



Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**FOUNDATION INVESTIGATION & DESIGN REPORT
RETAINING STRUCTURES
HIGHWAY 406 TWINNING
PORT ROBINSON ROAD TO EAST MAIN STREET
AGREEMENT No. 2008-E-0016, W.P. 280-99-00
GEOCRES No. 30M3-266**

PREPARED FOR: Giffels Associates Ltd./IBI Group
30 International Blvd.
Toronto, Ontario

Attention: Mr. Stephen Chiu, P.Eng.
Manager, Transportation Engineering

File No. 1-09-4135
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Terraprobe Inc.
10 Bram Court
Brampton, Ontario
L6W 3R6
Phone: (905) 796 2650
Fax: (905) 796 2250

Distribution:

- 2 Copies - MTO Project Manager (Central Region)
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- 1 Copy - Terraprobe Inc., Brampton

Terraprobe Inc.

Greater Toronto
10 Bram Court
Brampton, Ontario L6W 3R6
(905) 796-2650 Fax: 796-2250
brampton@terraprobe.ca

Hamilton – Niagara
903 Barton Street, Unit 22
Stoney Creek, Ontario L8E 5P5
(905) 643-7560 Fax: 643-7559
stoneycreek@terraprobe.ca

Central Ontario
220 Bayview Drive, Unit 25
Barrie, Ontario L4N 4Y8
(705) 739-8355 Fax: 739-8369
barrie@terraprobe.ca

Northern Ontario
1012 Kelly Lake Rd., Unit 1
Sudbury, Ontario P3E 5P4
(705) 670-0460 Fax: 670-0558
sudbury@terraprobe.ca

www.terraprobe.ca

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Site 2

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Appendix B2 – Laboratory Test Results
Appendix C2 – Drawings titled “Borehole Locations and Soil Strata”

Site 3

Appendix A3 – Record of Borehole Sheets
Appendix B3 – Laboratory Test Results
Appendix C3 – Drawings titled “Borehole Locations and Soil Strata”

Site 4

Appendix A4 – Record of Borehole Sheets
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DESIGN SUMMARY

This project (W.P. 280-99-00) is the Ministry of Transportation of Ontario undertaking to twin Highway 406 from 1.0 km north of Port Robinson Road to its current terminus at East Main Street.

Terraprobe carried out the investigation as a sub-consultant to Giffels Associates Limited/IBI Group (Giffels), under the Ministry of Transportation Ontario (MTO) Agreement Number 2008-E-0016.

The project is located in the Regional Municipality of Niagara, City of Thorold and City of Welland, Ontario. Approximately 6.5 km of two lane staged freeway will be twinned from Sta. 10+000 to Sta. 6+400. Within the project limits Highway 406 has signalized intersections at Merritt Road, Woodlawn Road and East Main Street and one un-signalized intersection at Port Robinson Road.

Retaining structures are required at the sites outlined below:

Site 1: Right of Highway 406 NBL from Sta. 11+816 to Sta. 11+947.

Site 2: Immediately north and south of Trillium Railway. The north alignment extends from Sta. 9+930 to Sta. 10+091 and the south alignment extends from Sta. 9+916 to Sta. 10+057. Station numbering is referenced to the Trillium Railway alignment.

Site 3: Immediately north and south of Woodlawn Road. The north alignment extends from Sta. 9+909 to Sta. 9+997 and the south alignment extends from Sta. 9+890 to Sta. 9+992. Station numbering is referenced to ramp stationing.

Site 4: On the right side of the new Merritt Road from about Sta. 9+700 to Sta. 9+910.

The main design recommendations are:

- A gabion structure is recommended at Site 1.
- RSS walls are recommended at Sites 2 and 3. These walls should be specified as “High Performance” and “High Appearance” and a two-stage RSS system is recommended since the soils at these two sites are compressible.
- The temporary retaining wall at Merritt Road should be specified as “Low Performance” and “Low Appearance”.
- Construction operations could have adverse effects on the railway track. A NSSP is required for track monitoring and repairs and requires specific inputs from Trillium Railway.

Notwithstanding the foregoing the designer is advised to review this report in its entirety to ensure that the geotechnical recommendations provided herein are adequately addressed in the designs and contract documents.



FOUNDATION INVESTIGATION REPORT
RETAINING STRUCTURES
HIGHWAY 406 TWINNING
ONTARIO
AGREEMENT No. 2008-E-0016, W.P. 280-99-00
GEOCRES No. 30M3-266
PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from foundation investigations conducted at four sites where retaining structures are proposed within a project area that extends from East Main Street, City of Welland to about 1.0 km north of Port Robinson Road, City of Thorold, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the four sites and based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and a description of the subsurface conditions. Models of the subsurface conditions were developed from the data obtained.

Terraprobe conducted the investigation as a sub-consultant to Giffels Associates Ltd./IBI Group, under the Ministry of Transportation Ontario (MTO) Agreement Number 2008-E-0016.

The following documents are referenced in the preparation of this report:

- Terraprobe Inc., “Foundation Investigation and Design Report, Ramp Woodlawn E/W-S Bridge at Trillium Railway”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-464/3, GEOCRES 30M3-258, dated September 10, 2010.
- Terraprobe Inc., “Foundation Investigation and Design Report, Trillium Overhead, Highway 406 SBL”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-464/2, GEOCRES 30M3-256, dated September 10, 2010.
- Terraprobe Inc., “Foundation Investigation and Design Report, Trillium Overhead, Highway 406 NBL”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-464/1, GEOCRES 30M3-255, dated September 03, 2010.
- Terraprobe Inc., “Foundation Investigation and Design Report, Ramp 406S-Woodlawn E/W Bridge at Trillium Railway”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-464/4, GEOCRES 30M3-257, dated September 17, 2010.



- Terraprobe Inc., “Foundation Investigation and Design Report, Woodlawn Road Overpass, Highway 406 SBL”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-463/2, GEOCRETS 30M3-260, dated September 29, 2010.
- Terraprobe Inc., “Foundation Investigation and Design Report, Woodlawn Road Overpass, Highway 406 NBL”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Welland, Ontario, W.P. 280-99-00, Site 34-463/1, GEOCRETS 30M3-259, dated September 29, 2010.
- Terraprobe Inc., “Foundation Investigation and Design Report, High Fills, Merritt Road Interchange”, Highway 406 Twinning, Port Robinson Road to East Main Street, City of Thorold, Ontario, W.P. 280-99-00, GEOCRETS 30M3-252, dated September 03, 2010.

For reporting purposes the investigated sections are identified as follows:

Site 1: Right of Highway 406 NBL from Sta. 11+816 to Sta. 11+947.

Site 2: Immediately north and south of Trillium Railway. The north alignment extends from Sta. 9+930 to Sta. 10+091 and the south alignment extends from Sta. 9+916 to Sta. 10+057. Station numbering is referenced to the Trillium Railway alignment.

Site 3: Immediately north and south of Woodlawn Road. The north alignment extends from Sta. 9+909 to Sta. 9+997 and the south alignment extends from Sta. 9+890 to Sta. 9+992. Station numbering is referenced to ramp stationing.

Site 4: Right side of the new Merritt Road from about Sta. 9+700 to Sta. 9+910.

2 SITE DESCRIPTION & PHYSIOGRAPHY

The south limit of the project is Sta. 10+000 located at the existing Highway 406 terminus at East Main Street in the City of Welland. The north limit is about Sta. 6+400 approximately 1.0 km north of Port Robinson Road in the City of Thorold. This approximately 6.5 km long route traverses across generally flat terrain and intersects Woodlawn Road, Merritt Road and Port Robinson Road. There is an at grade railway intersection (Trillium Railway) about 265 m south of Woodlawn Road. The alignment also crosses the Welland River and Old Welland Canal.

The site is located between the Niagara Escarpment and Lake Erie in the physiographic region of Southern Ontario referred to as the Haldimand Clay Plain. The Haldimand Clay Plain is best described as falling into a series of parallel belts with the highest ground adjacent to the Escarpment. Generally this region is flat and poorly drained although it includes several distinctive landforms such as dunes, cobble, clay and sand beaches, limestone pavements and back-shore wetland basins¹.

¹ Chapman and Putnam, “The Physiography of South Ontario”, 3rd Edition, 1984.



The Niagara Region is underlain by a sequence of very gently south-dipping dolostones, limestones, shales and sandstones overlying Precambrian basement rock. The key elements in the bedrock geology of the region are the multiple layers of softer sedimentary limestones, shale, sandstone and dolostone.

The bedrock units within the project limits consist of the Salina Formation and Guelph Formation of Upper Silurian Age². The Salina Formation consists essentially of easily weathered, grey, very finely crystalline, laminated argillaceous dolostone with grey, calcareous shale partings and gypsum veins and lenses of varying thicknesses. The Guelph Formation consists essentially of unweathered, grey, laminated argillaceous dolostone.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at the four sites are outlined below:

Site 1: Four boreholes drilled and sampled to depths of 11.2 m during the period June 28, 2010 to June 30, 2010. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata drawing in Appendix C1.

Site 2: Twenty-seven boreholes drilled and sampled to depths ranging from 11.2 m to 35.0 m during the period of November 04, 2009 to July 27, 2010. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata drawing in Appendix C2.

Site 3: Sixteen boreholes drilled and sampled to depths ranging from 11.2 m to 32.2 m during the period of November 10, 2009 to June 30, 2010. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata drawing in Appendix C3.

Site 4: Four boreholes drilled and sampled to depths ranging from 7.5 m to 17.3 m during the period of September 09, 2009 to June 24, 2010. The approximate borehole locations are shown on the attached Borehole Locations and Soil Strata drawing in Appendix C4.

The borehole locations were marked in the field by surveyors from Callon Dietz Inc. who also provided Terraprobe with their coordinates and geodetic elevations. Access to some borehole locations was difficult due to locally steep slopes, utilities and existing structures. These boreholes were therefore relocated to be as close as feasible to the staked out location while allowing safe operation of the drill rig. Utility clearances were obtained by Terraprobe prior to drilling.

² Ontario Division of Mines, "Quaternary Geology Of The Welland Area", Preliminary Map P.796, 1972.



Samples of the overburden soils were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT), as specified in ASTM Method D1586. In the cohesive (clayey) deposits the undrained shear strength of the soil was measured in-situ by means of field vane tests using an MTO type field vane. Relatively undisturbed soil samples were also collected with thin-walled Shelby Tube samplers. Some of the boreholes were also drilled at proposed bridge abutments and these boreholes were advanced into bedrock by NQ size diamond coring techniques.

Ground water conditions in the open boreholes were observed throughout the drilling operations and standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen enclosed in sand were installed in selected boreholes to permit longer term ground water level monitoring. The remaining boreholes were abandoned in accordance with MOE Regulation 903 by sealing/grouting with a clay slurry mixture after drilling was complete.

The locations and completion details of the piezometers are provided in Tables 3.1 to 3.4.

Table 3.1 – Piezometer Installation Details (Site #1)

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
RW1	10.7/179.3	Piezometer with 1.5 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
RW3	10.7/181.1	Piezometer with 1.5 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
RW4	6.1/185.4	Hole sealed to 6.1 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 4.0 m, bentonite seal from 4.0 m to 3.4 m, silty clay cuttings from 3.4 m to 0.6 m and bentonite seal from 0.6 m to ground surface.



Table 3.2 – Piezometer Installation Details (Site #2)

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
NBL 12+375Lt	11.1/172.2	Piezometer with 3.0 m slotted screen installed with filter sand to 7.1 m, bentonite seal from 7.1 m to 6.5 m, silty clay cuttings from 6.5 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
NBL 12+440Rt	12.2/170.8	Piezometer with 3.0 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.3 m and bentonite seal from 0.3 m to ground surface.
SBL 12+360CL	12.2/170.7	Piezometer with 3.0 m slotted screen installed with filter sand to 9.0 m, bentonite seal from 9.0 m to 8.4 m, silty clay cuttings from 8.4 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
SBL 12+410CL	12.2/170.3	Piezometer with 1.5 m slotted screen installed with filter sand to 10.3 m, bentonite seal from 10.3 m to 10.0 m, silty clay cuttings from 10.0 m to 0.3 m and bentonite seal from 0.3 m to ground surface.
S-EW 10+050CL	12.2/171.2	Piezometer with 3.0 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 8.1 m, silty clay cuttings from 8.1 m to 0.5 m and bentonite seal from 0.5 m to ground surface.
TEW1	15.2/167.3	Hole sealed to 15.2 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 12.8 m and bentonite seal from 12.8 m to ground surface.
TEW4	28.3/154.3	Hole sealed to 28.3 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 26.2 m and bentonite seal from 26.2 m to ground surface.
TN2	25.9/158.3	Hole sealed to 25.9 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 23.5 m, bentonite seal from 23.5 m to 1.5 m, sand from 1.5 m to 0.3 m and a flush mounted casing installation from 0.15 m to ground surface.
TN3	19.8/164.3	Hole sealed to 19.8 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 17.7 m, bentonite seal from 17.7 m to 0.3 m, and a flush mounted casing installation from 0.3 m to ground surface.
TRW1	10.7/172.5	Piezometer with 1.5 m slotted screen installed with filter sand to 8.8 m, bentonite seal from 8.8 m to 8.2 m, silty clay cuttings from 8.2 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
TRW2	13.7/168.8	Piezometer with 1.5 m slotted screen installed with filter sand to 11.6 m, bentonite seal from 11.6 m to 11.0 m, silty clay cuttings from 11.0 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
TRW3	16.8/166.3	Piezometer with 1.5 m slotted screen installed with filter sand to 14.6 m, bentonite seal from 14.6 m to 14.0 m, silty clay cuttings from 14.0 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
TRW4	12.2/171.8	Hole sealed to 12.2 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 10.1 m, bentonite seal from 10.1 m to 9.4 m, silty clay cuttings from 9.4 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
TS1	28.0/154.6	Hole sealed to 28.0 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 25.0 m and bentonite seal from 25.0 m to ground surface.
TS4	28.3/154.1	Hole sealed to 28.3 m with bentonite, piezometer with 3.0 m slotted screen installed with filter sand to 24.7 m and bentonite seal from 24.7 m to ground surface.
TSEW2	24.2/159.1	Silty clay cuttings to 25.0 m, hole sealed to 24.4 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 21.6 m and bentonite seal from 21.6 m to ground surface.
TSEW4	22.9/160.6	Hole sealed to 23.2 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 20.4 m and bentonite seal from 20.4 m to ground surface.
WE-S 10+345CL	12.6/170.2	Piezometer with 1.5 m slotted screen installed with filter sand to 10.7 m, bentonite seal from 10.7 m to 10.1 m, silty clay cuttings from 10.1 m to 0.6 m and bentonite seal from 0.6 m to ground surface.



Table 3.3 – Piezometer Installation Details (Site #3)

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
NBL 12+695Lt	12.2/170.7	Piezometer with 3.0 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.3 m and bentonite seal from 0.3 m to ground surface.
NBL 12+750Rt	12.6/170.2	Piezometer with 3.0 m slotted screen installed with filter sand to 9.0 m, bentonite seal from 9.0 m to 8.4 m, silty clay cuttings from 8.4 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
SBL 12+685CL	10.7/172.0	Piezometer with 3.0 m slotted screen installed with filter sand to 7.0 m, bentonite seal from 7.0 m to 6.4 m, silty clay cuttings from 6.4 m to 0.3 m, bentonite seal from 0.3 m to ground surface with a flush mounted casing installation.
SBL 12+750CL	10.5/172.4	Piezometer with 3.0 m slotted screen installed with filter sand to 6.9 m, bentonite seal from 6.9 m to 6.6 m, silty clay cuttings from 6.6 m to 0.3 m and bentonite seal from 0.3 m to ground surface.
WN2	26.3/155.3	Hole sealed to 26.3 m with bentonite, piezometer with 1.8 m slotted screen installed with filter sand to 24.1 m, bentonite seal from 24.1 m to ground surface.
WN3	22.6/159.5	Hole sealed to 22.6 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 20.7 m, bentonite seal from 20.7 m to ground surface with a flush mounted casing installation.
WRW2	15.2/167.4	Piezometer with 1.5 m slotted screen installed with filter sand to 12.8 m, bentonite seal from 12.8 m to 12.2 m, silty clay cuttings from 12.2 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
WRW3	10.7/173.0	Piezometer with 1.5 m slotted screen installed with filter sand to 8.6 m, bentonite seal from 8.6 m to 8.0 m, silty clay cuttings from 8.0 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
WRW4	15.2/167.8	Piezometer with 1.5 m slotted screen installed with filter sand to 12.8 m, bentonite seal from 12.8 m to 12.2 m, silty clay cuttings from 12.2 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
WS1	22.9/159.8	Hole sealed to 22.9 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 20.4 m, bentonite seal from 20.4 m to ground surface.
WS4	24.4/158.3	Hole sealed to 24.4 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 21.9 m, bentonite seal from 21.9 m to ground surface.

Table 3.4 – Piezometer Installation Details (Site #4)

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
MR 9+850Rt	6.1/173.7	Piezometer with 1.5 m slotted screen installed with filter sand to 4.3 m, bentonite seal from 4.3 m to 4.0 m, silty clay cuttings from 4.0 m to 0.3 m and bentonite seal from 0.3 m to ground surface.
MRW1	10.3/170.1	Silty clay cuttings to 10.3 m, piezometer with 1.5 m slotted screen installed with filter sand to 8.2 m, bentonite seal from 8.2 m to 7.6 m, silty clay cuttings from 7.6 m to 0.6 m and bentonite seal from 0.6 m to ground surface with a flush mounted casing installation.
MRW3	10.7/169.8	Piezometer with 1.5 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.6 m and bentonite seal from 0.6 m to ground surface with a flush mounted casing installation.



The drilling, sampling and in-situ testing operations were observed on a full time basis by members of Terraprobe's technical staff who logged the boreholes and processed the recovered soil and rock samples for transport to Terraprobe's Brampton laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. Select samples were also subjected to a laboratory testing programme consisting of gradation analysis and Atterberg Limits tests, consolidation tests, unit weight, unconfined compression tests and undrained shear strength testing with a laboratory vane. The results of this testing program are shown on the Record of Borehole sheets in Appendices A1 – A4 and the Figures in Appendices B1 – B4.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 Site 1 – Sta. 11+816 to Sta. 11+947

Reference is made to the Record of Borehole sheets in Appendix A1. Details of the encountered soil stratigraphy are presented in this appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix C1. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil, fill material (silty sand and silty clay) and a native silty clay deposit.

5.1.1 Topsoil

Topsoil ranging from 150 mm to 200 mm thick was encountered at this site. Topsoil thickness may vary between and beyond the boreholes.

5.1.2 Fill – Silty Sand

Silty sand fill material was encountered in Borehole RW2. This fill material extends to a depth of 0.7 m (Elev. ± 190.3 m) below ground surface.

A Standard Penetration test in this fill gave an 'N' value of 23 blows for 0.3 m penetration. Based on this result the fill is considered to have a compact relative density. The moisture content of a sample of this fill was 18% by weight.

5.1.3 Fill – Silty Clay

Silty clay fill material was encountered in all of the boreholes extending to depths ranging from 7.1 m to 8.6 m below ground surface or to elevations of ± 183.2 m to ± 182.9 m.

Samples of the silty clay fill were subjected to grain size distribution tests and the results are presented in Figures B1-1 and B1-2. These results show grain size distributions consisting of 0-10% gravel, 2-6% sand, 54-63% silt and 31-43% clay size particles.



Samples of the fill were also subjected to Atterberg Limits tests and the results are plotted on the plasticity charts, Figures B1-3 and B1-4. The index values from these tests are summarized below:

Liquid Limit:	30-40%
Plastic Limit:	17-20%
Plasticity Index:	13-20%
Natural Moisture Content:	14-23%

These values are characteristic of clayey soils of low to intermediate plasticity.

Standard Penetration tests in the silty clay fill gave 'N' values that ranged from 5 to 47 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 60 kPa to in excess of 100 kPa. Based on these results the fill is considered to have a firm to hard consistency. The moisture content of samples of this fill ranged from 10% to 33% by weight.

5.1.4 Silty Clay

A silty clay deposit was encountered across the site extending to borehole termination depths of 11.2 m below ground surface or to elevations ranging from ± 180.6 m to ± 178.8 m.

The grain size distribution plots of tested samples of the silty clay (Figure B1-5) show a grain size distribution consisting of 0% gravel, 1-10% sand, 43-52% silt and 41-56% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity chart, Figure B1-6. The index values from these tests are summarized below:

Liquid Limit:	38-48%
Plastic Limit:	20-24%
Plasticity Index:	18-24%
Natural Moisture Content:	20-21%

These values indicate that the silty clay has a generally intermediate plasticity.

The blow counts from Standard Penetration tests conducted in this stratum ranged from 26 to 65 blows for 0.3 m penetration indicating that the silty clay has a very stiff to hard consistency. The moisture content of samples of the silty clay ranged from 19% to 22% by weight.



5.1.5 Water Levels

A standpipe piezometer was installed in selected boreholes. The water level readings measured on separate visits made after the completion of drilling are presented in Table 5.1.1.

Table 5.1.1 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
RW1	July 07, 2010	6.3	183.7
	July 14, 2010	6.3	183.7
	July 21, 2010	6.2	183.8
RW3	July 07, 2010	8.3	183.5
	July 14, 2010	6.6	185.2
	July 21, 2010	7.1	184.7
	July 28, 2010	7.0	184.8
RW4	July 07, 2010	Dry	-
	July 14, 2010	5.7	185.8
	July 21, 2010	5.0	186.5
	July 28, 2010	4.9	186.6

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of moisture contents of the retrieved samples. This interpretation indicates that the ground water table generally follows the topography of the land. The water level is estimated to be at Elev. ± 183.8 m at the south limit of the alignment, rising gradually to about Elev. ± 184.8 at Sta. 11+900 and increasing to the north limit where it is estimated to be at Elev. ± 186.6 m. Perched water can also be expected to occur where permeable layers of silty sand are underlain by more impermeable silty clay soils.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.2 Site 2 – North and South of Trillium Railway

Reference is made to the Record of Borehole sheets in Appendix A2. Details of the encountered soil and rock stratigraphy are presented in this appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix C2. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil and about 28.4 m to 30.6 m of overburden soils consisting of fill material (gravelly sand to sandy gravel, silty sand and silty clay) and native deposits of silty clay, silty clay to clayey silt till, sand, silty sand to sandy silt till, and gravelly sand to sandy gravel till. These soils are underlain by bedrock consisting primarily of dolostone and shale of the Salina formation.

5.2.1 Topsoil

Topsoil ranging from 30 mm to 380 mm in thickness was encountered on this site. Topsoil thickness may vary between and beyond the boreholes.



5.2.2 Fill – Gravelly Sand to Sandy Gravel

Some of the boreholes encountered granular fill material ranging in composition from gravelly sand to sandy gravel. This fill extends to depths ranging from 0.7 m to 0.8 m below ground surface or to elevations ranging from ± 183.4 m to ± 182.6 m.

The grain size distribution plots of tested samples of this granular fill are depicted in Figure B2-1. These results show a grain size distribution consisting of 10-72% gravel, 17-76% sand, 7-25% silt and up to 15% clay size particles.

Standard Penetration tests in the granular fill gave 'N' values that ranged from 6 to 53 blows for 0.3 m penetration, but generally 'N' values ranged from 19 to 53 blows for 0.3 m penetration. Based on these results the fill is considered to have a generally compact to very dense relative density with occasional loose zones. The moisture content of samples of the fill ranged from 1% to 29% by weight.

5.2.3 Fill – Silty Sand

Silty sand fill material was encountered in Borehole TN1 extending to a depth of 1.4 m (Elev. ± 182.1 m) below ground surface.

The grain size distribution plot (Figure B2-2) of a tested sample of this fill is depicted shows a grain size distribution consisting of 13% gravel, 65% sand and 22% silt and clay size particles.

Standard Penetration tests in this fill gave 'N' values ranging from 14 to 16 blows for 0.3 m penetration. Based on this result the fill is considered to have a compact relative density. The moisture content of samples of this fill ranged from 14% to 19% by weight.

5.2.4 Fill – Silty Clay

Silty clay fill material was encountered at this site extending to depths ranging from 0.7 m (Elev. ± 182.7 m) to 2.9 m (Elev. ± 180.1 m) below ground surface.

Samples of the silty clay fill were subjected to grain size analysis and the results (Figure B2-3) show a grain size distribution consisting of 0-15% gravel, 3-18% sand, 33-58% silt and 22-64% clay size particles.

Samples of the fill material were also subjected to Atterberg Limits tests and the results are presented in Figure B2-4. The index values from these tests are summarized below:

Liquid Limit:	24-62%
Plastic Limit:	14-27%
Plasticity Index:	10-35%
Natural Moisture Content:	15-27%

These values indicate that fill is generally a low to intermediate plasticity silty clay with occasional high plasticity silty clay inclusions.



Standard Penetration tests in the silty clay fill gave 'N' values that ranged from 2 to 35 blows for 0.3 m penetration, but generally 'N' values ranged from 5 to 35 blows for 0.3 m penetration. Based on these results, the fill is considered to have a generally firm to hard consistency with infrequent soft zones. The moisture content of samples of this fill ranged from 6% to 44% by weight.

5.2.5 Silty Clay

A major silty clay deposit was encountered across the site. Boreholes NBL 12+375Lt, NBL 12+440Rt, SBL 12+360CL, SBL 12+410CL, SEW 10+050CL, TRW1, TRW2, WE-S 10+295CL, and WE-S 10+345CL were terminated in this deposit at depths ranging from 11.2 m (Elev. ± 172.0 m) to 14.6 m (Elev. ± 168.2 m) below ground surface. This deposit was fully penetrated in all of the remaining boreholes where it extended to depths ranging from 14.6 m to 15.8 m below ground surface or to elevations of ± 169.5 m to ± 166.8 m.

The grain size distribution plots of tested samples of the silty clay are presented in Figures B2-5 to B2-22 inclusive. These results show a grain size distribution consisting of 0-7% gravel, 1-13% sand, 36-87% silt and 12-62% clay size particles. One tested sample from borehole TN3 at approximately 5.5 m depth (Elev. ± 178.6 m) contained 41% sand.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B2-23 to B2-39 inclusive. The index values from these tests are summarized below:

Liquid Limit:	23-58%
Plastic Limit:	11-25%
Plasticity Index:	5-33%
Natural Moisture Content:	12-33%

These values indicate that the silty clay has a generally low to intermediate plasticity with occasional zones of high plasticity and infrequent clayey silt zones.

The Atterberg Limits test results are plotted against elevation, Figure B2-54. These results illustrate that the natural moisture contents are generally at or below the plastic limit down to about Elev. ± 177.0 m. Below Elev. ± 177.0 m the data indicates that the moisture contents generally exist between the plastic and liquid limits.

Standard Penetration tests in this stratum gave 'N' values that ranged from 3 to 77 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 40 kPa to in excess of 120 kPa. Unconfined compression tests gave undrained shear strength ranging from 65 kPa to 93 kPa and laboratory vane tests on relatively undisturbed Shelby tube samples gave undrained shear strengths ranging from 34 kPa to 140 kPa. These values indicate that the consistency of the silty clay is generally stiff to hard with occasional firm zones. The moisture content of samples of the silty clay range from 6% to 33% by weight and the unit weight of tested samples ranged from 20.4 to 20.8 kN/m³.



The variation of undrained shear strength with elevation is depicted in Figure B2-55. The plot illustrates a wide scatter in the data with no obvious trend with depth and an interpreted dashed line is shown representing a lower bound trend with depth for the data. The upper portion of this deposit down to about Elev. ± 177.0 m is estimated to have relatively high shear strength i.e. in excess of 100 kPa. Below Elev. ± 177.0 m the undrained shear strength decreases with depth and is about 50 kPa from Elev. ± 172.0 m to Elev. ± 170.0 m. Below Elev. ± 170.0 m the trend indicates increasing undrained shear strength with depth.

Consolidation tests were also performed on Shelby tube samples retrieved from Boreholes WE-S 10+345CL, SBL 12+360CL, NBL 12+375Lt, SEW 10+050CL, WE-S 10+295CL, SBL 12+410CL, NBL 12+440Rt, and TSEW3 and the results are presented in Figures B2-56 to B2-79. Preconsolidation pressures were estimated from the e-log p curves. Due to the rounded nature of the curves the preconsolidation pressures were also assessed based on the 'Work' – method proposed by Becker et al. (1987). The details of the test results are summarized in the following table.

Borehole/Sample No.	Sample Depth/Elevation (m)	P_c (kPa)	C_c	C_r	e_o
WE-S 10+345CL TW10	10.7/172.1	230 – 370	0.183	0.019	0.56
SBL 12+360CL TW10	10.7/172.2	340 – 500	0.201	0.030	0.57
NBL 12+375Lt TW9	9.1/174.2	310	0.204	0.036	0.60
SEW 10+050CL TW9	9.1/174.3	310 – 400	0.221	0.027	0.63
WE-S 10+295CL TW10	9.1/173.7	350	0.160	0.028	0.55
SBL 12+410CL TW9	9.1/173.4	300 – 350	0.205	0.031	0.60
NBL 12+440Rt TW10	10.7/172.3	370 – 480	0.193	0.025	0.59
TSEW3 TW13	12.2/171.1	230 – 300	0.208	0.037	0.62

Where: P_c = Preconsolidation pressure
 C_c = Compression index
 C_r = Recompression index
 e_o = Initial void ratio

5.2.6 Silty Clay to Clayey Silt Till

Discontinuous layers of silty clay to clayey silt till were encountered at this site extending to depths ranging from 23.8 m (Elev. ± 158.9 m) to 28.4 m (Elev. ± 155.1 m) below ground surface. Boreholes TRW3 and TRW4 were terminated in this deposit at depths of 17.3 m (Elev. ± 165.8 m) and 15.7 m (Elev. ± 168.3 m) below ground surface respectively.

The grain size distribution plots of tested samples from these strata are presented in Figures B2-40 to B2-43 inclusive. These results show a grain size distribution consisting of 0-28% gravel, 2-39% sand, 32-63% silt and 12-42% clay size particles. Till soils will also contain random cobble and boulder inclusions.



Selected samples were also subjected to Atterberg Limits tests and the results are presented in Figures B2-44 to B2-48 inclusive. The index values from these tests are summarized below:

Liquid Limit:	17-32%
Plastic Limit:	11-16%
Plasticity Index:	5-16%
Natural Moisture Content:	7-29%

These values are characteristic of clayey soils of low plasticity.

Standard Penetration tests in these deposits yielded 'N' values ranging from 10 to more than 100 blows per 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 88 kPa to in excess of 100 kPa. Based on these results, the silty clay to clayey silt till is considered to have a stiff to hard consistency. The moisture content of samples from these deposits varies from 1% to 29% by weight.

5.2.7 Sand

Discontinuous layers of sand and gravel to gravelly sand were encountered at this site. These deposits are approximately 0.8 m to 2.4 m thick and extend to depths ranging from 23.1 m (Elev. ± 159.6 m) to 26.2 m (Elev. ± 157.1 m) below ground surface.

Samples from these strata were subjected to grain size analysis and the results are illustrated in Figure B2-49. These results show a grain size distribution consisting of 31-32% gravel, 56-57% sand, 10-12% silt and up to 2% clay size particles.

Standard Penetration tests in these deposits gave 'N' values that ranged from 34 to more than 100 blows per 0.3 m penetration. Based on these results, the deposits are considered to have a dense to very dense relative density. The moisture content of samples from these strata ranged from 5% to 14% by weight.

5.2.8 Silty Sand to Sandy Silt Till

Deposits of silty sand to sandy silt till were encountered at this site extending to depths ranging from 23.9 m to 30.6 below ground surface or to elevations ranging from ± 160.3 m to ± 153.0 m.

Samples from these deposits were subjected to grain size distribution tests and the results are illustrated in Figures B2-50 and B2-51. These results show a grain size distribution consisting of 4-35% gravel, 28-72% sand, 15-38% silt and 6-17% clay size particles. Till soils will also contain random cobble and boulder inclusions.

Standard Penetration tests in these deposits gave 'N' values that ranged from 29 to more than 100 blows per 0.3 m penetration indicating a compact to very dense relative density. The moisture content of samples from these strata ranged from 4% to 28% by weight.



5.2.9 Gravelly Sand to Sandy Gravel Till

Till deposits consisting of sandy gravel to sand and gravel were encountered in some of the deep boreholes drilled at this site. These deposits were found to extend to depths ranging from 28.4 m to 30.5 m below the ground surface or to elevations ranging from ± 154.5 m to ± 153.6 m.

Grain size distribution tests were performed on samples from these deposits and the results are illustrated in Figures B2-52 and B2-53. These results show grain size distributions consisting of 2-51% gravel, 26-95% sand, 3-29% silt and 5-8% clay size particles. Random cobble and boulder inclusions are also expected to occur in till soils.

The blow counts from Standard Penetration tests conducted in these deposits ranged from 18 to more than 100 blows for 0.3 m penetration indicating a compact to very dense relative density. The moisture content of samples from these strata ranged from 1% to 16% by weight.

5.2.10 Bedrock (Salina Formation)

The overburden soils described above are underlain by the Salina Formation. Bedrock was proved by coring at the abutment locations of the proposed bridge structures. Table 5.2.1 summarizes the bedrock depth and the elevations to the top of bedrock.

Table 5.2.1 – Depth to Bedrock

Bridge	Location	BH Number	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
Trillium E/W-S	South Abutment	TEW1	28.8	153.7
		TEW2	28.7	154.0
	North Abutment	TEW3	28.9	153.7
		TEW4	28.7	153.9
Trillium NBL	South Abutment	TN1	30.5	153.0
		TN2	30.5	153.7
	North Abutment	TN3	29.6	154.5
		TN4	30.6	153.4
Trillium SBL	South Abutment	TS1	28.4	154.2
		TS2	29.4	153.9
	North Abutment	TS3	28.7	153.8
		TS4	28.4	154.0
Trillium S-E/W	South Abutment	TSEW1	29.7	153.8
		TSEW2	29.6	153.7
	North Abutment	TSEW3	29.7	153.6
		TSEW4	29.5	154.0

The bedrock is described as unweathered interbedded dolostone and shale and its colour is generally grey. It is thinly laminated with white unweathered gypsum and calcite veins and coarse grained calcitic vugs.

Total core recovery in the bedrock ranged from 20% to 100%. The RQD values ranged widely from 0% to 84% but generally, most of the RQD values were below 50%. An RQD of 0% was obtained in Run 1 of Boreholes TEW3, TN2, TN4, TS3, and TSEW4 and in Run 2 of Boreholes TEW4 and TSEW4. Rubble and highly fractured zones were observed in the rock cores, which contributed to the relatively low RQD values. The core data also reveals that there is no trend of



improving rock quality with depth. Based on these results the rock quality is considered to be very poor to poor with occasional zones of fair to good quality rock.

5.2.11 Water Levels

Standpipe piezometers were installed in selected boreholes and the water level readings measured on separate visits made after the completion of drilling are presented in the following tables.

Table 5.2.2 – Water Level Measurements (South Alignment)

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
TRW1	July 05, 2010	1.5	181.7
	July 12, 2010	1.6	181.6
	July 19, 2010	1.9	181.3
	July 28, 2010	2.2	181.0
	August 06, 2010	2.4	180.8
WE-S 10+345CL	November 19, 2009	4.0	178.8
	November 30, 2009	3.4	179.4
	December 07, 2009	3.1	179.7
	December 15, 2009	3.0	179.8
	January 11, 2010	2.6	180.2
	January 27, 2010	2.7	180.1
TEW1	January 19, 2010	3.2	179.3
	January 27, 2010	2.4	180.1
	February 08, 2010	2.4	180.1
TS1	January 19, 2010	10.6	172.0
	January 27, 2010	10.4	172.2
	February 08, 2010	10.5	172.1
SBL 12+360CL	November 19, 2009	5.0	177.9
	November 30, 2009	2.6	180.3
	December 07, 2009	2.4	180.5
	December 15, 2009	2.3	180.6
	January 04, 2010	2.1	180.8
	January 11, 2010	2.1	180.8
NBL 12+375Lt	November 19, 2009	5.8	177.5
	November 30, 2009	3.2	180.1
	December 07, 2009	1.3	182.0
	December 15, 2009	1.8	181.5
	January 19, 2010	1.7	181.6
TN2	April 16, 2010	2.6	181.6
	April 29, 2010	1.6	182.6
	May 04, 2010	6.2	178.0
	May 06, 2010	6.2	178.0
S-EW 10+050CL	December 08, 2009	2.4	181.0
	December 15, 2009	2.4	181.0
	January 04, 2010	2.4	181.0
	January 11, 2010	2.4	181.0
TSEW2	January 11, 2010	8.5	174.8
	January 19, 2010	8.6	174.7
	January 27, 2010	8.8	174.5
	February 08, 2010	8.8	174.5
TRW2	July 12, 2010	2.8	179.7
	July 19, 2010	2.9	179.6



Table 5.2.3 – Water Level Measurements (North Alignment)

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
TRW3	July 05, 2010	2.3	180.8
	July 12, 2010	3.2	179.9
	July 19, 2010	2.3	180.8
	July 28, 2010	3.5	179.6
	August 06, 2010	3.5	179.6
TEW4	January 11, 2010	10.2	172.4
	January 19, 2010	10.6	172.0
	January 27, 2010	10.5	172.1
	February 08, 2010	10.6	172.0
TS4	January 11, 2010	9.4	173.0
	January 19, 2010	9.9	172.5
	January 27, 2010	10.2	172.2
	February 08, 2010	10.4	172.0
SBL 12+410CL	November 30, 2009	1.7	180.8
	December 07, 2009	1.4	181.1
	December 15, 2009	1.3	181.2
TN3	April 16, 2010	3.9	180.2
	April 29, 2010	4.7	179.4
	May 04, 2010	8.7	175.4
	May 06, 2010	9.4	174.7
	May 18, 2010	3.8	180.3
TSEW4*	-	-	-
NBL 12+440Rt	November 09, 2009	8.2	174.8
	November 19, 2009	2.1	180.9
	November 30, 2009	1.9	181.1
	December 08, 2009	1.9	181.1
TRW4	July 28, 2010	10.6	173.4
	August 06, 2010	3.4	180.6
	August 13, 2010	2.9	181.1
	August 23, 2010	3.1	180.9

* Piezometer destroyed after installation.

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of moisture contents of the retrieved samples. This interpretation indicates a ground water table that is estimated to range between Elev. ± 179.5 m and Elev. ± 181.0 m. Perched water can also be expected to occur where permeable layers of sand and gravel and sand and silts are underlain by more impermeable silty clay soils.

All ground water observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.3 Site 3 – North and South of Woodlawn Road

Reference is made to the Record of Borehole sheets in Appendix A3. Details of the encountered soil and rock stratigraphy are presented in this appendix and on the “Borehole Locations and Soil Strata” drawings in Appendix C3. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.



In general, the site is underlain by topsoil and about 25.9 m to 27.5 m of overburden soils consisting of topsoil, fill material (sand and gravel and silty clay) and native deposits of silty clay, silt, silty clay to clayey silt till and silty sand to sandy silt till. These soils are underlain by bedrock of the Salina Formation.

5.3.1 Topsoil

Topsoil ranging from 25 mm to 200 mm in thickness was encountered at this site. Topsoil thickness may vary between and beyond the boreholes.

5.3.2 Fill – Sand and Gravel

Boreholes SBL 12+685CL and WN3 were extended through the gravel shoulders of existing roadways where they encountered fill material consisting of sand and gravel. This fill is approximately 470 mm to 700 mm thick and extends to depths ranging from 0.5 m (Elev. ± 182.2 m) to 0.7 m (Elev. ± 181.4 m) below ground surface.

The grain size distribution plots of tested samples of this granular fill are shown in Figure B3-1. These results show a grain size distribution consisting of 41% gravel, 42-44% sand, 13% silt and 2-4% clay size particles.

Standard Penetration tests in the granular fill gave 'N' values that ranged from 11 to 48 blows for 0.3 m penetration. Based on these results the fill is considered to have a compact to dense relative density. The moisture content of samples of the fill ranged from 4% to 6% by weight.

5.3.3 Fill – Silty Clay

Silty clay fill material was encountered at this site extending to depths ranging from 0.7 m (Elev. ± 183.0 m) to 3.7 m (Elev. ± 178.8 m) below ground surface.

The grain size distribution plots of tested samples of this fill are illustrated in Figures B3-2 and B3-3. These results show a grain size distribution consisting of 0-5% gravel, 2-4% sand, 35-67% silt and 31-63% clay size particles.

Samples of the fill were also subjected to Atterberg Limits tests and the results are presented in Figure B3-4. The index values from these tests are summarized below:

Liquid Limit:	27-58%
Plastic Limit:	16-26%
Plasticity Index:	11-32%
Natural Moisture Content:	16-27%

These values indicate that the fill material consists of generally intermediate to high plasticity soils with infrequent low plasticity silty clay inclusions.

Standard Penetration tests in the silty clay fill gave 'N' values ranging from 3 to 43 blows for 0.3 m penetration, but generally 'N' values ranged from 7 to 43 blows for 0.3 m penetration. Based on these results the fill is considered to have a firm to hard consistency with occasional soft zones. The moisture content of samples of the silty clay fill ranged from 16% to 31% by weight.



5.3.4 Silty Clay

A major silty clay deposit was encountered at this site. This deposit was fully penetrated in some of the boreholes at depths ranging from 13.2 m (Elev. ± 168.4 m) to 14.7 m (Elev. ± 167.8 m) below ground surface. Boreholes NBL 12+695Lt, NBL 12+750Rt, SBL 12+685CL, SBL 12+750CL, WRW1 and WRW3 were terminated in this deposit at depths ranging from 11.2 m (Elev. ± 172.5 m) to 13.7 m (Elev. ± 169.1 m) below ground surface.

The grain size distribution plots of tested samples of the silty clay are presented in Figures B3-5 to B3-14 inclusive. These results show a grain size distribution consisting of 0-17% gravel, 0-10% sand, 31-83% silt and 12-68% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B3-15 to B3-24 inclusive. The index values from these tests are summarized below:

Liquid Limit:	24-49%
Plastic Limit:	14-23%
Plasticity Index:	8-27%
Natural Moisture Content:	16-24%

These values indicate that the silty clay has a low to intermediate plasticity.

The Atterberg Limits tests results are plotted against elevation, Figure B3-32. These results illustrate that the natural moisture contents are generally at or below the plastic limit above Elev. ± 178.0 m. Below Elev. ± 178.0 m the moisture content increases and is generally between the plastic and liquid limits.

Standard Penetration tests in this stratum gave 'N' values that ranged from 1 to 61 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 48 kPa to in excess of 100 kPa. Unconfined compression tests gave undrained shear strengths ranging from 36 kPa to 77 kPa and laboratory vane tests on relatively undisturbed Shelby tube samples gave undrained shear strengths ranging from 49 kPa to in excess of 120 kPa. These values indicate that the consistency of the silty clay is generally stiff to hard with occasional firm zones. The moisture content of samples from this stratum ranged from 12% to 27% by weight and the unit weight of tested samples ranged between 20.6 and 21.1 kN/m³.

The variation of undrained shear strength with elevation is depicted in Figure B3-33. The plot illustrates a wide scatter in the data with no obvious trend with depth and an interpreted dashed line is shown representing a lower bound trend with depth for the data. The upper portion of this deposit down to about Elev. ± 178.0 m is estimated to have relatively high shear strength i.e. in excess of 100 kPa. Below Elev. ± 178.0 m the undrained shear strength decreases with depth and is about 50 kPa between Elev. ± 175.0 m and Elev. ± 172.0 m. Below Elev. ± 172.0 m the trend indicates increasing undrained shear strength with depth.



Consolidation tests were performed on Shelby tube samples retrieved from Boreholes NBL 12+695Lt, NBL 12+750Rt, SBL 12+685CL, and SBL 12+750CL and the results are presented in Figures B3-34 to B3-45 inclusive. Preconsolidation pressures were estimated from the e-log p curves. Due to the rounded nature of the curves the preconsolidation pressures were also assessed based on the 'Work' – method proposed by Becker et al. (1987). The details of the test results are summarized below.

Borehole/Sample No.	Sample Depth/Elevation (m)	P _c (kPa)	C _c	C _r	e _o
NBL 12+695Lt TW11	12.2/170.7	320 – 450	0.224	0.028	0.60
NBL 12+750Rt TW9	9.1/173.7	320 – 340	0.194	0.026	0.57
SBL 12+685CL TW10	10.7/172.0	370 – 550	0.233	0.027	0.59
SBL 12+750CL TW10	9.9/173.0	370 – 380	0.171	0.020	0.50

Where: P_c = Preconsolidation pressure
C_c = Compression index
C_r = Recompression index
e_o = Initial void ratio

5.3.5 Silt

A discontinuous silt deposit was encountered at this site. The deposit is approximately 0.5 m to 1.5 m thick and extends to depths ranging from 3.5 m (Elev. ±178.1 m) to 5.9 m (Elev. ±176.8 m) below ground surface. Based on visual and tactile examinations of the retrieved samples, the unit is essentially a cohesionless silt with frequent cohesive silty clay seams and partings.

The grain size distribution plots of tested samples of the silt are presented in Figure B3-25. These results show a grain size distribution consisting of 0-1% gravel, 0-2% sand, 75-84% silt and 15-22% clay size particles.

The deposit is considered to have a loose to very dense relative density based on SPT 'N' values that ranged from 9 to 64 blows for 0.3 m penetration. The moisture content of samples from this deposit ranged from 16% to 22% by weight.

5.3.6 Silty Clay to Clayey Silt Till

Layers of silty clay to clayey silt till were encountered at this site. An upper silty clay to clayey silt till unit was encountered directly underlying the native silty clay deposit. This unit was fully penetrated in the deep boreholes drilled at the proposed Woodlawn Overhead structures where it was found to extend to depths ranging from 16.2 m (Elev. ±165.4 m) to 18.7 m (Elev. ±164.0 m) below ground surface. Boreholes WRW2 and WRW4 were terminated within the upper silty clay to clayey silt till stratum at a depth of 15.7 m below ground surface, corresponding to elevations of ±166.9 m and ±167.3 m respectively. Boreholes WS1, WS2 and WS3 encountered a lower deposit of clayey silt till approximately 1.6 m to 2.5 m thick that extends to depths of 22.3 m below ground surface or to elevations of ±160.8 m to ±160.4 m.



The grain size distribution plots of samples of the silty clay to clayey silt till deposits are presented in Figures B3-26 and B3-27. These results show a grain size distribution consisting of 2-17% gravel, 9-35% sand, 35-62% silt and 15-25% clay size particles. Till soils can also be expected to contain random cobble and boulder inclusions.

Samples of the silty clay to clayey silt till were also subjected to Atterberg Limits tests and the results are presented in Figures B3-28 and B3-29. The index values from these tests are summarized below:

Liquid Limit:	15-26%
Plastic Limit:	11-22%
Plasticity Index:	4-11%
Natural Moisture Content:	7-19%

These values indicate low plasticity silty clay and clayey silt soils.

Standard Penetration tests in the silty clay to clayey silt till yielded 'N' values ranging from 18 to more than 100 blows for 0.3 m penetration. Field vane tests were also attempted in these deposits and the results (no-turn on vane) indicate undrained shear strengths more than 100 kPa. These values indicate that the consistency of the silty clay to clayey silt till is very stiff to hard. The moisture contents of samples of the silty clay to clayey silt till range from 7% to 19% by weight.

5.3.7 Silty Sand to Sandy Silt Till

Till deposits ranging in composition from silty sand to sandy silt were encountered at this site extending to depths ranging from 25.9 m (Elev. ± 157.1 m) to 27.5 m (Elev. ± 155.2 m) below ground surface.

The results of grain size distribution tests conducted on samples obtained from these till deposits are illustrated in Figures B3-30 and B3-31. These results show grain size distributions of 2-26% gravel, 10-48% sand, 31-72% silt and 4-16% clay size particles. Till soils will also contain random cobble and boulder inclusions.

Standard Penetration tests in these deposits gave 'N' values that ranged from 28 to more than 100 blows per 0.3 m penetration indicating a compact to very dense relative density. The moisture content of samples from these strata ranged from 3% to 13% by weight.



5.3.8 Bedrock (Salina Formation)

The overburden soils described above are underlain by the Salina Formation. Bedrock was proved by coring at the abutment locations of the proposed bridge structures on the NBL and SBL alignments. Table 5.3.1 summarizes the bedrock depth and the elevations to the top of bedrock.

Table 5.3.1 – Depth to Bedrock

Bridge	Location	BH Number	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
Woodlawn NBL	South Abutment	WN1	27.4	155.7
		WN2	25.9	155.7
	North Abutment	WN3	26.4	155.7
		WN4	26.0	156.5
Woodlawn SBL	South Abutment	WS1	27.5	155.2
		WS2	27.3	155.8
	North Abutment	WS3	25.9	157.1
		WS4	26.3	156.4

The bedrock is described as unweathered interbedded dolostone and shale and its colour is generally grey. It is thinly laminated with white unweathered gypsum and calcite veins.

Total core recovery in the bedrock ranged from 19% to 100%. The RQD values ranged widely from 0% to 70% but generally most of the RQD values were below 50%. An RQD of 0% was obtained in Run 1 of Boreholes WN3 and WS1. Rubble and highly fractured zones were observed in the rock cores, which contributed to the relatively low RQD values. The core data also reveals that there is no trend of improving rock quality with depth. Based on these results the rock quality is considered to be very poor to poor with occasional zones of fair quality rock.

5.3.9 Water Levels

A standpipe piezometer was installed in selected boreholes. The water level readings measured on separate visits made after the completion of drilling are presented in the following tables.

Table 5.3.2 – Water Level Measurements (South Alignment)

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
WS1	January 27, 2010	6.8	175.9
	February 08, 2010	6.8	175.9
SBL 12+685CL*	-	-	-
NBL 12+695Lt	November 30, 2009	9.3	173.6
	December 15, 2009	3.4	179.5
	January 04, 2010	3.2	179.7
	January 11, 2010	3.3	179.6
	January 19, 2010	3.4	179.5
WN2	January 04, 2010	5.2	176.4
	January 11, 2010	4.2	177.4
	January 19, 2010	5.2	176.4
	January 27, 2010	5.2	176.4
WRW2	July 05, 2010	9.7	172.9
	July 13, 2010	4.4	178.2
	July 21, 2010	3.6	179.0
	July 27, 2010	3.6	179.0



Table 5.3.3 – Water Level Measurements (North Alignment)

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
WRW3	July 05, 2010	3.2	180.5
	July 13, 2010	3.2	180.5
	July 20, 2010	2.9	180.8
	July 27, 2010	2.6	181.1
	August 06, 2010	3.4	180.3
	August 13, 2010	3.6	180.1
WS4	February 08, 2010	4.7	178.0
	April 16, 2010	2.1	180.6
	April 29, 2010	5.1	177.6
	May 04, 2010	5.7	177.0
	May 06, 2010	4.1	178.6
	May 18, 2010	5.9	176.8
SBL 12+750CL	November 19, 2009	4.6	178.3
	November 30, 2009	7.8	175.1
	December 08, 2009	4.1	178.8
	December 15, 2009	3.2	179.7
	January 04, 2010	2.7	180.2
	January 11, 2010	2.7	180.2
	January 19, 2010	2.6	180.3
WN3	April 16, 2010	7.7	174.4
	April 29, 2010	3.9	178.2
	May 04, 2010	5.2	176.9
	May 06, 2010	4.8	177.3
NBL 12+750Rt	December 15, 2009	5.1	177.7
	January 04, 2010	2.7	180.1
	January 11, 2010	2.7	180.1
	January 19, 2010	2.8	180.0
WRW4	July 05, 2010	9.7	173.3
	July 13, 2010	4.7	178.3
	July 21, 2010	4.1	178.9
	July 27, 2010	3.0	180.0
	August 06, 2010	2.6	180.4
	August 13, 2010	3.3	179.7
	August 23, 2010	3.5	179.5

* Piezometer destroyed after installation.

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of moisture contents of the retrieved samples. This interpretation indicates a ground water table that is estimated to range between Elev. ± 179.5 m and Elev. ± 181.0 m. Perched water can also be expected to occur where permeable layers of sand and gravel and sand and silts are underlain by more impermeable silty clay soils.

All ground water observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.



5.4 Site 4 – Right Side of Merritt Road Sta. 9+700 to 9+910

Reference is made to the Record of Borehole sheets in Appendix A4. Details of the encountered soil stratigraphy are presented in this appendix and on the “Borehole Locations and Soil Strata” drawing in Appendix C4. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil, fill material (gravel and sand to sandy gravel, silty sand, and silty clay) and native overburden deposits of silty clay, silt and silty clay to clayey silt.

5.4.1 Topsoil

A 60 mm thick layer of topsoil was encountered in Borehole MR 9+850Rt. Topsoil thickness may vary between and beyond the boreholes.

5.4.2 Fill – Gravel and Sand to Sandy Gravel

Boreholes MRW1, MRW2 and MRW3 were drilled through the existing shoulder of Merritt Road. These boreholes encountered approximately 460 mm to 700 mm thick layers of granular fill material ranging in composition from gravel and sand to gravelly sand. This fill extends to depths ranging from 0.5 m (Elev. ± 180.3 m) to 0.7 m (Elev. ± 179.7 m) below ground surface.

The grain size distribution plot of a tested sample of this granular fill is depicted in Figure B4-1. These results show a grain size distribution consisting of 31% gravel, 53% sand, 14% silt and 2% clay size particles.

Standard Penetration tests in the granular fill gave ‘N’ values that ranged from 19 to 27 blows for 0.3 m penetration. Based on these results the fill is considered to have a compact relative density. The moisture content of samples of the fill ranged from 2% to 3% by weight.

5.4.3 Fill – Silty Sand

Silty sand fill material was encountered underlying the gravel and sand to gravelly sand fill in Boreholes MRW1, MRW2 and MRW3. This fill material is approximately 0.7 m to 2.1 m thick and extends to depths ranging from 1.4 m (Elev. ± 179.0 m) to 2.6 m (Elev. ± 178.2 m) below ground surface.

The grain size distribution plots of tested samples of the silty sand fill are depicted in Figure B4-2. These results show a grain size distribution consisting of 0-7% gravel, 68-70% sand, 21-25% silt and 4-5% clay size particles.

Standard Penetration tests in this fill gave ‘N’ values ranging from 2 to 20 blows for 0.3 m penetration. Based on these results the fill is considered to have a very loose to compact relative density. The moisture content of samples of this fill ranged from 6% to 25% by weight.



5.4.4 Fill – Silty Clay

Silty clay fill material was encountered at this site in Borehole MRW3 extending to a depth of 2.9 m (Elev. ± 177.6 m) below ground surface.

A sample of the silty clay fill was subjected to a grain size distribution test and the results are presented in Figure B4-3. These results show a grain size distribution consisting of 0% gravel, 5% sand, 59% silt and 36% clay size particles.

A sample of the fill was also subjected to an Atterberg Limits test and the results are presented in Figure B4-4. The index values from these tests are summarized below:

Liquid Limit:	39%
Plastic Limit:	20%
Plasticity Index:	19%
Natural Moisture Content:	21%

These values are characteristic of clayey soils of intermediate plasticity.

A Standard Penetration test in the silty clay fill gave an 'N' value of 14 blows for 0.3 m penetration. Based on this result the fill is considered to have a stiff consistency. The moisture content of samples of this fill ranged from 21% to 24% by weight.

5.4.5 Silty Clay

A major silty clay deposit was encountered across the site. Borehole MR 9+850Rt was terminated within this deposit at a depth of 7.5 m (Elev. ± 172.3 m) below ground surface. The deposit was fully penetrated in the remaining boreholes where it was found to extend to depths ranging from 8.6 m (Elev. ± 171.9 m) to 10.1 m (Elev. ± 170.3 m) below ground surface.

The grain size distribution plots of tested samples of the silty clay are presented in Figures B4-5 and B4-6. These results show a grain size distribution consisting of 0% gravel, 0-4% sand, 33-66% silt and 33-67% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B4-7 and B4-8. The index values from these tests are summarized below:

Liquid Limit:	31-40%
Plastic Limit:	17-21%
Plasticity Index:	14-20%
Natural Moisture Content:	19-33%

These values indicate that the silty clay has a generally low to intermediate plasticity.

The Atterberg Limits test results are plotted against elevation, Figure B4-12. These results illustrate that the natural moisture contents within the silty clay stratum are generally at or below the plastic limit above Elev. ± 177.0 m. Below Elev. ± 177.0 m the moisture content increases and is generally between the plastic and liquid limits.



Standard Penetration tests in this stratum gave 'N' values that ranged from 1 to 27 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 40 kPa to in excess of 100 kPa. A laboratory vane test on a relatively undisturbed Shelby tube sample gave undrained shear strength of 30 kPa. These values indicate that the consistency of the silty clay is generally firm to very stiff with infrequent soft zones. The moisture content of samples of the silty clay ranged from 18% to 45% by weight and the unit weight of a tested sample was 18.3 kN/m³.

The variation of undrained shear strength with elevation is depicted in Figure B4-13. There is a wide scatter in the data and an interpreted dashed line is shown representing a lower bound trend with depth for the data. The upper portion of this deposit down to about Elev. ± 176.0 m is estimated to have shear strength in excess of 85 kPa. Below Elev. ± 176.0 m the undrained shear strength decreases with depth and is about 50 kPa at Elev. ± 173.0 m. The trend also indicates increasing undrained shear strength below Elev. ± 173.0 m.

Consolidation tests were also performed on a Shelby tube sample retrieved from Borehole MR 9+850Rt and the results are presented in Figures B4-14 to B4-16 inclusive. Preconsolidation pressures were estimated from the e-log p curves. Due to the rounded nature of the curves the preconsolidation pressures were also assessed based on the 'Work' – method proposed by Becker et al. (1987). The details of the test results are summarized below.

Borehole/Sample No.	Sample Depth/Elevation (m)	P _c (kPa)	C _c	C _r	e _o
MR 9+850Rt TW7	6.1/173.7	280	0.478	0.091	1.06

Where: P_c = Preconsolidation pressure
C_c = Compression index
C_r = Recompression index
e_o = Initial void ratio

5.4.6 Silt

A native silt deposit was encountered at this site. The deposit is approximately 1.6 m to 3.1 m thick and extends to depths of 11.7 m below ground surface or to elevations ranging from ± 169.1 m to ± 168.7 m. Based on visual and tactile examinations of the retrieved samples, the unit is essentially a cohesionless silt with occasional cohesive silty clay seams and partings.

The grain size distribution plot of a tested sample from the silt deposit is presented in Figure B4-9. The results show a grain size distribution consisting of 0% gravel, 1% sand, 93% silt and 6% clay size particles.

The deposit is considered to have a loose to compact relative density based on SPT 'N' values that ranged from 7 to 16 blows for 0.3 m penetration. The moisture content of samples from this deposit ranged from 20% to 22% by weight.



5.4.7 Silty Clay to Clayey Silt

A lower silty clay to clayey silt deposit was encountered at this site. Boreholes MRW1, MRW2 and MRW3 were terminated within this deposit at depths of 17.3 m below ground surface or at elevations ranging from ± 163.5 m to ± 163.1 m.

The grain size distribution plots of tested samples of the silty clay to clayey silt are presented in Figure B4-10. These results show grain size distributions consisting of 0-1% gravel, 1-3% sand, 77-82% silt and 17-19% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity chart, Figure B4-11. The index values from these tests are summarized below:

Liquid Limit:	24%
Plastic Limit:	16-17%
Plasticity Index:	7-8%
Natural Moisture Content:	17-18%

These values indicate that the silty clay to clayey silt is of low plasticity.

The Atterberg Limits test results are plotted against elevation, Figure B4-12. These results illustrate that the natural moisture contents of the silty clay to clayey silt stratum are generally near the plastic limit.

Standard Penetration tests in this stratum gave 'N' values that ranged from 4 to 31 blows for 0.3 m penetration and field vane tests gave in-situ undrained shear strengths ranging from 64 kPa to in excess of 100 kPa. These values indicate that the consistency of the silty clay is generally stiff to hard with occasional firm zones. The moisture content of samples of the silty clay ranged from 16% to 22% by weight.

The variation of undrained shear strength with elevation is depicted in Figure B4-13. The plot illustrates a wide scatter in the data with no obvious trend with depth and an interpreted dashed line is shown representing a lower bound trend with depth for the data. The upper portion of this deposit is estimated to have shear strength of about 50 kPa. The undrained shear strength increases with depth within this deposit and is about 75 kPa at Elev. ± 166.0 m.



5.4.8 Water Levels

A standpipe piezometer was installed in selected boreholes. The water level readings measured on separate visits made after the completion of drilling are presented in Table 5.4.1.

Table 5.4.1 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
MR 9+850Rt	September 10, 2009	6.0	173.8
	September 11, 2009	4.6	175.2
	September 15, 2009	3.9	175.9
MRW1	July 05, 2010	1.5	178.9
	July 13, 2010	1.4	179.0
	July 20, 2010	1.6	178.8
	July 27, 2010	1.3	179.1
	August 06, 2010	2.0	178.4
	August 13, 2010	2.7	177.7
	August 23, 2010	2.1	178.3
MRW3	July 05, 2010	1.8	178.7
	July 13, 2010	1.4	179.1
	July 20, 2010	1.5	179.0

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of moisture contents of the retrieved samples. This interpretation indicates a ground water table that is estimated to exist at about Elev. ± 179.0 m. Perched water can also be expected to occur where permeable layers of sand and gravel and silty sand are underlain by more impermeable silty clay soils.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.5 Miscellaneous

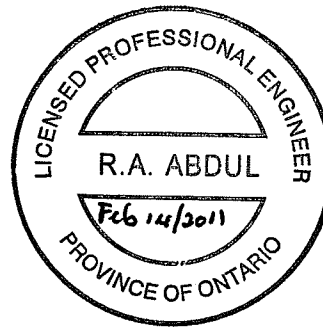
The drilling, sampling and in-situ testing operations were conducted with track and truck mounted drill rigs owned and operated by Groundworks Drilling Limited of Toronto, Ontario, DBW Drilling Limited of Ajax, Ontario, Determination Drilling & Soil Investigations of Hamilton, Ontario, Strong Soil Search Inc. of Claremont, Ontario, and Kodiak Drilling of Oakville, Ontario. The boreholes were advanced using both solid stem and hollow-stem auger drilling techniques and casing and washboring methods. NQ size rock cores of the bedrock were obtained using diamond drilling techniques.

Messrs. Phil Khuu, B.A.T., Marc Paoliello, E.I.T., Alexander Winkelmann, E.I.T., Lucas Yu, E.I.T., and Brady Lin, P.Eng. observed and recorded the field work. The laboratory testing was performed at Terraprobe's Brampton laboratory and the Mississauga laboratory of Golder Associates. The report was written by Rehman Abdul, P.Eng. and reviewed by Michael Tanos, P.Eng.



R. Abdul

Prepared by:
R. Abdul, P.Eng.,
Senior Geotechnical Engineer



Michael Tanos

Report Reviewed by:
Michael Tanos, P.Eng.,
Review Principal



FOUNDATION DESIGN REPORT
RETAINING STRUCTURES
HIGHWAY 406 TWINNING
ONTARIO
AGREEMENT No. 2008-E-0016, W.P. 280-99-00, SITE:
GEOCRES No. 30M3-266
PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 DISCUSSION AND RECOMMENDATIONS

6.1 General

This report presents interpretation of the geotechnical data in the factual report and provides geotechnical design recommendations to assist the design team to select and design suitable retaining structures at four sites within the project limits.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigations.

Three wall types were considered, namely retained soil system (RSS) walls, post and panel wall systems and conventional cantilever and gravity retaining walls. However, the choice of wall type is governed by the performance and appearance design requirements, the permanency of the installation as well as the type of any proposed structures next to these walls.

6.2 Site 1 – Sta. 11+816 to Sta. 11+947

Between Sta. 11+816 and Sta. 11+947 additional property will be required if cut slopes are constructed at the recommended 3H:1V side slopes. Property acquisition is a costly and lengthy process and an alternative solution consisting of a retaining structure within the cut slope was considered in order to mitigate the need to acquire additional property, reduce costs and prevent unnecessary delays.

Since the retained soil heights will not exceed 2 m and the design requirement for this site is a permanent structure that meets the “Medium Performance” and “Low Appearance” criteria, the alternatives are limited. Conventional cantilever walls and post and panel wall systems etc. exceed the design criteria and would be uneconomical if used. A gabion structure was selected since it meets the design criteria, is practical and is also the most economical.

Gabion structures should be specified to be “Medium Performance” and “Low Appearance”. The contract drawings should include information on the longitudinal alignment of the wall in plan, the top and base elevations of the wall in profile, cross-sectional space constraints etc. The design, supply, and construction of gabion walls should be in accordance with OPSS 512 as amended by



Special Provision SP 512S01, January 1999. Materials assembly and securing lids should be in accordance with SP 512S02.

6.2.1 Geotechnical Resistances

The recommended founding depths and geotechnical resistances for a gabion structure (minimum width of 1 m) founded on undisturbed competent natural soils are tabulated in Table 6.1.

Table 6.1 – Gabion Wall Geotechnical Resistances

Borehole Location	Existing Ground Surface Elev. (m)	Recommended Bottom of Footing Level Below Existing Ground Surface (m)	Founding Elevation (m)	Factored Geotech. Resistance at ULS (kPa)	Geotech. Resistance at SLS (kPa)	Subgrade Material
RW1	190.0	Below 0.7	Below 189.3	250	125	Fill
RW2	191.0	0.7 – 3.5	190.3 – 189.0	250	125	Fill
		Below 3.5	Below 189.0	150	100	
RW3	191.8	0.2 – 2.8	191.6 – 189.5	250	125	Fill
		Below 2.8	Below 189.5	150	100	
RW4	191.5	0.2 – 1.5	191.3 – 190.0	250	125	Fill
		1.5 – 2.5	190.0 – 189.0	150	100	

These values are for vertical, concentric loads only. Effects of load inclination and eccentricity should be taken into account as illustrated in CHBDC 2006, Clause 6.7.3 and Clause 6.7.4. The SLS values quoted above corresponds to a settlement of up to 25 mm.

It is recommended that the gabion structure be constructed on a 300 mm thick levelling pad of OPSS Granular “A” compacted to 100% of its Standard Proctor maximum dry density (SPMDD) at $\pm 2\%$ of optimum moisture content. Alternatively 20 mm clear crushed stone can be used. The subgrade soils should be compacted to a minimum of 98% SPMDD prior to placing the granular pad.

Resistance to lateral forces/sliding resistance between the concrete footing and the subgrade soils should be evaluated in accordance with the CHBDC 2006, Clause 6.7.5. The sliding resistance of a gabion structure founded on a compacted Granular “A” pad or clear crushed stone may be computed on the basis of ultimate coefficients of friction of 0.7 and 0.8 respectively.

6.2.2 Global Stability

The commercially available slope stability program Slide 5.0 developed by Rocscience Inc. was used. The Spencer, Janbu and Bishop’s simplified method for stability analysis were employed and a minimum target factor of safety of 1.3 was established. Tabulated below are the soil parameters used for the slope stability analyses.



Material Type	Short-Term Analysis			Long-Term Analysis		
	ϕ (degrees)	c (kPa)	γ (kN/m ³)	ϕ' (degrees)	c' (kPa)	γ' (kN/m ³)
Upper Fill – Silty Clay	0	90	19	28	0	19
Lower Fill – Silty Clay	0	30	19	28	0	19
Silty Clay	0	150	21	28	5	21

The global stability of the gabion structure is dependent on the properties of the existing soils, the slope geometry and the location of the wall within the slope. Stability analyses were conducted at three selected sections of the alignment and both short term (un-drained) and long term (drained) conditions were analysed. The analysis also considered temporary traffic (construction traffic etc.) at the top of the slope. Our analyses indicate that the factors of safety will be greater than the target factor of safety of 1.3. The slope stability models depicting the corresponding factors of safety are provided in Appendix D.

The following requirements must also be met:

- No traffic, construction equipment, stockpiles (including snow) or other construction supplies is permitted at the top of the slope within a horizontal distance of at least 1.5 m from face of the cut.
- Exposed soil must be protected from surface erosion.
- Construction activities should be scheduled so that the length of time any temporary cut slope is left open is reduced to the extent practical.
- Surface water must be diverted away from the excavation and from the top of the slope and runoff from the site should be reduced to the extent practical.

Proper erosion control measures should be implemented both during construction and permanently. Temporary erosion and sediment control must be provided in accordance with OPSS 577. All exposed slopes must be provided with permanent erosion protection in accordance with OPSS 571 and/or OPSS 572 after construction is complete.

6.2.3 Backfill

Backfill to the gabion structure should be in accordance with OPSS 902. A Class II woven geotextile fabric (FOS of 120 microns or less) is recommended between the wall and backfill material.

Compaction equipment to be used adjacent to retaining structures should be restricted in accordance with Special Provision 105S10 “Amendment to OPSS 501, February 1996”.



6.3 SITES 2, 3 and 4 (Trillium Railway, Woodlawn Road & Merritt Road)

6.3.1 General

Trillium Railway and Woodlawn Road

At the Woodlawn Road interchange two overpasses are required to carry Highway 406 NBL and SBL over the realigned Woodlawn Road. The Trillium Railway track is located about 325 m south of the Woodlawn Road overpasses and the interchange geometry requires four bridges over the track. Grade separation structures are required between the railway and Highway 406 NBL and SBL, Woodlawn E/W – 406S Ramp and Ramp 406S-Woodlawn E/W.

The proposed bridges at these sites are integral abutment structures and RSS walls will be used for false abutments. Therefore, it would be most feasible and practical to use the same type of retaining structure to retain the forward slopes of the approach fills beyond the bridge abutments and to ensure that the walls are seamlessly integrated with the false abutments of the bridges. Hence, cantilever type walls and post and panel systems were ruled out.

Although RSS walls are a feasible alternative, the soils at this site are settlement sensitive and this aspect must be taken into account in the designs. A standard one-stage MSE wall is not recommended because the facing panels cannot accommodate the estimated settlement. However, a two-stage RSS system can be used at this site since this type of wall has provisions for installing a cast-in-place facing after settlement is complete

RSS walls should be specified to be “High Performance” and “High Appearance”. The contract drawings should include information on the longitudinal alignment of the wall in plan, the top and base elevations of the wall in profile, cross-sectional space constraints and a NSSP for the RSS wall. The design, supply, and construction of RSS should be in accordance with SP 599S22. Materials quality control and quality assurance testing and acceptance criteria for precast concrete facing elements should be in accordance with SP 599S23.

Merritt Road

The construction staging operation requires that traffic be maintained on Merritt Road while the west approach embankment of the bridge is constructed. It is therefore necessary to retain embankment fill temporarily between Sta. 9+700 to Sta. 9+910. The fill will be approximately 1 m high at Sta. 9+700 increasing to a maximum height of about 5.5 m at Sta. 9+825 then decreasing to about 1.3 m at Sta. 9+910.

This wall is a temporary structure that will be left in place (buried) when the right side of the approach is constructed. Since the wall is a temporary structure, “high performance” and “high appearance” structures such as cantilever type walls and post and panel systems would not be the most economically viable option and these alternatives were ruled out. RSS walls are considered to be a feasible alternative however the soils at this site are settlement sensitive and this aspect must be taken into account when designing a wall at this site.



Temporary RSS walls should be specified to be “Low Performance” and “Low Appearance”. The contract drawings should include information on the longitudinal alignment of the wall in plan, the top and base elevations of the wall in profile, cross-sectional space constraints and a NSSP for the RSS wall. The design, supply, and construction of the RSS should be in accordance with SP 599S22.

6.3.2 Foundation

The performance of an RSS is dependent, among other factors, on the characteristics of its foundation. Failure to provide an adequate foundation may lead to settlement and distortion of the RSS and, in severe cases, to possible failure of the system.

At the Trillium Railway and Woodlawn Road sites a levelling pad is required. It is recommended that the levelling pad be centred on top of a pad of engineered fill consisting of OPSS Granular A compacted in accordance with the OPSS 501, Method A. The engineered fill pad should be at least 500 mm thick and should be at least twice as wide as the levelling pad.

In addition to the requirements for the levelling pad, the RSS can be founded on the native soils or well compacted fill. All topsoil, organics and soft soils should be removed from the subgrade of the RSS wall prior to placement of the fill. The founding subgrades should be inspected and evaluated by the Quality Verification Engineer (QVE), at the time of construction.

The recommended factored ULS geotechnical resistances and construction details for the proposed RSS walls are provided in the following tables.

Trillium Railway – South Wall

RSS Location	RSS Wall Base Elev. (m)	Max. Wall Height (m)	Required SLS Bearing Resistance (kPa)	Recommended Geotechnical Resistances (kPa)		Relevant Borehole & Subgrade Soil	Additional Requirements
				ULS	SLS		
Sta. 9+916 to Sta. 9+950	±182.3	8.2	213	475	N/A*	TRW1/TEW1 Silty Clay	Settlement monitoring required.
Sta. 9+950 to Sta. 10+000	±182.3	8.5	221	425	N/A*	TEW1/TEW2 TS1/TS2 Silty Clay	Settlement monitoring required.
Sta. 10+000 to Sta. 10+023	±181.9	9.0	234	425	N/A*	TN1/TN2 Silty Clay	Settlement monitoring required.
Sta. 10+023 to Sta. 10+029	±181.9	9.0	234	425	N/A*	TN1/TN2 TSEW1 Silty Clay	Settlement monitoring required.
Sta. 10+029 to Sta. 10+045	±181.9	8.5	221	450	N/A*	TSEW1/TSEW2 Silty Clay	Settlement monitoring required.
Sta. 10+045 to Sta. 10+057	±181.9	8.5	221	450	N/A*	TSEW2/TRW2 Silty Clay	Settlement monitoring required.

* Settlement will be greater than 25 mm and a geotechnical resistance for 25 mm settlement is not provided.



Trillium Railway – North Wall

RSS Location	RSS Wall Base Elev. (m)	Max. Wall Height (m)	Required SLS Bearing Resistance (kPa)	Recommended Geotechnical Resistances (kPa)		Relevant Borehole & Subgrade Soil	Additional Requirements
				ULS	SLS		
Sta. 9+930 to Sta. 9+950	±182.7	6.3	164	425	N/A*	TRW3/TEW3 Silty Clay	Settlement monitoring required.
Sta. 9+950 to Sta. 9+993	±182.1	8.5	221	425	N/A*	TEW3/TEW4 TS3/TS4 Silty Clay	Settlement monitoring required.
Sta. 9+993 to Sta. 10+016	±182.1	8.9	231	425	N/A*	TS4/TN3 Silty Clay	Settlement monitoring required.
Sta. 10+016 to Sta. 10+033	±182.1	8.9	231	425	N/A*	TN3/TN4 Silty Clay	Settlement monitoring required.
Sta. 10+033 to Sta. 10+041	±182.1	8.9	231	300	N/A*	TN4/ TSEW4 Silty Clay	Settlement monitoring required.
Sta. 10+041 to Sta. 10+050	±182.1	8.1	211	300	N/A*	TSEW4/TSEW3 Silty Clay	Settlement monitoring required.
Sta. 10+050 to Sta. 10+091	±181.5	8.7	226	300	N/A*	TSEW3/TRW4 Silty Clay	Settlement monitoring required.

* Settlement will be greater than 25 mm and a geotechnical resistance for 25 mm settlement is not provided.

Woodlawn Road – South Wall

RSS Location	RSS Wall Base Elev. (m)	Max. Wall Height (m)	Required SLS Bearing Resistance (kPa)	Recommended Geotechnical Resistances (kPa)		Relevant Borehole & Subgrade Soil	Additional Requirements
				ULS	SLS		
Sta. 9+989 to Sta. 9+901	±181.4	6.9	180	425	N/A*	WRW1/WS1 Silty Clay	Settlement monitoring required.
Sta. 9+901 to Sta. 9+925	±181.4	6.9	180	425	N/A*	WS1/WS2 Silty Clay	Settlement monitoring required.
Sta. 9+925 to Sta. 9+943	±181.4	6.9	180	300	N/A*	WS2/WN1 Silty Clay	Settlement monitoring required.
Sta. 9+943 to Sta. 9+964	±181.4	6.3	164	300	N/A*	WN1/WN2 Silty Clay	Settlement monitoring required.
Sta. 9+964 to Sta. 9+992	±181.4	6.3	164	300	N/A*	WN2/WRW2 Silty Clay	Settlement monitoring required.

* Settlement will be greater than 25 mm and a geotechnical resistance for 25 mm settlement is not provided



Woodlawn Road – North Wall

RSS Location	RSS Wall Base Elev. (m)	Max. Wall Height (m)	Required SLS Bearing Resistance (kPa)	Recommended Geotechnical Resistances (kPa)		Relevant Borehole & Subgrade Soil	Additional Requirements
				ULS	SLS		
Sta. 9+909 to Sta. 9+927	±182.4	4.4	115	140	N/A*	WN4/WRW4 Silty Clay	Settlement monitoring required.
Sta. 9+927 to Sta. 9+948	±182.4	4.4	115	140	N/A*	WN3/WN4 Sand and Gravel Silty Clay	Settlement monitoring required.
Sta. 9+948 to Sta. 9+965	±182.4	5.0	130	425	N/A*	WS4/WN3 Silty Clay Sand and Gravel	Settlement monitoring required.
Sta. 9+965 to Sta. 9+988	±182.4	5.0	130	425	N/A*	WS3/WS4 Silty Clay	Settlement monitoring required.
Sta. 9+988 to Sta. 9+997	±182.4	5.0	130	450	N/A*	WRW3/WS3 Silty Clay	Settlement monitoring required.

* Settlement will be greater than 25 mm and a geotechnical resistance for 25 mm settlement is not provided

Merritt Road – Temporary Wall

RSS Location	RSS Wall Base Elev. (m)	Max. Wall Height (m)	Required SLS Bearing Resistance (kPa)	Recommended Geotechnical Resistances (kPa)		Relevant Borehole & Subgrade Soil	Additional Requirements
				ULS	SLS		
Sta. 9+700 to Sta. 9+725	±181.1	1.8	50	300	N/A*	MRW3 Granular A	Raise existing grade where required with Granular A
Sta. 9+725 to Sta. 9+750	±180.9	2.6	70	300	N/A*	MRW3 Granular A	Raise existing grade where required with Granular A
Sta. 9+750 to Sta. 9+775	±180.9	3.4	90	300	N/A*	MRW3 Granular A	Raise existing grade where required with Granular A
Sta. 9+775 to Sta. 9+800	±180.9	4.0	105	325	N/A*	MRW2 Granular A	Raise existing grade where required with Granular A
Sta. 9+800 to Sta. 9+825	±181.0	5.5	145	325	N/A*	MRW2 Granular A	Raise existing grade as and where required with Granular A
Sta. 9+825 to Sta. 9+850	±180.9	5.5	145	325	N/A*	MRW2 MR9+850 Rt. Granular A	Raise existing grade where required with Granular A
Sta. 9+850 to Sta. 9+875	±180.7	4.3	115	325	N/A*	MR9+850 Rt. Granular A	Raise existing grade where required with Granular A
Sta. 9+875 to Sta. 9+900	±180.6	3.2	85	450	N/A*	MRW1 Granular A	Raise existing grade where required with Granular A
Sta. 9+900 to Sta. 9+910	±180.5	2.4	65	450	N/A*	MRW1 Granular A	Raise existing grade where required with Granular A

* Settlement will be greater than 25 mm and a geotechnical resistance for 25 mm settlement is not provided



The following parameters may be used for the design of the RSS:

- Bearing resistance for the levelling pad on engineered fill:
 - Factored ULS 150 kPa, SLS 100 kPa
- Ultimate coefficient of sliding resistance of cast in-situ concrete levelling pad on Granular A = 0.70
- Ultimate coefficient of sliding resistance of RSS mass on Granular A = 0.70
- Ultimate coefficient of sliding resistance of RSS mass on silty clay soils = 0.5

The entire block of reinforced earth must also be designed against various modes of failure including sliding and overturning.

6.3.3 Settlement

The RSS wall at Merritt Road is a “Low Performance” and “Low Appearance” temporary structure without facing panels. At this site the estimated settlement of a 5.5 m high wall will be about 110 mm. Settlement is not considered to be an issue since no settlement sensitive elements are being installed.

The RSS walls at the Trillium and Woodlawn sites are “High Performance” and “High Appearance” structures and settlement is an important design requirement. The settlement of RSS walls at these sites will depend on the material used, the foundation soils and the quality of construction.

Time dependent consolidation settlement will occur in the underlying silty clay deposits and the parameters used for the settlement calculations are tabulated below. There is a wide scatter in the data and a slight variation of P_c with depth. Therefore the two rows of data represent the range of values for the upper and lower half of the two strata.

Settlement Parameters – Trillium Site

Parameter	Upper Crust	Lower Silty Clay
Preconsolidation Pressure Range - P_c (kPa)	600 to 450 500 to 400	450 to 300 400 to 300
Coefficient of Compressibility - C_c	0.19 to 0.22	0.15 to 0.18
Recompression Index - C_r	0.03	0.02 to 0.025
Initial Void Ratio - e_o	0.9	0.70
Coefficient of Consolidation - C_v (cm ² /s)	6x10 ⁻³ to 2.8x10 ⁻²	

Settlement Parameters – Woodlawn Site

Parameter	Upper Crust	Lower Silty Clay
Preconsolidation Pressure Range - P_c (kPa)	600 to 450 500 to 400	450 to 300 400 to 300
Coefficient of Compressibility - C_c	0.20 to 0.22	0.15 to 0.18
Recompression Index - C_r	0.04	0.02 to 0.029
Initial Void Ratio - e_o	0.9	0.60
Coefficient of Consolidation - C_v (cm ² /s)	3.3x10 ⁻³ to 5.0x10 ⁻³	



Settlement analyses were undertaken where the RSS walls are the highest i.e. at the bridge abutments. Where the load induced by the RSS core does not exceed the estimated preconsolidation pressure the recompression index (C_r) was used for settlement calculations. Where the RSS loads exceed the preconsolidation pressure the analysis was based on soil recompression and consolidation and both the recompression index (C_r) and the coefficient of consolidation (C_c) were used. The total settlement and the range of predicted settlements at various time periods are tabulated in the following table.

RSS Wall Location	Settlement At Various Time Periods (mm)				Total Settlement (mm)
	6 months	12 months	18 months	24 months	
Trillium Site	95 – 110	105 – 120	110 – 125	110 – 130	110 – 130
Woodlawn Site	105 – 115	110 – 125	115 – 130	120 – 135	120 – 135

The facing should be designed to accommodate the settlements outlined above and a 12 month target time for facing installation is recommended. However, the timing for installation will be contingent upon approval by the geotechnical engineer and the contract documents should contain an NSSP for this aspect of the work. We recommend that the timing for facing installation be controlled by the settlement monitoring plans developed for the corresponding bridge structures.

6.3.4 Global Stability

The global stability of the RSS wall is dependent on the characteristics of the embankment fill and the foundation soils, the geometry of the embankment and location of the RSS within the embankment. The RSS wall will be in the form of a rectangular block from ground surface extending to the maximum wall height, or in the form of a triangular wedge along the embankment side slopes.

Stability analyses on selected configurations were carried out considering the following variables:

- RSS founded at the base of the embankment at the proposed design elevations.
- Fill behind the RSS is horizontal.
- RSS block with full retained height and block width (length of RSS reinforcement) equal to 70% of the height.
- Water Levels at Elev. ± 181.0 m (Sites 2 & 3) and Elev. ± 179.0 (Site 4).

Analysis carried out on RSS walls located at the base of the embankment where the wall height is a maximum indicates that for a minimum anchor length equivalent to 70% of the wall height the factor of safety will be greater than the target factor of safety of 1.3.

Consequently, it may be assumed that RSS walls founded at the proposed design elevations will be stable against global failure. If an RSS wall is founded in the embankment slope, the specific geometry and soil conditions must be analyzed to determine the requirements for global stability. The internal stability of the RSS wall should be analyzed by the supplier/designer of the proprietary product selected for this site.



7 FROST COVER

All footings including levelling pads should be provided with a minimum of 1.2 m of earth cover or equivalent protection.

8 EXCAVATION AND BACKFILL

8.1 General

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the soils encountered at the various sites may be classified as follows:

- Fill (Gravel and Sand to Sandy Gravel and Silty Clay) - Type 2 Soils
- Fill (Silty Sand) - Type 2 Soils above the water table and Type 3 soils below the water table.
- Silty Clay - Type 3 Soils above and below the water table.

Provided unwatering is carried out as described below, excavations may be sloped at 1.5H:1V.

9 GROUNDWATER CONTROL

Depending on the depth of excavation it is likely that ground water and perched water could be encountered in excavations. The silty clay soils are relatively impermeable and are not expected to yield significant quantities of water. Higher yields are expected from the more permeable fill soils if perched water is encountered but this seepage will diminish with time.

The design of the unwatering system should be the responsibility of the Contractor. However, a suitable system that might be employed is a system of interceptor trenches and pumping from strategically located filtered sumps.

Any accumulation of water from the base of the excavation should be removed prior to placing concrete or compacting granular fill. Placement of concrete or compacting engineered fill must be done in the dry.

10 SEISMIC CONSIDERATIONS

Reference to Annex A3.1 of the CHBDC indicates that the following seismic parameters (Welland) should be used for design:

- | | |
|-------------------------------------|--------------------------|
| • Velocity Related Seismic Zone | 0 |
| • Zonal Velocity Ratio | 0 |
| • Acceleration Related Seismic Zone | 1 |
| • Zonal Acceleration Ratio | 0.05 |
| • Peak Horizontal Acceleration | 0.08 g (10% in 50 years) |



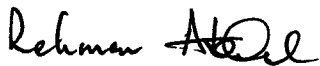
The soil profile types at these sites are classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.0 should be used in seismic design.

Structures should be designed in accordance with Clause 7.5.5 of the CHBDC for a seismic event having a 10% probability of being exceed in 50 years. The vertical component of the earthquake acceleration ratio (A_v) shall be two-thirds of the horizontal ground acceleration ratio (A_h) and A_h shall be set equal to the zonal acceleration ratio.

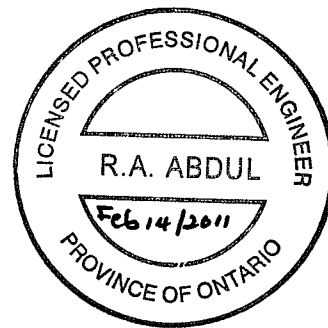
Since the sites are classified as Seismic Performance Zone 1, seismic stability analysis is not required as per Clause 4.6 of the CHBDC 2006.

10.1.1 Liquefaction Potential

Liquefaction assessment was undertaken in accordance with the Seed and Idriss (1971) simplified procedure. Liquefaction is not considered to be an issue at this site. The underlying overburden soils are not prone to liquefaction.



Engineering Analysis and Report Preparation by:
R. Abdul, P.Eng.,
Senior Geotechnical Engineer



Report Reviewed by:
Michael Tanos, P.Eng.,
Review Principal



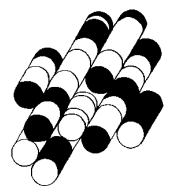
TABLE 1

DOCUMENT	TITLE
OPSS 501	Construction Specification for Compacting.
OPSS 512	Construction Specification for Installation of Gabions
OPSS 571	Construction Specification for Sodding
OPSS 572	Construction Specification for Seed and Cover
OPSS 577	Construction Specification for Temporary Erosion and Sediment Control Measures.
OPSS 902	Construction Specification for Excavating and Backfilling - Structures



APPENDICES

TERRAPROBE INC.



LIMITATIONS AND RISK

Procedures

The soil conditions were confirmed at the borehole and test pit locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of stratigraphic change.

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities.

Changes In Site And Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report

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EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

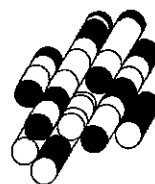
m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

PHYSICAL PROPERTIES OF SOIL

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

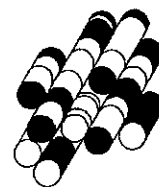
SITE 1

TERRAPROBE INC.



A1

TERRAPROBE INC.



RECORD OF BOREHOLE No RW1

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763366.8 E:327685.6 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.28.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
190.0	Ground Surface													
189.9	150mm TOPSOIL													
0.2	FILL - Silty Clay, trace sand, stiff to hard, brown, damp to moist		1	SS	8						○			
			2	SS	34		189				○			0 5 61 34
			3	SS	15		188				○			
			4	SS	17						○			
	----- frequent silt seams and partings -----		5	SS	10		187				○			
			6	SS	12		186				○			
			7	SS	18		185				○			0 3 54 43
			8	SS	17		184				○			
182.9	SILTY CLAY trace sand, hard, brown, damp to moist		9	SS	31		183				○			
7.1			10	SS	55		181				○	43		0 2 48 50
			11	SS	57		179				○			
178.8	End of Borehole													
11.2	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July 07.10 6.3 183.7 July 14.10 6.3 183.7 July 21.10 6.2 183.8													

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

ON_MOT_1-09-4135 RW RET WALLS.GPJ ON_MOT.GDT 9/3/10

RECORD OF BOREHOLE No RW2

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763410.3 E:327684.3 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.29.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)		
191.0	Ground Surface												
190.9	150mm TOPSOIL												
0.2	FILL - Silty Sand, trace organics, compact, brown, moist to wet		1	SS	23								
190.3													
0.7	FILL - Silty Clay, trace sand, stiff to very stiff, brown, damp to moist		2	SS	24		190						
			3	SS	21								
							189						
			4	SS	15								
							188						0 2 61 37
			5	SS	11								
	some gravel		6	SS	11		187						
			7	SS	9								10 5 54 31
							186						
							185	1.0	2.0				
			8	SS	15								
							184						
183.1	topsoil stained		9	SS	32		183						
7.9	SILTY CLAY trace sand, hard, brown, damp to moist						182						
			10	SS	39								
							181						
179.8			11	SS	41		180						0 4 52 44
11.2	End of Borehole												
	Borehole was dry (not stabilized) and hole open to 10.4m on completion.												

+³, X³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ON MOT 1-09-4135 RW/RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No RW3

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763453.1 E:327683.4 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.29.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
191.8	Ground Surface							20 40 60 80 100						
191.6	200mm TOPSOIL							20 40 60 80 100						
0.2	FILL - Silty Clay, trace sand, occasional gravel inclusions, firm to hard, brown, damp to moist		1	SS	15		191							
			2	SS	38									
			3	SS	16		190							0 5 61 34
			4	SS	10									
			5	SS	7		189							
														0 2 63 35
			6	SS	7		188							
	SILTY CLAY trace to some sand, very stiff to hard, brown, damp to moist		7	SS	7		187							
							186							
							185							
			8	SS	13		184							
183.2							183							0 10 49 41
8.6			9	SS	26		182							
							181							
180.6	End of Borehole		10	SS	30									
11.2	Sampler wet at 4.6m. Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.07.10 8.3 183.5 July.14.10 6.6 185.2 July.21.10 7.1 184.7 July.28.10 7.0 184.8													

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

ON_MOT_1-09-4135 RW RET WALLS.GPJ ON_MOT.GDT 9/3/10

RECORD OF BOREHOLE No RW4

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763494.5 E:327678.7 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.30.10 CHECKED BY RA

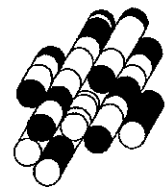
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
191.5	Ground Surface													
191.4	150mm TOPSOIL													
0.2	FILL - Silty Clay, trace sand, firm to hard, brown, damp to moist		1	SS	40		191							
			2	SS	47		190							
			3	SS	21		189							
			4	SS	13		188							0 5 61 34
			5	SS	8		187							
			6	SS	5		186							0 6 57 37
			7	SS	5		185							
			8	SS	14		184							
			9	SS	13		183							
182.9	SILTY CLAY trace sand, hard, brown, damp to moist		10	SS	54		182							0 1 43 56
8.6			11	SS	65		181							
180.3	End of Borehole													
11.2	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.07.10 dry - July.14.10 5.7 185.8 July.21.10 5.0 186.5 July.28.10 4.9 186.6													

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

ON MOT 1-09-4195 RW RET WALLS GPJ ON MOT GDT 9/3/10

B1

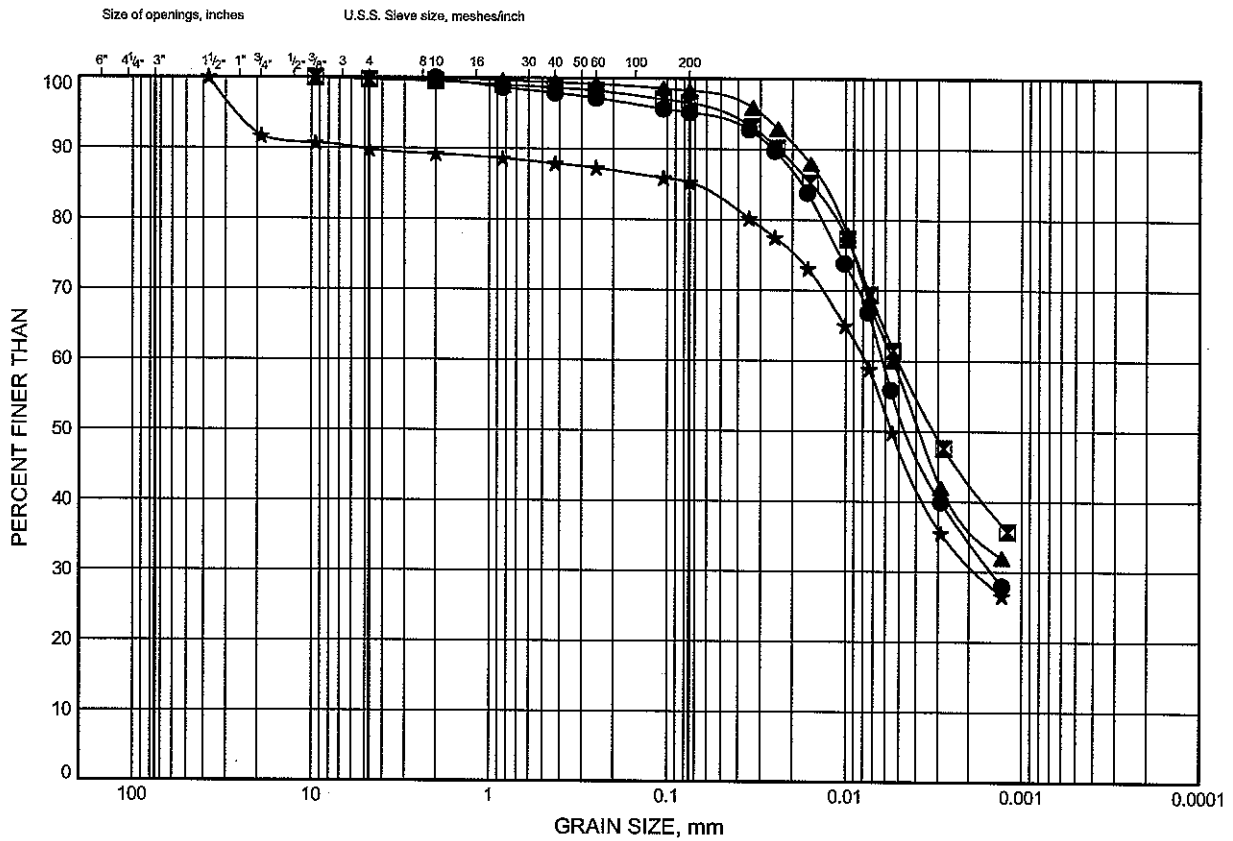
TERRAPROBE INC.



GRAIN SIZE DISTRIBUTION

FIGURE B1-1

FILL - Silty Clay



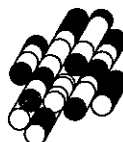
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	RW1	1.0	189.0
⊠	RW1	4.7	185.3
▲	RW2	2.5	188.5
★	RW2	4.0	187.0

Date August 2010

Project 1-09-4135



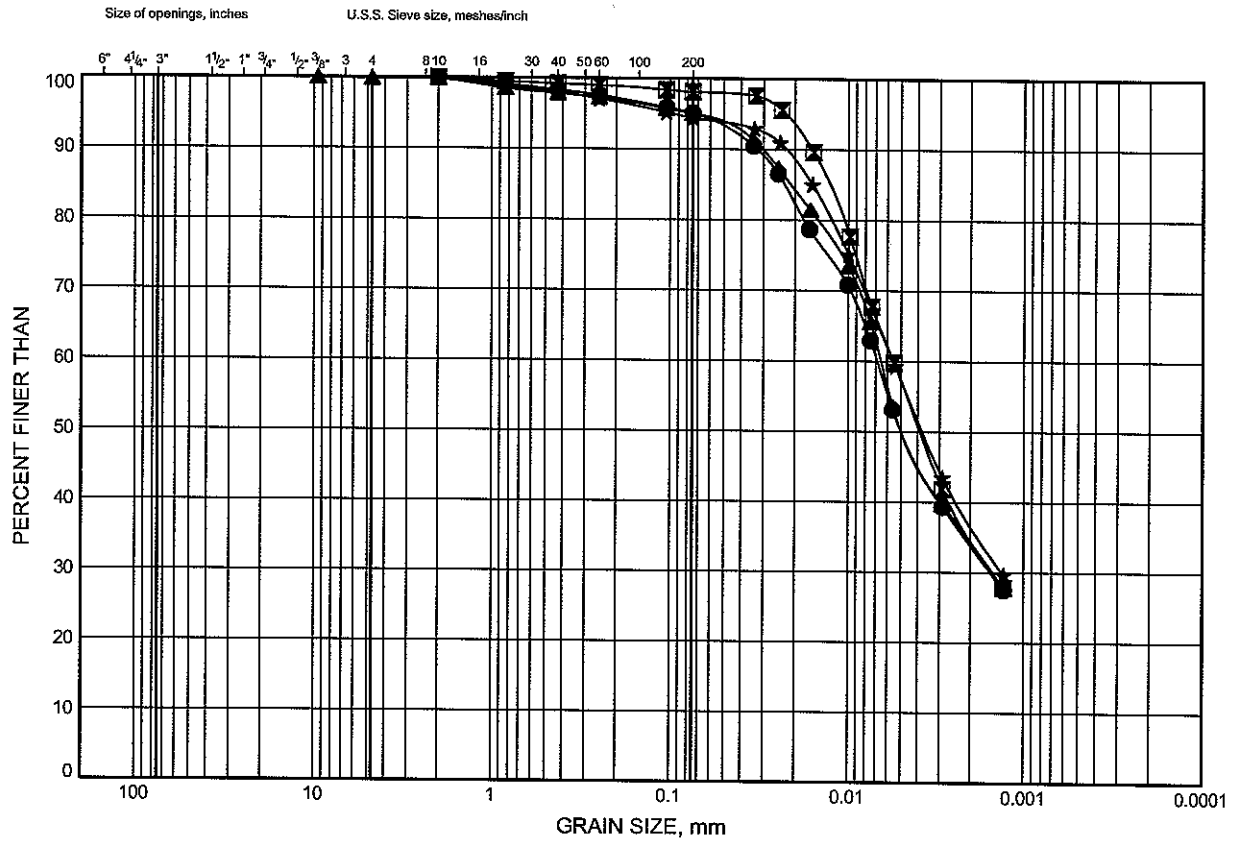
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B1-2

FILL - Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	RW3	1.7	190.1
■	RW3	3.2	188.6
▲	RW4	2.5	189.0
★	RW4	4.0	187.5

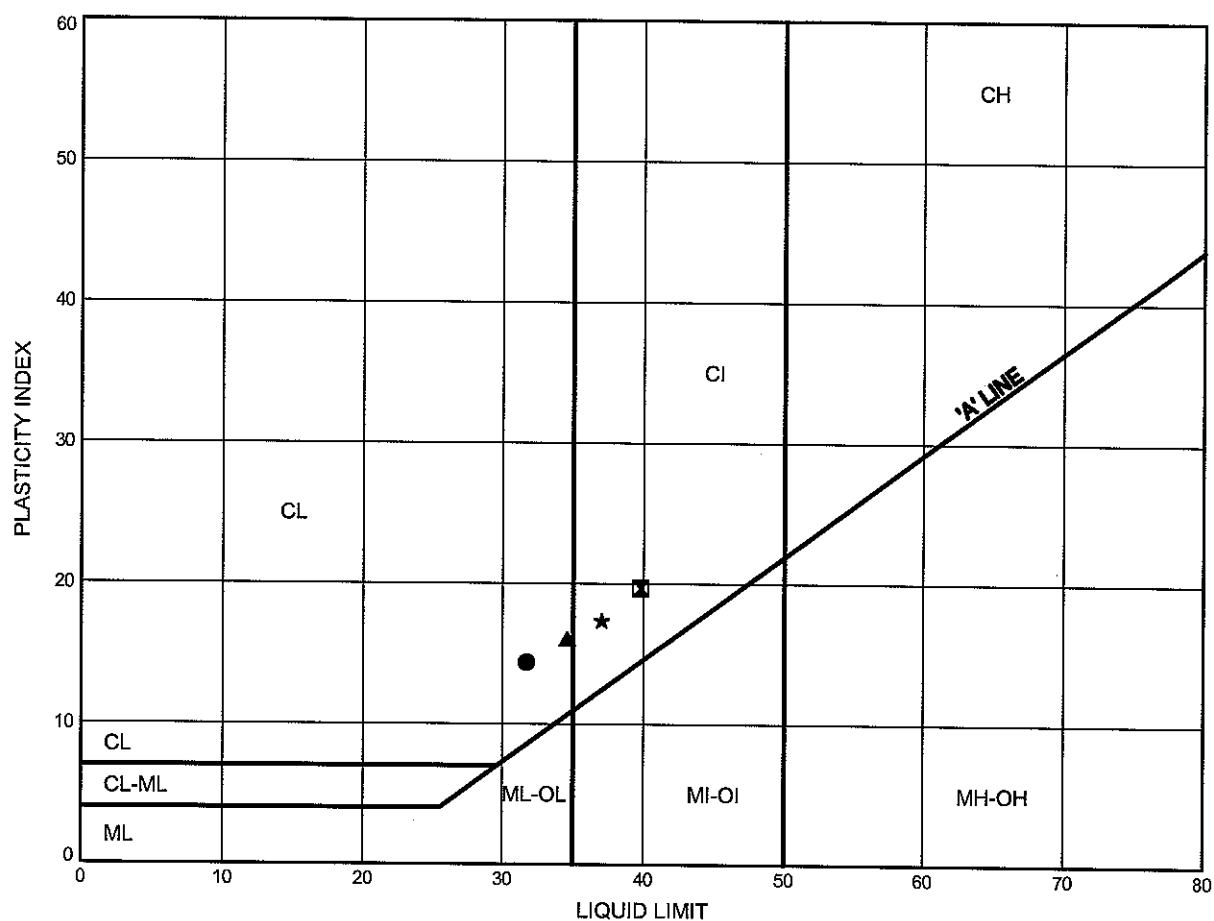
Date August 2010
Project 1-09-4135



Prep'd DB
Chkd. MP

FIGURE B1-3

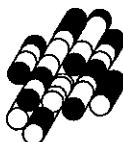
FILL - Silty Clay



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	RW1	1.0	189.0
☒	RW1	4.7	185.3
▲	RW2	2.5	188.5
★	RW2	4.0	187.0

Date August 2010.....

Project 1-09-4135...



Prep'dDB.....

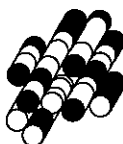
Chkd.MP.....

