

**FOUNDATION INVESTIGATION AND
DESIGN REPORTS – HIGHWAY 401
EXPANSION, EMBANKMENT FILLS AND
EXCAVATION CUT, TOWN OF COBOURG
AND TOWNSHIP OF HAMILTON, ONTARIO
G.W.P. NO. 205-00-01,
GEOCRES 30M16-48**

AECOM

TRANETOB10434AA-AH
January 30, 2012

FINAL REPORT

January 30, 2012

AECOM
5080 Commerce Boulevard
Mississauga, ON L4W 4P2

Attention: Ms. Peggy Baleka

Dear Ms. Baleka,

RE: Draft Foundation Investigation and Design Reports, Highway 401 Expansion, Embankment Fills and Excavation Cut, Town of Cobourg and Township of Hamilton, Ontario G.W.P. No. 205-00-01, Geocres 30M16-48

Coffey Geotechnics Inc (Coffey) is pleased to present the Draft Foundation Investigation and Design Reports for the proposed Highway 401 widening that included embankment fills and excavation cut located within the Town of Cobourg and Township of Hamilton, Ontario.

Please call us on 416 213 1255 should you require further clarification on any aspects of the reports.

For and on behalf of Coffey Geotechnics Inc.


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Distribution: Original held by Coffey Geotechnics Inc.
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1 hard copy to MTO Pavements and Foundation Section

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 401 EXPANSION
EMBANKMENT FILLS AND EXCAVATION
CUT, TOWN OF COBOURG AND
TOWNSHIP OF HAMILTON, ONTARIO
G.W.P. NO. 205-00-01,
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**FOUNDATION INVESTIGATION REPORT
HIGHWAY 401 EXPANSION – EMBANKMENT FILLS AND EXCAVATION CUT
TOWN OF COBOURG AND TOWNSHIP OF HAMILTON, ONTARIO
G.W.P. 205-00-01, Geocres 30M16-48**

1 INTRODUCTION

At the request of AECOM, Coffey Geotechnics Inc. (Coffey) has prepared this foundation investigation report for the proposed embankment fills and cut for the Expansion (6-Laning) of Highway 401 from Burnham Street to approximately 2.0 km east of Nagle Road, within the Town of Cobourg and the Township of Hamilton, Ontario. The foundation investigation was generally carried out in accordance with Coffey proposal (Reference PO 9236, dated May 25, 2009) and the requirements of the RFP.

Table 1.1 below presents the locations of the proposed embankment fills and proposed excavation cut.

Table 1.1: Embankment Fills and Excavation Cut Location

Fill/Cut Number	Stations	Eastbound / Westbound	Length (m)	Comments
Fill Area 1	20+150 to 20+400	Eastbound	250	In the vicinity of Midtown Creek East
Fill Area 2	20+300 to 20+500	Westbound	200	In the vicinity of Midtown Creek East
Fill Area 3	21+650 to 21+750	Both	100 x 2	In the vicinity of Brook Creek
Fill Area 4	22+230 to 22+380	Westbound	150	In the vicinity of Brook Creek East
Fill Area 5	22+330 to 22+400	Eastbound	70	In the vicinity of Brook Creek East
Cut Area 1	21+920 to 22+150	Eastbound	230	East of Nagle Road

The purpose of the investigation was to obtain information about the subsurface conditions at the site by means of boreholes and to assess the engineering characteristics of the subsurface soils by means of field and laboratory tests.

This report provides factual information concerning subsurface conditions, in situ test results and laboratory test results, based on the foundation investigation undertaken.

2 SITE DESCRIPTION AND PHYSIOGRAPHY

2.1 Site Description

Based on the cross sections provided to us by AECOM, the existing side slopes at Fill Areas 1 to 5 and Cut Area 1 typically range from 2H:1V to 3H:1V. Visual observation of the existing embankment slopes during our field work did not indicate apparent signs of instability.

The proposed five embankment fill areas are located in the vicinity of watercourses that cross Highway 401. Existing embankments, with heights ranging from 4 to 7 m and a culvert, are present at each of these areas.

The proposed cut section is located east of Nagle Road. An existing 4 to 11 m high cut, typically sloped at 2H:1V, is located within this area. The terrain rises at about 7 to 10.5 percent behind the cut.

Photographs of the embankment fill and cut sites are presented in Appendices D1 to D6.

2.2 Physiography

According to "The Physiography of Southern Ontario" by L.J. Chapman and D.F. Putnam, 1984, the proposed embankment fill sections and the cut are located within the physiographic region known as the Iroquois Plain. The Iroquois Plain was previously inundated by a body of water known as Lake Iroquois, the fore-runner of the present Lake Ontario. Iroquois Plain at Cobourg is about five kilometers in width and has a peculiar belted pattern.

The terrain within the project area is gently rolling with steeper slopes along the water courses. The site is covered by glaciolacustrine deposits overlying sandy glacial till deposits.

The bedrock underlying the project area is known to belong to the Trenton and Black River Groups (Simcoe Group), which are approximately 480 million years old, and consist of primarily limestone, with some dolostone, shale, arkose and sandstone (Bedrock Geology of Ontario, Southern Sheet, Map 2544 and Geological Highway Map Southern Ontario, Map 2441).

3 METHOD OF INVESTIGATION

3.1 Fieldwork

The fieldwork for the investigation was carried out between May 2010 and December 2010 and comprised of drilling 84 boreholes at the locations shown on the Borehole Location Plans (Drawings A1 to A6), in Appendices A1 to A6. The boreholes drilled for the foundation investigation of the proposed culvert extensions that fall within the proposed fill embankment locations are also presented in this report to provide more coverage and better understanding of the subsurface conditions at the proposed fill embankments. Tables 3.1 to 3.6 below present summaries of the borehole details drilled for the proposed embankment fills and the proposed cut.

Table 3.1: Borehole Details – Fill Area 1 – Stations 20+150 to 20+400 EB

Borehole No.	Stations	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
C7	20+298	16 m Right of C/L	120.6	15.7 / 16.9
C8	20+289	31 m Right of C/L	115.1	10.7
F1	20+150	17 m Right of C/L	118.6	12.3
F2	20+203	15 m Right of C/L	119.2	18.7
F3	20+245	17 m Right of C/L	119.6	16.8 / 17.6
F4	20+349	16 m Right of C/L	121.5	15.5
F5	20+399	16 m Right of C/L	122.8	12.5
F6	20+150	28 m Right of C/L	115.3	10.1
F7	20+196	30 m Right of C/L	114.6	14.3
F8	20+248	30 m Right of C/L	115.3	12.3
F9	20+350	34 m Right of C/L	115.8	9.1
F10	20+398	34 m Right of C/L	118.0	6.6

Table 3.2: Borehole Details – Fill Area 2 – Stations 20+300 to 20+500 WB

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
C5	20+328	37 m Left of C/L	116.0	13.8 / 14.1
C6	20+315	17 m Left of C/L	120.9	22.1
F11	20+299	17 m Left of C/L	120.7	21.4
F11B	20+200	33 m Left of C/L	116.0	10.2

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
F11D	20+252	31 m Left of C/L	117.9	14.2 / 18.6
F13	20+352	17 m Left of C/L	121.8	16.9
F14	20+378	17 m Left of C/L	122.3	15.3
F15	20+399	17 m Left of C/L	122.9	15.3
F16	20+425	17 m Left of C/L	123.5	12.3
F17	20+450	17 m Left of C/L	124.1	10.8
F18	20+474	17 m Left of C/L	124.9	11.1
F18B	20+500	31 m Left of C/L	121.6	6.3
F18D	20+550	28 m Left of C/L	124.1	6.3
F19	20+300	31 m Left of C/L	117.7	14.2 / 15.5
F22	20+388	32 m Left of C/L	117.4	12.3
F23	20+400	33 m Left of C/L	117.4	8.7
F24	20+428	34 m Left of C/L	118.5	11
F25	20+451	30 m Left of C/L	120.1	6.2
F26	20+475	28 m Left of C/L	121.1	6.2

Table 3.3: Borehole Details – Fill Area 3 – Stations 21+650 to 21+750 EB & WB

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
C9	21+729	38 m Left of C/L	128.5	9.3
C10	21+724	14 m Left of C/L	134.4	15.5
C11	21+705	18 m Right of C/L	133.9	14
C12	21+720	29 m Right of C/L	130.8	13.8
C12A	21+707	38 m Right of C/L	126.6	9.3
F27	21+651	18 m Left of C/L	133.8	16.9
F28	21+678	15 m Left of C/L	134.1	12.7
F29	21+700	15 m Left of C/L	134.2	15.5
F30	21+751	15 m Left of C/L	134.6	16.9
F31	21+650	17 m Right of C/L	133.8	13.9
F32	21+677	17 m Right of C/L	133.8	12.5
F33	21+725	18 m Right of C/L	134.0	16.8
F34	21+750	17 m Right of C/L	134.3	18.3
F35	21+650	30 m Left of C/L	131.0	13.8
F36	21+677	31 m Left of C/L	130.5	9.6
F37	21+700	33 m Left of C/L	129.9	9.5
F38A	21+799	30 m Left of C/L	131.6	13.8
F38C	21+774	30 m Left of C/L	131.0	15.5
F39	21+656	28 m Right of C/L	131.1	10.9

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
F40	21+676	29 m Right of C/L	130.3	8.5
F42	21+750	27 m Right of C/L	132.2	15.4

Table 3.4: Borehole Details – Fill Area 4 – Stations 22+230 to 22+380 WB

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
C13	22+351	32 m Left of C/L	139.6	9.3
C14	22+345	15 m Left of C/L	144.9	12.4
F43	22+200	14 m Left of C/L	142.5	9.3
F44	22+250	15 m Left of C/L	143.3	12.3
F45	22+274	15 m Left of C/L	143.7	12.5
F46	22+300	15 m Left of C/L	144.2	12.5
F48	22+400	15 m Left of C/L	145.9	9.6
F49	22+200	29 m Left of C/L	139.0	6.4
F50	22+250	31 m Left of C/L	138.6	7.9
F51	22+275	31 m Left of C/L	138.6	7.7
F52	22+301	32 m Left of C/L	138.3	7.8
F54	22+400	30 m Left of C/L	142.2	7.9

Table 3.5: Borehole Details – Fill Area 5 – Stations 22+330 to 22+400 EB

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
C15	22+345	17 m Right of C/L	144.2	11.9
C16	22+342	29 m Right of C/L	139.7	5.5
F55	22+326	17 m Right of C/L	144.0	8.6
F56	22+374	17 m Right of C/L	144.7	9.5
F57	22+401	17 m Right of C/L	145.1	9.3
F58	22+332	29 m Right of C/L	139.7	5
F59	22+358	26 m Right of C/L	140.5	6.4
F60	22+391	26 m Right of C/L	141.3	9.3

Table 3.6: Borehole Details – Cut Area 1 – Stations 21+920 to 21+150 EB

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
F61	21+901	16 m Right of C/L	137.0	5.4
F62	21+950	18 m Right of C/L	137.9	4.7
F63	22+000	18 m Right of C/L	138.6	5.5
F64	22+048	19 m Right of C/L	139.2	4.7
F65	22+098	19 m Right of C/L	140.0	4.7
F66	22+148	18 m Right of C/L	140.9	5
F67	21+916	38 m Right of C/L	141.3	12.6
F68	21+956	38 m Right of C/L	145.1	14

Borehole No.	Station	Offset from Hwy 401 C/L	Existing Ground Elevation (m)	Drilled/Tested Depth (m)
F69	21+993	42 m Right of C/L	148.2	13.8
F70	22+078	41 m Right of C/L	149.5	16.9
F71	22+120	44 m Right of C/L	148.4	15.3
F72	22+151	37 m Right of C/L	145.6	13.1

The borehole drilling was carried out by two drilling subcontractors, Eastern Soil Investigation Limited and Strong Soil Search. The boreholes were drilled using either a track mounted (Bombardier) or a truck mounted drilling rig. Each borehole was advanced using solid flight or hollow stem augers, to depths of about 4.7 to 22.1 m below the ground surface. Standard Penetration Tests (SPTs) were carried out in the overburden at selected depth intervals, to assess the soil strength and obtain samples for logging and testing purposes. SPTs were carried out in general accordance with ASTM D1586. The test consists of freely dropping a 63.5 kg hammer at a vertical distance of 0.76 m to drive a 51 mm outside diameter (OD) split-barrel (SS-split-spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the N-value of the soil which is indicative of the compactness condition of granular (or cohesionless) soils (gravels, sands and silts) or the consistency of cohesive soils (clays and clayey soils). Thin walled tube samples were collected within cohesive soils, where the consistency permitted.

The soil samples were described in the field, placed in appropriate containers, labelled and transported to our Etobicoke geotechnical laboratory where the samples underwent further detailed visual examination and samples were selected for geotechnical laboratory testing.

Dynamic Cone Penetration Tests (DCPT) were carried out in Boreholes C5, C7, F3, F11D and F19 below the drilled depths. The DCPT consists of driving an uncased 50 mm diameter cone, attached to A-size drill rods, with a driving energy of 475 kJ (63.5 kg hammer free falling for a distance of 0.76 m) per blow, continuously. The number of blows for each 0.3 m of penetration is recorded, providing an indication of the relative changes in the soil density and/or consistency with respect to depth.

In cohesive (clayey soils), where the consistency permitted, field vane tests were performed to measure in-situ undrained shear strength of the clayey soils. Standard MTO 'N' type vane was used for this purpose and the testing was done in compliance with normal MTO procedures.

Groundwater levels and inflows observed in the open boreholes during drilling were recorded. In each of Boreholes C6, C8, C9, C12, C13, C16, F62, F64, F66, F68, F70 and F72, a piezometer was installed to enable long term groundwater level monitoring. The remaining boreholes were grouted upon their completion using a cement/bentonite mixture, as per MTO procedures. Note the piezometers installed have not been decommissioned as they may be useful in monitoring water level prior to or during the

construction. As part of the construction, the piezometers need to be decommissioned in accordance with Ontario Regulation 903 (amended to Ontario regulation 372/07).

The boreholes were located on site using existing site features. The borehole location coordinates and ground elevations were subsequently measured by the client's surveyors and were provided to Coffey.

A Coffey representative was present during the drilling operations to direct sampling and testing, record test results and log materials encountered.

Appendices A1 to A6 present the Record of Borehole Sheets.

3.2 Laboratory Testing

Soil samples obtained during the investigation were taken to our Etobicoke laboratory. The following tests were performed on selected soil samples:

- Natural moisture content tests;
- Unit weight tests;
- Grain size analyses (sieve);
- Grain size analyses (sieve and hydrometer tests);
- Atterberg Limits tests; and
- Consolidation tests.

Appendices B1 to B6 present laboratory test results sheets for all the tests carried out except the natural moisture content and unit weight tests results as they are presented on the Record of Borehole Sheets in Appendices A1 to A6.

4 SUBSURFACE CONDITIONS

The following sections present the subsurface conditions for each of the proposed embankment fills as well as the proposed excavation cut.

The drawings (Borehole Location Plan and Soil Stratigraphic Sections) and Record of Borehole Sheets for each of the proposed embankment fills and the excavation cut are presented in Appendices A1 to A6 and the corresponding laboratory test results are presented in Appendices B1 to B6.

As mentioned before, the boreholes drilled for the foundation investigation of the proposed culvert extensions that fall within the proposed fill embankment locations are also presented in this report to provide more coverage and better understanding of the subsurface conditions at the proposed fill embankments.

The Record of Borehole Sheets and inferred stratigraphic sections indicate the subsurface conditions only at the borehole locations. Note that the material boundaries indicated on the logs are approximate and based on visual observations. These boundaries typically represent a transition from one material type to

another and should not be regarded as an exact plane of geological change. It should be pointed out that the subsurface conditions may vary in between and beyond the borehole locations.

4.1 Fill Area 1 – Stations 20+150 to 20+400 EB

Fill Area 1 is located between Stations 20+150 to 20+400 on the eastbound lanes of Highway 401, in the Town of Cobourg. This proposed fill section is approximately 250 m in length, and the existing fill embankment at this location is about 4 to 6 m high. Visual inspection at this location did not reveal any signs of embankment instability. A total of twelve boreholes, F1 to F10, C7 and C8, was drilled at the location of Fill Area 1. The details of these boreholes are presented in Table 3.1 in Section 3. Drawing A1 in Appendix A1 shows the locations of the boreholes.

The top of the road elevation (i.e. centerline elevation) in this stretch ranges from about 118.8 m at Station 20+150 gradually increasing easterly to about 122.8 m at Station 20+400 (i.e. an elevation rise of 4 m over a horizontal distance of 250 m), representing an approximate 1.6 % average gradient. The original ground level (o.g.) elevations between Stations 20+150 to 20+400 in the eastbound range from 114.6 to 118.0 m.

Detailed descriptions of the materials encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A1. The inferred stratigraphy is presented on Drawing A1 in Appendix A1.

The boreholes were drilled from either the top of the highway embankment or near the bottom. Consequently, those boreholes from the top encountered embankment fill which ranged in depth from about 3.8 to 6.6 m while in those which were drilled close to the toe of the existing highway embankment, the thickness of the embankment fill ranged from 0.8 to 3.0 m. In general, boreholes advanced from the top of the highway embankment (Boreholes F1 to F5 and C7), the top portion of the embankment fill consisted of granular pavement fill (up to 0.7 m thick), while in the boreholes advanced from the toe of the embankment (Boreholes F6 to F10 and C8) an up to 0.8 m thick layer of topsoil was encountered at the ground surface. As mentioned before, below the pavement fill and topsoil, embankment fill was encountered in the boreholes extending to depths of 0.8 to 6.6 m below the ground surface. Underlying the embankment fill a clayey silt to silty clay deposit was encountered at Elevations 116.9 to 112.1 m, with a thickness ranging from 1.6 to 12.6 m. Underlying the clayey silt to silty clay deposit, a glacial till deposit was encountered at depths of 4.6 to 16.8 m below the ground surface or at Elevations 113.7 to 100.5 m. All boreholes were terminated within the till deposit at depths of 6.6 to 18.7 m below the ground surface or at Elevations 111.4 to 100.3 m.

The following summarizes the surface conditions encountered in the boreholes.

4.1.1 Topsoil

Topsoil was encountered at the ground surface in Boreholes F6 to F10 and C8 which were drilled near the toe of the existing embankment. The thickness of topsoil at these borehole locations ranged from 0.2 to 0.8 m.

Note that in our experience, the thickness of organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.1.2 Fill

4.1.2.1 Pavement Fill

In Boreholes F1 to F5 and C7 drilled on top of the existing fill embankment, a 0.5 to 0.7 m thick granular pavement fill (generally sand and gravel, with underlying sand in Borehole F4 and sand layer only in Borehole F5) was encountered from the surface.

Standard Penetration Tests yielded SPT N-values of 16 to 31 blows/0.3 m within the granular pavement fill layer, indicating a compact to dense condition.

4.1.2.2 Embankment Fill

Below the topsoil and pavement fill, embankment fill was encountered. The embankment fill was found to extend to depths of 0.8 m (Borehole F8) to 6.6 m (Boreholes F4 and F7) below the existing ground surface or to Elevations 116.9 m (Borehole F5) to 112.1 m (Borehole C8). In general, the embankment fill was found to consist of silty sand to sandy silt with traces of clay and traces of gravel size particles in all the boreholes. In Boreholes F4 and F5, cobbles and boulders were also encountered within the upper 2.7 and 3.8 m depth of the embankment fill. As well, in some of the boreholes, organic materials were encountered near the base of the embankment fill.

Grain size distribution analyses carried out on six samples taken from the embankment fill indicate the following distribution, as shown in Figure B1-1, in Appendix B1.

Gravel:	0 – 7 %
Sand:	35 – 58 %
Silt:	23 – 39 %
Clay:	14 – 21 %

The embankment fill is considered to be a granular (non-cohesive) material.

SPT N-values recorded within the embankment fill ranged from 2 to in excess of 100 blows/0.3 m indicating varying relative densities from very loose to very dense. However, SPT N-values indicating very loose to loose densities were generally recorded in the boreholes drilled near the toe of the embankment, but in isolated zones within the boreholes drilled from the shoulder of the road embankment. The relatively high SPT N-values were recorded within the cobbles and boulders zones in the embankment fill encountered in Boreholes F4 and F5. Generally, the embankment fill, encountered in the boreholes drilled under the roadway, was assessed to have compact to dense relative density with some loose zones.

4.1.3 Clayey Silt to Silty Clay

Underneath the embankment fill, a clayey silt to silty clay deposit was encountered at Elevations 116.9 to 112.1 m, with a thickness ranging from 1.6 to 12.6 m. The material contains traces of gravel and sand. It is considered a practically impervious, cohesive soil but contains occasional fine grained granular (non-cohesive) seams/layers of relatively pervious silty sand.

The following are the grain size distribution of eleven selected samples taken from this deposit, as shown in Figure B1-2, in Appendix B1.

Gravel:	0 %
Sand:	2 – 11 %
Silt:	48 – 69 %
Clay:	20 – 50 %

A thin sandy layer was encountered within this deposit at C8 SS6 and the following is the grain size distribution, also presented in Figure B1-3, in Appendix B1.

Gravel:	3 %
Sand:	23 %
Silt:	48 %
Clay:	26 %

Atterberg Limits tests conducted on the thirteen samples taken from this deposit indicated the following results, also shown in Figure B1-4, in Appendix B1.

Liquid Limit:	19 – 36 %
Plastic Limit:	13 – 22 %
Plasticity Index:	5 – 16 %

Based on the above, this deposit is considered to have low to medium degree of plasticity.

The measured natural moisture contents ranged from about the measured plastic limits values to in excess of liquid limits values, thus showing a large variation.

SPT N-values of 2 to 40 blows/0.3 m were recorded within this deposit. Typical N-values ranged between 3 and 18 blows/0.3 m. It is of interest to note that the relatively higher N-values were recorded in the eastern half of the site, in Boreholes F4, F5, F8, F9 and particularly in F10. Boreholes drilled from the full height of the embankment recorded relatively higher N-values, as can be expected. Field vane testing recorded in-situ, undrained shear strength values of 40 to greater than 100 kPa. Based on the SPT and field vane testing, the clayey silt to silty clay deposit is considered to have a consistency of firm to very stiff with a hard zone in Borehole F10. Sensitivity values ranging from 1.2 to 4.9 and an isolated value of 8.0 were recorded within this deposit, indicating that the clayey silt has sensitivity ranging from low sensitivity to medium sensitive.

Consolidation tests were carried out on two samples from this deposit (samples F1 TW7 and F6 TW9). The test results are presented in Figures B1-5 and B1-6, in Appendix B1. The results showed that the deposit is considered to have a possible pre-consolidation pressure in excess of the existing overburden pressure, $P'_c - P'_0$ of the order of 180 to 220 kPa or over consolidation ratio, OCR, equal to 2.8 to 3.6. A compression index, C_c , of about 0.3 to 0.4 and a recompression index, C_r , of about 0.03 to 0.05 were

calculated from the results. A coefficient of consolidation, c_v , of about 0.003 to 0.006 cm²/sec was calculated from the results.

We also assessed the engineering characteristics of the clayey silt to silty clay by plotting undrained shear strength, overburden pressure, P'_0 and $0.23 \times P'_0$ versus elevation. The plots are presented in Appendix C. Figure C1 presents the measured undrained shear strengths versus elevation from all the boreholes drilled on the existing embankment and outside the existing embankment. The measured undrained shear strengths versus elevation of the boreholes in Fill Area 1 are presented in Figure C2. Figures C3 and C4 present the distribution of undrained shear strength, overburden pressure, P'_0 , and $0.23 \times P'_0$ versus the elevation for Boreholes F1 and F6, where the consolidation tests were carried out. It is commonly acknowledged that with Ontario clays if the measured undrained shear strength are in excess of $0.23 P'_0$ line, the deposit may be over consolidated. Based on this criterion, the clayey silt to silty clay deposit appears to be generally over consolidated, which is consistent with the results of the consolidation tests discussed above.

4.1.4 Glacial Till

A granular (non-cohesive) glacial till deposit was encountered underlying the clayey silt to silty clay deposit. The deposit consists of a heterogeneous mixture of silty sand with some gravel and clay size particles. It was contacted at depths of 4.6 to 16.8 m below the ground surface or at Elevations 113.7 to 100.5 m. All boreholes were terminated within the till deposit at depths of 6.6 to 18.7 m below the ground surface or at Elevations 111.4 to 100.3 m.

The following are the grain size distribution of selected (seven) samples taken from this granular deposit, as presented in Figure B1-7, in Appendix B1.

Gravel:	0 – 27 %
Sand:	28 – 56 %
Silt:	13 – 40 %
Clay:	8 – 23 %

The presence of cobbles and boulders should always be anticipated in the glacial till deposits, owing to their mode of deposition.

Typical SPT N-values of 11 to in excess of 100 blows/0.3 m were recorded within the deposit, indicating a compact to very dense relative density. Relatively lower SPT blow counts of 9 blows/0.3 m were recorded in Boreholes C8 and F8, just below the clayey silt to silty clay deposit, indicating isolated loose zones. Generally, SPT N-values indicating compact condition were recorded just below the clayey silt to silty clay deposit and relatively higher SPT N-values were recorded below that indicating that this deposit is generally in dense to very dense condition.

4.1.5 Groundwater Conditions

Groundwater levels were observed in the open boreholes while drilling and upon completion of each borehole. Groundwater levels measured on completion of the boreholes may not be reliable. A piezometer was installed in Borehole C8 to monitor the groundwater levels over a prolonged period without interference from surface water. The groundwater levels observed during the investigation are presented on the Record of Borehole Sheets in Appendix A1. The groundwater levels observations are summarized in the following table.

Table 4.1: Groundwater Level Observations – Fill Area 1 – Stations 20+150 to 20+400 EB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
C7	-	Jul 30 2010	4.6 / 116.0*	Measured upon borehole completion
C8	9.1 / 109.0	Aug 19 2010 Oct 15 2010	2.0 / 113.1 1.9 / 113.2	Measured within the piezometer installed
F1	-	Jul 28 2010	3.1 / 115.5*	Measured upon borehole completion
F2	-	Jul 28 2010	2.4 / 116.8*	Measured upon borehole completion
F3	-	Jul 29 2010	3.7 / 115.9*	Measured upon borehole completion
F4	-	Aug 3 2010	9.8 / 111.7*	Measured upon borehole completion
F5	-	Aug 3 2010	10.1 / 112.7*	Measured upon borehole completion
F6	-	Jul 28 2010	6.1 / 109.2*	Measured upon borehole completion
F7	-	Jul 28 2010	6.4 / 108.2*	Measured upon borehole completion
F8	-	Jul 29 2010	3.1 / 112.2*	Measured upon borehole completion
F9	-	Aug 3 2010	4.6 / 111.2*	Measured upon borehole completion
F10	-	Aug 3 2010	5.5 / 112.5*	Measured upon borehole completion

Note: * Groundwater level measured not stabilized.

Based on the moisture condition of the soil samples and results of the piezometer readings, the site groundwater level at the time of our investigations was typically at about Elevation 115 to 111 m.

It should be noted that groundwater levels are subject to variations due to the influence of rainfall, temperature, local drainage, seasons and other factors. There may also be potential for development of perched groundwater tables following periods of rainfall and groundwater may rise to the ground surface. In addition, the water level in the watercourse would influence the groundwater level at the site.

4.2 Fill Area 2 – Stations 20+300 to 20+500 WB

Fill Area 2 is located between Stations 20+300 to 20+500 on the westbound lanes of Highway 401. The sub-surface conditions were explored at nineteen (19) boreholes including two boreholes (C5 & C6) for the culvert extension (see Table 3.2 in Section 3) for Fill Area 2. These boreholes were drilled on existing shoulders and toe areas, between Stations 20+200 and 20+550, on the left (north) side of the existing highway. Eight of the boreholes were put down from the top of the embankment while eleven boreholes from the bottom (i.e. from the original ground level). Three DCPTs were performed from bottom of boreholes in ditch boreholes F11D, F19 and C5. Drawings A2-1 and A2-2 in Appendix A2 show the locations of the boreholes.

The top of the road elevation (i.e. centerline elevation) in this stretch of the highway ranges from about 120.9 m at Station 20+300 gradually increasing easterly to about 125.1 m at Station 20+475 (i.e. an elevation rise of 4.2 m over a horizontal distance of 175 m), representing an approximately 2.4 % average gradient.

The original ground level elevations in this area range from about 116 m at Station 20+200 to about 124 m at Station 20+550. The existing embankment is typically 3.0 to 5.5 m high.

Detailed descriptions of the materials encountered on the boreholes are presented on the Record of Borehole Sheets in Appendix A2. The inferred stratigraphy is presented on Drawings A2-1 and A2-2 in Appendix A2.

In general, the site is underlain by topsoil, fill (pavement fill and embankment fill), organic silt (in some areas), clayey silt to silty clay (in most boreholes), sandy silt (in some areas) and a basal glacial till deposit. Embankment fill was found to extend to depths of 3.7 to 8.2 m below the ground surface or to Elevations 120.5 to 113.6 m. In Boreholes F13 and F14, a 0.7 m thick black organic silt layer was encountered below embankment fill. A sandy silt layer was contacted below the embankment fill in Boreholes F25 and F26, and was found to extend to depths ranging from 2.3 to 2.4 m below the ground surface or to Elevations 118.7 to 117.8 m. Below the embankment fill and organic silt (in Boreholes F13 and F14 only), a clayey silt to silty clay deposit was encountered in most of the boreholes at depths of 0.8 to 8.2 m below the ground surface or at Elevations 120.8 to 113.6 m. Underlying the clayey silt to silty clay and sandy silt deposit, a glacial till deposit was generally encountered at depths of 0.6 to 12.0 m or Elevation 119.9 to 108.4 m in all the boreholes, except in Borehole F11D. Glacial till was not encountered in the sampling of Borehole F11D which was terminated at 14.2 m or Elevation 103.7. However, based on the DCPT carried out below the drilled/sampled depth of Borehole F11D, glacial till was inferred at about 17.7 m depth below the ground surface or at Elevation 100.2 m. Sampling and DCPT in all the boreholes were terminated within the till deposit at depths of 6.2 to 22.1 m below the ground surface or at Elevations 117.8 to 98.8 m.

The various soil strata encountered in the boreholes and their geotechnical properties are described in the following sections.

4.2.1 Topsoil

The boreholes which were advanced from the toe area of the existing embankment, except for Borehole F19, encountered a 0.1 to 0.7 m thick topsoil layer.

It should however be pointed out that in our experience, the thickness of topsoil and other organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.2.2 Fill

4.2.2.1 Pavement Fill

Boreholes F11, C6, F13 to F18 were advanced from the left shoulder of Highway 401 and these contacted an about 0.3 to 0.8 m thick pavement fill. This granular fill consists of sand and gravel with traces of silt to sand with some gravel and silt.

The grain-size distribution of four samples (F11-SS1A, F13-SS1, F15-SS1A, F17-SS1A) from the pavement fill is presented on Figure B2-1 in Appendix B2 and this indicates the following particle size distribution.

Gravel:	30 – 45 %
Sand:	46 – 56 %
Silt and Clay:	9 – 14 %

Standard Penetration Tests performed on this granular fill yielded N-values of 6 to 20 blows/0.3 m. These results indicate that the relative density of the granular fill can be described as loose to compact.

4.2.2.2 Embankment Fill

Below the pavement granular fill, the boreholes drilled from the existing road shoulder encountered embankment fill materials extending to 3.7 to 8.2 m (Elevation 120.5 to 113.6 m). The boreholes drilled around the toe area also encountered embankment fill below the topsoil and extended to 0.6 to 2.0 m depth (Elevation 123.0 to 114.4 m). This embankment fill consists of silty sand to sandy silt with trace to some gravel and clay with occasional asphalt fragments.

The grain-size distribution of eight samples from this embankment fill is given in Figure B2-2 in Appendix B2. These show the following grain-size distribution.

Gravel:	0 – 15 %
Sand:	39 – 61 %
Silt:	32 – 41 %
Clay:	7 – 20 %

Standard Penetration Tests performed in this granular (non-cohesive) fill yielded N-values ranging from 0 to 100 blows/0.3 m but generally 4 to 30 blows/0.3 m indicating a very loose to compact condition. The bulk unit weight tested on one representative fill sample gave a value of 20.0 kN/m³.

Borehole F11 (drilled near the Creek) encountered a finer grained fill, described as clayey silt with sand, at the bottom of embankment fill. The result of grain-size analysis of this cohesive fill is presented in Figure B2-3 and Atterberg Limits in Figure B2-4 in Appendix B2. The results indicate 1% gravel, 27% sand, 45% silt and 27% clay with Liquid and Plastic Limits of 21.8 and 16.5 respectively. Measured N-values of 16 and 19 blows/0.3 m were recorded in this fill layer, indicating very stiff consistency.

In Borehole C6, which was drilled adjacent to a culvert from the top of embankment, a more compact silty sand with traces of clay was encountered at the bottom of the embankment fill. This layer was contacted at a depth of 5.8 m (Elevation 115.1 m) and was found to extend to a depth of 7.2 m below the ground surface or Elevation 113.7 m and it is likely to be a bedding/backfill material for the culvert. One grain-size analysis was carried out on a representative sample and the result is presented on the Record of Borehole sheets in Appendix A2. The grain size curve is presented in Figure B2-5 in Appendix B2. The results show 69% sand, 21% silt and 10% clay size particles. Standard Penetration Tests performed in this material yielded an N-value of 30 blows/0.3 m which indicates a compact to dense condition.

In some boreholes which were drilled from the shoulder such as Boreholes C6, F13, F14, F16 and F18, a 0.3 to 0.9 m thick topsoil/organic soil was contacted at the bottom portion of the embankment fill (i.e. topsoil/organic soils appear not to have been properly stripped prior to placing the embankment fill).

4.2.3 Organic Sandy Silt

Boreholes F13 and F14 encountered a 0.7 m thick black organic silt layer, underlying the embankment fill. This organic layer was found at 6.5 to 7.5 m depth (Elevation 115.8 to 114.3 m) and extended to 7.2 to 8.2 m depth (Elevation 115.1 to 113.6 m). This layer consists of organic sandy silt with traces of clay and traces of rootlets. Standard Penetration Tests performed in this material yielded an N-value 10 blows/0.3 m which indicates a loose relative density.

4.2.4 Clayey Silt to Silty Clay

In all toe boreholes, except for F24, F25, F26 and F18D, underlying the embankment fill, a clayey silt to silty clay deposit was contacted at depths of 0.8 to 2.0 m (Elevation 120.8 to 114.4 m). In Borehole F11D which was terminated at 14.2 m, the bottom of this deposit was not encountered during sampling/drilling. Therefore, in the toe boreholes, this deposit was found to extend to depths ranging from 1.7 m to at least 14.2 m below the ground surface or Elevation 119.9 to below 103.7 m. Its thickness was found to range from 0.9 to more than 12.8 m. In the boreholes drilled from the existing highway shoulder, underlying the embankment fill, the clayey silt to silty clay deposit was contacted at depths of 4.4 to 8.2 m (Elevation 120.5 to 113.6 m). In these boreholes, the deposit was found to extend to depths ranging from 5.8 m to 12.0 m below the ground surface or Elevation 119.1 to 108.9 m. Its thickness was found to range from 1.1 to 5.9 m. In general, the thickness of the clayey silt to silty clay layer is greater towards west of Midtown East Creek and gradually decreases easterly from the Creek.

Fourteen grain-size analyses were carried out on representative samples of this cohesive soil. The results are presented on the Record of Borehole sheets in Appendix A2, and the grain size curves are shown in an envelope form in Figure B2-6 in Appendix B2.

These show the following grain-size distribution.

Gravel:	0 – 1 %
Sand:	3 – 17 %
Silt:	43 – 64 %
Clay:	27 – 50 %

The results of Atterberg Limits test performed on twenty two samples recovered from the deposit are given on the individual Record of Borehole Sheets and also on Figure B2-7 and B2-8 in Appendix B2. The following index values were obtained:

Liquid Limit:	19 – 33 %	(Average: 26 %)
Plastic Limit:	14 – 21 %	(Average: 16 %)
Plasticity Index:	4 – 15 %	(Average: 10 %)
Natural Moisture Content:	18 – 34 %	(Average: 25 %)

These results are characteristic of clayey soils with low plasticity.

Standard Penetration Tests performed in the deposit yielded N-values ranging from 2 to 19 blows/0.3 m. Field vane tests yielded undrained in-situ shear strengths of 44 to in excess of 100 kPa. These results indicate a firm to very stiff but typically stiff to very stiff consistency.

Two oedometer (one dimensional consolidation) tests were performed in the laboratory on thin-walled tube (TW) samples (TW8A sample from Borehole F19 and TW7 sample from Borehole C5) from this cohesive deposit. The results are presented in Figure B2-9 and Figure B2-10 in Appendix B2. The results show that the deposit has a possible pre-consolidation pressure in excess of the existing overburden pressure, $P'_c - P'_0$, of the order of 130 to 140 kPa or over consolidation ratio, OCR, equal to 2.8 to 2.9. Compression index (C_c) of about 0.1 and 0.2 with recompression index (C_r) of about 0.01 and 0.02 respectively were obtained. The test results also indicate coefficient of consolidation (c_v) of about $5 \times 10^{-3} \text{ cm}^2/\text{s}$.

Similar to the clayey silt to silty clay in Fill Area 1, we also assessed the consolidation characteristics of this deposit by plotting undrained shear strength, overburden pressure, P'_0 and $0.23 \times P'_0$ versus depth. In Appendix C, the measured undrained shear strengths versus elevation of the boreholes in Fill Area 2 are presented in Figure C5. Figures C6 and C7 present the distribution of undrained shear strength, overburden pressure, P'_0 , and $0.23 \times P'_0$ versus the elevation for Boreholes F19 and C5. Generally, for Ontario clays, if the measured undrained shear strength are in excess of $0.23 P'_0$ line, the deposit may be over consolidated. Based on this criterion, the clayey silt deposit appears to be over consolidated, which is consistent with the results of the consolidation tests discussed above.

The clayey silt to silty clay deposit is considered to be considerably less pervious than the overlying embankment fill and the organic sandy silt deposit as well as the underlying silty sand till.

4.2.5 Sandy Silt

Boreholes F25 and F26, below the embankment fill, contacted a sandy silt layer. This layer was contacted at depths of 1.4 to 1.5 m (Elevation 119.7 to 118.6 m) and was found to extend to depths ranging from 2.3 to 2.4 m (Elevation 118.7 to 117.8 m).

Two grain-size analyses were carried out on representative samples and results are presented on the Record of Borehole sheets in Appendix A2 and in Figure B2-11 in Appendix B2.

These show the following grain-size distribution.

Gravel:	0 – 1 %
Sand:	26– 35 %
Silt:	54 – 63 %
Clay:	10 – 11 %

Standard Penetration Tests performed in the deposit yielded N-values of 2 and 12 blows/0.3 m which indicate a very loose to compact relative density.

4.2.6 Glacial Till

Underlying the clayey silt to silty clay or the sandy silt, all boreholes contacted a massive glacial till deposit consisting of a heterogeneous mixture of silty sand with traces to some gravel and clay size particles. Occasional cobbles were also encountered within the glacial till deposit. Due to their mode of deposition, the presence of cobbles and boulders should always be anticipated in the glacial till deposits.

In all toe boreholes except for Borehole F11D, silty sand till deposit was contacted at depths of 0.6 to 9.0 m (Elevation 119.9 to 108.4 m) and was found to extend to the remaining depth of the boreholes. This deposit was not encountered within the sampled zone of Borehole F11D, which was terminated at 14.2 m or Elevation 103.7. However, based on the DCPT carried out below the drilled/sampled depth of Borehole F11D, glacial till was inferred at about 17.7 m depth below the ground surface or at Elevation 100.2 m. In all boreholes drilled from the existing shoulder, silty sand till was also encountered at depths of 5.8 to 12.0 m (Elevation 119.1 to 108.9 m) and was found to extend to the remaining depth of the boreholes.

The silty sand till is basically a granular material but in some cases, where the clay content is high, and this deposit shows some apparent cohesion. The grain size distribution of twelve samples from the till deposit is presented in Figure B2-12 in Appendix B2. The results indicate the following grain-size distribution.

Gravel:	2 – 16 %
Sand:	38 – 65 %
Silt:	21 – 40 %
Clay:	5 – 20 %

N-values recorded in this soil deposit range from 3 to in excess of 100 blows/0.3 m which indicate a very loose to very dense compactness condition.

4.2.7 Groundwater Conditions

The groundwater conditions in the open boreholes were observed during the drilling and upon completion of each borehole, as shown on the individual Record of Borehole Sheets in Appendix A2. The observations made in the boreholes are summarized in Table 4.2.

Table 4.2: Groundwater Level Observations – Fill Area 2 – Stations 20+300 to 20+500 WB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
C5	-	Jun 11 2010	1.0 / 115.0*	Measured upon borehole completion
C6	12.2 / 108.7	Jun 15 2010 Jun 16 2010 Jul 16 2010 Aug 19 2010 Oct 15 2010	5.8 / 115.1* 5.6 / 115.3 5.5 / 115.4 5.9 / 115.0 5.8 / 115.1	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F11	-	Jun 14 2010	6.7 / 114.0*	Measured upon borehole completion
F11B	-	Jun 9 2010	0.9 / 115.1*	Measured upon borehole completion
F11D	-	Jun 9 2010	2.5 / 115.4*	Measured upon borehole completion
F13	-	Jun 18 2010	5.5 / 116.3*	Measured upon borehole completion

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
F14	-	Jul 5 2010	5.5 / 116.8*	Measured upon borehole completion
F15	-	Jun 17 2010	5.5 / 117.4*	Measured upon borehole completion
F16	-	Jun 17 2010	4.4 / 119.1*	Measured upon borehole completion
F17	-	Jun 17 2010	5.2 / 118.9*	Measured upon borehole completion
F18	-	Jun 16 2010	6.4 / 118.5*	Measured upon borehole completion
F18B	-	Jun 7 2010	0.6 / 121.0*	Measured upon borehole completion
F18D	-	Jun 4 2010	0.8 / 123.3*	Measured upon borehole completion
F19	-	Jun 10 2010	2.6 / 115.1*	Measured upon borehole completion
F22	-	Jun 8 2010	0.5 / 116.9*	Measured upon borehole completion
F23	-	Jun 8 2010	0.3 / 117.1*	Measured upon borehole completion
F24	-	Jun 7 2010	0.6 / 117.9*	Measured upon borehole completion
F25	-	Jun 7 2010	1.8 / 118.3*	Measured upon borehole completion
F26	-	Jun 7 2010	0.9 / 120.2*	Measured upon borehole completion

Note: * Groundwater level measured not stabilized.

As the observations were made upon completion of each borehole except for one piezometer (stabilized water level) the recorded levels are unlikely to represent the stabilized groundwater levels. In general, however, the groundwater table at the site at the time of our investigation was found to range from near the original ground (o.g.) to about 2.5 m below the original ground level or from about Elevation 123 to 114 m

It should be pointed out that the observed groundwater levels represent the conditions at the time of our investigation and that the groundwater level would be subject to fluctuations, both seasonally and in response to major weather events. In addition to observed groundwater conditions, a perched water condition could possibly be encountered at the site due to accumulation of surface water in fill materials, overlying the practically impervious clayey silt to silty clay deposit. The water level in the watercourse would also influence the groundwater level at the site.

4.3 Fill Area 3 – Stations 21+650 to 21+750 EB & WB

Fill Area 3 is located between Stations 21+650 to 21+750 on the eastbound and westbound lanes of Highway 401. The sub-surface conditions in this stretch were explored at eleven (11) boreholes along the westbound and ten (10) boreholes along the eastbound of Hwy 401 (see Table 3.3 in Section 3). These boreholes were drilled on the existing shoulder and in the ditch areas in between Stations 21+650 and 21+750 in the eastbound and between Stations 21+650 to 21+800 in the westbound. Ten of the boreholes were put down from the top of the embankment while the other eleven were advanced from the bottom (i.e. from the original ground level). Drawings A3-1 and A3-2 in Appendix A3 show the locations of the boreholes.

The top of the road elevation (i.e. centerline elevation) in this stretch ranges from about 134.0 m at Station 21+650 gradually increasing to about 134.8 m at Station 21+750 (i.e. an elevation rise of 0.8 m over a horizontal distance of 100 m), representing an approximate 0.8 % average gradient.

The original ground level elevations between Stations 21+650 and 21+800 in the westbound lanes range from 131.6 to 128.5 m (i.e. 2.8 to 5.9 m high embankments). The original ground level elevations between Stations 21+650 and 21+750 in the eastbound lanes range from 132.2 to 130.3 m (i.e. 2.1 to 3.5 m high).

Detailed descriptions of the materials encountered on the boreholes are presented on the Record of Borehole Sheets in Appendix A3. The inferred stratigraphy is presented on Drawings A3-1 and A3-2 in Appendix A3.

In general, the site is underlain by topsoil, fill (pavement fill and embankment fill), silty sand to sandy silt (in some boreholes), silt (in Borehole F38A) and clayey silt to silty clay (in most boreholes), all underlain by a massive glacial till deposit. Embankment fill was found to extend to depths of 1.5 to 7.6 m below the ground surface or to Elevations 129.8 to 126.8 m. In Boreholes F27, F35, F38A and F38C, a 0.6 to 4.4 m thick silty sand to sandy silt deposit was encountered either below the embankment fill or the topsoil. A silt layer was encountered below the silty sand to sandy silt in Borehole F38A, and was found to extend to a depth of 3.1 m below the ground surface or to Elevation 128.5 m. Below the embankment fill and the silty sand to sandy silt and silt, a clayey silt to silty clay deposit (0.7 to 8.7 m thick) was encountered in most of the boreholes at depths of 0.2 to 4.6 m below the ground surface or at Elevations 129.8 to 126.4 m. Underlying the clayey silt to silty clay and silty sand to sandy silt deposit, a glacial till deposit was generally encountered at depths of 2.3 to 14.5 m or at Elevations 128.9 to 120.3 m. All the boreholes were terminated within the till deposit at depths of 8.5 to 18.3 m below the ground surface or at Elevations 121.8 to 115.5 m.

The various soil strata encountered in the boreholes and their geotechnical properties are described in the following sections.

4.3.1 Topsoil

The boreholes which were advanced from the toe area of the existing embankment, except Borehole F42, encountered a 0.1 to 0.2 m thick topsoil layer.

It should however be pointed out that in our experience, the thickness of topsoil and other organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.3.2 Fill

4.3.2.1 Pavement Fill

Boreholes F27 to F30 and C10 were advanced from left shoulder (westbound) and Boreholes F31 to F34 and C11 were advanced from right shoulder (eastbound) of Highway 401 and contacted granular pavement materials which ranged in thickness from 0.4 to 1.5 m. This granular fill consists of sand and gravel with traces of silt to sand, with traces of gravel and some silt.

The grain-size distribution of two samples (F29-SS1 and F34-SS1) from the pavement fill is given on Figure B3-1 in Appendix B3 and this indicates the following particle size distribution.

Gravel:	22 – 30 %
Sand:	57 – 69 %
Silt and Clay:	9 – 13 %

Standard Penetration Tests performed on this granular fill yielded N-values of 9 to 27 blows/0.3 m. These results indicate that the relative density of the granular fill can be described as loose to compact.

4.3.2.2 Embankment Fill

Boreholes drilled from the existing road shoulder encountered embankment fill materials below the granular fill, extending to depths of 4.5 to 7.6 m (Elevation 129.8 to 126.8 m). The boreholes drilled around the toe area encountered embankment fill below the topsoil and extended to 1.5 to 3.1 m (Elevation 129.6 to 127.4 m) except at Boreholes C9, F38C and F38A on westbound, which encountered native soil just after the topsoil. The embankment fill typically consists of silty sand to sandy silt with traces to some gravel and clay. However, it is noted that in Boreholes F39 and F40 (eastbound toe area) at Stations 21+650 to 21+675, the encountered embankment fill consists of mixture of clayey silt and sandy silt to silty sand with organics.

The grain-size distribution of thirteen samples from this embankment fill material is given in Figure B3-2 in Appendix B3. These show the following grain-size distribution.

Gravel:	0 – 16 %
Sand:	28 – 61 %
Silt:	29 – 60 %
Clay:	4 – 18 %

Standard Penetration Tests performed in this typically granular (non-cohesive) fill yielded N-values ranging from 0 to 68 blows/0.3 m but generally 6 to 38, indicating a generally loose to dense relative density, with some very loose and very dense zones.

In some boreholes, which were drilled from the shoulder, such as Boreholes F27, F28, F29, C10, F31, C11 and F33, organic soils were contacted at the bottom of the embankment fill (i.e. topsoil/organic soils appear not to have been properly stripped prior to placing the embankment fill).

4.3.3 Silty Sand to Sandy Silt

A silty sand to sandy silt deposit was encountered in Boreholes F27, F35, F38A and F38C. Along the westbound toe, Boreholes F38A and F38C encountered this silty sand to sandy silt deposit below the topsoil, where it extended to 0.8 to 4.6 m depth (Elevation 130.8 to 126.4 m). In Borehole F35, the deposit was contacted below the fill at 1.5 m, extending to 4.0 m (Elevation 127.0 m) below the ground surface. In shoulder borehole (F27), this layer was encountered at 4.6 m depth (Elevation 129.1 m) and extended to 5.3 m depth (Elevation 128.5 m). This deposit contains traces to some clay and gravel size particles. It is classified as a fine grained granular (i.e. cohesionless) material.

Four grain-size analyses were carried out on representative samples and results are presented on the Record of Borehole sheets in Appendix A3, and in Figure B3-3 in Appendix B3.

These show the following grain-size distribution.

Gravel:	0 - 1 %
Sand:	28 - 86 %
Silt:	13 - 58 %
Clay:	11 - 19 %

Standard Penetration Tests performed in the deposit yielded N-values ranging from 4 to 34 blows/0.3 m which indicate a loose to dense relative density.

4.3.4 Silt

Borehole F38A encountered a dilatant silt layer below the silty sand layer, at a depth of 0.8 m and extended to 3.1 m (Elevation 128.5 m) below the ground surface. This deposit contains some clay and traces of sand. The grain-size distribution of a sample from this deposit is given in Figure B3-4 in Appendix B3.

This shows the following grain-size distribution.

Gravel:	0 %
Sand:	8 %
Silt:	79 %
Clay:	13 %

Standard Penetration Tests performed in the deposit yielded N-values ranging from 11 to 17 blows/0.3 m which indicate compact relative density.

4.3.5 Clayey Silt to Silty Clay

Below the embankment fill and the surficial silty sand to sandy silt deposit, all boreholes except Boreholes F28, F29, F31, F32, F39 and F40 encountered a clayey silt to silty clay deposit of varying thickness. In the toe area boreholes, this clayey silt to silty clay deposit was encountered at 0.2 to 4.6 m depth (Elevation 129.6 to 126.4 m) and extended to 3.1 to 11.3 m depth (Elevation 126.8 to 120.3 m). Its thickness was found to range from 1.6 to 8.7 m.

In the boreholes drilled from existing shoulder, the deposit was contacted at depths of 4.5 to 7.6 m (Elevation 129.8 to 126.8 m) and was found to extend to depths ranging from 7.2 to 14.5 m below the ground surface or to Elevation 126.6 to 120.1 m. Its thickness was found to range from 0.7 to 8.4 m. In general, the thickness of clayey silt to silty clay layer is greater towards east of Brook Creek (west branch) and gradually decreases towards west side of this creek.

Twenty four grain-size analyses were carried out on representative samples of this cohesive soil. The results are presented on the Record of Borehole sheets in Appendix A3, and the grain size curves are shown in an envelope form in Figure B3-5 in Appendix B3.

These show the following grain-size distribution.

Gravel:	0 – 16 %
Sand:	3 – 51 %
Silt:	32 – 68 %
Clay:	15 – 43 %

This is a cohesive soil.

The results of Atterberg Limits tests performed on twenty three samples recovered from the deposit are given on the individual Record of Borehole Sheets and also on Plasticity Chart (Figure B3-6) in Appendix B3. The following index values were obtained:

Liquid Limit:	20 – 34 %	(Average: 26 %)
Plastic Limit:	13 – 22 %	(Average: 17 %)
Plasticity Index:	6 – 17 %	(Average: 9 %)
Natural Moisture Content:	14 – 33 %	(Average: 23 %)

These results are characteristic of clayey soils exhibiting low plasticity characteristics.

Standard Penetration Tests performed in the deposit yielded N-values ranging from 0 to 35 blows/0.3 m but generally 2 to 13 blows/0.3 m and field vane tests yielded undrained in-situ shear strengths of 30 to in excess of 100 kPa. These results indicate a firm to very stiff consistency.

Two oedometer (one dimensional consolidation) tests were performed in the laboratory on thin-walled tube (TW) samples (TW7 and TW11 samples from Borehole C12) from this cohesive deposit. The results are presented in Figure B3-7 and Figure B3-8 in Appendix B3. The results show that the deposit can be considered to have a possible pre-consolidation pressure in excess of the existing overburden pressure, P'_0 – P'_0 of the order of 95 to 210 kPa or over consolidation ratio, OCR, equal to 1.9 to 3.8. The test results also show that the deposit is more over consolidated within the upper zone than the lower zone. A compression index (C_c) of about 0.3 to 0.4 along with a recompression index (C_r) of about 0.05 and 0.07 were obtained. The test results also indicate a coefficient of consolidation (c_v) of about 3 to 5×10^{-3} cm²/s.

The measured undrained shear strengths versus elevation of the boreholes in Fill Area 3 are presented in Figure C8 in Appendix C. As discussed above for Fill Area 1 and Fill Area 2, the consolidation characteristics of the clayey silt to silty clay deposit were assessed by plotting undrained shear strength, overburden pressure, P'_0 and $0.23 \times P'_0$ versus depth. Figure C9 in Appendix C presents the variation of the measured undrained in-situ shear strength, overburden pressure, P'_0 , and $0.23 \times P'_0$ versus the elevation for Borehole C12. It is commonly acknowledged that with Ontario clays if the measured undrained shear strength are in excess of $0.23 P'_0$ line, the deposit may be over consolidated. Based on this criterion, the clayey silt to silty clay deposit appears to be over consolidated, which is consistent with the results of the consolidation tests discussed above.

The clayey silt deposit is considered to be relatively less pervious than the overlying embankment fill and the underlying till deposit.

4.3.6 Glacial Till

Underlying the clayey silt to silty clay or the silty sand to sandy silt, all boreholes contacted a glacial deposit consisting of silty sand to sandy silt till. The deposit consists of a heterogeneous mixture of sand and silt with traces to some gravel and clay. The presence of cobbles and boulders was also inferred within the glacial till deposit. Due to their mode of deposition, the presence of cobbles and boulders should always be anticipated in the glacial till deposits. In Borehole C11, a gravelly sand layer was found inter-bedded in the glacial till deposit.

In all toe boreholes, this deposit was contacted at depths of 2.3 to 11.3 m (Elevation 128.8 to 120.3 m) and was found to extend to the remaining depths of the boreholes. In all boreholes drilled from the existing shoulder, the till deposit was encountered at depths of 4.9 to 14.5 m (Elevation 128.9 to 120.9 m) and was found to extend to the remaining depth of the boreholes.

This till deposit is basically a granular material (i.e. non-cohesive) but in some cases, where the clay content is high, the deposit shows some apparent cohesion. The grain size distribution of twenty three samples from the till deposit is presented in an envelope form in Figure B3-9 in Appendix B3. The results indicate the following grain-size distribution.

Gravel:	1 – 43 %
Sand:	27 – 73 %
Silt:	21 – 59 %
Clay:	6 – 18 %

N-values recorded in this soil deposit range from 4 to in excess of 100 blows/0.3 m which indicate loose to very dense compactness condition, but generally dense to very dense.

4.3.7 Groundwater Conditions

The groundwater conditions in the open boreholes were observed during the drilling and upon completion of each borehole, as shown on the individual Record of Borehole Sheets in Appendix A3. The observations made in the boreholes are summarized in Table 4.3.

Table 4.3: Groundwater Level Observations – Fill Area 3 – Stations 20+650 to 20+750 EB & WB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
C9	9.3 / 119.2	Jun 3 2010 Aug 19 2010 Oct 15 2010	+2.1 / 130.6* +1.4 / 129.9 +0.8 / 129.3	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
C10	-	Jul 26 2010	5.8 / 128.6*	Measured upon borehole completion
C11	-	Jul 8 2010	5.8 / 128.1*	Measured upon borehole completion
C12	9.1 / 121.7	Jul 7 2010 Jul 22 2010 Aug 19 2010 Oct 15 2010	3.7 / 127.1* 0.4 / 130.4 0.8 / 130.0 0.9 / 129.9	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
C12A	-	Dec 7 2010	0.9 / 125.7*	Measured upon borehole completion
F27	-	Jul 5 2010	5.5 / 128.3*	Measured upon borehole completion
F28	-	Jul 27 2010	2.4 / 131.7*	Measured upon borehole completion
F29	-	Jul 27 2010	3.5 / 130.7*	Measured upon borehole completion
F30	-	Jul 21 2010	Dry to Elevation 129.8 m*	Measured upon borehole completion
F31	-	Jul 12 2010	Dry to Elevation 130.3 m*	Measured upon borehole completion
F32	-	Jul 9 2010	4.6 / 129.2*	Measured upon borehole completion
F33	-	Jul 8 2010	5.8 / 128.2*	Measured upon borehole completion
F34	-	Jul 7 2010	3.2 / 131.1*	Measured upon borehole completion

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
F35	-	Jun 6 2010	2.1 / 128.9*	Measured upon borehole completion
F36	-	Jun 3 2010	2.1 / 128.4*	Measured upon borehole completion
F37	-	Jun 3 2010	1.2 / 128.7*	Measured upon borehole completion
F38A	-	May 28 2010	1.2 / 130.4*	Measured upon borehole completion
F38C	-	Jun 2 2010	2.1 / 128.9*	Measured upon borehole completion
F39	-	Jul 14 2010	1.4 / 129.7*	Measured upon borehole completion
F40	-	Jul 14 2010	1.8 / 128.5*	Measured upon borehole completion
F42	-	Jul 6 2010	1.1 / 131.1*	Measured upon borehole completion

Note: * Groundwater level measured not stabilized.

As the observations were made upon completion of each borehole, except for the two piezometers (stabilized water level), which were installed in Boreholes C9 and C12, the recorded levels are unlikely to represent the stabilized groundwater levels. In general, the groundwater table at the site at the time of investigation varies from about 2 m above original ground level (i.e. artesian condition – Boreholes C9 and C12) to about 2 m below the original ground level or ranging from about Elevation 131 to 126 m.

It should be pointed out that the observed groundwater levels represent the conditions at the time of our investigation and that the groundwater level would be subject to fluctuations, both seasonally and in response to major weather events. In addition to the observed groundwater conditions, a perched water condition could possibly be encountered at the site due to accumulation of surface water in fill materials, overlying the practically impervious clayey silt to silty clay deposit. The water level in the watercourse would also influence the groundwater level at the site.

4.4 Fill Area 4 – Stations 22+230 to 22+380 WB

Fill Area 4 is located between Stations 22+230 and 22+380 along the westbound lanes of Highway 401, in the Township of Hamilton. This embankment fill is approximately 150 m in length and the proposed height is about 4 to 6 m above the o.g. levels (i.e. the existing embankment will be widened matching the existing embankment grade). Visual inspection of the existing embankment at this location did not reveal any signs of embankment instability. Boreholes F43 to F54, C13 and C14 were advanced for the foundation investigation for this fill location. The details of these boreholes are presented in Table 3.4 in Section 3 and are shown on Drawing A4 in Appendix A4.

The top of the road elevation (i.e. centerline elevation) in this stretch ranges from about 142.6 m at Station 22+330, gradually increasing to about 145.6 m at Station 22+400 (i.e. an elevation rise of 3.0 m over a horizontal distance of 170 m), representing an approximate 1.8 % average gradient.

The original ground level elevations between Stations 22+330 to 22+400 in the westbound range from 138.3 to 142.2 m. The existing embankment is typically 4 to 6 m high in the westbound.

Detail descriptions of the boreholes can be found on the Record of Boreholes Sheets in Appendix A4 and the laboratory test results are presented in Appendix B4. The inferred stratigraphy is presented on Drawing A4 in Appendix A4.

In general, the boreholes advanced from the top of the highway embankment (Boreholes F43 to F48 and C14) encountered pavement fill while the boreholes advanced from the toe of the embankment (Boreholes F49 to F54 and C13) encountered topsoil from the ground surface. All boreholes, except for Borehole C13, encountered embankment fill, at depths between 0.1 to 0.6 m below the existing ground surface, immediately below the pavement fill or topsoil. Below the embankment fill in Boreholes F44, F48, F51, F52 and C14, and topsoil in Borehole C13, a clayey silt deposit was encountered at 0.2 to 5.3 m below the ground surface (Elevation 142.7 to 136.3 m). Underlying the topsoil, fill material or clayey silt, a glacial till deposit was contacted in all boreholes at 0.9 to 7.5 m from the ground surface or at Elevations 142.1 to 135.9 m. All boreholes were terminated within the glacial deposit at between Elevation 136.3 and 130.3 m.

The following summarizes the surface conditions encountered in the boreholes.

4.4.1 Topsoil

Topsoil, 0.1 to 0.2 m in thickness, was contacted at the ground surface in the boreholes drilled from the toe of the embankment (i.e. Boreholes F49 to F54 and C13).

Note that in our experience, the thickness of organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.4.2 Fill

4.4.2.1 Pavement Fill

Boreholes F43 to F48 and C14, advanced at highway shoulder, from the top of the highway embankment, encountered pavement fill at the ground surface. This pavement fill consists of a 0.4 to 0.6 m of sand and gravel to gravelly sand.

Standard Penetration Tests performed within this granular (i.e. non-cohesive) material yielded N-values between 17 and 26 blows/0.3 m, indicating that this pavement fill is compact in condition. These results show that the fill material has received systematic compaction when it was first placed.

4.4.2.2 Embankment Fill

All boreholes, except for Borehole C13, encountered embankment fill immediately below the pavement fill (Boreholes F43 to F48 and C14) or topsoil (Boreholes F49 to F54), at 0.1 to 0.6 m below the existing

ground level or Elevations 145.4 to 138.1 m. This embankment fill consists of silty sand to sandy silt with trace to some gravel and clay. Rootlets and organics were occasionally encountered within the layer. This layer extends to 0.7 to 7.5 m below the ground surface (Elevation 142.7 to 136.6 m).

Grain-size distribution of eight samples from the embankment fill was analysed in the laboratory. The distributions are presented in Figure B4-1 and summarized as follows:

Gravel:	3 – 18 %
Sand:	36 – 54 %
Silt and Clay:	39 – 50 % (Typically 27 – 39 % silt and 9 – 14 % clay)

This layer is considered as a granular (i.e. non-cohesive) soil.

N-values obtained from Standard Penetration Tests performed within this layer ranged from 2 to 78 blows/0.3 m, indicating that the embankment fill is very loose to very dense in relative density, typically compact to dense. In Borehole F46, N-value in excess of 100 blows/0.3 m was recorded as the split spoon encountered some large gravel.

4.4.3 Organic Silt

Boreholes F50 and F51 encountered a layer of organic silt underlying the embankment fill. A layer of sand and silt was encountered at the bottom of the organic silt deposit in Borehole F51. Grain-size analysis was performed on a sample retrieved from the organic silt. The sample contained 0 % gravel, 57 % sand, 41 % silt and 2 % clay. These results are presented in Figure B4-2, in Appendix B4.

Standard Penetration Tests performed within the organic silt deposit yielded N-values between 3 and 7 blows/0.3 m. This indicates that the deposit is very loose to loose.

4.4.4 Clayey Silt

A layer of clayey silt was contacted in Boreholes F44, F48, F51, F52, C13 and C14, at 0.2 to 5.3 m below the ground level (Elevations 142.7 to 136.3 m) and extended to 2.2 to 7.3 m below the ground surface (Elevations 142.1 to 135.9 m). This clayey silt deposit ranges between 0.4 and 2.4 m in thickness and contains traces of gravel and some sand.

The grain-size distribution of five samples from this layer is presented in Figure B4-3 in Appendix B4. The distribution can be summarized as follows:

Gravel:	0 – 6 %
Sand:	12 – 19 %
Silt:	45 – 58 %
Clay:	28 – 31 %

Atterberg Limits tests were performed on six samples retrieved from this cohesive deposit. The results from these tests are presented in Figure B4-4 in Appendix B4.

Liquid Limit:	20 – 26 %
Plastic Limit:	14 – 17 %
Plasticity Index:	6 – 9 %

The results presented above indicate that this clayey (cohesive) deposit is of low plasticity.

A field shear vane test was performed in Borehole F44 and yielded an in-situ undrained shear strength in excess of 100 kPa, shown in Figure C10 in Appendix C. Standard Penetration Tests performed within this deposit yielded N-values between 2 and 33 blows/0.3 m. From the results of the field testing (shear vane and SPT), the consistency of this cohesive layer can be described as very soft to very stiff, but typically firm to stiff.

4.4.5 Glacial Till

All boreholes contacted glacial deposits immediately below the embankment fill, organic silt or clayey silt at depths between 0.9 and 7.5 m (Elevation 142.1 and 135.9). All boreholes were terminated within the till deposits at Elevations between 136.3 and 130.3 m. These consist of a heterogeneous mixture of sand and silt with some gravel and traces of clay (i.e. glacial till) but a wide range of grain-size distribution in the glacial till deposit was noted along the boreholes drilled in this stretch (i.e. these are all basically granular – i.e. non-cohesive soils but some were found to be relatively much coarser – i.e. high gravel size particle content). In general, however, two major groups of till, namely, silty sand to sandy silt till and sand and gravel till, were contacted within this deposit.

4.4.5.1 Silty Sand to Sandy Silt Till

This deposit was contacted in all boreholes except for Borehole F46 and it consists of mainly sand and silt in various proportions with traces to some gravel and clay. The composition of this material is basically similar to the till deposit encountered at other locations (i.e. Fill Areas 1, 2 and 3) drilled along the Highway. Due to its mode of deposition, cobbles and boulders should always be expected within this deposit.

Grain size analyses were performed on thirteen samples retrieved from this deposit. The grain-size distribution is presented in Figure B4-5 in Appendix B4.

Gravel:	0 – 20 %
Sand:	12 – 94 %
Silt and Clay:	6 – 74 % (typically 18 – 59 % silt and 5 – 21 % clay)

A gravelly sand layer was encountered in Borehole F50 within the till deposit. The grain-size distribution is presented in Figure B4-6, in Appendix B4. The grain-size analysis revealed that the sample retrieved from this layer had 31% gravel, 56 % sand and 13 % silt and clay size particles

Standard Penetration Tests performed within this granular (i.e. non-cohesive) deposit yielded N-values between 15 and in excess of 100 blows/0.3 m, indicating this deposit is in a compact to very dense in condition, typically compact to dense.

A thin sand till deposit was contacted near the bottom of Boreholes F48 and F54, underlying the silty sand to sandy silt till deposit at 8.8 and 7.2 m below the ground surface, respectively. Grain-size analysis was performed on one sample retrieved from this deposit. The distribution is presented in Figure B4-7 and summarized as follows.

Gravel:	11 %
Sand:	75 %
Silt and Clay:	14 %

4.4.5.2 Sand and Gravel Till

A gravelly till deposit consisting of primarily sand and gravel was contacted in Boreholes F44, F48, F51, F52, C13 and C14. This deposit contains a heterogeneous mixture of gravel, sand, silt and clay, with the major constituents being gravel and sand. As such it is relatively coarser than the silty sand to sandy silt till deposits contacted along this stretch and elsewhere at the site along Highway 401. This deposit is described as a coarse grained granular material and can be expected to be more pervious than the silty sand to sandy silt till and considerably more pervious than the overlying clayey silt to silty clay deposits. Due to its mode of deposition, cobbles and boulders should always be expected within this deposit.

Grain size distribution of five samples retrieved from this deposit was analysed. The results are presented in Figure B4-8 and summarized below.

Gravel:	33 – 47 %
Sand:	45 – 60 %
Silt and Clay:	7 – 22 %

Standard Penetration Tests performed within this deposit recorded N-values between 27 and in excess of 100 blows/0.3 m, indicating that the relative density of this granular (i.e. non-cohesive) deposit is compact to very dense.

4.4.6 Groundwater Conditions

The groundwater conditions were observed during drilling and upon completion of each borehole. A piezometer was also installed into Borehole C13 to observe the stabilized water levels. The groundwater conditions observed in the boreholes are summarized in Table 4.4 and presented in the individual Record of Borehole Sheets in Appendix A4.

Table 4.4: Groundwater Level Observations – Fill Area 4 – Stations 22+230 to 22+380 WB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
C13	9.1 / 130.5	Jun 2 2010 Aug 19 2010 Oct 15 2010	0.9 / 138.7* 0.4 / 139.2 0.6 / 139.0	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
C14	-	Jul 19 2010	5.8 / 139.1*	Measured upon borehole completion
F43	-	Jul 20 2010	4.3 / 138.2*	Measured upon borehole completion
F44	-	Jul 20 2010	5.8 / 137.5*	Measured upon borehole completion
F45	-	Jul 20 2010	5.2 / 138.5*	Measured upon borehole completion
F46	-	Jul 19 2010	4.6 / 139.6*	Measured upon borehole completion
F48	-	Jul 19 2010	6.1 / 139.8*	Measured upon borehole completion
F49	-	May 27 2010	2.1 / 136.9*	Measured upon borehole completion
F50	-	May 26 2010	1.5 / 137.1*	Measured upon borehole completion
F51	-	May 26 2010	1.8 / 136.8*	Measured upon borehole completion
F52	-	May 26 2010	1.4 / 136.9*	Measured upon borehole completion
F54	-	May 25 2010	3.4 / 138.8*	Measured upon borehole completion

Note: * Groundwater level measured not stabilized.

It should be noted that the water levels observed in open boreholes upon completion of drilling is likely to be unreliable as it had not been stabilized.

Based on the water level observations in the boreholes and on the stabilized water level observed in the piezometer installed in Borehole C13, the groundwater table at the time of our investigation along this stretch ranged between Elevations 140 and 137 m. It should also be noted that the groundwater levels are subjected to seasonal variations and fluctuations due to major weather events. In addition, the water level in the watercourse would influence the groundwater level at the site.

4.5 Fill Area 5 – Stations 22+330 to 22+400 EB

Fill Area 5 is located between Stations 22+330 and 22+400 along the eastbound lanes of Highway 401, in the Township of Hamilton. This proposed fill section is approximately 70 m long. Existing fill embankment at this location is about 4 to 5 m high. Visual inspection of the existing embankments along this stretch did not reveal any signs of embankment instability. A total of eight boreholes, F55 to F60, C15 and C16, were drilled at the location of Fill Area 5. The details of these boreholes are presented in Table 3.5 in Section 3. Drawing A5 in Appendix A5 shows the locations of the boreholes.

The top of the road elevation (i.e. centerline elevation) in this stretch ranges from about 144.4 m at Station 22+330 gradually increasing to about 145.6 m at Station 22+400 (i.e. an elevation rise of 1.2 m over a horizontal distance of 70 m), representing an approximate 1.7 % average gradient. The original ground level elevations between Stations 22+330 to 22+400 in the eastbound range from 139.7 to 141.3 m.

Detailed descriptions of the materials encountered in the boreholes are presented on the Record of Borehole Sheets in Appendix A5. An inferred stratigraphy is presented on Drawing A5 in Appendix A5.

In general, the site is underlain by topsoil, fill (pavement fill and embankment fill), clayey silt (in Boreholes F58 and C15 only), which are in turn underlain by glacial till and/or sand and gravel deposits. Below the topsoil (in Boreholes C16 and F58 to F60) and pavement fill (in Boreholes C15 and F55 to F57), embankment fill was encountered which was found to extend to depths of 0.8 to 7.0 m below the ground surface. In Boreholes F58 and C16, a clayey silt deposit was encountered below the embankment fill, with thicknesses of 0.6 and 3.0 m, respectively. The underlying glacial deposit was encountered at depths of 1.7 to 7.0 m below the ground surface or at Elevations 139.3 to 135.9 m. Sand & gravel deposit was encountered within the western portion of the site at depths of about 3.7 to 6.1 m or at Elevations 136.0 to 137.9 m in Boreholes F55 and F58 and below the till deposit at 5.8 m depth or at Elevation 135.5 m in Borehole F60. All boreholes were terminated within the glacial deposit or the underlying sand and gravel deposits at depths of 5.0 to 11.9 m below the ground surface or at Elevations 135.8 to 132.0 m.

The following paragraphs summarize the surface conditions encountered in the boreholes.

4.5.1 Topsoil

Topsoil was encountered at the ground surface in Boreholes F58 to F60 and C16 which were drilled at the toe of the existing embankment. The thickness of the topsoil at these borehole locations is 0.2 m.

Note that in our experience, the thickness of organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.5.2 Fill

4.5.2.1 Pavement Fill

In the boreholes drilled from the shoulder of Highway 401 (Boreholes F55 to F57 and C15), pavement fill was encountered at the ground surface. This pavement fill consists of 0.3 m of sand and gravel and 0.4 m of sand with some gravel.

Standard Penetration Tests yielded SPT N-values of 14 to 20 blows/0.3 m within the granular pavement fill layer, indicating compact condition.

4.5.2.2 Embankment Fill

Below the topsoil and pavement fill, embankment fill was encountered. The embankment fill was described as silty sand and was found to extend to depths of 0.8 to 7.0 m below the existing ground surface or to Elevations 139.3 to 135.9 m. In most of the boreholes, organic materials were encountered near the base of the embankment fill.

Grain size distribution analyses carried out on five samples taken from the embankment fill indicate the following distribution, as shown in Figure B5-1, in Appendix B5.

Gravel:	2 – 9 %
Sand:	36 – 51 %
Silt:	28 – 44 %
Clay:	10 – 18 %

The embankment fill is considered to be a granular (non-cohesive) material.

A thin clayey silt fill layer was found within the embankment fill in Borehole F57 (SS6A) with the following grain size distribution, as shown in Figure B5-2, in Appendix B5.

Gravel:	1 %
Sand:	19 %
Silt:	52 %
Clay:	28 %

Atterberg Limits tests conducted on the clayey silt fill sample (F57 SS6A) indicated the following results, also shown in Figure B5-3, in Appendix B5.

Liquid Limit:	29 %
Plastic Limit:	17 %
Plasticity Index:	12 %

SPT N-values recorded within the embankment fill varied from 4 to 69 blows/0.3 m indicating varying densities from very loose to very dense condition. However, SPT N-values indicating very loose to loose densities were generally recorded in the boreholes drilled at the bottom of the embankment and in isolated zones within the embankment. The relatively high SPT N-value (69 blows/0.3 m) was only recorded within Borehole F56. Generally, the embankment fill was assessed to have a relative density of compact to dense.

