommon in the northern sites, the piles may drive several meters below the tip elevations given above. We recommend that these aspects be taken into consideration when ordering the piles.

The piles should be driven with a suitably heavy hammer capable of delivering an energy of at least 50 kJ/blow. The energy should however be restricted to not more than 60 kJ/blow.

The driving of the piles should be controlled by a recognized pile driving formula, such as the Hiley Formula. The estimated ultimate resistance of the piles (driven to practical refusal in the overburden) by the Hiley Formula is approximately 3800kN. Because of the presence of cobbles and boulders, the piles should be equipped with reinforced tips as per MTO Standards. Based on the available data, the surface of the bedrock slopes down from west to east, but not very steeply (i.e. a difference in elevation of about 6 m was recorded over a horizontal distance of about 80 m between Borehole Nos. LH2 and LH5) and based on this rock points are not deemed to be necessary. Field observations to the contrary may however necessitate

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the use of rock points. Oversize materials (e.g. greater than 75 mm nominal diameter) should not be used in the fills through which piles would be driven.

We recommend that at each support location at least one-quarter of the piles be retapped one to two days after driving to check that relaxation has not occurred. If it has then all the piles should be retapped. Heave of the adjacent piles should also be observed.

For frost protection the pile caps should have a permanent earth cover of at least 2.0 m.

The recommended horizontal resistances for the HP310X110 steel H-piles are as follows:

| | |
|--|---------|
| Factored Horizontal Resistance at U.L.S. | = 120kN |
| Horizontal Resistance at S.L.S. | = 60kN |

At the pier location (and also at the abutment location if an integral abutment type is not to be constructed), the unbalanced horizontal loads could be resisted by battered piles.

In accordance with MTO requirements (MTO Structural Office Standard), piles for integral abutments require a 3 m long flex zone. In essence the current MTO standard for the flex zone consists of an annular space in between two consecutive CSP's. One of the CSP's surrounds the H-pile (i.e. has a diameter slightly greater than the pile width, while the second CSP has a somewhat larger diameter (typically 0.6 m for a 310mm H-pile). The annular space in between the CSP's is the 3 m long flex zone. After the pile is driven the space between the H-pile and the inner CSP is filled with cement bentonite or coarse sand.

4.2 SETTLEMENTS OF EMBANKMENT APPROACH FILLS

The height of the fill for both east and west approaches are generally 16 m above the existing grades.

Assuming that all organic soils, fill, weak or otherwise unsuitable materials are removed as per MTO Standards before placing the fill, the anticipated settlements of the founding soils due to stresses induced by the embankments (i.e. not including the settlement of the embankment itself under its own weight) are approximately 0.3 m at Borehole No. LH4 location (i.e. west approach), increasing to about 0.4 m at Borehole No. LH3 location (about 20 m west of the proposed west abutment location), further increasing to about 0.5 m at Borehole No. LH2 at the proposed west abutment location. If a lightweight fill with a compacted unit weight of 11.5 kN/m^3 is used, the settlements would be about 60% of the quoted values. These settlements would be practically completed after about 3 months of the placement of the fill to its full height.

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At the (central) pier location where the height of the fill will be about 7 to 8 m above the existing grade, the anticipated settlement of the foundation soils is 0.25 m for normal earth fill and about 60% of this value for lightweight fill. These settlements would be substantially completed after about three months of the placement of the fill to its full height.

At the east abutment location (Borehole No. LH5) the anticipated settlement is approximately 0.7 m increasing to about 0.8 m at Borehole No. LH6 (about 20 m east) and to about 0.9 m at Borehole No. LH7 about 20 m further east. For lightweight fill the predicted settlements would be about 60% of the figures quoted. The findings of these boreholes indicate that the thickness of the clay layer increases easterly and while at Borehole No. LH5 the calculated settlements can be expected to be substantially completed within about 6 months after the placement of the fill to its full height, the anticipated time (due to the consolidation of the silty clay/clayey silt stratum) can be expected to increase to eight months at Borehole No. LH6 location. At Borehole No. LH7 location, the settlement can be expected to take about 1 year with a further settlement of about 50 to 100 mm after this period. These time rates of settlements can be expected to increase further east due to the anticipated increase in the thickness of the clayey stratum.

4.3 EMBANKMENT STABILITY

The presence of loose to compact upper sand and silt and particularly weak silty clay/clayey silt deposits requires consideration for both the long and especially the short-term stability of the approach embankments and of the abutments.

The stability of the embankments was analyzed by the limit equilibrium method, utilizing Bishop's simplified method of analysis. For this purpose the computer programme Slope/W and the following assumed soil parameters were utilized.

Drained Stability Analyses

Embankment Fill (Select Subgrade Material - SSM):

$$\phi = 32 \text{ degrees}$$

$$c' = 0$$

$$\gamma = 22 \text{ kN/m}^3$$

Embankment Fill (Lightweight Fill - Blast Furnace Slag, 3/8" Structural Coarse):

$$\phi = 35 \text{ degrees}$$

$$c' = 0$$

$$\gamma = 11.5 \text{ kN/m}^3$$

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Fine Sand:

$$\phi' = 30 \text{ degrees}$$

$$c' = 0$$

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

Silt/Sandy Silt:

$$\phi' = 28-29 \text{ degrees}$$

$$c' = 0$$

$$\gamma = 18.5 \text{ kN/m}^3$$

Silty Clay/Clayey Silt:

$$\phi' = 24 \text{ degrees}$$

$$c' = 3 \text{ kPa}$$

$$\gamma' = 18-19 \text{ kN/m}^3$$

Lower Sand:

$$\phi' = 30-35 \text{ degrees}$$

$$c' = 0$$

$$\gamma = 19-20 \text{ kN/m}^3$$

For undrained (short-term) analysis the same parameters were used except for the silty clay/clayey silt layer. In this case an undrained cohesion value (c-value) was calculated by averaging out the measured field vane test results at each individual borehole location and assuming a ϕ value of zero. The assumed individual c-values for individual layers used for the analyses ranged from 18 to 50 kPa. The groundwater table was assumed to be at the present ground surface level. The embankment slope stability results can be summarized as follows.

4.3.1 West Approach

Borehole No. LH4: The silty clay/clayey silt was not encountered in this Borehole and therefore short and long term analyses are identical. Figure No. 14 shows that the obtained factor of safety for a normal 2H:1V slope with two 2 m wide berms is satisfactory (i.e. F.S. = 1.60).

Borehole No. LH3: This boreholes showed the presence of an approximately 2 m thick silty clay/clayey silt layer. Based on a vane test result an undrained shear strength of 37 kPa was assigned to this layer. Normal 2H:1V side slopes (with two 2 m wide berms) gave an unacceptably low short-term safety factor, while as shown in Figure No. 15, the calculated safety factor for a 2H:1V slope with three 4 m wide berms is acceptable (i.e. 1.41). The calculated factor of safety for the long term condition is also acceptable (Figure No. 16).

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For lightweight fill with a 2H:1V slope with two 2 m wide berms, acceptable factors of safety were calculated for both short and long term conditions (Figure Nos. 17 and 18).

Borehole No. LH2 (proposed west abutment location): This borehole did not encounter the silty clay/clayey silt deposit and an acceptable safety factor of 1.40 was obtained for both short and long term conditions (Figure No. 19).

These findings indicate that it is feasible to build the west approach embankment using an SSM fill with three 4 m wide berms or a lightweight fill with normal 2H:1V side slopes with two 2 m wide berms. The construction sequence however will require the latter. The construction sequence dictates that the southbound lanes be constructed first, during which time the traffic on Highway 11 will be maintained along the existing (future northbound) Highway. After the southbound lanes are constructed these will carry the traffic when the northbound lanes are being constructed. The construction of the west approach will require a temporary 2.5H:1V forward slope as shown on Figure No. 20. This slope will have to be maintained for at least 3 months in order to effect settlements prior to the construction of the highway. Stability analyses at Borehole Nos. LH2 and LH1 locations (Figure Nos. 21 and 22) show that the use of lightweight fill is necessary to achieve desirable factor of safety figures. The lightweight fill should extend westerly to about Station 9+930 and west of this station normal SSM can be used with normal 2H:1V side slopes (with two 2 m wide berms).

After the three month period that portion of the fill above the proposed highway elevation can be removed, as shown on Figure No. 23 and the southbound lanes can be built. After the construction of these, the traffic can be diverted to the newly constructed highway and the construction of the fill for the northbound lanes can start.

4.3.2 East Approach

Borehole No. LH5 (east abutment): Here the embankment will be about 16.5 m high. Figure No. 24 shows that an inadequate short-term safety factor (i.e. F.S. = 1.1) is obtained for normal SSM fill, even with two, 6 m wide berms. Figure No. 25 shows that the construction of only a 10 m high embankment (with a 14 m wide mid height berm) is feasible. For this reason a staged construction or the use of lightweight fill will be necessary. Figure Nos. 26 and 27 show that with a lightweight fill, the embankment constructed of 2H:1V side slopes (with two 2 m wide embankments) possesses an adequate safety factor both in the short and long term.

Borehole No. LH6: This borehole is located about 20 m east of Borehole No. LH5 and the weak silty clay/clayey silt layer thickens in an easterly direction. Figure No. 28 shows that short-term factor of safety of a 16 m high SSM embankment (with 2H:1V vertical slopes and two 2 m wide berms) is less than unity, while the long term factor of safety is acceptable (Figure No. 29).

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An acceptable short-term factor of safety is obtained with a 8 m high embankment incorporating a 20 m wide mid-height berm (Figure No. 30).

A 16.0 m high lightweight fill with 3H:1V side slopes, incorporating two 4 m wide berms has an acceptable safety factor (Figure No. 31). The long term condition with this configuration is shown in Figure No. 32 and is acceptable.

Borehole No. LH7: Stability conditions become less favourable in an easterly direction at Borehole No. LH7.

Figure No. 33 shows that at this borehole location only a 7 m high embankment can be constructed of SSM with 2H:1V slopes and a 20 m long mid-height berm, while Figure No. 34 indicates that if lightweight fill is used, a 16 m high embankment can be built with a 4H:1V slope and two berms (5 m and 7 m wide). Figure No. 35 shows the long term stability condition for the same configuration.

In order to effect the consolidation settlements, sufficiently ahead of the bridge construction, the fill must be in place at the east abutment location for about 6 to 8 months, unless this is accelerated by means of the installation of prefabricated vertical drains (i.e. wick drains). The magnitude and the time length for the anticipated settlements can be expected to increase further east, along with possibly less favourable conditions for slope stability.

In conclusion, the unfavourable conditions encountered at the site require the use of lightweight fill (with very flat side slopes on the east side) to build the approach embankments, or a staged construction (with SSM or lightweight fill). In addition, in order to effect a significant portion of the foundation settlements of the embankments and to substantially eliminate down-drag forces on the piles, the fills will need to be constructed three months (west approach and abutment) to six to eight months (at the east abutment) with a further increase towards the east (i.e. more than one year at Borehole No. LH7 and possibly more further east), unless wick drains are used to accelerate the time rate of consolidation.

It should be pointed out that staged construction assumes that the shear strength of the silty clay/clayey silt stratum will increase in time under the weight of the staged embankment fill in such a manner that the next stage (higher) fills can be placed in a timely manner. While this is usually the case, exceptions to this have been reported. Such construction will therefore require advance planning and field instrumentation. Again the time required for the staged construction can be reduced by means of prefabricated vertical drains.

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For these reasons we recommend that consideration be given to reducing the height of embankments, especially on the east side. It is believed that this can be achieved by providing an overpass structure rather than an underpass. It is also believed that even more favourable conditions can probably be created for the construction of the bridge by moving the structure site slightly north of its present location.

5.0 CLOSURE

Our report will be revised and finalized after receiving your initial comments. We will then issue a draft report for your comments/review.

Sincerely,

Houshang Shad, Ph.D.

Z.S. Ozden, P. Eng.

ZSO/dee

APPENDIX A

PROCEDURES

The field work for this project was performed during the period of November 3 to 14, December 19 to 21, 1998 and January 6 to 17, 1999, and consisted of drilling and sampling seven boreholes, performing dynamic cone penetration tests at the adjacent locations of two boreholes and coring the bedrock at two locations. The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No. 1.

Three boreholes were drilled to depths ranging between 20.0 and 24.5 m, at the proposed abutment locations and pier position; two boreholes were drilled to 14.8 m and 17.2 m along the centre-line of the bridge, for the west approach fill; two boreholes to 15.8 and 20.2 m along the centre-line of the bridge, for the east approach fill. Dynamic cone penetration tests were adjacent to the boreholes drilled for the pier and the west bridge abutment, and the bedrock below the east and west bridge abutments was cored for about 3.0 m. The boreholes for this geotechnical investigation were advanced using a track mounted auger drills capable of completing augered holes or wash borings. Diamond drilling capability was used to advance the boreholes into the bedrock. The field work was carried out under the full-time supervision of soils engineers for AGRA.

Sampling in the boreholes was effected at frequent intervals of depth by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.3 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the compactness condition of the soil deposit. Thin wall (Shelby tube) samples were also obtained within the cohesive deposits, and the undrained in-situ shear strength together with the sensitivity of these deposits were determined using field vane.

The borehole locations were established in the field by our engineering staff and the elevations together with the northings and eastings of the borehole locations were provided to us by Deaden & Stanton Limited.

APPENDIX B

AGRA

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

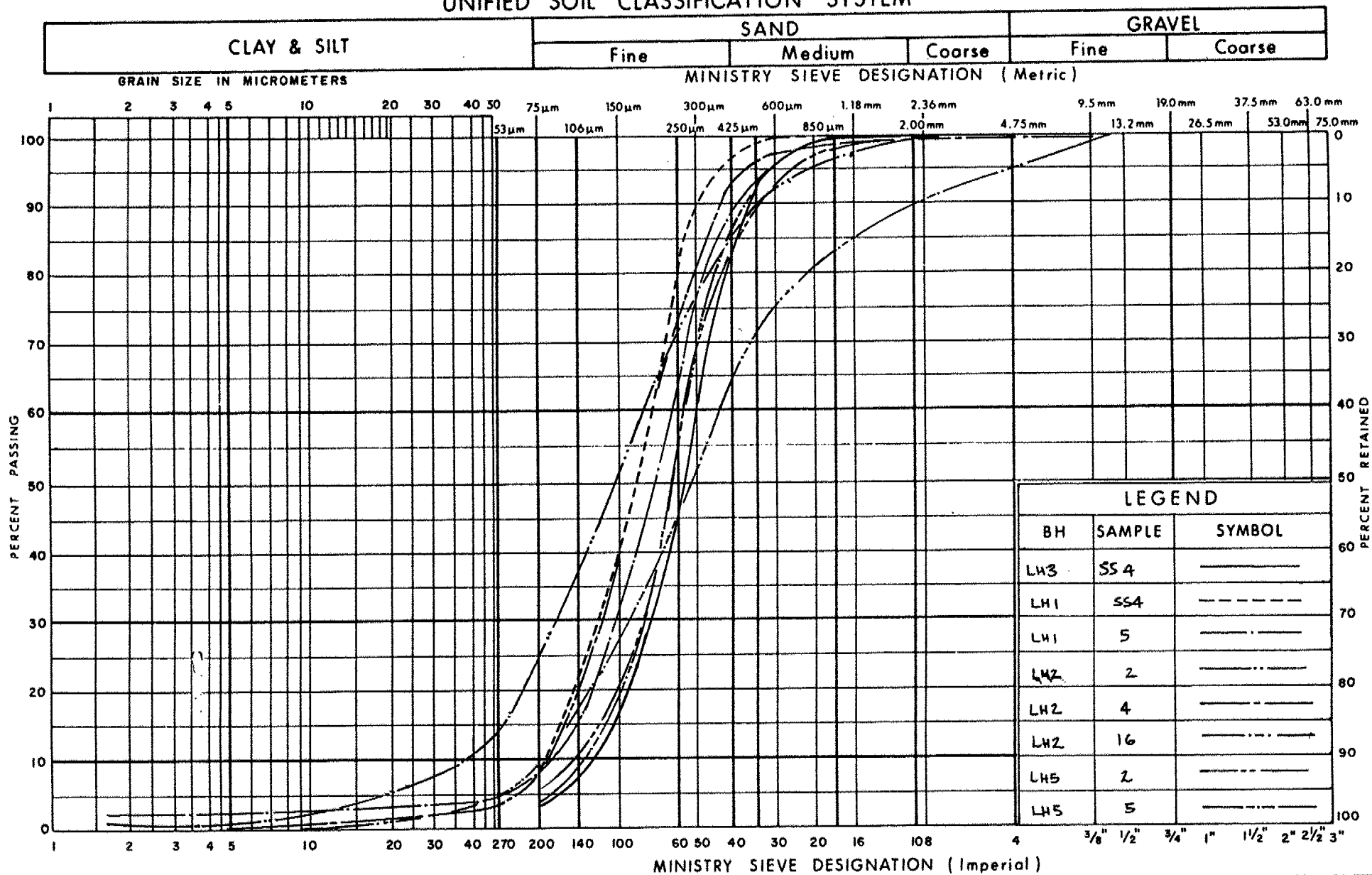
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final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