FIGURE B1-4

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	RW3	1.7	190.1
⊠	RW3	3.2	188.6
▲	RW4	2.5	189.0
★	RW4	4.0	187.5

Date August 2010

Project 1-09-4135

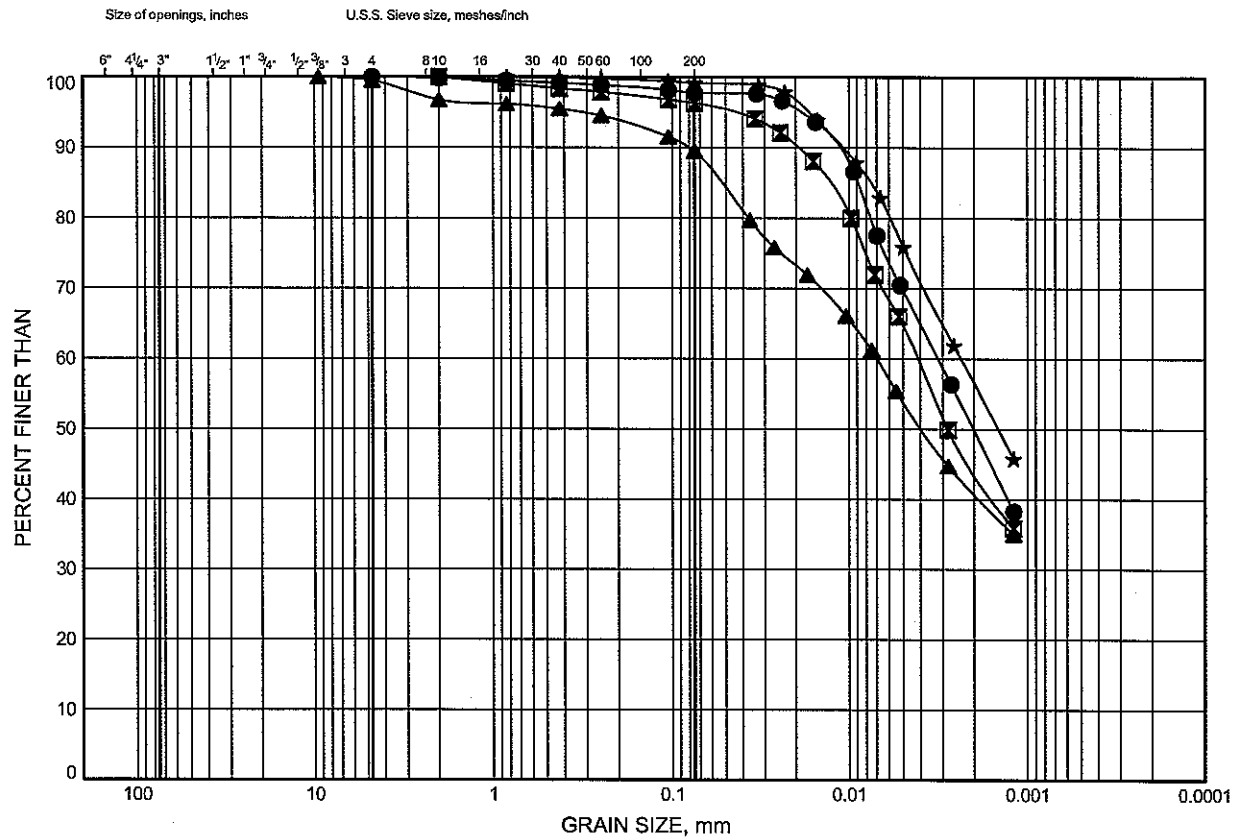
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B1-5

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	RW1	9.3	180.7
⊠	RW2	10.9	180.1
▲	RW3	9.3	182.5
★	RW4	9.3	182.2

Date August 2010
Project 1-09-4135

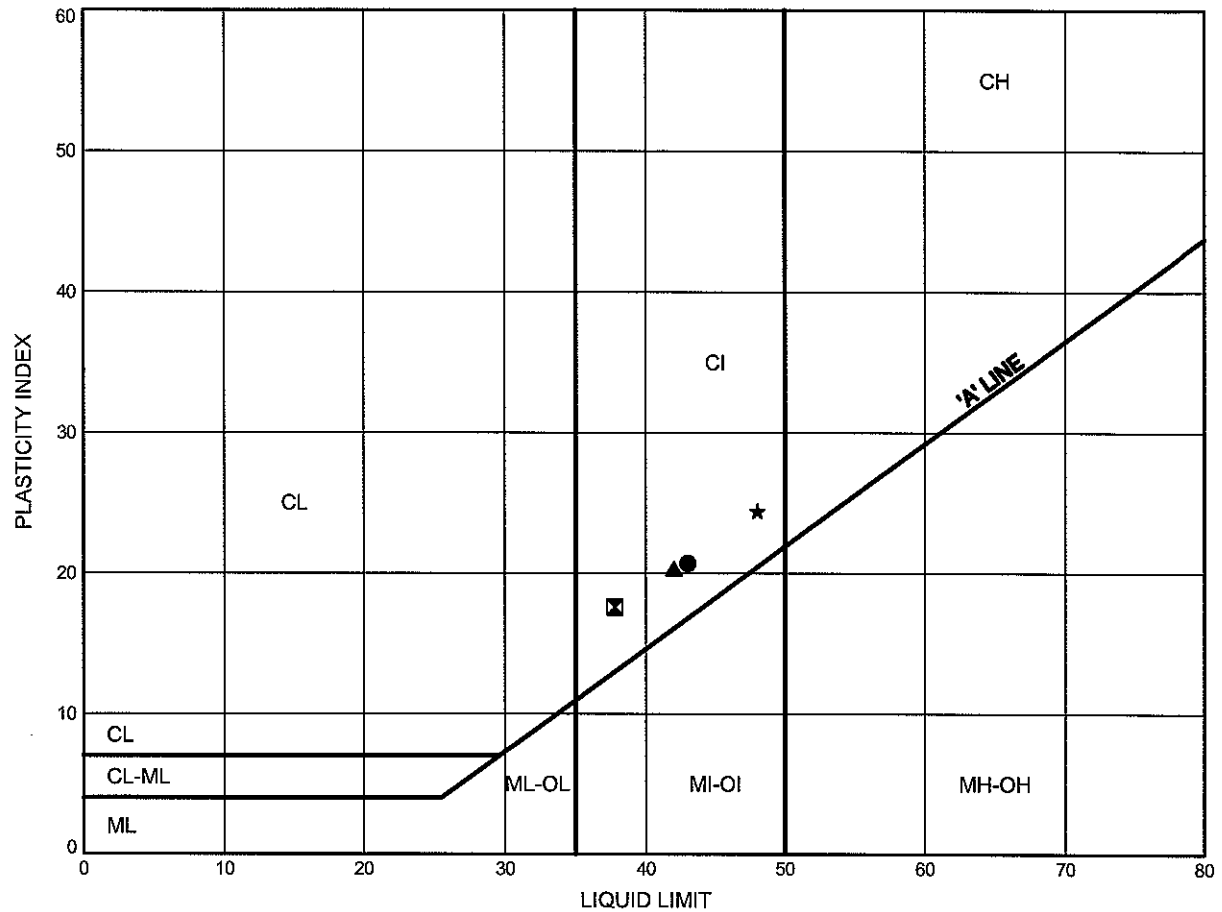


Prep'd DB
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

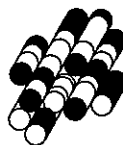
FIGURE B1-6

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	RW1	9.3	180.7
⊠	RW2	10.9	180.1
▲	RW3	9.3	182.5
★	RW4	9.3	182.2

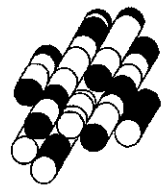
Date August 2010
Project 1-09-4135

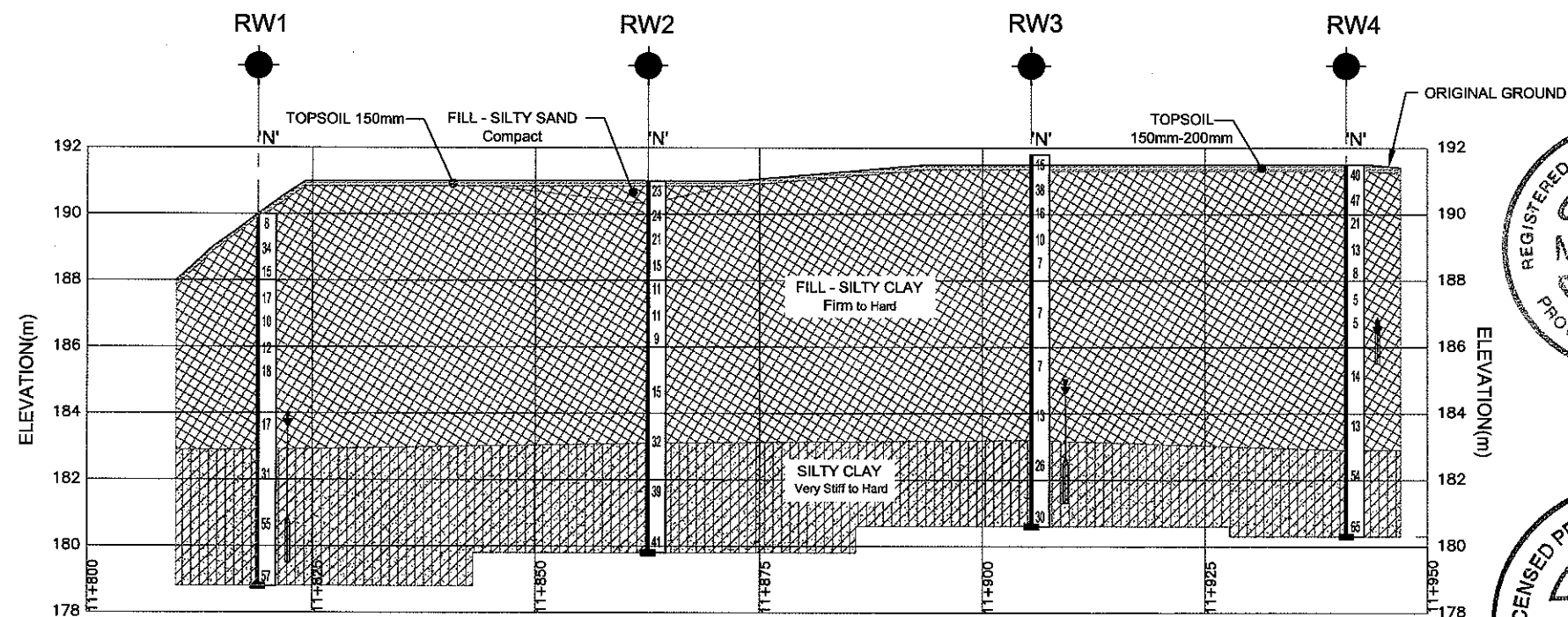
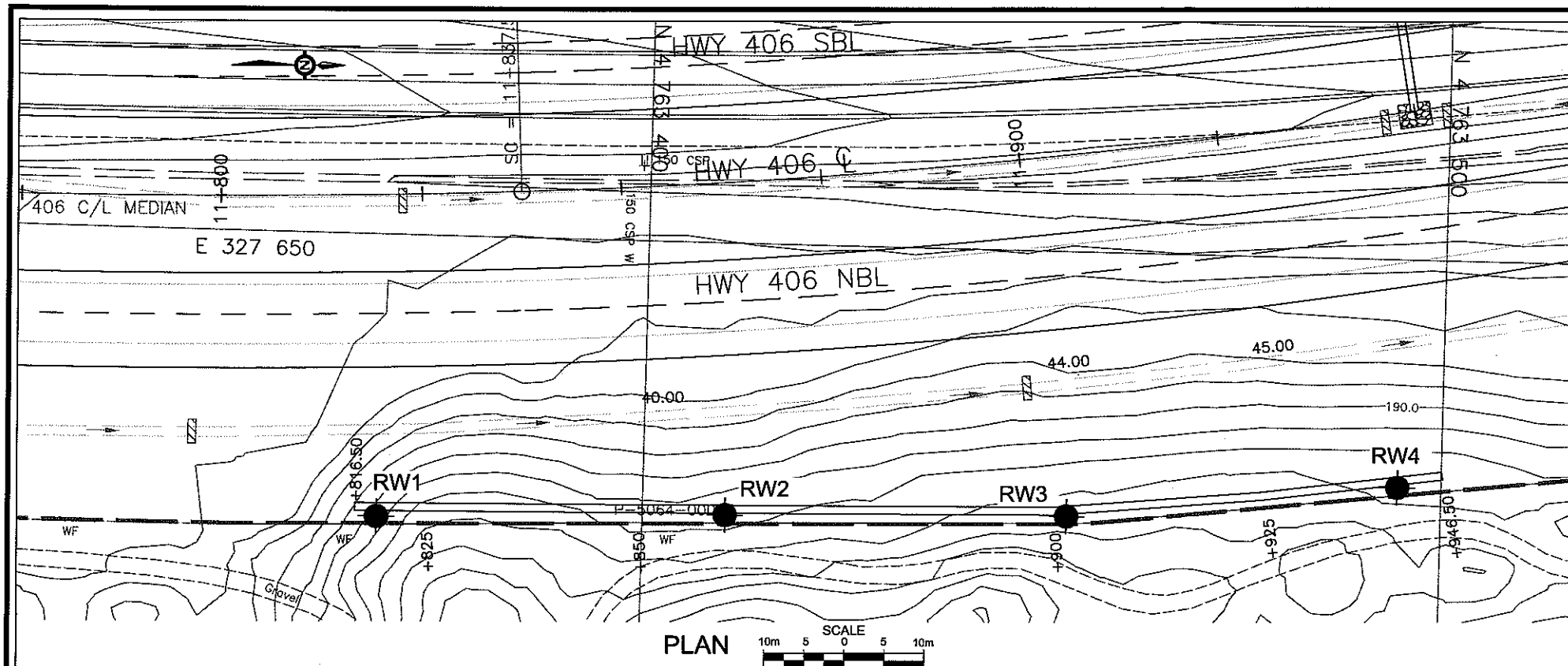


Prep'd DB
Chkd. MP

C1

TERRAPROBE INC.





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No 2011-2005
WP No 280-99-00

WP No 280-99-00

HIGHWAY 406

Sta. 11+816 to 11+947 RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

BOREHOLE LOCATIONS AND SOIL STRATA

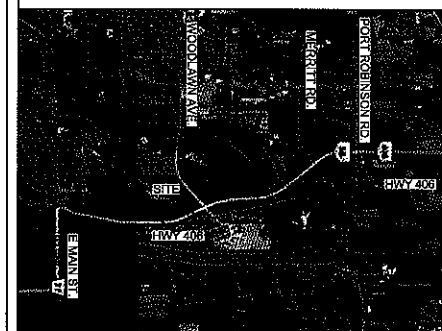


Terraprobe Inc.

10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650











10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650

10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650



KEY PLAN

LEGEND

	Bore Hole
	Dynamic Cone Penetration Test
	Bore Hole And Cone
	Blows/0.3m (Std Pen Test, 475 J/blow)
	Blows/0.3m (60' Cone, 475 J/blow)
	WL at Time of Investigation
	WL in Piezometer (JULY. 2010)
	Piezometer
	Rock Quality Designation
	Auger Refusal

	Dynamic Cone Penetration Test
---	-------------------------------

 Bore Hole And Cone

'N'	Blows/0.3m (Std Pen Test, 475 J/blow)
-----	---------------------------------------

CONE	Blows/0.3m (60° Cone, 475 J/blow)
------	-----------------------------------

$\frac{W}{L}$	WL at Time of Investigation
---------------	-----------------------------

WL in Piezometer (JULY. 2010)

	Piezometer
---	------------

90%	Rock Quality Designation
-----	--------------------------

A/R	Auger Refusal
-----	---------------

[illegible]

NOTE

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

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS					
	DATE	BY	DESCRIPTION		
DESIGN	R.A.	CODE	CHBOC2006	LOAD	DATE FEB. 2011
DRAWN	K.C.	CHK	R.A.	STRUCT	GEOCRES 30MS-265

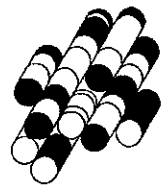


SHEET

A circular professional engineer seal for the Province of Ontario. The outer ring contains the text "LICENSED PROFESSIONAL ENGINEER" at the top and "PROVINCE OF ONTARIO" at the bottom. The center of the seal is divided into three horizontal sections. The top section contains the handwritten license number "24102". The middle section contains the name "R.A. ABDUL". The bottom section contains the expiration date "Feb 14/2011".

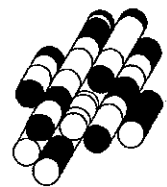
SITE 2

TERRAPROBE INC.



A2

TERRAPROBE INC.



RECORD OF BOREHOLE No TRW1

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763828.9 E:327437.2 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 6.24.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
183.2	Ground Surface							20 40 60 80 100						
183.0	230mm TOPSOIL							20 40 60 80 100						
0.2	FILL - Silty Clay, trace sand, trace organics, very stiff, dark brown, moist		1	SS	18		183							
182.5	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist occasional silt seams and partings		2	SS	40		182							
0.7			3	SS	64		181							
			4	SS	33		180							0 3 63 34
			5	SS	33		179							
			6	SS	29		178							
			7	SS	23		177							0 3 67 30
			8	SS	33		176							
			9	SS	27		175							
			10	SS	26		174							
			11	SS	31		173							
172.0	End of Borehole						172							0 3 66 31
11.2	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.05.10 1.5 181.7 July.12.10 1.6 181.6 July.19.10 1.9 181.3 July.28.10 2.2 181.0 Aug.06.10 2.4 180.8													

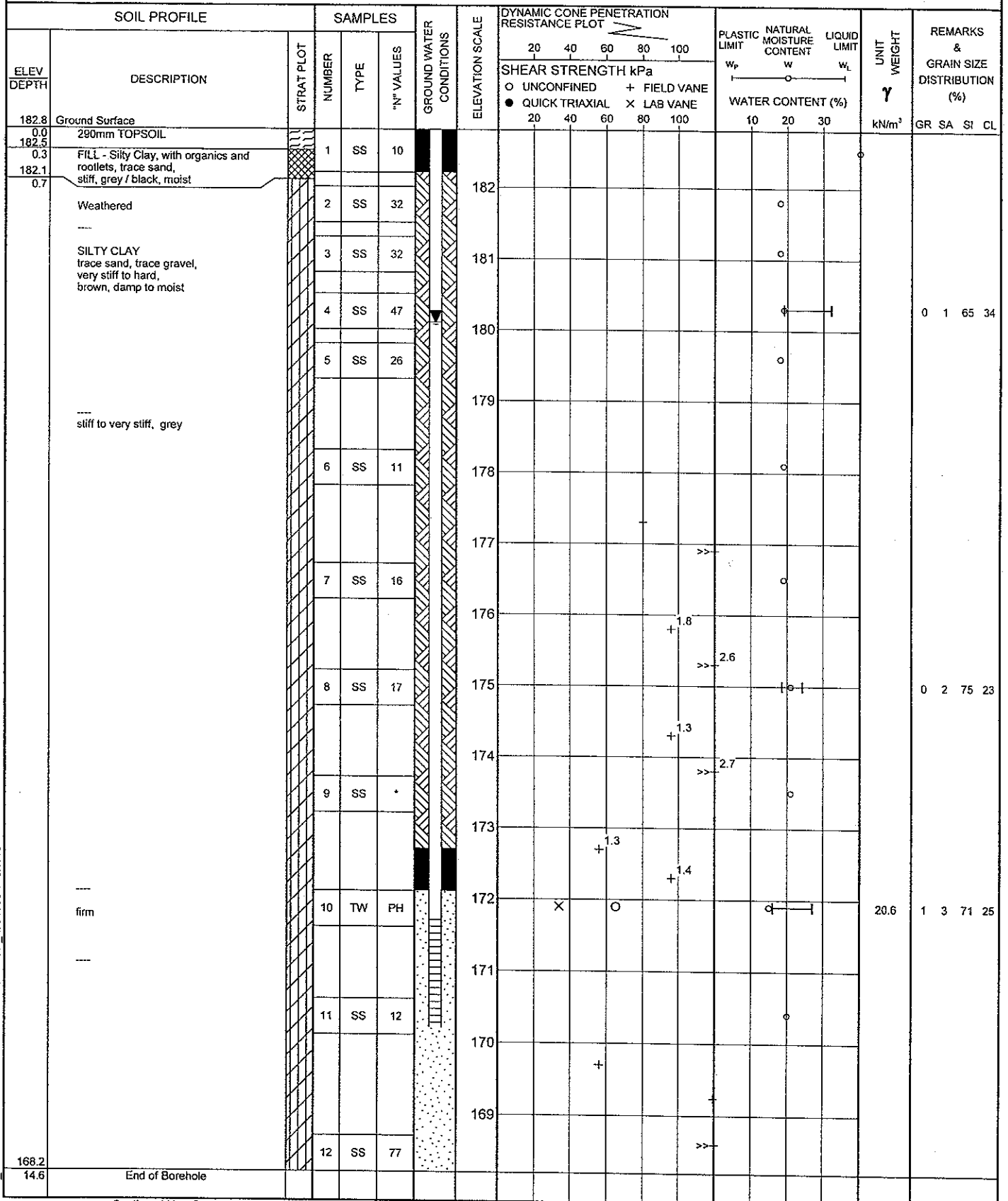
ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No WE-S 10+345CL

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763845.9 E:327457.4 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.4.09 CHECKED BY RA



Continued Next Page

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

RECORD OF BOREHOLE No WE-S 10+345CL

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763845.9 E:327457.4 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.4.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	60	80	100	W _p	W	W _L																					
	<p>* TW sampling attempted at 9.1m. No recovery, split spoon sample collected.</p> <p>Consolidation test performed on TW 10.</p> <p>Borehole was dry (not stabilized) and hole open to full depth on completion.</p> <p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>Water Level Readings:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth(m)</th> <th>Elevation(m)</th> </tr> </thead> <tbody> <tr> <td>Nov.19.09</td> <td>4.0</td> <td>178.8</td> </tr> <tr> <td>Nov.30.09</td> <td>3.4</td> <td>179.4</td> </tr> <tr> <td>Dec.07.09</td> <td>3.1</td> <td>179.7</td> </tr> <tr> <td>Dec.15.09</td> <td>3.0</td> <td>179.8</td> </tr> <tr> <td>Jan.11.10</td> <td>2.6</td> <td>180.2</td> </tr> <tr> <td>Jan.27.10</td> <td>2.7</td> <td>180.1</td> </tr> </tbody> </table>	Date	Depth(m)	Elevation(m)	Nov.19.09	4.0	178.8	Nov.30.09	3.4	179.4	Dec.07.09	3.1	179.7	Dec.15.09	3.0	179.8	Jan.11.10	2.6	180.2	Jan.27.10	2.7	180.1														
Date	Depth(m)	Elevation(m)																																		
Nov.19.09	4.0	178.8																																		
Nov.30.09	3.4	179.4																																		
Dec.07.09	3.1	179.7																																		
Dec.15.09	3.0	179.8																																		
Jan.11.10	2.6	180.2																																		
Jan.27.10	2.7	180.1																																		

RECORD OF BOREHOLE No TEW1

1 OF 3

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763851.9 E:327450.6

ORIGINATED BY MP

DIST HWY 406

BOREHOLE TYPE

Hollow Stem Augers / Casing and Washboring / NQ Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE

12.23.09 - 1.8.10

CHECKED BY RA

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 (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
182.5	Ground Surface																		
182.3	230mm TOPSOIL																		
0.2	FILL - Silty Clay, trace sand, trace organics, firm, brown, damp to moist		1	SS	7														
181.8																			
0.7	SILTY CLAY trace sand, occasional gravel inclusions, stiff to hard, brown, damp to moist		2	SS	27														
			3	SS	34														
			4	SS	54														
			5	SS	35														
			6	SS	31														
			7	SS	18														
			8	TW	PH														
			9	SS	22														
			10	SS	18														
			11	SS	16														
			12	SS	19														
			13	SS	32														

Continued Next Page

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

RECORD OF BOREHOLE No TEW1

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763851.9 E:327450.6 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.23.09 - 1.8.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
167.3 15.2	CLAYEY SILT TO SILTY CLAY sandy, trace to some gravel, hard, brown, damp (GLACIAL TILL)		14	SS	33		167							
			15	SS	79		166							11 30 43 16
	occasional cobbles		16	SS	170		165							commence casing and washboring
163.3 19.2	SAND and gravel, trace to some silt, very dense, grey, wet						164							Dec.23
162.5 20.0	CLAYEY SILT sandy, trace to some gravel, hard, brown, damp (GLACIAL TILL)		17	SS	94		163							Jan.05
161.2 21.3	SAND gravelly, trace clay, trace silt, dense to very dense, grey, wet		18	SS	70		162							
159.4 23.1	SILTY CLAY some gravel, trace to some sand, hard, brown, damp (GLACIAL TILL)		19	SS	34		161							32 56 10 2
158.3 24.2	SAND AND SILT some gravel, trace clay, occasional cobbles, very dense, brown, moist to wet (GLACIAL TILL)		20	SS	75		160							
			21	SS	99		159							15 40 38 7
			22	SS	125		158							
153.7 28.8	BEDROCK		1	RUN	NQ		157							Jan.05
							156							Jan.08
							155							RUN#1 TCR=88% SCR=78% RQD=48%
							154							
							153							

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

3 OF 3

METRIC

[illegible]

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No TEW2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763860.7 E:327455.5 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.18.09 - 12.22.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa														
								○ UNCONFINED + FIELD VANE														
								● QUICK TRIAXIAL × LAB VANE														
							20	40	60	80	100	WATER CONTENT (%)		10	20	30	GR	SA	SI	CL		
182.7	Ground Surface																					
182.4	300mm TOPSOIL		1	SS	8																	
0.3	FILL - Silty Clay, trace sand, trace organics, firm to stiff, brown, moist																					
182.0																						
0.7	SILTY CLAY trace sand, occasional gravel inclusions, stiff to hard, brown, damp to moist		2	SS	27		182															
			3	SS	28		181															
			4	SS	28		180															
			5	SS	42		179															
			6	SS	36		178															
			7	SS	14		177															
			8	SS	19		176															
			9	SS	17		175															
			10	SS	22		174															
			11	TW	PH		173															
			12	TW	PH		172															
			13	SS	21		171															
							170															
							169															
							168															
167.8																						

Continued Next Page

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

RECORD OF BOREHOLE No TEW2

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763860.7 E:327455.5 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.18.09 - 12.22.09 CHECKED BY RA

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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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14.9	CLAYEY SILT TO SILTY CLAY sandy, trace gravel, occasional cobbles, hard, brown, damp to moist (GLACIAL TILL) — sand and gravel, grey, wet —		14	SS	88																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

Continued Next Page

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

RECORD OF BOREHOLE No TEW2

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763860.7 E:327455.5 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.18.09 - 12.22.09 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE										
							20	40	60	80	100							

+ 3, X 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No TS1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763865.7 E:327459.1 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 1.11.10 - 1.13.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
182.6	Ground Surface						20	40	60	80	100					
0.0	380mm TOPSOIL						20	40	60	80	100					
182.2																
0.4	FILL - Silty Clay, some organics, trace sand, soft, black, moist		1	SS	2											
181.9																
0.7	SILTY CLAY trace sand, stiff to hard, brown, damp to moist		2	SS	20											
			3	SS	23											
			4	SS	37											
			5	SS	38											
			6	SS	26											
			7	SS	22											
			8	SS	24											
			9	SS	17											

Continued Next Page

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

2 OF 3

METRIC

[illegible]

ON_MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

Continued Next Page

+3, X3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SBL 12+360CL

1 OF 2

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763866.5 E:327470.3

ORIGINATED BY AW

DIST HWY 406

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY DB

DATUM Geodetic

DATE

11.17.09

CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100					
182.9	Ground Surface												
0.0	40mm TOPSOIL		1	SS	19								
182.2	FILL - Silty Clay, trace to some sand, trace gravel, trace organics, very stiff, dark brown, moist		2	SS	25								0 1 50 49
0.7	SILTY CLAY trace sand, stiff to very stiff, brown, moist		3	SS	14								
			4	SS	23								
			5	SS	18								0 1 52 47
			6	SS	15								
			7	SS	19								
			8	SS	12								0 3 65 32
			9	SS	10								
			10	TW	PH							20.7	0 2 74 24
			11	SS	21								0 1 83 16
170.2	End of Borehole												
12.7	Water level at 9.8m (not stabilized) and hole open to full depth on completion. Consolidation test performed on TW 10.												

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No SBL 12+360CL

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763866.5 E:327470.3 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 11.17.09 CHECKED BY RA

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 60 80 100	20 40 60 80 100					
	Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Nov.19.09 5.0 177.9 Nov.30.09 2.6 180.3 Dec.07.09 2.4 180.5 Dec.15.09 2.3 180.6 Jan.04.10 2.1 180.8 Jan.11.10 2.1 180.8													

RECORD OF BOREHOLE No TS2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763881.2 E:327466.3 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 11.30.09 - 12.8.09 CHECKED BY RA

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							WATER CONTENT (%)			
								○ UNCONFINED								+ FIELD VANE		
								● QUICK TRIAXIAL								× LAB VANE		
183.3	Ground Surface						20	40	60	80	100							
0.0	FILL - Silty Clay, trace sand, trace gravel, trace organics, stiff to very stiff, dark brown / brown, damp to moist		1	SS	12													
			2	SS	12													
			3	SS	21													
181.2	SILTY CLAY trace sand, trace gravel, very stiff to hard, brown, damp to moist ----- stiff to very stiff		4	SS	32											Nov.30		
2.1			5	SS	61											Dec.03		
			6	SS	25													
			7	SS	25													
			8	SS	21											1 3 66 30		
			9	SS	15													
			10	SS	13													
			11	SS	16											0 3 67 30		
			12	SS	14													
			13	SS	14													
		14	SS	18											7 1 66 26			
		15	TW	PH														

Continued Next Page

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

RECORD OF BOREHOLE No TS2

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763881.2 E:327466.3 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 11.30.09 - 12.8.09 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
168.1 15.2	SILTY CLAY trace to some sand, trace gravel, very stiff to hard, brown, damp to moist (GLACIAL TILL)		16	SS	22		168							8 15 50 27 Dec.03 Dec.04
			17	SS	26		167							
			18	SS	124		166							
	frequent wet sand and gravel inclusions		19	SS	47		165							
162.5 20.8	SAND gravelly, some silt, dense, brown, wet		20	SS	50		162							31 57 (12)
160.9 22.4	CLAYEY SILT and sand, trace gravel, very stiff, brown, damp (GLACIAL TILL)		21	SS	30		161							7 39 38 16
159.4 23.9	SAND gravelly, trace silt, dense, grey, moist to wet		22	SS	47		160							
			23	SS	61		159							Dec.04 Dec.07
157.1 26.2	CLAYEY SILT sandy, trace gravel, hard, brown, damp (GLACIAL TILL)		24	SS	77		157							
156.2 27.1	SAND AND GRAVEL some silt, trace to some clay, occasional cobbles, very dense, brown / grey, moist (GLACIAL TILL)		25	SS	155/ 18cm		156							Dec.07 Dec.08
153.9 29.4	BEDROCK						155							

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

METRIC

[illegible]

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

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

RECORD OF BOREHOLE No NBL 12+375Lt

1 OF 2

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763888.1 E:327476.6

ORIGINATED BY AW

DIST HWY 406

BOREHOLE TYPE

Hollow Stem Augers

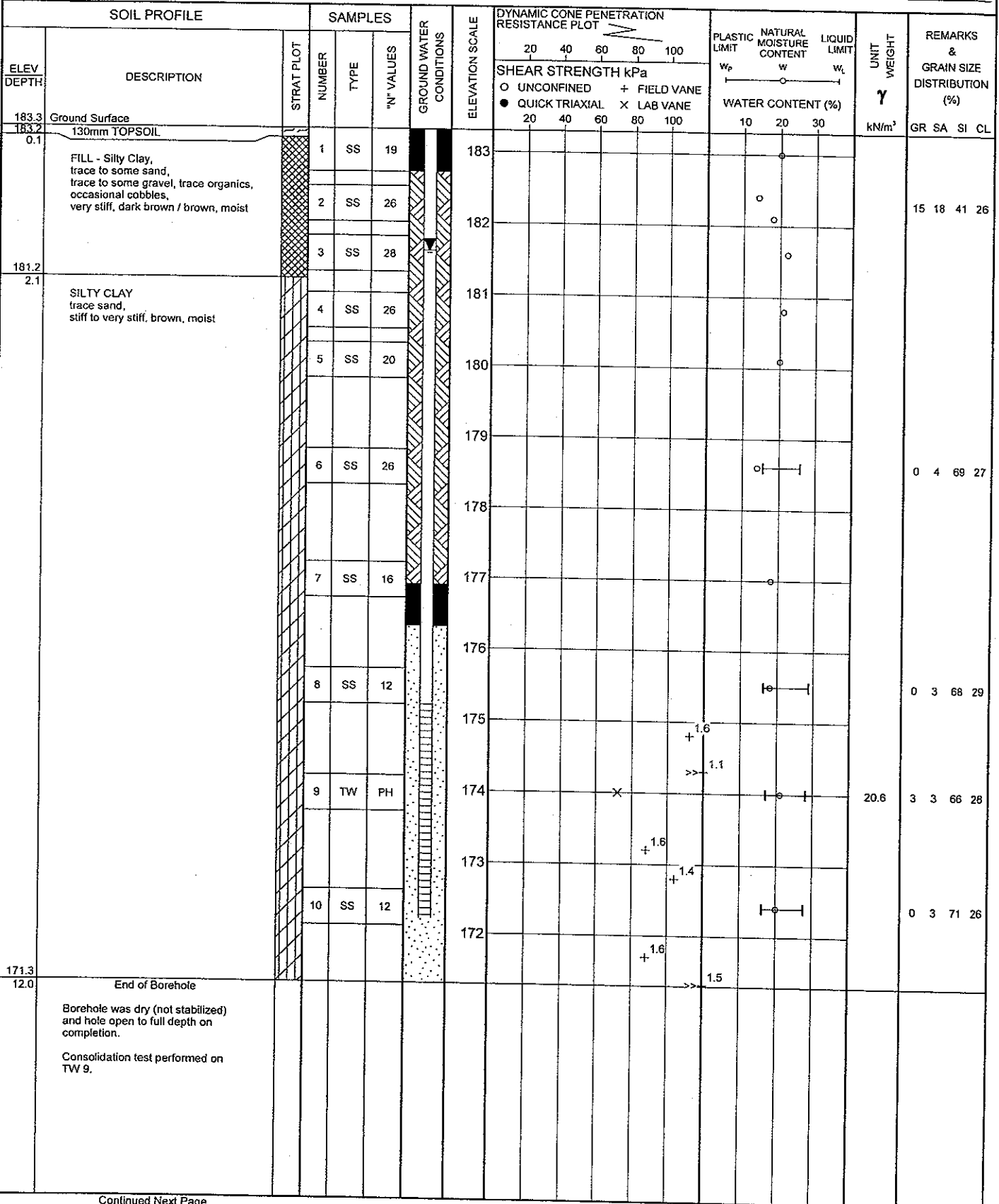
COMPILED BY DB

DATUM Geodetic

DATE

11.18.09

CHECKED BY RA



RECORD OF BOREHOLE No TN1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763901.9 E:327473.4 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)				
								UNCONFINED								FIELD VANE		QUICK TRIAXIAL	LAB VANE
								20	40							60	80		
183.5	Ground Surface							20	40	60	80	100							
0.1	50mm TOPSOIL		1	SS	16		183												
	FILL - Silty Sand, some gravel, trace organics, compact, black / brown, moist		2	SS	14											13 65 (22)			
182.1			3	SS	24		182												
1.4	SILTY CLAY trace sand, occasional gravel inclusions, stiff to hard, brown, damp to moist		4	SS	33		181									0 1 41 58			
			5	SS	36		180												
			6	SS	36		179									1 4 54 41			
			7	SS	21		178												
			8	SS	32		177												
			9	SS	22		176									0 2 68 30			
			10	SS	19		175									commence casing and washboring			
			11	SS	15		174												
			12	SS	20		173									1 7 69 23			
			13	TW	PH		172												
			14	SS	23		171												
168.8							170												
14.7							169												

Continued Next Page

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

RECORD OF BOREHOLE No TN1

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763901.9 E:327473.4 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

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								WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							× LAB VANE
								20 40 60 80 100	20 40 60 80 100	20 40 60 80 100							
	SILTY CLAY trace to some sand, trace gravel, very stiff to hard, brown, damp to moist (GLACIAL TILL)		15	SS	22		168							4 12 57 27			
			16	SS	133/ 28cm		167										
			17	SS	117		166										
							165										
163.8 19.7	SAND some silt, trace clay, trace gravel, very dense, grey, wet (GLACIAL TILL)		18	SS	60		164							Dec.10 Dec.11 7 72 15 6			
							163										
162.0 21.5	CLAYEY SILT trace to some gravel, trace sand, hard, brown, moist (GLACIAL TILL)		19	SS	77		162										
							161										
			20	SS	95		160										
159.6 23.9	SILTY SAND trace to some clay, trace gravel, very dense, brown, wet (GLACIAL TILL)		21	SS	73		159							4 51 28 17			
							158										
			22	SS	78		157										
156.6 26.9	CLAYEY SILT TO SILTY CLAY some gravel, trace to some sand, very stiff, brown, wet (GLACIAL TILL)		23	SS	19		156							Dec.11 Dec.14			
155.1 28.4	SILTY SAND some gravel, trace clay, very dense, brown, moist to wet (GLACIAL TILL)		24	SS	90		155										
							154										

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TN1

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763901.9 E:327473.4 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

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										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
153.0 30.5	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		1	RUN	NQ		153									RUN#1 TCR=95% SCR=87% RQD=59% RUN#2 TCR=93% SCR=83% RQD=67%				
			2	RUN	NQ		151													
150.0 33.6	End of Borehole						150													
	Borehole open to full depth and filled with drill water upon completion of drilling. Unable to push vane to 16.4m and 28.6m. Borehole sealed with bentonite slurry to ground surface.																			

RECORD OF BOREHOLE No TN2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763920.1 E:327481.1 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.5.10 - 2.17.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)						
184.2 0.0	Ground Surface						20 40 60 80 100				10 20 30			GR SA SI CL	
183.4 0.8	800mm FILL - Sandy Gravel, trace silt, very dense, grey, dry		1	SS	19										
			2	SS	35									13 12 53 22	
	FILL - Silty Clay, trace to some sand, trace to some gravel, trace organics, very stiff to hard, brown / dark brown, damp to moist		3	SS	18										
182.1 2.1			4	SS	37										
	SILTY CLAY trace sand, occasional gravel inclusions, stiff to hard, brown, damp to moist		5	SS	42								43	0 2 44 54	
			6	SS	32									Jan.26	
			7	SS	19									Feb.05	
			8	SS	21										
			9	SS	17									0 2 60 38	
			10	SS	19										
			11	SS	10									0 5 65 30	
			12	SS	11										
			13	TW	PH										
	firm		14	SS	16									1 3 72 24	
169.5 14.7															

Continued Next Page

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

RECORD OF BOREHOLE No TN2

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763920.1 E:327481.1 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.5.10 - 2.17.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
								UNCONFINED + FIELD VANE													
								● QUICK TRIAXIAL x LAB VANE													
							20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	WATER CONTENT (%)						
							20	40	60	80	100	10	20	30							
163.5 20.7	SILTY CLAY trace sand, trace gravel, stiff to very stiff, brown, damp (GLACIAL TILL)		15	SS	14		169								○	├──┤		2	9	63	26
							168														
			16	SS	16		167								○						
							166														
			17	SS	26		165								○						Feb.05
							164														Feb.12
							163														
			18	SS	70		162								○						
							161								○						
160.3 23.9	SAND some silt, trace to some gravel, trace clay, very dense, brown, moist to wet (GLACIAL TILL)		19	SS	61		160														
							159														
			20	SS	30		158														
							157														
			21	SS	29		156														11 39 38 12
							155														
			22	SS	38																
															○						
155.8 28.4	GRAVEL AND SAND some silt, trace clay, compact, brown, moist (GLACIAL TILL)		23	SS	23																
															○						39 36 18 7

Continued Next Page

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

RECORD OF BOREHOLE No TN2

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763920.1 E:327481.1 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.5.10 - 2.17.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED	○ UNCONFINED	○ UNCONFINED	○ UNCONFINED	○ UNCONFINED						○ UNCONFINED
153.7			24	SS	100/ 15cm												Feb. 12	
30.5	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		1	RUN	NQ												Feb. 17	
			2	RUN	NQ													RUN#1 TCR=0% SCR=0% RQD=0%
			3	RUN	NQ													RUN#2 TCR=71% SCR=66% RQD=16%
			4	RUN	NQ													RUN#3 TCR=100% SCR=78% RQD=44%
150.1	End of Borehole																RUN#4 TCR=93% SCR=92% RQD=54%	
34.1	Borehole filled with drill water upon completion of drilling. No sample recovery at SS9. Sampler redriven and disturbed sample collected. Unable to push vane to 16.1m. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Apr.16.10 2.6 181.6 Apr.29.10 1.6 182.6 May.04.10 6.2 178.0 May.06.10 6.2 178.0																	

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No TSEW1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763922.8 E:327487.0 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 1.8.10 - 1.18.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
183.5	Ground Surface													
0.0	30mm TOPSOIL		1	SS	32		183				o			30 30 25 15
182.8	FILL - Sand and Gravel, silty, some clay, dense, moist to wet													
0.7	SILTY CLAY trace sand, trace gravel, stiff to hard, brown, damp to moist		2	SS	16		182				o			
			3	SS	27						o		50	0 3 40 57
			4	SS	40		181				o			
			5	SS	34		180				o			
			6	SS	34		179				o			0 2 66 32
			7	SS	42		178				o			
			8	SS	23		177				o			
			9	SS	24		176				o			1 3 70 26
			10	SS	21		175				o			
			11	SS	16		174				o			2 3 66 29
			12	TW	PH		173				o			
			13	SS	13		172				o			
			14	SS	13		171				o			1 2 70 27
168.8							170				o			
14.7							169				o			

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

2 OF 3

METRIC

LOCATION

Coords: N:4763922.8 E:327487.0

ORIGINATED BY AW

DIST _____ HWY 406

BOREHOLE TYPE

Hollow Stem Augers / Casing and Washboring / NQ Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE _____

1.8.10 - 1.18.10

CHECKED BY RA

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No TSEW1

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763922.8 E:327487.0 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.8.10 - 1.18.10 CHECKED BY RA

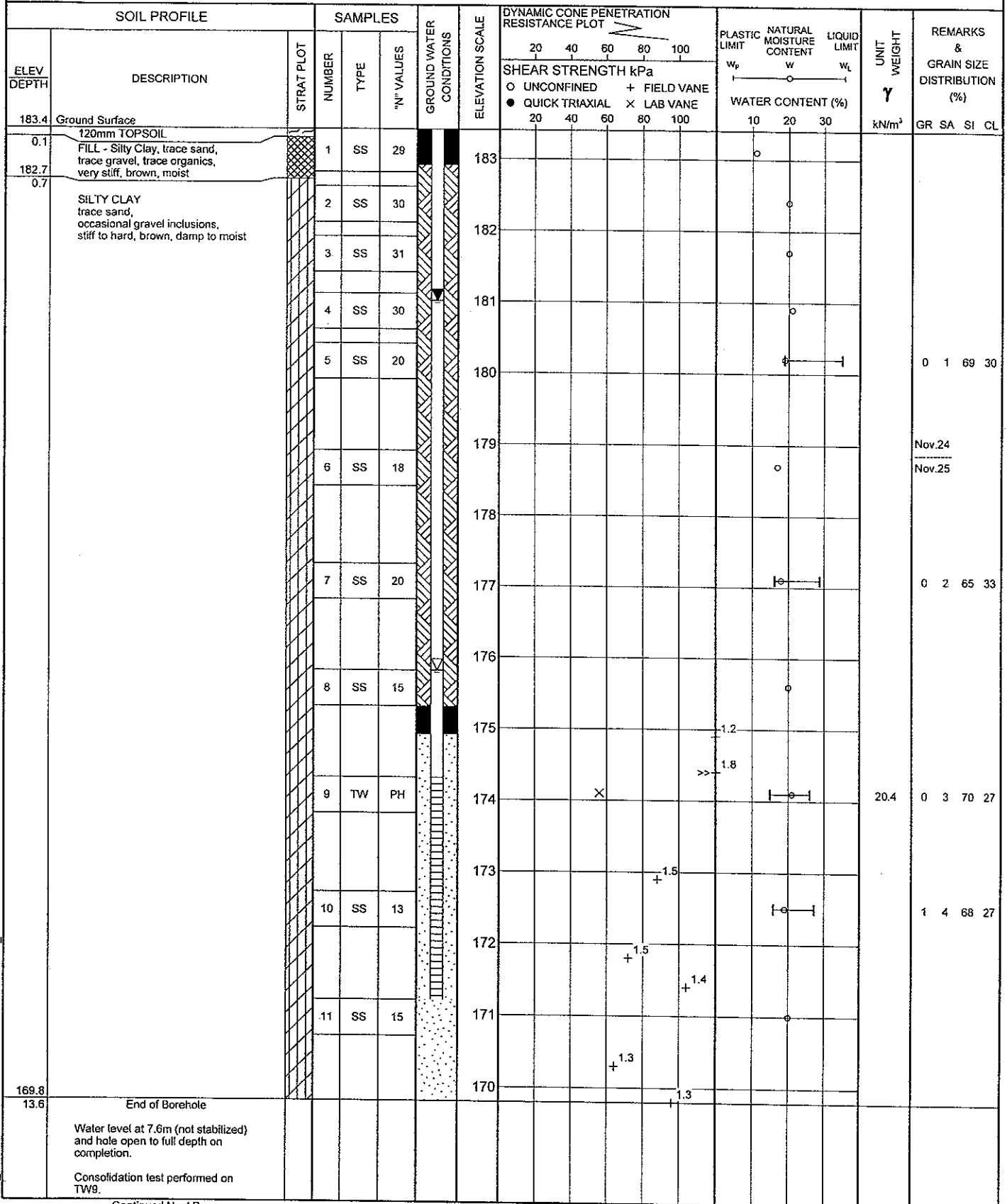
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE												
	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		1	RUN	NQ		153									RUN#1 TCR=89% SCR=75% RQD=54% RUN#2 TCR=93% SCR=81% RQD=52%				
			2	RUN	NQ		152													
150.8							151													
32.7			End of Borehole																	
	Borehole sealed with bentonite slurry to ground surface.																			
	No sample recovery at SS16 and SS17. Sampler redriven and disturbed sample collected.																			
	Resistance to augering at 19.8m and 23.8m.																			
	Unable to push vane beyond 6.6m and 15.7m and 26.4m.																			

RECORD OF BOREHOLE No S-EW 10+050CL

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763920.4 E:327494.1 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.24.09 - 11.25.09 CHECKED BY RA



Continued Next Page

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

RECORD OF BOREHOLE No S-EW 10+050CL

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763920.4 E:327494.1 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.24.09 - 11.25.09 CHECKED BY RA

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																							
	<p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen.</p> <p>Water Level Readings:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth(m)</th> <th>Elevation(m)</th> </tr> </thead> <tbody> <tr> <td>Dec.08.09</td> <td>2.4</td> <td>181.0</td> </tr> <tr> <td>Dec.15.09</td> <td>2.4</td> <td>181.0</td> </tr> <tr> <td>Jan.04.10</td> <td>2.4</td> <td>181.0</td> </tr> <tr> <td>Jan.11.10</td> <td>2.4</td> <td>181.0</td> </tr> </tbody> </table>	Date	Depth(m)	Elevation(m)	Dec.08.09	2.4	181.0	Dec.15.09	2.4	181.0	Jan.04.10	2.4	181.0	Jan.11.10	2.4	181.0															
Date	Depth(m)	Elevation(m)																													
Dec.08.09	2.4	181.0																													
Dec.15.09	2.4	181.0																													
Jan.04.10	2.4	181.0																													
Jan.11.10	2.4	181.0																													

RECORD OF BOREHOLE No TSEW2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763936.1 E:327490.9 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 1.5.10 - 1.7.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
183.3 0.0	Ground Surface													
182.6 0.7	FILL - Sand, some gravel, some silt, compact, brown, wet		1	SS	25		183							10 76 (14)
			2	SS	26		182						58	0 1 43 56
	SILTY CLAY trace sand, occasional gravel inclusions, stiff to hard, brown, moist		3	SS	40		181							
			4	SS	31		180							0 2 37 61
			5	SS	26		179							
			6	SS	24		178							
			7	SS	22		177							
	dark brown		8	SS	25		176							
			9	SS	20		175							0 2 68 30
			10	TW	PH		174							commence casing and washboring
			11	SS	12		173							1 3 66 30
			12	SS	22		172							Jan.05
			13	SS	23		171							Jan.06
	reddish brown		14	SS	13		170							
168.6 14.7							169							

Continued Next Page

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

METRIC

SOIL PROFILE						DYNAMIC CONE PENETRATION RESISTANCE PLOT	SHEAR STRENGTH kPa	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER TYPE "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE					
162.9 20.4	SILTY CLAY TO CLAYEY SILT trace to some sand, trace gravel, occasional cobbles, hard, brown, damp to moist (GLACIAL TILL)	[Pattern]	15 SS 36	[Water Level]	168	>>	o			
			16 SS 74		167		o			
			17 SS 70		166		o			
			18 SS 129		165		o			
			19 SS 76		164		o			
			20 SS 52		163		o			
			21 SS 104		162		o			
157.9 25.4	SILTY CLAY trace sand, trace gravel, occasional cobbles, hard, reddish brown, moist (GLACIAL TILL)	[Pattern]	22 SS 33		161		o			3 2 63 32
156.4 26.9	SAND AND GRAVEL silty, trace clay, occasional cobbles, compact to very dense, grey, moist to wet (GLACIAL TILL)	[Pattern]	23 SS 29		160		o			
			24 SS 100/ 10cm		159		o			
153.7 29.6	BEDROCK	[Pattern]			158					

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TRW2

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763963.4 E:327497.0 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 7.5.10 - 7.6.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
182.5	Ground Surface																
0.1	80mm TOPSOIL																
	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		1	SS	17												
			2	SS	28											0 1 53 46	
			3	SS	52												
			4	SS	58												
			5	SS	37												
			6	SS	31											0 5 61 34	
	----- frequent silt seams and partings -----		7	SS	28												
			8	SS	25												
			9	SS	28											0 3 67 30	
			10	TW	PH												
			11	SS	20											Jul.05 Jul.06	
			12	SS	19												
			13	SS	35											0 5 68 27	
168.3	End of Borehole																
14.2	Unable to push vane beyond 10.1m.																

Continued Next Page

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

RECORD OF BOREHOLE No TRW2

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763963.4 E:327497.0 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 7.5.10 - 7.6.10 CHECKED BY RA

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								
	<p>Borehole was dry (not stabilized) and hole open to full depth on completion.</p> <p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>Water Level Readings: Date Depth(m) Elevation(m) July.12.10 2.8 179.7 July.19.10 2.9 179.6</p>															

RECORD OF BOREHOLE No TRW3

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763855.8 E:327427.4 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.29.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
183.1	Ground Surface														
0.1	80mm TOPSOIL		1	SS	8		183								0 8 52 40
182.4	FILL - Silty Clay, trace sand, trace organics, firm to stiff, brown / black stained, moist		2	SS	41		182								
0.7	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		3	SS	35		181								
			4	SS	40		180								
			5	SS	35		179								
			6	SS	35		178								
			7	SS	22		177								0 3 69 28
			8	SS	27		176								
			9	TW	PH		175								
	occasional gravel inclusions		10	SS	17		174								
			11	SS	17		173								
			12	SS	37		172								2 4 70 24
			13	SS	27		171								
168.4							170								
14.7							169								

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

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

2 OF 2

METRIC

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

RECORD OF BOREHOLE No TEW3

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763877.2 E:327436.9 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.7.09 - 12.10.09 CHECKED BY RA

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60						80	100
182.6	Ground Surface																
0.1	120mm TOPSOIL		1	SS	8		182										
181.9	FILL - Silty Clay, trace sand, trace organics, firm to stiff, brown, moist																
0.7	SILTY CLAY trace sand, occasional gravel inclusions, very stiff to hard, brown, damp to moist		2	SS	33		181										
			3	SS	26												
			4	SS	31		180										
			5	SS	25												
			6	SS	33		179										
			7	SS	26		178										
			8	SS	31		177										
			9	SS	33		176										
			10	SS	38		175										
							174										
			11	SS	32		173										
			12	SS	23		172										
			13	TW	PH		171										
							170										
			14	SS	22		169										
							168										

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TEW3

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763877.2 E:327436.9 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.7.09 - 12.10.09 CHECKED BY RA

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						
						20	40	60	80	100				
166.8 15.8	CLAYEY SILT TO SILTY CLAY some sand to sandy, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		15	SS	26									
			16	SS	61									4 13 62 21
			17	SS	42									
			18	SS	38									
		19	SS	31									5 30 46 19	
													Dec.07	
													Dec.08	
		20	SS	38										
157.9 24.7	SILTY SAND some gravel to gravelly, trace clay, compact to dense, brown, damp to moist (GLACIAL TILL)		21	SS	100/ 13cm									
			22	SS	29									
		23	SS	38									25 38 29 8	
													Dec.08	
													Dec.09	
153.7 28.9	BEDROCK		1	RUN	NQ								RUN#1 TCR=52% SCR=40% RQD=0%	
													RUN#2 TCR=95% SCR=83% RQD=49%	

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

Continued Next Page

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

RECORD OF BOREHOLE No TEW3

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763877.2 E:327436.9 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.7.09 - 12.10.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		2	RUN	NQ												
			3	RUN	NQ												
150.5 32.1	End of Borehole Water level at 15.2m (not stabilized) on completion of overburden sampling. Unable to push vane beyond 15.1m and 16.5m. Borehole sealed with bentonite slurry to ground surface.															RUN#3 TCR=98% SCR=83% RQD=28%	

RECORD OF BOREHOLE No TEW4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763885.4 E:327439.2 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.15.09 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE				
182.6	Ground Surface														
0.1	110mm TOPSOIL		1	SS	9										
181.9	FILL - Silty Clay, trace sand, trace organics, stiff, brown, moist														
0.7	SILTY CLAY trace sand, occasional gravel inclusions, very stiff to hard, brown, damp to moist		2	SS	47										0 2 58 40
			3	SS	55										
			4	SS	49										
			5	SS	55										
			6	SS	42										
			7	SS	41										0 3 67 30
			8	SS	30										
			9	SS	30										
			10	SS	24										
			11	SS	24										0 7 69 24
			12	SS	12										Dec.10 Dec.11
			13	SS	19										
			14	TW	PH										
168.0															
14.6															

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

ON MOT -09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TEW4

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763885.4 E:327439.2 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.10.09 - 12.15.09 CHECKED BY RA

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 × LAB VANE	WATER CONTENT (%) 20 40 60 80 100					
	CLAYEY SILT TO SILTY CLAY some sand to sandy, trace to some gravel, occasional cobbles, very stiff to hard, brown, damp to moist (GLACIAL TILL)		15	SS	30		167							5 17 58 20
			16	SS	100/ 0cm		166							commence casing and washboring
			17	SS	70		164							
			18	SS	78		162							
			19	SS	60		161							
			20	SS	68		160							
			21	SS	87		158							
			22	SS	34		156							
			23	SS	100/ 14cm		155							
157.8 24.8	SILTY SAND some gravel to gravelly, trace clay, occasional cobbles, dense to very dense, brown, damp to moist (GLACIAL TILL)						154							
153.9 28.7	frequent cobbles		1	RUN	NQ									
	BEDROCK		2	RUN	NQ		153							

RUN#1
TCR=50%
SCR=40%
RQD=13%

RUN#2
TCR=71%
SCR=57%
RQD=0%

Continued Next Page

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


ON_MOT_1-09-4135 TRW RET WALLS.GPJ ON_MOT.GDT 9/7/10

RECORD OF BOREHOLE No TEW4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763885.4 E:327439.2 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.15.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
151.2	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE. Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		3	RUN	NQ		152										RUN#3 TCR=100% SCR=74% RQD=22%
31.4	End of Borehole Borehole filled with drill water upon completion of coring. Unable to push vane beyond 14.9m. No sample recovery at SS10, SS16, SS20, SS21, SS23. Sampler redriven and disturbed sample collected. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Jan.11.10 10.2 172.4 Jan.19.10 10.6 172.0 Jan.27.10 10.5 172.1 Feb.08.10 10.6 172.0																

RECORD OF BOREHOLE No WE-S 10+295CL

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763889.2 E:327432.2 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.4.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
182.8	Ground Surface						20	40	60	80	100						
0.0	FILL - Silty Clay, trace sand, stiff to very stiff, brown, damp to moist		1	SS	8									○			
			2	SS	27									○			
181.4														○			
1.4	SILTY CLAY trace sand, trace gravel, very stiff to hard, brown, damp to moist		3	SS	32									○			
			4	SS	45									○	—	0 3 66 31	
			5	SS	40									○			
			6	SS	67									○			
			7	SS	32									○			
	---- grey																
			8	SS	33									○			
			9	SS	37									○	—	2 4 66 28	
			10	TW	PH							>>X		○	—	20.8 0 3 73 24	
			11	SS	17									○			
171.6																	
11.2	End of Borehole																
	Borehole was dry (not stabilized) and hole open to full depth on completion.																
	Consolidation test performed on TW 10.																

RECORD OF BOREHOLE No TS3

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763891.8 E:327445.1 ORIGINATED BY LY
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.15.09 - 12.16.09 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
182.5	Ground Surface													
0.0	FILL - Silty Clay, trace sand, trace gravel, trace organics, firm, brown, moist		1	SS	5		182							
181.8														
0.7	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		2	SS	46									
			3	SS	39		181							0 2 36 62
			4	SS	32									
			5	SS	36		180							
			6	SS	44									
			7	SS	46		179							
			8	SS	28									
			9	SS	29		178							0 6 61 33
			10	SS	19		177							
							176							0 3 64 33
							175							
							174							Dec.15
														Dec.16
			11	TW	PH		173							
							172							
			12	SS	18									0 3 69 28
							171							
			13	SS	18									
							170							
							169							
			14	SS	26									
							168							
167.8														
14.7														

Continued Next Page

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

ON MOT. 1-09-4135 TRW/RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TS3

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763891.8 E:327445.1 ORIGINATED BY LY
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.15.09 - 12.16.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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										
								20 40 60 80 100										
○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE								PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	WATER CONTENT (%)							
20 40 60 80 100								10	20	30								
	CLAYEY SILT TO SILTY CLAY some sand to sandy, trace to some gravel, occasional cobbles, hard, brown, damp (GLACIAL TILL)		15	SS	73		167											
							166											
			16	SS	83													
							165											
			17	SS	66		164										20 25 40 15	
							163											
			18	SS	53		162											
161.7 20.8	SAND gravelly, trace silt, very dense, grey, moist		19	SS	82		161											
160.6 21.9	CLAYEY SILT trace sand, trace gravel, occasional cobbles, very stiff, brown, damp (GLACIAL TILL)		20	SS	21		160											
159.1 23.4	SAND and gravel, trace silt, very dense, grey, moist						159											
157.7 24.8	SILTY CLAY trace sand, trace gravel, occasional cobbles, hard, brown, moist (GLACIAL TILL)		21	SS	83		158											
156.2 26.3	SANDY GRAVEL some silt, trace clay, frequent cobbles, very dense, brown, moist (GLACIAL TILL)		22	SS	31		157											
							156											
			23	SS	102		155										51 26 18 5	
153.8 28.7	BEDROCK		1	RUN	NQ		154										RUN#1 TCR=20% SCR=4% RQD=0%	
							153										RUN#2 TCR=72%	

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

Continued Next Page

+³, X³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

3 OF 3

METRIC

LOCATION

Coords: N:4763891.8 E:327445.1

ORIGINATED BY LY

BOREHOLE TYPE

Hollow Stem Augers / NQ Rock Coring

COMPILED BY DB

DATE _____

12.15.09 - 12.16.09

CHECKED BY RA

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No TS4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763903.8 E:327455.3 ORIGINATED BY LY
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.17.09 - 12.22.09 CHECKED BY RA

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
182.4	Ground Surface															
0.0	FILL - Silty Clay, trace sand, trace gravel, trace organics, firm, brown, moist		1	SS	6											
181.7																
0.7	SILTY CLAY trace sand, stiff to hard, brown, damp to moist		2	SS	51											
			3	SS	36											
			4	SS	39											
			5	SS	52											
			6	SS	29											
			7	SS	26											
			8	SS	16											
			9	TW	PH											
			10	SS	14											
			11	SS	27											
			12	SS	13											
			13	SS	17											
167.7																
14.7																

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

Continued Next Page

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

RECORD OF BOREHOLE No TS4

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763903.8 E:327455.3 ORIGINATED BY LY
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.17.09 - 12.22.09 CHECKED BY RA

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 kNm ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100							SHEAR STRENGTH kPa		WATER CONTENT (%)	
								UNCONFINED ○	FIELD VANE +						QUICK TRIAXIAL ●	LAB VANE ×	10 20 30	
	CLAYEY SILT TO SILTY CLAY some sand, some gravel, frequent cobbles, stiff to hard, brown, damp (GLACIAL TILL)		14	SS	10									16 19 49 16				
			15	SS	100/ 28cm													
164.3 18.1	SAND AND GRAVEL trace to some silt, trace clay, occasional cobbles, very dense, grey, damp to moist (GLACIAL TILL)		16	SS	77													
			17	SS	80													
			18	SS	76													
			19	SS	100/ 28cm													
158.5 23.9	CLAYEY SILT trace sand, trace gravel, very stiff, brown, damp (GLACIAL TILL)		20	SS	25													
157.0 25.4	GRAVEL AND SAND some silt, occasional cobbles, very dense, grey, moist to wet (GLACIAL TILL)		21	SS	100/ 25cm													
			22	SS	100/ 18cm									45 41 (14)				
154.0 28.4	BEDROCK		1	RUN	NQ									Dec.21 RUN#1 TCR=90% SCR=72% RQD=41%				
														RUN#2				

Continued Next Page

+ 3 x 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ONTARIO MOT. 1-09-4135 TS BRIDGE.GPJ ONTARIO MOT.GDT 05/20/10

RECORD OF BOREHOLE No TS4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763903.8 E:327455.3 ORIGINATED BY LY
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.17.09 - 12.22.09 CHECKED BY RA

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	20						40	60	80
								20	40	60	80	100								
			</																	

+ 3, X 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No SBL 12+410CL

1 OF 2

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763911.8 E:327444.8

ORIGINATED BY PK

DIST HWY 405

BOREHOLE TYPE

Hollow Stem Augers

COMPILED BY DB

DATUM Geodetic

DATE

11.18.09

CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
182.5	Ground Surface													
182.3	180mm TOPSOIL													
0.2	FILL - Silty Clay, trace sand, trace organics, stiff, brown, moist		1	SS	13		182							
181.8														
0.7	SILTY CLAY trace sand, stiff to hard, brown, moist		2	SS	45		181							
			3	SS	36		180							0 3 62 35
			4	SS	39		179							
			5	SS	40		178							0 4 66 30
			6	SS	20		177							
			7	SS	20		176							
			8	SS	14		175							
	trace gravel		9	TW	PH		174							
			10	SS	11		173						20.4	1 3 70 26
			11	SS	16		172							0 2 72 26
168.9	End of Borehole						171							
13.6	Borehole was dry (not stabilized) and hole open to full depth on completion. Consolidation test performed on TW 9.						170							
							169							

Continued Next Page

+³ X³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ON_MOT_1-09-4135 TRW RET WALLS.GPJ ON_MOT_GDT_97/10

RECORD OF BOREHOLE No SBL 12+410CL

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763911.8 E:327444.8 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.18.09 CHECKED BY RA

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	<p>No sample recovery at SS8. Sampler redriven and disturbed sample collected.</p> <p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>Water Level Readings: Date Depth(m) Elevation(m) Nov.30.09 1.7 180.8 Dec.07.09 1.4 181.1 Dec.15.09 1.3 181.2</p>																

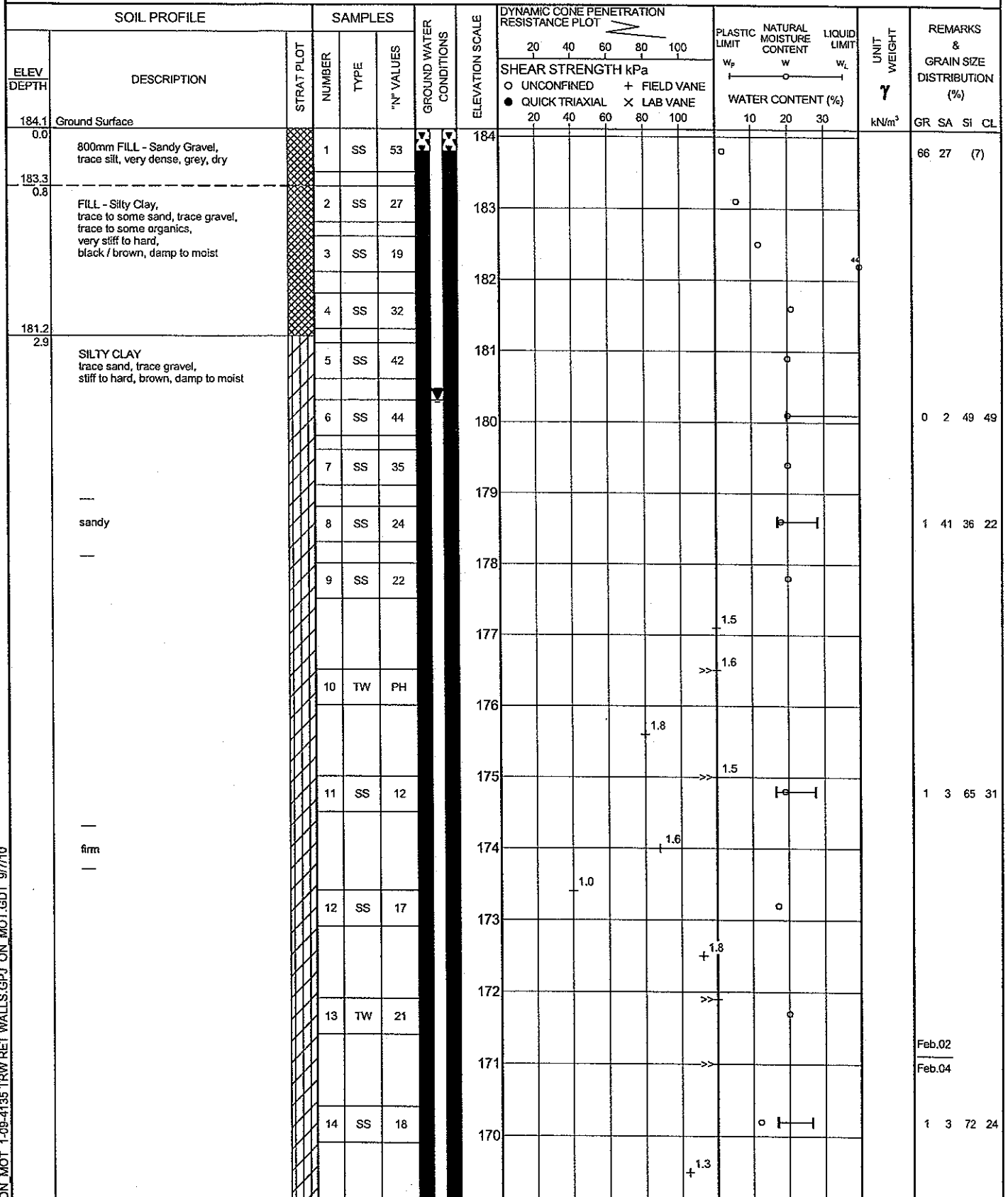
ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TN3

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763930.0 E:327463.7 ORIGINATED BY MP
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.2.10 - 2.11.10 CHECKED BY RA



Continued Next Page

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

ON MOT. 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

RECORD OF BOREHOLE No TN3

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763930.0 E:327463.7 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 2.2.10 - 2.11.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	W _p	W	W _L	
168.9 15.2	SILTY CLAY some sand, trace gravel, very stiff to hard, brown, damp to moist (GLACIAL TILL)		15	SS	27		169			1.2						
							168			1.6						
			16	SS	26		167			1.4						4 17 56 23
							166			1.8						
			17	SS	74		165									
	SANDY SILT TO SILTY SAND some gravel, trace clay, dense to very dense, brown, moist (GLACIAL TILL)		18	SS	100		164									
162.5 21.6			19	120	100/ 13cm		163									commence casing and washboring
							162									
			20	SS	71		161									Feb.04
							160									Feb.08
	CLAYEY SILT TO SILTY CLAY trace sand, trace gravel, hard, brown, moist (GLACIAL TILL)		21	SS	48		159									
							158									Feb.08
157.2 26.9			22	SS	43		157									Feb.09
156.4 27.7	SAND AND GRAVEL silty, trace clay, very dense, brown, moist (GLACIAL TILL)		23	SS	112		156									
							155									
154.5 29.6	BEDROCK		24	SS	108											31 33 29 7 Feb.09 Feb.11

Continued Next Page

+ 3 x 3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

3 OF 3

METRIC

+3, X3: Numbers refer to Sensitivity □ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No TN4

1 OF 3

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763941.4 E:327469.8

ORIGINATED BY MP

DIST

HWY 406

BOREHOLE TYPE

Solid Stem Augers / NO Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE

1.26.10 - 2.17.10

CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
184.0 0.0	Ground Surface													
183.3 0.7	740mm FILL - Gravel, some sand, trace to some silt, dense, grey, damp		1	SS	41									72 17 (11)
181.9 2.1	FILL - Silty Clay, some gravel, trace sand, trace organics, stiff, dark brown / brown, damp to moist		2	SS	10		183							
			3	SS	15		182							
	SILTY CLAY trace sand, stiff to hard, brown, damp to moist		4	SS	29		181						44	0 3 47 50
			5	SS	36		180							
			6	SS	50		179							0 3 74 23
			7	SS	43		178							
			8	SS	23		177							Jan.26
			9	SS	17		176							Feb.05
			10	SS	23		175							0 3 65 32
			11	SS	9		174							
			12	TW	PH		173							
			13	SS	16		172							
			14	SS	17		171							
169.3 14.7							170							

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

2 OF 3

METRIC

LOCATION

Coords: N:4763941.4 E:327469.8

ORIGINATED BY MP

DIST HWY 406

BOREHOLE TYPE

Solid Stem Augers / NQ Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE _____

1.26.10 - 2.17.10

CHECKED BY RA

Continued Next Page

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

ON_MOT 1-09-4135 TRW RET WALLS.GPJ ON_MOT.GDT 9/7/10

3 OF 3

METRIC

LOCATION

Coords: N:4763941.4 E:327469.8

ORIGINATED BY MP

BOREHOLE TYPE

Solid Stem Augers / NQ Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE _____

1.26.10 - 2.17.10

CHECKED BY RA

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

RECORD OF BOREHOLE No TSEW4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763951.2 E:327473.9 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.2.09 - 12.7.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
183.5 0.0	Ground Surface													
	FILL - Silty Clay, some sand, trace gravel, trace organics, stiff to very stiff, dark brown / brown, moist		1	SS	11		183							
	firm		2	SS	18		182							3 11 48 38
181.4 2.1	SILTY CLAY trace sand, trace gravel, stiff to very stiff, brown, damp to moist		3	SS	6		181							0 1 54 45
	some sand		4	SS	14		180							
			5	SS	18		179							1 13 55 31
			6	SS	19		178							
			7	SS	18		177							
			8	SS	13		176							2 3 70 25
			9	SS	11		175							
			10	SS	7		174							0 6 63 31
			11	SS	3		173							
			12	SS	8		172							
			13	SS	9		171							1 2 70 27
168.8 14.7			14	TW	PH		170							
							169							

Continued Next Page

+³ X³: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

2 OF 3

METRIC

DATUM Geodetic DATE 12.2.09 - 12.7.09 CHECKED BY RA

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 (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	× LAB VANE	
							20	40	60	80	100							

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

RECORD OF BOREHOLE No TSEW4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763951.2 E:327473.9 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.2.09 - 12.7.09 CHECKED BY RA

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
	BEDROCK - INTERBEDDED DOLOSTONE AND SHALE Unweathered, thinly laminated, grey, medium strength, argillaceous with unweathered, laminated, white, very low strength gypsum and calcite layers / veins and frequent unweathered, white, low strength, coarse grained calcitic vugs.		1	RUN	NQ		153										RUN#1 TCR=69% SCR=66% RQD=0% RUN#2 TCR=80% SCR=70% RQD=0% RUN#3 TCR=100% SCR=100% RQD=59% RUN#4 TCR=99% SCR=99% RQD=84%			
			2	RUN	NQ		152													
			3	RUN	NQ															
			4	RUN	NQ		151													
150.5																				
33.0	End of Borehole																			
	Resistance to augering at 26.7m. No sample recovery at SS24. Sampler redriven and disturbed sample collected. Borehole sealed with bentonite slurry from 33.0m to 23.2m. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Piezometer destroyed after installation.																			

RECORD OF BOREHOLE No NBL 12+440Rt

1 OF 2

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763962.9 E:327465.8

ORIGINATED BY MP

DIST HWY 406

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY DB

DATUM Geodetic

DATE

11.4.09

CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)			
183.0	Ground Surface													
182.9	130mm TOPSOIL													
0.1	FILL - Silty Clay, trace sand, trace gravel, trace organics, firm to stiff, brown, damp to moist		1	SS	6									
			2	SS	12									
			3	SS	13									
			4	SS	14									
180.1	SILTY CLAY trace sand, occasional gravel inclusions, stiff to very stiff, brown, moist		5	SS	17									
2.9			6	SS	26									
			7	SS	15									
			8	SS	25									
			9	SS	10									
			10	TW	PH									
			11	SS	12									
169.6	End of Borehole													
13.4	Borehole was dry (not stabilized) and hole open to full depth on completion. Consolidation test performed on TW 10.													

Continued Next Page

+ 3 X 3 Numbers refer to Sensitivity 0 3% STRAIN AT FAILURE

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

2 OF 2

METRIC

W.P. 280-99-00

LOCATION

Coords: N:4763962.9 E:327465.8

ORIGINATED BY MP

DIST _____ HWY 406

BOREHOLE TYPE

Hollow Stem Augers

COMPILED BY DB

DATUM Geodetic

DATE _____

11.4.09

CHECKED BY RA

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

RECORD OF BOREHOLE No TSEW3

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4763960.8 E:327478.6 ORIGINATED BY LY
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.8.09 - 12.10.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
183.3	Ground Surface													
0.0														
182.6	FILL - Sand and Gravel, trace silt, loose, grey, dry		1	SS	6		183							
0.7														
182.0	FILL - Silty Clay, some sand, some gravel, firm, grey, damp to moist		2	SS	5		182							
1.3														
	SILTY CLAY trace sand, trace gravel, stiff to very stiff, brown, moist		3	SS	18		181							
			4	SS	18									
			5	SS	24		180						45	0 2 46 52
			6	SS	24		179							
			7	SS	12		178							1 4 61 34
			8	SS	10		177							
			9	SS	14		176							
			10	SS	16		175							
			11	SS	9		174							0 4 64 32
			12	SS	9		173							4 5 67 24
			13	TW	PH		171						20.8	2 2 75 21
			14	SS	12		170							3 3 70 24
168.6							169							
14.7														

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

O 3% STRAIN AT FAILURE

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 9/7/10

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100			WATER CONTENT (%)		
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100						GR SA SI CL

Depth (m)	Soil Description	SS (%)	Gravel (%)	Notes
164.0	SILTY CLAY TO CLAYEY SILT trace sand, trace gravel, occasional cobbles, very stiff to hard, brown, damp to moist (GLACIAL TILL)	15	15	
164.0		16	52	
164.0		17	54	
164.0		18	72	
164.0		19	30	
164.0		20	59	
164.0		21	42	
157.9	SILTY CLAY sandy, gravelly, occasional cobbles, hard, brown, moist (GLACIAL TILL)	22	100/25cm	
156.4	SAND AND GRAVEL silty, trace clay, compact, brown, moist (GLACIAL TILL)	23	18	
153.6	BEDROCK			

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

3 OF 3

METRIC

LOCATION

Coords: N:4763960.8 E:327478.6

ORIGINATED BY LY

DIST HWY 406

BOREHOLE TYPE

Hollow Stem Augers / Casing and Washboring / NQ Rock Coring

COMPILED BY DB

DATUM Geodetic

DATE _____

12.8.09 - 12.10.09

CHECKED BY RA

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No TRW4

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764001.2 E:327484.0 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 07.27.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES			SHEAR STRENGTH kPa						
184.0	Ground Surface							20 40 60 80 100						GR SA SI CL
0.2	150mm TOPSOIL		1	SS	18			○ UNCONFINED + FIELD VANE						
	SILTY CLAY trace sand, occasional gravel inclusions, very stiff to hard, brown, damp to moist		2	SS	48		183	● QUICK TRIAXIAL × LAB VANE						
			3	SS	39		182							
			4	SS	33		181						1 3 47 49	
			5	SS	48		180							
			6	SS	42		179						0 2 69 29	
			7	SS	46		178							
			8	SS	27		177							
			9	SS	22		176						2 5 64 29	
			10	SS	24		175							
			11	SS	29		174							
			12	SS	32		173							
			13	SS	36		172							
		frequent silt seams and partings					171							
						170								
169.3														
14.7														

Continued Next Page

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

ON MOT 1-09-4135 TRW RET WALLS.GPJ ON MOT.GDT 11/04/10

RECORD OF BOREHOLE No TRW4

2 OF 2

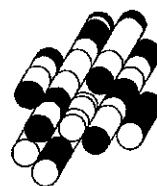
METRIC

W.P. 280-99-00 LOCATION Coords: N:4764001.2 E:327484.0 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 7.27.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
168.3	SILTY CLAY trace sand, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		14	SS	37												
15.7	End of Borehole																
	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.28.10 10.6 173.4 Aug.06.10 3.4 180.6 Aug.13.10 2.9 181.1 Aug.23.10 3.1 180.9																

B2

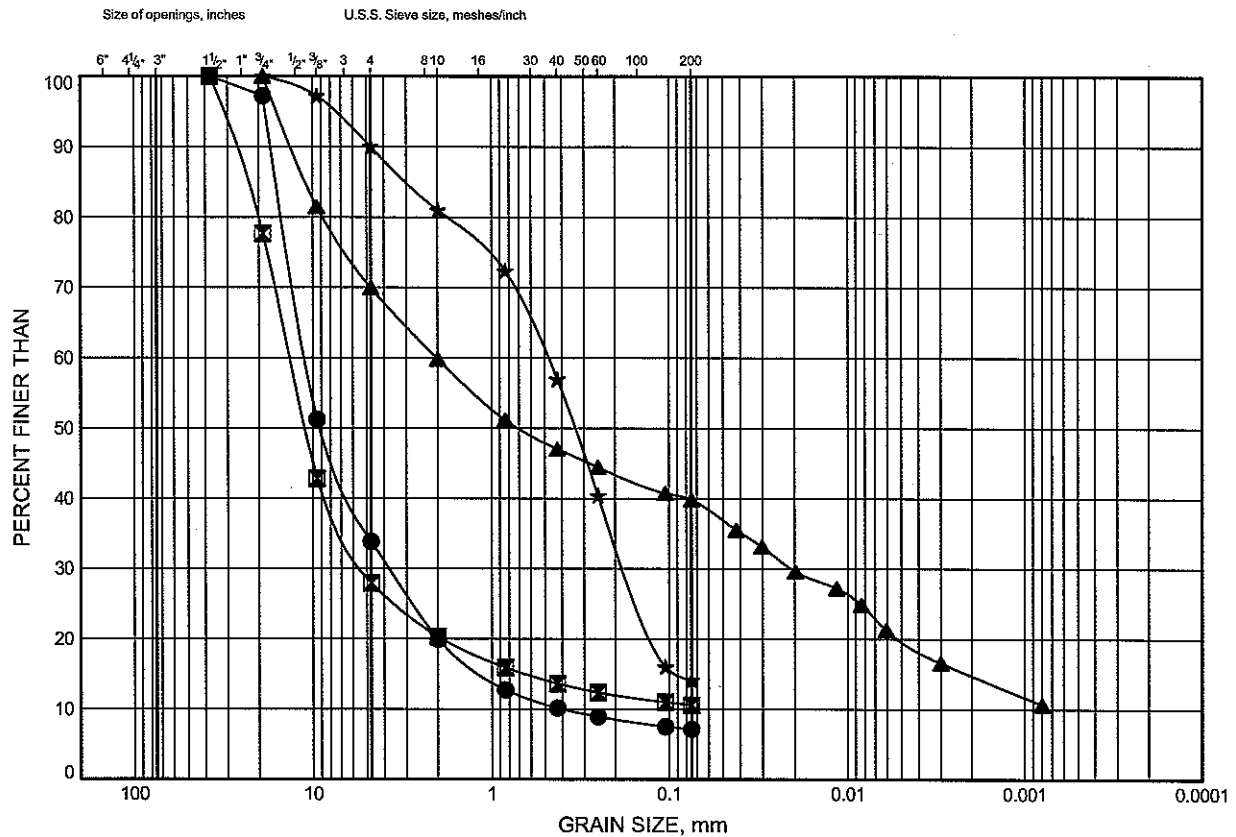
TERRAPROBE INC.



GRAIN SIZE DISTRIBUTION

FIGURE B2-1

FILL - Gravelly Sand to Sandy Gravel



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN3	0.3	183.8
■	TN4	0.3	183.7
▲	TSEW1	0.3	183.2
★	TSEW2	0.3	183.0

Date August 2010
Project 1-09-4135

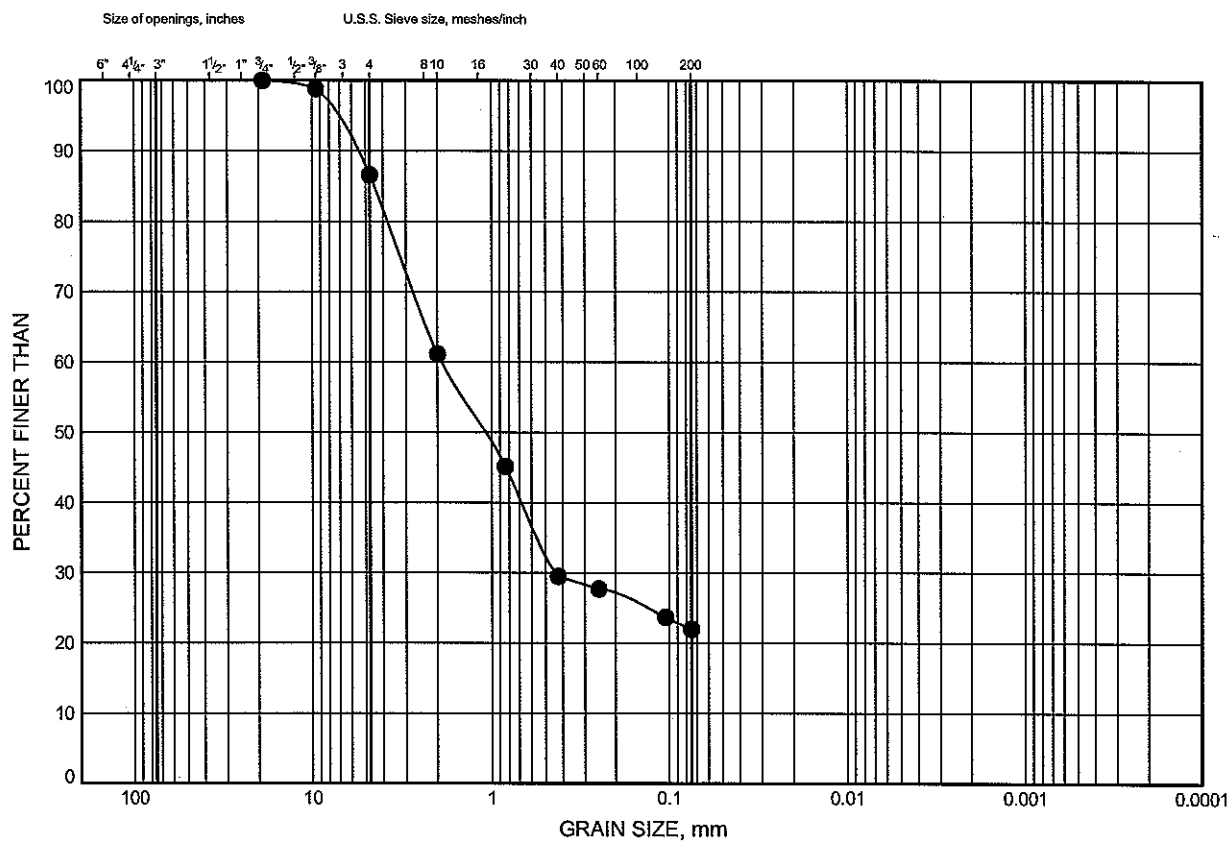


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-2

FILL - Silty Sand



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN1	1.0	182.5

Date August 2010
Project 1-09-4135

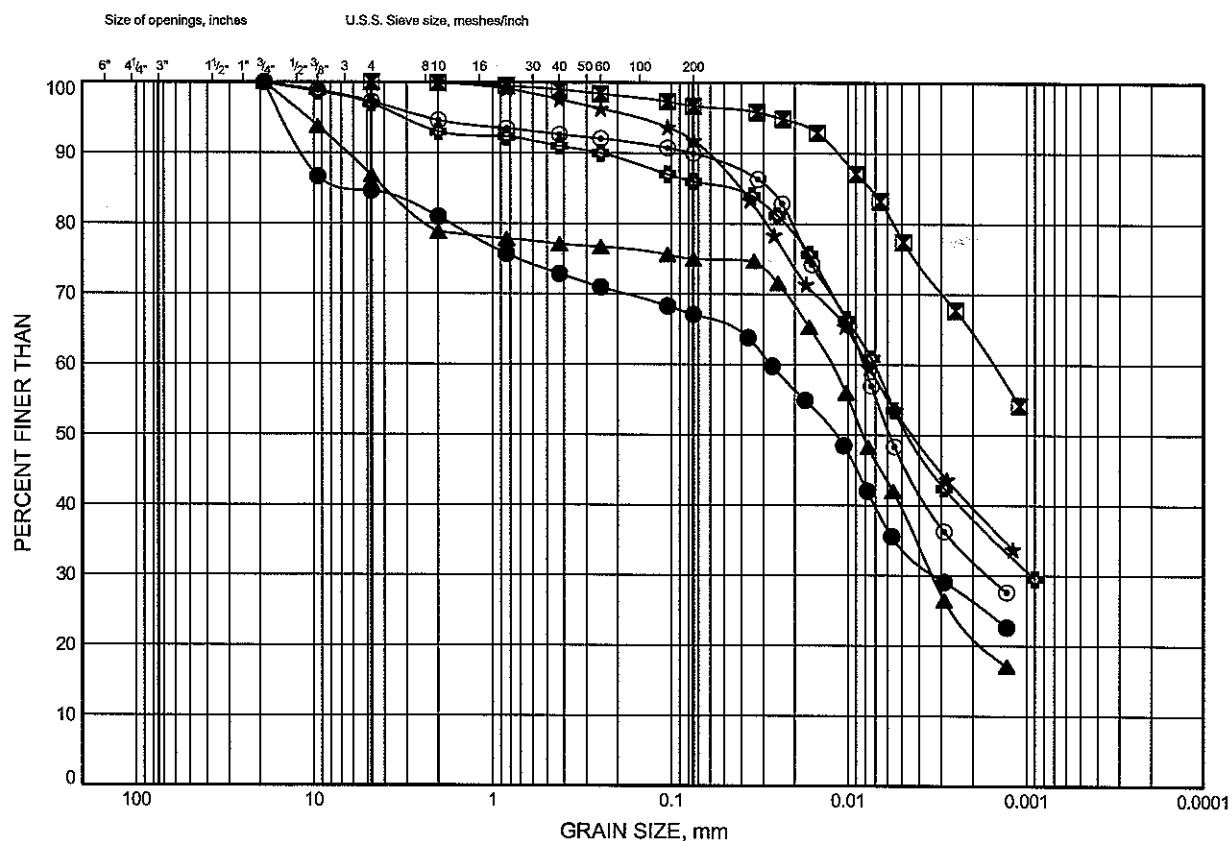


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Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-3

FILL - Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+375Lt	1.0	182.3
⊠	TEW1	0.3	182.2
▲	TN2	1.0	183.2
★	TRW3	0.3	182.8
⊙	TS2	1.0	182.3
⊞	TSEW4	1.0	182.5

Date August 2010
Project 1-09-4135

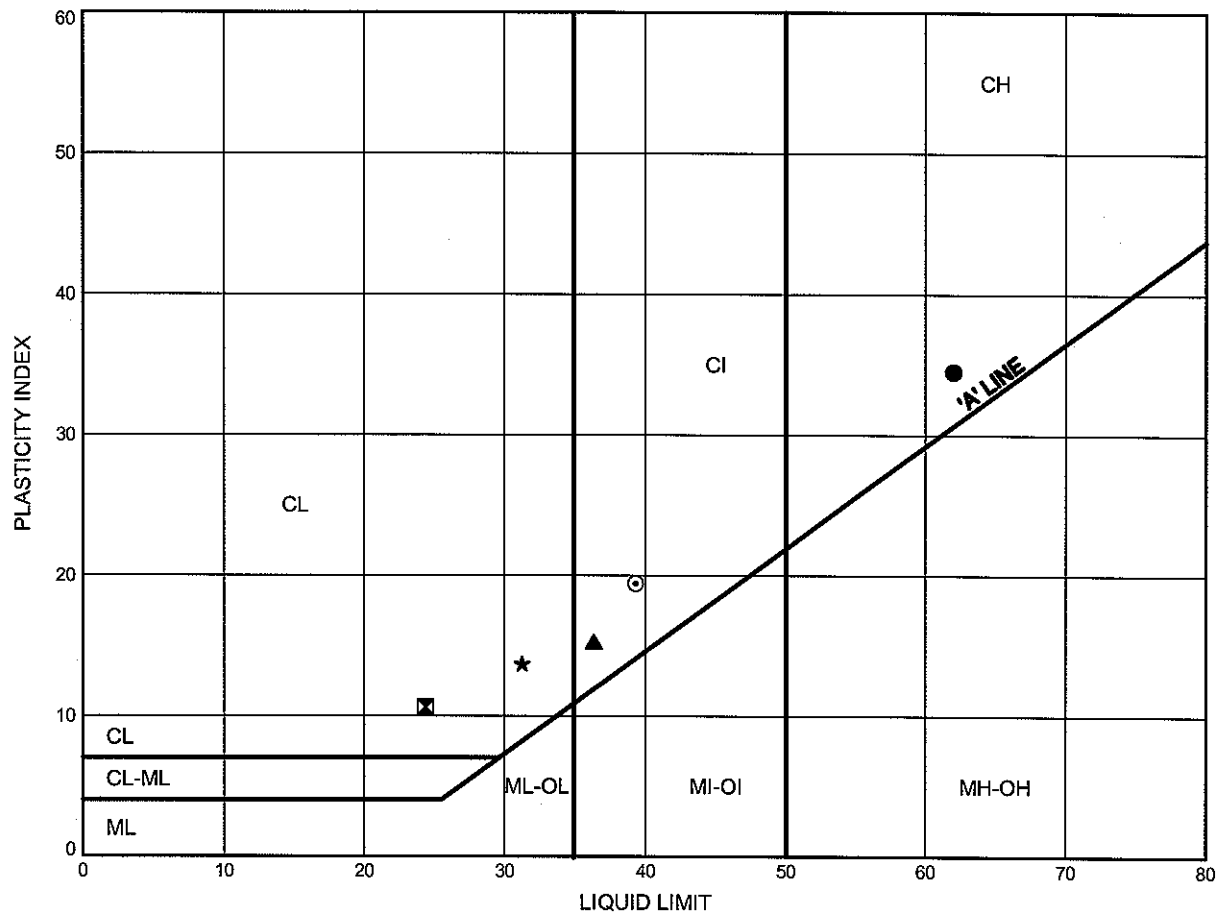


Prep'd DB
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-4

FILL - Silty Clay



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW1	0.3	182.2
⊠	TN2	1.0	183.2
▲	TRW3	0.3	182.8
★	TS2	1.0	182.3
⊙	TSEW4	1.0	182.5

Date August 2010
Project 1-09-4135

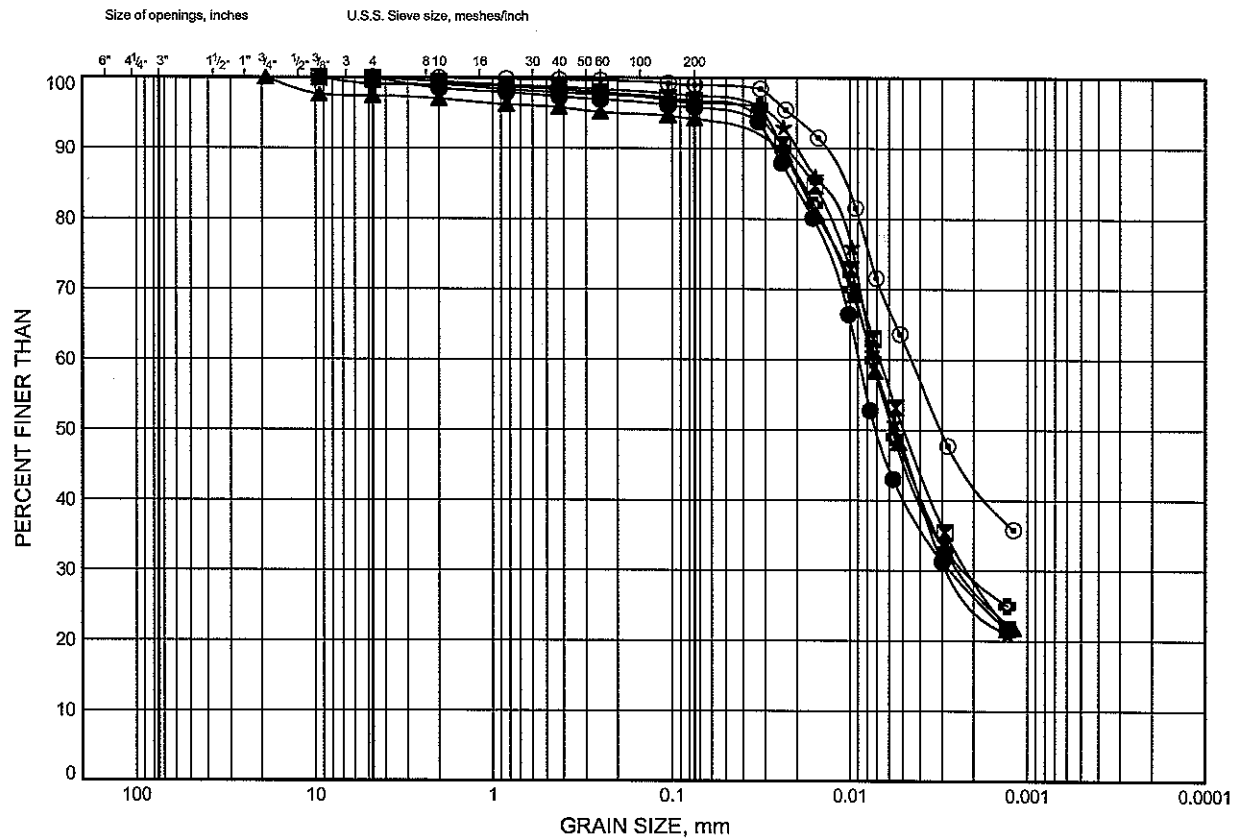


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Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-5

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+375Lt	4.7	178.6
■	NBL 12+375Lt	7.8	175.5
▲	NBL 12+375Lt	9.3	174.0
★	NBL 12+375Lt	10.9	172.4
⊙	NBL 12+440Rt	3.2	179.8
⊕	NBL 12+440Rt	6.3	176.7

Date August 2010
Project 1-09-4135

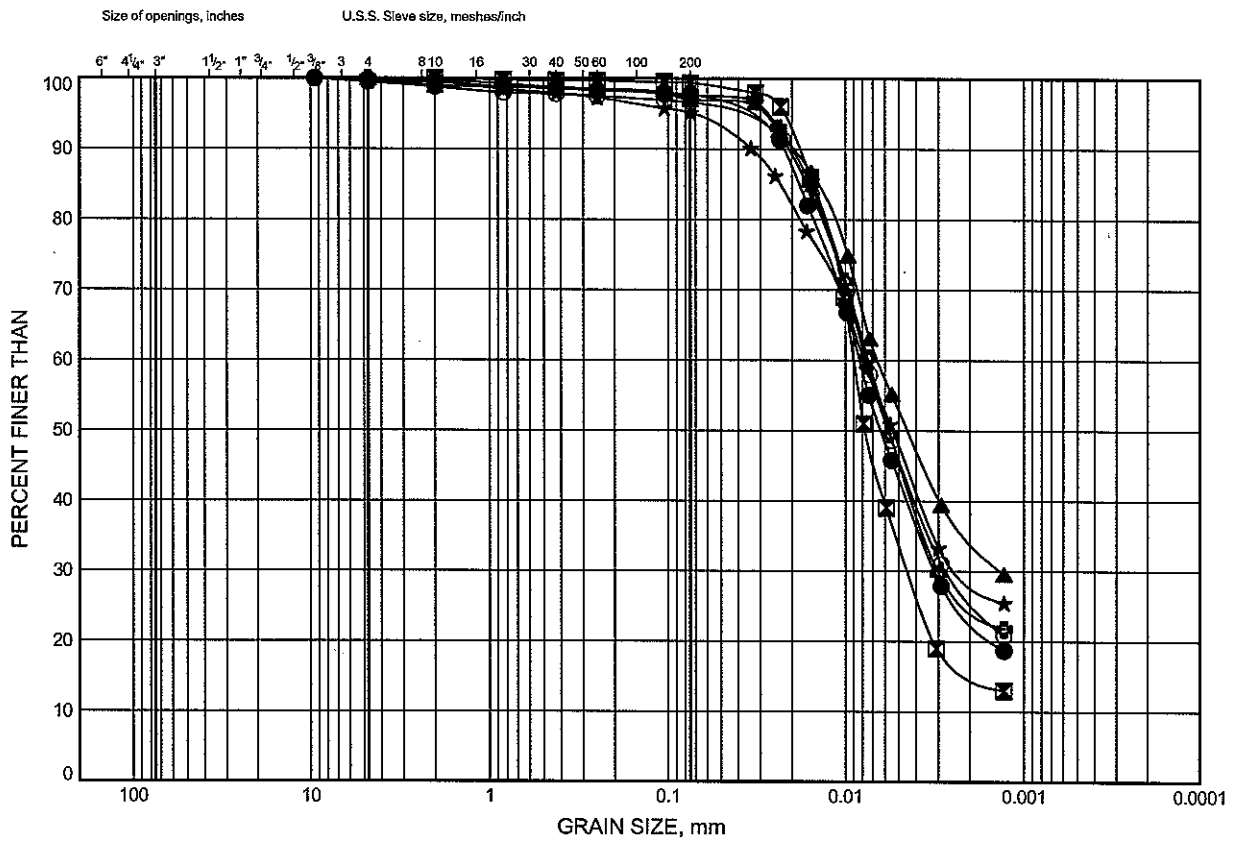


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Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-7

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SBL 12+360CL	10.9	172.0
⊠	SBL 12+360CL	12.4	170.5
▲	SBL 12+410CL	1.7	180.8
★	SBL 12+410CL	4.7	177.8
⊙	SBL 12+410CL	9.3	173.2
⊕	SBL 12+410CL	10.9	171.6

Date August 2010
Project 1-09-4135

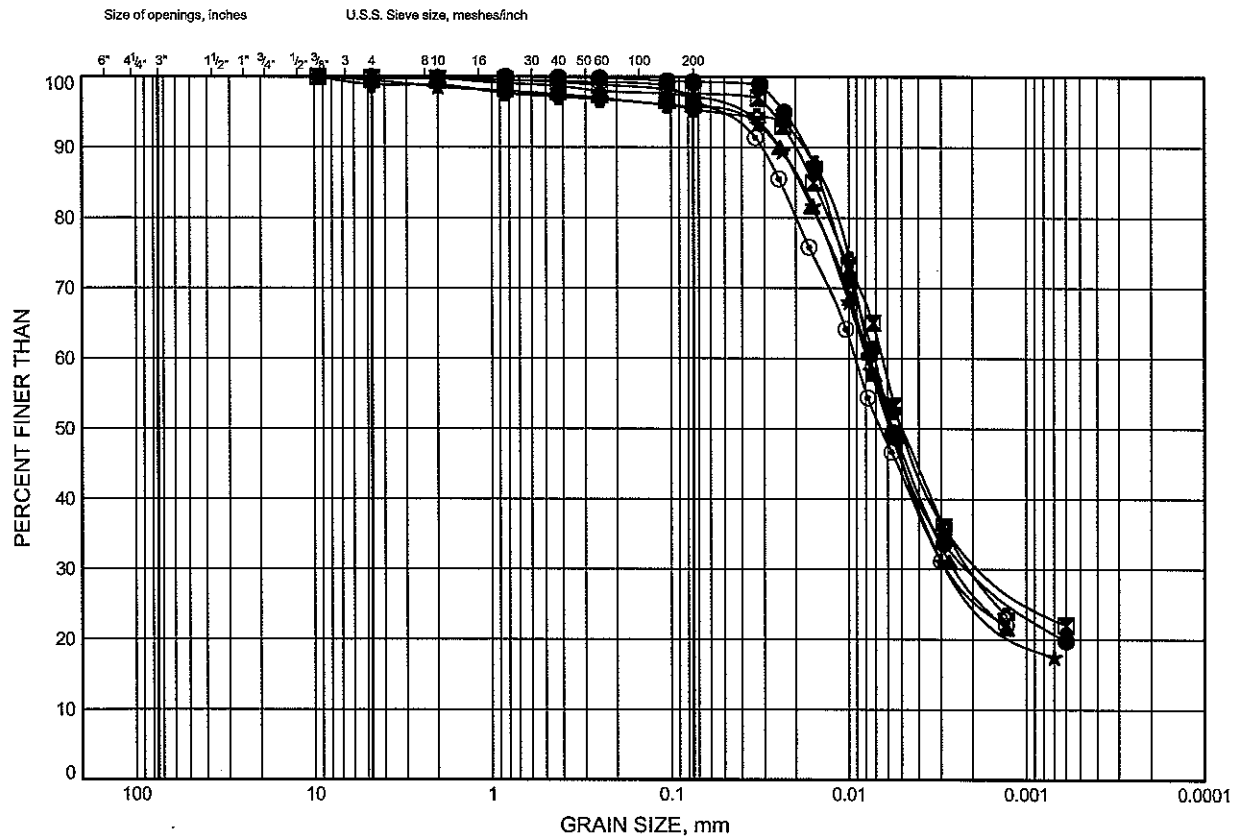


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-8

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	S-EW 10+050CL	3.2	180.2
■	S-EW 10+050CL	6.3	177.1
▲	S-EW 10+050CL	9.3	174.1
★	S-EW 10+050CL	10.9	172.5
⊙	TEW1	2.5	180.0
⊕	TEW1	4.7	177.8