4.5.3 Clayey Silt

In western portion of Fill Area 5 (i.e. Boreholes F58 and C16 only), a clayey silt deposit was encountered below the embankment fill at Elevation 137.4 and 138.9 m, with thicknesses of 0.6 and 3.0 m, respectively.

The following are the grain size distribution of the two samples taken from this deposit, as shown in Figure B5-4, in Appendix B5.

Gravel:	0 %
Sand:	5 – 8 %
Silt:	60 %
Clay:	32 – 35 %

Atterberg Limits tests conducted on the same two samples taken from this deposit indicated the following results, also shown in Figure B5-5, in Appendix B5.

Liquid Limit:	26 – 27 %
Plastic Limit:	16 – 18 %
Plasticity Index:	8 – 10 %

This clayey deposit is considered to have low degree of plasticity.

Typically, SPT N-values of 9 to 26 blows/0.3 m were recorded within this deposit. A relatively low SPT N-value of 5 blows/0.3 m was recorded in C16 just below the embankment fill where organic topsoil was encountered within this deposit. We assess that the clayey silt deposit is considered to have a consistency of stiff to very stiff.

4.5.4 Glacial Till

Below the embankment fill and clayey silt deposit, a granular (non-cohesive) glacial deposit was encountered at depths of 1.7 to 7.0 m below the ground surface or at Elevations 139.3 to 135.9 m. The glacial deposit was described as generally silty sand to sandy silt till in the western portion of Fill Area 5. All boreholes (except Boreholes F55, F58 and F60) were terminated within the glacial deposit at depths of 3.7 to 11.9 m below the ground surface or at Elevations 136.0 to 132.3 m.

The following are the grain size distribution of the selected eight samples taken from the till deposit, as presented in Figure B5-6, in Appendix B5.

Gravel:	1 – 22 %
Sand:	18 – 60 %
Silt:	15 – 60 %
Clay:	4 – 18 %

SPT N-values of 22 to in excess of 100 blows/0.3 m were recorded within the deposit, indicating compact to very dense relative densities. Generally, SPT N-values indicating compact condition were recorded just below the clayey silt deposit or embankment fill and relatively higher SPT N-values were recorded below that indicating that this deposit is generally in dense to very dense condition.

4.5.5 Sand and Gravel

A granular deposit consisting of primarily sand and gravel was contacted in Boreholes F55, F58 and F60. This deposit contains traces of silt and clay size particles.

Grain size distribution test were carried out on selected two samples taken from the sand and gravel deposit, as presented in Figure B5-7, in Appendix B5.

Gravel:	48– 52 %
Sand:	41 – 44 %
Silt and Clay:	4 – 11 %

SPT N-values of 63 to in excess of 100 blows/0.3 m were recorded within the deposit, indicating a very dense relative density.

4.5.6 Groundwater Conditions

Groundwater levels were observed in the open boreholes while drilling and upon completion of each borehole. Groundwater levels measured on completion of the boreholes may not be reliable. A piezometer was installed in Borehole C16 to monitor the groundwater levels over a prolonged period without interference from surface water. The groundwater levels observed during the investigation are presented on the Record of Borehole Sheets in Appendix A5. The groundwater levels observations are summarized in the following table.

Table 4.5: Groundwater Level Observations – Fill Area 5 – Stations 22+330 to 22+400 EB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
C15	-	Aug 4 2010	5.2 / 139.0*	Measured upon borehole completion
C16	5.5 / 134.2	Jun 30 2010 Aug 19 2010 Oct 15 2010	1.5 / 138.2* 0.5 / 139.2 0.7 / 139.0	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F55	-	Aug 4 2010	dry*	Measured upon borehole completion

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
F56	-	Aug 5 2010	5.2 / 139.5*	Measured upon borehole completion
F57	-	Aug 2 2010	6.4 / 138.7*	Measured upon borehole completion
F58	-	Jun 28 2010	1.1 / 138.6*	Measured upon borehole completion
F59	-	Jul 12 2010	2.4 / 138.1*	Measured upon borehole completion
F60	-	Jul 12 2010	2.1 / 139.2*	Measured upon borehole completion

Note: * Groundwater level measured not stabilized.

Based on the moisture condition of the soil samples and results of the piezometer readings, the site groundwater level at the time of our investigations was at about Elevations 139 to 138 m.

It should be noted that groundwater levels are subject to variations due to the influence of rainfall, temperature, local drainage, seasons and other factors. There may also be potential for development of perched groundwater tables following periods of rainfall and groundwater may rise to the ground surface. In addition the water level in the watercourse would influence the groundwater level at the site.

4.6 Cut Area 1 – Stations 21+920 to 22+150 EB

Cut Area 1 is located at Stations 21+920 to 22+150, on the south (right) side of Highway 401, about 0.8 km east of Nagle Road. During our field inspection, no significant sign of slope instability was noted. Site photographs are presented in Appendix D6.

Twelve (12) boreholes (Boreholes F61 to F72) were advanced for this cut location. Boreholes F61 to F66 were drilled approximately 17 to 18 m south of the median centreline of Highway 401, from the granular shoulder of the highway; Boreholes F67 to F72 were advanced at the top of the proposed cut, approximately 1.2 to 8.0 m north of the south fence line. The details of the boreholes are listed in Table 3.6 in Section 3 and their locations are shown on Drawing A6 in Appendix A6.

The top of the road elevation (i.e. centerline elevation) in this stretch ranges from about 137.3 m at Station 21+920 gradually increasing to about 141.4 m at Station 22+150 (i.e. an elevation rise of 4.1 m over a horizontal distance of 230 m), representing an approximate 1.8 % average gradient.

The original ground level elevations between Stations 21+920 and 22+150 in the eastbound are range from 141.3 to 149.9 m. The existing cut is typically 4 to 11 m high in the eastbound.

Detail descriptions of the boreholes can be found in the Record of Boreholes Sheets in Appendix A6 and the laboratory test results are presented in Appendix B6. The inferred stratigraphy is presented on Drawing A6 in Appendix A6.

Below the topsoil or granular fill, the subsoil at this location generally consists of dense to very dense glacial till. From the top of the existing cut slope, 0.2 m topsoil was contacted in Boreholes F67 to F72 while Boreholes F61 to F66, advanced from the shoulder of the highway, contacted a granular pavement fill which extends to 0.4 to 0.7 m below the ground surface or Elevations 140.3 to 136.3 m. Borehole F64 encountered a layer of sand while Borehole F65 encountered a sandy silt layer under the pavement fill. All boreholes contacted a silty sand to sandy silt till at depths between 0.2 and 3.7 m from the ground surface or between Elevation 149.3 and 136.3 m, below topsoil, pavement fill, sand or sandy silt. The till deposit extends to the remaining depth of the boreholes, except in Boreholes F67 and F68. In these two boreholes, the silty sand to sandy silt till extends to depths of 10.4 and 13.7 m, respectively, and is underlain by sand till. These two boreholes terminated at 12.6 and 14.0 m below the existing ground, respectively.

The following summarizes the surface conditions encountered in the boreholes.

4.6.1 Topsoil

Topsoil, 0.2 m in thickness, was contacted in Boreholes F67 to F72.

Note that in our experience, the thickness of organic rich soils frequently varies in between and beyond borehole locations. In particular, thicker organic soils frequently occur in depressed areas and within watercourse valleys.

4.6.2 Fill

Boreholes F61 to F66 were drilled from the granular shoulder of Highway 401 and these contacted granular fill between 0.4 and 0.7 m in thickness. At Borehole F62, the upper zone (0.1 m) of granular fill was mixed with some topsoil. This granular fill consists of gravel and sand in various proportions.

Grain-size analysis of a sample retrieved from the granular fill was conducted in the laboratory and it contains 32 % gravel, 59 % sand and 9 % silt and clay size particles. The grain-size distribution of this sample is presented in Figure B6-1 in Appendix B6.

Standard Penetration Tests were performed within the fill layers and yielded N-values between 7 and 33 blows/0.3 m, indicating this deposit is loose to dense in relative density, typically compact in condition. This result shows that the fill material generally received systematic compaction when it was first placed, with the exception of Borehole F62.

4.6.3 Sand

Borehole F64 contacted a sand deposit immediately below the granular fill at 0.5 m below the existing ground (Elevation 138.7 m). This 1.0 m thick deposit extends to 1.5 m below the ground level (Elevation 137.7 m) and contains some silt and traces of clay-size particles.

Grain-size distribution of a sample from this deposit was analysed in the laboratory. The results are presented in Figure B6-2 in Appendix B6 and summarized below.

Gravel:	0 %
Sand:	75 %
Silt:	16 %
Clay:	9 %

This deposit is a granular (i.e. non-cohesive) material.

Standard Penetration Test performed within this layer yielded 25 blows/0.3 m, indicating this deposit is compact in condition.

4.6.4 Sandy Silt

A sandy silt deposit was contacted in Borehole F65 from 0.4 to 3.7 m below the ground level (Elevation 139.6 to 136.3 m). This deposit contains traces of clay and dilatancy was also observed.

Grain-size distribution of a sample retrieved from this deposit yielded results as 0 % gravel, 38 % sand, 51 % silt and 11 % clay (Figure B6-3, Appendix B6).

Standard Penetration Tests conducted within this deposit yielded N-values between 63 and in excess of 100 blows/0.3 m, indicating this deposit is very dense in condition.

4.6.5 Glacial Till

4.6.5.1 Silty Sand to Sandy Silt Till

Overlain by topsoil, pavement fill, sand or sandy silt, all boreholes contacted a predominant silty sand to sandy silt till deposit at depths between 0.2 and 3.7 m below the ground surface (Elevations 149.3 to 136.3 m). This till deposit consists of heterogeneous mixture of gravel, sand, silt and clay-size particles with sand and silt being the major constituents. Frequent layers of sand and gravel and sand of various proportions were contacted within this till deposit. Due to its mode of deposition, cobbles and boulders should be expected within this deposit.

Boreholes F61 to F66 and F69 to F72 were terminated within this deposit at depths 4.7 to 16.9 m (Elevation 135.9 to 131.6 m) while Boreholes F67 and F68 contacted a sand till deposit underlying this deposit at depths 10.4 and 13.7 (Elevation 131.4 and 130.9 m).

Grain-size analyses were performed on eleven samples retrieved from this till deposit. The distribution is summarized as follows and presented in Figure B6-4 in Appendix B6.

Gravel:	2 – 11 %
Sand:	30 – 59 %
Silt:	25 – 56 %
Clay:	5 – 13 %

The grain-size distribution of three samples from the sand layers within the till deposit is presented in Figure B6-5 and summarized below.

Gravel:	0 – 9 %
Sand:	79 – 85 %
Silt and Clay:	12 – 20 %

The grain-size distribution of three samples from the sand and gravel to gravelly sand layer was obtained in the laboratory and they contain 24 – 51 % gravel, 44 – 65 % sand and 5 – 22 % silt and clay-size particles. The grain-size distribution is shown in Figure B6-6, Appendix B6.

The unit weight of two (2) samples from this till deposit was measured in the laboratory. The results are 23.4 and 20.8 kN/m³ for Samples F61/SS3 and F65/SS3, respectively.

N-values obtained from Standard Penetration Tests performed within this granular (i.e. non-cohesive) till deposit ranged from 4 to in excess of 100 blows/0.3 m. These results indicate that this till deposit is very loose to very dense in relative density, typically very dense throughout the deposit with loose to compact zones near the surface.

4.6.5.2 Sand Till

Boreholes F67 and F68 contacted a sand till deposit at 10.4 and 13.7 m below the ground surface, immediately below the silty sand to sandy silt till deposit. This deposit consists mainly of sand with various proportions of gravel, silt and clay-size particles. Boreholes F67 and F68 were terminated within this deposit at 12.6 and 14.0 m below the ground surface or Elevation 131.1 and 128.7 m. Due to its mode of deposition, cobbles and boulders should always be expected within this deposit.

Grain-size distribution of a sample obtained from this deposit yielded 1 % gravel, 83 % sand and 16 % silt and clay-size particles. The grain-size distribution is presented in Figure B6-7, Appendix B6.

N-values yielded from the Standard Penetration Tests performed within this deposit are in excess of 100 blows/0.3 m indicating that this deposit is very dense in condition.

4.6.6 Groundwater Conditions

The groundwater conditions were observed during drilling and upon completion of each borehole. Piezometers were also installed into selected boreholes to observe the stabilized water levels. The groundwater conditions observed within the boreholes are summarized in Table 4.6 and presented in the individual Record of Borehole Sheets in Appendix A6.

Table 4.6: Groundwater Level Observations – Cut Area 1 – Stations 21+920 to 22+150 EB

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
F61	-	Jul 13 2010	4.7 / 132.3*	Measured upon borehole completion
F62	4.0 / 133.9	Jul 13 2010 Aug 19 2010 Oct 15 2010	2.4 / 135.5* 1.1 / 136.8 0.9 / 137.0	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F63	-	Jul 13 2010	1.8 / 136.8*	Measured upon borehole completion
F64	4.6 / 134.6	Jul 13 2010 Aug 19 2010 Oct 15 2010	2.3 / 136.9* 1.6 / 137.6 1.4 / 137.8	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F65	-	Jul 13 2010	1.8 / 138.2*	Measured upon borehole completion
F66	4.0 / 136.9	Jul 13 2010 Aug 19 2010 Oct 15 2010	3.1 / 137.8* 2.6 / 138.3 2.3 / 138.6	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F67	-	Jun 28 2010	7.9 / 133.4*	Measured upon borehole completion
F68	13.7 / 131.4	Jun 29 2010 Jun 30 2010 Aug 19 2010 Oct 15 2010	10.0 / 135.1* 7.1 / 138.0 7.1 / 138.0 6.3 / 138.8	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed

Borehole No.	Depth/Elevation of the Tip of Piezometer (m)	Date of Water Level Measurement	Measured Water Level Depth/Elevation (m)	Comments
F69	-	Jun 25 2010	10.4 / 137.8*	Measured upon borehole completion
F70	13.7 / 135.8	Jun 30 2010 Aug 19 2010 Oct 15 2010	10.8 / 138.7* 11.4 / 138.1 10.9 / 138.6	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed
F71	-	Jun 24 2010	10.5 / 137.9*	Measured upon borehole completion
F72	12.2 / 132.8	Jun 29 2010 Jun 30 2010 Aug 19 2010 Oct 15 2010	8.1 / 137.5* 6.8 / 138.8 7.3 / 138.3 6.8 / 138.8	First reading measured upon borehole completion and succeeding readings measured within the piezometer installed

Note: * Groundwater level measured not stabilized.

From the observed water levels, the groundwater table generally ranges between Elevations 138 and 137 m. However, observations made in Boreholes F61 and F67 revealed that the groundwater table may be lower (Elevation 134 m) near Stations 21+900 and 21+920.

It should be noted that the water levels observed in open boreholes upon completion of drilling is likely to be unreliable as they had not been stabilized. It should also be noted that the groundwater levels are subject to seasonal variations and fluctuations due to major weather events.

For and on behalf of Coffey Geotechnics Inc.

Sanket Shah

Engineer in Training

Delfa Sarabia, M.Eng.

Senior Geotechnical Engineer

Ramon Miranda, P.Eng.

Principal



Zuhtu Ozden, P.Eng.

Senior Principal



Appendix A1

Drawing and Record of Borehole Sheets

Fill Area 1 – Stations 20+150 to 20+400 EB

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

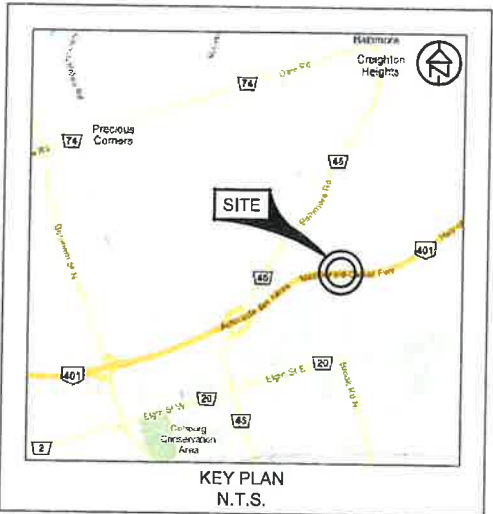
GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 1 - STATIONS
20+150 TO 20+400 EB
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- Borehole
- N
- Blows/0.3m (Std. Pen. Test, 475 Jblow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
C7	120.6	412734.3	4873397.0
C8	115.1	412725.2	4873381.3
F1	118.6	412596.0	4873390.6
F2	119.2	412638.8	4873394.3
F3	119.6	412665.8	4873394.1
F4	121.5	412785.3	4873398.5
F5	122.8	412835.4	4873400.1
F6	115.3	412586.6	4873380.4
F7	114.6	412632.5	4873379.2
F8	115.3	412684.5	4873381.5
F9	115.8	412786.7	4873380.6
F10	118.0	412835.0	4873382.2

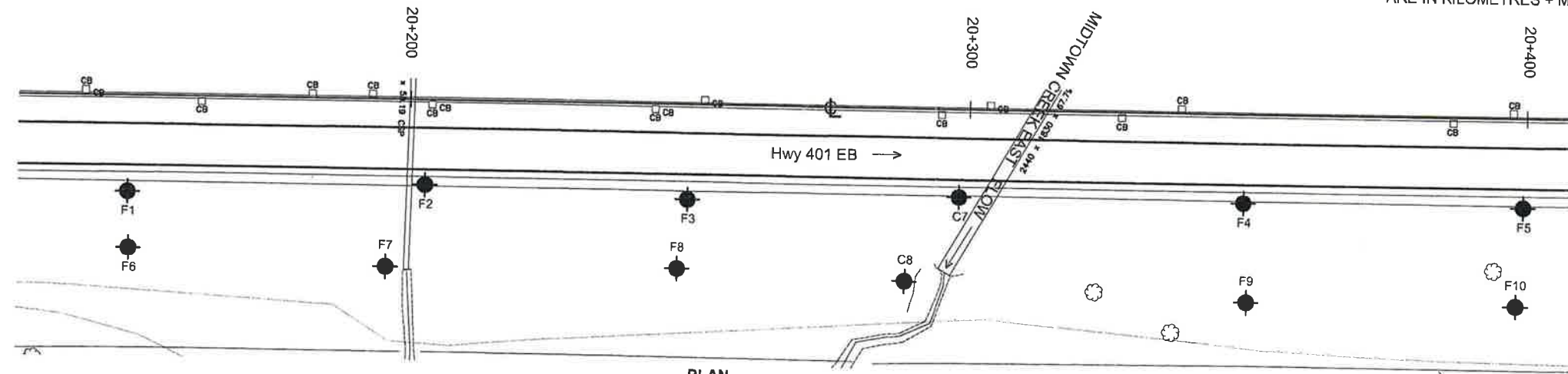
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

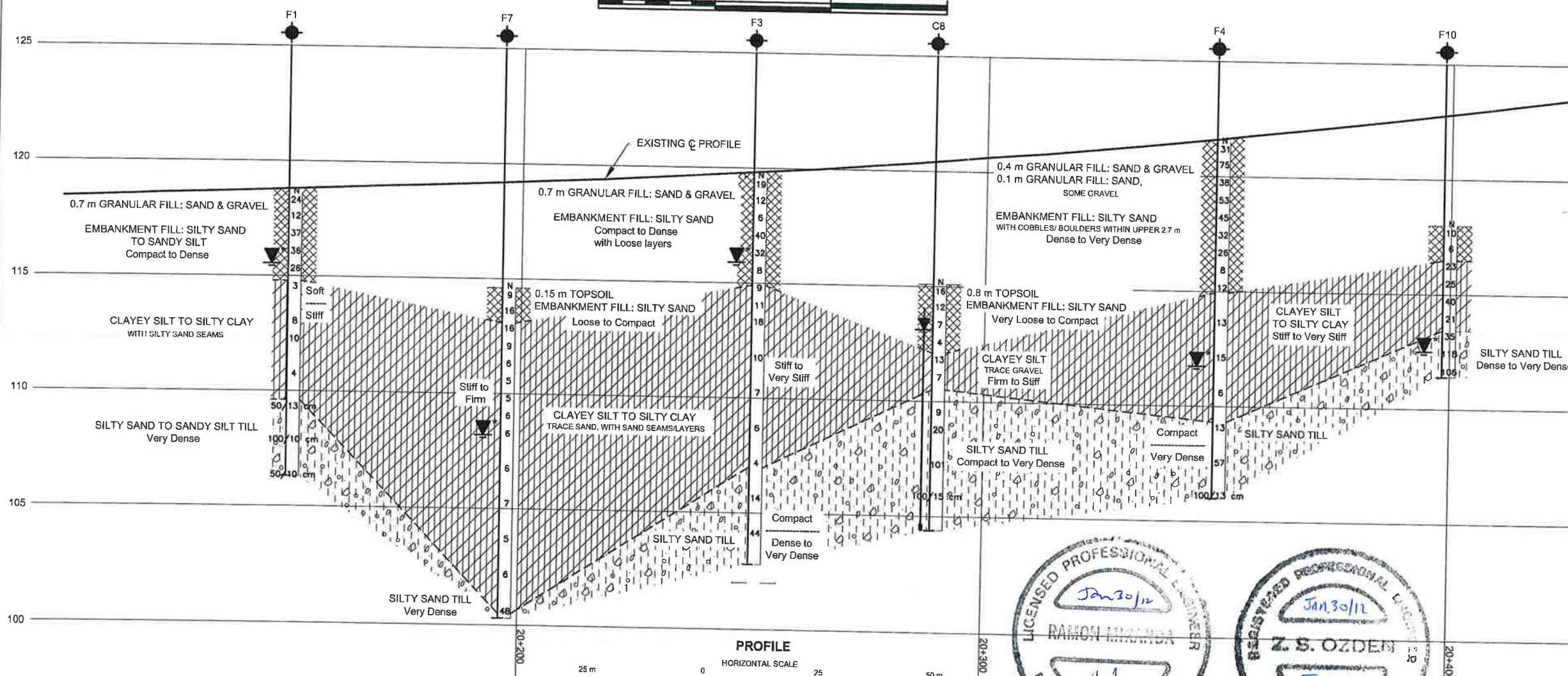
NOTE: This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION

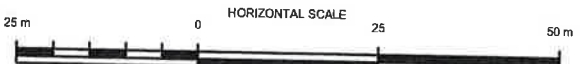
Geoties No.	TRANET010434AA	DIST
SUBMD	CHECKED	DATE Aug 25, 2011
DRAWN	SH	CHECKED RM
APPROVED	ZO	DWG
		A1



PLAN



PROFILE



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C7

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+298, 16 m Rt of C/L (E 412734.3, N 4873397.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger, DCPT COMPILED BY WC
 DATUM Geodetic DATE 7/29/2010 7/30/2010 CHECKED BY ZO

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	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
120.6 0.0	GROUND SURFACE		1	SS	16		120					
	0.6 m GRANULAR FILL: sand and gravel, tr. asphalt, concrete pieces brown, compact, moist		2	SS	20		119					
	EMBANKMENT FILL: Silty Sand tr. to some clay, tr. to some gravel brown, v. loose to dense, moist to wet		3	SS	35		118					
			4	SS	38		117					
			5	SS	34		116					
			6	SS	11		115					
			7	SS	2		114					
			8	SS	17		113					
114.0 6.6	black, some organics		9	SS	15		112					
	CLAYEY SILT TO SILTY CLAY brown, firm to stiff, moist		10	SS	8		111					
112.1 8.5	SILTY SAND TILL tr. clay, tr. to some gravel grey, compact to v. dense, wet		11	SS	24		110					
			12	SS	12		109					
			13	SS	46		108					
			14	SS	33		107					
							106					

Continued Next Page

+ ³ × ³ Numbers refer to
Sensitivity

20
15-5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C7

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+298, 16 m Rt of C/L (E 412734.3, N 4873397.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger, DCPT COMPILED BY WC
 DATUM Geodetic DATE 7/29/2010 7/30/2010 CHECKED BY ZO

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								
105.6													
104.9			15	SS	51								
15.7	End of borehole Dynamic cone penetration test (DCPT) from 15.8 m to 16.9 m												
103.7													
16.9	Water level @ 4.6 m (not stabilized) upon completion. Borehole caved-in @ 9.1 m upon completion.												

+ ³ × ³ Numbers refer to
Sensitivity

20
15-0.5
10 (%) STRAIN AT FAILURE

TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No C8

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+289, 31 m Rt of C/L (E 412725.2, N 4873381.3) ORIGINATED BY LG
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

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 (%)	
115.1 0.0	GROUND SURFACE 0.8 m TOPSOIL		1	SS	16		115											
	EMBANKMENT FILL: Silty Sand grey, v. loose to compact, moist		2	SS	12		114											
			3	SS	7		113										0 48 34 18	
			4	SS	4		112											
112.1 3.0	CLAYEY SILT tr. gravel grey, firm to stiff, wet <div>sandy</div>	5	SS	13	111											spoon wet below 3.1 m		
		6	SS	7	110												0 4 57 39	
110.5 4.6	SILTY SAND TILL tr. to some gravel grey, compact to v. dense, wet		7	SS	9		109										3 23 48 26	
			8	SS	20		108											
			9	SS	101		107											2.1 m of soil back-up @ 7.6 m
			10	SS100 / 15			106											23 56 13 8
						105												
104.4 10.7	End of Borehole Auger refusal @ 10.7 m Piezometer installed @ 9.1 m. Borehole caved-in @ 9.1 m upon completion. Date / Measured Water Level August 19, 2010 / 2.0 m October 15, 2010 / 1.9 m															1.5 m of soil back-up @ 10.7 m		

+ 3 × 3 Numbers refer to
Sensitivity 20
15 10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F1

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+150, 17 m Rt of C/L (E 412586.0, N 4873390.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/28/2010 CHECKED BY ZO

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
118.6 0.0	GROUND SURFACE		1	SS	24									
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. gravel, tr. to some clay brown, compact to dense, moist		2	SS	12									
			3	SS	37									
			4	SS	36									
			5	SS	26									
114.8 3.8			6	SS	3									
	CLAYEY SILT TO SILTY CLAY with silty sand seams brown, wet soft stiff		7	TW	PH									
			8	SS	8									
			9	SS	10									
			10	SS	4									
109.6 9.0			11	SS 50 / 13 cm										
	SILTY SAND TO SANDY SILT TILL gray, v. dense, moist		12	SS 100 / 10 cm										
			13	SS 50 / 10 cm										
106.3 12.3	End of Borehole. Water level @ 3.1 m (not stabilized)* upon completion. Borehole caved-in @ 7.3 m upon completion.													

+³, X³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

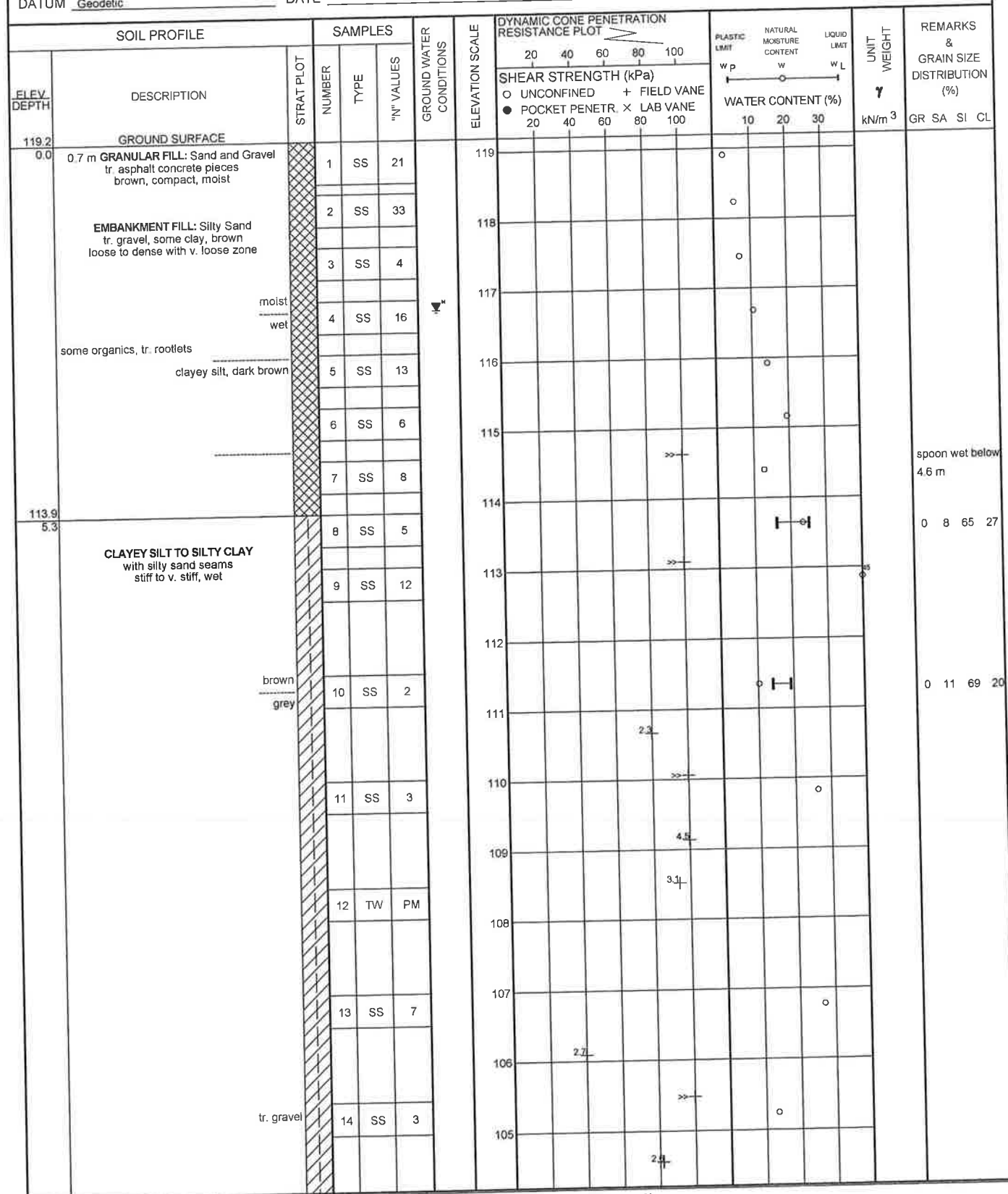
TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F2

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 20+203, 15 m Rt of C/L (E 412638.8, N 4873394.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 7/28/2010 CHECKED BY ZO



Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE


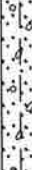
TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F2

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+203, 15 m Rt of C/L (E 412638.8, N 4873394.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 7/29/2010 CHECKED BY ZO

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)							WATER CONTENT (%)
								20 40 60 80 100							
104.2															
	CLAYEY SILT TO SILTY CLAY with silty sand seams stiff to v. stiff, wet		15	SS	4		104								
102.4							103								
16.8															
	SILTY SAND TILL grey, wet	 compact v. dense	16	SS	12		102								
100.5							101								
18.7	End of Borehole. Water level @ 2.4 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.														

+ 3 X 3 Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F3

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 20+245, 17 m Rt of C/L (E 412685.8, N 4873394.1) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger, DCPT COMPILED BY WC
 DATUM Geodetic DATE 7/29/2010 CHECKED BY ZO

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			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		
119.6 0.0	GROUND SURFACE													
	0.7 m GRANULAR FILL: Sand and Gravel tr. asphalt concrete pieces brown, compact, moist		1	SS	19		119							
			2	SS	12		118							
	EMBANKMENT FILL: Silty Sand tr. to some clay, tr. gravel, brown compact to dense with loose layers, moist		3	SS	6		117							
			4	SS	40		116							
			5	SS	32		115							
			6	SS	8		114							
114.9 4.7	with organics, tr. rootlets, black		7	SS	9		113							
	CLAYEY SILT TO SILTY CLAY tr. sand, with silty sand seams/layers stiff to v. stiff, wet		8	SS	11		112							
			9	SS	18		111							
			10	SS	10		110							
			11	SS	7		109							
			12	SS	6		108							
			13	SS	4		107							
107.0 12.6	SILTY SAND TILL grey, compact, wet		14	SS	14		106							
							105							

Continued Next Page

+ 3 x 3

Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

hard to push vane
deeper than 11.6
m

spoon wet below
13.7 m

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F3

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+245, 17 m Rt of C/L (E 412685.8, N 4873394.1) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger, DCPT COMPILED BY WC
 DATUM Geodetic DATE 7/29/2010 CHECKED BY ZO

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH (kPa)	WATER CONTENT (%)	W _P	W		
104.6							20 40 60 80 100	20 40 60 80 100	10 20 30				
	SILTY SAND TILL grey, dense to v. dense, wet		15	SS	44								
102.8													
16.8	End of Borehole. Water level @ 3.7 m (not stabilized)* upon completion.												
102.0	Borehole caved-in @ 15.9 m upon completion.												
17.6	End of DCPT												

+ 3 × 3 : Numbers refer to
Sensitivity

20
15 10 5 0
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F4

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+349, 16 m Rt of C/L (E 412785.3, N 4873398.5) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

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	● POCKET PENETR						
121.5	GROUND SURFACE						20 40 60 80 100									
0.0	0.4 m GRANULAR FILL: Sand and Gravel 0.1 m GRANULAR FILL: Sand, some gravel		1	SS	31											
	EMBANKMENT FILL: Silty Sand with cobbles/boulders within upper 2.7 m tr. gravel, brown, dense to v. dense, moist		2	SS	75										high SPT due to cobbles/boulders	
			3	SS	38										Auger grinding @ 1.8 to 2.4 m	
			4	SS	53											
			5	SS	45										6 43 36 15	
			6	SS	32											
			7	SS	26											
			8	SS	8											
			9	SS	12											
114.9	dark grey, some organics, tr. rootlets															
6.8	CLAYEY SILT TO SILTY CLAY tr. gravel and sand, grey, stiff		10	SS	13											
			11	SS	15										spoon wet @ 9.1 m	
		moist														
		wet														
			12	SS	6											
		sandy														
109.3			13	SS	13										Auger grinding @ 12.8 m	
12.2	SILTY SAND TILL grey, wet															
		compact														
		v. dense	14	SS	57										Auger grinding @ 14.3 to 14.6 m	

Continued Next Page

+ 3 X 3 Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F4

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+349, 16 m R/L of C/L (E 412785.3, N 4873398.5) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

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					
106.5																
106.0	SILTY SAND TILL grey, v. dense, wet		15	SS100 / 13 cm		106										
105.5	End of Borehole. Water level @ 9.8 m (not stabilized)* upon completion. Borehole caved-in @ 12.5 m upon completion.															

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F5

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+399, 16 m Rt of C/L (E 412835.4, N 4873400.1) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					WATER CONTENT (%)
122.8	GROUND SURFACE							20 40 60 80 100	PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		GR SA SI CL
0.0	0.6 m GRANULAR FILL: Sand, some gravel		1	SS	27								
	EMBANKMENT FILL: Silty Sand with cobbles/boulders within upper 3.8 m tr. gravel, dense to v. dense		2	SS	109 / 25 cm		122						high SPT due to cobbles/boulders
			3	SS	115		121						Auger grinding @ 1.2, 1.8 and 2.1 m
			4	SS	38		120						
			5	SS	48		119						Auger grinding @ 3.4 m
			6	SS	46		118						
	brown, moist grey, wet		7	SS	69		117						
	dark grey to black, some organics, tr. rootlets		8	SS	14		116						
116.9			9	SS	11		115						
5.9	CLAYEY SILT TO SILTY CLAY tr. gravel, grey, stiff to v. stiff, wet		10	SS	16		114						
	tr. sand						113						
113.7			11	SS	35		112						10 47 32 17
9.1	SILTY SAND TILL grey, dense to v. dense, wet		12	SS	83		111						Augering grinding @ 9.8 to 10.4 m
													spoon wet below 10.7 m
110.3			13	SS	100 / 15 cm								
12.5	End of Borehole. Water level 10.1 m (not stabilized)* upon completion. Borehole caved-in @ 11.3 m upon completion.												

+³, x³: Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F6

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+150, 28 m Rt of C/L (E 412586.7, N 4873380.4) ORIGINATED BY SK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/27/2010 7/28/2010 CHECKED BY ZO

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 (%)					
115.3	GROUND SURFACE													
0.0	0.15 m TOPSOIL		1	SS	6									
	EMBANKMENT FILL: Silty Sand some clay, lr. gravel, rootlets brown, loose to compact, moist		2	SS	11									5 58 23 14
113.8														
1.5	CLAYEY SILT TO SILTY CLAY tr. sand, v. stiff to stiff		3	SS	18									0 5 63 32
			4	SS	15									
			5	SS	12									
			6	SS	7									
			7	SS	6									
			8	SS	5									
			9	TW	PH									
			10	SS	8									
			11	SS	100 / 23 cm									
105.9	some gravel, tr. sand													
9.4	SILTY SAND TILL grey, v. dense, moist		12	SS	50 / 8 cm									hard augering
105.2														
10.1	End of Borehole Water level @ 6.1 m upon completion													

+ 3, × 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F7

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+196, 30 m Rt of C/L (E 412632.5, N 4873379.2) ORIGINATED BY SK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/28/2010 CHECKED BY ZO

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 ● POCKET PENETR × LAB VANE	WATER CONTENT (%)					
114.6 0.0	GROUND SURFACE													
	0.15 m TOPSOIL		1	SS	9									
	EMBANKMENT FILL: Silty Sand tr. to some clay brown, loose to compact, moist		2	SS	16									
113.1 1.5	CLAYEY SILT TO SILTY CLAY tr. sand, stiff to firm		3	SS	16									
			4	SS	9									
			5	SS	6									
			6	SS	5									
			7	SS	5									
			8	SS	6									
			9	SS	6									
			10	SS	6									
			11	SS	7									
			12	SS	5									
			13	SS	6									
			14	SS	48									
100.5 14.1	SILTY SAND TILL													
100.3 14.3	grey, v. dense, moist													
	End of Borehole Water level @ 6.4 m upon completion.													

+ 3, × 3 Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE

spoon wet below
3.8 m

0 4 59 37

spoon bouncing
@ 14.3 m

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F8

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 20+248, 30 m Rt of C/L (E 412684.6, N 4873381.5) ORIGINATED BY SK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/28/2010 7/29/2010 CHECKED BY ZO

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 ● POCKET PENETR. X LAB VANE								
115.3 0.0	GROUND SURFACE															
	0.15 m TOPSOIL		1	SS	6		115									
114.5 0.8	EMBANKMENT FILL: Silty Sand tr. gravel and clay brown, loose, moist		2	SS	8		114									
	CLAYEY SILT TO SILTY CLAY tr. sand, v. stiff to stiff, moist		3	SS	22		113									
			4	SS	12		112									
			5	SS	11		111									
			6	SS	13		110									
			7	SS	9		109									
110.0 5.3			8	SS	9		108									
			9	SS	16		107									
			10	SS	11		106									
			11	SS	65		105									
			12	SS	38		104									
103.0 12.3			13	SS	100/6 cm		103									
	End of Borehole. Water level @ 3.1 m (not stabilized)* upon completion.															

+ 3, X 3: Numbers refer to
Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F9

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+350, 34 m Rt of C/L (E 412786.7, N 4873380.6) ORIGINATED BY LG
DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

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 ● POCKET PENETR X LAB VANE				
115.8 0.0	GROUND SURFACE							20 40 60 80 100		10 20 30		
	0.6 m TOPSOIL		1	SS	16		115					
	EMBANKMENT FILL: Silty Sand tr. gravel, brown compact, moist		2	SS	15							
114.3 1.5			3	SS	13		114					
	CLAYEY SILT TO SILTY CLAY tr. sand, tr. gravel, grey stiff to v. stiff		4	SS	16		113					
			5	SS	24		112					
			6	SS	9		111					
		moist wet	7	TW				7.2				
110.5 5.3			8	SS	20		110					
	SILTY SAND TILL grey, wet		9	SS	22		109					
		compact v. dense	10	SS	131		108					
106.7 9.1			11	SS	100 / 15 cm		107					
	End of Borehole. Water level @ 4.6 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.											

+ ³ × ³ Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F10

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+398, 34 m Rt of C/L (E 412835.0, N 4873382.2) ORIGINATED BY LG
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/3/2010 CHECKED BY ZO

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		
118.0 0.0	GROUND SURFACE						118							
	0.6 m TOPSOIL		1	SS	10		117							
	EMBANKMENT FILL: Silty Sand lr. topsoil, brown loose, moist		2	SS	6		116							
116.5 1.5	CLAYEY SILT TO SILTY CLAY grey, very stiff, moist		3	SS	23		115							
			4	SS	25		114							
			5	SS	40		113							
			6	SS	21		112							
113.4 4.6	SILTY SAND TO SANDY SILT TILL grey, dense to v. dense		7	SS	35									
			8	SS	118									
			9	SS	106									
111.4 6.6	End of Borehole. Water level @ 5.5 m (not stabilized)* upon completion. Borehole caved-in @ 5.8 m upon completion.													

+ 3 x 3 Numbers refer to 20
Sensitivity 15 5
10 (%) STRAIN AT FAILURE

Appendix A2

Drawings and Record of Borehole Sheets

Fill Area 2 – Stations 20+300 to 20+500 WB

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 2 - STATIONS
20+300 TO 20+500 WB
BOREHOLE LOCATION PLAN
AND SOIL STRATA 1 OF 2



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- Borehole
- N
- Blows/0.3m (Std. Pen. Test, 475 Jblow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
C5	116.0	412762.4	4873451.0
C6	120.9	412750.1	4873430.6
F11	120.7	412734.3	4873430.4
F11B	116.0	412634.1	4873442.2
F11D	117.9	412686.9	4873442.0
F13	121.8	412787.1	4873432.0
F14	122.3	412812.9	4873432.9
F19	117.7	412734.6	4873443.3

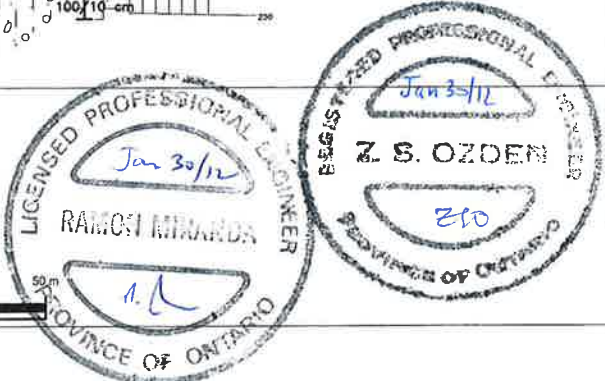
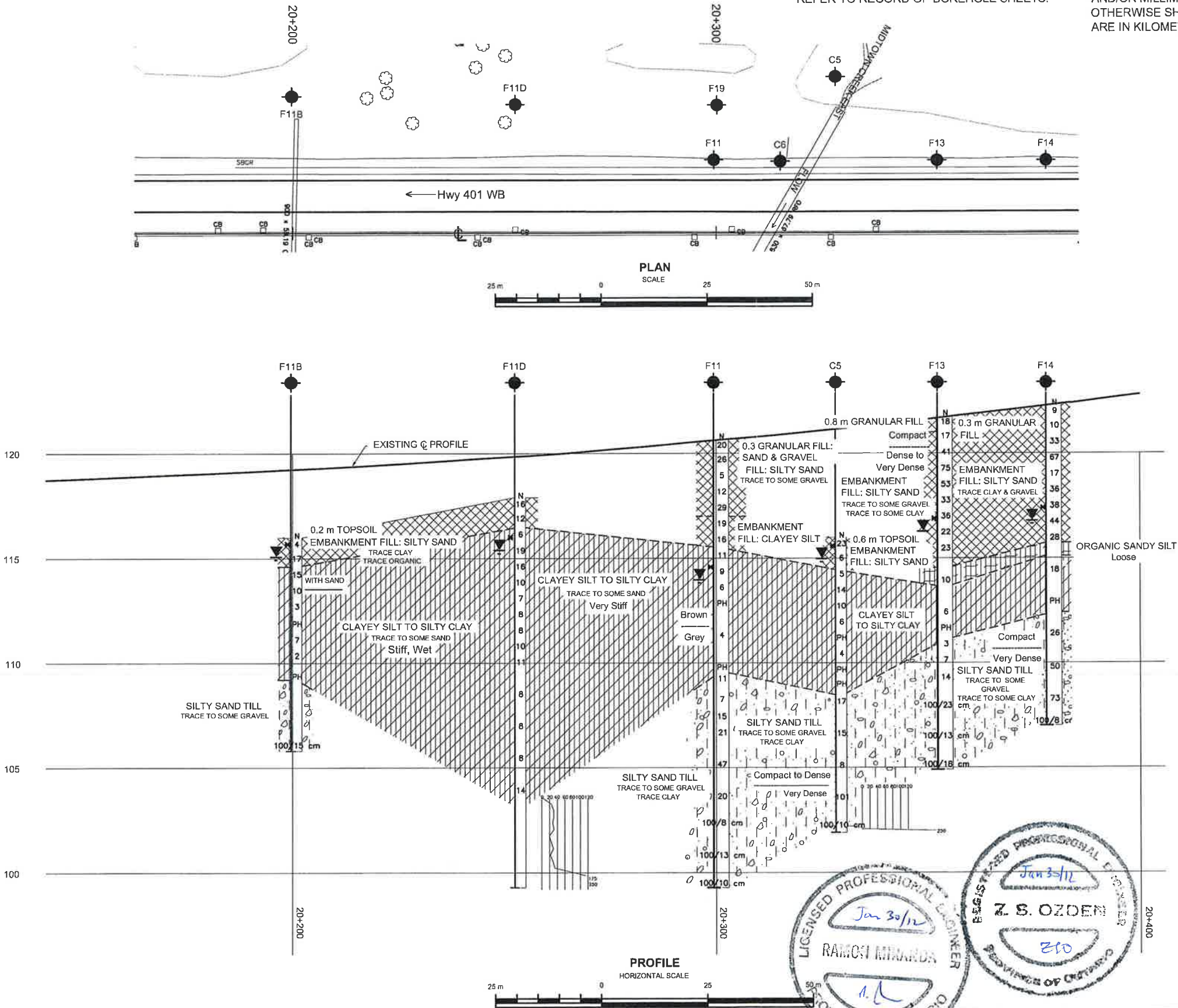
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRANET0810434AA	DIST
SUBMD	CHECKED	DATE Aug 25, 2011
DRAWN	SH	CHECKED RM
APPROVED	ZO	DWG A2-1



NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 2 - STATIONS
20+300 TO 20+500 WB
BOREHOLE LOCATION PLAN
AND SOIL STRATA 2 OF 2



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- Borehole
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
F15	122.9	412833.9	4873433.6
F16	123.5	412859.9	4873434.3
F17	124.1	412864.5	4873435.2
F18	124.9	412909.1	4873435.8
F18B	121.6	412933.8	4873450.8
F18D	124.1	412984.8	4873449.7
F22	117.4	412822.3	4873447.8
F23	117.4	412834.4	4873449.1
F24	118.5	412861.9	4873451.0
F25	120.1	412885.5	4873448.4
F26	121.1	412909.5	4873446.6

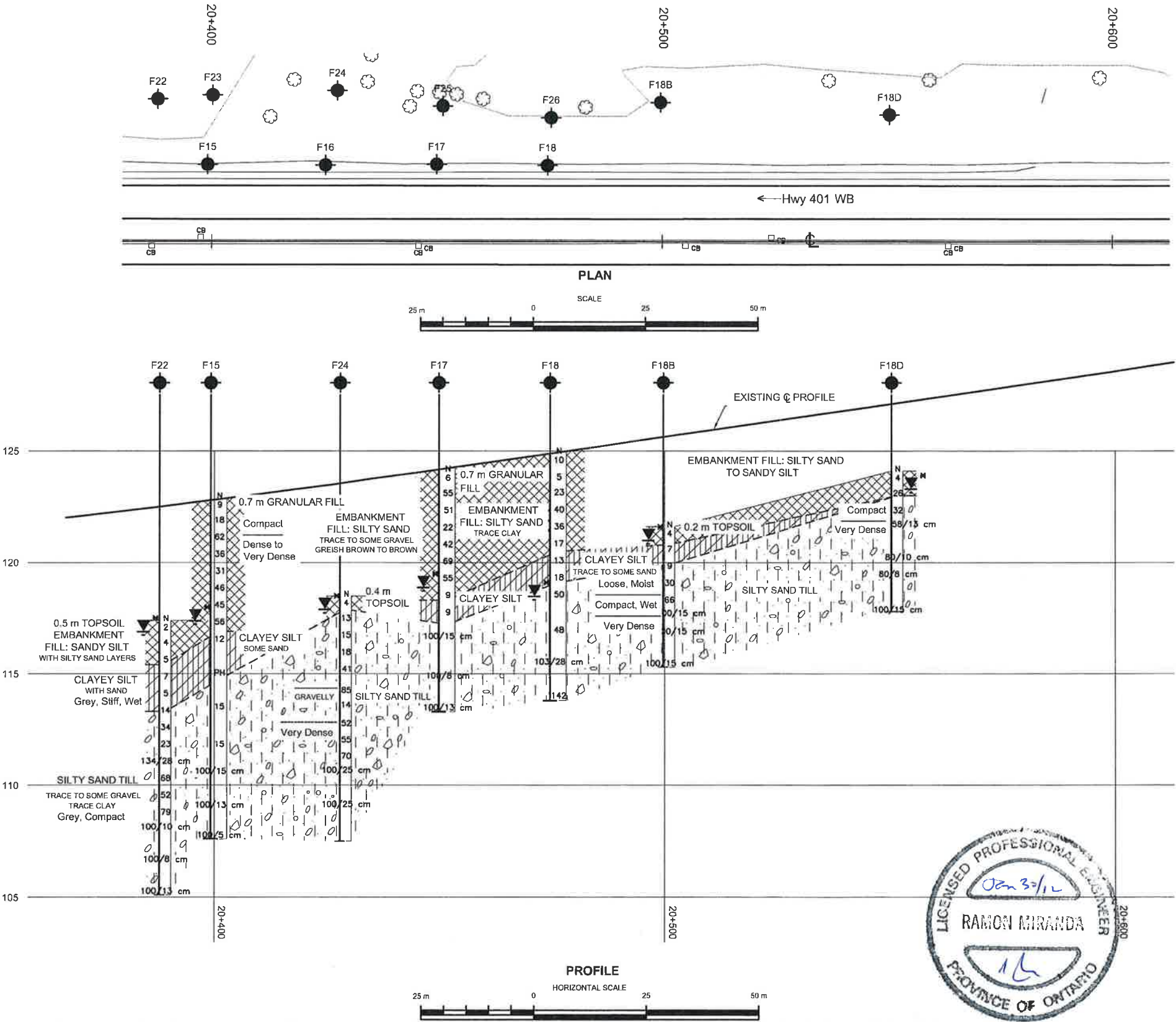
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRANETO10434AA	DIST
SUBMD	CHECKED	DATE Aug 25, 2011
DRAWN	SH	CHECKED RM
APPROVED	ZO	DWG A2-2



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C5

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+328, 37 m Lt of C/L (E 412762.4, N 4873451.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger, DCPT COMPILED BY SK
 DATUM Geodetic DATE 6/11/2010 CHECKED BY ZO

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			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
116.0 0.0	GROUND SURFACE						116						
	0.6 m TOPSOIL		1	SS	23		115						"N" value not reliable
	EMBANKMENT FILL: Silty Sand some clay with rootlets black, loose, moist		2	SS	6		114						
114.2 1.8			3	SS	5		113						
	sandy		4	SS	14		112						spoon wet
	brown		5	SS	10		111						
	grey		6	SS	6		110						
	CLAYEY SILT trace sand stiff, wet		7	TW	PH		109						
			8	SS	4		108						
			9	TW	PH		107						
	tr. to some sand		10	TW	PH		106						
108.3 7.7			11	SS	17		105						
	SILTY SAND TILL trace to some gravel trace clay grey, wet		12	SS	15		104						
			13	SS	8		103						
	compact to loose v. dense		14	SS	101		102						
102.2 13.8			15	SS	101.7 m								
	End of borehole @ 13.8 m Dynamic cone penetration test (DCPT) from bottom of borehole to 14.1 m Water level @ 1.0 m (not stabilized) upon completion. Borehole caved-in @ 9.1 m upon completion.												

+³ . X³ : Numbers refer to Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C6

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 20+315, 17 m Lt of C/L (E 412750.1, N 4873430.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/15/2010 CHECKED BY ZO

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)						
120.9	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100					
0.0	0.3 m GRANULAR FILL: Sand and gravel		1	SS	9					○				
	0.3 m GRANULAR FILL: Sand some gravel and silt, trace clay brown, loose to compact, moist		2	SS	27					○				
	EMBANKMENT FILL: Silty Sand trace to some gravel, trace clay brown, loose to compact, moist		3	SS	5					○				
			4	SS	14					○				
	asphalt fragments		5	SS	100					○				13 44 33 10
			6	SS	24					○				
			7	SS	7					○				
	black, some org.		8	SS	14					○				
	grey compact to dense		9	SS	30					○				spoon wet 0 69 21 10
113.7	CLAYEY SILT TO SILTY CLAY		10	SS	10									
7.2	trace sand brown, stiff, wet		11	TW	PH			1.9						0 3 56 41
			12	TW	PH			2.1						
								5.9						0 3 47 50
108.9	SILTY SAND TILL		13	SS	3									
12.0	trace to some clay, trace to some gravel grey, wet		14	AS										
	v. loose compact to dense		15	SS	20									11 58 21 10

Continued Next Page

+³ ×³ Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C6

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+315, 17 m Lt of C/L (E 412750.1, N 4873430.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/15/2010 CHECKED BY ZO

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			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		
105.9	SILTY SAND TILL trace clay, trace to some gravel grey, v. dense, wet		16	SS	51		105							
							104							
			17	SS	100/13.5		103							
							102							
			18	AS			101							
			19	SS	100/10.2		100							
98.8			20	SS	100/15.2		99							
22.1	End of Borehole sampling @ 20.0 m Water Level @ 5.8 m (not stabilized) upon completion Auger drilled down to 22.1 m for piezometer Borehole caved-in @ 12.2 m upon completion. Piezometer installed to 12.2 m Piezometer water level records : June 16, 2010 5.6 m July 16, 2010 5.5 m Aug 19, 2010 5.9 m Oct 15, 2010 5.8 m													

+ , x : Numbers refer to Sensitivity
 20 15-10 5 10 (%) STRAIN AT FAILURE




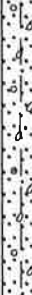
TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F11

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+299, 17 m Lt of C/L (E 412734.3, N 4873430.4) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/14/2010 CHECKED BY ZO

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)					WATER CONTENT (%)
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE 20 40 60 80 100	● POCKET PENETR. 20 40 60 80 100			
120.7	GROUND SURFACE												
0.0	0.3 m GRANULAR FILL: Sand and Gravel tr. asphalt, grey, compact, moist		1	SS	20								37 53 (10)
	EMBANKMENT FILL: Silty Sand tr. to some gravel, tr. clay brownish grey, wet to moist		2	SS	26								
	compact		3	SS	5								
	loose		4	SS	12								
	compact		5	SS	29								
			6	SS	19								
	Clayey Silt sandy, tr. gravel brown to dark brown v. stiff, moist		7	SS	16								
115.5			8	SS	11								
5.2	CLAYEY SILT trace to some sand, trace gravel firm to v. stiff, wet		9	SS	9								spoon wet
			10	SS	6								spoon wet
			11	TW	PH								
			12	SS	4								
109.6			13	TW	PH								
11.1			14	SS	11								
	SILTY SAND TO SANDY SILT TILL tr. to some gravel tr. clay grey, loose to v. dense, wet		15	SS	7								no recovery gravel pieces on spoon tip
			16	SS	15								
			17	SS	21								
105.7											21.9	14 62 (24)	

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F11

2 OF 2

METRIC

GWP GWP 205-00-01 LOCATION Station 20+299, 17 m Lt of C/L (E 412734 3, N 4873430.4) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/14/2010 CHECKED BY ZO

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						10 20 30
105.7 15.0	SILTY SAND TO SANDY SILT TILL tr. to some gravel, some clay grey, loose to v. dense, moist		18	SS	47									0.45 m caved-in	
			19	SS	20										0.75 m caved-in
			20	SS	100/8.4m										
			21	SS	100/13.2m										2 38 40 20
99.3 21.4	End of Borehole @ 21.4 m Water Level @ 6.7 m (not stabilized)* upon completion Borehole caved-in @ 10.7 m upon completion		22	SS	100/7.10.2m										

+ 3 x 3 Numbers refer to
Sensitivity 20
15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F11B

1 OF 1

METRIC

GWP GWP 205-00-01 LOCATION Station 20+200, 33 m LI of C/L (E 412634.1, N 4873442.2) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/9/2010 CHECKED BY ZO

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						
								● POCKET PENETR.	× LAB VANE						
						20	40	60	80	100	10	20	30		
116.0 0.0	GROUND SURFACE		1	SS	4										
	0.2 m TOPSOIL EMBANKMENT FILL: Silty Sand trace clay, trace organics brown, loose to compact, moist to wet		2	SS	17										
114.6 1.4	CLAYEY SILT TO SILTY CLAY stiff, wet		3	SS	15									spoon wet	
	with sand brown		4	SS	10									spoon wet	
	tr. to some sand grey		5	SS	3									0 4 56 40	
			6	TW	PH									no recovery	
			7	SS	7									vane value between El. 110 to 112 m from additional borehole drilled 1 m north	
			8	SS	2									1 5 56 38	
			9	TW	PH									no recovery but sample collected from inside wall of Shelby tube	
109.2 6.8	SILTY SAND TILL trace to some clay trace to some gravel grey, v. dense, moist		10	SS 100/15 cm										4 41 36 19	
			11	SS 100/13 cm										auger grinding hardly from 8.7 m to 9.1 m	
			12	SS 100/10 cm											
105.8 10.2	End of Borehole @ 10.2 m Water Level @ 0.9 m (not stabilized)* upon completion Borehole caved-in @ 3.1 m upon completion		13	SS 100/15 cm											

+ 3 × 3 Numbers refer to 20
Sensitivity 15 5 10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F11D

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+252, 31 m Lt of C/L (E 412686 9, N 4873442 0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/9/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE 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	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)			
117.9 0.0	GROUND SURFACE													
	0.1 m TOPSOIL		1	SS	16									
	EMBANKMENT FILL: Sand and Gravel trace silt, brown, compact, moist		2	SS	12									
116.5 1.4		silty												
			3	SS	6									
		moist	4	SS	19									
		wet	5	SS	16									
			6	SS	10									
			7	SS	7									
		brown	8	SS	8									
		grey	9	SS	8									
	CLAYEY SILT		10	SS	10									
	trace to some sand		11	SS	11									
	v. stiff		12	SS	8									
			13	SS	8									
			14	SS	8									
103.7 14.2			15	SS	14									
	End of Borehole @ 14.2 m Water Level @ 2.5 m (not stabilized)* upon completion Borehole caved-in @ 4.9 m upon completion													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F11D

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+252, 31 m Lt of C/L (E 412686.9, N 4873442.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/9/2010 CHECKED BY ZO

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								
102.9												
99.3												
18.6	DCPT performed from bottom of borehole and ended at 18.6 m on refusal probably on boulder/cobble											

+³ . ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F13

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+352, 17 m Lt of C/L (E 412787.1, N 4873432.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/18/2010 CHECKED BY ZO

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 ● POCKET PENETR	+ FIELD VANE × LAB VANE						
121.8	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30						
0.0	0.4 m GRANULAR FILL: Sand and Gravel trace silt		1	SS	18					○				45 46 (9)	
	0.4 m GRANULAR FILL: Sand, some gravel trace silt, dark brown, compact, moist		2	SS	17						○				
	compact		3	SS	41						○				
	dense to v. dense		4	SS	75						○				
	EMBANKMENT FILL: Silty Sand trace to some gravel trace to some clay grey, moist		5	SS	53						○				
			6	SS	33						○				
			7	SS	36						○				
			8	SS	22						○				
	compact		9	SS	23						○				
													1 59 33 7		
114.3															
7.5	ORGANIC SANDY SILT trace clay, tr. rootlets, black, loose, moist		10	SS	10										
113.6															
8.2	CLAYEY SILT TO SILTY CLAY trace gravel, trace to some sand grey, firm, wet		11	SS	6										
			12	TW	PH										
			13	SS	3										
111.1		with clay	14	SS	7										
10.7			15	SS	14										
	loose to compact														
	v. dense		16	SS100 / 23 cm											
	SILTY SAND TILL trace to some gravel trace clay grey, moist														
			</												

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+ 3 . X 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

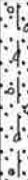
TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F13

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+352, 17 m Lt of C/L (E 412787.1, N 4873432.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/18/2010 CHECKED BY ZO

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 ● POCKET PENETR. X LAB VANE								WATER CONTENT (%)
106.8							20	40	60	80	100					
	SILTY SAND TILL trace to some gravel trace clay grey, v. dense, moist		17	SS100/13	13.2m											
			18	AS												
104.9			19	SS100/18	18.2m											
16.9	End of Borehole @ 16.9 m Water Level @ 5.5 m (not stabilized)* upon completion Borehole caved-in @ 6.4 m upon completion															

+ $\frac{3}{1} \times \frac{3}{1}$ Numbers refer to
Sensitivity

20
15 10 5 0
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F14

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+378, 17 m Lt of C/L (E 412812.9, N 4873432.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 7/5/2010 CHECKED BY ZO

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 ● POCKET PENETR. × LAB VANE								
							20	40	60	80	100	10	20	30		
122.3 0.0	GROUND SURFACE		1	SS	9											
	EMBANKMENT FILL: Silty Sand trace clay, gravel and rock fragments brown, compact to dense, moist		2	SS	10											
			3	SS	33											
			4	SS	67											
			5	SS	17											
			6	SS	36											
			7	SS	38											
			8	SS	44											
115.8 6.5	ORGANIC SANDY SILT trace clay, black, loose, moist		9	SS	28											
115.1 7.2	CLAYEY SILT trace sand brown, v. stiff, moist		10	SS	18											
			11	TW	PH											
112.4 9.9	SILTY SAND TILL trace to some gravel grey, wet		12	SS	26											
			13	SS	50											
			14	SS	73											

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+ 3, × 3 Numbers refer to 20
Sensitivity 15-5 10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F14

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+378, 17 m Lt of C/L (E 412812.9, N 4873432.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 7/5/2010 CHECKED BY ZO

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			20	40	60	80	100		
107.3														
107.0	SILTY SAND TILL		15	SS	1007.8 cm		107							
15.3	End of Borehole. Water level @ 5.5 m (not stabilized)* upon completion. Borehole caved-in @ 10.7 m upon completion.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F15

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+399, 17 m Lt of C/L (E 412833.9, N 4873433.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/17/2010 CHECKED BY ZO

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 ● POCKET PENETR. x LAB VANE	WATER CONTENT (%)					
122.9 0.0	GROUND SURFACE		1	SS	9								41 50 (9)	
	0.4 m GRANULAR FILL: Sand and Gravel 0.3 m GRANULAR FILL: Sand some silt, tr. gravel		2	SS	18									
	compact dense to v. dense		3	SS	62									
	EMBANKMENT FILL: Silty Sand trace to some clay trace to some gravel greyish brown to brown, moist to wet		4	SS	36								15 42 32 1	
			5	SS	31									
			6	SS	46									
			7	SS	45									
			8	SS	56									
116.9 6.0	CLAYEY SILT some sand greyish brown, stiff, moist to wet		9	SS	12								0 15 57 28	
			10	TW	PH									
114.7 8.2	SILTY SAND TILL some gravel, trace clay grey		11	SS	15									
	compact, wet v. dense, moist		12	SS	15									
			13	SS100/15 cm										
			14	SS100/13 cm										

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+³ × 3: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F15

2 OF 2

METRIC

GWP GWP 205-00-01 LOCATION Station 20+399, 17 m Lt of C/L (E 412833.9, N 4873433.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/17/2010 CHECKED BY ZO

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		
107.9																
107.6	SILTY SAND TILL		15	SS	100/5 cm											
15.3	End of Borehole @ 15.3 m Water Level @ 5.5 m (not stabilized)* upon completion Borehole caved-in @ 5.5 m upon completion					107										

+³ . X³ : Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F16

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+425, 17 m Lt of C/L (E 412859 9, N 4873434 3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/17/2010 CHECKED BY ZO

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 7 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		
123.5	GROUND SURFACE																		
0.0	0.4 m GRANULAR FILL: Sand and Gravel 0.3 m GRANULAR FILL: Gravelly Sand some silt		1	SS	9														
	EMBANKMENT FILL: Silty Sand trace to some gravel trace clay brown, moist, dense to v. dense		2	SS	33														
	clayey, stiff		3	SS	50														
			4	SS	13														
			5	SS	57														
	silty fine sand		6	SS	33														
			7	SS	30														
	with topsoil blackish brown compact		8	SS	28														
117.5	CLAYEY SILT		9	SS	8														
6.0	trace sand brown, stiff to v. stiff, moist		10	TW	PH														
116.0	SILTY SAND TILL		11	SS	14														
7.5	trace gravel, trace clay wet																		
	compact v. dense brown grey		12	SS103 / 23 cm															
			13	SS100 / 23 cm															
			14	SS100 / 13 cm															
111.2	End of Borehole @ 12.3 m Water Level @ 4.4 m (not stabilized)* upon completion Borehole caved-in @ 5.2 m upon completion																		
12.3																			

+ 3 . X 3 Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F17

1 OF 1

METRIC

GWP GWP 205-00-01 LOCATION Station 20+450, 17 m Lt of C/L (E 412884.5, N 4873435.2) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/17/2010 CHECKED BY ZO

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		
124.1	GROUND SURFACE													
0.0	0.3 m GRANULAR FILL: Gravelly Sand some silt		1	SS	6		124							30 56 (14)
	0.4 m GRANULAR FILL: Silty Sand tr. gravel, brown, loose, moist		2	SS	55		123							
	EMBANKMENT FILL: Silty Sand		3	SS	51		122							
	trace to some gravel		4	SS	22		121							6 44 40 10
	trace clay		5	SS	42		120							
	dense to v. dense, moist		6	SS	69		119							
	compact		7	SS	55		118							
			8	SS	9		117							
118.3	CLAYEY SILT		9	SS	9		116							spoon wet
5.8	trace sand						115							
	grey, stiff, wet						114							
117.2														
6.9	SILTY SAND TILL		10	SS	100 / 15.4 m									9 53 33 5
	trace gravel, trace clay													
	grey, v. dense, moist to wet													
			11	SS	100 / 8.1 m									
			12	SS	100 / 13.2 m									
113.3														
10.8	End of Borehole @ 10.8 m Water Level @ 5.2 m (not stabilized)* upon completion Borehole caved-in @ 7.6 m upon completion													

+³ . X³ : Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F18

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+474, 17 m Lt of C/L (E 412909.1, N 4873435.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/16/2010 CHECKED BY ZO

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		
124.9 0.0	GROUND SURFACE													
	0.4 m GRANULAR FILL: Sand, some gravel		1	SS	10		124							
	0.4 m GRANULAR FILL: Sand tr. gravel, tr. silt		2	SS	5									
			3	SS	23		123							
	EMBANKMENT FILL: Silty Sand trace to some gravel trace clay brown, compact to dense		4	SS	40		122							
			5	SS	36									
	some org blackish brown		6	SS	17		121							
120.5 4.4	CLAYEY SILT		7	SS	13		120							0 9 55 36
	trace sand		8	SS	18		119							
	grey to brown													
	v. stiff, moist		9	SS	50		118							
119.1 5.8	SILTY SAND TILL		10	SS	48		117							spoon wet
	trace clay, trace gravel						116							spoon wet
	grey, wet		11	SS	103 / 28 cm		115							
							114							
			12	SS	142									
113.8 11.1	End of Borehole @ 11.1 m Water Level @ 6.4 m (not stabilized)* upon completion Borehole caved-in @ 10.1 m upon completion													

+ 3 . X 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F18B

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+500, 31 m Lt of C/L (E 412933.8, N 4873450.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/7/2010 CHECKED BY ZO

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)					
							20 40 60 80 100	20 40 60 80 100	10 20 30				
121.6 0.0	GROUND SURFACE 0.2 m TOPSOIL with rootlets		1	SS	4		121						
120.8 0.8	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. clay, tr. gravel brown, loose, wet		2	SS	7								
119.9 1.7	CLAYEY SILT some sand, tr. gravel brown, v. stiff, moist	3	SS	9	120								spoon wet
	loose, moist	4	SS	30	119								6 51 34 9
	compact, wet	5	SS	66	118								low recovery as sample composed of gravel low recovery as sample composed of gravel auger grinding hardly from 4.6 m to 6.1 m refusal @ 6.3 m
	v. dense	6	SS100 / 15 cm		117								on boulder/cobbles
	SILTY SAND TILL tr. to some gravel, tr. clay grey	7	SS100 / 15 cm		116								
115.3 6.3	End of Borehole @ 6.3 m Water Level @ 0.6 m (not stabilized)* upon completion Borehole caved-in @ 2.4 m upon completion	8	SS100 / 15 cm										

+ 3 x 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F18D

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+550, 28 m Lt of C/L (E 412964.8, N 4873449.7) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/4/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y 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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
124.1 0.0	GROUND SURFACE						124							
	0.2 m TOPSOIL		1	SS	4		123							
123.0 1.1	EMBANKMENT FILL: Silty Fine Sand tr. gravel, brown loose to compact, wet		2	SS	26		122							
	SILTY SAND TILL trace to some gravel, moist		3	SS	32		121							
	compact		4	SS	58 / 13 cm		120							
	v. dense		5	SS	80 / 13 cm		119							
	brown		6	SS	80 / 10 cm		118							
	grey		7	SS	80 / 8 cm									
117.8 6.3	End of Borehole @ 6.3 m Water Level @ 0.8 m (not stabilized)* upon completion Borehole caved-in @ 4.6 m upon completion		8	SS	100 / 15 cm									

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

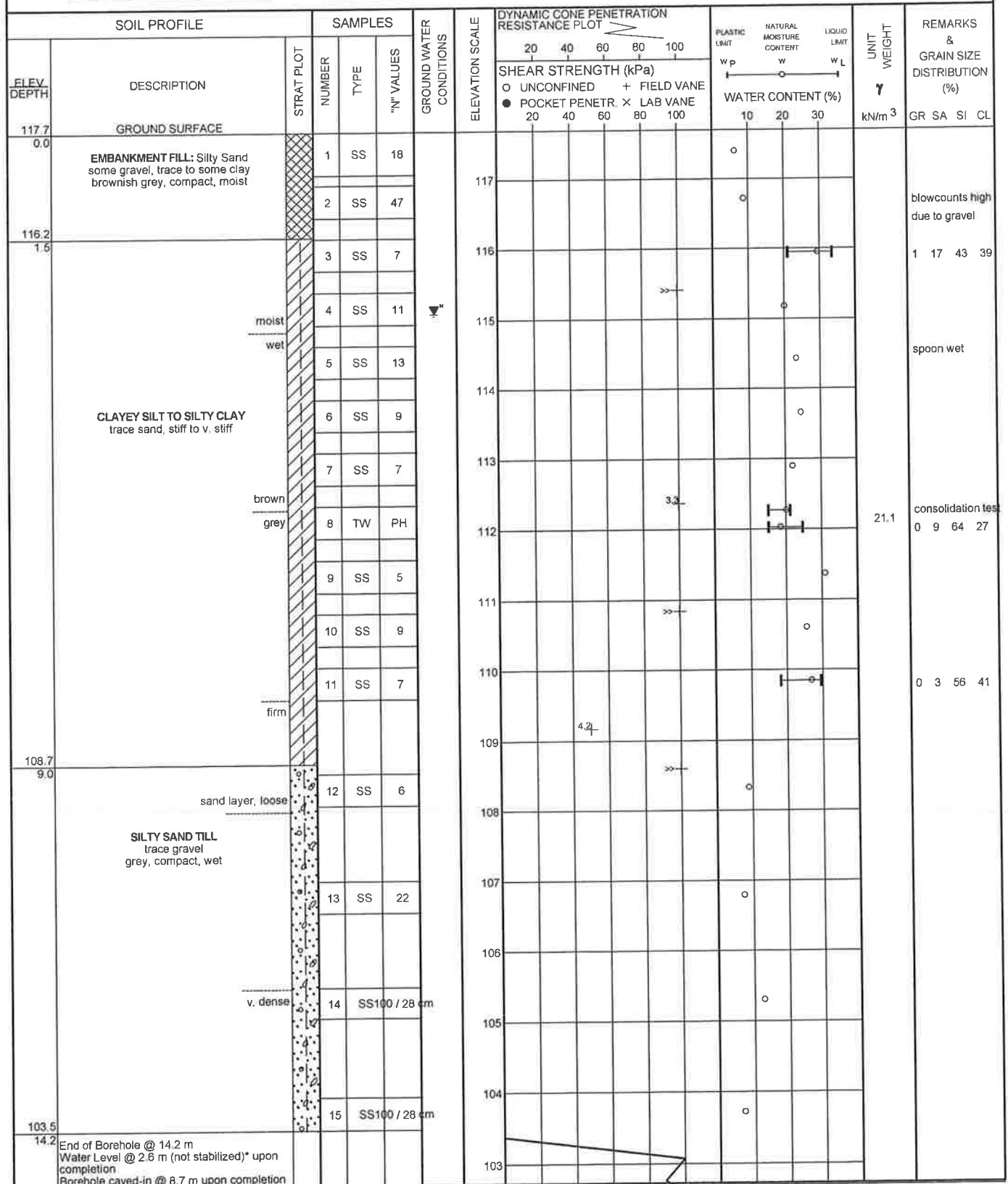
TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F19

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+300, 31 m Lt of C/L (E 412734.6, N 4873443.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/10/2010 CHECKED BY ZO



Continued Next Page

+ 3, X 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F19

2 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 20+300, 31 m Lt of C/L (E 412734.6, N 4873443.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/10/2010 CHECKED BY ZQ

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT W 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	W P	W	W L		
102.7																	
102.2																	
15.5	DCPT performed from 14.3 m and ended at 15.5 m on refusal						102										

+³ ×³ : Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F22

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+388, 32 m Lt of C/L (E 412822.3, N 4873447.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/8/2010 CHECKED BY ZO

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		
117.4 0.0	GROUND SURFACE													
	0.5 m TOPSOIL		1	SS	2		117							
	v. loose													
	loose		2	SS	4									
	EMBANKMENT FILL : Sandy Silt with Silty Sand layers black, with organics, wet						116							
115.4 2.0			3	SS	5								20.0	0 39 41 20
	CLAYEY SILT with sand becoming sandy silt, tr. gravel grey, stiff, wet		4	SS	7		115							spoon wet
			5	SS	5		114							spoon wet
113.3 4.1			6	SS	14									
	SILTY SAND TILL tr. to some gravel trace clay grey, compact		7	SS	34		113							14 47 32 7
			8	SS	23		112							
	v. dense		9	SS	134 / 28 cm		111							auger grinding hardly
	gravelly		10	SS	68		110							
			11	SS	52		109							0.46 m up-heaved
	gravelly, wet		12	SS	79		108							
	moist		13	SS	100 / 10 cm		107							
			14	SS	100 / 8 cm		106							
105.1 12.3			15	SS	100 / 13 cm									
	End of Borehole @ 12.3 m Water Level @ 0.5 m (not stabilized)* upon completion Borehole caved-in @ 7.3 m upon completion													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F23

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 20+400, 33 m Lt of C/L (E 412834.4, N 4873449.1) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/8/2010 CHECKED BY ZO

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		
117.4 0.0	GROUND SURFACE													
	0.3 m TOPSOIL		1	SS	6		117							
	EMBANKMENT FILL: Silty Sand with organics blackish brown, moist to wet		2	SS	4		116							
	loose to v. loose disturbed		3	SS	13		115							spoon wet
115.4 2.0		compact	4	SS	13		114							spoon wet
	CLAYEY SILT		5	SS	14		113							spoon wet
	Ir. to some sand		6	SS	8		112							
	greyish brown, stiff to v. stiff		7	TW	PH		111							
112.5 4.9			8	SS	100 / 15 cm		110							no recovery but sample collected from inside wall of shelby tube
		cobbles	9	SS	160		109							
	SILTY SAND TILL		10	SS	160 / 28 cm									
	some gravel		11	SS	129									up-heave of 0.3 m
	grey, v. dense, wet		12	SS	100 / 15 cm									
108.7 8.7	End of Borehole @ 8.7 m probably on boulder Water Level @ 0.3 m (not stabilized)* upon completion Borehole caved-in @ 6.4 m upon completion													

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F24

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 20+428, 34 m Lt of C/L (E 412861.9, N 4873451.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/7/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE 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	20 40 60 80 100	W _P W W _L	20 40 60 80 100	10 20 30		
118.5 0.0	GROUND SURFACE													
117.9 0.6	0.4 m TOPSOIL		1	SS	4									
	EMBANKMENT FILL: Silty Sand, brown, wet		2	SS	13									spoon wet
	SILTY SAND TILL some gravel, trace clay compact, moist to wet		3	SS	15									spoon wet
			4	SS	18									12 51 30 7
			5	SS	41									
			6	SS	85									
			7	SS	14									
			8	SS	52									possible up-heave of 0.3 m
			9	SS	55									
			10	SS	70									
			11	SS100 / 25 cm										
			12	SS100 / 25 cm										
107.5 11.0	End of Borehole @ 11.0 m Water Level @ 0.6 m (not stabilized)* upon completion Borehole caved-in @ 6.4 m upon completion		13	SS100 / 23 cm										

+³, X³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F25

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 20+451, 30 m Lt of C/L (E 412885.5, N 4873448.4) ORIGINATED BY GJ
DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
DATUM Geodetic DATE 6/7/2010 CHECKED BY ZO

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		
120.1	GROUND SURFACE													
0.0	0.2 m TOPSOIL EMBANKMENT FILL: Silty Sand some gravel		1	SS	12		120							
	tr. to some org. brown to dk. brown loose, moist		2	SS	4		119							0 61 (39)
118.6														
1.5	SANDY SILT tr. to some clay dilatant, brown, loose, wet		3	SS	2		118							spoon wet 0 26 63 11
117.8														
2.3			4	SS	19									spoon wet
	compact													
	v. dense		5	SS	127		117							
	SILTY SAND TILL tr. clay, tr. to some gravel wet		6	SS	126		116							
	brown													
	grey		7	SS	100		115							
			8	SS	100 / 15 cm									
113.9							114							
6.2	End of Borehole @ 6.2 m Water Level @ 1.8 m (not stabilized)* upon completion Borehole caved-in @ 3.7 m upon completion													

+ ³ × ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F26

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 20+475, 28 m Lt of C/L (E 412909.5, N 4873446.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/7/2010 CHECKED BY ZO

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		
121.1 0.0	GROUND SURFACE													
	0.1 m TOPSOIL		1	SS	0		121							
	EMBANKMENT FILL: Silty Sand to Sand dk. brown to brown, compact, wet		2	SS	22		120							spoon wet
119.7 1.4	SANDY SILT trace clay brownish grey, compact, moist to wet		3	SS	12		119							spoon wet 1 35 54 10
118.7 2.4	SILTY SAND TILL tr. clay, tr. to some gravel grey, moist compact v. dense		4	SS	30		118							
			5	SS	147		117							9 65 (26)
			6	SS	100		116							auger grinding hardly from 4.6 m to 6.1 m
			7	SS	100 / 15 cm		115							
			8	SS	100 / 8 cm									
114.9 6.2	End of Borehole @ 6.2 m Water Level @ 0.9 m (not stabilized)* upon completion Borehole caved-in @ 1.5 m upon completion		9	SS	100 / 5 cm									

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

Appendix A3

Drawings and Record of Borehole Sheets

Fill Area 3—Stations 21+650 to 21+750 EB & WB

NOTES:
FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

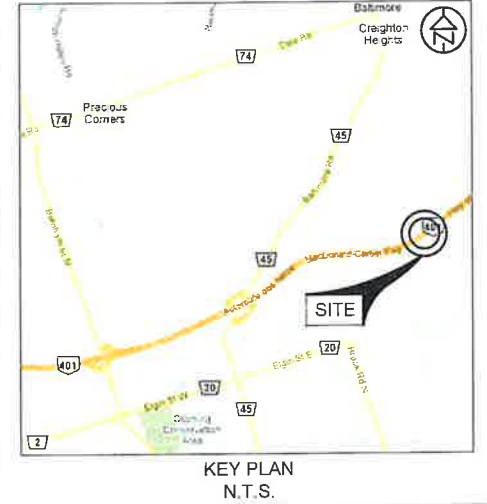
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
ARE IN KILOMETRES + METRES.