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

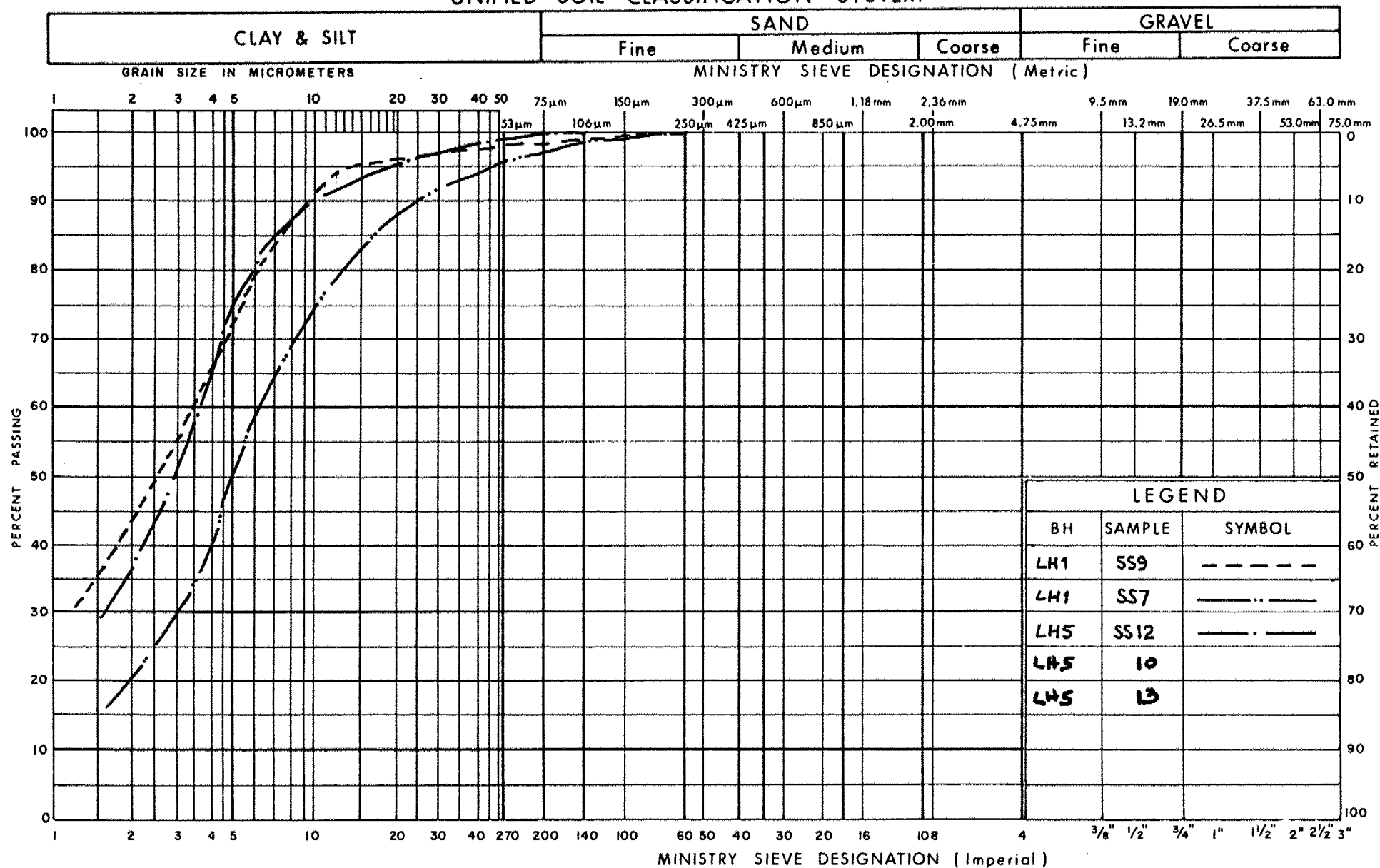
FINE SAND

FIG No 1

W P 772-93-01

SITE: 44-375

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

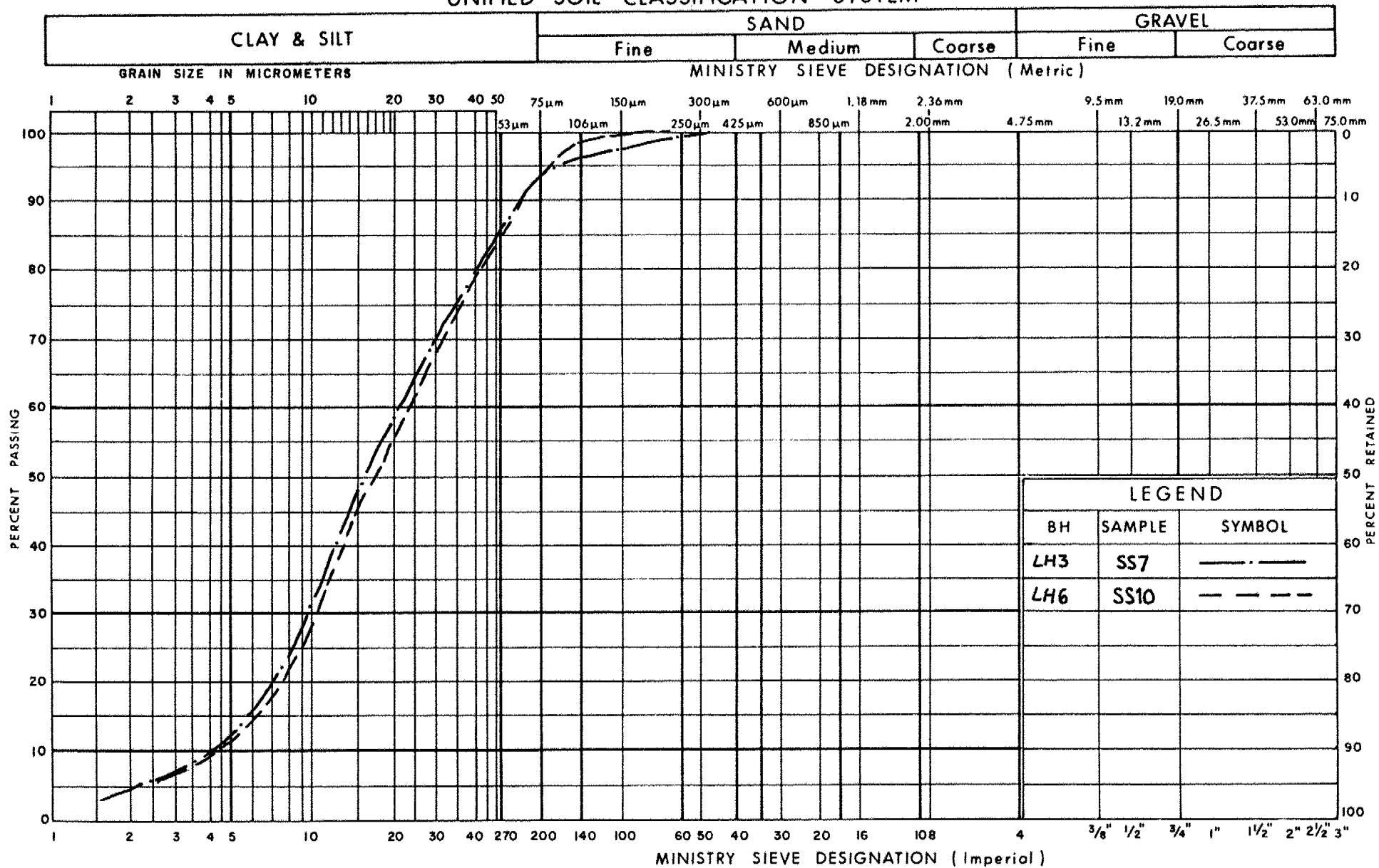
SILTY CLAY/CLAYEY SILT

FIG No 2

W P 772-93-01

SITE: 44-375

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

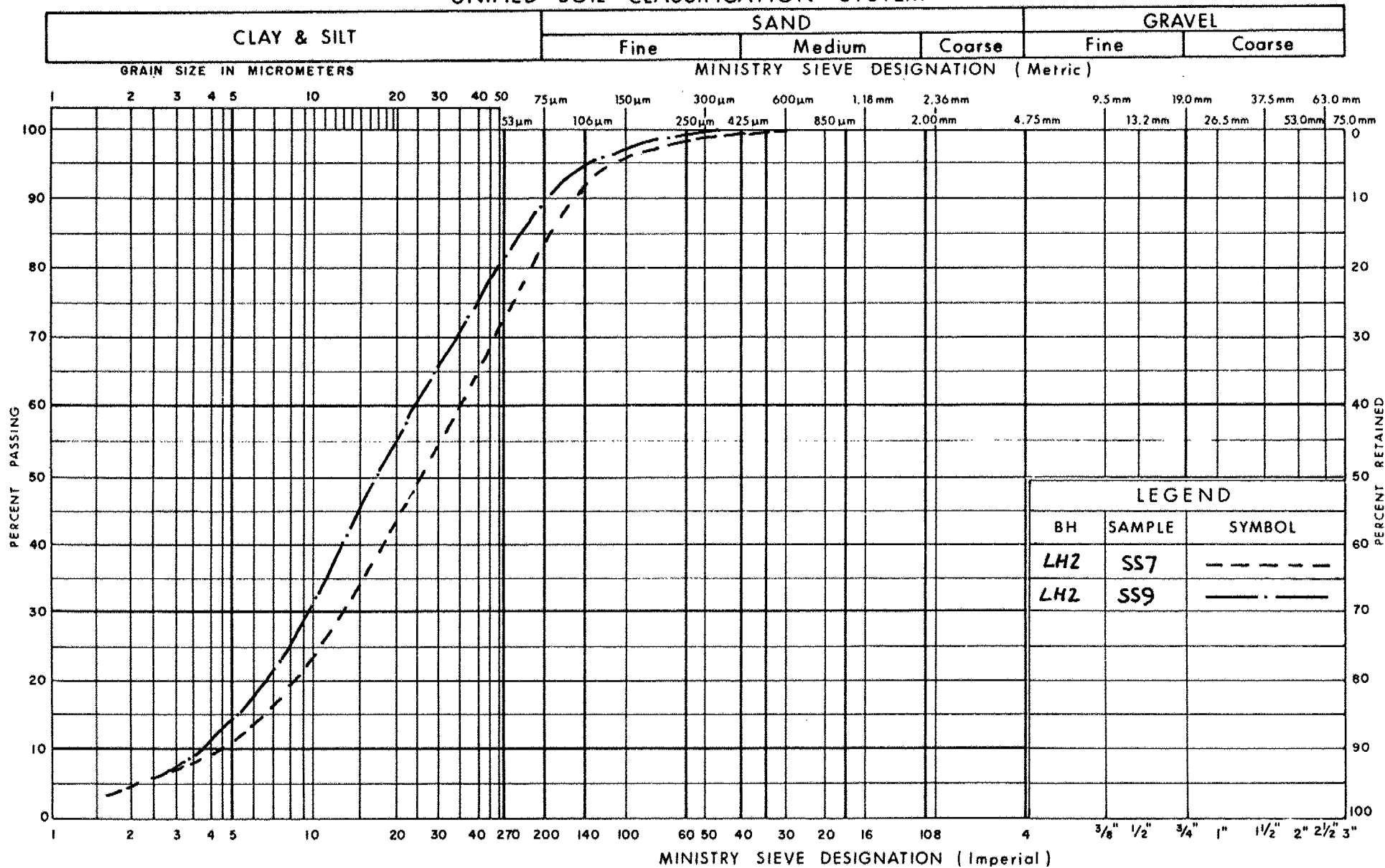
SILT ZONES IN SILTY CLAY/CLAYEY SILT

FIG No 3

W P 772-93-01

SITE: 44-375

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

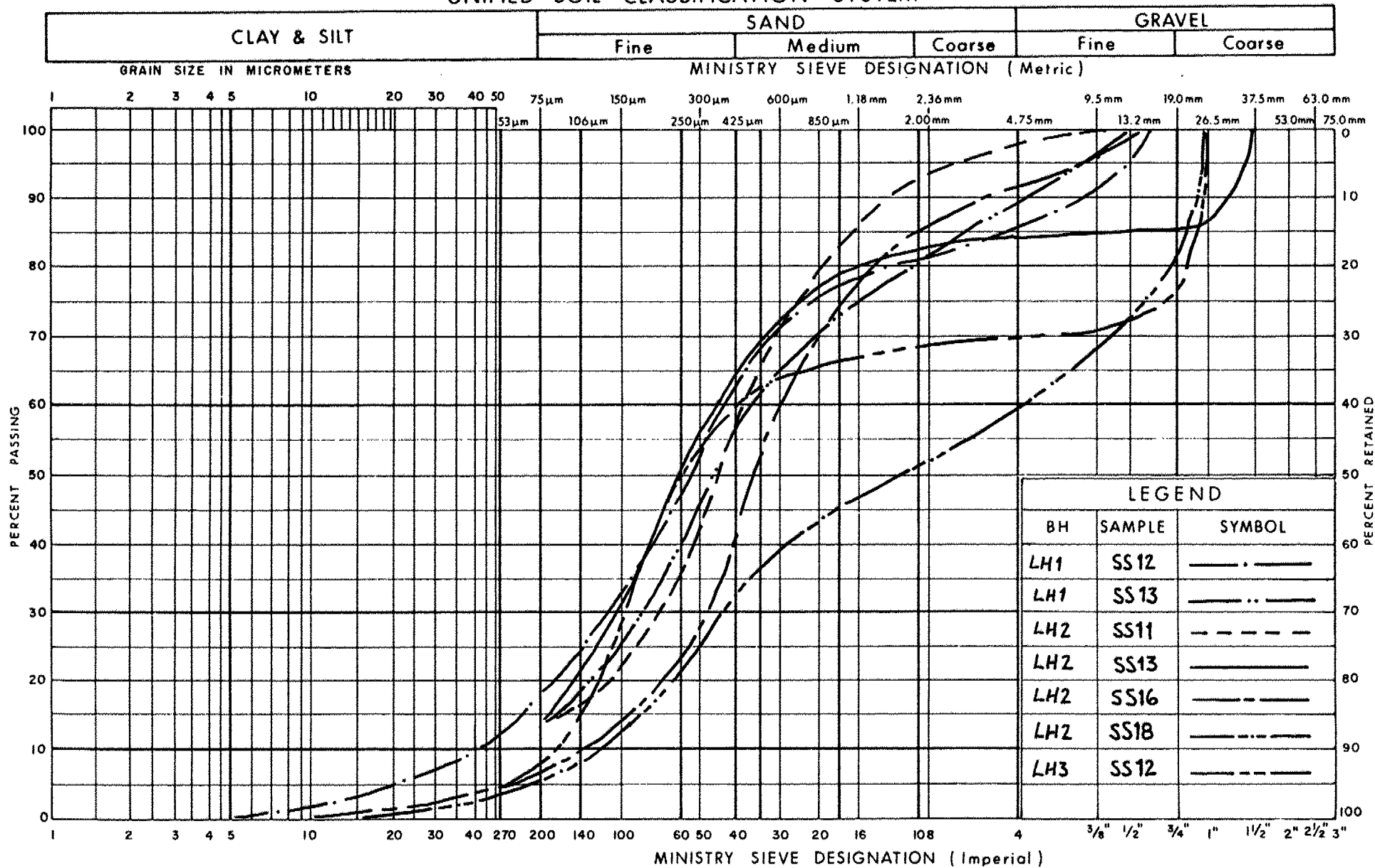
SILT

FIG No 4

W P 772-93-01

SITE: 44-375

UNIFIED SOIL CLASSIFICATION SYSTEM



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Transportation

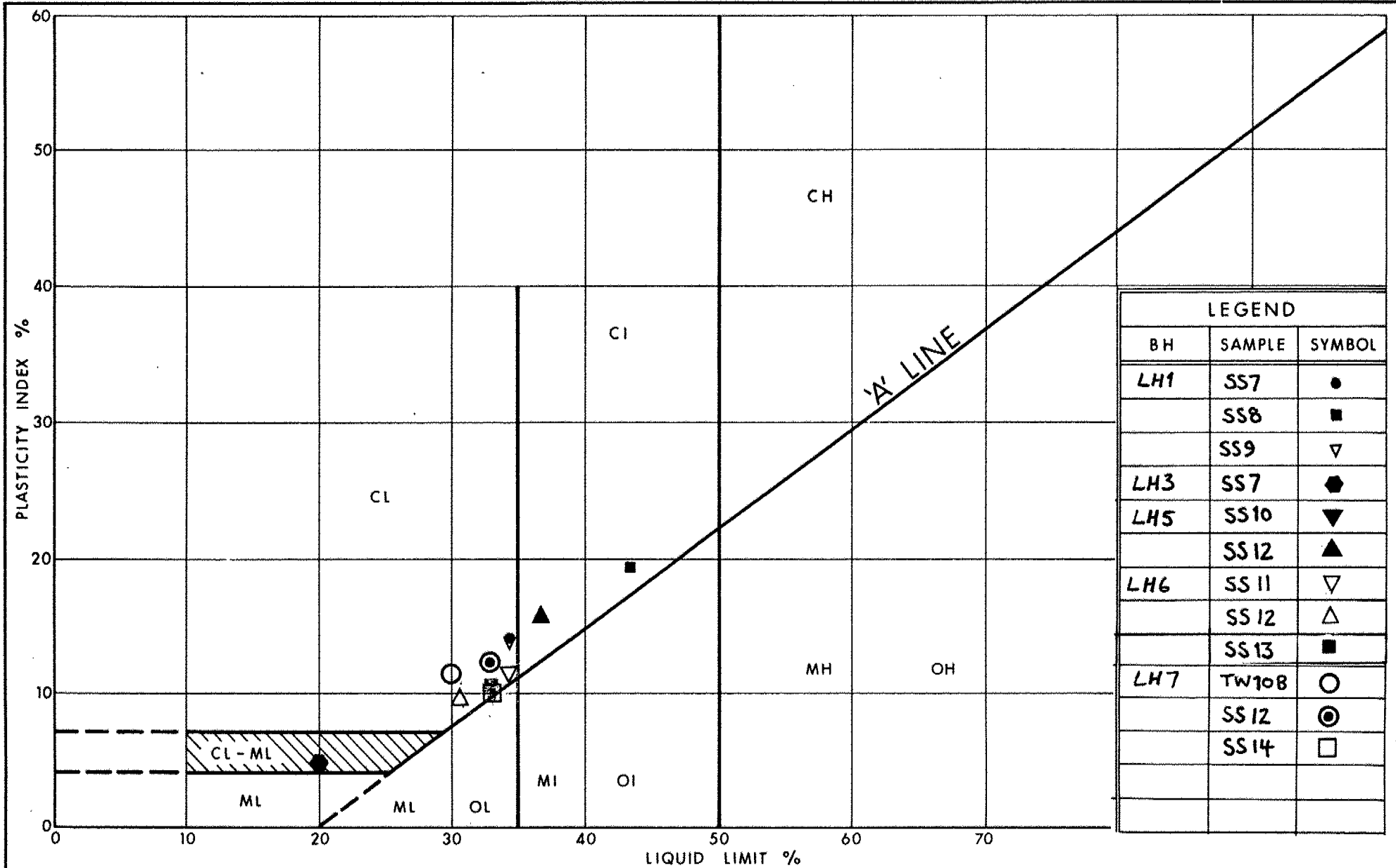
GRAIN SIZE DISTRIBUTION

SAND

FIG No 5

W P 772-93-01

SITE: 44-375



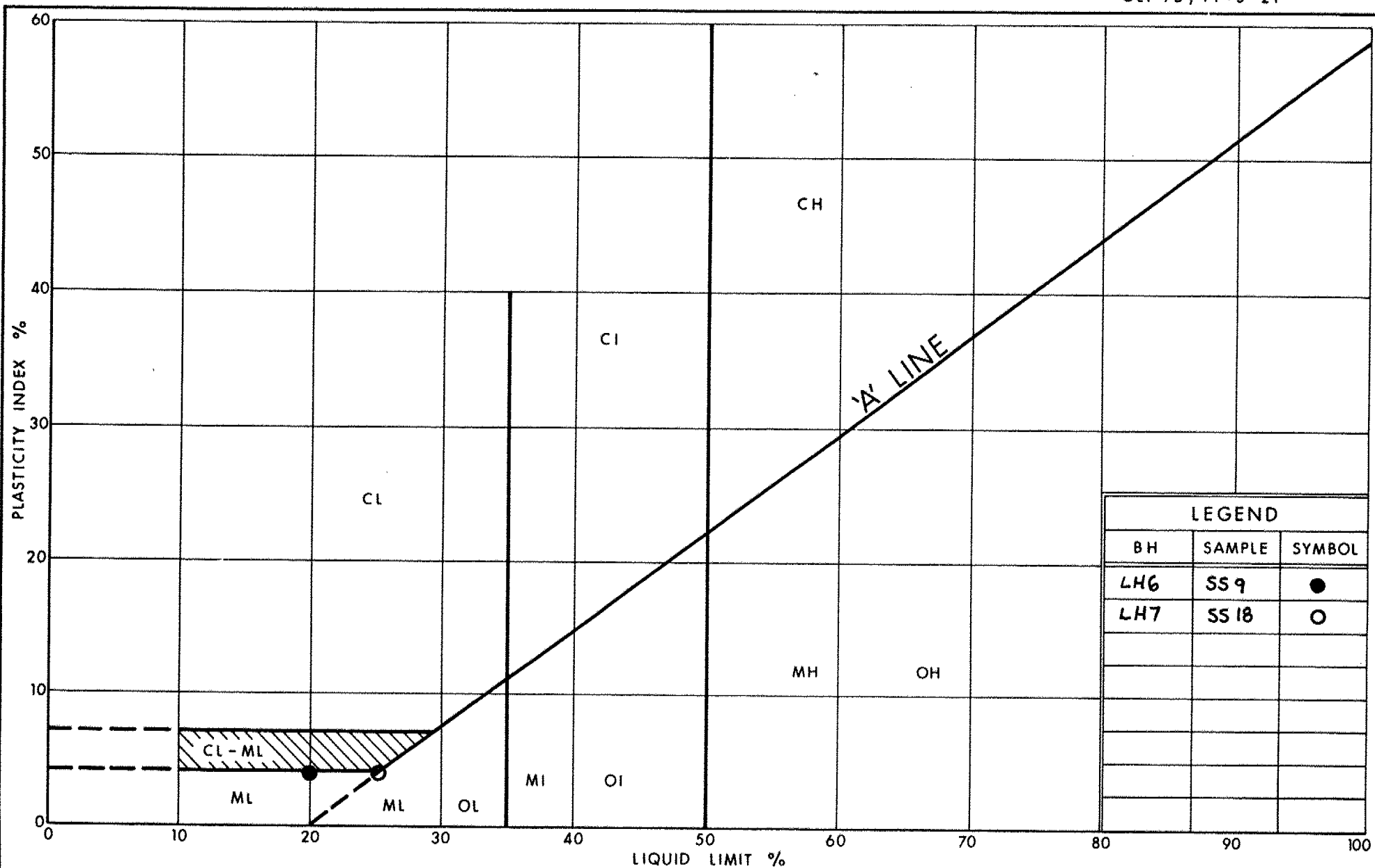
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Ontario

PLASTICITY CHART CLAYEY SILT/SILTY CLAY

FIG No 6

W P 772-93-01

SITE: 44-375



Ontario

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Transportation

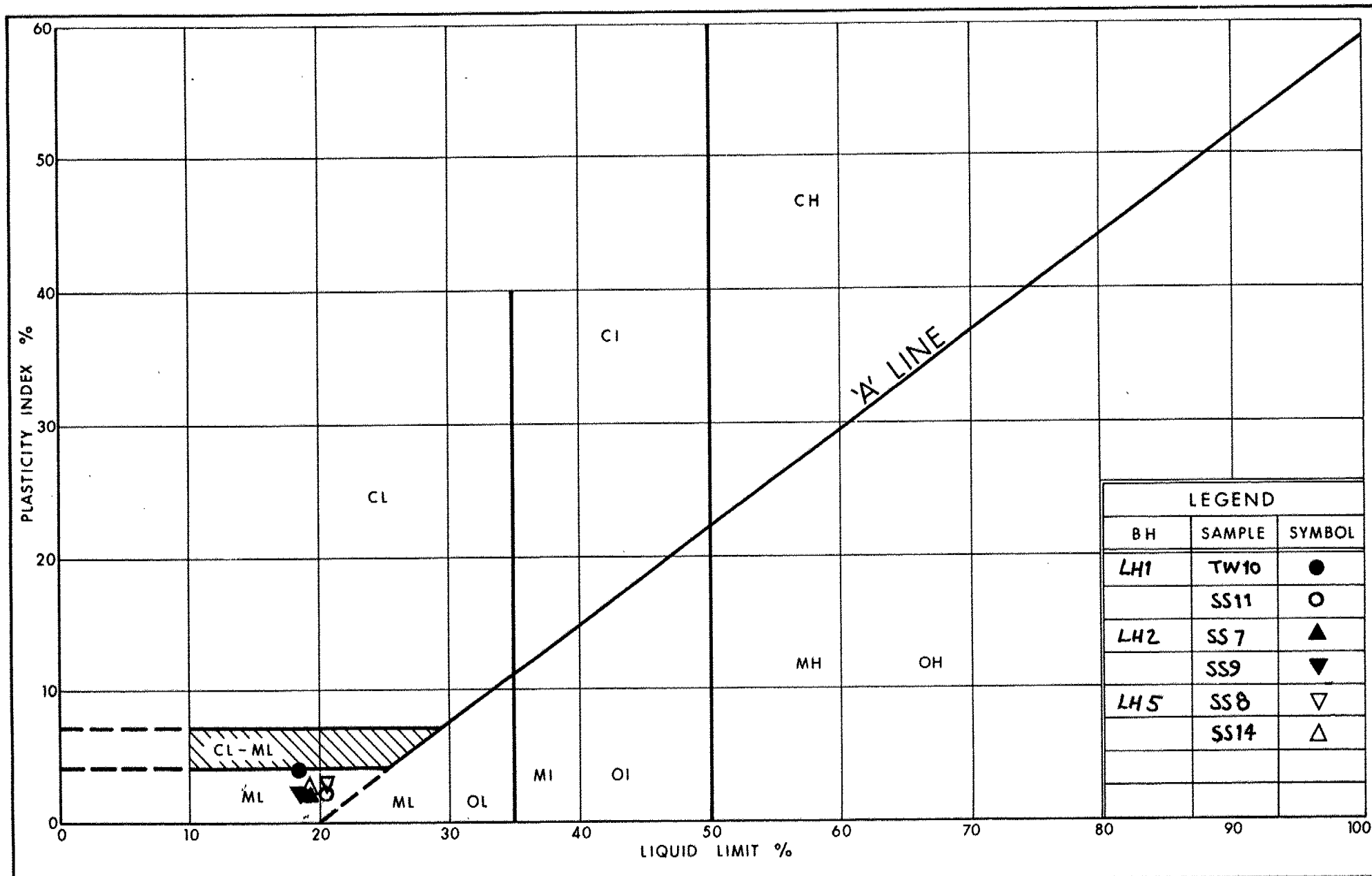
PLASTICITY CHART

SILT ZONES IN SILTY CLAY/CLAYEY SILT

FIG No 7

W P 772-93-01

SITE: 44-375



Ministry of
Transportation
Ontario

PLASTICITY CHART SILT/SANDY SILT

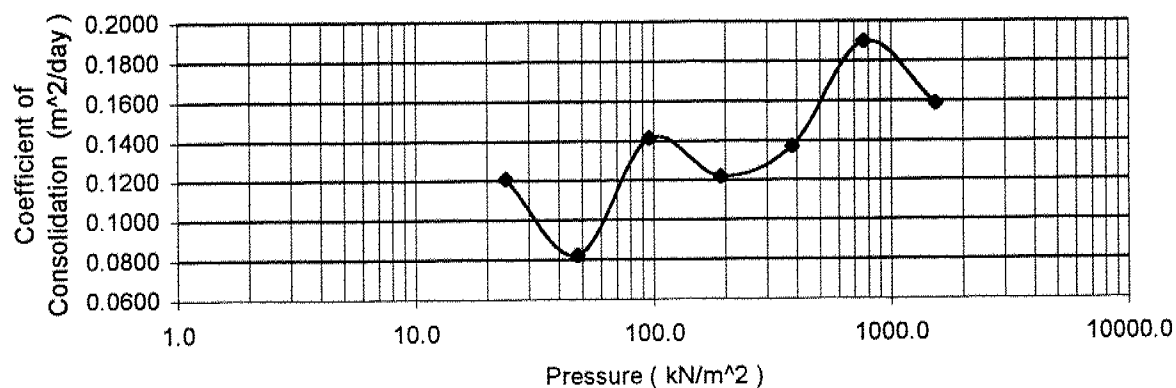
FIG No 8

W P 772-93-01

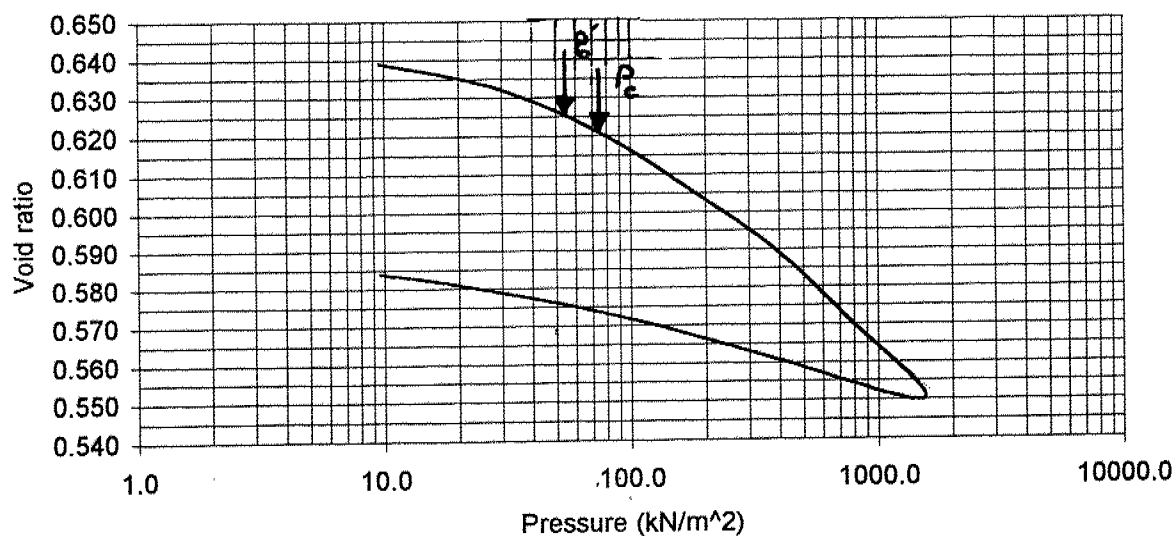
SITE: 44-375

| | Presssure (tsf) | Cv (ft ² /day) | Presssure (kN/m ²) | Cv (m ² /day) | Void ratio | |
|-----------------|--------------------|------------------------------|-----------------------------------|-----------------------------|------------|---------------------|
| Job# : TT98801 | 0.10 | | 9.6 | | 0.639 | BH# : LH 3 |
| Sample# : TW 8B | 0.25 | 1.303 | 24.0 | 0.1211 | 0.634 | Depth : 5.5m |
| | 0.50 | 0.886 | 47.9 | 0.0823 | 0.627 | Date : Dec.02, 1998 |
| | 1.00 | 1.522 | 95.8 | 0.1414 | 0.617 | |
| | 2.00 | 1.315 | 191.7 | 0.1222 | 0.604 | |
| | 4.00 | 1.477 | 383.3 | 0.1372 | 0.590 | |
| | 8.00 | 2.045 | 766.7 | 0.1900 | 0.571 | |
| Cc = 0.062 | 16.00 | 1.706 | 1533.4 | 0.1585 | 0.550 | |
| | 4.00 | | 383.3 | | 0.561 | |
| | 1.00 | | 95.8 | | 0.572 | |
| | 0.25 | | 24.0 | | 0.580 | |
| | 0.10 | | 9.6 | | 0.584 | |