Date August 2010
Project 1-09-4135

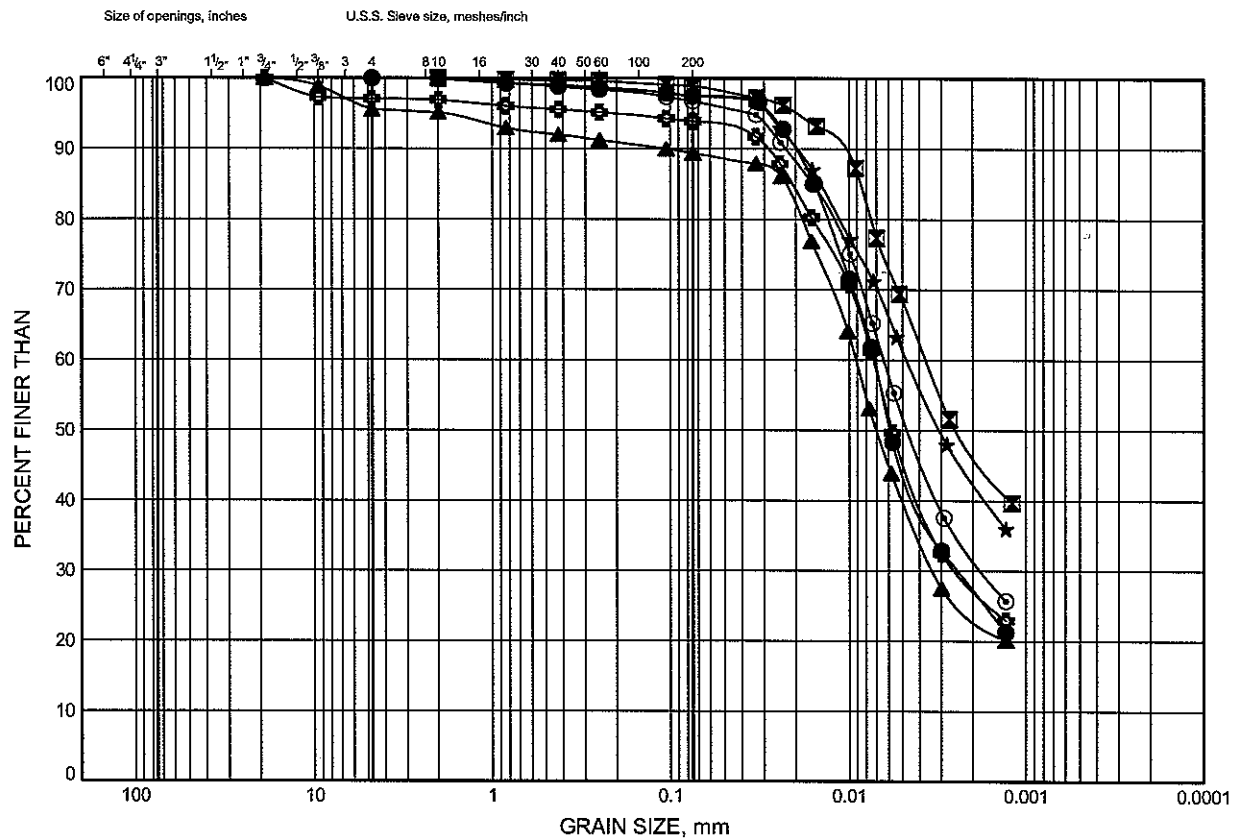


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-9

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW1	9.3	173.2
⊠	TEW2	2.5	180.2
▲	TEW2	13.9	168.8
★	TEW3	3.2	179.4
⊙	TEW3	4.7	177.9
⊕	TEW3	7.8	174.8

Date August 2010
Project 1-09-4135

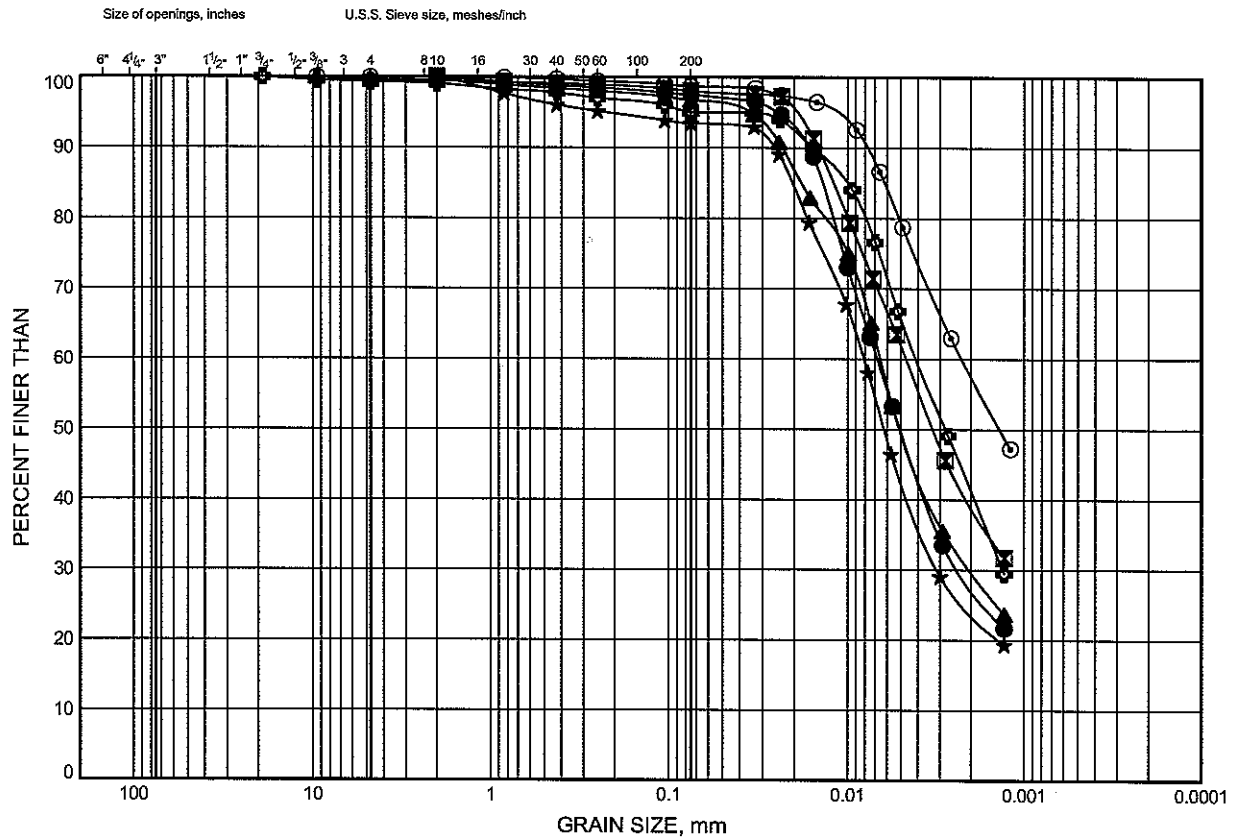


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Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-10

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW3	10.9	171.7
⊠	TEW4	1.0	181.6
▲	TEW4	4.7	177.9
★	TEW4	9.3	173.3
⊙	TN1	2.5	181.0
⊕	TN1	4.7	178.8

Date August 2010
Project 1-09-4135

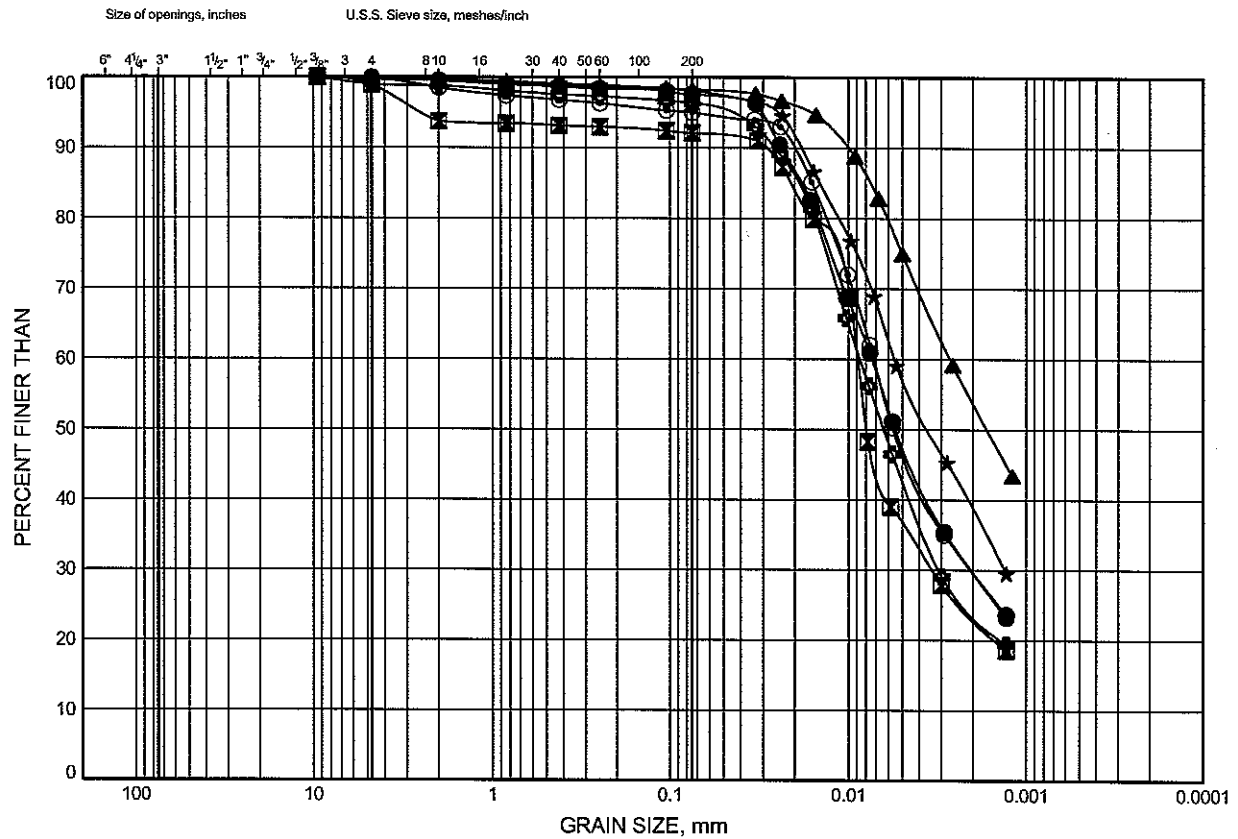


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-11

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN1	7.8	175.7
⊠	TN1	10.9	172.6
▲	TN2	3.2	181.0
★	TN2	5.5	178.7
⊙	TN2	9.3	174.9
⊕	TN2	13.9	170.3

Date August 2010
Project 1-09-4135

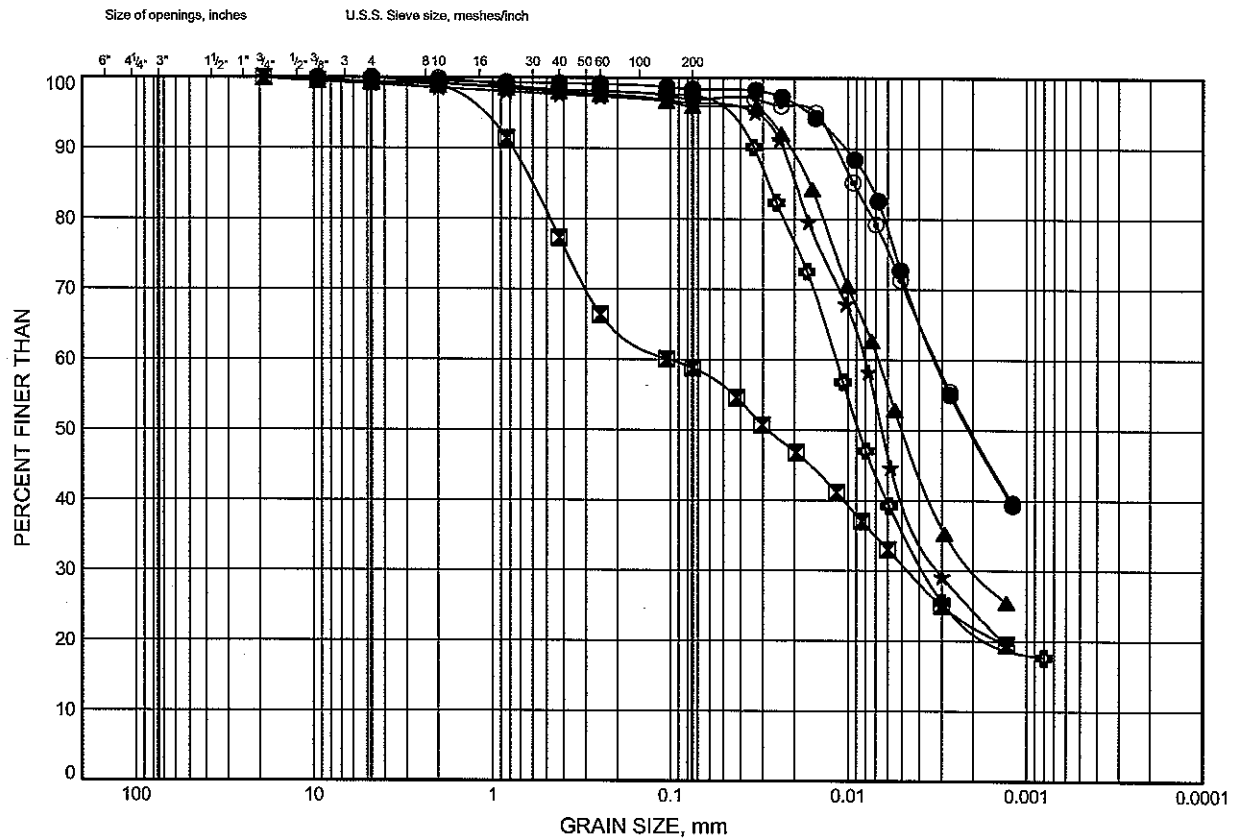


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-12

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN3	4.0	180.1
⊠	TN3	5.5	178.6
▲	TN3	9.3	174.8
★	TN3	13.9	170.2
⊙	TN4	2.5	181.5
⊞	TN4	4.0	180.0

Date August 2010
Project 1-09-4135

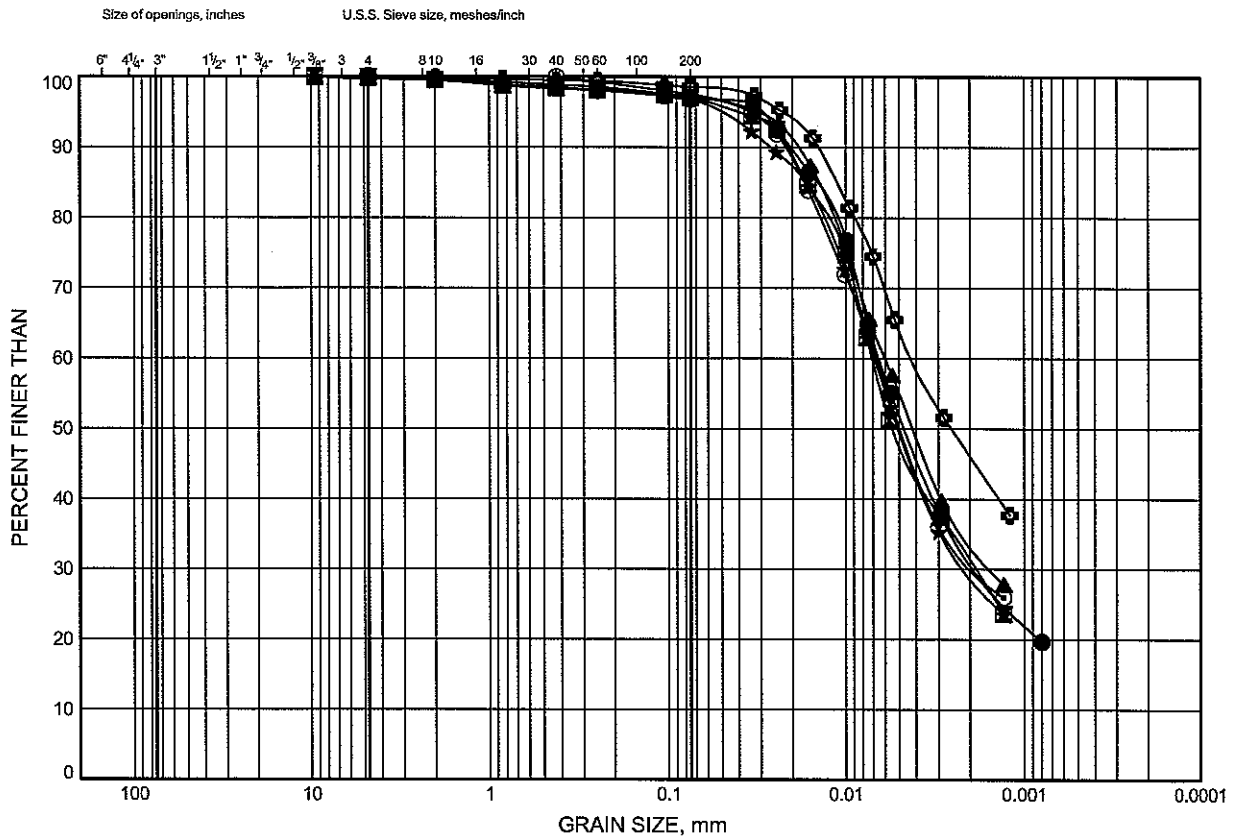


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-13

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN4	5.5	178.5
⊠	TN4	9.3	174.7
▲	TRW1	3.2	180.0
★	TRW1	4.7	178.5
⊙	TRW1	10.9	172.3
⊗	TRW2	1.0	181.5

Date August 2010
Project 1-09-4135

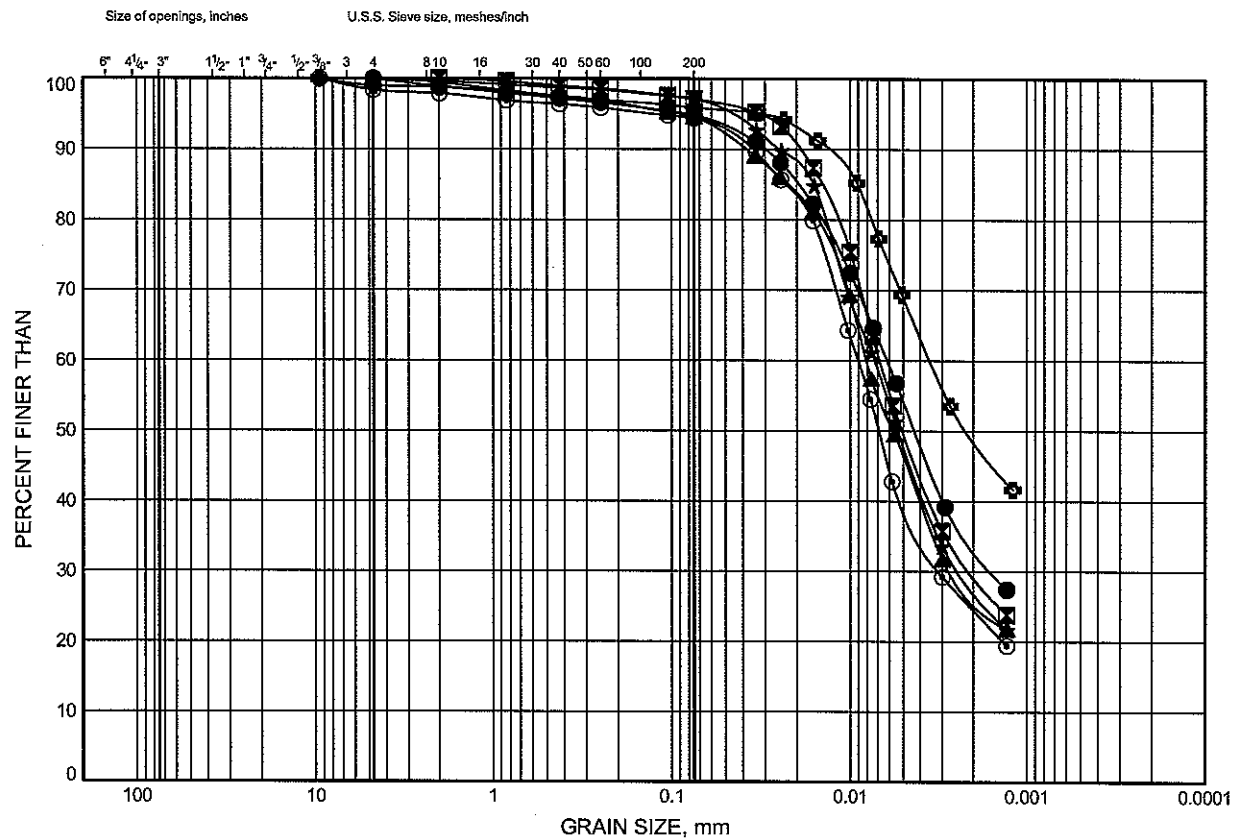


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-14

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW2	4.0	178.5
⊠	TRW2	7.8	174.7
▲	TRW2	13.9	168.6
★	TRW3	4.7	178.4
⊙	TRW3	10.9	172.2
⊕	TRW4	2.5	181.5

Date August 2010
Project 1-09-4135

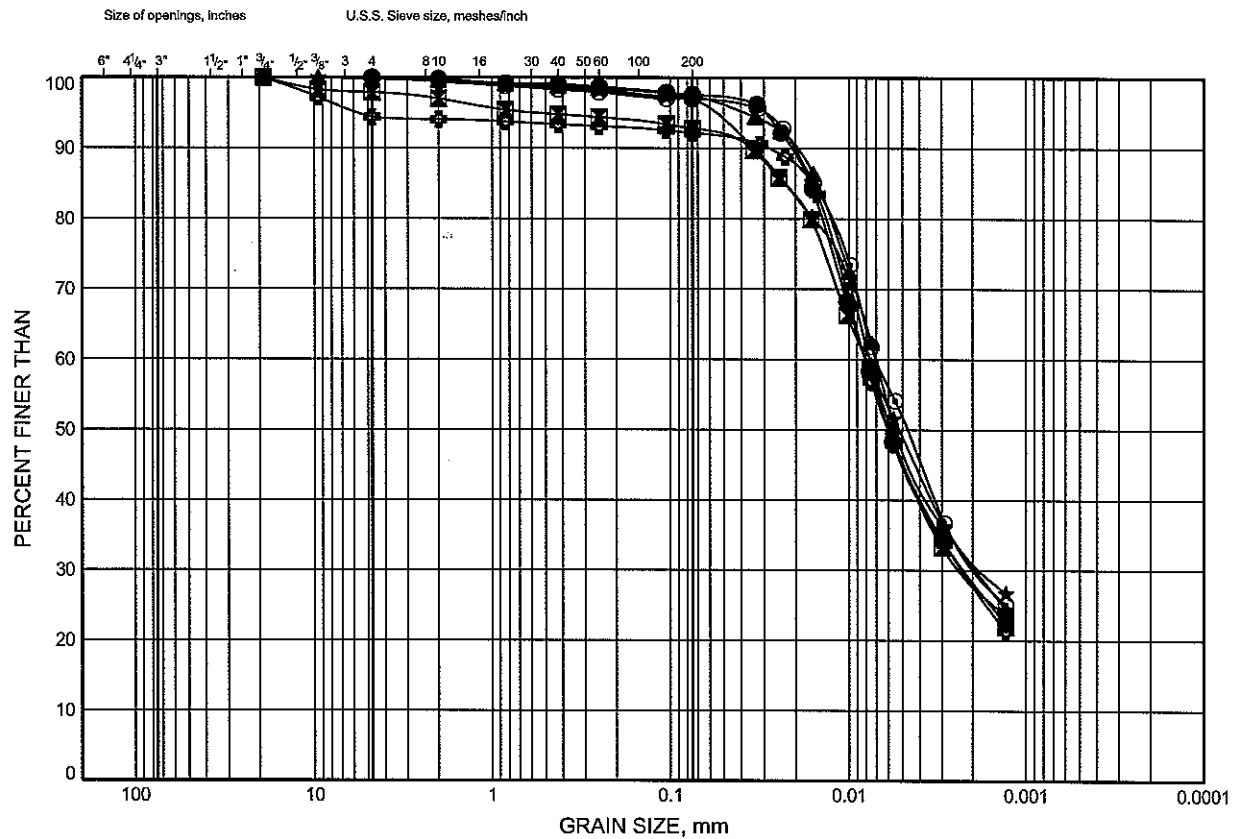


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-15

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW4	4.7	179.3
⊠	TRW4	7.8	176.2
▲	TRW4	12.4	171.6
★	TS1	2.5	180.1
⊙	TS1	4.7	177.9
⊕	TS1	9.3	173.3

Date August 2010
Project 1-09-4135

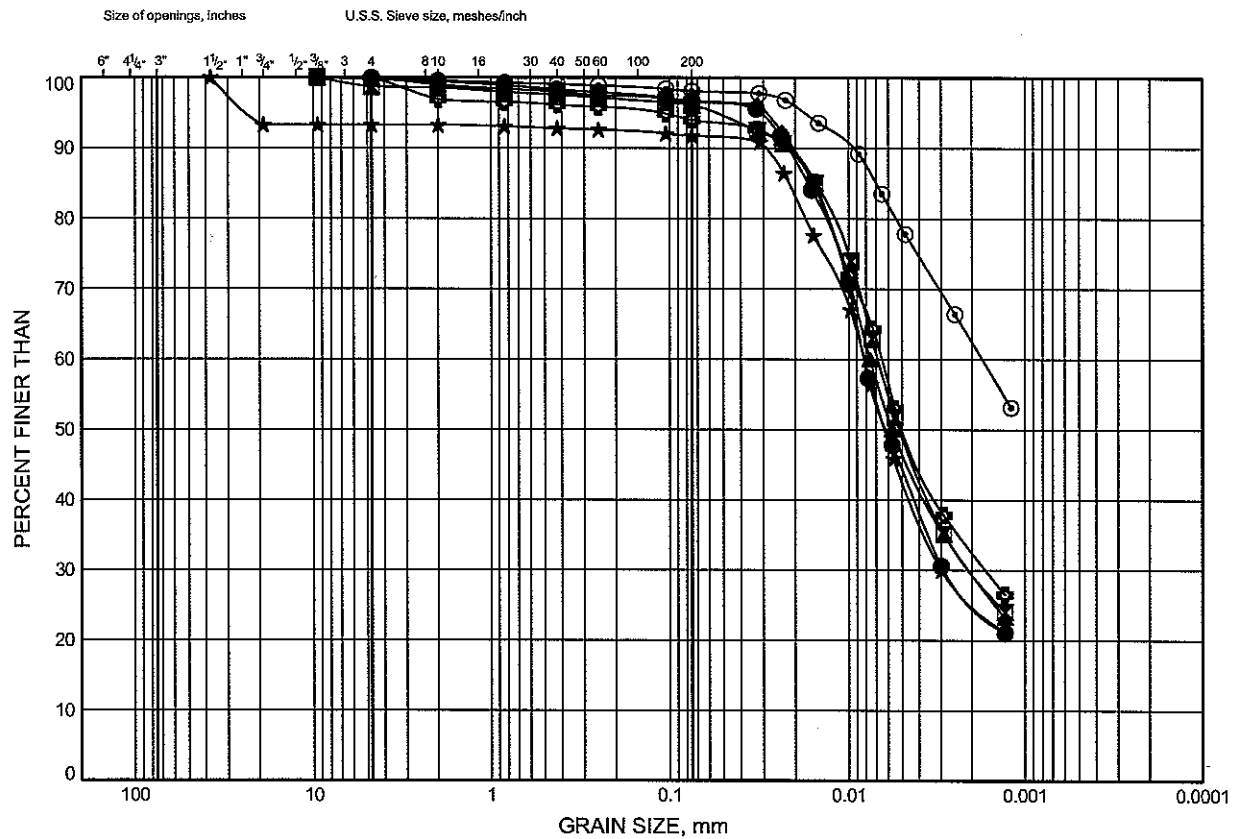


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-16

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS1	13.9	168.7
⊠	TS2	5.5	177.8
▲	TS2	9.3	174.0
★	TS2	13.9	169.4
⊙	TS3	1.7	180.8
⊕	TS3	4.0	178.5

Date August 2010
Project 1-09-4135

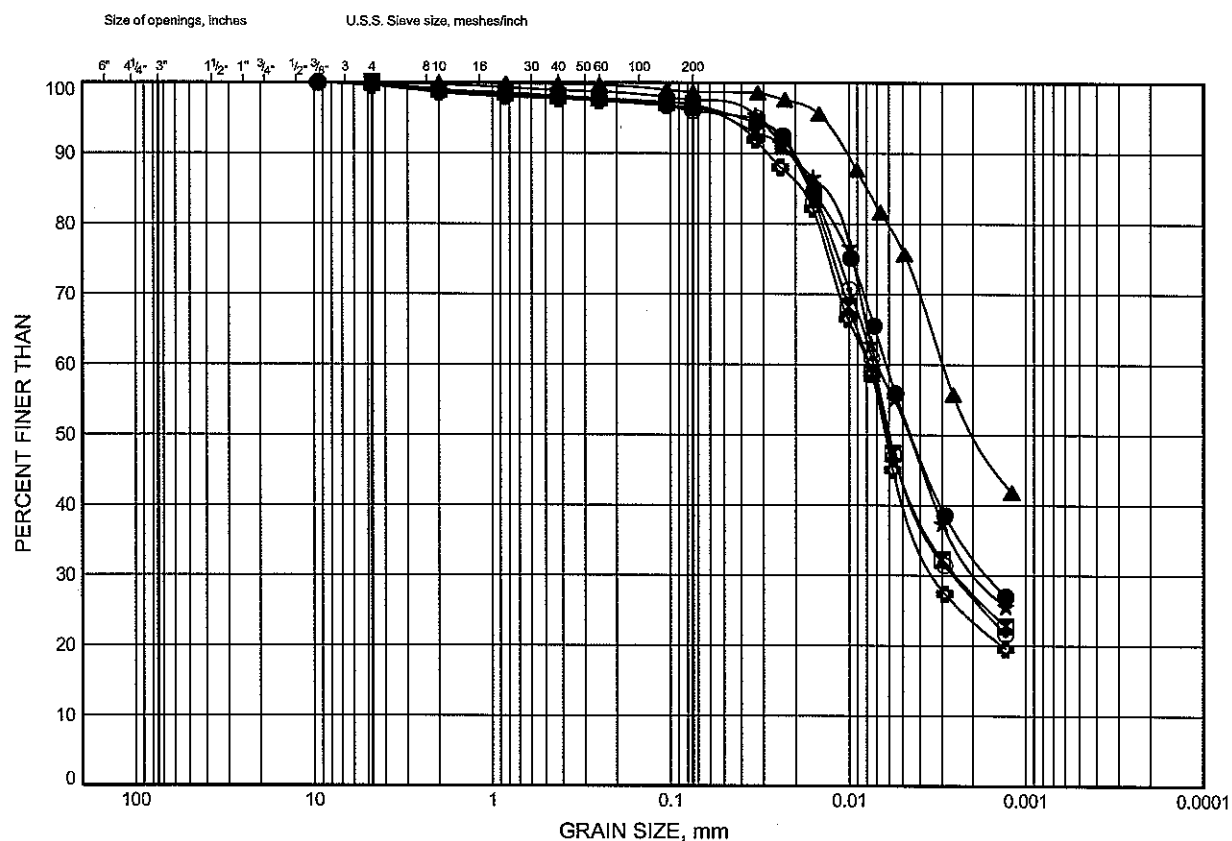


Prep'd DB
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GRAIN SIZE DISTRIBUTION

FIGURE B2-17

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS3	6.3	176.2
⊠	TS3	10.9	171.6
▲	TS4	1.0	181.4
★	TS4	3.2	179.2
⊙	TS4	6.3	176.1
⊛	TS4	9.3	173.1

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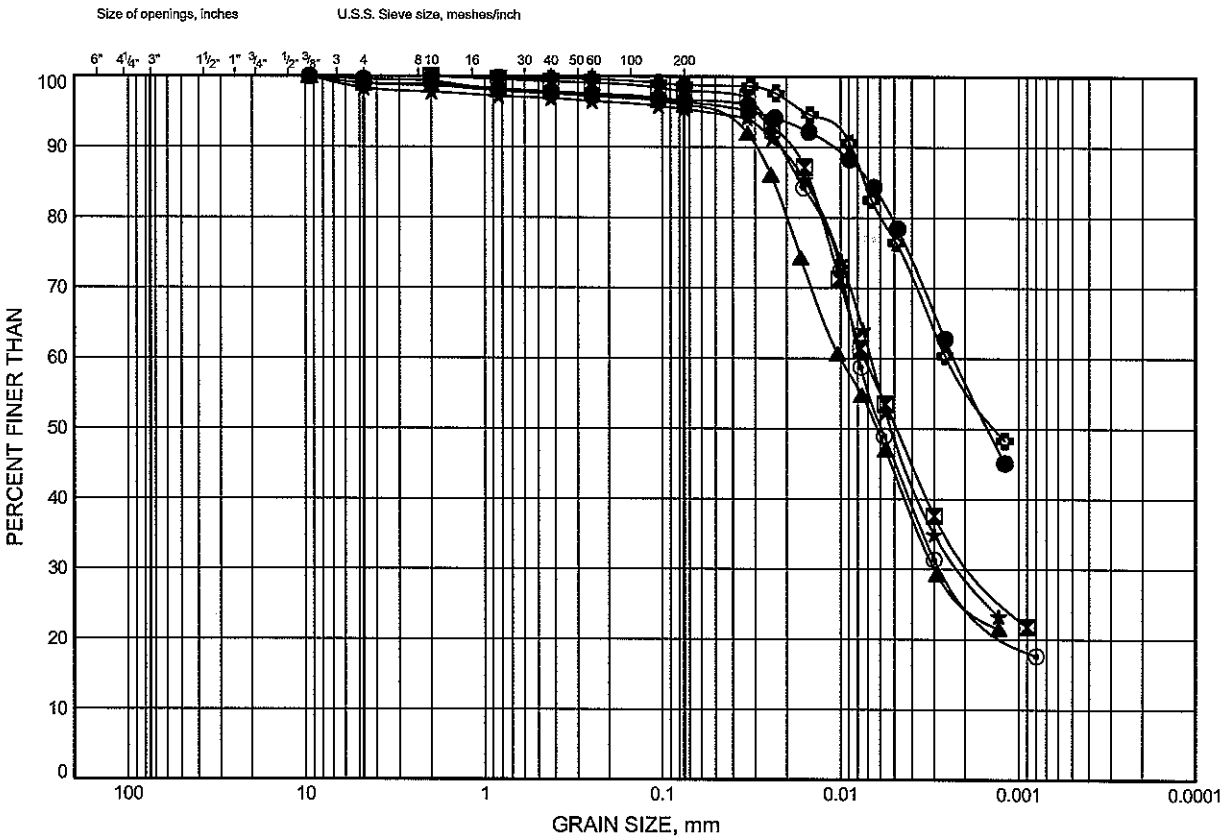


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-18

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW1	1.7	181.8
⊠	TSEW1	4.0	179.5
▲	TSEW1	6.3	177.2
★	TSEW1	9.3	174.2
⊙	TSEW1	12.4	171.1
⊕	TSEW2	1.0	182.3

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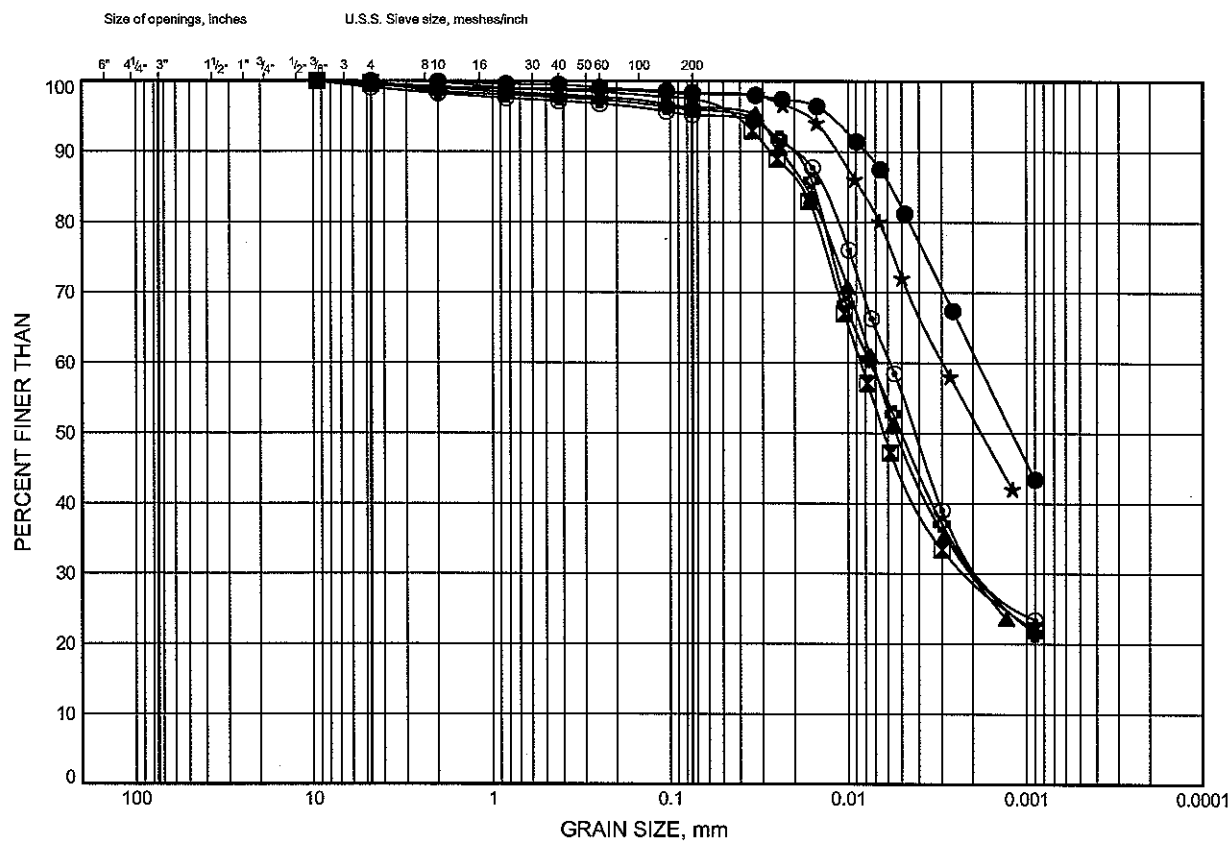


Prep'd DB
 Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-19

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW2	2.5	180.8
⊠	TSEW2	5.5	177.8
▲	TSEW2	9.3	174.0
★	TSEW3	3.2	180.1
⊙	TSEW3	4.7	178.6
⊕	TSEW3	9.3	174.0

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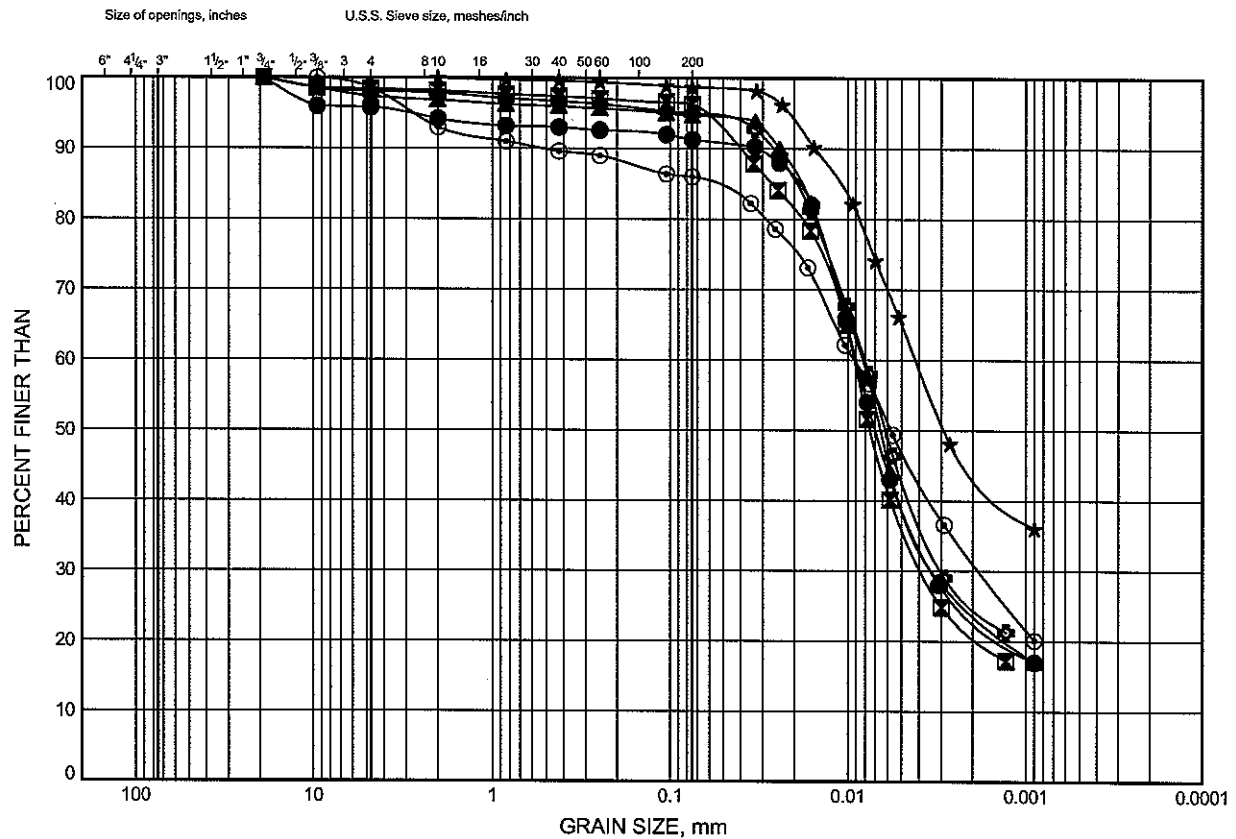


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-20

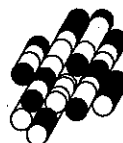
SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW3	10.9	172.4
⊠	TSEW3	12.4	170.9
▲	TSEW3	13.9	169.4
★	TSEW4	2.5	181.0
⊙	TSEW4	4.7	178.8
⊗	TSEW4	7.8	175.7

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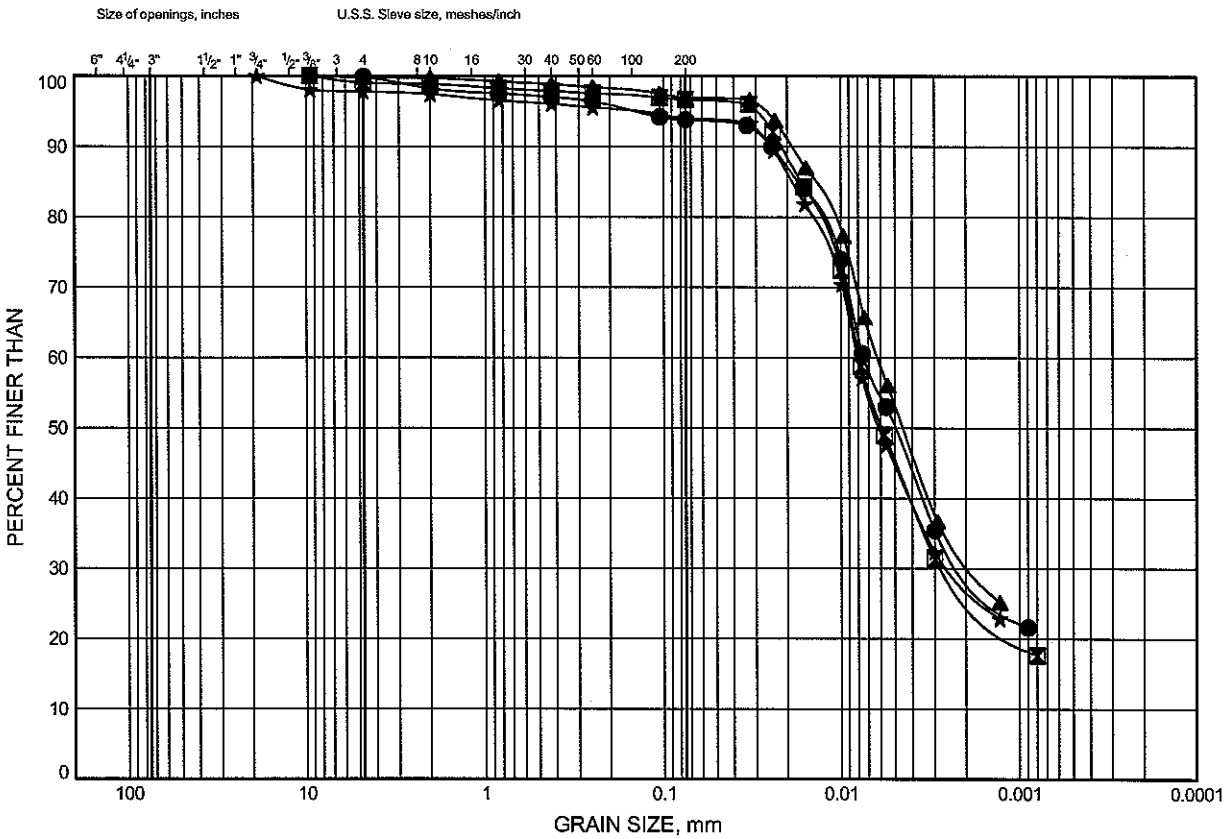


Prep'd DB
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-21

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW4	9.3	174.2
⊠	TSEW4	12.4	171.1
▲	WE-S 10+295CL	2.5	180.3
★	WE-S 10+295CL	7.8	175.0

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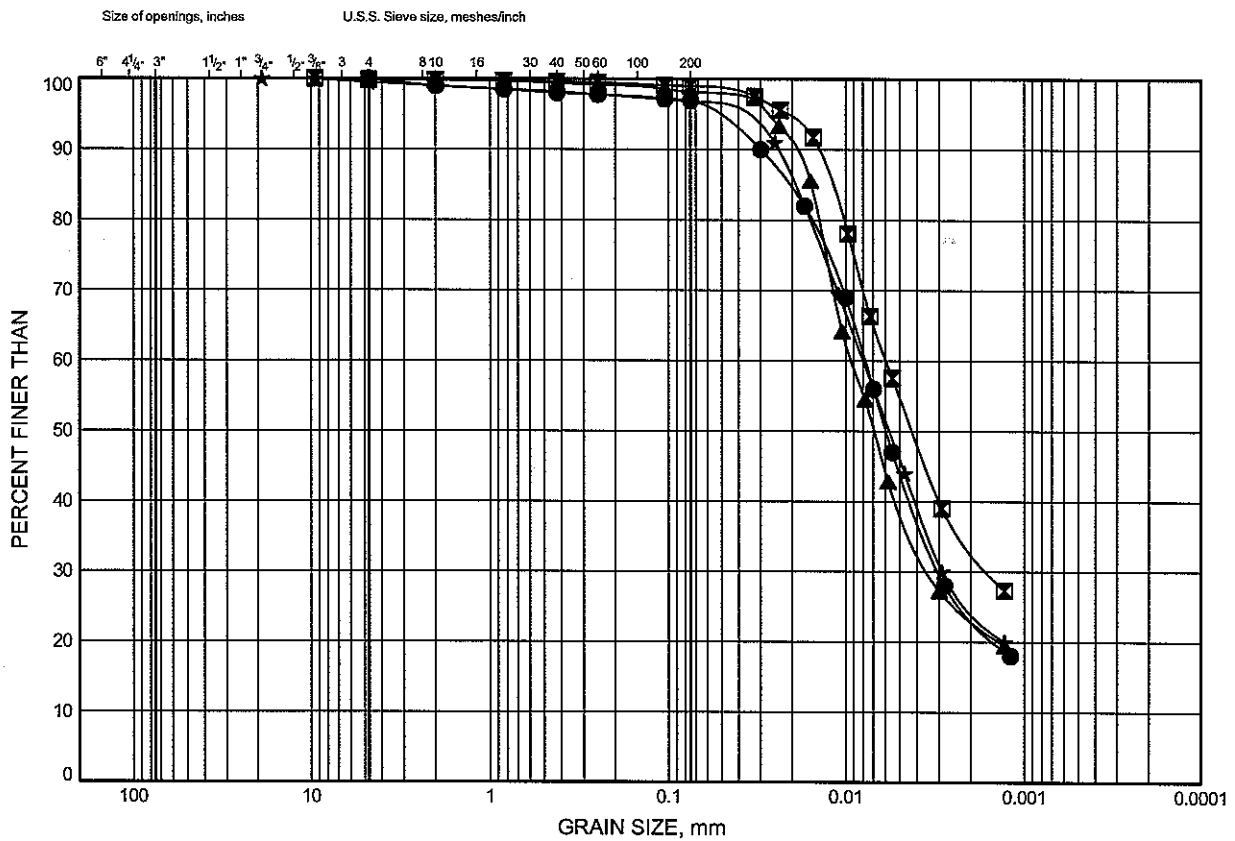


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 Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-22

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

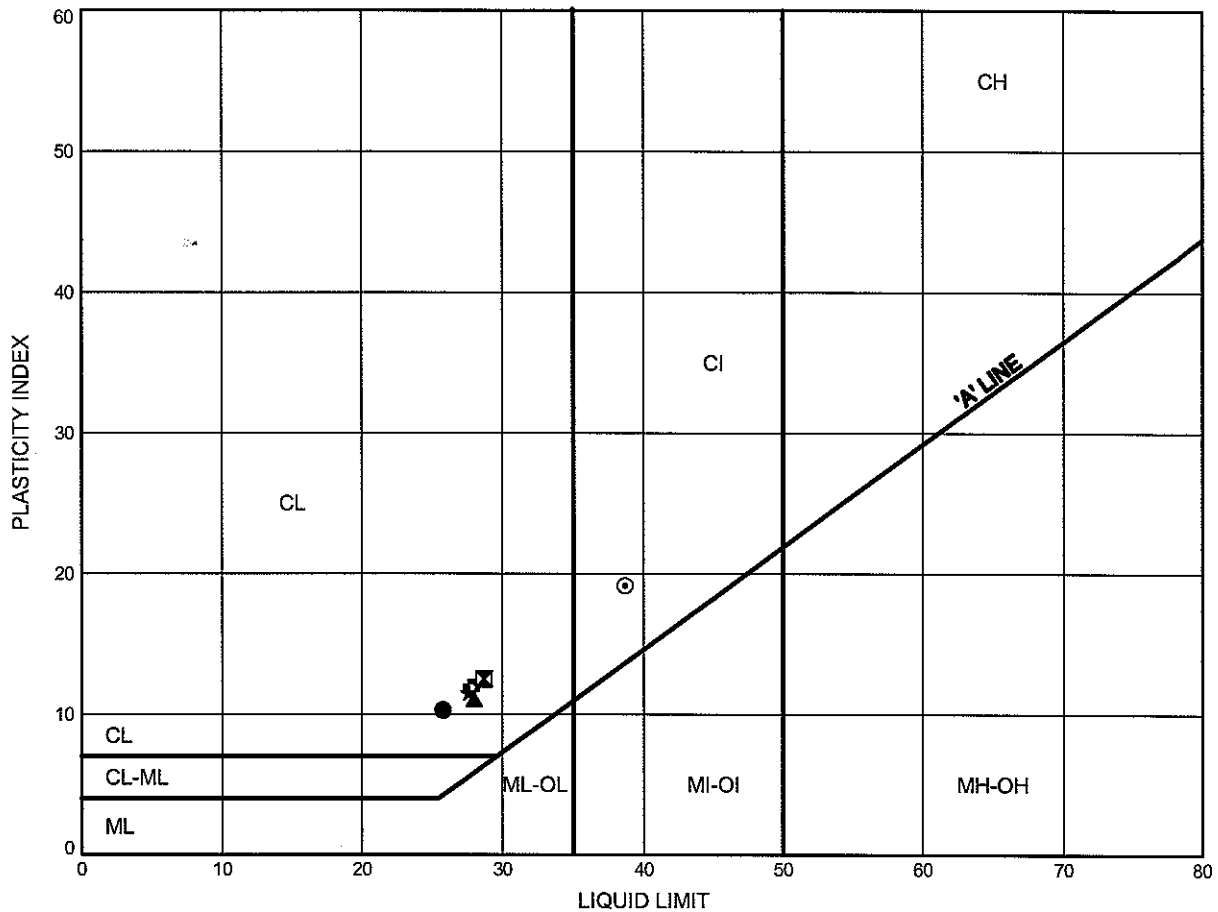
SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WE-S 10+295CL	9.3	173.5
⊠	WE-S 10+345CL	2.5	180.3
▲	WE-S 10+345CL	7.8	175.0
★	WE-S 10+345CL	10.9	171.9

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FIGURE B2-23



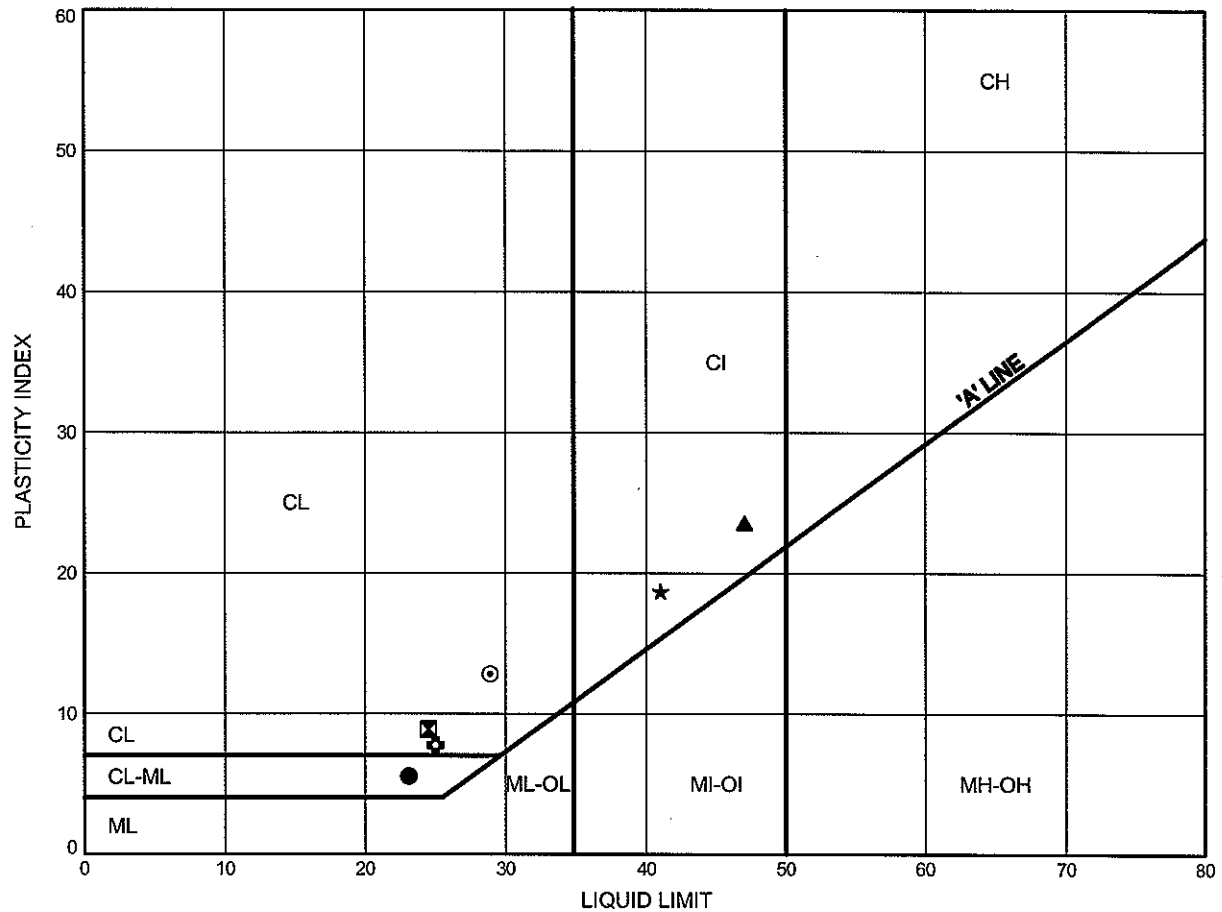
SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+375Lt	4.7	178.6
⊠	NBL 12+375Lt	7.8	175.5
▲	NBL 12+375Lt	9.3	174.0
★	NBL 12+375Lt	10.9	172.4
⊙	NBL 12+440Rt	3.2	179.8
⊕	NBL 12+440Rt	6.3	176.7

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FIGURE B2-24



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+440Rt	7.8	175.2
⊠	NBL 12+440Rt	12.4	170.6
▲	SBL 12+360CL	1.0	181.9
★	SBL 12+360CL	3.2	179.7
⊙	SBL 12+360CL	7.8	175.1
⊛	SBL 12+360CL	12.4	170.5

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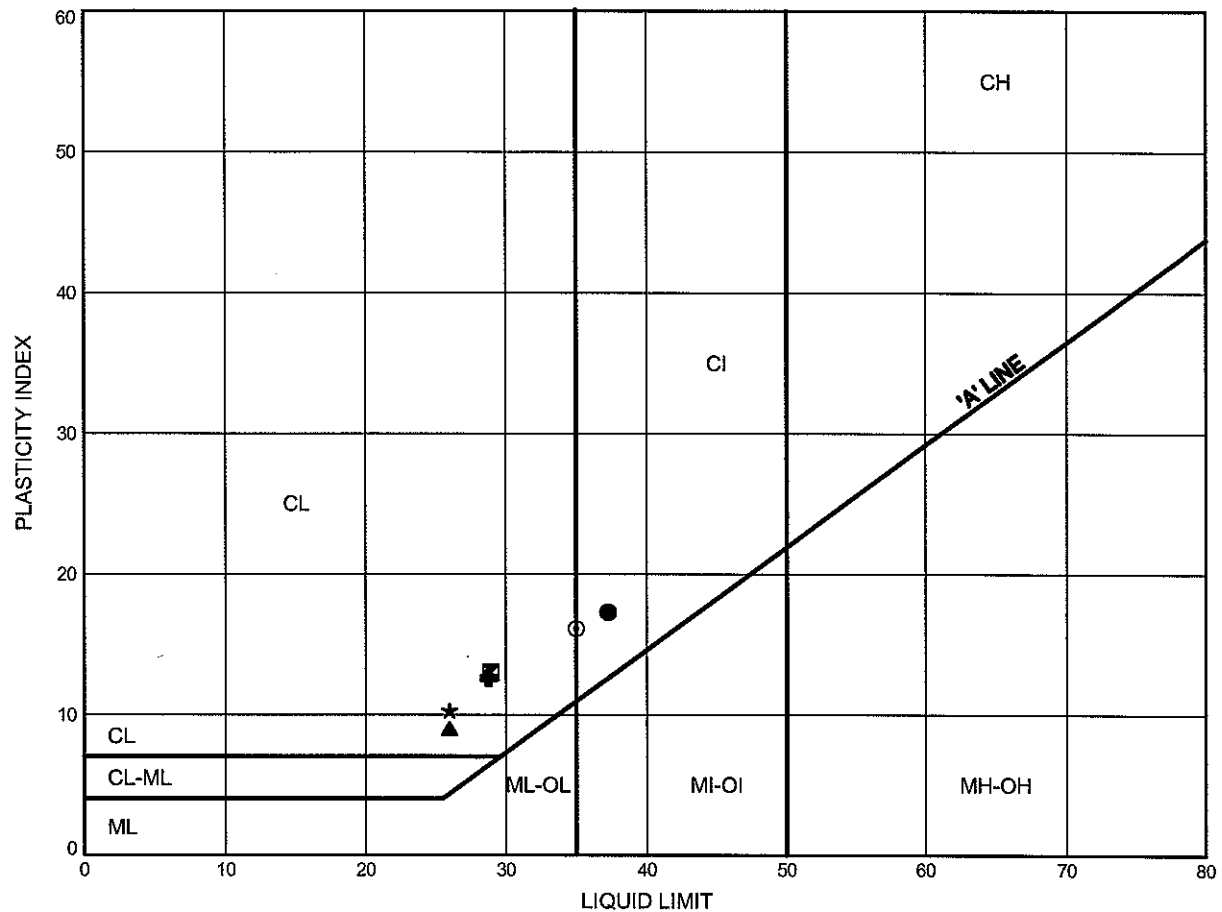
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-25

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SBL 12+410CL	1.7	180.8
⊠	SBL 12+410CL	4.7	177.8
▲	SBL 12+410CL	9.3	173.2
★	SBL 12+410CL	10.9	171.6
⊙	S-EW 10+050CL	3.2	180.2
⊛	S-EW 10+050CL	6.3	177.1

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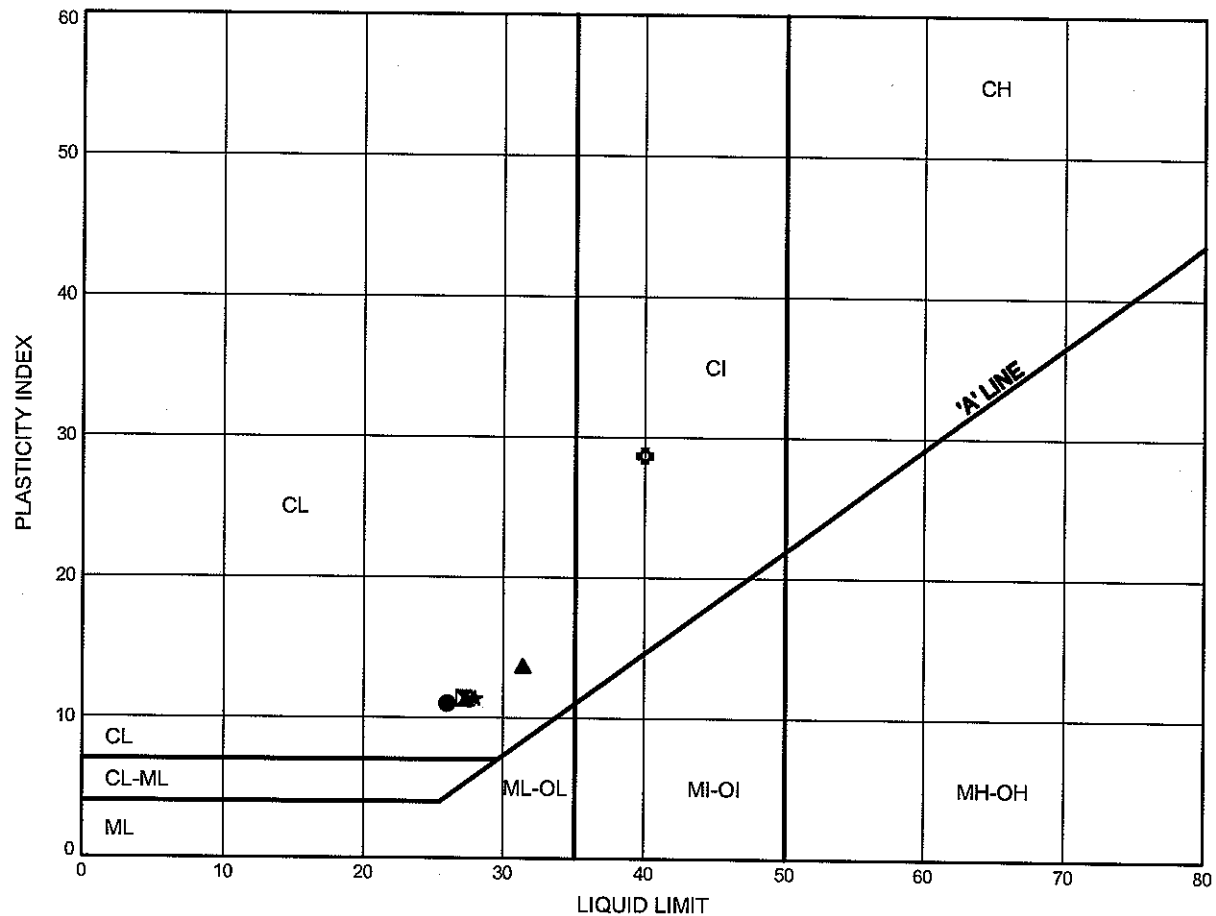
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

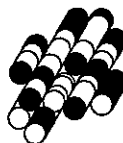
FIGURE B2-26

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	S-EW 10+050CL	9.3	174.1
⊠	S-EW 10+050CL	10.9	172.5
▲	TEW1	2.5	180.0
★	TEW1	4.7	177.8
⊙	TEW1	9.3	173.2
⊕	TEW2	2.5	180.2

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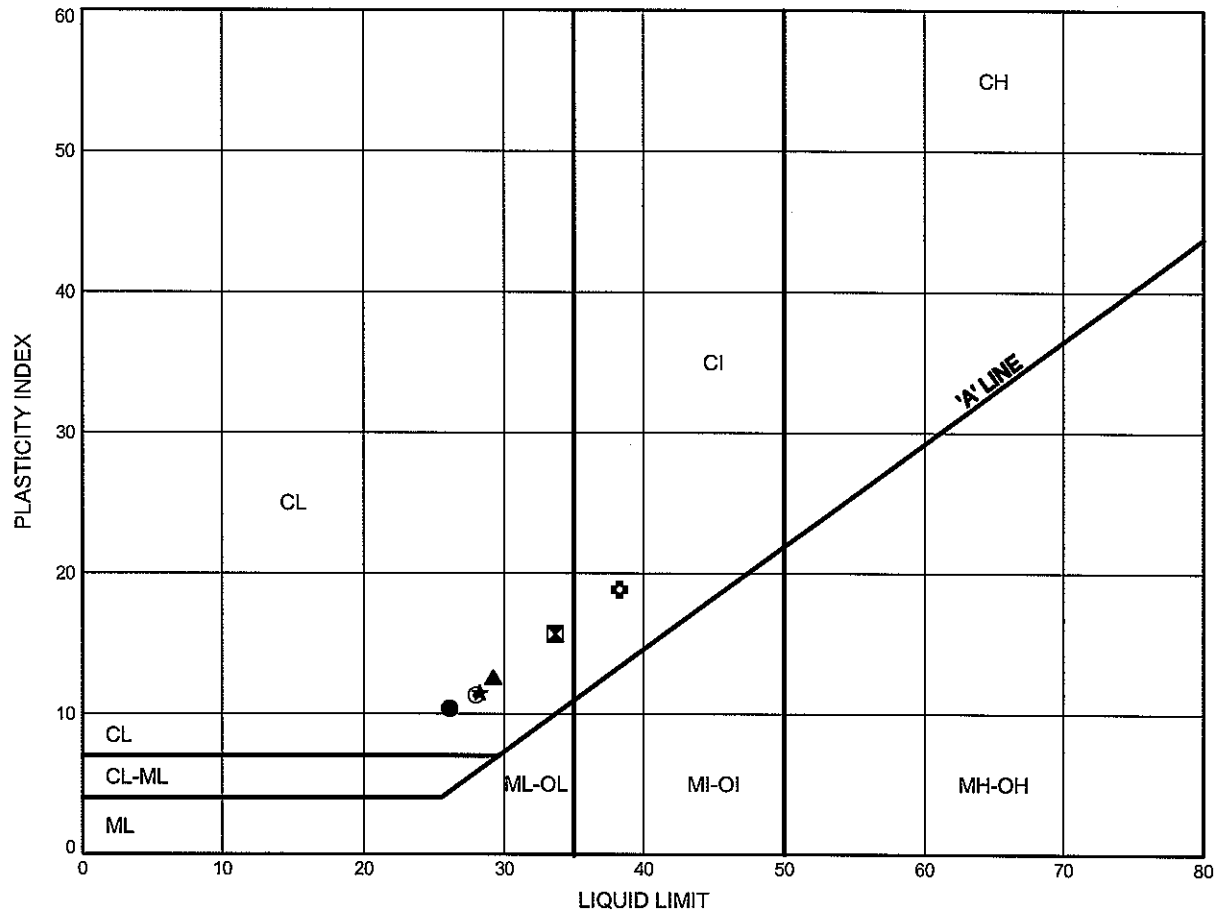


Prep'd JS
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-27

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW2	13.9	168.8
⊠	TEW3	3.2	179.4
▲	TEW3	4.7	177.9
★	TEW3	7.8	174.8
⊙	TEW3	10.9	171.7
⊕	TEW4	1.0	181.6

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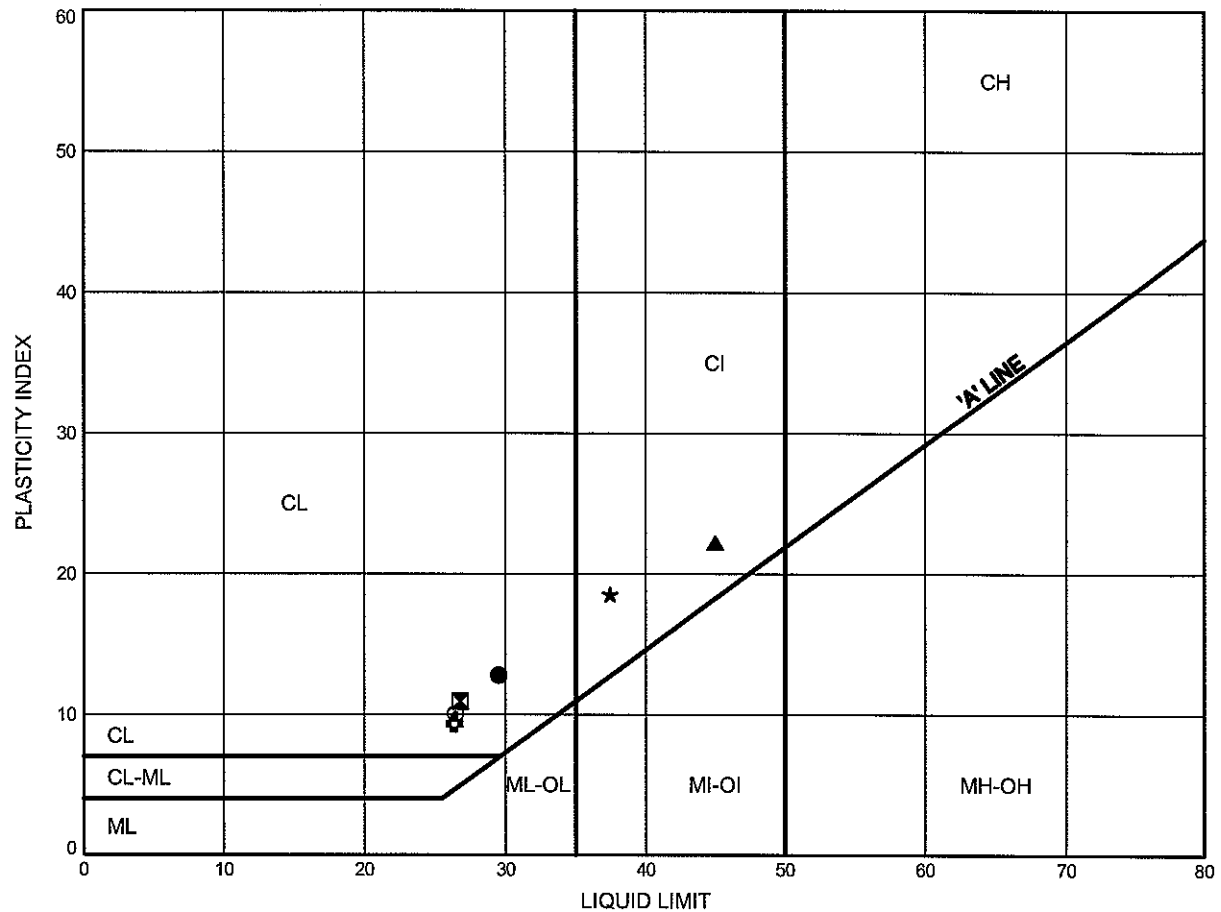
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-28

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW4	4.7	177.9
⊠	TEW4	9.3	173.3
▲	TN1	2.5	181.0
★	TN1	4.7	178.8
⊙	TN1	7.8	175.7
⊕	TN1	10.9	172.6

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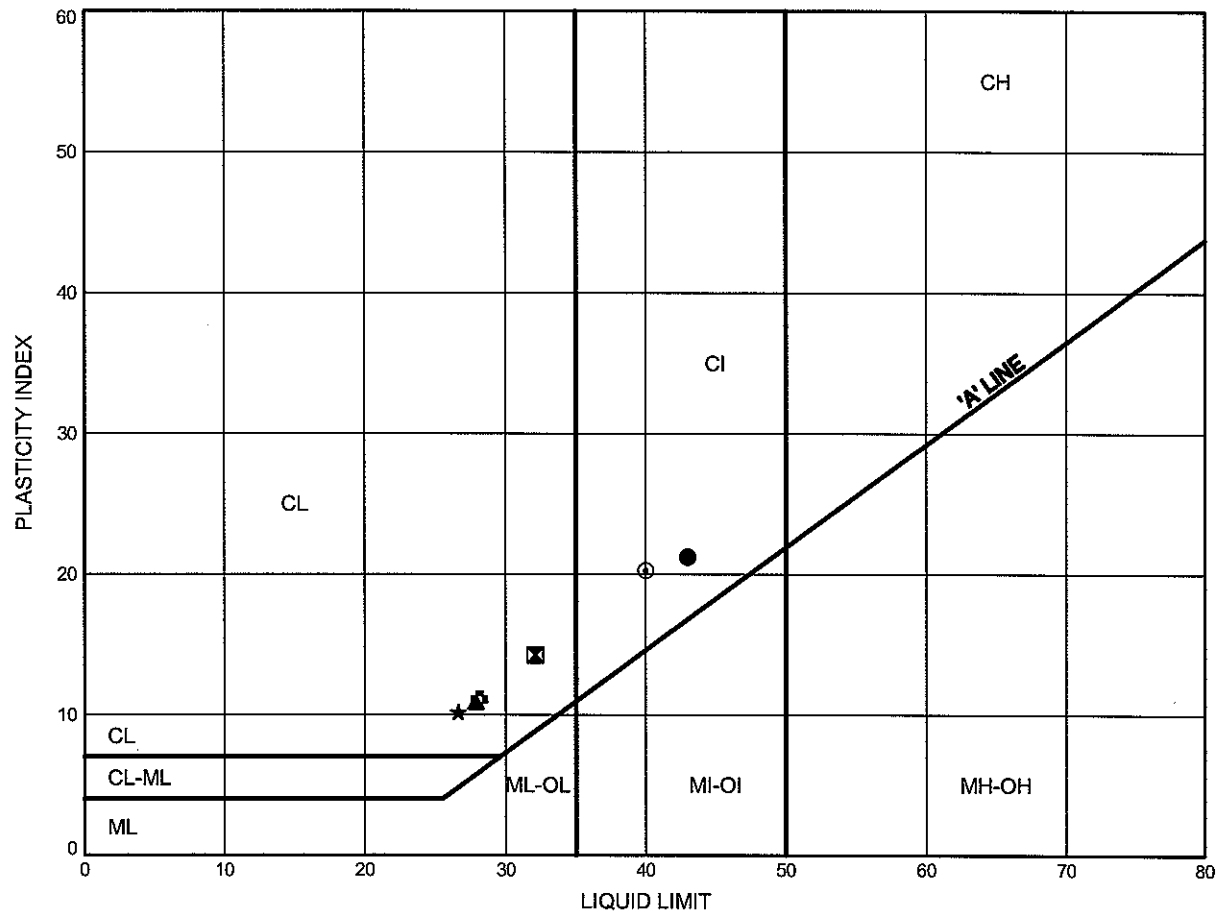


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Chkd. MP

ATTERBERG LIMITS TEST RESULTS

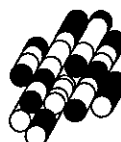
FIGURE B2-29

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TN2	3.2	181.0
⊠	TN2	5.5	178.7
▲	TN2	9.3	174.9
★	TN2	13.9	170.3
⊙	TN3	4.0	180.1
⊕	TN3	5.5	178.6

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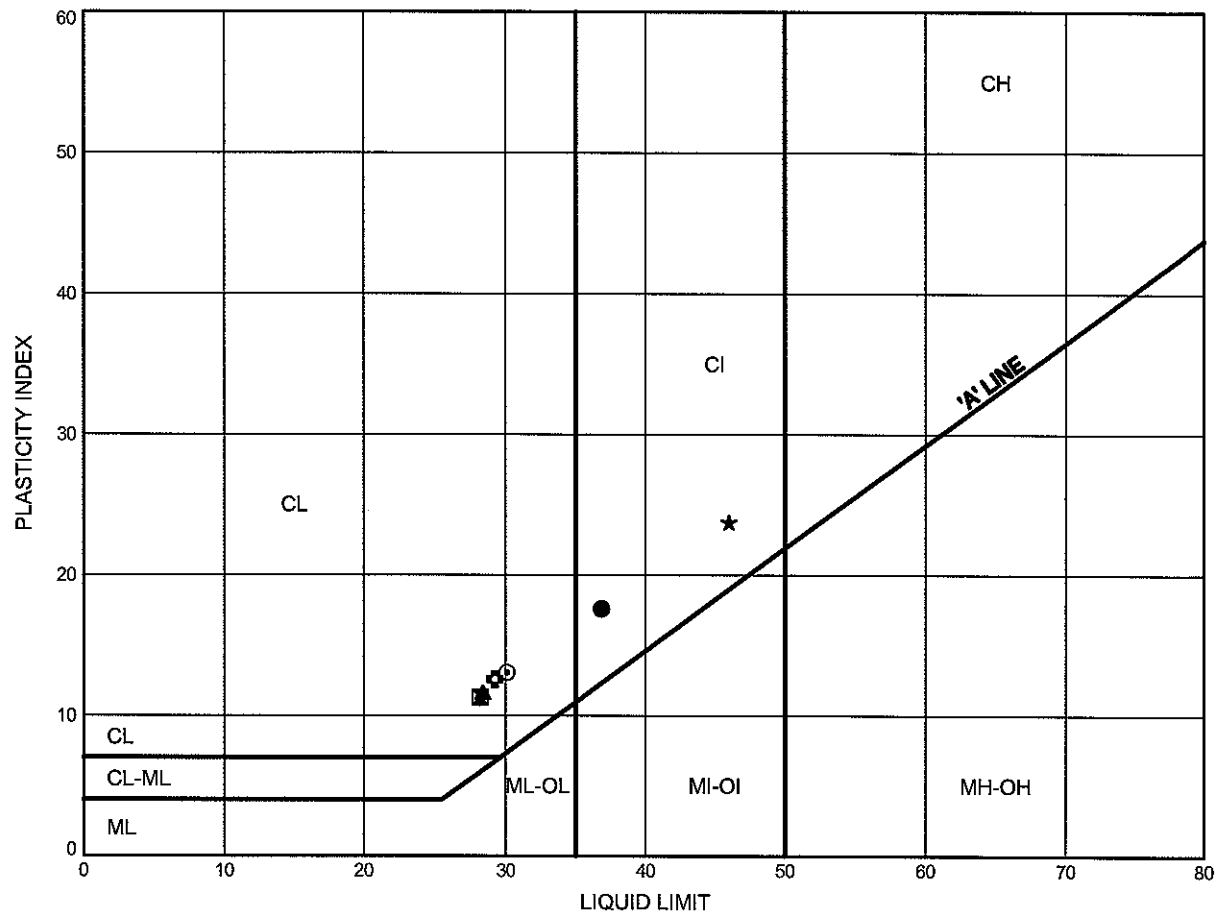


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ATTERBERG LIMITS TEST RESULTS

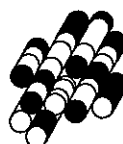
FIGURE B2-31

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW1	3.2	180.0
⊠	TRW1	4.7	178.5
▲	TRW1	10.9	172.3
★	TRW2	1.0	181.5
⊙	TRW2	4.0	178.5
⊕	TRW2	7.8	174.7

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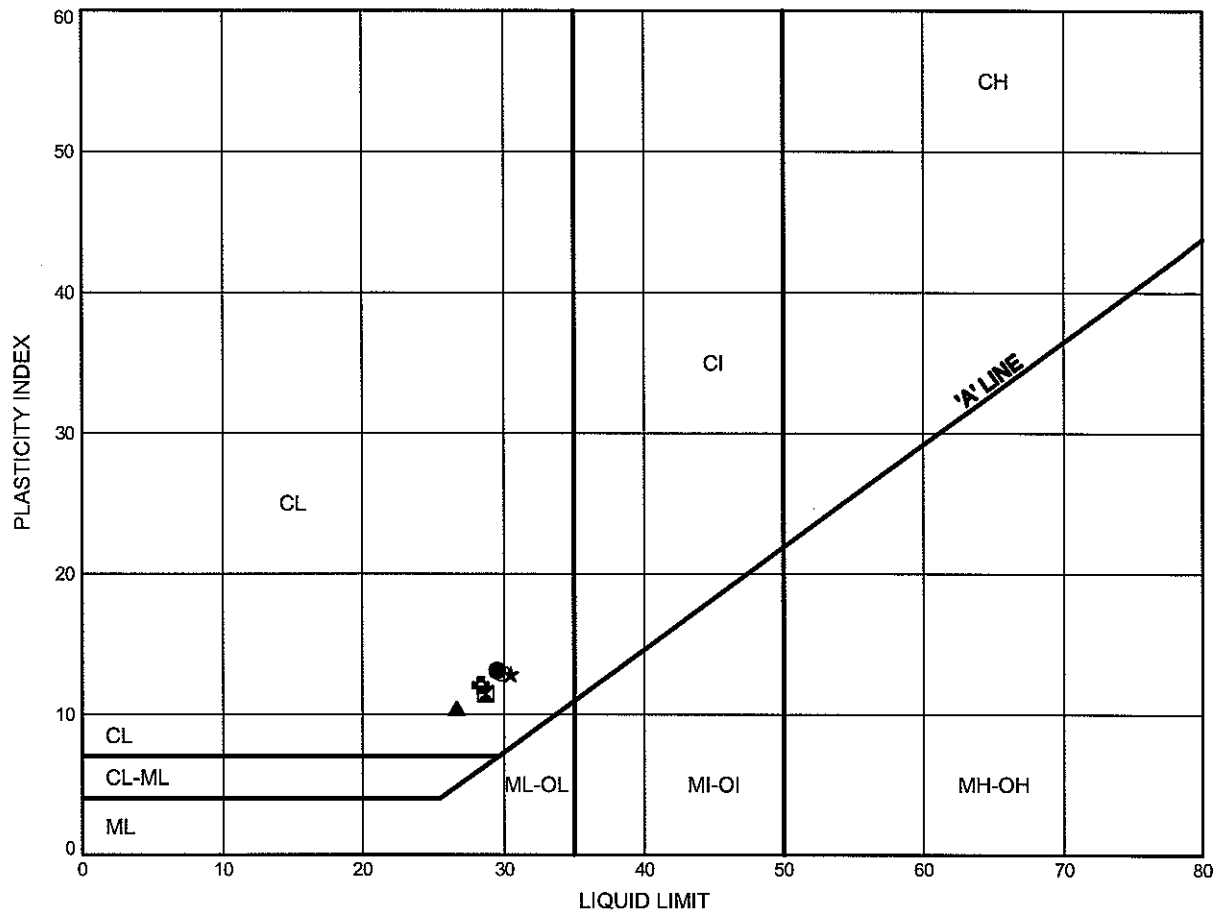


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ATTERBERG LIMITS TEST RESULTS

FIGURE B2-32

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW2	13.9	168.6
⊠	TRW3	4.7	178.4
▲	TRW3	10.9	172.2
★	TRW4	2.5	181.5
⊙	TRW4	4.7	179.3
⊕	TRW4	7.8	176.2

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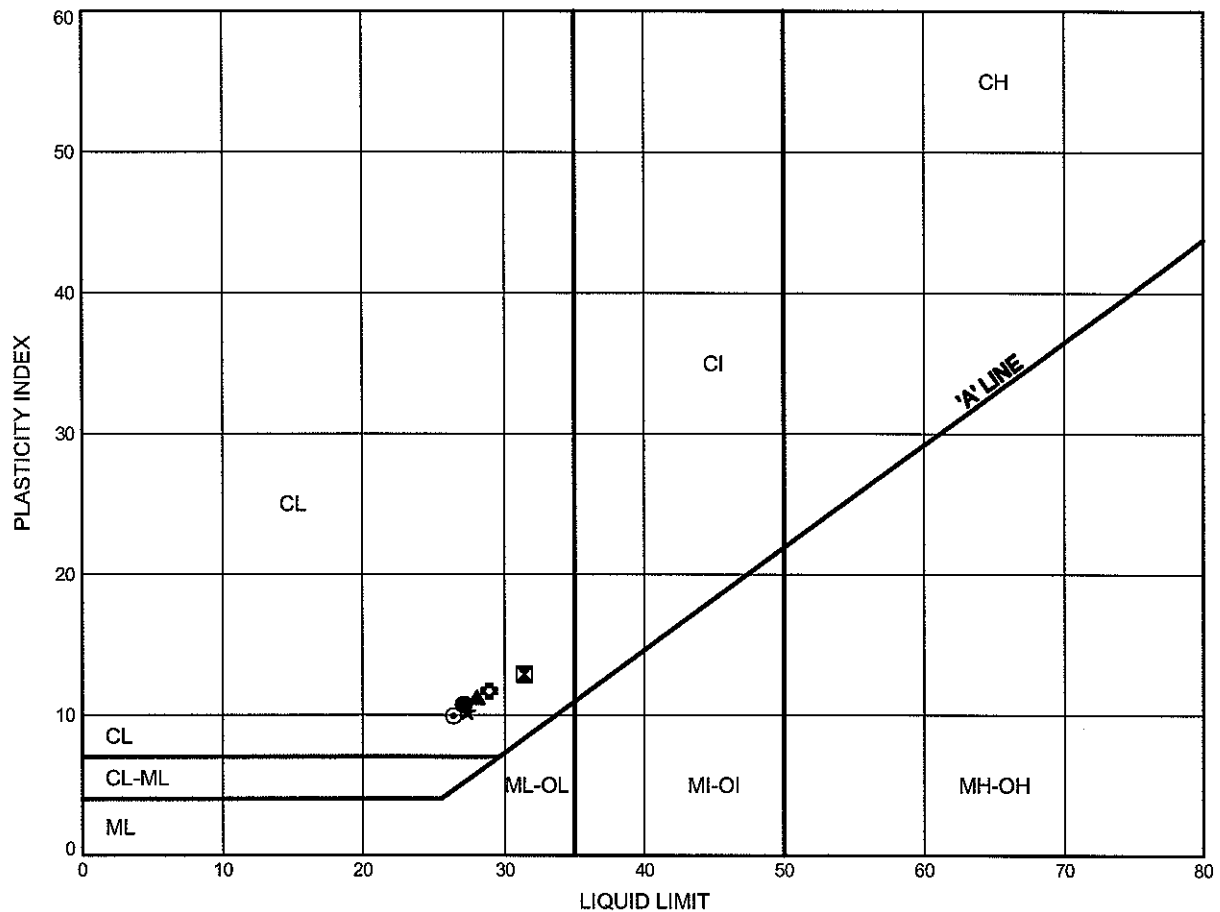
Prep'd DB

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ATTERBERG LIMITS TEST RESULTS

FIGURE B2-33

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW4	12.4	171.6
⊠	TS1	2.5	180.1
▲	TS1	4.7	177.9
★	TS1	9.3	173.3
⊙	TS1	13.9	168.7
⊕	TS2	5.5	177.8

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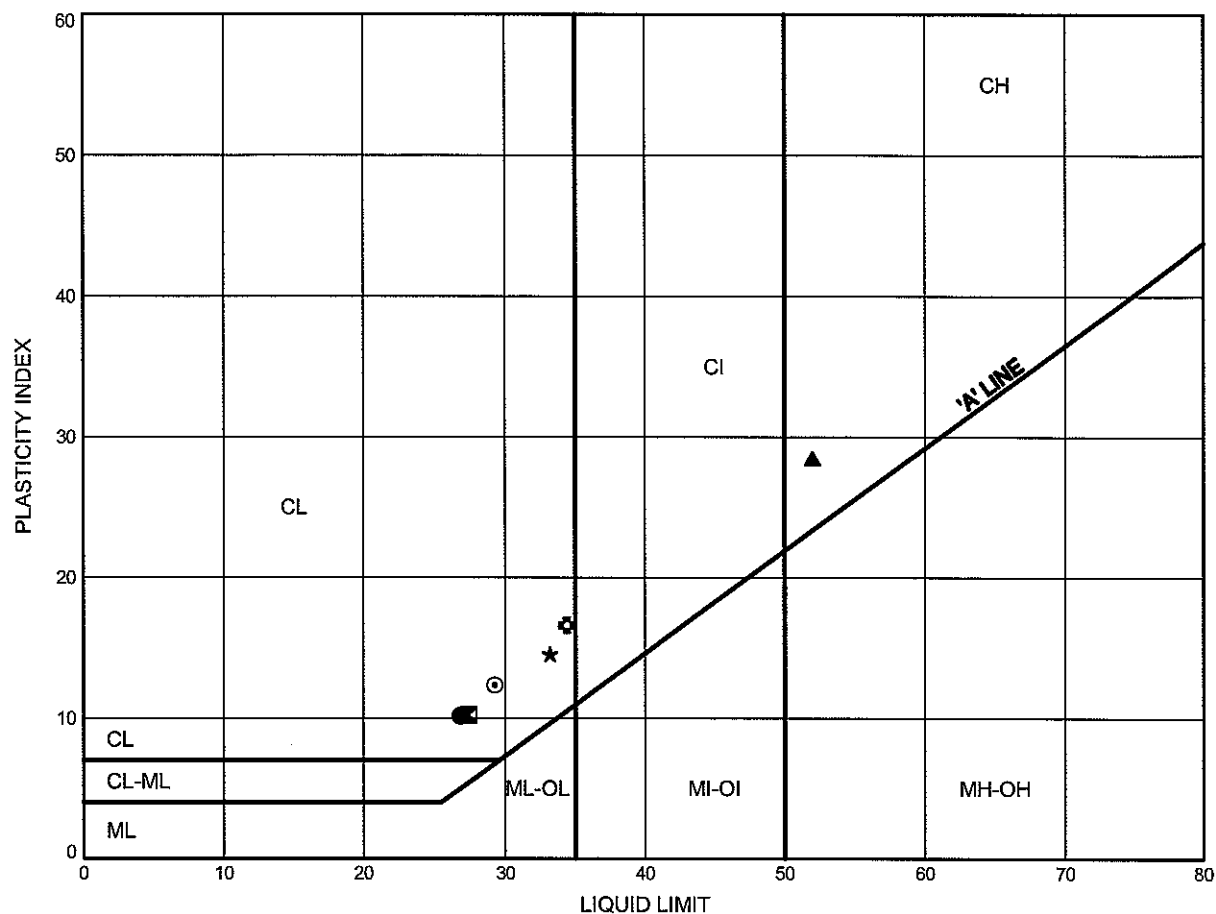
Prep'd DB.....

Chkd. MP.....

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-34

SILTY CLAY



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TS2	9.3	174.0
⊠	TS2	13.9	169.4
▲	TS3	1.7	180.8
★	TS3	4.0	178.5
⊙	TS3	6.3	176.2
⊕	TS3	10.9	171.6

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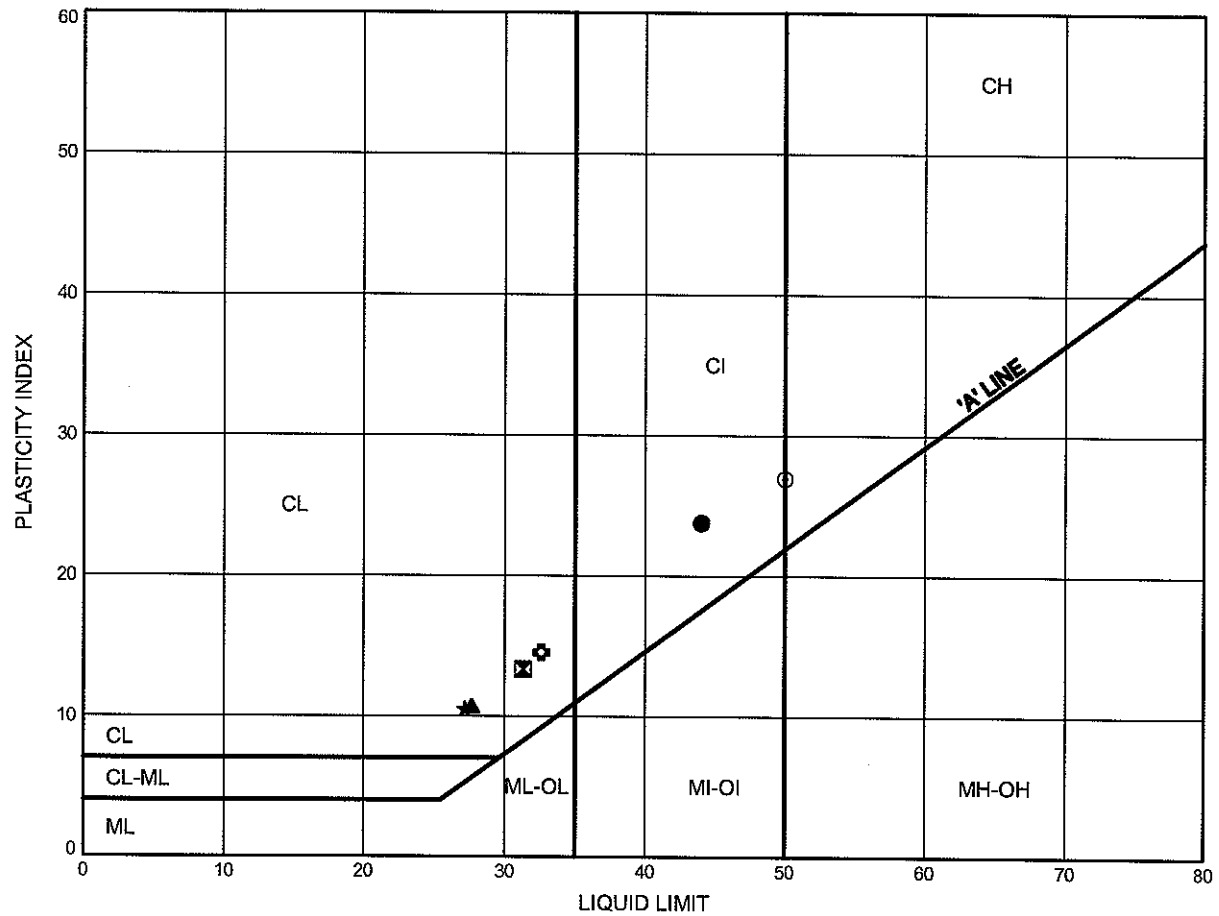
Prep'd DB

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ATTERBERG LIMITS TEST RESULTS

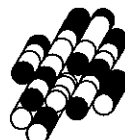
FIGURE B2-35

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS4	1.0	181.4
⊠	TS4	3.2	179.2
▲	TS4	6.3	176.1
★	TS4	9.3	173.1
⊙	TSEW1	1.7	181.8
⊛	TSEW1	4.0	179.5

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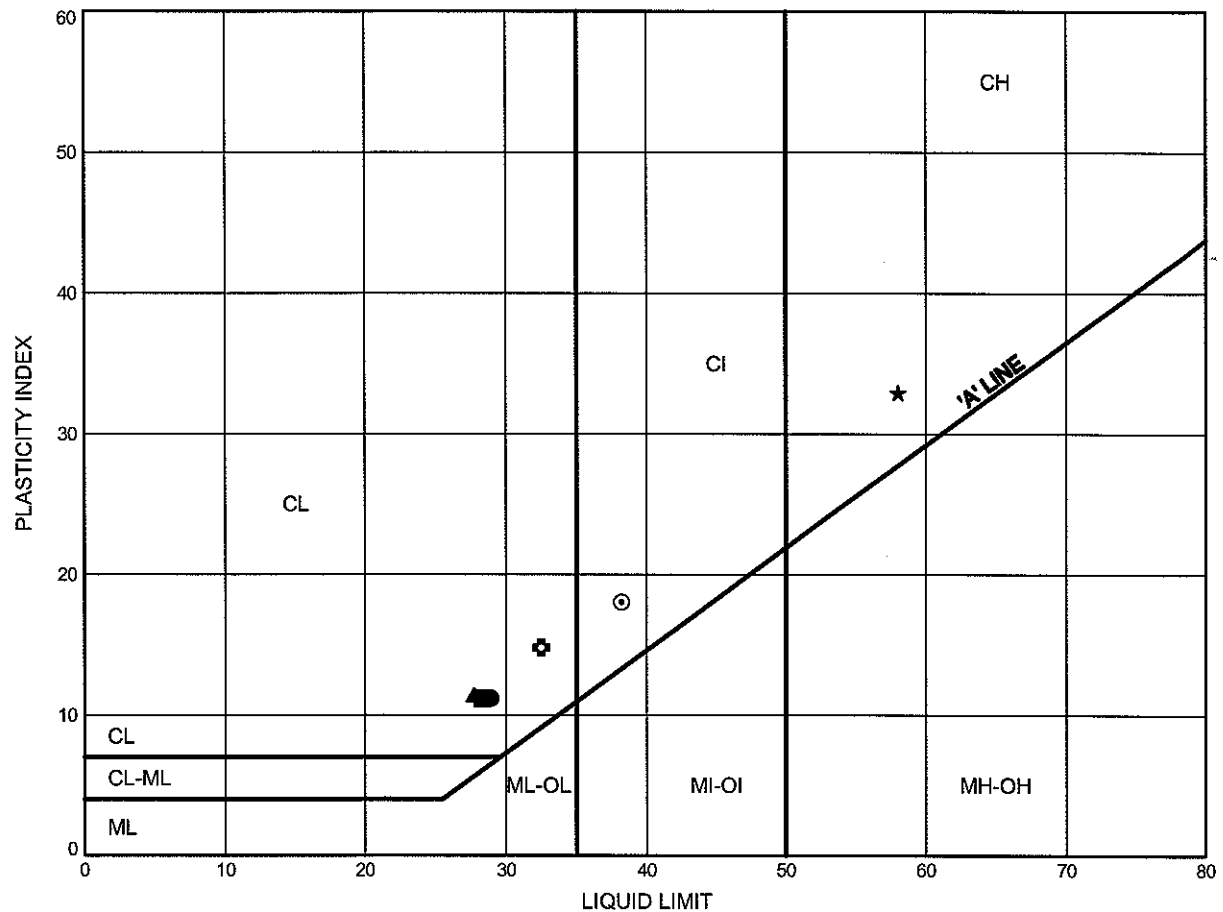


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ATTERBERG LIMITS TEST RESULTS

FIGURE B2-36

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW1	6.3	177.2
⊠	TSEW1	9.3	174.2
▲	TSEW1	12.4	171.1
★	TSEW2	1.0	182.3
⊙	TSEW2	2.5	180.8
⊕	TSEW2	5.5	177.8

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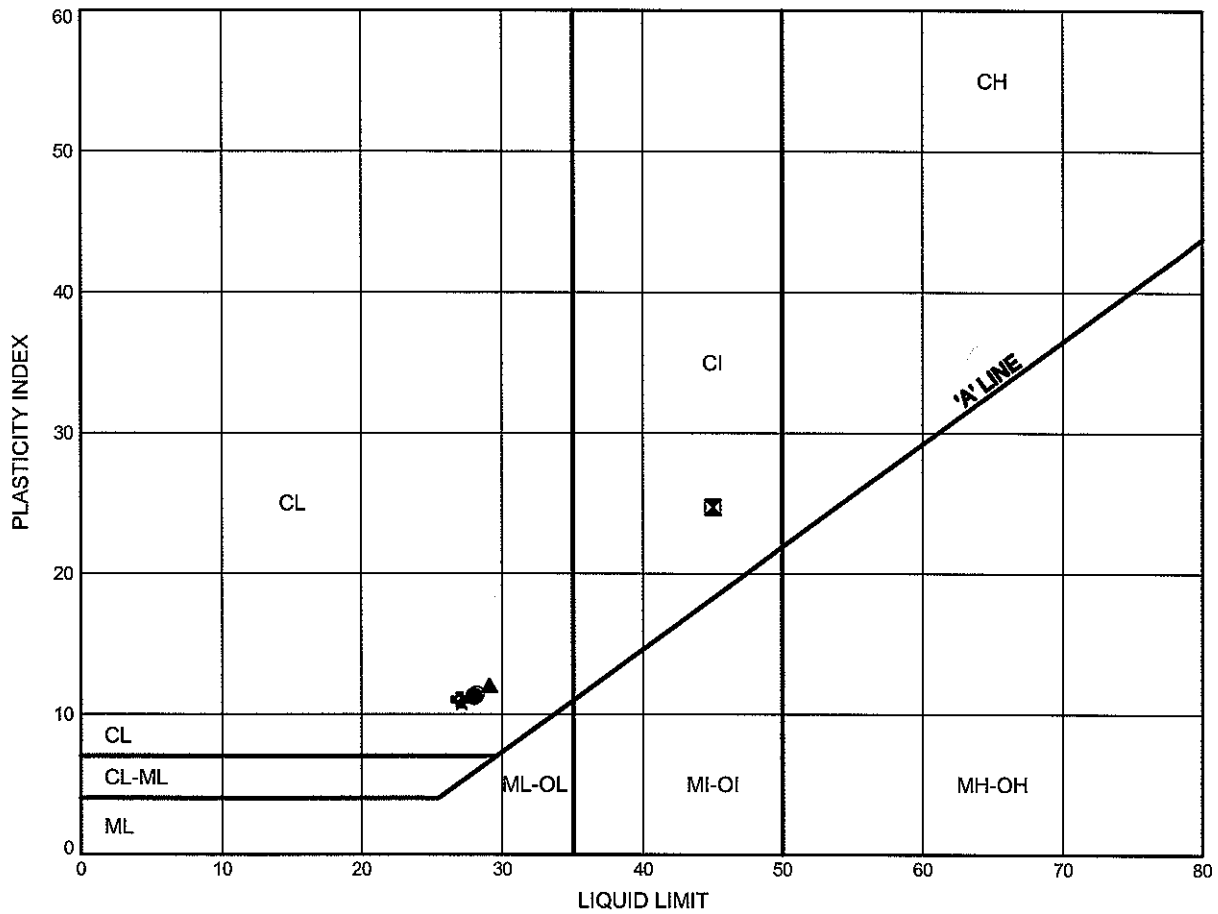
Prep'd DB.....

Chkd. MP.....