CONT No.
GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 3 - STATIONS
21+650 TO 21+750 EB & WB
BOREHOLE LOCATION PLAN
AND SOIL STRATA 1 OF 2

SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



LEGEND

Borehole

Blows/0.3m (Std. Pen. Test, 475 J/blow)

Water Level at Time of Investigation (W.L. NOT STABILIZED)

Water Level in Piezometer

Piezometer

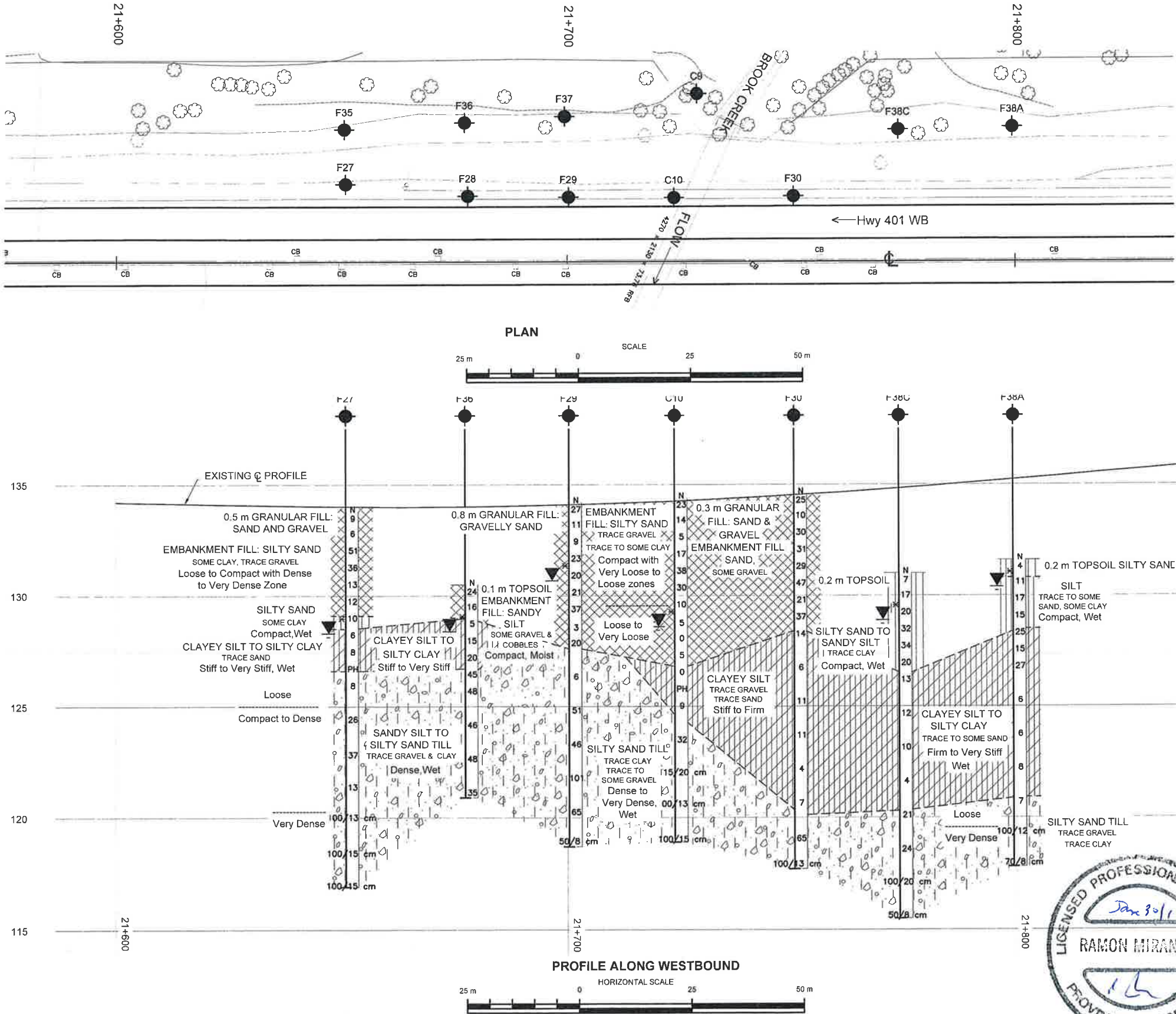
No.	ELEVATION	EASTING	NORTHING
C9	126.5	414022.5	4873888.6
C10	134.4	414032.7	4873866.9
F27	133.6	413972.9	4873824.8
F28	134.1	413995.9	4873839.2
F29	134.2	414014.0	4873852.7
F30	134.6	414053.6	4873883.5
F35	131.0	413965.1	4873834.4
F36	130.5	413965.3	4873851.8
F37	129.9	414002.2	4873866.6
F38A	131.6	414082.9	4873925.5
F38C	131.0	414063.0	4873909.6

-NOTE-
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No	TRANET010434AA	DIST	
SUBMD	CHECKED	DATE	Aug 26, 2011
DRAWN	SH	CHECKED	RM
APPROVED	ZO	DWG	A3-1



NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 3 - STATIONS
21+650 TO 21+750 EB & WB
BOREHOLE LOCATION PLAN
AND SOIL STRATA 2 OF 2



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- Borehole
- N Blows/0.3m (Std. Pen. Test, 475 Jiblow)
- Water Level at Time of Investigation (W. L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
C11	133.9	414037.3	4873830.0
C12	130.8	414056.2	4873830.3
C12A	126.6	414051.1	4873815.2
F31	133.8	413993.2	4873796.6
F32	133.8	414014.7	4873812.9
F33	134.0	414053.2	4873842.2
F34	134.3	414073.2	4873857.9
F39	131.1	414005.3	4873791.9
F40	130.3	414021.2	4873803.4
F42	132.2	414078.2	4873849.9

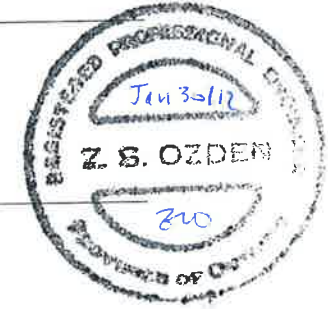
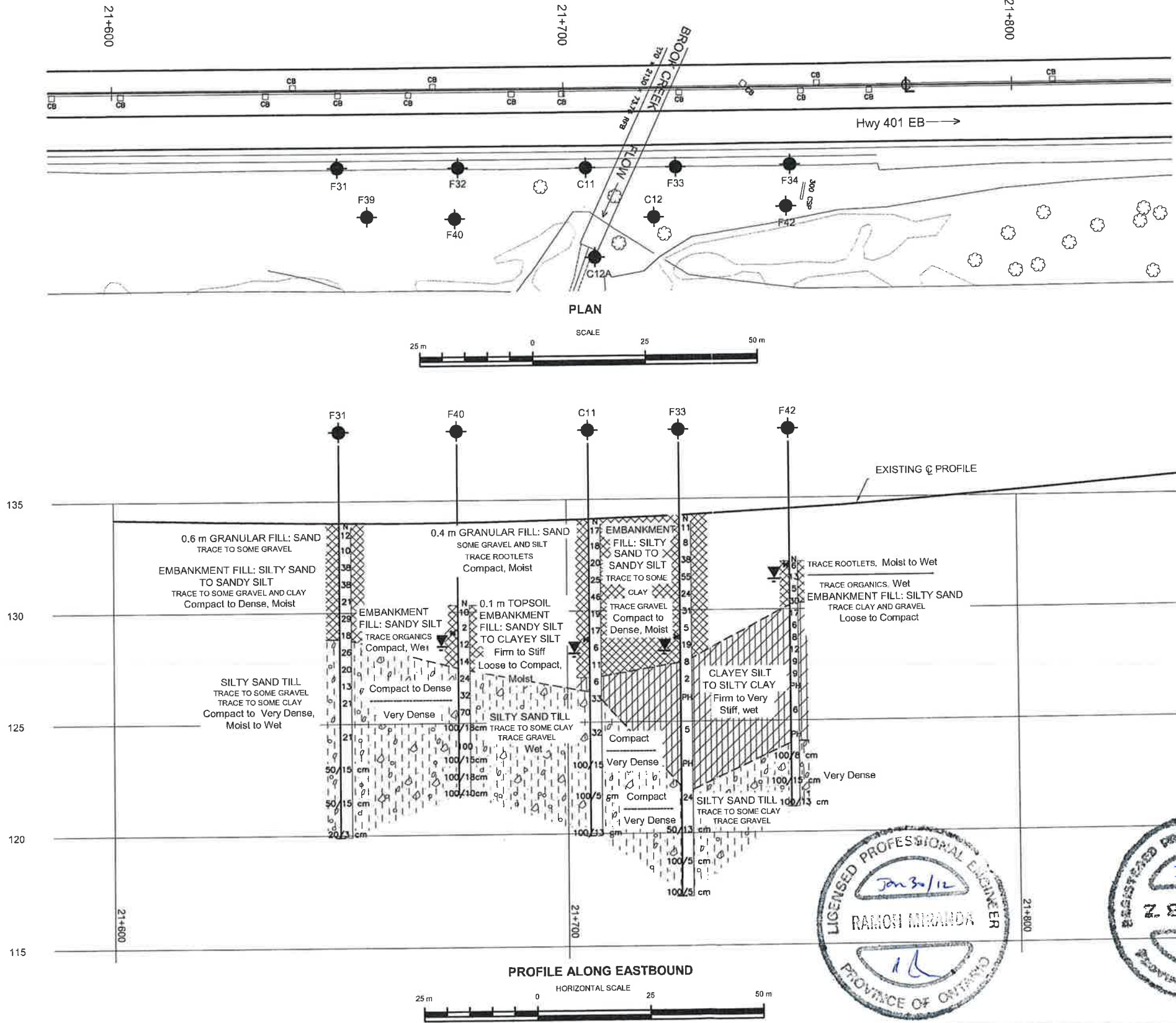
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRANET0810434AA	DIST
SUBMD	CHECKED	DATE Aug 25, 2011
DRAWN	SH	CHECKED RM
APPROVED	ZO	DWG A3-2



TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No C9

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+729, 38 m Lt of C/L (E 414022.5, N 4873888.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/3/2010 CHECKED BY ZO

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)				
								20 40 60 80 100				
								20 40 60 80 100				
						○ UNCONFINED	+ FIELD VANE					
						● POCKET PENETR	× LAB VANE					
						WATER CONTENT (%)						
		</										

+ 3, x 3, Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No C10

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+724, 14 m Lt of C/L (E 414032.7, N 4873866.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/26/2010 CHECKED BY ZO

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)							
134.4 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30					
	0.7 m GRANULAR FILL : Sand and Gravel tr. asphalt and concrete pieces brown, compact, moist		1	SS	23		134								
	EMBANKMENT FILL : Silty Sand, tr. gravel tr. to some clay compact with loose to v. loose zones		2	SS	14		133								
			3	SS	5		132								10 42 30 18
			4	SS	17		131								
	moist to wet		5	SS	38		130								
	wet		6	SS	30		129								
			7	SS	10		128								
	loose to v. loose		8	SS	5		127								
	brown		9	SS	0		126								
	grey		10	SS	5		125								
	with organics blackish grey		11	SS	0		124								
126.8 7.6	CLAYEY SILT TO SILTY CLAY grey, firm, wet		12	TW	PH		123								spoon wet below 7.6 m 0 3 63 34
	with fine sand lenses brown, stiff		13	SS	9		122								
124.5 9.9	SILTY SAND TILL tr. clay tr. to some gravel grey, dens to v. dense, wet		14	SS	32		121								failed to push vane deeper than 9.9 m due to dense material underneath low recovery due to presence of gravel
			15	SS1	5 / 20 cm		120								
			16	SS100	13 cm										

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C10

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+724, 14 m Lt of C/L (E 414032.7, N 4873866.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/26/2010 CHECKED BY ZO

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)									
119.4								20	40	60	80	100					
118.9	SILTY SAND TILL tr clay, lr. to some gravel grey, v. dense		17	SS100 / 15	cm		119										
15.5	End of Borehole. Water level @ 5.8 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.																

+ ³ , × ³ Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE




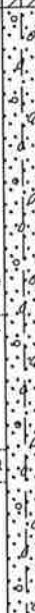
TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C11

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+705, 18 m Rt of C/L (E 414037.3, N 4873830.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/8/2010 CHECKED BY ZO

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)				
133.9 0.0	GROUND SURFACE							20 40 60 80 100	10 20 30			
0.0 127.0 6.9	0.4 m GRANULAR FILL: Sand, some gravel and silt, tr. rootlets, brown, compact, moist EMBANKMENT FILL: Silty Sand to Sandy Silt tr. to some clay, tr. gravel grey to greyish brown compact to dense, moist		1	SS	17							
			2	SS	18							
			3	SS	20							
			4	SS	25							
			5	SS	46							
			6	SS	19							
			7	SS	17							
			8	SS	6							
			9	SS	11							
127.0 6.9	CLAYEY SILT TO SILTY CLAY brown, firm to stiff, wet		10	SS	6							
126.3 7.6	SILTY SAND TILL tr. to some gravel tr. to some clay grey, wet		11	SS	33							
12			SS	32								
13			SS100 / 15 cm									
			14	SS100 / 5 cm								
			15	SS100 / 13 cm								
119.9 14.0	End of Borehole. Water level @ 5.8 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.											

+³ X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

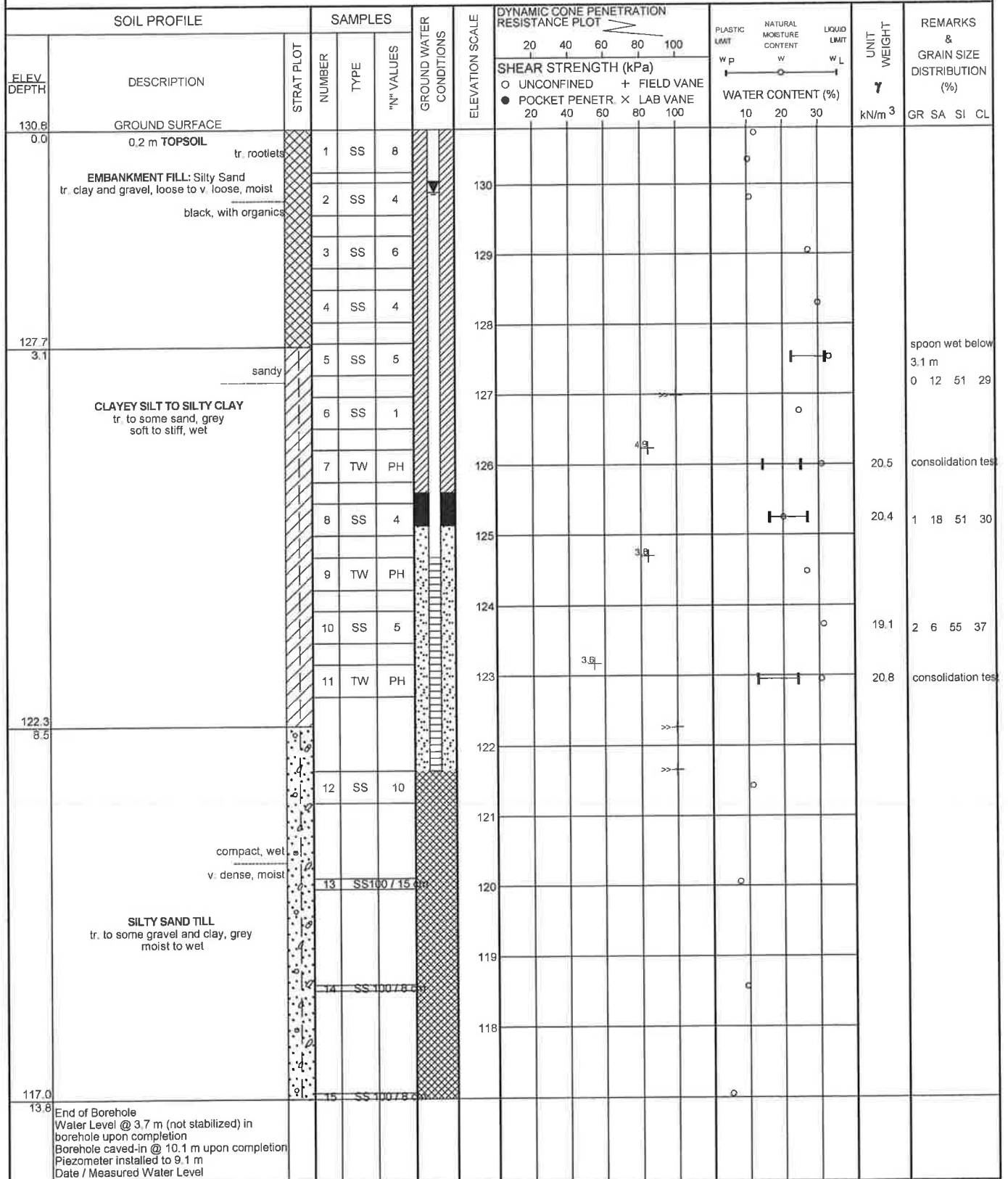
TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No C12

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+720, 29 m Rt of C/L (E 414056.2, N 4873830.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/6/2010 7/7/2010 CHECKED BY ZO



Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15 10 5 0
 (%) STRAIN AT FAILURE

TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No C12

2 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+720, 29 m Rt of C/L (E 414056.2, N 4873830.3) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/6/2010 7/7/2010 CHECKED BY ZO

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					
115.8	July 6, 2010 / 3.7 m July 22, 2010 / 0.4 m August 19, 2010 / 0.8 m October 15, 2010 / 0.9 m															

+³, ×³ : Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C12A

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 21+707, 38 m Rt of C/L (E 414051.1, N 4873815.2) ORIGINATED BY LG
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 12/7/2010 CHECKED BY ZO

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)					
126.6	GROUND SURFACE												
0.0	0.2 m TOPSOIL		1	SS	5								
	EMBANKMENT FILL: Silty Sand some organics		2	SS	43*								* A piece of gravel in spoon
125.1			3	SS	3								
1.5	CLAYEY SILT TO SILTY CLAY grey, soft to firm, moist		4	SS	3								
			5	SS	6								
			6	SS	20								
	some gravel v. stiff		7	SS	14								
122.0			8	SS	85								
4.6	compact v. dense		9	SS	135								
	SILTY SAND TILL some gravel grey, moist to wet		10	SS	100 / 7.5 cm								
			11	SS	100 / 15 cm								
117.3	End of Borehole Water level @ 0.9 m (not stabilized)* upon completion Borehole caved-in @ 1.6 m upon completion												
9.3													

+ 3 × 3 Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F27

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 21+651, 18 m Lt of C/L (E 413972.9, N 4873624.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/5/2010 CHECKED BY ZO

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)					WATER CONTENT (%)
								20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
								○ UNCONFINED + FIELD VANE	W P	W	W L		
								● POCKET PENETR. X LAB VANE	WATER CONTENT (%)				
								20 40 60 80 100	10	20	30		
133.8 0.0	GROUND SURFACE												
	0.5 m GRANULAR FILL : Sand and Gravel		1	SS	9				○				
	EMBANKMENT FILL : Silty Sand some clay, tr. gravel		2	SS	6		133		○				9 43 32 16
	loose												
	brown to grey moist to wet		3	SS	51		132		○				
	v. dense to dense		4	SS	36					○			
	compact		5	SS	13		131		○	○			
			6	SS	12		130		○				
	black with org												
129.1 4.7	SILTY SAND		7	SS	10		129			○			0 52 37 11
	some clay, grey, compact to loose, wet												
128.5 5.3	CLAYEY SILT TO SILTY CLAY		8	SS	6		128			○			spoon wet below 5.8 m
	grey, stiff to v. stiff, wet		9	SS	8			∞			○		1 4 59 36
	sandy		10	TW	PH		127				○		16 37 32 15
126.6 7.2	SANDY SILT TO SILTY SAND TILL		11	SS	8		126	∞		○			
	trace gravel, clayey within upper zone grey, wet												
	loose						125			○			
	compact to dense		12	SS	26								
							124						
			13	SS	37		123			○			
							122						
			14	SS	13		121			○			
							120			○			
	v. dense		15	SS100/13.2m			119						

Continued Next Page

+³ . X³ : Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F27

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+651, 18 m Lt of C/L (E 413972 9, N 4873824 8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/5/2010 CHECKED BY ZO

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					
118.8			16	SS100 / 15 cm		118										3 33 50 14
116.9	fine sand interbeds SANDY SILT TO SILTY SAND TILL trace gravel, some clay grey, v. dense, moist to wet		17	SS100 / 15 cm		117										
16.9	End of Borehole Water level @ 5.5 m (not stabilized)* upon completion. Borehole caved-in @ 7.6 m upon completion.															

+ 3, × 3 Numbers refer to
Sensitivity

20
15-5
10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F28

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+678, 15 m Lt of C/L (E 413995.9, N 4873639.2) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/27/2010 CHECKED BY ZO

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		
134.1 0.0	GROUND SURFACE													
	0.7 m GRANULAR FILL : Sand and Gravel		1	SS	20		134							
	EMBANKMENT FILL : Silty Sand to Sandy Silt some gravel and cobbles within upper zone tr. gravel within lower zone tr. to some clay brown, compact with isolated loose zone moist to wet		2	SS	19		133							
			3	SS	8		132							
			4	SS	13		131							
			5	SS	19		130							
			6	SS	29		129							
			7	SS	13		128							
128.8 5.3	tr. org.		8	SS	30		127							
	mixed with org. gravelly		9	SS	4		126							
	v. loose						125							
	SILTY SAND TILL tr. gravel, tr. to some clay grey, wet		10	SS	16		124							
	compact						123							
	sand layer		11	SS	78		122							
	v. dense													
			12	SS	50 / 8 cm									
			13	SS	51									
121.4 12.7	End of Borehole. Water level @ 2.4 m (not stabilized)* upon completion. Borehole caved-in @ 6.7 m upon completion.													

+ 3, x 3 : Numbers refer to Sensitivity
 20
 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F29

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+700, 15 m Lt of C/L (E 414014.0, N 4873852.7) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/21/2010 7/27/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
134.2	GROUND SURFACE													
0.0	0.8 m GRANULAR FILL : Gravelly Sand		1	SS	27		134							30 57 (13)
	EMBANKMENT FILL : Silty Sand tr. gravel and cobbles tr. to some clay brown, compact with v. loose to loose zones moist to wet		2	SS	11		133							
			3	SS	9		132							
	some org.		4	SS	23		131							9 45 35 11
			5	SS	20		130							
			6	SS	21		129							
			7	SS	37		128							
	some org.		8	SS	3		127							
			9	SS	20		126							
127.6							125							spoon wet below 7.6 m
6.6			10	SS	6		124							0 51 32 17
	loose, clayey v. dense with dense zone		11	SS	51		123							
	SILTY SAND TILL grey, wet		12	SS	46		122							2 73 (25)
			13	SS	101		121							
			14	SS	65		120							

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+ 3, X 3 Numbers refer to
Sensitivity 20
15 10 5 10 (%) STRAIN AT FAILURE


TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F29

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+700, 15 m Lt of C/L (E 414014.0, N 4873852.7) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/21/2010 7/27/2010 CHECKED BY ZO

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 (%)					
119.2														
118.7	SILTY SAND TILL v. dense, grey, wet		15	SS	50 / 8 cm		119							
115.5	End of Borehole. Water level @ 3.5 m (not stabilized)* upon completion. Borehole caved-in @ 3.7 m upon completion.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F30

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+751, 15 m Lt of C/L (E 414053.6, N 4873883.5) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/21/2010 CHECKED BY ZO

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		
134.6 0.0	GROUND SURFACE													
	0.3 m GRANULAR FILL: Sand and Gravel		1	SS	25		134							
	EMBANKMENT FILL: sand, some gravel brown, compact		2	SS	10									
133.1 1.5			3	SS	30		133							
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. to some gravel brown, compact some dense zones, moist		4	SS	31		132							
			5	SS	29		131							
			6	SS	47		130							
			7	SS	21		129							
			8	SS	37									
128.5 6.1			9	SS	14		128							
							127							
			10	SS	6		126							
							125							
			11	SS	11		124							
							123							
			12	SS	11		122							
							121							
			13	SS	4		120							
			14	SS	7									
120.1 14.5														
	SILTY SAND TILL													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F30

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+751, 15 m Lt of C/L (E 414053.6, N 4873883.5) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/21/2010 CHECKED BY ZO

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
FLEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE									
119.6	SILTY SAND TILL trace clay, trace gravel some sand layers brown, v. dense, wet		15	SS	65												
117.7																	
116.9	End of Borehole. Borehole was dry upon completion. Borehole caved-in @ 4.9 m upon completion.																

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F31

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 21+650, 17 m Rt of C/L (E 413993.2, N 4873796.6) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/12/2010 CHECKED BY ZO

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
133.8 0.0	GROUND SURFACE		1	SS	12											
	0.6 m GRANULAR FILL: Sand, tr. to some gravel		2	SS	10											
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. to some gravel and clay brown to grey, compact to dense, moist		3	SS	38											4 32 51 13
			4	SS	38											
			5	SS	21											
	black, with organics, wet		6	SS	29											16 45 29 10
128.8 5.0			7	SS	18											
	SILTY SAND TILL tr. to some gravel tr. to some clay grey, moist to wet		8	SS	26											spoon wet below 5.3 m
			9	SS	20											
			10	SS	13											
			11	SS	21											
			12	SS	21											
			13	SS	50 / 15 cm											auger hard below 9.9 m
	compact cemented, v. dense		14	SS	50 / 15 cm											
	wet moist		15	SS	20 / 3 cm											
119.9 13.9	End of Borehole. Borehole was dry upon completion. Borehole caved-in @ 3.7 m upon completion.															

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F32

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 21+677, 17 m Rt of C/L (E 414014.7, N 4873812.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 7/9/2010 CHECKED BY ZO

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W P	W	W L		
133.8	GROUND SURFACE													
0.0	0.5 m GRANULAR FILL: Sand, some gravel brown, compact, moist		1	SS	12									
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. to some clay and gravel brownish grey to grey, moist to wet		2	SS	6									
			3	SS	2									
			4	SS	3									
	v. loose to loose		5	SS	20									
	compact		6	SS	32									
			7	SS	42									
128.9	4.9	gravelly	8	SS	29									
	SILTY SAND TILL some gravel, trace clay grey, wet		9	SS	15									
			10	SS	22									
			11	SS	36									
			12	SS	22									
	compact to dense		13	SS	51									
	v. dense		14	SS	88 / 23 cm									
			15	SS	50 / 13 cm									
121.3	12.5													
	End of Borehole. Water level @ 4.6 m (not stabilized)* upon completion. Borehole caved-in @ 8.8 m upon completion.													

+ 3 x 3 Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F33

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+725, 18 m Rt of C/L (E 414053.2, N 4873842.2) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/8/2010 CHECKED BY ZO

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					
134.0	GROUND SURFACE												
0.0	0.4 m GRANULAR FILL: Sand, some gravel brown, compact, moist		1	SS	11								
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. gravel, tr. to some clay, brown to grey loose to v. dense, moist		2	SS	8								
			3	SS	38								4 48 37 11
			4	SS	55								
	tr. organics		5	SS	24								
			6	SS	31								
	dilatant wet		7	SS	5								
			8	SS	19								
127.7	black with organics		9	SS	8								
6.3			10	SS	2								0 5 64 31
	CLAYEY SILT TO SILTY CLAY with silty sand lenses grey, firm to v. stiff, wet		11	TW	PH								Shelby tube wet
			12	SS	5								
			13	TW	PH								
			14	SS	24								
121.8	SILTY SAND TILL tr. gravel, tr. to some clay grey		15	SS 50 / 13 cm									Failed to push vane further beyond 11.7 m
12.2	compact, wet v. dense, moist												9 45 34 12

Continued Next Page

+ 3 × 3 Numbers refer to
Sensitivity 15-5 10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F33

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+725, 18 m Rt of C/L (E 414053.2, N 4873842.2) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/8/2010 CHECKED BY ZO

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 ● POCKET PENETR × LAB VANE					WATER CONTENT (%)					
						20 40 60 80 100					10	20	30			
119.0																
	SILTY SAND TILL tr. gravel, tr. to some clay grey, v. dense		16	SS	100 / 5 cm											
117.2																
116.8	End of Borehole Water level @ 5.8 m (not stabilized)* upon completion. Borehole caved-in @ 6.4 m upon completion.		17	SS	100 / 5 cm											

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F34

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+750, 17 m Rt of C/L (E 414073.2, N 4873857.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/7/2010 CHECKED BY ZO

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
134.3	GROUND SURFACE																		
0.0	0.4 m GRANULAR FILL: Sand, some gravel tr. silt, tr. rootlets, brown, compact, moist		1	SS	10														22 69 (9)
	EMBANKMENT FILL: Silty Sand to Sandy Silt tr. gravel and clay, brown, compact to v. dense, moist		2	SS	26														
			3	SS	68														7 38 45 10
			4	SS	36														
			5	SS	36														
			6	SS	34														
129.8	moist to wet brown grey		7	SS	35														spoon wet below 4.6 m
4.5	CLAYEY SILT TO SILTY CLAY with fine sand lenses, stiff to v. stiff, wet		8	SS	17														0 8 64 28
			9	SS	11														
			10	SS	6														
			11	SS	9														3 20 52 25
			12	TW	PH														
			13	SS	9														
121.5	SILTY SAND TILL tr. to some gravel and clay grey, compact, wet		14	SS	16														Failed to push vane deeper than 12.7 m due to hard material below.
12.8																			13 46 31 10

Continued Next Page

+ 3, X 3 Numbers refer to
Sensitivity 20
15 10 5 10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F34

2 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 21+750, 17 m Rt of C/L (E 414073.2, N 4873857.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/7/2010 CHECKED BY ZO

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 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	W P	W		
119.3	SILTY SAND TILL tr. to some gravel and clay grey, v. dense, wet		15	SS	100 / 3 cm								
116.0			16	SS	100 / 15 cm								
118.3			17	SS	100 / 3 cm								
116.0	End of Borehole. Water level @ 3.2 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.												

+ 3, X 3

Numbers refer to
Sensitivity

20
15 10 5

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F35

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 21+650, 30 m Lt of C/L (E 413965.1, N 4873834.4) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/4/2010 CHECKED BY ZO

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					
131.0 0.0	GROUND SURFACE													
	0.2 m TOPSOIL EMBANKMENT FILL : Silty Sand to Sandy Silt trace gravel, grey to brown, compact to v. loose, moist		1	SS	16									
			2	SS	3									
129.5 1.5	some clay black with org dilutant v. loose		3	SS	5									0 28 53 19
	SILTY SAND TO SANDY SILT grey to dark grey dense to compact, wet		4	SS	31									
			5	SS	15									1 86 (13) spoon wet
127.0 4.0	CLAYEY SILT TO SILTY CLAY tr. to some sand grey, stiff to firm, wet		6	SS	13									
			7	SS	8									0 3 54 43
				TW	PH									no sample retrieved
124.0 7.0	SANDY SILT TO SILTY SAND TILL trace gravel, some clay grey, wet		8	SS	17									4 39 39 18
	compact to loose		9	SS	7									
	v. dense		10	SS100 / 28 cm										1 43 44 12
	gravelly zone		11	SS 70 / 10 cm										auger grinding
			12	SS100 / 13 cm										
117.2 13.8	End of Borehole @ 13.8 m Water Level @ 2.1 m (not stabilized)* upon completion Borehole caved-in @ 6.4 m upon completion													

+ 3 × 3 Numbers refer to
Sensitivity 20
15-5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F36

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+677, 31 m Lt of C/L (E 413985.3, N 4873851.8) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/3/2010 CHECKED BY ZO

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 ● POCKET PENETR. X LAB VANE	WATER CONTENT (%) 10 20 30					
130.5 0.0	GROUND SURFACE													
	0.1 m TOPSOIL EMBANKMENT FILL: Sandy Silt some gravel and cobbles brown to dark grey, compact, moist		1	SS	24									
			2	SS	16									
129.0 1.5	with org. dark grey to black firm		3	SS	5									
	CLAYEY SILT TO SILTY CLAY grey, stiff to v. stiff, wet		4	SS	15									
			5	SS	20									1 10 56 33
126.7 3.8	SANDY SILT TO SILTY SAND TILL tr. to some gravel and clay grey, dense, wet		6	SS	45									
			7	SS	48									11 38 36 15
			8	SS	46									
			9	SS	48									
			10	SS	35									
120.9 9.6	End of Borehole @ 9.6 m Water Level @ 2.1 m (not stabilized)* upon completion Borehole caved-in @ 6.1 m upon completion													

+ 3 × 3 Numbers refer to
Sensitivity 15 20 5 10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F37

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+700, 33 m Lt of C/L (E 414002.2, N 4873866.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 6/3/2010 CHECKED BY ZO

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)					
							20 40 60 80 100	20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
							○ UNCONFINED + FIELD VANE			WATER CONTENT (%)			
							● POCKET PENETR. × LAB VANE						
							20 40 60 80 100					GR SA SI CL	
129.9 0.0	GROUND SURFACE												
	0.1 m TOPSOIL		1	SS	4								
	EMBANKMENT FILL : Silty Sand to Sandy Silt some clay, some to tr. gravel brown to grey v. loose to loose, wet		2	SS	9								
128.4 1.5			3	SS	2								
	with org. wood pieces grey and black soft		4	SS	7								
	CLAYEY SILT TO SILTY CLAY some sand, tr. gravel grey, firm, wet												
126.8 3.1			5	SS	10								
	SANDY SILT TO SILTY SAND TILL tr. gravel, some clay in upper zone grey, wet		6	SS	27								
			7	SS	17								
	compact sand layer		8	SS	70								
	v. dense												
			9	SS100 / 28 cm									
									</				

+ 3 × 3 Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F38A

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 21+799, 30 m Lt of C/L (E 414082.9, N 4873925.5) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/28/2010 CHECKED BY ZO

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		
131.6 0.0	GROUND SURFACE													
130.8 0.8	0.2 m TOPSOIL SILTY SAND tr. rootlets, brown, v. loose, moist		1	SS	4		131							0 8 79 13
	SILT tr. to some sand, some clay dilatant, compact, wet		2	SS	11		130							
			3	SS	17		129							spoon wet
		brown					128							
		grey					127							
128.5 3.1			4	SS	15		126							
			5	SS	25		125							
			6	SS	15		124							0 5 62 33
	CLAYEY SILT TO SILTY CLAY tr. to some sand grey, wet		7	SS	27		123							
			8	SS	6		122							
		dilatant					121							
		v. stiff					120							
		firm to stiff					119							
			9	SS	6		118							1 6 57 36
			10	SS	8									
120.9 10.7	SILTY SAND TILL tr. gravel, tr. clay grey		11	SS	7									7 62 23 8
			12	SS	100 / 12 m									
		loose												
		v. dense												auger grinding
			13	SS	10 / 8 cm									
		wet												
117.8 13.8		moist												
	End of Borehole @ 13.8 m Water Level @ 1.2 m (not stabilized)* upon completion Borehole caved-in @ 3.1 m upon completion													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F38C

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 21+774, 30 m Lt of C/L (E 414063.0, N 4873909.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger, Hollow Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/28/2010 6/2/2010 CHECKED BY ZO

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 ● POCKET PENETR × LAB VANE	WATER CONTENT (%)					
131.0 0.0	GROUND SURFACE													
	0.2 m TOPSOIL		1	SS	7									
	black and brown with org. loose		2	SS	17									
	SILTY SAND TO SANDY SILT tr. clay dilatant, brown, compact, wet		3	SS	20									0 28 58 14
			4	SS	32									spoon wet below
			5	SS	34									
			6	SS	20									
126.4 4.6	dilatant		7	SS	13									0 7 68 25
	CLAYEY SILT TO SILTY CLAY tr. sand grey, wet		8	SS	12									
			9	SS	10									
			10	SS	4									borehole caved to up to 5.2 m and drilling resumed on June 02, 2010 with hollow stem auger auger grinding
120.3 10.7	v. stiff to stiff firm to stiff		11	SS	21									7 43 35 15
	SANDY SILT TO SILTY SAND TILL trace gravel, trace to some clay grey, compact, wet		12	SS	24									auger grinding
			13	SS	100 / 20 cm									1 71 (28)
	sand interbeds v. dense													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15 10 5 0
 (%) STRAIN AT FAILURE

TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No F38C

2 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+774, 30 m Lt of C/L (E 414063.0, N 4873909.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger, Hollow Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/28/2010 6/2/2010 CHECKED BY ZO

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)									
116.0							116	20	40	60	80	100					
115.5	SANDY SILT TO SILTY SAND TILL trace gravel, trace clay, grey, v. dense		14	SS	50 / 8 cm												
15.5	End of Borehole @ 15.5 m Water Level @ 2.1 m (not stabilized)* upon completion Borehole caved-in @ 11.6 m upon completion																

+ ³ × ³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F39

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 21+656, 28 m Rt of C/L (E 414005.3, N 4873791.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/14/2010 CHECKED BY ZO

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 ● POCKET PENETR. X LAB VANE					WATER CONTENT (%) PLASTIC LIMIT (w _p) NATURAL MOISTURE CONTENT (w) LIQUID LIMIT (w _L)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
131.1 0.0	GROUND SURFACE 0.2 m TOPSOIL		1	SS	3		131																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

+ ³, × ³; Numbers refer to
Sensitivity 20
15 10 5 0 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F40

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+676, 29 m Rt of C/L (E 414021.2, N 4873803.4) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/14/2010 CHECKED BY ZO

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 (%)
FLYV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _p	W		
130.3	GROUND SURFACE												
0.0	0.1 m TOPSOIL		1	SS	10								
	EMBANKMENT FILL: Sandy Silt to Clayey Silt with organics, brown to grey and black firm to stiff / loose to compact, moist		2	SS	2								
			3	SS	12								
128.0			4	SS	14								
2.3	FILL: Sandy Silt tr. organics, grey, compact, wet												
127.4			5	SS	24								
2.9	SILTY SAND TILL tr. to some clay, tr. gravel grey, wet		6	SS	32								
	compact		7	SS	70								
	dense		8	SS100 / 18 cm									
	v. dense		9	SS	100								
			10	SS100 / 15 cm									
			11	SS100 / 18 cm									
			12	SS100 / 10 cm									
121.8	End of Borehole. Water level @ 1.8 m (not stabilized)* upon completion. Borehole caved-in @ 4.0 m upon completion.												

+³ ×³ Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F42

1 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 21+750, 27 m Rt of C/L (E 414078.2, N 4873849.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/6/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
FLEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)				
							20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
							POCKET PENETR. X LAB VANE	WATER CONTENT (%)				
							20 40 60 80 100	10 20 30				
132.2 0.0	GROUND SURFACE											
	tr. rootlets, moist to wet		1	SS	6		132					
	EMBANKMENT FILL: Silty Sand		2	SS	13		131					0 61 30 9
	tr. organics, wet											spoon wet below
	tr. clay and gravel, brown		3	SS	5		130					1.5 m
	loose to compact		4	SS	30		129					
129.6 2.6			5	SS	17		128					0 8 67 25
	v. stiff		6	SS	6		127					
	firm to stiff		7	SS	8		126					0 6 66 28
	CLAYEY SILT TO SILTY CLAY		8	SS	12		125					
	with fine sand lenses, grey, wet		9	SS	9		124					
			10	SS	9		123					
			11	TW	PH		122					
			12	SS	6		121					Failed to push
120.9 11.3			13	TW	PH		120					vane deeper than
	SILTY SAND TILL		14	SS 100/8 cm			119					11.3 m due to
	grey, moist		15	SS 100/15 cm			118					hard material
												below

Continued Next Page

+3 x 3 Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE


TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F42

2 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+750, 27 m Rt of C/L (E 414078.2, N 4873848.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/6/2010 CHECKED BY ZO

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			20	40	60	80	100		
117.2														
116.8	SILTY SAND TILL		16	SS100/13.3m		117								
15.4	tr. to some clay, tr. gravel grey, v. dense, moist													
	End of Borehole. Water level @ 1.1 m (not stabilized)* upon completion. Borehole caved-in @ 4.6 m upon completion.													

+ 3, X 3 Numbers refer to 20
Sensitivity 15 5 10 (%) STRAIN AT FAILURE

Appendix A4

Drawing and Record of Borehole Sheets

Fill Area 4 – Stations 22+230 to 22+380 WB

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

GWP: 205-00-01

HIGHWAY 401 EXTENSION
FILL AREA 4 - STATIONS
22+230 TO 22+380
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



LEGEND

- Borehole
- Blows/0.3m (Std. Pen. Test, 475 Jblow)
- Water Level at Time of Investigation (W, L, NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
C13	139.6	414533.9	4874249.7
C14	144.9	414537.3	4874231.8
F43	142.5	414413.1	4874154.9
F44	143.3	414454.7	4874182.7
F45	143.7	414475.3	4874195.4
F46	144.2	414497.9	4874208.9
F48	145.9	414588.2	4874258.1
F49	139.0	414404.0	4874166.4
F50	138.6	414446.6	4874196.4
F51	138.6	414468.3	4874209.8
F52	138.3	414490.3	4874225.1
F54	142.2	414579.0	4874271.1

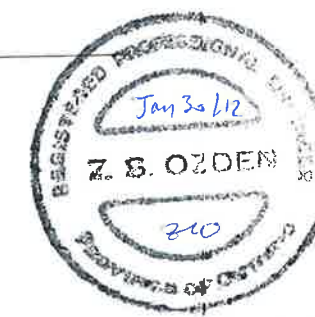
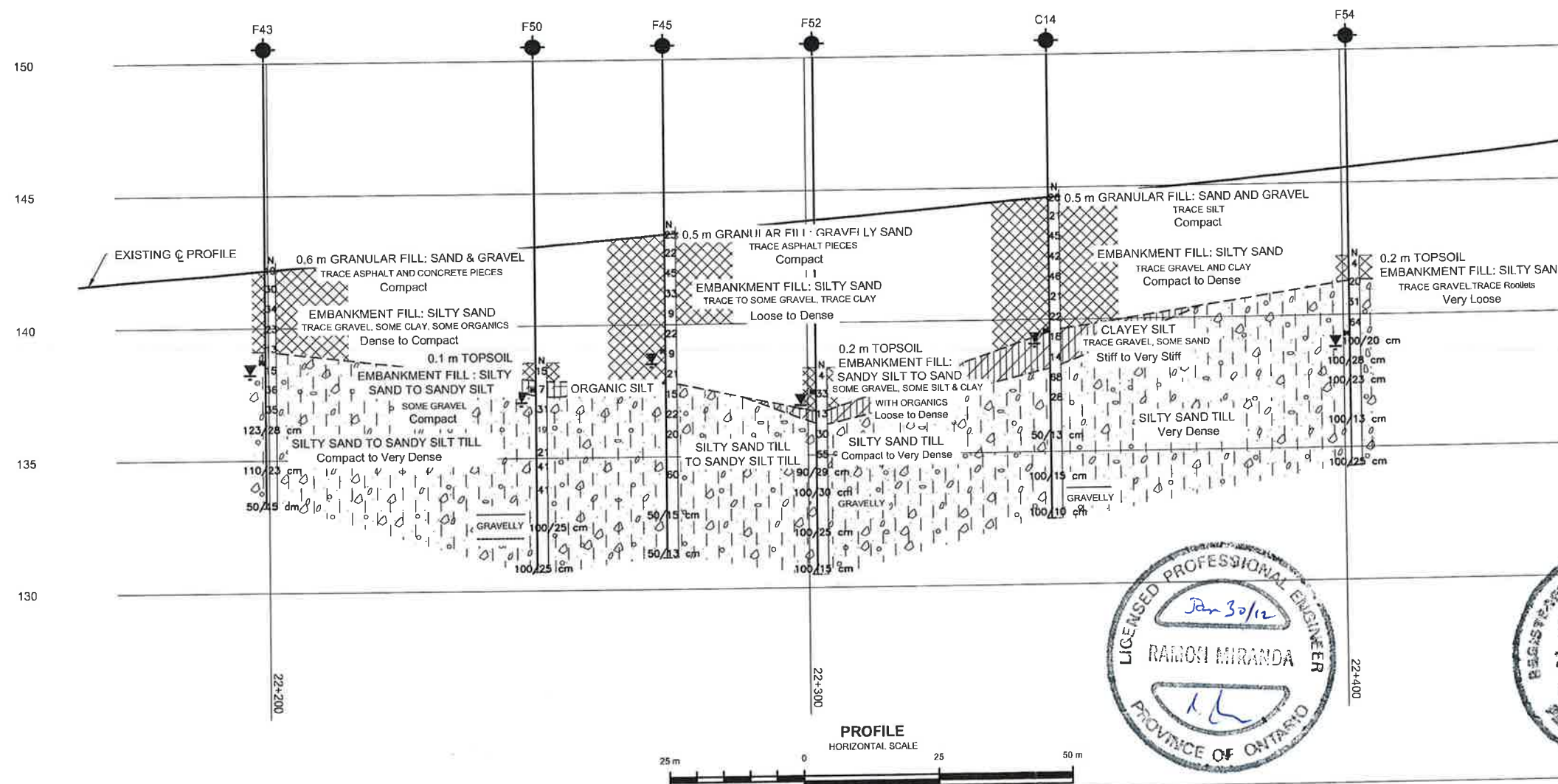
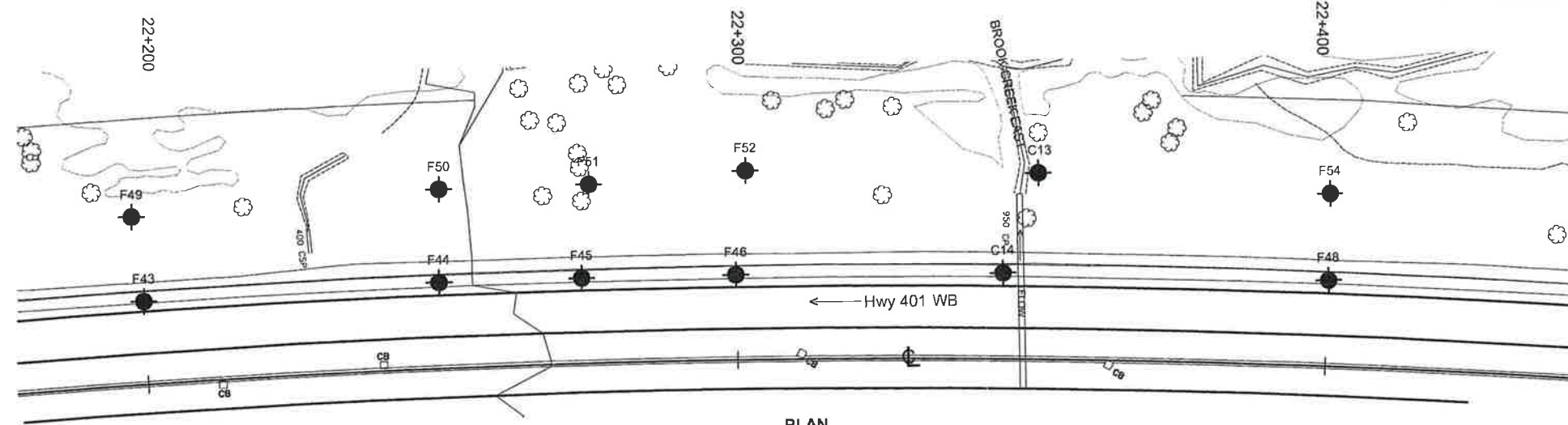
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRANET0810434AA	DIST	
SUBM'D	CHECKED	DATE	Aug.25, 2011
DRAWN	SH	CHECKED	RM
		APPROVED	ZO
			DWG
			A4



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C13

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+351, 32 m Lt of C/L (E 414533.9, N 4874249.7) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/25/2010 CHECKED BY ZO

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			SHEAR STRENGTH (kPa)		WATER CONTENT (%)		W _P	W	W _L	GR		
139.6 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30							
	0.2 m TOPSOIL	soft	1	SS	2		139										
		stiff	2	SS	11												
	CLAYEY SILT tr. to some sand, tr. gravel, brown	moist	3	SS	11		138										
137.3 2.3		wet	4	SS	33		137										spoon wet
		dense	5	SS	42												spoon wet
	v. dense high gravel content above 4.4 m		6	SS	62		136										43 45 (12)
			7	SS100/25.0			135										
	SILTY SAND TILL grey, v. dense, wet		8	SS100/20.0			134										20 53 (27)
			9	SS100/20.0			132										
130.3 9.3		gravelly	10	SS100/12.5			131										
End of Borehole @ 9.3 m Piezometer installed to 9.1 m Date / Measured Water Level June 02, 2010 / 0.9 m (on completion) August 19, 2010 / 0.4 m October 15, 2010 / 0.6 m																	

+ 3 x 3 Numbers refer to
Sensitivity

20
15 10 5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C14

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 22+345, 15 m Lt of C/L (E 414537.3, N 4874231.8) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/19/2010 CHECKED BY ZO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE 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	20 40 60 80 100	W P	W	W L					
144.9 0.0	GROUND SURFACE		1	SS	26												
	0.5 m GRANULAR FILL: Sand and Gravel tr. silt, brown, compact, moist		2	SS	21												
	EMBANKMENT FILL: Silty Sand tr. gravel, tr. clay, brown compact to dense		3	SS	45												
			4	SS	42												
			5	SS	46												
	moist		6	SS	21												
	wet		7	SS	22												
	tr. organics		8	SS	18												
139.6 5.3	CLAYEY SILT some sand, grey, stiff to v. stiff		9	SS	14												
138.2 6.7	SILTY SAND TILL grey, v. dense, wet		10	SS	68												
			11	SS	28												
			12	SS 50 / 13 cm													
			13	SS 100 / 15 cm													
			14	SS 100 / 10 cm													
132.5 12.4	End of Borehole. Water level @ 5.8 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.																

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F43

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+200, 14 m Lt of C/L (E 414413 1, N 4874154.9) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/20/2010 CHECKED BY ZO

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 ● POCKET PENETR × LAB VANE					
142.5	GROUND SURFACE												
0.0	0.6 m GRANULAR FILL: Sand and Gravel tr. asphalt and concrete pieces brown, compact, moist		1	SS	19								
	EMBANKMENT FILL: Silty Sand tr. gravel, some clay, some organics dense to compact, moist		2	SS	30								
			3	SS	34								
			4	SS	23								
			5	SS	13								
			6	SS	15								
138.2			7	SS	36								
4.3			8	SS	35								
	SILTY SAND TO SANDY SILT TILL grey, dense to v. dense, wet		9	SS	123 / 28 cm								
			10	SS	110 / 23 cm								
133.2			11	SS	50 / 15 cm								
9.3	End of Borehole. Water level @ 4.3 m (not stabilized)* upon completion. Borehole caved-in @ 4.9 m upon completion.												

+ 3 × 3 : Numbers refer to 20
Sensitivity 15-6-5 (%) STRAIN AT FAILURE
10

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F44

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+250, 15 m Lt of C/L (E 414454 7, N 4874182 7) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/20/2010 CHECKED BY ZO

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)				
							20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
							20 40 60 80 100	WATER CONTENT (%)				
												GR SA SI CL
143.3 0.0	GROUND SURFACE		1	SS	17		143					
	0.4 m GRANULAR FILL: Gravelly Sand tr. asphalt pieces, brown compact, moist		2	SS	10		142					
	EMBANKMENT FILL: Silty Sand tr. to some gravel, v. loose to dense		3	SS	43		141					
			4	SS	44		140					
	brown, moist		5	SS	10		139					
	grey, wet		6	SS	2		138					
			7	SS	3		137					
	with organics		8	SS	8		136					
138.1 5.2	CLAYEY SILT tr. gravel, grey, stiff to v. stiff, moist		9	SS	11		135					
			10	SS	32		134					
136.0 7.3	SILTY SAND TO SANDY SILT TILL grey, dense to v. dense, wet		11	SS	110		133					
	dense		12	SS	137		132					
	v. dense		13	SS	100/78 cm		131					
	gravelly											
	dilatant											
131.0 12.3	End of Borehole. Water level @ 5.8 m (not stabilized)* upon completion Borehole caved-in @ 5.8 m upon completion.											

+ ³ × ³ : Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F45

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+274, 15 m Lt of C/L (E 414475.3, N 4874195.4) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/20/2010 CHECKED BY ZO

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 ● POCKET PENETR. x LAB VANE	WATER CONTENT (%) 20 40 60 80 100					
143.7 0.0	GROUND SURFACE		1	SS	23									
	0.5 m GRANULAR FILL: Gravelly Sand tr. asphalt pieces, brown compact, moist		2	SS	22									
	EMBANKMENT FILL: Silty Sand tr. to some gravel, tr. clay loose to dense		3	SS	45									
			4	SS	33									
			5	SS	9									
			6	SS	22									
			7	SS	9									
	brown, moist grey, wet		8	SS	21									
137.8 5.9	SILTY SAND TO SANDY SILT TILL grey, compact, wet		9	SS	15									
			10	SS	22									
	compact v. dense		11	SS	20									
			12	SS	60									
			13	SS 50 / 15 cm										
			14	SS 50 / 13 cm										
131.2 12.5	End of Borehole. Water level @ 5.2 m (not stabilized)* upon completion. Borehole caved-in @ 5.5 m upon completion.													

+ ³ x ³: Numbers refer to Sensitivity
 20
15 10 5 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

1 OF 1

METRIC

+ 3, X 3, Numbers refer to Sensitivity

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F48

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 22+400, 15 m Lt of C/L (E 414586.2, N 4874258.1) ORIGINATED BY GJ
DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
DATUM Geodetic DATE 7/19/2010 CHECKED BY ZO

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					
145.9	GROUND SURFACE																
0.0	0.5 m GRANULAR FILL: Gravelly Sand brown, compact, moist		1	SS	26		145										
	EMBANKMENT FILL: Silty Sand tr. to some gravel, tr. clay brown to grey, v. dense, moist		2	SS	24												
			3	SS	78		144										18 43 (39)
			4	SS	41												
142.7			5	SS	18		143										
3.2	CLAYEY SILT tr. gravel, tr. sand, grey, v. stiff		6	SS	63		142										4 12 56 28
142.1			7	SS	53		141										
3.8	SILTY SAND TILL brown, v. dense		8	SS	100 / 23 cm		140										
			9	SS	50 / 13 cm		139										1 61 30 8
			10	SS	100 / 13 cm		138										
			11	SS	122 / 25 cm		137										
136.3	End of Borehole Water level @ 6.1 m (not stabilized)* upon completion. Borehole caved-in @ 6.1 m upon completion.																

+ 3 x 3 Numbers refer to
Sensitivity 20
15 10 5 10 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F49

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 22+200, 29 m Lt of C/L (E 414404.0, N 4874166.4) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/27/2010 CHECKED BY ZO

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)					
							20 40 60 80 100						
							○ UNCONFINED + FIELD VANE						
							● POCKET PENETR. X LAB VANE						
							WATER CONTENT (%)						
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W P W W L						
							10 20 30						
139.0	GROUND SURFACE						139						
0.0	0.2 m TOPSOIL		1	SS	7								3 47 39 11
	EMBANKMENT FILL: Silty Sand with rootlets, some clay brown, loose, moist												
	some organics		2	SS	24		138						blow counts may be high due to gravel
137.7													7 48 39 6
1.3			3	SS	27		137						
	compact dense		4	SS	32								spoon wet below 2.3 m
	SILTY SAND TILL		5	SS	48		136						auger grinding
	moist to wet		6	SS100 / 28 cm			135						auger grinding
	v. dense gravelly wet		7	SS100 / 15 cm			134						
							133						
132.6			8	SS100 / 28 cm									
6.4	End of Borehole @ 6.4 m Water Level @ 2.1 m (not stabilized)* upon completion Borehole caved-in @ 5.2 m upon completion												

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F50

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 22+250, 31 m Lt of C/L (E 414446.6, N 4874196.4) ORIGINATED BY RK
DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SK
DATUM Geodetic DATE 5/26/2010 CHECKED BY ZO

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 ● POCKET PENETR. x LAB VANE						
138.8	GROUND SURFACE													
0.0	0.1 m TOPSOIL		1	SS	15									
137.9	EMBANKMENT FILL: Silty Sand to Sandy Silt some gravel, brown, compact, moist													
0.7	ORGANIC SILT some clay, some rootlets blackish grey, wet		2	SS	7									
137.3														
1.3			3	SS	31									
	SILTY SAND TILL TO SANDY SILT TILL grey, moist to wet		4	SS	19									spoon wet 0 94 (6)
			5	SS	21									spoon wet
			6	SS	41									
	compact to dense													
	some cobbles		7	SS	41									
	dense													
	gravelly, v. dense		8	SS100 / 25 cm										31 56 (13)
	v. dense													
130.7			9	SS100 / 25 cm										1 25 59 15
7.9	End of Borehole @ 7.9 m Water level @ 1.5 m (not stabilized)* upon completion Borehole caved-in @ 3.7 m upon completion													

+ ³ x ³ Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F51

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+275, 31 m LI of C/L (E 414468.3, N 4874209.8) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/26/2010 CHECKED BY ZO

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)					WATER CONTENT (%)		
								20	40	60			80	100	10
138.6	GROUND SURFACE														
0.0	0.2 m TOPSOIL		1	SS	9		138						3 54 34 9		
137.9	EMBANKMENT FILL: Silty Sand tr. gravel and clay, brown, loose, moist														
0.7	ORGANIC SILT		2	SS	3										
	some sand, tr. clay, blackish grey														
	sand and silt		3	SS	7		137						0 57 41 2		
136.3	CLAYEY SILT		4	SS	12		136						2 12 57 29		
2.3	some sand, brown, v. stiff, moist														
135.9	SILTY SAND TILL TO SAND TILL		5	SS	28		135								
2.7	compact														
	brown		6	SS	29		134						33 60 (7)		
	grey, moist														
	coarse sand, wet		7	SS	49		133								
	gravelly														
	dense to v. dense		8	SS	100 / 28 cm		132						0.9 m sand back-in the hollow stem auger pulled up and drilled further		
130.9	End of Borehole @ 7.7 m		9	SS	140 / 12 cm		131								
7.7	Water Level @ 1.8 m (not stabilized)* upon completion														
	Borehole caved-in @ 5.2 m upon completion														

+ 3, x 3 Numbers refer to
Sensitivity 20
15 10 5 (%) STRAIN AT FAILURE


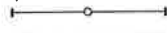
TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No F52

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+301, 32 m Lt of C/L (E 414490.3, N 4874225.1) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger, Hollow Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/26/2010 CHECKED BY ZO

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)		WATER CONTENT (%)				
138.3 0.0	GROUND SURFACE 0.2 m TOPSOIL		1	SS	4		20 40 60 80 100	20 40 60 80 100	10 20 30		GR SA SI CL			
136.6 1.7	EMBANKMENT FILL: Sandy Silt to Sand some gravel, some silt and clay with organics tr, rootlets grey, loose to dense, moist		2	SS	33		138							
136.1 2.2	CLAYEY SILT tr. gravel, some sand, brown, stiff, moist		3	SS	13		137							
	SILTY SAND TILL grey, compact, wet		4	SS	30		136							spoon wet 1 19 52 28
	gravelly v. dense moist to wet		5	SS	55		135							spoon wet
			6	SS	90 / 29 cm		134							33 45 18 4
			7	SS	100 / 30 cm		133							auger grinding
			8	SS	100 / 25 cm		132							caved-in up to 5.2 m started to use hollow stem
130.5 7.8	End of Borehole @ 7.8 m Water Level @ 1.4 m (not stabilized)* upon completion Borehole caved-in @ 5.6 m upon completion		9	SS	100 / 15 cm		131							47 45 (8)

+ 3 x 3 Numbers refer to
Sensitivity 20
15 10 5 (%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F54

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+400, 30 m Lt of C/L (E 414579.0, N 4874271.1) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY SK
 DATUM Geodetic DATE 5/25/2010 CHECKED BY ZO

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			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W
142.2	GROUND SURFACE															
0.0	0.2 m TOPSOIL EMBANKMENT FILL: Silty Sand tr. gravel, tr. rootlets brown, v. loose, moist		1	SS	4											
141.3			2	SS	20											17 51 27 5
0.9	compact															
	brownish grey		3	SS	31											
	grey dense															
	v. dense		4	SS	64											
	SILTY SAND TILL moist		5	SS100 / 20 cm												
			6	SS100 / 28 cm												spoon wet
			7	SS100 / 23 cm												spoon wet
			8	SS100 / 13 cm												spoon wet
	sand till															
134.3			9	SS100 / 25 cm												11 75 (14)
7.9	End of Borehole @ 7.9 m Water Level @ 3.4 m (not stabilized)* upon completion Borehole caved-in @ 6.4 m upon completion															

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

Appendix A5

Drawing and Record of Borehole Sheets

Fill Area 5 – Stations 22+330 to 22+400 EB

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

METRIC

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

CONT No.

GWP: 205-00-01

HIGHWAY 401 EXPANSION
FILL AREA 5 - STATIONS
22+330 TO 22+400 EB
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



KEY PLAN
N.T.S.

LEGEND

- Borehole
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Water Level at Time of Investigation (W.L. NOT STABILIZED)
- Water Level in Piezometer
- Piezometer

No.	ELEVATION	EASTING	NORTHING
C15	144.2	414552.9	4874204.3
C16	139.8	414558.4	4874192.6
F55	144.0	414536.3	4874195.2
F56	144.7	414577.9	4874218.0
F57	145.1	414601.4	4874230.6
F58	140.4	414547.4	4874187.2
F59	140.5	414568.7	4874202.2
F60	141.3	414598.7	4874217.7

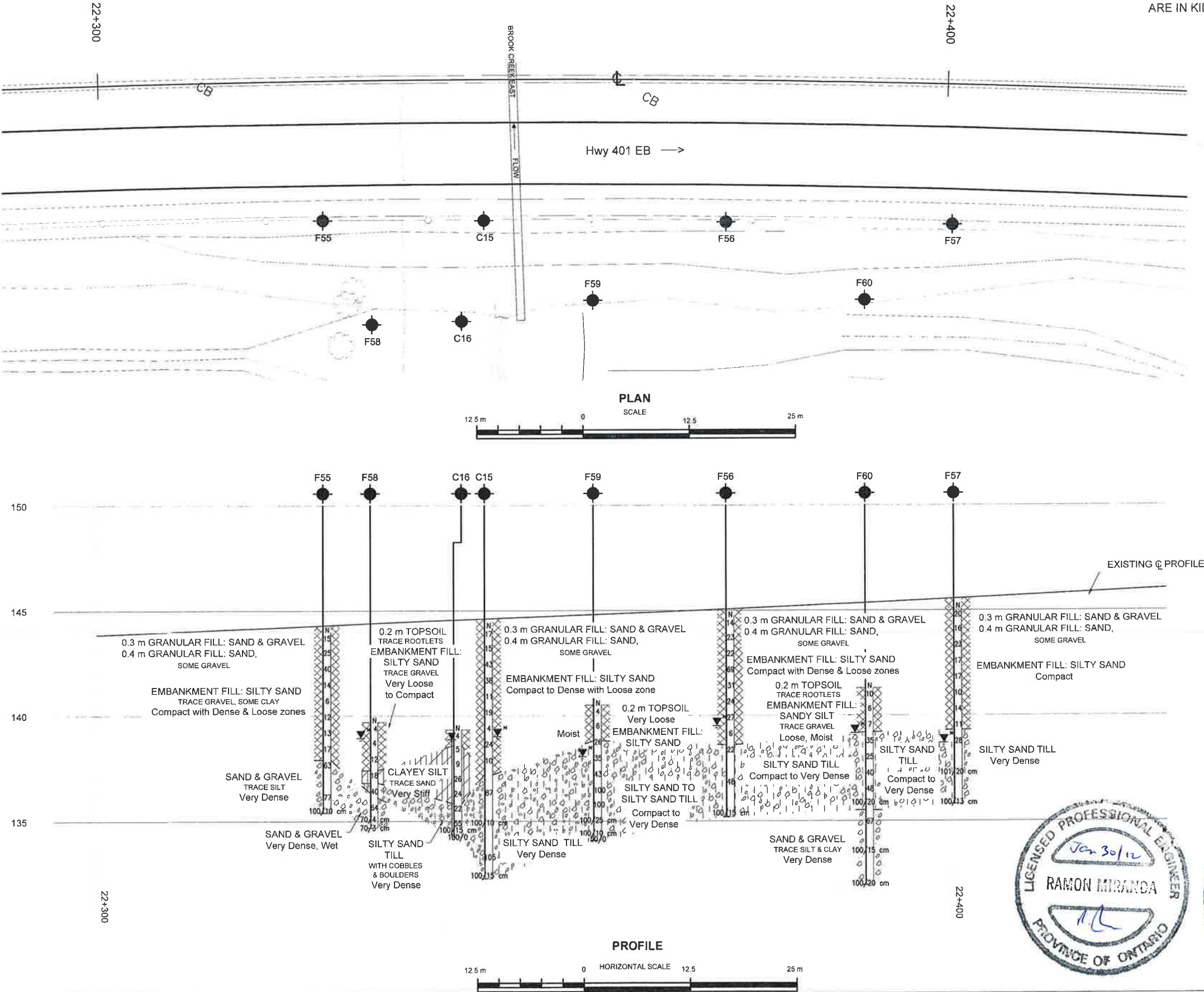
-NOTE-

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRANET010434AA	DIST	
SUBMD	CHECKED	DATE	Aug 25, 2011
DRAWN	SH	CHECKED	RM
APPROVED	ZO	DWG	A5



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No C15

1 OF 1

METRIC

GWP <u>G.W.P 205-00-01</u>		LOCATION <u>Station 22+345, 17 m Rt of C/L (E 414552.9, N 4874204.3)</u>	ORIGINATED BY <u>RK</u>
DIST <u> </u>	HWY <u>401</u>	BOREHOLE TYPE <u>Hollow Stem Auger</u>	COMPILED BY <u>WC</u>
DATUM <u>Geodetic</u>	DATE <u>8/4/2010</u>		CHECKED BY <u>ZO</u>

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
144.2	GROUND SURFACE																	
0.0	0.3 m GRANULAR FILL: Sand and Gravel 0.4 m GRANULAR FILL: Sand, some gravel		1	SS	17										Auger grinding @ 0.3 and 0.6 m			
			2	SS	15													
			3	SS	43													
	EMBANKMENT FILL: Silty Sand tr. to some gravel, tr. to some clay occ. cobbles and boulder v. loose to dense moist to wet		4	SS	38											Auger grinding @ 2.4 and 2.7 m		
			5	SS	11													
			6	SS	19											Auger grinding @ 4.0 m		
			7	SS	4											8 51 28 13		
			8	SS	24													
	organics		9	SS	10											Spoon wet below 6.1 m		
137.2																		
7.0	SILTY SAND TILL tr. to some gravel v. dense, moist to wet		10	SS	87										Auger grinding @ 7.6 to 9.8 m			
				11	SS	100 / 10 cm										4 18 60 18		
	cobbles and boulders	12	SS	105											Auger advanced slowly from 10.4 to 10.7 m			
															Auger grinding very hard @ 10.7 m			
132.3			13	SS	100 / 15 cm													
11.9	End of Borehole. Water level @ 5.2 m (not stabilized)* upon completion. Borehole caved-in @ 5.3 m upon completion.														m. Soil back-up @ 10.7 m, borehole flushed with water Auger refusal @ 11.7			

+ ³, × ³: Numbers refer to Sensitivity

TRANETO810434AA: Highway 401

RECORD OF BOREHOLE No C16

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+342, 29 m Rt of C/L (E 414556 4, N 4874192.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/30/2010 CHECKED BY ZO

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 ● POCKET PENETR. × LAB VANE						
139.7 0.0	GROUND SURFACE													
138.9 0.8	0.2 m TOPSOIL EMBANKMENT FILL: Silty Sand tr. gravel and clay brown, v. loose, moist	topsoil	1	SS	4									
			2	SS	5									
	CLAYEY SILT tr. to some sand stiff to v. stiff, moist to wet		3	SS	9									spoon wet
			4	SS	26									
			5	SS	24									0 5 60 35
135.9 3.8	SILTY SAND TILL some gravel, some clay occ. cobbles and boulders v. dense, wet		6	SS	22									auger grinding at 4.4, 4.5 to 4.8 m
			7	SS	55									auger grinding
134.2 5.5	End of Borehole. Piezometer installed @ 5.5 m upon completion. Date / Measured Water Level June 30, 2010 / 1.5 m (on completion) August 19, 2010 / 0.5 m October 15, 2010 / 0.7 m		8	SS	100/15 cm									hard from 5.2 to 5.3 m spoon bouncing and auger refusal at 5.5 m (possible bedrock)
			9	SS	100/0									

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F55

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+326, 17 m Rt of C/L (E 414536.4, N 4874195.2) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/4/2010 CHECKED BY ZO

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)					
								20 40 60 80 100					
						</							

+ 3 x 3 Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F56

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+374, 17 m Rt of C/L (E 414578.0, N 4874218.0) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/5/2010 CHECKED BY ZO

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 (%)					
144.7	GROUND SURFACE													
0.0	0.3 m GRANULAR FILL: Sand and Gravel 0.4 m GRANULAR FILL: Sand, some gravel		1	SS	14									Auger grinding @ 0.6 and 0.9 m
	EMBANKMENT FILL: Silty Sand tr. gravel, tr. clay, brown compact with dense and loose zones, moist		2	SS	23									9 46 35 10
			3	SS	22									Auger grinding @ 2.0 and 2.4 m
			4	SS	69									
			5	SS	31									
			6	SS	24									
			7	SS	27									
	some organic dark grey, wet		8	SS	6									
138.6			9	SS	22									14 52 24 10
6.1	SILTY SAND TILL grey, compact to v. dense, wet													Spoon wet below 6.1 m
	coarse sand, tr. gravel and silt		10	SS	48									0.9 m of soil back-up @ 7.6 m
			11	SS	100 / 15 cm									
135.2														
9.5	End of Borehole. Water level @ 5.2 m (not stabilized)* upon completion. Borehole caved-in @ 6.7 m upon completion.													