Coefficient of Consolidation Vs Pressure

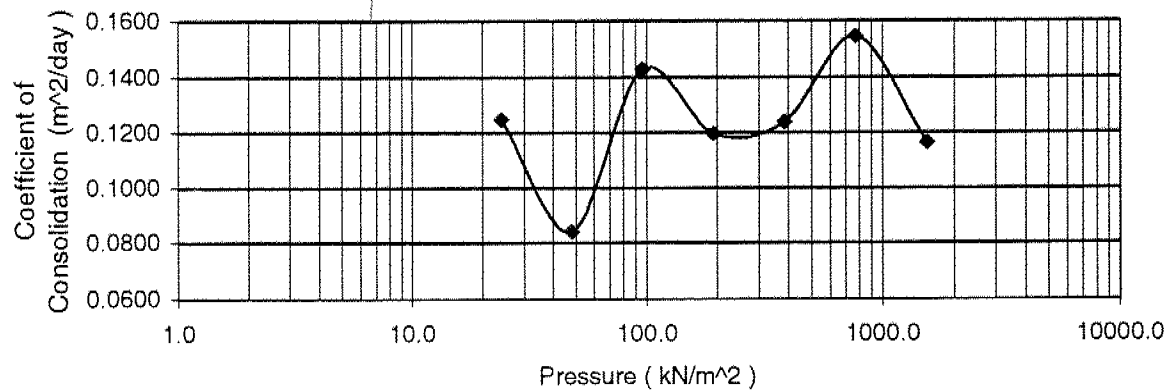


Void ratio Vs Pressure

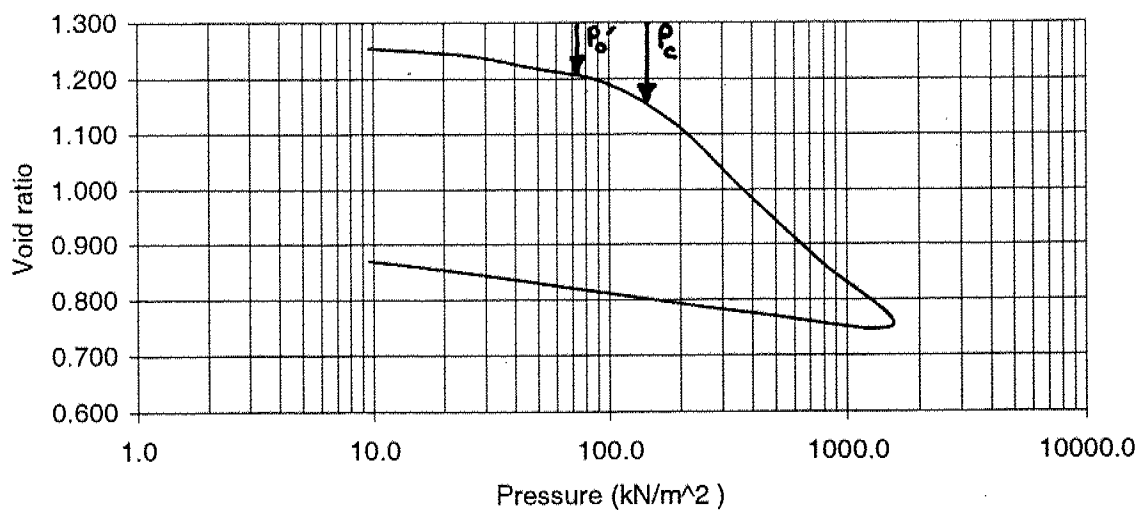


| | Pressure (tsf) | Cv (ft ² /day) | Pressure (kN/m ²) | Cv (m ² /day) | Void ratio | |
|----------------|-------------------|------------------------------|----------------------------------|-----------------------------|------------|---------------------|
| Job# : TT98801 | 0.10 | | 9.6 | | 1.255 | BH# : LH5 |
| Sample# : TW12 | 0.25 | 1.342 | 24.0 | 0.1247 | 1.242 | Depth : 8.4m |
| | 0.50 | 0.905 | 47.9 | 0.0841 | 1.219 | Date : Nov.27, 1998 |
| | 1.00 | 1.537 | 95.8 | 0.1428 | 1.192 | |
| | 2.00 | 1.286 | 191.7 | 0.1195 | 1.118 | |
| | 4.00 | 1.333 | 383.3 | 0.1238 | 0.991 | |
| | 8.00 | 1.663 | 766.7 | 0.1545 | 0.869 | |
| Cc = 0.38 | 16.00 | 1.252 | 1533.4 | 0.1163 | 0.751 | |
| | 4.00 | | 383.3 | | 0.777 | |
| | 1.00 | | 95.8 | | 0.813 | |
| | 0.25 | | 24.0 | | 0.850 | |
| | 0.10 | | 9.6 | | 0.870 | |

Coefficient of Consolidation Vs Pressure

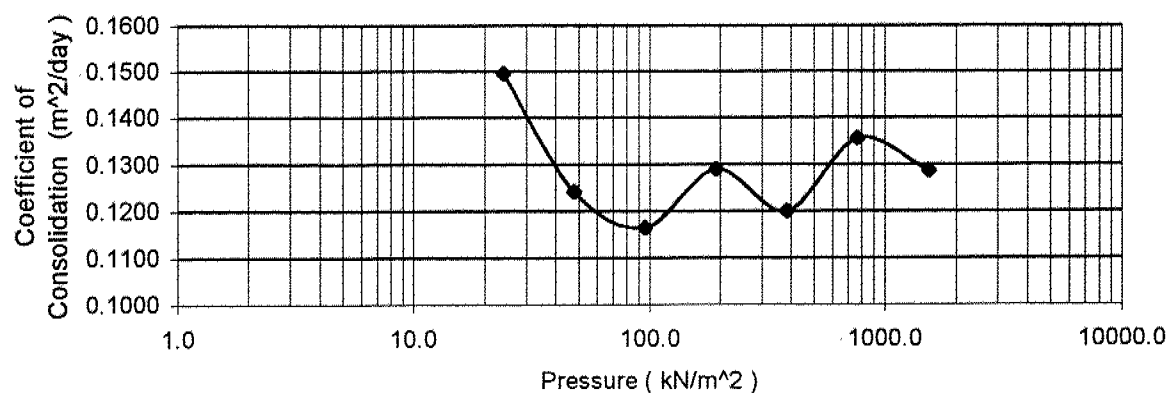


Void ratio Vs Pressure

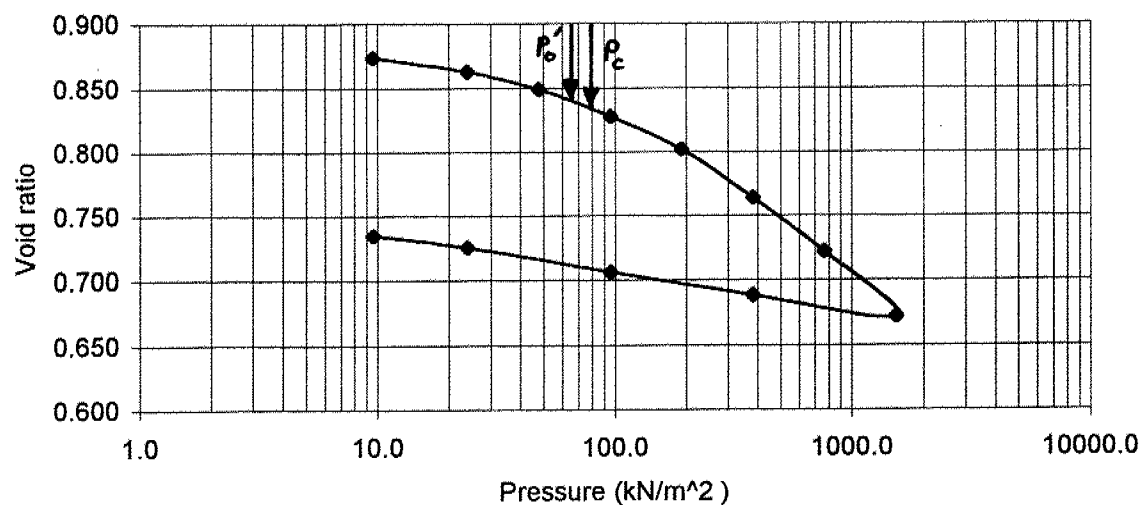


| | Pressure (tsf) | Cv (ft ² /day) | Pressure (kN/m ²) | Cv (m ² /day) | Void ratio | |
|--------------------|-------------------|------------------------------|----------------------------------|-----------------------------|------------|---------------------|
| Job# : TT98801 | 0.10 | | 9.6 | | 0.874 | BH# : LH6 |
| Sample # : LH6/ 9A | 0.25 | 1.610 | 24.0 | 0.1496 | 0.863 | Depth : 7.5m |
| | 0.50 | 1.336 | 47.9 | 0.1241 | 0.849 | Date : Dec.22, 1998 |
| | 1.00 | 1.254 | 95.8 | 0.1165 | 0.828 | |
| | 2.00 | 1.388 | 191.7 | 0.1289 | 0.802 | |
| | 4.00 | 1.292 | 383.3 | 0.1200 | 0.764 | |
| | 8.00 | 1.460 | 766.7 | 0.1357 | 0.722 | |
| Cc = 0.14 | 16.00 | 1.385 | 1533.4 | 0.1286 | 0.672 | |
| | 4.00 | | 383.3 | | 0.688 | |
| | 1.00 | | 95.8 | | 0.706 | |
| | 0.25 | | 24.0 | | 0.725 | |
| | 0.10 | | 9.6 | | 0.735 | |

Coefficient of Consolidation Vs Pressure

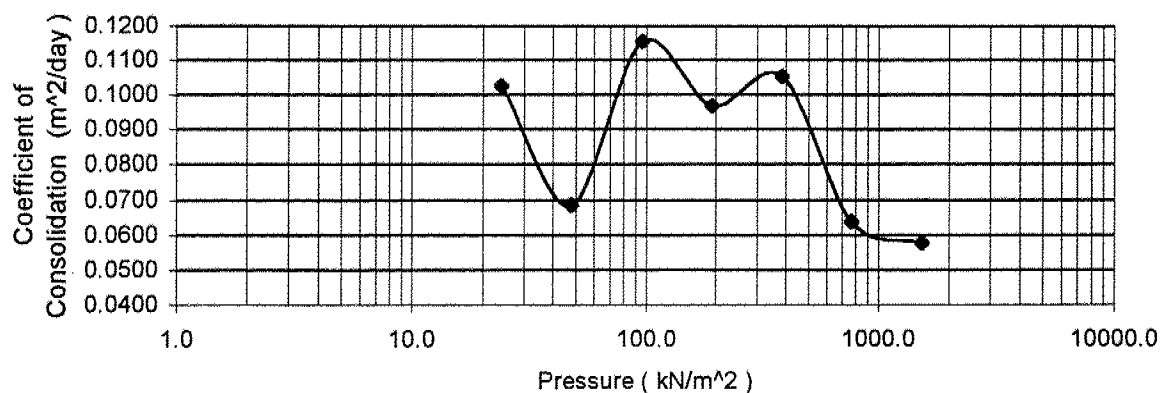


Void ratio Vs Pressure



| | Pressure (tsf) | Cv (ft ² /day) | Pressure (kN/m ²) | Cv (m ² /day) | Void ratio | |
|-------------------|-------------------|------------------------------|----------------------------------|-----------------------------|------------|---------------------|
| Job# : TT98801 | 0.10 | | 9.6 | | 0.902 | BH# : LH7 |
| Sample# : TW10B | 0.25 | 1.105 | 24.0 | 0.1027 | 0.887 | Depth : 7.6m |
| | 0.50 | 0.739 | 47.9 | 0.0687 | 0.858 | Date : Nov.30, 1998 |
| | 1.00 | 1.243 | 95.8 | 0.1155 | 0.826 | |
| | 2.00 | 1.044 | 191.7 | 0.0970 | 0.781 | |
| | 4.00 | 1.135 | 383.3 | 0.1054 | 0.739 | |
| | 8.00 | 0.687 | 766.7 | 0.0638 | 0.687 | |
| Cc = 0.165 | 16.00 | 0.622 | 1533.4 | 0.0578 | 0.622 | |
| | 4.00 | | 383.3 | | 0.642 | |
| | 1.00 | | 95.8 | | 0.672 | |
| | 0.25 | | 24.0 | | 0.690 | |
| | 0.10 | | 9.6 | | 0.704 | |

Coefficient of Consolidation Vs Pressure



Void ratio Vs Pressure

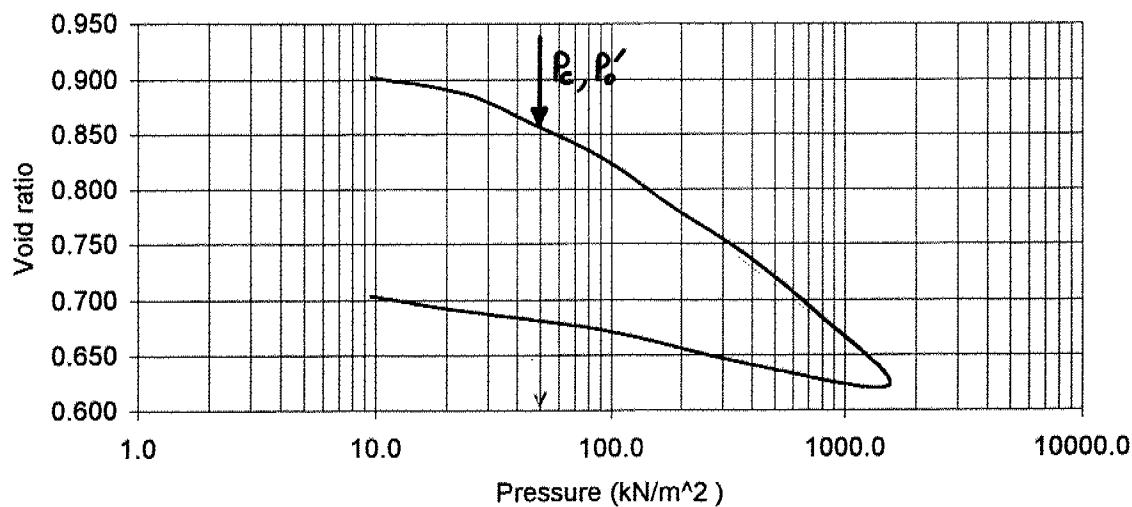


Fig: 13 Field Vane and
Quick Triaxial Test Results

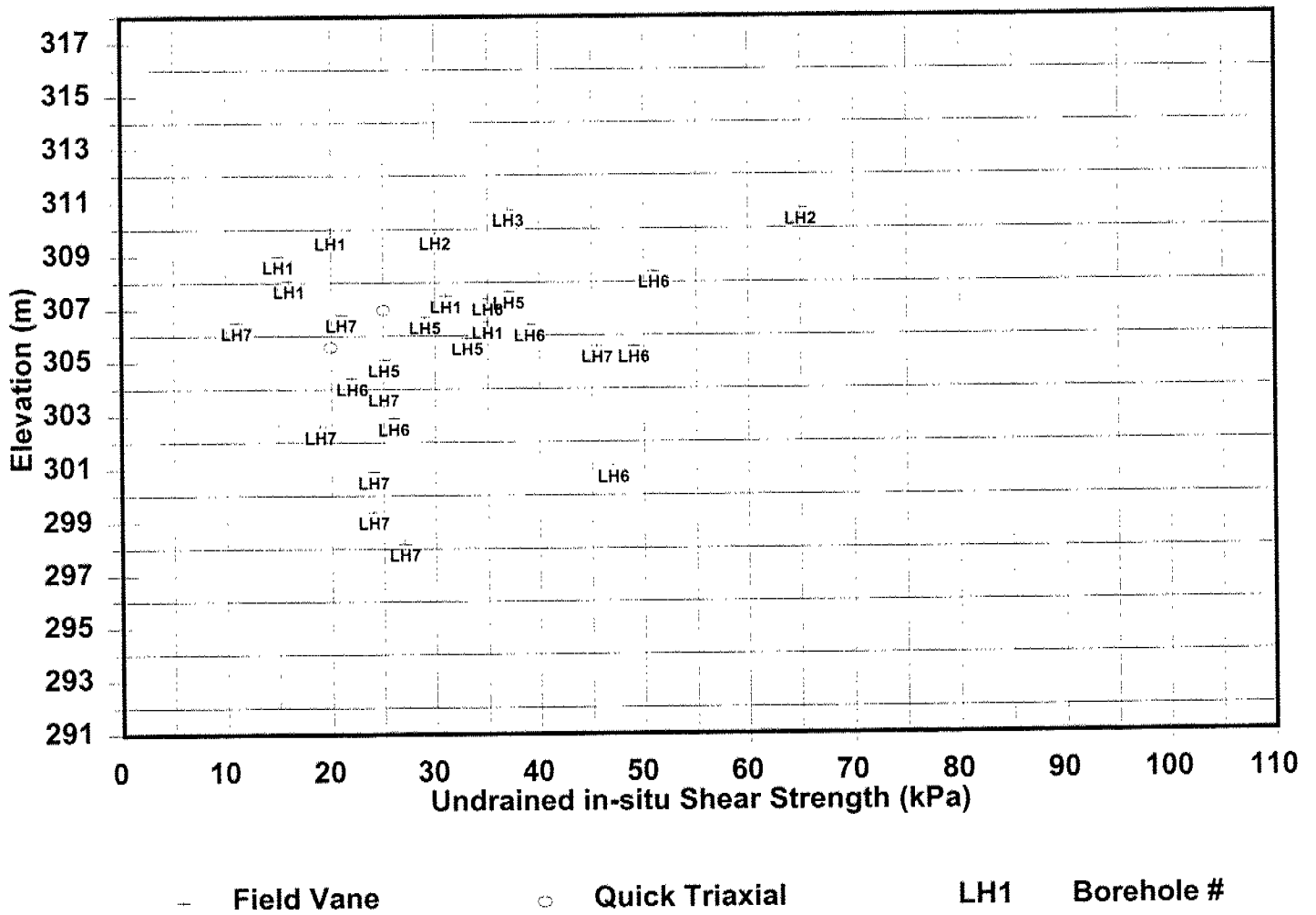
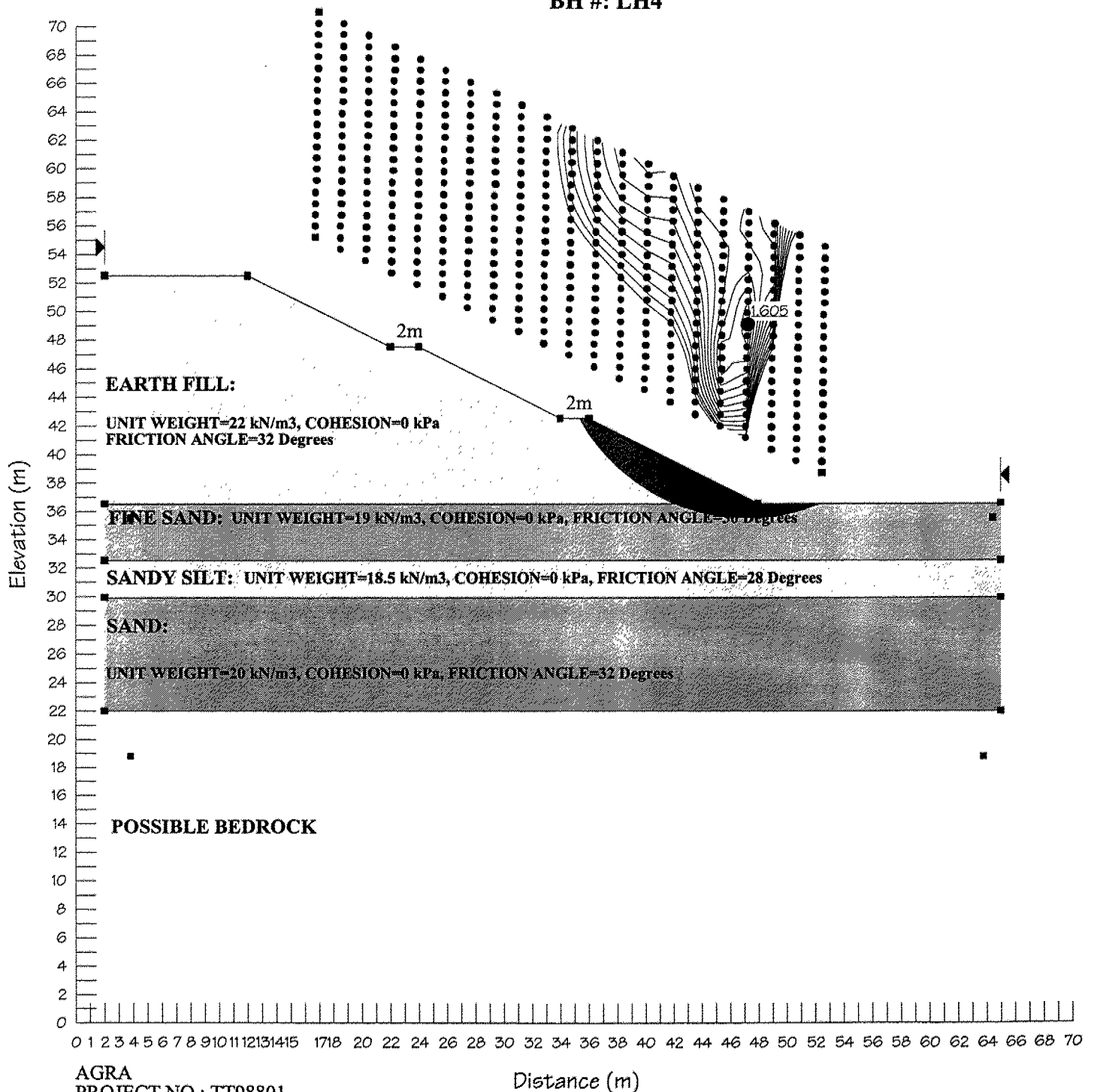