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-37

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW2	9.3	174.0
⊠	TSEW3	3.2	180.1
▲	TSEW3	4.7	178.6
★	TSEW3	9.3	174.0
⊙	TSEW3	10.9	172.4
⊛	TSEW3	12.4	170.9

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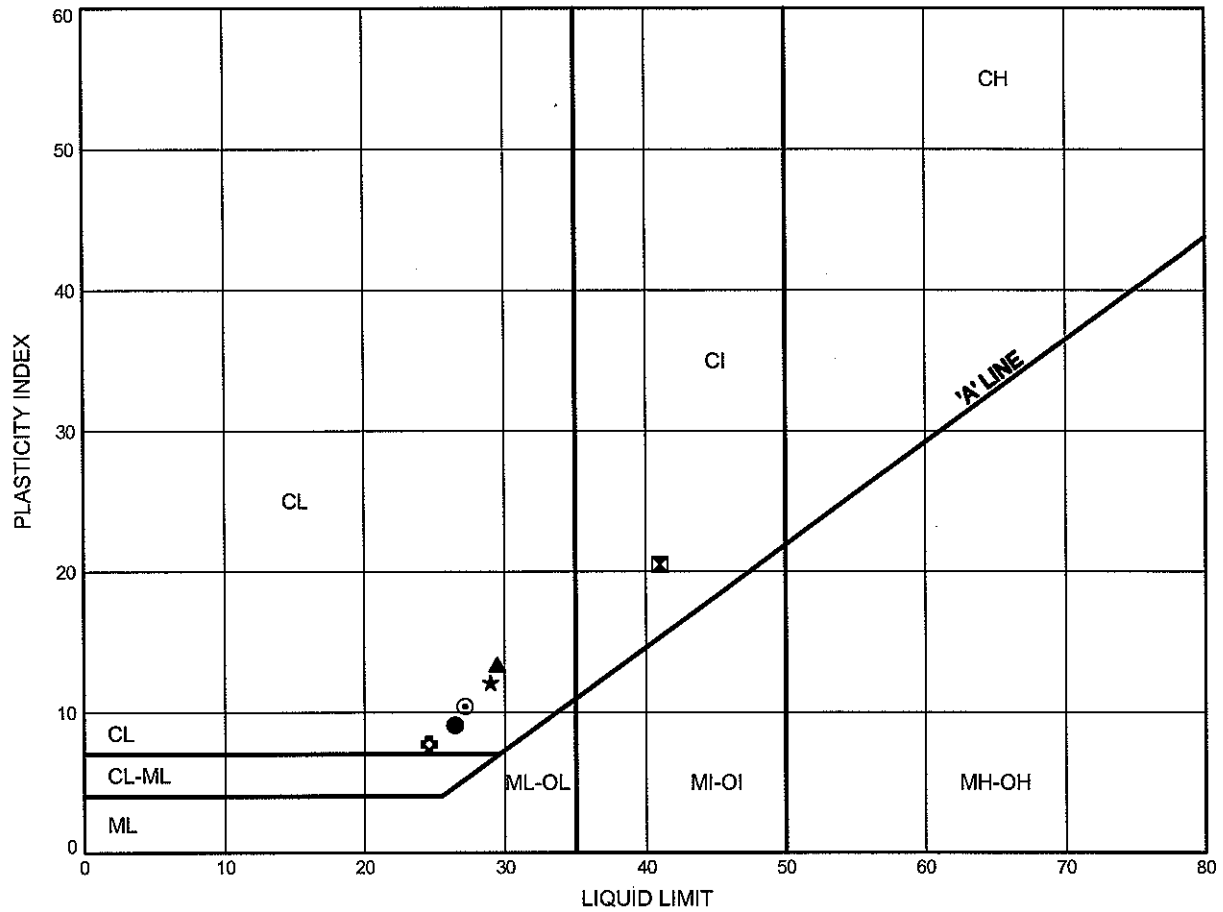
Prep'd DB

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ATTERBERG LIMITS TEST RESULTS

FIGURE B2-38

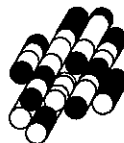
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW3	13.9	169.4
⊠	TSEW4	2.5	181.0
▲	TSEW4	4.7	178.8
★	TSEW4	7.8	175.7
⊙	TSEW4	9.3	174.2
⊕	TSEW4	12.4	171.1

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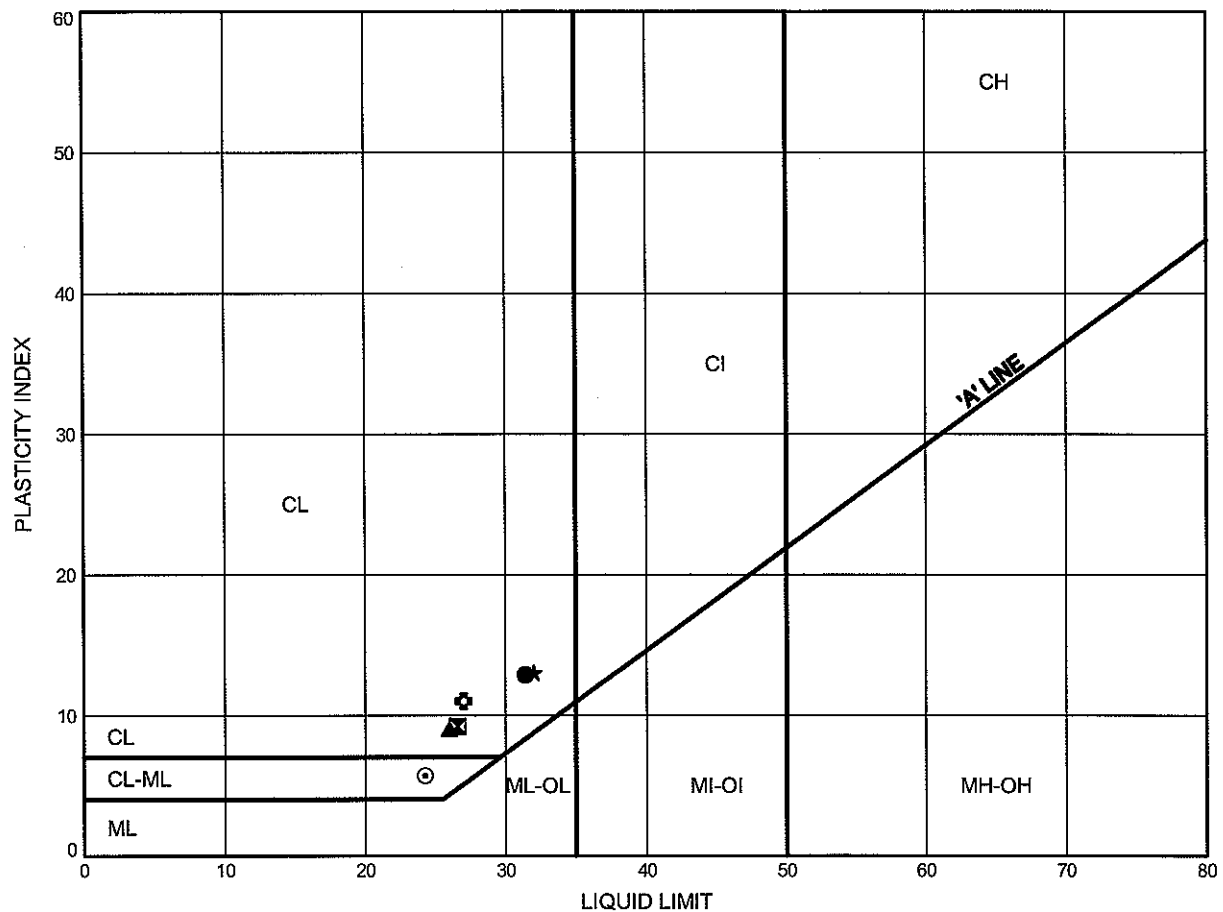
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FIGURE B2-39



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WE-S 10+295CL	2.5	180.3
⊠	WE-S 10+295CL	7.8	175.0
▲	WE-S 10+295CL	9.3	173.5
★	WE-S 10+345CL	2.5	180.3
⊙	WE-S 10+345CL	7.8	175.0
⊕	WE-S 10+345CL	10.9	171.9

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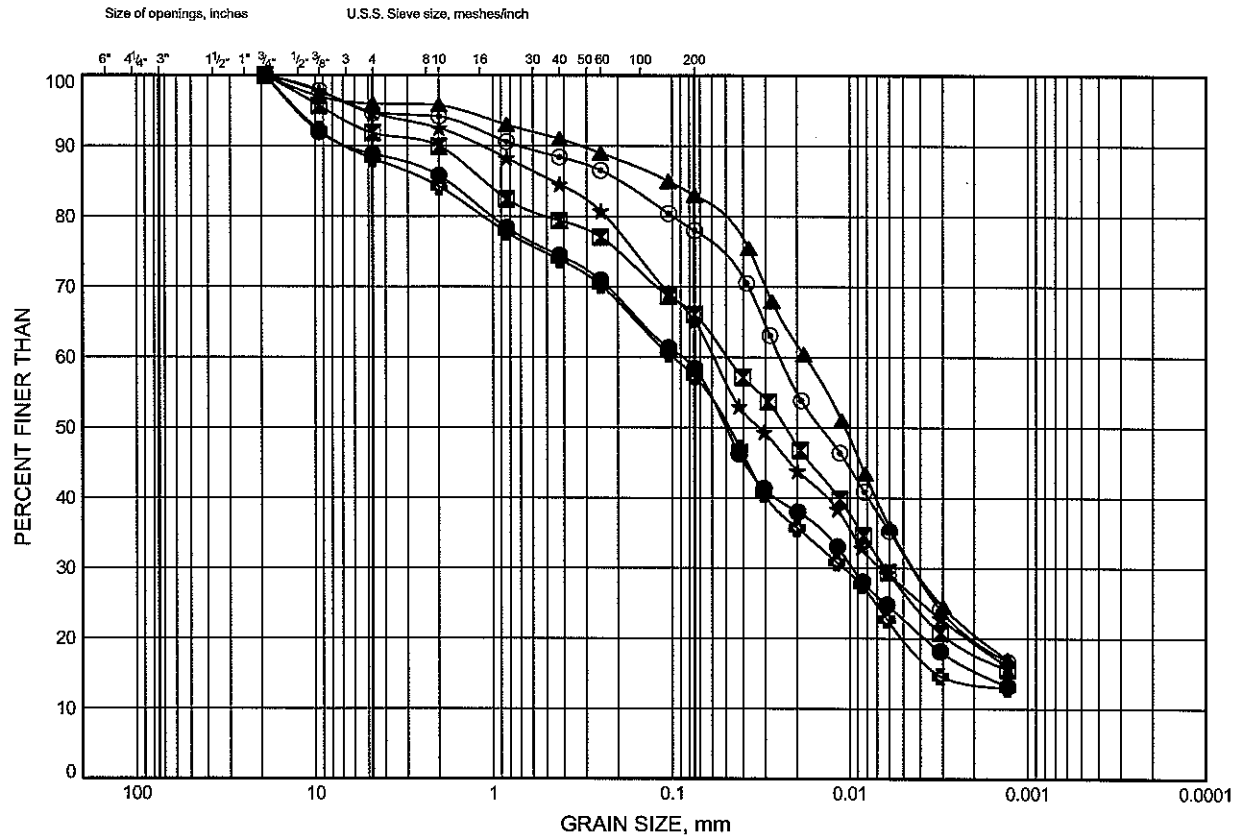
Prep'dDB.....

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GRAIN SIZE DISTRIBUTION

FIGURE B2-40

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TEW1	17.0	165.5
⊠	TEW2	15.4	167.3
▲	TEW3	17.0	165.6
★	TEW3	21.5	161.1
⊙	TEW4	15.4	167.2
⊕	TEW4	20.0	162.6

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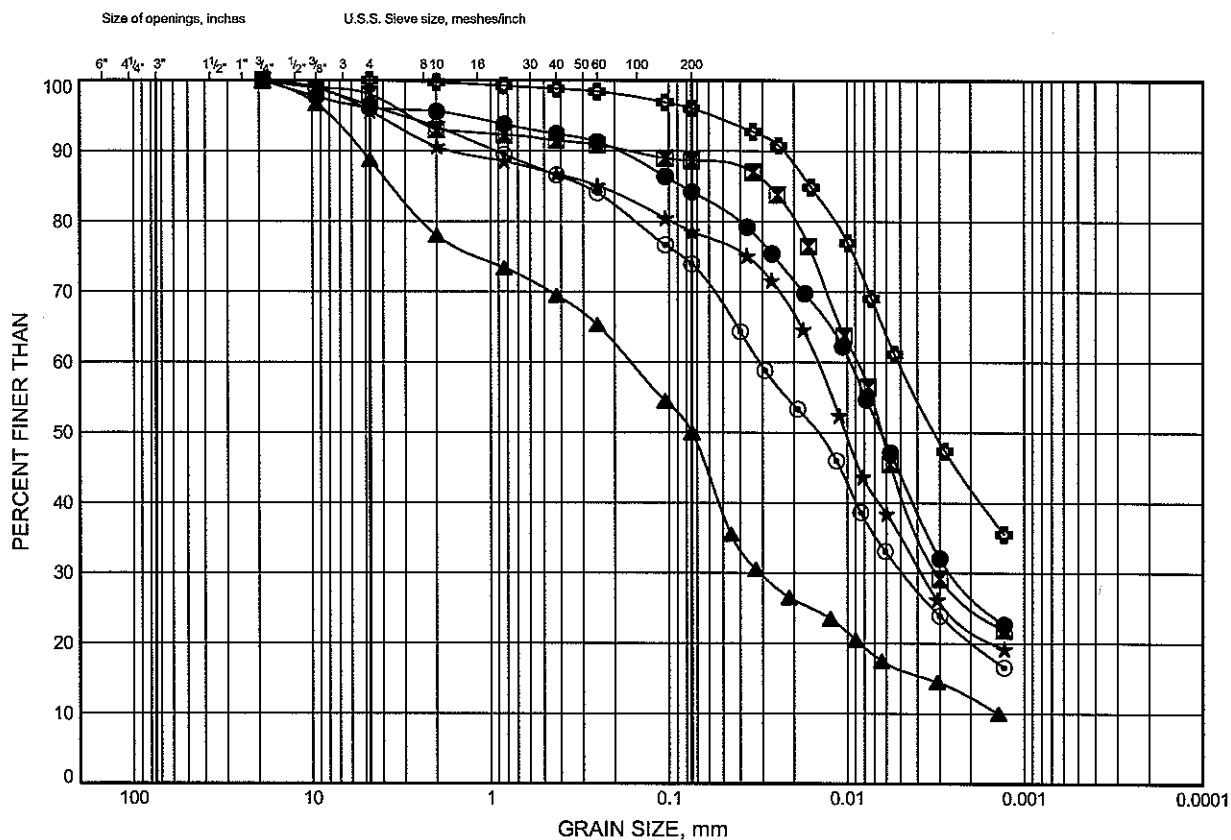
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-41

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TN1	15.4	168.1
⊠	TN2	15.4	168.8
▲	TN2	26.1	158.1
★	TN3	17.0	167.1
⊙	TN4	17.0	167.0
⊕	TN4	27.6	156.4

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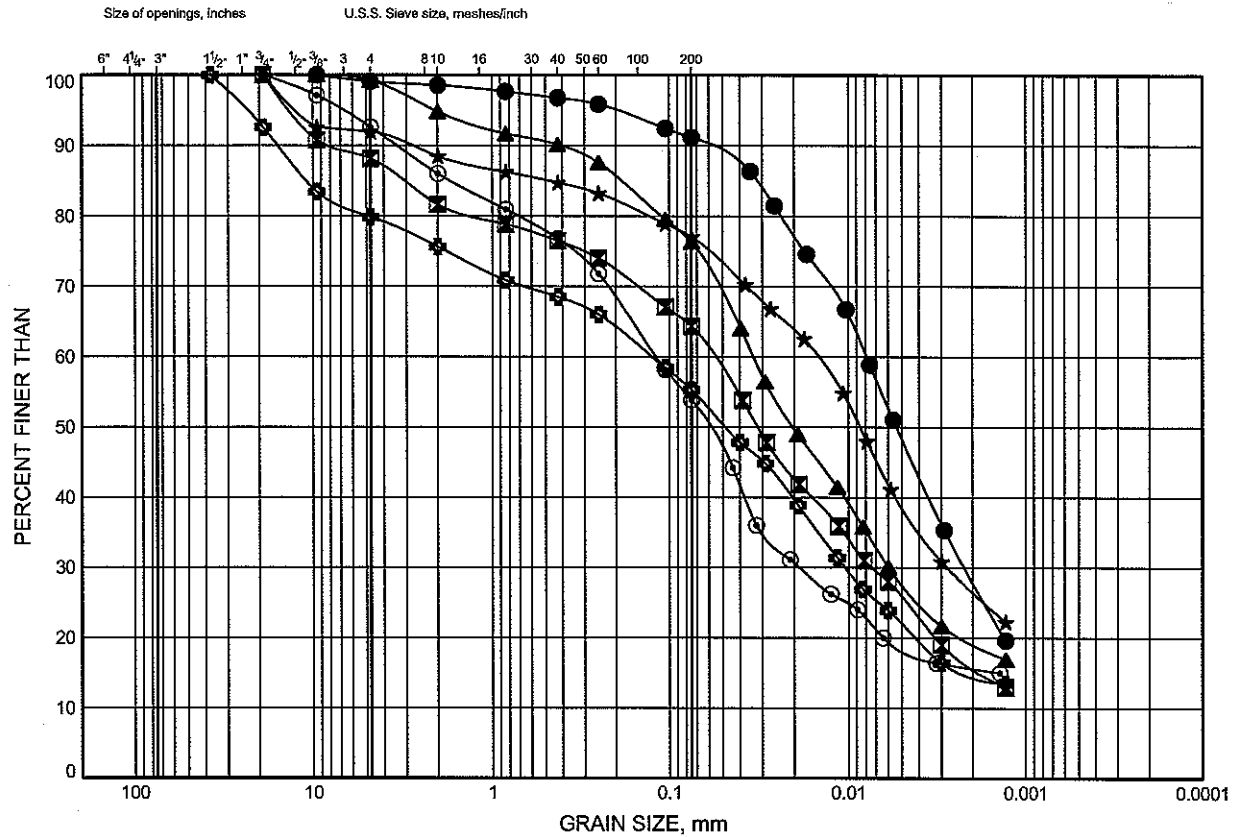
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-42

SILTY CLAY TO CLAYEY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TRW3	15.4	167.7
⊠	TS1	17.0	165.6
▲	TS1	26.1	156.5
★	TS2	15.4	167.9
⊙	TS2	23.1	160.2
⊕	TS3	18.5	164.0

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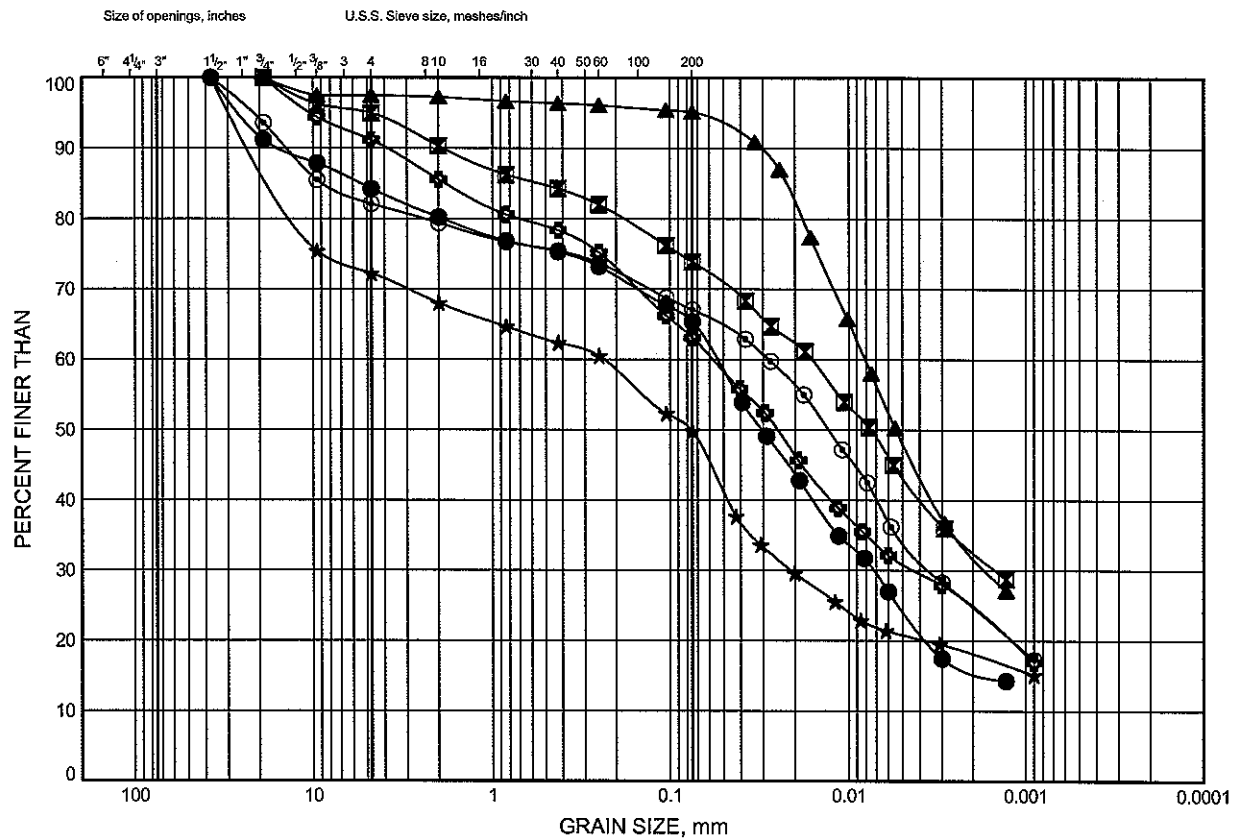
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-43

SILTY CLAY TO CLAYEY SILT TILL

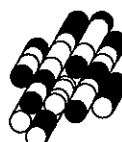


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS4	15.4	167.0
⊠	TSEW1	26.1	157.4
▲	TSEW2	26.1	157.2
★	TSEW3	26.1	157.2
⊙	TSEW4	18.5	165.0
⊕	TSEW4	26.1	157.4

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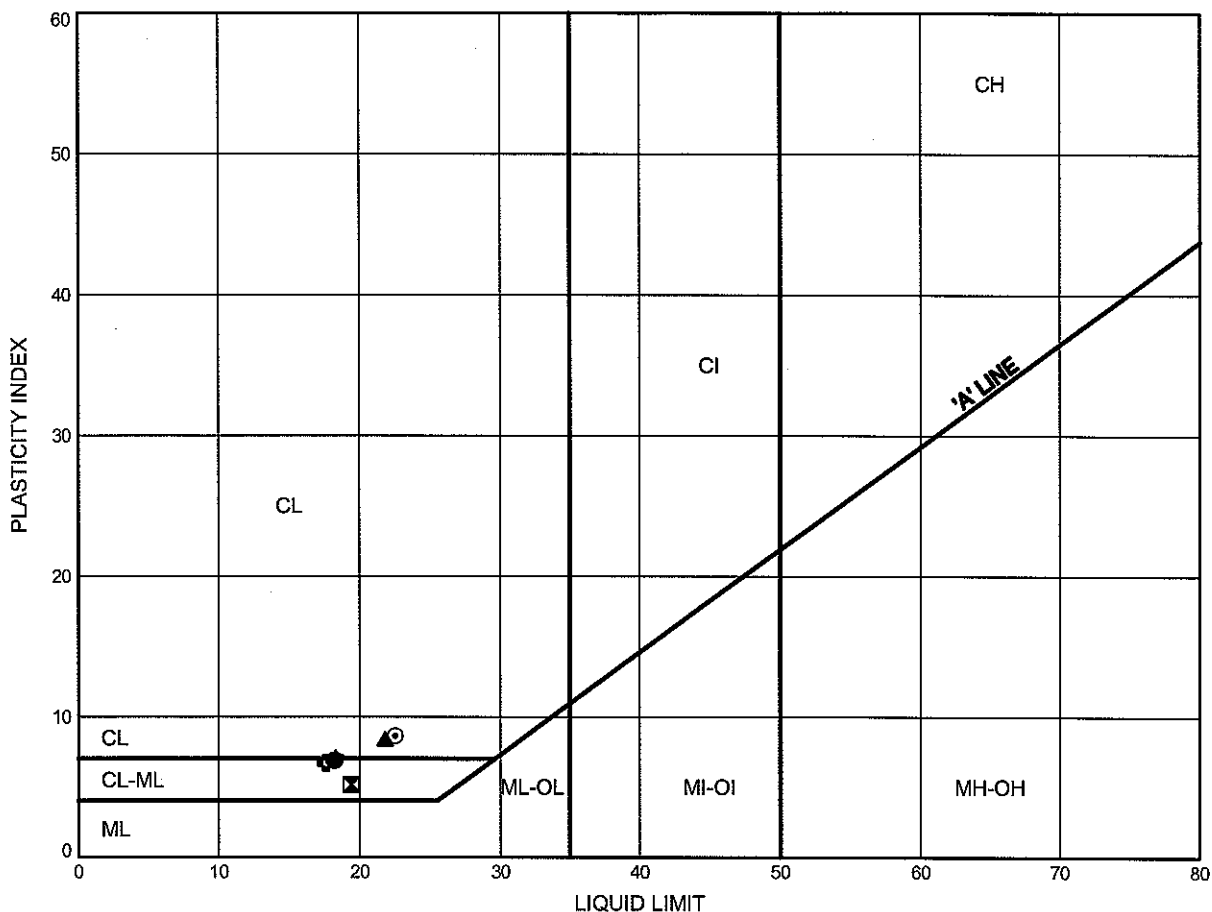
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-44

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TEW1	17.0	165.5
⊠	TEW2	15.4	167.3
▲	TEW3	17.0	165.6
★	TEW3	21.5	161.1
⊙	TEW4	15.4	167.2
⊕	TEW4	20.0	162.6

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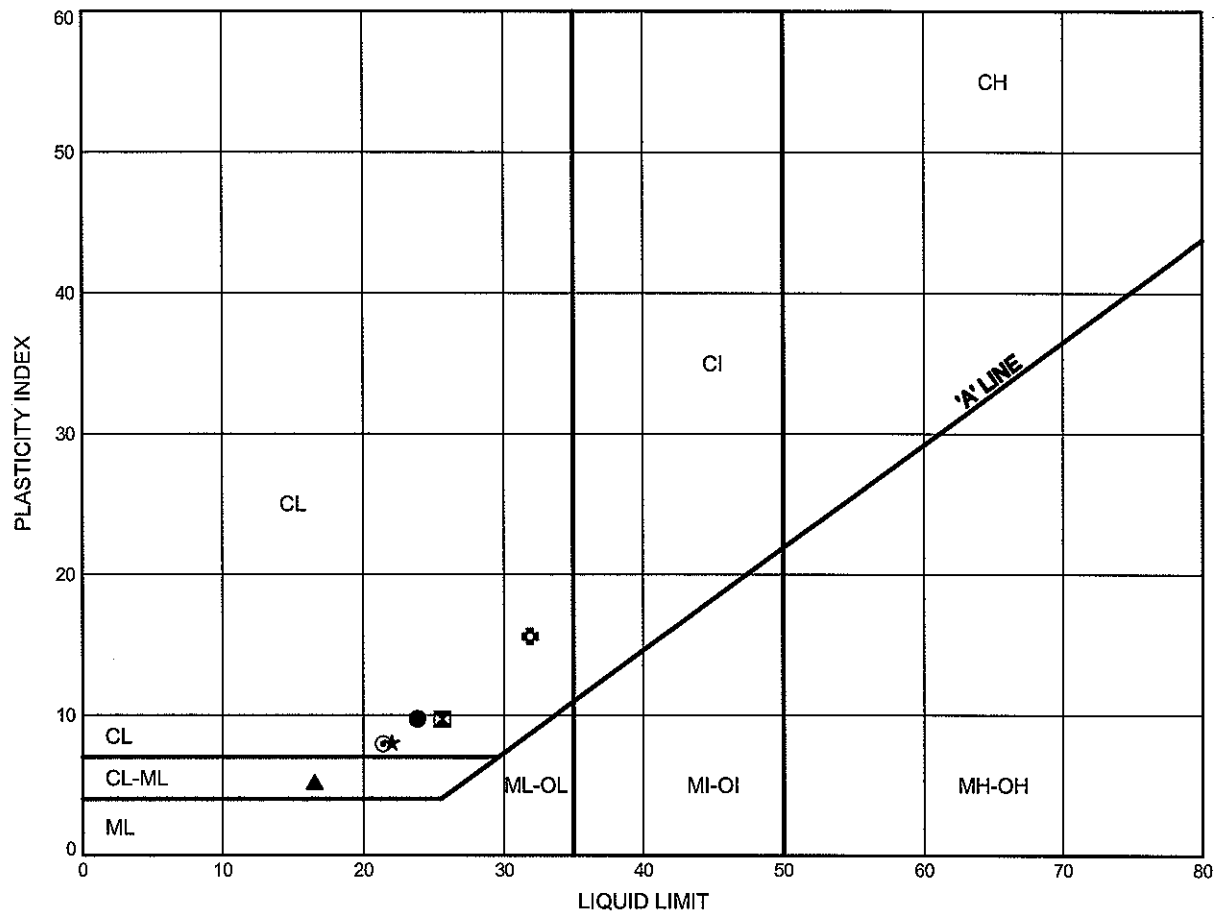
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-45

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TN1	15.4	168.1
⊠	TN2	15.4	168.8
▲	TN2	26.1	158.1
★	TN3	17.0	167.1
⊙	TN4	17.0	167.0
⊕	TN4	27.6	156.4

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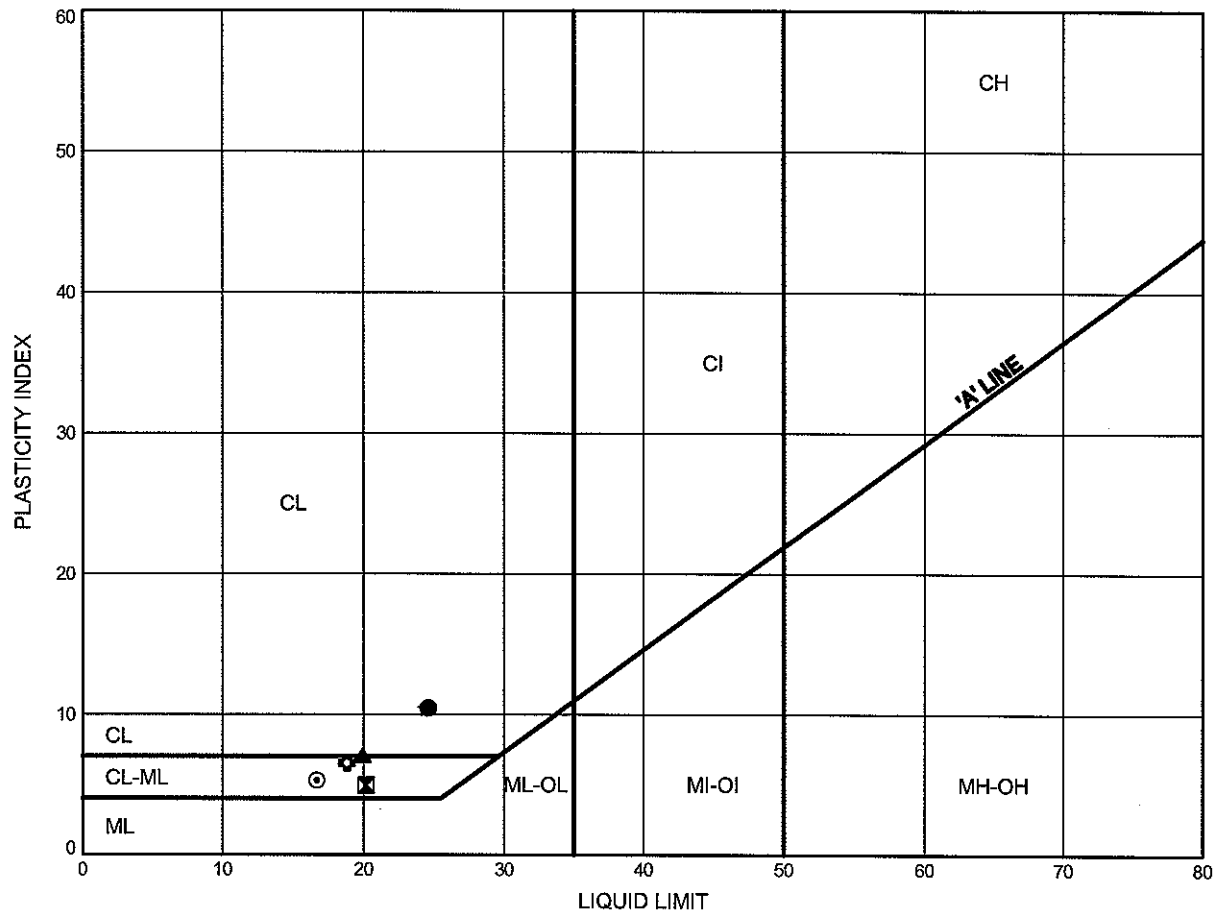
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-46

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TRW3	15.4	167.7
⊠	TS1	17.0	165.6
▲	TS1	26.1	156.5
★	TS2	15.4	167.9
⊙	TS2	23.1	160.2
⊕	TS3	18.5	164.0

Date August 2010
 Project 1-09-4135

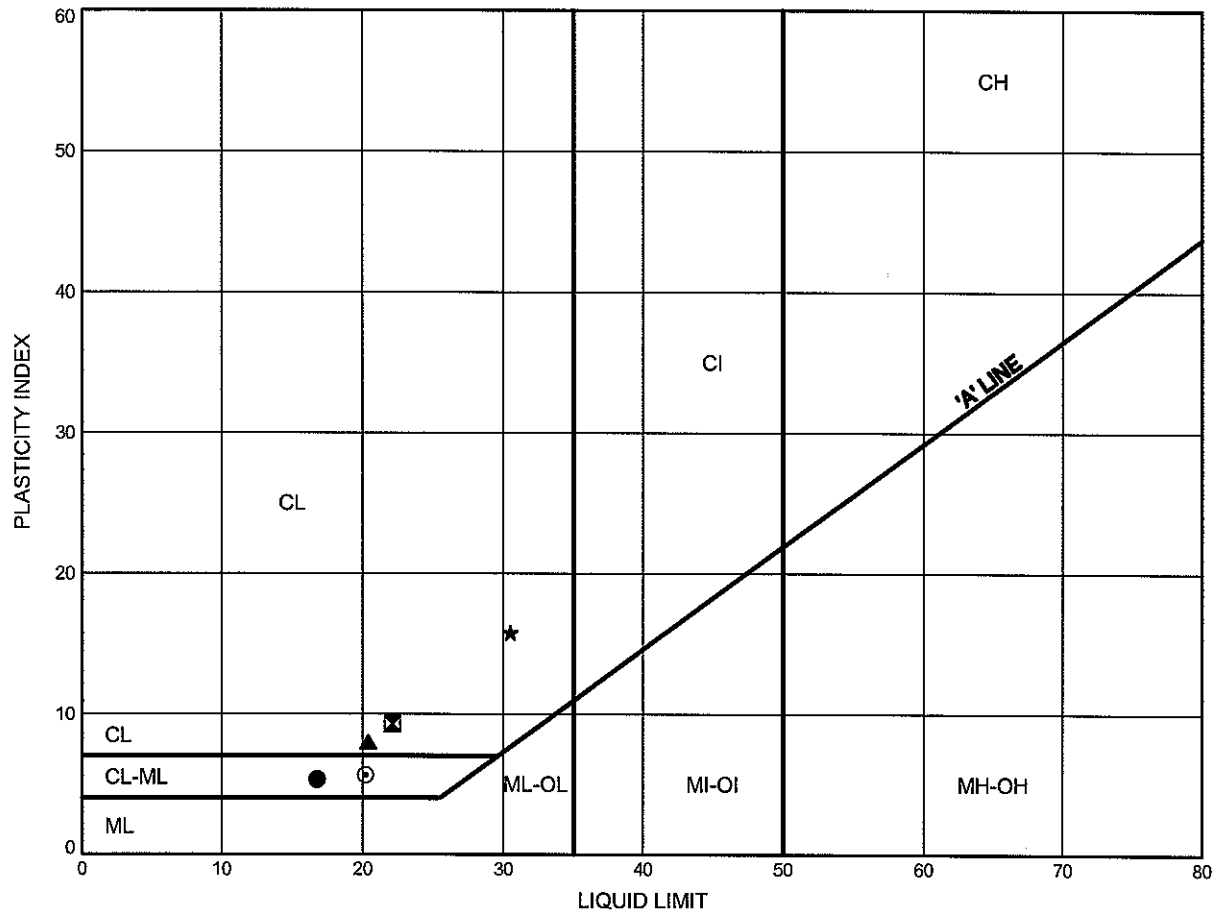


Prep'd DB
 Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-47

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS3	23.1	159.4
⊠	TS3	26.1	156.4
▲	TS4	15.4	167.0
★	TSEW1	26.1	157.4
⊙	TSEW2	18.5	164.8

Date August 2010

Project 1-09-4135



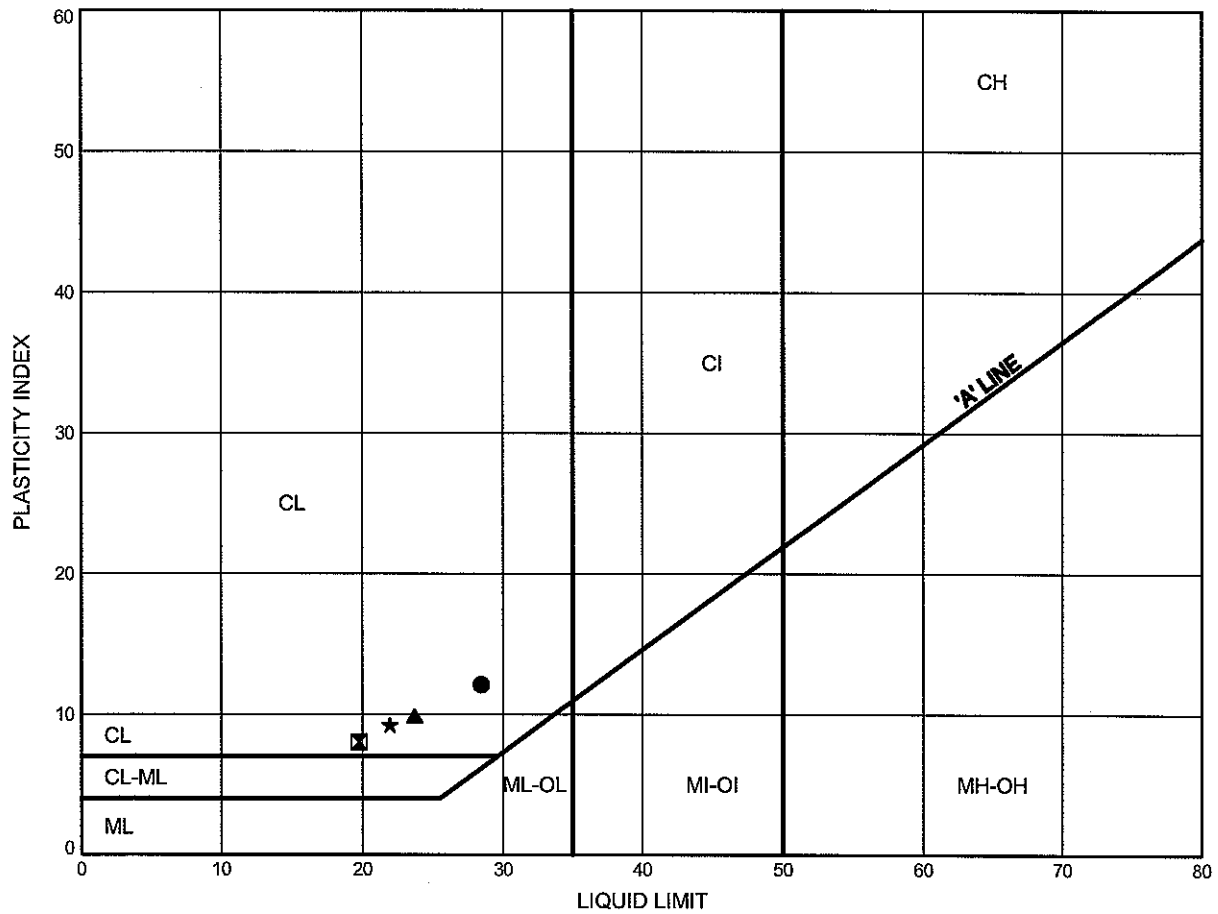
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B2-48

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TSEW2	26.1	157.2
⊠	TSEW3	26.1	157.2
▲	TSEW4	18.5	165.0
★	TSEW4	26.1	157.4

Date August 2010

Project 1-09-4135



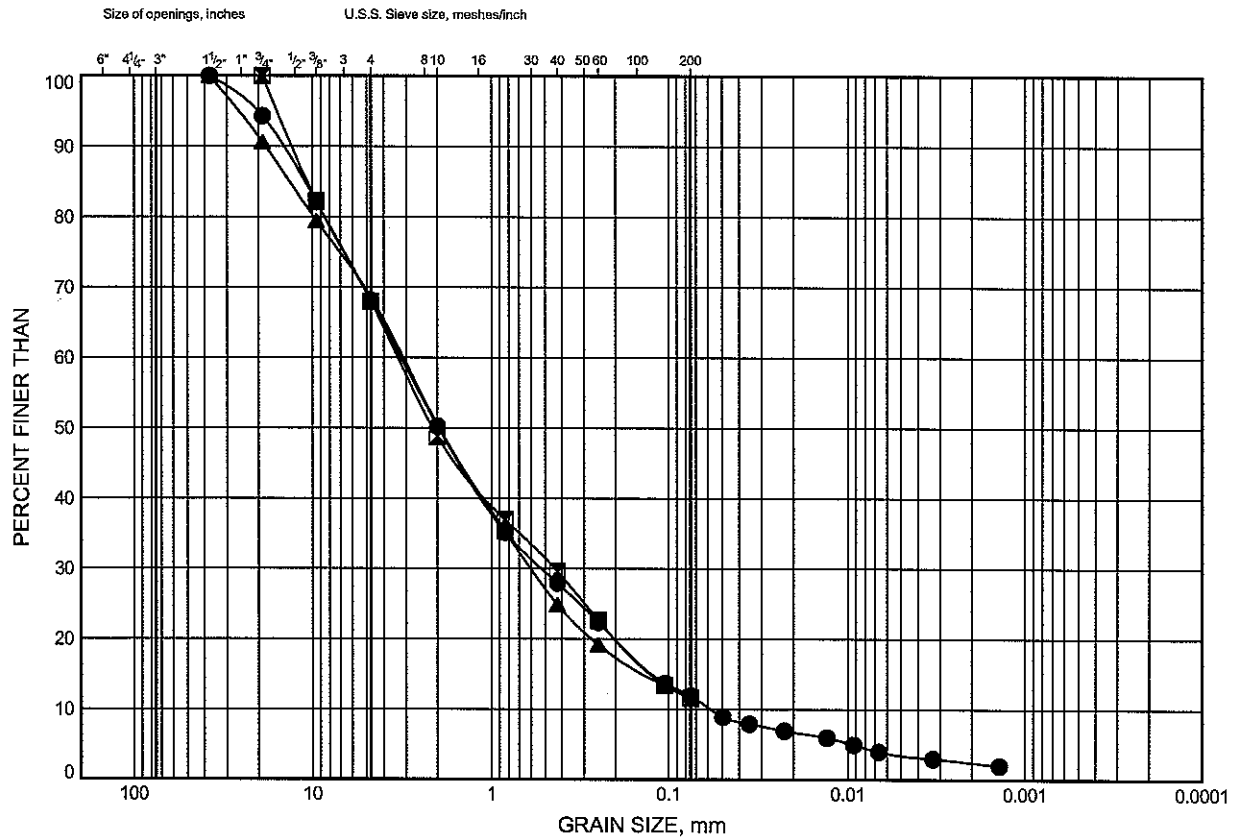
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-49

SAND



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TEW1	21.5	161.0
■	TS1	21.4	161.2
▲	TS2	21.5	161.8

Date August 2010

Project 1-09-4135



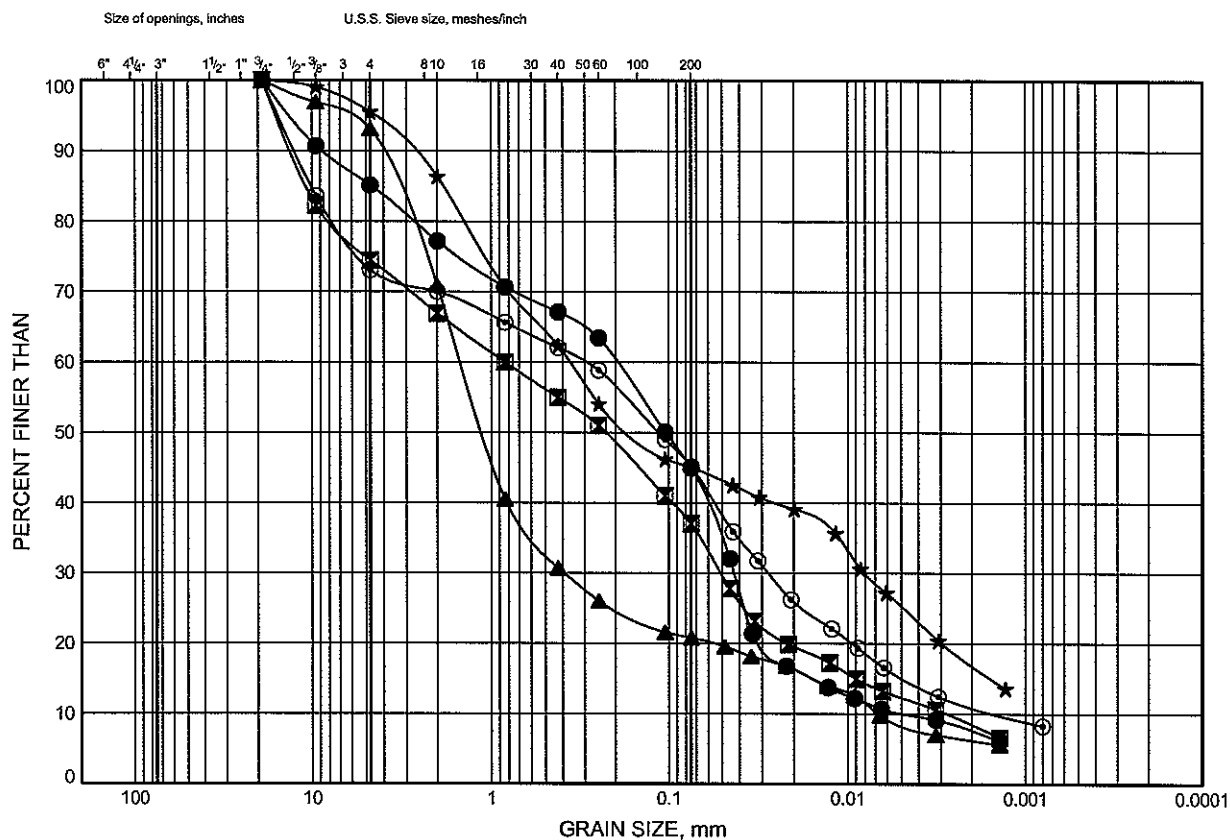
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-50

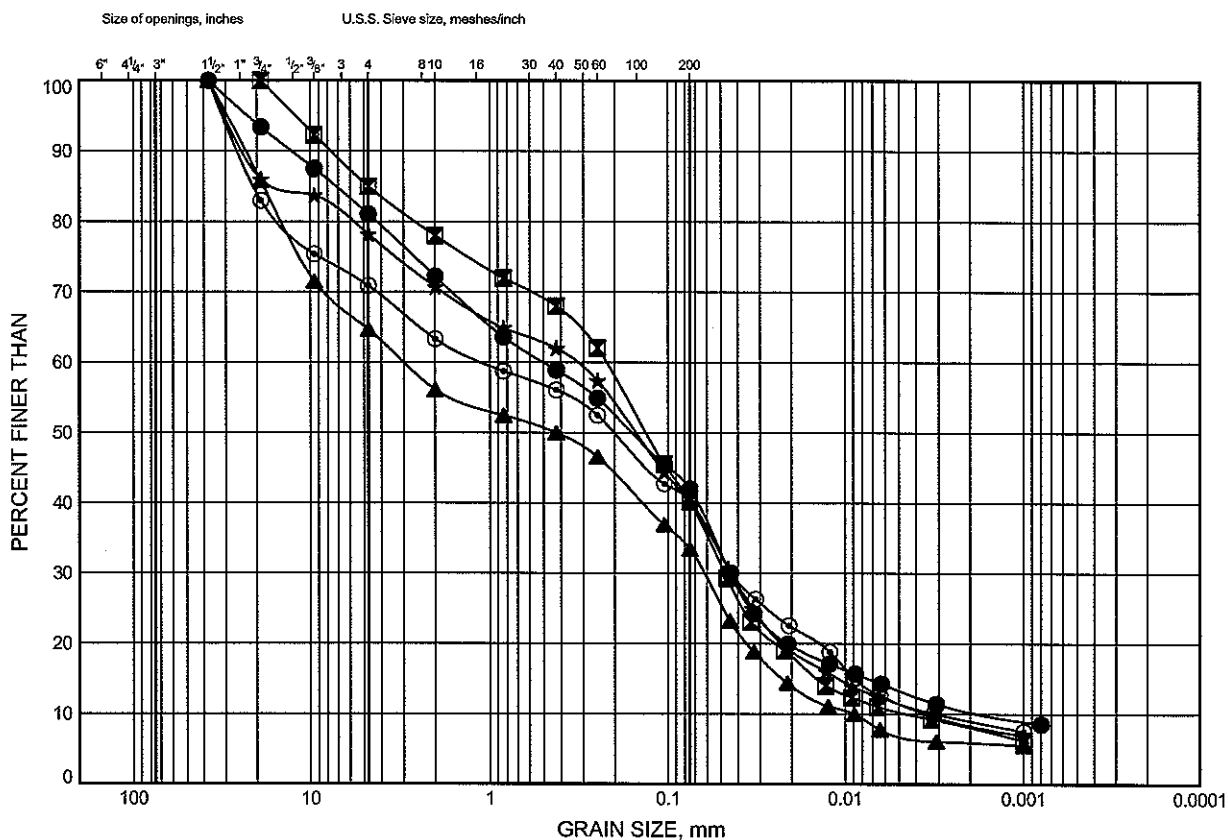
SILTY SAND TO SANDY SILT TILL



GRAIN SIZE DISTRIBUTION

FIGURE B2-51

SILTY SAND TO SANDY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	TN4	29.2	154.8
■	TSEW3	20.0	163.3
▲	TSEW3	23.1	160.2
★	TSEW4	20.0	163.5
○	TSEW4	23.1	160.4

Date August 2010

Project 1-09-4135



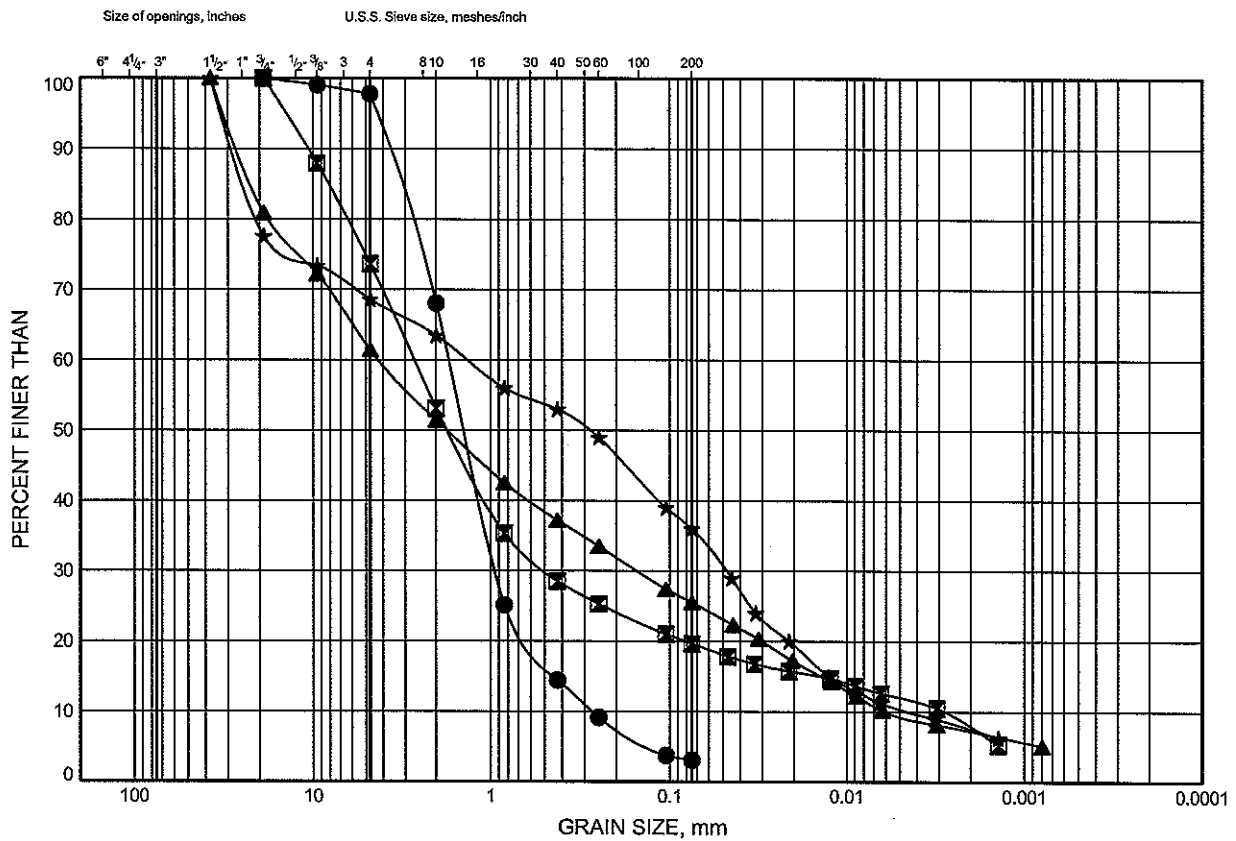
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B2-52

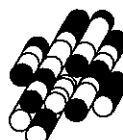
GRAVELLY SAND TO SANDY GRAVEL TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TEW2	24.6	158.1
⊠	TEW2	27.6	155.1
▲	TN2	29.2	155.0
★	TN3	29.2	154.9

Date August 2010
Project 1-09-4135



Prep'd DB
Chkd. MP

FIGURE B2-53

Figure 1 is a semi-logarithmic graph showing the relationship between grain size and the percentage of material finer than a given size. The x-axis represents grain size in millimeters (mm) on a logarithmic scale from 100 to 0.001. The y-axis represents the percentage finer than a given grain size, ranging from 0 to 100. The graph includes curves for various sieve sizes, labeled at the top: 6", 4 1/4", 3", 1 1/2", 1", 3/4", 1/2", 3/8", 3/16", 3/32", 1/16", 8, 10, 16, 30, 40, 50, 60, 100, and 200. The curves show that as the grain size decreases, the percentage finer than increases, approaching 100% for very fine grains.

COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	TS3	27.6	154.9
⊠	TS4	27.5	154.9
▲	TSEW1	29.2	154.3
★	TSEW3	27.6	155.7

Date August 2010.....

Project 1-09-4135.....



Prep'dDB.....

Chkd. MP

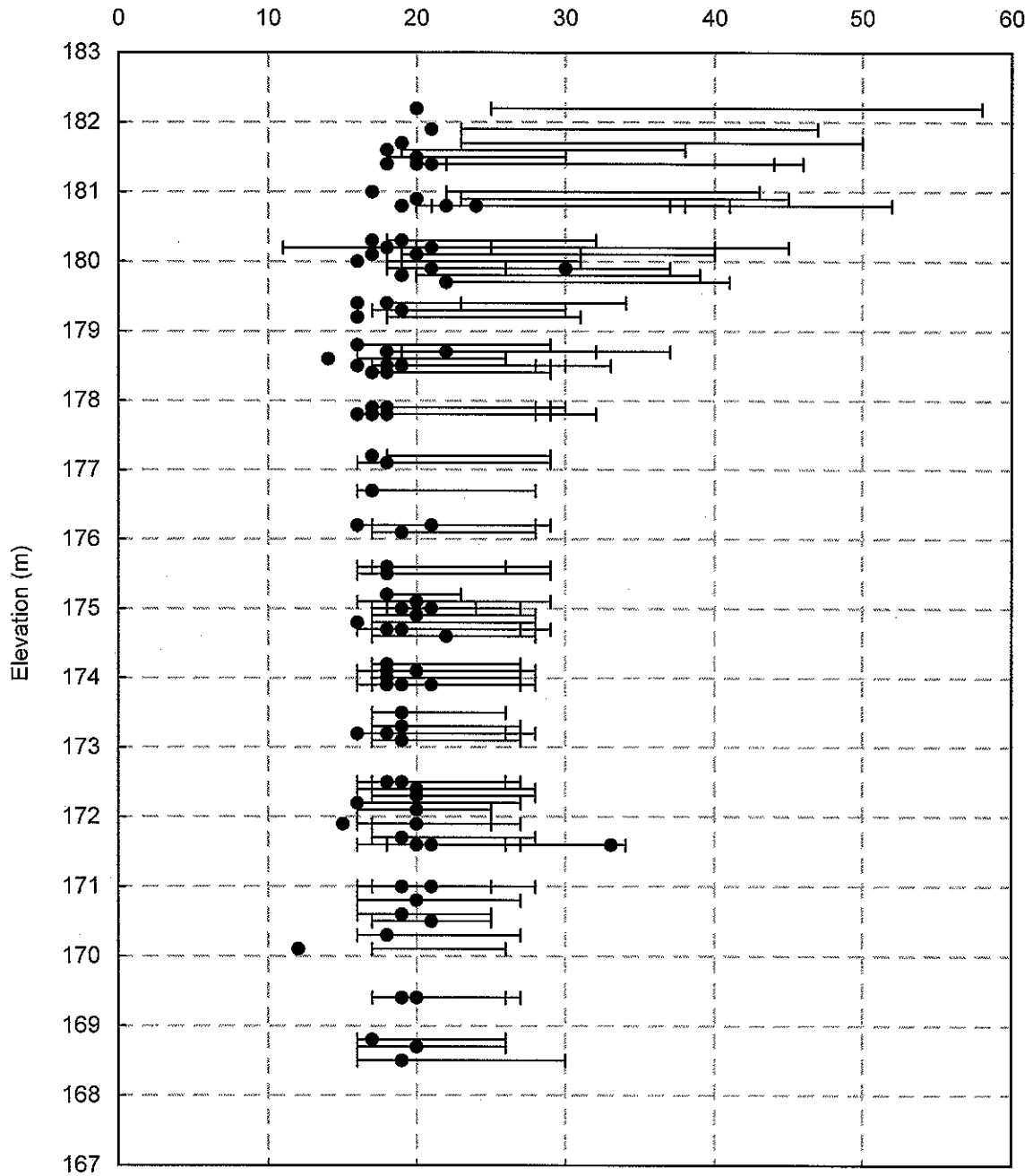
ATTERBERG LIMITS AND WATER CONTENTS

FIGURE B2-54

HWY 406 TWINNING - RETAINING WALL SITE #2

Silty Clay

Atterberg Limits & Water Contents (%)



Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

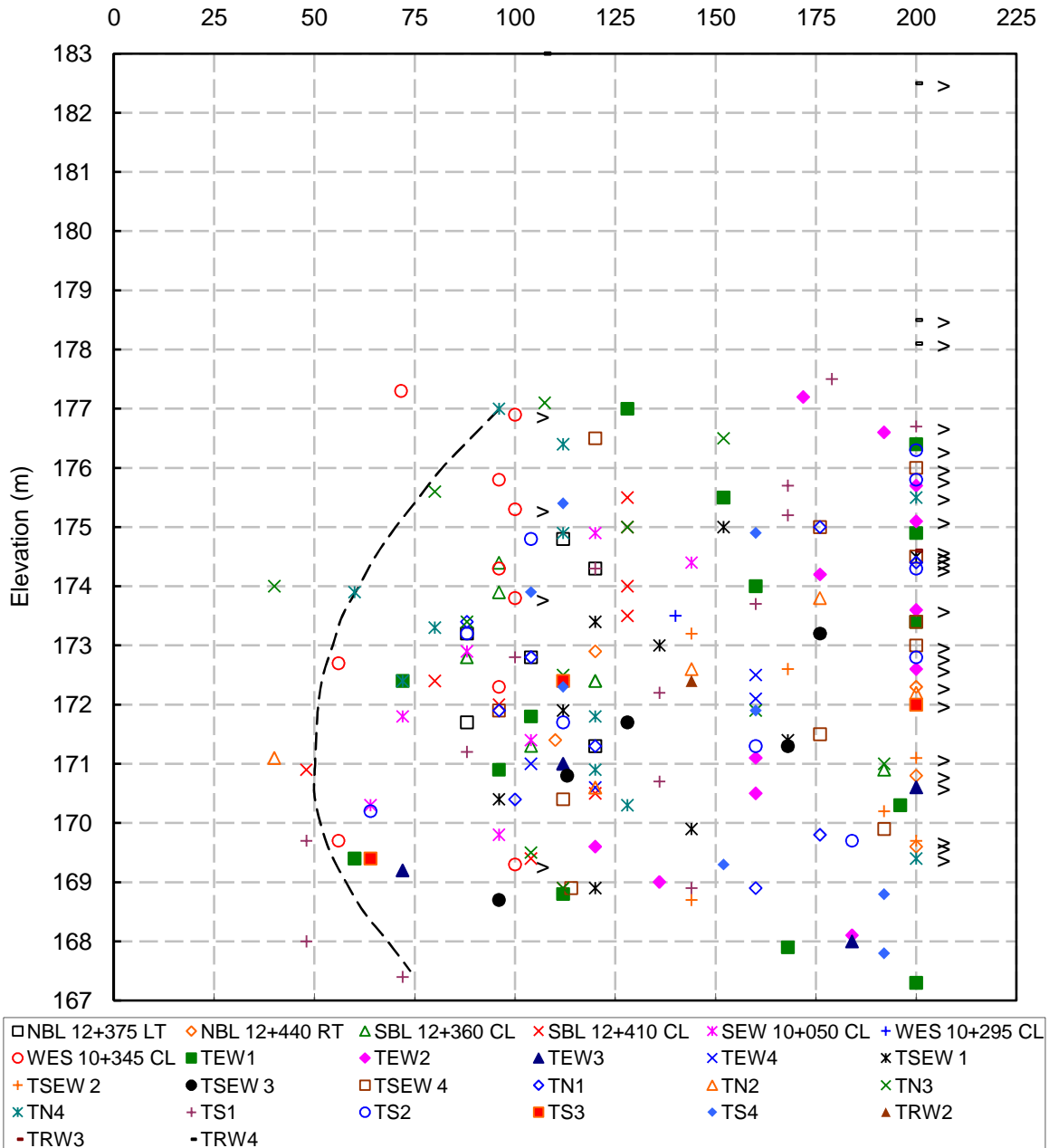
CORRECTED UNDRAINED SHEAR STRENGTH

FIGURE B2-55

HWY 406 TWINNING - RETAINING WALL SITE #2

Silty Clay

Corrected Cu (kPa)



Field Shear Vane Correction

Morris & Williams (1994)

($\mu = 1.18 \text{ EXP}(-0.08 \text{ Ip}) + 0.57$)

Applied Correction Factors

0.89 (Elev.>177m)

1.00 (Elev.<177m)

Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

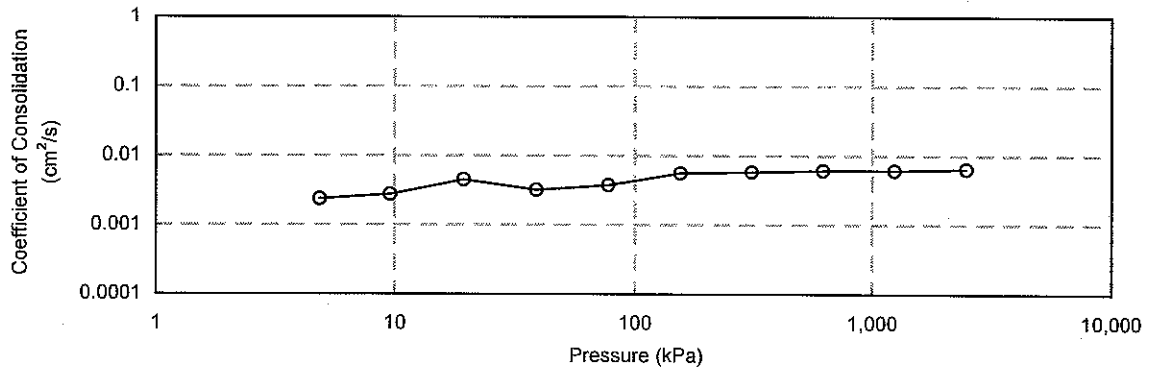
HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-56

CONSOLIDATION TEST

Cv vs Pressure

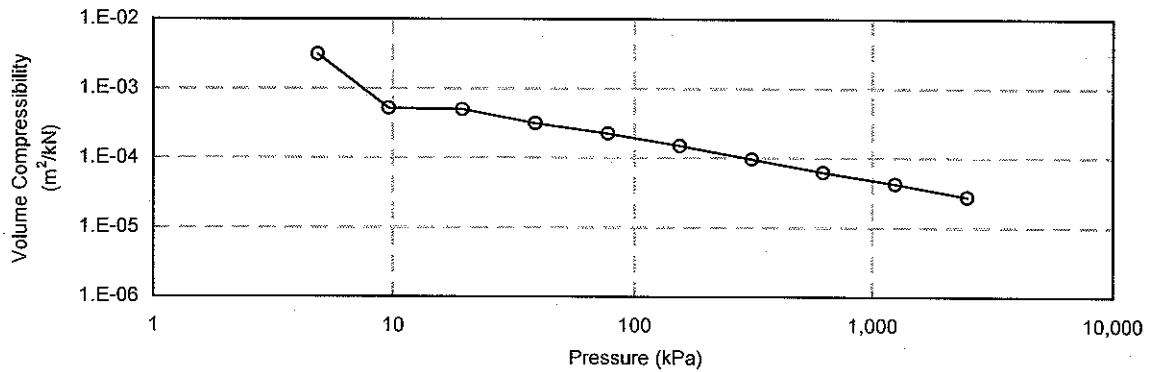
NBL 12+375 LT, TW9



CONSOLIDATION TEST

mv vs Pressure

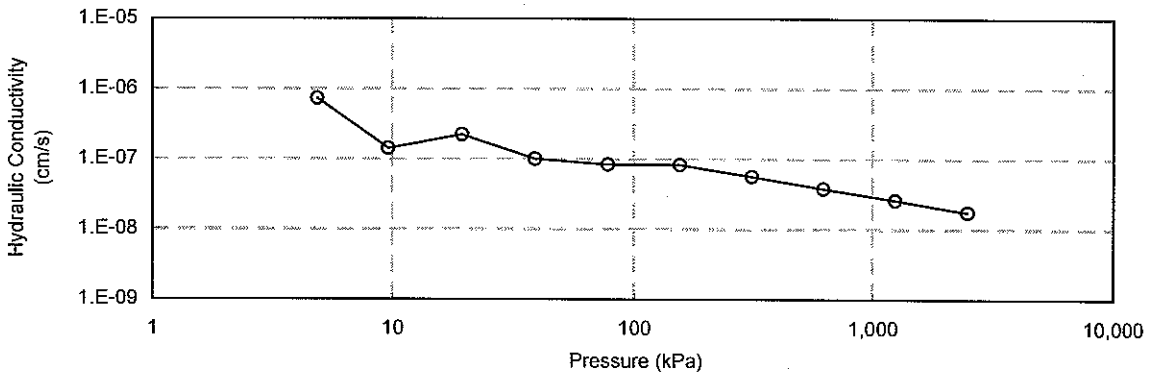
NBL 12+375 LT, TW9



CONSOLIDATION TEST

k vs Pressure

NBL 12+375 LT, TW9



Project No. : 1-09-4135
Date : November 2010



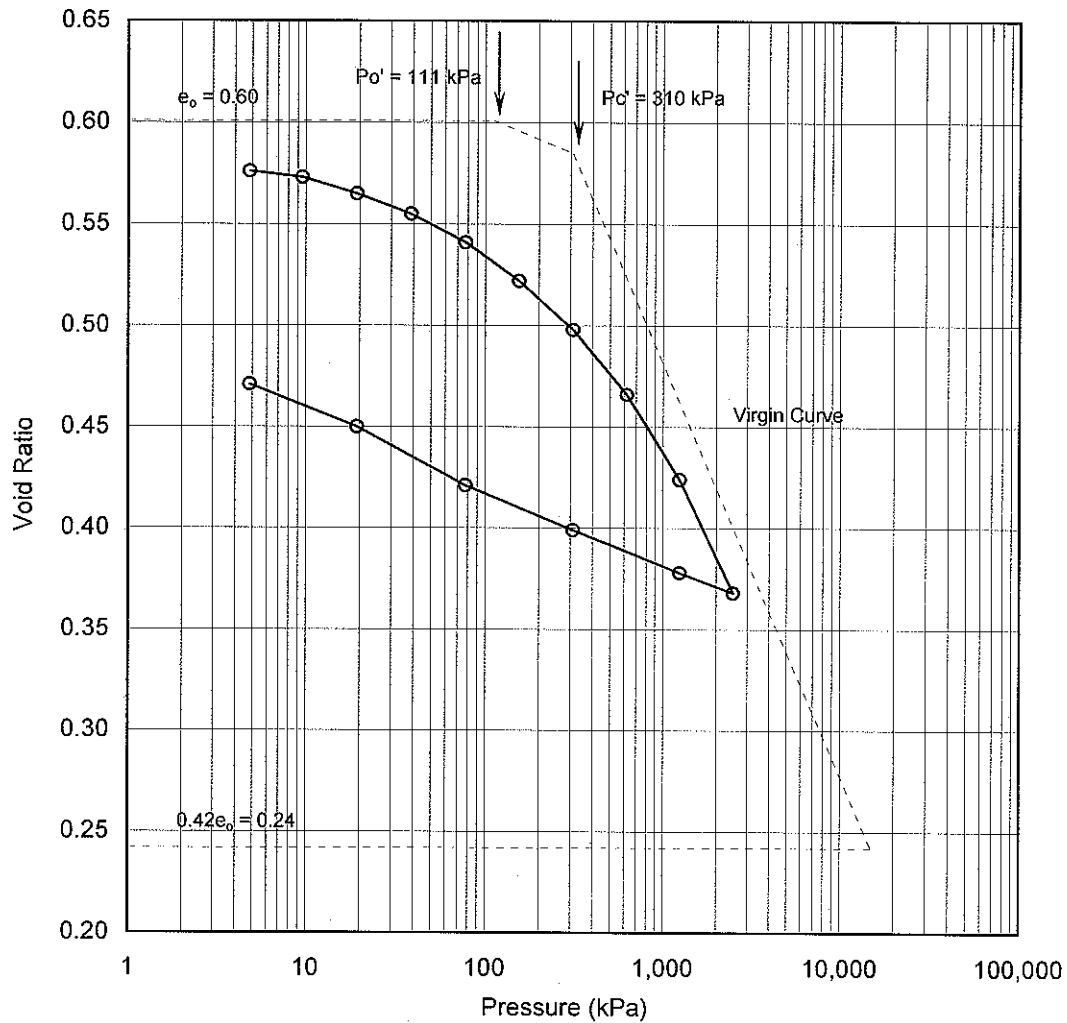
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

NBL 12+375 LT, TW9



Soil Type : Silty Clay

$e_o =$	0.60	$\omega_L =$	28%	$P_o' =$	111 kPa
$\omega =$	21%	$\omega_p =$	16%	$P_c' =$	310 kPa
$\gamma =$	20.6 kN/m ³	PI =	12%	Cc =	0.204
Gs =	2.77			Cr =	0.036

Project No. : 1-09-4135
Date : November 2010



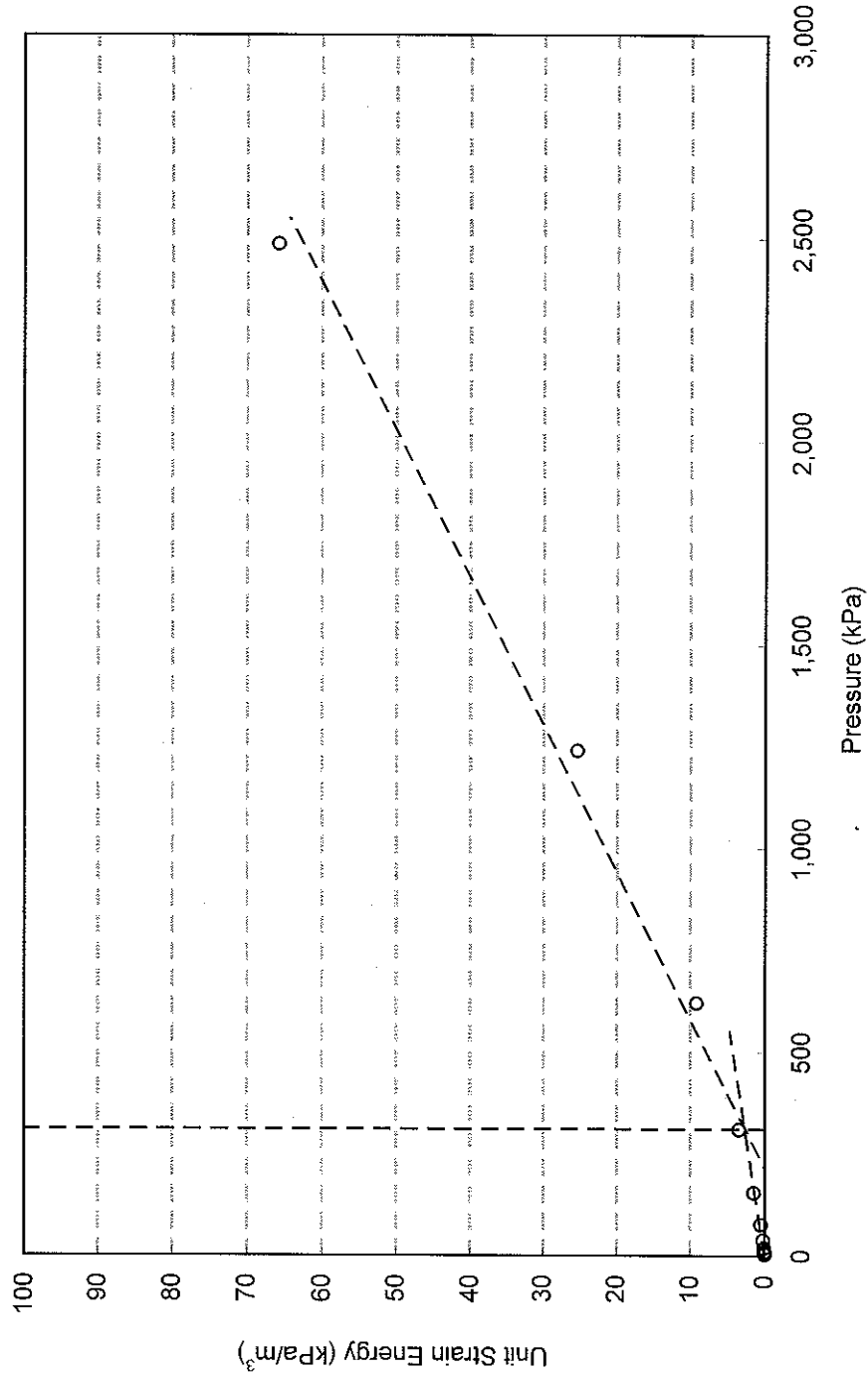
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-58

CONSOLIDATION TEST Unit Strain Energy vs Pressure NBL 12+375 LT, TW9



Project No. : 1-09-4135

Date : November 2010



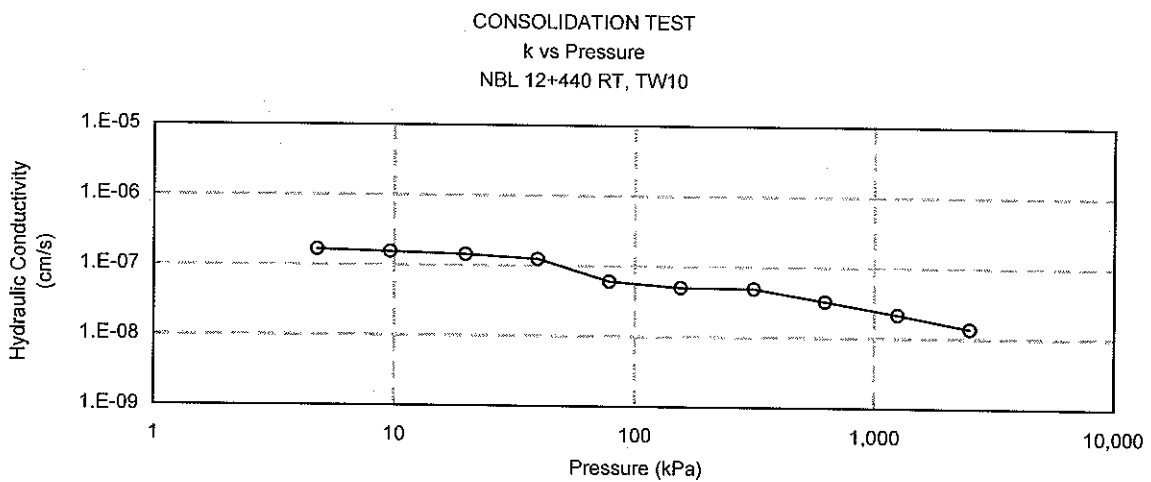
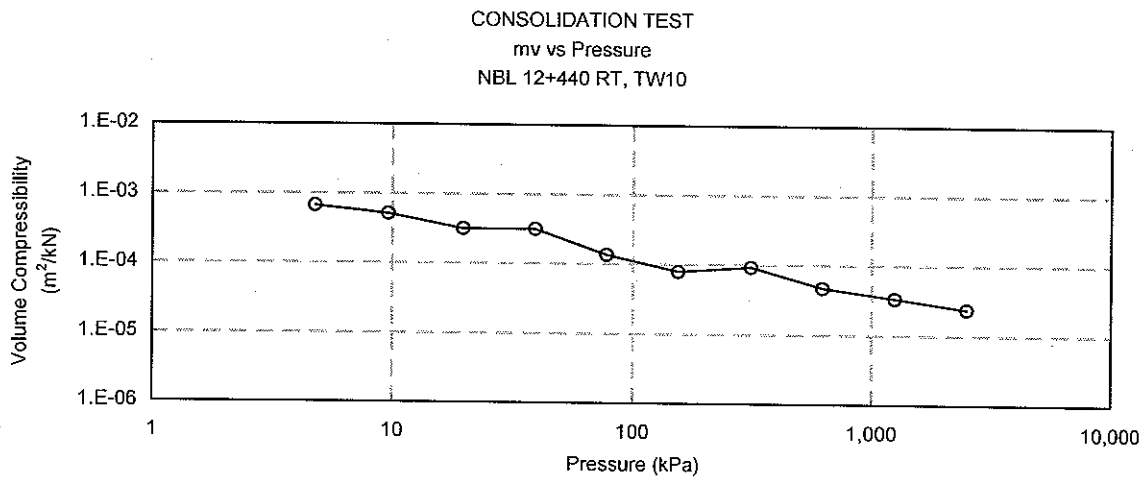
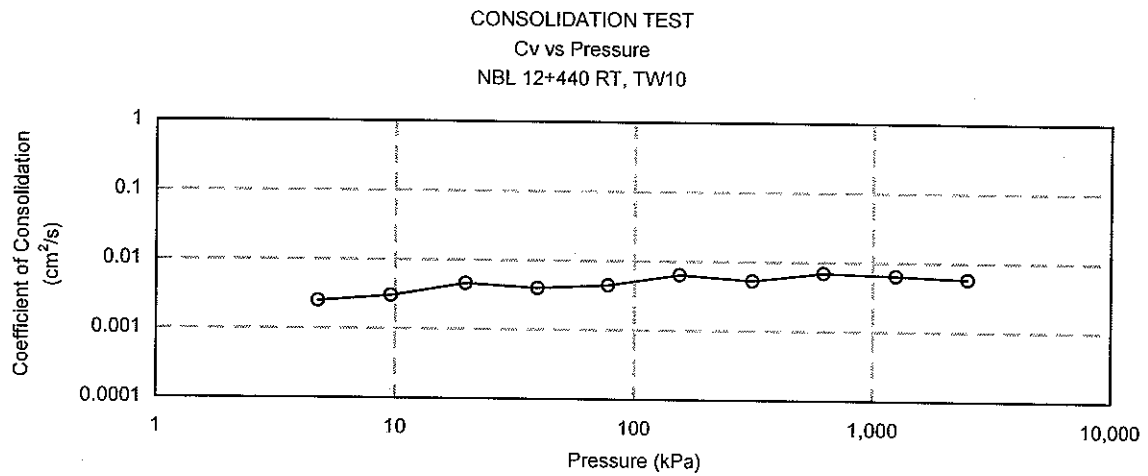
Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-59



Project No. : 1-09-4135
Date : November 2010



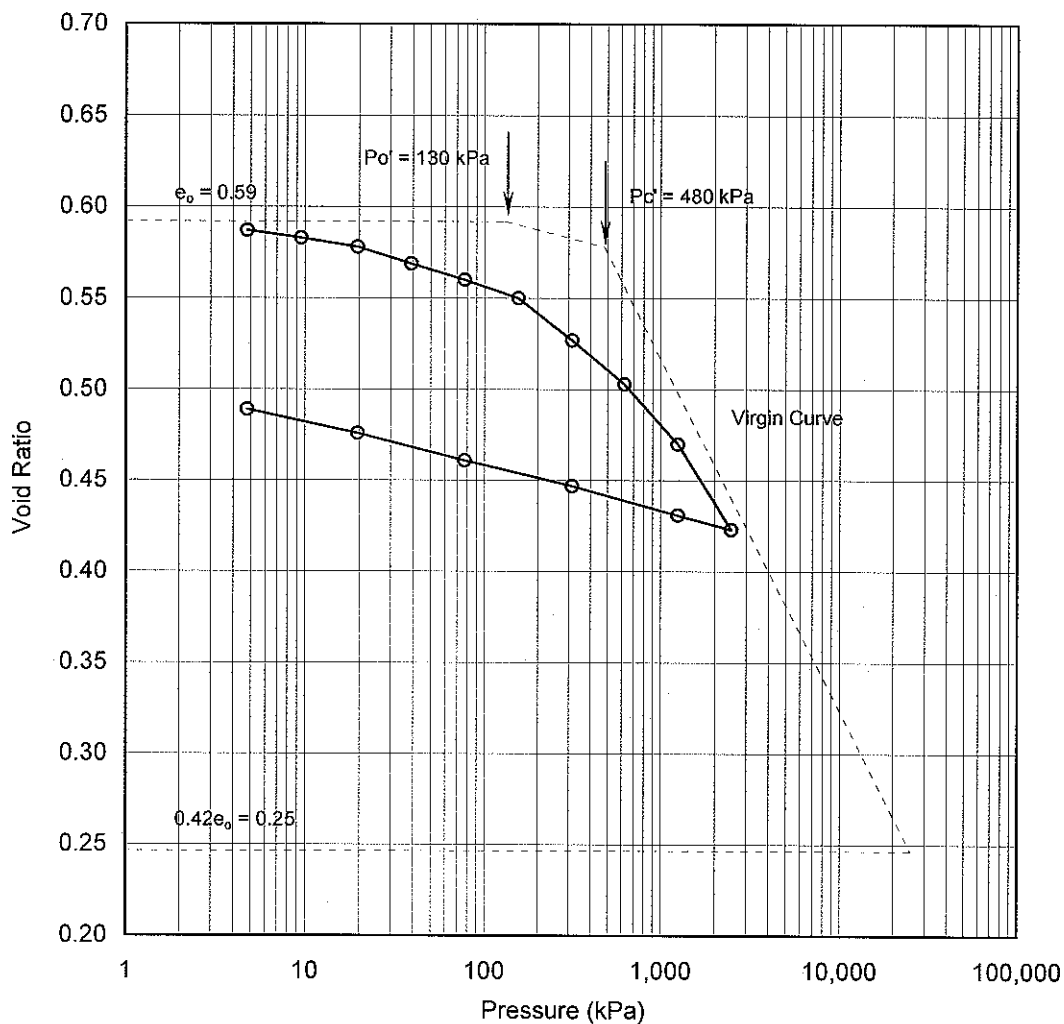
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

NBL 12+440 RT, TW10



Soil Type : Silty Clay

$e_o =$	0.59	$\omega_L =$	25%	$Po' =$	130 kPa
$\omega =$	21%	$\omega_P =$	15%	$Pc' =$	480 kPa
$\gamma =$	20.7 kN/m ³	$PI =$	10%	$Cc =$	0.193
$G_s =$	2.79			$Cr =$	0.025

Project No. : 1-09-4135
 Date : November 2010



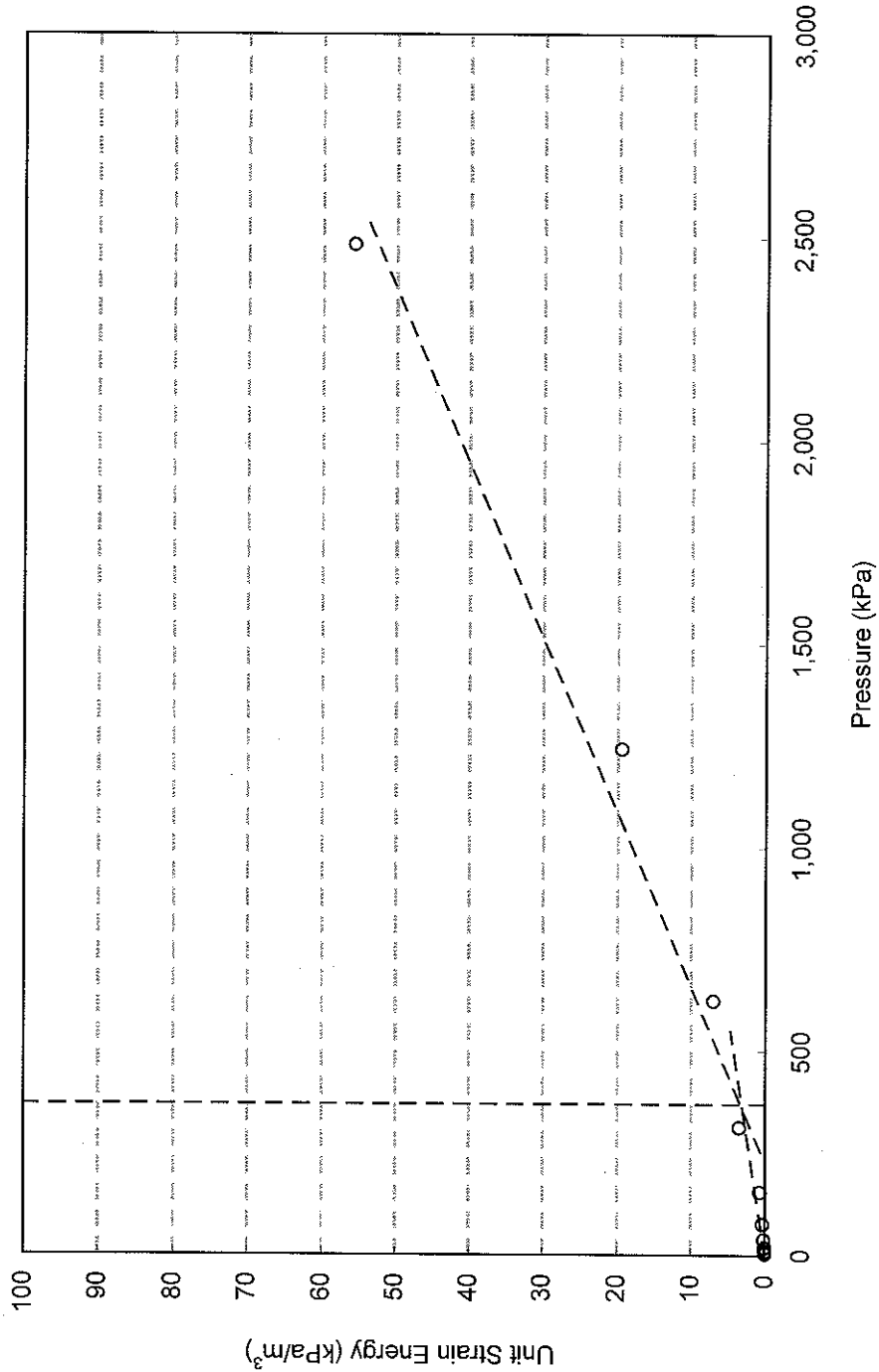
Terraprobe Inc.

Prepared By : HW
 Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-61

CONSOLIDATION TEST
Unit Strain Energy vs Pressure
NBL 12+440 RT, TW10



Project No. : 1-09-4135

Date : November 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

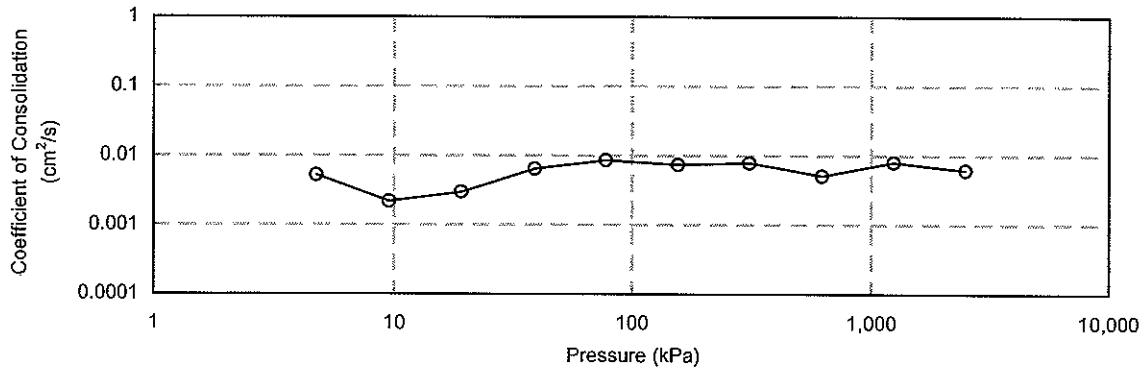
FIGURE B2-62

c:\Documents and Settings\Admin\My Documents\Marc P\Projects 2008\Hwy 406 Expansion\1-09-4135 (Hwy 406 Foundations)\Culverts and Retaining Walls\Retaining Walls\Lab Results\1-09-4135R3 Consolidation Results.xls

CONSOLIDATION TEST

Cv vs Pressure

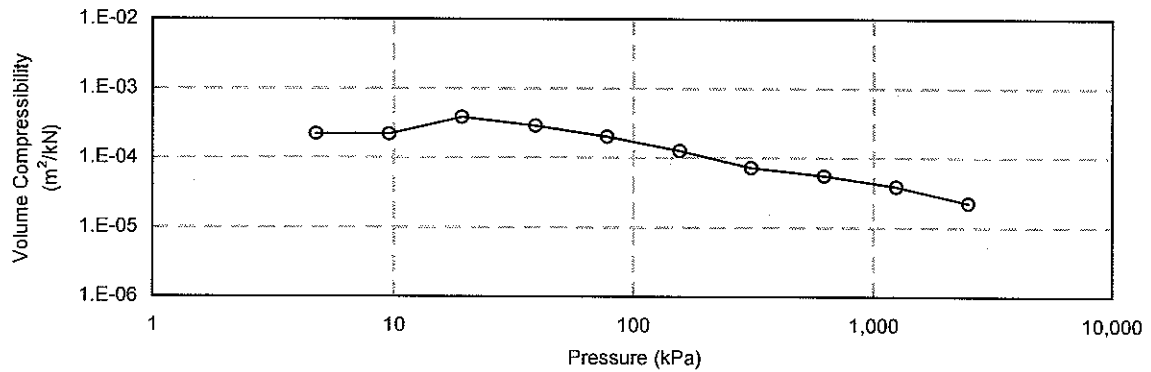
SBL 12+360 CL, TW10



CONSOLIDATION TEST

mv vs Pressure

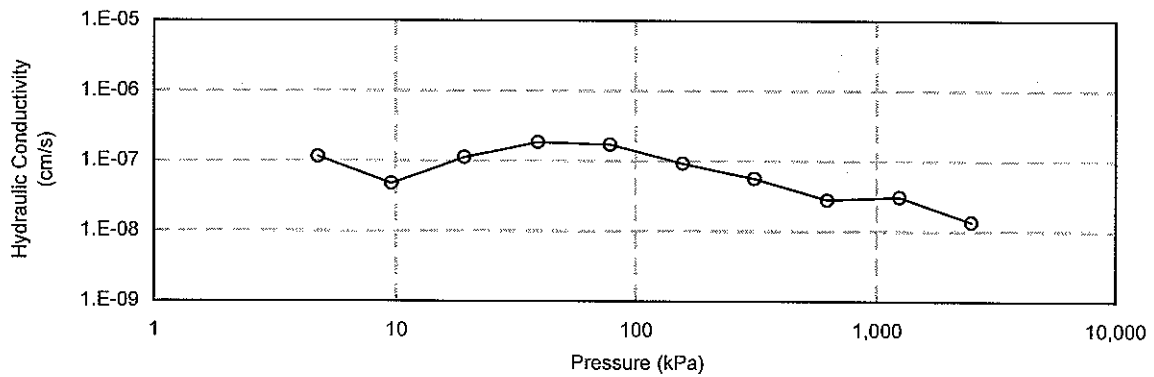
SBL 12+360 CL, TW10



CONSOLIDATION TEST

k vs Pressure

SBL 12+360 CL, TW10



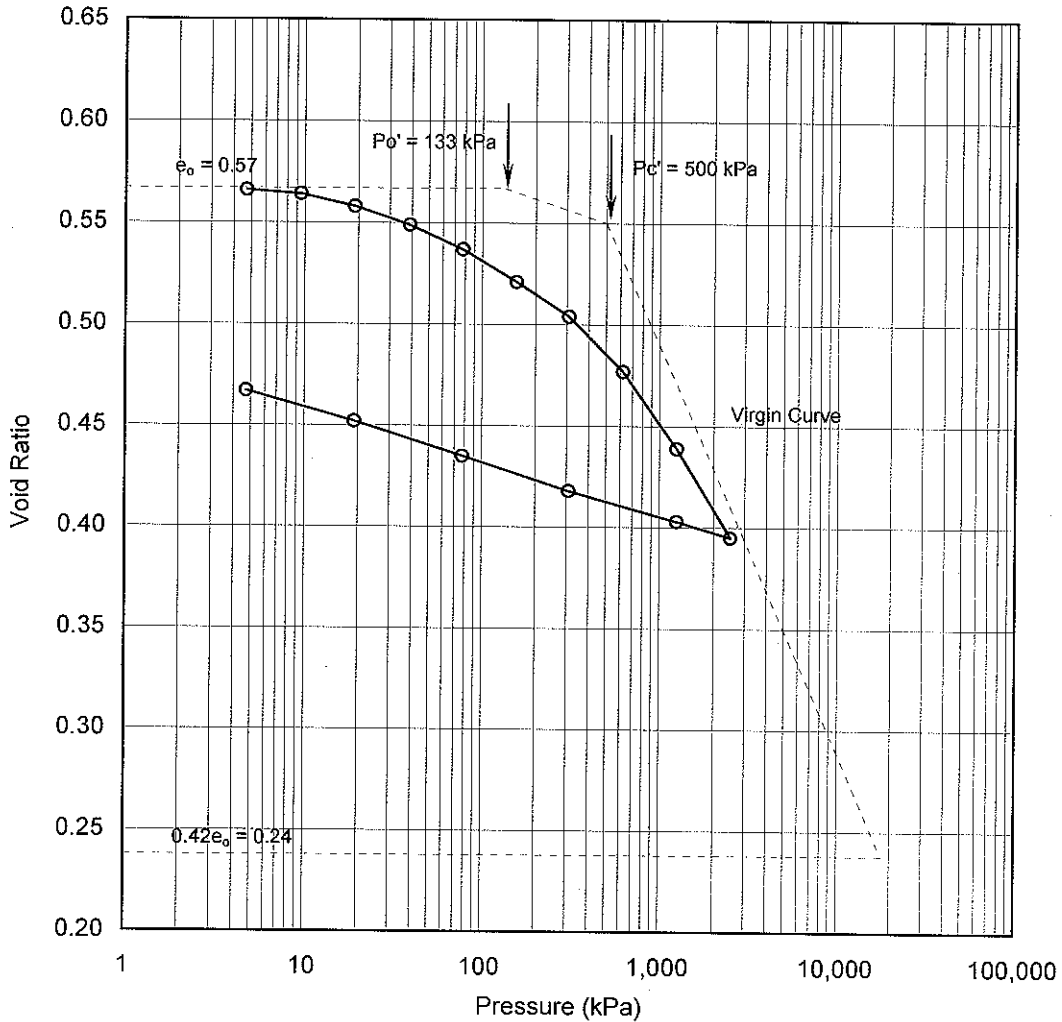
Project No. : 1-09-4135
Date : November 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
e vs Pressure
SBL 12+360 CL, TW10



Soil Type : Silty Clay

$e_o =$	0.57	$\omega_L =$	25%	$P_o' =$	133 kPa
$\omega =$	21%	$\omega_p =$	17%	$P_c' =$	500 kPa
$\gamma =$	20.7 kN/m ³	PI =	8%	Cc =	0.201
Gs =	2.74			Cr =	0.030

Project No. : 1-09-4135
Date : November 2010



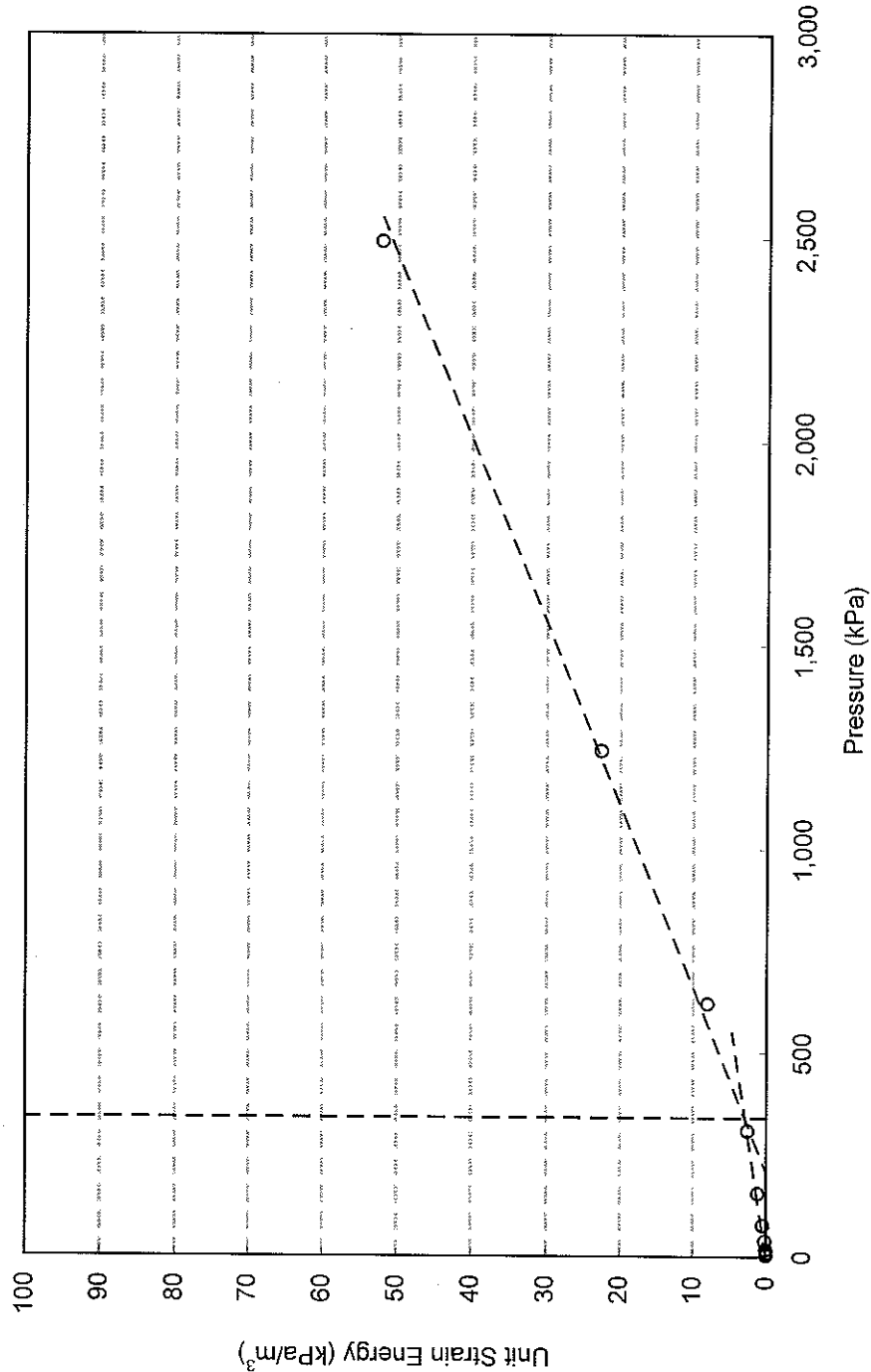
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-64

CONSOLIDATION TEST Unit Strain Energy vs Pressure SBL 12+360 CL, TW10



$P_c = 340 \text{ kPa}$

Project No. : 1-09-4135

Date : November 2010



Terraprobe Inc.