+ 3, x 3: Numbers refer to Sensitivity
 20 15 10 5 0 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F57

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+401, 17 m Rt of C/L (E 414601 5, N 4874230.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 8/2/2010 CHECKED BY ZO

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		
145.1	GROUND SURFACE													
0.0	0.3 m GRANULAR FILL: Sand and Gravel 0.4 m GRANULAR FILL: Sand, some gravel		1	SS	20		145							Auger grinding @ 0.3 and 0.6 m
	EMBANKMENT FILL: Silty Sand tr. gravel brown, compact, moist		2	SS	16		144							
			3	SS	23		143							
			4	SS	17		142							
			5	SS	17		141							
	clayey silt dark grey, stiff		6	SS	10		140							
	tr. rootlets and some organic from 3.8 to 5.8 m		7	SS	14		139							1 19 52 28
139.3			8	SS	11		138							
5.8	gravelly, compact		9	SS	28		137							21 60 15 4 Spoon wet below 6.1 m
	SILTY SAND TILL grey, v. dense, wet		10	SS101 / 20 cm			136							Auger grinding @ 7.9 and 8.2 m
135.8			11	SS160 / 13 cm										
9.3	End of Borehole. Water level @ 6.4 m (not stabilized)* upon completion. Borehole caved-in @ 6.7 m upon completion.													

+ 3 x 3 : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

1 OF 1

METRIC

GWP	G W P 205-00-01	LOCATION	Station 22+332, 29 m Rt of C/L (E 414547 5, N 4874187 2)	ORIGINATED BY	RK
DIST	HWY 401	BOREHOLE TYPE	Hollow Stem Auger, Solid Stem Auger	COMPILED BY	RK
DATUM	Geodetic	DATE	6/28/2010	CHECKED BY	ZO

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								● POCKET PENETR.		X LAB VANE
139.7	GROUND SURFACE						20	40	60	80	100									
0.0	0.2 TOPSOIL		1	SS	4															
	tr. rootlets, brown																			
	grey		2	SS	4															
	EMBANKMENT FILL: Silty Sand																			
	tr. gravel, v. loose to compact, wet																			
138.2	EMBANKMENT FILL: Silty Sand		3	SS	12															
1.5	tr. gravel, some organic and decayed wood																			
	pieces, dark grey, compact, wet																			
137.4	CLAYEY SILT		4	SS	18															
2.3	tr. sand, brown, v. stiff																			
136.8	SILTY SAND TILL		5	SS	40															
2.9	grey, dense, wet																			
136.0	SAND AND GRAVEL		6	SS	64															
3.7	grey, v. dense, wet																			
134.7			7	SS	70/4 cm															
5.0			8	SS	70/3 cm															
	End of Borehole.																			
	Water Level @ 1.1 m (not stabilized)* upon																			
	completion.																			
	Borehole caved-in @ 2.1 m upon completio																			

+ 3, × 3 Numbers refer to Sensitivity

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F59

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+358, 26 m Rt of C/L (E 414568 8, N 4874202.3) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/12/2010 CHECKED BY ZO

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) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. x LAB VANE					WATER CONTENT (%) W P W L
140.5	GROUND SURFACE												
0.0	0.2 m TOPSOIL brown, v. loose		1	SS	4								
	EMBANKMENT FILL: Silty Sand grey, loose moist		2	SS	6								
138.8	mixed with organic and wood pieces		3	SS	26								
1.7			4	SS	35								
	SILTY SAND TO SANDY SILT TILL grey, compact to v. dense, wet		5	SS	43								
			6	SS	100								
			7	SS	100								
			8	SS	100 / 25 cm								
			9	SS	100 / 10 cm								
134.1			10	SS	50 / 0								
6.4	End of Borehole. Water level @ 2.4 m (not stabilized)* upon completion. Borehole caved-in @ 5.8 m upon completion.												

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F60

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+391, 26 m Rt of C/L (E 414596.8, N 4874217.8) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Hollow Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/12/2010 CHECKED BY ZO

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 ● POCKET PENETR. × LAB VANE				
141.3 0.0	GROUND SURFACE							20 40 60 80 100	10 20 30			GR SA SI CL
	0.2 m TOPSOIL	tr rootlets	1	SS	10		141					
	EMBANKMENT FILL: Sandy Silt tr. gravel, brown, loose, moist		2	SS	6		140					2 36 44 18
	some organic		3	SS	7							
139.2 2.1			4	SS	35		139					spoon wet below 2.3 m
	SILTY SAND TILL grey, compact to v. dense, wet		5	SS	25		138					
			6	SS	40		137					auger grinding @ 3.8 m
			7	SS	48							11 48 31 10
			8	SS100 / 20 cm			136					auger grinding @ 4.9 m
135.5 5.8			9	SS	67		135					48 41 (11)
	SAND AND GRAVEL tr. silt and clay grey, v. dense, wet						134					auger grinding @ 7.3 m
			10	SS100 / 15 cm			133					spoon bounces @ 7.6 m
132.0 9.3			11	SS100 / 20 cm			132					augering very slowly from 8.8 to
	End of Borehole. Water level @ 2.1 m (not stabilized)* upon completion. Borehole caved-in @ 5.9 m upon completion											9.1 m spoon bounces @ 9.1 m

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

Appendix A6

Drawing and Record of Borehole Sheets

Cut Area 1 – Stations 21+920 to 22+150 EB

METRIC

NOTES:

FOR DETAILED SUBSURFACE CONDITIONS
REFER TO RECORD OF BOREHOLE SHEETS.

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

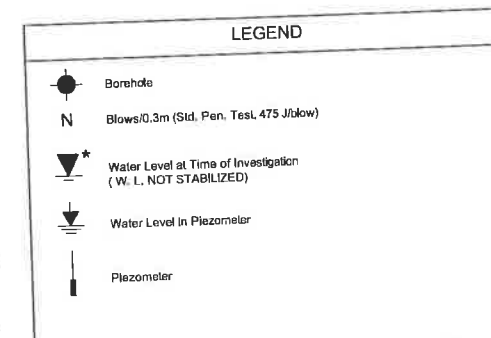
CONT No.
GWP: 205-00-01

HIGHWAY 401 EXPANSION
CUT AREA 1 - STATIONS
21+920 TO 22+150 EB
BOREHOLE LOCATION PLAN
AND SOIL STRATA



SHEET

coffey geotechnics
SPECIALISTS MANAGING THE EARTH



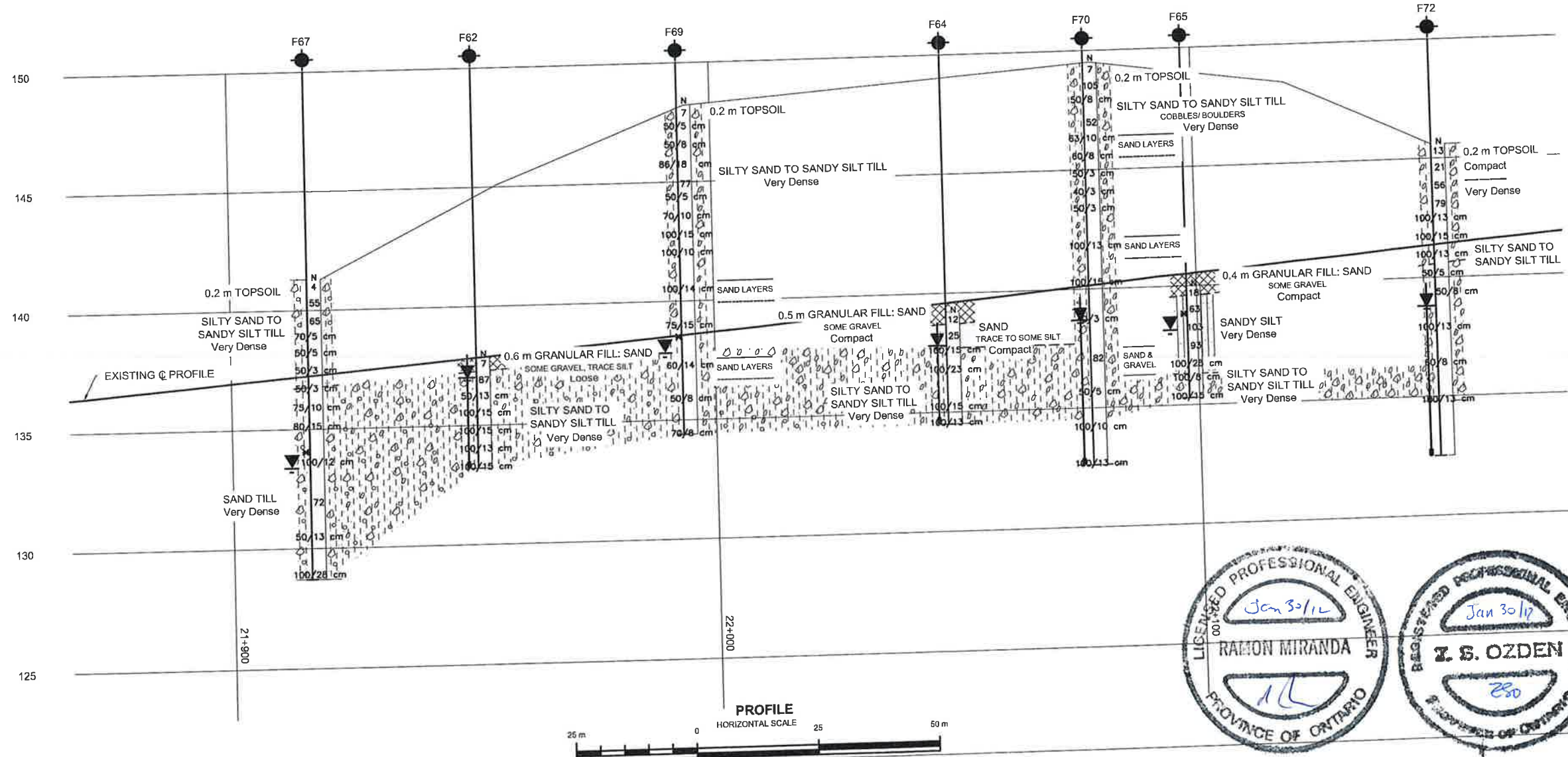
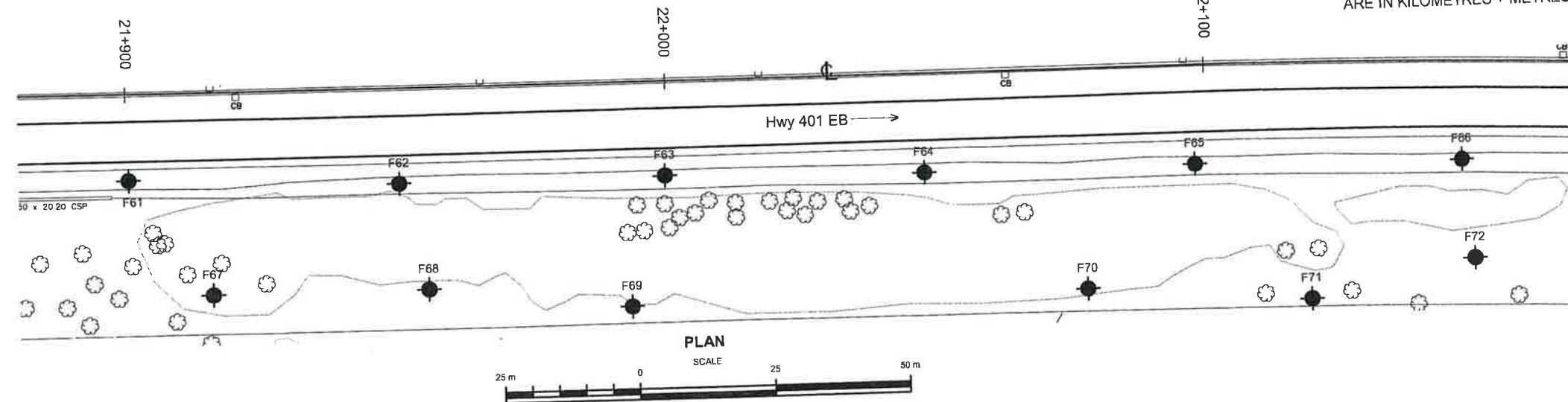
No.	ELEVATION	EASTING	NORTHING
F61	137.0	414191.4	4873950.4
F62	137.9	414232.0	4873979.5
F63	136.6	414271.0	4874009.6
F64	139.3	414309.7	4874038.3
F65	140.0	414349.5	4874068.9
F66	140.9	414389.2	4874098.5
F67	141.3	414216.8	4873942.5
F68	145.1	414248.3	4873966.8
F69	148.2	414280.7	4873986.4
F70	149.5	414347.1	4874038.5
F71	148.4	414381.9	4874061.2
F72	145.7	414402.0	4874085.0

-NOTE-
The boundaries between soil strata have been established only
at borehole locations. Between boreholes the boundaries are
assumed from geological evidence.

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No.	TRAN0610434AA	DIST	
SUBMD	CHECKED	DATE	Aug. 25, 2011
DRAWN	SH	CHECKED	RM
		APPROVED	ZO
			DWG
			A6



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F61

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 21+901, 16 m Rt of C/L (E 414191.5, N 4873950.4) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/13/2010 CHECKED BY ZO

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)						WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● POCKET PENETR. × LAB VANE						W _P	W	W _L
						20	40	60	80	100	10	20	30			
137.0	GROUND SURFACE															
0.0	GRANULAR FILL: Gravelly Sand tr. silt, brown, dense, moist		1	SS	33						○			32 59 (9)		
136.3																
0.7			2	SS	24						○			3 54 33 10		
			3	SS	13						○					
	compact															
	v. dense		4	SS	73						○					
	SILTY SAND TO SANDY SILT TILL brown to grey, wet		5	SS	94						○			spoon wet below 3.1 m		
			6	SS106 / 23 cm							○					
			7	SS100 / 13 cm							○					
131.6			8	SS100 / 10.2 cm							○					
5.4	End of Borehole. Water level @ 4.7 m (not stabilized)* upon completion. Borehole caved-in @ 5.0 m upon completion.															

+³, x³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F62

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+950, 18 m Rt of C/L (E 414232.1, N 4873979.5) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/13/2010 CHECKED BY ZO

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		
137.9	GROUND SURFACE													
0.0	GRANULAR FILL: Sand some gravel, tr. silt, some topsoil, dark brown loose, moist		1	SS	7									
137.3														
0.6	gas odour		2	SS	87		137							
			3	SS	50 / 13									9 44 37 10
	SILTY SAND TO SANDY SILT TILL brown to grey, v. dense, wet to moist		4	SS	100 / 15		136							spoon wet below 2.3 m
			5	SS	100 / 15		135							
			6	SS	100 / 13		134							
133.2			7	SS	100 / 15									
4.7	End of Borehole. Piezometer installed @ 4.0 m upon completion. Date / Measured water level July 13, 2010 / 2.4 m (on completion) August 19, 2010 / 1.1 m October 15, 2010 / 0.9 m													

+ 3, X 3 Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F63

1 OF 1

METRIC

GWP G W P 205-00-01 LOCATION Station 22+000, 18 m Rt of C/L (E 414271.0, N 4874009.7) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/13/2010 CHECKED BY ZO

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) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. x LAB VANE 20 40 60 80 100					
138.6	GROUND SURFACE												
0.0	GRANULAR FILL: Sand tr gravel, brown, compact, moist		1	SS	14								
138.2			2	SS	52								
0.4			3	SS	94								
	SILTY SAND TO SANDY SILT TILL brown, v. dense, wet		4	SS100 / 23 cm									
			5	SS100 / 15 cm									
			6	SS100 / 13 cm									
			7	SS 50 / 15 cm									
133.1			8	SS100 / 15 cm									
5.5	End of Borehole. Water level @ 1.8 m (not stabilized)* upon completion. Borehole caved-in @ 3.7 m upon completion.												

+ 3 x 3 : Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No F64

1 OF 1

METRIC

GWP GWP 205-00-01

LOCATION Station 22+048, 19 m Rt of C/L (E 414309.7, N 4874036.4)

ORIGINATED BY GJ

DIST _____ HWY 401

BOREHOLE TYPE Solid Stem Auger

COMPILED BY WC

DATUM Geodetic

DATE 7/13/2010

CHECKED BY ZO

[illegible]

+ 3, x 3: Numbers refer to Sensitivity

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F65

1 OF 1

METRIC

GWP G.W P 205-00-01 LOCATION Station 22+098, 19 m Rt of C/L (E 414349.5, N 4874069.0) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/13/2010 CHECKED BY ZO

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		
140.0	GROUND SURFACE						140							
0.0	GRANULAR FILL: Sand some gravel, brown, compact, moist		1	SS	18		139							
139.6			2	SS	63		138							
0.4	SANDY SILT brown, v. dense, moist to wet		3	SS	103		137							
			4	SS	93		136							
			5	SS	100 / 28 cm									
136.3			6	SS	100 / 8 cm									
3.7	SILTY SAND TO SANDY SILT TILL brown, v. dense, wet		7	SS	100 / 15 cm									
135.3														
4.7	End of Borehole. Water level @ 1.8 m (not stabilized)* upon completion. Borehole caved-in @ 2.1 m upon completion.													

+³ . X³ : Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F66

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+148, 18 m Rt of C/L (E 414389.2, N 4874098.5) ORIGINATED BY GJ
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY WC
 DATUM Geodetic DATE 7/13/2010 CHECKED BY ZO

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	10
140.9	GROUND SURFACE																	
0.0	GRANULAR FILL: Sand some gravel, tr. silt, tr. rootlets brown, compact, moist		1	SS	29													
140.3			2	SS	18													
0.6			3	SS100 / 15														
			4	SS 60 / 15														
	SILTY SAND TO SANDY SILT TILL brown, v dense		5	SS100 / 15														
			6	SS 50 / 13														
			7	SS100 / 28														
135.9	End of Borehole.																	
5.0	Piezometer installed @ 4.0 m upon completion. Date / Measured water level July 13, 2010 / 3.1 m (on completion) August 19, 2010 / 2.6 m October 15, 2010 / 2.3 m																	

 $\times 3$

Numbers refer to Sensitivity

 $\times 5$

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F67

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+916, 38 m Rt of C/L (E 414216.9, N 4873942.5) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/28/2010 CHECKED BY ZO

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		
141.3 0.0	GROUND SURFACE													
	0.2 m TOPSOIL		1	SS	4		141							
			2	SS	55		140							10 59 25 6 High SPT-N value due to rock fragments
			3	SS	65		139							auger grinding auger grinding
	SILTY SAND TO SANDY SILT TILL v. dense		4	SS	70 / 5 cm		138							auger grinding auger grinding
			5	SS	50 / 5 cm		137							auger grinding
			6	SS	60 / 3 cm		136							
			7	SS	50 / 3 cm		135							
			8	SS	75 / 10 cm		134							
			9	SS	80 / 15 cm		133							
			10	SS	100 / 12 cm		132							
			11	SS	72		131							4 43 46 7 spoon wet
130.9 10.4			12	SS	50 / 13 cm		130							1 83 (16)
	SAND TILL grey, v. dense, wet		13	SS	100 / 28 cm		129							
128.7 12.6	End of Borehole @ 12.6 m Water Level @ 7.9 m (not stabilized)* upon completion. Borehole caved-in @ 10.7 m upon completion													

+³, x³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F68

1 OF 2

METRIC

GWP G.W.P 205-00-01 LOCATION Station 21+956, 38 m Rt of C/L (E 414248.4, N 4873966.9) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/29/2010 CHECKED BY ZO

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		
145.1 0.0	GROUND SURFACE											
	0.2 m TOPSOIL		1	SS	4		145					
			2	SS 50/15 cl			144					auger grinding
			3	SS 100/10 cl			143					auger grinding
			4	SS 100/8 cl			142					4 41 44 11
			5	SS 50/8 cl			141					auger grinding
			6	SS 100/13 cl			140					auger grinding
			7	SS 100/10 cl			139					auger grinding
			8	SS 70/6 cl			138					
			9	SS 100/15 cl			137					
			10	SS 100/12 cl			136					
			11	SS 70/8 cl			135					
			12	SS	100		134					0 80 (20) spoon wet
			13	SS 70/13 cl			133					spoon wet
131.4 13.7 131.1 14.0	SAND TILL grey, v. dense, wet		14	SS 75/15 cl			132					
End of Borehole. Piezometer installed @ 13.7 m upon completion.												

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F68

2 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+956, 38 m Rt of C/L (E 414248.4, N 4873966.9) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/28/2010 CHECKED BY ZO

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					
130.1	Date / Measured Water Level June 29, 2010 / 10.0 m June 30, 2010 / 7.1 m August 19, 2010 / 7.1 m October 15, 2010 / 6.3 m													

 $+^3, \times^3$: Numbers refer to Sensitivity

 20
15-5
10 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F69

1 OF 1

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 21+993, 42 m Rt of C/L (E 414280.7, N 4873986.5) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/25/2010 CHECKED BY ZO

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 ● POCKET PENETR. × LAB VANE					
148.2 0.0	GROUND SURFACE 0.2 m TOPSOIL		1	SS	7	148							
	tr. rootlets, loose		2	SS	50 / 5 cm	147							auger grinding
	v. dense		3	SS	50 / 8 cm	146							auger grinding
			4	SS	85 / 18 cm	145							
	SILTY SAND TO SANDY SILT TILL		5	SS	77	144							spoon bouncing auger grinding
			6	SS	50 / 5 cm	143							auger grinding at 4.8 and 5.5 m
			7	SS	70 / 10 cm	142							auger grinding
			8	SS	100 / 15 cm	141							
			9	SS	100 / 10 cm	140							
			10	SS	100 / 14 cm	139							0 85 (15)
	sand layer		11	SS	75 / 15 cm	138							auger grinding at 9.4 and 10.0 m
			12	SS	60 / 14 cm	137							spoon wet
	brownish grey, moist		13	SS	50 / 8 cm	136							spoon wet
	grey, wet sand layer		14	SS	70 / 8 cm	135							auger grinding
134.4 13.8	End of Borehole. Water level @ 10.4 m (not stabilized)* upon completion. Borehole caved-in at 10.7 m												

+³ ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F70

1 OF 2

METRIC

GWP G.W P 205-00-01 LOCATION Station 22+078, 41 m Rt of C/L (E 414347.2, N 4874038.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/25/2010 CHECKED BY ZO

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
149.5	GROUND SURFACE																	
0.0	0.2 m TOPSOIL		1	SS	7													
	tr. rootlets, brown, loose																	
	v. dense		2	SS	105													
			3	SS	50/8 c													
			4	SS	52													
			5	SS	63/10 c													
	sand layers		6	SS	60/8 c													
			7	SS	50/3 c													
	SILTY SAND TO SANDY SILT TILL		8	SS	40/3 c													
	cobbles / boulder inferred, wet		9	SS	40/3 c													
			10	SS	100/13 c													
	brownish grey, moist		11	SS	100/15 c													
	grey, moist to wet sand layer		12	SS	40/3 c													
			13	SS	82													
	sand and gravel		14	SS	50/5 c													
134.5																		

Continued Next Page

 + 3, X 3
Sensitivity

 20
15
10
(%) STRAIN AT FAILURE

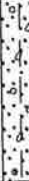
TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F70

2 OF 2

METRIC

GWP G W P 205-00-01 LOCATION Station 22+078, 41 m Rt of C/L (E 414347.2, N 4874038.6) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/25/2010 CHECKED BY ZO

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	SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● POCKET PENETR. X LAB VANE					WATER CONTENT (%)				
						20	40	60	80	100	W _p	W	W _L				
134.5 15.0	SILTY SAND TO SANDY SILT TILL cobbles / boulder inferred, v. dense, wet		15	SS100 / 10.8													
132.6 16.9			16	SS100 / 13.6													
End of Borehole. Piezometer installed @ 13.7 m Date / Measured Water Level June 30, 2010 / 10.8 m August 19, 2010 / 11.4 m October 15, 2010 / 10.9 m																	

+ 3, × 3 : Numbers refer to
Sensitivity
 20
15
10
(%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F71

1 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+120, 44 m Rt of C/L (E 414382.0, N 4874061.3) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/24/2010 CHECKED BY ZO

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 (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P	W	W _L		
148.4 0.0	GROUND SURFACE													
	0.2 m TOPSOIL		1	SS	7									
	tr. rootlets, brown, loose, compact		2	SS	20									
	compact		3	SS	25									
	v. dense		4	SS	50 / 8 cm									
	SILTY SAND TO SANDY SILT TILL		5	SS	100 / 15 cm									
	moist		6	SS	100 / 8 cm									
			7	SS	100 / 10 cm									
			8	SS	50 / 8 cm									
			9	SS	70 / 10 cm									
	brownish grey		10	SS	100 / 13 cm									
	grey													
			11	SS	50 / 10 cm									
	sand layer													
	moist		12	SS	65 / 15 cm									
	gravelly, wet													
			13	SS	65 / 15 cm									
			14	SS	100 / 15 cm									

Continued Next Page

+³ ×³: Numbers refer to Sensitivity
 20
 15 10 5
 (%) STRAIN AT FAILURE

TRANETOB10434AA: Highway 401

RECORD OF BOREHOLE No F71

2 OF 2

METRIC

GWP G.W.P. 205-00-01 LOCATION Station 22+120, 44 m Rt of C/L (E 414382.0, N 4874051.3) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/24/2010 CHECKED BY ZO

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			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		
133.4														
133.1	SILTY SAND TO SANDY SILT TILL		15	SS	20/78 cm		133							
15.3	grey, v. dense, moist													
	End of Borehole @ 15.3 m Water Level @ 10.5 m (not stabilized)* upon completion Borehole caved-in @ 10.7 m upon completion													

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

TRANETO10434AA: Highway 401

RECORD OF BOREHOLE No F72

1 OF 1

METRIC

GWP G.W.P 205-00-01 LOCATION Station 22+151, 37 m Rt of C/L (E 414402.0, N 4874085.0) ORIGINATED BY RK
 DIST HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY RK
 DATUM Geodetic DATE 6/24/2010 CHECKED BY ZO

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)							
145.6 0.0	GROUND SURFACE 0.2 m TOPSOIL							20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30	10 20 30	10 20 30		
		tr. rootlets	1	SS	13		145								
		compact	2	SS	21		144								
		v. dense	3	SS	56		143								
			4	SS	79		142								
			5	SS	100 / 130		141								
			6	SS	100 / 150		140								
			7	SS	100 / 130		139								
		brownish grey	8	SS	50 / 50		138								
			9	SS	50 / 80		137								
		moist	10	SS	100 / 130		136								
		wet	11	SS	60 / 80		135								
			12	SS	100 / 130		134								
134.8 10.8	End of Borehole. Piezometer installed @ 12.2 m. Date / Measured Water Level June 29, 2010 / 8.1 m June 30, 2010 / 6.8 m August 19, 2010 / 7.3 m October 15, 2010 / 6.8 m						133								
132.5 13.1															

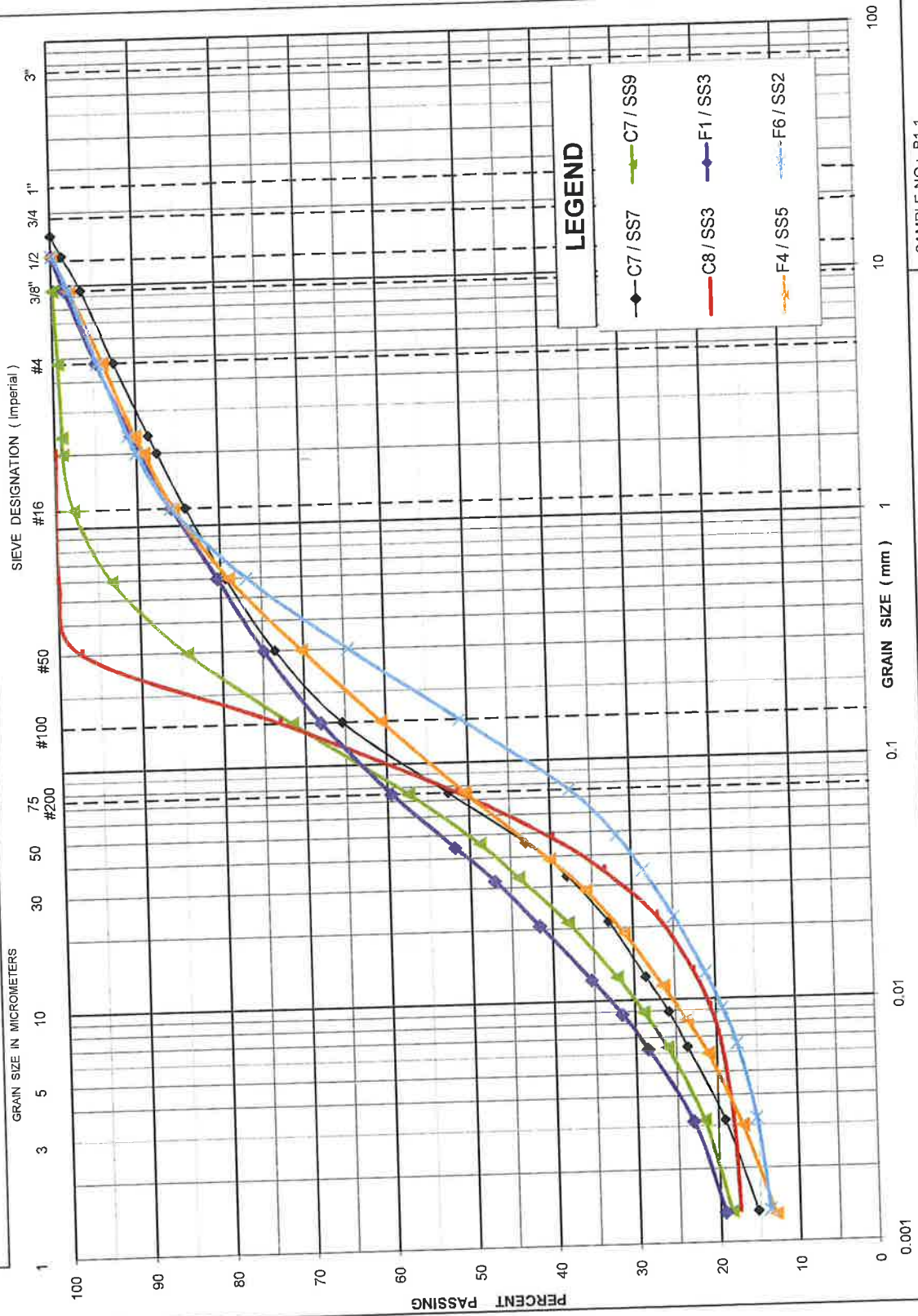
+ 3 x 3 Numbers refer to Sensitivity 20 15 10 (%) STRAIN AT FAILURE

Appendix B1

Laboratory Test Results – Fill Area 1 – Stations 20+150 to 20+400 EB

UNIFIED SOIL CLASSIFICATION SYSTEM

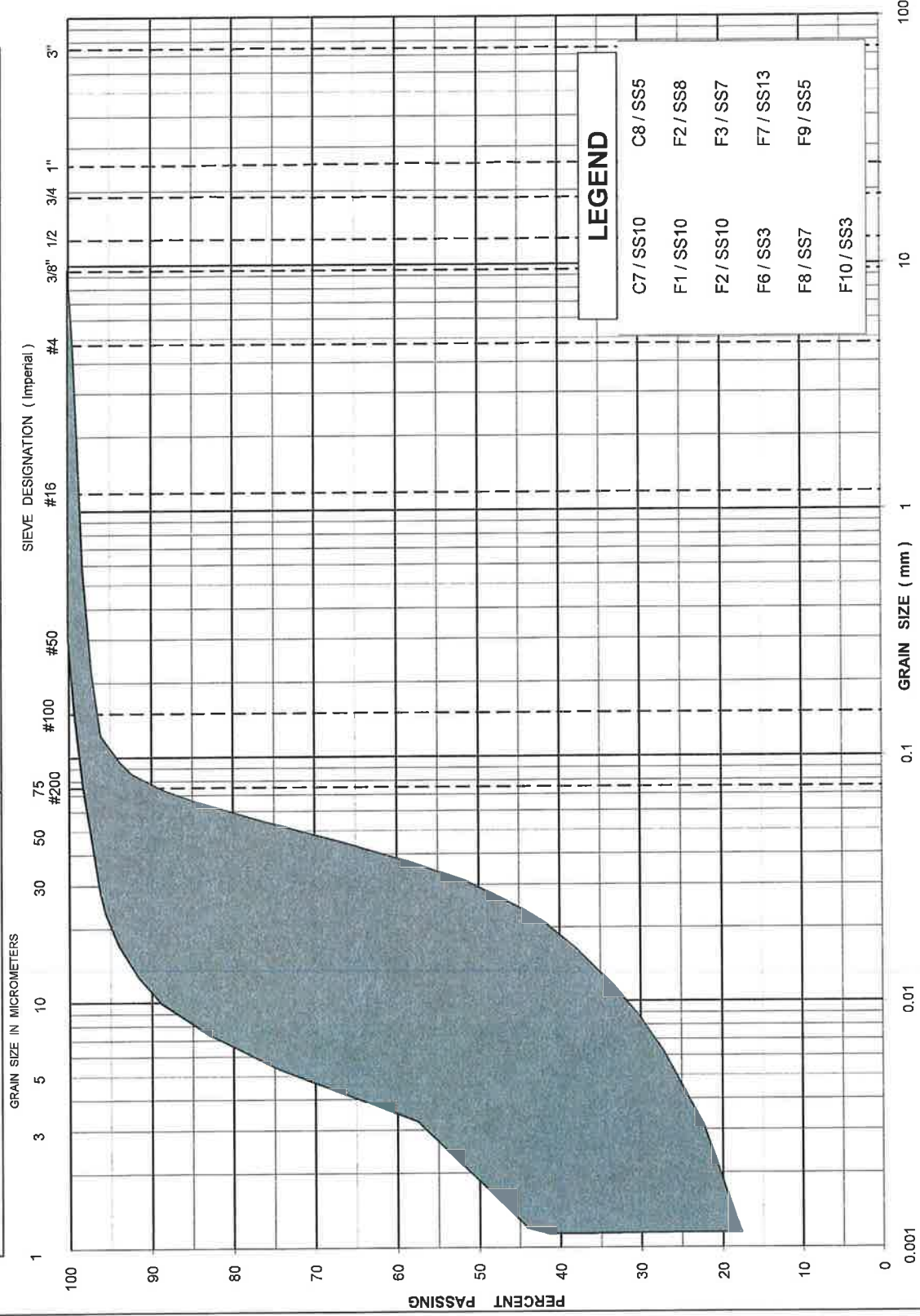
CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



<p>geotechnics SPECIALISTS MANAGING THE EARTH</p>		<p>GRAIN SIZE DISTRIBUTION</p>		<p>SAMPLE NO.: B1-1</p>
<p>coffey</p>		<p>EMBANKMENT FILL - Silty Sand</p>		<p>PROJECT #: TRANETOBI0434AA</p>
				<p>DATE: JAN 2011</p>

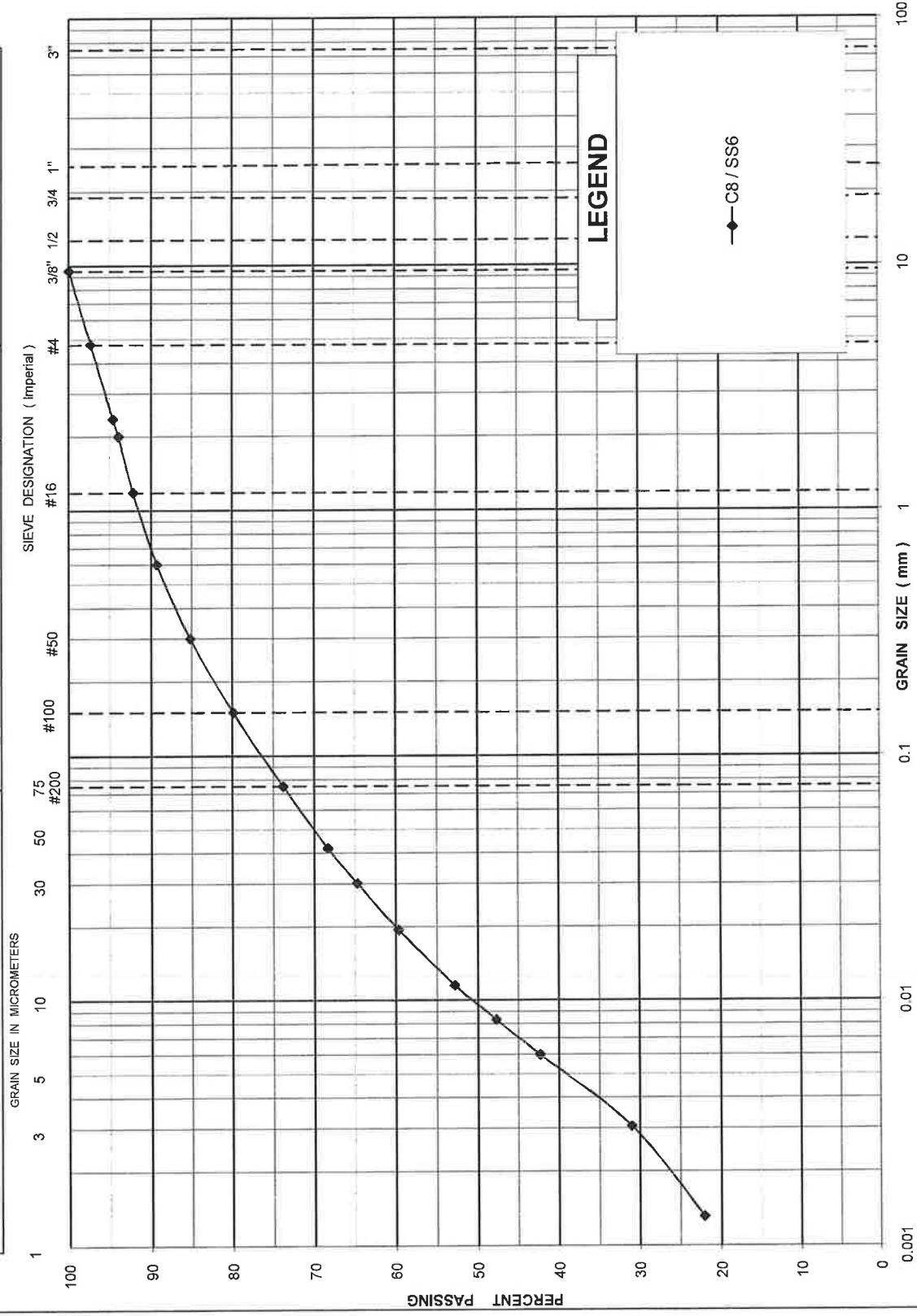
UNIFIED SOIL CLASSIFICATION SYSTEM

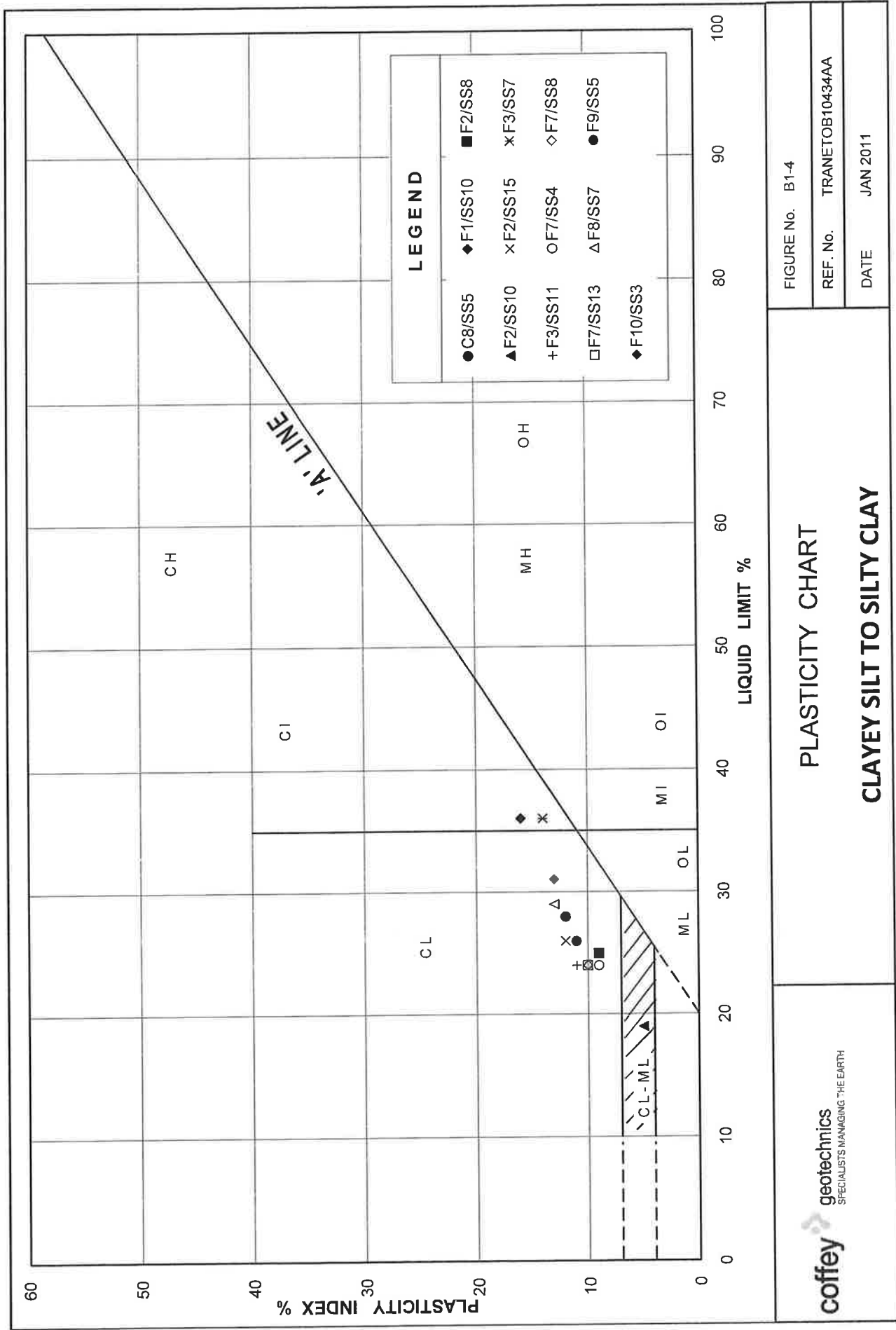
CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



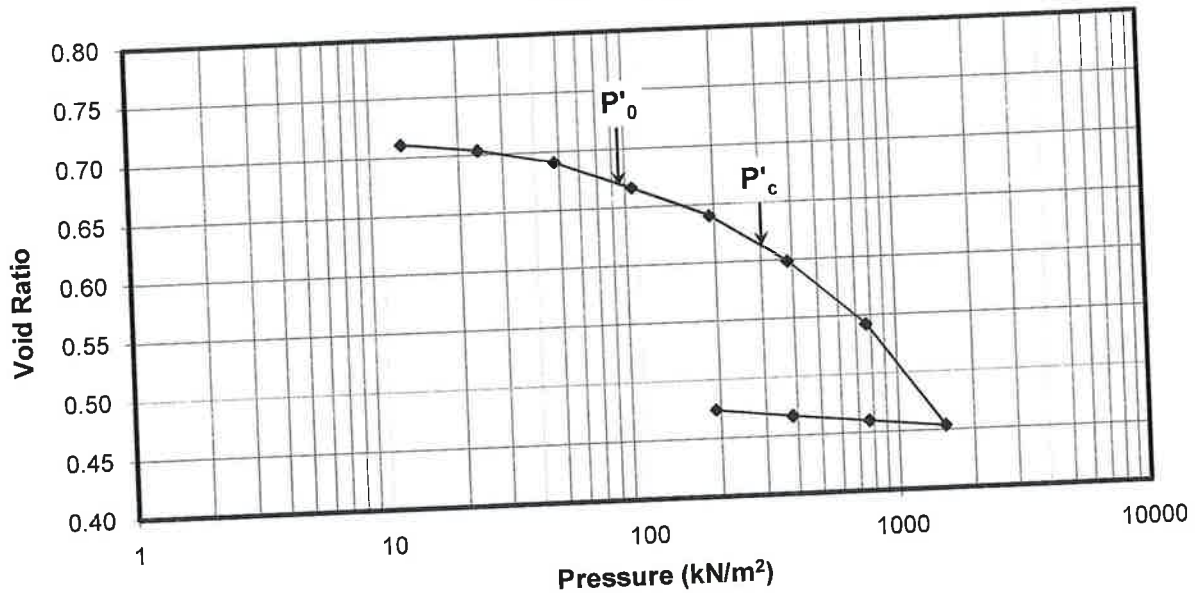
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

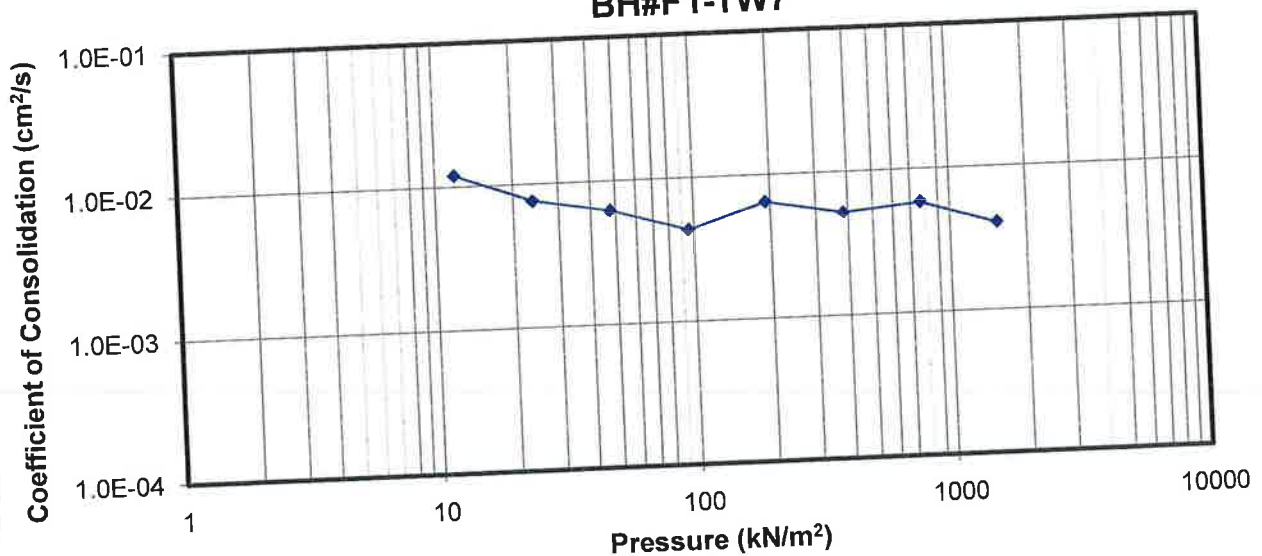





Void Ratio versus Pressure BH#F1 -TW7



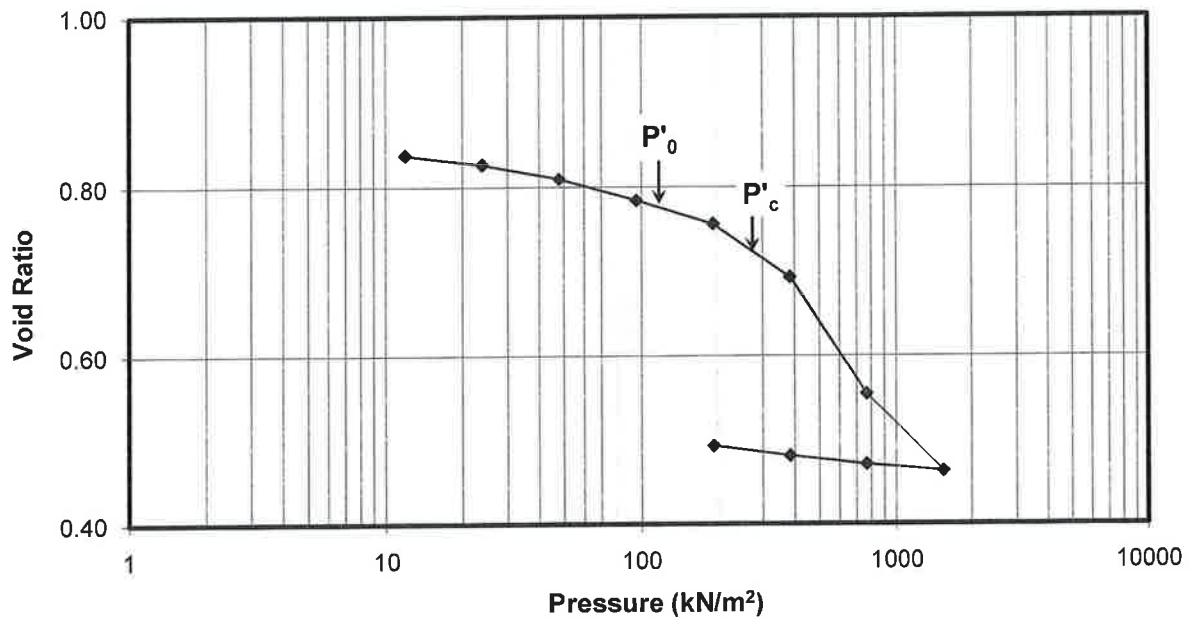
Coefficient of Consolidation vs. Pressure BH#F1-TW7



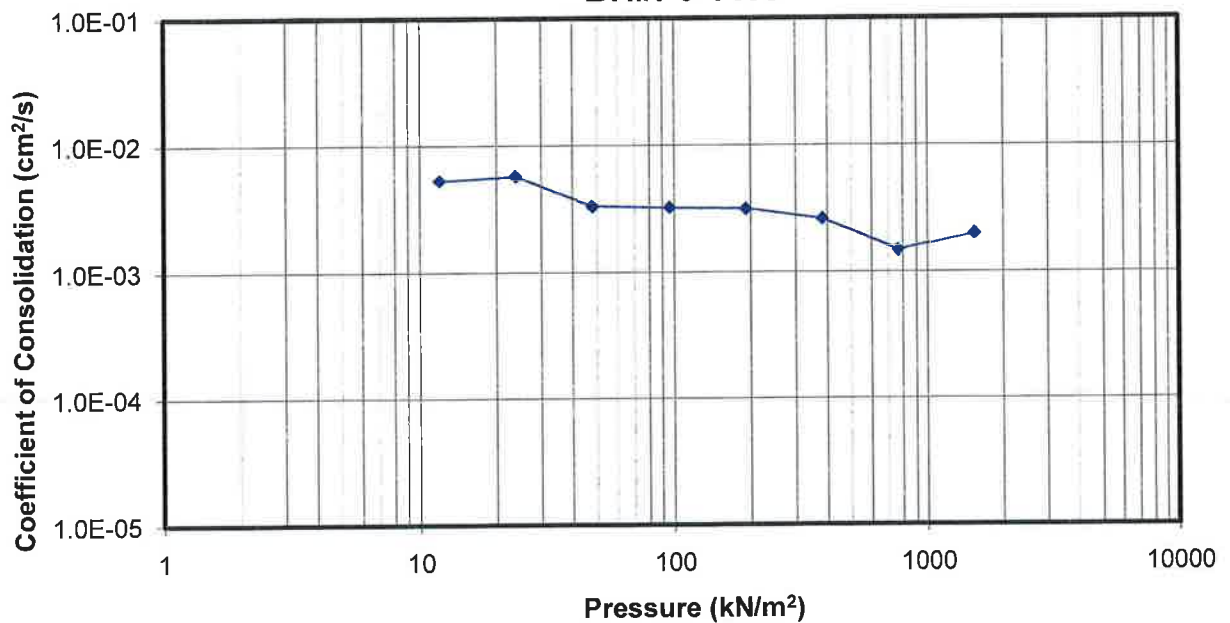
drawn	DS	 SPECIALISTS MANAGING THE EARTH	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 1 - STATION 20+150 to 20+400 EB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - F1 TW7	
original size	Letter		project no:	TRANETOB10434AA	figure no: B1-5


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Void Ratio versus Pressure BH#F6-TW9



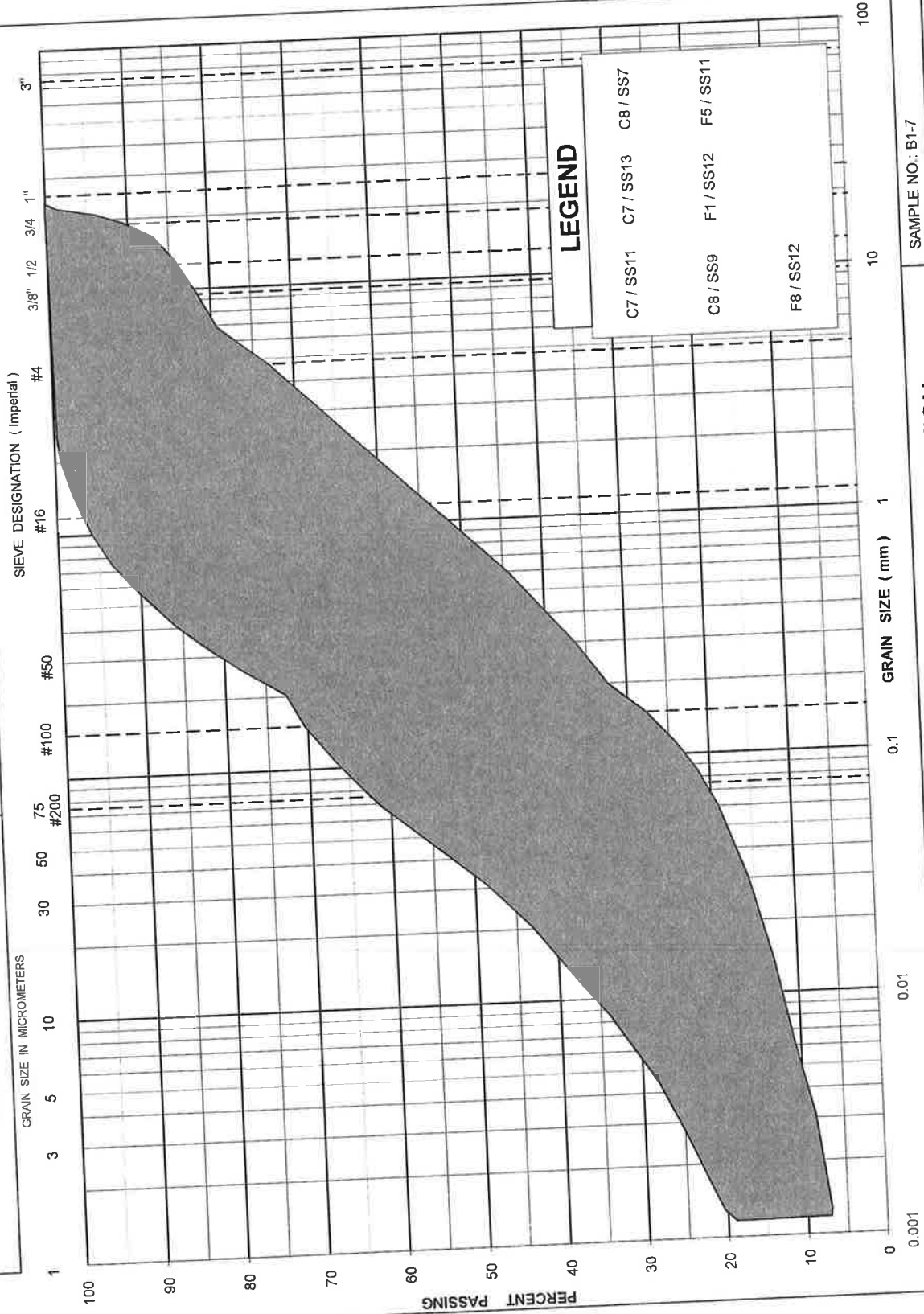
Coefficient of Consolidation vs. Pressure BH#F6-TW9



drawn	DS	 SPECIALISTS MANAGING THE EARTH	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 1 - STATION 20+150 to 20+400 EB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - F6 TW9	
original size	Letter		project no:	TRANETOB10434AA	figure no: B1-6

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



SAMPLE NO.: B1-7

PROJECT #: TRANETOB10434AA

DATE JAN 2011

GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

geotechnics
SPECIALISTS MANAGING THE EARTH

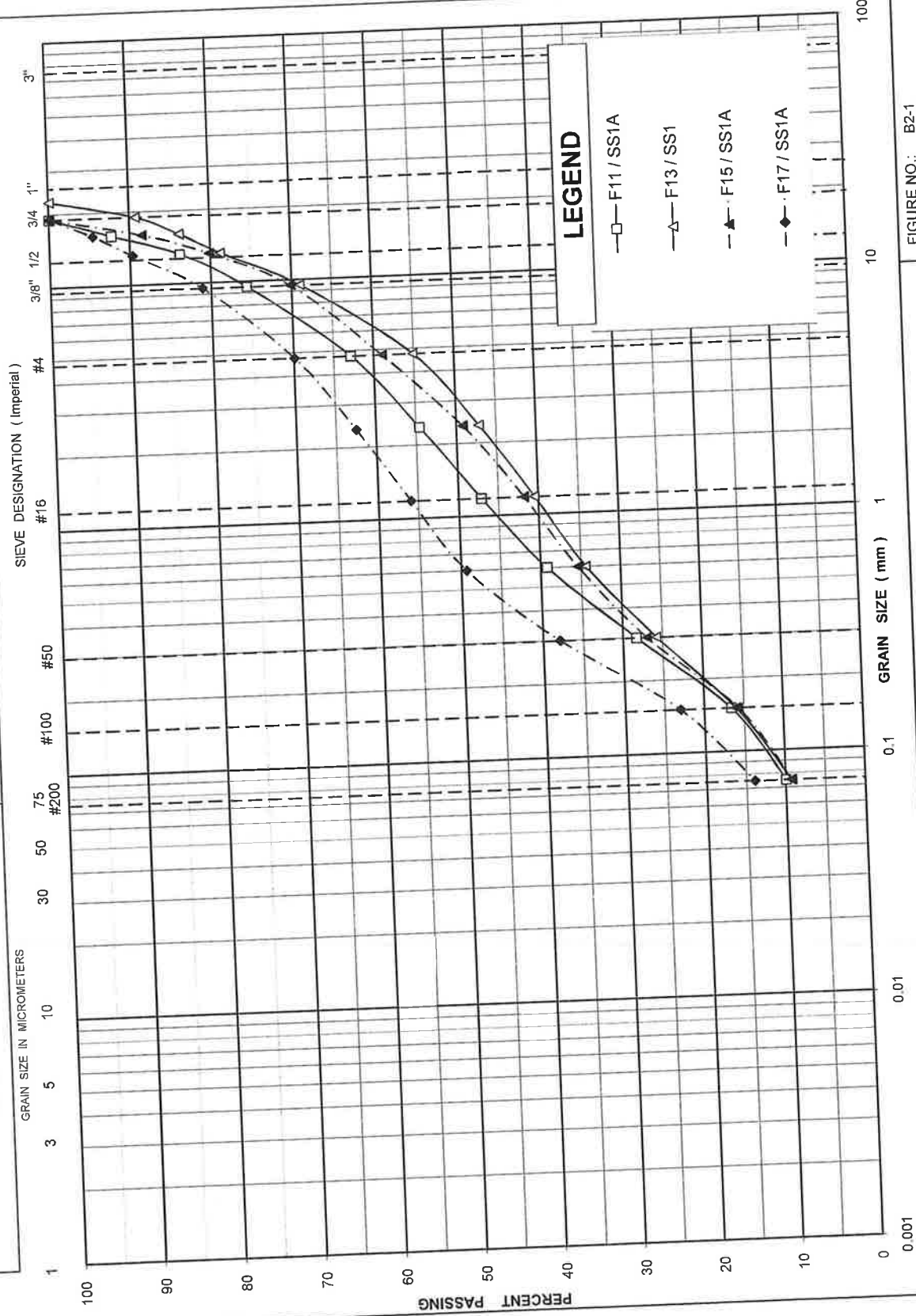
coffey

Appendix B2

Laboratory Test Results – Fill Area 2 – Stations 20+300 to 20+500 WB

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION
PAVEMENT FILL - Sand & Gravel to Gravelly Sand

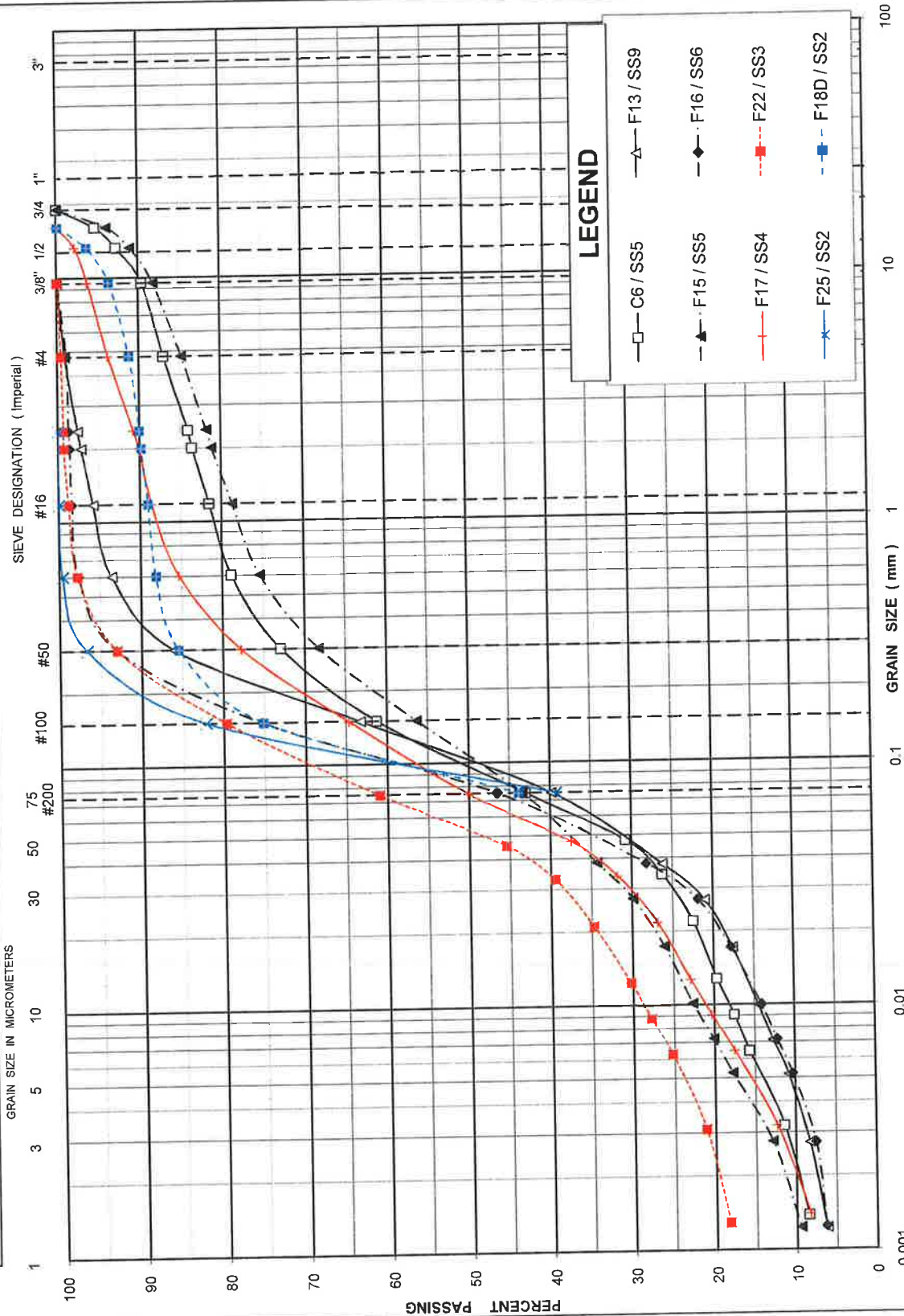
FIGURE NO.: B2-1

PROJECT NO: TRANETOB10434AA

DATE: Sept, 2010

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT SAND GRAVEL

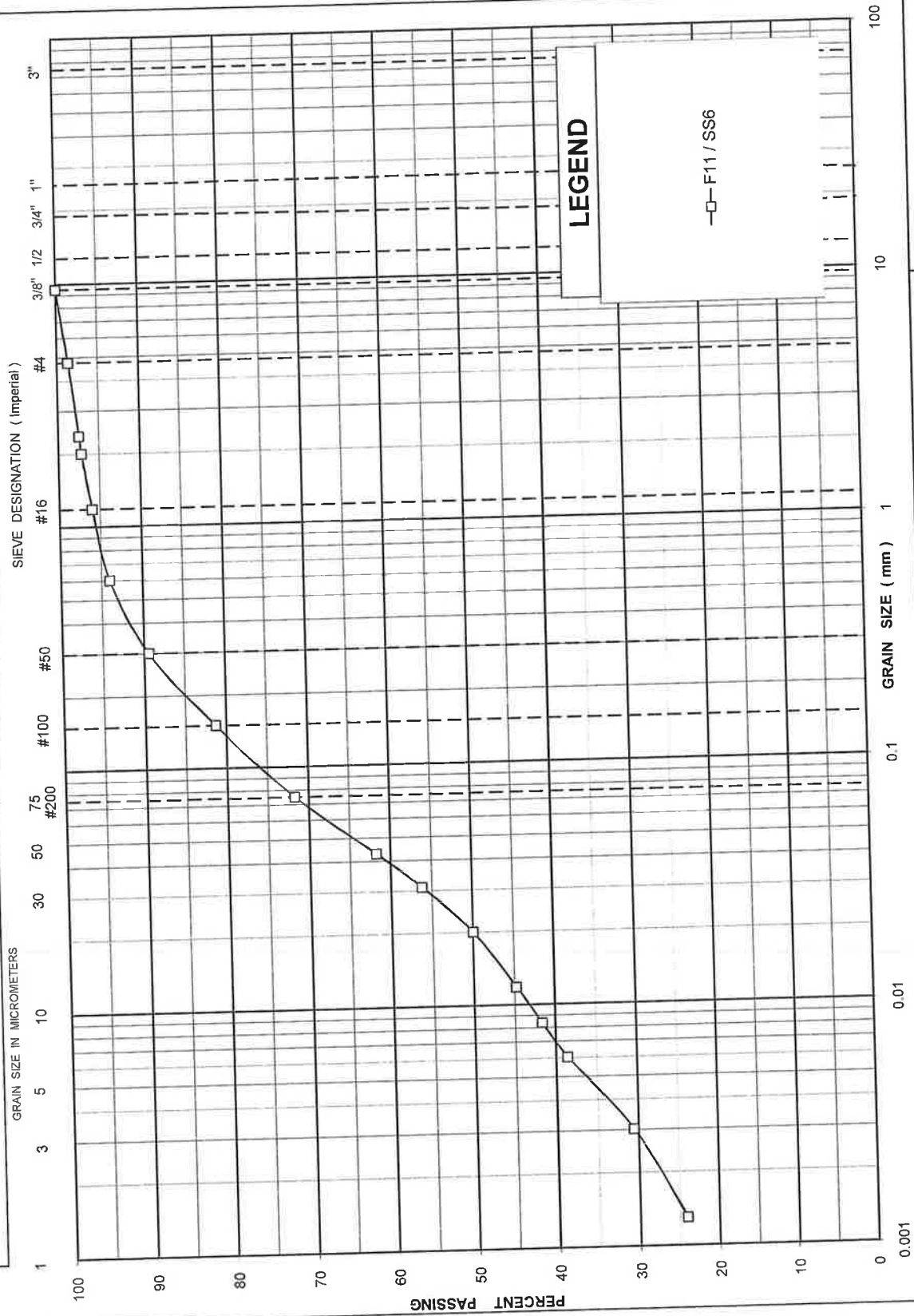
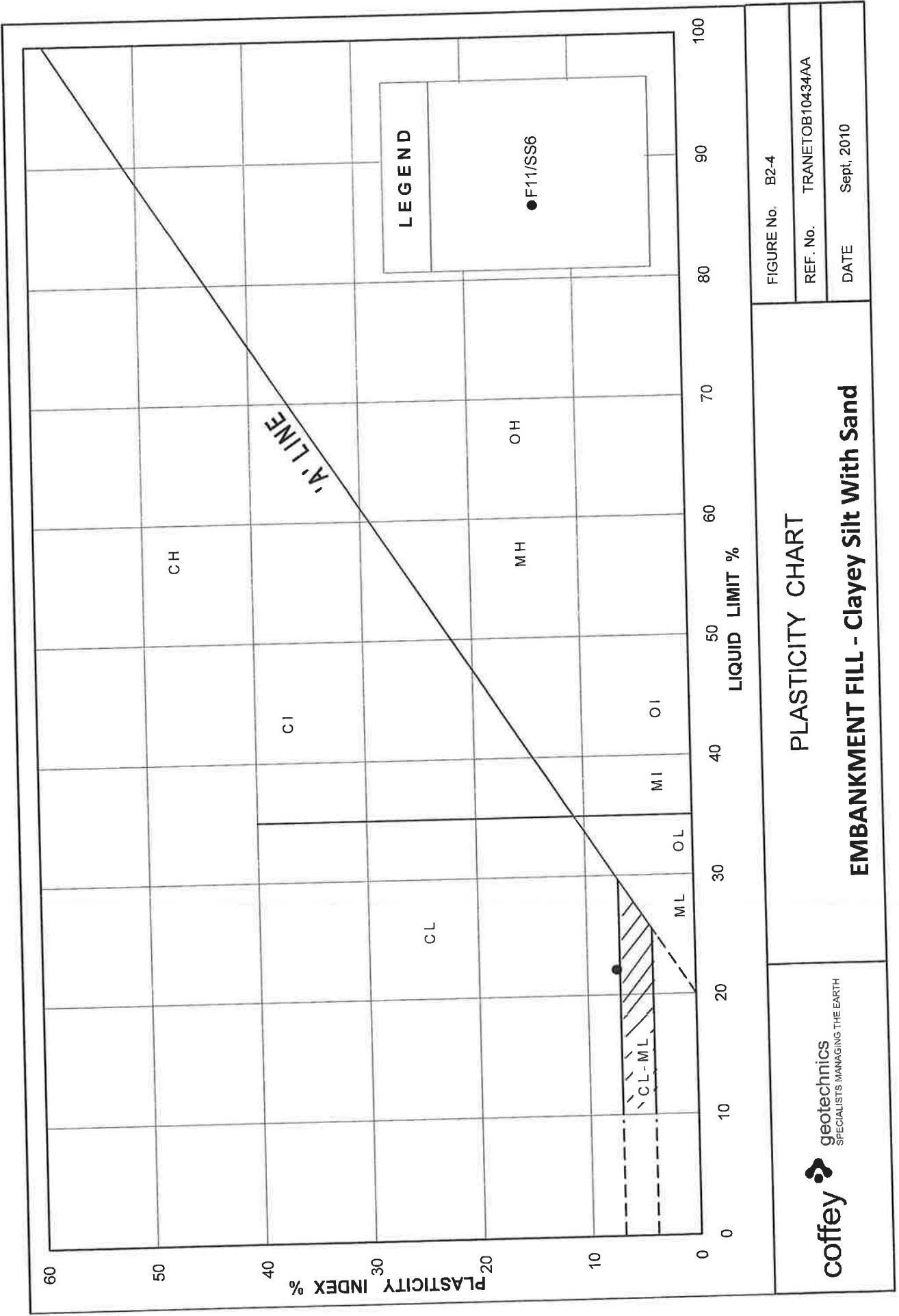