FIGURE - 14

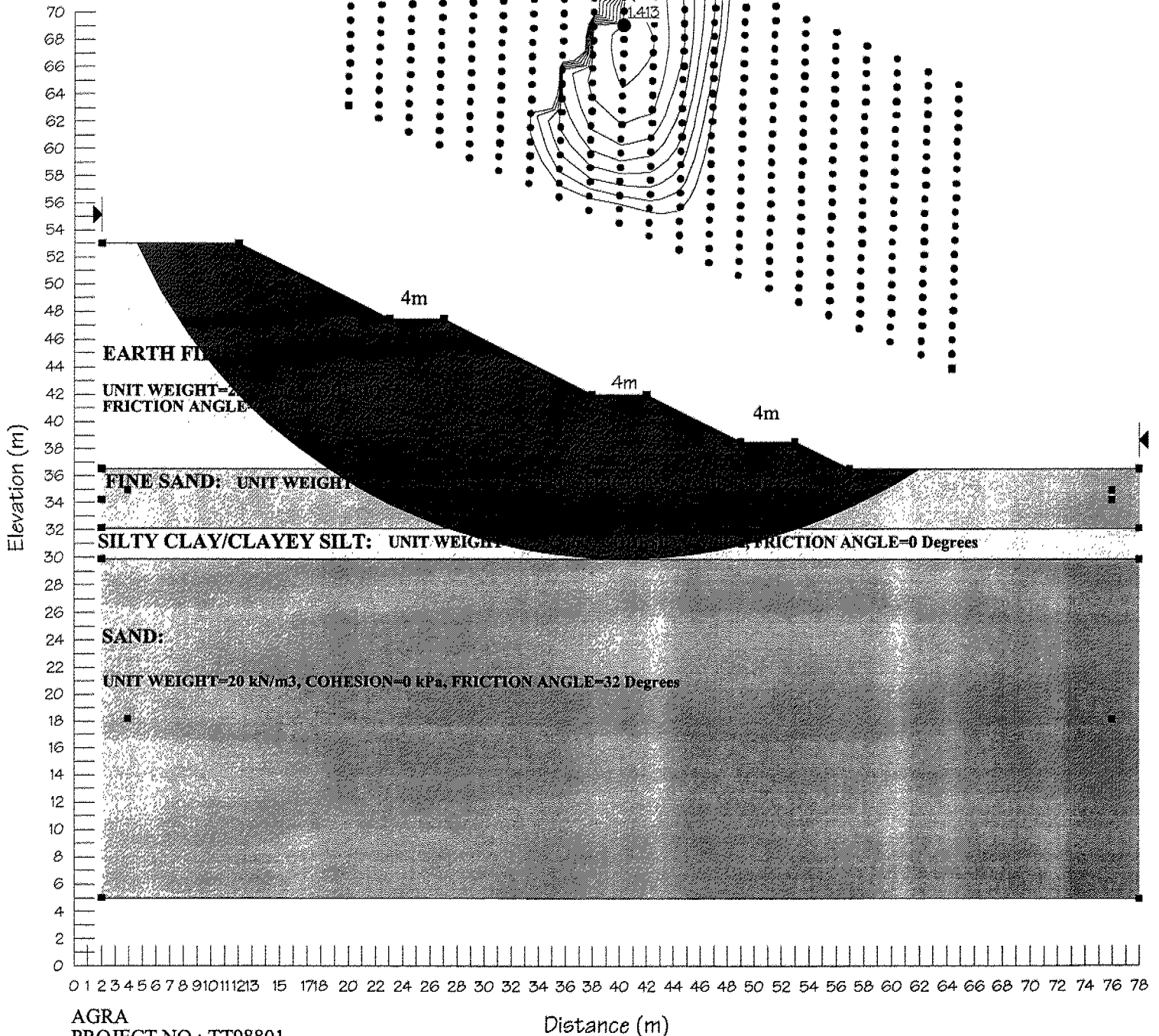
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
SHORT & LONG TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 2m BERM
BH #: LH4



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-westapproach-12)/ Date: February 22, 1999

FIGURE - 15

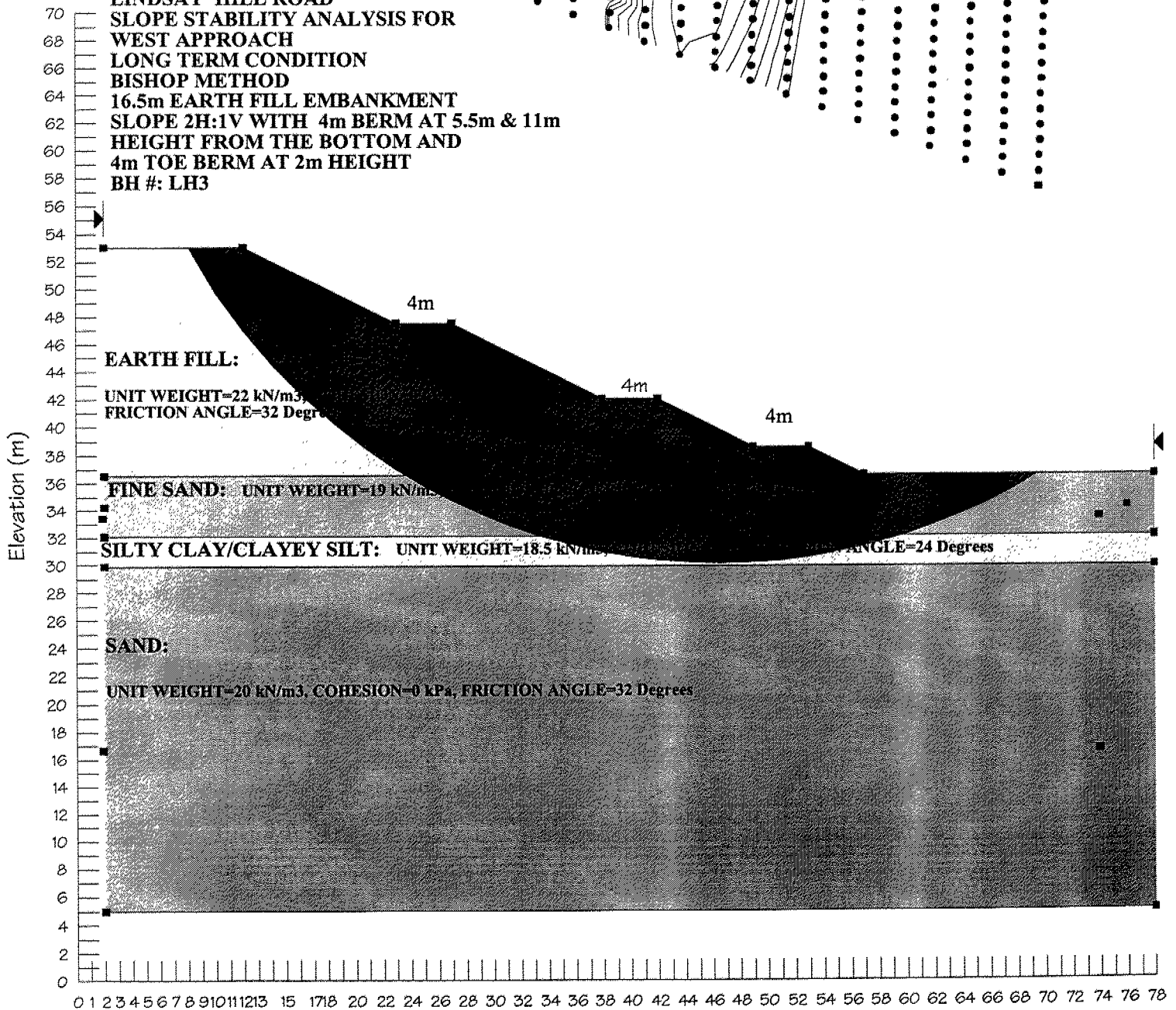
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.5m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 4m BERM AT 5.5m & 11m
HEIGHT FROM THE BOTTOM AND
4m TOE BERM AT 2m HEIGHT
BH #: LH3



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-westapproach-12LH3-2)/Date: February 22, 1999

FIGURE - 16

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.5m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 4m BERM AT 5.5m & 11m
HEIGHT FROM THE BOTTOM AND
4m TOE BERM AT 2m HEIGHT
BH #: LH3



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-westapproach-12LH3-2)/Date: February 22, 1999

FIGURE - 17

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
AT 5.5m AND 11m FROM THE BOTTOM
BH #: LH3

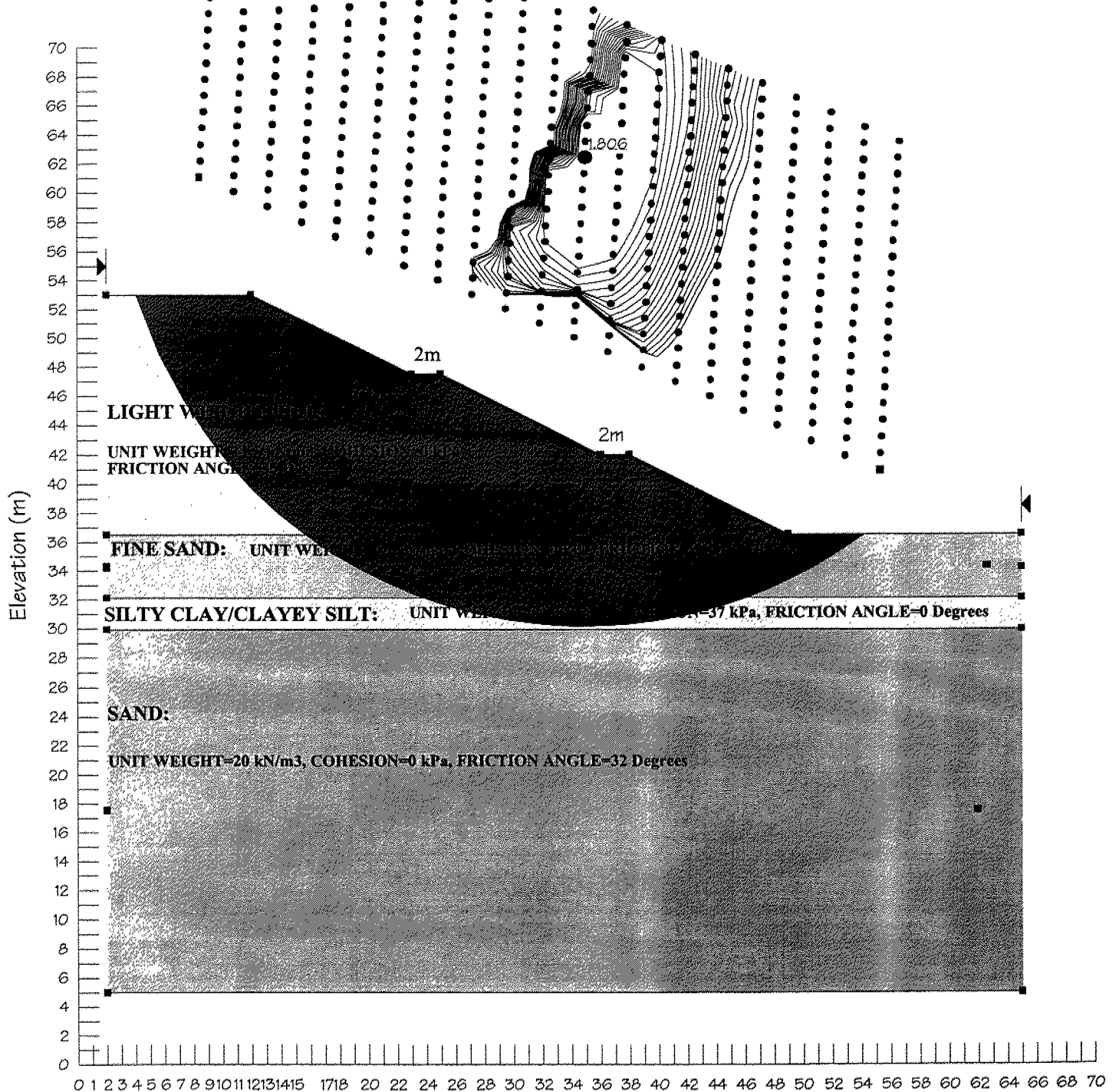


FIGURE - 18

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
WEST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
AT 5.5m AND 11m FROM THE BOTTOM
BH #: LH3

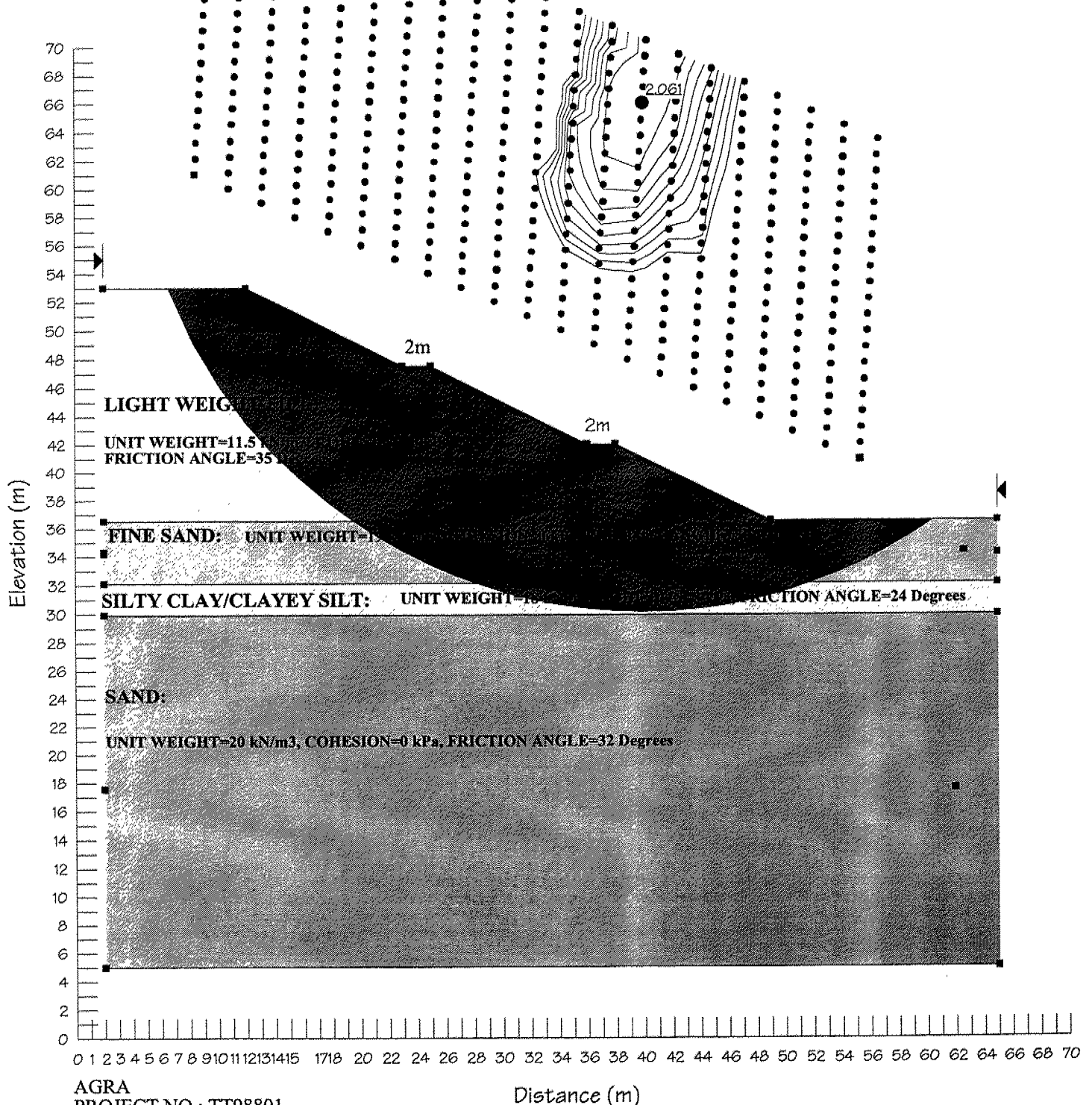
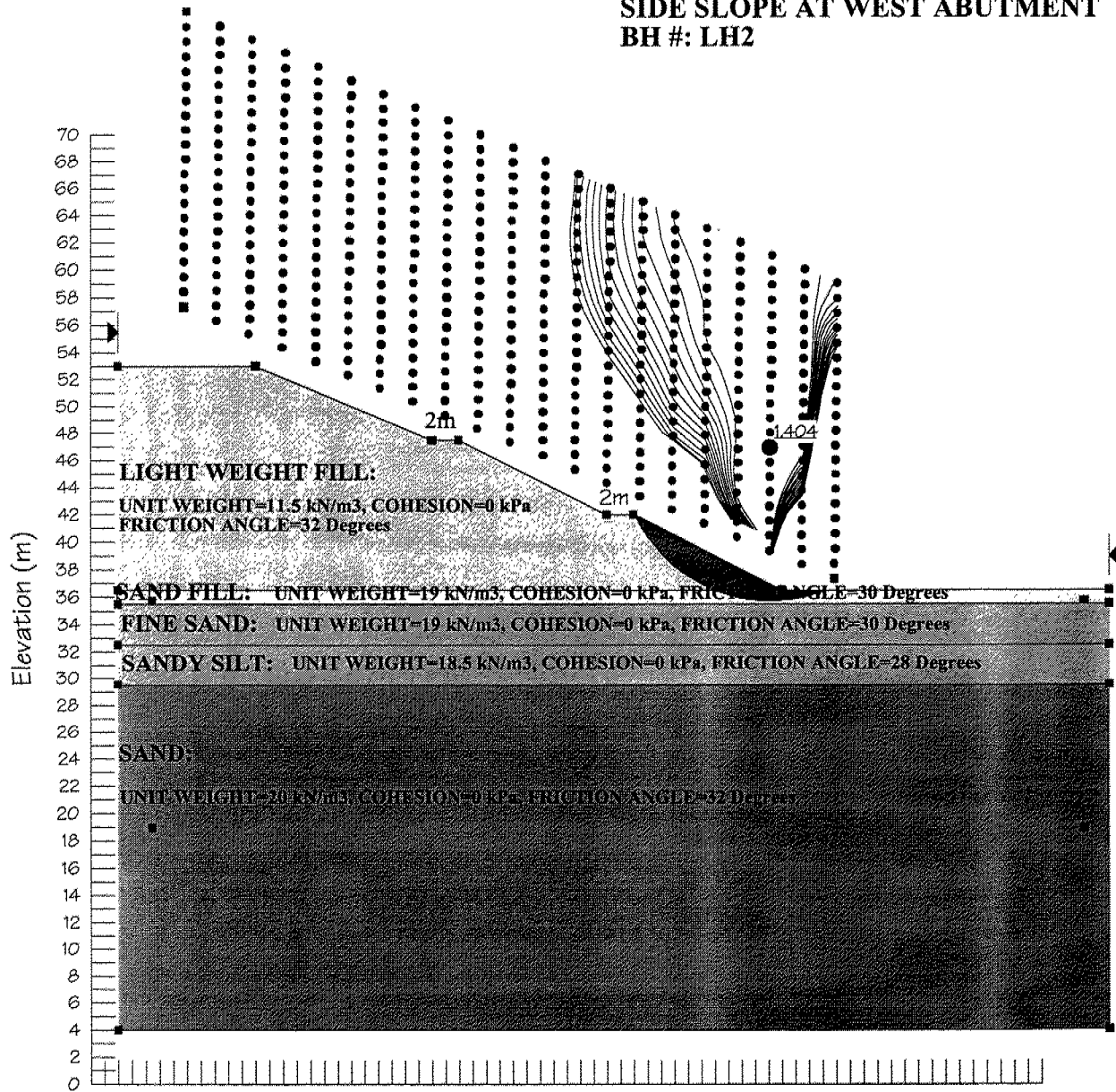


FIGURE - 19

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
SHORT & LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m BERM AT
5.5m & 11.0m FROM THE BOTTOM
SIDE SLOPE AT WEST ABUTMENT
BH #: LH2



0 1 2 3 4 5 6 7 8 9 11 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70

AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANEING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH2S)/ Date: February 22, 1999

Distance (m)