Prepared By : HW

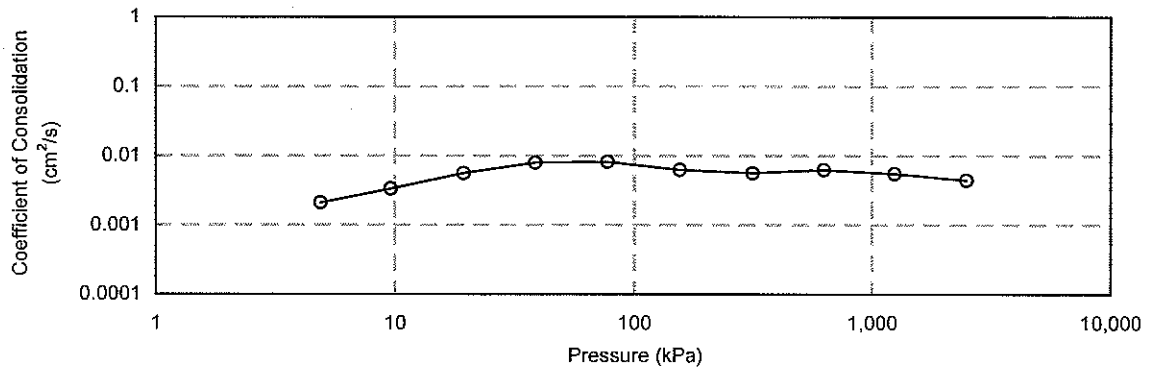
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

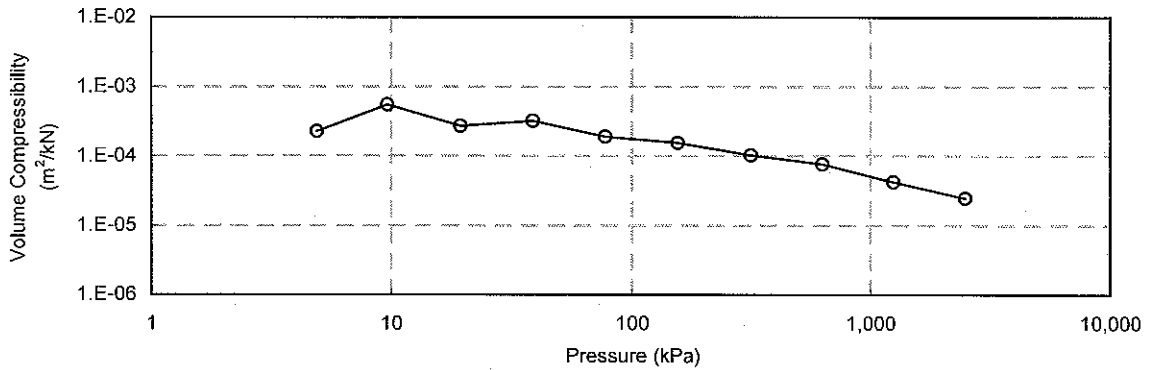
FIGURE B2-65

C:\Documents and Settings\Admin\My Documents\Marc P\Projects 2009\Hwy 406 Expansion\1-09-4135 (Hwy 406 Foundations)\Culverts and Retaining Walls\Retaining Walls\Lab Results\Results.xls

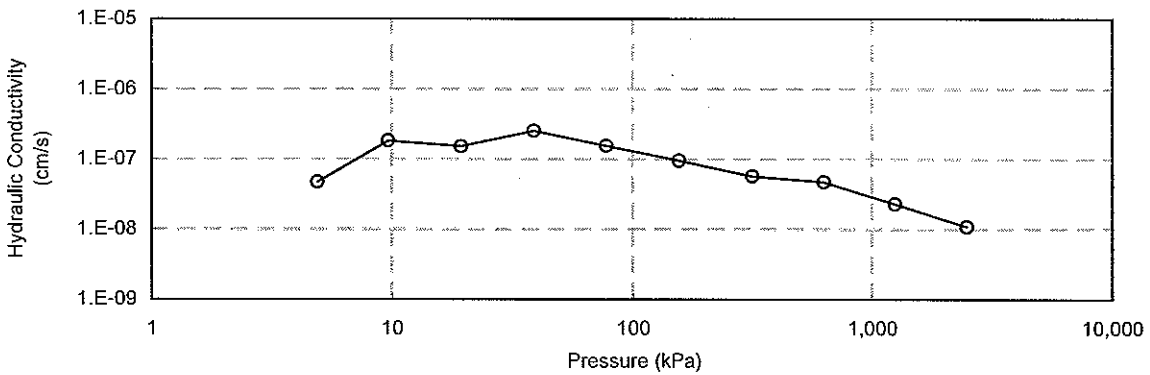
CONSOLIDATION TEST
Cv vs Pressure
SBL 12+410 CL, TW9



CONSOLIDATION TEST
mv vs Pressure
SBL 12+410 CL, TW9



CONSOLIDATION TEST
k vs Pressure
SBL 12+410 CL, TW9



Project No. : 1-09-4135
Date : November 2010



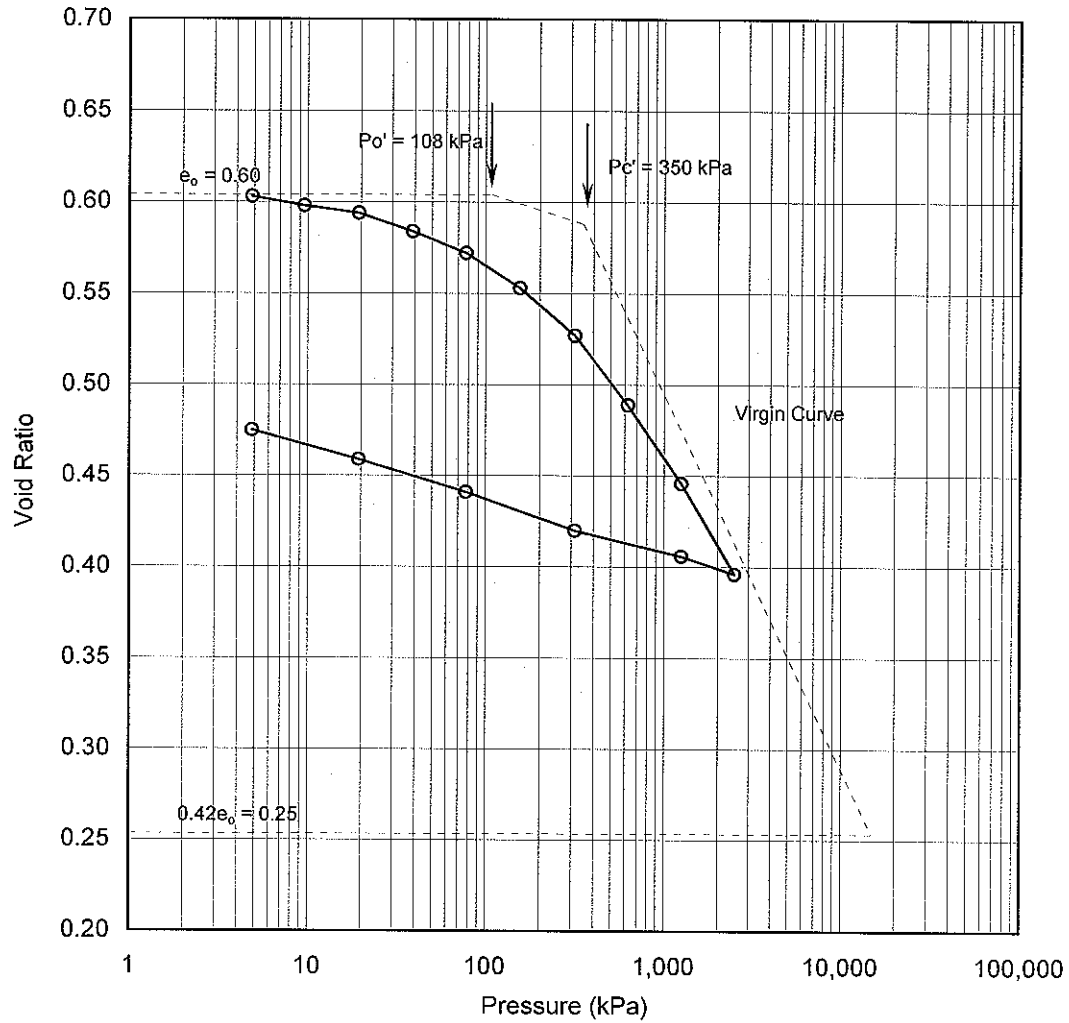
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

SBL 12+410 CL, TW9



Soil Type : Silty Clay

$e_o =$	0.60	$\omega_L =$	26%	$P_o' =$	108 kPa
$\omega =$	21%	$\omega_p =$	17%	$P_c' =$	350 kPa
$\gamma =$	20.4 kN/m ³	$PI =$	9%	$C_c =$	0.205
$G_s =$	2.76			$Cr =$	0.031

Project No. : 1-09-4135
Date : November 2010



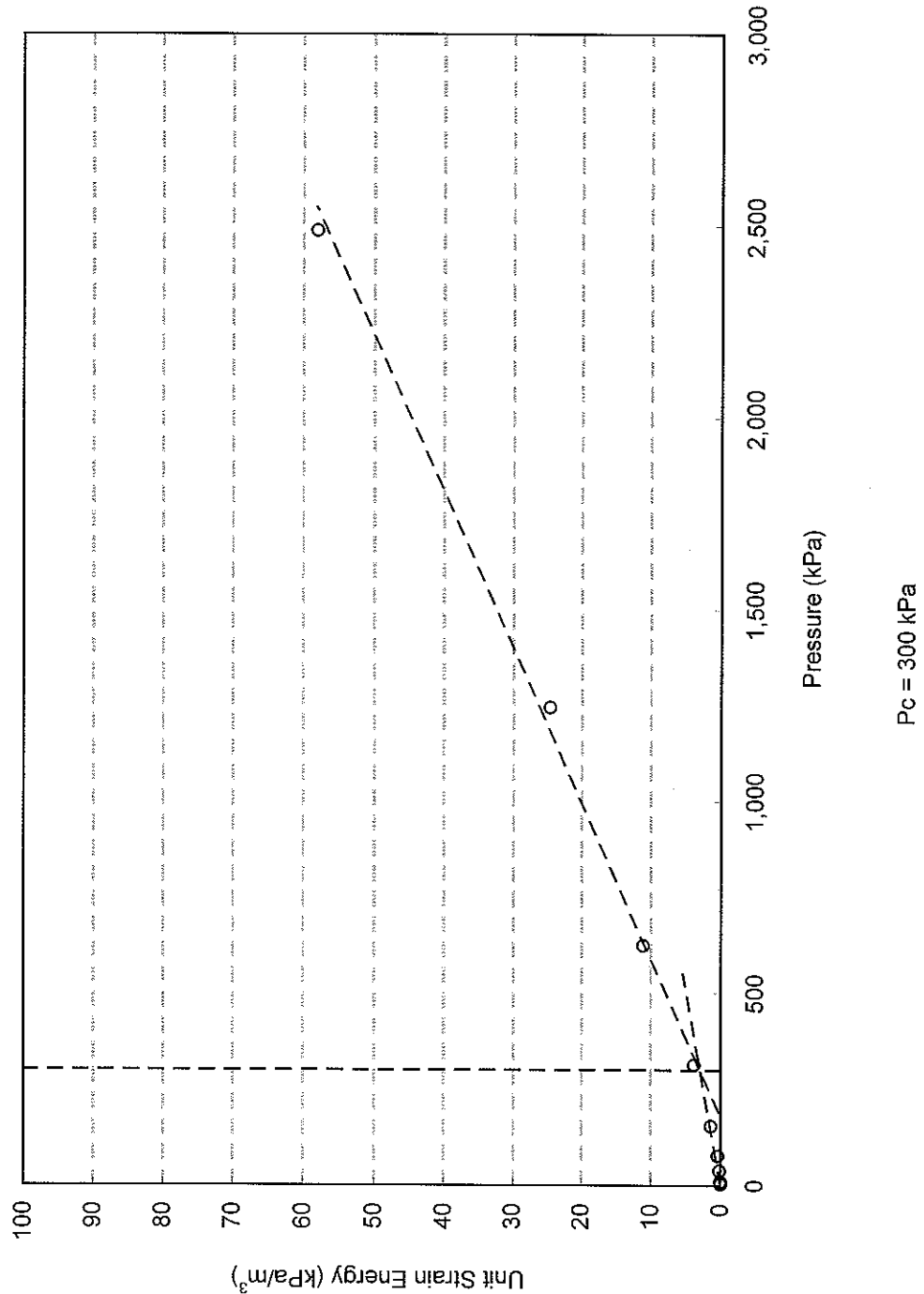
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-67

CONSOLIDATION TEST Unit Strain Energy vs Pressure SBL 12+410 CL, TW9



Project No. : 1-09-4135

Date : November 2010



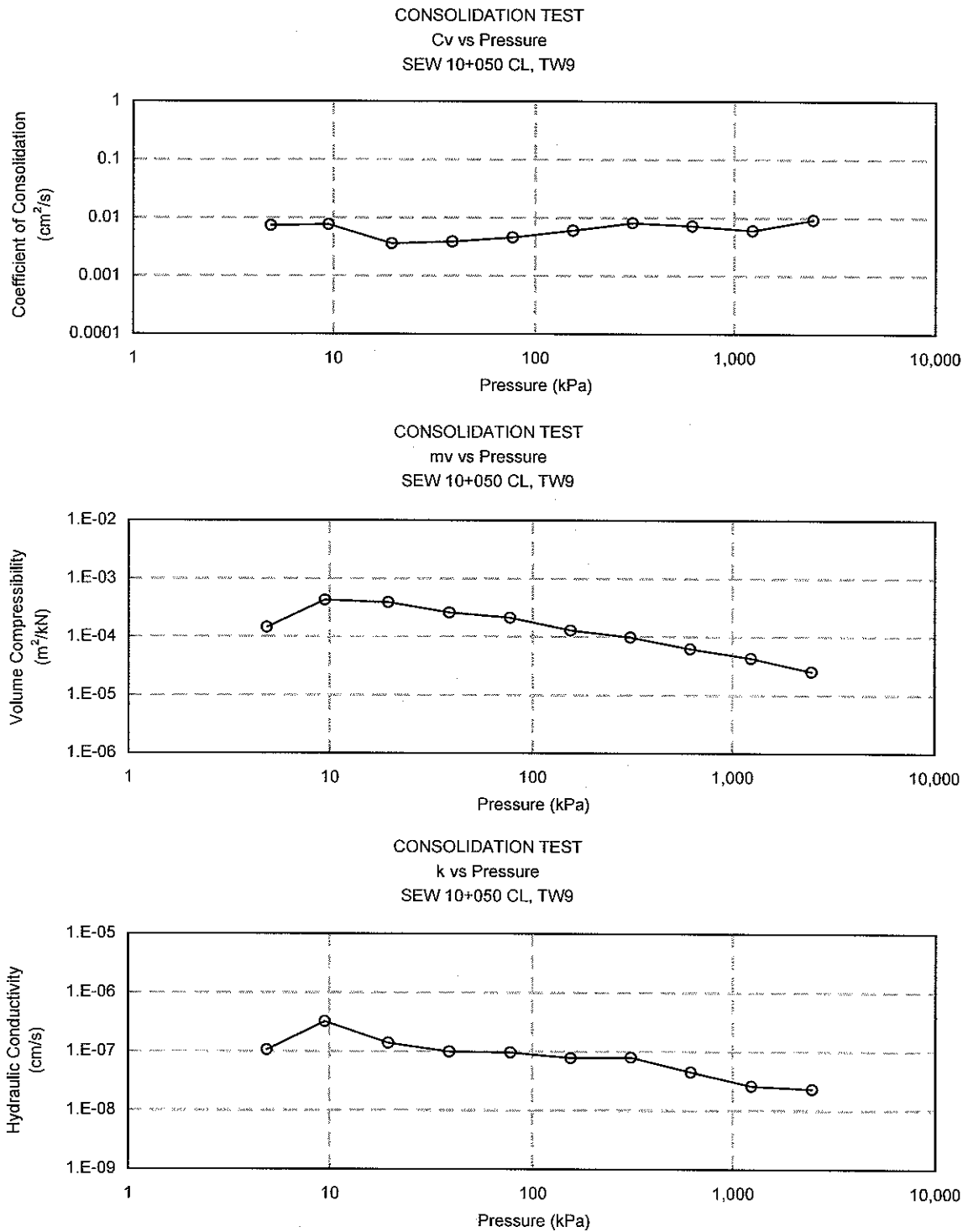
Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-68



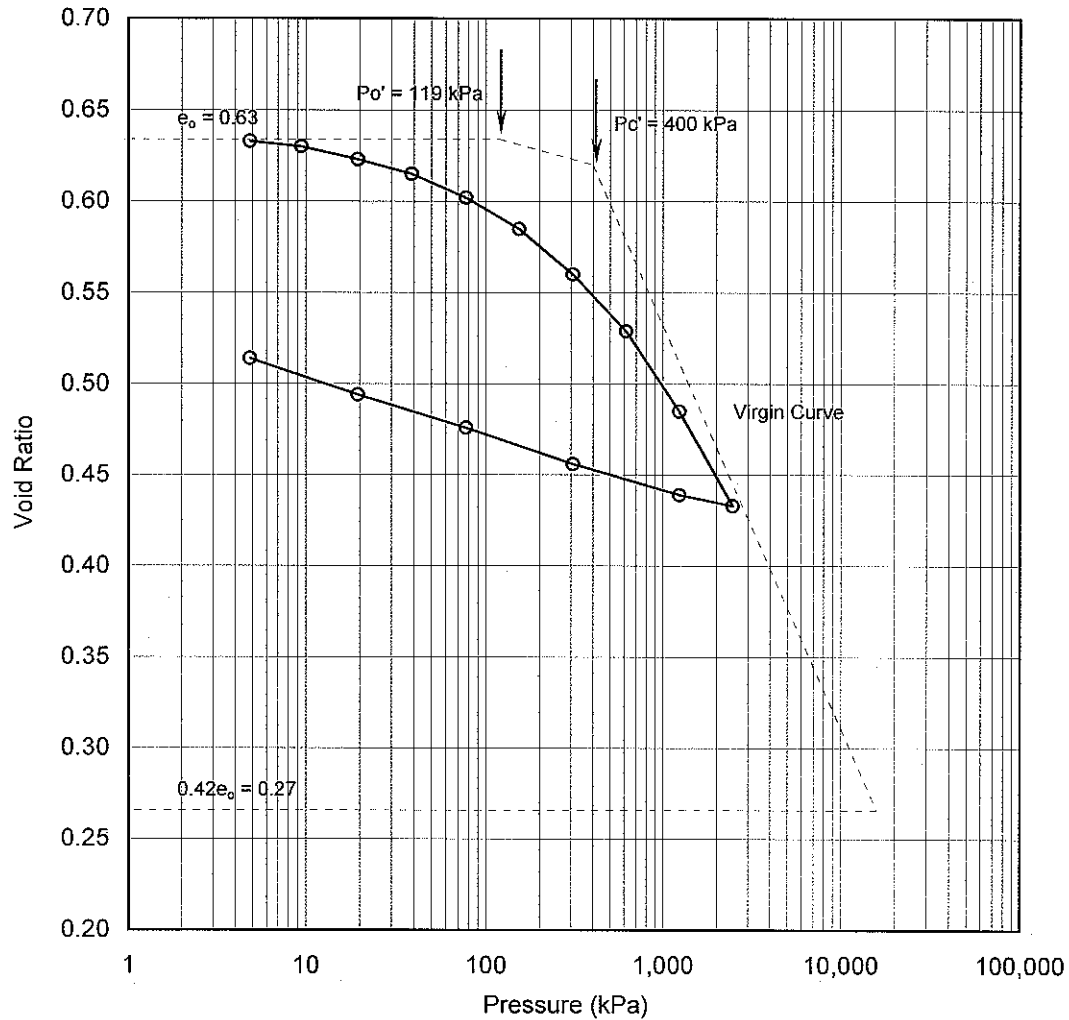
Project No. : 1-09-4135
Date : November 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
e vs Pressure
SEW 10+050 CL, TW9



Soil Type : Silty Clay

$e_o =$	0.63	$\omega_L =$	27%	$P_o' =$	119 kPa
$\omega =$	22%	$\omega_p =$	16%	$P_c' =$	400 kPa
$\gamma =$	20.4 kN/m ³	PI =	11%	Cc =	0.221
Gs =	2.78			Cr =	0.027

Project No. : 1-09-4135
Date : November 2010



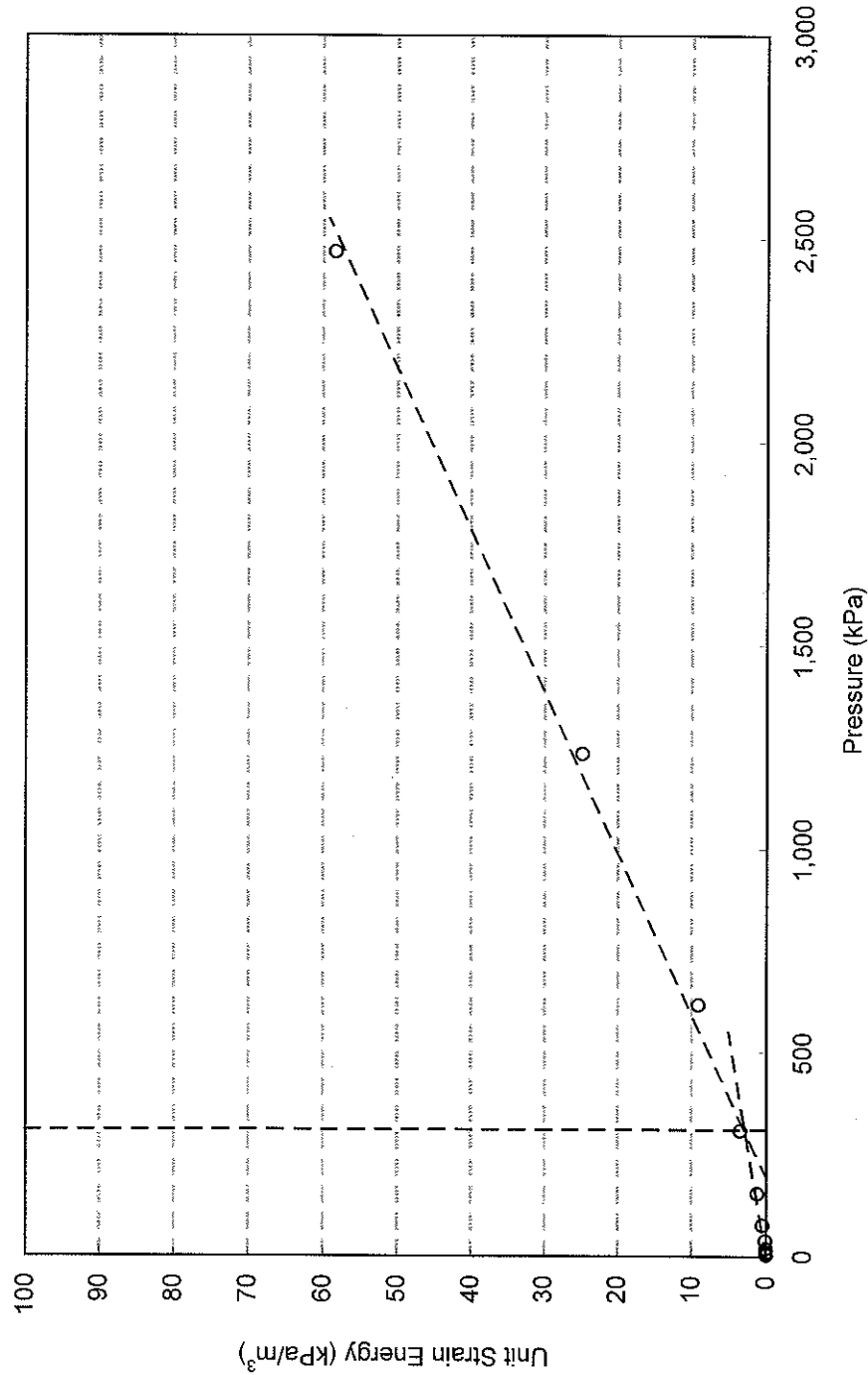
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-70

CONSOLIDATION TEST Unit Strain Energy vs Pressure SEW 10+050 CL, TW9



Pc = 310 kPa

Project No. : 1-09-4135

Date : November 2010



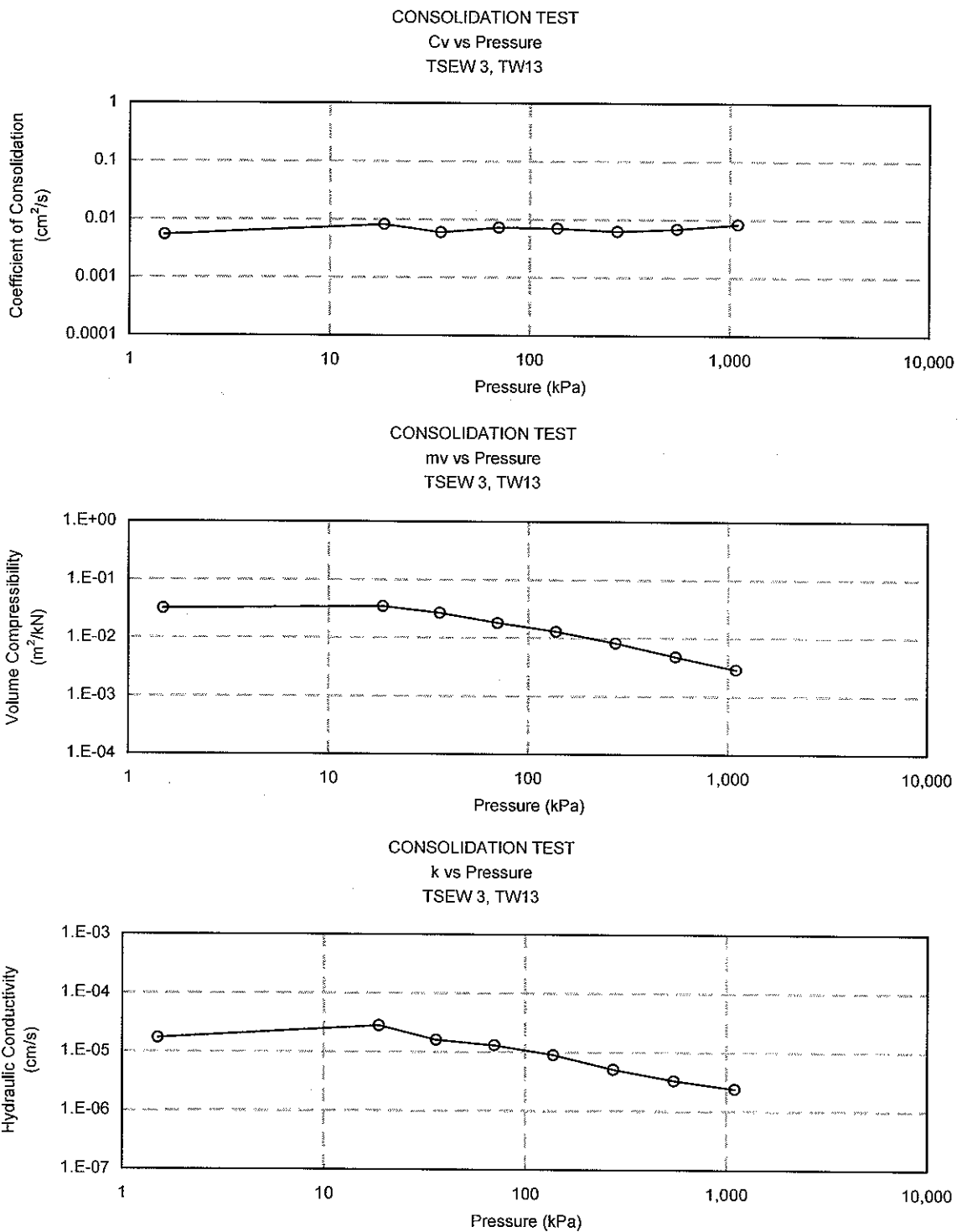
Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-71



Project No. : 1-09-4135
Date : November 2010



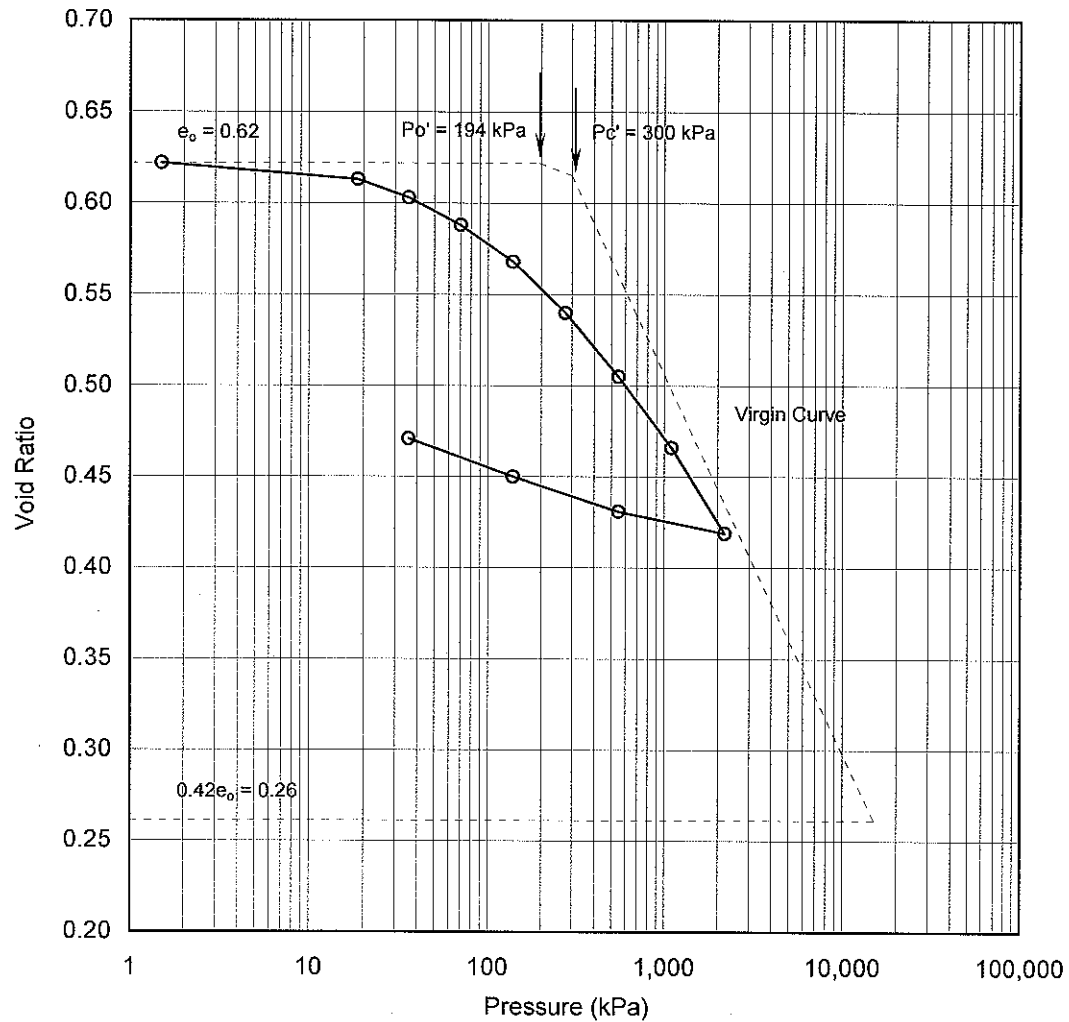
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

TSEW 3, TW13



Soil Type : Silty Clay

$e_o =$	0.62	$\omega_L =$	27%	$P_o' =$	194 kPa
$\omega =$	20%	$\omega_p =$	16%	$P_c' =$	300 kPa
$\gamma =$	20.8 kN/m ³	PI =	10%	Cc =	0.208
Gs =	2.75			Cr =	0.037

Project No. : 1-09-4135
 Date : November 2010



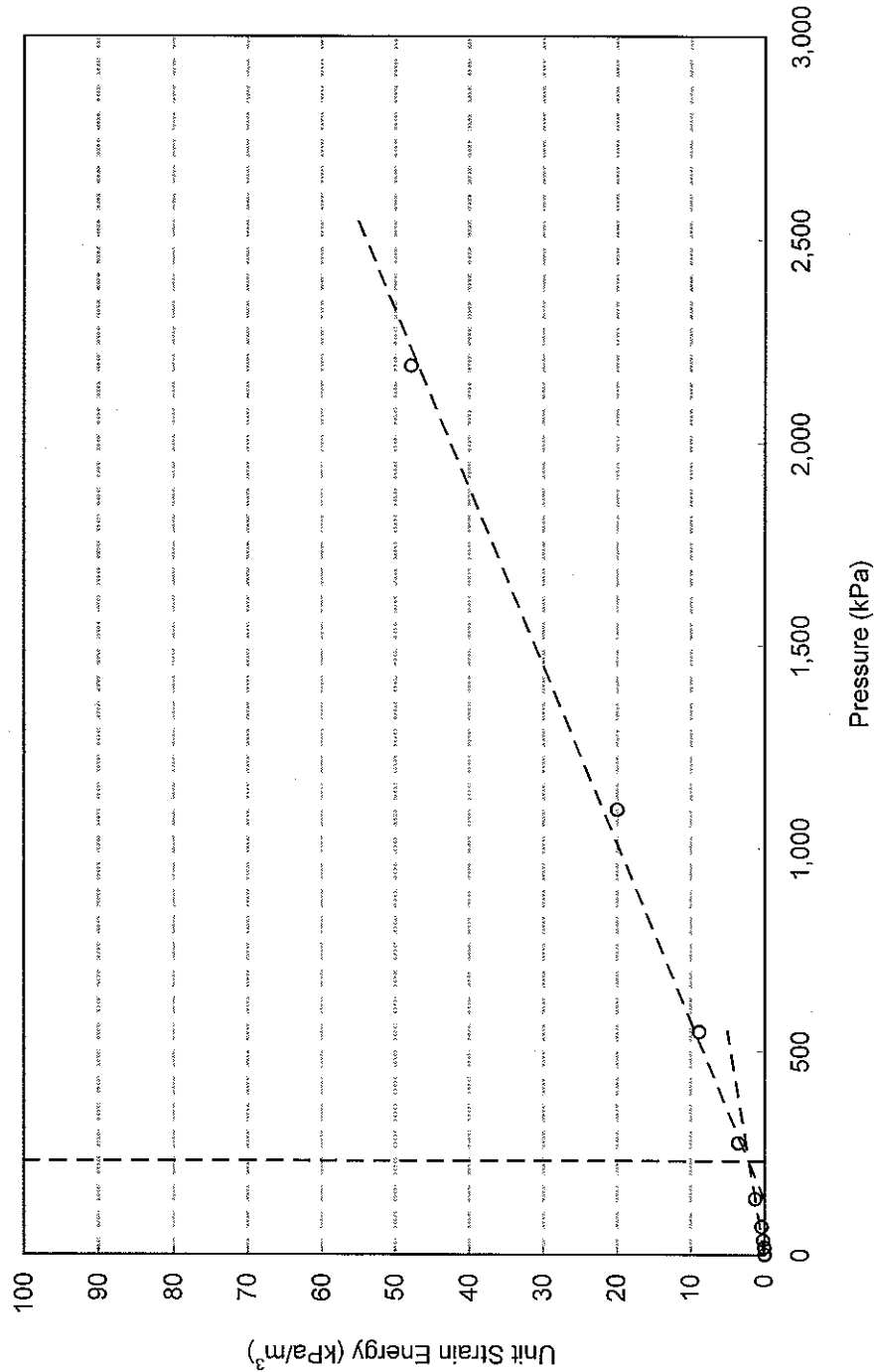
Terraprobe Inc.

Prepared By : HW
 Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-73

CONSOLIDATION TEST Unit Strain Energy vs Pressure TSEW 3, TW13



Pc = 230 kPa

Project No. : 1-09-4135

Date : November 2010



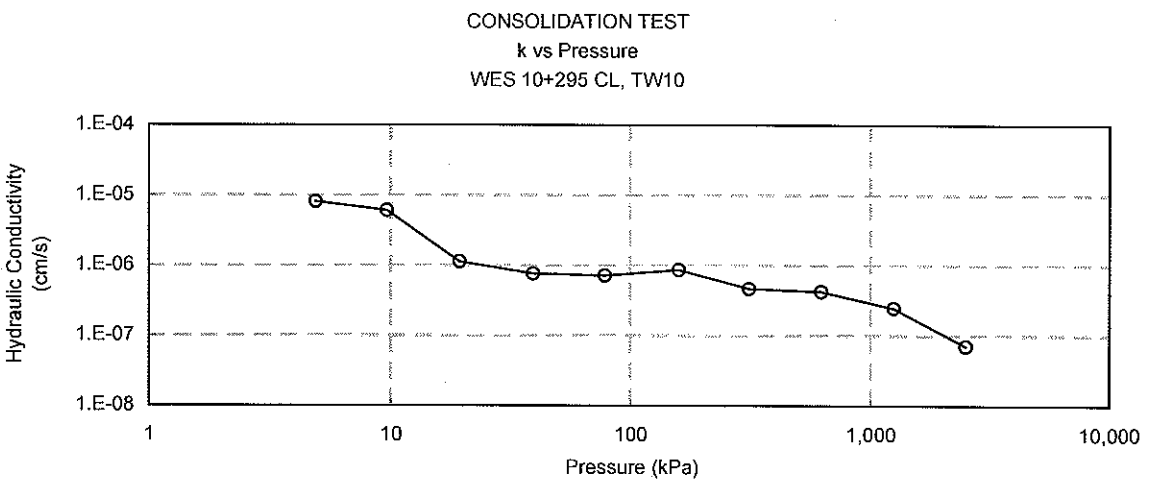
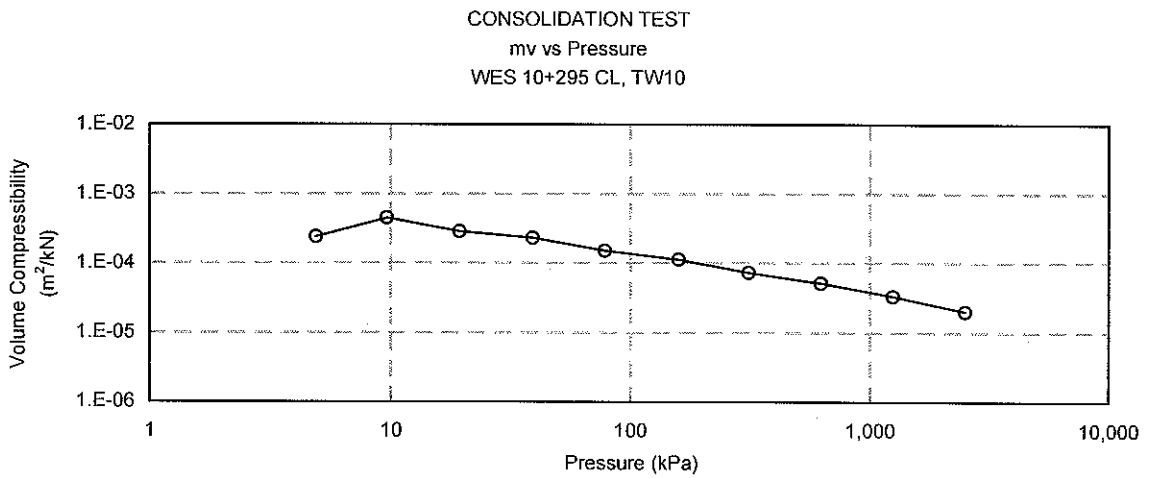
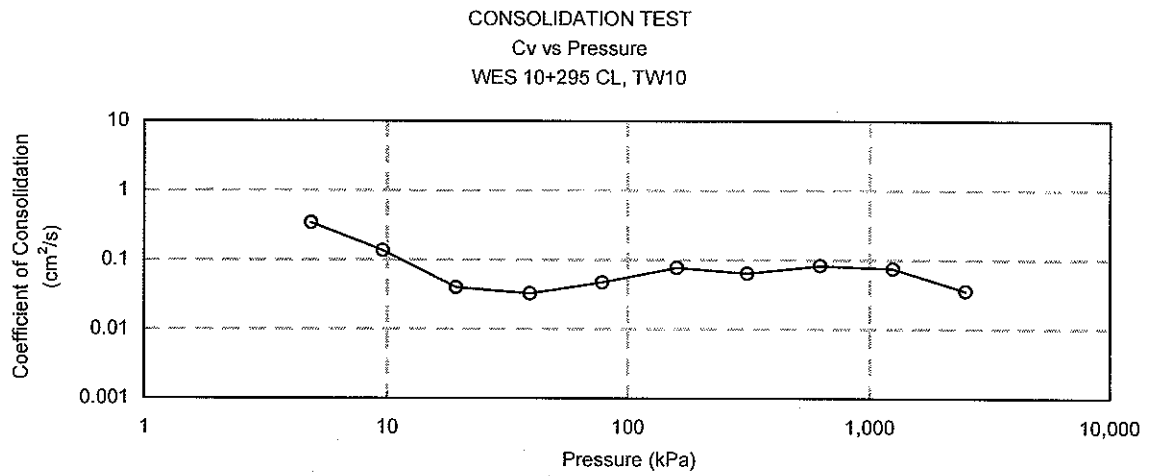
Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-74



Project No. : 1-09-4135
Date : November 2010



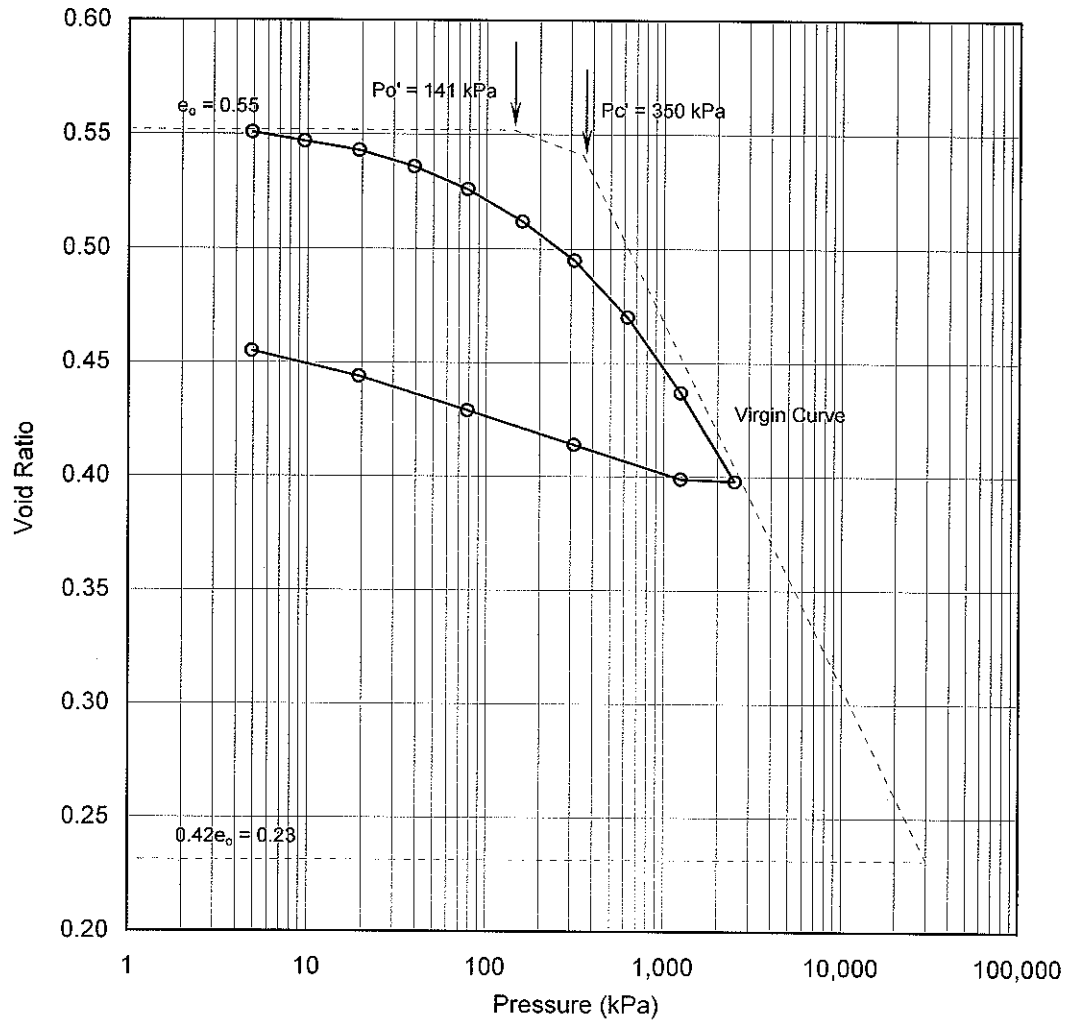
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

WES 10+295 CL, TW10



Soil Type : Silty Clay

$e_0 =$	0.55	$\omega_L =$	26%	$P_{o'} =$	141 kPa
$\omega =$	19%	$\omega_p =$	17%	$P_{c'} =$	350 kPa
$\gamma =$	20.8 kN/m ³	PI =	9%	Cc =	0.160
Gs =	2.77			Cr =	0.028

Project No. : 1-09-4135
 Date : November 2010



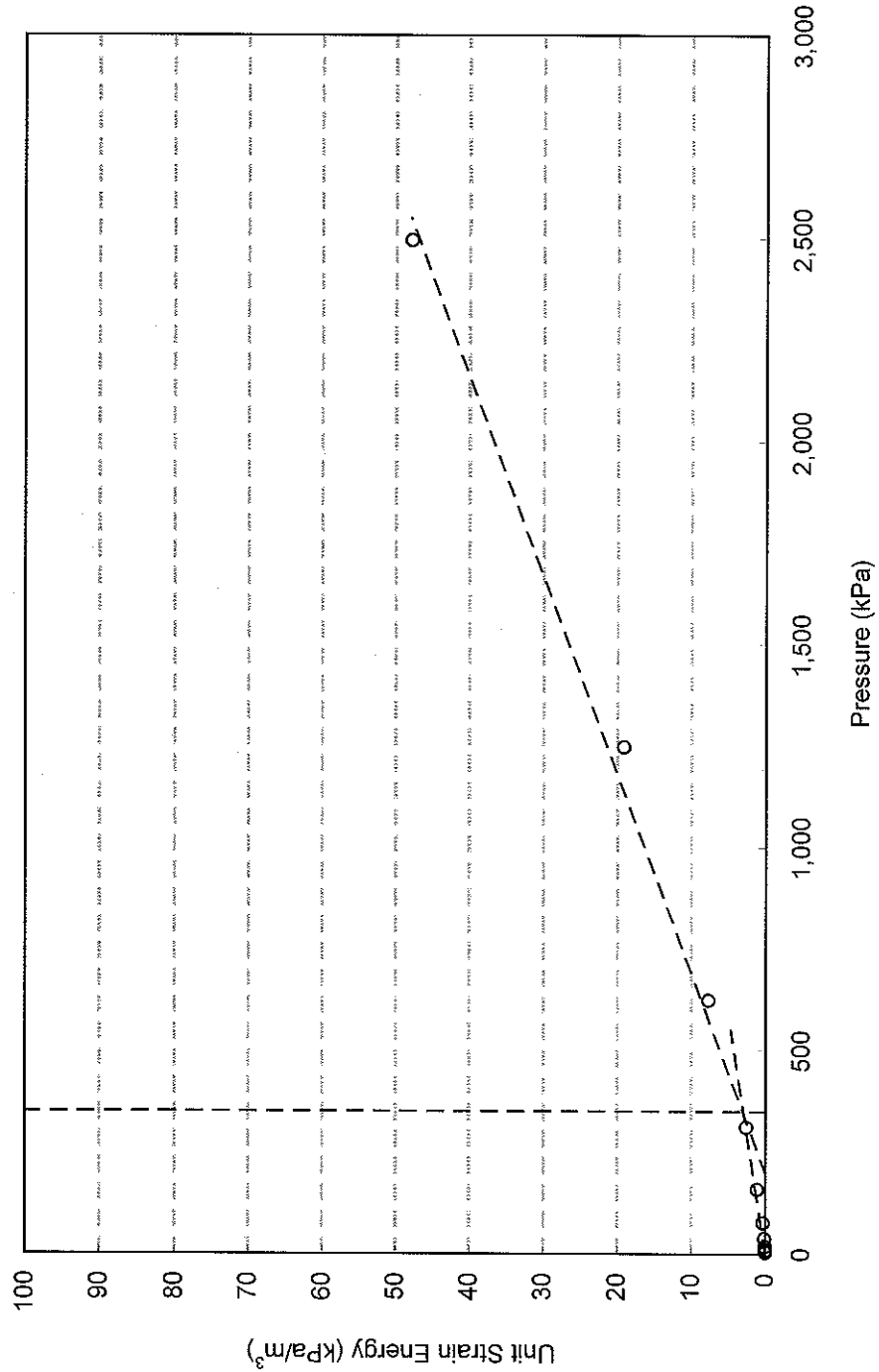
Terraprobe Inc.

Prepared By : HW
 Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-76

CONSOLIDATION TEST Unit Strain Energy vs Pressure WES 10+295 CL, TW10



Pc = 350 kPa

Project No. : 1-09-4135

Date : November 2010



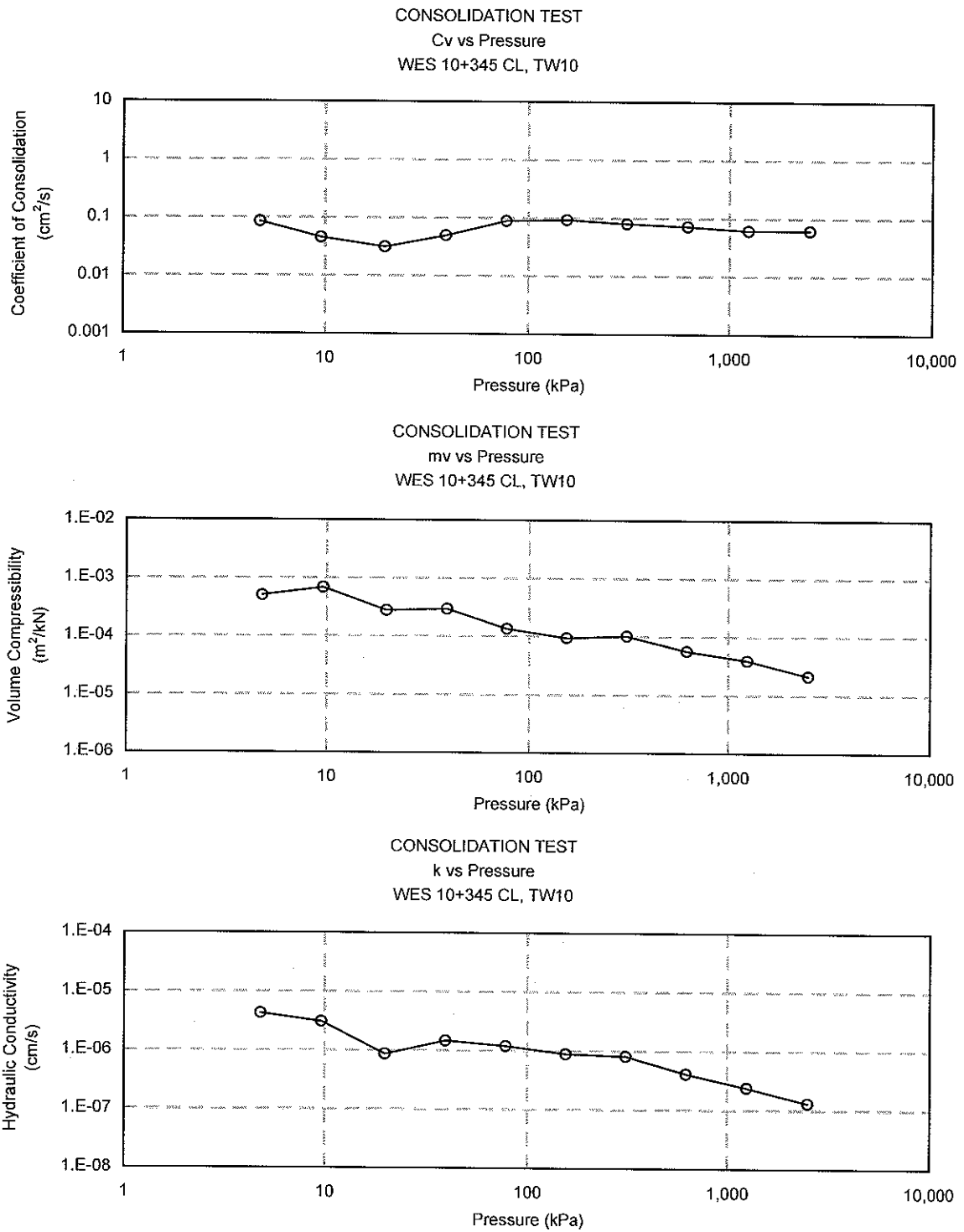
Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-77



Project No. : 1-09-4135
Date : November 2010



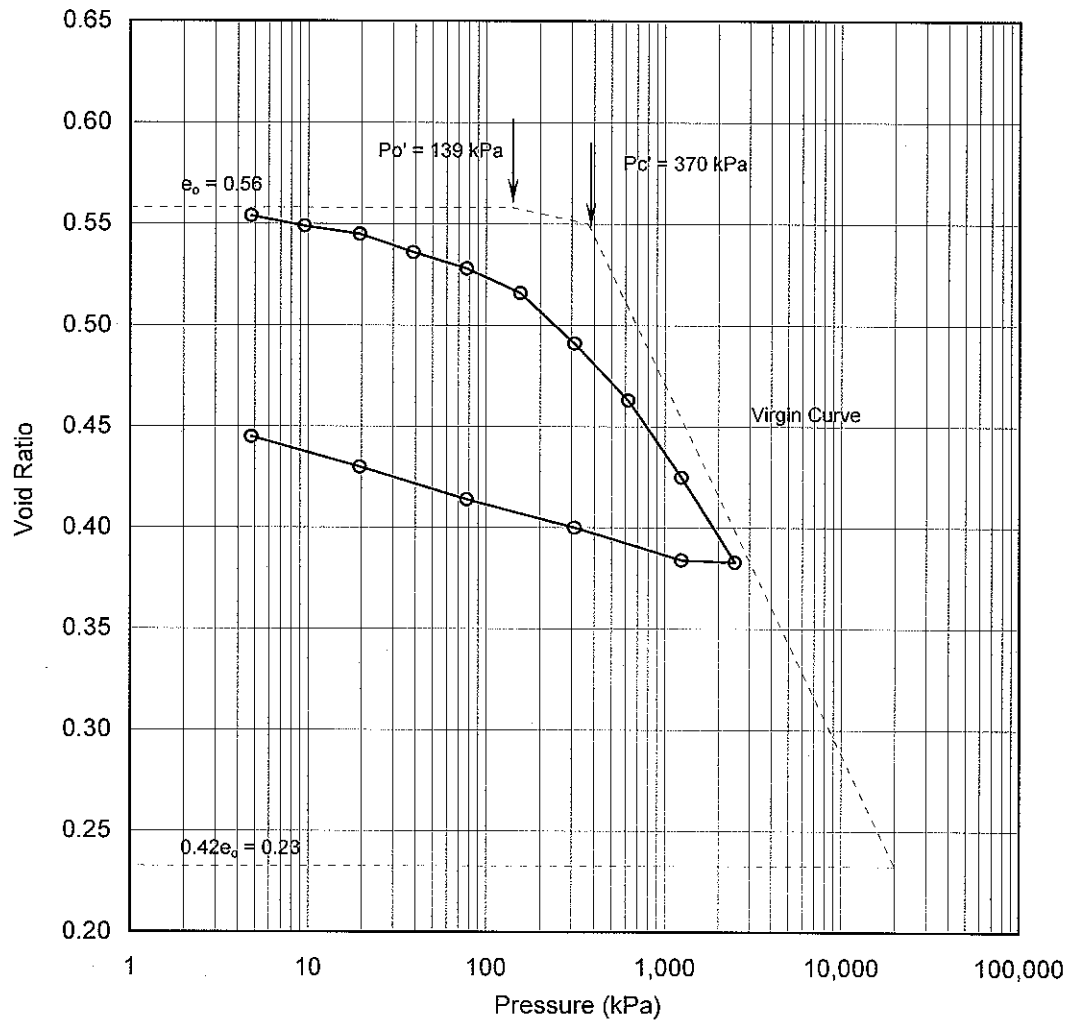
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

WES 10+345 CL, TW10



Soil Type : Silty Clay

 $e_0 = 0.56$ $\omega_L = 27\%$ $P_{o'} = 139$ kPa $\omega = 21\%$ $\omega_P = 16\%$ $P_{c'} = 370$ kPa $\gamma = 20.7$ kN/m³

PI = 11%

Cc = 0.183

Gs = 2.70

Cr = 0.019

Project No. : 1-09-4135
 Date : November 2010



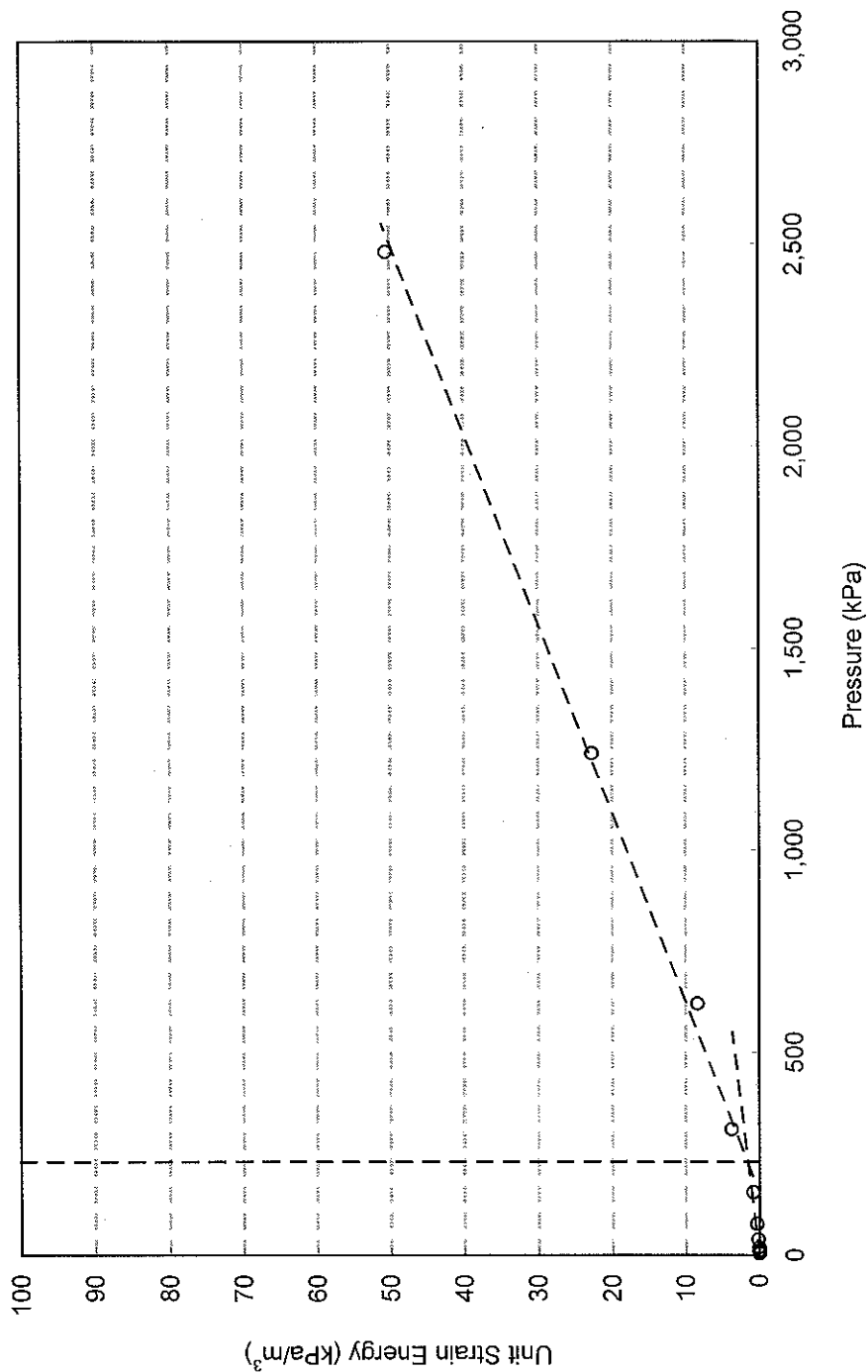
Terraprobe Inc.

Prepared By : HW
 Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #2

FIGURE B2-79

CONSOLIDATION TEST Unit Strain Energy vs Pressure WES 10+345 CL, TW10



Pc = 230 kPa

Project No. : 1-09-4135

Date : November 2010



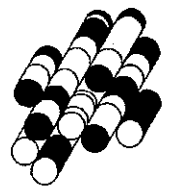
Terraprobe Inc.

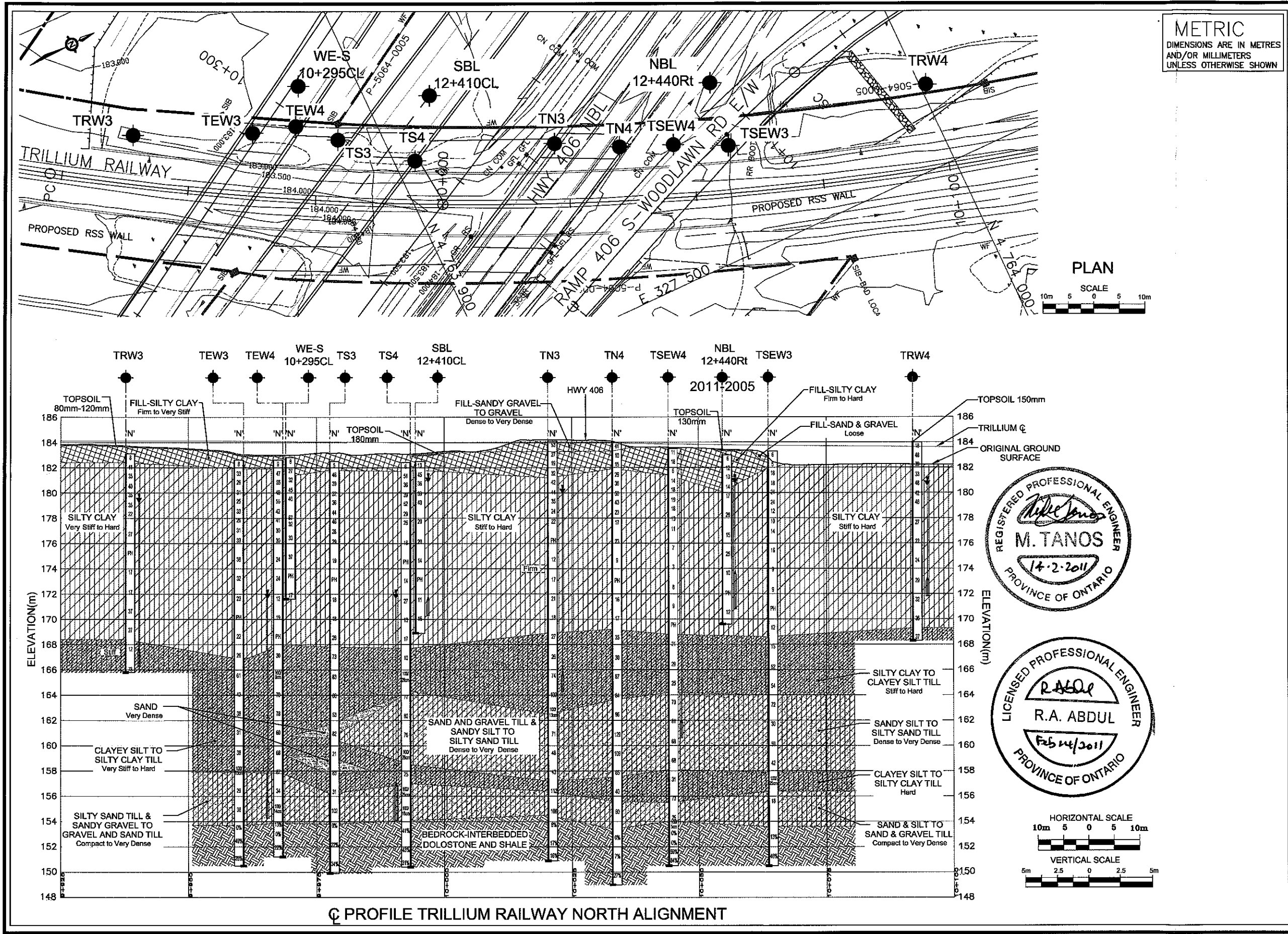
Prepared By : HW

Checked By : RA

C2

TERRAPROBE INC.





METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No 2011-2005
WP No 280-99-00

HIGHWAY 406
TRILLIUM RAILWAY NORTH RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

IBI GROUP

Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing
10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650

KEY PLAN

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test
- Bore Hole And Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60' Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer (AUG. 2010)
- Piezometer
- 90% Rock Quality Designation
- Auger Refusal

No	ELEV.	COORDINATES	
		NORTHING	EASTING
NBL12+440Rt	183.0	4 763 962.9	327 465.8
SBL 12+410CL	182.5	4 763 911.8	327 444.8
TEW3	182.6	4 763 877.2	327 436.9
TEW4	182.6	4 763 885.4	327 439.2
TN3	184.1	4 763 930.0	327 463.7
TN4	184.0	4 763 941.4	327 469.8
TRW3	183.1	4 763 855.8	327 427.4
TRW4	184.0	4 764 001.2	327 484.0
TS3	182.5	4 763 891.8	327 445.1
TS4	182.4	4 763 903.8	327 455.3
TSEW3	183.3	4 763 960.8	327 478.6
TSEW4	183.5	4 763 951.2	327 473.9
WE-S 10+295CL	182.8	4 763 889.2	327 432.2

NOTE

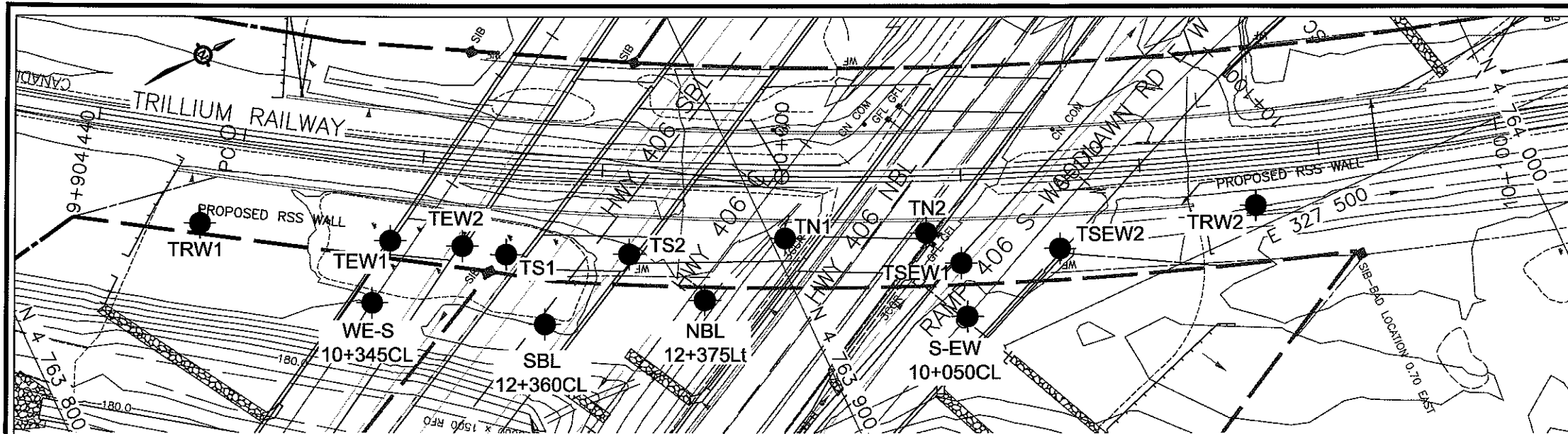
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION

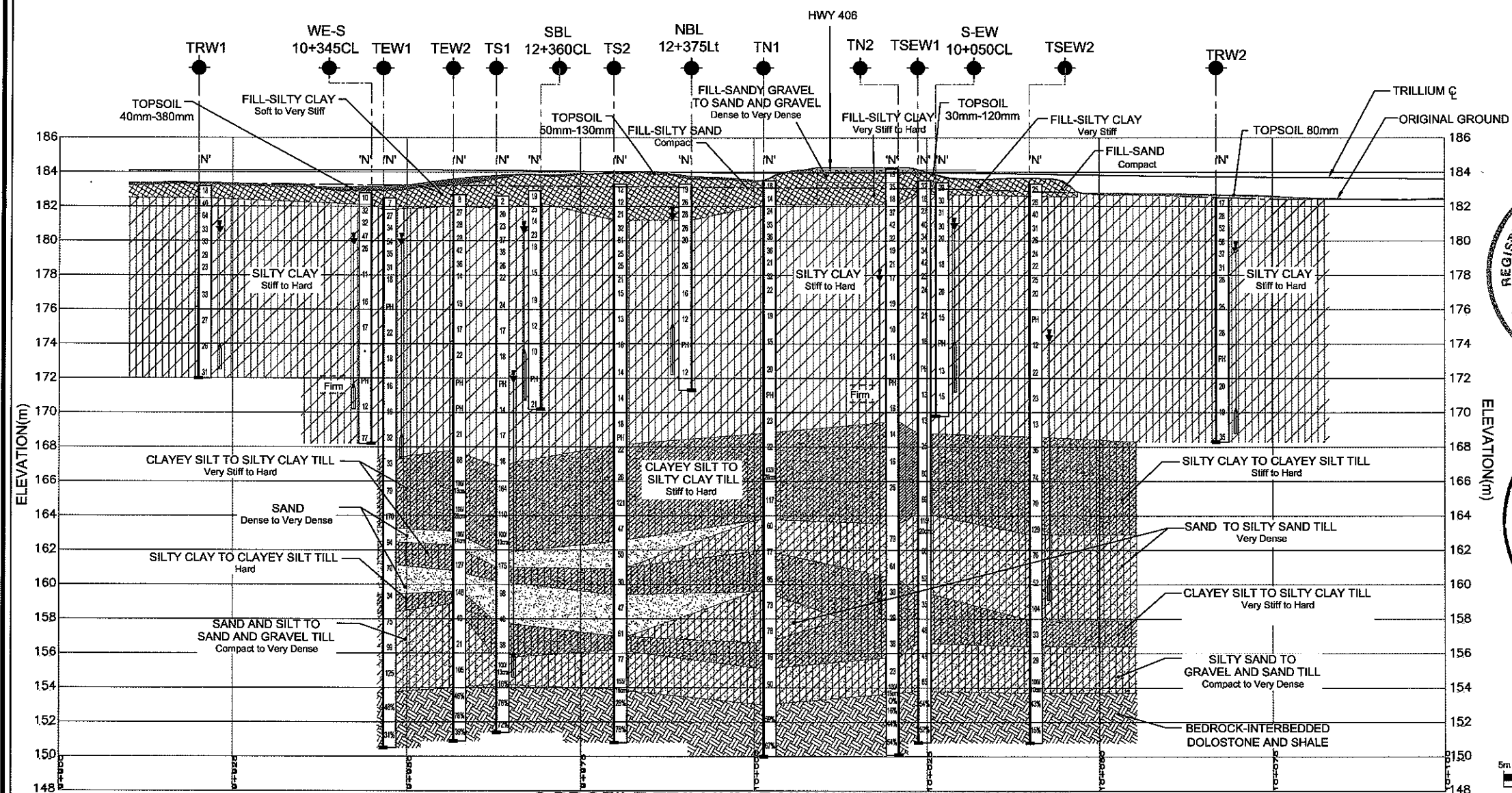
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DRAWN	K.C.	CHK	R.A.	STRUCT	GEOCRES 30M3-268	

C:\Users\jw\Documents\1-9-4133 HWY 406 RETAINING WALLS UPDATE\1-9-4133 TRILLIUM RAILWAY NORTH RETAINING WALL TEST-406.DWG

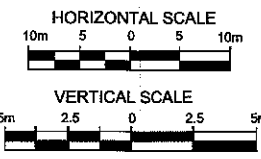
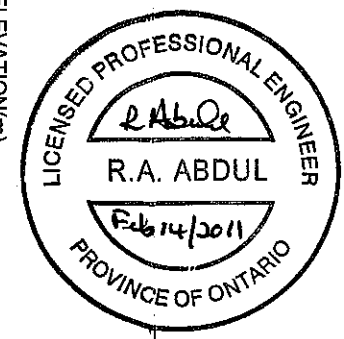


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

PLAN



Q PROFILE TRILLIUM RAILWAY SOUTH ALIGNMENT

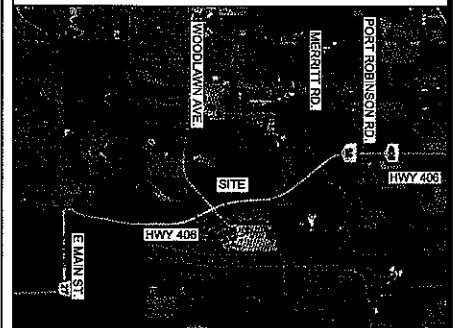


CONT No 2011-2005
WP No 280-99-00

HIGHWAY 406
TRILLIUM RAILWAY SOUTH RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA



Terraprobe Inc.
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KEY PLAN

- LEGEND
- Bore Hole
 - Dynamic Cone Penetration Test
 - Bore Hole And Cone
 - Blows/0.3m (Std Pen Test, 475 J/blow)
 - Blows/0.3m (60° Cone, 475 J/blow)
 - WL at Time of Investigation
 - WL in Piezometer (AUG. 2010)
 - Piezometer
 - 90% Rock Quality Designation
 - Auger Refusal

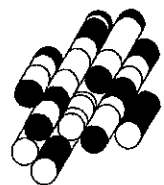
No	ELEV.	COORDINATES	
		NORTHING	EASTING
NBL 12+375Lt	183.3	4 763 888.1	327 476.6
SBL 12+360CL	182.9	4 763 866.5	327 470.3
S-EW 10+050CL	183.4	4 763 920.4	327 494.1
TEW1	182.5	4 763 851.9	327 480.6
TEW2	182.7	4 763 880.7	327 455.5
TN1	183.5	4 763 901.9	327 473.4
TN2	184.2	4 763 920.1	327 481.1
TRW1	183.2	4 763 828.9	327 437.2
TRW2	182.5	4 763 963.4	327 487.0
TS1	182.6	4 763 885.7	327 459.1
TS2	183.3	4 763 881.2	327 466.3
TSEW1	183.5	4 763 922.8	327 487.0
TSEW2	183.3	4 763 936.1	327 490.9
WE-S 10+345CL	182.8	4 763 845.9	327 457.4

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	R.A.	CODE	CHBDC2006
DRAWN	K.C.	CHK	R.A.
LOAD		STRUCT	
DATE	FEB. 2011		
GEORES	30M3-266		

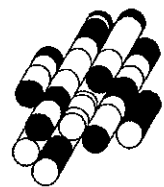
SITE 3

TERRAPROBE INC.



A3

TERRAPROBE INC.



RECORD OF BOREHOLE No WRW1

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764145.1 E:327283.6 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 6.24.10 CHECKED BY RA

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20 40 60 80 100									
182.9	Ground Surface																
182.7	180mm TOPSOIL																
0.2	FILL - Silty Clay, trace sand, trace organics, stiff, brown, moist		1	SS	9								58	0 2 44 54			
182.2																	
0.7	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		2	SS	33		182										
			3	SS	37		181										
			4	SS	46		180										
			5	SS	30		179							0 2 69 29			
			6	SS	37		178										
			7	SS	31		177										
			8	SS	26		176										
			9	SS	21		175							0 3 72 25			
			10	SS	24		174										
			11	SS	29		173										
171.7							172										
11.2	End of Borehole																
	Water level at 6.2m (not stabilized) and hole open to full depth on completion.																

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764163.6 E:327303.9 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / Casing and Washboring / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.19.10 - 4.29.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	w_p	w	w	w	w_L	w_L		
182.7	Ground Surface																
0.1	80mm TOPSOIL		1	SS	7		182										
	FILL - Silty Clay, trace sand, firm to hard, brown, damp		2	SS	28												0 2 36 62
			3	SS	37		181										
180.6																	
2.1	SILTY CLAY trace sand, trace gravel, hard, brown, damp		4	SS	32		180										
			5	SS	33												
			6	SS	52		179										
178.3																	
4.4	SILT trace sand, trace gravel, frequent silty clay seams and partings, dense, brown, damp		7	SS	47		178										1 2 75 22
			8	SS	39												
176.8							177										
5.9	SILTY CLAY trace sand, trace gravel, very stiff to hard, brown, damp to moist		9	SS	15												
							176										
			10	SS	23		175										0 5 83 12
							174										
			11	SS	25												0 4 62 34
							173										
			12	TW	PH		172										
							171										
			13	SS	41												
							170										
			14	SS	28		169										1 3 72 24
168.0																	
14.7							168										

Continued Next Page

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

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

2 OF 3

METRIC

SOIL PROFILE	SAMPLES		...	DYNAMIC CONE PENETRATION				
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ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

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

3 OF 3

METRIC

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No SBL 12+685CL

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764160.4 E:327319.7 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.17.09 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
182.7	Ground Surface																
0.0	470mm FILL - Sand and Gravel, some silt, trace clay, compact, grey, damp		1	SS	11												41 42 13 4
182.2	SILTY CLAY trace sand, occasional gravel inclusions, very stiff, brown, moist		2	SS	18		182										
0.5			3	SS	15		181										
			4	SS	16		180										0 1 50 49
			5	SS	19		179										
			6	SS	15		178										
			7	SS	13		177										
			8	SS	11		176										
			9	SS	8		175										
			10	TW	PH		174										
							173										
							172										
							171										
170.5	End of Borehole																
12.2	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Piezometer destroyed after drilling. Consolidation test performed on TW 10.																

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

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764174.7 E:327313.4 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 1.28.10 - 2.1.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
183.1 0.0	Ground Surface							20 40 60 80 100	10 20 30					GR SA SI CL	
	firm		1	SS	7		183				○				
	SILTY CLAY trace sand, trace gravel, hard, brown, damp		2	SS	38		182				○	45		2 3 37 58	
			3	SS	43		181				○				
			4	SS	36		180				○	47		0 1 51 48	
			5	SS	29		179				○				
178.7 4.4	SILT trace sand, frequent silty clay seams and partings, dense, brown, damp		6	SS	24		178				○			0 1 79 20	
			7	SS	37		177				○				
			8	SS	36		176				○				
177.2 5.9	SILTY CLAY trace sand, trace gravel, stiff to very stiff, brown, damp to moist		9	SS	21		175				○			0 5 68 27	
			10	SS	22		174			>>	○				
			11	TW	PH		173				1.6				
			12	SS	10		172				1.2			0 3 70 27	
			13	SS	15		171				1.1			0 2 72 26	
			14	SS	28		170				1.3				
168.4 14.7							169				2.5				



Continued Next Page

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

2 OF 3

METRIC

ELEV. DEPTH	SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION		STRAT.PLOT	NUMBER	TYPE			"N" VALUES						
								20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	W _p W W _L WATER CONTENT (%) 10 20 30					

[illegible]

Continued Next Page

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS2

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764174.7 E:327313.4 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.28.10 - 2.1.10 CHECKED BY RA

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/m³	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									
							20	40	60	80	100						
29.9	End of Borehole No sample recovery at SS12. Sampler redriven and disturbed sample collected. Unable to push vane beyond 12m. Borehole open to full depth and filled with drill water upon completion of drilling. Borehole sealed with bentonite slurry to ground surface.																

ON MOT 1-09-4135 WRWRET WALLS.GPJ ON MOT.GDT 9/3/10

METRIC

ORIGINATED BY MP

COMPILED BY DB

CHECKED BY RA

Continued Next Page

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

RECORD OF BOREHOLE No NBL 12+695Lt

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764175.1 E:327333.0 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.18.09 CHECKED BY RA

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																						
	<p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen.</p> <p>Water Level Readings:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth(m)</th> <th>Elevation(m)</th> </tr> </thead> <tbody> <tr> <td>Nov.30.09</td> <td>9.3</td> <td>173.6</td> </tr> <tr> <td>Dec.15.09</td> <td>3.4</td> <td>179.5</td> </tr> <tr> <td>Jan.04.10</td> <td>3.2</td> <td>179.7</td> </tr> <tr> <td>Jan.11.10</td> <td>3.3</td> <td>179.6</td> </tr> <tr> <td>Jan.19.10</td> <td>3.4</td> <td>179.5</td> </tr> </tbody> </table> <p>Consolidation test performed on TW 11.</p>	Date	Depth(m)	Elevation(m)	Nov.30.09	9.3	173.6	Dec.15.09	3.4	179.5	Jan.04.10	3.2	179.7	Jan.11.10	3.3	179.6	Jan.19.10	3.4	179.5											
Date	Depth(m)	Elevation(m)																												
Nov.30.09	9.3	173.6																												
Dec.15.09	3.4	179.5																												
Jan.04.10	3.2	179.7																												
Jan.11.10	3.3	179.6																												
Jan.19.10	3.4	179.5																												

ON_MOT 1-09-4135 WRW RET WALLS.GPJ ON_MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764187.0 E:327332.0 ORIGINATED BY AW
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.16.10 - 2.18.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
183.1	Ground Surface						183							
0.1	80mm TOPSOIL		1	SS	13		183							
	FILL - Silty Clay, trace sand, trace organics, stiff to very stiff, brown, moist		2	SS	23		182					46		0 2 35 63
			3	SS	24									
181.0							181							
2.1	SILTY CLAY trace sand, stiff to very stiff, brown, moist		4	SS	25									
			5	SS	14		180							0 1 54 45
			6	SS	15		179							
178.7							179							
4.4	SILT frequent silty clay seams and partings, compact, brown, moist		7	SS	16		178							0 0 80 20
177.9							178							
5.2	SILTY CLAY trace sand, stiff to very stiff, brown, damp to moist		8	SS	11		177							0 3 65 32
			9	SS	11									
							176			1.6				
			10	SS	11		175							0 9 70 21
							174			1.6				
			11	TW	PH					1.5				
							173			2.0				
			12	SS	8		172			1.6				0 2 71 27
							171			1.0				
			13	SS	9		170			1.6				
							169			1.2				0 2 70 28
168.4			14	SS	10					1.4				
14.7										1.2				

Continued Next Page

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

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

METRIC

[illegible]

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No WN2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764202.3 E:327354.1 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
181.6	Ground Surface							20 40 60 80 100							
181.5	150mm TOPSOIL							20 40 60 80 100							
0.2															
	SILTY CLAY trace sand, stiff to very stiff, brown, damp to moist		1	SS	8		181				○				
			2	SS	16						○	—		0 2 55 43	
			3	SS	16		180				○				
179.3															
2.3	SILT trace sand, frequent silty clay seams and partings, compact, brown, moist		4	SS	19		179				○			0 1 80 19	
			5	SS	12						○				
178.1							178								
3.5	SILTY CLAY trace sand, trace gravel, firm to very stiff, brown, moist		6	SS	6						—	—		0 3 64 33	
			7	SS	7		177				○				
			8	SS	6		176	+ 1.2						1 5 65 29	
										1.3					
							175				—	—			
			9	SS	2		174	+ 2.3							
							173	+ 1.6							
			10	TW	PH		172	+ 1.8							
							171	+ 1.7						Dec.10	
														Dec.11	
			11	SS	8		170	+ 1.6				—	—	1 2 73 24	
							169								
			12	SS	9										
168.4															
13.2	SILTY CLAY TO CLAYEY SILT some sand, trace gravel, very stiff to hard, brown, damp (GLACIAL TILL)						168	+ 1.4							
			13	SS	25							—	—	8 19 54 19	
							167								

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN2

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764202.3 E:327354.1 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

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 (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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+³, x³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN2

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764202.3 E:327354.1 ORIGINATED BY PK
 DIST HWY 405 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.10.09 - 12.14.09 CHECKED BY RA

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
							20	40	60	80	100		10	20	30		GR SA SI CL	
	Borehole open to full depth and filled with drill water upon completion of drilling. No sample recovery at SS7. Sampler redriven and disturbed sample collected. Resistance to augering from 18.2m to 19.2m, 22.9m to 23.2m and at 25.1m. Unable to push vane beyond 13.1m. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.9m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Jan.04.10 5.2 176.4 Jan.11.10 4.2 177.4 Jan.19.10 5.2 176.4 Jan.27.10 5.2 176.4																	

ON_MOT_1-09-4135 WRW/RET WALLS.GPJ ON_MOT.GDT 9/3/10

RECORD OF BOREHOLE No WRW2

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764215.1 E:327368.0 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 6.30.10 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
182.6	Ground Surface													
0.1	80mm TOPSOIL		1	SS	17		182				o			
181.9	FILL - Silty Clay, trace sand, very stiff, brown, damp to moist													
0.7	SILTY CLAY trace sand, hard, brown, damp to moist		2	SS	32		181				o			
			3	SS	41								49	0 1 47 52
			4	SS	35		180				o			
			5	SS	30									
			6	SS	42		179				o			
178.4	SILT - occasional silty clay seams and partings, compact to dense, brown, moist to wet		7	SS	26		178				o			
4.2														
177.9	SILTY CLAY trace sand, stiff to very stiff, brown, damp to moist		8	SS	16		177							
4.7			9	TW	PH		176						0 1 74 25	
			10	SS	11		175							
			11	SS	12		174	1.3						
			12	SS	14		173	1.4						
			13	SS	16		172	1.5						
							171	1.4						
							170						0 3 72 25	
167.9							169							
14.7							168							

Continued Next Page

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

ON MOT 1-09-1135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WRW2

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764215.1 E:327368.0 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 6.30.10 CHECKED BY RA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
166.9	SILTY CLAY TO CLAYEY SILT some sand, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		14	SS	65											4 12 61 23
15.7	End of Borehole Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.05.10 9.7 172.9 July.13.10 4.4 178.2 July.21.10 3.6 179.0 July.27.10 3.6 179.0															

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No WRW3

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764178.3 E:327273.3 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.25.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
183.7	Ground Surface							20 40 60 80 100							
183.6	130mm TOPSOIL							20 40 60 80 100							
0.1	FILL - Silty Clay, trace to some sand, trace organics, very stiff, brown, damp to moist		1	SS	17		183								
183.0															
0.7	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		2	SS	32		182								
			3	SS	41		181								
			4	SS	35		180								
			5	SS	35		179								
			6	SS	44		178								
			7	SS	41		177								
			8	SS	33		176								
			9	SS	37		175								
			10	SS	20		174								
			11	SS	23		173								
172.5	End of Borehole														
11.2	Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.05.10 3.2 180.5 July.13.10 3.2 180.5 July.20.10 2.9 180.8 July.27.10 2.6 181.1 Aug.06.10 3.4 180.3 Aug.13.10 3.6 180.1														

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS3

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764192.6 E:327292.7 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.20.10 - 1.22.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
183.0	Ground Surface						20 40 60 80 100								
0.1	50mm TOPSOIL		1	SS	17										
	FILL - Silty Clay, trace sand, very stiff to hard, brown, damp		2	SS	23										
		3	SS	36											
		4	SS	43											
180.1			5	SS	39										
2.9	SILTY CLAY trace sand, trace gravel, stiff to hard, brown, damp		6	SS	30										
		7	SS	24											
		8	SS	20											
		9	TW	PH											
			10	SS	9										
			11	SS	13										
			12	SS	17										
			13	SS	23										
			14	SS	23										
168.3															
14.7															

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

Continued Next Page

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

2 OF 2

METRIC

ELEV DEPTH	SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	W _p W W _L	WATER CONTENT (%) 10 20 30			
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
							20 40 60 80 100						

DEPTH (m)	DEPTH (ft)	SOIL DESCRIPTION	UNIT	TESTS	REMARKS	DATE
164.8	18.2	SILTY CLAY trace sand to sandy, trace gravel, hard, brown, damp (GLACIAL TILL)	15	SS	46	
163.2	19.8	SANDY SILT some clay, trace gravel, dense to very dense, brown, damp to moist (GLACIAL TILL)	16	SS	79	
160.7	22.3	CLAYEY SILT sandy, trace to some gravel, hard, brown, damp (GLACIAL TILL)	17	SS	65	
157.1	25.9	SANDY SILT trace to some gravel, trace clay, very dense, brown, damp to moist (GLACIAL TILL)	18	SS	44	
154.8	28.2	bedrock	19	SS	68	
152.1	30.5	bedrock	20	SS	100/5cm	
149.4	32.8	bedrock	21	SS	100/2.5cm	
146.7	35.1	bedrock	1	RUN	NQ	
144.0	37.4	bedrock	2	RUN	NQ	
141.3	39.7	bedrock				
138.6	42.0	bedrock				
135.9	44.3	bedrock				
133.2	46.6	bedrock				
130.5	48.9	bedrock				
127.8	51.2	bedrock				
125.1	53.5	bedrock				
122.4	55.8	bedrock				
119.7	58.1	bedrock				
117.0	60.4	bedrock				
114.3	62.7	bedrock				
111.6	65.0	bedrock				
108.9	67.3	bedrock				
106.2	69.6	bedrock				
103.5	71.9	bedrock				
100.8	74.2	bedrock				
98.1	76.5	bedrock				
95.4	78.8	bedrock				
92.7	81.1	bedrock				
90.0	83.4	bedrock				
87.3	85.7	bedrock				
84.6	88.0	bedrock				
81.9	90.3	bedrock				
79.2	92.6	bedrock				
76.5	94.9	bedrock				
73.8	97.2	bedrock				
71.1	99.5	bedrock				
68.4	101.8	bedrock				
65.7	104.1	bedrock				
63.0	106.4	bedrock				
60.3	108.7	bedrock				
57.6	111.0	bedrock				
54.9	113.3	bedrock				
52.2	115.6	bedrock				
49.5	117.9	bedrock				
46.8	120.2	bedrock				
44.1	122.5	bedrock				
41.4	124.8	bedrock				
38.7	127.1	bedrock				
36.0	129.4	bedrock				
33.3	131.7	bedrock				
30.6	134.0	bedrock				
27.9	136.3	bedrock				
25.2	138.6	bedrock				
22.5	140.9	bedrock				
19.8	143.2	bedrock				
17.1	145.5	bedrock				
14.4	147.8	bedrock				
11.7	150.1	bedrock				
9.0	152.4	bedrock				
6.3	154.7	bedrock				
3.6	157.0	bedrock				
0.9	159.3	bedrock				
End of Borehole		Unable to push vane beyond 12m. Resistance to augering at 24.3m. Borehole open to full depth and filled with drill water upon completion of drilling. Borehole sealed with bentonite slurry to ground surface.				

ON_MOT 1-09-4135 WRW RET WALLS.GPJ ON_MOT.GDT 9/3/10

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No WS4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764202.3 E:327305.2 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.28.10 - 2.1.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE ELEVATION	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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
182.7	Ground Surface																
0.0	25mm TOPSOIL		1	SS	13		182										
	FILL - Silty Clay, trace sand, trace gravel, stiff to very stiff, brown, damp to moist		2	SS	17												
			3	SS	13		181										
180.6			4	SS	45		180										1 1 48 50
2.1	SILTY CLAY trace sand, trace gravel, hard, brown, damp		5	SS	45												
			6	SS	43		179										
			7	SS	61		178										
177.7			8	SS	64		177										
5.0	SILT trace clay, trace sand, frequent silty clay seams and partings, very dense, brown, damp		9	SS	37		176										
			10	SS	37		175										
176.8			11	SS	20		174										0 3 67 30
5.9	SILTY CLAY trace sand, trace gravel, stiff to hard, brown, damp		12	TW	PH		173										
			13	SS	25		172										
			14	SS	23		171										1 6 71 22
168.0							170										
14.7							169										
							168										

Continued Next Page

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

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS4

2 OF 3

METRIC

W.P. 280-89-00 LOCATION Coords: N:4764202.3 E:327305.2 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.28.10 - 2.1.10 CHECKED BY RA

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)	
								20 40 60 80 100									
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+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON MOT. 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WS4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764202.3 E:327305.2 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 1.28.10 - 2.1.10 CHECKED BY RA

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	● QUICK TRIAXIAL	+	×	FIELD VANE						LAB VANE																			
	<p>Water level at approx. 9.1m (not stabilized) and hole open to full depth on completion.</p> <p>Unable to push vane beyond 14.7m.</p> <p>Resistance to augering from 25.0m to 25.8m.</p> <p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.</p> <p>Water Level Readings:</p> <table><tr><td>Date</td><td>Depth(m)</td><td>Elevation(m)</td></tr><tr><td>Feb.08.10</td><td>4.7</td><td>178.0</td></tr><tr><td>Apr.16.10</td><td>2.1</td><td>180.6</td></tr><tr><td>Apr.29.10</td><td>5.1</td><td>177.6</td></tr><tr><td>May.04.10</td><td>5.7</td><td>177.0</td></tr><tr><td>May.06.10</td><td>4.1</td><td>178.6</td></tr><tr><td>May.18.10</td><td>5.9</td><td>176.8</td></tr></table>	Date	Depth(m)	Elevation(m)	Feb.08.10	4.7	178.0	Apr.16.10	2.1	180.6	Apr.29.10	5.1	177.6	May.04.10	5.7	177.0	May.06.10	4.1	178.6	May.18.10	5.9	176.8															
Date	Depth(m)	Elevation(m)																																			
Feb.08.10	4.7	178.0																																			
Apr.16.10	2.1	180.6																																			
Apr.29.10	5.1	177.6																																			
May.04.10	5.7	177.0																																			
May.06.10	4.1	178.6																																			
May.18.10	5.9	176.8																																			

RECORD OF BOREHOLE No SBL 12+750CL

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764219.9 E:327296.2 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 11.10.09 CHECKED BY RA

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
182.9	Ground Surface													
182.7	200mm TOPSOIL													
0.2	FILL - Silty Clay, trace sand, trace organics, stiff, dark brown, moist		1	SS	8									
182.2														
0.7	SILTY CLAY trace sand, very stiff to hard, brown, moist		2	SS	24		182							
			3	SS	37		181							
			4	SS	46		180							
			5	SS	33		179							0 0 60 40
			6	SS	20		178							
			7	SS	27		177							
			8	SS	34		176							
			9	SS	21		175							0 4 68 28
	trace gravel		10	TW	PH		174							
							173						21.1	6 3 65 26
							172							
171.6	End of Borehole													
11.3	Water level at 10.4m (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Nov.19.09 4.6 178.3 Nov.30.09 7.8 175.1 Dec.08.09 4.1 178.8 Dec.15.09 3.2 179.7 Jan.04.10 2.7 180.2 Jan.11.10 2.7 180.2 Jan.19.10 2.6 180.3 Consolidation test performed on TW 10													

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN3

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764212.0 E:327314.7 ORIGINATED BY KB
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 2.18.10 - 2.22.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
182.1	Ground Surface						20	40	60	80	100					
0.0	FILL - Sand and Gravel, some silt, trace clay, dense, grey, damp		1	SS	48											41 44 13 2
181.4																
0.7	firm		2	SS	6											
	—		3	SS	22											
	SILTY CLAY trace sand, trace gravel, very stiff, brown, damp		4	SS	14											
			5	SS	27											
178.4																
3.7	SILT trace sand, frequent silty clay seams and partings, compact, brown, damp		6	SS	26											0 1 84 15
177.4			7	SS	9											
4.7	SILTY CLAY trace sand, trace gravel, stiff to hard, brown, damp		8	SS	12											
			9	SS	10											
			10	SS	11											0 3 70 27
			11	SS	8											1 3 69 27
			12	TW	PH											
			13	SS	17											1 2 72 25

Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN3										3 OF 3		METRIC				
W.P. 280-99-00		LOCATION Coords: N:4764212.0 E:327314.7				ORIGINATED BY KB										
DIST _____ HWY 406		BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring				COMPILED BY DB										
DATUM Geodetic		DATE 2.18.10 - 2.22.10				CHECKED BY RA										
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								
							20	40	60	80	100					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					WATER CONTENT (%)				
							20	40	60	80	100	10	20	30		
30.0	End of Borehole Borehole open to full depth and filled with drill water upon completion of drilling. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Apr.16.10 7.7 174.4 Apr.29.10 3.9 178.2 May.04.10 5.2 176.9 May.06.10 4.8 177.3															

ON_MOT 1-09-4135 WPRW RET WALLS.GPJ ON_MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764228.4 E:327343.4 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.14.09 - 12.15.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
182.5	Ground Surface													
182.4	150mm TOPSOIL													
0.2	soft		1	SS	3		182							
	FILL - Silty Clay, trace sand, trace gravel, firm to stiff, brown, damp		2	SS	6									0 2 67 31
			3	SS	9		181							
			4	SS	8		180							5 3 56 36
			5	SS	5		179							
178.8														
3.7	SILT trace clay, trace sand, frequent silty clay seams and partings, compact, brown, damp		6	SS	16		178							
			7	SS	22		177							
177.6														
4.9	SILTY CLAY trace to some gravel, trace sand, stiff to very stiff, brown, damp		8	SS	5		176							17 10 37 36
			9	SS	10		175							
			10	TW	PH		174							
			11	SS	9		173							1 2 72 25
			12	SS	8		172							1 3 73 23
			13	SS	12		171							Dec.14 Dec.15
			14	SS	12		170							
							169							
							168							1 8 68 23
167.8														
14.7														


Continued Next Page

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

2 OF 3

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				w _p	w	w _L		
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				20 40 60 80 100 10 20 30		GR SA SI CL

	GR	SA	SI	C
6	35	47	12	
18	41	31	10	
RUN#1 TCR=92% SCR=77% RQD=44%				
RUN#2 TCR=100% SCR=90% RQD=35%				
RUN#3 TCR=98% SCR=95% RQD=36%				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

ON_MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 9/3/10

RECORD OF BOREHOLE No WN4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764228.4 E:327343.4 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.14.09 - 12.15.09 CHECKED BY RA

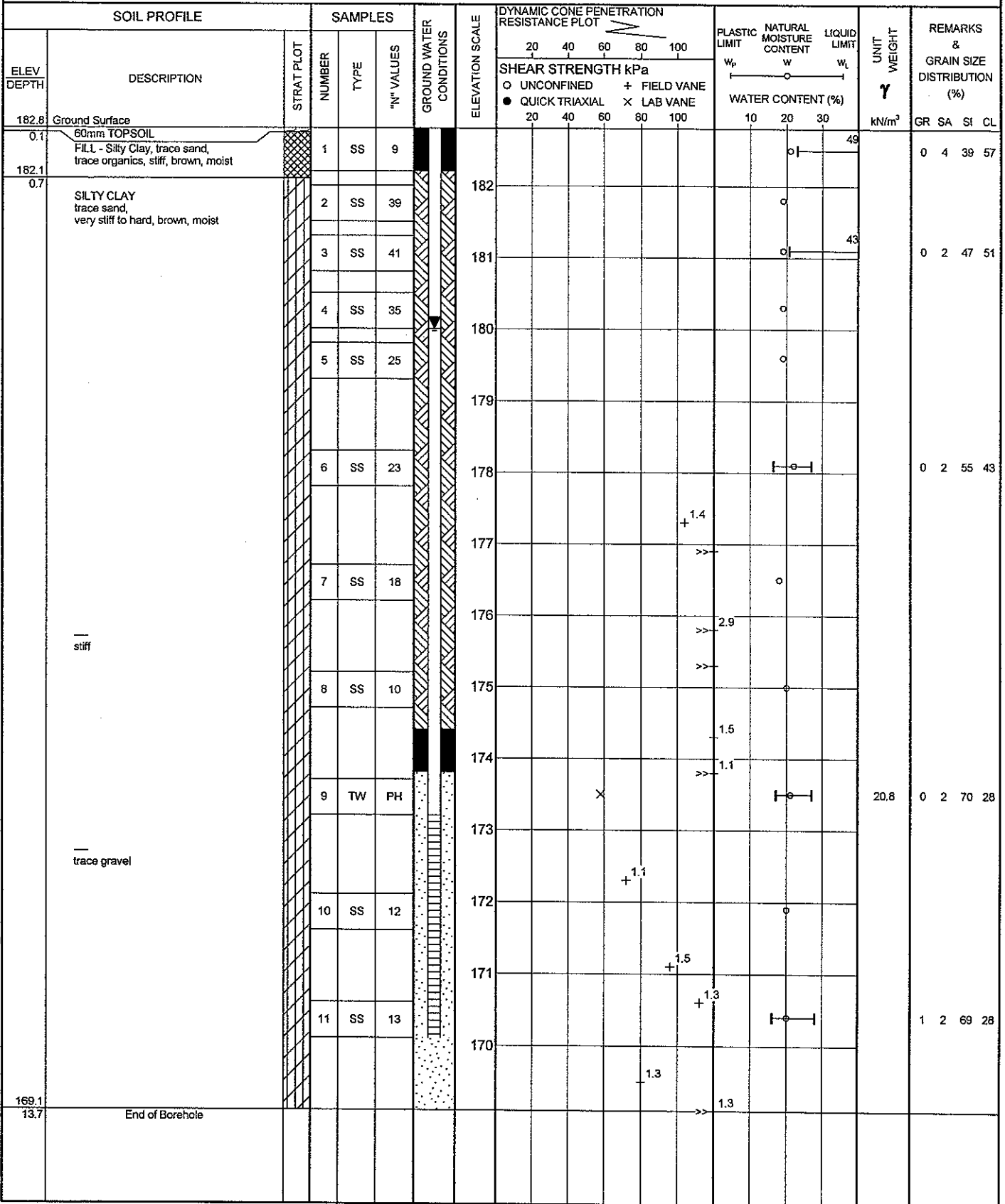
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	<p>Borehole open to full depth and filled with drill water upon completion of drilling.</p> <p>Borehole sealed with bentonite slurry to ground surface.</p> <p>Resistance to augering at 22.9m and 24.3m.</p> <p>Unable to push vane beyond 13.1m and 14.2m.</p>															

RECORD OF BOREHOLE No NBL 12+750Rt

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764237.5 E:327341.9 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY KL
DATUM Geodetic DATE 12.2.09 CHECKED BY RA



RECORD OF BOREHOLE No NBL 12+750Rt

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764237.5 E:327341.9 ORIGINATED BY AW
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY KL
DATUM Geodetic DATE 12.2.09 CHECKED BY RA

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																							
	<p>Borehole was dry (not stabilized) and hole open to full depth on completion.</p> <p>Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 3.0m slotted screen.</p> <p>Water Level Readings:</p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth(m)</th> <th>Elevation(m)</th> </tr> </thead> <tbody> <tr> <td>Dec.15.09</td> <td>5.1</td> <td>177.7</td> </tr> <tr> <td>Jan.04.10</td> <td>2.7</td> <td>180.1</td> </tr> <tr> <td>Jan.11.10</td> <td>2.7</td> <td>180.1</td> </tr> <tr> <td>Jan.19.10</td> <td>2.8</td> <td>180.0</td> </tr> </tbody> </table> <p>Consolidation test performed on TW 9.</p>	Date	Depth(m)	Elevation(m)	Dec.15.09	5.1	177.7	Jan.04.10	2.7	180.1	Jan.11.10	2.7	180.1	Jan.19.10	2.8	180.0															
Date	Depth(m)	Elevation(m)																													
Dec.15.09	5.1	177.7																													
Jan.04.10	2.7	180.1																													
Jan.11.10	2.7	180.1																													
Jan.19.10	2.8	180.0																													

+ 3, X 3: Numbers refer to Sensitivity

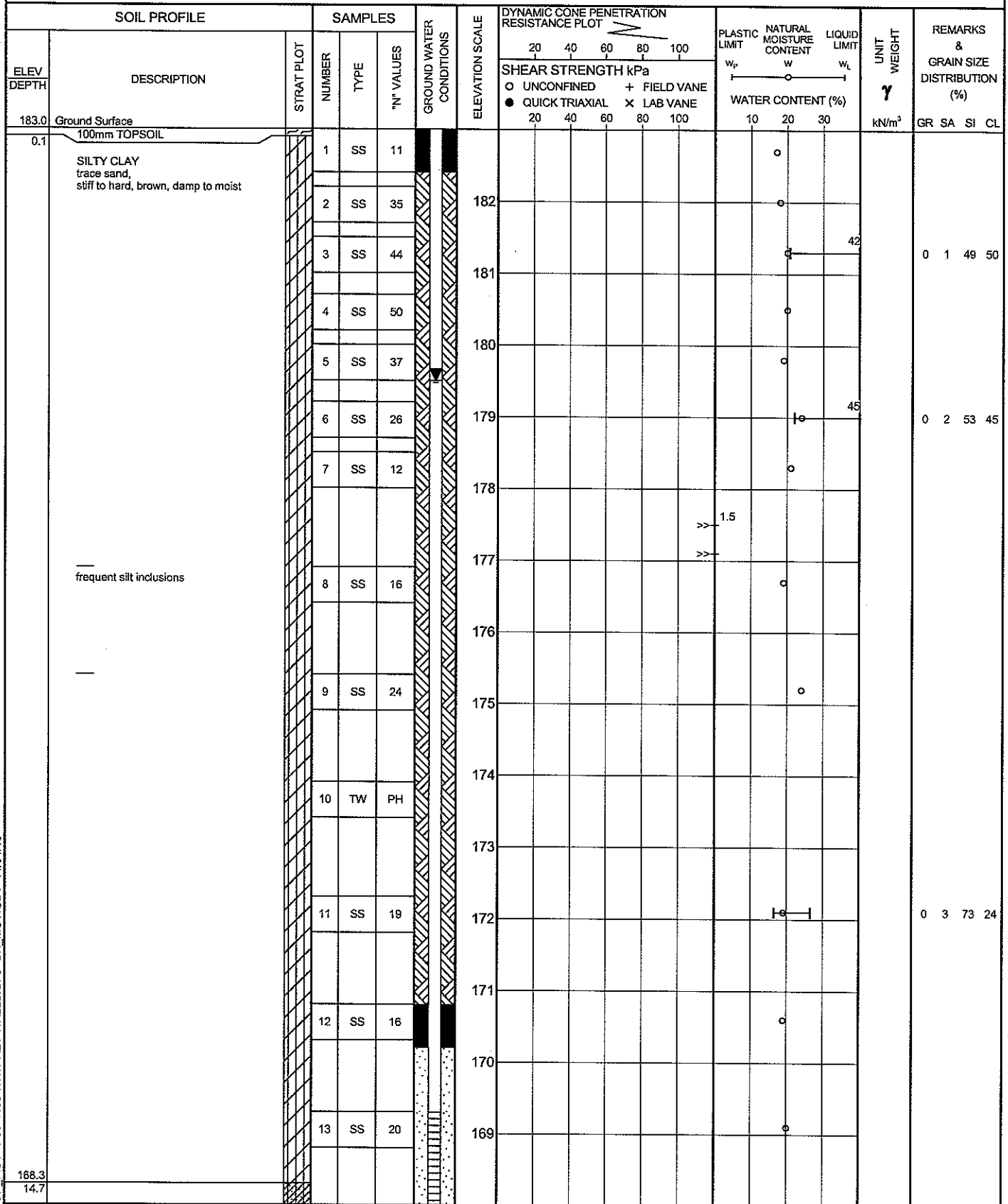
○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No WRW4

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4764237.6 E:327355.1 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 06.30.10 CHECKED BY RA



Continued Next Page

+³, X³: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

ON MOT 1-09-4135 WRW RET WALLS.GPJ ON MOT.GDT 11/04/10

RECORD OF BOREHOLE No WRW4

2 OF 2

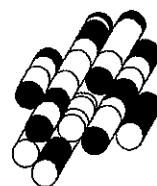
METRIC

W.P. 280-99-00 LOCATION Coords: N:4764237.6 E:327355.1 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 6.30.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
167.3	SILTY CLAY trace sand, trace gravel, hard, brown, damp to moist (GLACIAL TILL)		14	SS	52											4 9 62 25	
15.7	End of Borehole Borehole was dry (not stabilized) and hole open to full depth on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.05.10 9.7 173.3 July.13.10 4.7 178.3 July.21.10 4.1 178.9 July.27.10 3.0 180.0 Aug.06.10 2.6 180.4 Aug.13.10 3.3 179.7 Aug.23.10 3.5 179.5																

B3

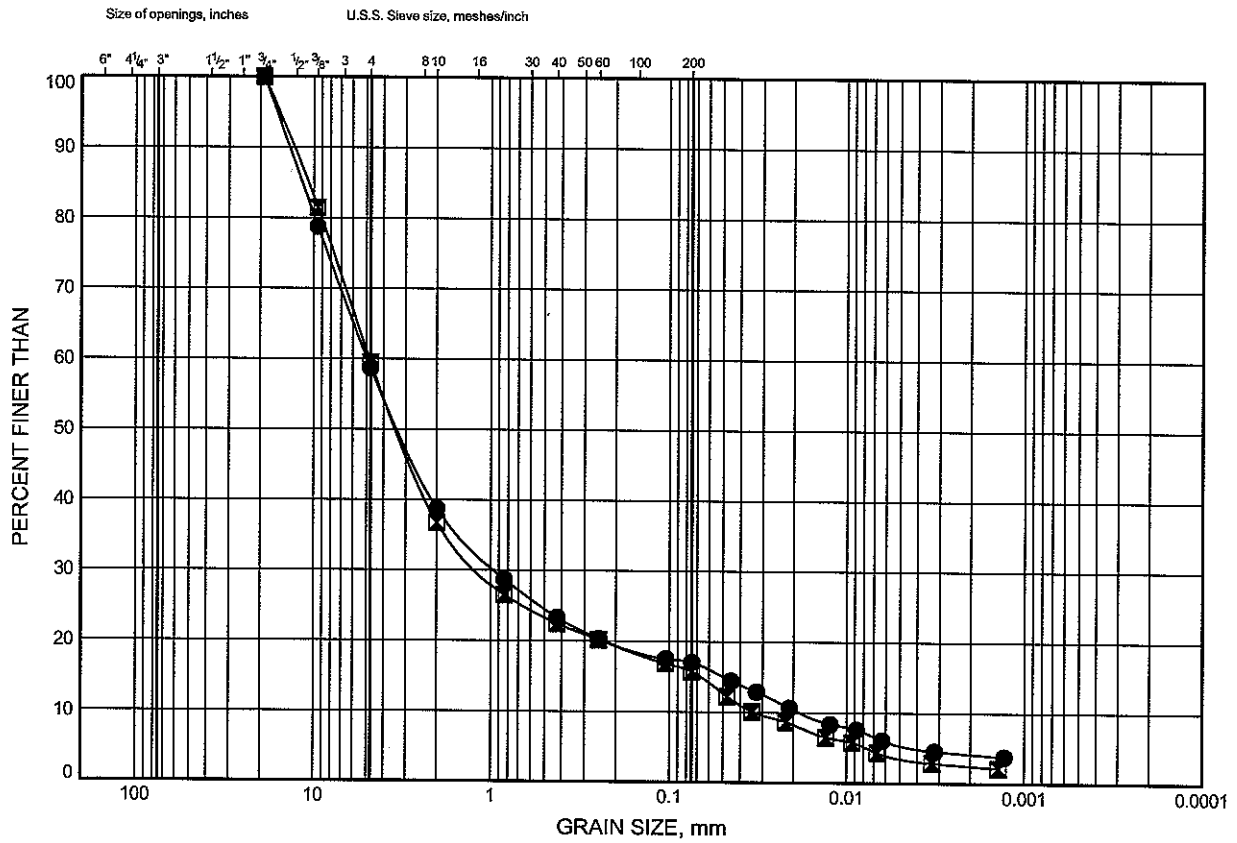
TERRAPROBE INC.