FIGURE NO.: B2-3
PROJECT NO: TRANETOB10434AA
DATE: Sept. 2010

GRAIN SIZE DISTRIBUTION
EMBANKMENT FILL - Clayey Silt With Sand

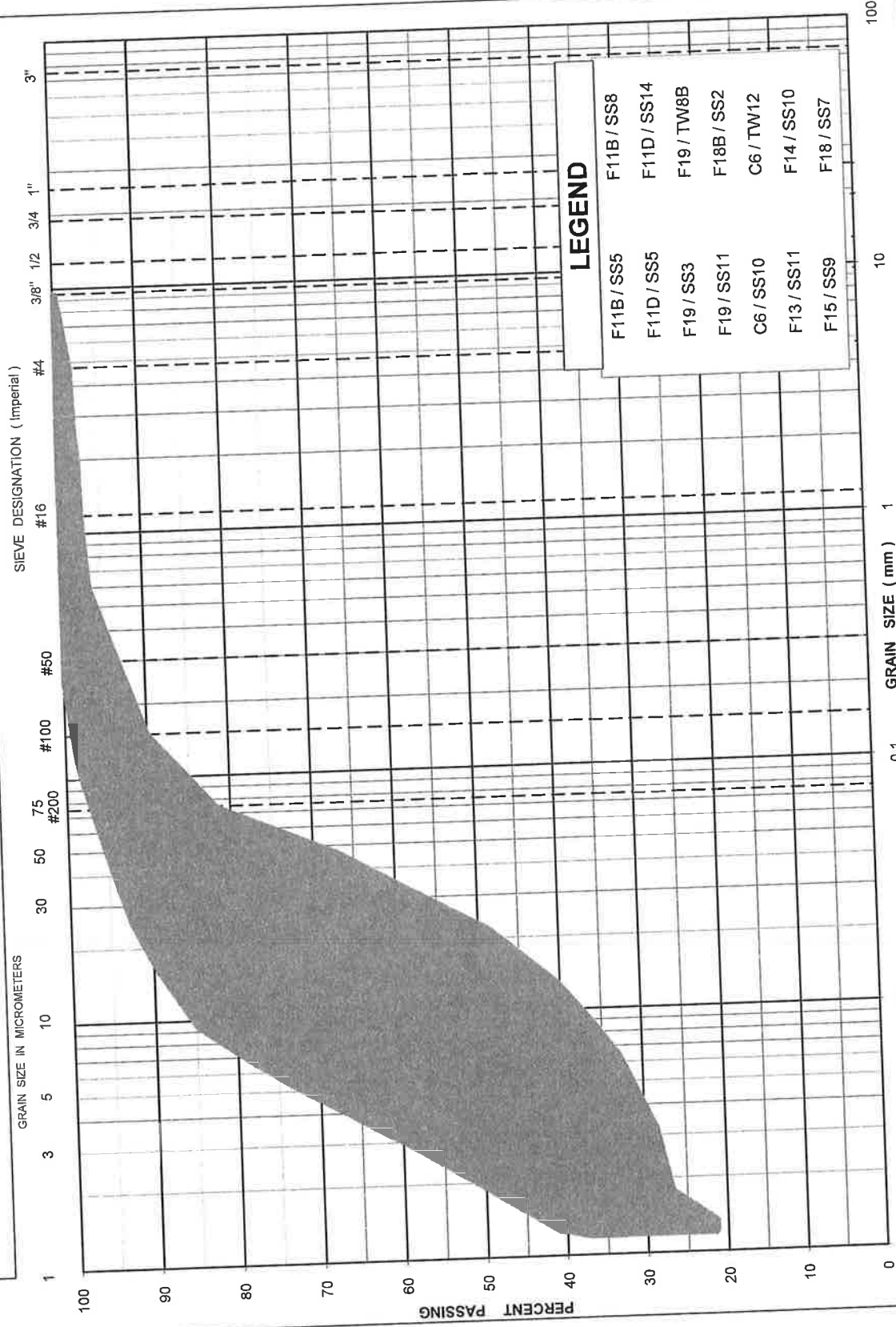


CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	GRAVEL	
				Fine	Coarse



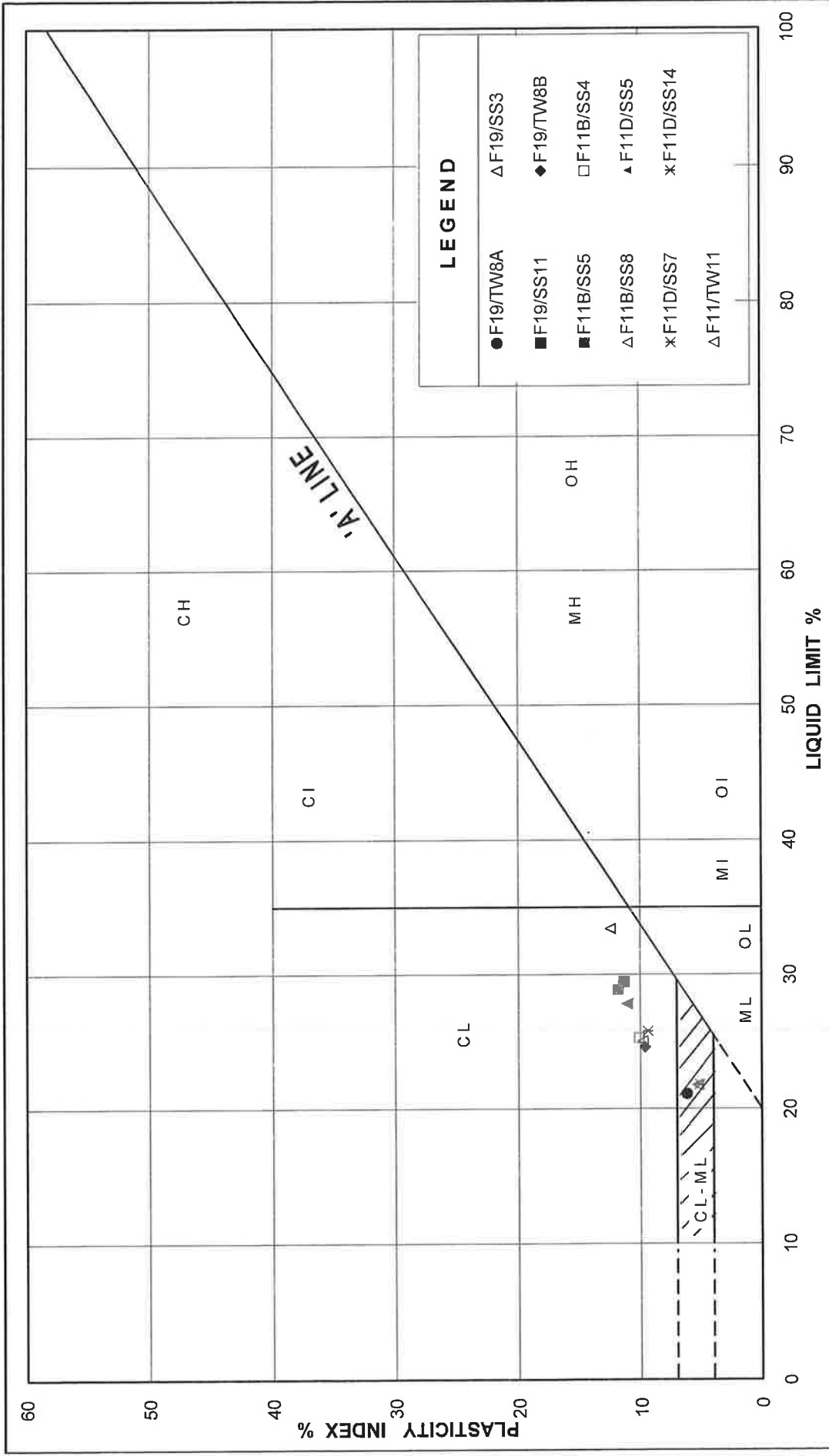
UNIFIED SOIL CLASSIFICATION SYSTEM

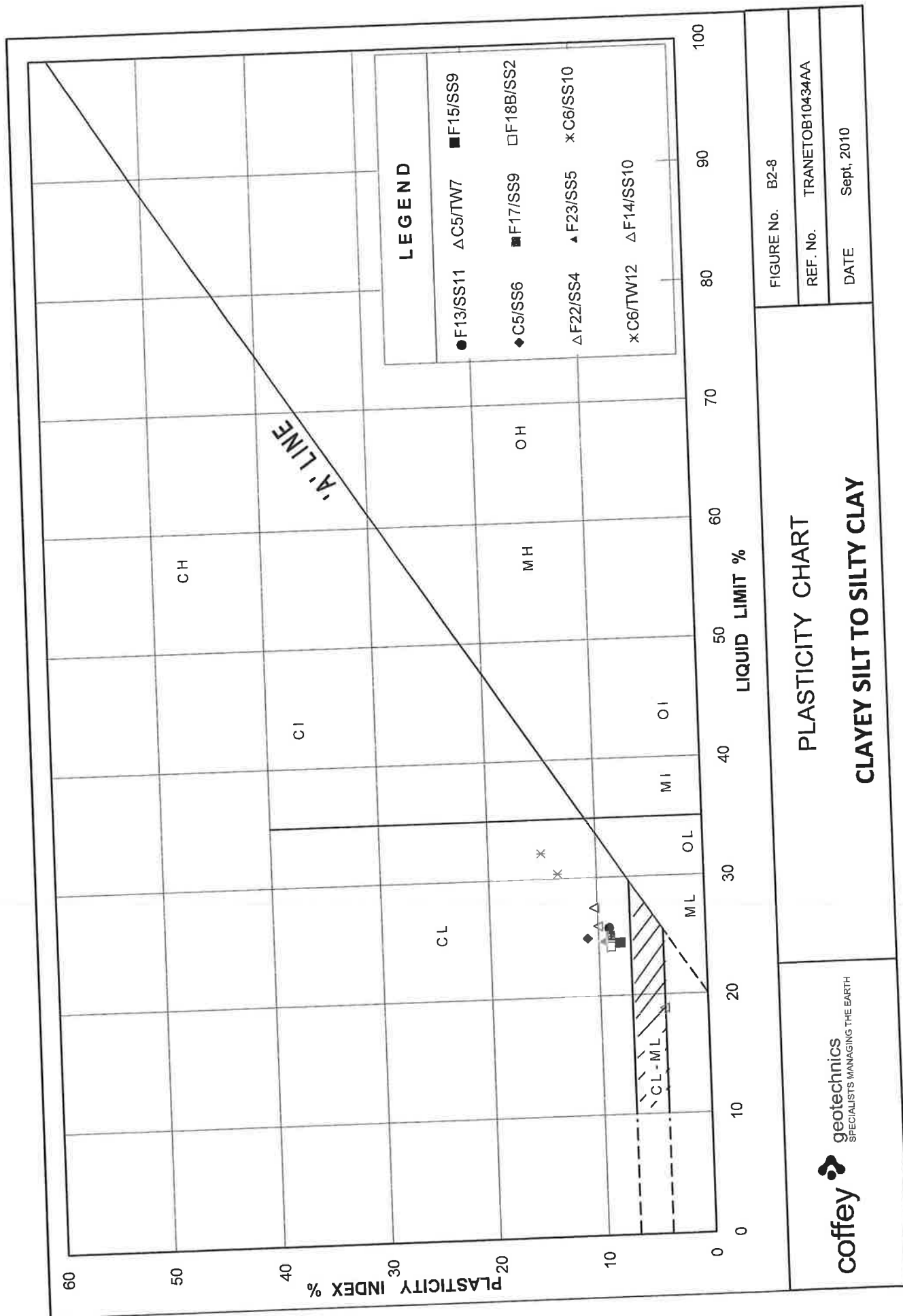
CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



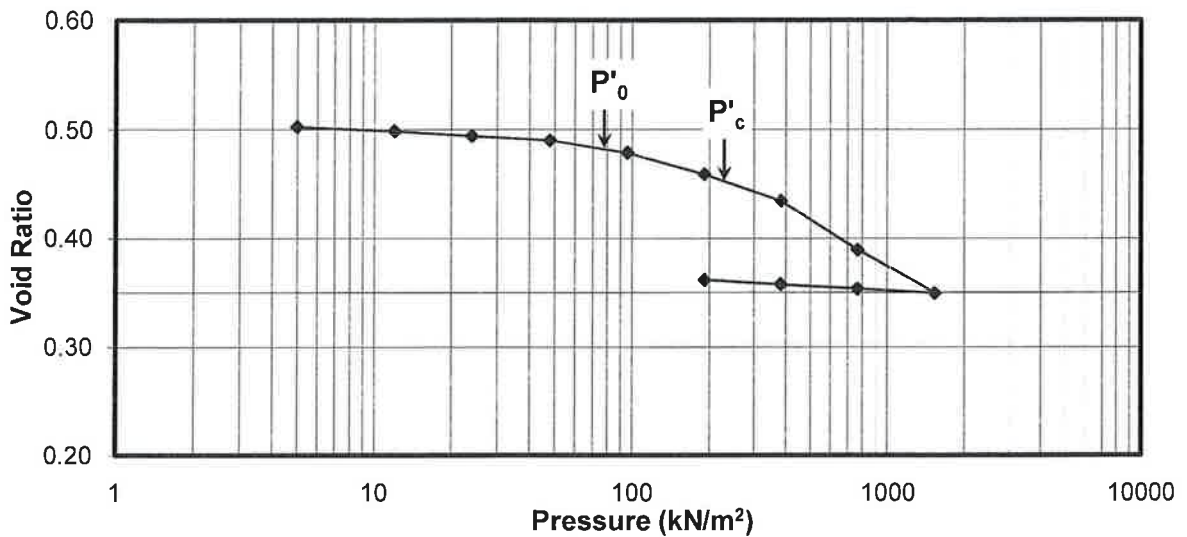
LEGEND	
F11B / SS5	F11B / SS8
F11D / SS5	F11D / SS14
F19 / SS3	F19 / TW8B
F19 / SS11	F18B / SS2
C6 / SS10	C6 / TW12
F13 / SS11	F14 / SS10
F15 / SS9	F18 / SS7

GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SILTY CLAY

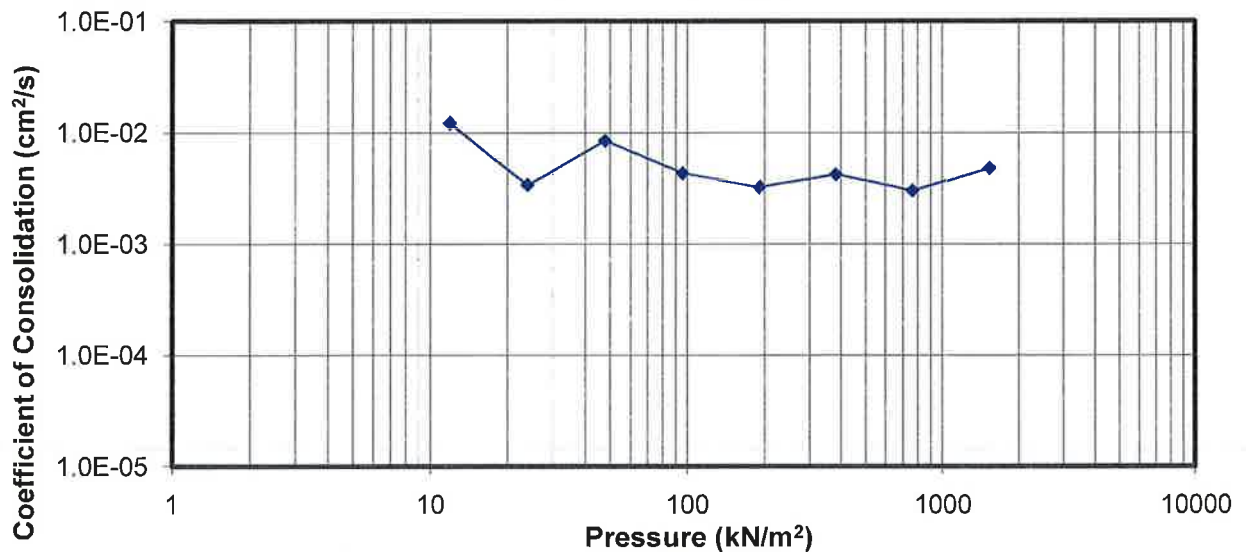





Void Ratio versus Pressure BH#F19-TW8A



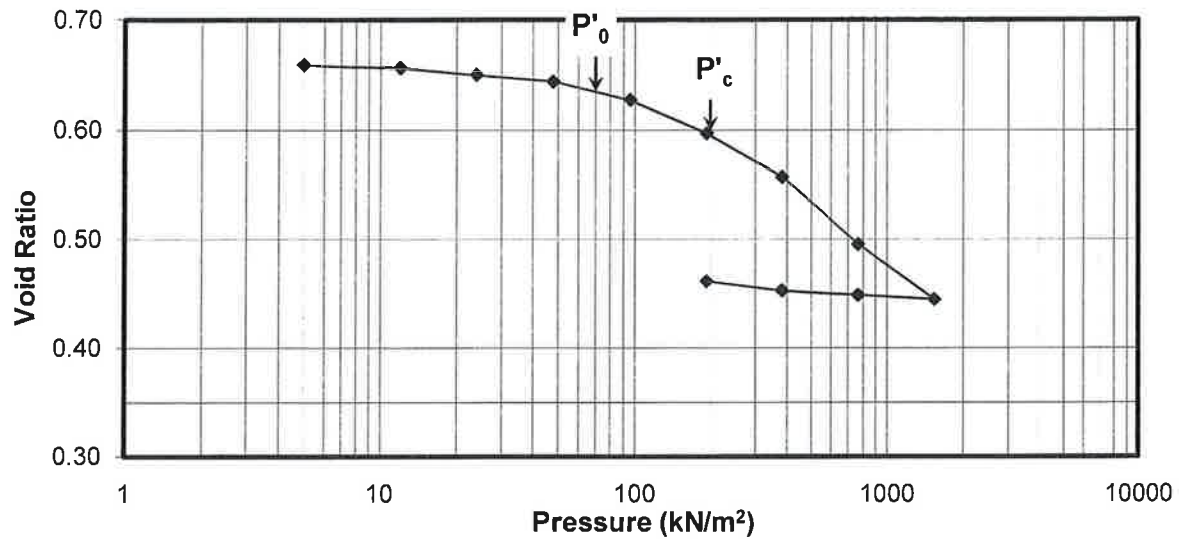
Coefficient of Consolidation vs. Pressure BH#F19-TW8A



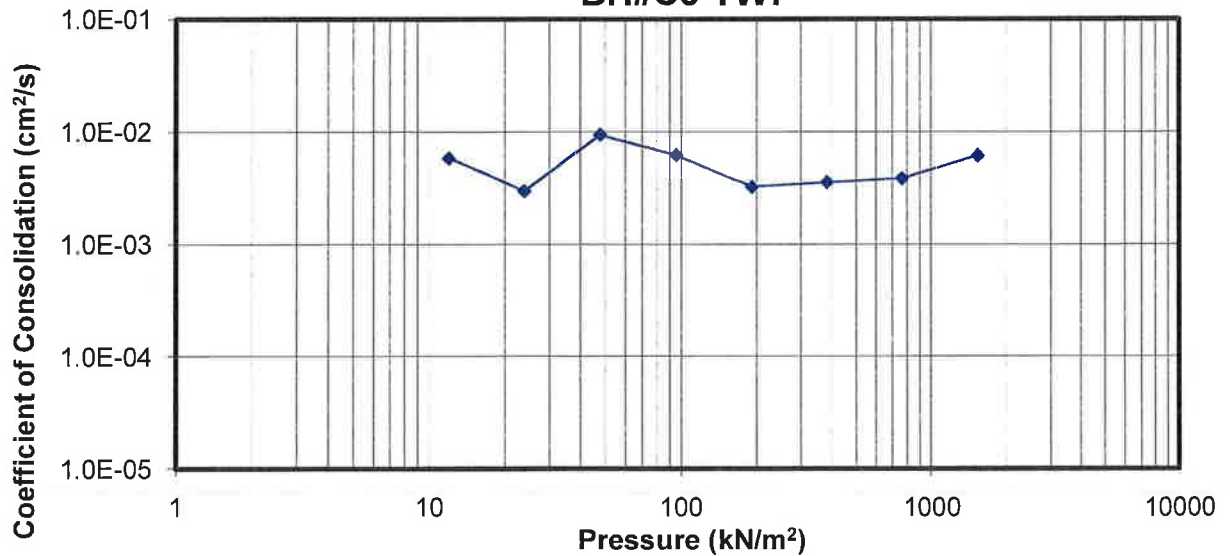
drawn	SS	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 2 – STATION 20+300 TO 20+500 WB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - F19 TW8A	
original size	Letter		project no:	TRANETOB10434AA	figure no: B2-9


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Void Ratio versus Pressure BH#C5-TW7



Coefficient of Consolidation vs. Pressure BH#C5-TW7



drawn	SS	 coffey geotechnics <small>SPECIALISTS MANAGING THE EARTH</small>	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 2 – STATION 20+300 TO 20+500 WB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - C5 TW7	
original size	Letter		project no:	TRANETOB10434AA	figure no: B2-10

F:\GEOT\transprt\ACTIVE\PROJECT\2010\10434 - TRANETOB10434AA - Hwy 401, Burnham to Nagle\foundation reports\Cut and Fill\Lab figures\b2 - fill 2\b2-9-10 consolidation.xls

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

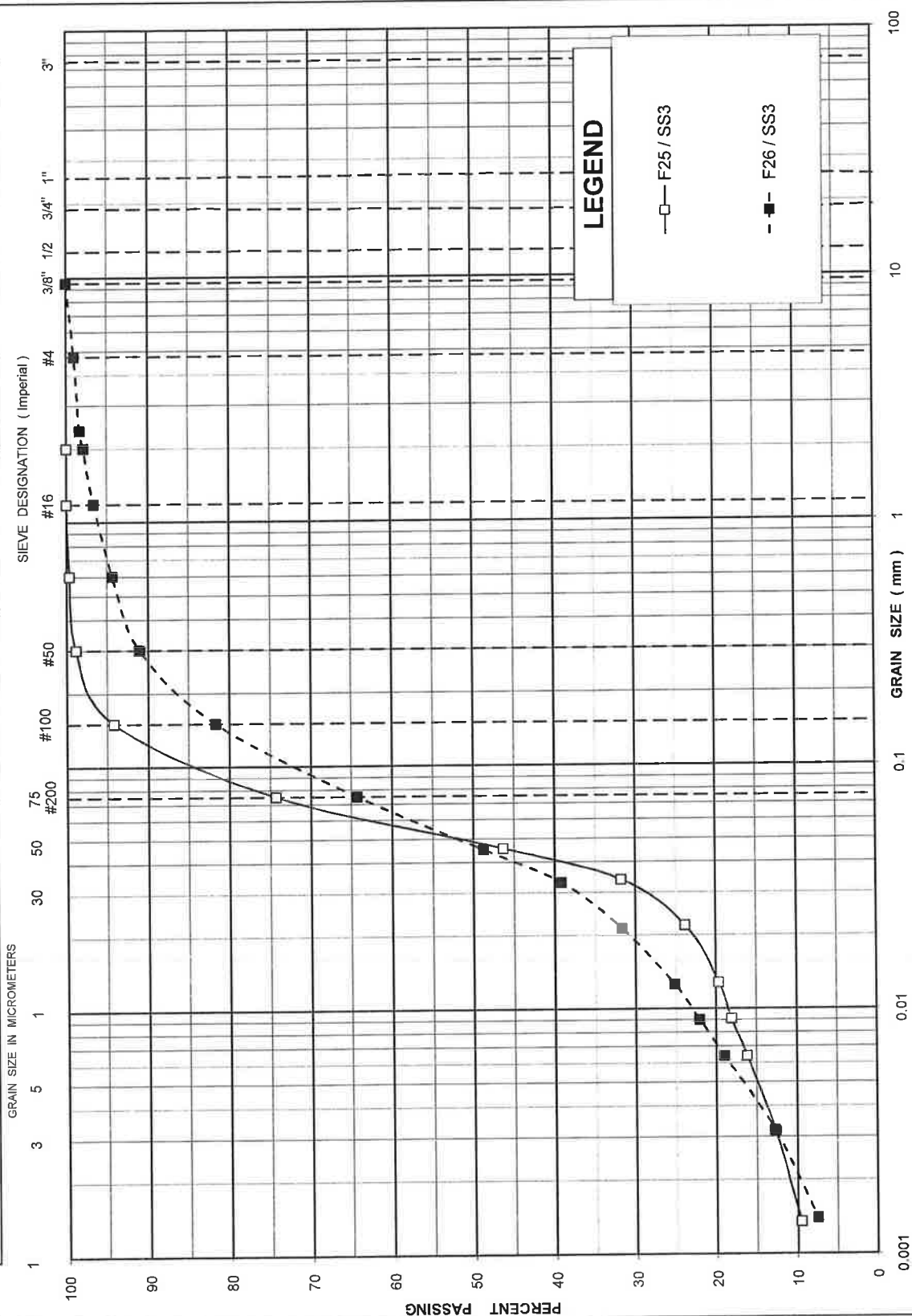


FIGURE NO.: B2-11

PROJECT NO: TRANETOB10434AA

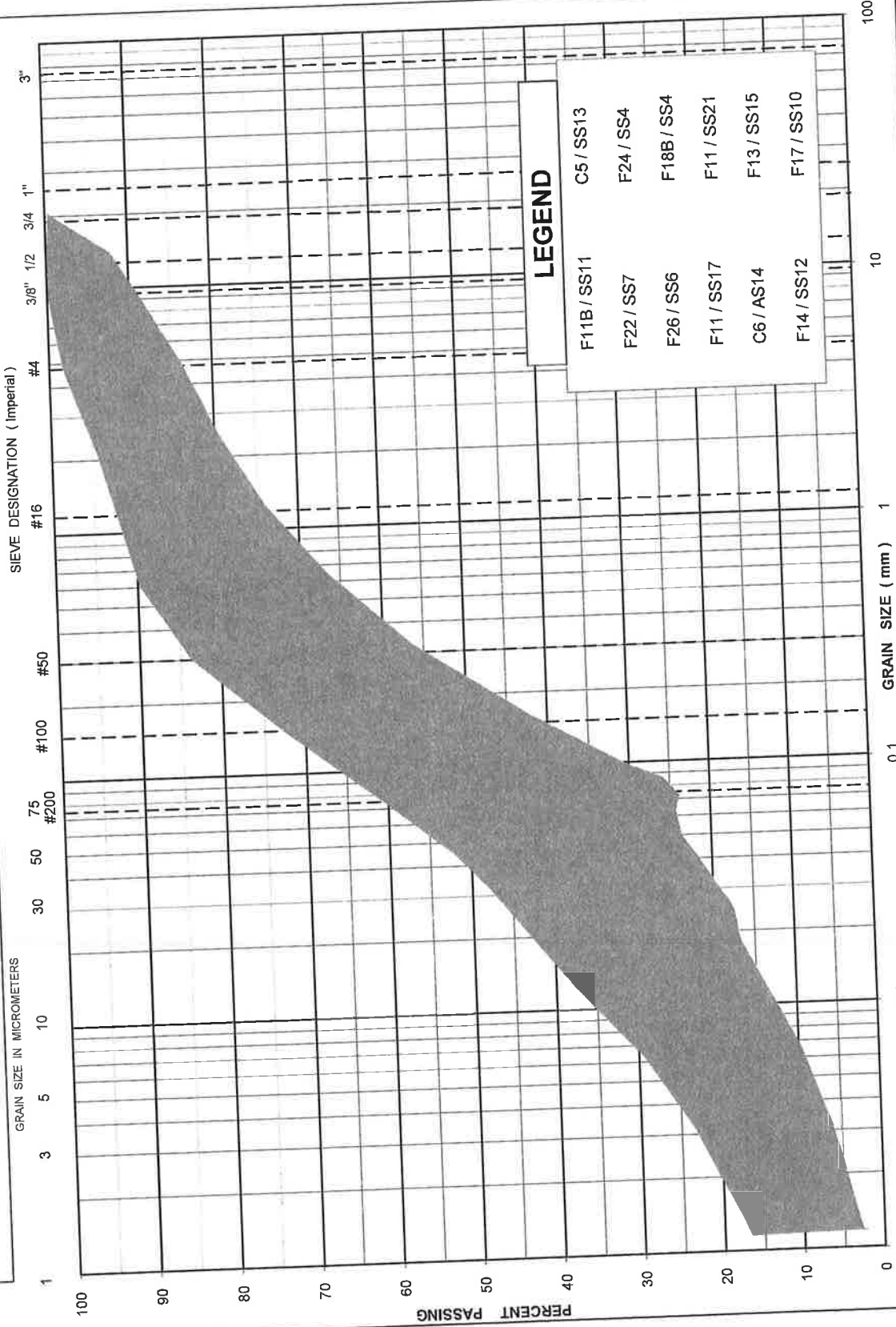
DATE: Sept, 2010

GRAIN SIZE DISTRIBUTION

SANDY SILT

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION

SILTY SAND TILL

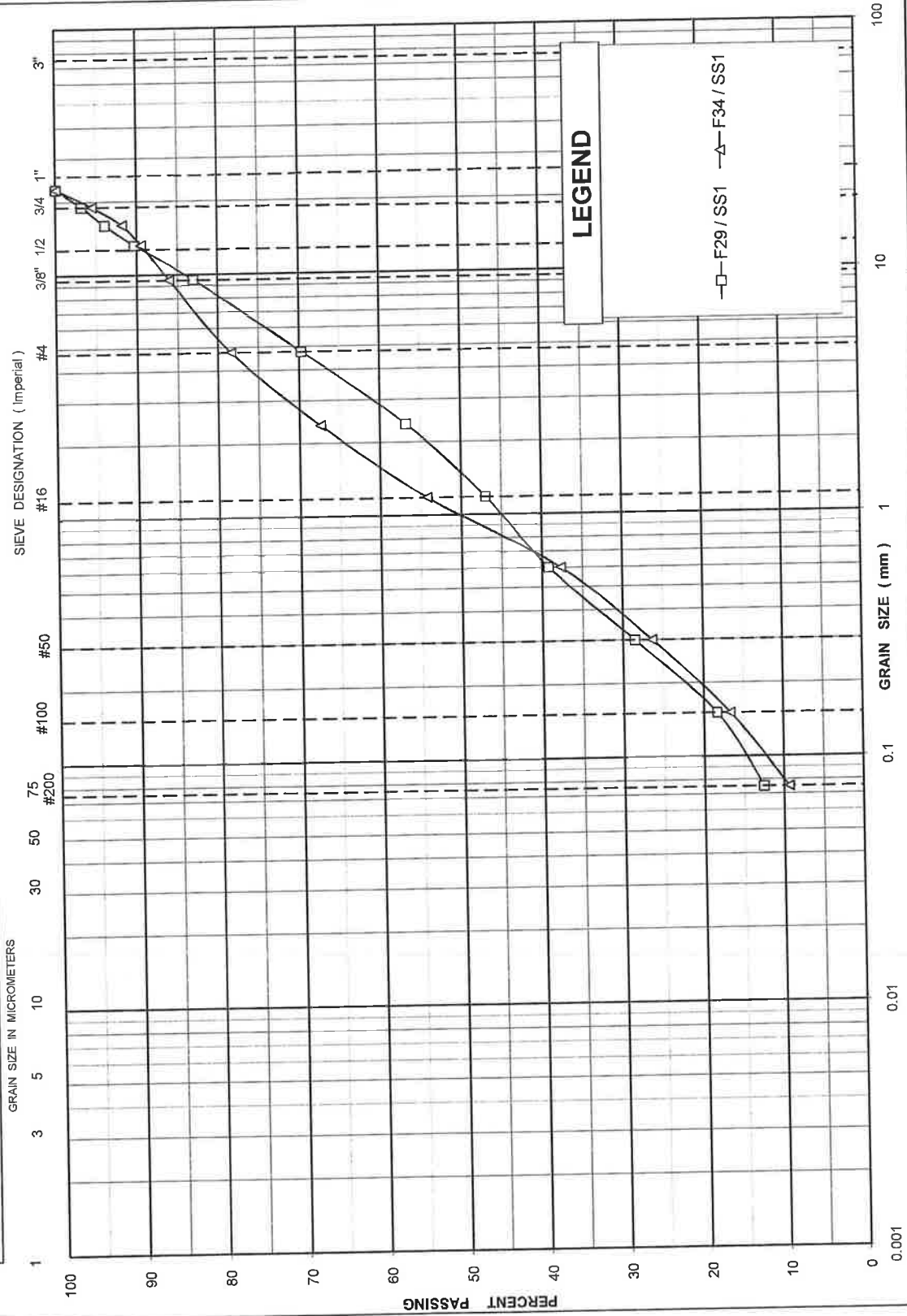
FIGURE NO.: B2-12
PROJECT NO: TRANETOB10434AA
DATE: Sept, 2010

Appendix B3

Laboratory Test Results – Fill Area 3–Stations 21+650 to 21+750 EB & WB

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



	SAND			GRAVEL	
CLAY AND SILT	Fine	Medium	Coarse	Fine	Coarse



DATE: Jan, 2011

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	

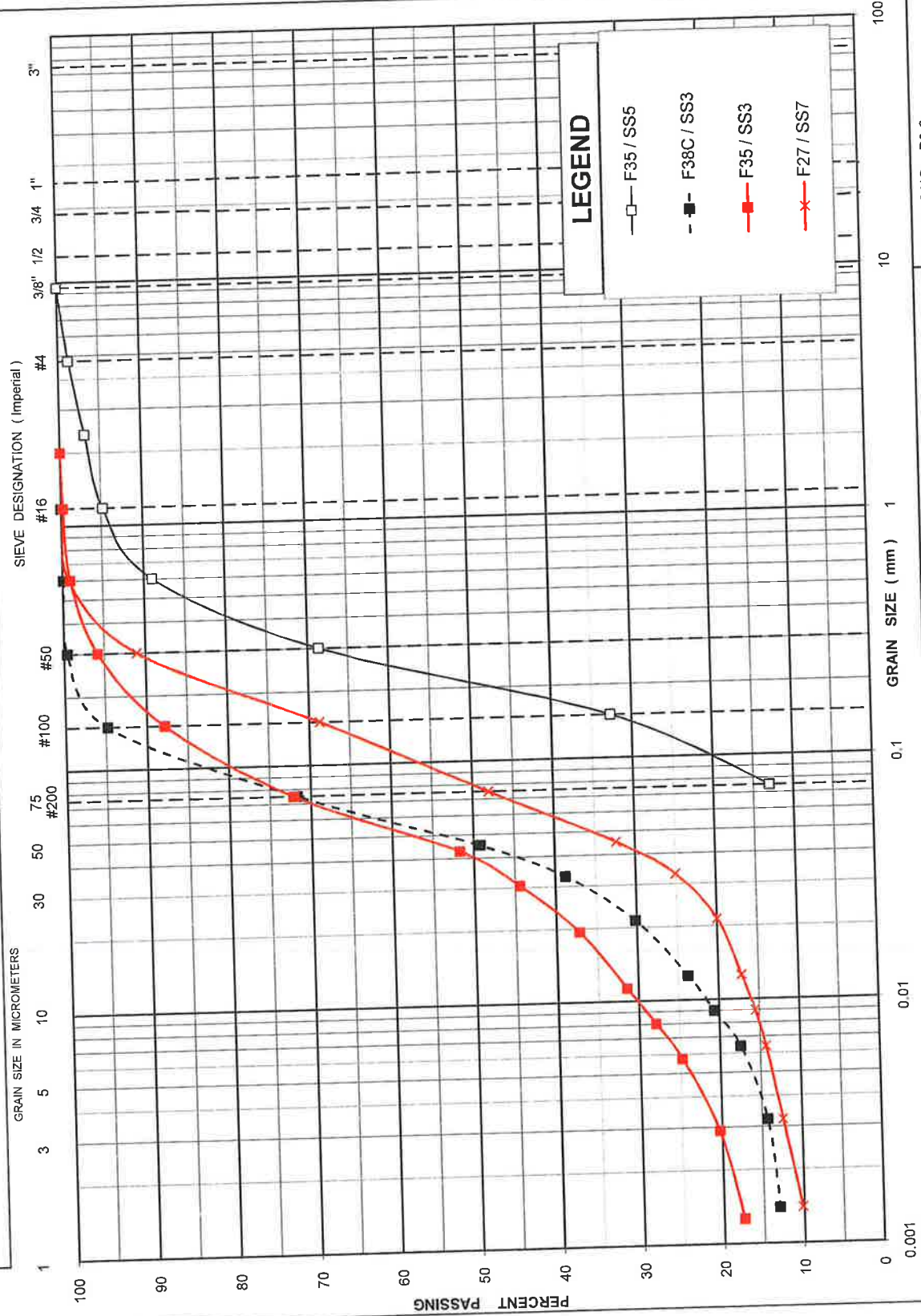


FIGURE NO.: B3-3

PROJECT NO: TRANETO810434AA

DATE: Jan, 2011

GRAIN SIZE DISTRIBUTION

SILTY SAND TO SANDY SILT

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	

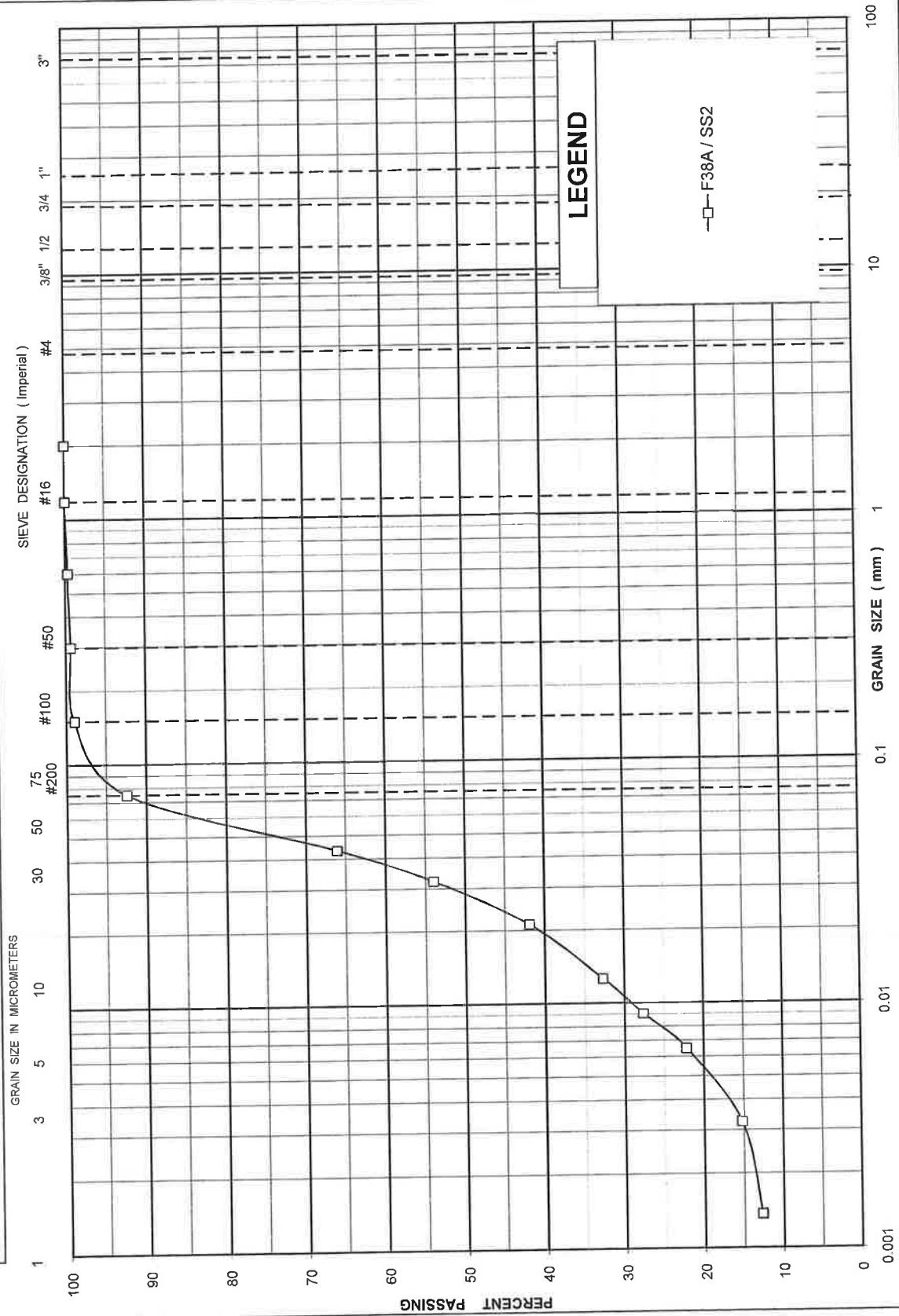
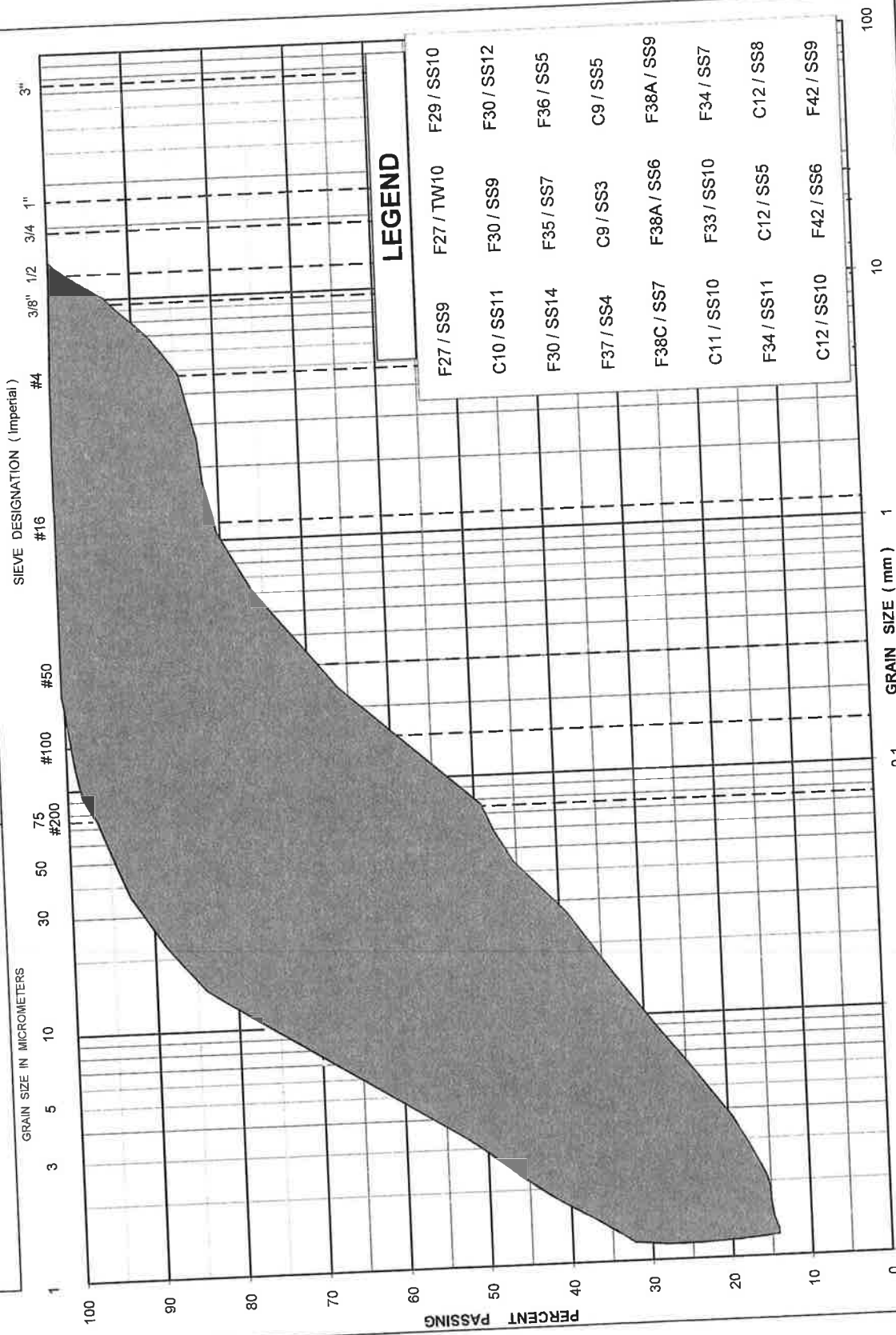


FIGURE NO.: B3-4
PROJECT NO: TRANETOBI0434AA
DATE: Jan, 2011

GRAIN SIZE DISTRIBUTION SILT

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	

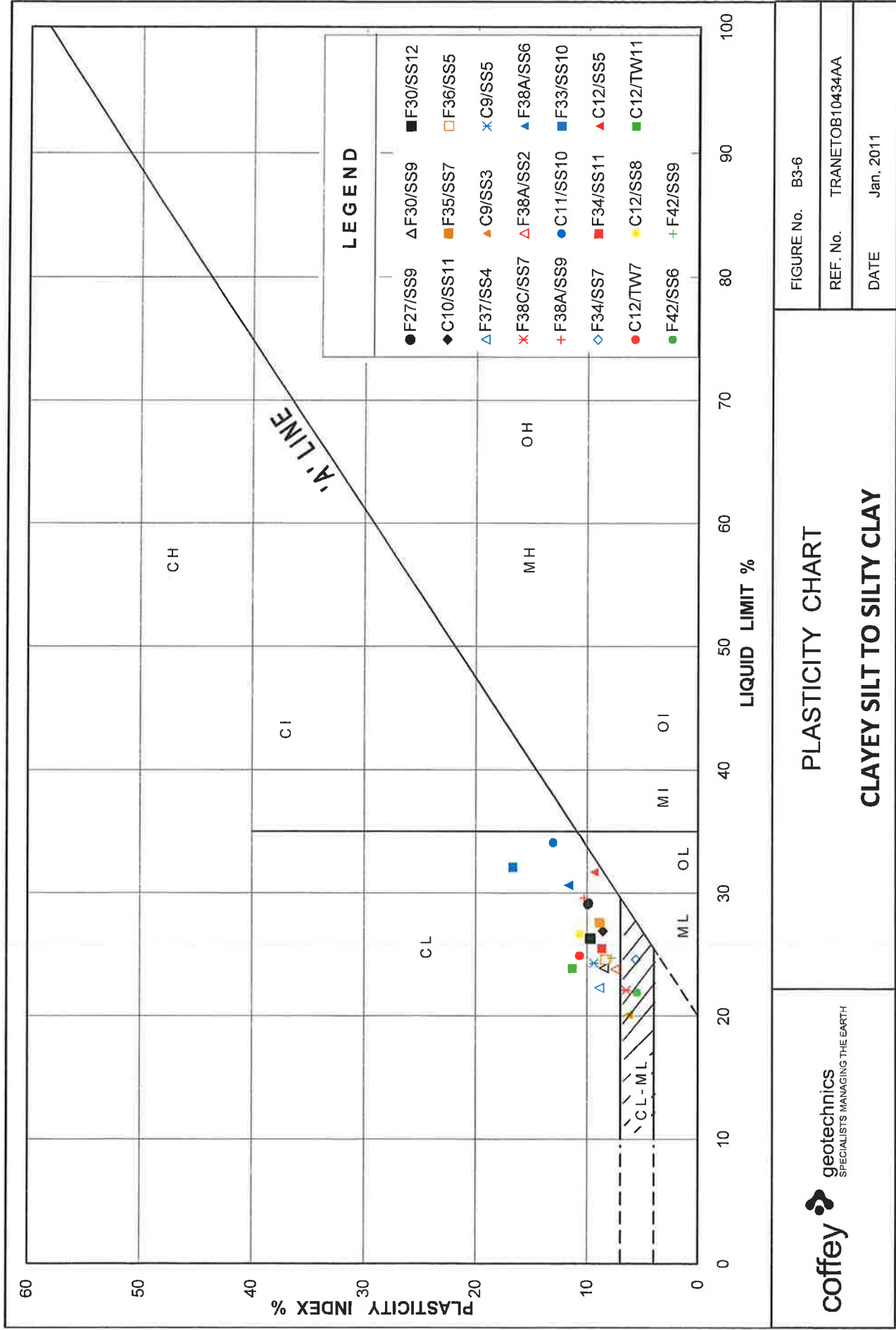


LEGEND

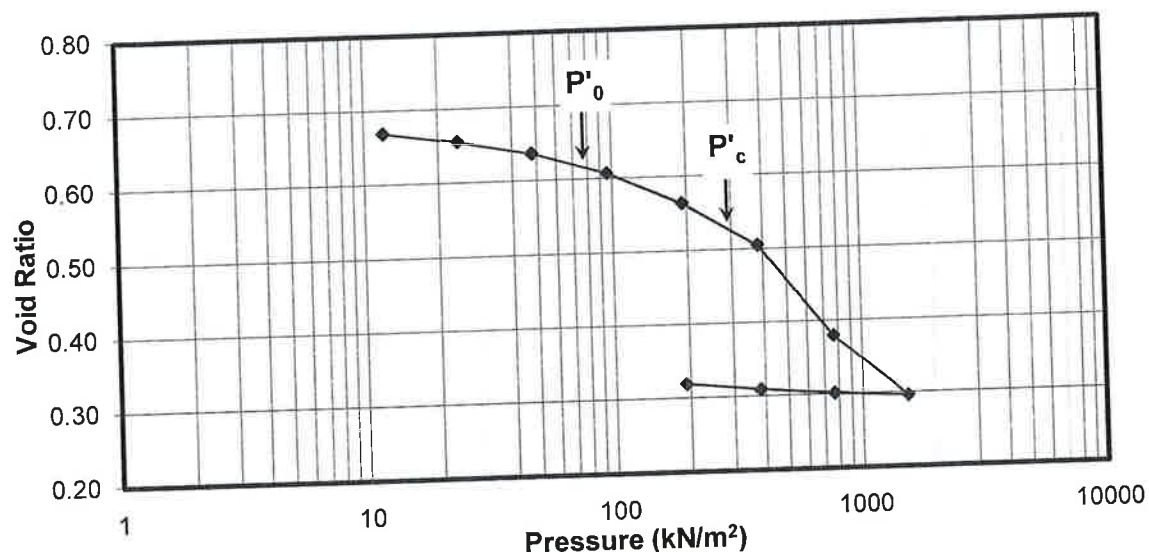
F27 / SS9	F27 / TW10	F29 / SS10
C10 / SS11	F30 / SS9	F30 / SS12
F30 / SS14	F35 / SS7	F36 / SS5
F37 / SS4	C9 / SS3	C9 / SS5
F38C / SS7	F38A / SS6	F38A / SS9
C11 / SS10	F33 / SS10	F34 / SS7
F34 / SS11	C12 / SS5	C12 / SS8
C12 / SS10	F42 / SS6	F42 / SS9

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY

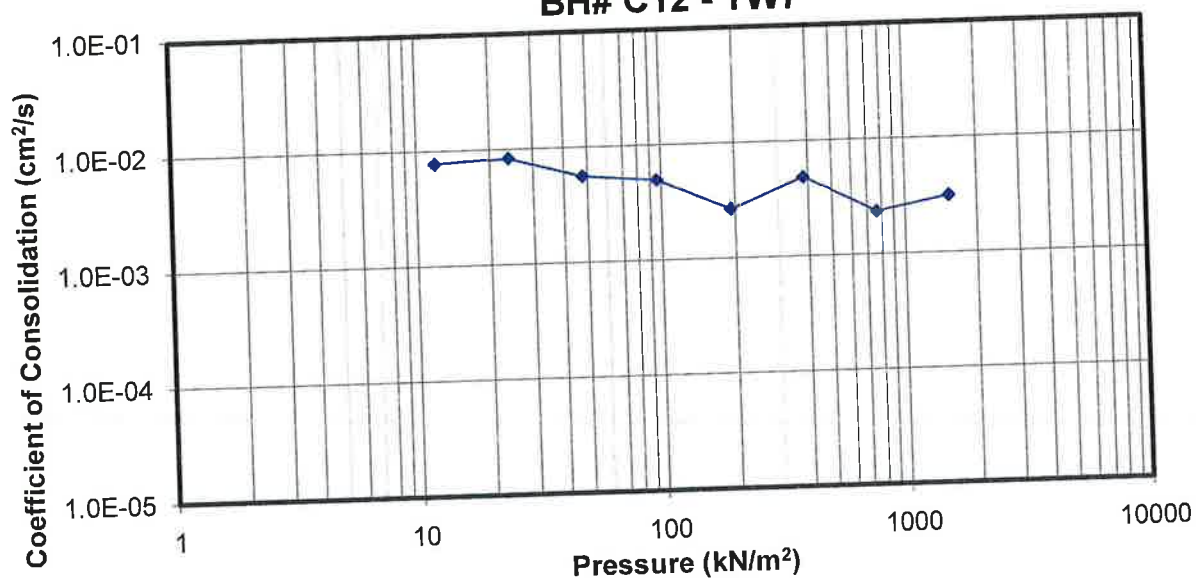
FIGURE NO.: B3-5
PROJECT NO: TRANETOB10434AA
DATE: Jan, 2011




Void Ratio versus Pressure BH# C12 - TW7



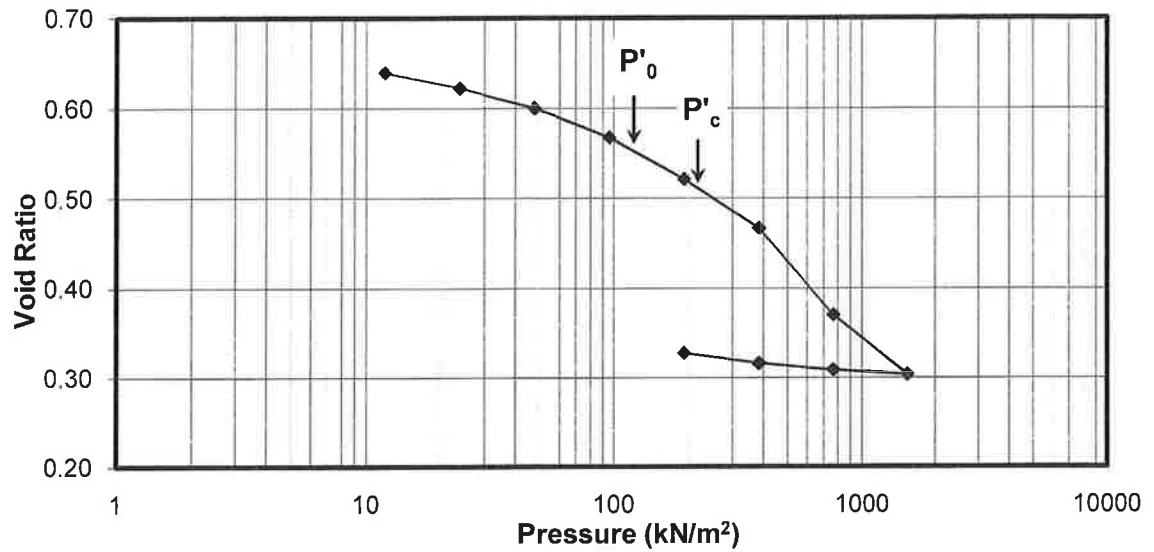
Coefficient of Consolidation vs. Pressure BH# C12 - TW7



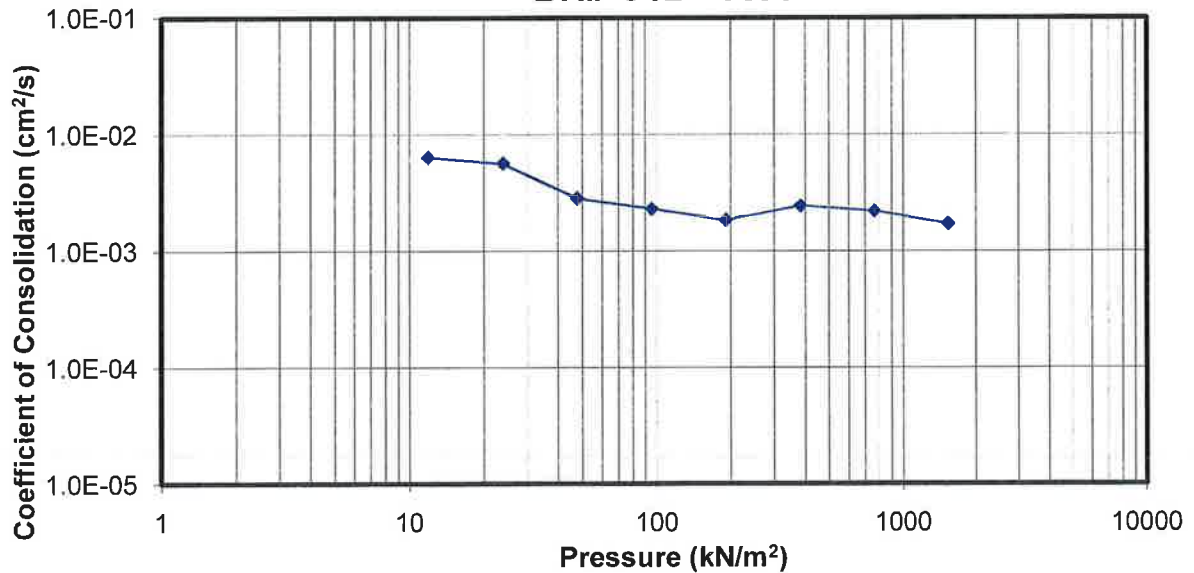
drawn	DS	 SPECIALISTS MANAGING THE EARTH	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 3 – STATION 21+650 TO 21+750 EB & WB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - C12 TW7	
original size	Letter		project no:	TRANETOB10434AA	figure no: B3-7


F:\GEO\transprt\ACTIVE\PROJECT\2010\10434 - TRANETOB10434AA - Hwy 401, Burnham to Nagle\foundation reports\Cut and Fill\Lab figures\b3 - fill 3\b3-7-8 consolidation.xls]B

Void Ratio versus Pressure BH# C12 - TW11



Coefficient of Consolidation vs. Pressure BH# C12 - TW11



drawn	DS	 coffey geotechnics SPECIALISTS MANAGING THE EARTH	client:	AECOM	
approved	ZO		project:	HIGHWAY 401 EXPANSION	
date	Jan-11			FILL 3 – STATION 21+650 TO 21+750 EB & WB	
scale	as shown		title:	CONSOLIDATION TEST RESULT - C12 TW11	
original size	Letter		project no:	TRANETOB10434AA	figure no: B3-8

F:\GEOI\transprt\ACTIVE\PROJECT\2010\10434 - TRANETOB10434AA - Hwy 401, Burnham to Nagle\foundation reports\Cut and Fill\Lab figures\b3 - fill 3\b3-7-8 consolidation.xls\B

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

GRAIN SIZE IN MICROMETERS

3 5 10 30 50 75 #200

Fine

#100

#50

#25

#12

#6

#3

#1.5

#0.75

#0.425

#0.25

#0.15

#0.075

#0.0425

#0.025

#0.015

#0.0075

#0.00425

#0.0025

#0.0015

#0.00075

#0.000425

#0.00025

#0.00015

#0.000075

#0.0000425

#0.000025

#0.000015

#0.0000075

#0.00000425

#0.0000025

#0.0000015

#0.00000075

#0.000000425

#0.00000025

#0.00000015

#0.000000075

SIEVE DESIGNATION (Imperial)

#4

#10

#20

#40

#60

#80

#100

#120

#140

#160

#180

#200

#220

#240

#260

#280

#300

#320

#340

#360

#380

#400

#420

#440

#460

#480

#500

#520

#540

#560

#580

#600

#620

#640

#660

#680

GRAVEL

Fine

Coarse

3/8" 1/2 3/4 1" 3"

3"

1 1/2"

3/4"

1/2"

3/8"

1/4"

3/16"

1/8"

3/32"

1/16"

3/64"

1/32"

3/128"

1/64"

3/256"

1/128"

3/512"

1/256"

3/1024"

1/512"

3/2048"

1/1024"

3/4096"

1/2048"

3/8192"

1/4096"

3/16384"

1/8192"

3/32768"

1/16384"

3/65536"

1/32768"

3/131072"

1/65536"

3/262144"

1/131072"

3/524288"

LEGEND

F27 / SS16	F28 / SS8	F28 / SS10
F29 / SS12	F35 / SS8	F35 / SS10
F36 / SS7	F37 / SS5	F37 / SS8
C9 / SS7	C9 / SS10	F38C / SS11
F38C / SS13	F38A / SS11	F32 / SS9
C11 / SS11	C11 / SS13	F33 / SS14
F34 / SS14	F39 / SS5	F39 / SS7
F40 / SS5	F40 / SS8	

100

10

1

0.1

0.01

0.001

GRAIN SIZE (mm)

FIGURE NO.: B3-9

PROJECT NO: TRANETOB10434AA

DATE: Jan, 2011

GRAIN SIZE DISTRIBUTION

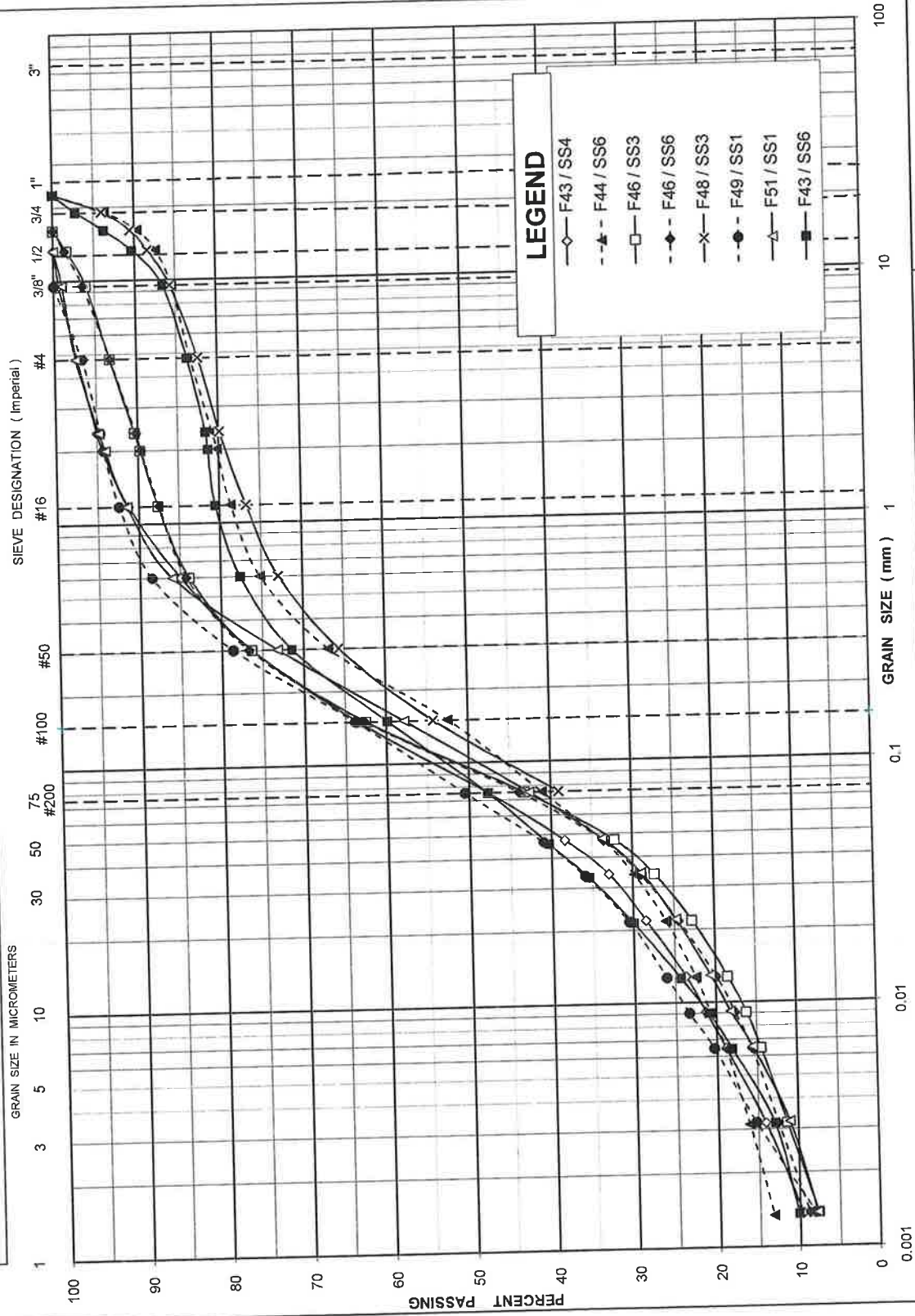
SILTY SAND TILL

Appendix B4

Laboratory Test Results – Fill Area 4 – Stations 22+230 to 22+380 WB

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	

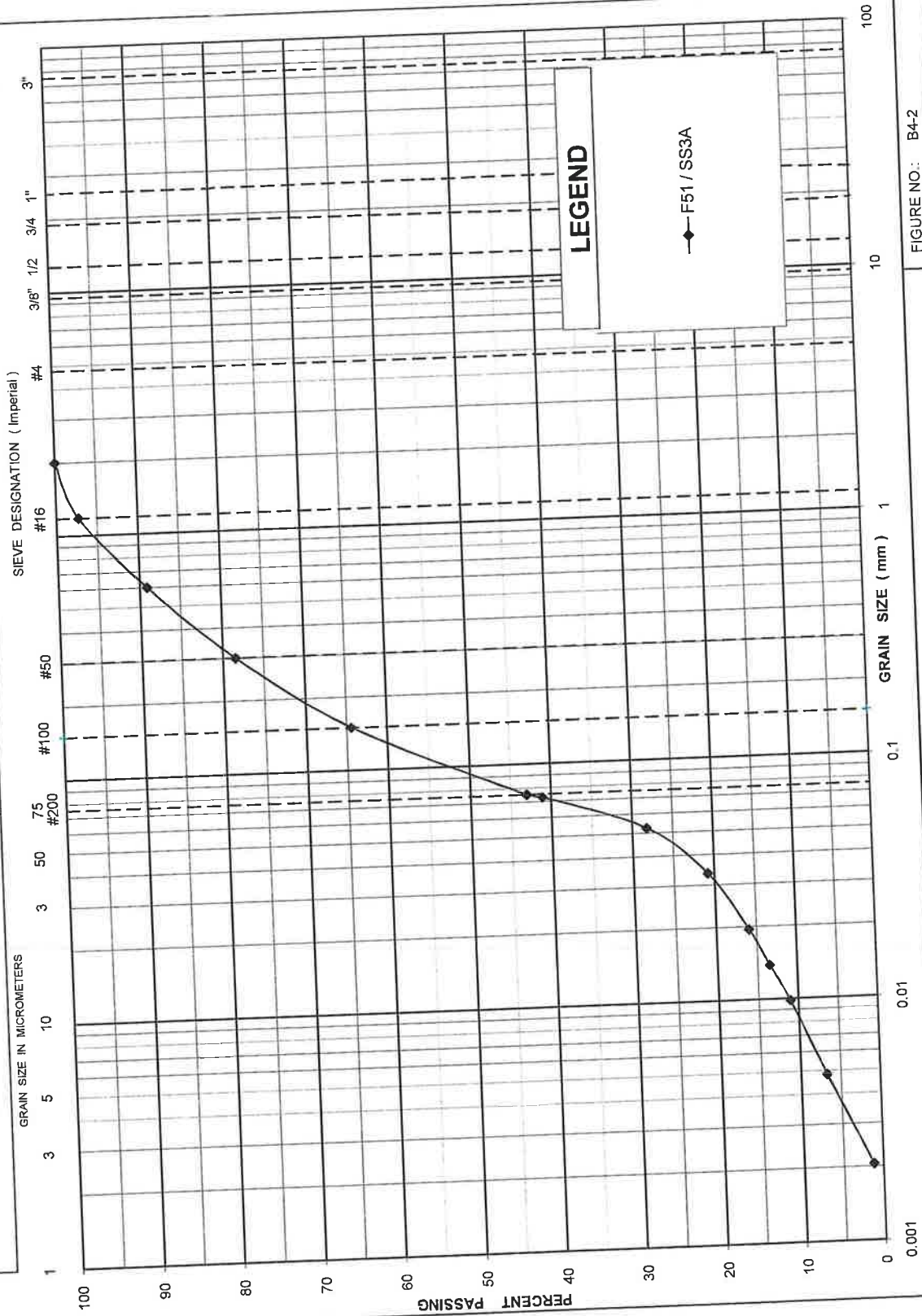


FIGURE NO.: B4-2
 PROJECT NO: TRANETOB10434AA
 DATE: JUNE, 2010

GRAIN SIZE DISTRIBUTION Sand and silt layer within ORGANIC SILT

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

GRAVEL

SAND

Fine

Coarse

Fine

Coarse

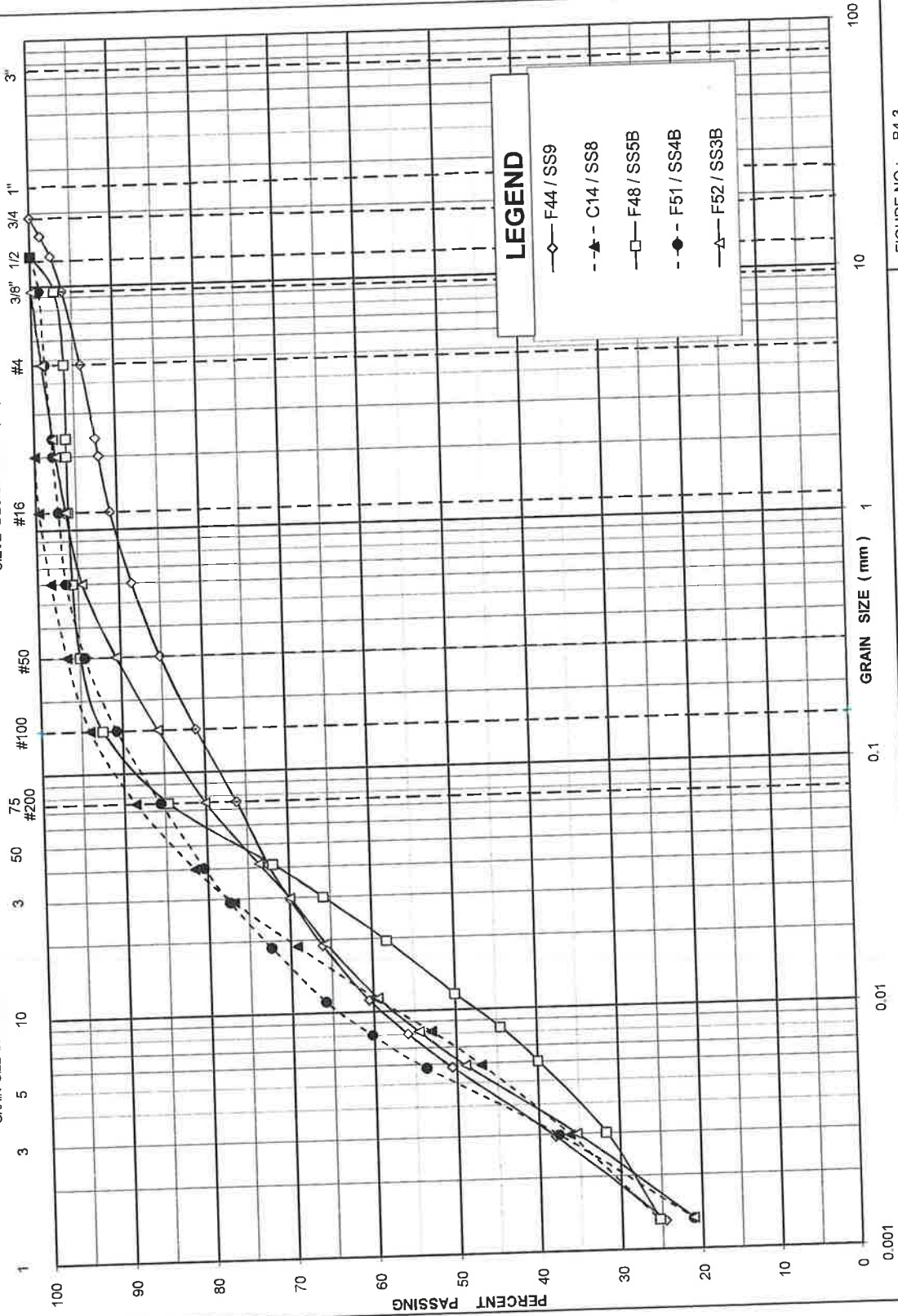
Medium

Fine

Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)