FIGURE NO. 20

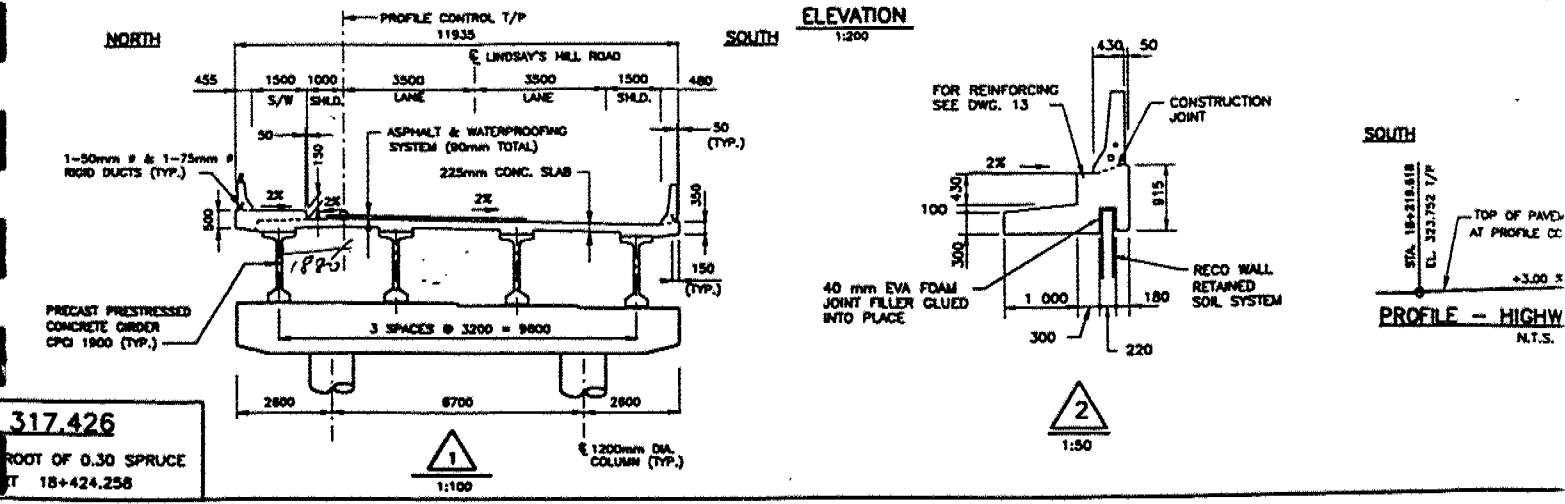
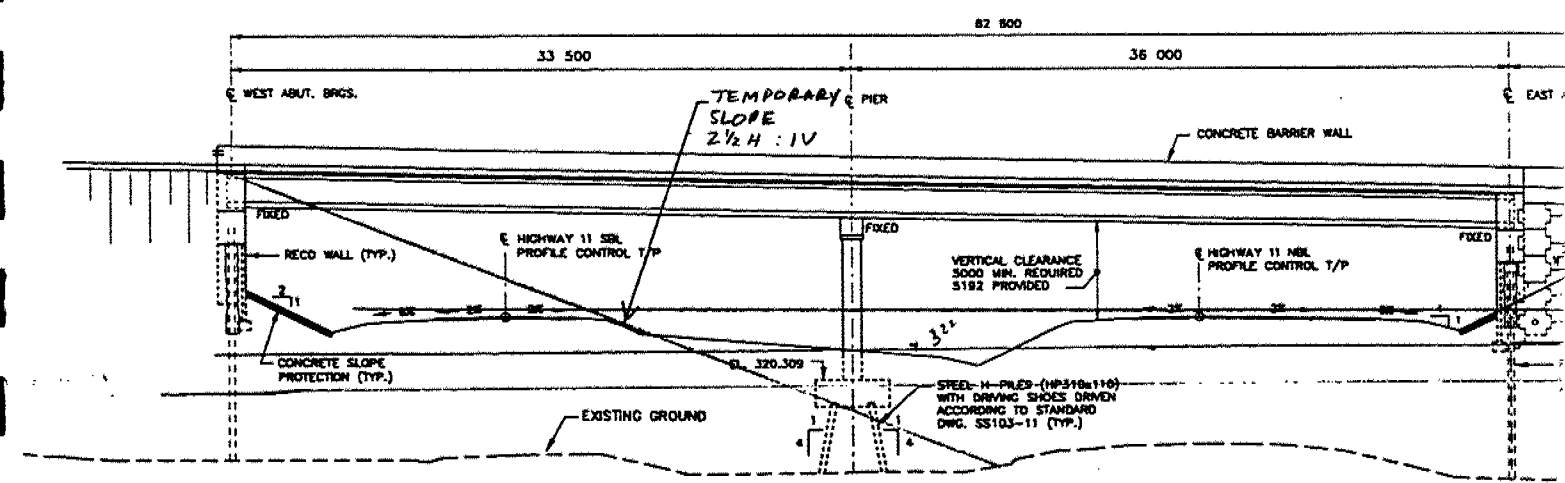
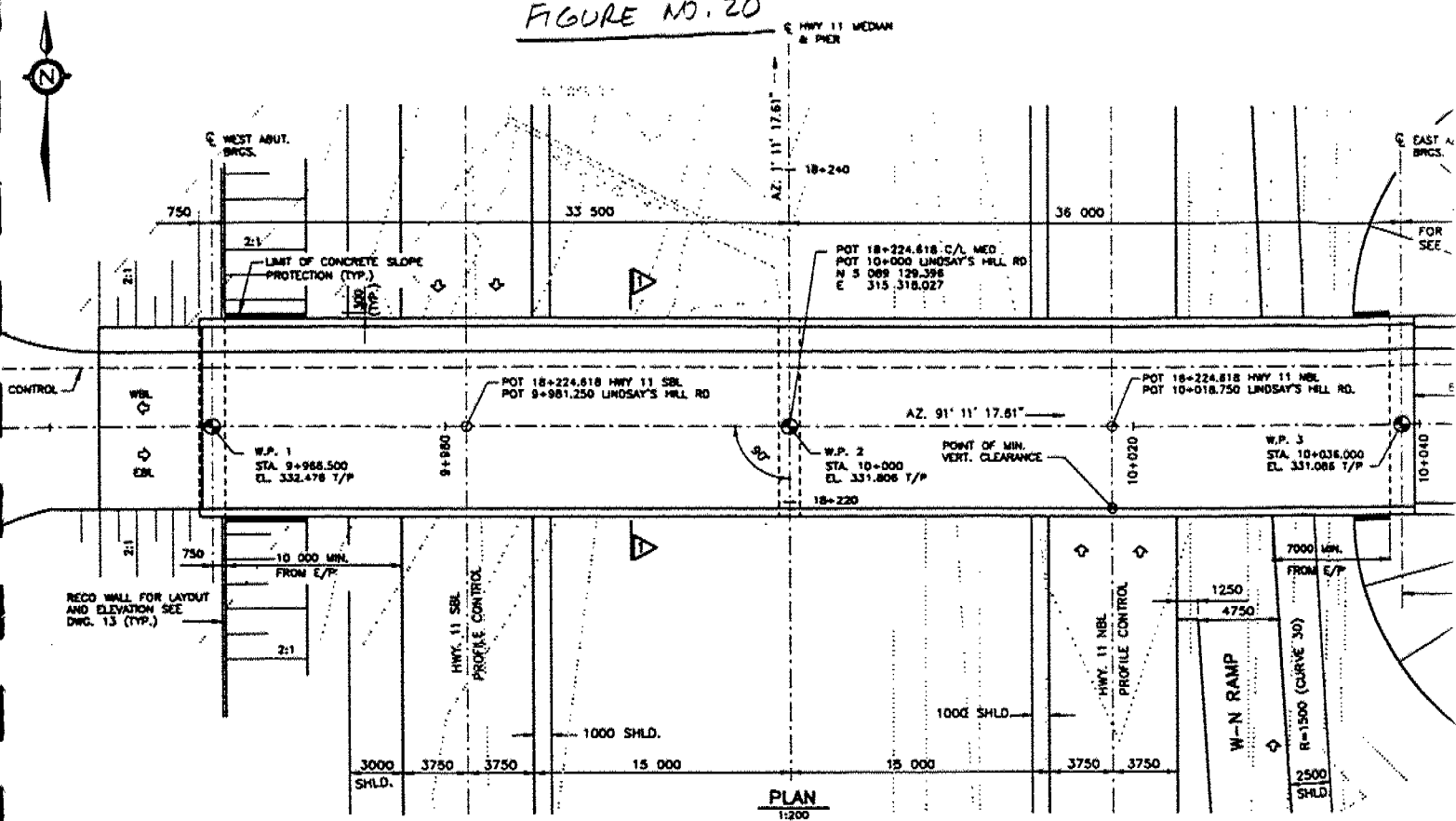
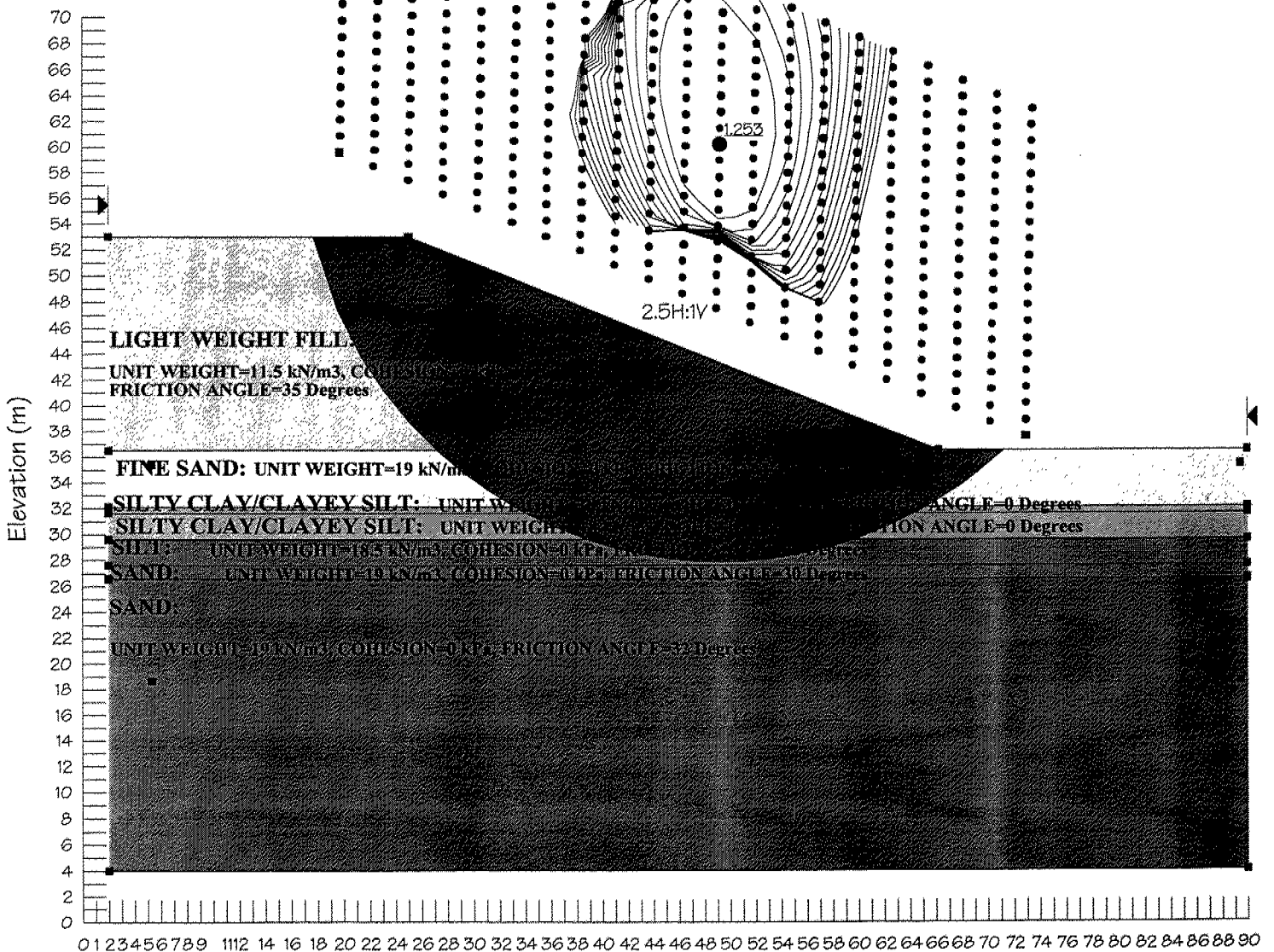


FIGURE NO. 20

FIGURE - 21

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
WEST ABUTMENT TO PIER
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V
BH #: LH1

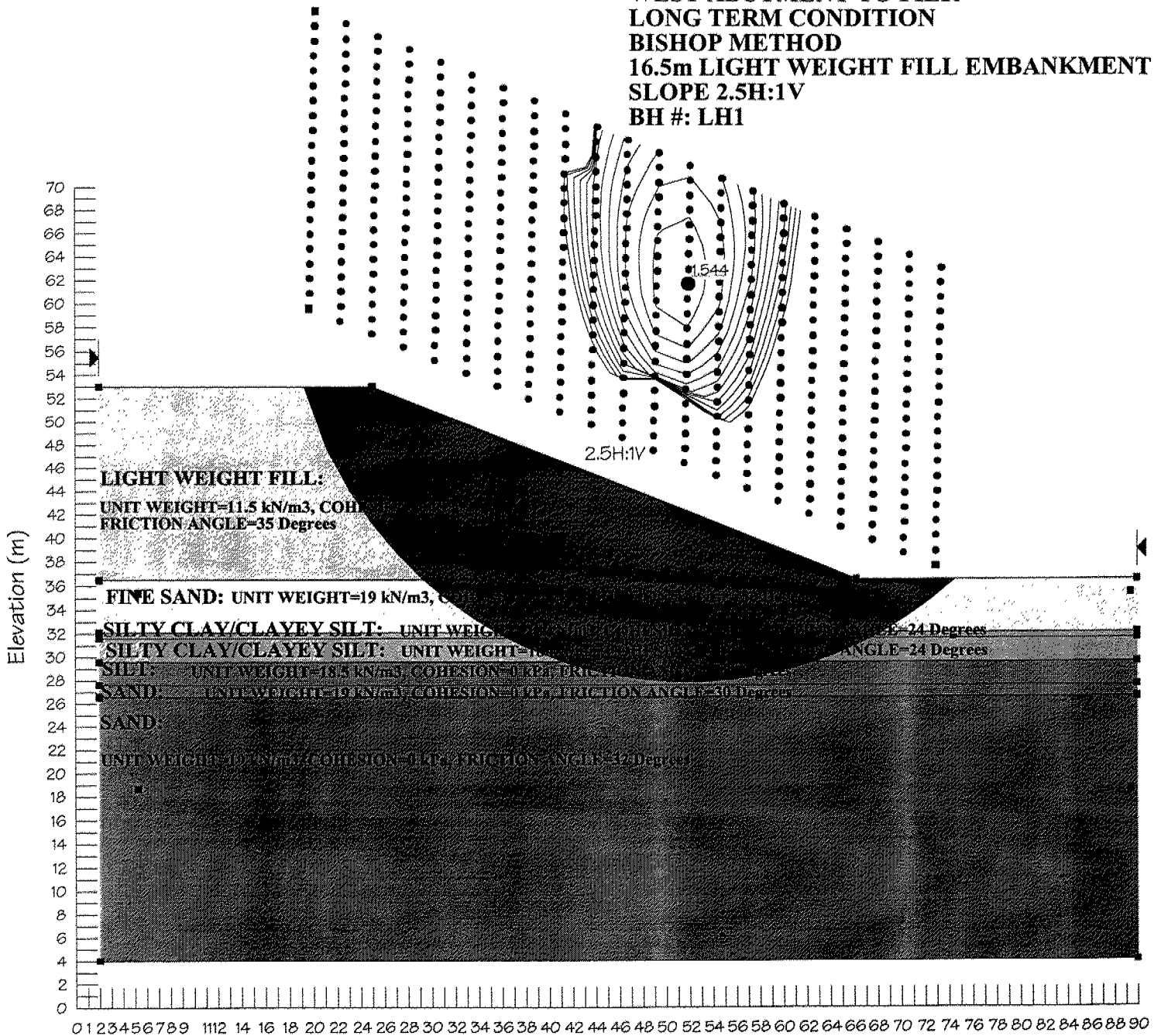


AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH1-2)/ Date: February 22, 1999

Distance (m)

FIGURE - 22

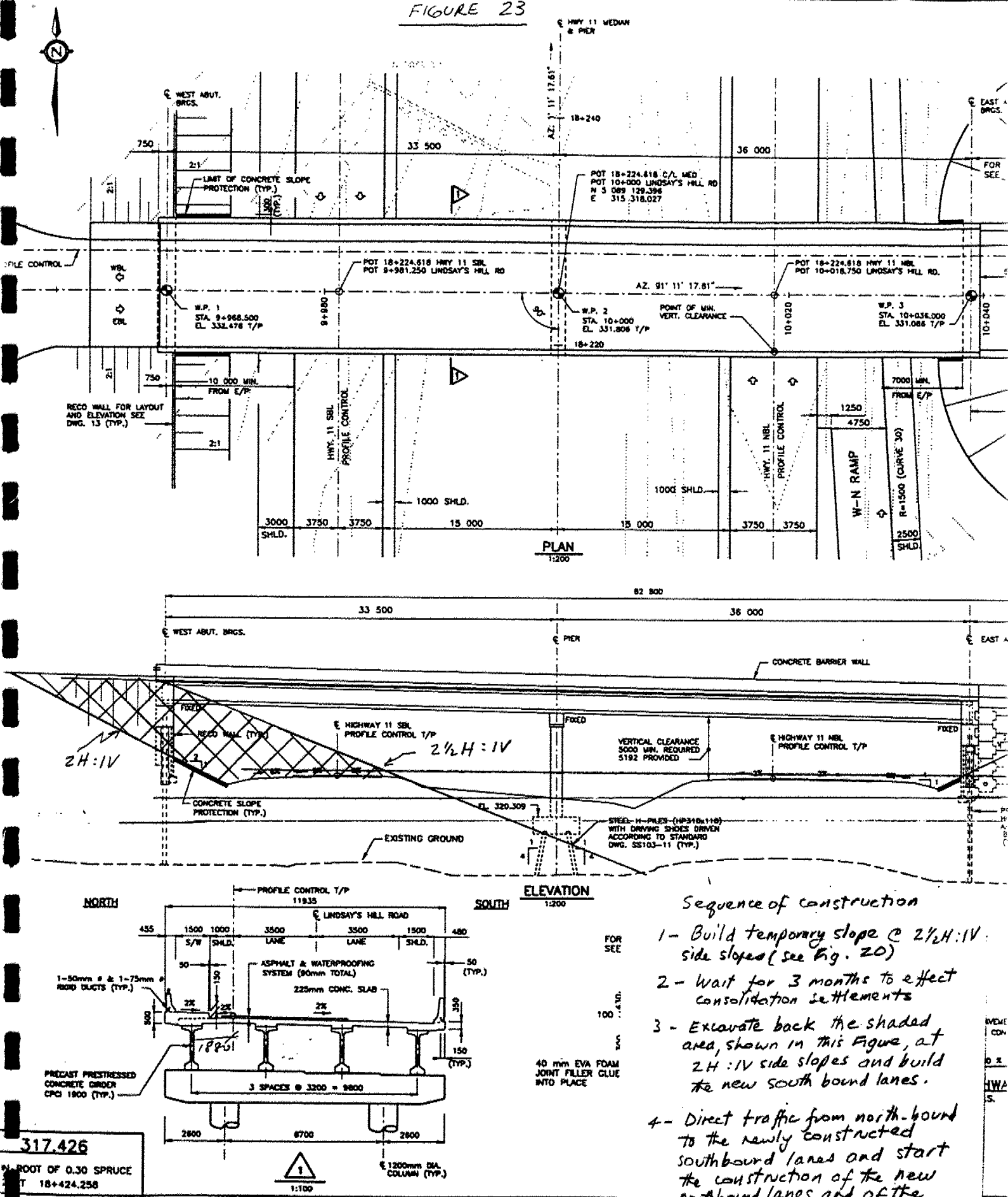
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
WEST ABUTMENT TO PIER
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V
BH #: LH1



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-WESTABUT1LH1-2)/ Date: February 22, 1999

Distance (m)

FIGURE 23



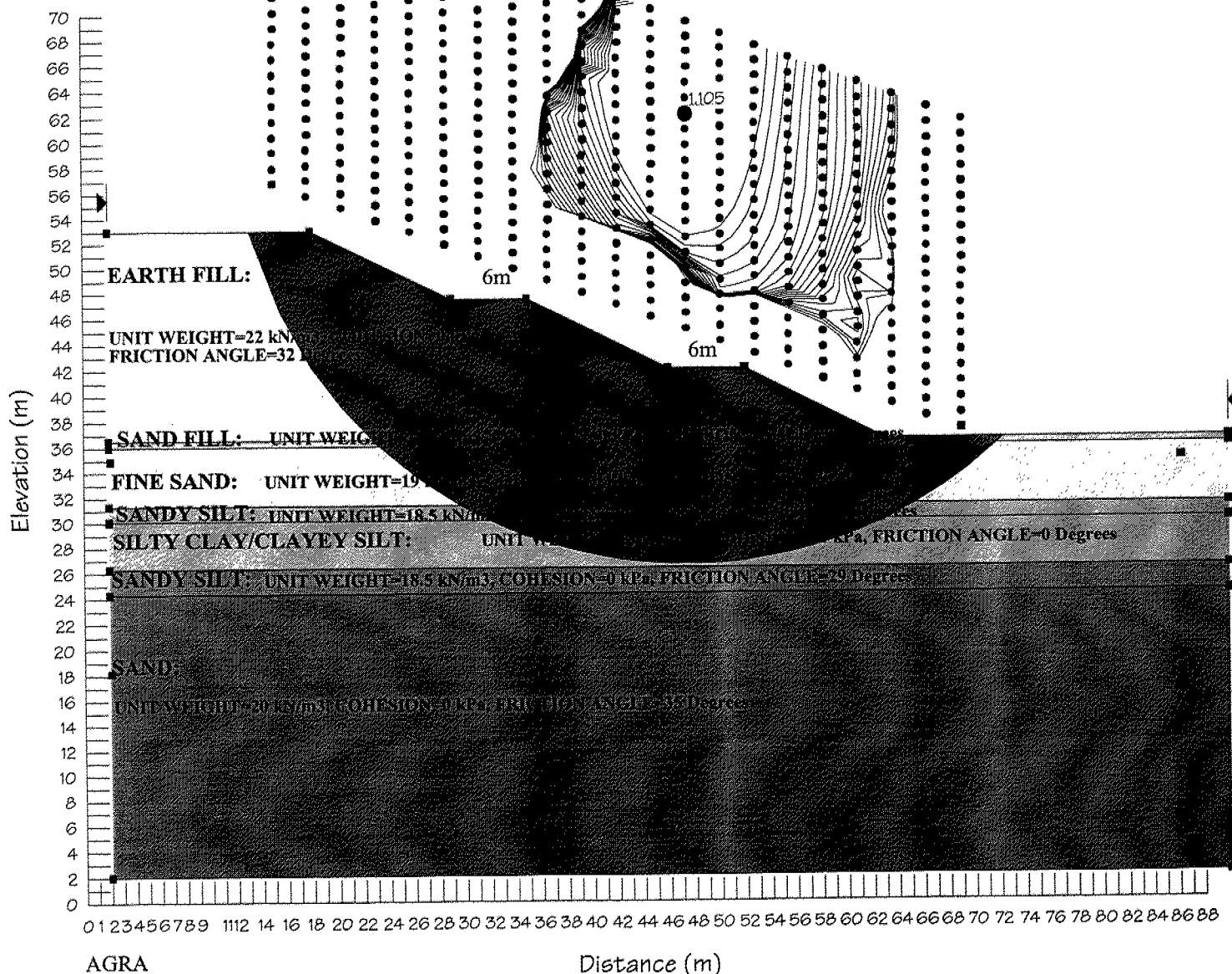
Sequence of construction

- 1 - Build temporary slope @ $2\frac{1}{2}H:1V$ side slopes (see Fig. 20)
- 2 - Wait for 3 months to effect consolidation settlements
- 3 - Excavate back the shaded area, shown in this figure, at $2H:1V$ side slopes and build the new south bound lanes.
- 4 - Direct traffic from north-bound to the newly constructed southbound lanes and start the construction of the new northbound lanes and of the east approach and embankment fills.

FIGURE 23

FIGURE - 24

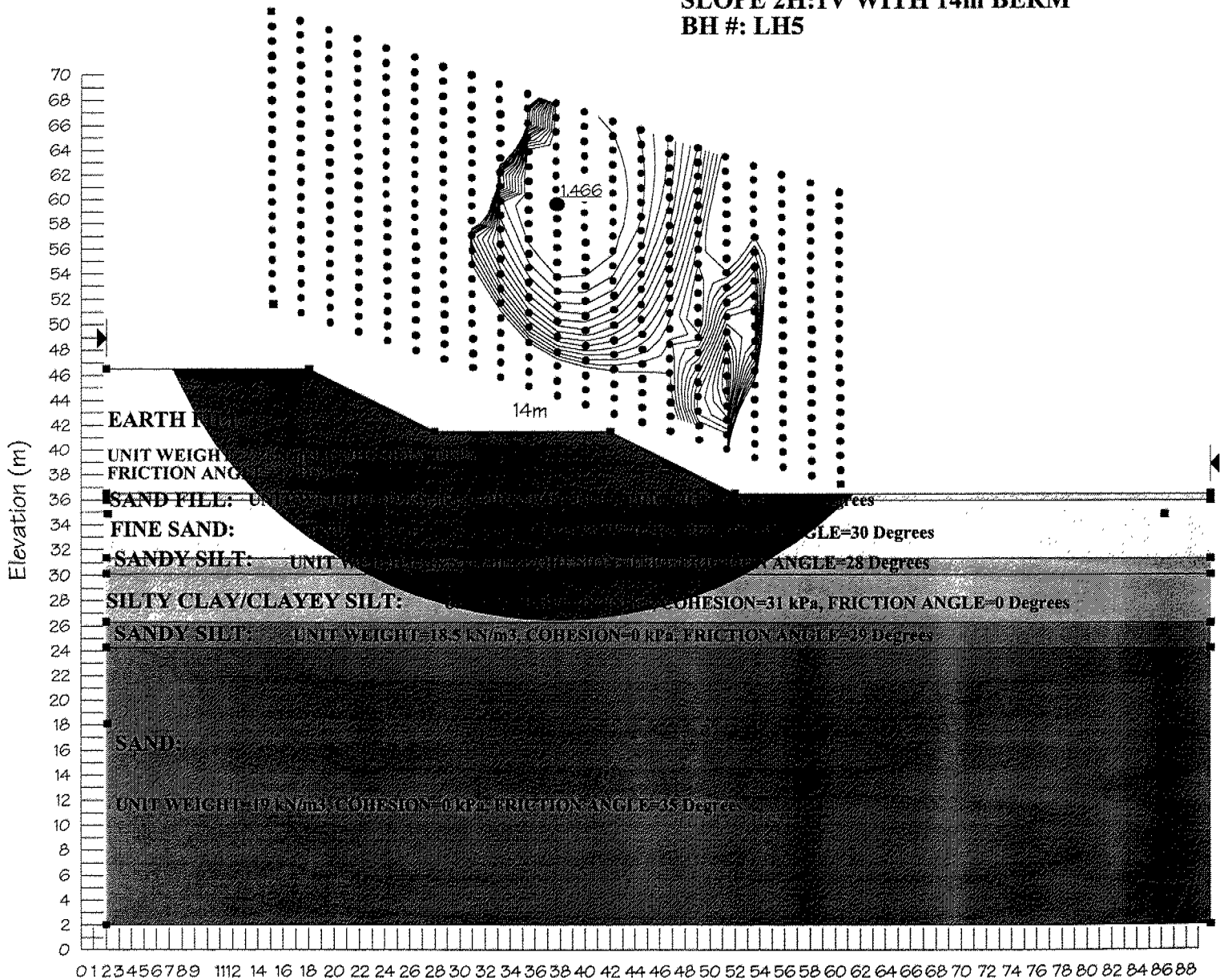
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH TWO 2m MIDHEIGHT BERM
BH #: LH5