GRAIN SIZE DISTRIBUTION

FIGURE B3-1

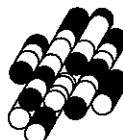
FILL - Sand and Gravel



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SBL 12+685CL	0.3	182.4
⊠	WN3	0.3	181.8

Date August 2010
Project 1-09-4135

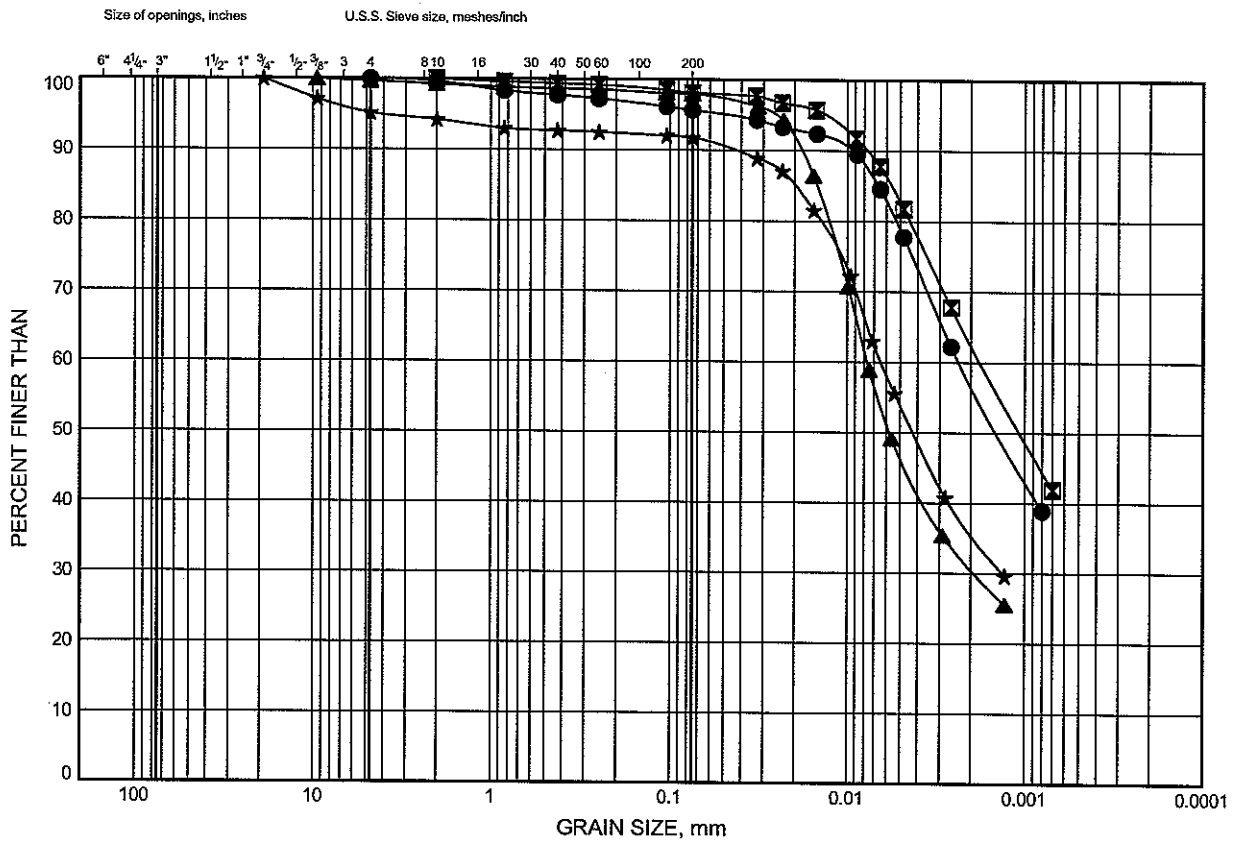


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-2

FILL - Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+750Rt	0.3	182.5
⊠	WN1	1.0	182.1
▲	WN4	1.0	181.5
★	WN4	2.5	180.0

Date August 2010
Project 1-09-4135

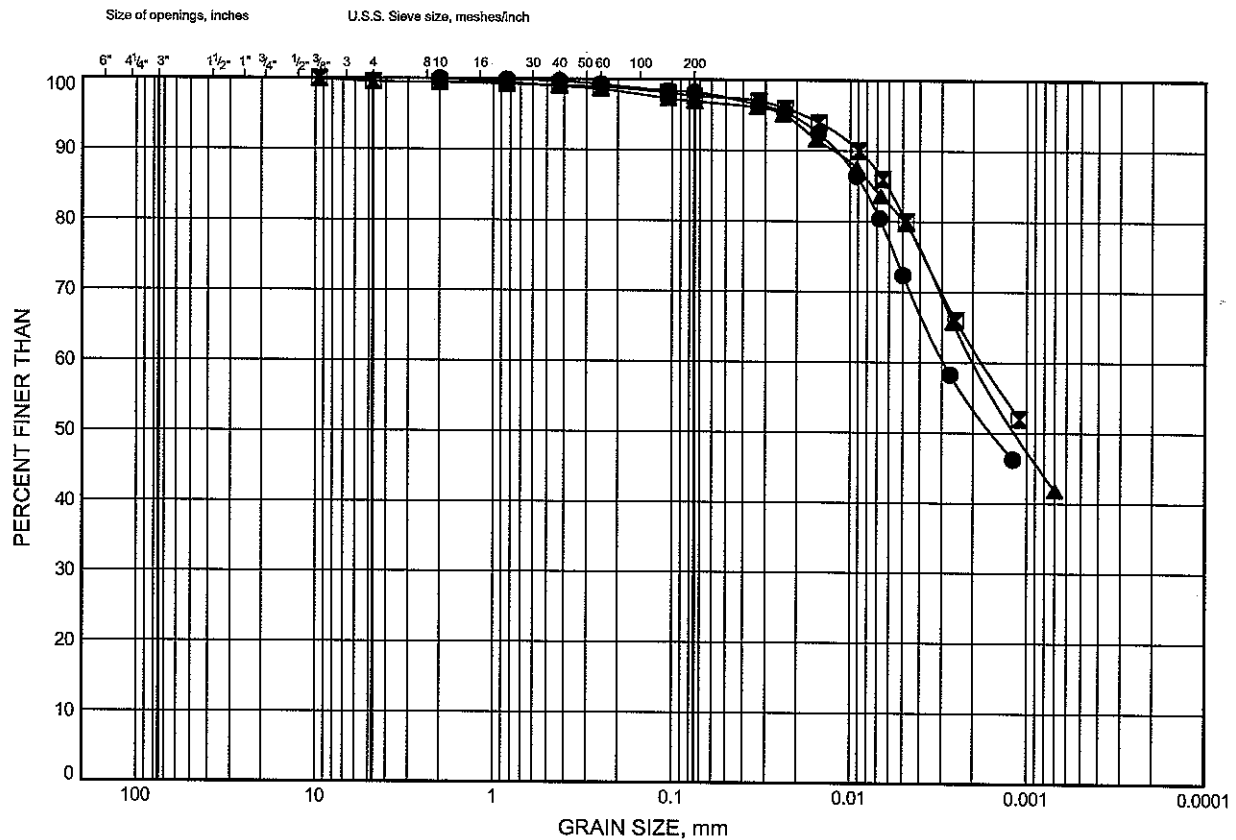


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-3

FILL - Silty Clay



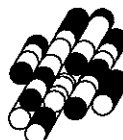
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WRW1	0.3	182.6
⊠	WS1	1.0	181.7
▲	WS3	1.7	181.3

Date August 2010

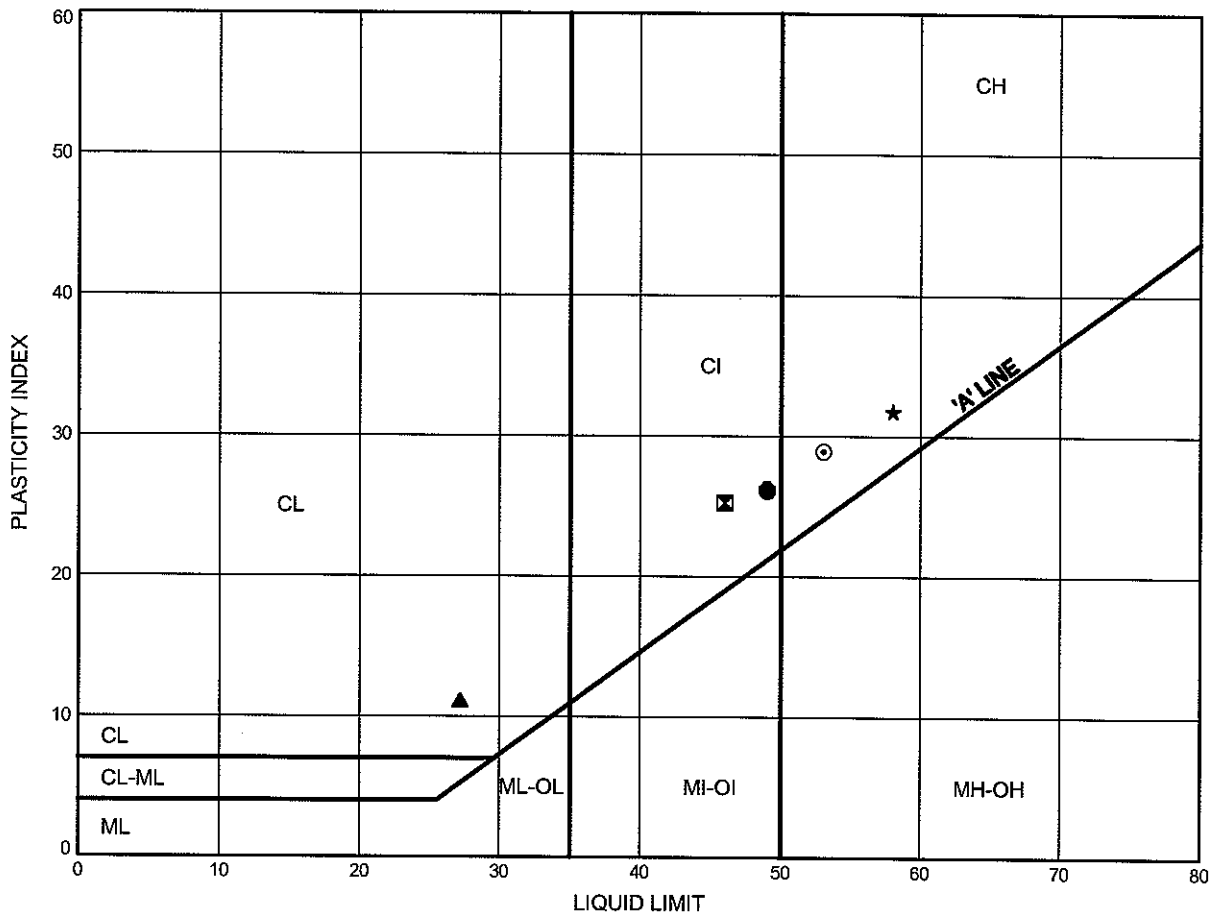
Project 1-09-4135



Prep'd JS

Chkd. MP

FIGURE B3-4



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+750Rt	0.3	182.5
⊠	WN1	1.0	182.1
▲	WN4	1.0	181.5
★	WRW1	0.3	182.6
⊙	WS1	1.0	181.7
⊕	WS3	1.7	181.3

Date August 2010
Project 1-09-4135

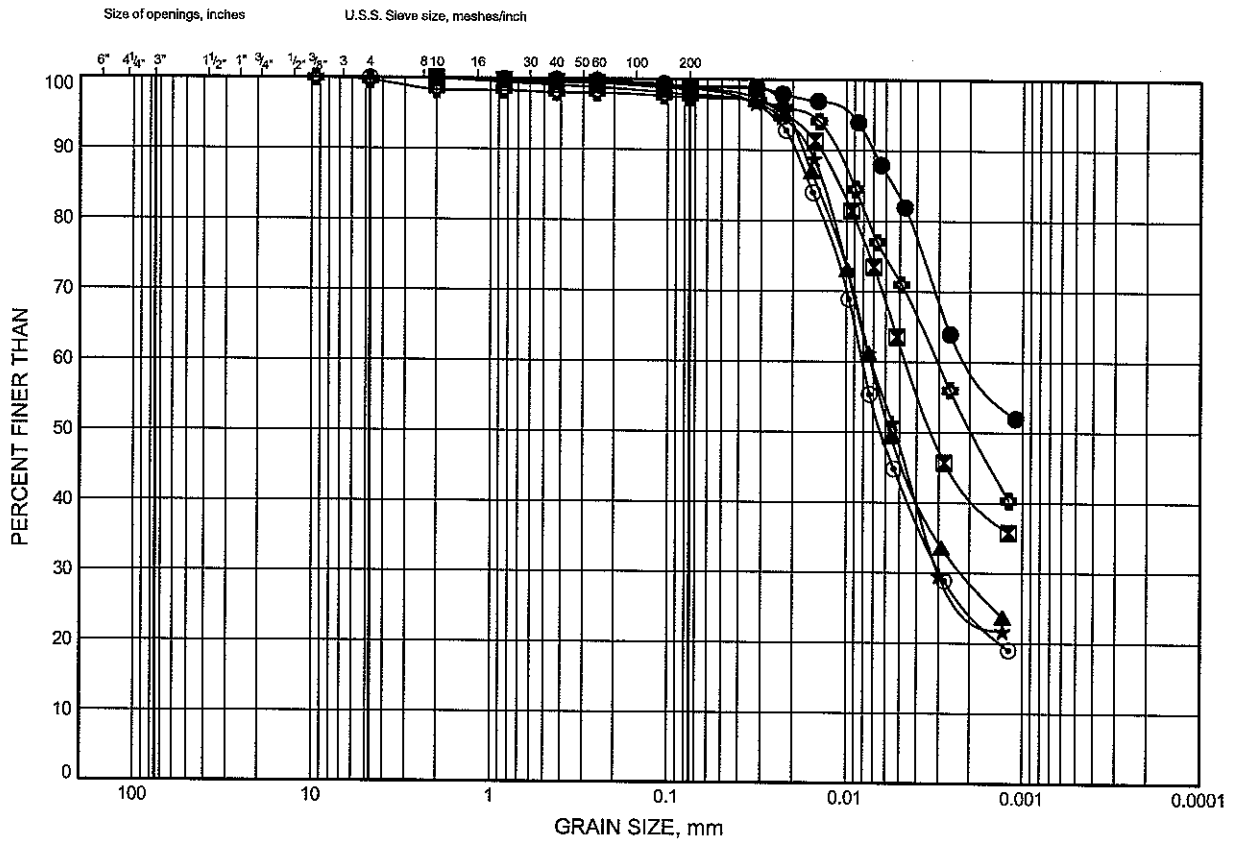


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-5

SILTY CLAY

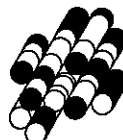


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+695Lt	1.7	181.2
⊠	NBL 12+695Lt	3.2	179.7
▲	NBL 12+695Lt	6.3	176.6
★	NBL 12+695Lt	9.3	173.6
⊙	NBL 12+695Lt	12.4	170.5
⊕	NBL 12+750Rt	1.7	181.1

Date August 2010

Project 1-09-4135



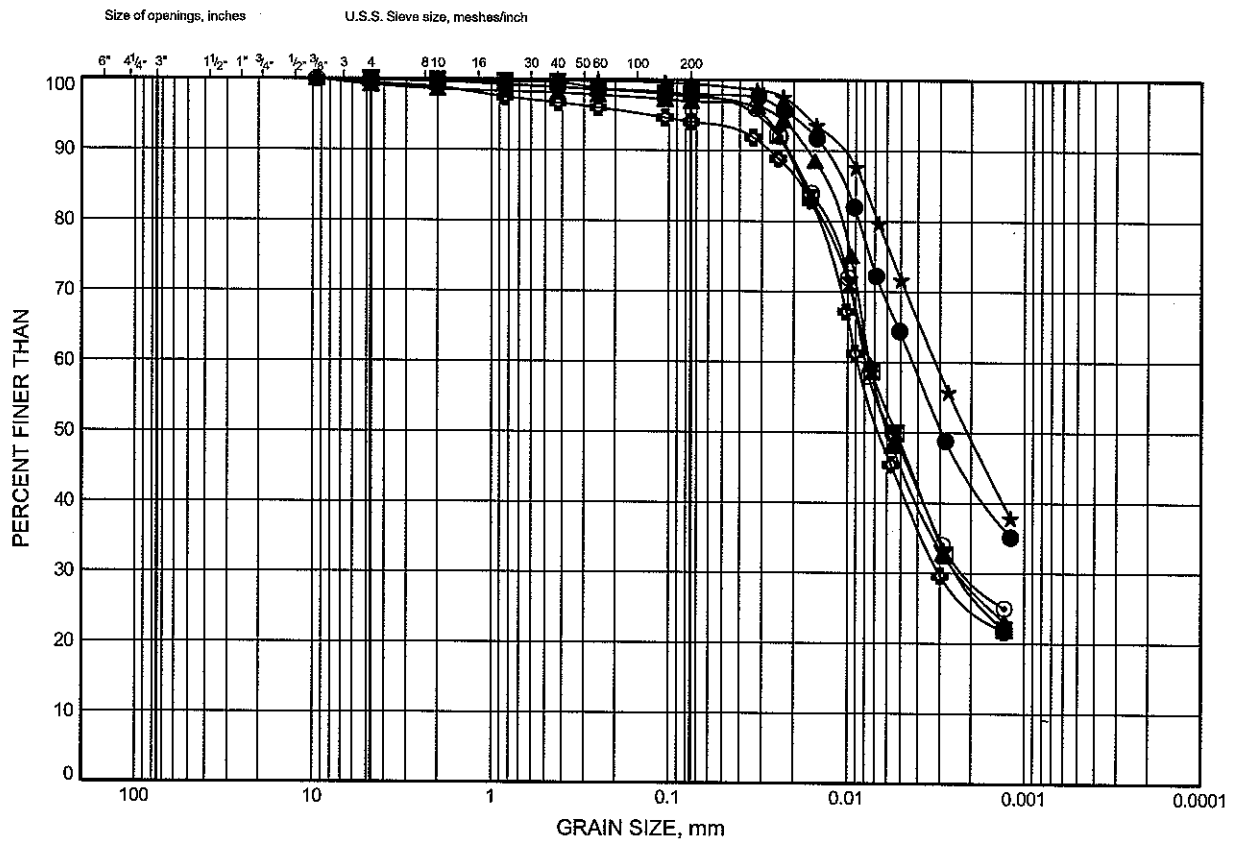
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-6

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	NBL 12+750Rt	4.7	178.1
⊠	NBL 12+750Rt	9.3	173.5
▲	NBL 12+750Rt	12.4	170.4
★	SBL 12+685CL	2.5	180.2
⊙	SBL 12+685CL	6.3	176.4
⊕	SBL 12+685CL	9.3	173.4

Date August 2010

Project 1-09-4135



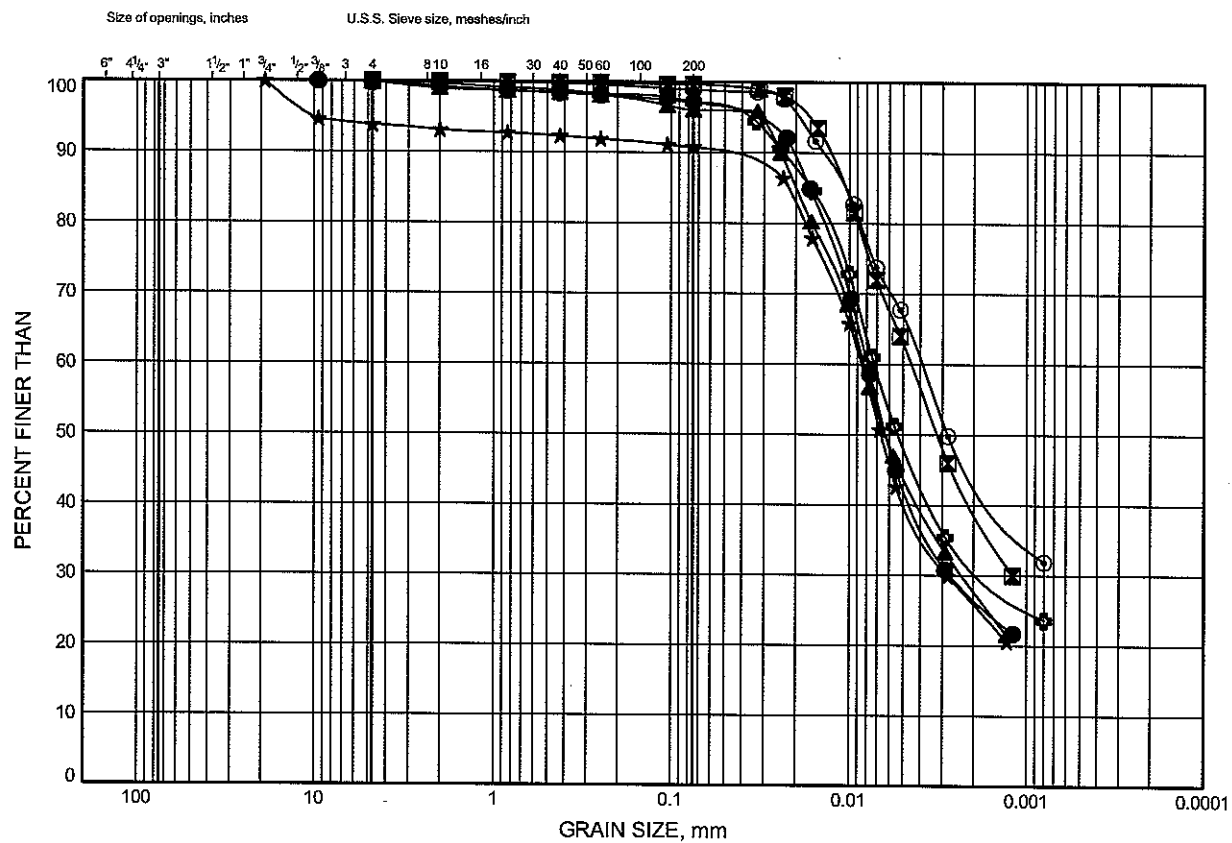
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-7

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SBL 12+685CL	10.9	171.8
⊠	SBL 12+750CL	3.2	179.7
▲	SBL 12+750CL	7.8	175.1
★	SBL 12+750CL	10.1	172.8
⊙	WN1	3.2	179.9
⊕	WN1	6.3	176.8

Date August 2010
Project 1-09-4135

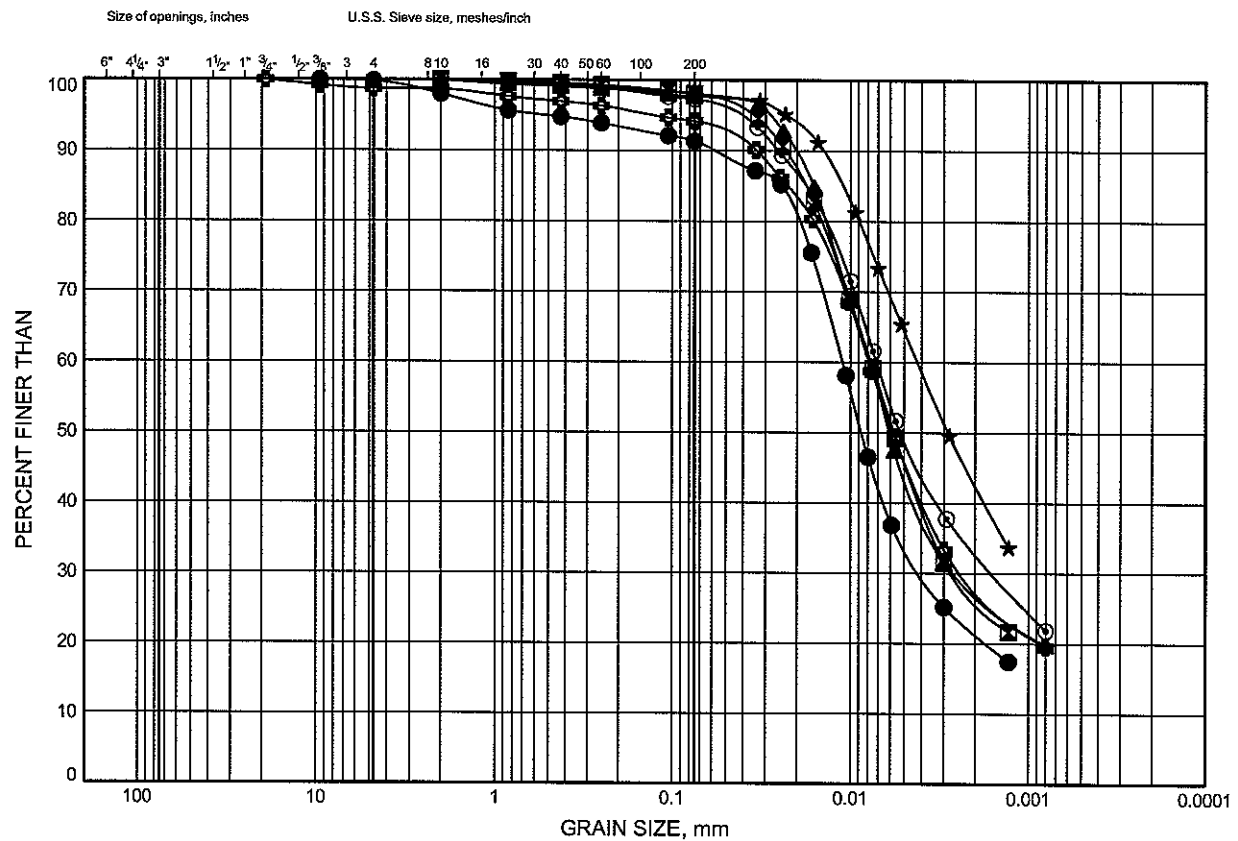


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GRAIN SIZE DISTRIBUTION

FIGURE B3-8

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN1	7.8	175.3
⊠	WN1	10.9	172.2
▲	WN1	13.9	169.2
★	WN2	1.0	180.6
⊙	WN2	4.0	177.6
⊕	WN2	6.3	175.3

Date August 2010

Project 1-09-4135



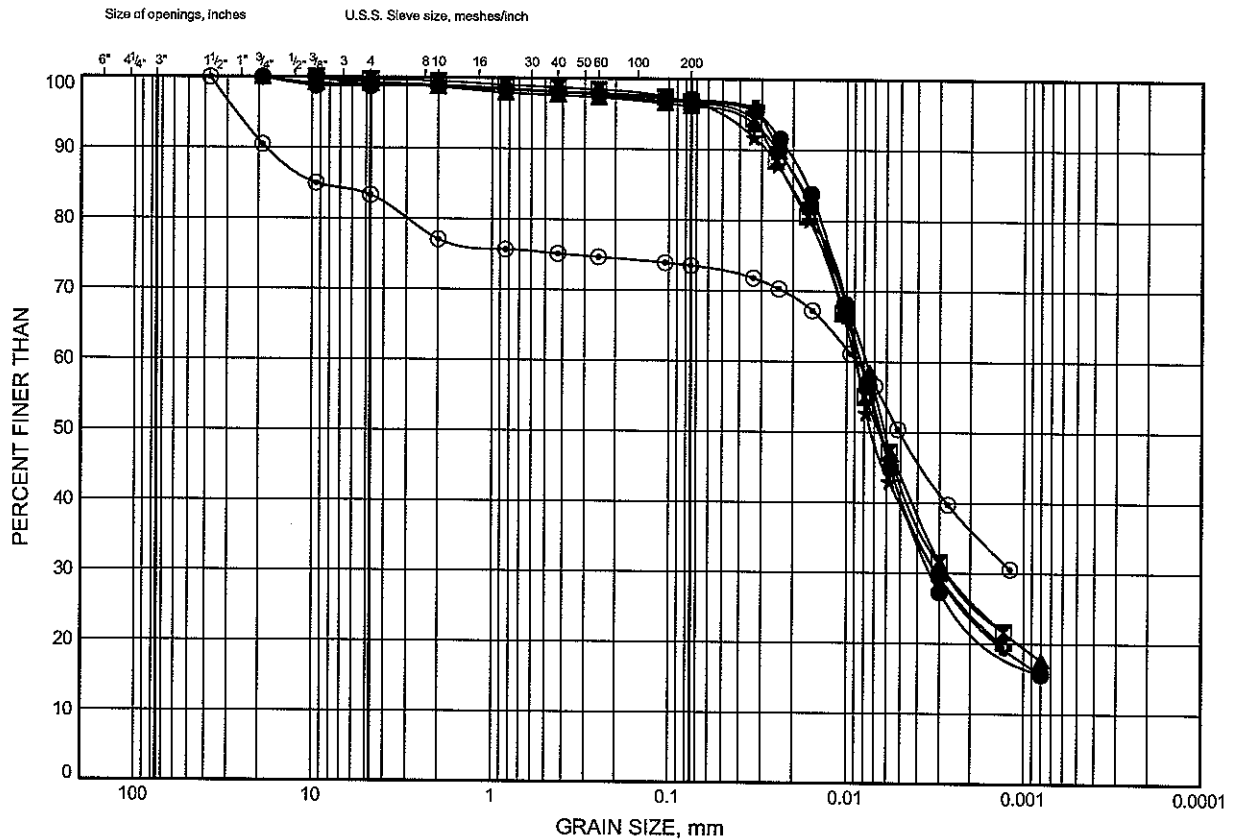
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-9

SILTY CLAY

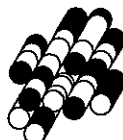


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN2	10.9	170.7
⊠	WN3	7.8	174.3
▲	WN3	9.3	172.8
★	WN3	12.4	169.7
⊙	WN4	5.5	177.0
⊕	WN4	9.3	173.2

Date August 2010

Project 1-09-4135



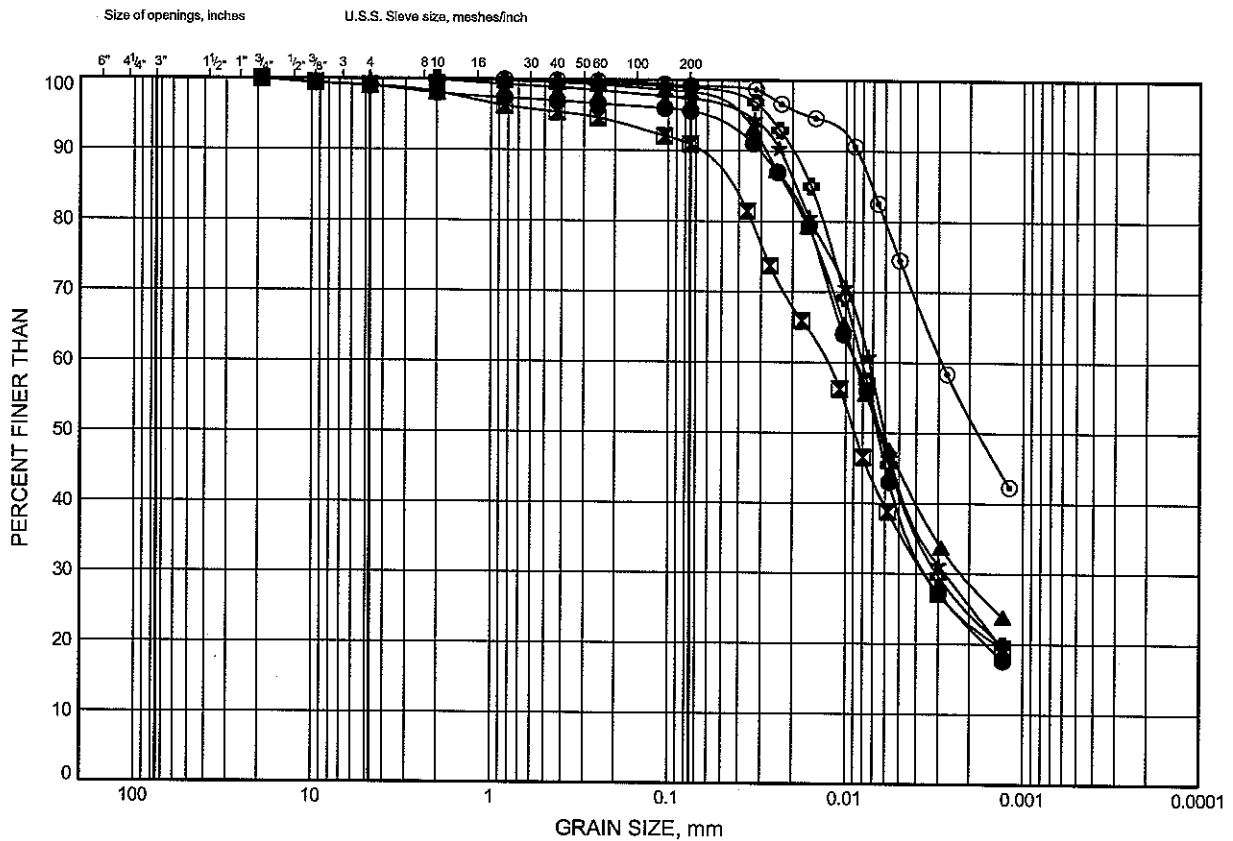
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-10

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN4	10.9	171.6
⊠	WN4	13.9	168.6
▲	WRW1	3.2	179.7
★	WRW1	7.8	175.1
⊙	WRW2	1.7	180.9
⊕	WRW2	6.3	176.3

Date August 2010
Project 1-09-4135

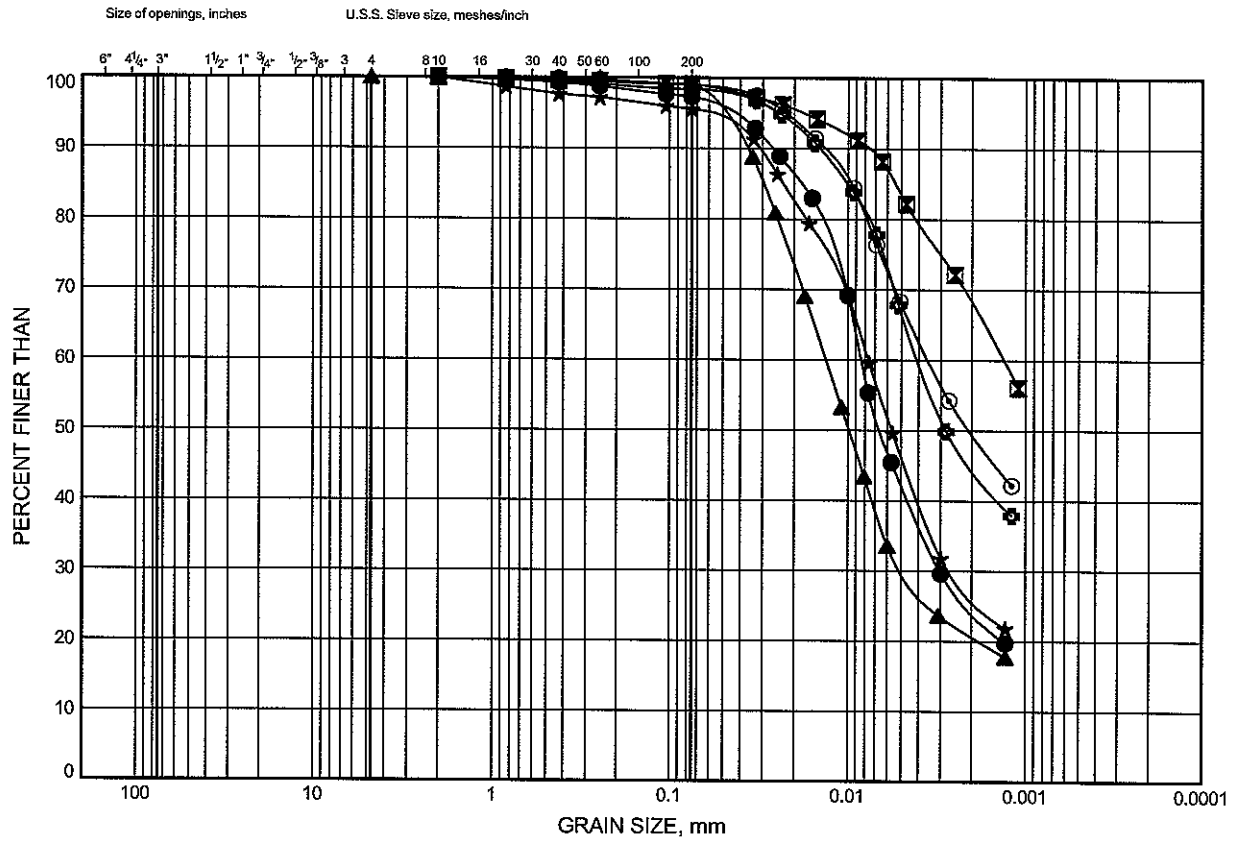


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Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-11

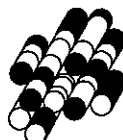
SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WRW2	12.4	170.2
⊠	WRW3	2.5	181.2
▲	WRW3	4.7	179.0
★	WRW3	7.8	175.9
⊙	WRW4	1.7	181.3
⊕	WRW4	4.0	179.0

Date August 2010
Project 1-09-4135

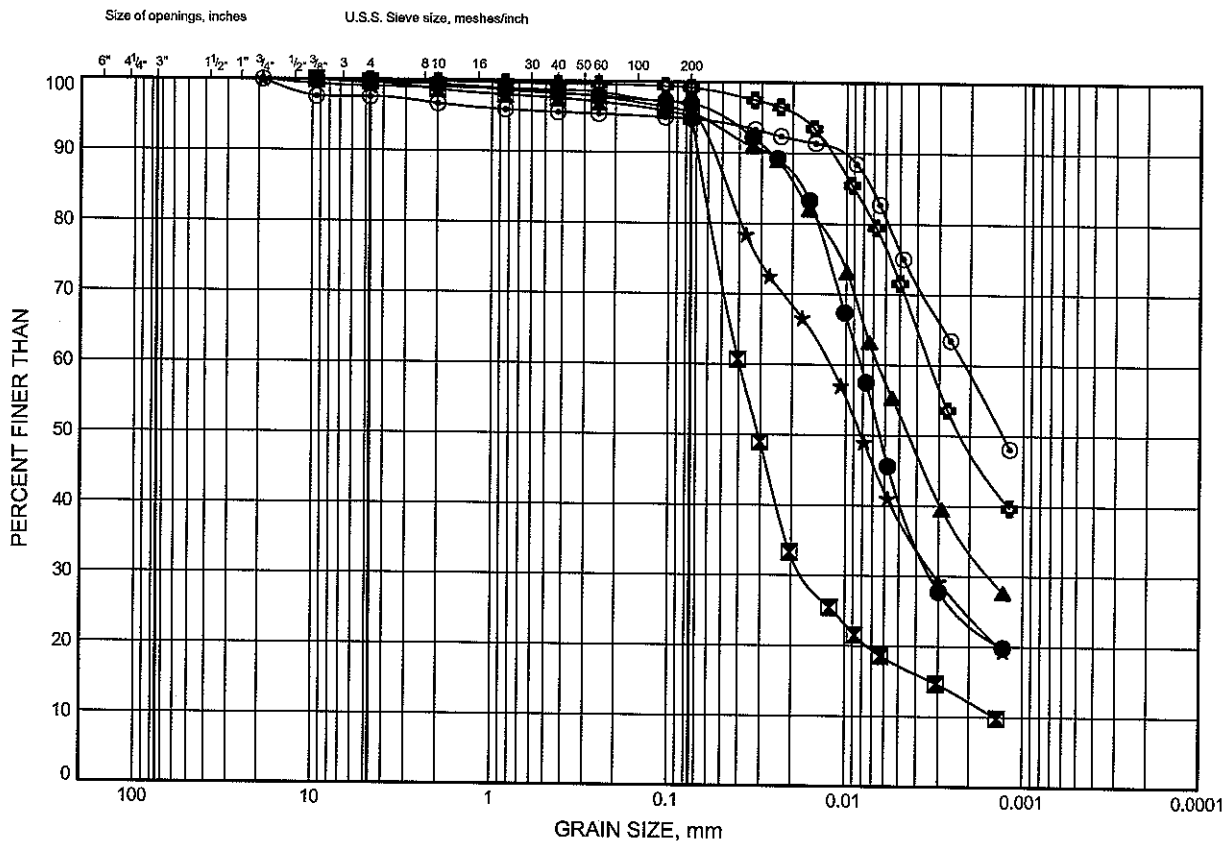


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-12

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WRW4	10.9	172.1
⊠	WS1	7.8	174.9
▲	WS1	9.3	173.4
★	WS1	13.9	168.8
⊙	WS2	1.0	182.1
⊕	WS2	2.5	180.6

Date August 2010

Project 1-09-4135



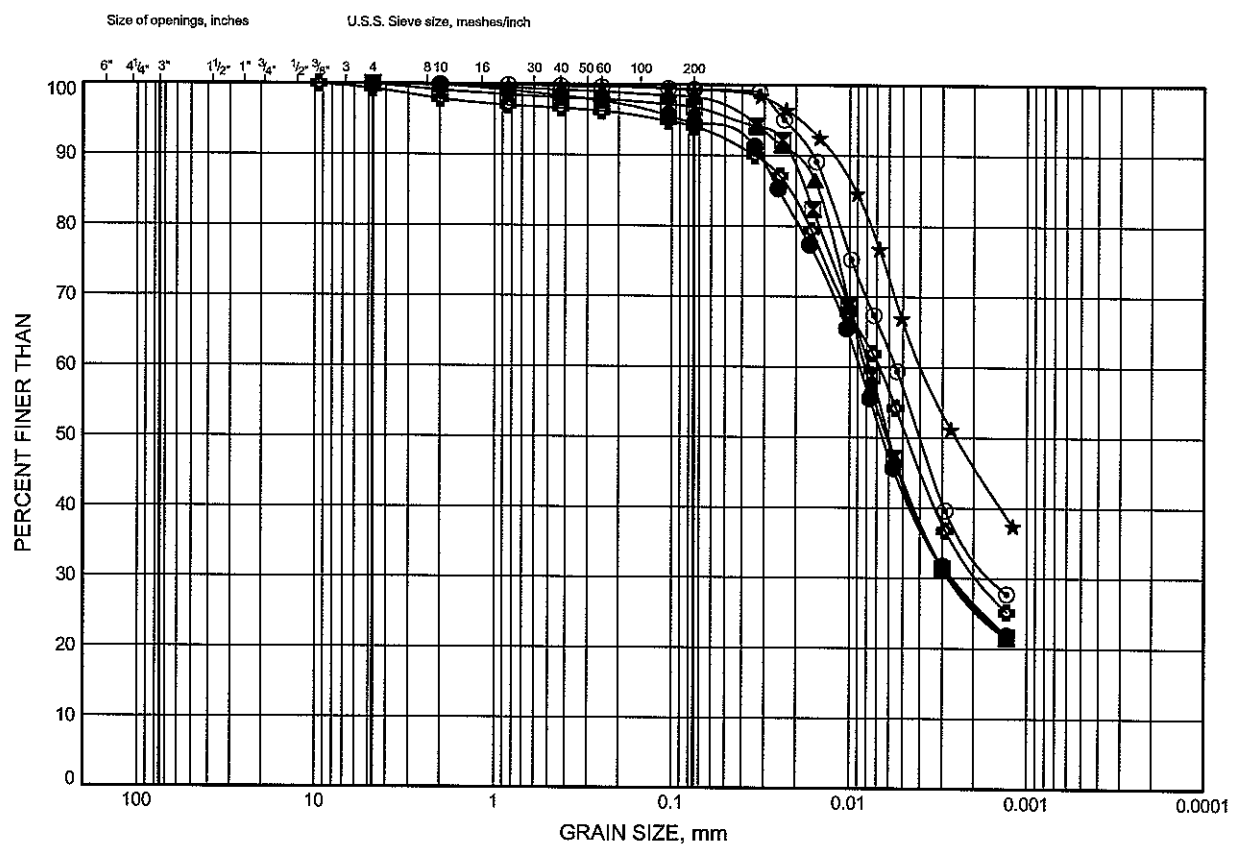
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-13

SILTY CLAY

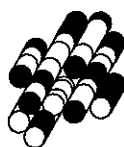


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	6.3	176.8
⊠	WS2	10.9	172.2
▲	WS2	12.4	170.7
★	WS3	3.2	179.8
⊙	WS3	4.7	178.3
⊕	WS3	7.8	175.2

Date August 2010

Project 1-09-4135



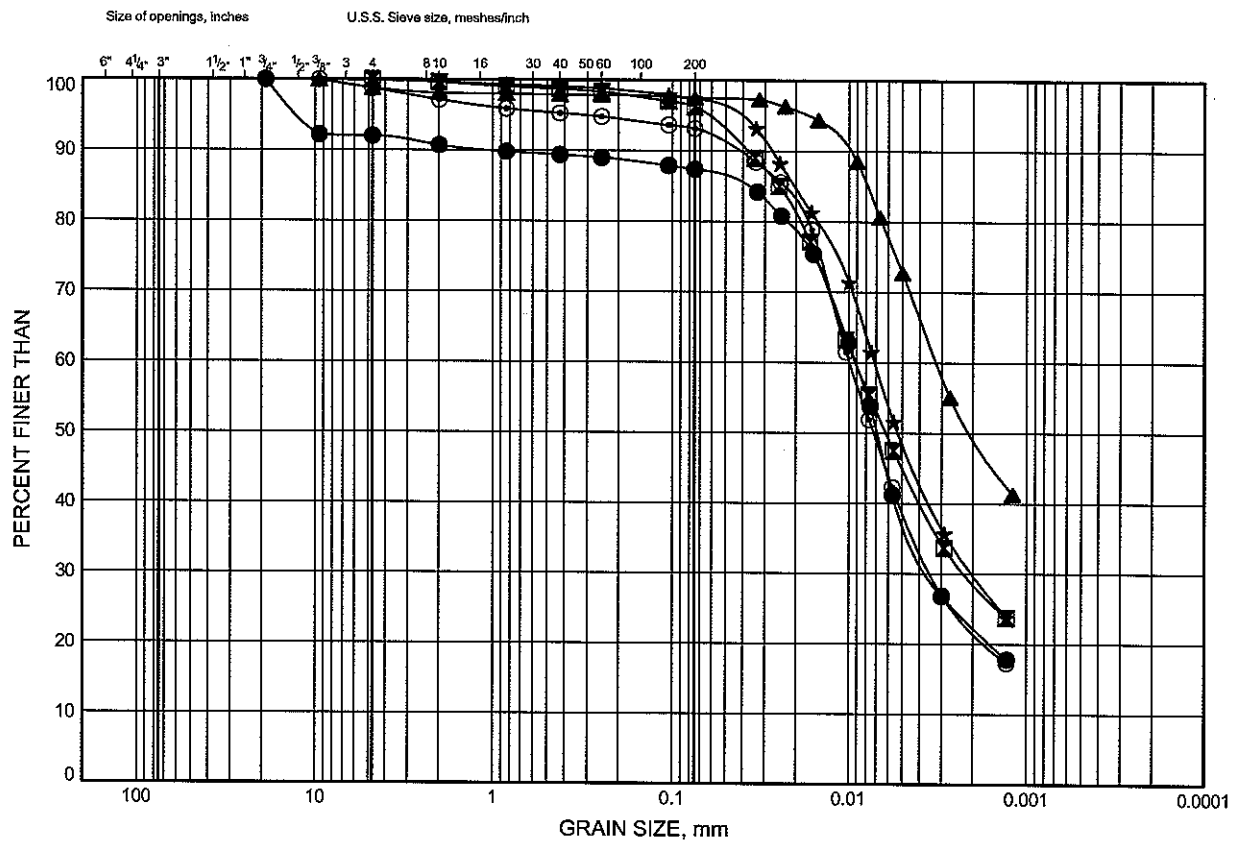
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-14

SILTY CLAY

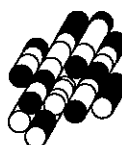


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS3	10.9	172.1
⊠	WS3	13.9	169.1
▲	WS4	2.5	180.2
★	WS4	9.3	173.4
⊙	WS4	12.4	170.3

Date August 2010

Project 1-09-4135



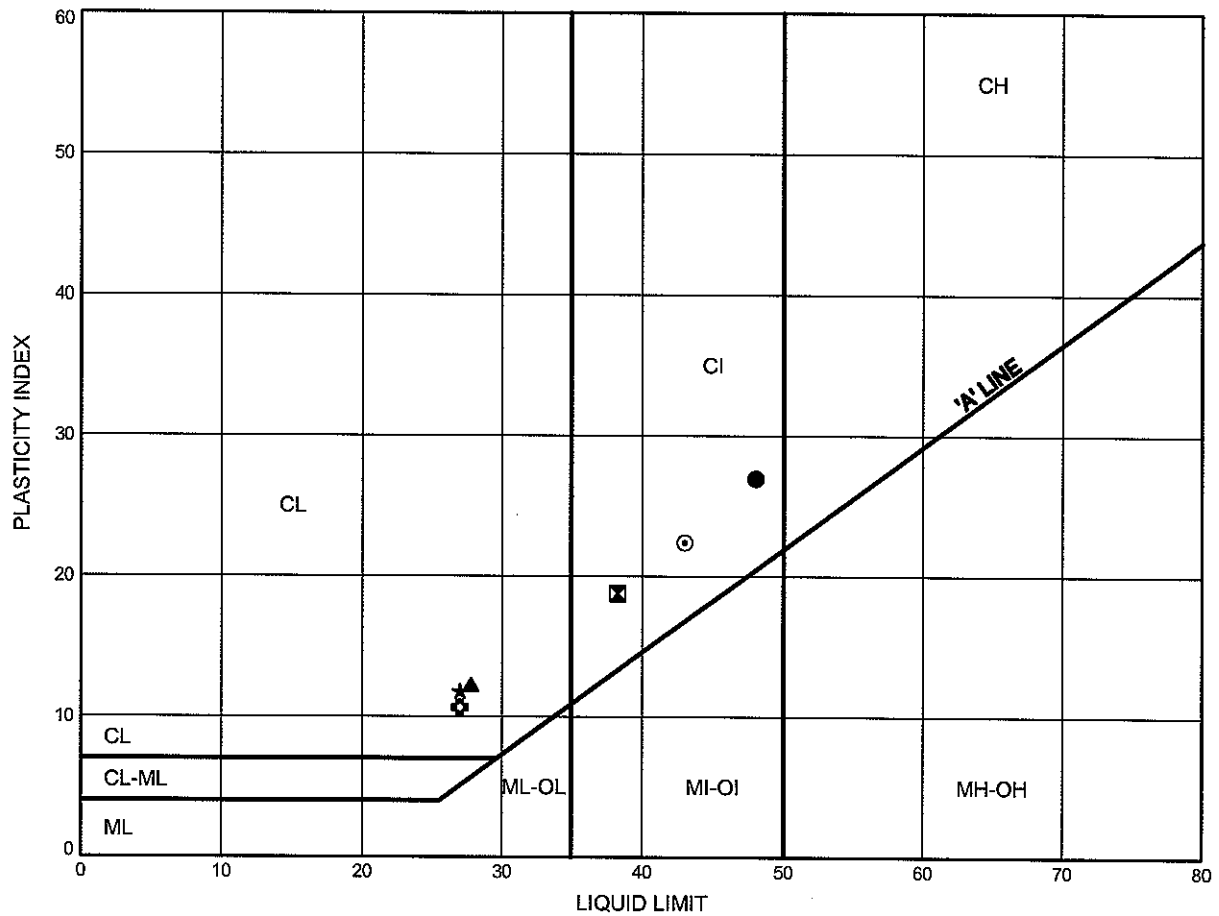
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

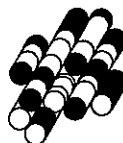
FIGURE B3-15

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+695Lt	1.7	181.2
⊠	NBL 12+695Lt	3.2	179.7
▲	NBL 12+695Lt	6.3	176.6
★	NBL 12+695Lt	9.3	173.6
⊙	NBL 12+750Rt	1.7	181.1
⊕	NBL 12+750Rt	4.7	178.1

Date August 2010
Project 1-09-4135

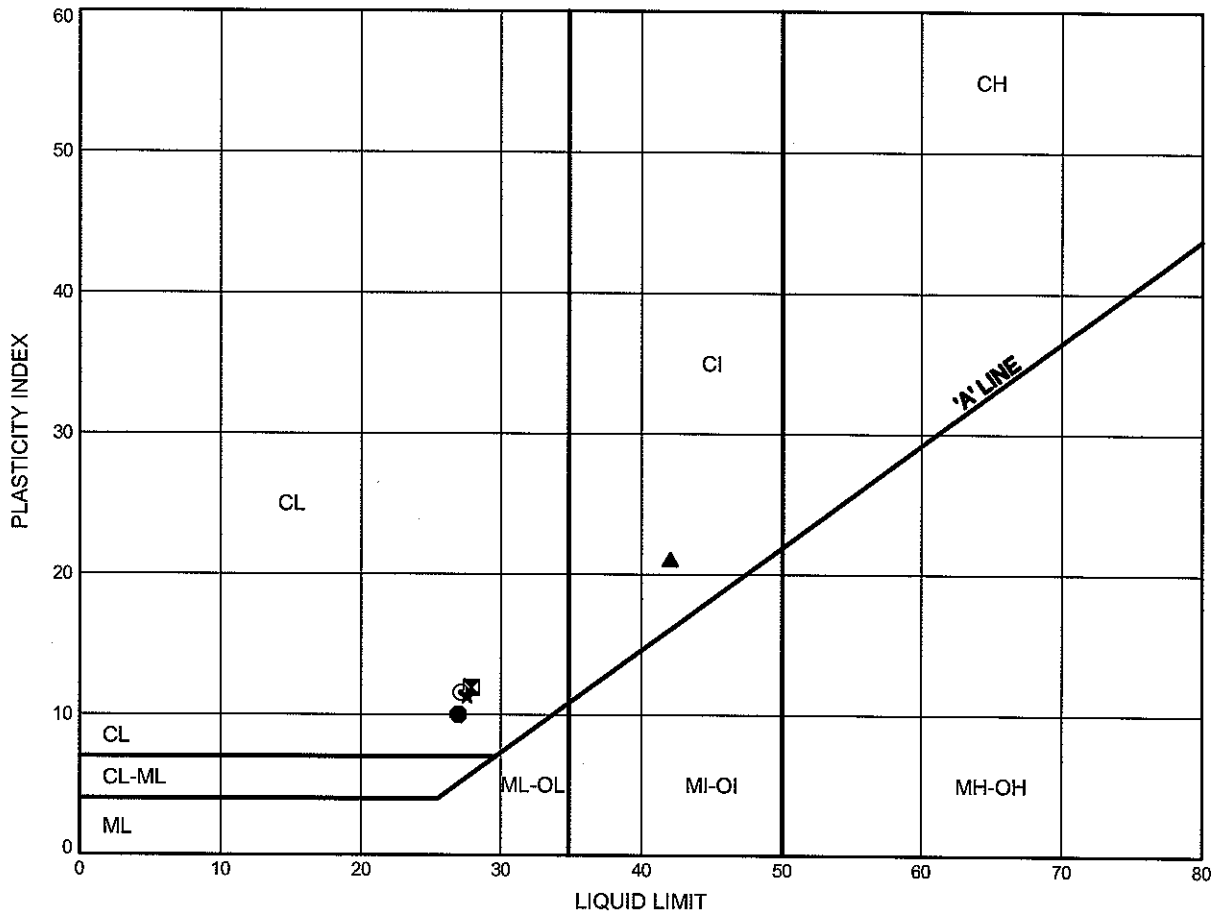


Prep'd JS
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-16

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	NBL 12+750Rt	9.3	173.5
⊠	NBL 12+750Rt	12.4	170.4
▲	SBL 12+685CL	2.5	180.2
★	SBL 12+685CL	6.3	176.4
⊙	SBL 12+685CL	9.3	173.4
⊕	SBL 12+685CL	10.9	171.8

Date August 2010
Project 1-09-4135

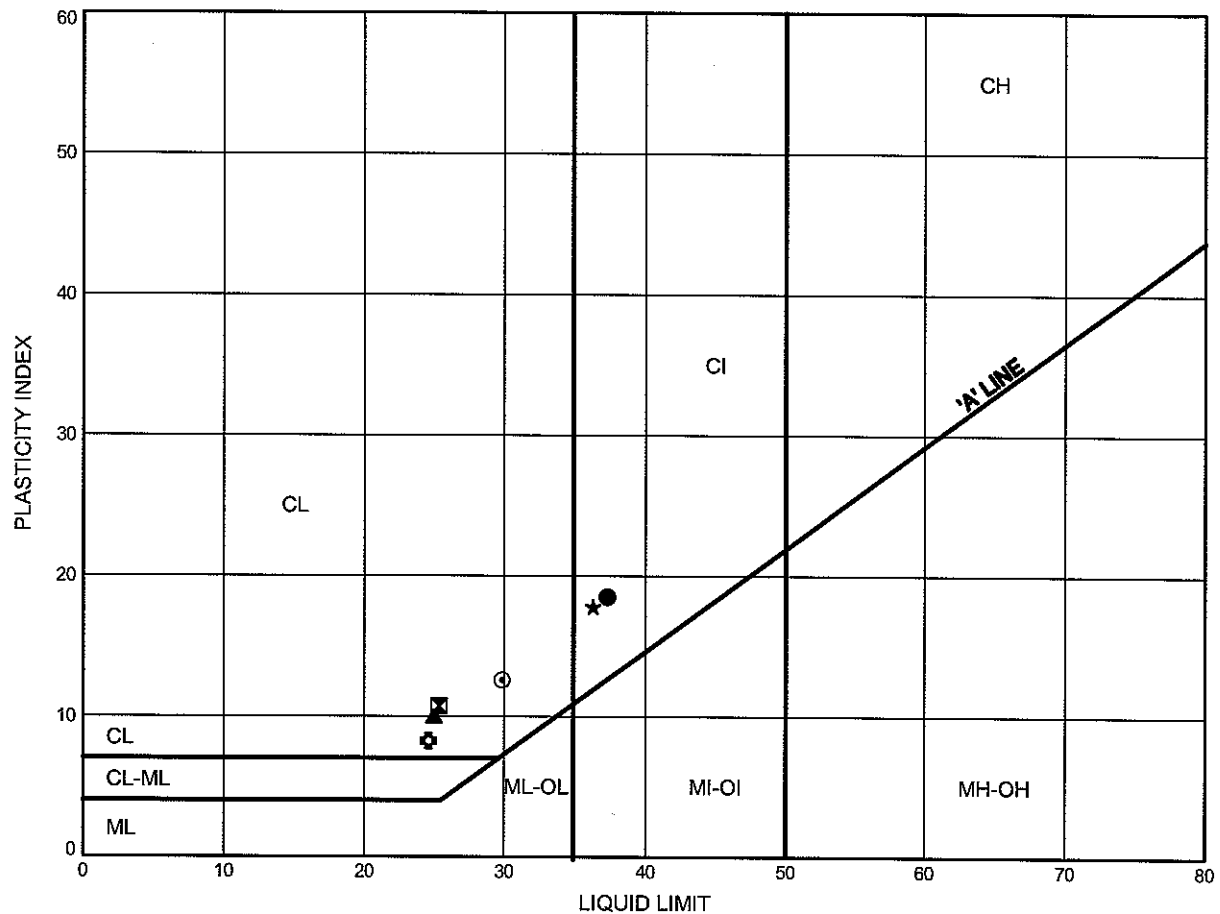


Prep'd JS
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-17

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	SBL 12+750CL	3.2	179.7
■	SBL 12+750CL	7.8	175.1
▲	SBL 12+750CL	10.1	172.8
★	WN1	3.2	179.9
⊙	WN1	6.3	176.8
⊕	WN1	7.8	175.3

Date August 2010

Project 1-09-4135



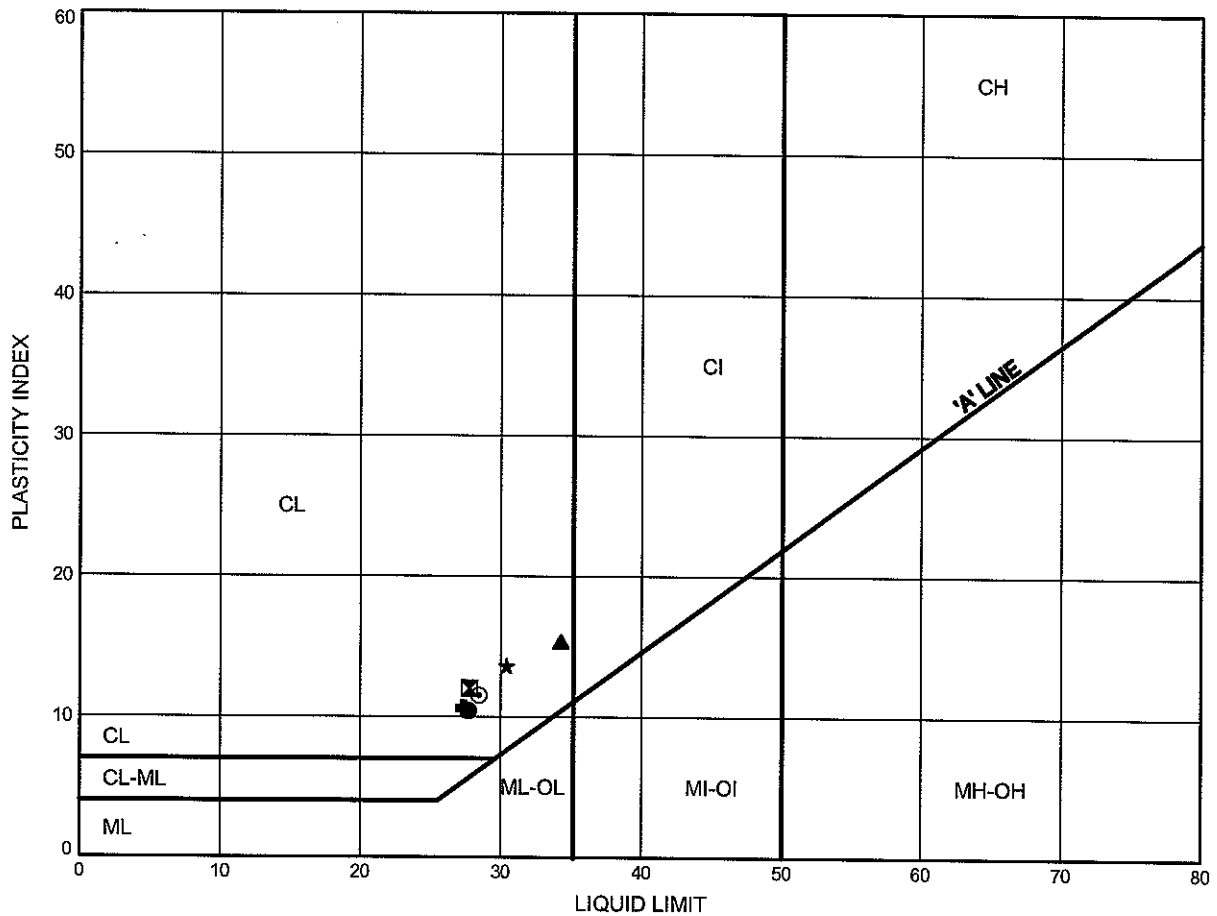
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-18

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN1	10.9	172.2
⊠	WN1	13.9	169.2
▲	WN2	1.0	180.6
★	WN2	4.0	177.6
⊙	WN2	6.3	175.3
⊕	WN2	10.9	170.7

Date August 2010
 Project 1-09-4135

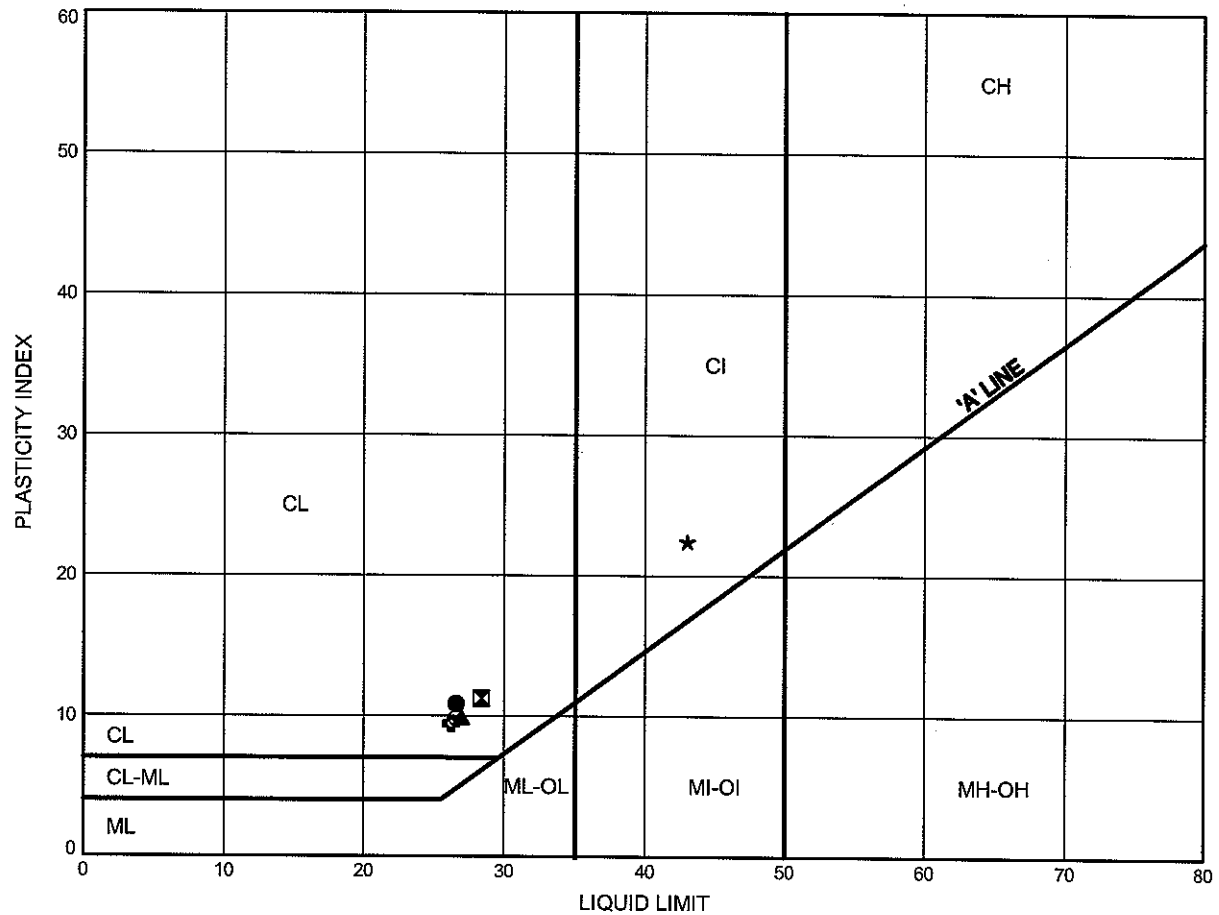


Prep'd JS
 Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-19

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN3	7.8	174.3
⊠	WN3	9.3	172.8
▲	WN3	12.4	169.7
★	WN4	5.5	177.0
⊙	WN4	9.3	173.2
⊕	WN4	10.9	171.6

Date August 2010

Project 1-09-4135



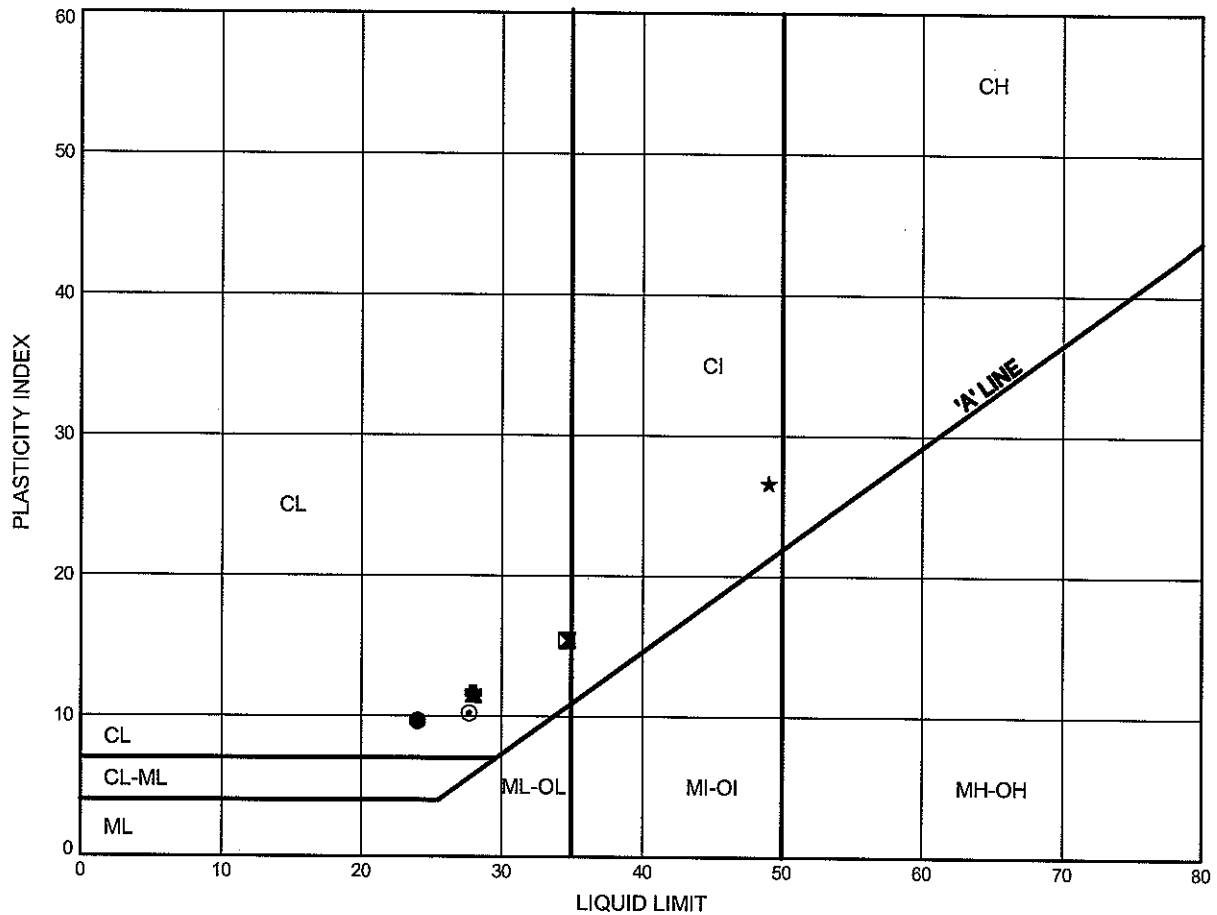
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-20

SILTY CLAY



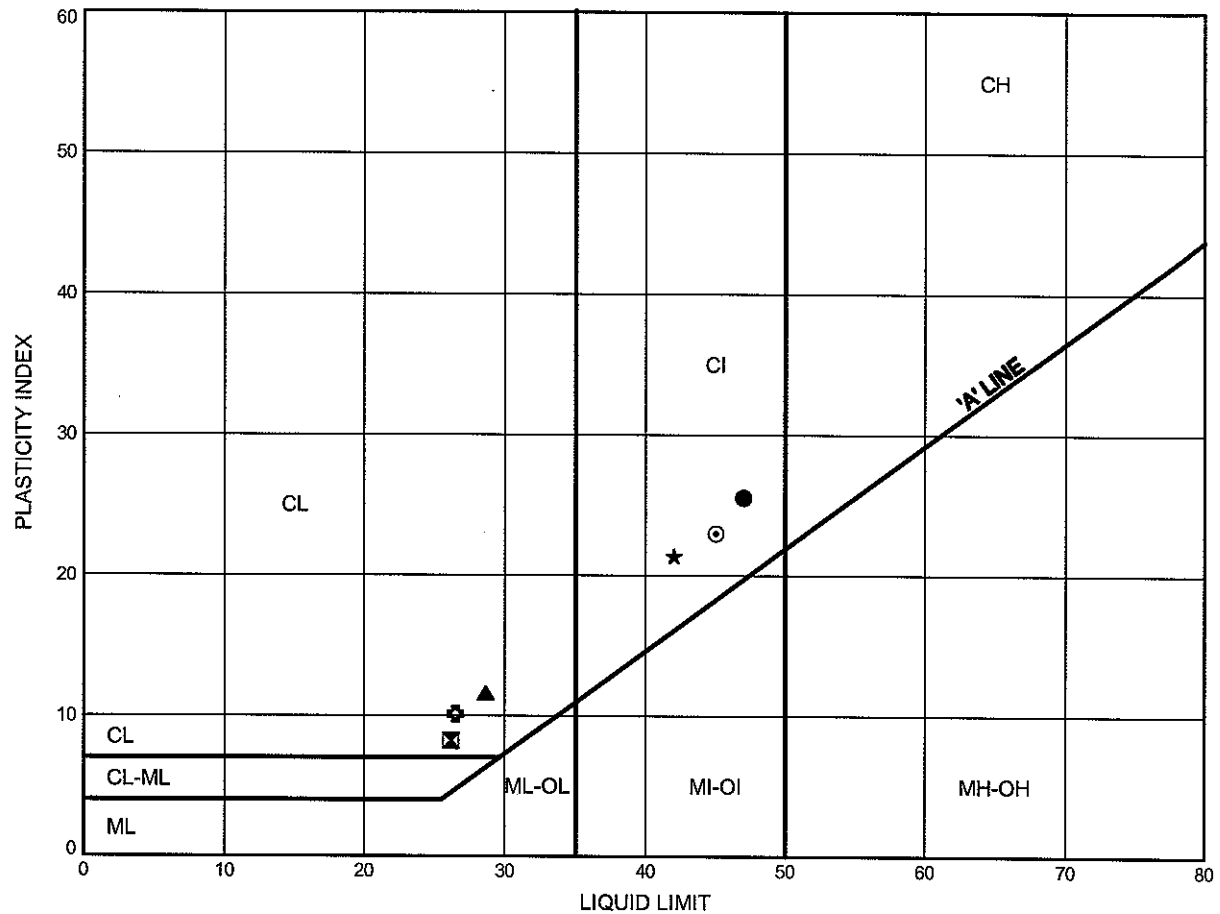
SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN4	13.9	168.6
⊠	WRW1	3.2	179.7
▲	WRW1	7.8	175.1
★	WRW2	1.7	180.9
⊙	WRW2	6.3	176.3
⊕	WRW2	12.4	170.2

Date August 2010
Project 1-09-4135



Prep'd JS
Chkd. MP

FIGURE B3-21



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WRW3	2.5	181.2
⊠	WRW3	4.7	179.0
▲	WRW3	7.8	175.9
★	WRW4	1.7	181.3
⊙	WRW4	4.0	179.0
⊕	WRW4	10.9	172.1

Date August 2010

Project 1-09-4135



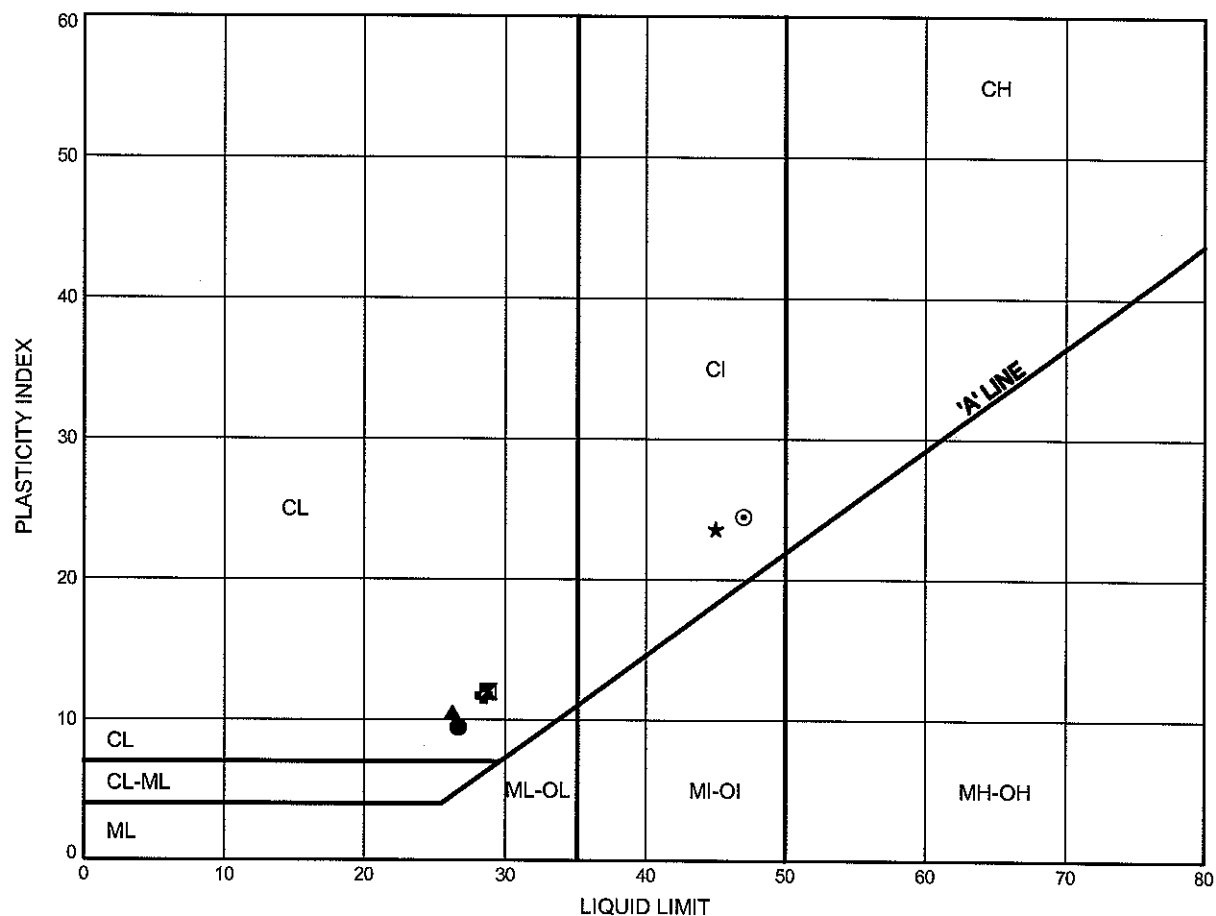
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-22

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS1	7.8	174.9
⊠	WS1	9.3	173.4
▲	WS1	13.9	168.8
★	WS2	1.0	182.1
⊙	WS2	2.5	180.6
⊕	WS2	6.3	176.8

Date August 2010

Project 1-09-4135



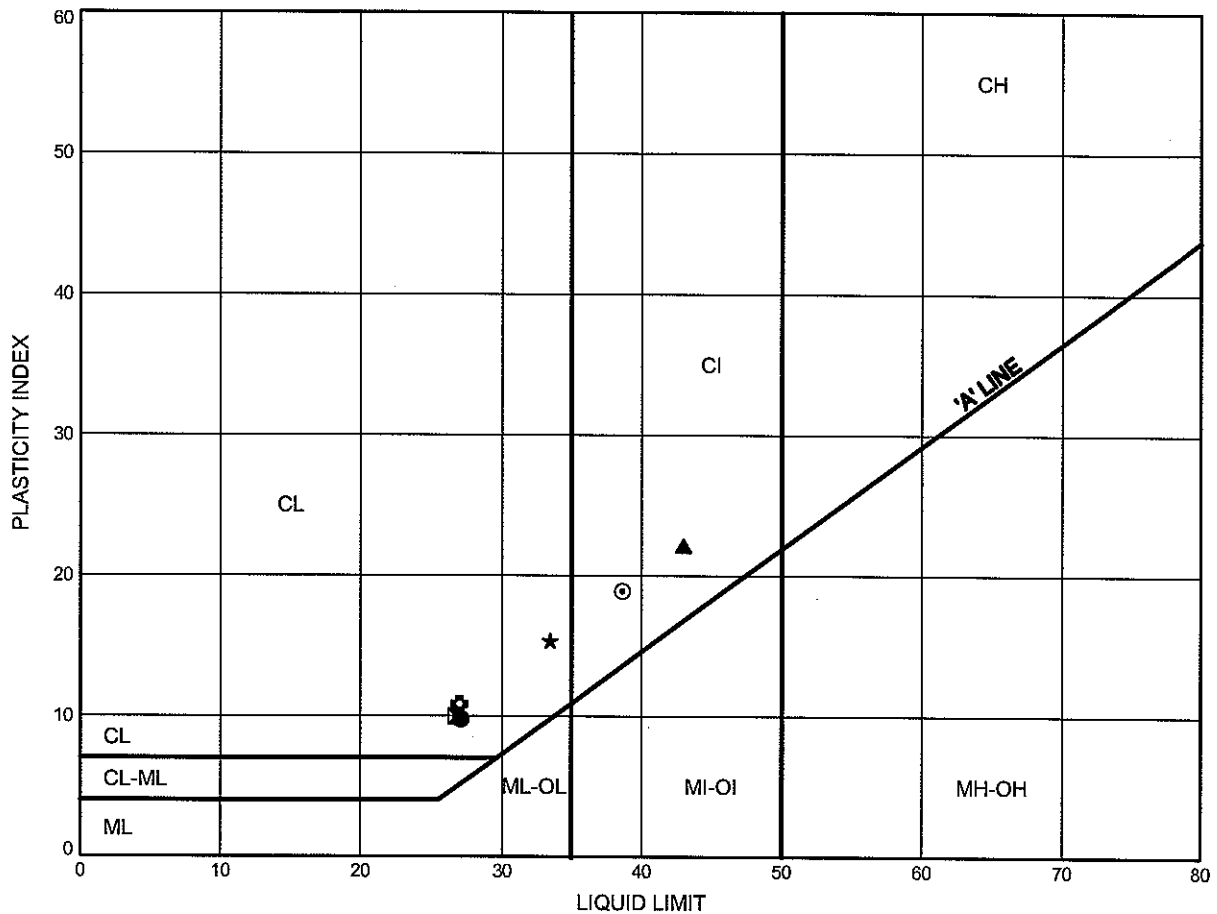
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-23

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS2	10.9	172.2
⊠	WS2	12.4	170.7
▲	WS3	3.2	179.8
★	WS3	4.7	178.3
⊙	WS3	7.8	175.2
⊕	WS3	10.9	172.1

Date August 2010

Project 1-09-4135



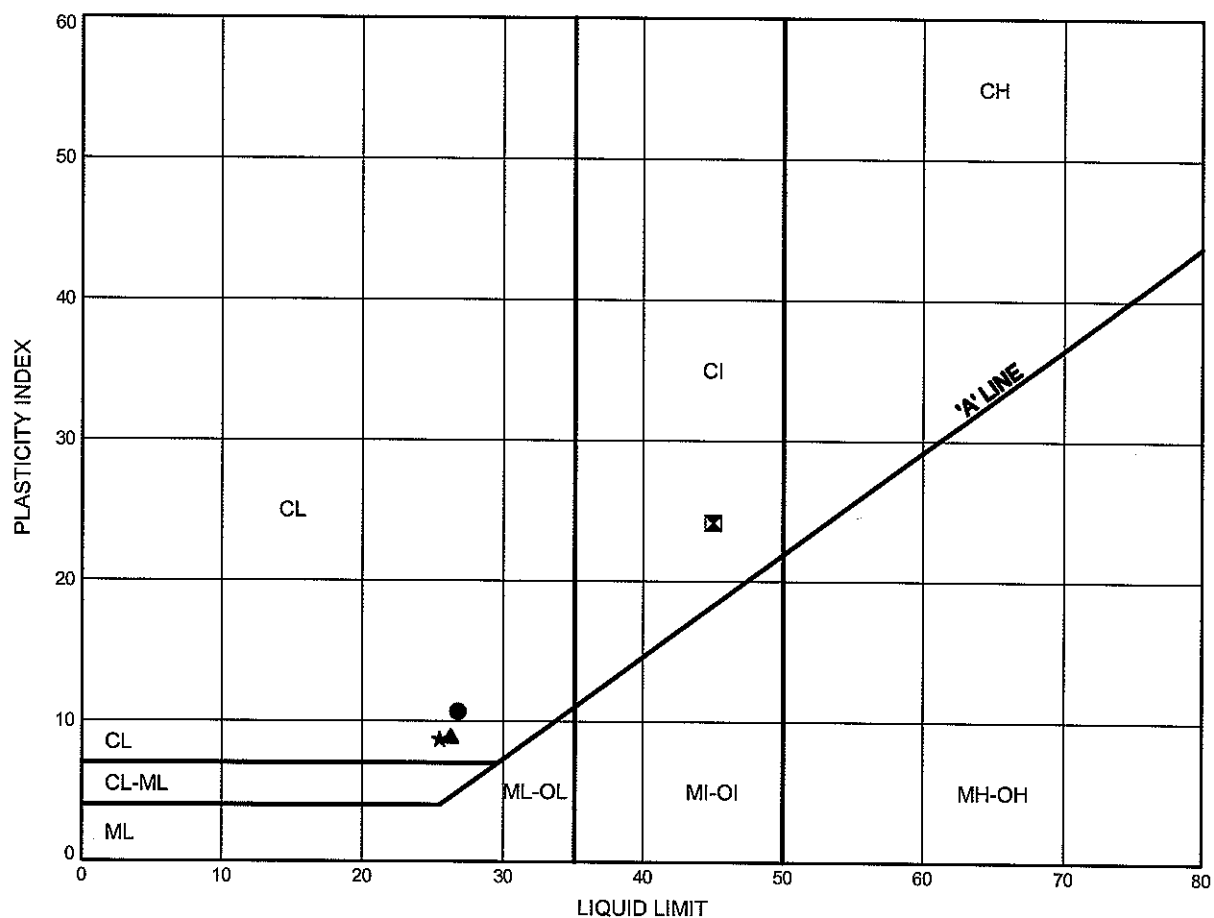
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-24

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS3	13.9	169.1
⊠	WS4	2.5	180.2
▲	WS4	9.3	173.4
★	WS4	12.4	170.3

Date August 2010
 Project 1-09-4135

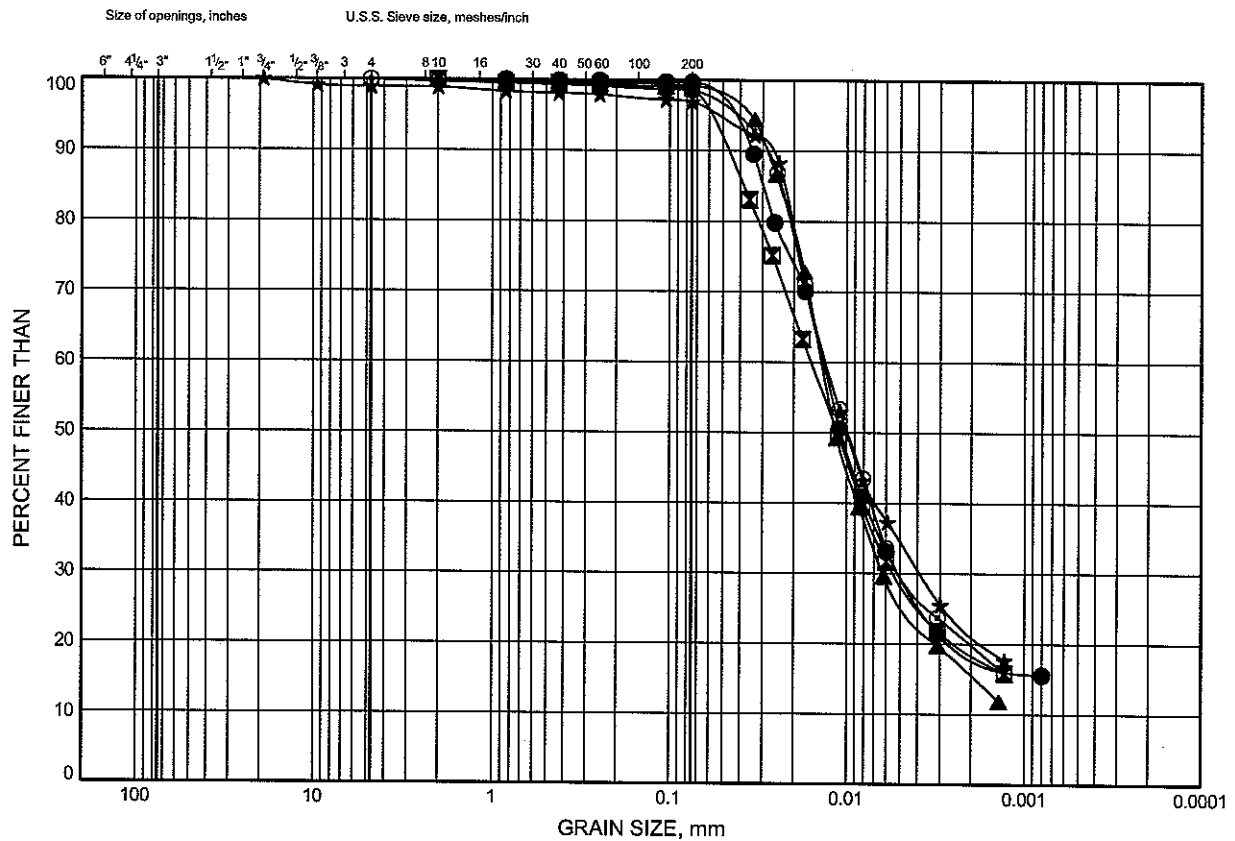


Prep'd JS
 Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-25

SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WN1	4.7	178.4
⊠	WN2	2.5	179.1
▲	WN3	4.0	178.1
★	WS1	4.7	178.0
⊙	WS2	4.7	178.4

Date August 2010
Project 1-09-4135

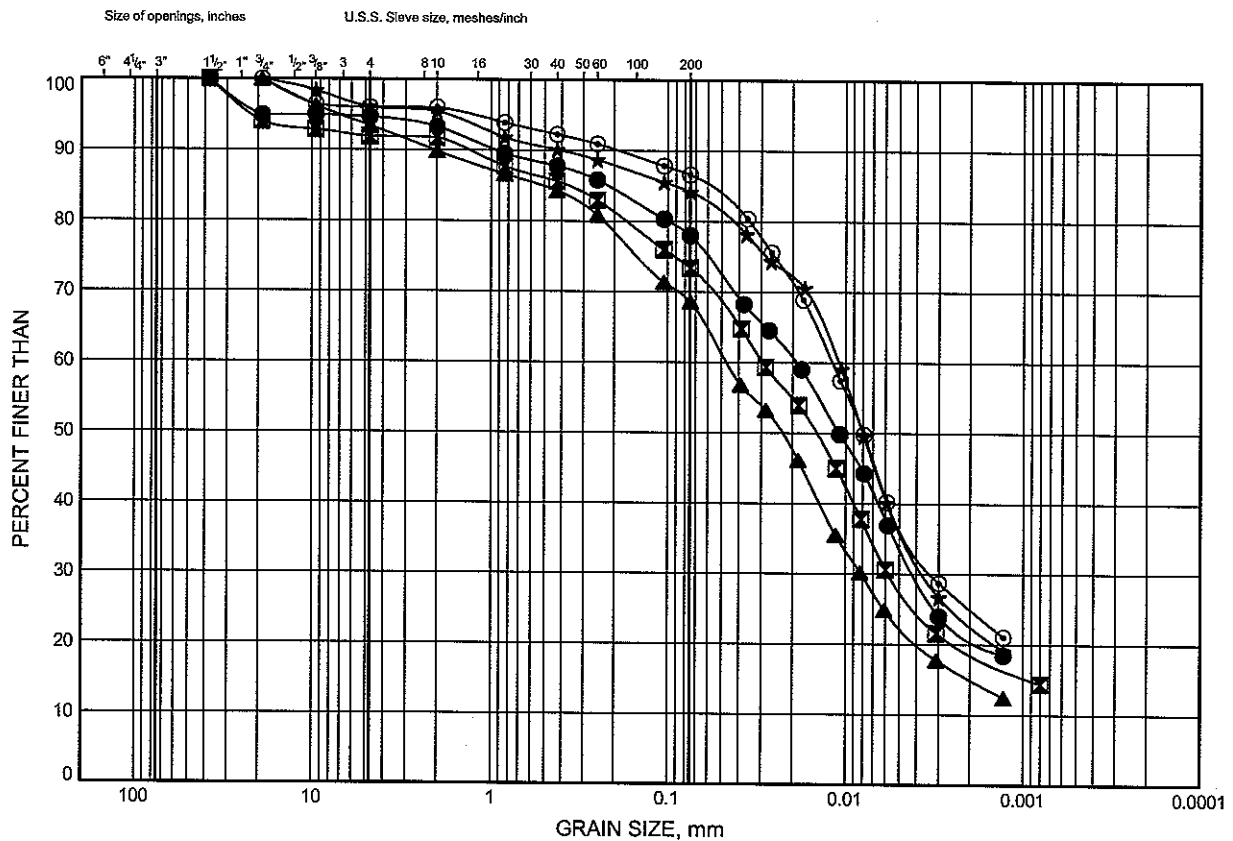


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-26

SILTY CLAY TO CLAYEY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN1	15.4	167.7
⊠	WN2	13.9	167.7
▲	WN3	15.4	166.7
★	WRW2	15.4	167.2
⊙	WRW4	15.4	167.6

Date August 2010
Project 1-09-4135

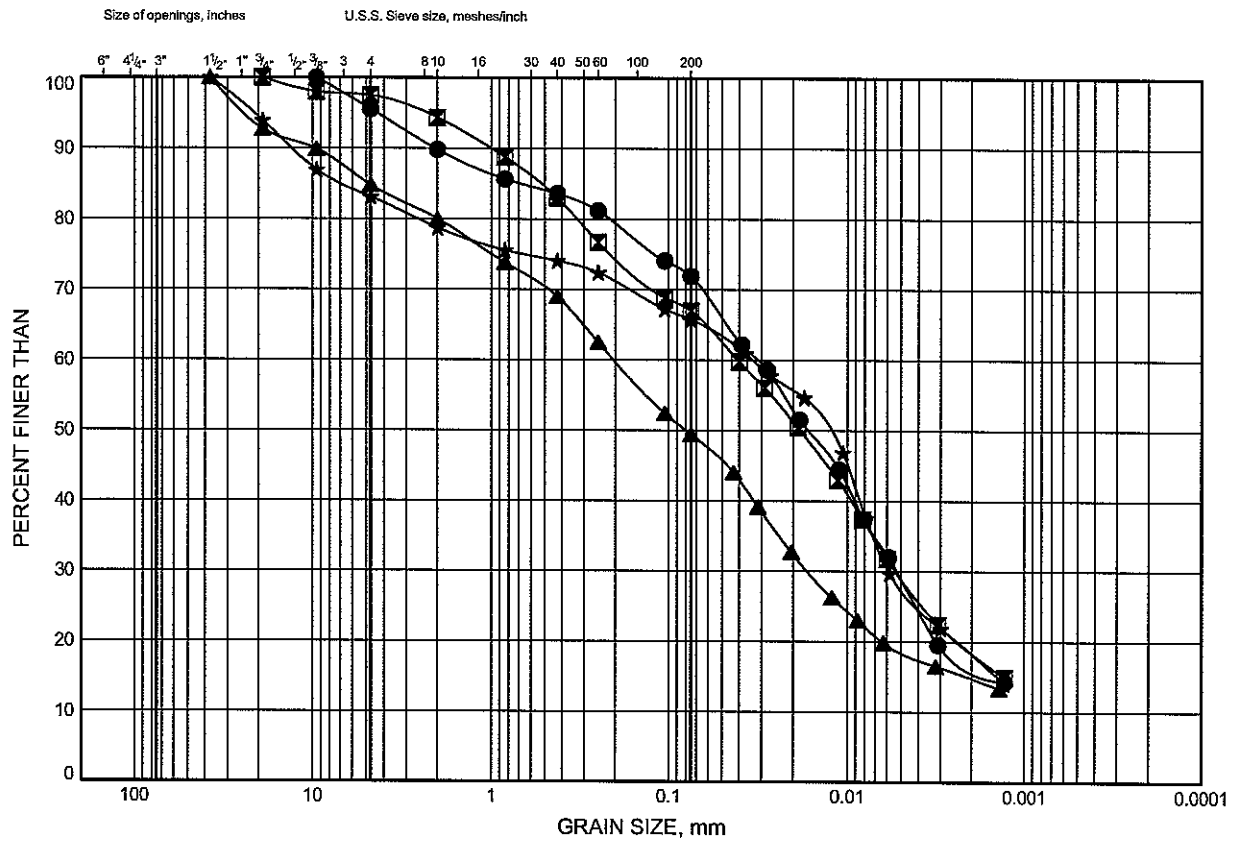


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-27

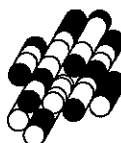
SILTY CLAY TO CLAYEY SILT TILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS1	15.4	167.3
⊠	WS1	21.5	161.2
▲	WS2	21.5	161.6
★	WS4	15.4	167.3

Date August 2010
Project 1-09-4135

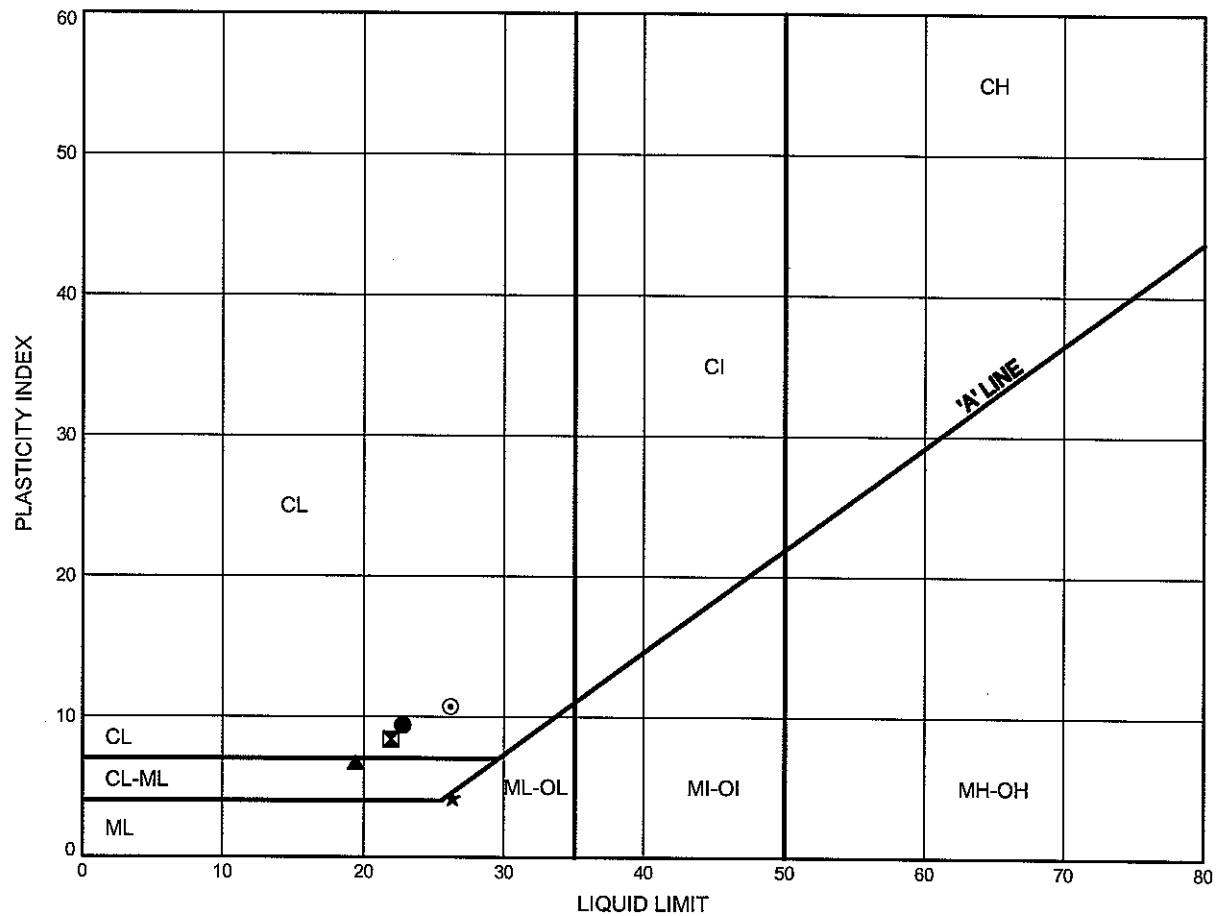


Prep'd JS
Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-28

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WN1	15.4	167.7
⊠	WN2	13.9	167.7
▲	WN3	15.4	166.7
★	WRW2	15.4	167.2
⊙	WRW4	15.4	167.6

Date August 2010

Project 1-09-4135



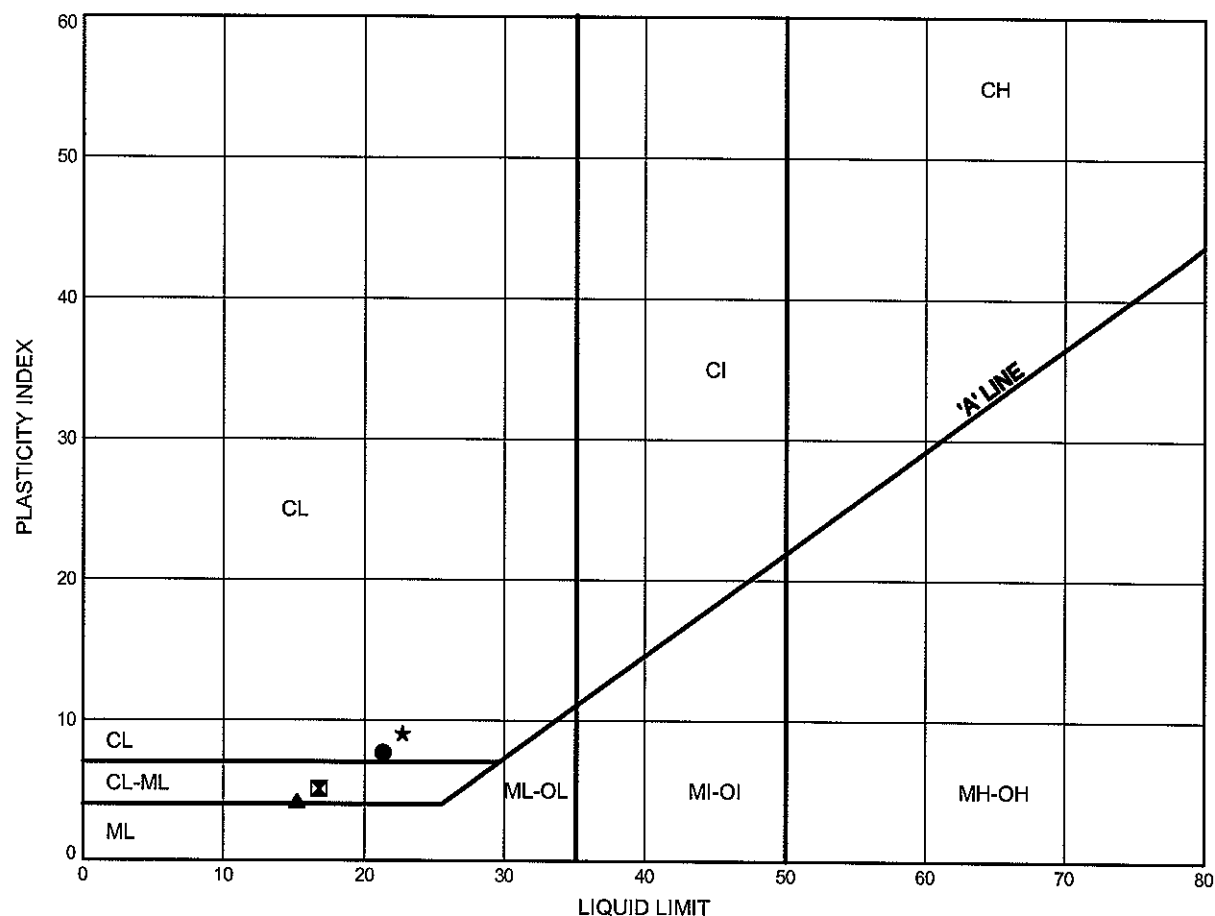
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B3-29

SILTY CLAY TO CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	WS1	15.4	167.3
⊠	WS1	21.5	161.2
▲	WS2	21.5	161.6
★	WS4	15.4	167.3

Date August 2010
Project 1-09-4135

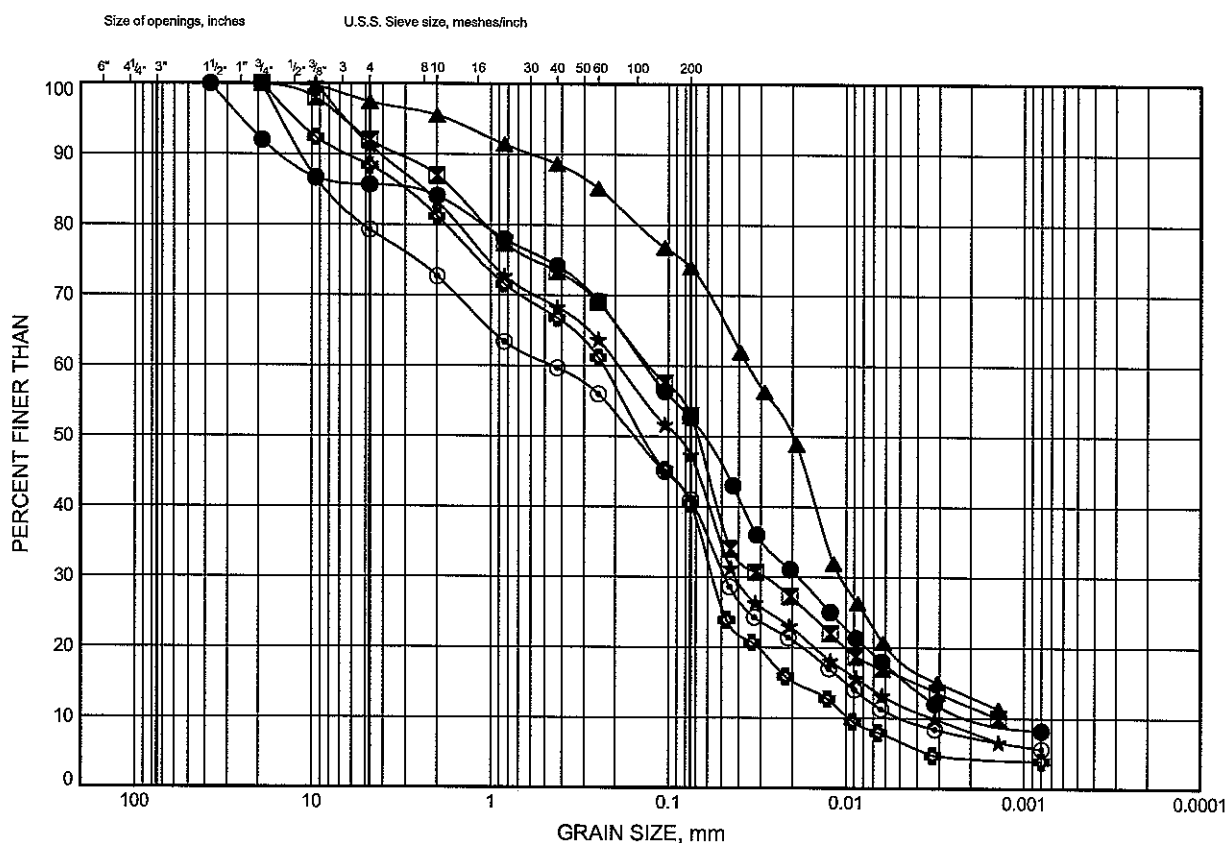


Prep'd JS
Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-30

SILTY SAND TO SANDY SILT TILL



SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	WN1	18.5	164.6
⊠	WN1	24.6	158.5
▲	WN2	17.0	164.6
★	WN2	20.0	161.6
⊙	WN2	21.5	160.1
⊕	WN3	18.5	163.6

Date August 2010

Project 1-09-4135...