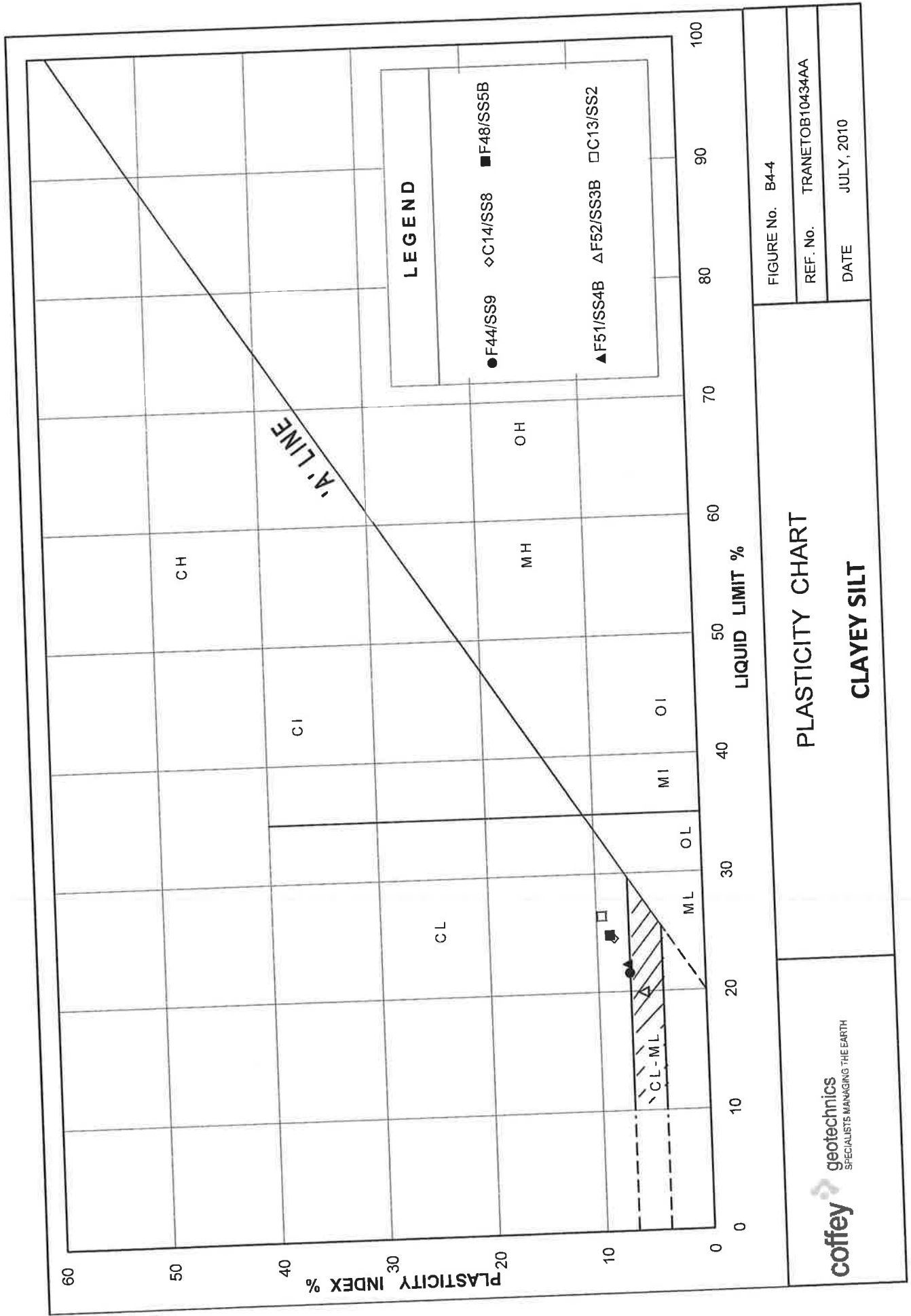


GRAIN SIZE DISTRIBUTION
CLAYEY SILT

FIGURE NO.: B4-3

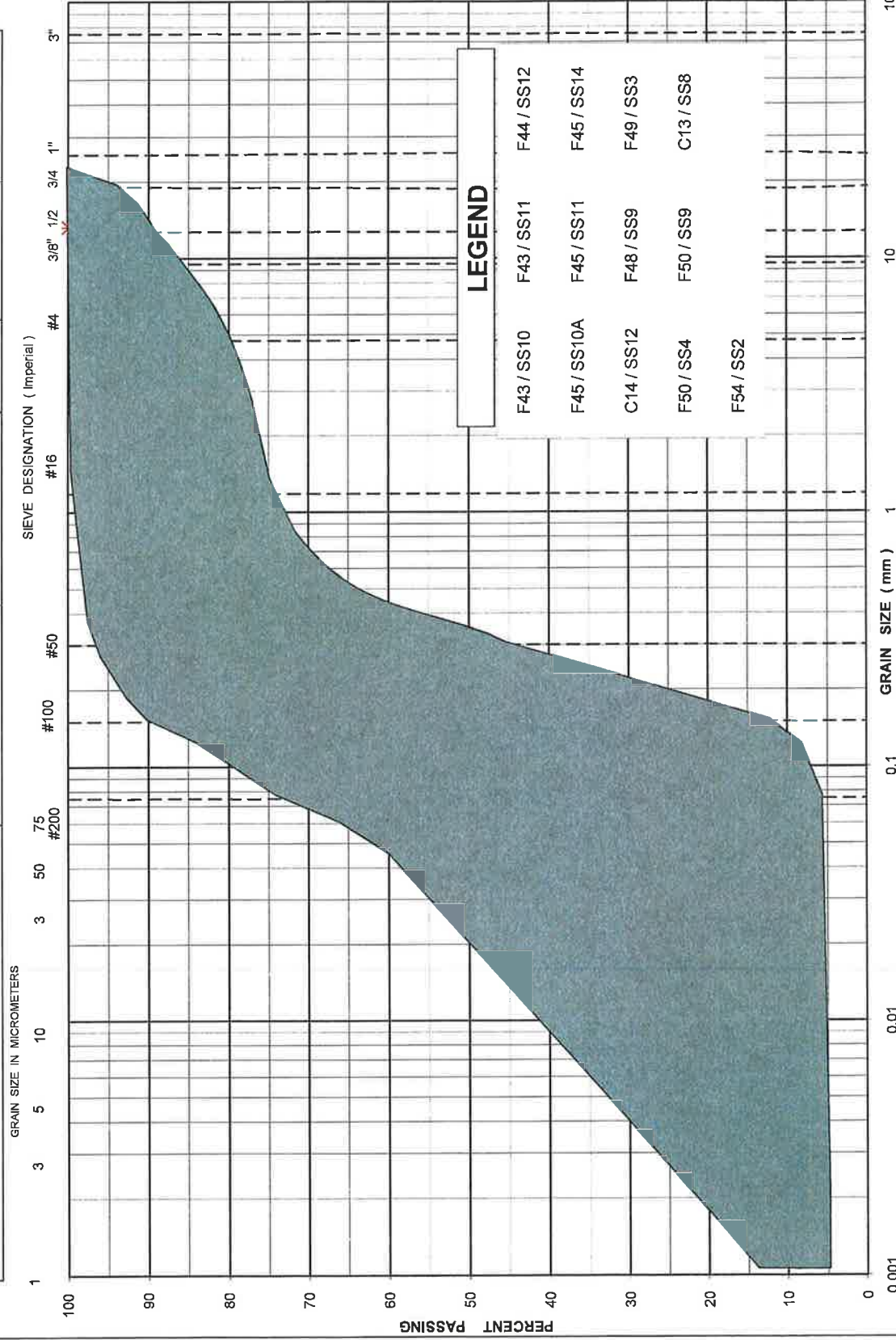
PROJECT NO: TRANETO10434AA

DATE: August, 2010



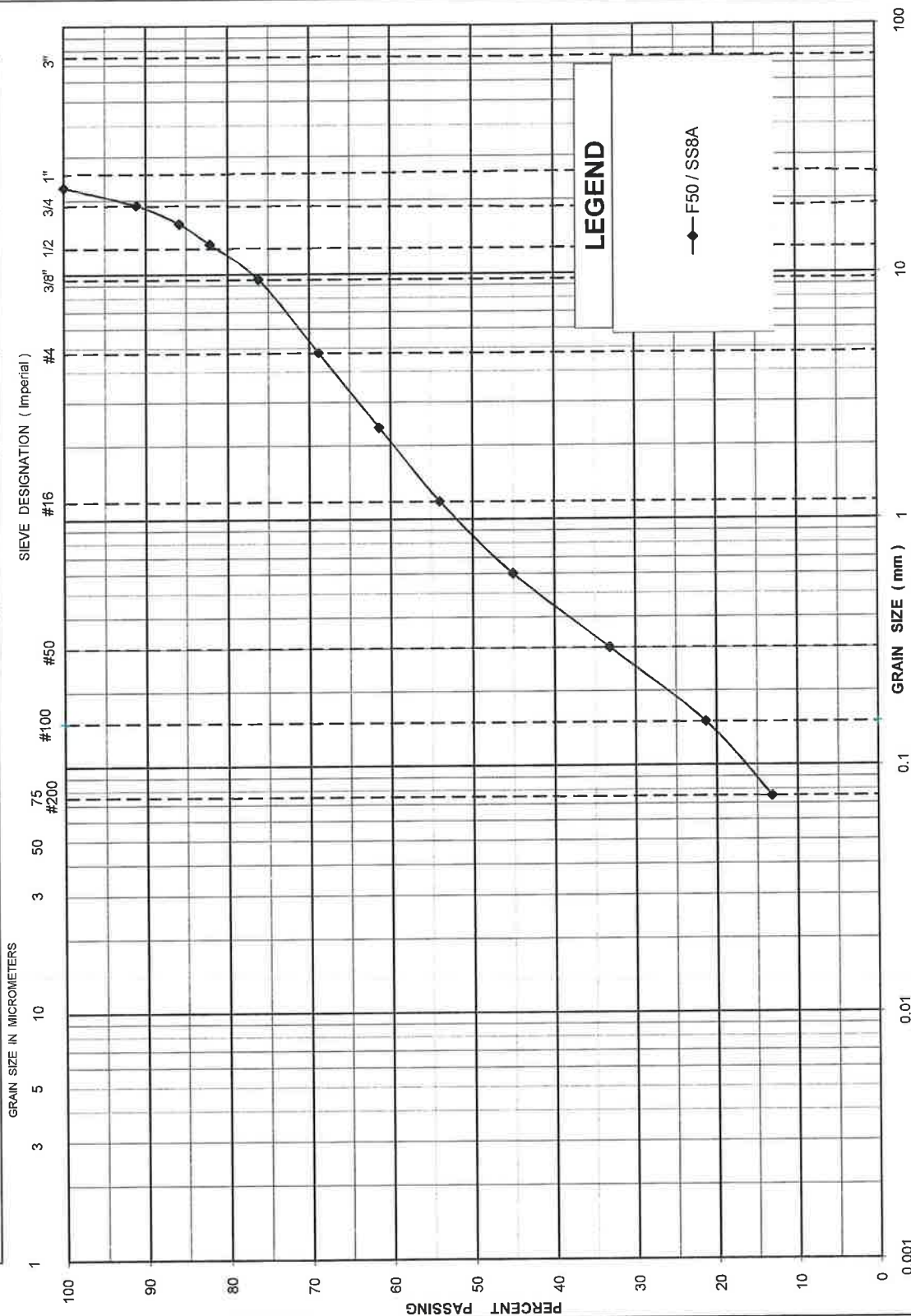
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

SAND

GRAVEL

Fine

Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

PERCENT PASSING

100

90

80

70

60

50

40

30

20

10

0

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

3"

1 1/2"

3/4"

1/2"

3/8"

#4

#16

#50

#100

#200

75

50

3

10

5

3

1

0.85

0.75

0.6

0.5

0.425

0.375

0.3

0.25

0.2

0.15

0.125

0.1

0.075

0.06

0.05

0.0425

0.0375

0.03

0.025

0.02

0.015

0.0125

0.01

0.001

0.01

0.1

1

10

100

GRAIN SIZE (mm)

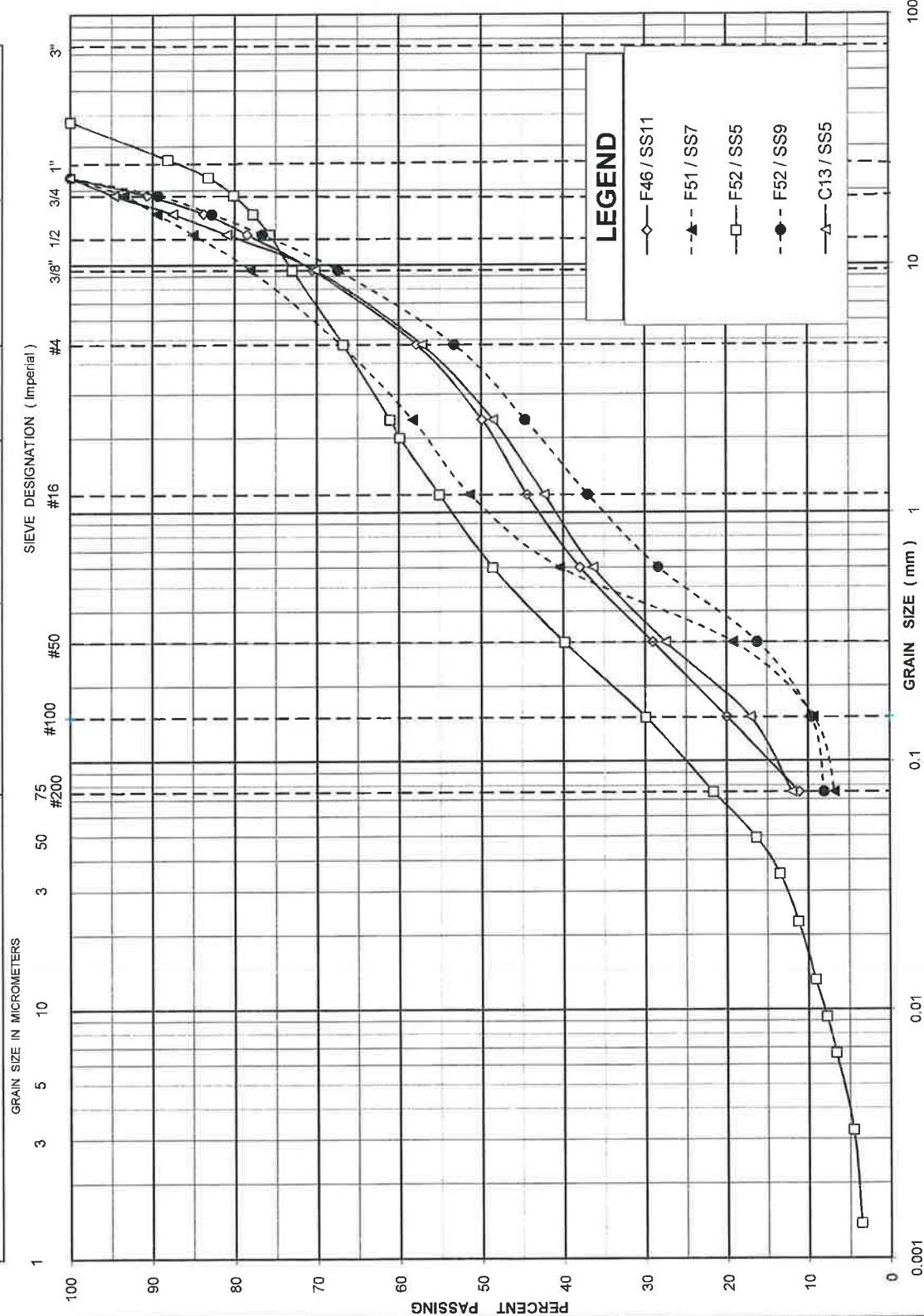
3"

1 1/2"

3/4"

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



Appendix B5

Laboratory Test Results – Fill Area 5 – Stations 22+330 to 22+400 EB

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	

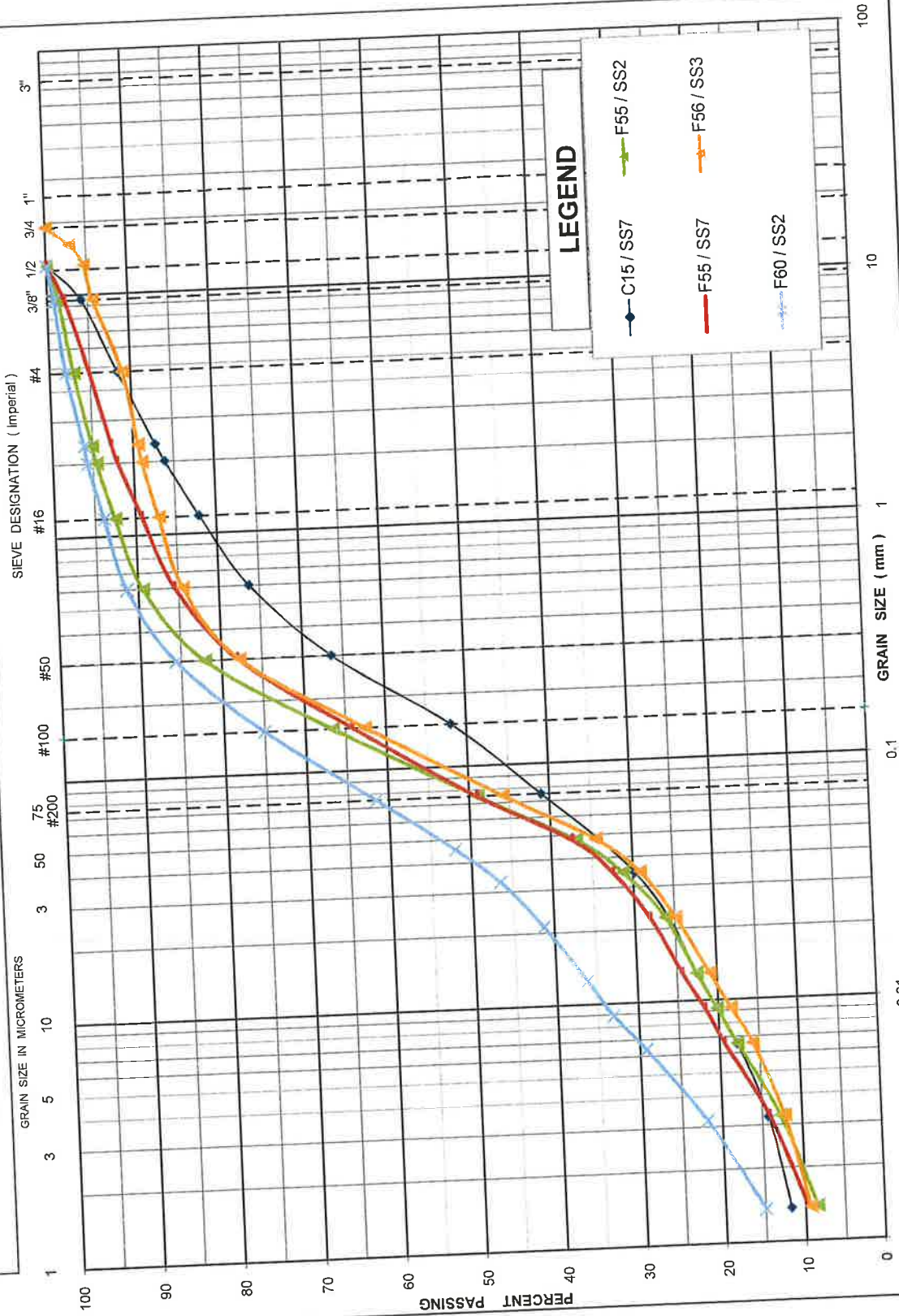
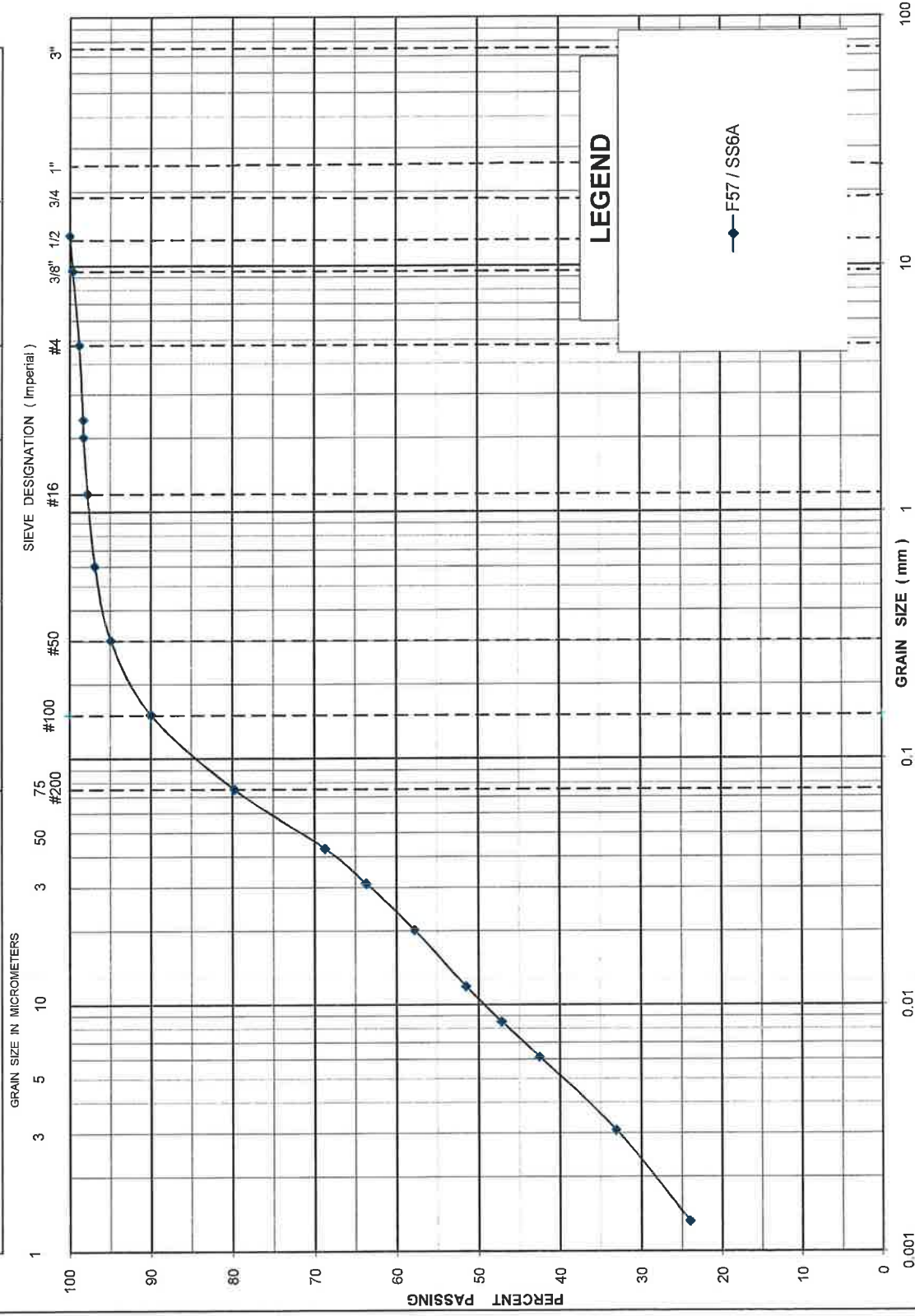


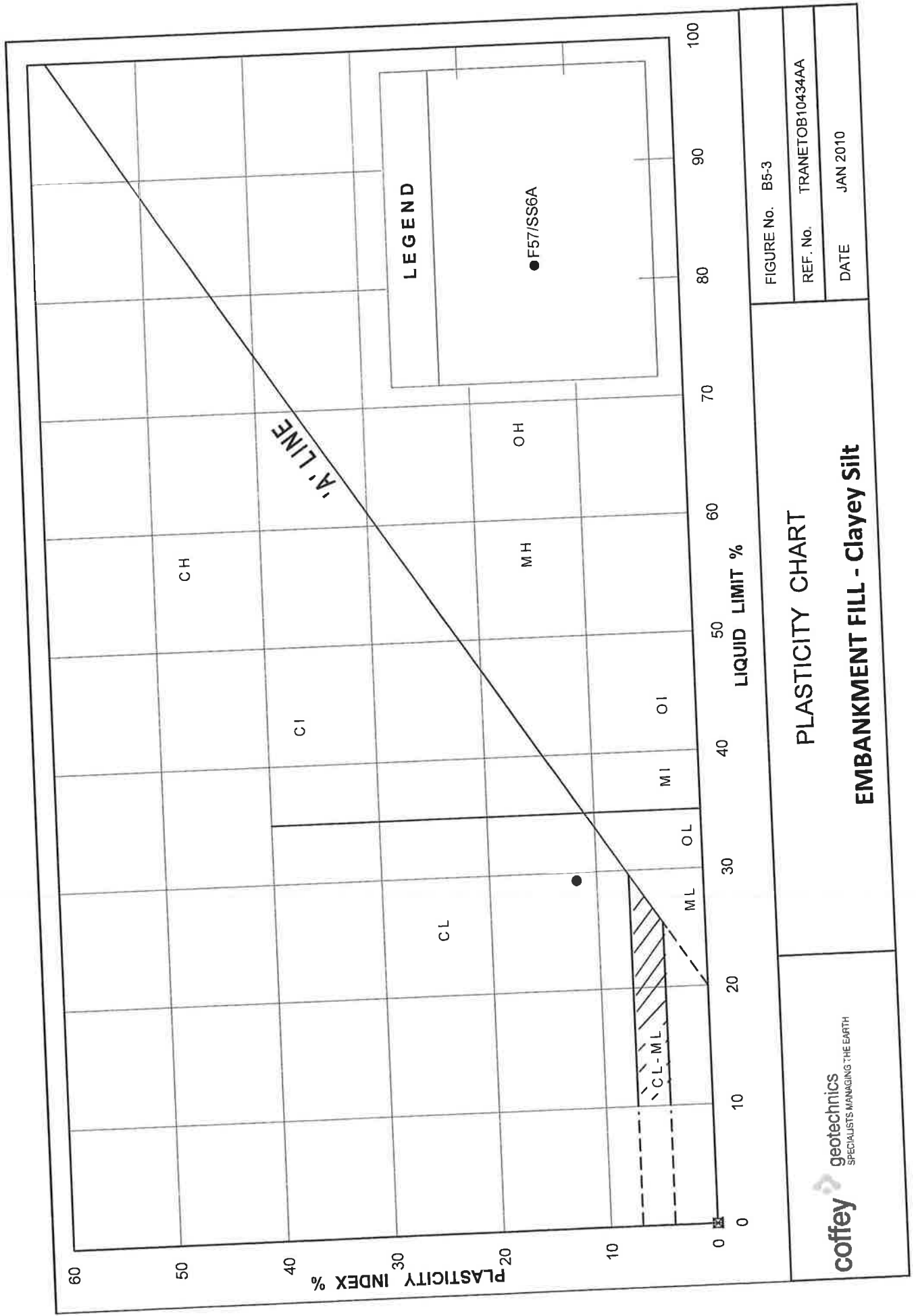
FIGURE NO.: BS-1
PROJECT NO: TRANETOB10434AA
DATE: JAN 2011

GRAIN SIZE DISTRIBUTION
EMBANKMENT FILL - Silty Sand

UNIFIED SOIL CLASSIFICATION SYSTEM

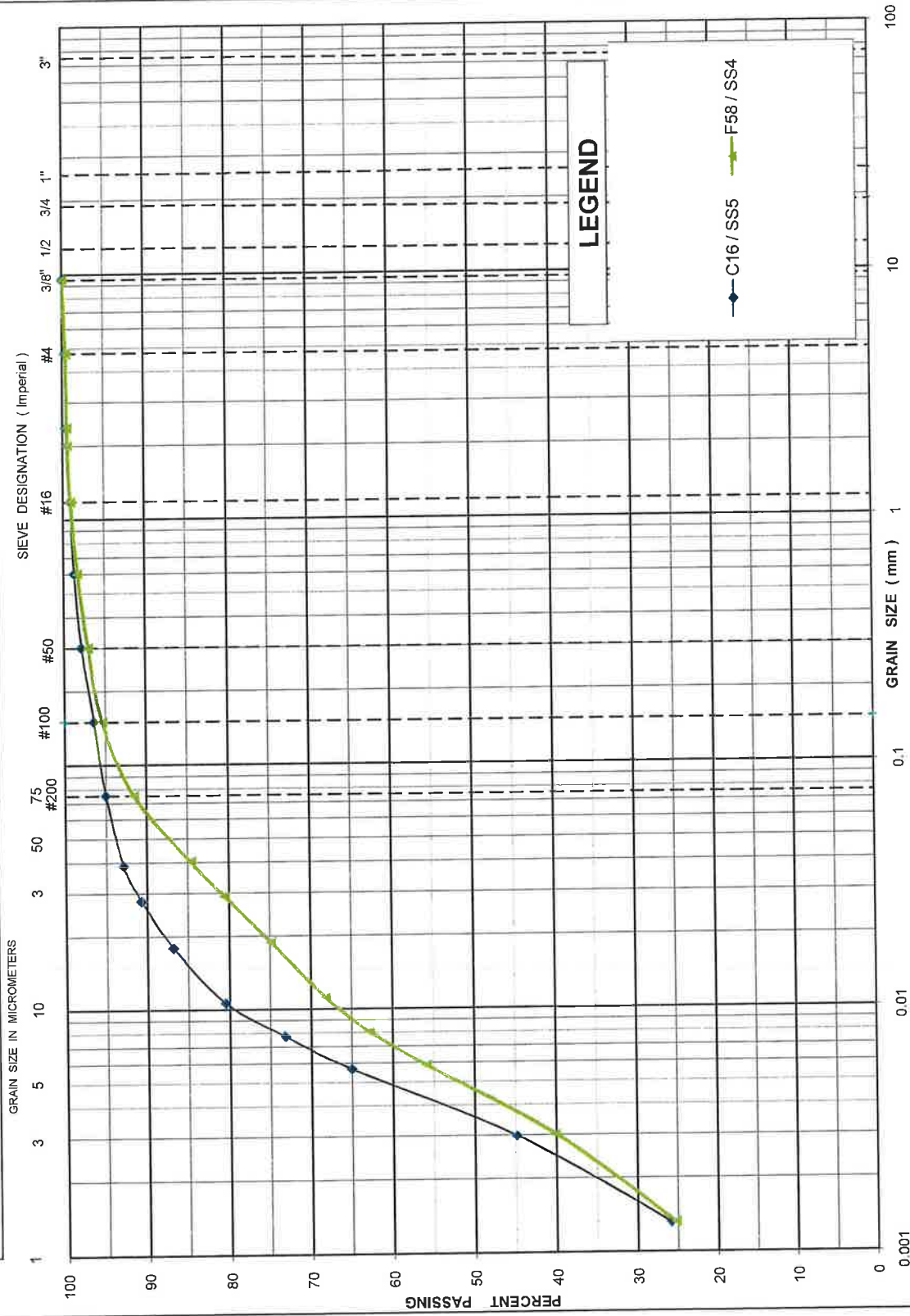
CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

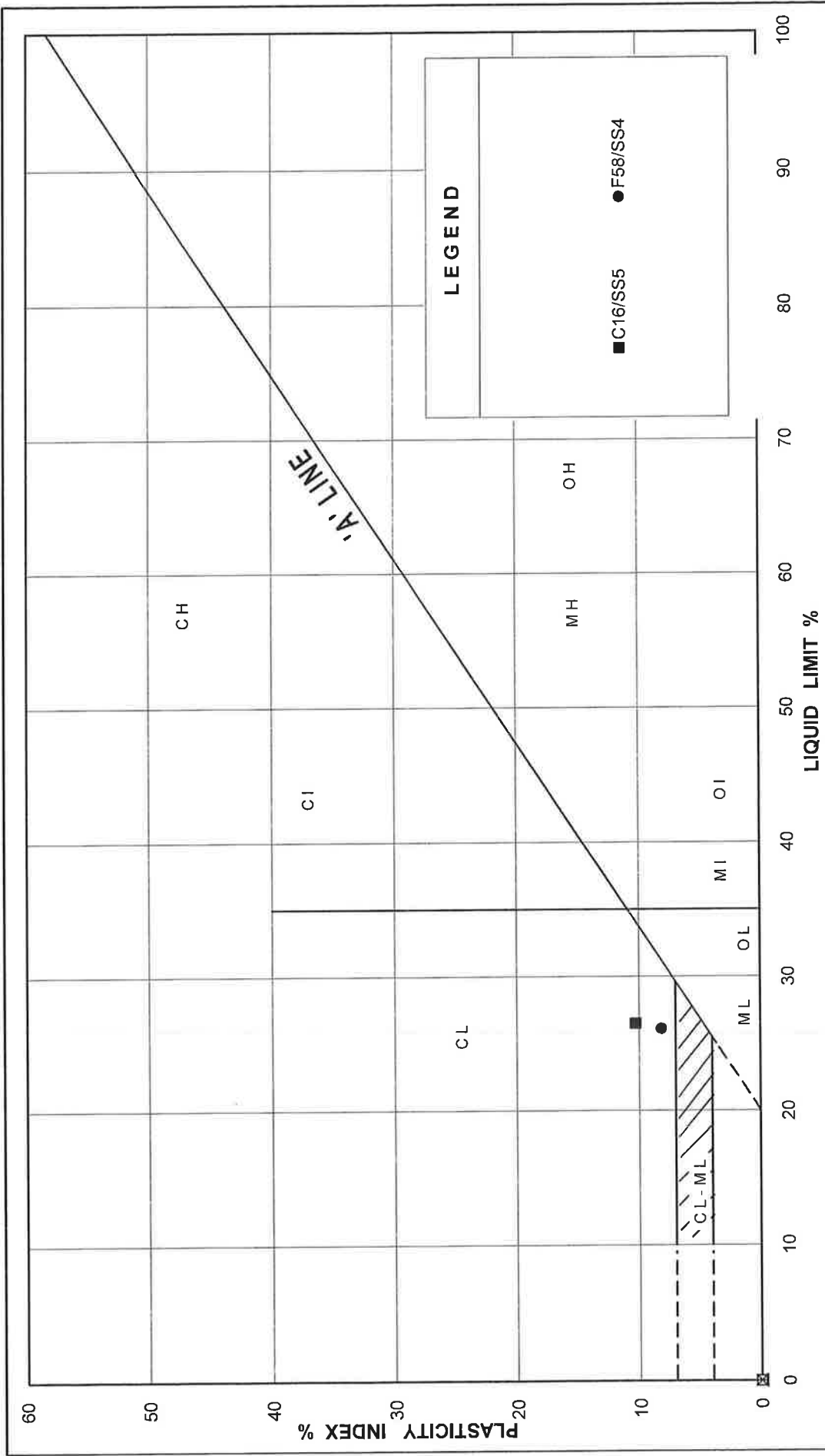





UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	

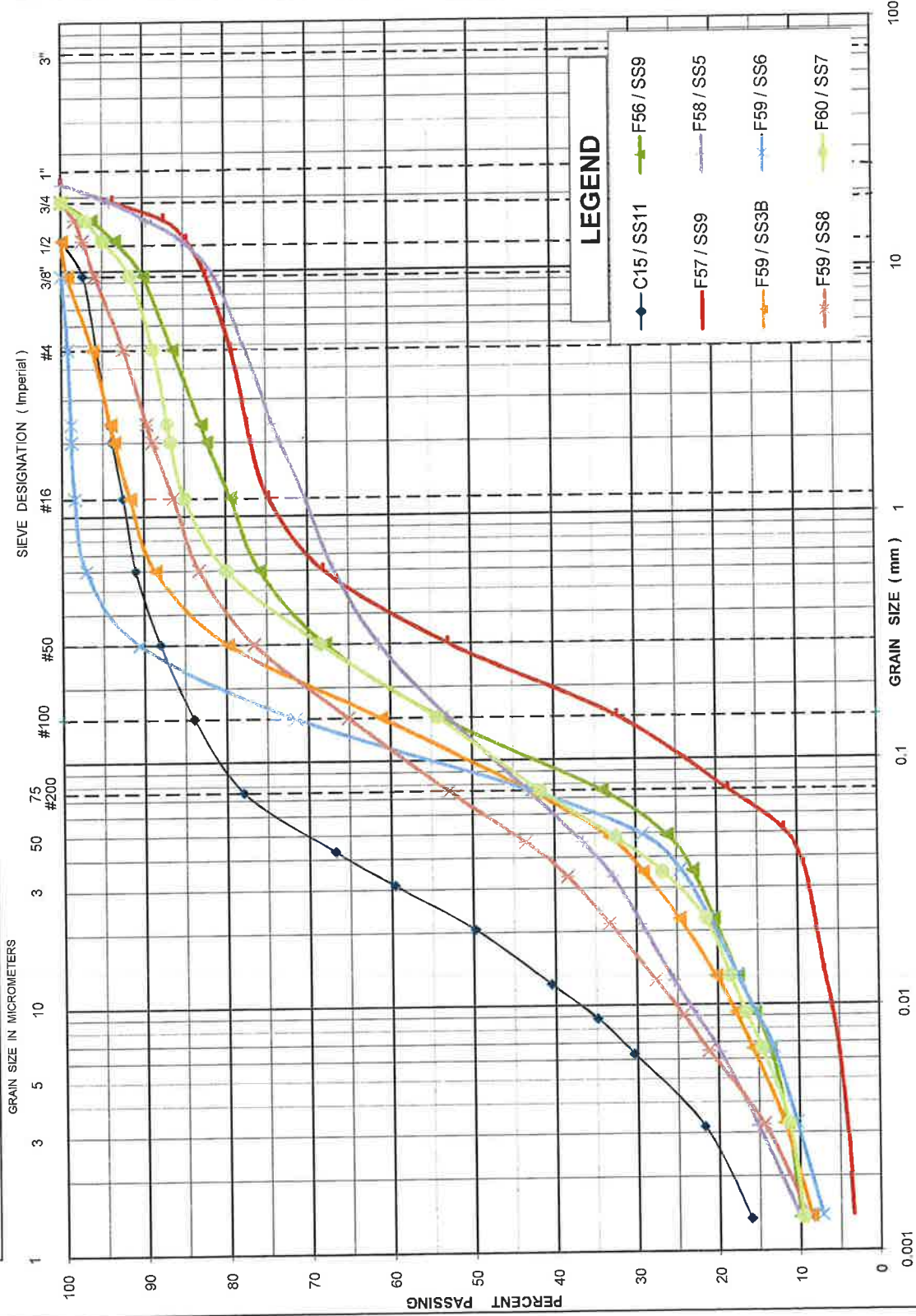




	PLASTICITY CHART		FIGURE No. B5-5
	CLAYEY SILT		REF. No. TRANETOB10434AA
			DATE JAN 2010

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

Fine

SAND

Medium

Coarse

GRAVEL

Fine

Coarse

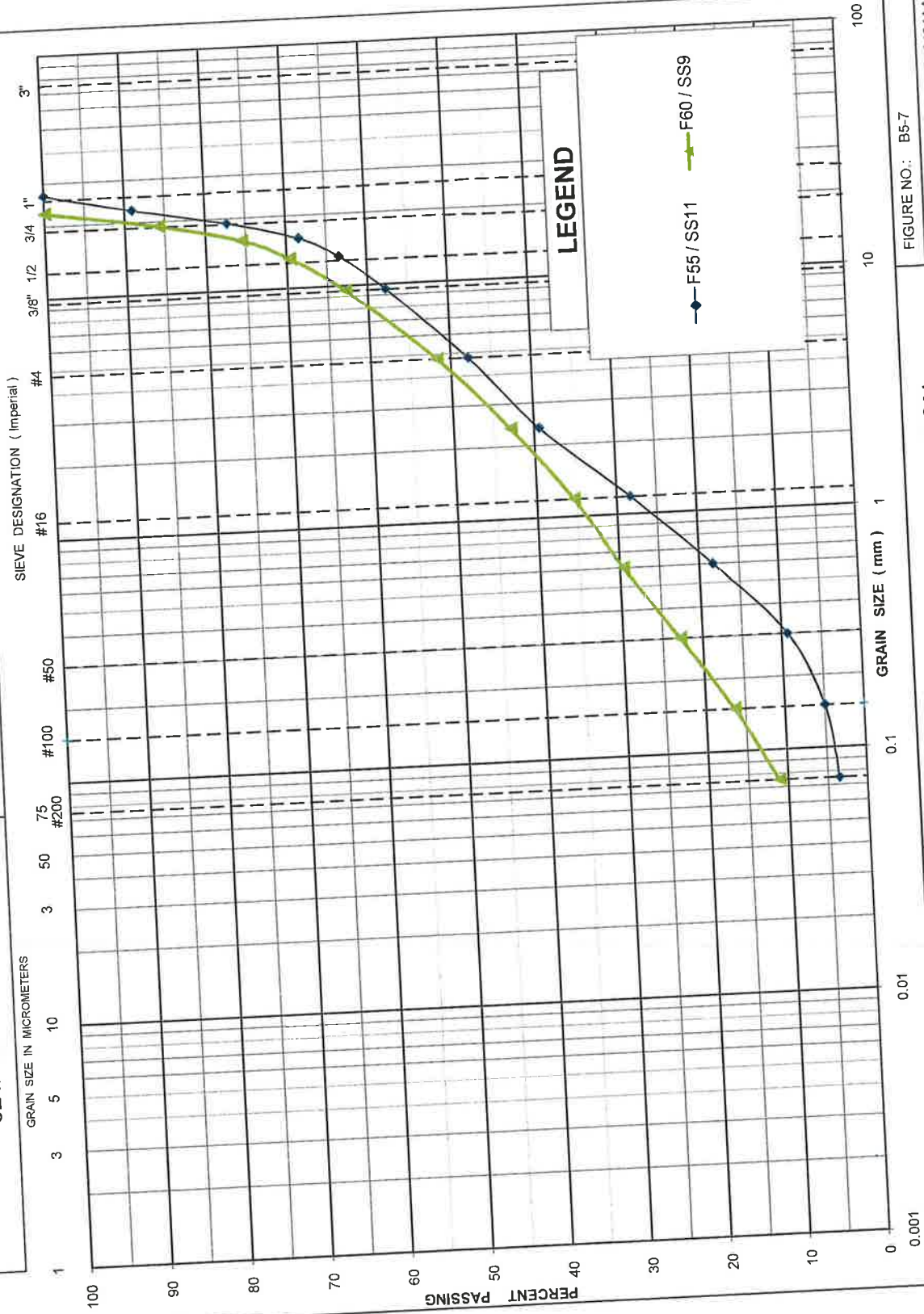


FIGURE NO.: B5-7
PROJECT NO: TRANETOB1043AA
DATE: JAN 2011

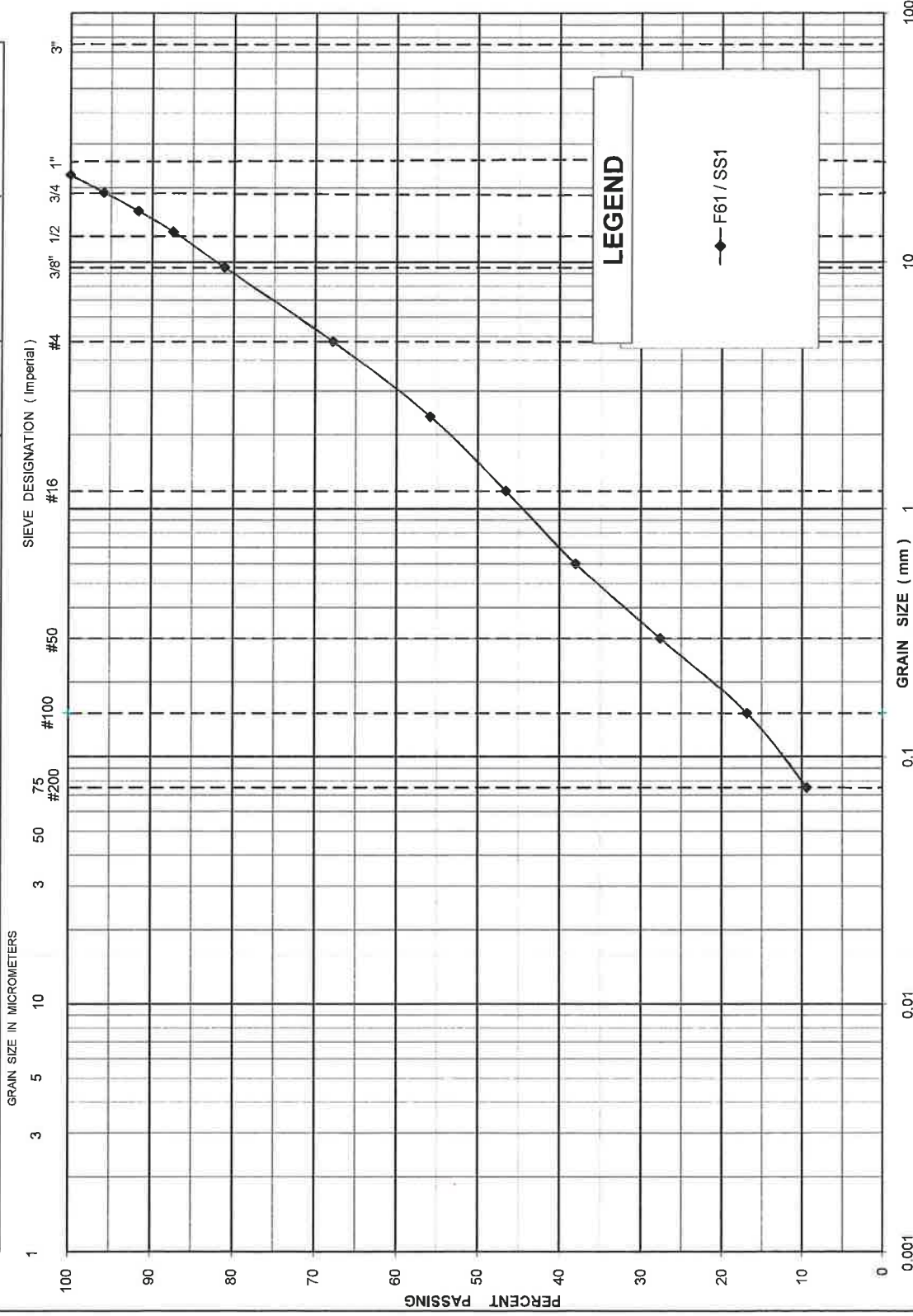
GRAIN SIZE DISTRIBUTION
SAND AND GRAVEL

Appendix B6

Laboratory Test Results – Cut Area 1 – Stations 21+920 to 22+150 EB

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

GRAIN SIZE IN MICROMETERS

SAND

Fine

#100

#50

Medium

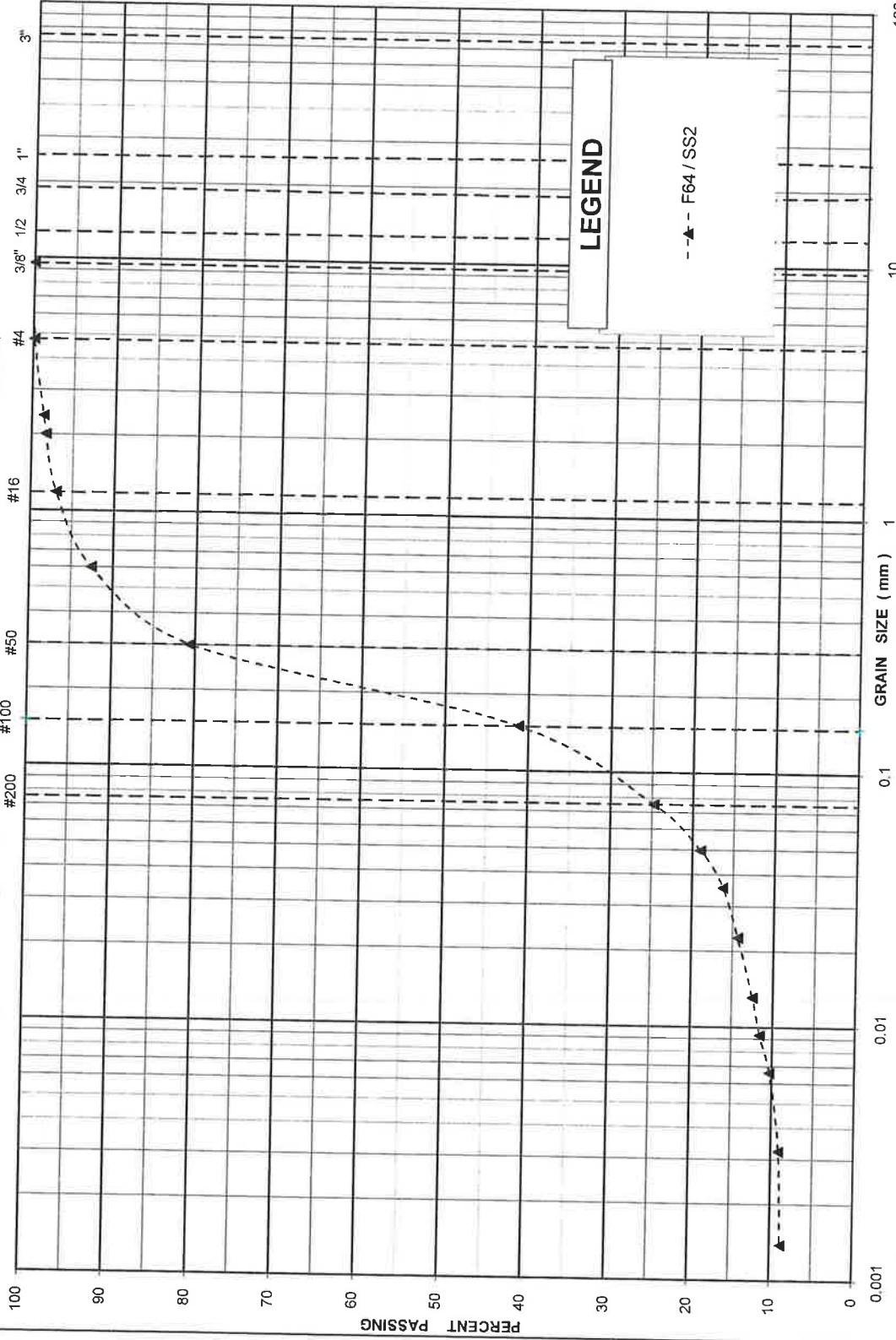
Coarse

Fine

GRAVEL

Coarse

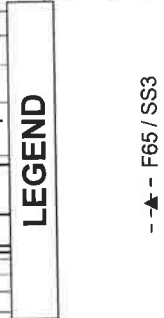
SIEVE DESIGNATION (Imperial)



LEGEND

--▲-- F64 / SS2

UNIFIED SOIL CLASSIFICATION SYSTEM					
	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse
CLAY AND SILT					



GRAIN SIZE DISTRIBUTION
SANDY SILT

FIGURE NO.: B6-3
PROJECT NO: TRANETOB10434AA
DATE: AUG, 2010

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT

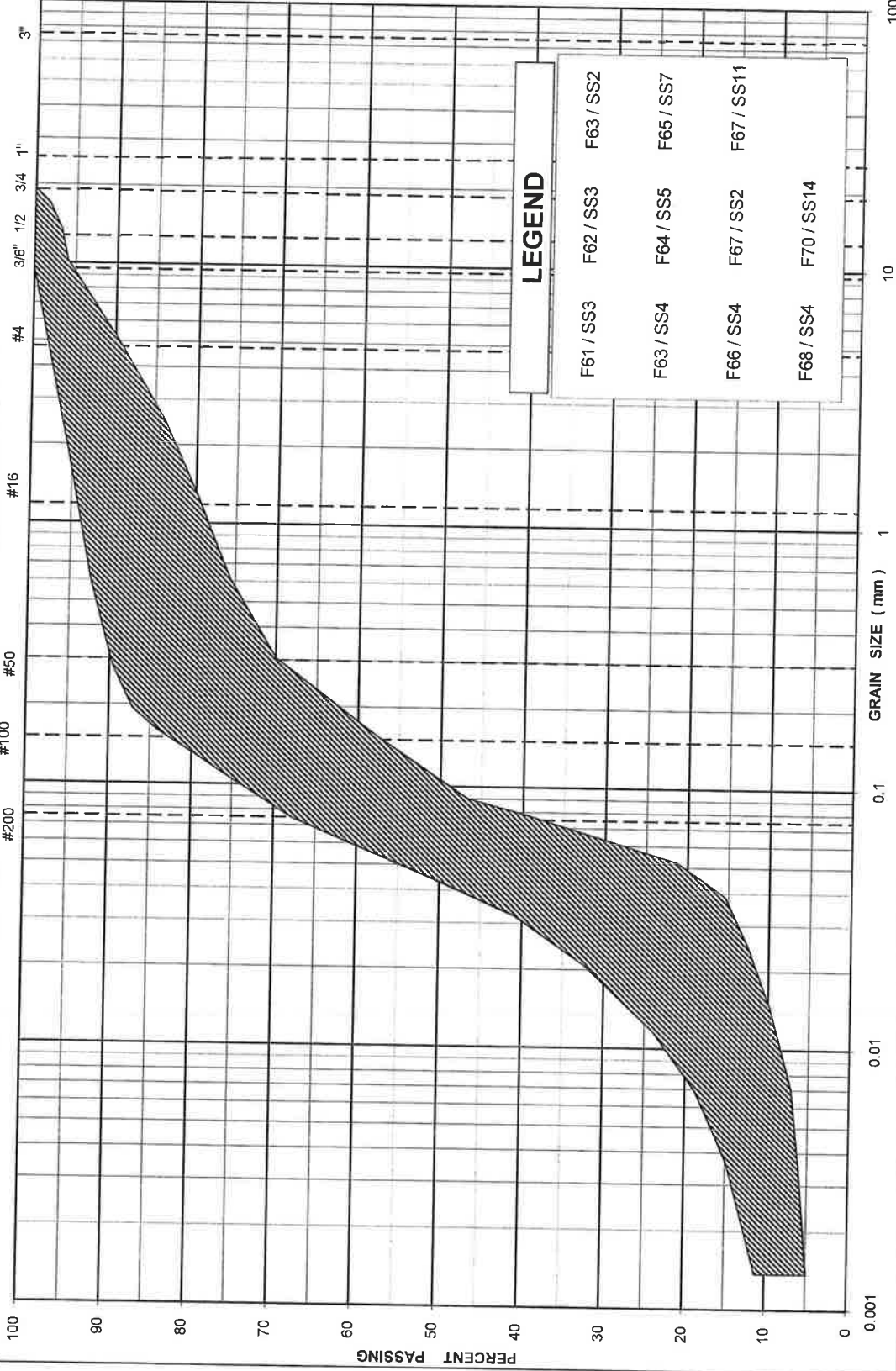
SAND

GRAVEL

GRAIN SIZE IN MICROMETERS

1 3 5 10 30 50 75 #200 #100 #50 #16 #4 3/8" 1/2 3/4 1" 3"

SIEVE DESIGNATION (Imperial)

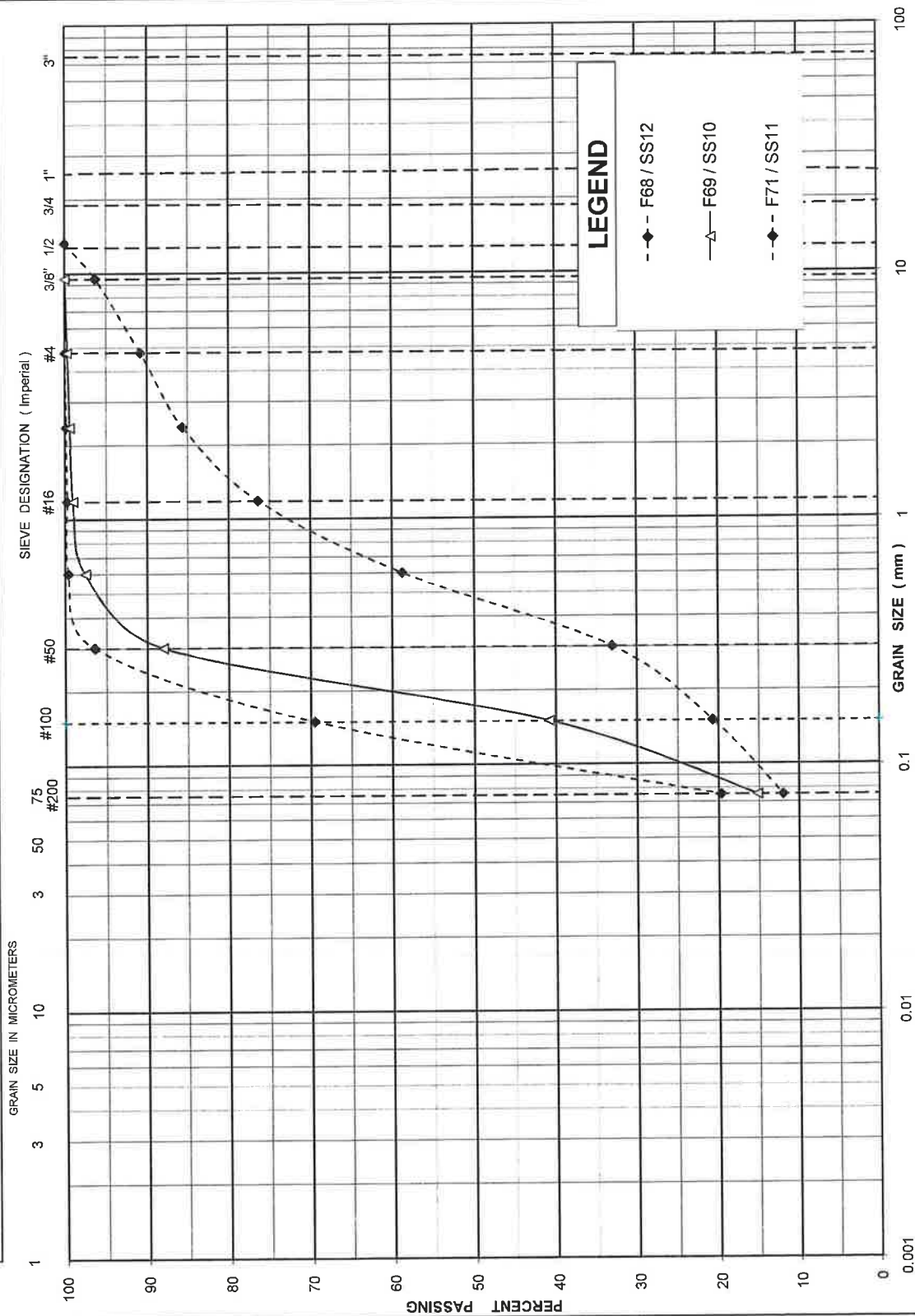


LEGEND

F61 / SS3	F62 / SS3	F63 / SS2
F63 / SS4	F64 / SS5	F65 / SS7
F66 / SS4	F67 / SS2	F67 / SS11
F68 / SS4	F70 / SS14	

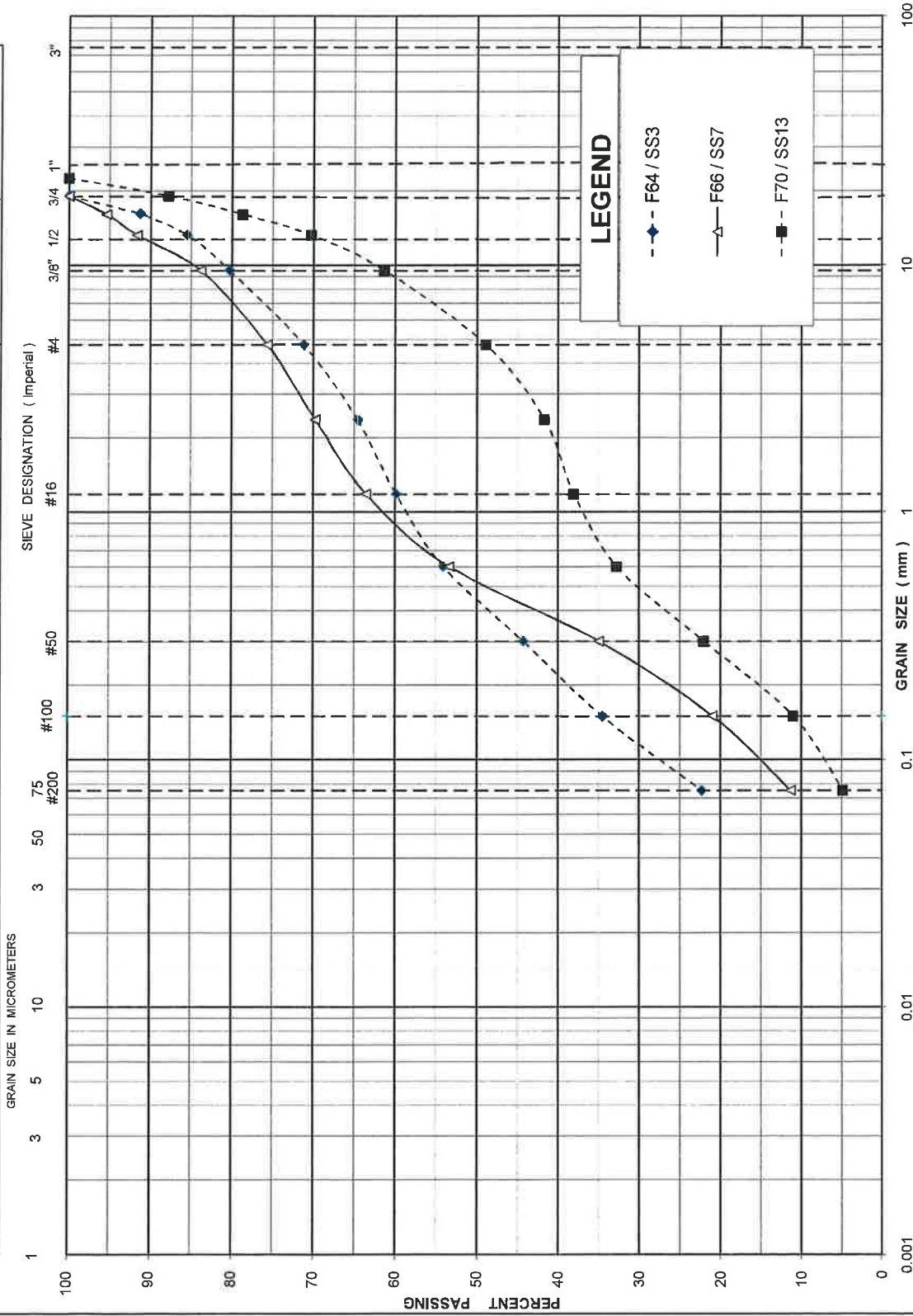
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	



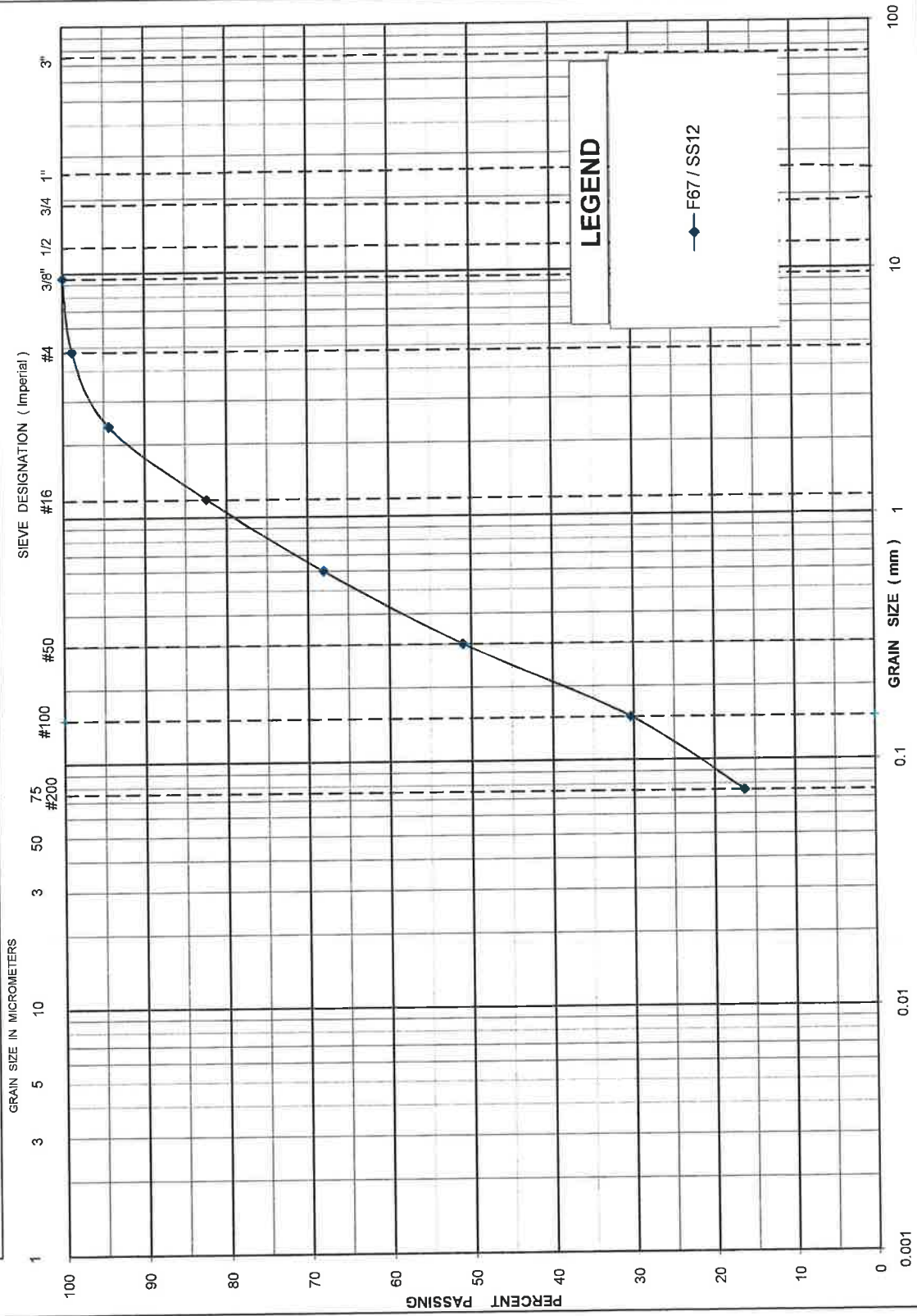
UNIFIED SOIL CLASSIFICATION SYSTEM


CLAY AND SILT			SAND			GRAVEL		
			Fine	Medium	Coarse	Fine	Coarse	



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT		SAND			GRAVEL		
		Fine	Medium	Coarse	Fine	Coarse	





coffey geotechnics
SPECIALISTS MANAGING THE EARTH

GRAIN SIZE DISTRIBUTION

SAND TILL

FIGURE NO.: B6-7

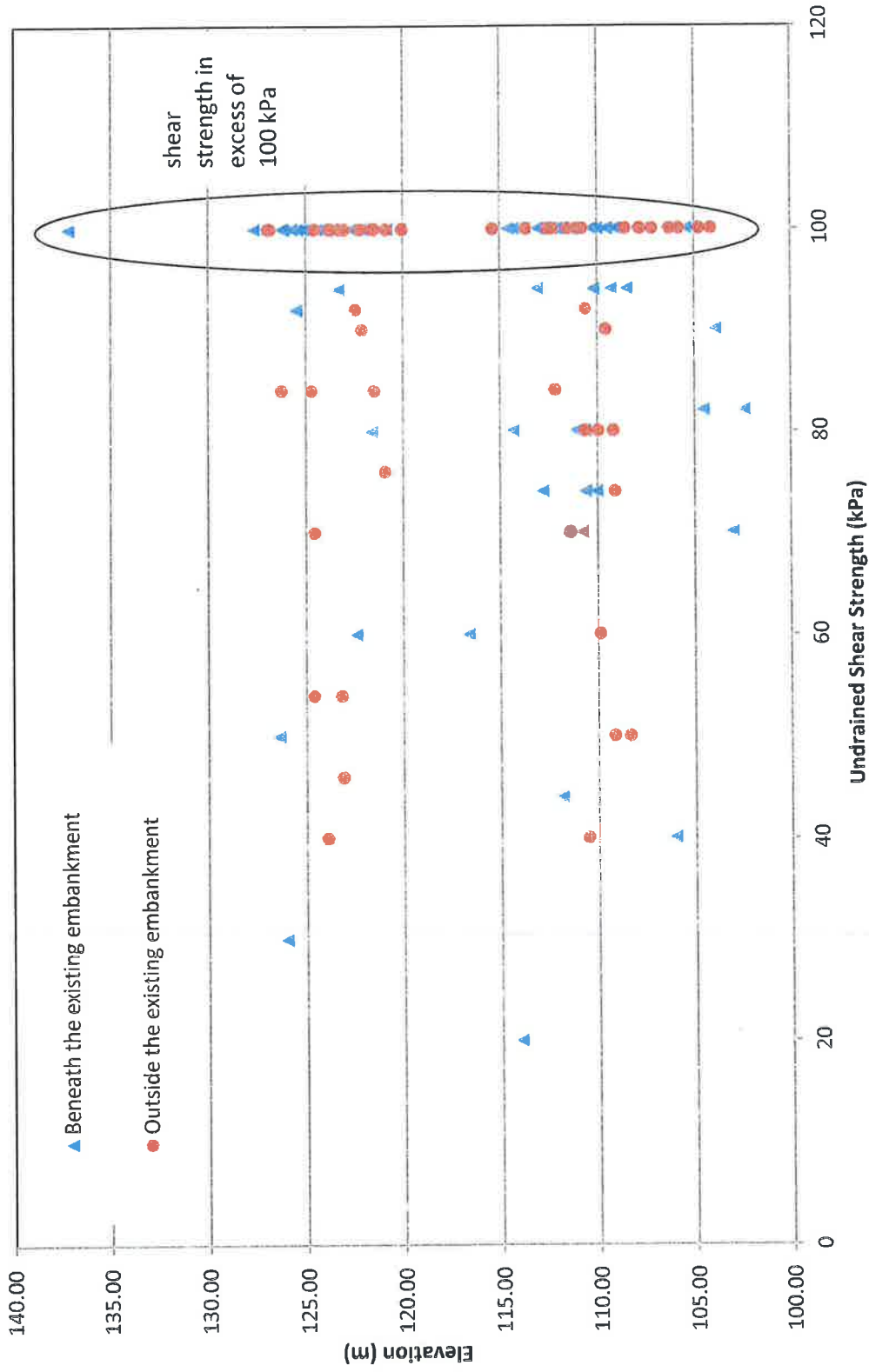
PROJECT NO: TRANETOB10434AA

DATE: AUG, 2010


Appendix C

Undrained Shear Strength – Clayey Silt to Silty Clay

Undrained Shear Strength vs. Elevation



client: AECOM		Highway 401 Expansion	
project:		Embankment Fills - Fill Area 1 to 5	
title:		Undrained Shear Strength vs Elevation	
project no:		TRANETOB10434AA	drawing no: C1

drawn	DS	 SPECIALISTS MANAGING THE EARTH
approved	ZO	
date	Mar 2011	
scale	As Shown	
original	Letter	

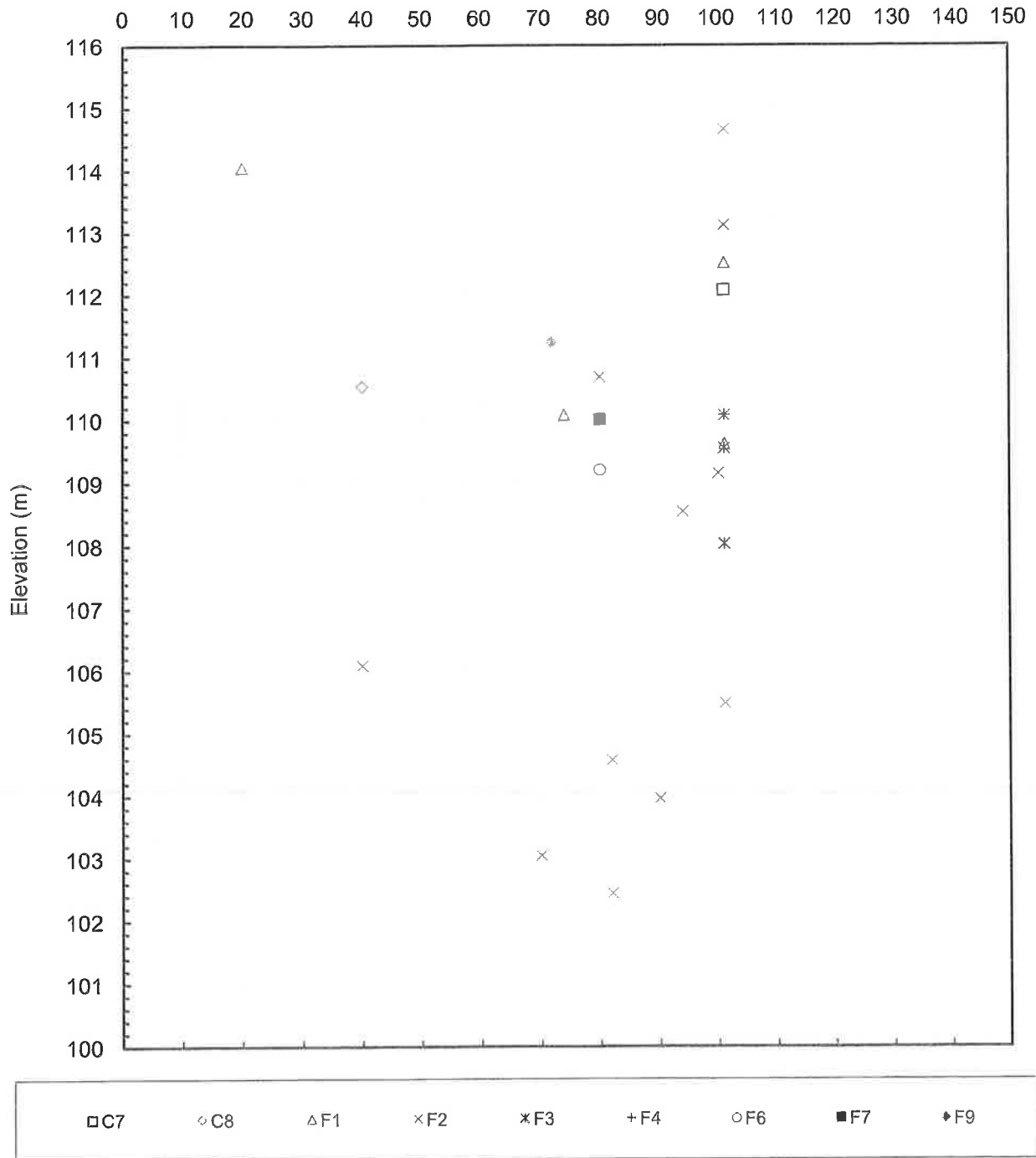
UNDRAINED SHEAR STRENGTH MEASURED BY FIELD VANE TESTS

FIGURE C2

Hwy 401 Expansion, Embankment Fills & Excavation Cut, Fill Area 1

Clayey Silt to Silty Clay

Undrained Shear Strength, C_u (kPa)



Project No. : TRANETOB10434AA

Date : January, 2012

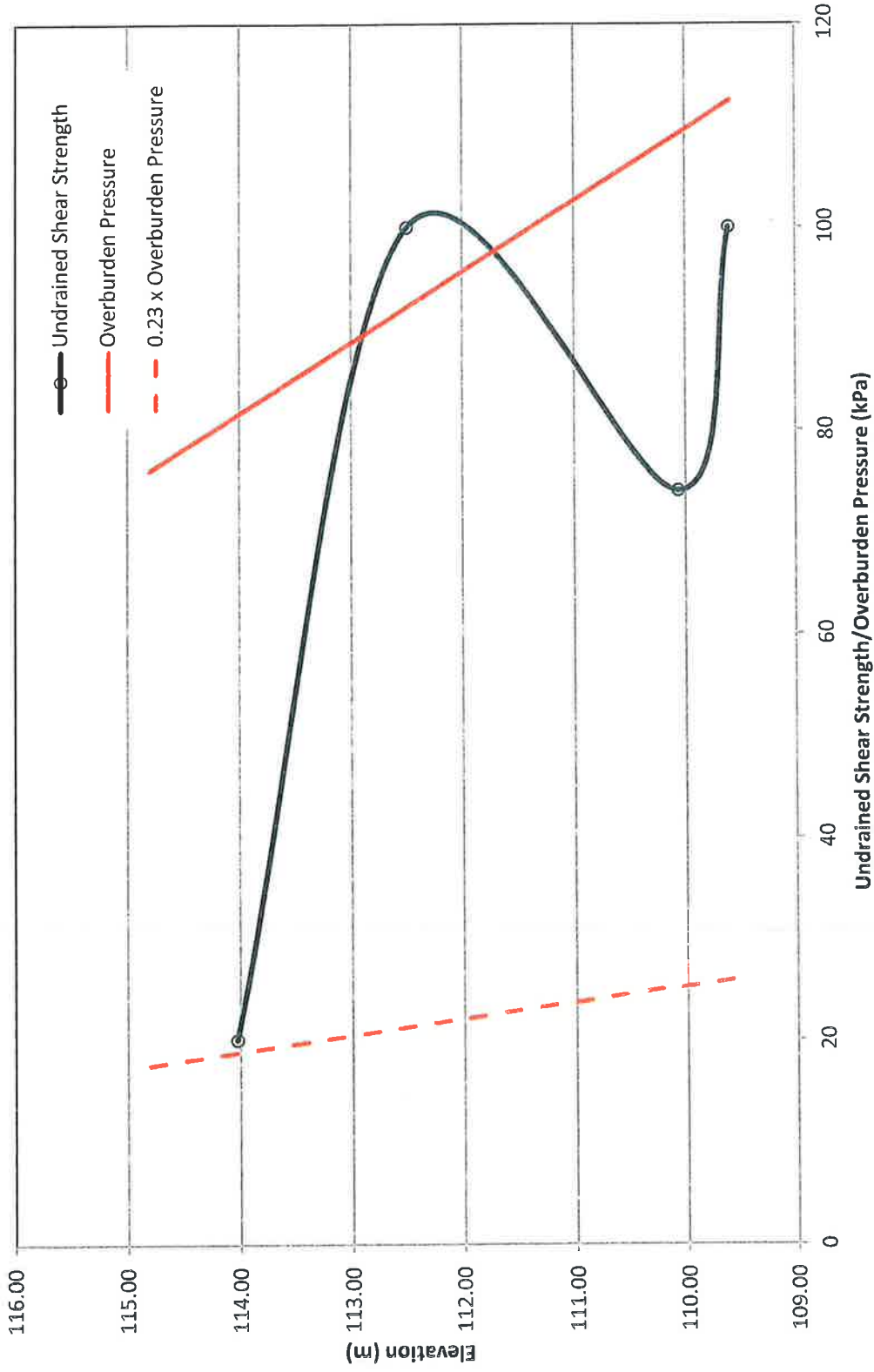
coffey geotechnics
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Prepared By : HW

Checked By : ZO

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Undrained Shear Strength Distribution - F1