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S)/ Date: February 22, 1999

FIGURE - 25

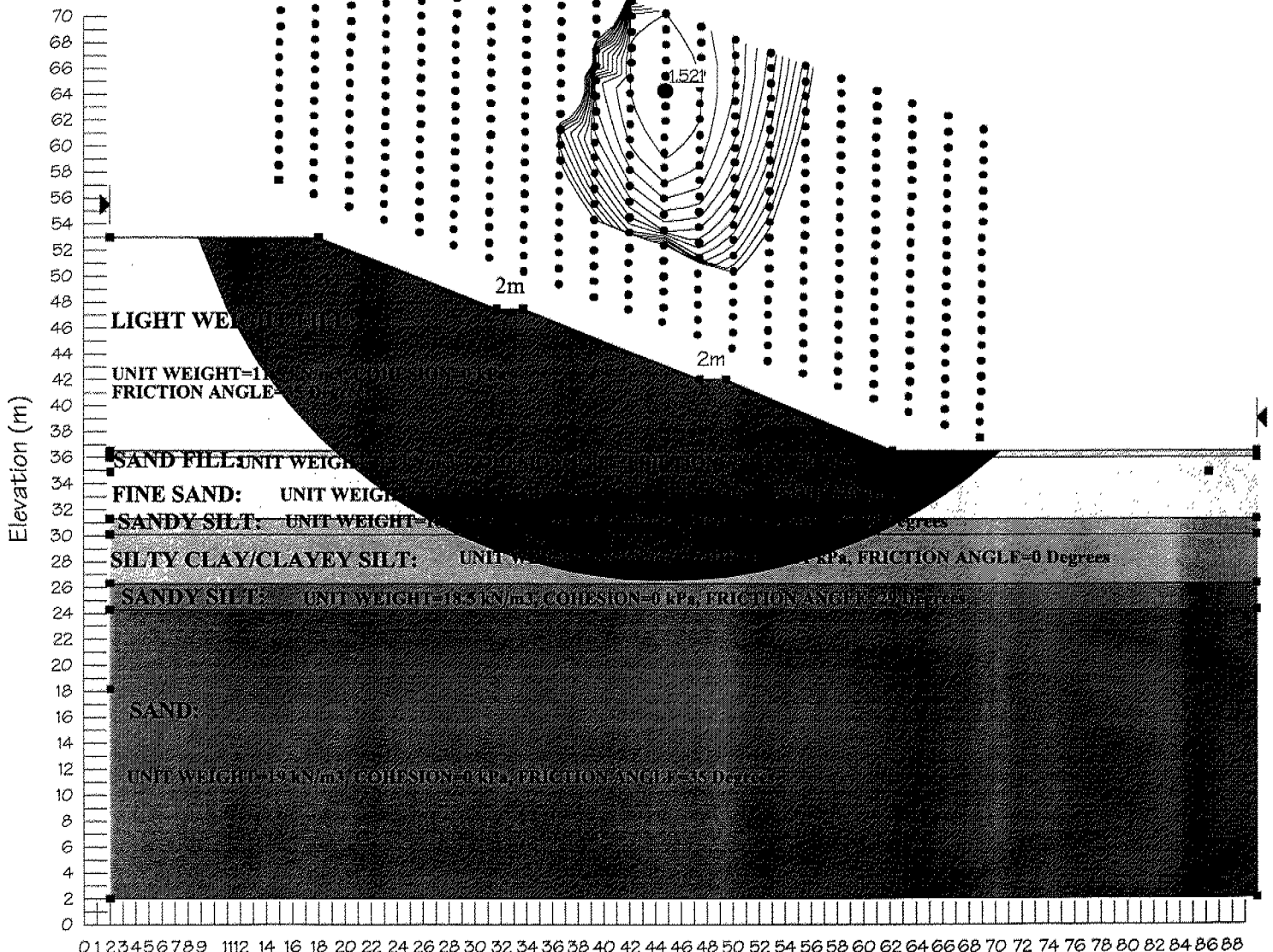
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
10m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 14m BERM
BH #: LH5



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANEING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-1)/ Date: February 22, 1999

FIGURE - 26

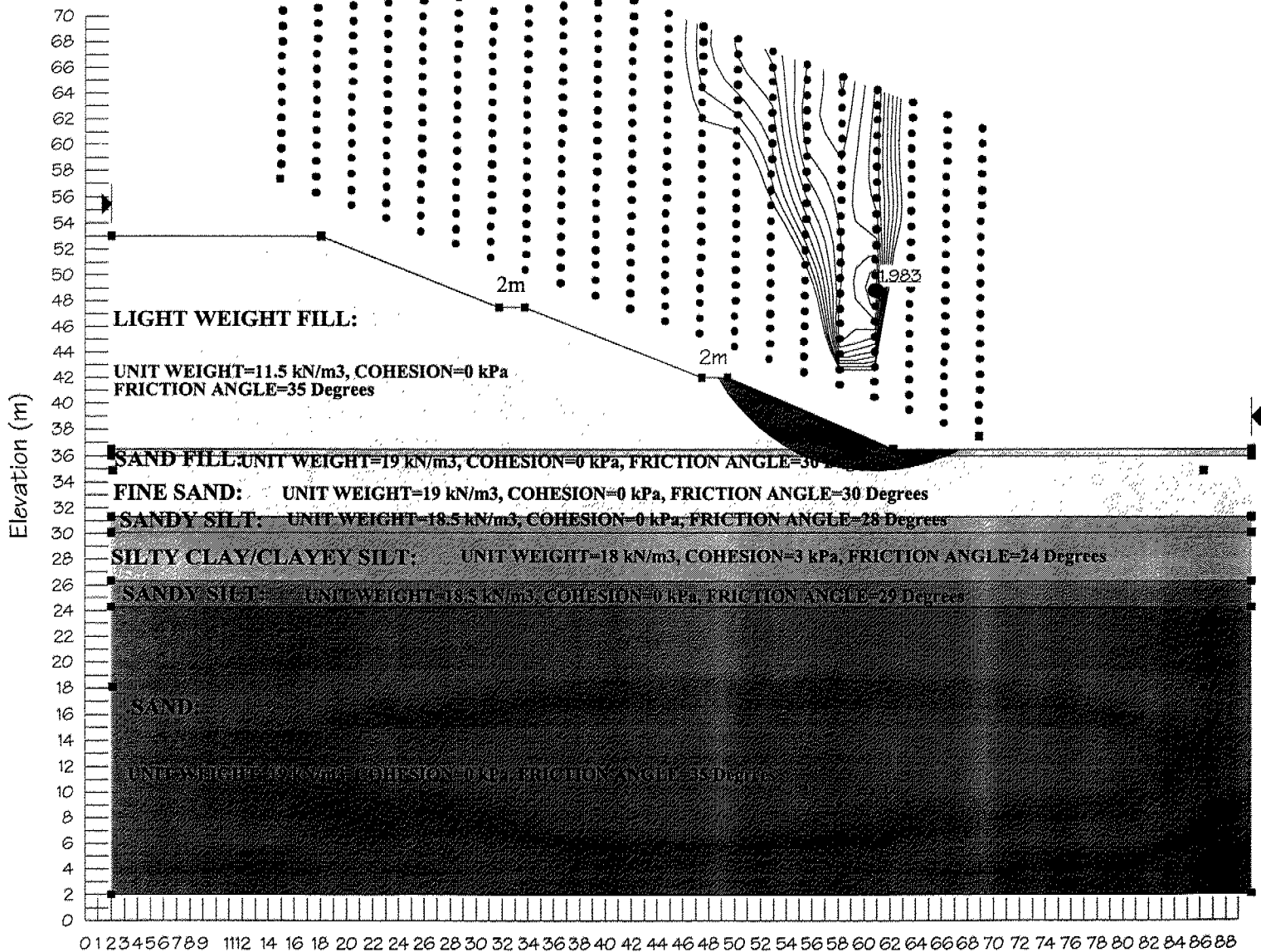
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
SHORT TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH 2m MID HEIGHT BERM
BH #: LH5



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-2)/ Date: February 22, 1999

FIGURE - 27

**LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST ABUTMENT SIDE SLOPE
LONG TERM CONDITION
BISHOP METHOD
16.5m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 2.5H:1V WITH 2m MID HEIGHT BERM
BH #: LH5**

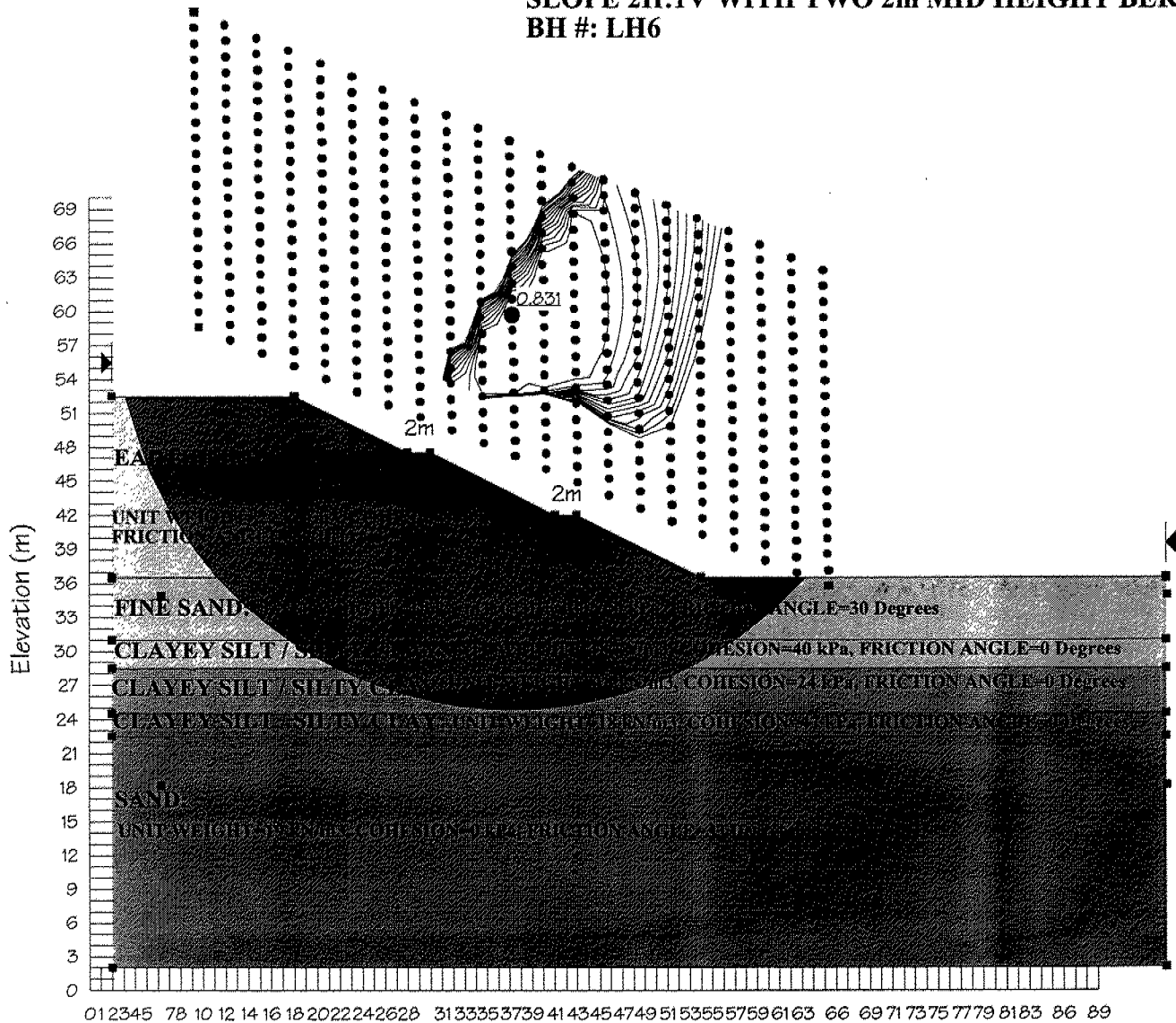


AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTABUT-LH5-S-2)/ Date: February 22, 1999

Distance (m)

FIGURE - 28

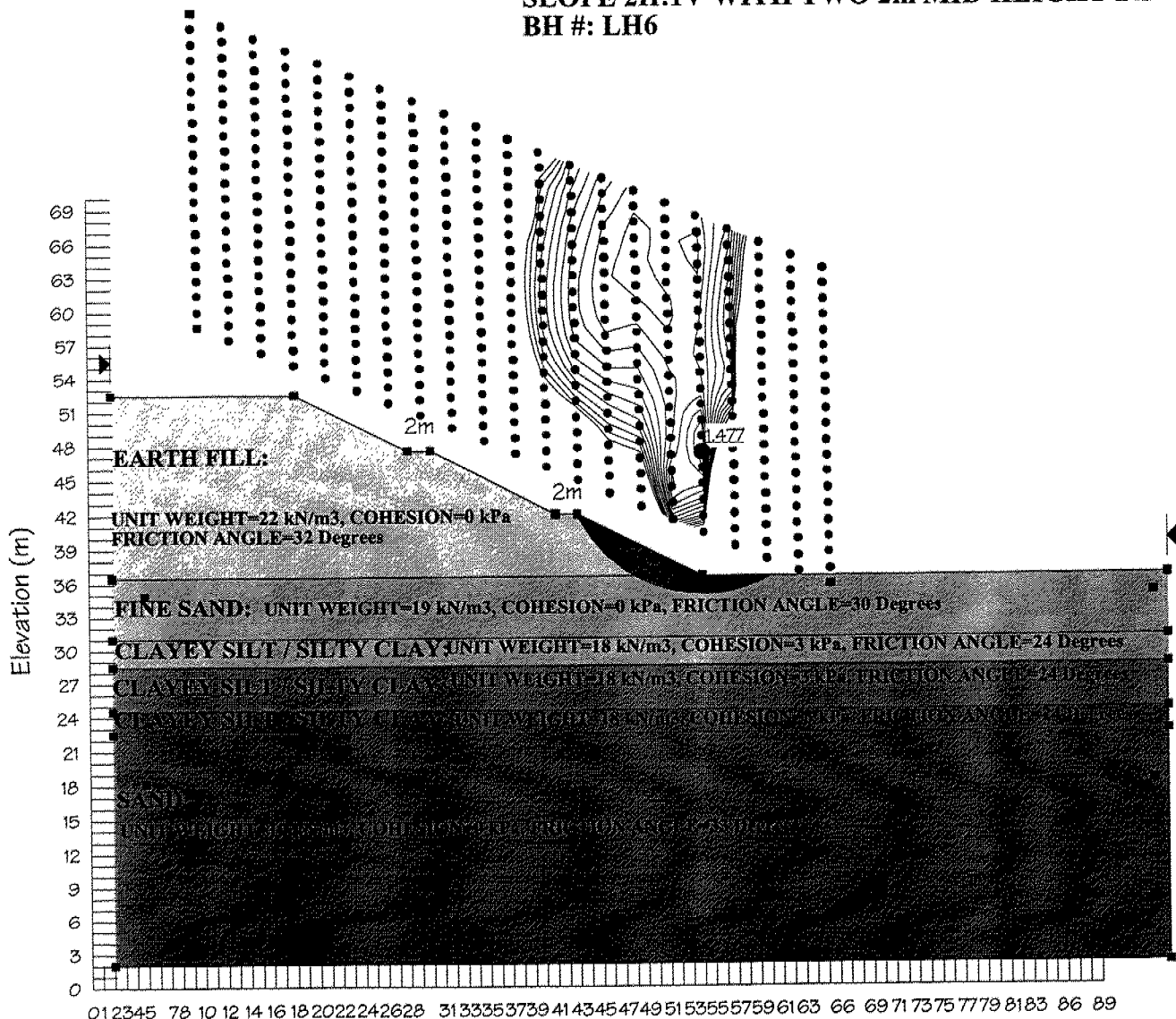
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANEING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6)

FIGURE - 29

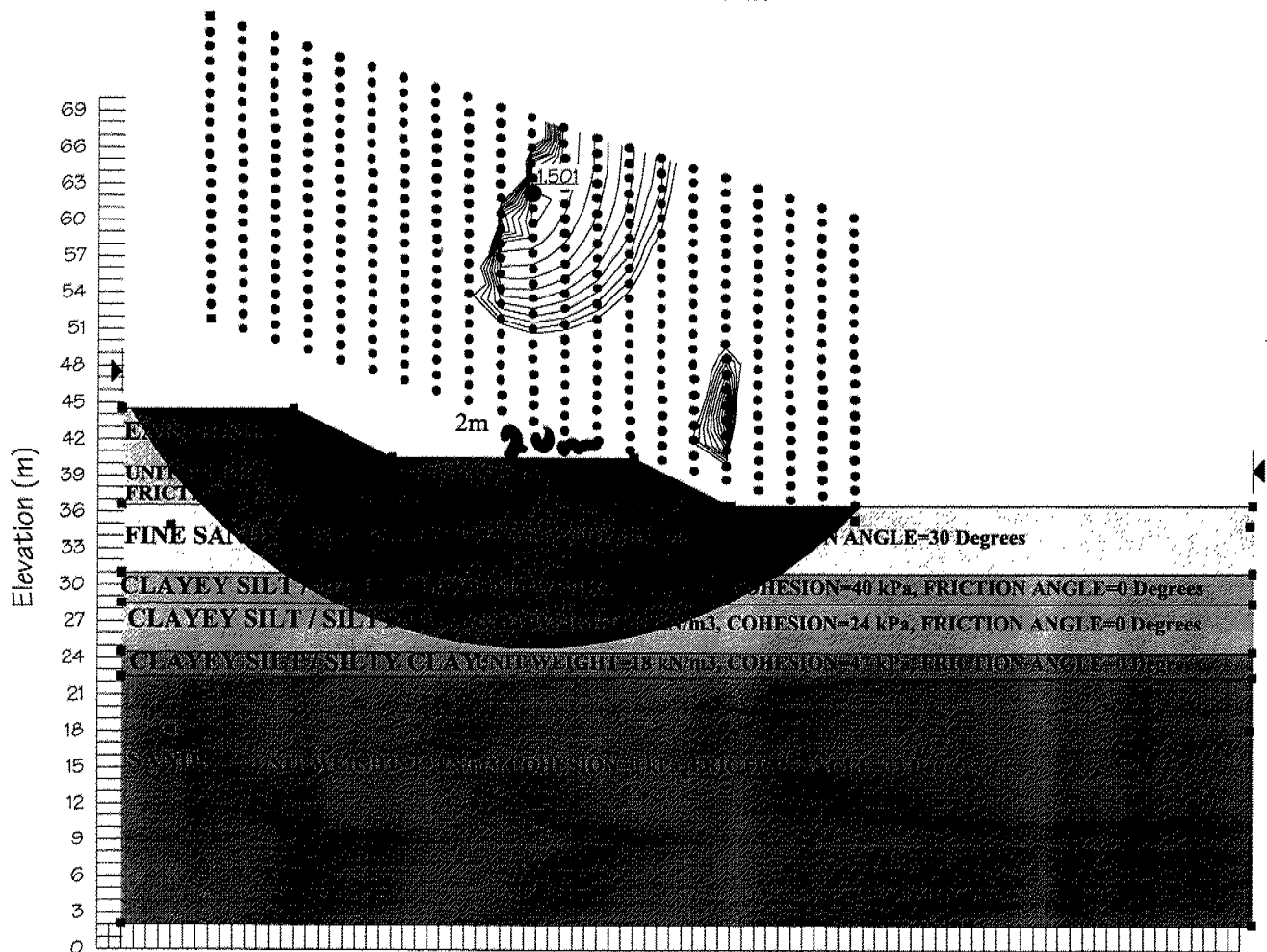
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH TWO 2m MID HEIGHT BERM
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6)/ Date: February 23, 1999

FIGURE - 30

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
8m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 20m BERM
AT 4m HEIGHT
BH #: LH6



012345 78 10 12 14 16 18 20 22 24 26 28 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 66 69 71 73 75 77 79 81 83 86 89 91 93

AGRA

PROJECT NO.: TT98801

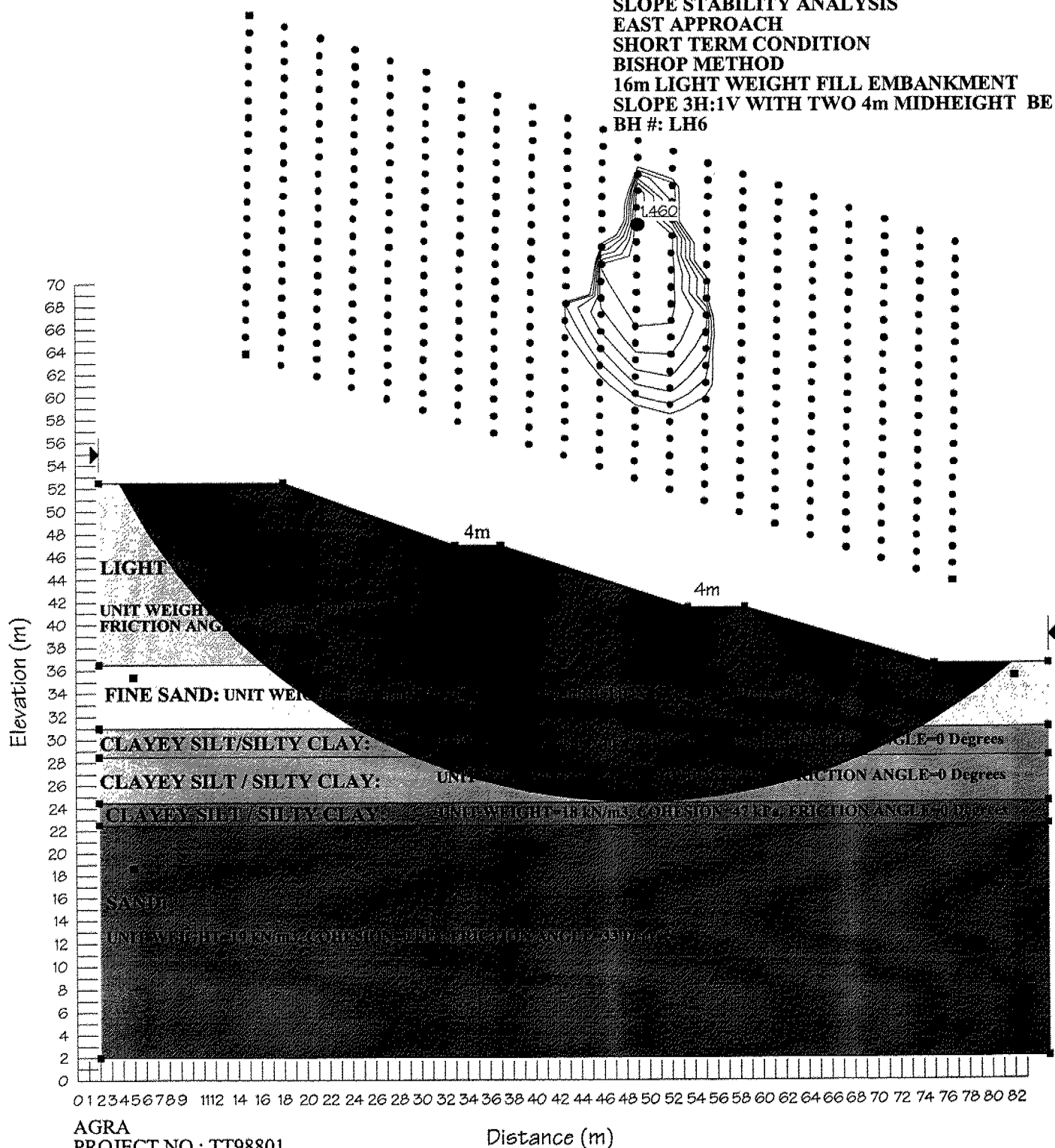
Distance (m)

PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER

(FILE NAME: TT98HWY11W-EASTAPP-LH6-2) / Date: February 23, 1999

FIGURE - 31

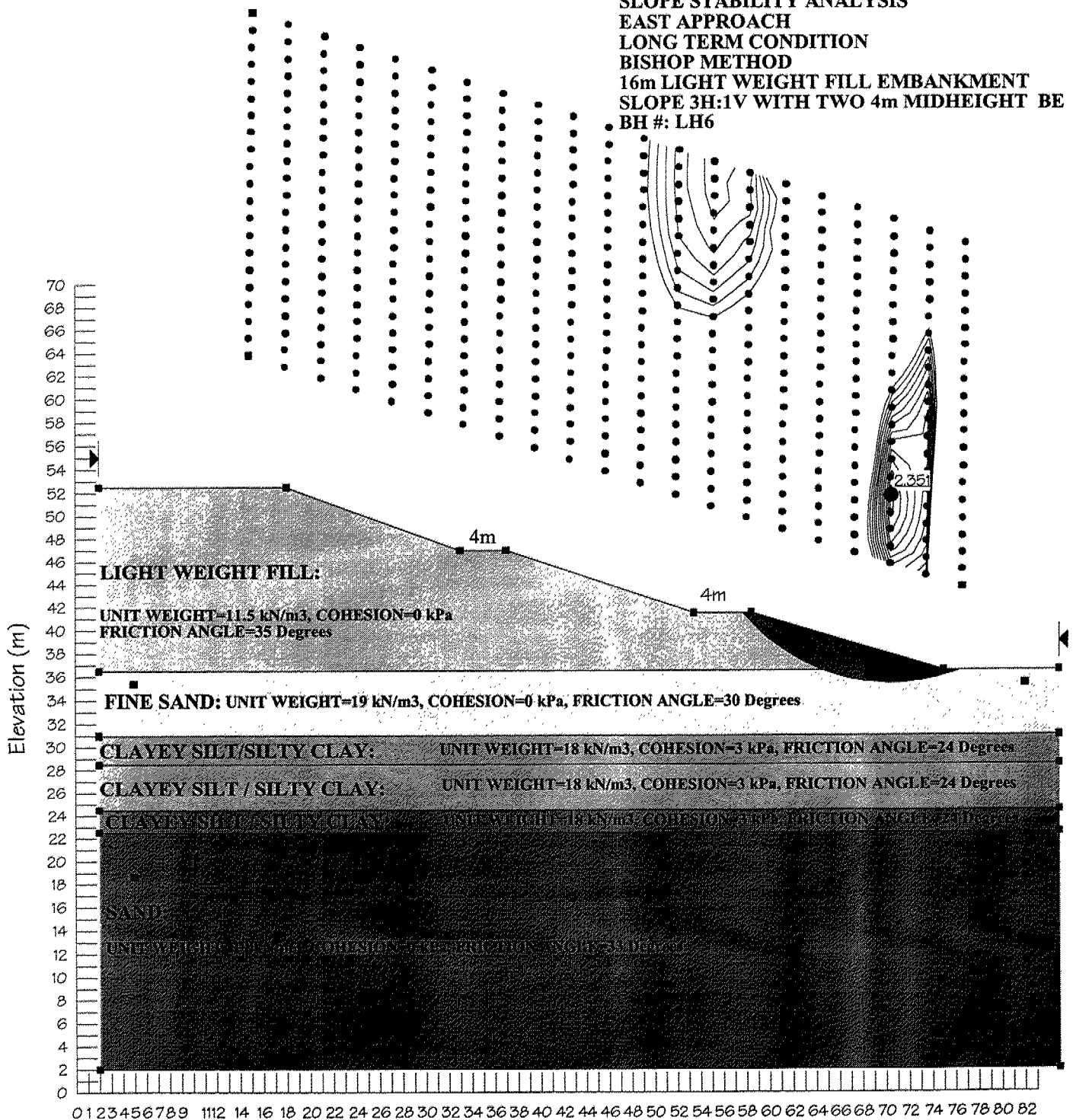
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 3H:1V WITH TWO 4m MIDHEIGHT BE
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANEING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6-1)/ Date: February 23, 1999

FIGURE - 32

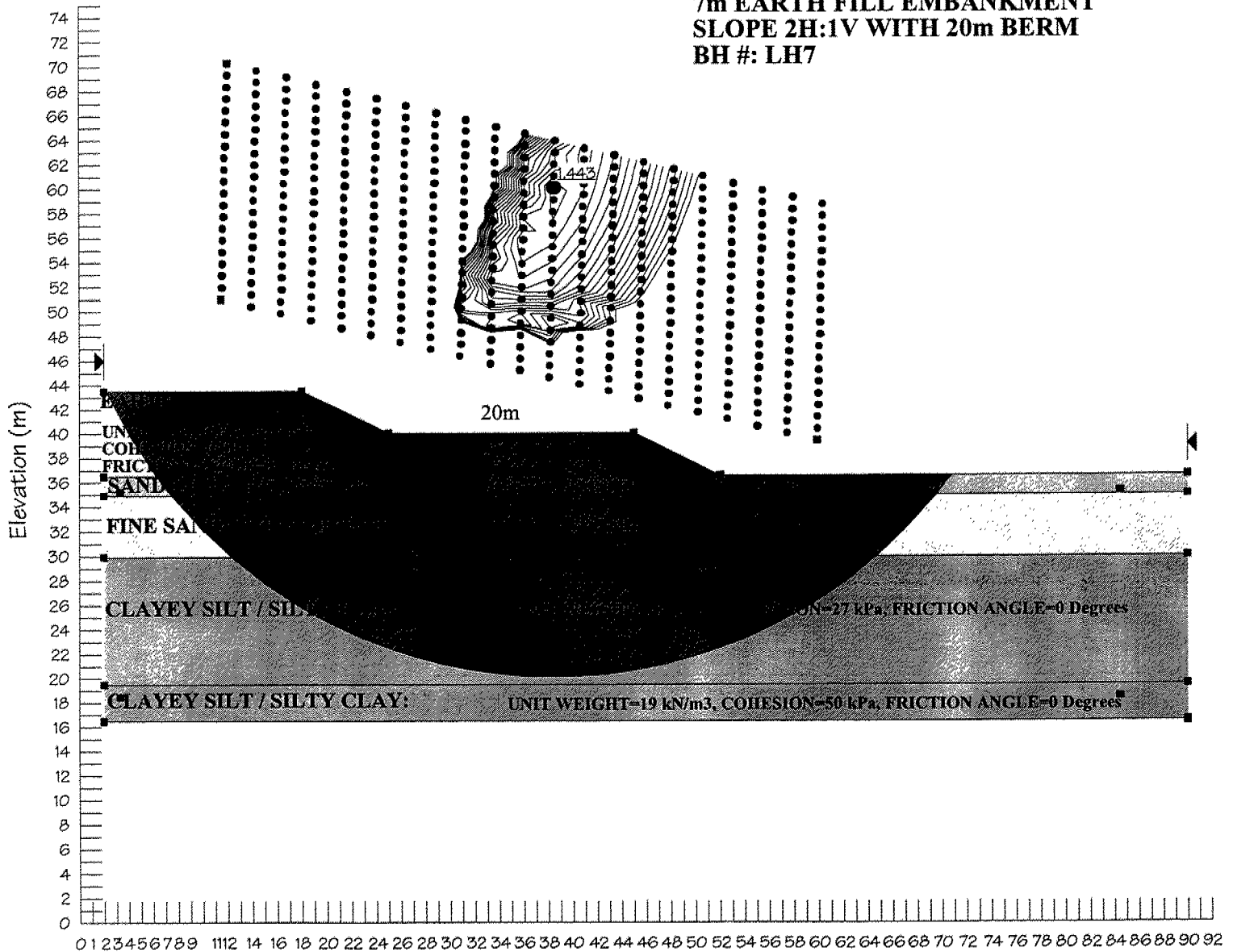
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16m LIGHT WEIGHT FILL EMBANKMENT
SLOPE 3H:1V WITH TWO 4m MIDHEIGHT BE
BH #: LH6



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPP-LH6-1)/ Date: February 23, 1999

FIGURE - 33

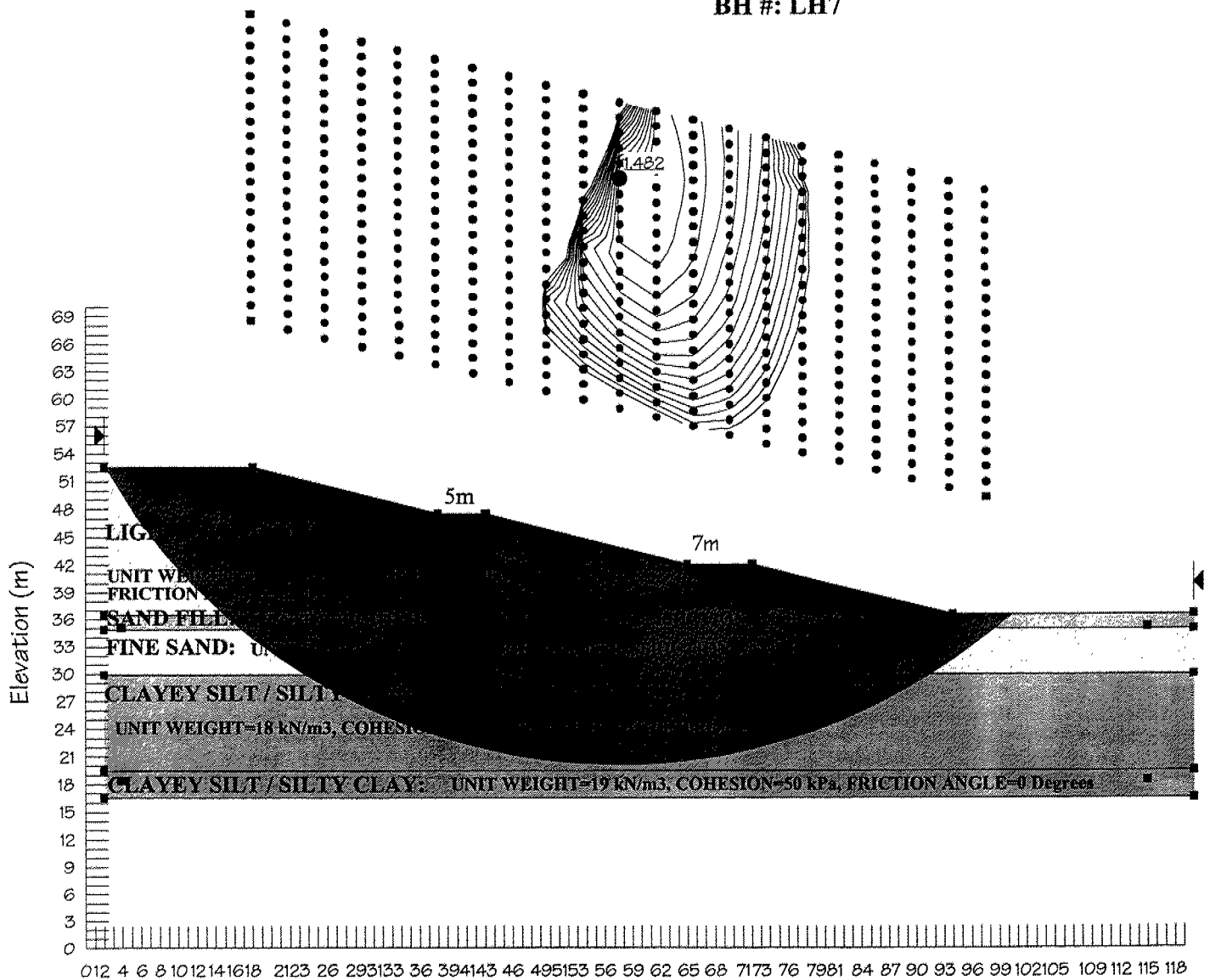
LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS FOR
EAST APPROACH SIDE SLOPE
SHORT TERM CONDITION
7m EARTH FILL EMBANKMENT
SLOPE 2H:1V WITH 20m BERM
BH #: LH7



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTapproach9.6-X)/ Date: February 23, 1999

FIGURE - 34

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
SHORT TERM CONDITION
BISHOP METHOD
16.0m EARTH FILL EMBANKMENT
SLOPE 4H:1V WITH TWO 5m & 7m BERM
BH #: LH7

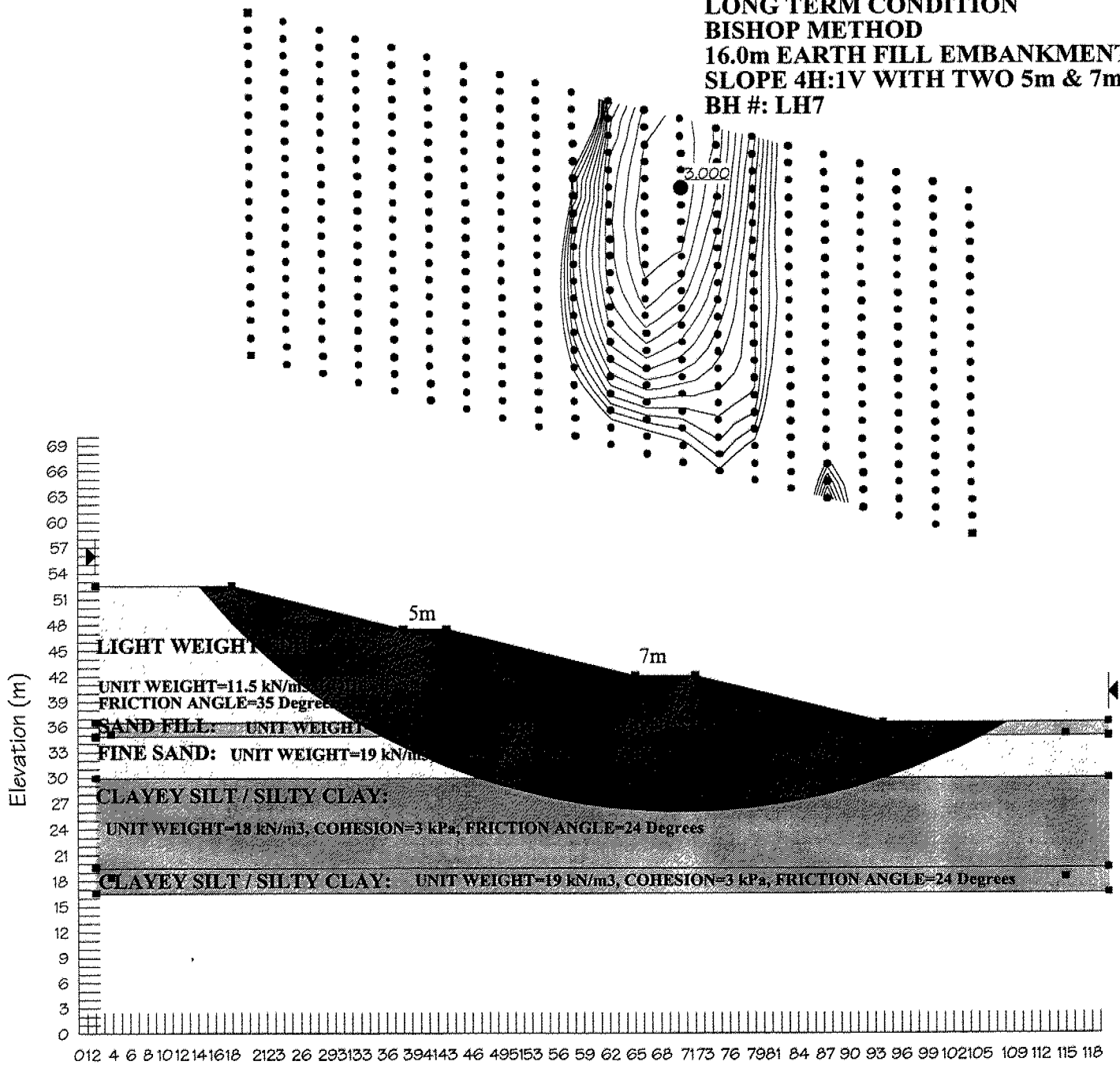


AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPPRO-LH7-1)/ Date: February 23, 1999

Distance (m)

FIGURE - 35

LINDSAY' HILL ROAD
SLOPE STABILITY ANALYSIS
EAST APPROACH
LONG TERM CONDITION
BISHOP METHOD
16.0m EARTH FILL EMBANKMENT
SLOPE 4H:1V WITH TWO 5m & 7m BERM
BH #: LH7



AGRA
PROJECT NO.: TT98801
PROJECT: HWY 11 FOUR LANEING, TROUT CREEK TO SOUTH RIVER
(FILE NAME: TT98HWY11W-EASTAPPRO-LH7-1)/ Date: February 23, 1999

ENCLOSURES

LOG OF BOREHOLE LH1

ENCL. No.: 1

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 3rd, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|---|----|-------------------|---------------|--------------|---------|------|-------------|--------|----------------------|------------|------------|---------------|---------|
| PL | w | LL | UNIT WT | UNDR Field | STRNG Lab | No. | TYPE | N- Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr kPa | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---------------------|----|----|--|--------------|--|-----|----|----|---|---|-----|----|---|---|
| SURFACE EL. 314.9 m | | | | | | | | | | | | | | |
| 76 | | | | | | 1 | SS | 2 | organic, v. loose | 0.3m organic TOPSOIL | | | | STATION 10+000 Lindsay's Hill Road C/L |
| 21 | | | | | | 2 | SS | 7 | tr. org., loose | | 314 | 1 | | |
| 20 | | | | | | 3 | SS | 10 | silty | | | | | |
| 20 | | | | | | 4 | SS | 14 | compact | FINE SAND traces of silt brown, wet | 313 | 2 | | |
| 17 | | | | | | 5 | SS | 4 | v. loose | | 312 | 3 | 0 92 (8) | |
| 17 | | | | | | 6 | SS | 4 | | | 311 | 4 | 0 92 (8) | |
| 20 | 34 | 34 | | | | 7 | SS | 5 | firm to soft | | 310 | 5 | 0 2 76 22 | |
| 24 | 39 | 43 | | 20 St=1.3 | | 8 | SS | 4 | soft | SILTY CLAY to CLAYEY SILT occ. silt & sand seams grey | 309 | 6 | 0 2 54 44 | |
| 20 | 34 | 34 | | 15 St=2.0 | | 9 | SS | 4 | | | | | | |
| 15 | 24 | 18 | | 16 St=1.1 | | 10 | TW | - | | | 308 | 7 | | |
| 19 | 24 | 21 | | 31 St=1.3 | | 11 | SS | 7 | | SILT with sandy silt & clayey silt seams grey, wet | 307 | 8 | | |
| | | | | 35 St=1.4 | | 12 | SS | 5 | loose to compact | | 306 | 9 | 14 68 18 0 | |
| 13 | | | | | | 13 | SS | 21 | cobbles | | 305 | 10 | | |
| 9 | | | | | | 14 | SS | 22 | | SAND traces to some silt & gravel grey, wet | 304 | 11 | 12 75 (13) | |
| 11 | | | | | | 15 | SS | 21 | more gravel | | 303 | 12 | | |
| 9 | | | | | | 16 | SS | 15 | | | 302 | 13 | | |
| 15 | | | | | | 17A | SS | 32 | | | 301 | 14 | | |
| | | | | | | 17B | SS | | | | 300 | 15 | Auger refusal on boulder @14.6m. Install NQ casing and continue using washboring method. | |
| 14 | | | | | | 18 | SS | 69 | silt & clayey silt seams, dense to v. dense | | 299 | 16 | | |
| | | | | | | | | | | | 298 | 17 | 8 85 (7) | |
| | | | | | | | | | | | 297 | 18 | St: Sensitivity | |

Vertical Scale: 1:100



Checked: RM

SHEET 1 OF 2 BH No. LH1

LOG OF BOREHOLE LH1

ENCL. No.:

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 3rd, 1998 |

| LABORATORY DATA | | | | | SAMPLES | | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|---|----|-------------------------|-------|-------------|--------------|---------------------|-------------|----------------------------------|---|----------------------|------------|------------|--|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N- Value | | | | | | | |
| % | % | % | WT kN/m ³ | Field | Lab | | | | | | | | | | |
| | | | | | Vane kPa | Compr kPa | SURFACE EL. 314.9 m | | | | | | | | |
| 9 | | | | | | 19 | SS | 52 | frequent cobble & boulders | End of Borehole @20.7m. Dynamic Cone Penetration Test conducted from 20.7m to 21.0m. Refusal @21.0m (100 blows/1cm). Notes: Water level @0.0m on completion. Standpipe piezometer installed to 18.3m W.L. in piezometer @0.75m on Dec.15/98. | 296 | 19 | | Refusal to further washboring at 19.2m. Continue with NQ casing. Cored between 19.2m and 20.7m, intermittent cobble and boulders. Attempted to core twice after dynamic cone refusal at 21.0m but casing silted-in, could not core. | |
| | | | | | | 20 | SS | 100/3 | | | | | | | 295 |





Vertical Scale: 1:100



Checked: RM

SHEET 2 OF 2 BH No. LH1

ENCL. No.: 2

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS | |
|---------------------|--------|---------|---------------------------------|-----------------------|-----------------------|---------|------|-------------|---|--|------------|------------|---|--|------------|
| PL % | w % | LL % | UNIT WT kN/m ³ | UNDR Field Vane | STRNG Lab Compr | No. | TYPE | N- Value | | | | | | | |
| | | | | | | Gr | Sa | Si | | | | | | Cl | |
| SURFACE EL. 315.8 m | | | | | | | | | | | | | | | |
| 22 | | | | | | 1 | SS | 4 | v.loose ----- loose ----- compact | organic stain ----- FINE SAND traces of silt brown, wet | 315 | 1 |  | 0 86 13 1 | |
| 20 | | | | | | 2 | SS | 9 | | | | | | | |
| 19 | | | | | | 3 | SS | 22 | | | | | | | |
| 18 | | | | | | 4 | SS | 12 | | | | | | | |
| 19 | | | | | | 5 | SS | 15 | | | | | | | |
| 14 | | | | | | 6A | SS | 13 | compact ----- loose | SILT with sandy silt & silty clay seams occ.sand seams brown, wet | 314 | 2 |  | 1 91 8 0 | |
| 24 | | | | | | 6B | SS | | | | | | | | |
| 17 | 22 | 19 | | | | 7 | SS | 16 | | | | | | | |
| 27 | | | | | | 8 | SS | 11 | | | | | | | |
| 16 | 21 | 18 | | | | 9 | SS | 6 | | | | | | | |
| 13 | | | | | | 10 | SS | 6 | loose to compact | SAND traces to some silt & gravel occ.cobble grey, wet | 313 | 3 |  | STATION 9+966 Lindsay's Hill Road C/L | |
| 11 | | | | | | 11 | SS | 11 | | | | | | | |
| 11 | | | | | | 12 | SS | 5 | | | | | | | |
| 19 | | | | | | 13 | SS | 18 | | | | | | | |
| 8 | | | | | | 14 | SS | 17 | | | | | | | |
| 12 | | | | | | 15 | SS | 25 | loose | | 312 | 4 |  | 6 85 (9) | |
| 12 | | | | | | 16 | SS | 7 | | | | | | | |
| 9 | | | | | | 17 | SS | 6 | | | | | | | |
| | | | | | | | | | | | 311 | 5 | | | 0 15 79 6 |
| | | | | | | | | | | | 310 | 6 | | | 0 11 83 6 |
| | | | | | | | | | | | 309 | 7 | | | |
| | | | | | | | | | | | 308 | 8 | | | 3 84 (13) |
| | | | | | | | | | | | 307 | 9 | | | |
| | | | | | | | | | | | 306 | 10 | | | |
| | | | | | | | | | | | 305 | 11 | | | 17 70 (13) |
| | | | | | | | | | | | 304 | 12 | | | |
| | | | | | | | | | | | 303 | 13 | | | |
| | | | | | | | | | | | 302 | 14 | | | |
| | | | | | | | | | | | 301 | 15 | | | |
| | | | | | | | | | | | 300 | 16 | | | |
| | | | | | | | | | | | 299 | 17 | | | |
| | | | | | | | | | | | 298 | 18 | | | |