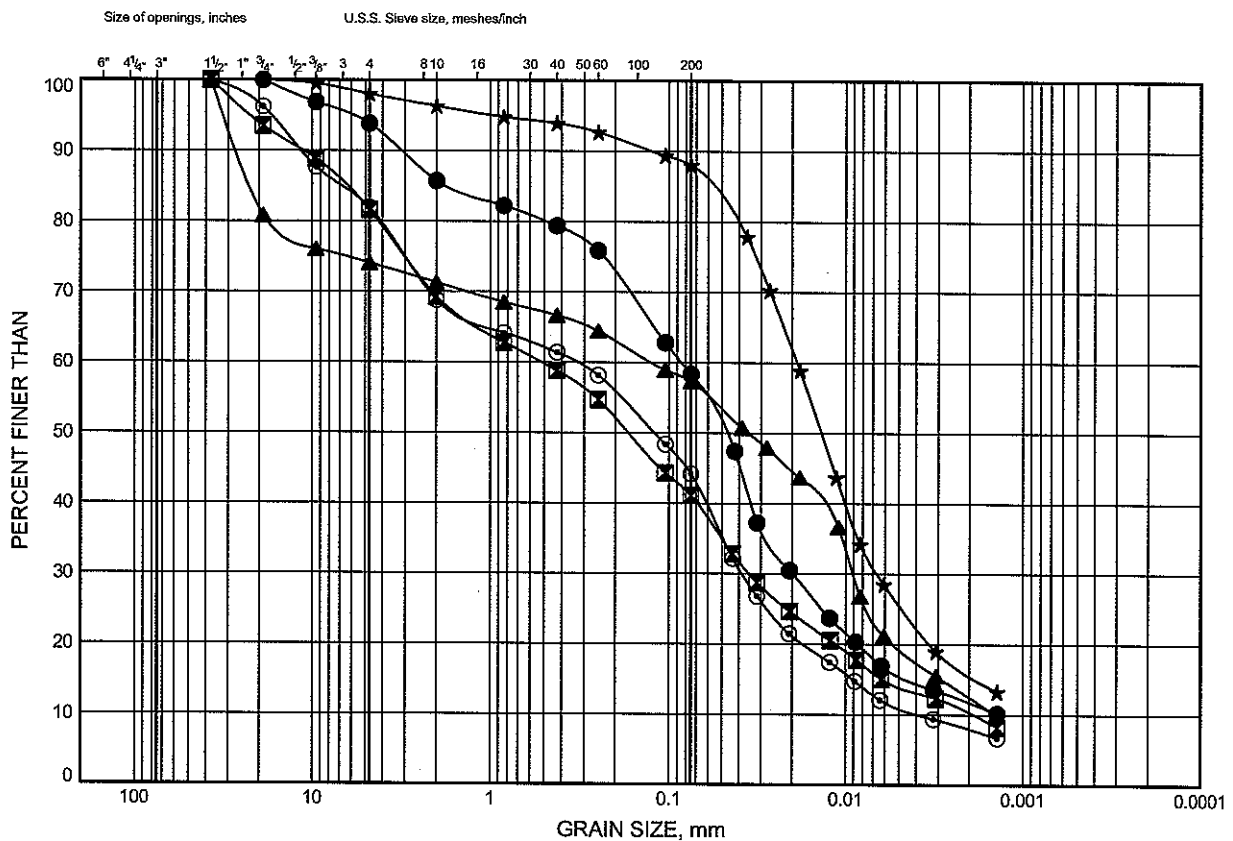
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B3-31

SILTY SAND TO SANDY SILT TILL



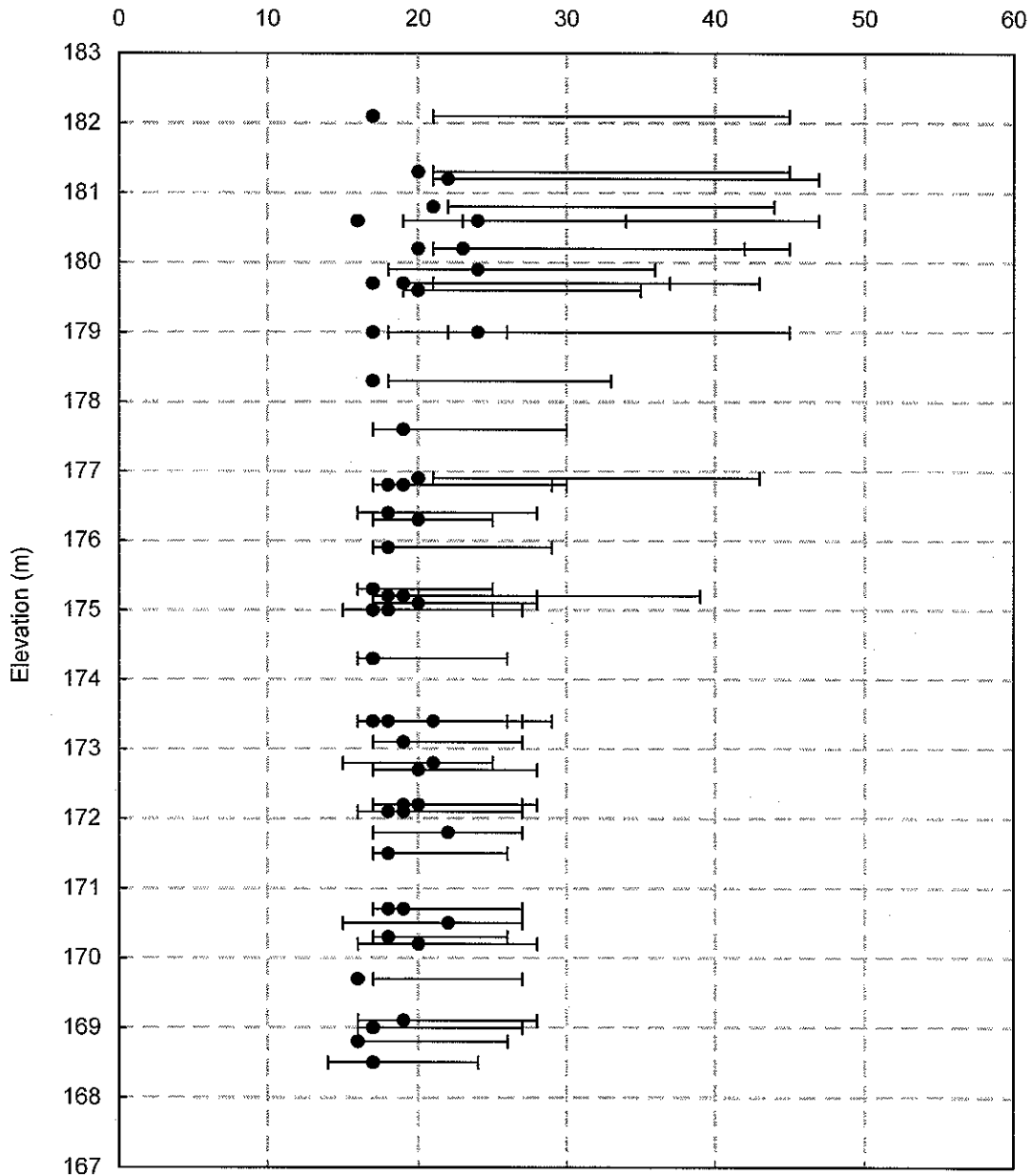
ATTERBERG LIMITS AND WATER CONTENTS

FIGURE B3-32

HWY 406 TWINNING - RETAINING WALL SITE #3

Silty Clay

Atterberg Limits & Water Contents (%)



Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

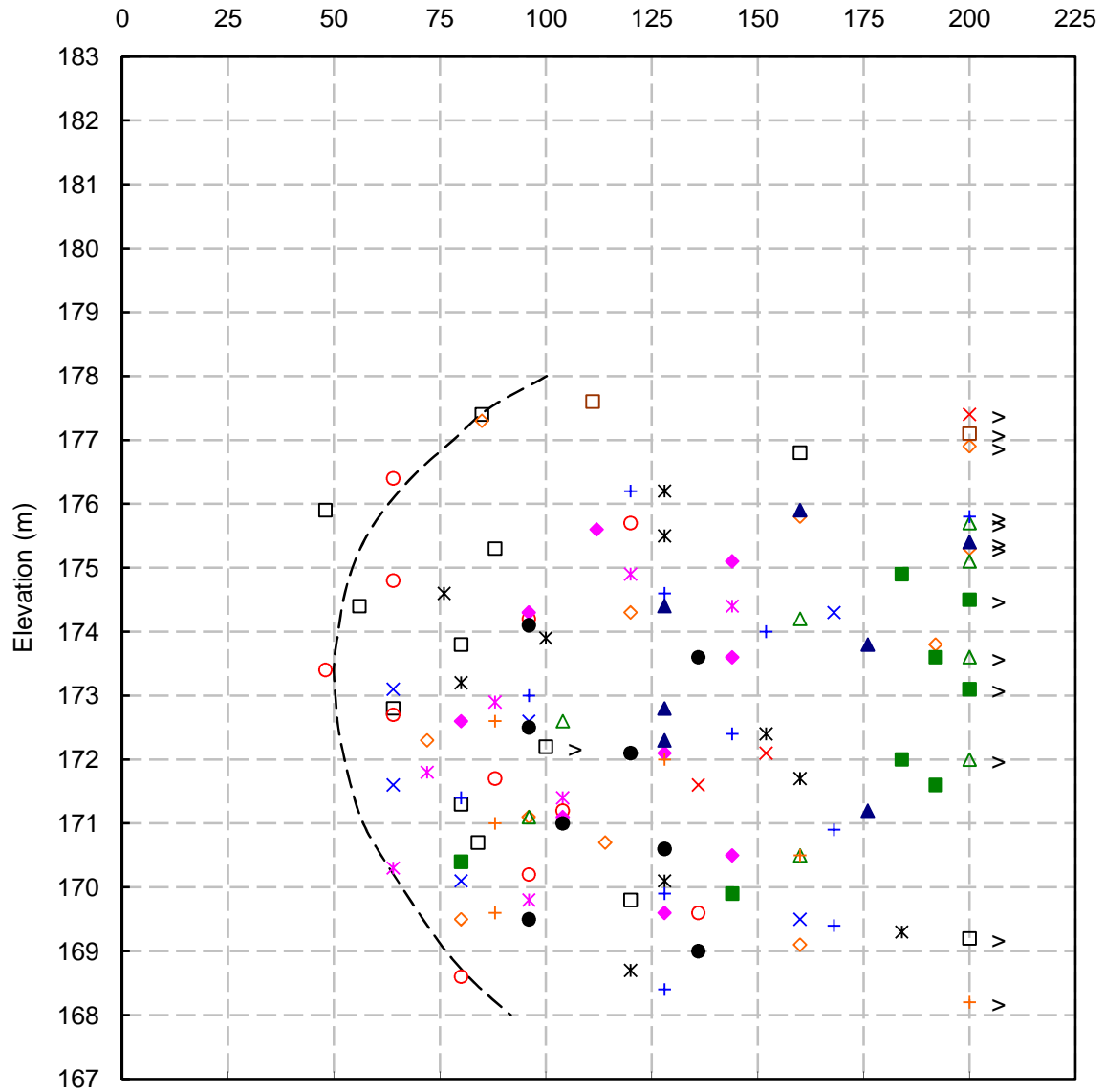
CORRECTED UNDRAINED SHEAR STRENGTH

FIGURE B3-33

HWY 406 TWINNING - RETAINING WALL SITE #3

Silty Clay

Corrected Cu (kPa)



□ NBL 12+695 LT	◇ NBL 12+750 RT	△ SBL 12+685 CL	× SBL 12+750 CL	* SEW 10+050 CL
+ WN1	○ WN2	■ WN3	◆ WN4	▲ WS1
× WS2	* WS3	+ WS4	● WRW2	□ WRW4

Field Shear Vane Correction

Morris & Williams (1994)

$$(\mu = 1.18 \text{ EXP}(-0.08 \text{ Ip}) + 0.57)$$

Applied Correction Factors

0.82 (Elev.>177m)

1.00 (Elev.<177m)

Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

Prepared By : HW

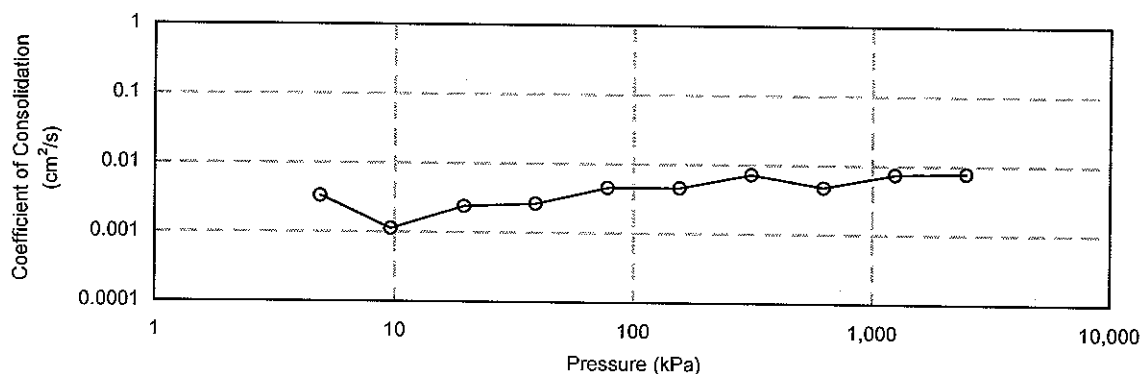
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

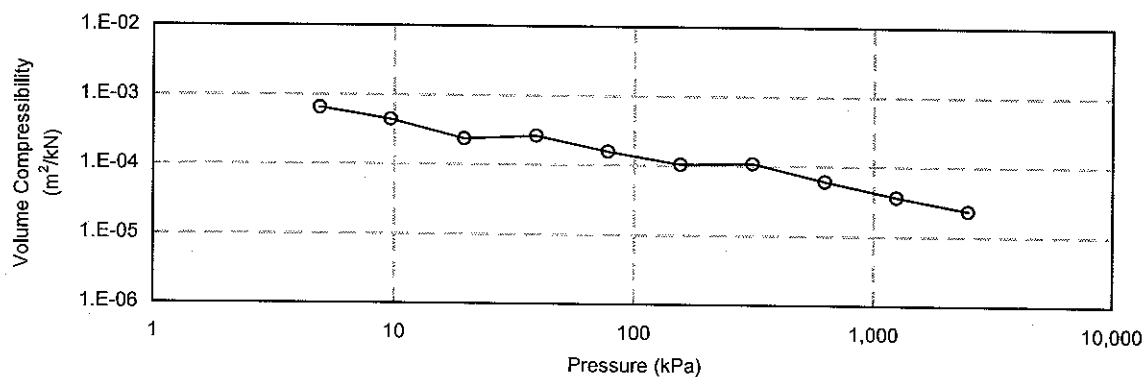
FIGURE B3-34

C:\Documents and Settings\Admin\My Documents\Marc P\Projects 2009\Hwy 406 Expansion\1-09-4135 (Hwy 406 Foundations)\Culverts and Retaining Walls\Lab Results\1-09-4135R4 Consolidation Results.xls

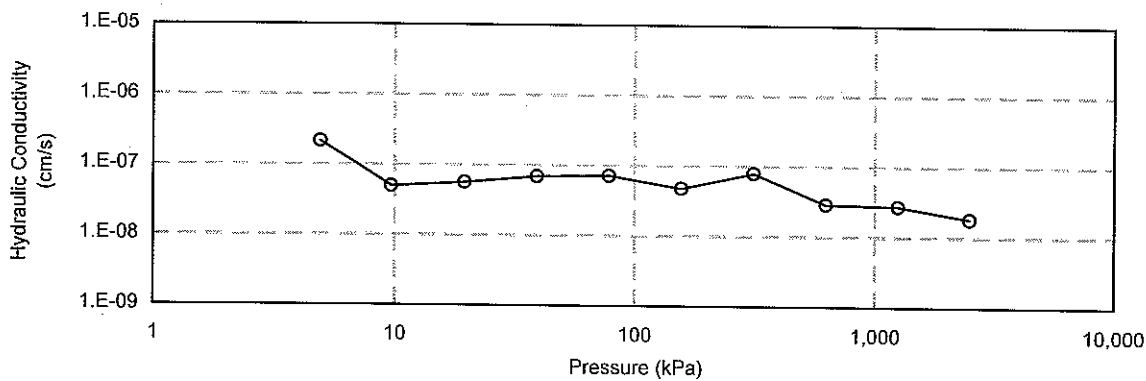
CONSOLIDATION TEST
Cv vs Pressure
NBL 12+695 LT, TW11



CONSOLIDATION TEST
mv vs Pressure
NBL 12+695 LT, TW11



CONSOLIDATION TEST
k vs Pressure
NBL 12+695 LT, TW11



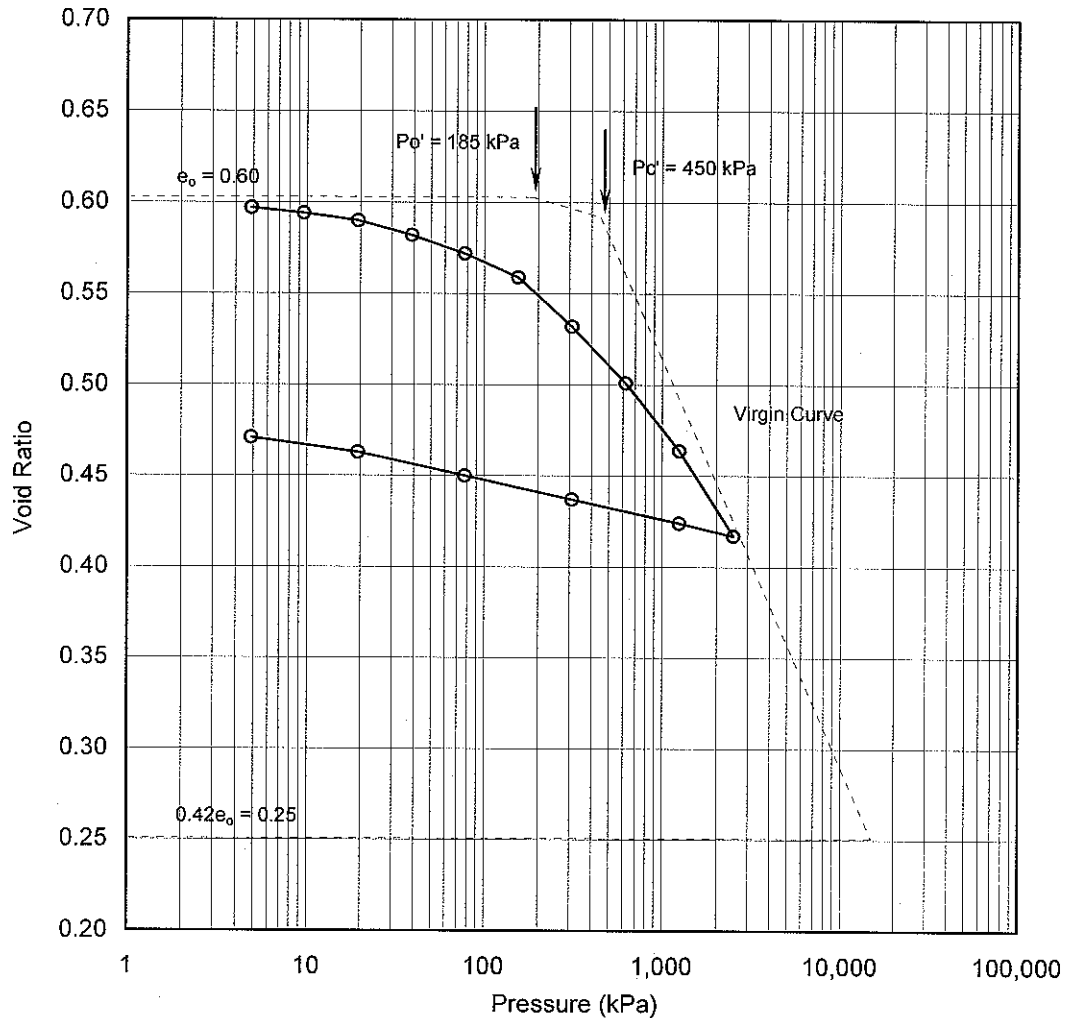
Project No. : 1-09-4135
Date : November 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
e vs Pressure
NBL 12+695 LT, TW11



Soil Type : Silty Clay

$e_0 =$	0.60	$\omega_L =$	25%	$P_{o'} =$	185 kPa
$\omega =$	22%	$\omega_p =$	15%	$P_{c'} =$	450 kPa
$\gamma =$	20.6 kN/m ³	PI =	10%	Cc =	0.224
Gs =	2.76			Cr =	0.028

Project No. : 1-09-4135
Date : November 2010



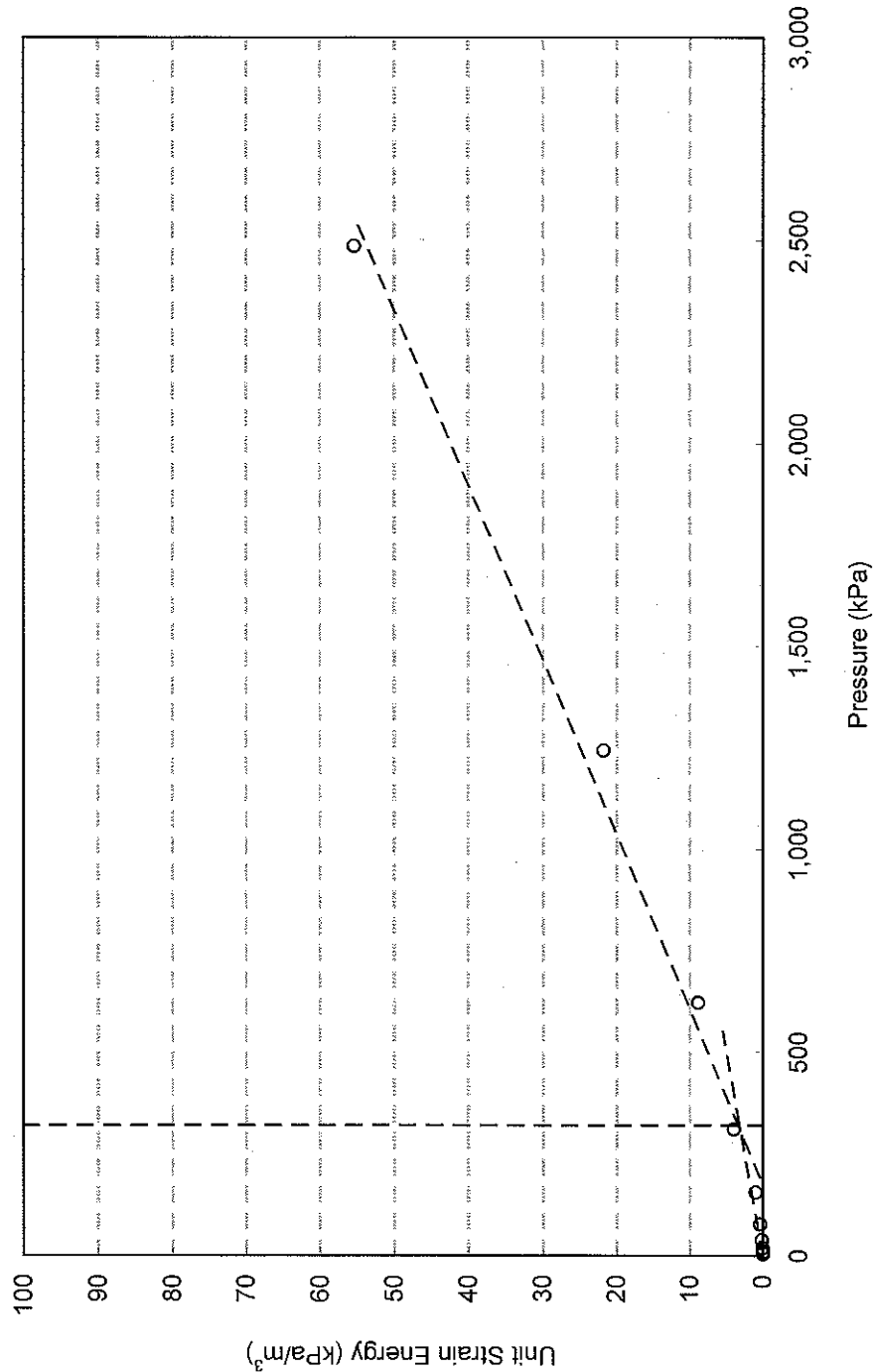
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-36

CONSOLIDATION TEST Unit Strain Energy vs Pressure NBL 12+695 LT, TW11



Pc = 320 kPa

Project No. : 1-09-4135

Date : November 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

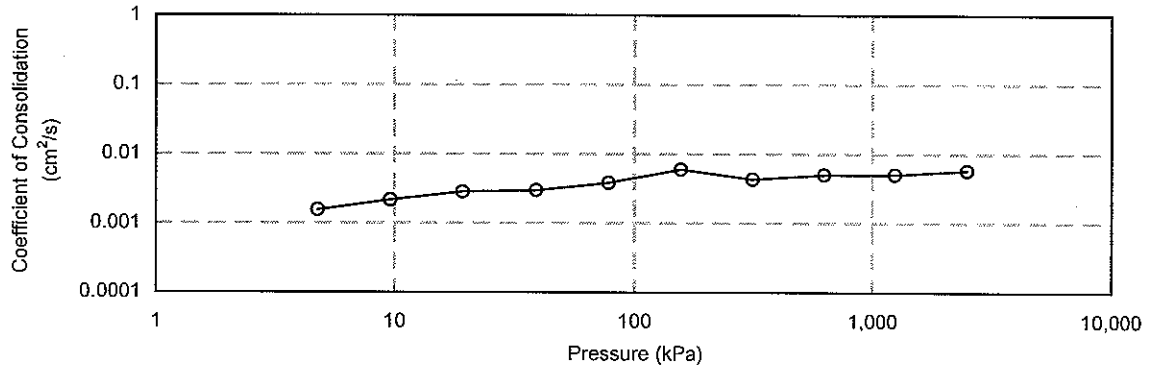
FIGURE B3-37

C:\Documents and Settings\Admin\My Documents\Marc P\Projects 2009\Hwy 406 Expansion\1-09-4135 (Hwy 406 Foundations)\Culverts and Retaining Walls\Retaining Walls\Lab Results\1-09-4135R4 Consolidation Results.xls

CONSOLIDATION TEST

Cv vs Pressure

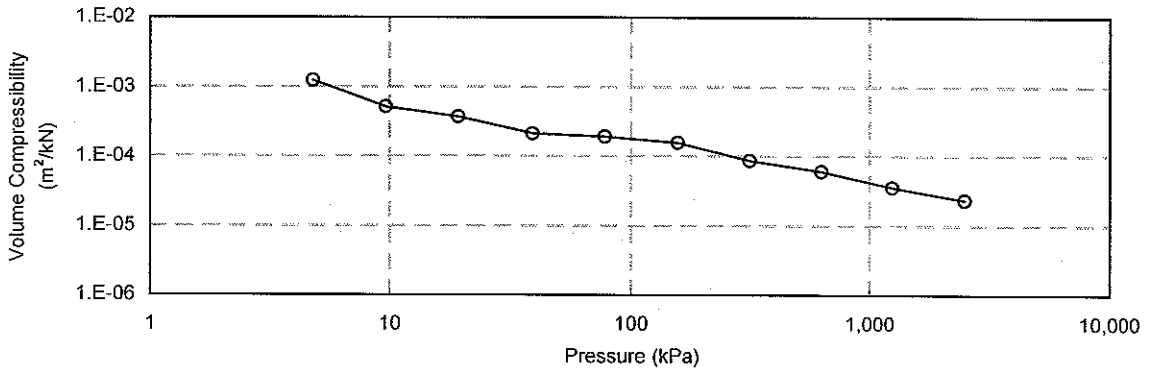
NBL 12+750 RT, TW9



CONSOLIDATION TEST

mv vs Pressure

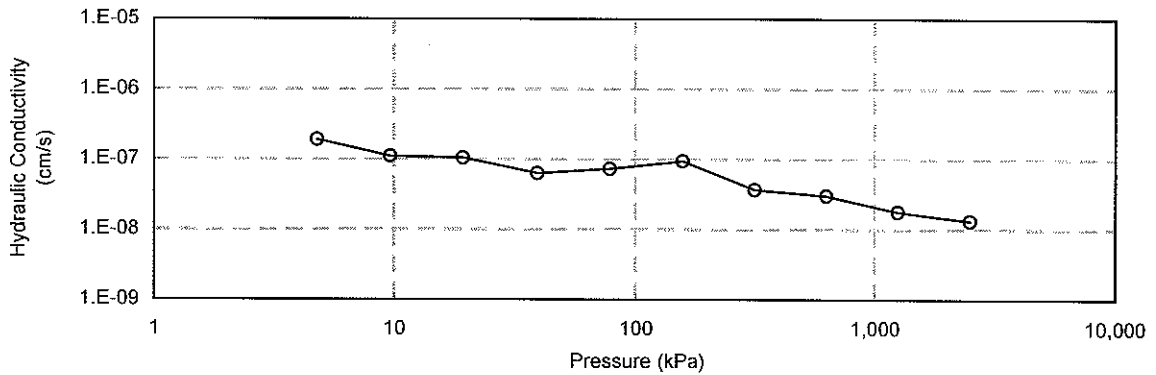
NBL 12+750 RT, TW9



CONSOLIDATION TEST

k vs Pressure

NBL 12+750 RT, TW9



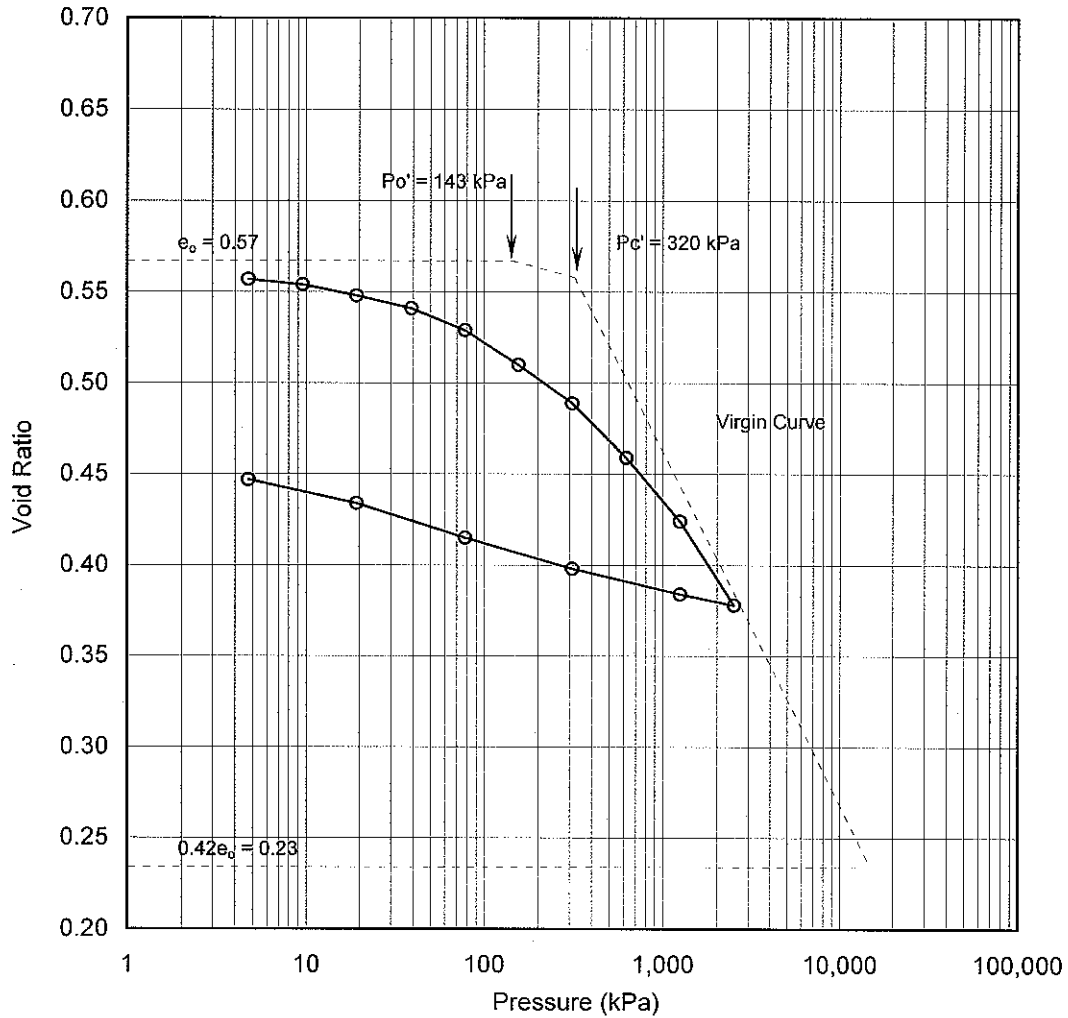
Project No. : 1-09-4135
Date : November 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
e vs Pressure
NBL 12+750 RT, TW9



Soil Type : Silty Clay

$e_o =$	0.57	$\omega_L =$	27%	$P_o' =$	143 kPa
$\omega =$	21%	$\omega_p =$	17%	$P_c' =$	320 kPa
$\gamma =$	20.8 kN/m ³	PI =	10%	Cc =	0.194
Gs =	2.74			Cr =	0.026

Project No. : 1-09-4135
Date : November 2010



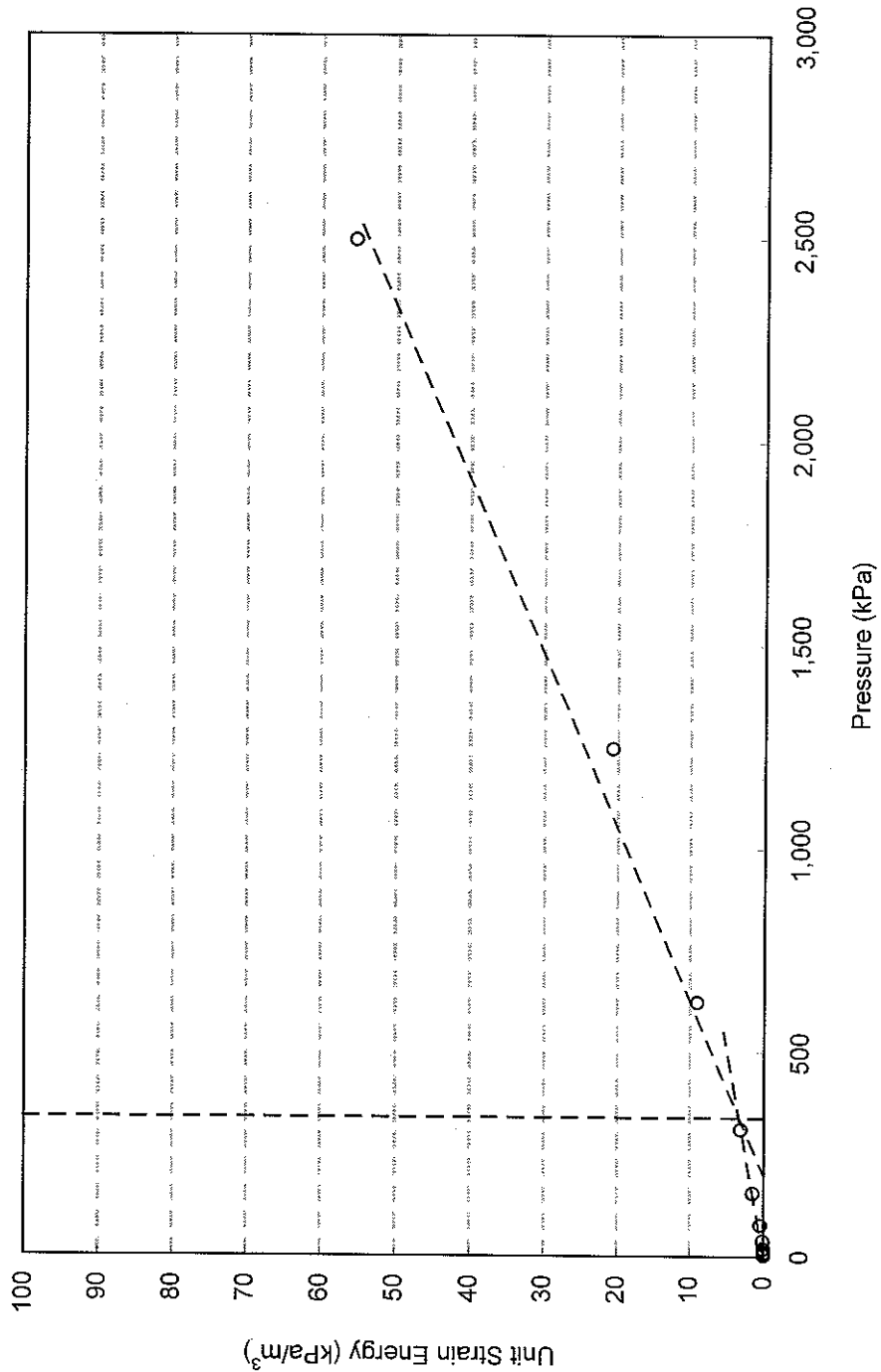
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-39

CONSOLIDATION TEST Unit Strain Energy vs Pressure NBL 12+750 RT, TW9



Pc = 340 kPa

Project No. : 1-09-4135

Date : November 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

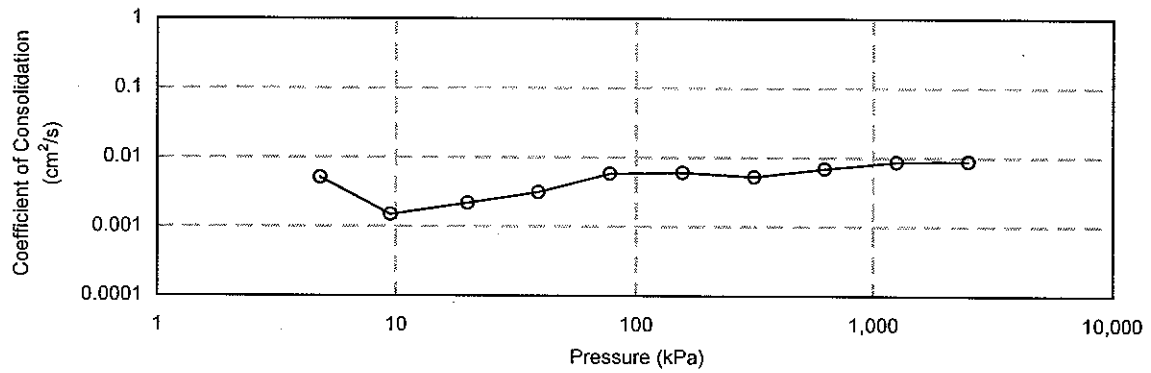
HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-40

CONSOLIDATION TEST

Cv vs Pressure

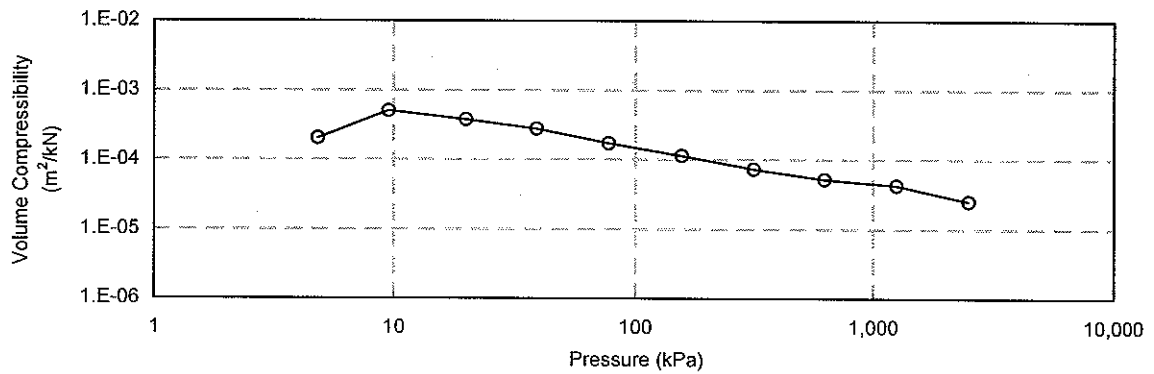
SBL 12+685 CL, TW10



CONSOLIDATION TEST

mv vs Pressure

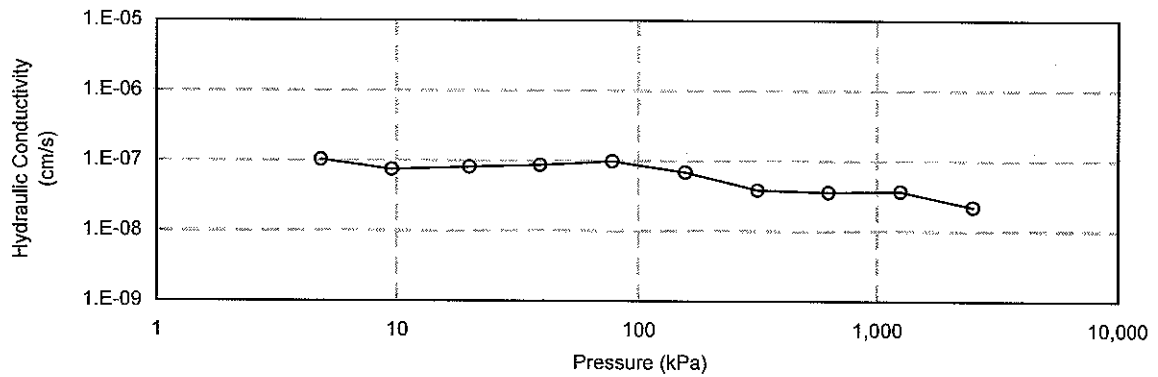
SBL 12+685 CL, TW10



CONSOLIDATION TEST

k vs Pressure

SBL 12+685 CL, TW10



Project No. : 1-09-4135
Date : November 2010



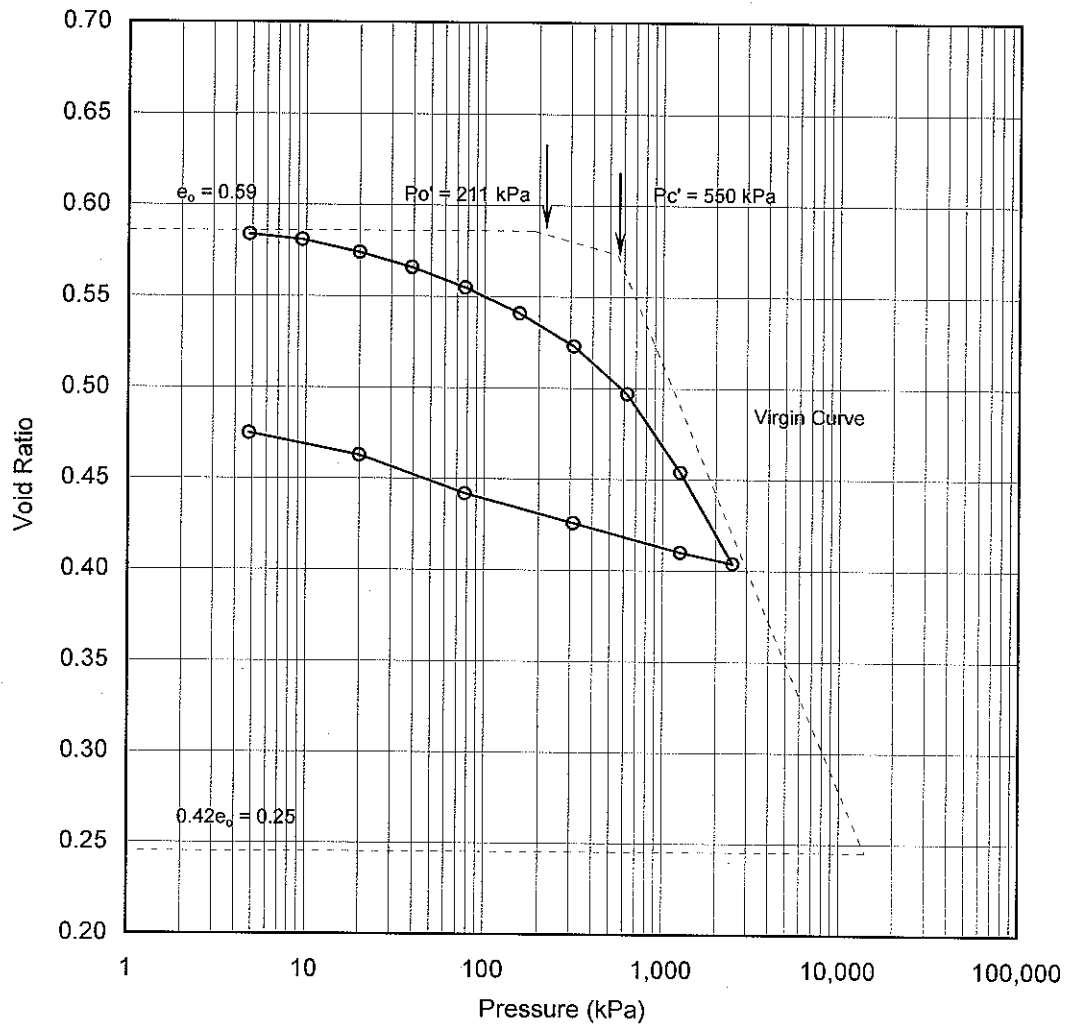
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

SBL 12+685 CL, TW10



Soil Type : Silty Clay

$e_o =$	0.59	$\omega_L =$	27%	$P_{o'} =$	185 kPa
$\omega =$	22%	$\omega_p =$	17%	$P_{c'} =$	550 kPa
$\gamma =$	20.7 kN/m ³	PI =	10%	Cc =	0.233
Gs =	2.75			Cr =	0.027

Project No. : 1-09-4135
 Date : November 2010



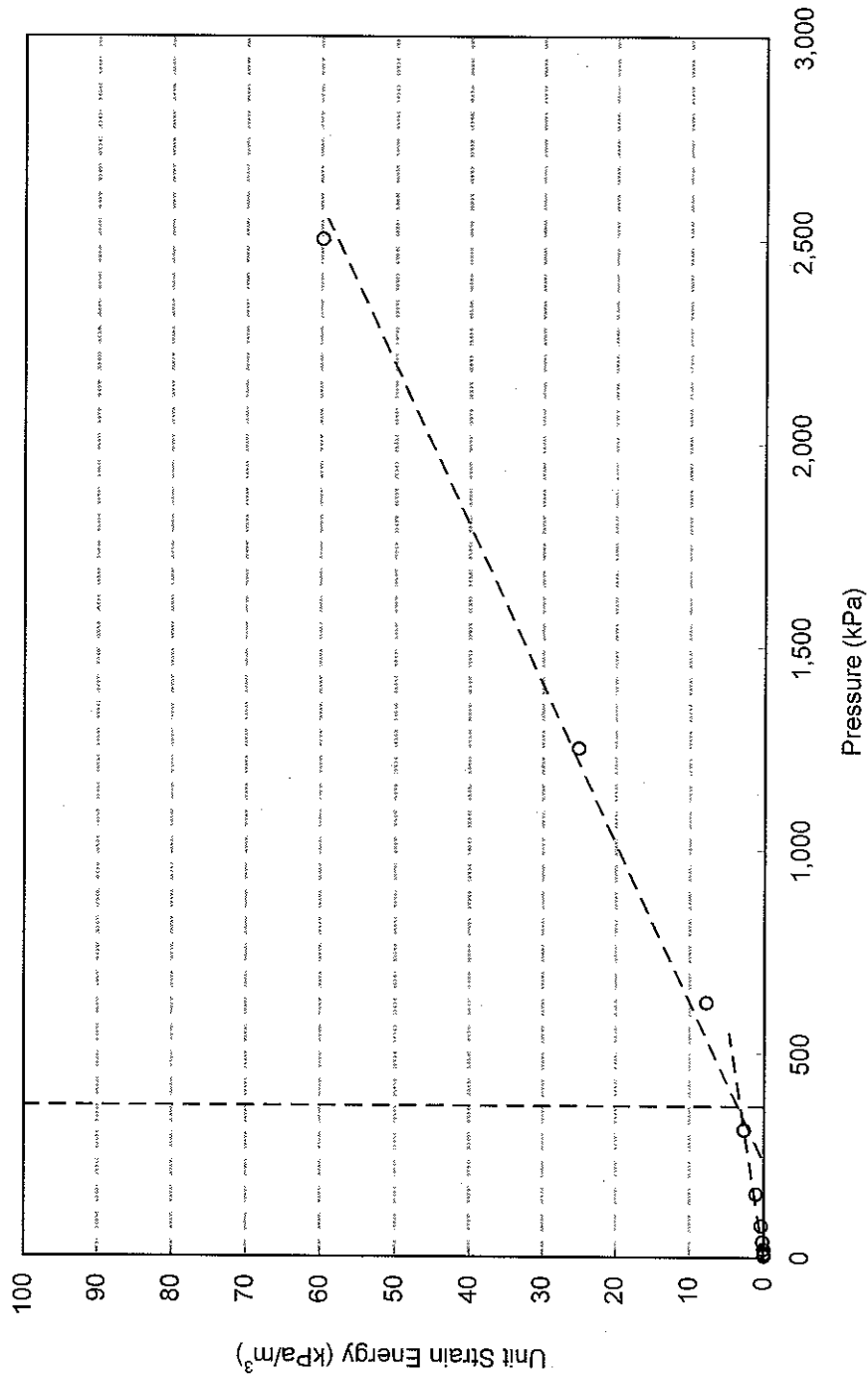
Terraprobe Inc.

Prepared By : HW
 Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-42

CONSOLIDATION TEST Unit Strain Energy vs Pressure SBL 12+685 CL, TW10



$P_c = 370 \text{ kPa}$

Project No. : 1-09-4135

Date : November 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

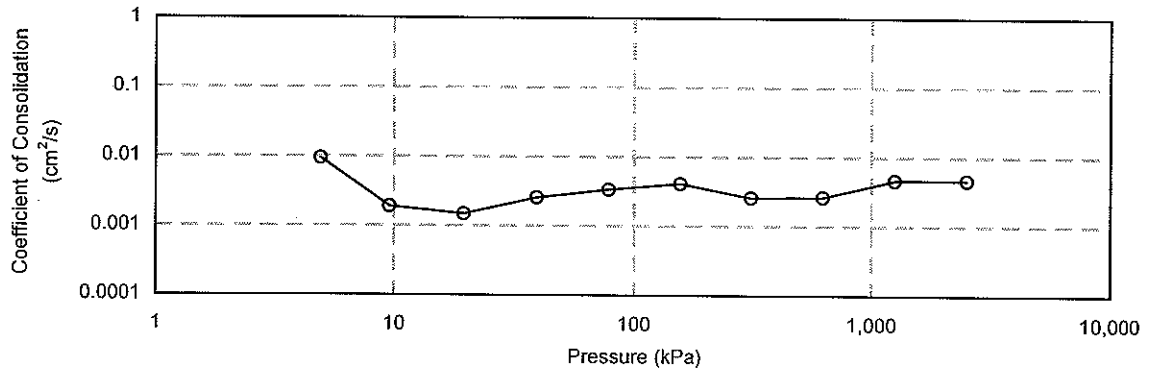
HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-43

CONSOLIDATION TEST

Cv vs Pressure

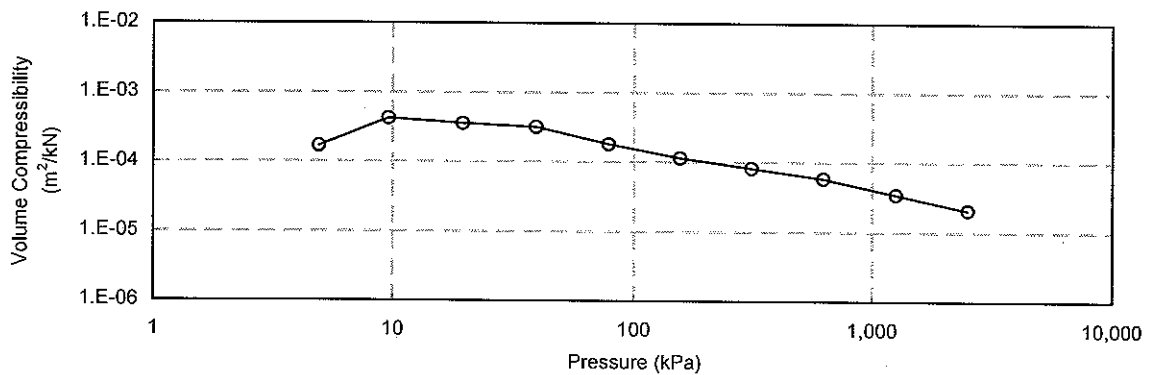
SBL 12+750 CL, TW10



CONSOLIDATION TEST

mv vs Pressure

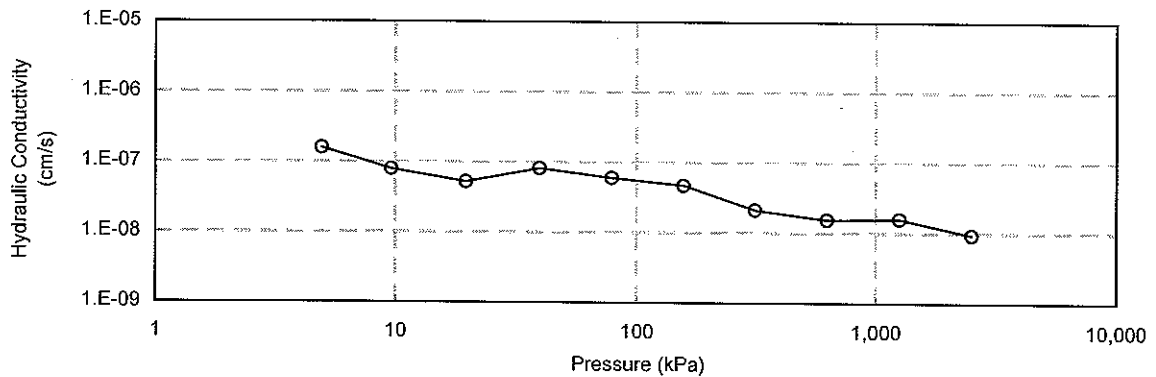
SBL 12+750 CL, TW10



CONSOLIDATION TEST

k vs Pressure

SBL 12+750 CL, TW10



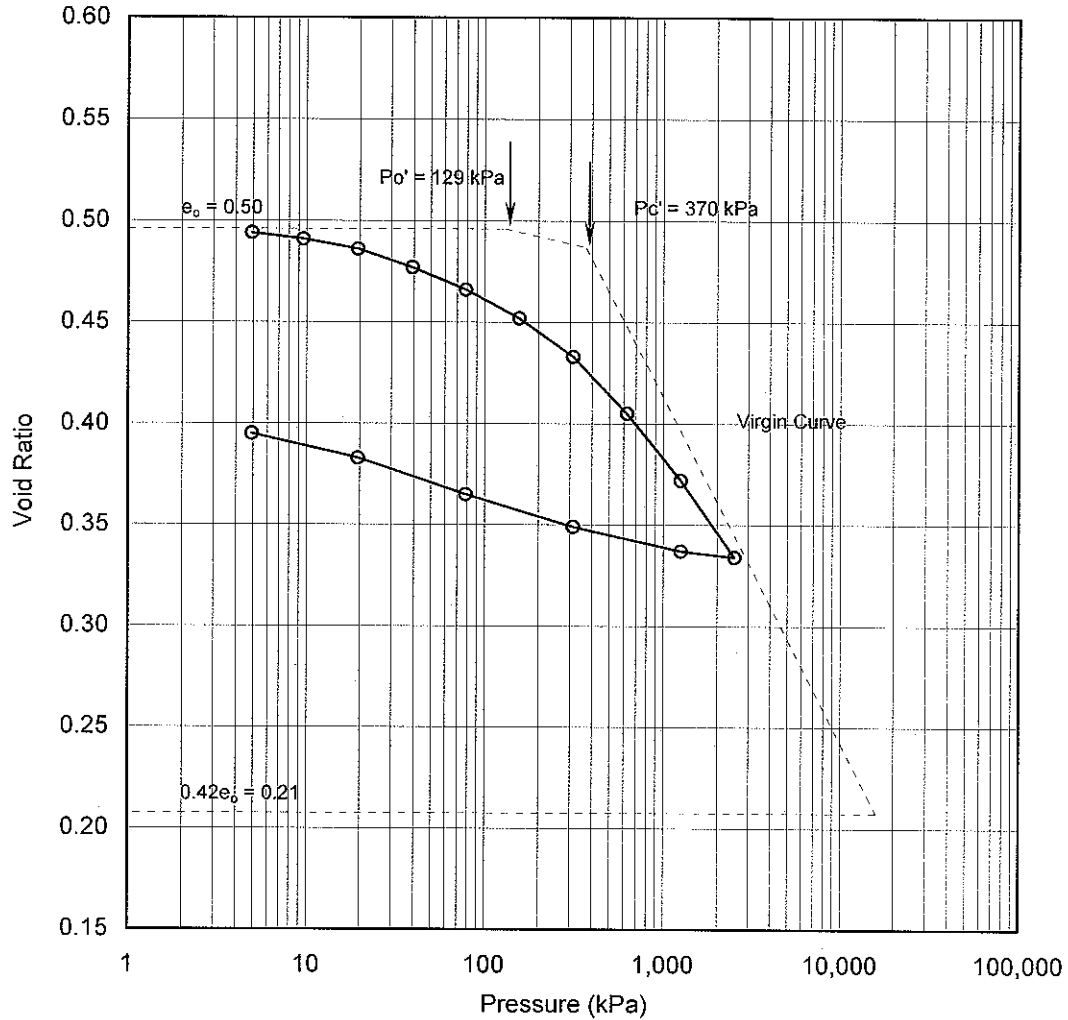
Project No. : 1-09-4135
Date : November 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
e vs Pressure
SBL 12+750 CL, TW10



Soil Type : Silty Clay

$e_0 =$	0.50	$\omega_L =$	25%	$Po' =$	129 kPa
$\omega =$	19%	$\omega_P =$	15%	$Pc' =$	370 kPa
$\gamma =$	21.1 kN/m ³	PI =	10%	Cc =	0.171
Gs =	2.70			Cr =	0.020

Project No. : 1-09-4135
Date : November 2010



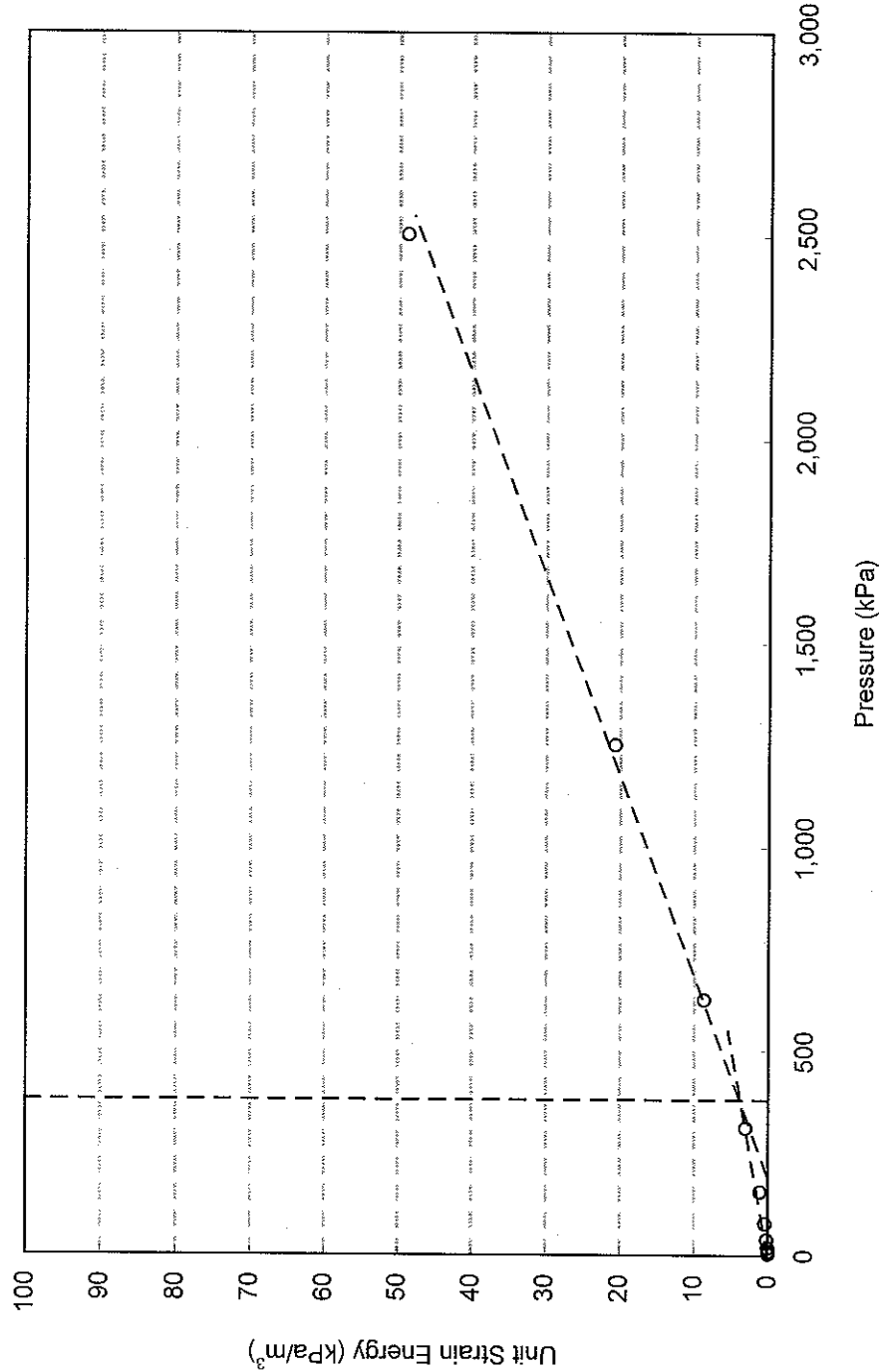
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #3

FIGURE B3-45

CONSOLIDATION TEST Unit Strain Energy vs Pressure SBL 12+750 CL, TW10



Project No. : 1-09-4135

Date : November 2010



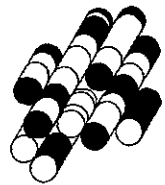
Terraprobe Inc.

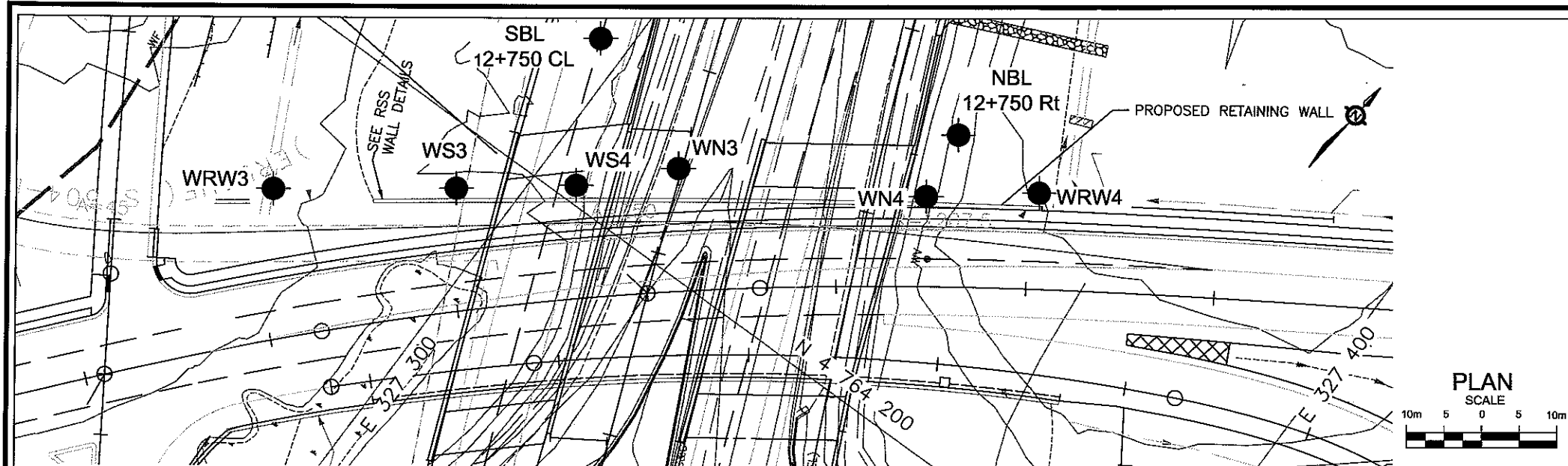
Prepared By : HW

Checked By : RA

C3

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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No 2011-2005
WP No 280-99-00



HIGHWAY 406
WOODLAWN RD NORTH RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
505



Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing
10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2660



KEY PLAN

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test
- ⊙ Bore Hole And 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
- ⊥ WL in Piezometer (AUG. 2010)
- ⊥ Piezometer
- 90% Rock Quality Designation
- A/R Auger Refusal

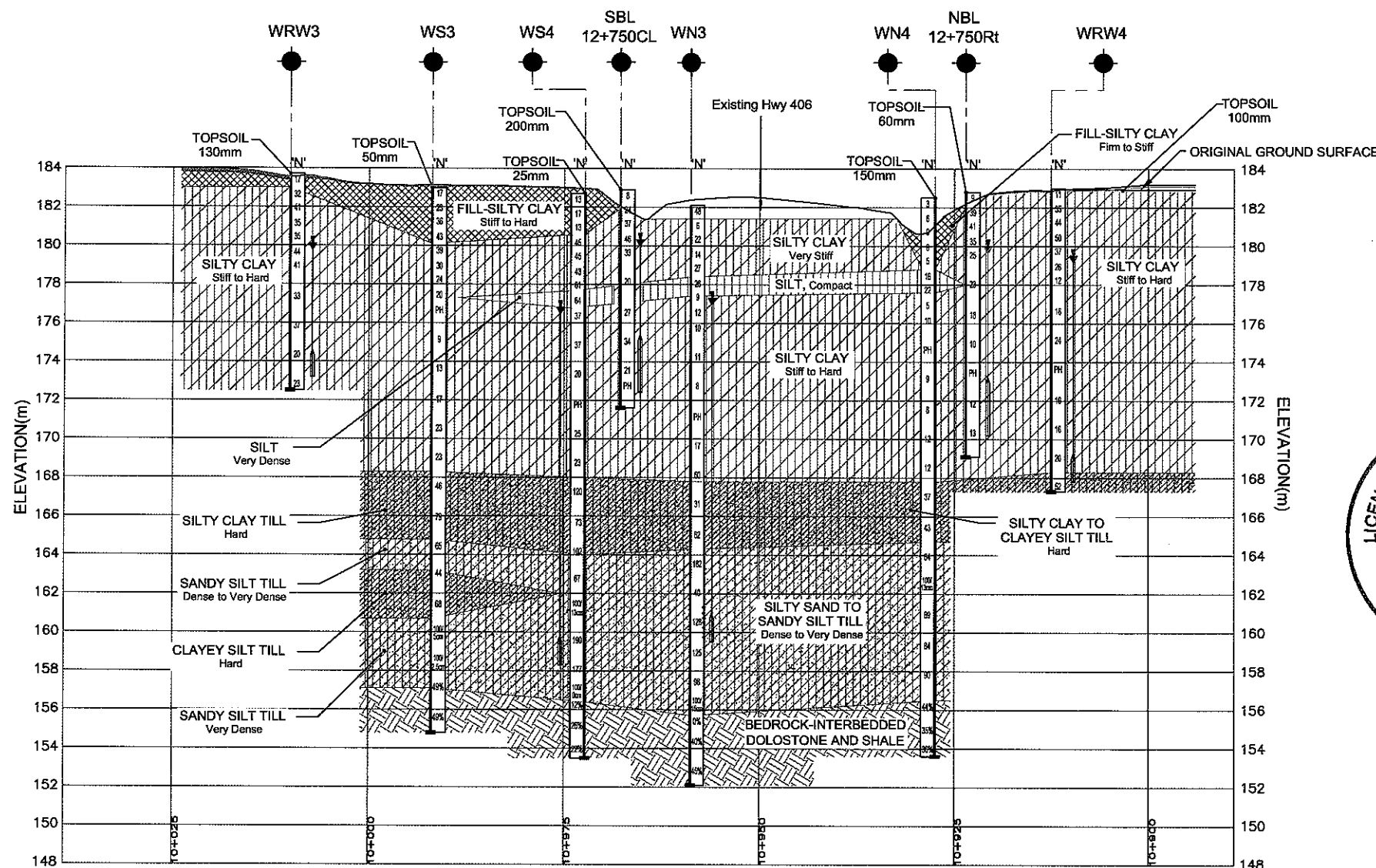
No	ELEV.	COORDINATES	
		NORTHING	EASTING
NBL 12+750Rt	182.8	4 764 237.5	327 341.9
SBL 12+750CL	182.9	4 764 219.9	327 296.2
WN3	182.1	4 764 212.0	327 314.7
WN4	182.5	4 764 228.4	327 343.4
WRW3	183.7	4 764 178.3	327 273.3
WRW4	183.0	4 764 237.8	327 355.1
WS3	183.0	4 764 192.6	327 292.7
WS4	182.7	4 764 202.3	327 305.2

NOTE

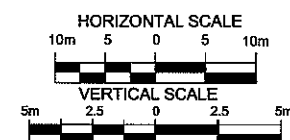
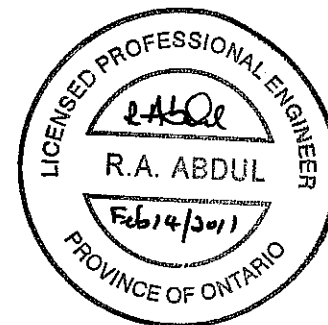
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

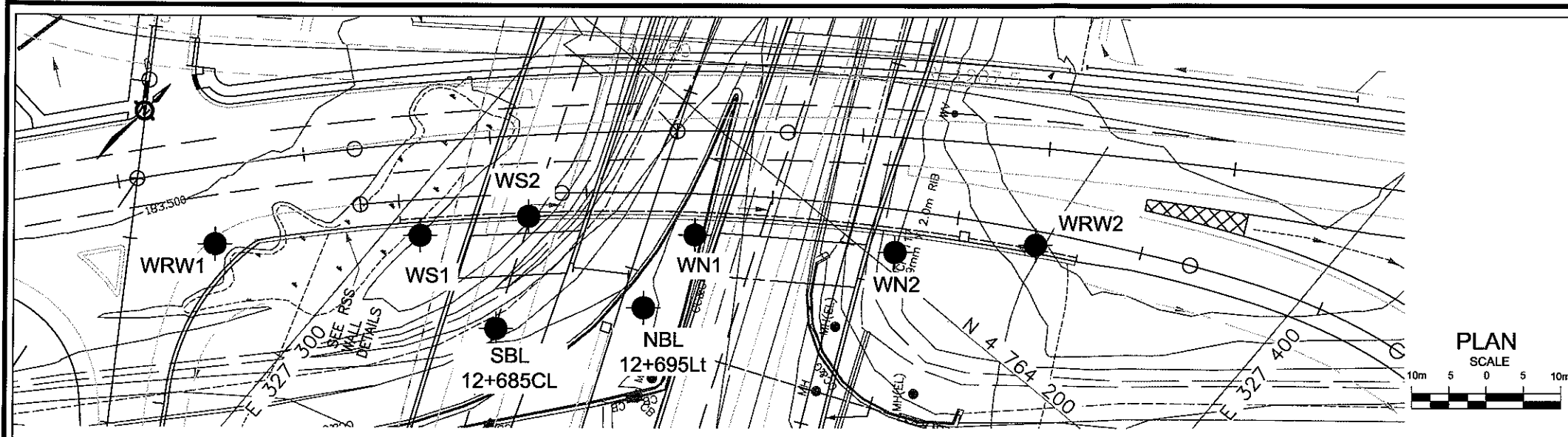
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN R.A.	CODE CHB0C2006	LOAD	DATE FEB. 2011
DRAWN K.C.	CHK R.A.	STRUCT	GEOCRE 3043-296



☐ PROFILE WOODLAWN ROAD NORTH ALIGNMENT





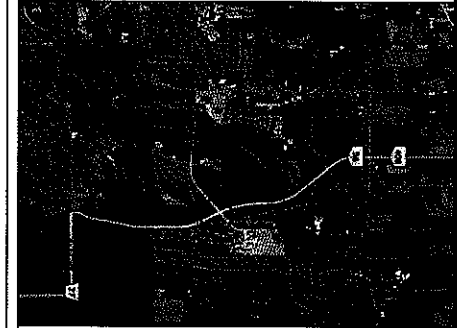
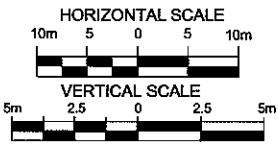
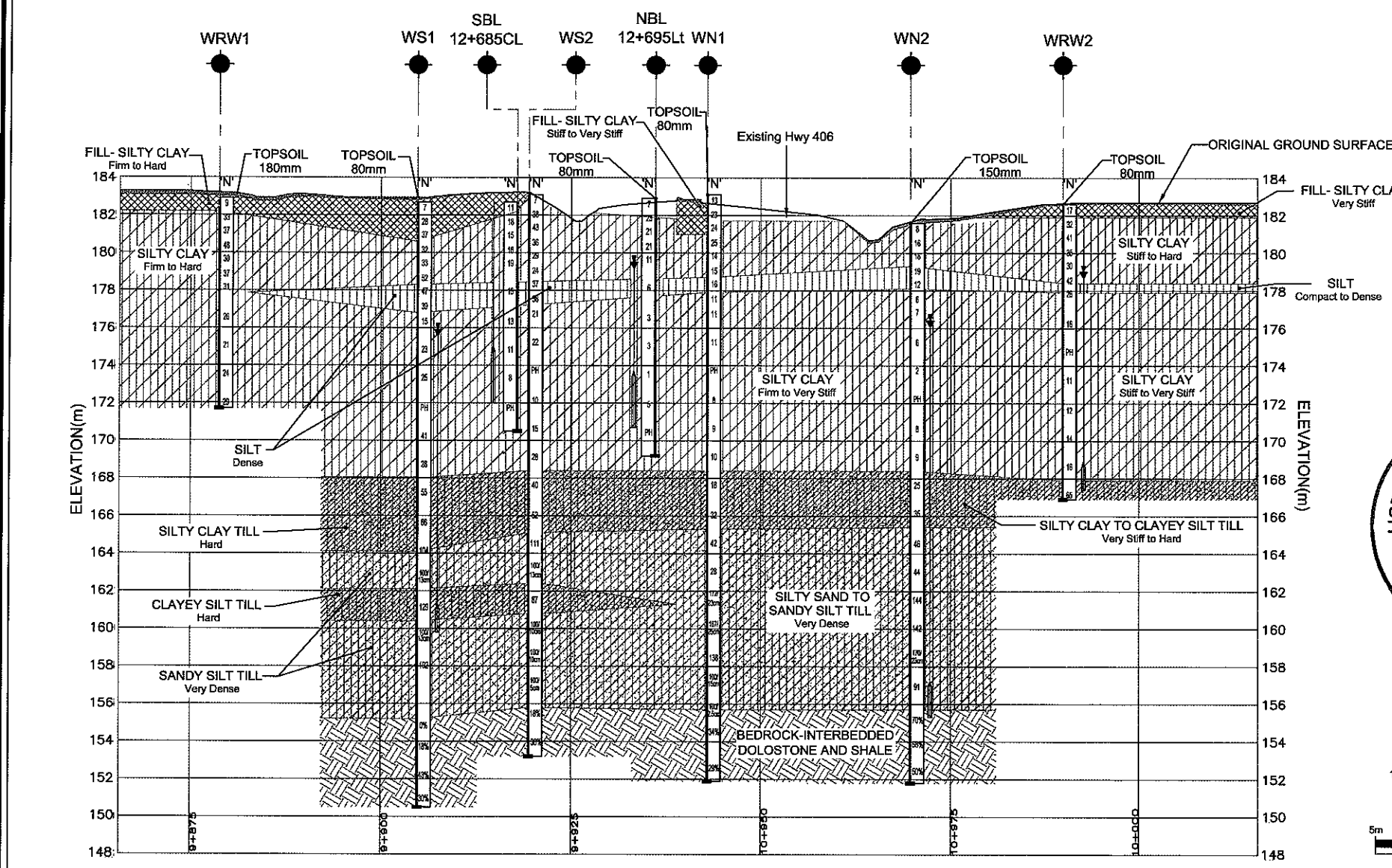
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No 2011-2005
WP No 280-99-00

HIGHWAY 406
WOODLAWN RD SOUTH RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

IBI GROUP

Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing
10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650



KEY PLAN			
LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test		
	Bore Hole And Cone		
	Blows/0.3m (Std Pen Test, 475 J/blow)		
	Blows/0.3m (60' Cone, 475 J/blow)		
	WL at Time of Investigation		
	WL in Piezometer (JULY, 2010)		
	Piezometer		
	Rock Quality Designation		
	Auger Refusal		

No	ELEV.	COORDINATES	
		NORTHING	EASTING
NBL 12+695Lt	182.9	4 764 175.1	327 333.0
SBL 12+685CL	182.7	4 764 160.4	327 319.7
WN1	183.1	4 764 187.0	327 332.0
WN2	181.6	4 764 202.3	327 354.1
WRW1	182.9	4 764 145.1	327 283.6
WRW2	182.6	4 764 215.1	327 368.0
WS1	182.7	4 764 163.6	327 303.9
WS2	183.1	4 764 174.7	327 313.4

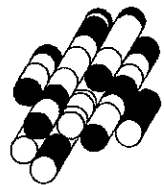
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN R.A.	CODE CHBCC2006	LOAD	DATE FEB. 2011
DRAWN K.C.	CHK R.A.	STRUCT	GEORES 30M3-266

PROFILE WOODLAWN ROAD SOUTH ALIGNMENT

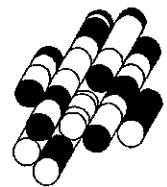
SITE 4

TERRAPROBE INC.



A4

TERRAPROBE INC.

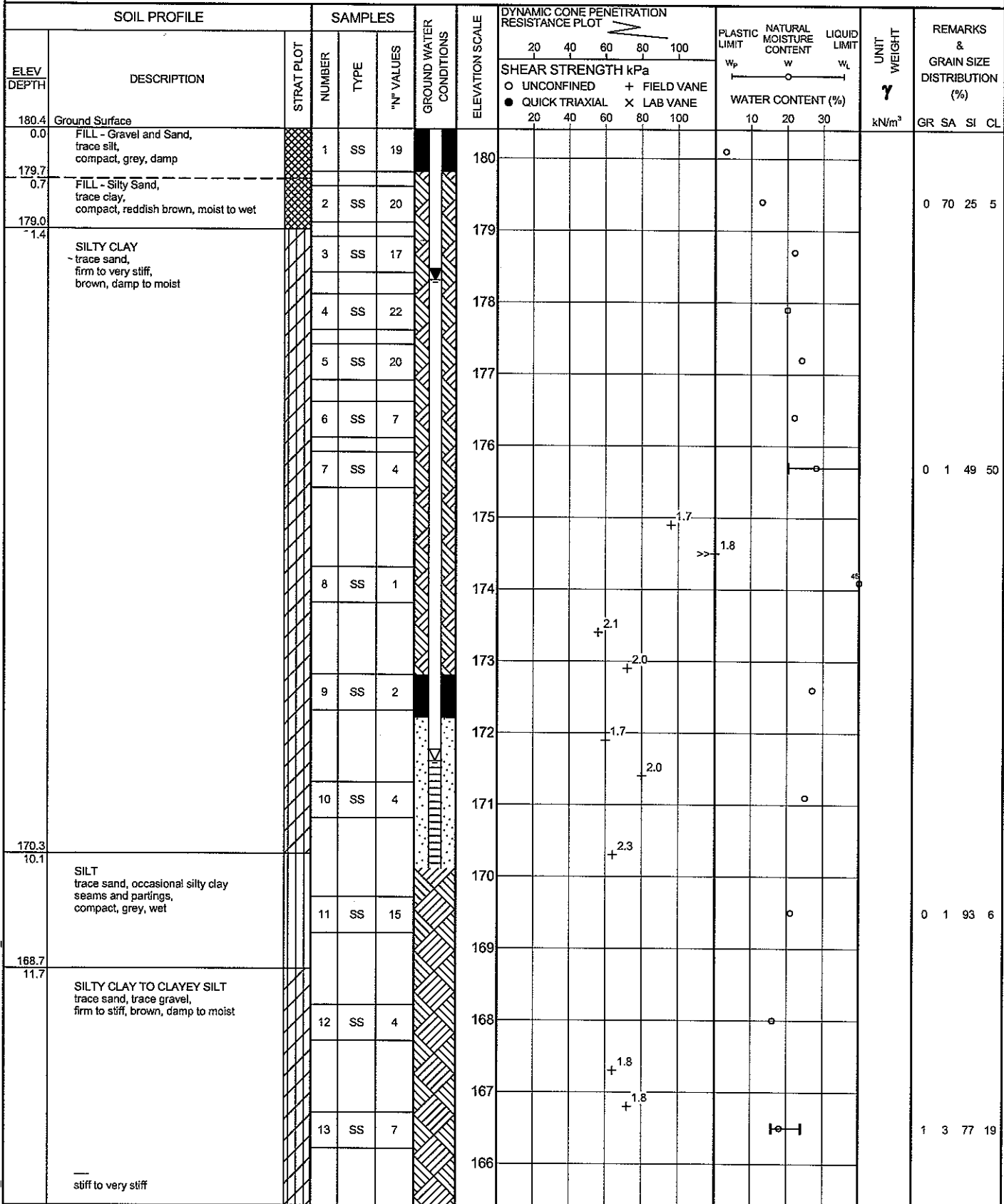


RECORD OF BOREHOLE No MRW1

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765961.0 E:326513.2 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 06.24.10 CHECKED BY RA



ON MOT 1-09-4135 MRW RET WALLS.GPJ ON MOT.GDT 11/04/10

Continued Next Page

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

RECORD OF BOREHOLE No MRW1

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765961.0 E:326513.2 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 06.24.10 CHECKED BY RA

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							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
			14	SS	11		165								
							164								
163.1			15	SS	15										
17.3	End of Borehole														
	Sampler wet at 3.8m. Water level at 8.8m (not stabilized) and hole open to 10.4m on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) July.05.10 1.5 178.9 July.13.10 1.4 179.0 July.20.10 1.6 178.8 July.27.10 1.3 179.1 Aug.06.10 2.0 178.4 Aug.13.10 2.7 177.7 Aug.23.10 2.1 178.3														

+ 3, X 3: Numbers refer to
Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No MR 9+850 Rt

1 OF 1

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765953.0 E:326458.1 ORIGINATED BY MP
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 09.09.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	10
179.8	Ground Surface																	
0.1	60mm TOPSOIL		1	SS	10													
	firm																	

	SILTY CLAY		2	SS	26													
	very stiff,																	
	brown to 4.0m, grey below,																	
	damp to moist																	

	firm to stiff		3	SS	27													
			4	SS	21													
			5	SS	10													
			6	SS	3													
			7	TW	PH													
					</													

ON MOT 1-09-4135 MRW RET WALLS.GPJ ON MOT GDT 09/02/10

RECORD OF BOREHOLE No MRW2

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765920.3 E:326420.3 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 06.21.10 CHECKED BY RA

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × LAB VANE									
							WATER CONTENT (%)										
							20 40 60 80 100					10 20 30					
180.8	Ground Surface																
0.0	460mm FILL - Gravelly Sand, trace silt, compact, grey, damp		1	SS	27												
180.3																	
0.5	FILL - Silty Sand, trace clay, trace gravel, very loose to compact, reddish brown, moist to wet		2	SS	11												
			3	SS	3												
178.2			4	SS	2												
2.6	SILTY CLAY trace sand, firm to very stiff, brown, damp to moist		5	SS	10												
			6	SS	10												
			7	SS	8												
			8	SS	5												

ON_MOT_1-09-4135 MRW RET WALLS.GPJ ON_MOT.GDT 09/02/10

Continued Next Page

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

RECORD OF BOREHOLE No MRW2

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765920.3 E:326420.3 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 06.21.10 CHECKED BY RA

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	60	80	100					
163.5	hard		15	SS	23												
17.3			16	SS	31												
	<p>End of Borehole</p> <p>Sampler wet at 1.5m.</p> <p>Water level at 2.4m (not stabilized) and hole open to 12.5m on completion.</p>																

ON MOT 1-09-4135 MRW RET WALLS.GPJ ON MOT.GDT 06/02/10

RECORD OF BOREHOLE No MRW3

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4765895.0 E:326376.6 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 06.23.10 - 06.24.10 CHECKED BY RA

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
180.5	Ground Surface							20 40 60 80 100							
0.0	460mm FILL - Gravelly Sand, some silt, trace clay, compact, grey, damp		1	SS	25					○				31 53 14 2	
180.0															
0.5	FILL - Silty Sand, very loose to compact, brown, wet		2	SS	10					○					
178.6			3	SS	2						○				
1.9	FILL - Silty Clay, trace sand, trace organics, stiff, grey / brown, moist		4	SS	14							○		0 5 59 36	
177.6															
2.9	SILTY CLAY stiff to very stiff, brown, moist		5	SS	21							○			
			6	SS	12								○		
			7	SS	8								○	0 0 51 49	
			8	SS	2								○		
			9	SS	2			1.3						0 0 61 39	
171.9															
8.6	SILT trace sand, frequent silty clay seams and partings, compact, brown, wet		10	SS	11							○			
			11	SS	16								○		
168.8															
11.7	SILTY CLAY TO CLAYEY SILT trace sand, trace gravel, stiff to very stiff, brown, damp to moist		12	SS	10							○			
			13	SS	9							○			

Continued Next Page

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

ON MOT 1-09-4135 MRW RET WALLS.GPJ ON MOT.GDT 09/02/10

METRIC

ON MOT 1-09-4135 MRW RET WALLS.GPJ ON_MOT.GDI 09/02/10

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					WATER CONTENT (%)									
						20			40	60	80	100	20						40	60
			14	SS	16		165													
							164													
163.2 17.3	End of Borehole		15	SS	19															
	Water level at 6.4m (not stabilized) and hole open to full depth on completion.																			
	Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.																			
	Water Level Readings:																			
	Date Depth(m) Elevation(m)																			
	July 05.10 1.8 178.7																			
	July 13.10 1.4 179.1																			
	July 20.10 1.5 179.0																			

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

B4

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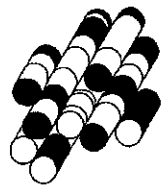


FIGURE B4-1

Size of openings, inches

U.S.S. Sieve size, meshes/inch

PERCENT FINER THAN

GRAIN SIZE, mm

Grain Size (mm)	Percent Finer (%)
4.75	100
2.0	83
0.85	69
0.425	53
0.25	34
0.15	27
0.106	23
0.075	18
0.06	16
0.0475	12
0.0375	10
0.03	8
0.025	5
0.02	4
0.015	3
0.0125	2
0.0106	1

COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW3	0.3	180.2

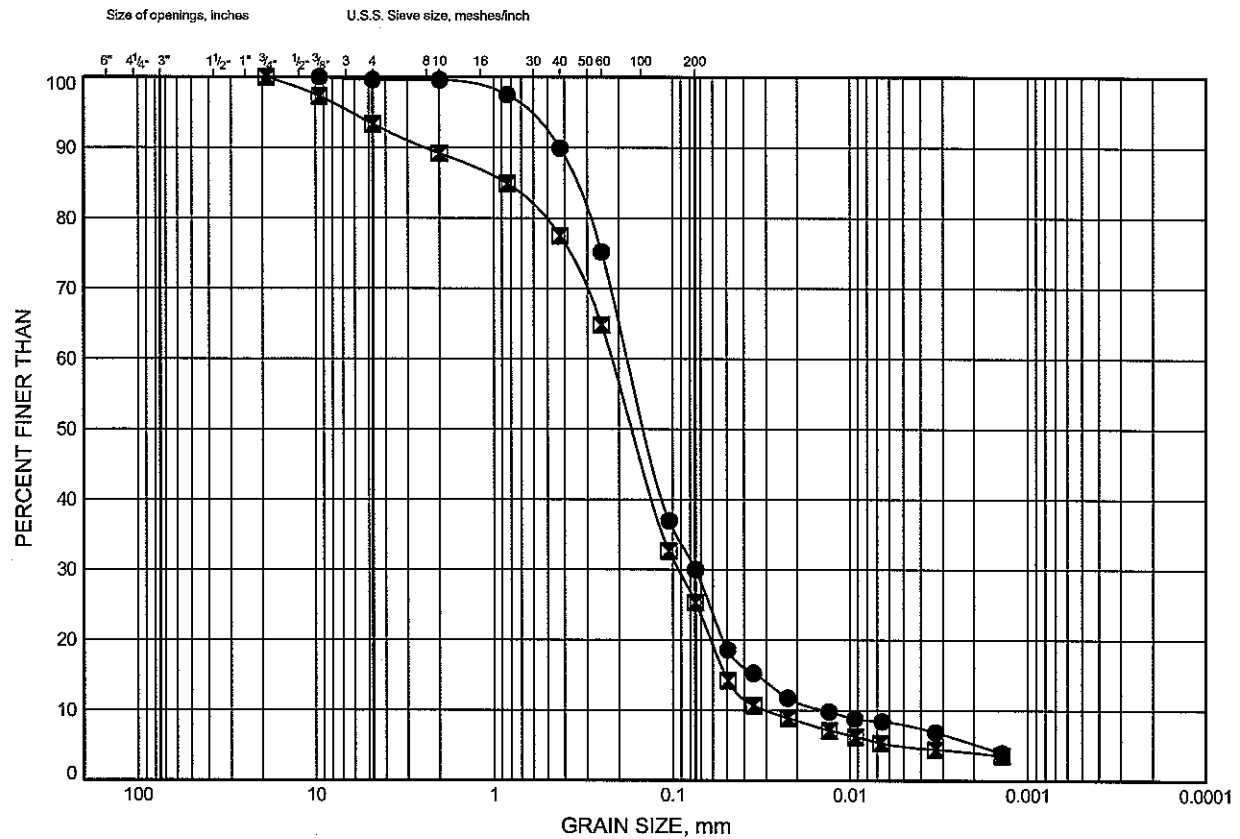
Chkd.MP.....



GRAIN SIZE DISTRIBUTION

FIGURE B4-2

FILL - Silty Sand



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	MRW1	1.0	179.4
⊠	MRW2	1.7	179.1

Date August 2010

Project 1-09-4135



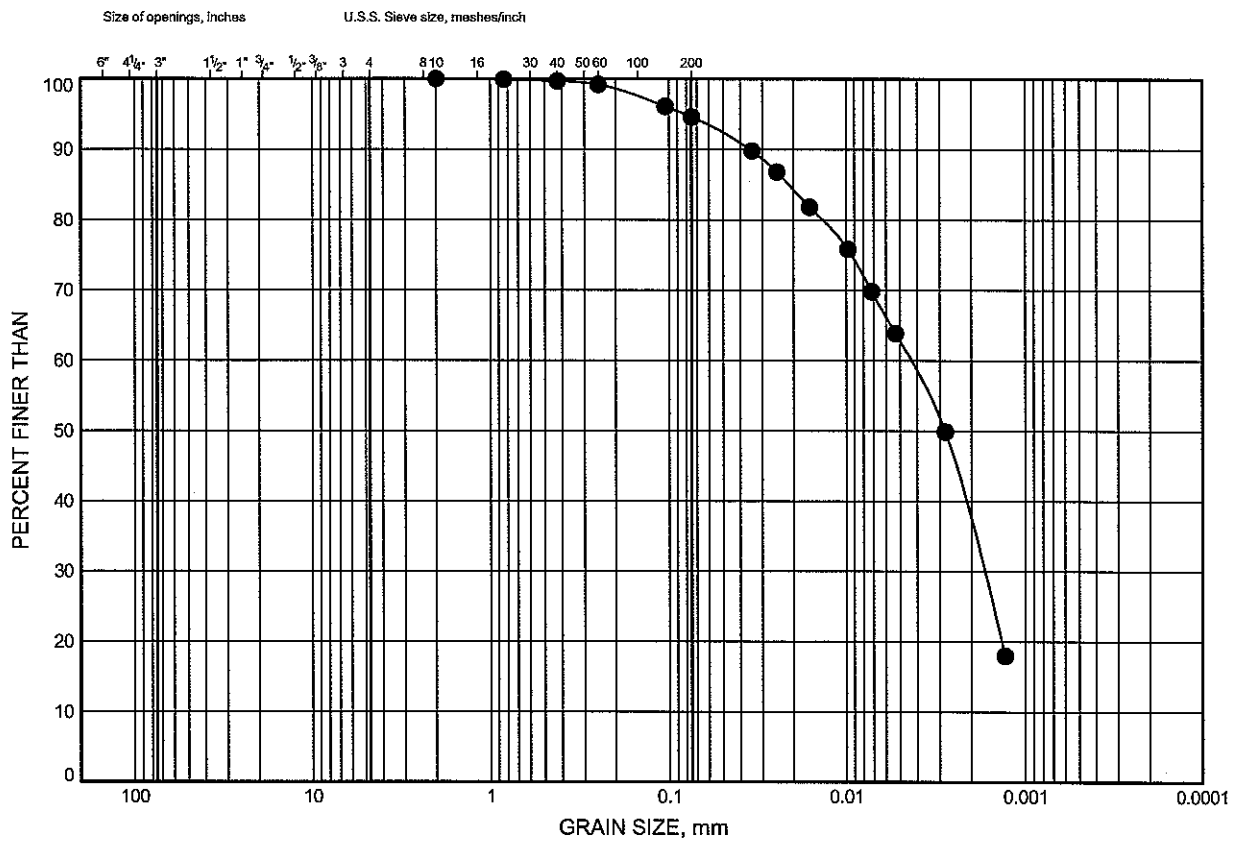
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B4-3

FILL- Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW3	2.5	178.0

Date August 2010.....

Project 1-09-4135....