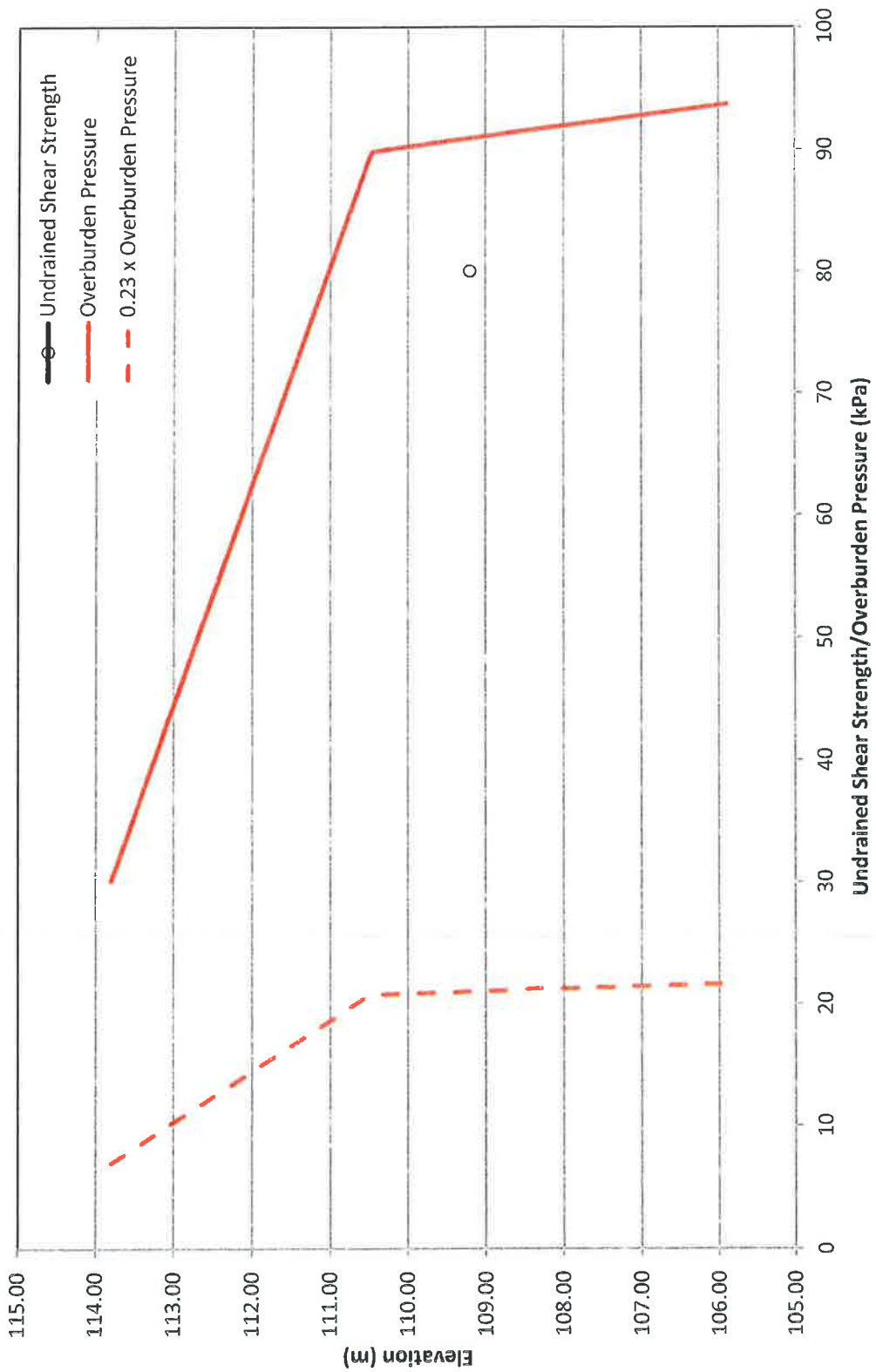



drawn	DS
approved	ZO
date	Mar 2011
scale	As Shown
original	Letter



client:	AECOM
project:	Highway 401 Expansion Embankment Fills
title:	Undrained Shear Strength Distribution - Borehole F1
project no:	TRANETOB10434AA
drawing no:	C3

Undrained Shear Strength Distribution - F6



client: AECOM		 SPECIALISTS MANAGING THE EARTH			
project: Highway 401 Expansion Embankment Fills		drawn	DS		
		approved	ZO		
title: Undrained Shear Strength Distribution - Borehole F6		date	Mar 2011		
project no: TRANETOB10434AA		scale	As Shown		
drawing no: C4		original	Letter		

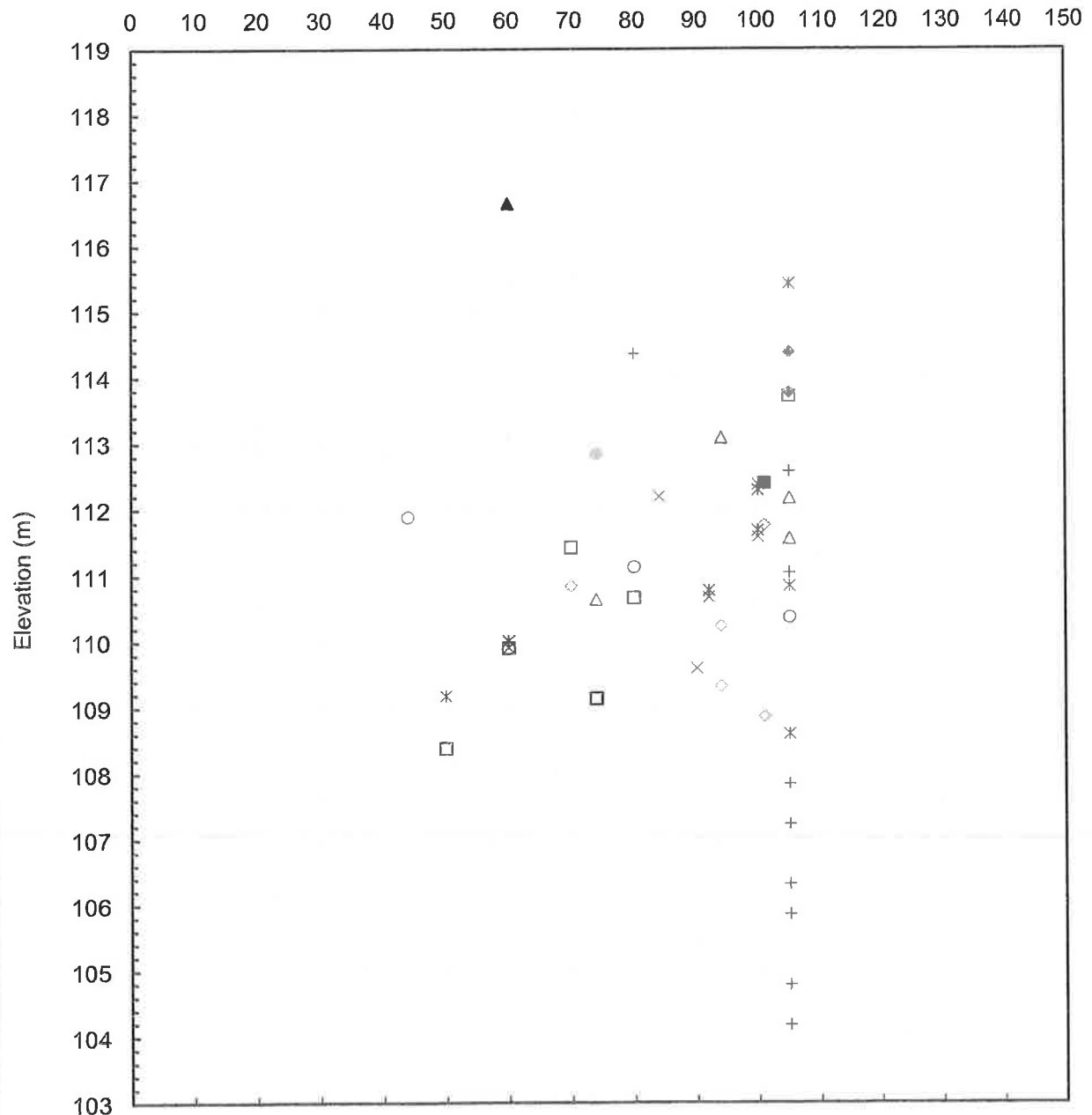
UNDRAINED SHEAR STRENGTH MEASURED BY FIELD VANE TESTS

FIGURE C5

Hwy 401 Expansion, Embankment Fills & Excavation Cut, Fill Area 2

Clayey Silt to Silty Clay

Undrained Shear Strength, C_u (kPa)



□ C5 ◇ C6 △ F11 × F11B × F11B(Additional) + F11D ○ F13 ■ F14 ◆ F15 ▲ F16 × F18B × F19 + F22 ● F23

Project No. : TRANETOB10434AA

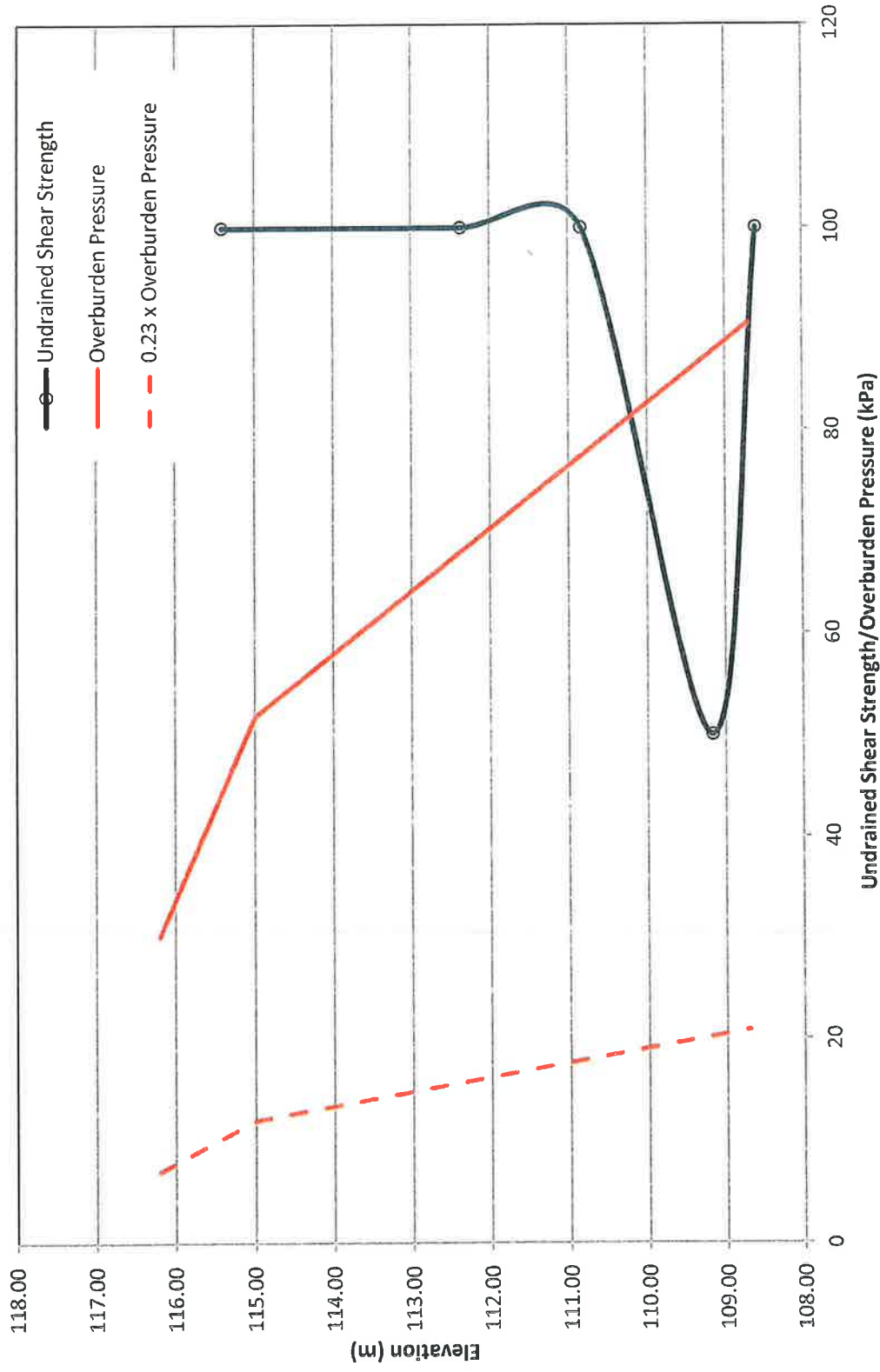
Date : January, 2012


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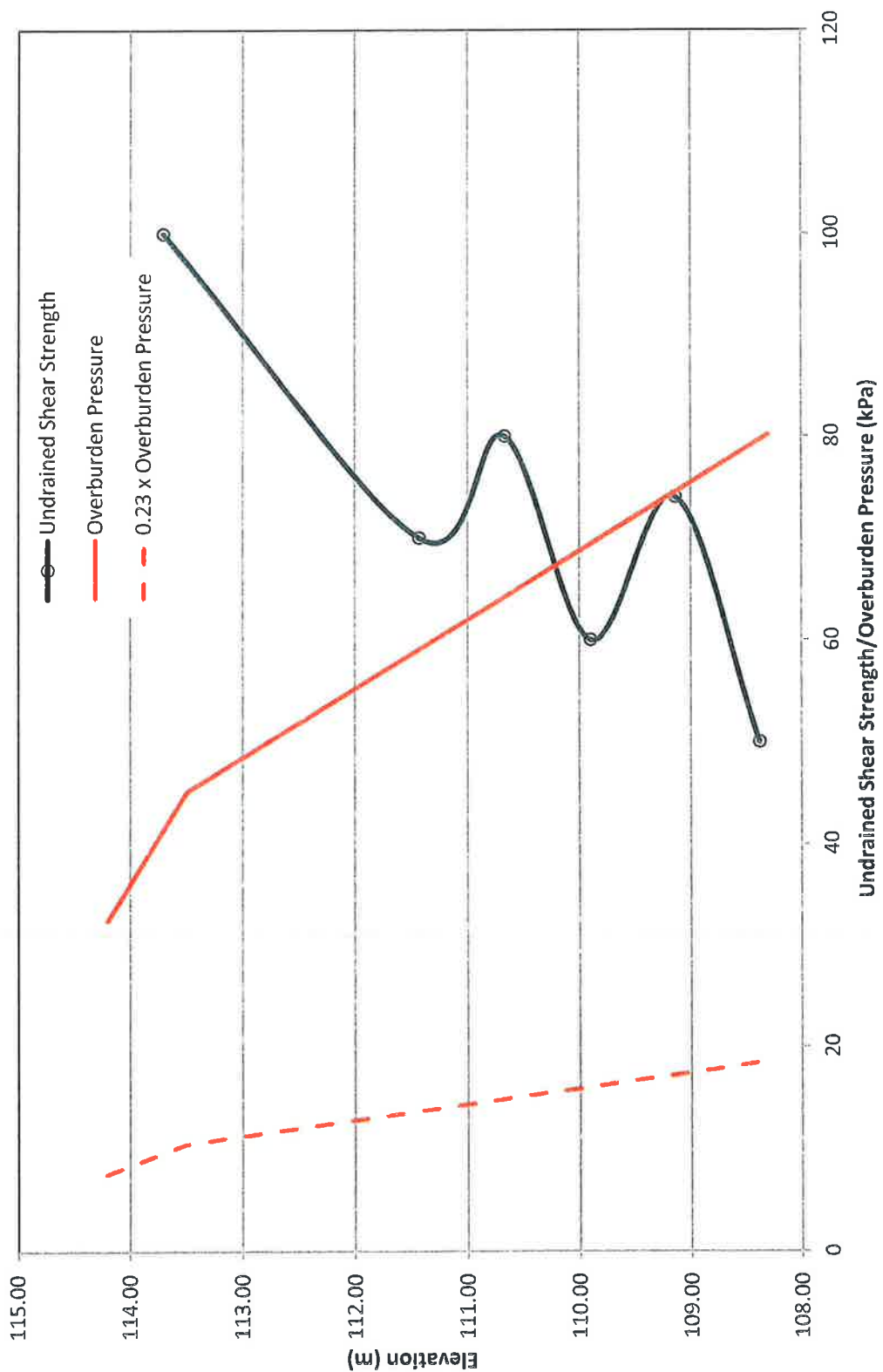
Checked By : ZO


Undrained Shear Strength Distribution - F19



client: AECOM					
project: Highway 401 Expansion Embankment Fills		drawn	DS		
title: Undrained Shear Strength Distribution - Borehole F19		approved	ZO		
project no: TRANETOB10434AA		date	Mar 2011	scale	As Shown
drawing no: C6		original	Letter		

Undrained Shear Strength Distribution - C5



drawn		DS	<div> SPECIALISTS MANAGING THE EARTH</div>	client:	AECOM	
approved		Z0		project:	Highway 401 Expansion Embankment Fills	
date		Mar 2011		title:	Undrained Shear Strength Distribution - Borehole C5	
scale		As Shown		project no:	TRANETOB10434AA	drawing no:
original		Letter				C7

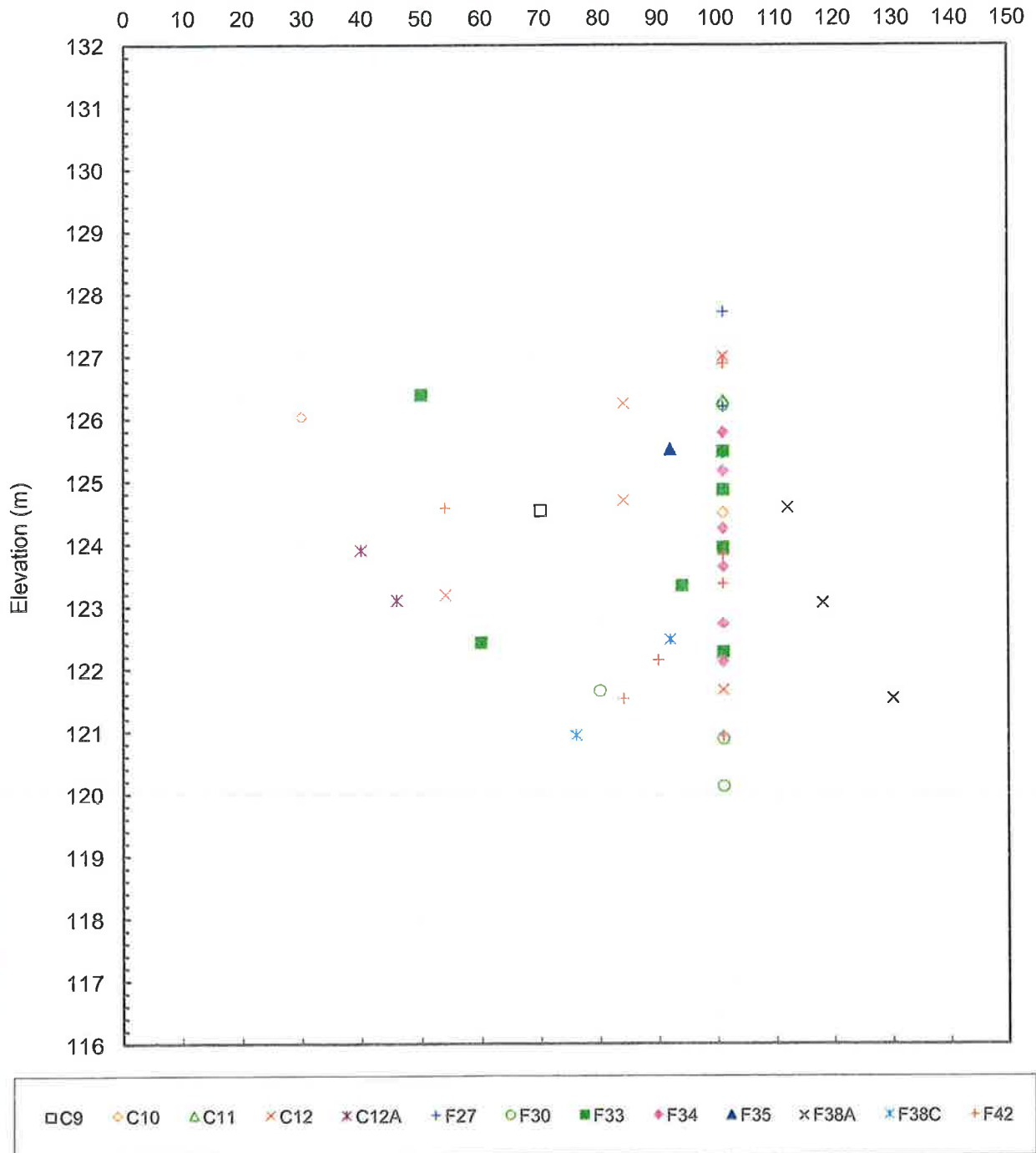
UNDRAINED SHEAR STRENGTH MEASURED BY FIELD VANE TESTS

FIGURE C8

Hwy 401 Expansion, Embankment Fills & Excavation Cut, Fill Area 3

Clayey Silt to Silty Clay

Undrained Shear Strength, c_u (kPa)



Project No. : TRANETOB10434AA

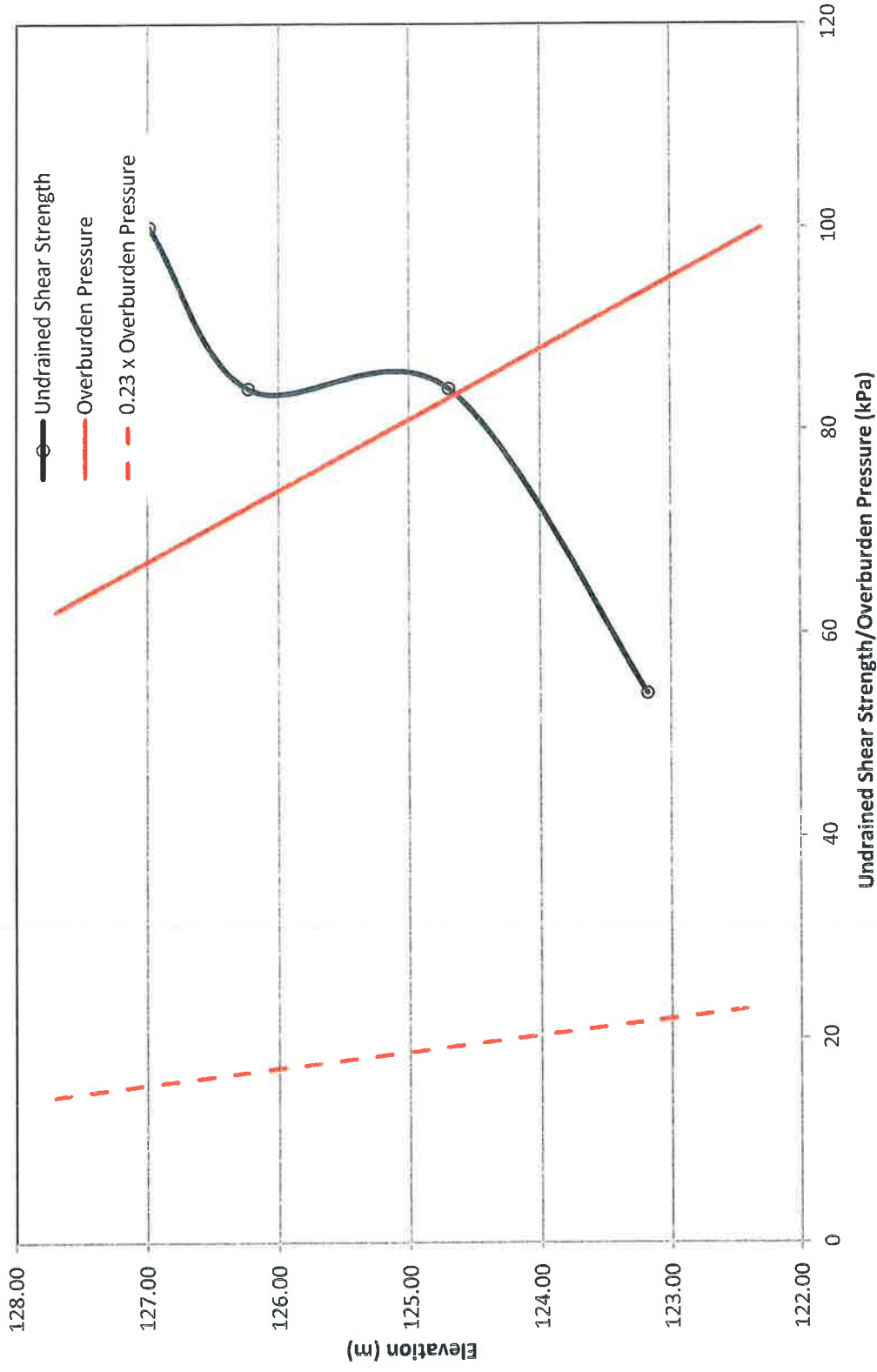
Date : January, 2012

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Prepared By : HW

Checked By : ZO

Undrained Shear Strength Distribution - C12



drawn		DS	client: AECOM	
approved		ZO	project: Highway 401 Expansion Embankment Fills	
date		Mar 2011	title: Undrained Shear Strength Distribution - Borehole C12	
scale		As Shown	project no: TRANETOB10434AA	
original		Letter	drawing no: C9	

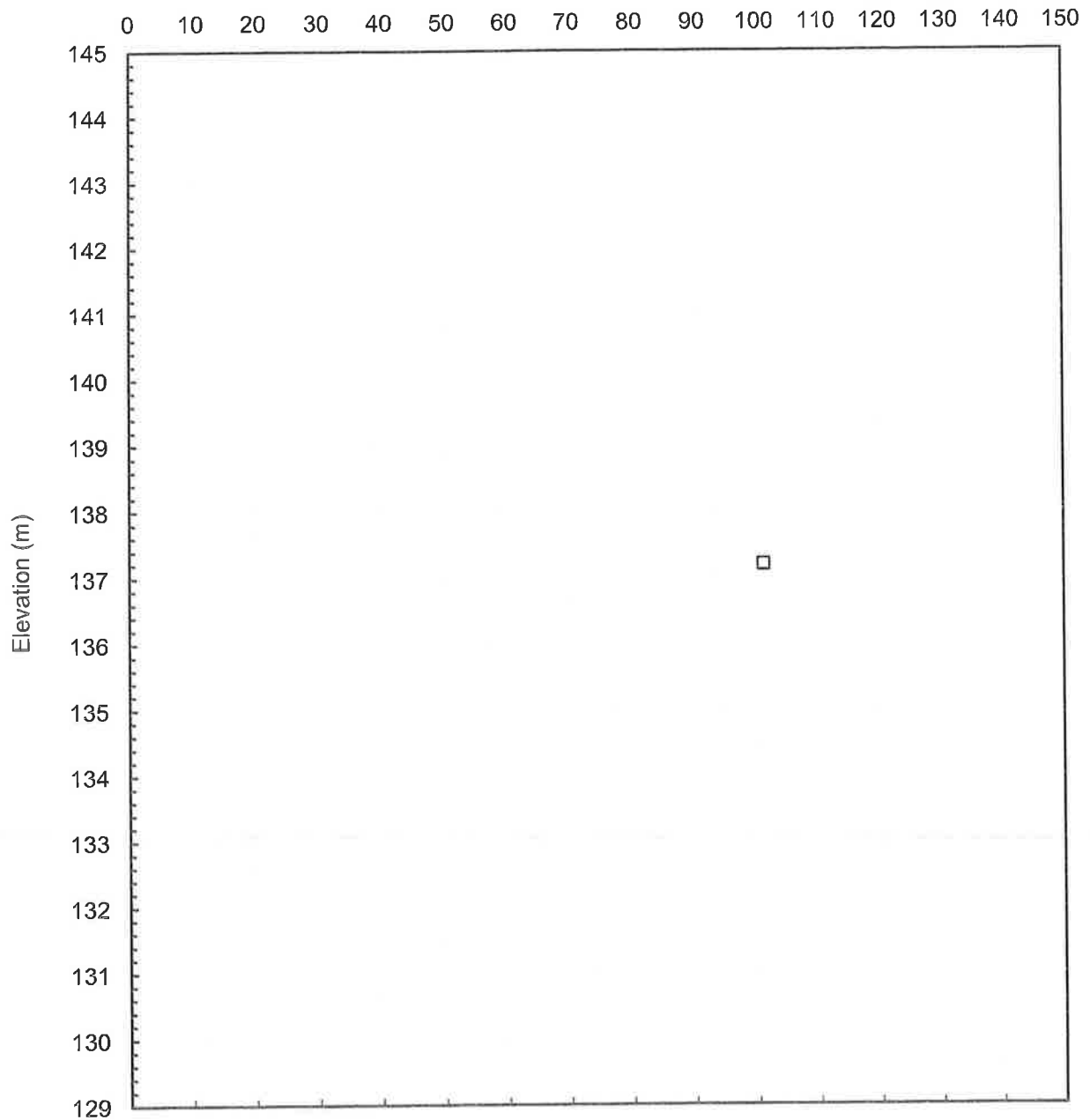
UNDRAINED SHEAR STRENGTH MEASURED BY FIELD VANE TESTS

FIGURE C10

Hwy 401 Expansion, Embankment Fills & Excavation Cut, Fill Area 4

Clayey Silt

Undrained Shear Strength, c_u (kPa)



□ F44

Project No. : TRANETOB10434AA

Date : January, 2012

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Prepared By : HW

Checked By : ZO

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Appendix D1

Site Photographs – Fill Area 1 – Stations 20+150 to 20+400 EB



Photograph D1-1. Fill Area 1 at Station 20+250, looking east from EB shoulder



Photograph D1-2. Fill Area 1 at Station 20+300, looking west from EB shoulder

Appendix D2

Site Photographs – Fill Area 2 – Stations 20+300 to 20+500 WB



Photograph D2-1. Fill Area 2 at Station 20+300, looking west from WB ditch (BHF19)



Photograph D2-2. Fill Area 2 at Station 20+425, looking north (ditch – BH F24) from WB shoulder (BH F16)



Photograph D2-3. Fill Area 2 at Station 20+475, looking north (ditch – BH F26) from WB shoulder (BH F18)



Photograph D2-4. Fill Area 2 at Station 20+300, looking west from WB shoulder

Appendix D3

Site Photographs –Fill Area 3–Stations 21+650 to 21+750 EB & WB



Photograph D3-1. Fill Area 3 at Station 21+720 EB, looking west



Photograph D3-2. Fill Area 3 at Station 21+720 EB, looking east



Photograph D3-3. Fill Area 3 at Station 21+740 WB, looking east



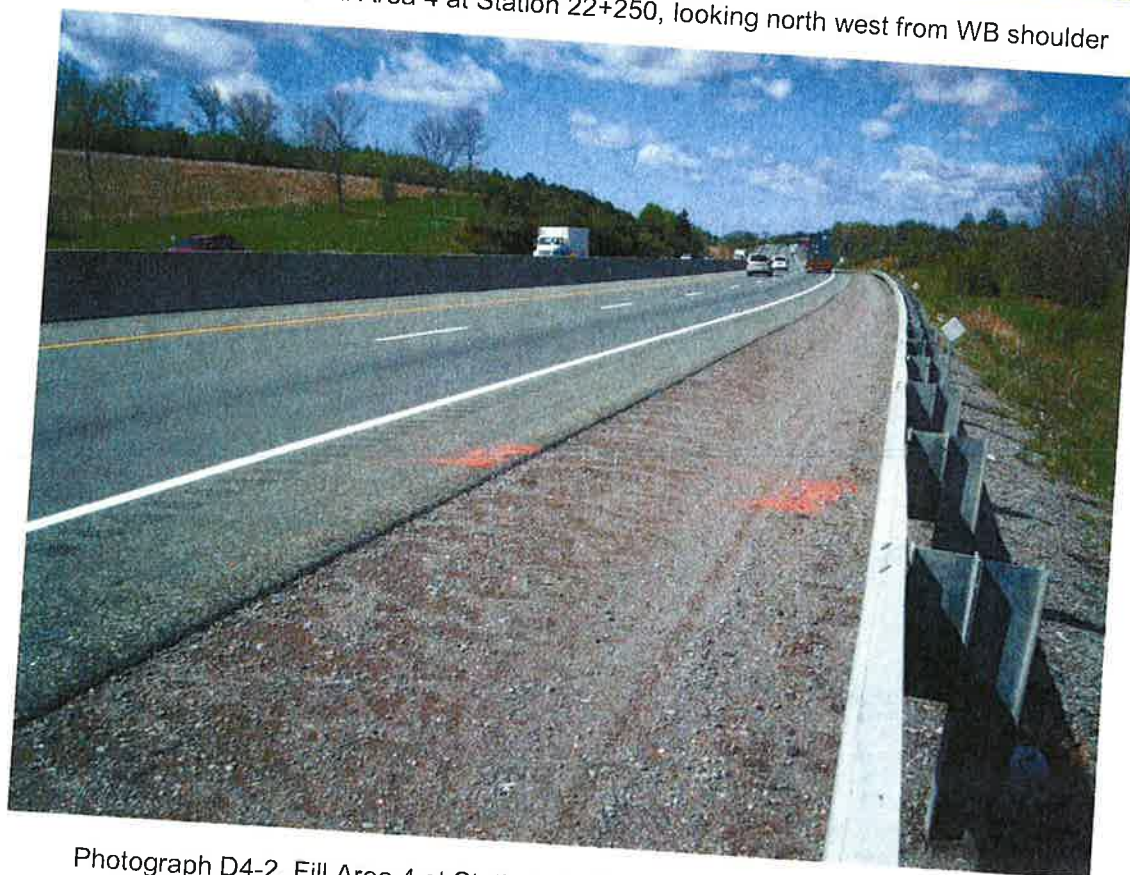
Photograph D3-4. Fill Area 3 at Station 21+740 WB, looking west

Appendix D4

Site Photographs – Fill Area 4 – Stations 22+230 to 22+380 WB



Photograph D4-1. Fill Area 4 at Station 22+250, looking north west from WB shoulder



Photograph D4-2. Fill Area 4 at Station 22+250, looking west from WB shoulder



Photograph D4-3. Fill Area 4 at Station 22+250, looking north east from WB shoulder



Photograph D4-4. Fill Area 4 at Station 22+250, looking east from WB shoulder

Appendix D5

Site Photographs – Fill Area 5 – Stations 22+330 to 22+400 EB



Photograph D5-1. Fill Area 5 at Station 22+340, looking east from EB shoulder



Photograph D5-1. Fill Area 5 at Station 22+340, looking west from EB shoulder

Appendix D6

Site Photographs – Cut Area 1 – Stations 21+920 to 22+150 EB



Photograph D6-1. Cut Area 1 at Station 22+100, looking west from bottom of the existing cut



Photograph D6-2. Cut Area 1 at Station 22+200, looking west from bottom of the existing cut



Photograph D6-3. Cut Area 1 at Station 22+100, looking west from top of the existing cut



Photograph D6-4. Cut Area 1 at Station 22+100, looking east from top of the existing cut

Appendix E

Explanation of Terms Used in Report

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 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 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 STRUCUTRAL 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

JOINT 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
τ_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_a	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
c	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ	$^\circ$	EFFECTIVE ANGLE OF INTERNAL FRICTION
ϕ_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	$^\circ$	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOVED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

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

**FOUNDATION DESIGN REPORT
HIGHWAY 401 EXPANSION,
EMBANKMENT FILL AND EXCAVATION
CUT AREAS, TOWN OF COBOURG AND
TOWNSHIP OF HAMILTON, ONTARIO
G.W.P. NO. 205-00-01,
GEOCRES 30M16-48**

AECOM

TRANETOB10434AA-AH
January 30, 2012

FINAL REPORT

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Appendix F: Typical Sections

Appendix G: Results of Slope Stability Analyses

Appendix H: Cross Sections Used for Settlement Calculations

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Appendix K: Suggested NSSP Wording

Appendix L: Limitations of Report

**FOUNDATION DESIGN REPORT
HIGHWAY 401 EXPANSION – EMBANKMENT FILL AND EXCAVATION CUT AREAS
TOWN OF COBOURG AND TOWNSHIP OF HAMILTON, ONTARIO
G.W.P. 205-00-01, Geocres 30M16-48**

5 DISCUSSION AND RECOMMENDATIONS

5.1 General

As part of the Highway 401 Expansion (6-Laning) from Burnham Street to approximately 2.0 km east of Nagle Road, within the Town of Cobourg and Township of Hamilton, Ontario, a foundation investigation was carried out for proposed five embankment fill areas and one excavation cut area.

Table 5.1 below presents the locations of the proposed embankment fill areas and of the excavation cut area.

Table 5.1: Embankment Fill Areas and Excavation Cut Area Location

Fill/Cut Number	Stations	Eastbound / Westbound	Length (m)	Max Height / Depth (m)	Comments
Fill Area 1	20+150 to 20+400	Eastbound	250	6.5	In the vicinity of Midtown Creek East
Fill Area 2	20+300 to 20+500	Westbound	200	6.5	In the vicinity of Midtown Creek East
Fill Area 3	21+650 to 21+750	Both	100	7.3	In the vicinity of Brook Creek
Fill Area 4	22+230 to 22+380	Westbound	150	6.2	In the vicinity of Brook Creek East
Fill Area 5	22+330 to 22+400	Eastbound	70	5.2	In the vicinity of Brook Creek East
Cut Area 1	21+920 to 22+150	Eastbound	230	14.5	East of Nagle Road

Cross sections provided by AECOM show that typically the existing two lane highway for each westbound or eastbound will be widened by adding another lane (3.75 m wide) and no grade raise is proposed, as shown in Appendix F. The actual widening of the embankment itself varies up to a maximum of 4 m wide. The proposed side slopes for the widened embankments are typically 3H:1V and 2.5H:1V in some areas while the proposed side slopes for the cut area are typically 2.5H:1V. We have however analyzed the feasibility of using steeper side slopes for both the proposed fills and cuts.

5.2 Proposed Embankment Fill Areas

5.2.1 Use of Fill Materials for Embankment Widening Construction

The materials used for the construction of the embankment fills should consist of approved, acceptable fill (e.g. Granular 'A' or 'B' for base and sub-base and Select Subgrade Materials SSM as per OPSS1010). Fill used for construction of the embankments should be in accordance with OPSS 212 and fill placement should meet or exceed the requirements of OPSS 501 and OPSS 206. Construction should be in accordance with SP 206S03. In general, the fills should be placed in suitable lift thicknesses not exceeding 300 mm loose when placed, and each lift should be uniformly compacted to at least 95 % of the material's Standard Proctor Maximum Dry Density (SPMDD). In as much as possible, within the upper 1.5 m (frost depth) the fill should match the existing, for the purpose of minimizing differential frost heave.

It is unlikely to encounter rock fill along these proposed embankment fills, however, if rock fill is exposed during the embankment widening, the rock fill should be properly chinked prior to placement of any fill on top. Also, adjacent to any exposed rock fill, a minimum 0.5 m of Granular 'B' Type II should be placed on the side prior to the placement of the earth fill for the widening. This Granular 'B' Type II will act as a filter between the coarse rock fill and the finer grained earth fill, which will reduce the amount of soil loss into the voids in the rock fill.

If as much as possible, the use of cohesive fills (i.e. clayey) should be discouraged, as in some instances such fills exhibit slope creep, as well as undergoing more time dependent settlements.

If required, rock fill can also be used. However, for this project which constitutes a single lane widening only, the use of rock fill may not be practical where the existing embankment consists of normal earth fill because of the following reasons:

- Possible differential frost heaving;
- Rock fill typically stands at 1¼H:1V side slopes;
- A filter will be required as a separator between the existing and the new sections to prevent earth fill in filling the rock fill after construction, which would cause differential movements.

For these reasons, the use of rock fill will be impractical and is not recommended, unless the existing embankment consists of rock fill. However, if the use of rock fill is preferred, we will be pleased to look into further details of the project, including slope stability analyses.

5.2.2 Embankment Stability

Based on the cross sections provided to us by AECOM, the existing side slopes at Fill Areas 1 to 5 typically range from 2H:1V to 3H:1V (see Appendix F). Visual inspections of the existing embankment slopes indicated no apparent signs of instability. The side slopes proposed, (see Appendix F), are typically 3H:1V or 2.5H:1V. As the existing slopes are standing at the same angle or generally steeper than the proposed side slopes and since the road will only be widened without any grade raise, problems with instability due to foundation soils and slope itself are not anticipated. We have however carried out slope stability analyses for completeness and for confirmatory purposes.

Slope stability analyses were carried out using the proposed typical embankment cross sections (as presented in Appendix F) provided by AECOM. The stability of the proposed embankments was analysed by the limit equilibrium approach. The analyses were carried out using the commercial two-dimensional slope stability computer program Slope/W and the Morgenstern-Price method of analysis which was adopted for both short-term (undrained) and long-term (drained) analyses.

Based on the typical cross sections, it is our understanding that the existing road shoulder under the proposed widening portions will be excavated to a depth about 1 m below the existing ground and replaced with new granular pavement fill material. We also assumed that the general fill used for the construction of the new embankment will be granular fill or SSM as discussed in Sections 5.2.1 and 5.2.3. The removal of the existing topsoil, organic or otherwise unsuitable weak materials underneath the widened sections and their replacement with suitable, compacted fill, as per standard MTO conventions, are also required. The anticipated stripping depths/elevations at the borehole locations are as follows:

Table 5.2: Anticipated Stripping Depths/Elevations at Borehole Locations

Borehole No.	Existing Ground Elevation at the Borehole Location (m)	Recommended Stripping Elevation/Depth (m)
Fill Area 1		
C7	120.6	N/A *
C8	115.1	114.2 / 0.9 **
F1	118.6	N/A *
F2	119.2	N/A *
F3	119.6	N/A *
F4	121.5	N/A *
F5	122.8	N/A **
F6	115.3	115.1 / 0.2 **
F7	114.6	114.4 / 0.2 **
F8	115.3	115.1 / 0.2 **
F9	115.8	115.1 / 0.7 **
F10	118.0	117.3 / 0.7 **
Fill Area 2		
C5	116.0	115.4 / 0.6 **
C6	120.9	N/A *
F11	120.7	N/A *

Borehole No.	Existing Ground Elevation at the Borehole Location (m)	Recommended Stripping Elevation/Depth (m)
F11B	116.0	115.6 / 0.4 **
F11D	117.9	117.8 / 0.1 **
F13	121.8	N/A *, ***
F14	122.3	N/A *, ***
F15	122.9	N/A *
F16	123.5	N/A *
F17	124.1	N/A *
F18	124.9	N/A *
F18B	121.6	121.2 / 0.4 **
F18D	124.1	123.7 / 0.4 **
F19	117.7	117.6 / 0.1 **
F22	117.4	116.8 / 0.6 **
F23	117.4	116.9 / 0.5 **
F24	118.5	118.0 / 0.5 **
F25	120.1	119.8 / 0.3 **
F26	121.1	120.5 / 0.6 **
Fill Area 3		
C9	128.5	128.3 / 0.2
C10	134.4	N/A *, ****
C11	133.9	N/A *
C12	130.8	130.5 / 0.3 **
C12A	126.6	126.3 / 0.3 **
F27	133.8	N/A *
F28	134.1	N/A *
F29	134.2	N/A *
F30	134.6	N/A *
F31	133.8	N/A *

Borehole No.	Existing Ground Elevation at the Borehole Location (m)	Recommended Stripping Elevation/Depth (m)
F32	133.8	N/A *
F33	134.0	N/A *
F34	134.3	N/A *
F35	131.0	130.7 / 0.3 **, ****
F36	130.5	130.4 / 0.1 **, ****
F37	129.9	129.7 / 0.2 **, ****
F38A	131.6	131.4 / 0.2
F38C	131.0	130.7 / 0.3
F39	131.1	130.8 / 0.3 **
F40	130.3	130.1 / 0.2 **
F42	132.2	132.0 / 0.2 **
Fill Area 4		
C13	139.6	139.3 / 0.3
C14	144.9	N/A *
F43	142.5	N/A *
F44	143.3	N/A *
F45	143.7	N/A *
F46	144.2	N/A *
F48	145.9	N/A *
F49	139.0	138.7 / 0.3 **
F50	138.6	137.3 / 1.3 **
F51	138.6	136.3 / 2.3 **
F52	138.3	138.0 / 0.3 **
F54	142.2	141.8 / 0.4 **
Fill Area 5		
C15	144.2	N/A *
C16	139.7	138.4 / 1.3 **

Borehole No.	Existing Ground Elevation at the Borehole Location (m)	Recommended Stripping Elevation/Depth (m)
F55	144.0	N/A *
F56	144.7	N/A *, ****
F57	145.1	N/A *
F58	139.7	139.0 / 0.7 **
F59	140.5	140.1 / 0.4 **
F60	141.3	141.0 / 0.3 **

* Borehole drilled from top of existing embankment

** Borehole drilled from top of the existing partial embankment fill

*** 0.7 m thick organic soil underlies the existing embankment fill at this borehole location

**** Organic soil present under the existing embankment fill

The above table shows that many of the boreholes were drilled from the top of the existing embankment and as such do not provide relevant information for stripping purpose. Attention is also drawn to situations (as revealed by some of the boreholes) where fill was placed on top of topsoil/organic deposits. These have the effect of obscuring the presence of organic deposits (e.g. see Boreholes F50, F51 and C16). Where this occurs at the borehole locations and elsewhere (conditions may change in between and beyond borehole locations), such materials must be removed and replaced with suitable, engineered fill materials. The required stripping depth can probably be best determined in the field at the time of construction, immediately prior to stripping, by digging test pits. We recommended that this aspect be red flagged to the Contractor and the QVE.

The following sections present a discussion on the slope stability analyses for each fill location. The results of the slope stability analyses are presented in Appendix G.

5.2.2.1 Embankment Stability – Fill Area 1 (Stations 20+150 to 20+400 EB)

Based on the borehole information (see Record of Borehole Sheets F1 through F10, C7 and C8 and also inferred subsurface profile, DWG A1), the following soil parameters were adopted in the analysis.

Table 5.3: Soil Parameters Used for Slope Stability Analyses – Fill Area 1

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New embankment/pavement fill	20.5	0	31	0	31
Existing embankment fill – Silty Sand	20.0	0	30	0	30
Clayey Silt to Silty Clay	18.0	20 - 50	0	3	25
Silty Sand Till	22.0	0	34	0	34

We have analyzed two sections, namely, Station 20+200, where the maximum thickness of clayey silt to silty clay deposit occurs and Station 20+300 where the maximum embankment fill height occurs (i.e. 6.5 m). It should be noted that where the maximum embankment fill height occurs, the thickness of clayey silt to silty clay deposit is not the maximum thickness, i.e. those two conditions do not coincide. We analyzed both undrained and drained conditions. The results of the analyses are shown on Figures G1-1 to G1-12 in Appendix G.

Normally FOS of not less than 1.3 is required for short term stability and not less than 1.5 for long term (drained case) stability. A minimum factor of safety (FOS) of about 1.4 was obtained at Station 20+300 for side slopes of 2H:1V, which increases to about 1.6 when the slope is flattened to 2.25H:1V. Based on this, it is concluded that the embankments can be built with 2.25H:1V side slopes. It is however recommended that 2.5H:1V side slopes be maintained for this project (as presently proposed by AECOM) for ease of construction, ease of maintenance and increased safety.

5.2.2.2 Embankment Stability – Fill Area 2 (Stations 20+300 to 20+500 WB)

Based on the borehole information (see Record of Borehole Sheets F11, F11B, F11D, F13 to F18, F18B, F18D, F19, F22 to F26, C5 and C6 and also inferred subsurface profile, DWGs A2-1 and A2-2), the following soil parameters were adopted in the analysis.

Table 5.4: Soil Parameters Used for Slope Stability Analyses – Fill Area 2

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New embankment/pavement fill	20.5	0	31	0	31
Existing embankment fill – Silty Sand	20.0	0	30	0	30
Clayey Silt to Silty Clay	18.5	40 - 50	0	5	25
Silty Sand Till	22.0	0	31	0	31

An embankment section at Station 20+350 was analyzed for Fill Area 2. At Station 20+350, the maximum embankment height occurs. It should be noted that where the maximum embankment height occurs, the thickness of clayey silt to silty clay deposit is not the maximum thickness. We analyzed the undrained and drained conditions. The results of the analyses are shown on Figures G2-1 to G2-6 in Appendix G.

Minimum factors of safety (FOS) of about 1.3 and 1.5 were for side slopes of 2H:1V and 2.25H:1V, respectively. The recommended side slope configuration is 2.5H:1V or flatter, based on ease of construction, maintenance and reliability (safety).

5.2.2.3 Embankment Stability – Fill Area 3 (Stations 21+650 to 21+750 EB and WB)

Based on the borehole information (see Record of Borehole Sheets F27 to F37, F38A, F38C, F39, F40, F42, C9 to C12, and C12A and also inferred subsurface profile, DWGs A3-1 and A3-2), the following soil parameters were adopted in the analysis.

Table 5.5: Soil Parameters Used for Slope Stability Analyses – Fill Area 3

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New embankment/pavement fill	20.5	0	31	0	31
Existing embankment fill – Silty Sand	20.0	0	30	0	30
Rock Fill	19.0	0	45	0	45
Clayey Silt to Silty Clay	18.0	35	0	3	25
Silty Sand Till	22.0	0	32	0	32

The boreholes show at Fill Area 3, the thickness of clayey silt to silty clay deposit increases towards the eastern end of this stretch. Concurrently, the height of the embankment is also greater towards the eastern end. We analysed embankment sections at Stations 21+700 EB and 21+750 WB, both in the undrained and drained conditions. The results of the analyses are shown on Figures G3-1 to G3-14 in Appendix G.

A minimum factor of safety (FOS) of slightly less than 1.5 was obtained with 2.25H:1V side slopes. Based on the results of the analyses, the use of 2.5H:1V side slopes is considered acceptable (as presently proposed by AECOM), based on ease of maintenance, construction and reliability.

5.2.2.4 Embankment Stability – Fill Area 4 (Stations 22+230 to 22+380 WB)

Based on the borehole information (see Record of Borehole Sheets F43 to F46, F48 to F52, F54, C13 and C14 and also inferred subsurface profile, DWG A4), following soil parameters were adopted in the analysis.

Table 5.6: Soil Parameters Used for Slope Stability Analyses – Fill Area 4

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New embankment/pavement fill	20.5	0	31	0	31
Existing embankment fill – Silty Sand	20.0	0	30	0	30
Clayey Silt	18.5	80	0	5	25
Silty Sand / Sand and Gravel Till	22.0	0	33	0	33

Embankment sections at Stations 22+300 and 22+350 were analyzed for Fill Area 4. At Station 22+300, the maximum embankment height of 6.2 m occurs while at Station 22+350, where the height of the embankment is 6.2 m and as well the maximum thickness of clayey silt occurs. We also analyzed the undrained and drained conditions. The results of the analyses are shown in Figures G4-1 to G4-12 in Appendix G.

The results indicate minimum factors of safety (FOS) of about 1.4 for 2.25H:1V side slopes. However, for reliability, ease of maintenance and construction, the use of 2.5H:1V side slopes are recommended, as presently proposed by AECOM. Needless to say, flatter side slopes would also be acceptable (if desired for other purposes than slope stability solely). As with elsewhere, we have assumed that any organic soil, such as the organic silt encountered in Boreholes F50 and F51, will be removed from beyond the tip of the existing embankment under the footprint of the widened section and replaced with compacted, suitable inorganic material. As with this section and all others, details regarding subgrade approval, proof-rolling, fill placement, etc. are given in Section 5.2.4.

5.2.2.5 Embankment Stability – Fill Area 5 (Stations 22+330 to 22+400 EB)

Based on the borehole information (see Record of Borehole Sheets F55 to F60, C15 and C16 and also inferred subsurface profile, DWG A5), the following soil parameters were adopted in the analysis.

Table 5.7: Soil Parameters Used for Slope Stability Analyses – Fill Area 5

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New embankment/pavement fill	20.5	0	31	0	31
Existing embankment fill – Silty Sand	20.0	0	30	0	30
Clayey Silt	18.5	50	0	5	25
Silty Sand Till / Sand and Gravel	22.0	0	34	0	34

We analyzed the section at Station 22+350, where an existing culvert is present and the maximum thickness of clayey silt as well as the maximum embankment height occurs. We also analyzed both undrained and drained conditions. The results of the analyses are shown on Figures G5-1 to G5-2 in Appendix G.

Using 2.25H:1V side slopes, a minimum factor of safety (FOS) of about 1.5 was calculated for both the drained and undrained conditions, which is acceptable. However, as with the other sections, the use of 2.5H:1V side slopes present a more practical solution. We therefore conclude that the proposed embankment widening, constructed at about 2.5H:1V slopes, is considered adequate against slope instability.

5.2.3 Settlements

Based on the borehole data, laboratory test results and the proposed widening configurations, as shown in Appendices A, B, F and H, we have estimated settlements induced by the proposed widening.

In our calculations, we assumed that the organic or unsuitable soils under the widened section of the embankment will be properly stripped, as per MTO convention, including all organic deposits such as encountered in Boreholes C10, F13, F14, F35, F36 and F37. We analyzed selected sections along the proposed new embankments where the maximum fill occurs (i.e. maximum load) and/or where the maximum thickness of clayey silt to silty clay or other weak deposits occurs (i.e. maximum settlement). Appendix H shows the cross sections used for the settlement calculations. The proposed widening in those cross sections are based on the typical cross sections provided in Appendix F where the proposed side slopes are 3.0H:1V or 2.5H:1V and a widening of 4 m maximum.

Table 5.8 presents a summary of the estimated settlements that include settlement of the new fill under its own weight, immediate settlement of the foundations soils and the consolidation settlement of the clayey soils.

Table 5.8: Summary of Estimated Settlements

Fill Number / Station	Maximum New Fill Height*	Clayey Silt /Silty Clay Thickness	New Fill Settlement	Immediate Settlement**	Consolidation Settlement / Expected Time of 90% Settlement	Total Settlement
	(m)	(m)	(mm)	(mm)	(mm)/(month)	(mm)
Fill Area 1 - 20+200 EB	2.0	12.6	10	5	25 / 36	40
Fill Area 1 - 20+300 EB	2.5	1.6	15	18	7 / 1	40
Fill Area 2 - 20+300 WB	1.0	7.5	5	5	7 / 12	17
Fill Area 2 - 20+375 WB	2.0	3.7	10	15	8 / 4	33
Fill Area 3 - 21+700 EB	2.0	5.4	10	10	15 / 9	35
Fill Area 3 - 21+750 EB	1.0	8.7	5	5	15 / 22	25
Fill Area 3 - 21+700 WB	1.8	1.6	10	12	8 / 1	30
Fill Area 3 - 21+750 WB	2.7	8.4	15	10	30 / 21	55
Fill Area 4 - 22+300 WB	3.0	0.5	15	10	3 / 1	28
Fill Area 4 - 22+350 WB	3.3	2.6	18	12	20 / 2	50

Fill Number / Station	Maximum New Fill Height*	Clayey Silt / Silty Clay Thickness	New Fill Settlement	Immediate Settlement**	Consolidation Settlement / Expected Time of 90% Settlement	Total Settlement
Fill Area 5 - 22+350 EB	2.0	3.0	10	10	16 / 3	36

Note: * at or beyond rounding.

** substantially completed within one month.

Assuming that the widened portion of the new embankment is constructed to MTO standards, the settlements of the new embankment fill under its own weight are estimated to be of the order of 5 to 18 mm. The time it takes for settlement to be completed will depend on the type of soil used to build the widened portion of the embankment (e.g. the settlement of granular soils is relatively rapid while clayey soils will settle more slowly). If select subgrade material (SSM) or granular soils are used, the settlement of the granular soils will be substantially completed at the end of loading while the settlement of the embankment constructed with SSM soils is estimated to be substantially completed within one to two months following placement.

Immediate settlements of the order of 5 to 18 mm were calculated. These settlements are mainly due to settlement of the granular type (i.e. non-cohesive) foundation soils (in this instance existing embankment fills and to a lesser extent the settlement of the glacial till deposit) under the stresses imposed by the widening. Since the soil is basically granular, the time rate of settlement is relatively rapid and depending on the amount of clay in the soil, the amount of time for substantial completion of the settlements can be expected to be completed by the end of loading (i.e. end of new embankment fill placement) to about one month.

The consolidation settlement which is due to the settlement of the clayey foundation soils will depend on the thickness of the clayey soils and the magnitude of the stresses imposed. This is a time dependent settlement which will be completed in a relatively longer time and will depend on the consolidation characteristics of the clay (i.e. consolidation coefficient, c_v), and the drainage path length (thickness of clay deposit and drainage condition at the top and bottom of the deposit). The estimated consolidation settlements are of the order of 3 to 30 mm and the time frame for substantial consolidation (i.e. t_{90} , 90% of total consolidation settlement) to occur is estimated to be of the order of one to 36 months. It should also be noted that the cohesive deposit encountered at the site may settle faster than that we anticipated due to the presence more pervious (silt and silty sand) interbeds within the deposit.

Total settlements of up to 55 mm were estimated which include the settlements during the construction period (i.e. fill settlement under its own weight and immediate settlement of foundation soils) and consolidation settlements.

These anticipated settlements are expected to occur mostly beyond the paved portion of the road (i.e. settlements will be highest either near the rounding or along the side slopes, gradually decreasing towards the paved portion of the road). This is because the grade raise is typically less in the paved portions (see proposed cross sections in Appendix H). In addition, settlements due to the increase in loads are gradual

rather than abrupt. In other words, with the proposed widening scheme, abrupt differential settlements which may cause major cracking affecting the performance of a flexible pavement are not anticipated. It is however recommended that paving of the road be implemented no sooner than four weeks after the completion of the embankment widening to its substantial fill height, if at all feasible. With this approach, the anticipated post construction settlements should be less than about 30 mm at Fill Area 3, and less than 25 mm in the remaining fill areas.

5.2.4 Construction

Based on the borehole information, topsoil and organic materials are present at the proposed widened sections, including loose to very loose granular embankment fill materials at the vicinity of the toe of the existing embankments. We recommend that all organic and unsuitable soils (e.g. loose to very loose materials) encountered during the widening process will need to be removed and replaced with suitable soils, as per established MTO practice. The Contract Documents should contain a NSSP alerting this issue. As was mentioned before, such materials were contacted in Boreholes C10, F13, F14, F35, F36 and F37.

The removal of organic and unsuitable soils should be carried out within an envelope given by an imaginary slope not steeper than 1H:1V from the toe of the proposed embankment widening. The excavated base should be properly proof rolled from the surface, using a suitably heavy compactor. If localized soft spots or excessive heave occurs during proof rolling, further excavate and replace with suitable fill. After stripping and proof rolling, the exposed subgrade should be inspected, approved by an experienced geotechnical engineer appointed by the QVE.

For preliminary estimating purposes, the depth of stripping can be taken as being between 0.1 and 2.3 m with an average thickness of about 0.5 m. It should however be pointed out that the thickness of topsoil and other unsuitable soils frequently varies in between and beyond borehole locations and may be thicker in depressed areas and near watercourses.

The face of the existing slope should be properly prepared for the widening, including benching as per MTO procedures in accordance with OPSD 208.010, as shown in Appendix J.

Depending on the time of construction, the excavation and backfilling may partially take place below the groundwater level (especially near the culvert locations). Dewatering such as gravity drainage and pumping from filtered sumps can be implemented to facilitate the construction. We also recommend a suitable, free-draining granular material be used for backfilling below the original ground (o.g.) levels and to at least about 0.3 m above the o.g., if groundwater table is encountered.

For excavations in excess of 0.3 m below existing ground, backfilling will need to be carried out in relatively short sections to prevent instability of the existing embankments, as well as the nearly vertical faces of the individual benches. The process of excavation and backfilling of each sufficiently narrow section (e.g. 10 to 12 m wide sections) should be carried out concurrently. At the bottom, the first lift of the backfill may be thicker than usual backfill thickness of 0.3 m (e.g. possibly up to 0.6 m thick), depending on the site and groundwater conditions at the time of construction. If relatively deep excavations are required (i.e. thick topsoil/organic soils are encountered) from the bottom of embankment, then the stripping and backfilling may need to be carried out in narrow sections (e.g. 3 to 4 m wide) and backfilled immediately to prevent

embankment instability. All of these works should be carried out under the direction and supervision of the QVE. We recommend that an NSSP be issued for this purpose. The NSSP should specify that if more than 1 m deep soil removal is anticipated for stripping purposes, the excavations should be carried out in narrow sections, not exceeding 4 m in width and backfill immediately to prevent an instability of the existing embankment.

Recommendations for the use of the materials for the construction of the embankment fills were discussed in Section 5.2.1 of this report, but are repeated here for the sake of completeness. The fill used for the construction of embankment widening should consist of approved, acceptable fill (e.g. Granular 'A' or 'B' for base and sub-base and Select Subgrade Materials SSM below - OPSS1010). Fill used for construction of the embankments should be in accordance with OPSS 212 and fill placement should meet or exceed the requirements of OPSS 501 and OPSS 206. Construction should be in accordance with SP 206S03. In general, the fills should be placed in suitable lift thicknesses not exceeding 300 mm loose when placed, and each lift should be uniformly compacted to at least 95 % of the material's Standard Proctor Maximum Dry Density (SPMDD). In as much as possible, within the upper 1.5 m (frost depth) the fill should match the existing, for the purpose of minimizing differential frost heave.

It is unlikely to encounter rock fill along these proposed embankment fills, however, if rock fill is exposed during the embankment widening, the rock fill should be properly chinked prior to placement of any fill on top. Also, adjacent to any exposed rock fill, a minimum 0.5 m of Granular 'B' Type II should be placed on the side prior to the placement of the earth fill for the widening. This Granular 'B' Type II will act as a filter between the coarse rock fill and the finer grained earth fill, which will reduce the amount of soil loss into the voids in the rock fill.

The excavated soils free from topsoil and organics can be used as general construction backfill where they can be compacted with smooth drum or pad-foot type rollers. Loose lifts of soil, which are to be compacted, should not exceed 300 mm. On site verification of the excavated fill for re-use as backfill by a suitably qualified person during construction would be required. The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used. Note that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should therefore be compacted at the surface or be covered with tarpaulins to help minimize moisture uptake.

Proper erosion control measures should be implemented both during the construction and permanently. This can be achieved by prompt seed and cover (OPSS 572) or sodding (OPSS 571). Furthermore, the use of granular sealing, as specified in OPSD 210.070, may be considered to reduce the risk of sloughing/erosion of the pavement granular fills on the proposed embankments.

5.3 Proposed Excavation Cut

5.3.1 Cut Design Components

The profile drawings provided to us by AECOM show that the existing cut slopes between Stations 21+920 and 22+150 are typically 4 to 11 m high and sloped at about 1.9H:1V to 2.5H:1V but typically 2H:1V (see Appendix F). Based on our field observations, the surface of the existing slope is heavily vegetated by shrubs and small trees and no apparent signs of instability were observed. Based on the borehole information, the subsurface conditions at this site comprise of mainly very dense glacial till with occasional loose to compact zones at or near the ground surface. The groundwater level at the time of our investigation was generally varied below the toe of the existing cut.

The proposed expansion of the highway will widen the existing road surface and thereby encroaching on the existing cut. This will necessitate new cut slopes to be constructed.

We have analyzed several slope configurations for the new cut slope, based on our observations of the existing slope and analytical method by carrying out numerical slope stability analysis. We also provided recommendations on slope components such as erosion control and drainage. Recommendations on stable slope for the new cut slopes are presented in the following sections where results of slope stability analyses are provided. Recommendations regarding drainage and erosion control for the new cut slope are presented below.

Based on borehole information, the groundwater level at the site is generally below the toe of the existing cut. However, during major weather events, the groundwater level can rise and, as well, a perch water condition may also occur. Sandy layers were noted within the till deposit. In these sandy layers, water can accumulate and if that occurs they will provide access for water flow that may daylight on the cut slope and may present surficial erosion instability problems. The boreholes indicated that the sandy layers located near the base of the cut were wet, while these in the upper zone appeared to be dry. While the till as well as the sandy layers in the till, are not considered to be highly erodible materials, nevertheless erosion protection measures as well as drainage need to be provided on the new cut slope.

Erosion protection measures, such as benching the cut slope, are recommended for the site. As per MTO normal procedures, benching is carried out at every 6 m height along the height of the slope. The advantage of including benches is to minimize the velocity of surface water runoff as the water's uninterrupted travel distance on the cut face will be lessened by the bench and therefore reducing the erosion potential and any slope instability that it may cause. The bench will also provide access for the maintenance of the cut slope. The bench is typically 2 m wide and the bench surface dips 3 % away from the cut face. Benches within the cut slope will however result in additional excavation and possible property acquisition beyond the crest of the existing cut slope. Therefore, the construction of the recommended cut slope geometry may extend beyond the property line. Purchase of land behind the existing cut slope may be required. This matter needs to be addressed prior to construction. The slope stability analyses, presented in the following section, provide a discussion on using one or two benches for the site's maximum slope height.

We also recommend that toe drains be installed at the cut slope to maintain the drained condition of the cut slope. At the toe of the cut, aside from the normally provided ditch, we recommend that subdrains, about

1.5 m deep, be constructed to intercept around water below the ground surface and keep the road embankment drained and reduce the adverse effects of frost action. The subdrain should be directed to a positive outlet or to a municipal sewer. At the crest of the cut slope, the ground is gently sloping down towards the cut slope. We recommend that an interceptor ditch be constructed behind the crest of the cut slope to intercept surface water coming down the slope and drain it sideways and away from the face of the slope. Depending on the design, they may be drained down the slope at controlled points at every 15 to 20 m or so. These drainage points will need to be properly designed to prevent any erosion.

In addition to the above drainage control, we recommend that a drainage blanket be installed on the lower half of the cut slope where wet sand interbeds were encountered within the till, as follows:

- A minimum 200 mm thick fine filter material against the surface of the cut slope. The fine filter material can consist of Concrete Fine Aggregates (Type FA1).
- A minimum 200 mm thick coarse filter consisting of Concrete Coarse Aggregate (Group 1/20-5) placed over the fine filter material.
- A minimum 250 mm thick riprap layer (20 – 120 mm in nominal particle size).

These materials should be placed without causing segregation of the coarse particles. A schematic representation of the recommended protection system is given in Figures I-1 and I-2 in Appendix I.

If this is considered impractical or too expensive to implement and if small degree of risk can be accommodated by MTO, a simplified design can be considered, as follows:

- A minimum 250 mm thick Granular 'A' material against the surface of the cut slope
- A minimum 250 mm thick rip-rap layer (20-120 mm nominal size) placed over Granular 'A' blanket

The risks associated with this simplified blanket system are possible clogging of the blanket due to soil fines infiltration from the natural soil and lower permeability for the rapid discharge of the seeping groundwater. A schematic representation of the recommended protection system is given in Figures I-3 and I-4 Appendix I.

5.3.2 Slope Stability

We have carried out slope stability analyses to assess new slopes for the proposed cut area. The stability of the new cut slopes was analysed by the limit equilibrium approach. The analyses were carried out using the commercial two-dimensional slope stability computer program Slope/W and the Morgenstern-Price method.

The existing cuts are standing at 1.9H:1V to 2.5H:1V side slopes and no signs of slope instability were observed. As the existing slopes appear to be stable, we have analyzed new cut slopes starting at 3H:1V slopes and other options such as 2.5H:1V and 2H:1V and presented the advantages and disadvantages for using the specified slope. We also assessed the sensitivity of using either one or two benches for the site's maximum slope height.

The height of the proposed cut slope within Stations 21+920 and 22+150 EB ranged from about 7.0 to 14.5 m (see Appendix F). The critical cross section for the cut slope is at Station 22+050 where the maximum

slope height (about 14.5 m) is located. Slope stability analyses were carried out using the cross section provided by AECOM at Station 22+050. Another cross section at Station 21+950 was analyzed to present the slope stability for the slopes with heights between 7 and 12 m. As the soils are mainly granular, only the drained condition analyses are applicable. Based on the borehole information, the groundwater was modelled below the toe of the cut slope. A sensitivity analysis was also carried out with respect to the position of the groundwater table by assuming a phreatic surface at a higher elevation. Surficial failures on the slope such as sloughing or localized erosion were not considered in our analyses, but rather only relatively deep seated failures such as failures extending to the roadway or within the slopes.

Based on the borehole information, the following, the soil parameters were adopted in the analysis.

Table 5.9: Soil Parameters Used for Slope Stability Analyses – Cut Area 1

Soil Type	Unit Weight (kN/m ³)	Undrained Cohesion, c (kPa)	Undrained Friction Angle, ϕ (degrees)	Drained Cohesion, c' (kPa)	Drained Friction Angle, ϕ' (degrees)
New pavement fill	20.5	0	31	0	31
Existing fill – Sand	20.0	0	30	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36	0	36

The results of the analyses are shown on Figures G6-1 to G6-14 in Appendix G.

The following table presents the slope options from 2H:1V to 3H:1V and the corresponding results of the analyses (i.e. calculated factor of safety) and the advantages and disadvantages for using the specified slope.

Table 5.10: Summary of Slope Stability Analyses

Slope Option	Factor of Safety (FOS)	Comments
2H:1V – no bench	1.4 – 1.7	<p>The 2H:1V slope appears to be generally stable, except at the condition of high water table. However, based on our experience with similar till deposits, relatively high 2H:1V cut slopes show signs of instability after some years, that may be due to creep, frost action, etc. As well, groundwater may rise due to unusually inclement weather conditions.</p> <p>The RFP indicated that 2H:1V slopes are prone to erosion and issues with catchments on top of cuts concentrating flows and perched water table causing localized scour holes. This approach deviates from MTO protocol to bench every 6 m high.</p>
2H:1V either 1 or 2 benches	1.4 – 1.9	<p>Advantages</p> <ul style="list-style-type: none"> • Theoretically stable. • Easier slope maintenance in comparison with no bench. • Follows the MTO protocol – bench every 6 m high. <p>Disadvantages</p> <ul style="list-style-type: none"> • More property to be acquired compared to the above option. • More excavation compared to the above option. • May exhibit signs of instability in the long-run, a characteristics of till cut slopes
2.25H:1V – 1 bench	1.5 – 1.9	<p>Advantages</p> <ul style="list-style-type: none"> • More stable compared to the 2H:1V no bench option. • Easier slope maintenance. • Follows the MTO protocol – bench every 6 m high. <p>Disadvantages</p> <ul style="list-style-type: none"> • More property to be acquired compared to the similar options as above. • More excavation required compared to the similar options as above.

Slope Option	Factor of Safety (FOS)	Comments
2.5H:1V – no bench	1.5 – 1.9	<p>Advantages</p> <ul style="list-style-type: none"> • More stable compared to the above no bench options. • Not likely prone to erosion compared to the above no bench options. • Easier slope maintenance compared to the above no bench options. <p>Disadvantages</p> <ul style="list-style-type: none"> • More property to be acquired compared to above options. • Requires the more excavation compared to above options. • Deviates from MTO protocol to bench every 6 m high.
2.5H:1V – 1 bench	1.5 – 2.1	<p>Advantages</p> <ul style="list-style-type: none"> • More stable compared to the above options. • Easier slope maintenance. • Unlikely to be adversely affected by creep, frost etc. <p>Disadvantages</p> <ul style="list-style-type: none"> • More property to be acquired compared to the above options. • More excavation required compared to the above options. • For slopes in excess of 12 m in height deviates from MTO protocol of two benches.
3H:1V – no bench	1.5 – 2.3	<p>Advantages</p> <ul style="list-style-type: none"> • More stable compared to the above no bench options. • Not likely prone to erosion. • Easier slope maintenance. <p>Disadvantages</p> <ul style="list-style-type: none"> • Requires the most property to be acquired compared to all other options. • Requires the most excavation compared to all other options.

The results indicated calculated factor of safety (FOS) values ranging from 1.4 to 2.3 against global/regional instability for the analyzed slope options.

Based on the results, the 2H:1V slope appears to be generally stable. However, as indicated in our comments above for 2H:1V slope option, relatively high 2H:1V cut slopes (i.e. in excess of 6 m) tend to display instability with the passage of time.

From a geotechnical point of view, the recommended option for slope 7 to 12 m in height, 2.25H:1V side slopes with one mid-height bench is considered sufficient with proper drainage measures below the mid-height bench. At the mid-height bench and above, prompt vegetation establishment as per OPSS571 or 572 is considered sufficient, based on findings of the boreholes. For slopes between 12 m to 14.5 m in height, we recommended that the slope be flattered to 2.5H:1V, but in our opinion, one mid-height bench would be sufficient, from a geotechnical and practical point of view.

Based on the above, the following are the recommended slope configurations.

Table 5.11: Recommended Cut Slopes – Cut Area 1

Height of Slope	Recommended Slope
7.0 to 12.0 m	2.25H:1V with mid-height bench, filters and riprap protection below mid-height bench*
12.0 to 14.5 m	2.5H:1V with mid-height bench, filters and riprap protection below mid-height bench**

Note: * see Figures I-1/I-3 in appendix I.

** see Figure I-2/I-4 in Appendix I.

To accommodate the proposed highway widening, additional land acquisition is required for the cut slopes in some sections even if 2H:1V slope configuration without any bench is selected. The cost of the land in this rural area along Highway 401 is relatively inexpensive as well, material excavated from flatter cuts can probably be used in other parts of this contract. It is therefore our opinion that flattening slopes beyond the normal 2H:1V side slope, along this corridor of this major highway, which is very important for the economy of the Province, is justified for long term stability of the cut slopes. However, final decision regarding this aspect should be made by the designer based on a benefit/cost/risk analyses.

5.3.3 Construction

The construction of the proposed cut will involve excavation onto the existing cut face. Based on the borehole information, the excavations are anticipated to be through the topsoil and the typically very dense silty sand to sandy silt till. A hydraulic excavator should be adequate for excavation in topsoil and till. Contractors should be notified of the possible presence of cobbles and boulders within the till.

The excavation of this new cut slope may extend several meters away (depending on the height of the proposed cut) behind the crest of the existing slope. As discussed above, the construction of the recommended slope geometry (i.e. inclusion of mid height bench) may extend beyond the present property line and this matter needs to be addressed prior to construction.

The groundwater readings from the piezometers installed at the crest and toe of the existing cut indicated that at the time of our investigation, the groundwater was below the toe of the existing cut. However, the construction of the new cut extends below the toe of the existing cut and excavations may take place below the groundwater level. Dewatering such as pumping from filtered sumps may therefore need to be implemented to facilitate construction. If these measures do not appear to be effective, additional measures such as vacuum well points may be required.

We recommend that erosion protection measures, including proper drainage and the riprap, be installed for the new cut slope as discussed in Section 5.3.1. The placement of filter materials should be carried out without causing the segregation of the coarser particles.

We also recommend that no additional loading such as stockpiles, heavy machinery or any surcharge loads be present near the crest of the slope during construction. An NSSP should be issued to alert the Contractor of this issue, as presented in Appendix K.

The excavated soils free from topsoil and organics can be used as general construction backfill (e.g. for flattening slopes beyond 2H:1V configurations) for the fill section of the project where they can be compacted with smooth drum or pad-foot type rollers, depending on the nature of the soil. The loose lifts should not exceed 300 mm when first placed. On site verification of the excavated fill for re-use as backfill by a suitably qualified personnel during construction would be required. The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used. Note that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should therefore be compacted at the surface or be covered with tarpaulins to help minimize moisture uptake.

6 CLOSURE

The "Limitations of Report" as presented in Appendix K are integral part of the report.

For and on behalf of Coffey Geotechnics Inc.


for **Delfa Sarabia, M.Eng.**

Senior Geotechnical Engineer


Ramon Miranda, P.Eng.