SHEET 1 OF 2 BH No. **LH2**

LOG OF BOREHOLE LH2

ENCL. No.:

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 6th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|-----------------|----|----|-------------------|-------|-------|---------|------|------------------------|--------|--|---------|---------|------------|--|
| PL | W | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Field | Lab | | | | | | | | | |
| | | | | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| | | | | | | 18 | SS | 53 | | SURFACE EL. 315.8 m | | | | |
| | 11 | | | | | | | | | SAND & GRAVEL v.dense grey, wet | 297 | 19 | | 42 52 (6) |
| | | | | | | 19 | SS | 100/0 | | | | | | |
| | | | | | | 20 | RC | REC.=95% R.Q.D.=70% | | | | | | |
| | | | | | | | | REC.=95% | | PINK GRANITE | 295 | 21 | | REC.: Recovery R.Q.D.: Rock Quality Designation |
| | | | | | | 21 | RC | R.Q.D.=80% | | | 294 | 22 | | |
| | | | | | | | | | | | 293 | 23 | | |
| | | | | | | | | | | End of Borehole Notes: Water level @1.8m on completion. Standpipe piezometer installed to 23.0m W.L. in piezometer @1.3m on Dec.15/98. | | | | |

Vertical Scale: 1:100



Checked: HS

SHEET 2 OF 2 BH No. LH2

LOG OF BOREHOLE LH3

ENCL. No.: 3

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 9th, 1998 |

| LABORATORY DATA | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---|----|----|-------------------|-------|---------|-------|------|--------|---|------------|------------|---------------|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | | | | | | |
| % | % | % | WT | Field | Lab | | | | | | | | |
| | | | kN/m ³ | Vane | Compr | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | |
| SURFACE EL. 316.7 m | | | | | | | | | | | | | |
| 27 | | | | | | 1 | SS | 13 | | | | | |
| 15 | | | | | | 2 | SS | 8 | loose | | | | |
| 16 | | | | | | 3 | SS | 23 | | | | | |
| 21 | | | | | | 4 | SS | 15 | FINE SAND traces of silt brown, compact | | | | |
| 21 | | | | | | 5 | SS | 18 | | | | | |
| 19 | | | | | | 6 | SS | 14 | | | | | |
| 15 | 22 | 20 | | | | 7 | SS | 12 | | | | | |
| 28 | | | | | | 8 | SS | 7 | | | | | |
| 14 | | | 20.5 | | 37 | 8B-TW | | | sand seams | | | | |
| 21 | | | | | | 9 | SS | 8 | | | | | |
| 16 | | | | | | 10 | SS | - | | | | | |
| | | | | | | 11 | SS | 10 | | | | | |
| 15 | | | | | | 12 | SS | 24 | | | | | |
| 10 | | | | | | 13 | SS | 75 | v.dense | | | | |
| 8 | | | | | | 14 | SS | 25 | SAND traces to some silt, some gravel grey, wet, compact occ. cobble | | | | |
| 10 | | | | | | 15 | SS | 26 | | | | | |
| 17 | | | | | | 16 | SS | 11 | | | | | |
| 13 | | | | | | 17 | SS | 30 | | | | | |
| End of Borehole Notes: Water level @2.3m and hole caved at 4.6m on completion. Standpipe piezometer installed to 17.2m W.L. in piezometer @2.2m on Dec.15/98. | | | | | | | | | | | | | |

Vertical Scale: 1:120



Checked: RM

SHEET 1 OF 1 BH No. LH3

LOG OF BOREHOLE LH4

ENCL. No.: 4

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|--|---------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: November 9th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---|---|----|-------------------|-------|-------|---------|------|---------|-------------|---|------------|------------|---------------|---|
| PL | W | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 316.9 m | | | | | | | | | | | | | | |
| 10 | | | | | | 1 | SS | 5 | loose | organic stain | | | | STATION 9+925 Lindsay's Hill Road C/L N=200/1: 200 blows for 1cm penetration. |
| 12 | | | | | | 2 | SS | 26 | ----- | | 316 | 1 | | |
| 23 | | | | | | 3 | SS | 11 | | FINE SAND brown, wet loose to compact | 315 | 2 | | |
| 19 | | | | | | 4 | SS | 16 | occ. gravel | | 314 | 3 | | |
| 22 | | | | | | 5 | SS | 18 | | | 313 | 4 | | |
| 12 | | | | | | 6A | SS | 26 | | | 312 | 5 | | |
| 18 | | | | | | 6B | SS | | | | 311 | 6 | | |
| 23 | | | | | | 7 | SS | 14 | compact | SANDY SILT occ. sand seams & clayey zones grey, wet | 310 | 7 | | |
| 20 | | | | | | 8A | SS | 9 | loose | | 309 | 8 | | |
| 15 | | | | | | 8B | SS | | compact | | 308 | 9 | | |
| 13 | | | | | | 9 | SS | 21 | | | 307 | 10 | | |
| 16 | | | | | | 10 | SS | 14 | compact | | 306 | 11 | | |
| | | | | | | 11 | SS | 20 | | | 305 | 12 | | |
| 19 | | | | | | 12 | SS | 9 | loose | SAND traces to some silt & gravel occ. cobble | 304 | 13 | | |
| 12 | | | | | | 13 | SS | 31 | dense | | 303 | 14 | | |
| 13 | | | | | | 14 | SS | 32 | | | | | | |
| 13 | | | | | | 15 | SS | 11 | compact | | | | | |
| | | | | | | 16 | SS | 200/1 | | possible BEDROCK | | | | |
| End of Borehole Auger refusal Notes: Water level @3.0m and hole caved at 3.0m on completion. Standpipe piezometer installed to 14.7m W.L. in piezometer @2.6m on Dec. 15/98. | | | | | | | | | | | | | | |

Vertical Scale: 1:120



Checked: RM

SHEET 1 OF 1 BH No. LH4

LOG OF BOREHOLE LH5

ENCL. No.: 5

| | | |
|---------------|----------------------|--------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 9th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|----|----|-------------------|-------|-------|---------|------|---------|--------|----------------------|----------------------|------------|---|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | | | | | | |
| % | % | % | WT | Field | Lab | | | | | | | | | |
| | | | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 314.5 m | | | | | | | | | | | | | | |
| 115 | | | | | | 1 | SS | 0 | | v. loose | 0.2m organic TOPSOIL | 314 | | |
| 19 | | | | | | 2 | SS | 6 | | loose | | 1 | 0 | 94 (6) |
| 24 | | | | | | 3 | SS | 13 | | | | 2 | | |
| 18 | | | | | | 4 | SS | 11 | | compact | FINE SAND | 312 | | |
| 19 | | | | | | 5 | SS | 12 | | | traces of silt | 311 | 0 | 97 (3) |
| 22 | | | | | | 6 | SS | 4 | | v. loose | brown, wet | 4 | 0 | 97 (3) |
| 20 | | | | | | 7 | SS | 21 | | compact | loose to compact | 310 | | |
| 18 | 27 | 21 | | | | 8 | SS | 11 | | | | 5 | STATION 10+040 Lindsay's Hill Road C/L | |
| | | | | | | 9 | TW | | | | | 6 | | |
| | | | | | | 10 | SS | 0 | | | | 7 | | |
| 23 | 38 | 33 | | | | 11 | SS | 2 | | | | 8 | 0 | 2 71 27 |
| | | | 37 | | | 12 | TW | | | | | 9 | 0 | 0 62 38 |
| | | | 29 | | | 13 | SS | 5 | | | | 10 | 0 | 0 72 28 |
| 21 | 38 | 37 | 17.8 | | | 14 | SS | 14 | | | | 11 | 0 | 7 85 8 |
| | | | 33 | | | 15 | SS | 18 | | | | 12 | TW12: Consolidation test, Fig.No.5 | |
| | | | 25 | | | 16 | SS | 43 | | | | 13 | | |
| | | | St=2.5 | | | 17 | SS | 25 | | | | 14 | | |
| 16 | 28 | 19 | | | | 18 | SS | 33 | | | | 15 | 2 | 65 31 2 |
| | | | | | | 19 | SS | 26 | | | | 16 | | |
| 17 | | | | | | 20 | SS | 35 | | | | 17 | | |
| 19 | | | | | | 21 | SS | 134 | | | | 18 | 6 | 70 22 2 |
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| 11 | | | | | | | | | | | | 22 | 23 | 63 (14) |
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Vertical Scale: 1:120



Checked: RM

ENCL. No.:

| | | | |
|--|-----------------------------|----------------------|---------------------------|
| REF. No.: TT98801 | | <i>DRILLING DATA</i> | |
| CLIENT: DELCAN | | | |
| PROJECT NAME: HWY 11, FOUR LANING | | Method: | HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: | 150 mm |
| DATUM: | Geodetic | Date: | November 9th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. | DEPTH | WATER DATA | REMARKS |
|---------------------|---|----|-------|-------|-------|---------|------|---------|---|--------|----------------------|-------|-------|------------|---------|
| PL | w | LL | UNIT | UNDR | STRNG | No. | TYPE | N-Value | m | | | m | | | |
| % | % | % | WT | Field | Lab | | | | | | | | | | |
| | | | kN/m3 | Vane | Compr | | | | | | | | | | |
| | | | kPa | kPa | | | | | | | | | | | |
| SURFACE EL. 314.5 m | | | | | | | | | | | | | | | |
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Vertical Scale: 1:120



Checked: **RM**

SHEET 2 OF 2 BH No. **LH5**

LOG OF BOREHOLE LH6

ENCL. No.: 6

| | | |
|---------------|----------------------|---------------------------|
| REF. No.: | TT98801 | DRILLING DATA |
| CLIENT: | DELCAN | |
| PROJECT NAME: | HWY 11, FOUR LANING | Method: HolSt Augering |
| LOCATION | TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: | Geodetic | Date: November 14th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|--|----|----|-------------------|--------------|-------|---------|------|---------|--------|---|------------|------------|---------------|---|
| PL | W | LL | WT | Field | Lab | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane | Compr | | | | | | | | | |
| | | | | kPa | kPa | | | | | | | | | |
| SURFACE EL. 314.4 m | | | | | | | | | | | | | | |
| 24 | | | | | | 1 | SS | 3 | | v. loose | 314 | | | STATION 10+060 Lindsay's Hill Road C/L 0 7 87 6 TW9A: Consolidation test, Fig. No. 6 |
| | | | | | | 2 | SS | 7 | | | | 1 | | |
| 23 | | | | | | 3 | SS | 10 | | | | 2 | | |
| 26 | | | | | | 4 | SS | 9 | | FINE SAND traces of silt brown, wet loose to compact | 312 | 3 | | |
| 19 | | | | | | 5 | SS | 5 | | | 311 | 4 | | |
| 17 | | | | | | 6 | SS | 24 | | | 310 | 5 | | |
| 23 | | | | | | 7 | SS | 13 | | | 309 | 6 | | |
| 23 | | | | | | 8 | SS | 14 | | | 308 | 7 | | |
| 16 | 24 | 20 | | 51 St=2.3 | | 9 | SS | 7 | | stiff to firm freq. silt seams | 307 | 8 | | |
| | | | 18.6 | 35 St=2.3 | 25 | 9A | TW | - | | | 306 | 9 | | |
| | 31 | | | 39 St=2.4 | | 9B | TW | 2 | | SILTY CLAY to CLAYEY SILT occ. sandy silt seams grey, wet firm to soft | 305 | 10 | | |
| | | | | 49 St=3.4 | | 10 | SS | | | | 304 | 11 | | |
| 22 | 38 | 34 | | 22 St=2.1 | | 11 | SS | 2 | | | 303 | 12 | | |
| 22 | 39 | 31 | | | | 12 | SS | 2 | | | 302 | 13 | | |
| | | | | 26 St=2.5 | | 13 | SS | 17 | | | 301 | 14 | | |
| 22 | 34 | 33 | | 47 St=3.8 | | 14 | SS | 17 | | stiff to v. stiff | 300 | 15 | | |
| | | | | | | 15 | SS | 52 | | compact v. dense | 299 | | | |
| End of Borehole Notes: Water level @ 0.0m and hole caved at 6.2m on completion. Standpipe piezometer installed to 15.7m W.L. in piezometer @ 0.2m on Dec. 15/98. | | | | | | | | | | | | | | |

Vertical Scale: 1:120



Checked: RM

SHEET 1 OF 1 BH No. LH6

LOG OF BOREHOLE LH7

ENCL. No.: 7

| | |
|---|----------------------------------|
| REF. No.: TT98801 | DRILLING DATA |
| CLIENT: DELCAN | |
| PROJECT NAME: HWY 11, FOUR LANEING | Method: HolSt Augering |
| LOCATION: TROUT CREEK, ONTARIO | Diameter: 150 mm |
| DATUM: Geodetic | Date: November 14th, 1998 |

| LABORATORY DATA | | | | | | SAMPLES | | | SYMBOL | MATERIAL DESCRIPTION | ELEV. m | DEPTH m | WATER DATA | REMARKS |
|---------------------|----|----|-------------------|-----------|---------------|---------|--------|---------|--------|---|---------|---------|------------|--|
| PL | W | LL | WT | Field | STRNG | No. | TYPE | N-Value | | | | | | |
| % | % | % | kN/m ³ | Vane kPa | Lab Compr kPa | | | | | | | | | |
| SURFACE EL. 314.4 m | | | | | | | | | | | | | | |
| 175 | | | | | | 1 | SS | 3 | | PEAT | 314 | 1 | | STATION 10+080 Lindsay's Hill Road C/L |
| | | | | | | 2 | SS | 11 | | | 313 | 2 | | |
| | | | | | | 3 | SS | 8 | | loose | | | | |
| 22 | | | | | | 4 | SS | 13 | | compact | | | | |
| 21 | | | | | | 5 | SS | 12 | | | | | | |
| 17 | | | | | | 6 | SS | 14 | | | | | | |
| 20 | | | | | | 7 | SS | 8 | | loose | | | | |
| 26 | | | | | | 8 | SS | 22 | | compact | | | | |
| 16 | | | | | | 9 | SS | 24 | | | | | | |
| 33 | | | | | | 10A | SS | 5 | | | | | | |
| 18 | 33 | 30 | 19.3 | St=1.2 | | 12 | 10B TW | - | | | | | | TW10B: Consolidation test, Fig.No.7 |
| | | | | 46 St=3 | | | | | | | | | | |
| 33 | | | | | | 11 | SS | 5 | | | | | | |
| | | | | 25 St=2 | | | | | | | | | | |
| 20 | 37 | 33 | | | | 12 | SS | 4 | | SILTY CLAY to CLAYEY SILT occ.silt & sand seams grey, wet soft to firm | | | | |
| | | | | 19 St=1.4 | | | | | | | | | | |
| 38 | | | | | | 13 | SS | 3 | | | | | | |
| | | | | 24 St=1.9 | | | | | | | | | | |
| 23 | 37 | 33 | | | | 14 | SS | 6 | | | | | | |
| | | | | 24 St=2.1 | | | | | | | | | | Extend borehole using tricone |
| 38 | | | | | | 15 | SS | 4 | | | | | | |
| | | | | 27 St=1.6 | | | | | | | | | | |
| 32 | | | | | | 16 | SS | 13 | | stiff to v.stiff | | | | |
| | | | | | | | | | | | | | | |
| 28 | | | | | | 17 | SS | 16 | | | | | | GROUNDWATER IN OPEN BORE on completion: 0.0m |
| | | | | | | | | | | | | | | IN PIEZOMETER: Dec.15/98 0.3m |
| 20 | 28 | 25 | | | | 18 | SS | 23 | | more silty | | | | |
| | | | | | | | | | | End of Borehole | | | | |

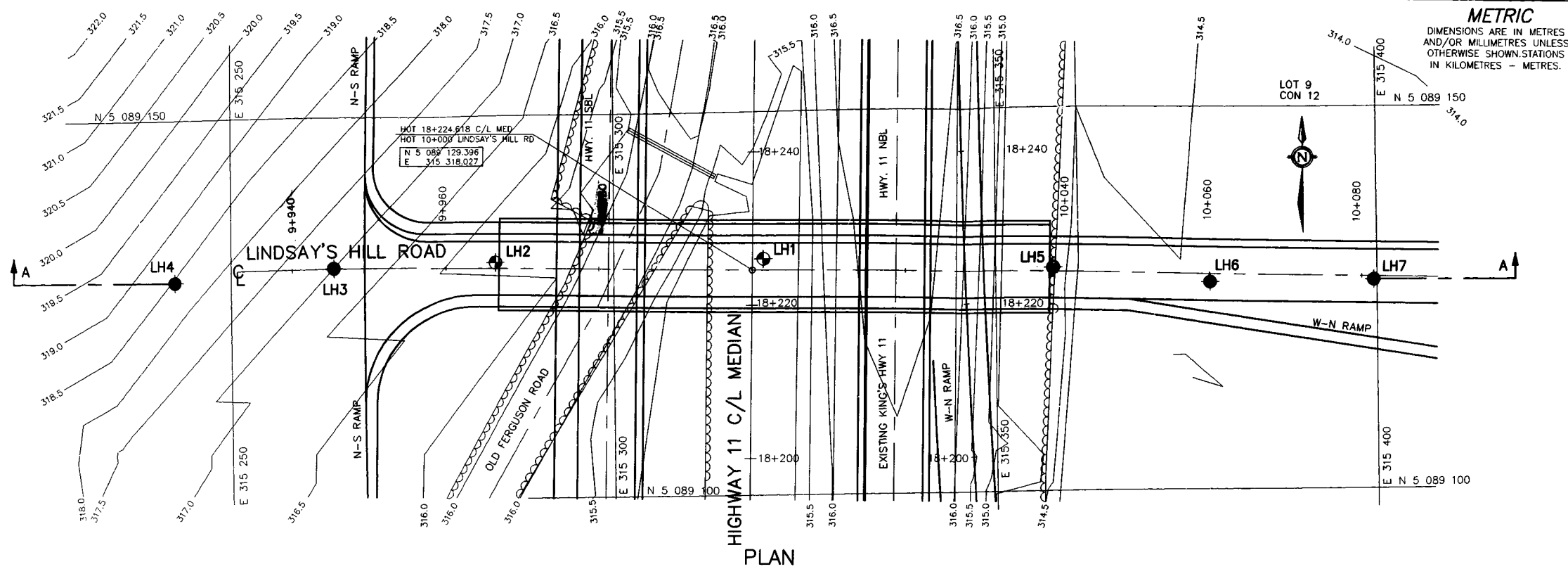
Vertical Scale: 1:120



Checked: RM

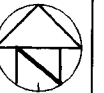
SHEET 1 OF 1 BH No. LH7

OVERSIZE DRAWING(S)



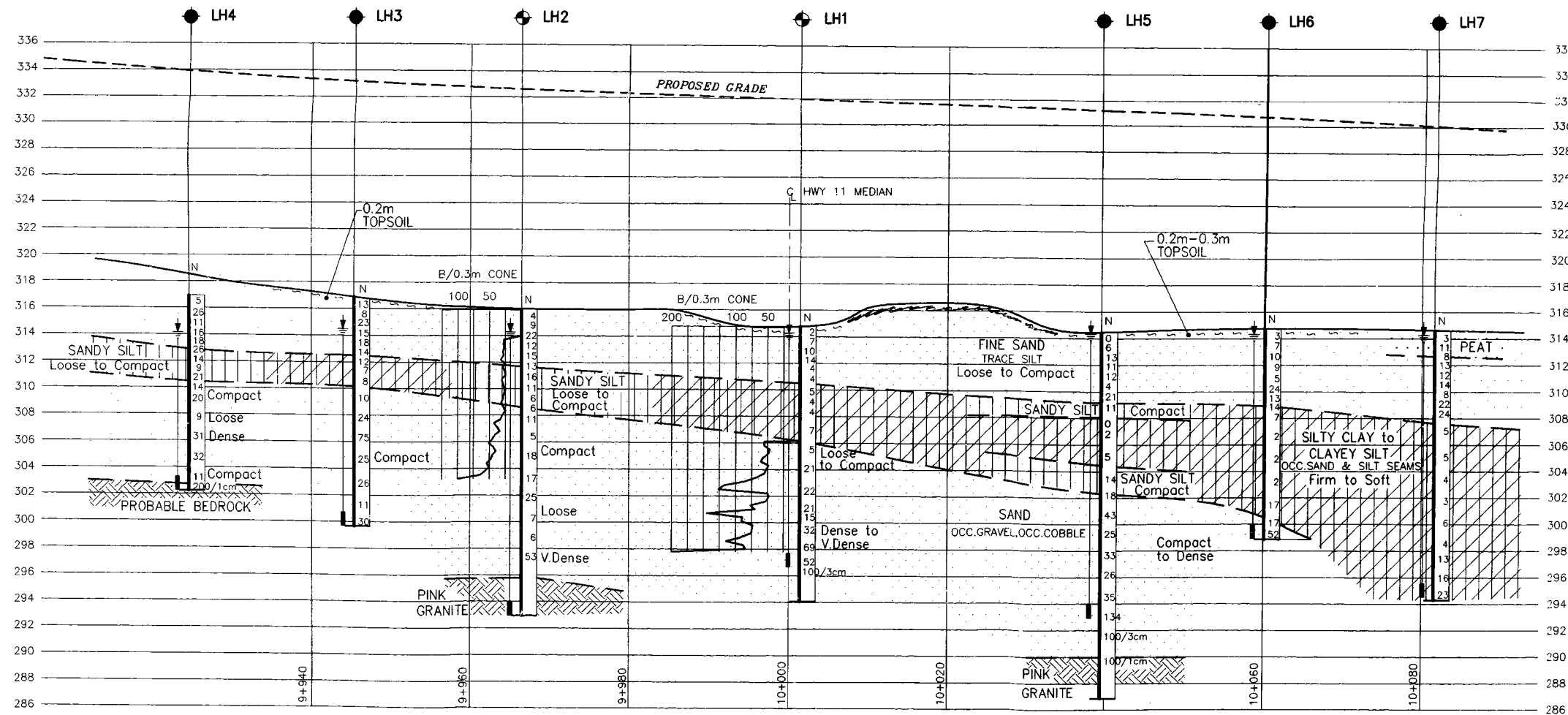
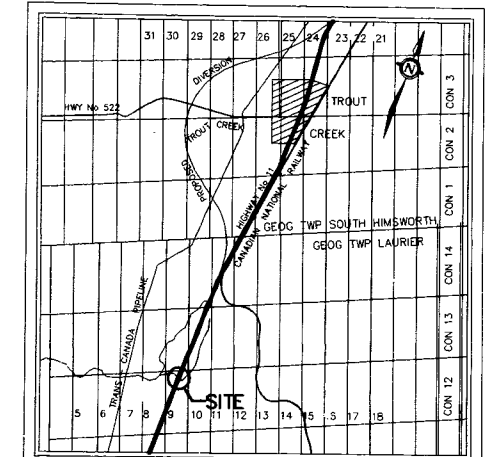
CONT. No. -
W.P. No. 772-93-01

LINDSAY'S HILL ROAD UNDERPASS
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

AGRA Earth & Environmental Ltd.



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 Nov. 98
- WL in Piezometer
- Piezometer

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|-----|-----------|-----------------------|---------|
| LH1 | 314.9 | 5 089 131 | 315 319 |
| LH2 | 315.8 | 5 089 131 | 315 285 |
| LH3 | 316.7 | 5 089 130 | 315 264 |
| LH4 | 316.9 | 5 089 129 | 315 242 |
| LH5 | 314.5 | 5 089 129 | 315 357 |
| LH6 | 314.4 | 5 089 127 | 315 378 |
| LH7 | 314.4 | 5 089 127 | 315 400 |

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 GC 2.01 of OPS Gen. Cond.

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

REF. Hwy 11 Bridge Site Plan
Dwg. by MTO: Oct. 1998

| | | | |
|-----------|-------------------|--------------------|------------------|
| HWY No 11 | SUBM'D HS CHECKED | DATE Jan. 19, 1999 | DIST PARRY SOUND |
| DRAWN MA | CHECKED | APPROVED | SITE 44-375 |
| | | | DWG 1 |

FILE