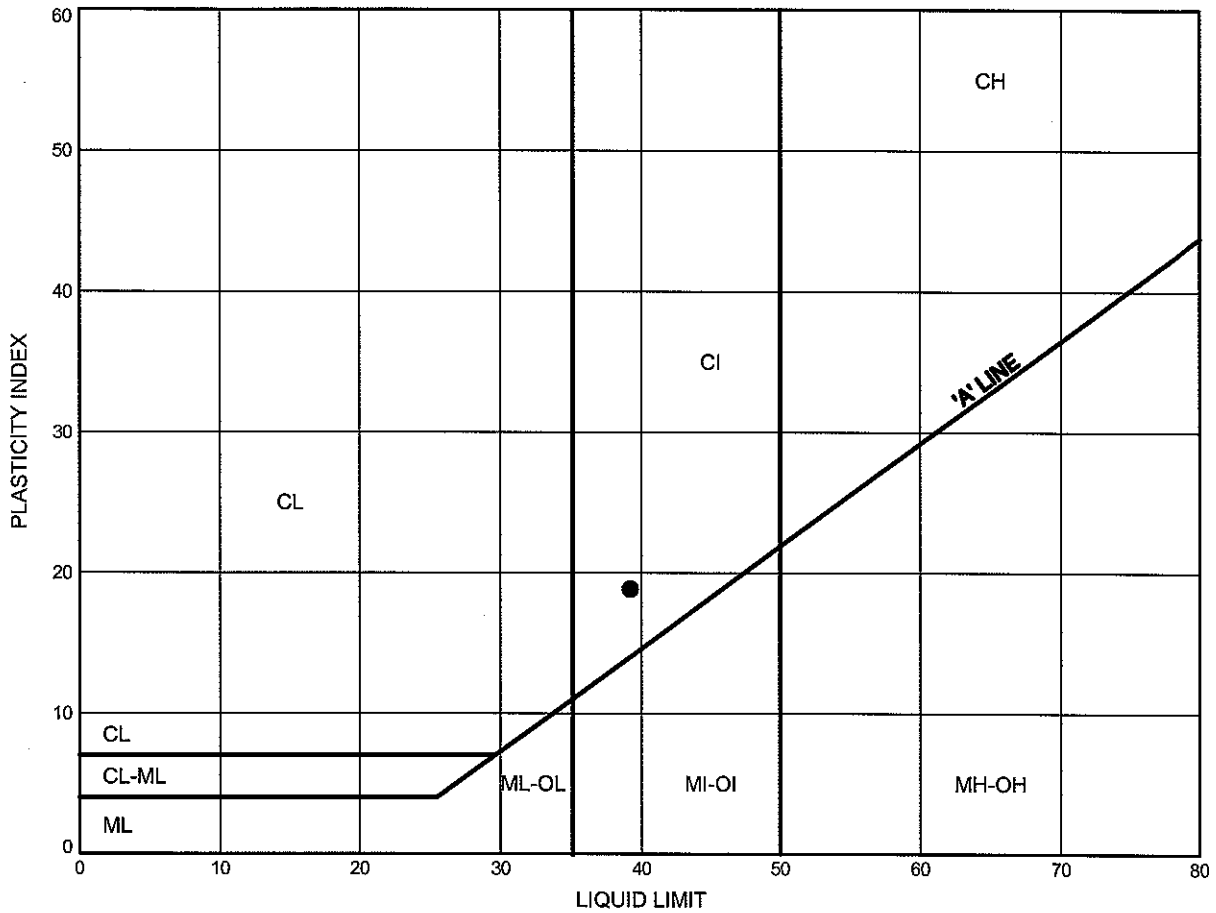
Prep'd JS.....

Chkd. MP.....

ATTERBERG LIMITS TEST RESULTS

FIGURE B4-4

FILL - Silty Clay



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW3	2.5	178.0

Date August 2010.....

Project 1-09-4135.....



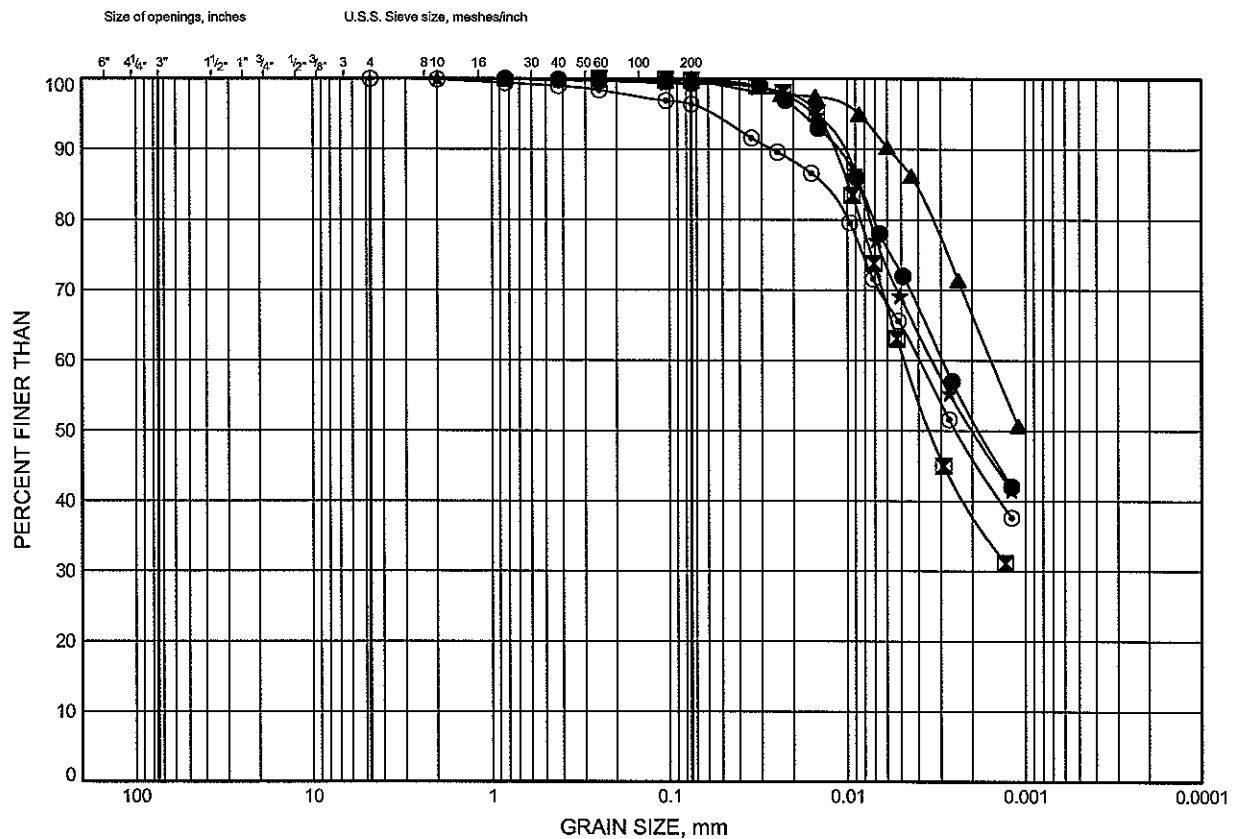
Prep'd JS.....

Chkd. MP.....

GRAIN SIZE DISTRIBUTION

FIGURE B4-5

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MR 9+850 Rt	1.7	178.1
■	MR 9+850 Rt	4.7	175.1
▲	MR 9+850 Rt	6.3	173.5
★	MRW1	4.7	175.7
⊙	MRW2	3.2	177.6

Date August 2010.....

Project 1-09-4135.....



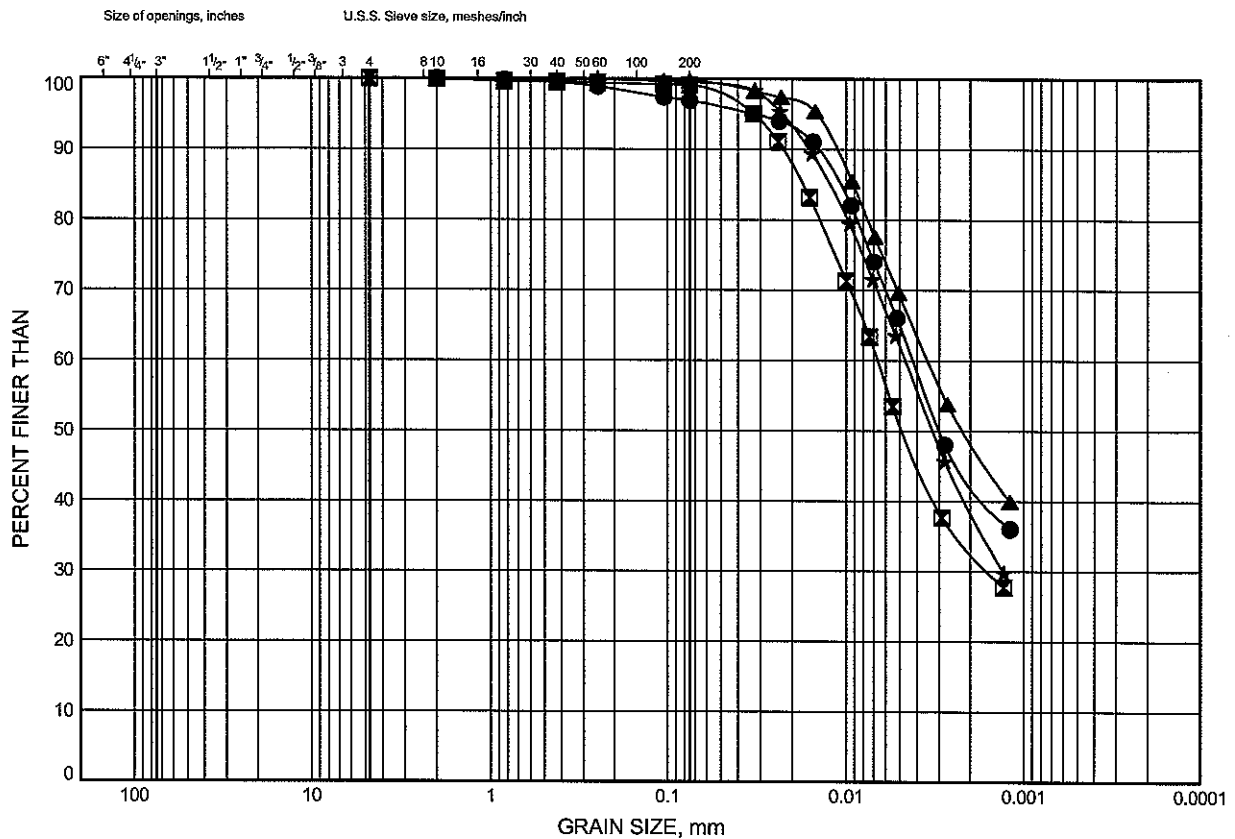
Prep'd JS.....

Chkd. MP.....

GRAIN SIZE DISTRIBUTION

FIGURE B4-6

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW2	4.7	176.1
■	MRW2	7.8	173.0
▲	MRW3	4.7	175.8
★	MRW3	7.8	172.7

Date August 2010

Project 1-09-4135



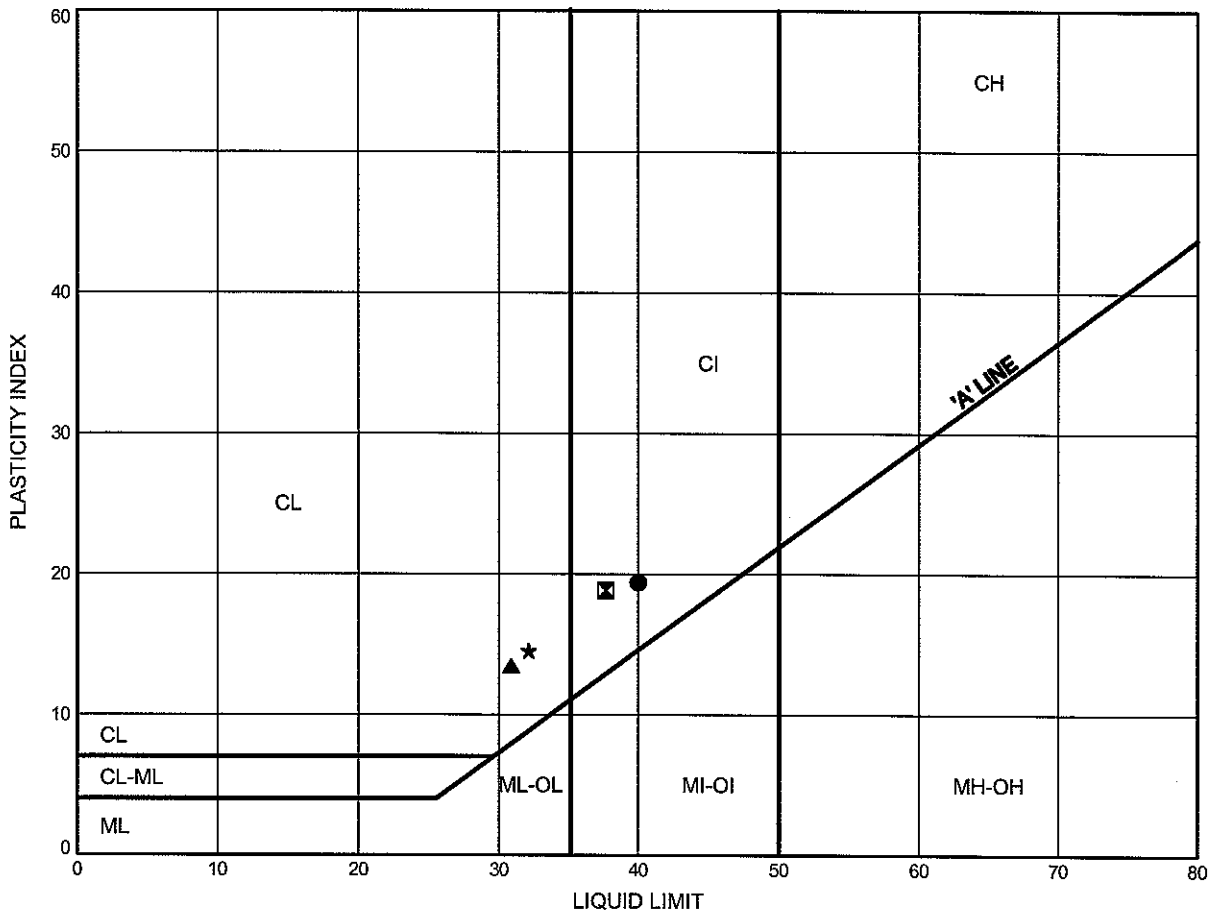
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B4-8

SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW2	3.2	177.6
⊠	MRW2	4.7	176.1
▲	MRW2	7.8	173.0
★	MRW3	7.8	172.7

Date August 2010

Project 1-09-4135



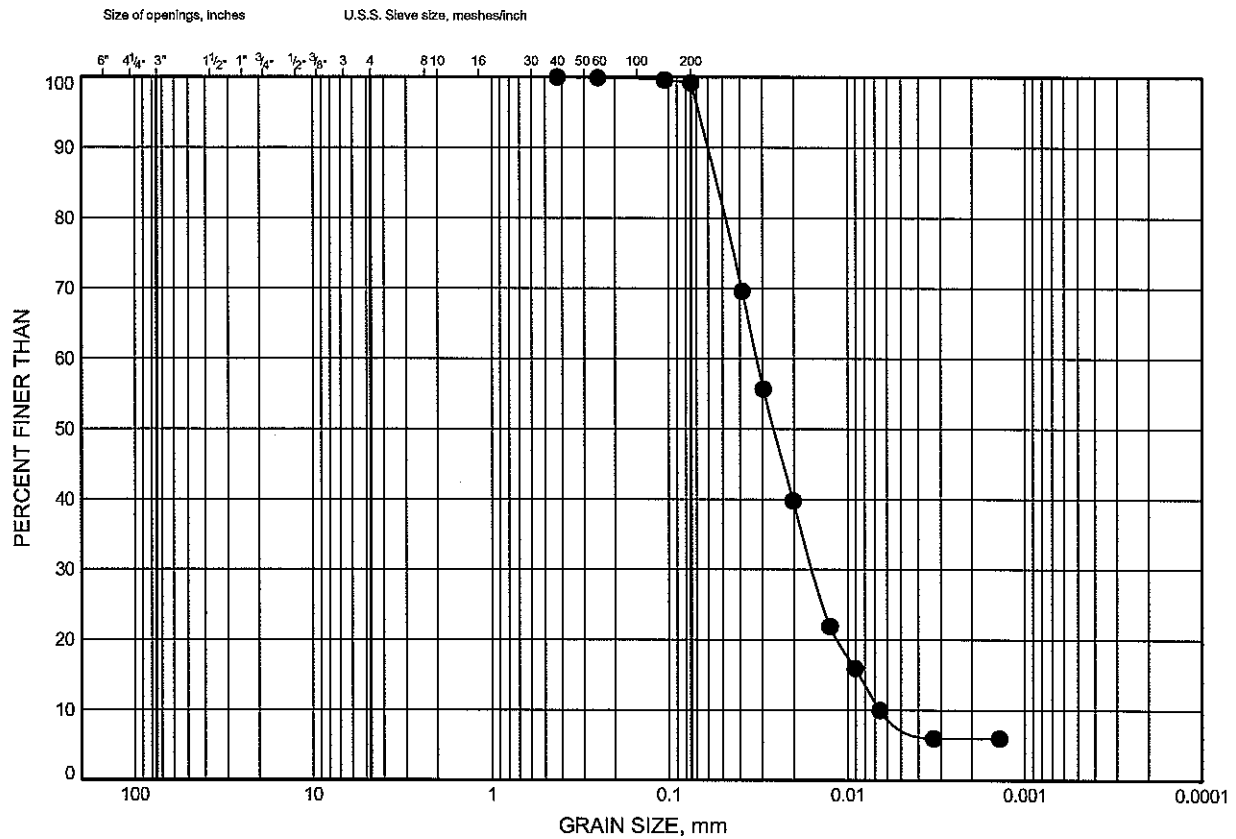
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B4-9

SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW1	10.9	169.5

Date August 2010

Project 1-09-4135



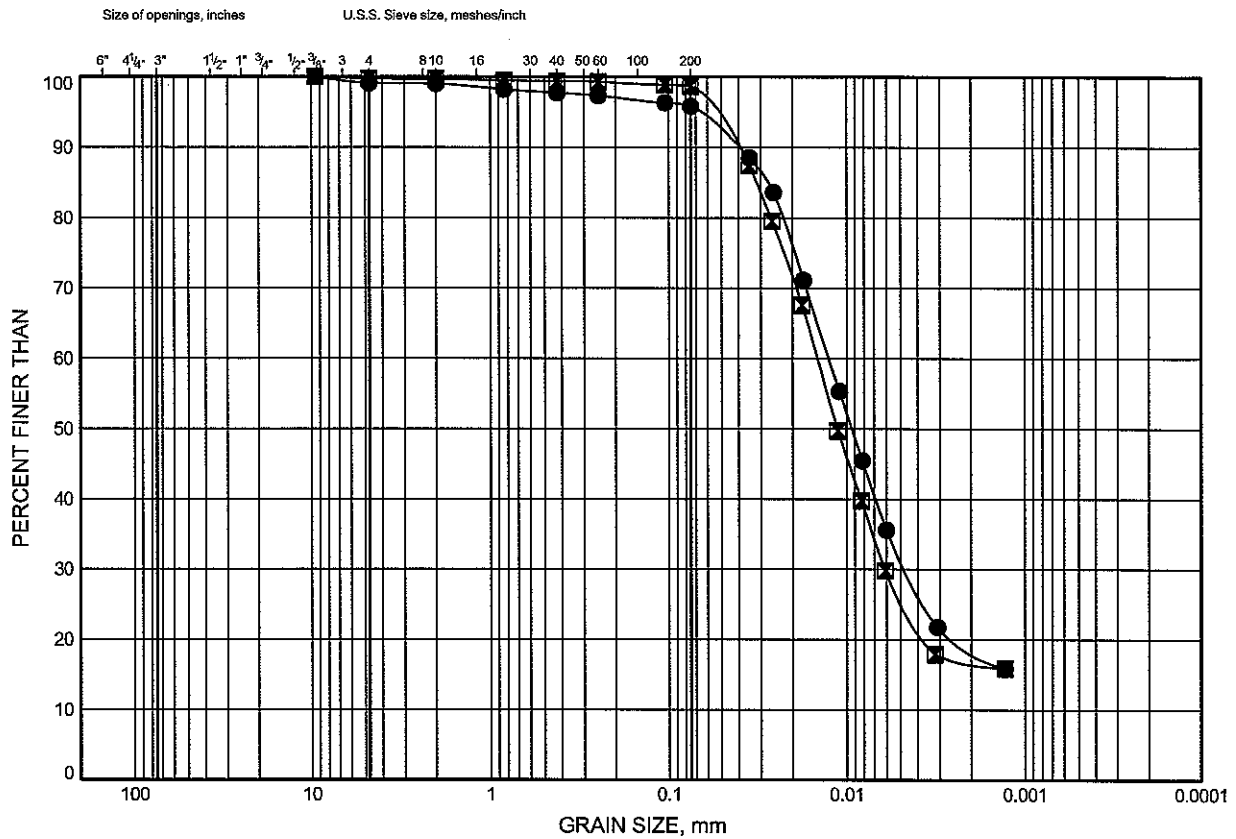
Prep'd JS

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B4-10

SILTY CLAY TO CLAYEY SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	MRW1	13.9	166.5
⊠	MRW2	13.9	166.9

Date August 2010

Project 1-09-4135



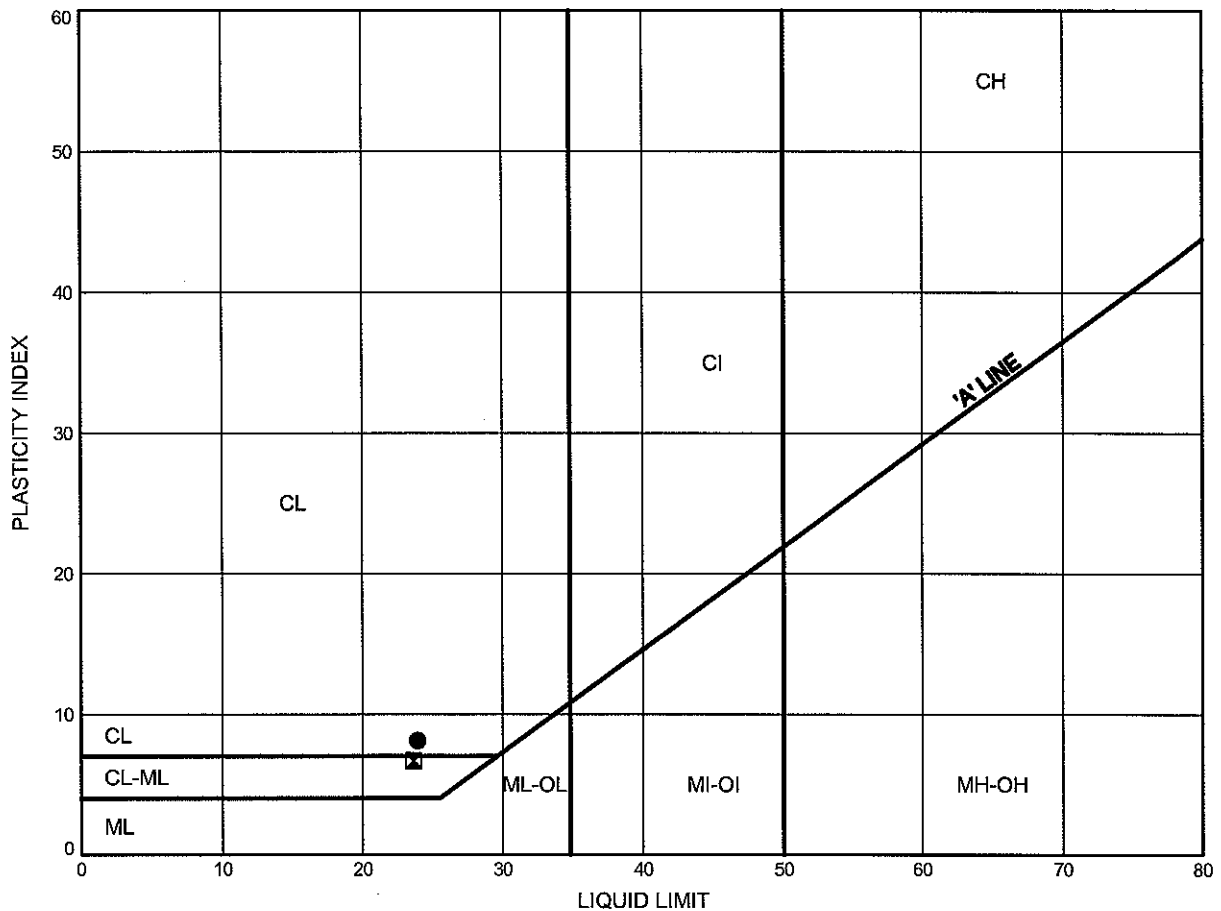
Prep'd JS

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B4-11

SILTY CLAY TO CLAYEY SILT



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	MRW1	13.9	166.5
⊠	MRW2	13.9	166.9

Date August 2010.....

Project 1-09-4135.....



Prep'dJS.....

Chkd.MP.....

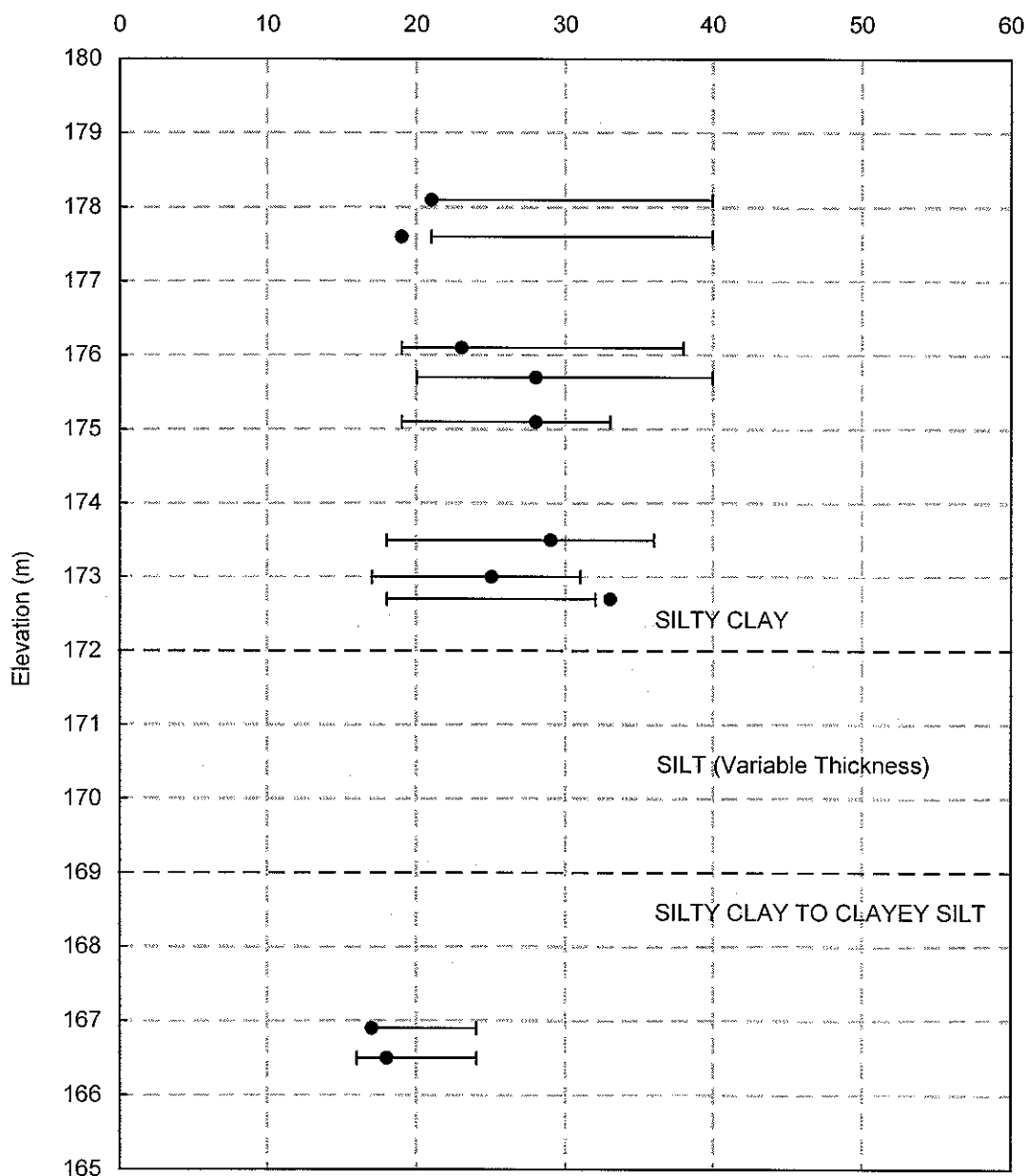
ATTERBERG LIMITS AND WATER CONTENTS

FIGURE B4-12

HWY 406 TWINNING - RETAINING WALL SITE #4

Silty Clay / Silty Clay to Clayey Silt

Atterberg Limits & Water Contents (%)



Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

Prepared By : HW

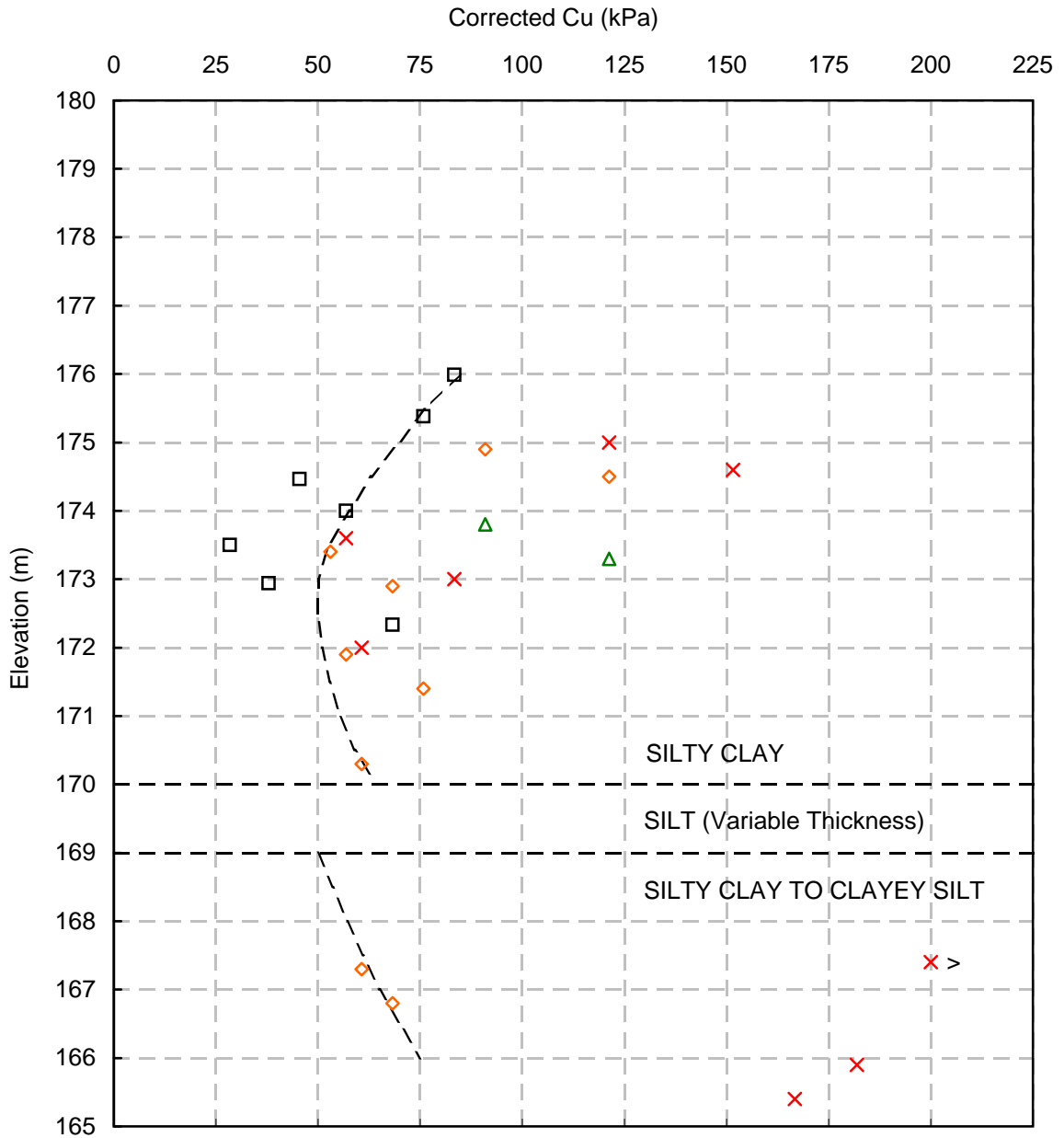
Checked By : RA

CORRECTED UNDRAINED SHEAR STRENGTH

FIGURE B4-13

HWY 406 TWINNING - RETAINING WALL SITE #4

Silty Clay / Silty Clay to Clayey Silt



MR 9+850 RT

MRW1

MRW2

MRW3

Field Shear Vane Correction

Morris & Williams (1994)

$(\mu = 1.18 \text{ EXP}(-0.08 \text{ Ip}) + 0.57)$

Applied Correction Factors

0.83 (Elev.>177m)

0.95 (Elev.<177m)

Project No. : 1-09-4135

Date : November, 2010



Terraprobe Inc.

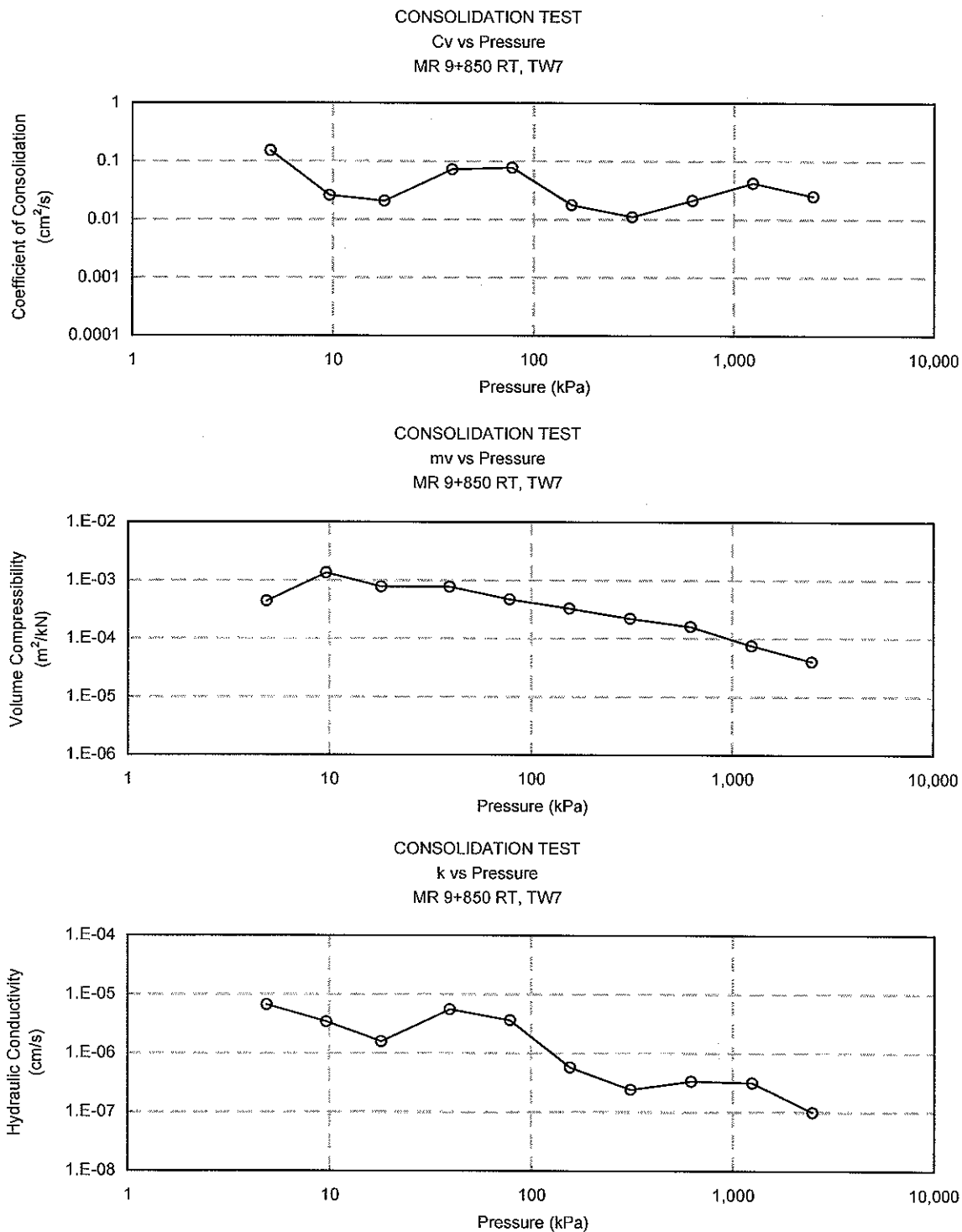
Prepared By : HW

Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #4

FIGURE B4-14

C:\Documents and Settings\Admin\My Documents\Marc P\Projects 2009\Hwy 406 Expansion\1-09-4135 (Hwy 406 Foundations)\Culverts and Retaining Walls\Retaining Walls\Lab Results\1-09-4135R5 Consolidation Results.xls



Project No. : 1-09-4135
Date : November 2010



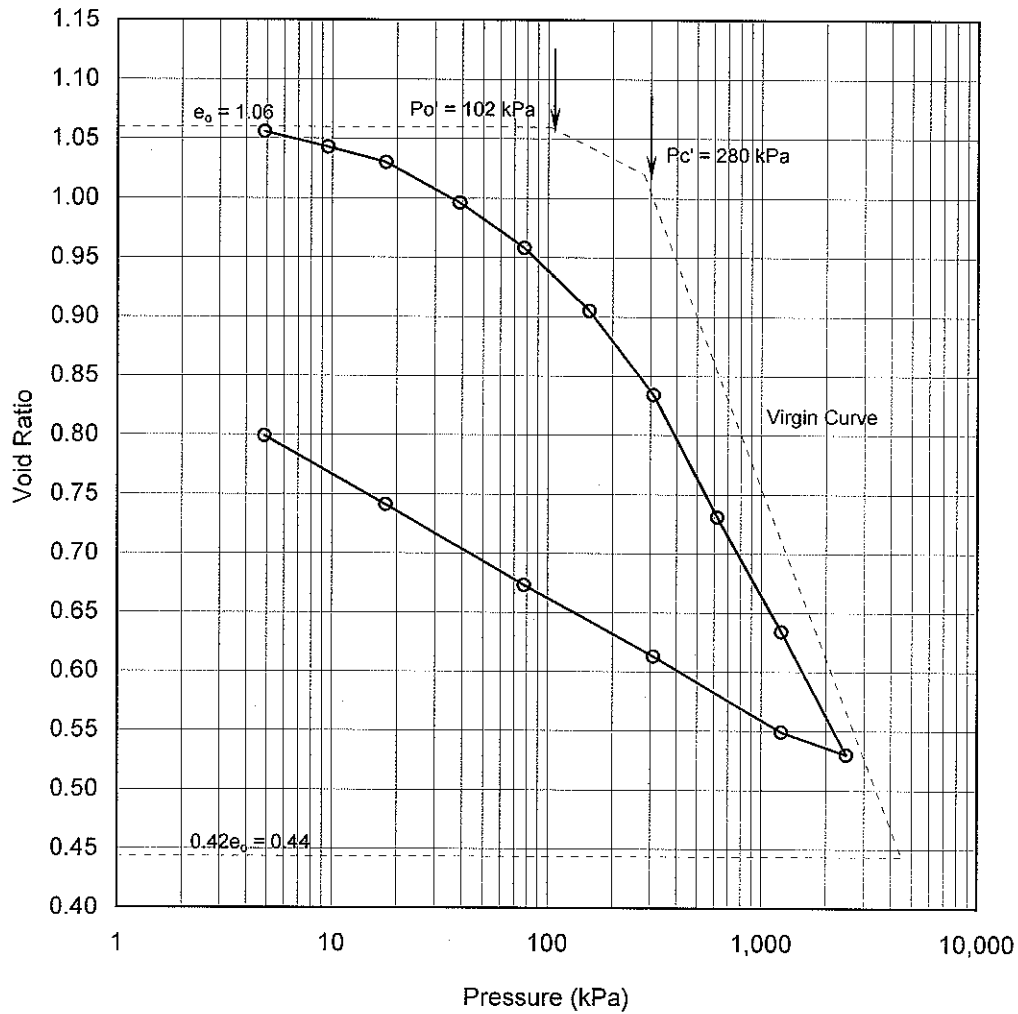
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

MR 9+850 RT, TW7



Soil Type : Silty Clay

$e_0 =$	1.06	$\omega_L =$	36%	$P_0' =$	102 kPa
$\omega =$	29%	$\omega_P =$	18%	$P_c' =$	280 kPa
$\gamma =$	18.3 kN/m ³	PI =	18%	Cc =	0.478
Gs =	2.78			Cr =	0.091

Project No. : 1-09-4135
Date : November 2010



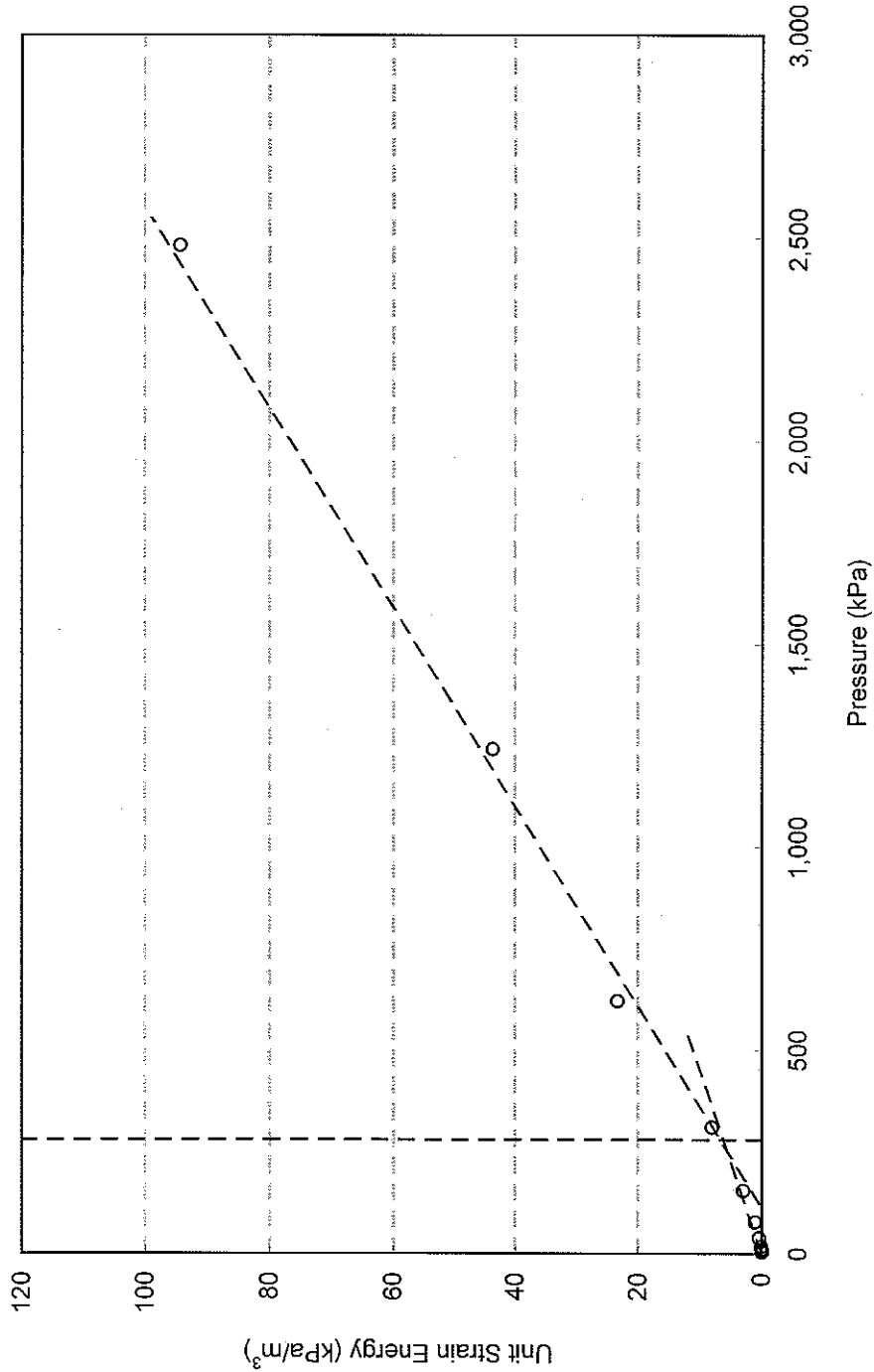
Terraprobe Inc.

Prepared By : HW
Checked By : RA

HWY 406 TWINNING - RETAINING WALL SITE #4

FIGURE B4-16

CONSOLIDATION TEST
Unit Strain Energy vs Pressure
MR 9+850 RT, TW7



Project No. : 1-09-4135

Date : November 2010



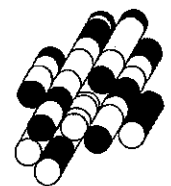
Terraprobe Inc.

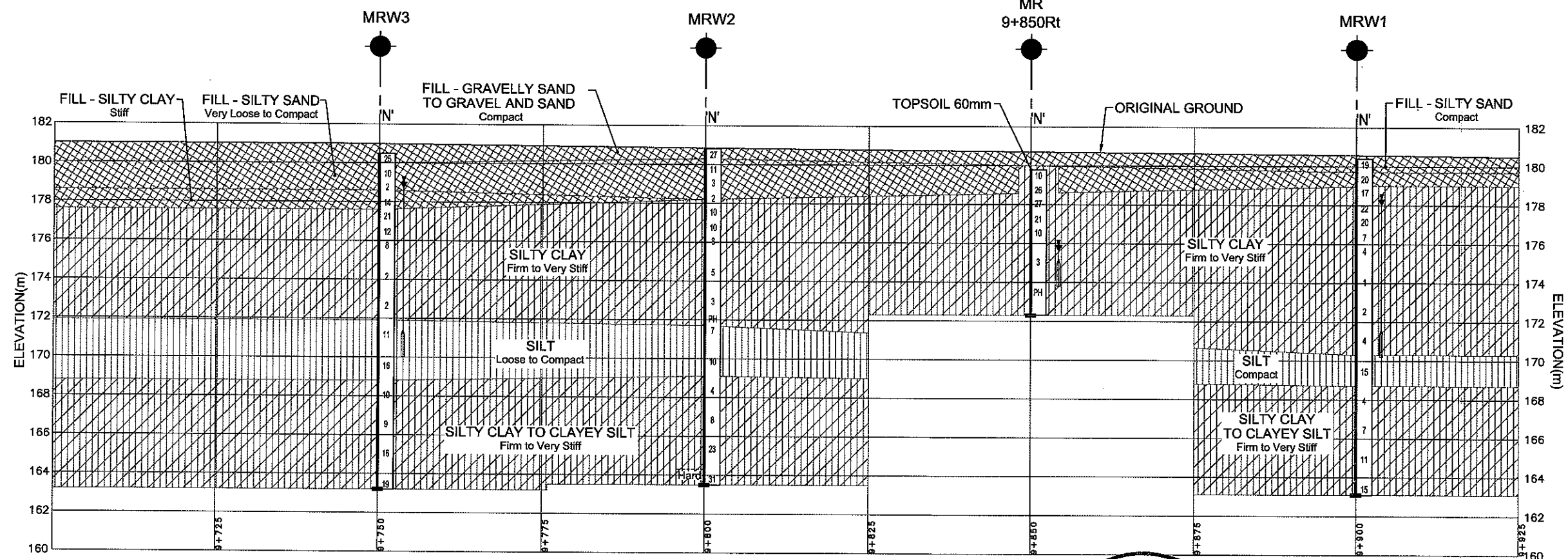
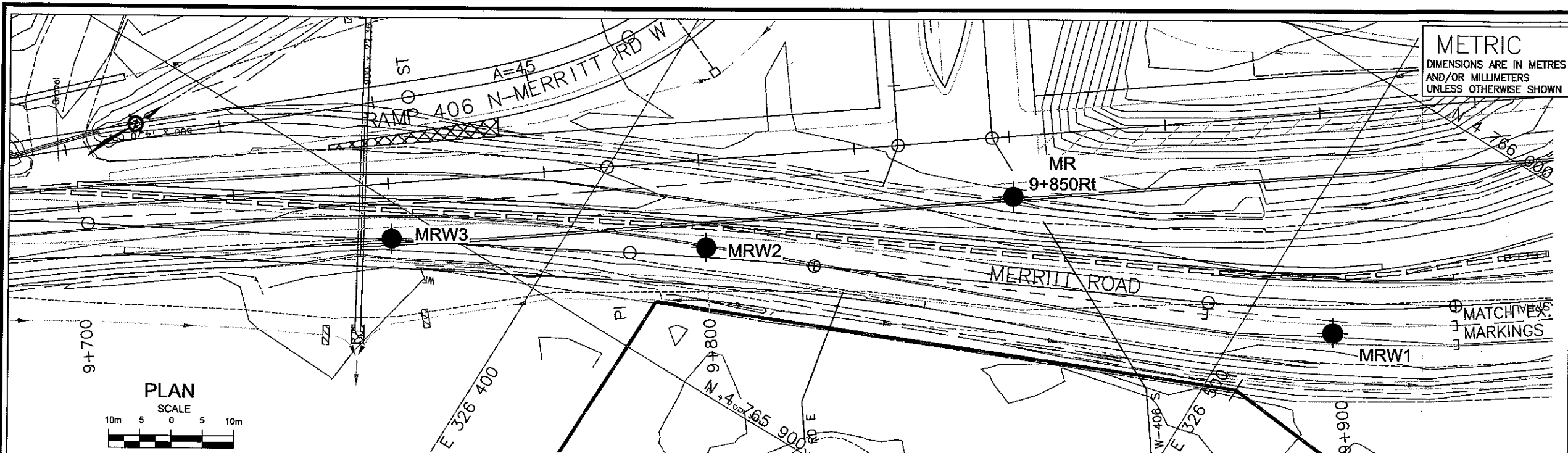
Prepared By : HW

Checked By : RA

C4

TERRAPROBE INC.





Q PROFILE MERRITT ROAD ALIGNMENT

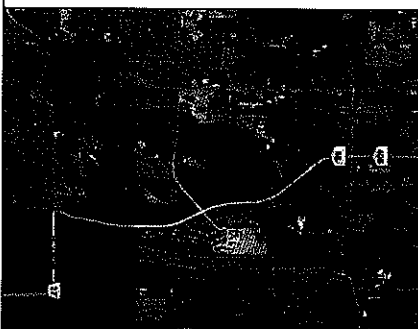
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No 2011-2005
WP No 280-99-00

HIGHWAY 406
MERRITT RD TEMPORARY RETAINING WALL
BOREHOLE LOCATIONS AND SOIL STRATA

IBI
GROUP

Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing
10 Bram Court - Brampton Ontario L6W 3R6 (905) 796-2650



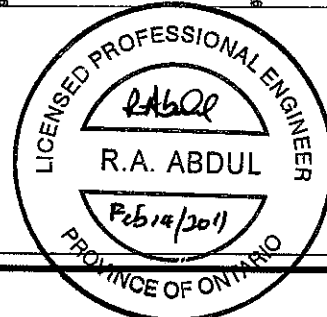
KEY PLAN

- LEGEND
- Bore Hole
 - ⊕ Dynamic Cone Penetration Test
 - ⊕ Bore Hole And 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
 - ≡ WL in Piezometer (AUG. 2010)
 - ≡ Piezometer
 - 90% Rock Quality Designation
 - A/R Auger Refusal

No	ELEV.	COORDINATES	
		NORTHING	EASTING
MR 9+850Rt	179.8	4 765 953.0	326 458.1
MRW1	180.4	4 765 961.0	326 513.2
MRW2	180.8	4 765 920.3	326 420.3
MRW3	180.5	4 765 895.0	326 376.6

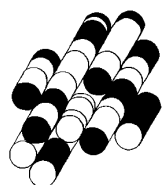
NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN R.A.	CODE CHBDC2008	LOAD	DATE FEB. 2011
DRAWN K.C.	CHK R.A.	STRUCT	GEORES 30M3-266



APPENDIX D

TERRAPROBE INC.



Terraprobe

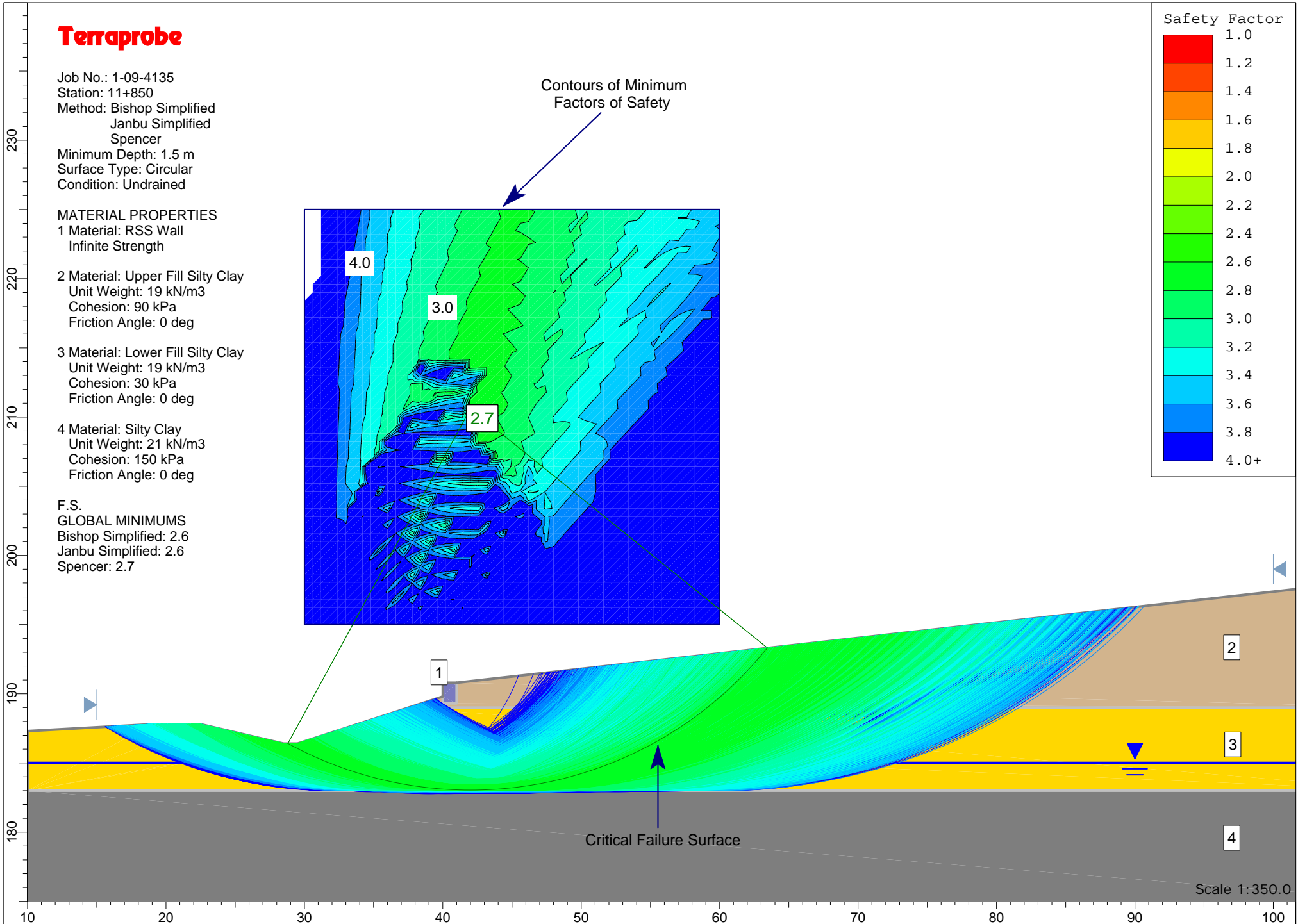
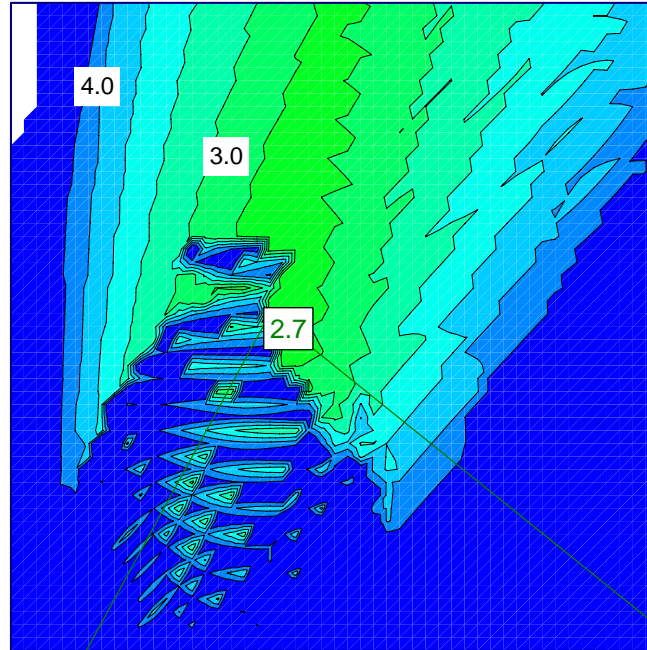
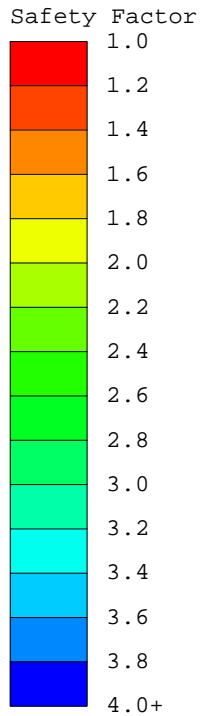
Job No.: 1-09-4135
Station: 11+850
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Undrained

MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 90 kPa
Friction Angle: 0 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 30 kPa
Friction Angle: 0 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 150 kPa
Friction Angle: 0 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 2.6
Janbu Simplified: 2.6
Spencer: 2.7

Contours of Minimum
Factors of Safety



Terraprobe

Job No.: 1-09-4135
Station: 11+850
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Drained

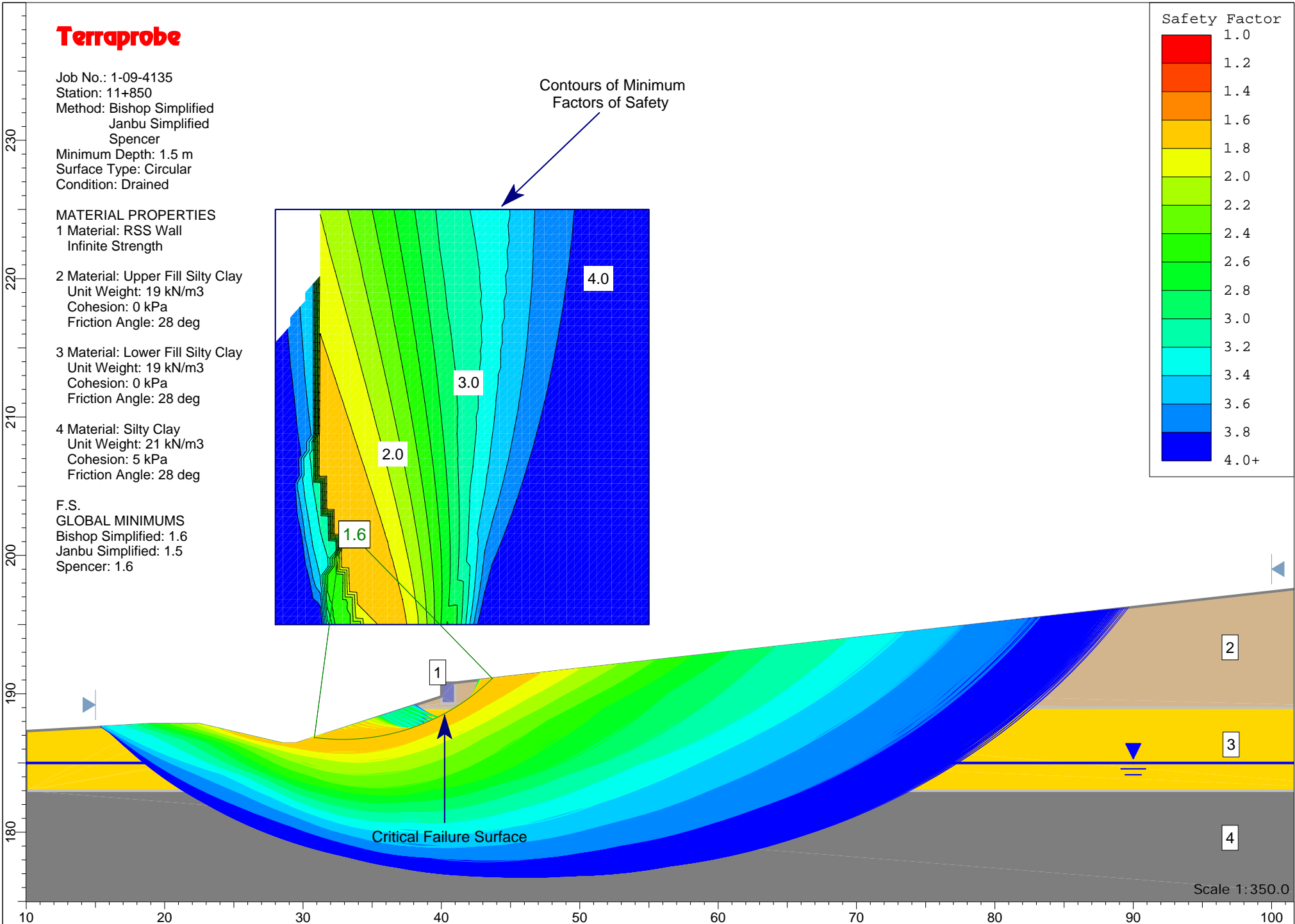
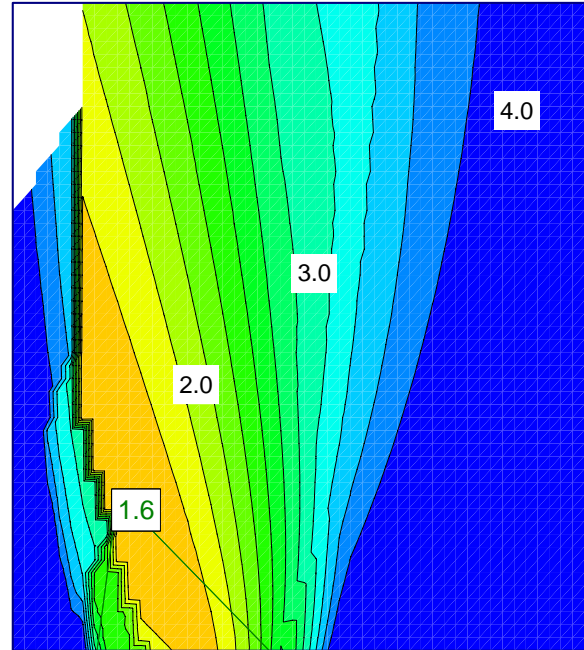
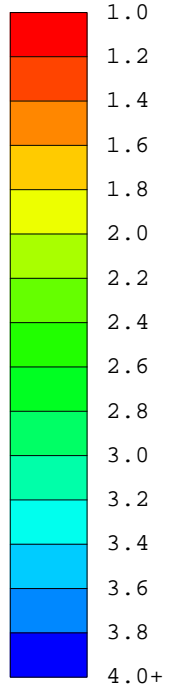
MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 1.6
Janbu Simplified: 1.5
Spencer: 1.6

Contours of Minimum
Factors of Safety

Safety Factor



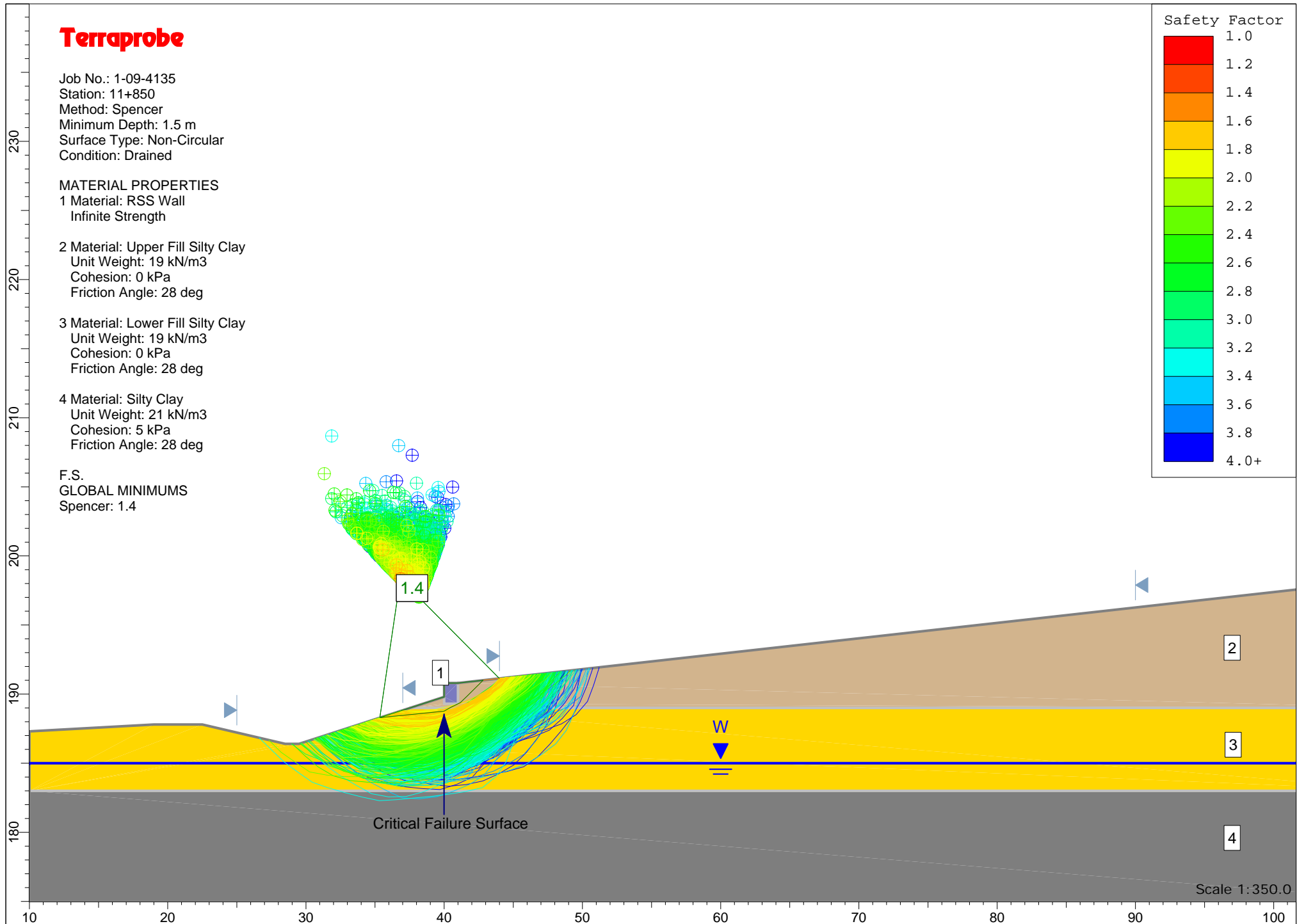
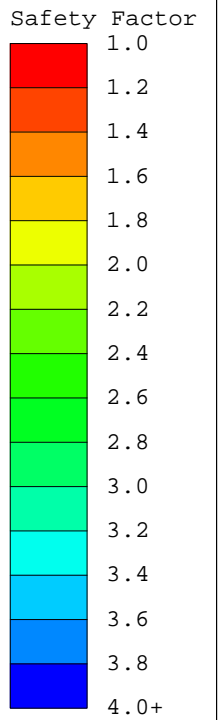
Terraprobe

Job No.: 1-09-4135
Station: 11+850
Method: Spencer
Minimum Depth: 1.5 m
Surface Type: Non-Circular
Condition: Drained

MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Spencer: 1.4



Terraprobe

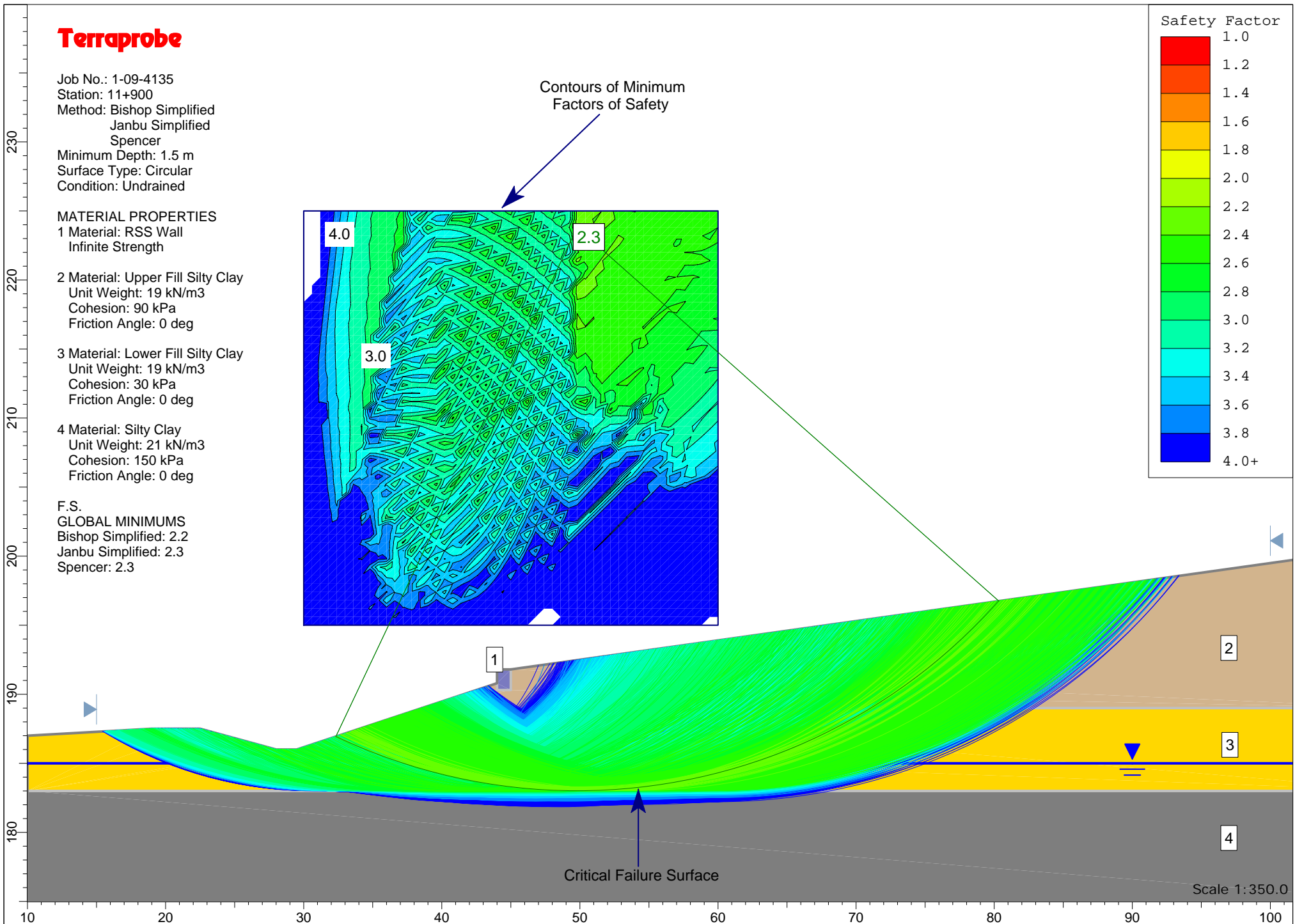
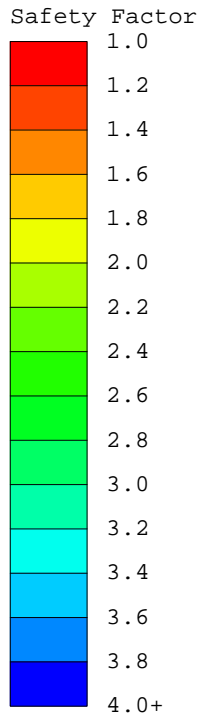
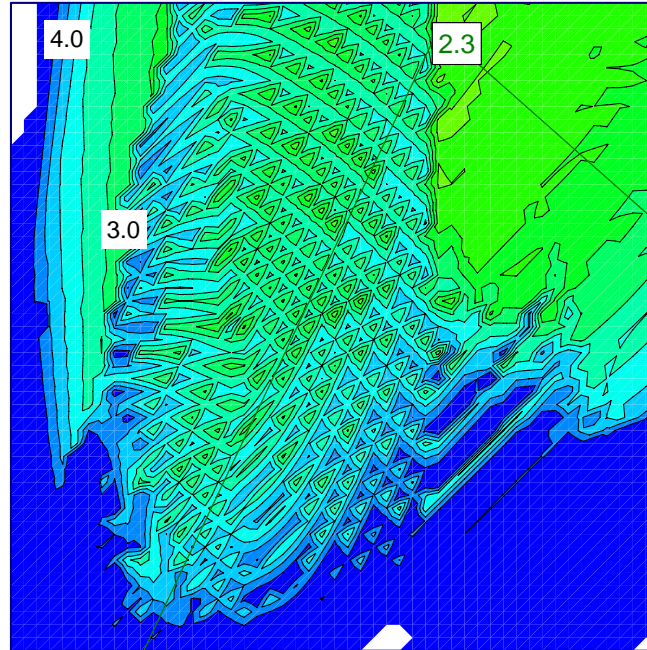
Job No.: 1-09-4135
Station: 11+900
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Undrained

MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 90 kPa
Friction Angle: 0 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 30 kPa
Friction Angle: 0 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 150 kPa
Friction Angle: 0 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 2.2
Janbu Simplified: 2.3
Spencer: 2.3

Contours of Minimum
Factors of Safety



Terraprobe

Job No.: 1-09-4135
Station: 11+900
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Drained

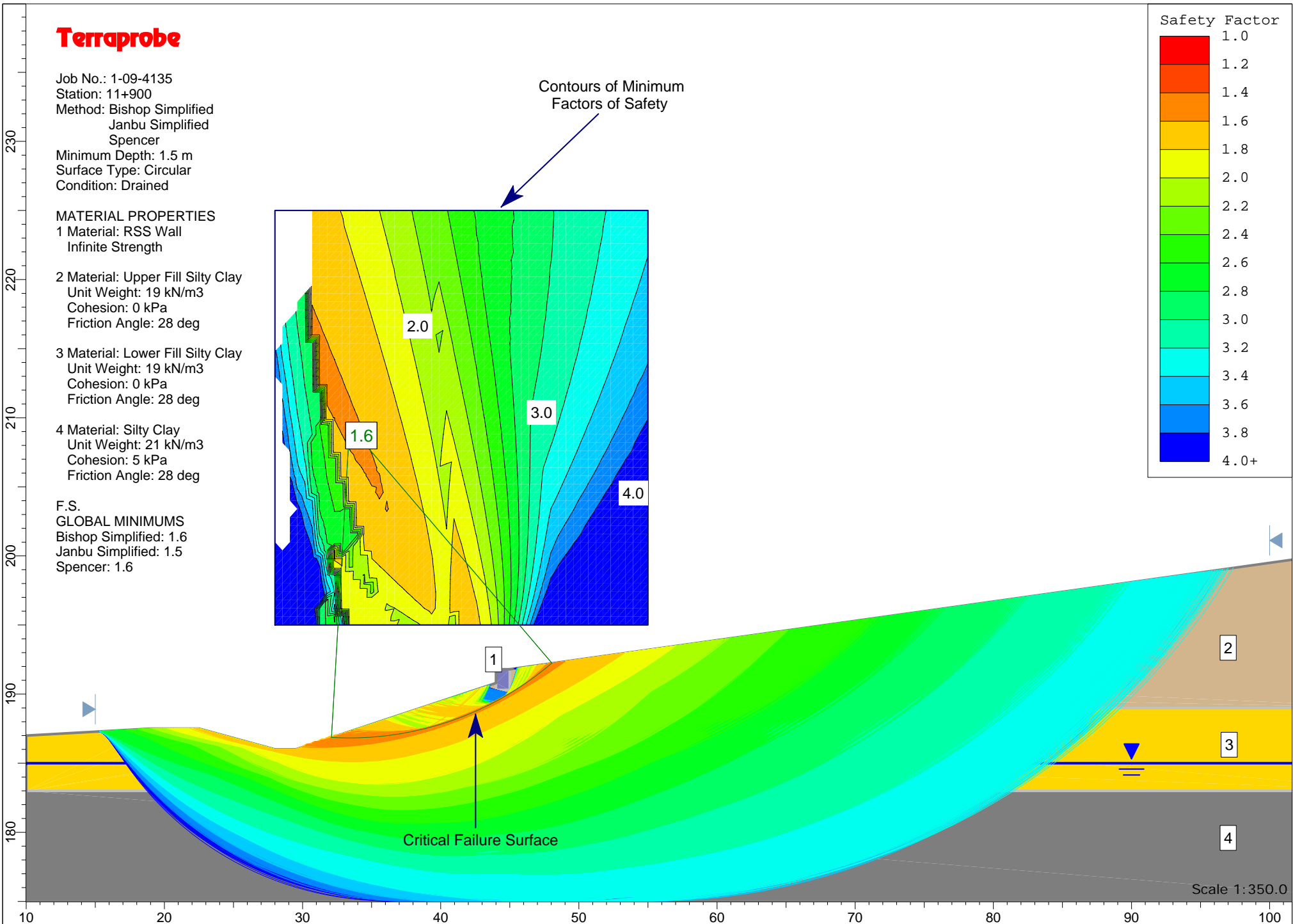
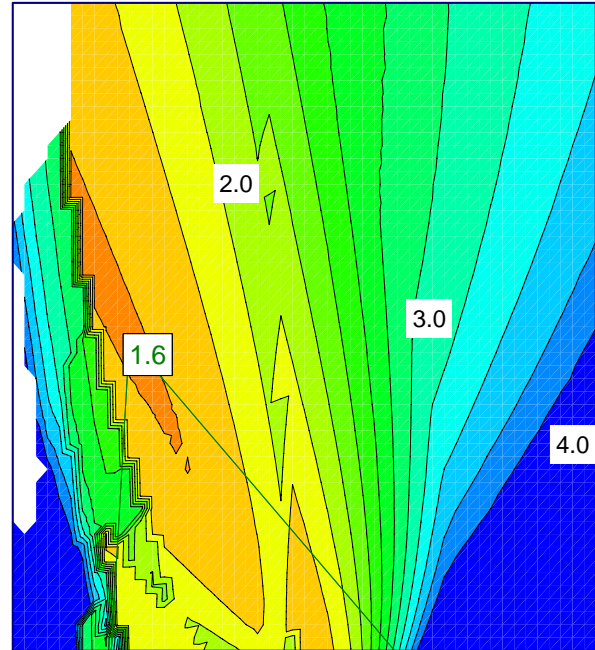
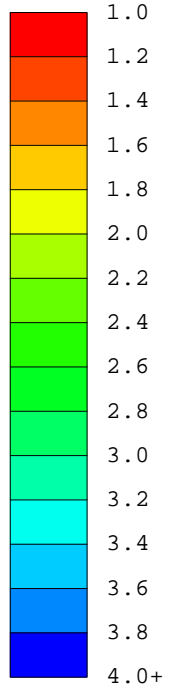
MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 1.6
Janbu Simplified: 1.5
Spencer: 1.6

Contours of Minimum
Factors of Safety

Safety Factor



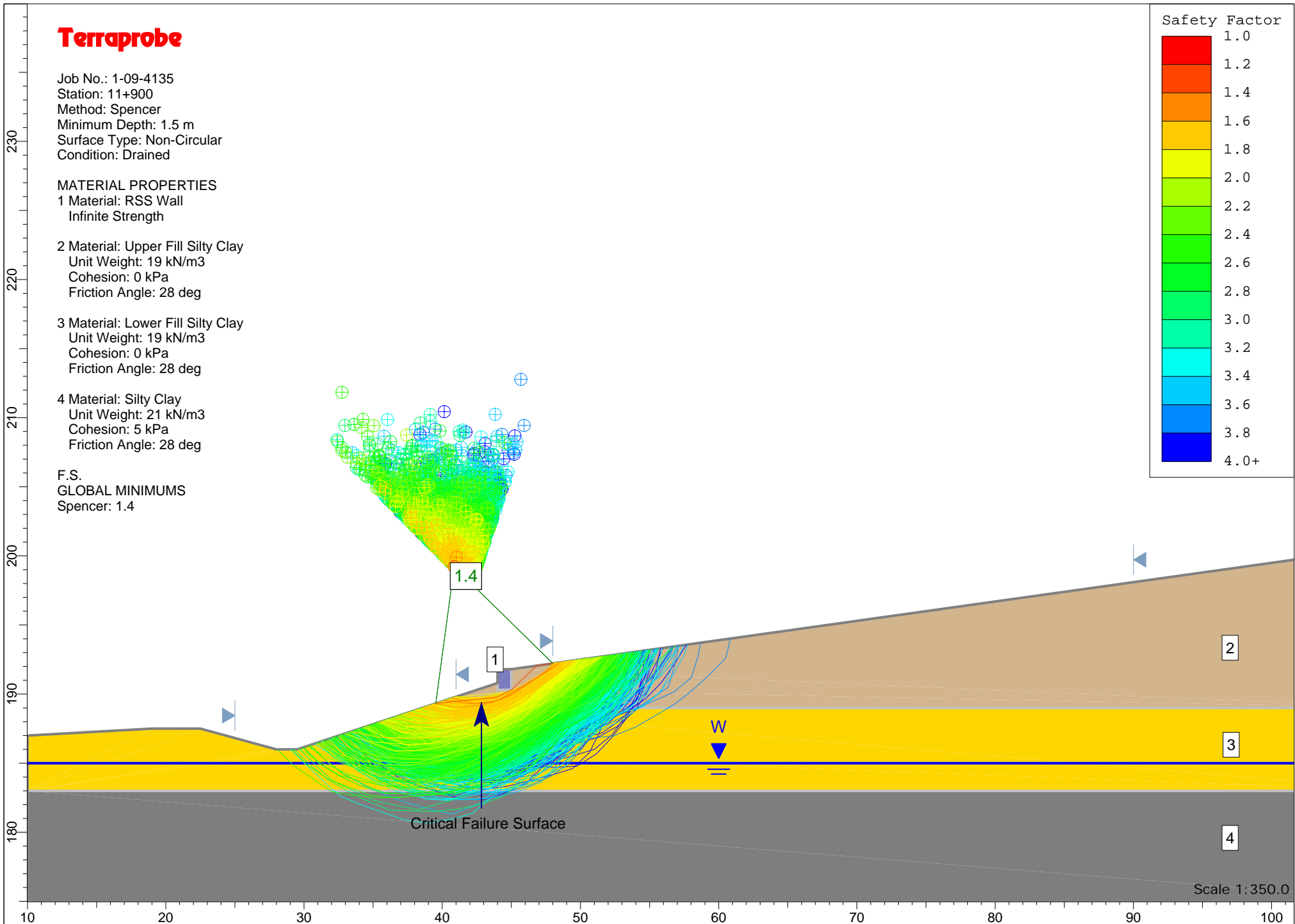
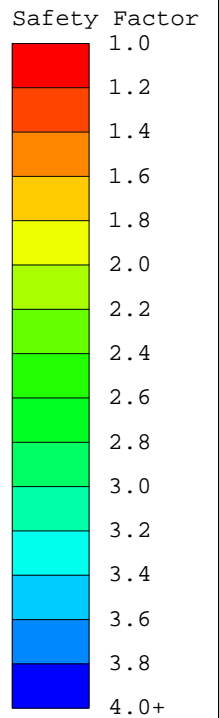
Terraprobe

Job No.: 1-09-4135
Station: 11+900
Method: Spencer
Minimum Depth: 1.5 m
Surface Type: Non-Circular
Condition: Drained

MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Spencer: 1.4



Terraprobe

Job No.: 1-09-4135
Station: 11+925
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Undrained

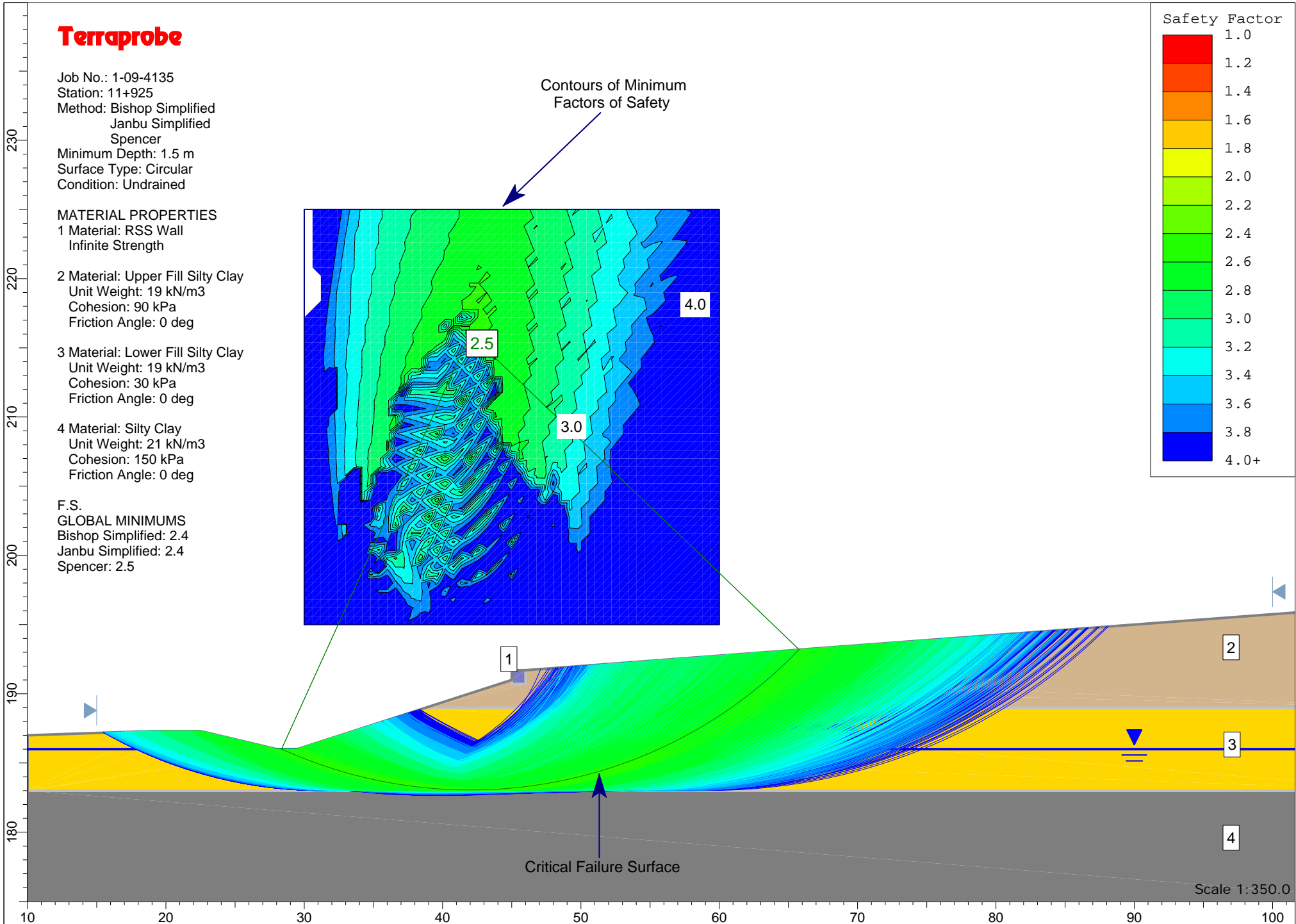
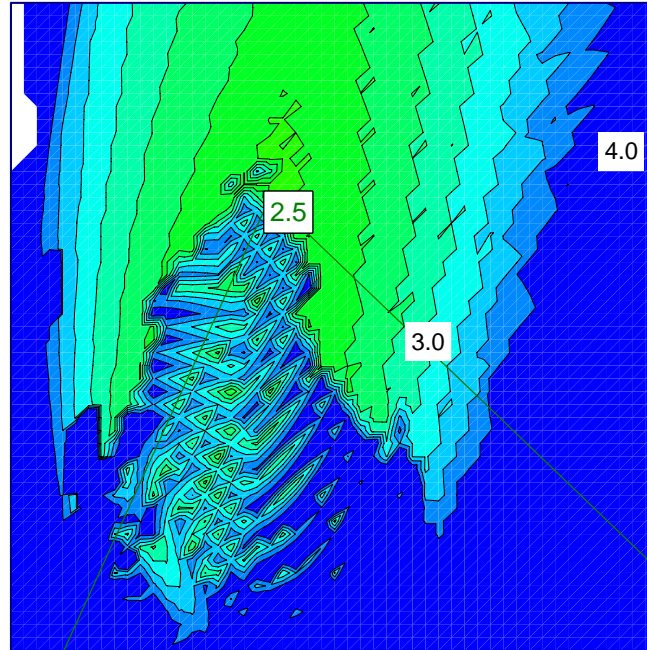
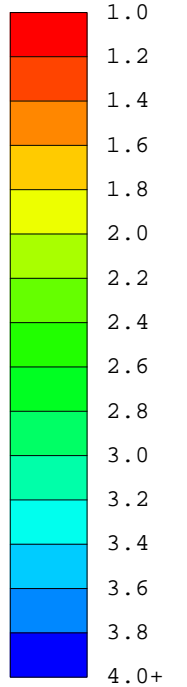
MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 90 kPa
Friction Angle: 0 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 30 kPa
Friction Angle: 0 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 150 kPa
Friction Angle: 0 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 2.4
Janbu Simplified: 2.4
Spencer: 2.5

Contours of Minimum
Factors of Safety

Safety Factor



Terraprobe

Job No.: 1-09-4135
Station: 11+925
Method: Bishop Simplified
Janbu Simplified
Spencer
Minimum Depth: 1.5 m
Surface Type: Circular
Condition: Drained

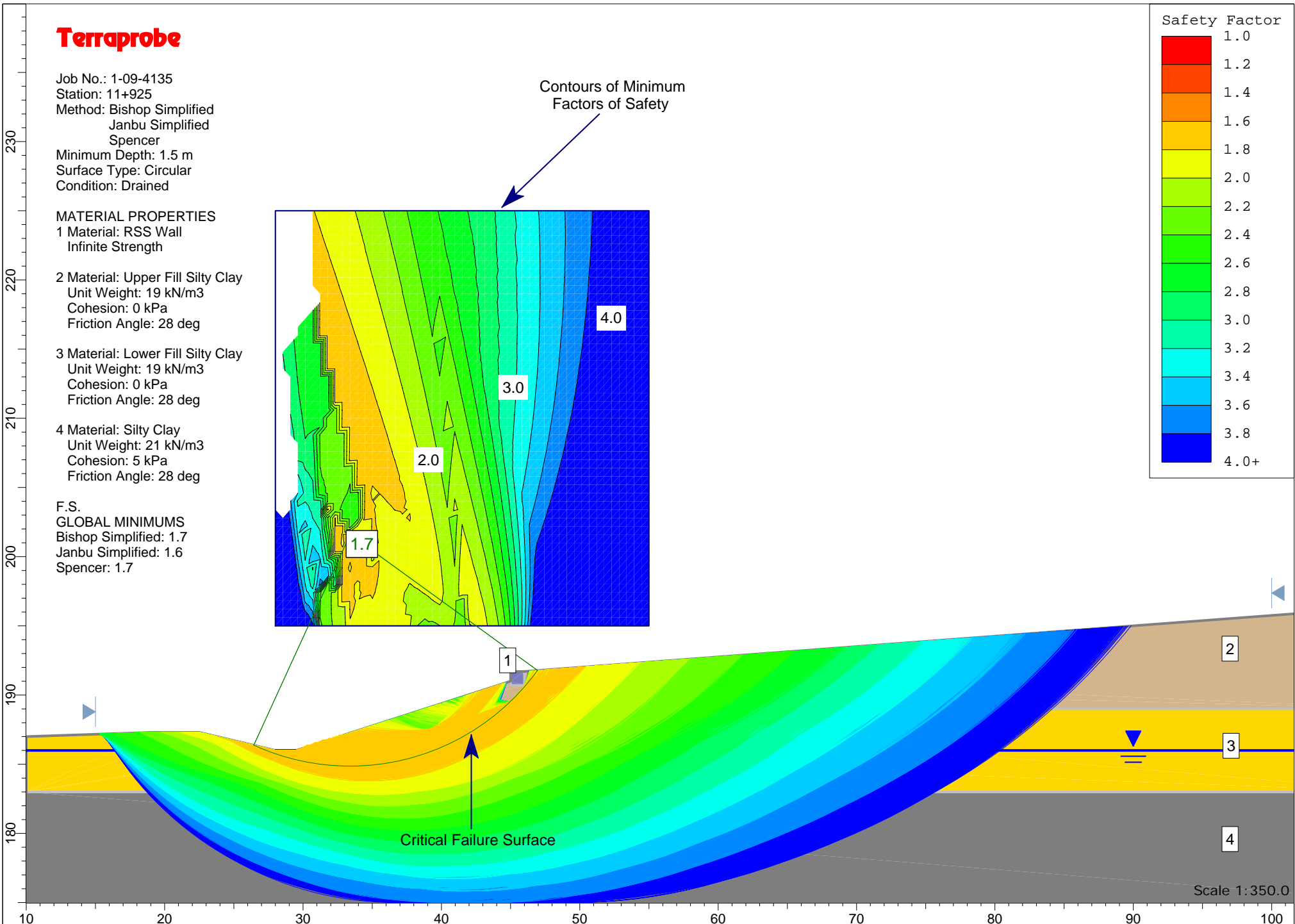
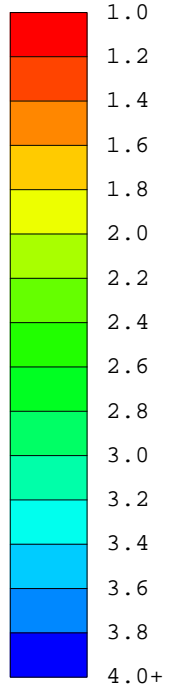
MATERIAL PROPERTIES

- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Bishop Simplified: 1.7
Janbu Simplified: 1.6
Spencer: 1.7

Contours of Minimum
Factors of Safety

Safety Factor



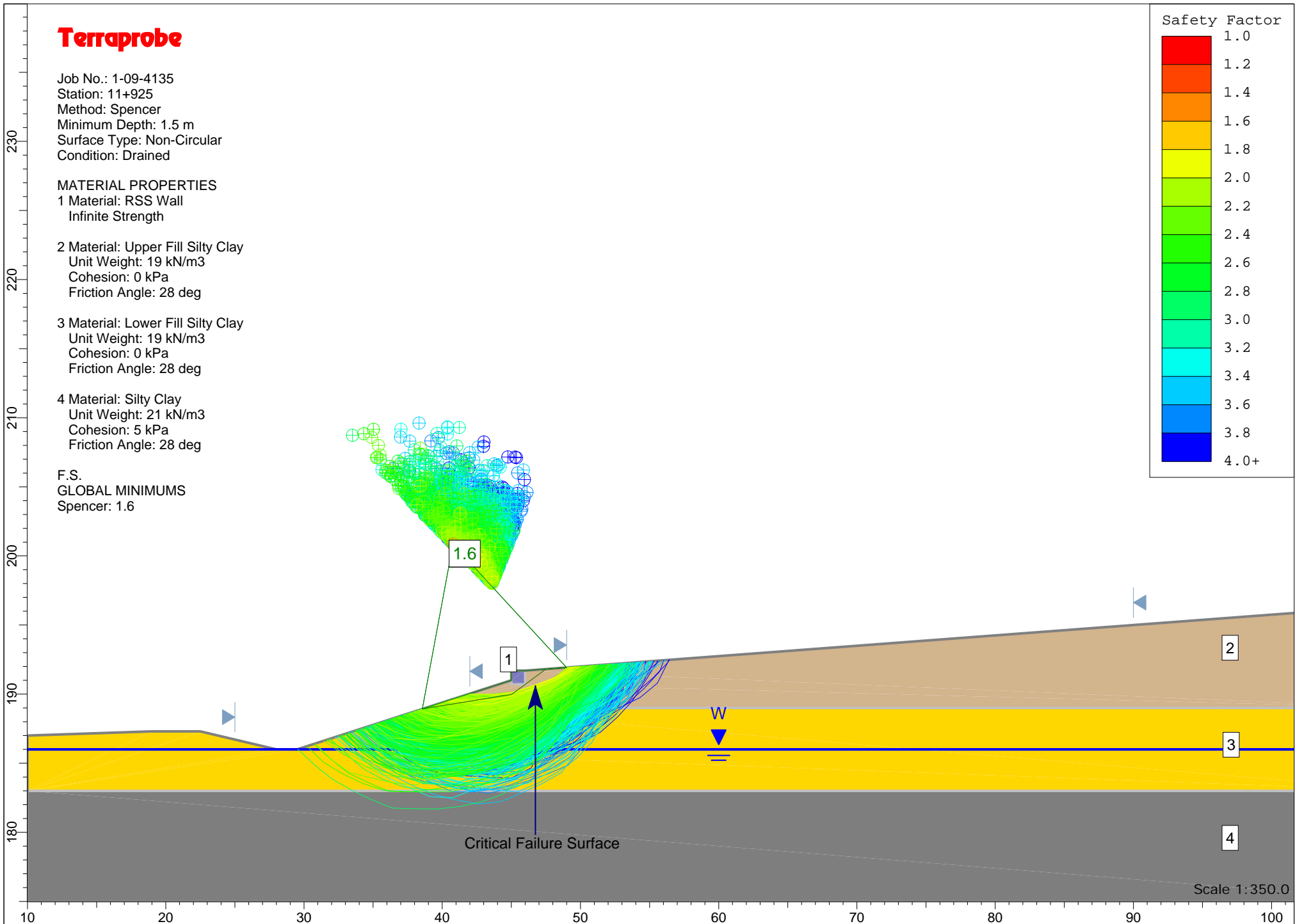
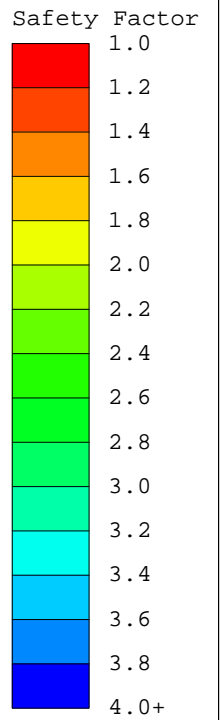
Terraprobe

Job No.: 1-09-4135
Station: 11+925
Method: Spencer
Minimum Depth: 1.5 m
Surface Type: Non-Circular
Condition: Drained

MATERIAL PROPERTIES

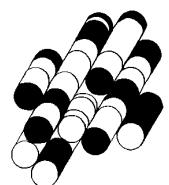
- 1 Material: RSS Wall
Infinite Strength
- 2 Material: Upper Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 3 Material: Lower Fill Silty Clay
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 28 deg
- 4 Material: Silty Clay
Unit Weight: 21 kN/m³
Cohesion: 5 kPa
Friction Angle: 28 deg

F.S.
GLOBAL MINIMUMS
Spencer: 1.6



APPENDIX E

TERRAPROBE INC.



COMPARISON OF RETAINING WALL ALTERNATIVES

SITE 1 Hwy 406 Sta. 11+816 to Sta. 11+947			
Wall Type	Advantages	Disadvantages	Remarks
Gabion Retaining Wall	<ul style="list-style-type: none"> i. Relatively fast construction schedule. ii. Easy to install. iii. Construction equipment and knowledge readily available. iv. Will tolerate more settlement compared to conventional retaining walls. v. Economical for small wall heights. vi. Performance and appearance requirements meet the desired design requirement for this site. 	<ul style="list-style-type: none"> i. None. 	<ul style="list-style-type: none"> i. Recommended for use due to economics, location of installation on slope and ability to tolerate large settlements.
Post and Panel Systems	<ul style="list-style-type: none"> i. Construction equipment and knowledge readily available. ii. More economical than conventional retaining walls. 	<ul style="list-style-type: none"> i. Requires a specialist subcontractor. ii. High level of construction required in order to install wall components (posts, panels and reinforcement). iii. Performance and appearance requirements exceed the desired design requirement for this site. iv. Not economical and practical for small wall heights. 	<ul style="list-style-type: none"> i. Not recommended at this site.
Conventional Retaining Walls	<ul style="list-style-type: none"> i. Construction equipment and knowledge readily available. 	<ul style="list-style-type: none"> i. Performance and appearance characteristics exceed the desired design requirement for this site. ii. Cannot tolerate significant settlement. iii. Not economical and practical at this site due to relatively small wall height and settlement sensitive soils. 	<ul style="list-style-type: none"> i. Not recommended at this site.

* Estimated costs provided by Giffels includes excavation, materials and backfilling.



SITES 2, & 3 Trillium Railway and Woodlawn Road			
Wall Type	Advantages	Disadvantages	Remarks
Retained Soil Systems	<ul style="list-style-type: none"> i. Relatively fast construction schedule. ii. Easy to install iii. Construction equipment and knowledge readily available. iv. More economical than conventional retaining walls and soldier pile and lagging walls. v. Allows for seamless integration with false abutment RSS at structure locations. vi. Performance and appearance requirements meet the desired design requirement for this site. vii. Can accommodate large settlements by using a two-stage system. 	<ul style="list-style-type: none"> i. Requires specialist subcontractor. ii. Requires a two-stage system because of settlement sensitive soils. 	<ul style="list-style-type: none"> i. Recommended for use due to economics, location of installation and ability to tolerate large settlements.
Post and Panel Systems	<ul style="list-style-type: none"> i. Relatively easy to construct. ii. Construction equipment and knowledge readily available. iii. More economical than conventional retaining walls. iv. Performance and appearance requirements meet the desired design requirement for this site. 	<ul style="list-style-type: none"> i. Requires specialist subcontractor. ii. Cannot be seamlessly integrated with the false abutment RSS at structure locations. iii. Not practical at this site due to settlement sensitive soils. 	<ul style="list-style-type: none"> i. Not recommended at this site.
Conventional Retaining Walls	<ul style="list-style-type: none"> i. Construction equipment and knowledge readily available. ii. Performance and appearance requirements meet the desired design requirement for this site. 	<ul style="list-style-type: none"> i. Most expensive option. ii. Relatively more construction effort required compared to other options. iii. Cannot be seamlessly integrated with the false abutment RSS at structure locations. iv. Soils at this site are settlement sensitive and this structure cannot tolerate significant settlements. 	<ul style="list-style-type: none"> i. Not recommended at this site.



SITE 4 – Merritt Road			
Wall Type	Advantages	Disadvantages	Remarks
Retained Soil Systems	<ul style="list-style-type: none"> i. Relatively fast construction schedule. ii. Easy to install iii. Construction equipment and knowledge readily available. iv. Performance and appearance requirements meet the desired design requirement for this site. v. More economical than conventional retaining walls. 	<ul style="list-style-type: none"> i. Requires specialist subcontractor. 	<ul style="list-style-type: none"> i. Recommended for use due to economics, location of installation and ability to tolerate large settlements.
Post and Panel Systems	<ul style="list-style-type: none"> i. Minimal construction space required for installation. ii. Relatively easy to construct. iii. Construction equipment and knowledge readily available. iv. More economical than conventional retaining walls. 	<ul style="list-style-type: none"> i. Performance and appearance requirements exceed the desired design requirement for this site. ii. Not practical at this site due to settlement sensitive soils. 	<ul style="list-style-type: none"> i. Not recommended at this site.
Conventional Retaining Walls	<ul style="list-style-type: none"> i. Construction equipment and knowledge readily available. 	<ul style="list-style-type: none"> i. Performance and appearance requirements exceed the desired design requirement for this site. ii. Most expensive option. iii. Not economical and practical at this site due to settlement sensitive soils. 	<ul style="list-style-type: none"> i. Not recommended at this site.