Principal



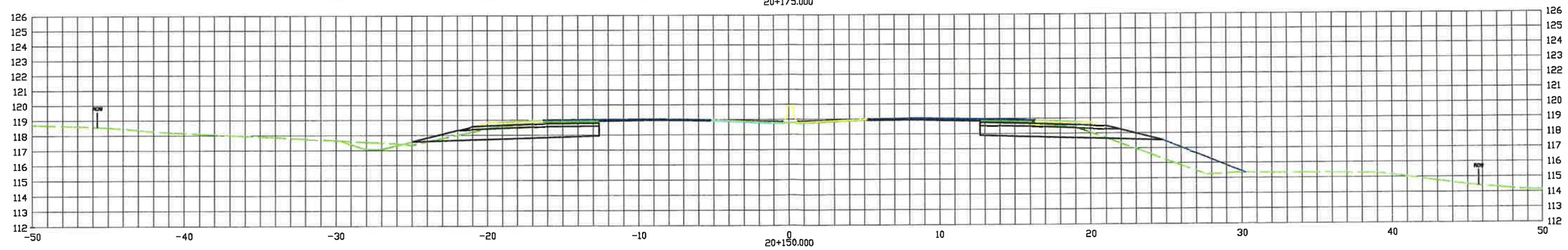
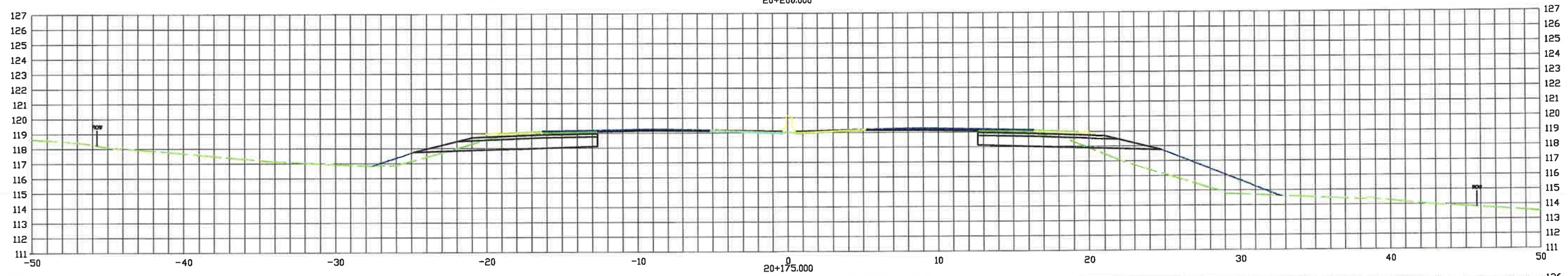
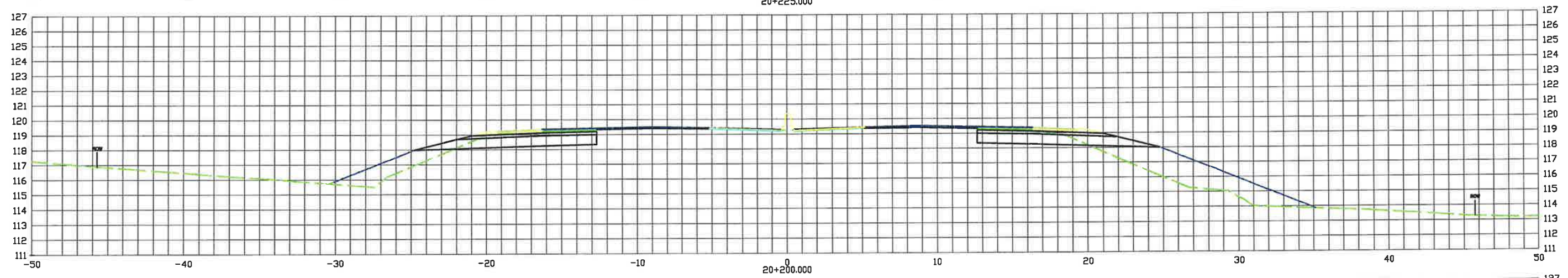
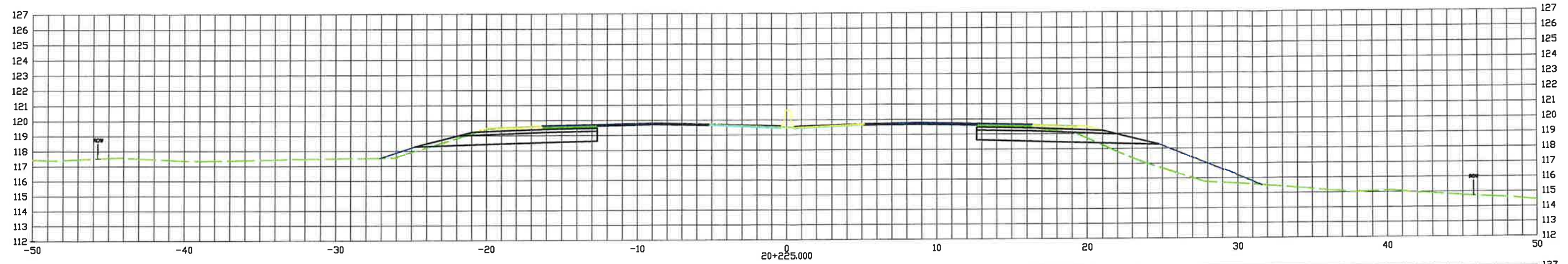

Zuhtu Ozden, P.Eng.

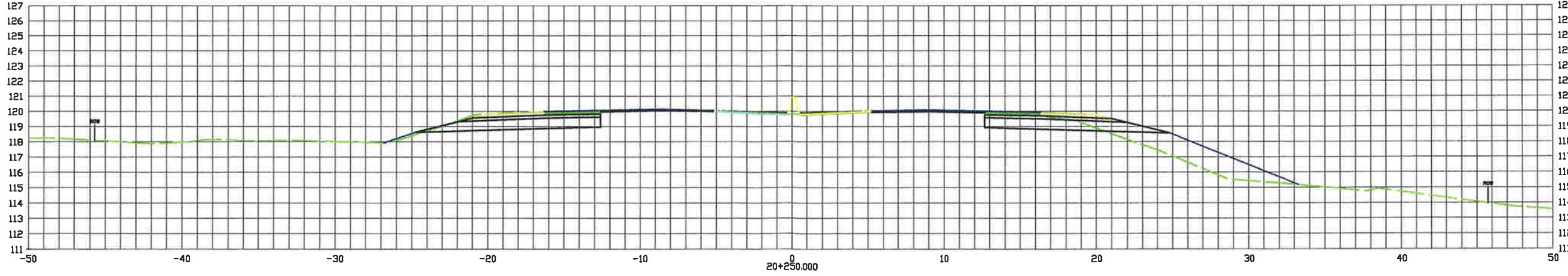
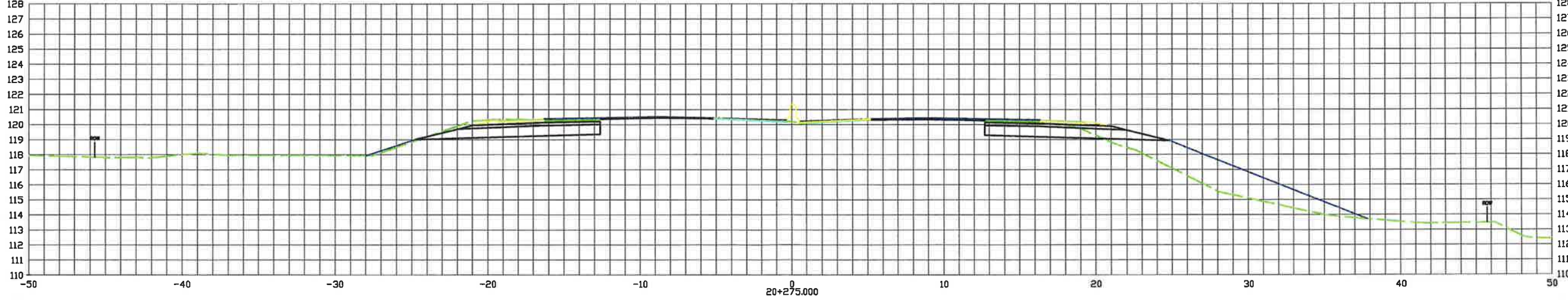
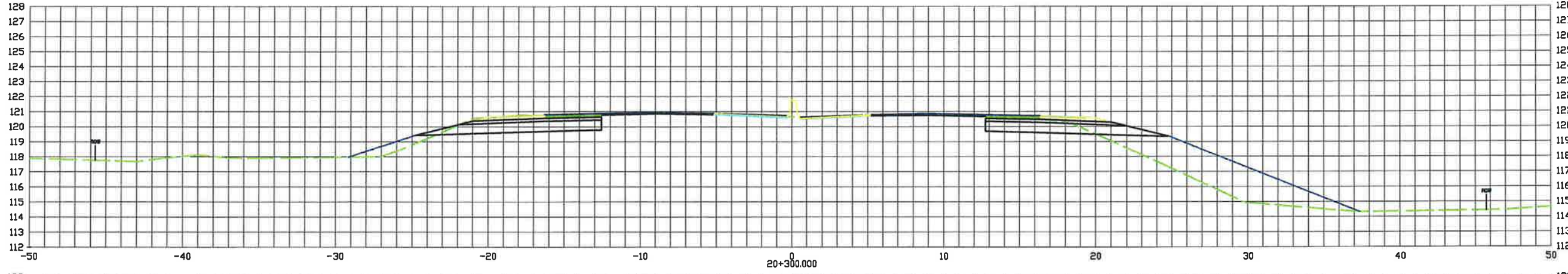
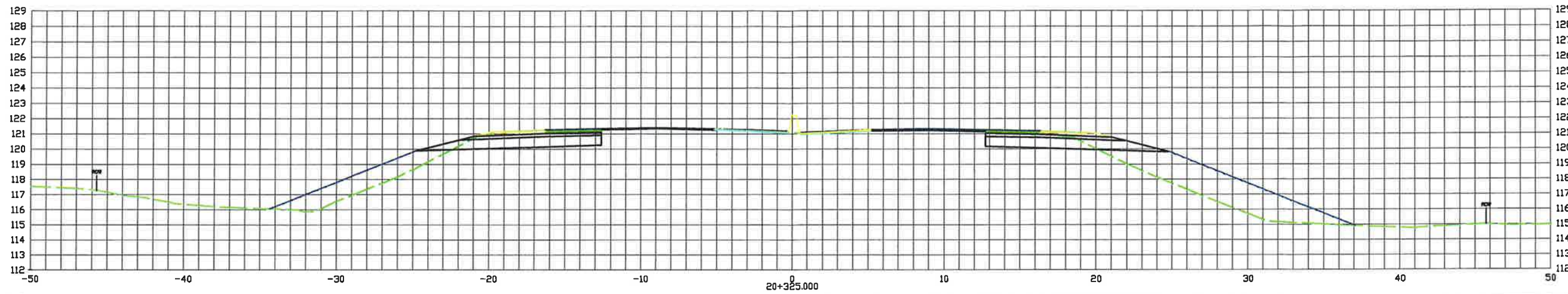
Senior Principal

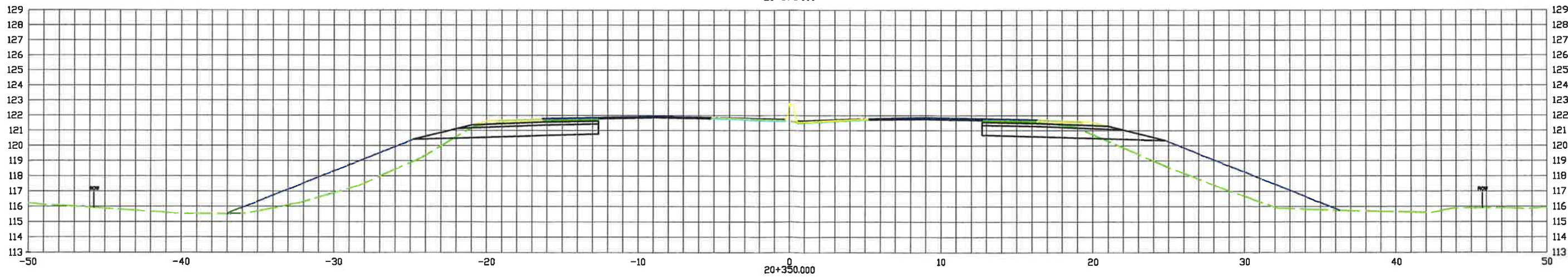
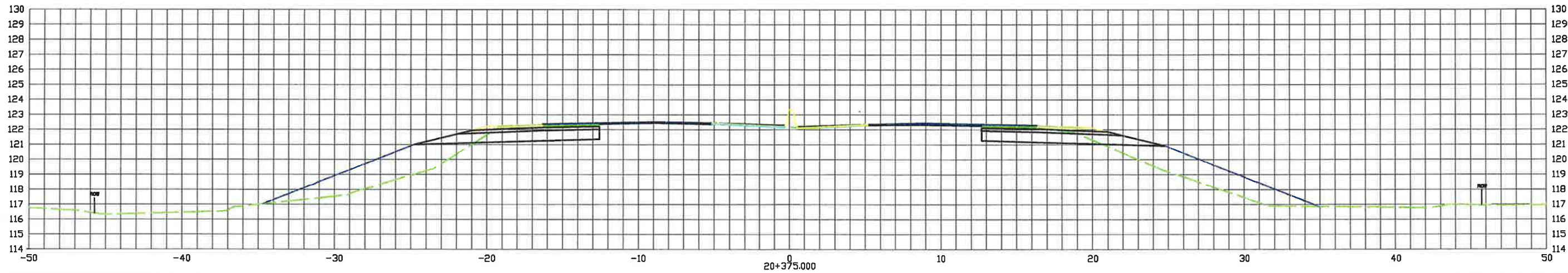
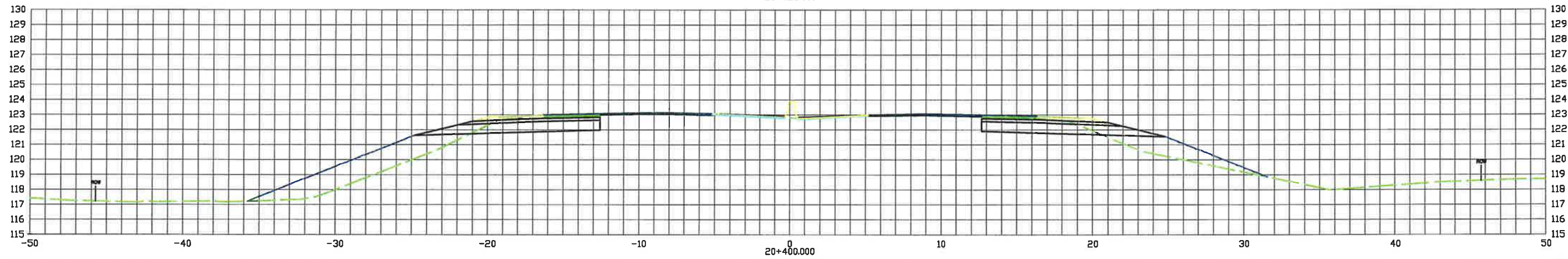
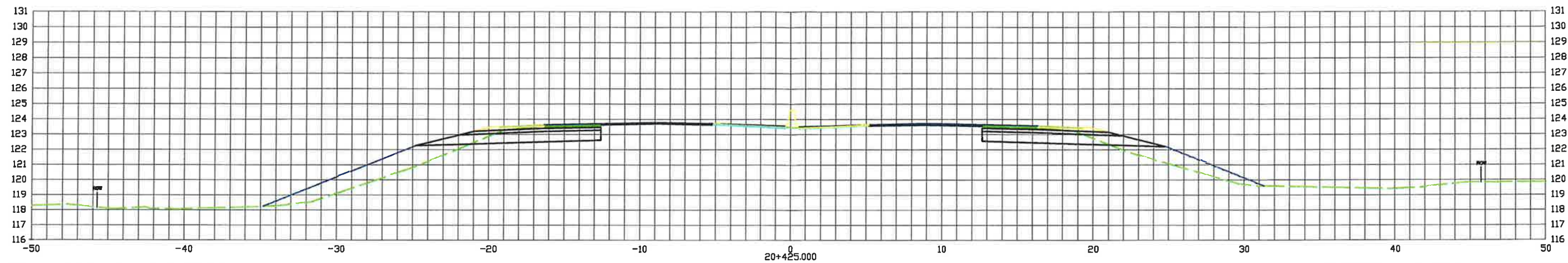


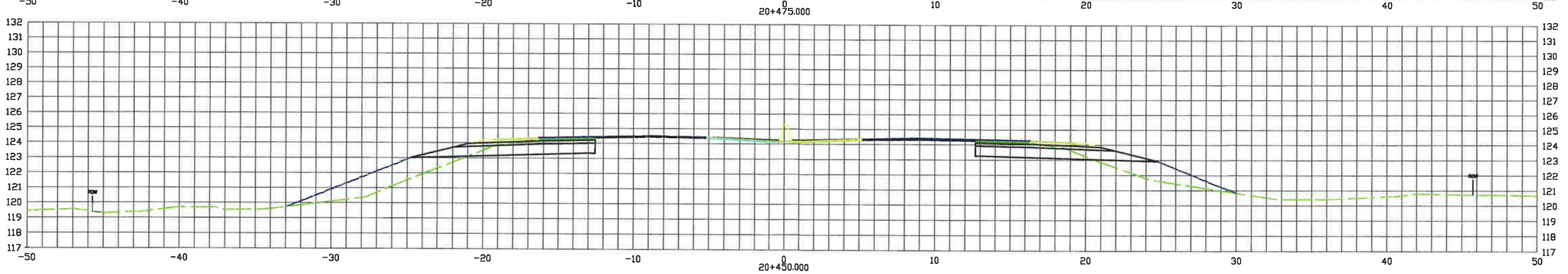
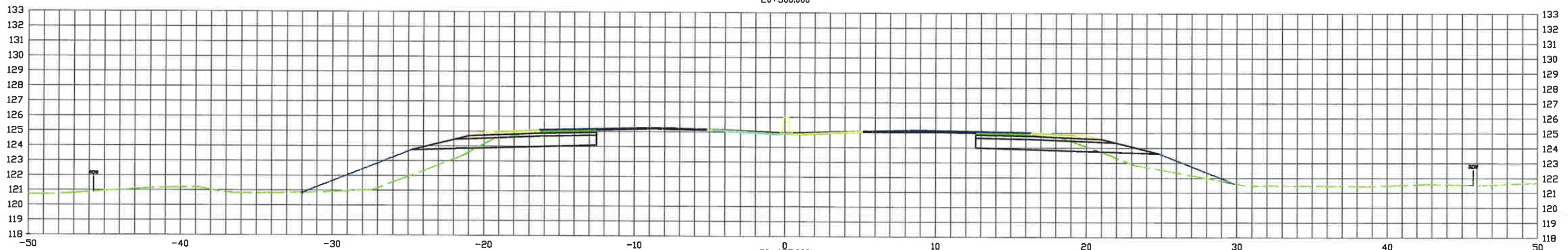
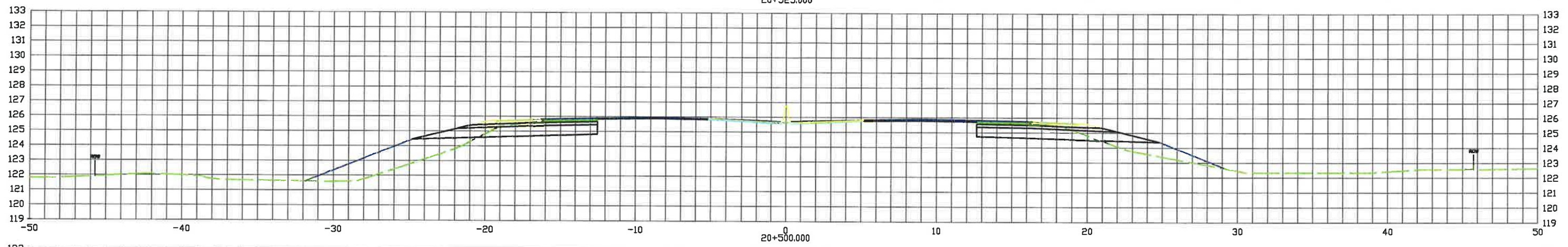
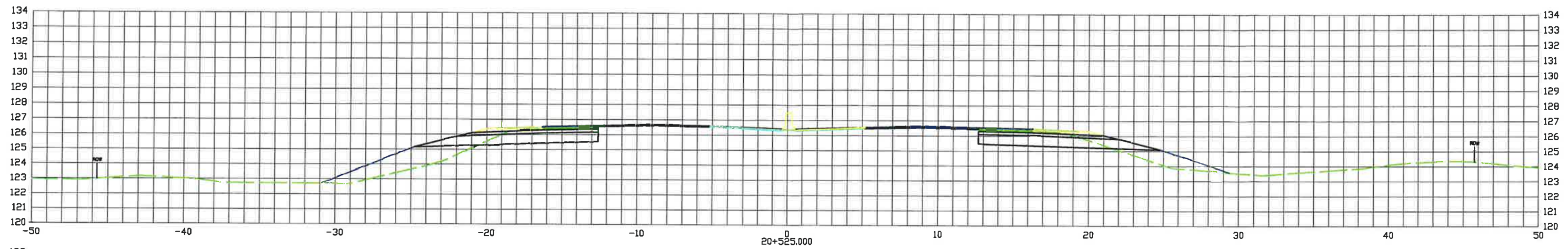
Appendix F

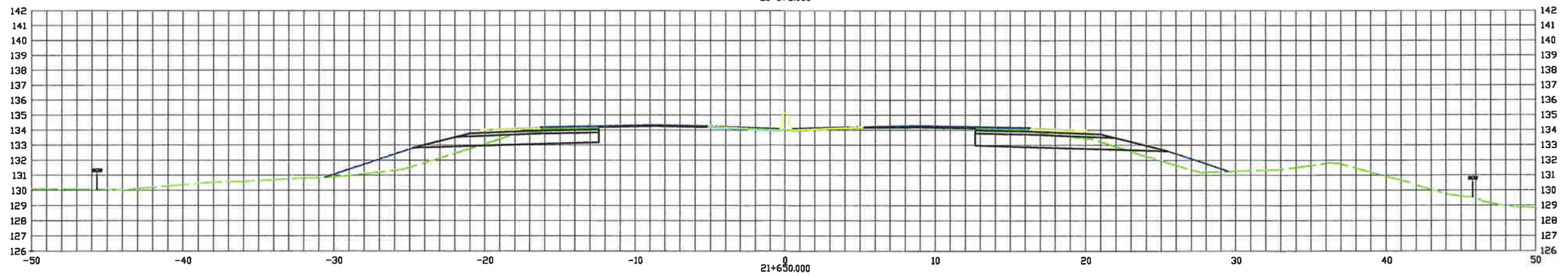
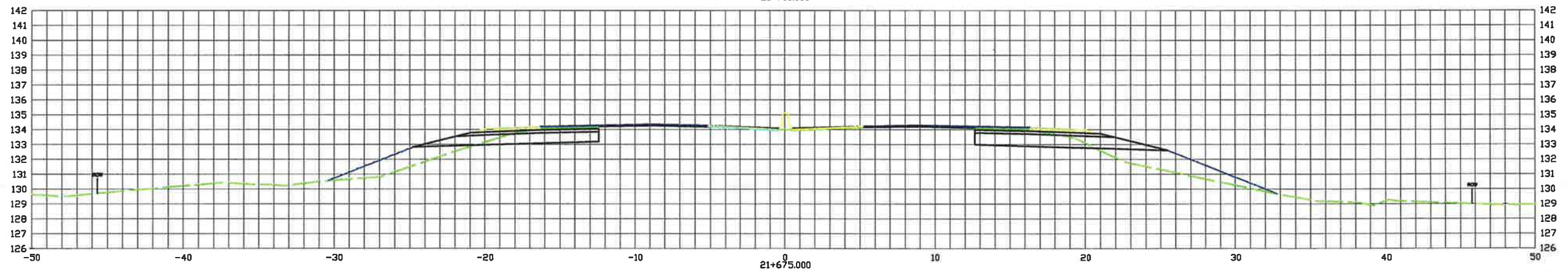
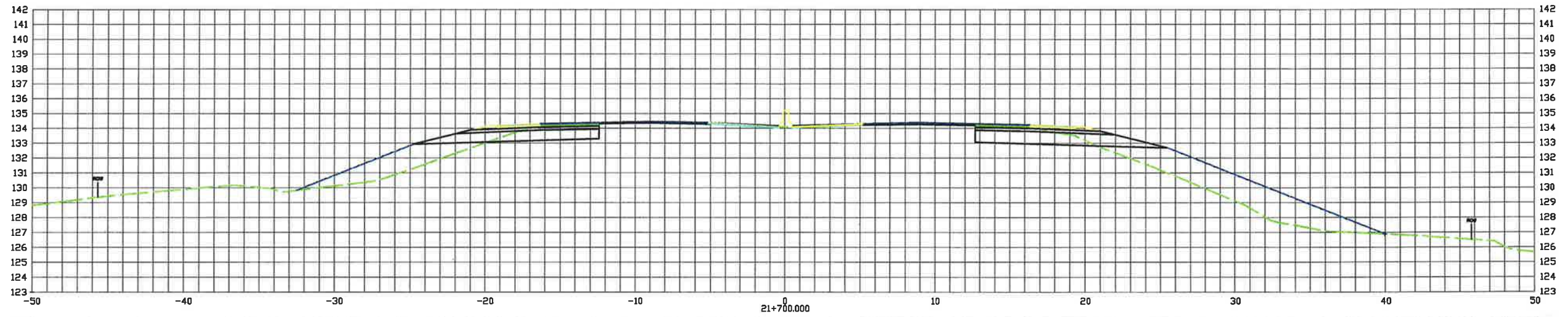
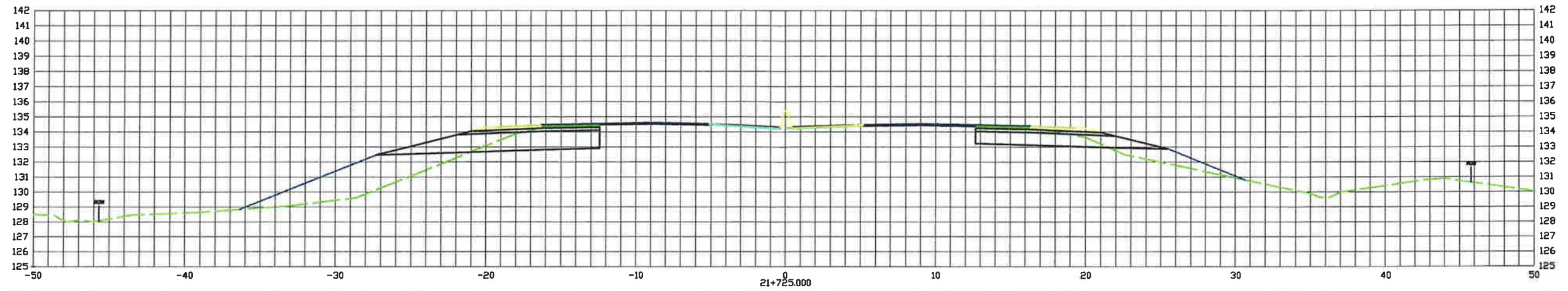
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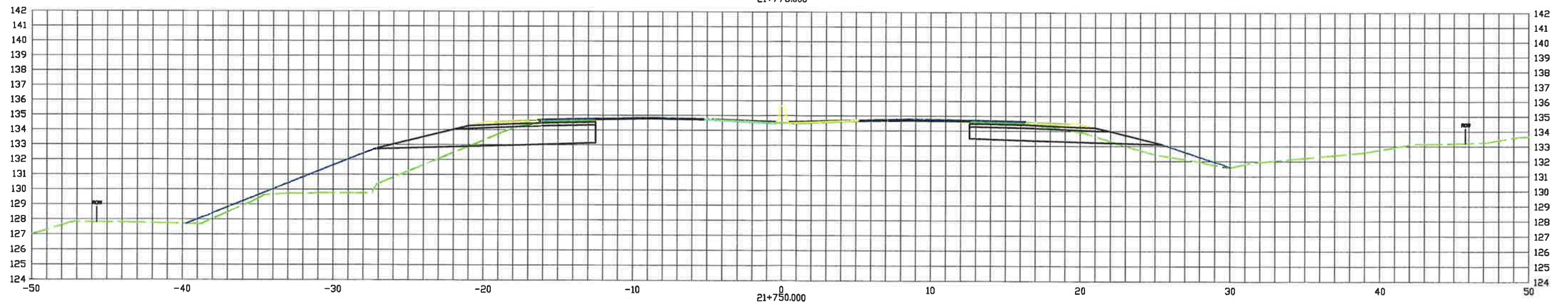
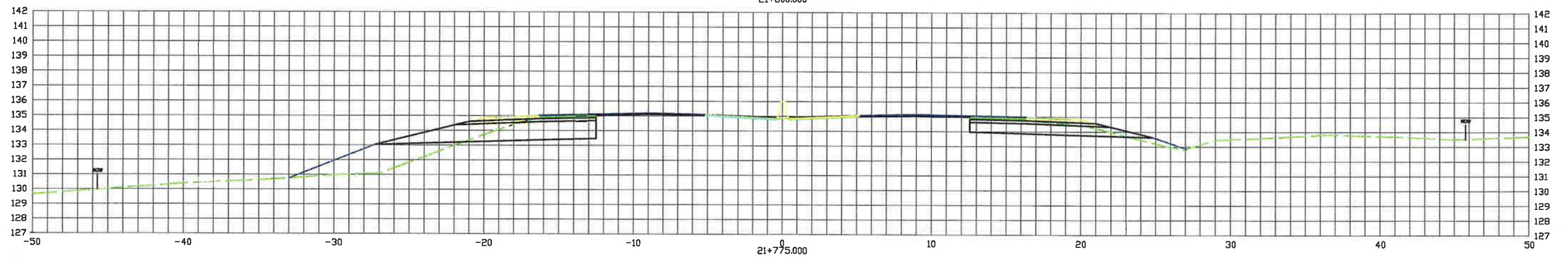
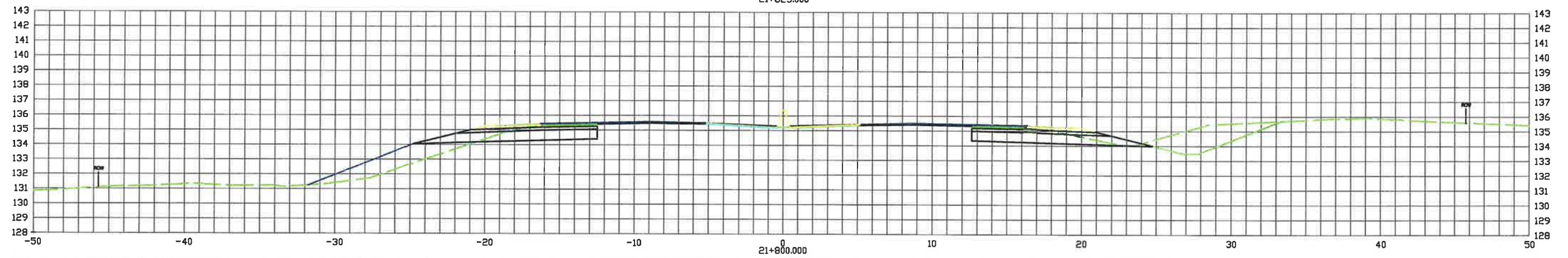
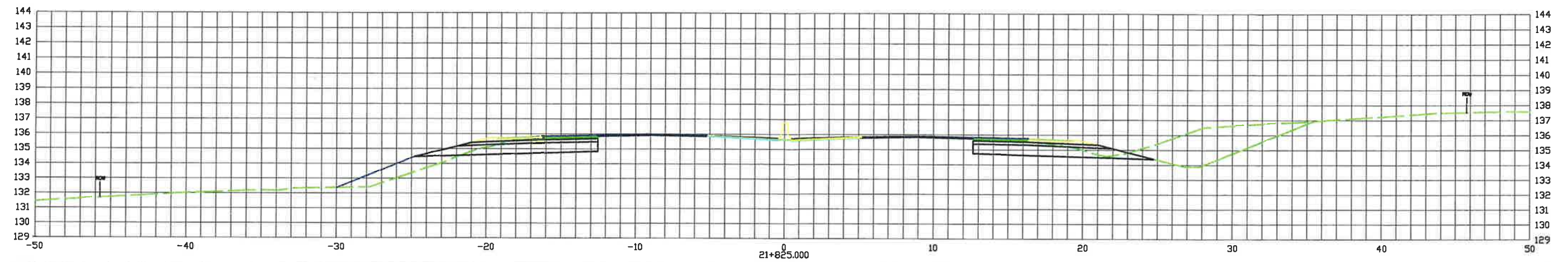


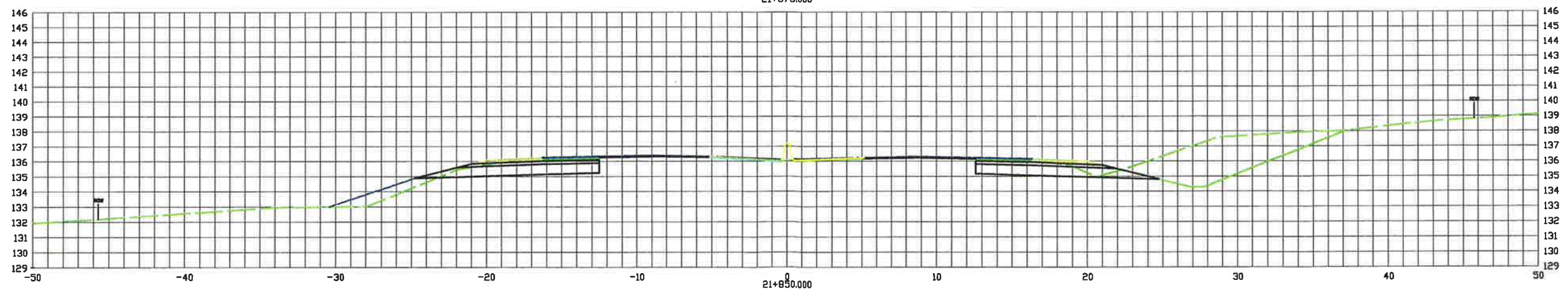
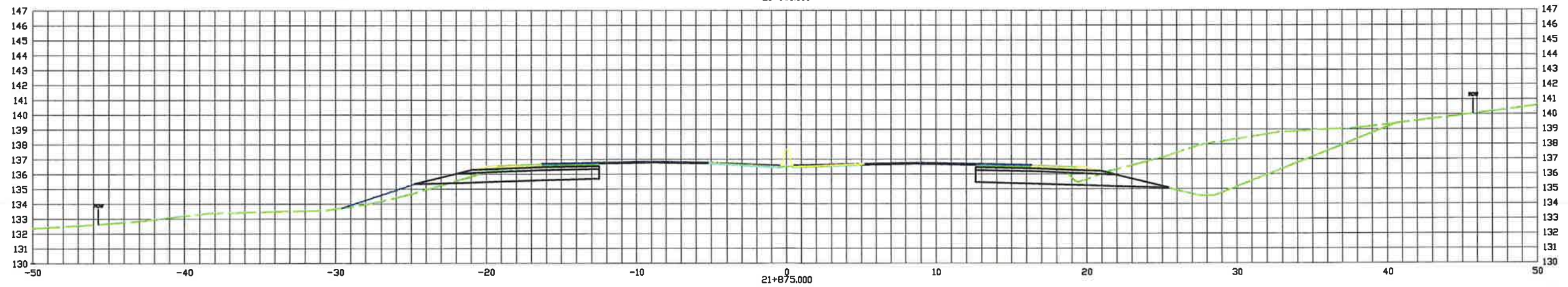
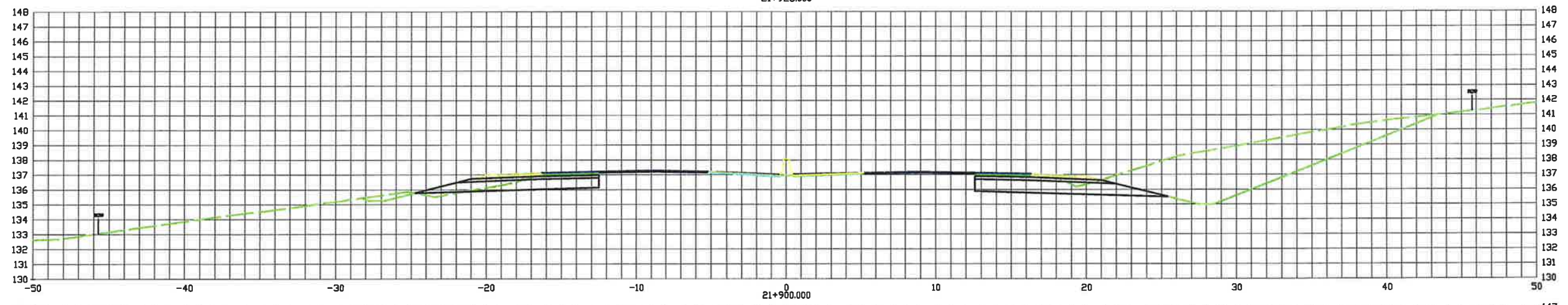
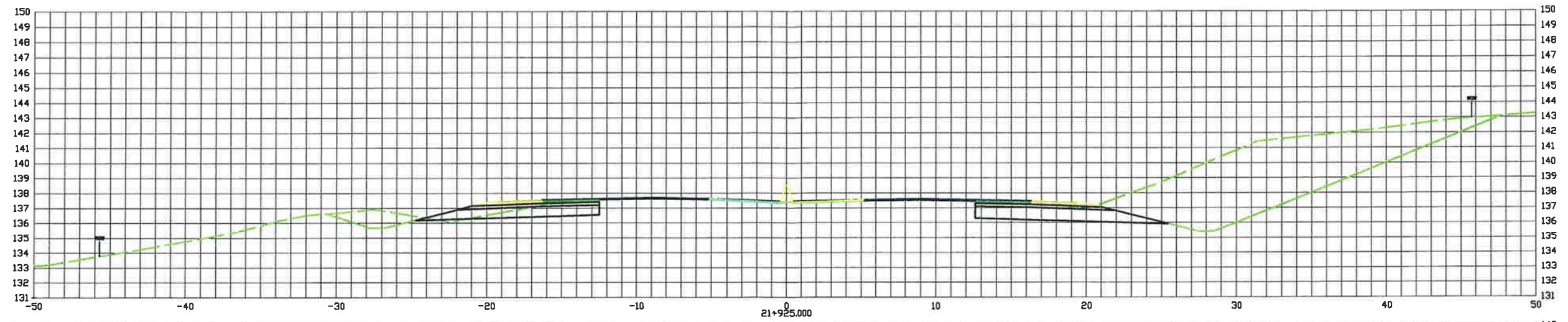


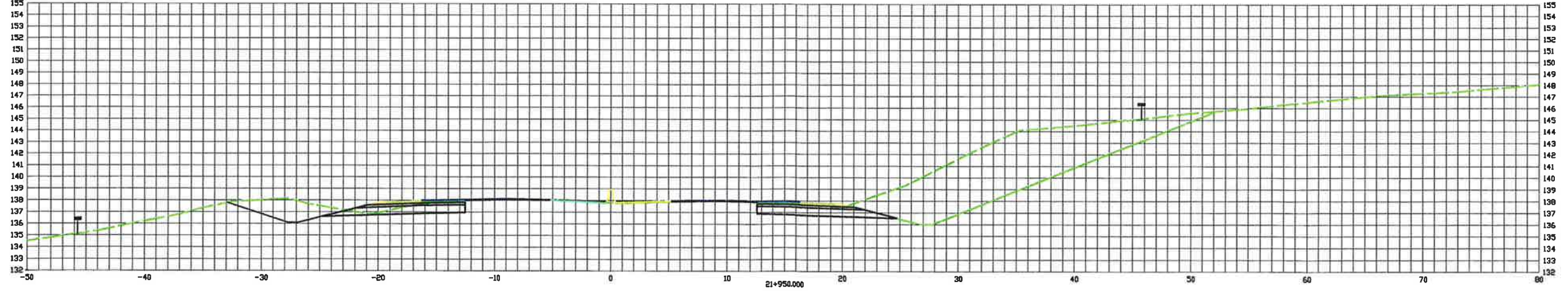
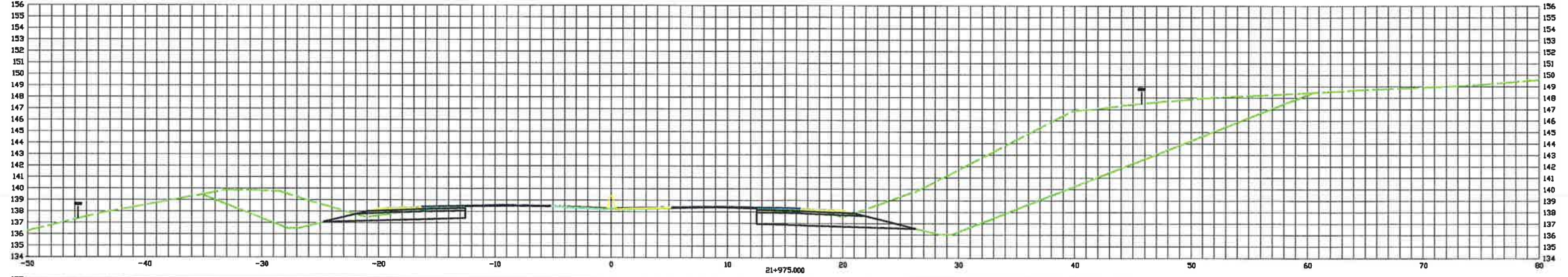
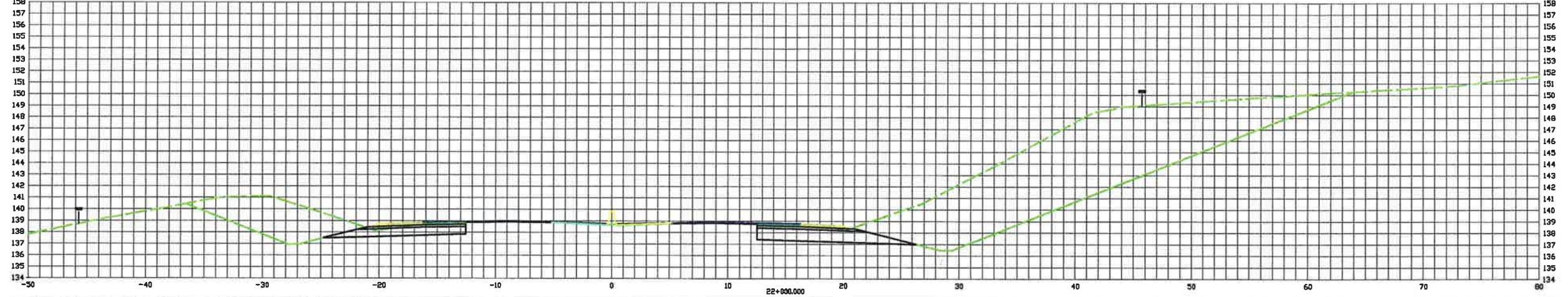
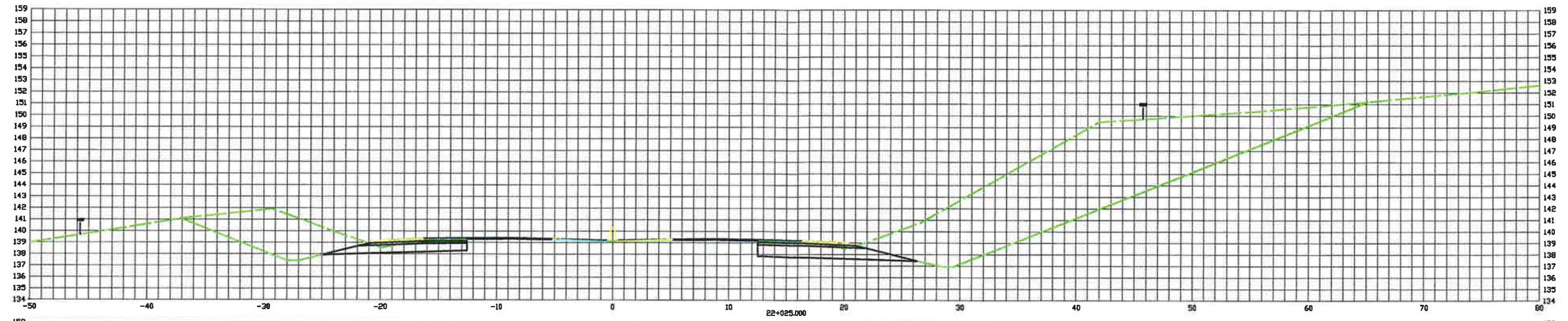


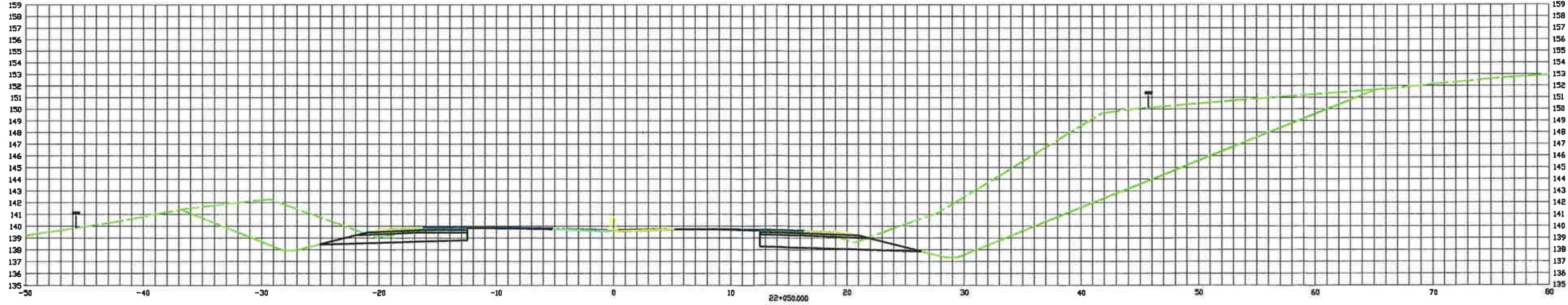
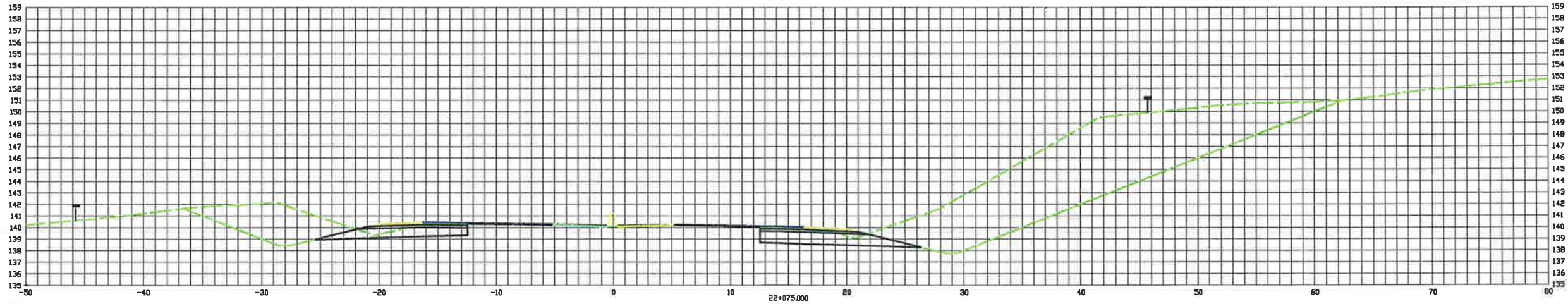
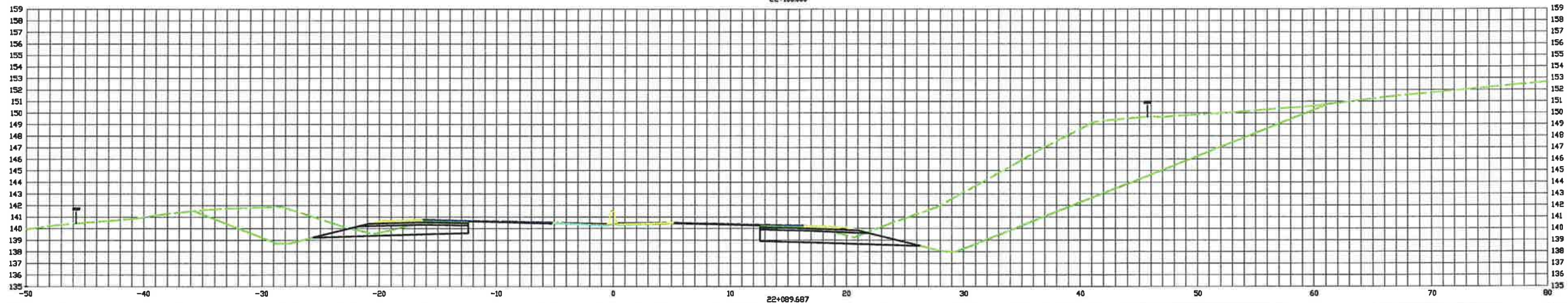
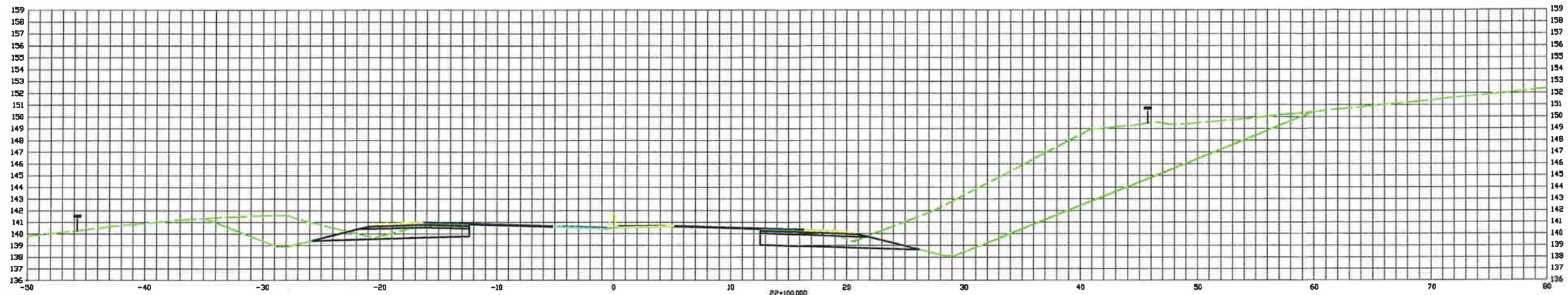


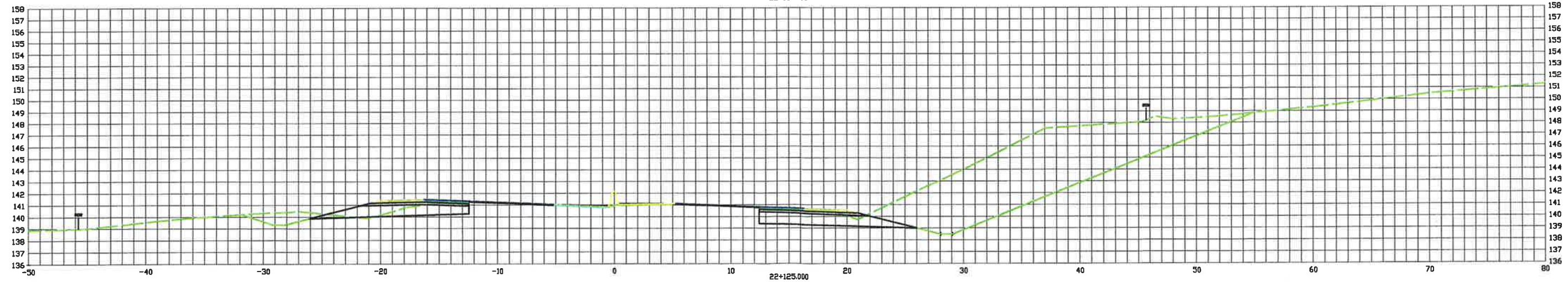
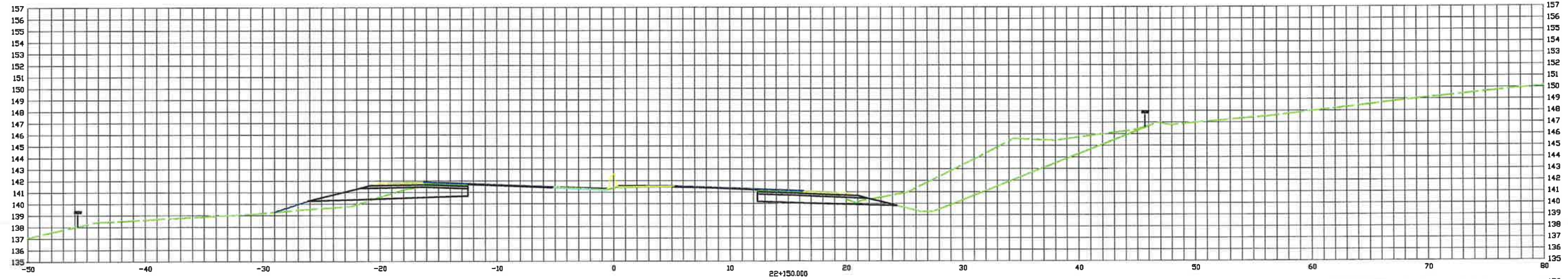
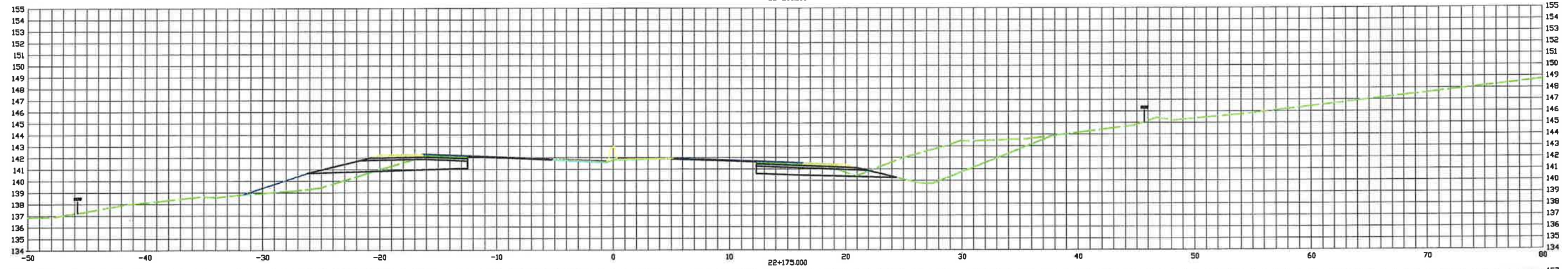
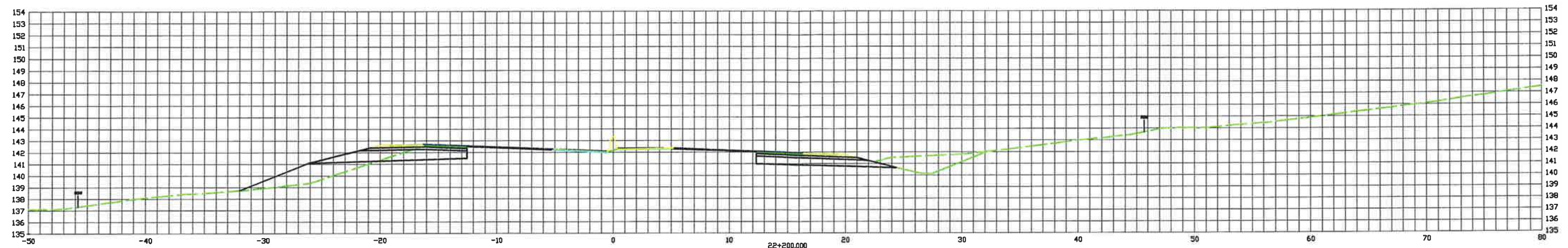


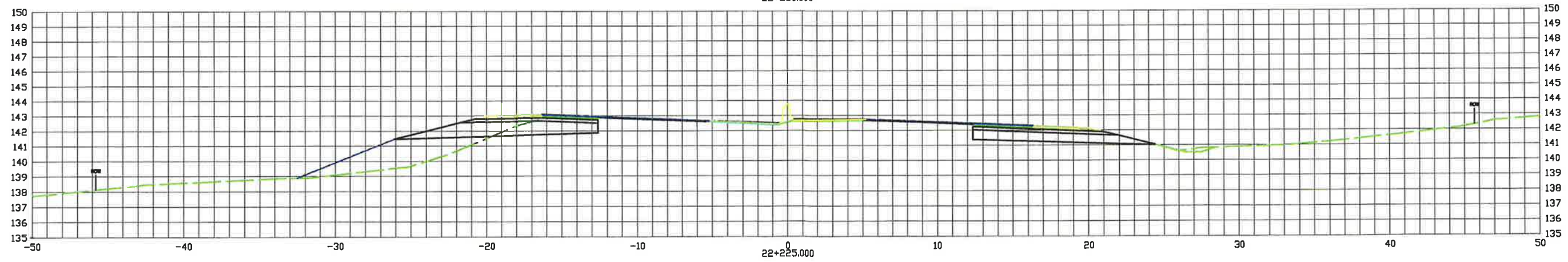
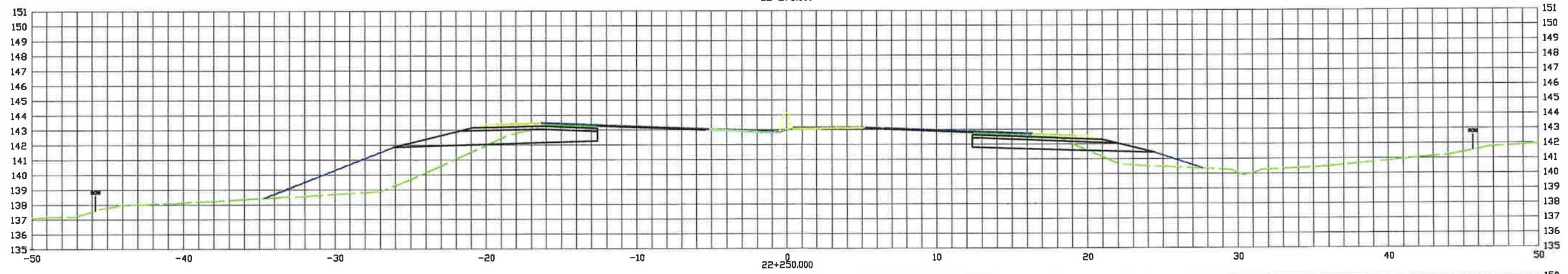
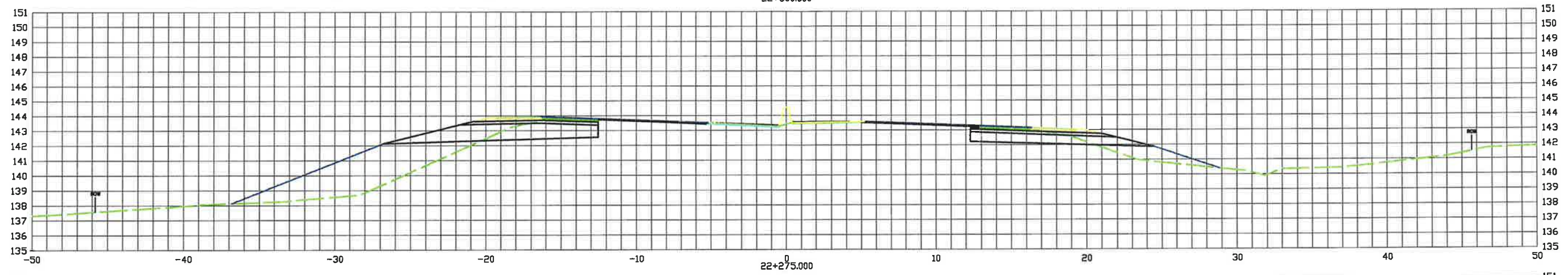
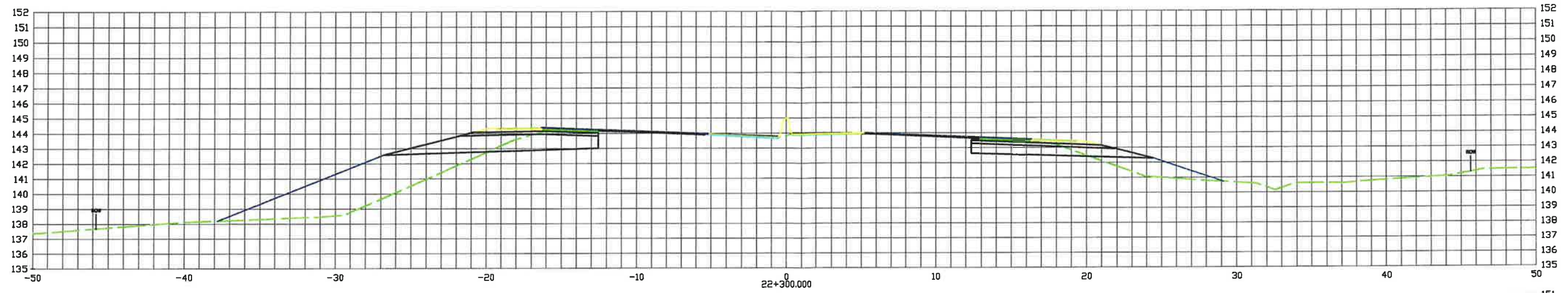


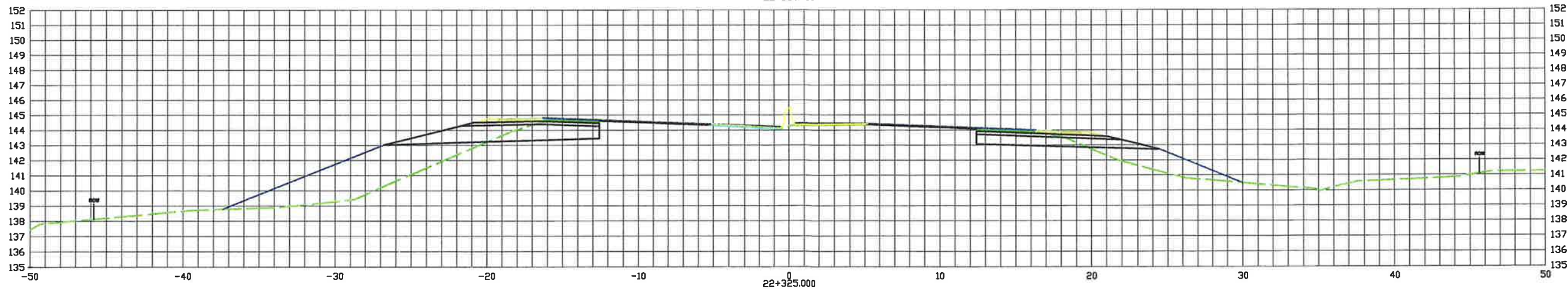
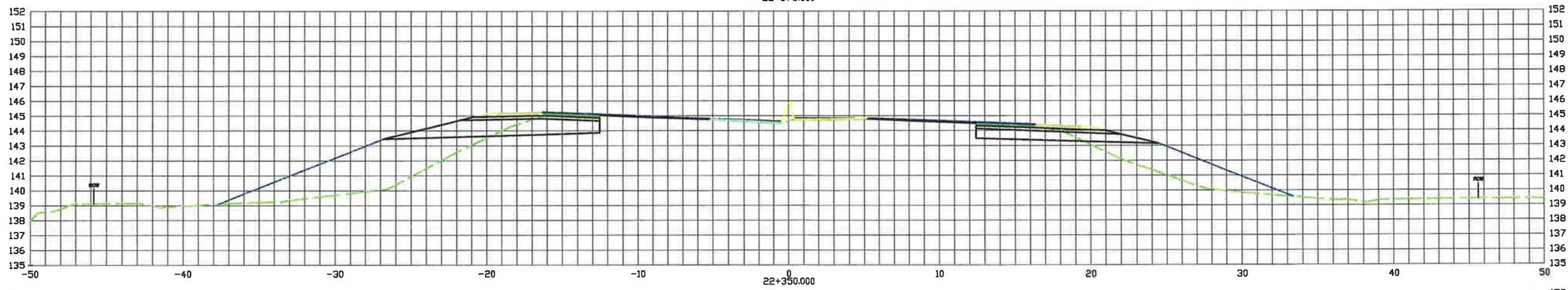
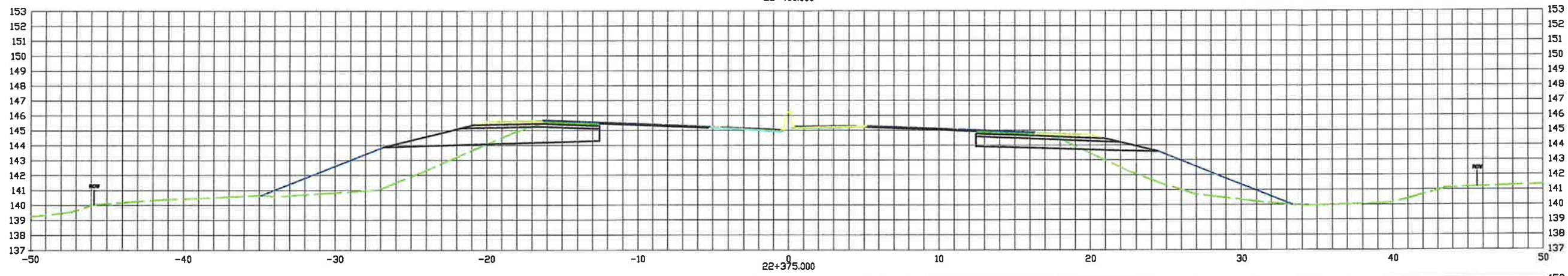
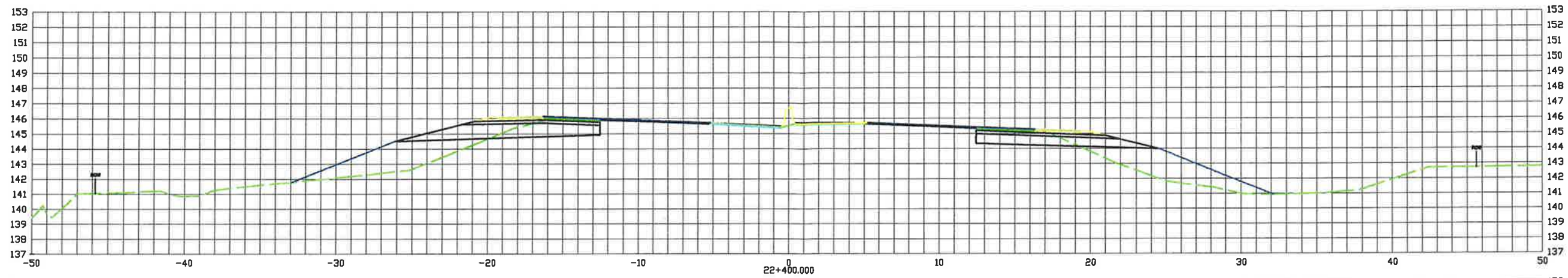






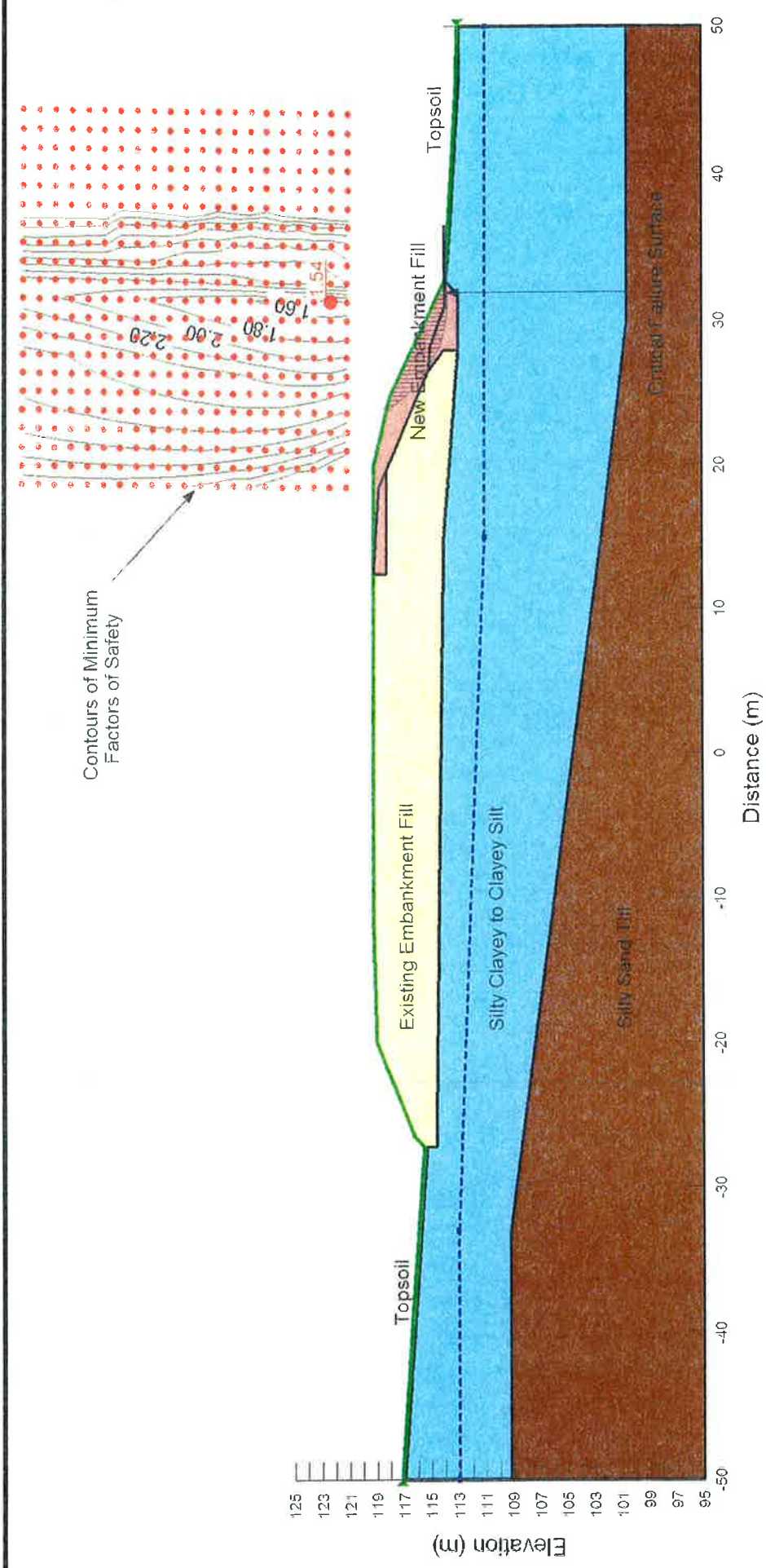






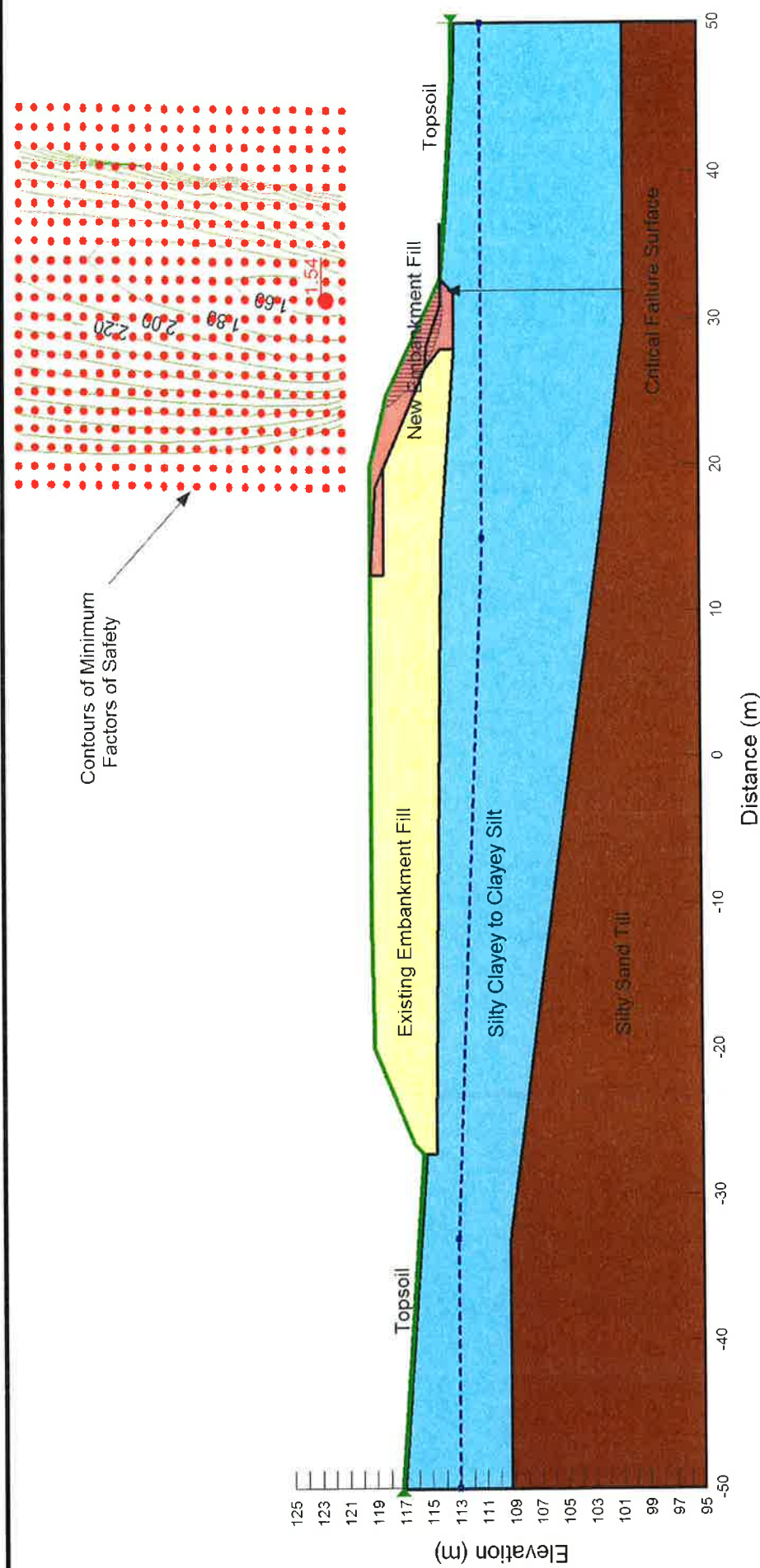
Appendix G

Results of Slope Stability Analyses



Section : Sta. 20+200 EB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	20 - 50	0
Silty Sand Till	22.0	0	34



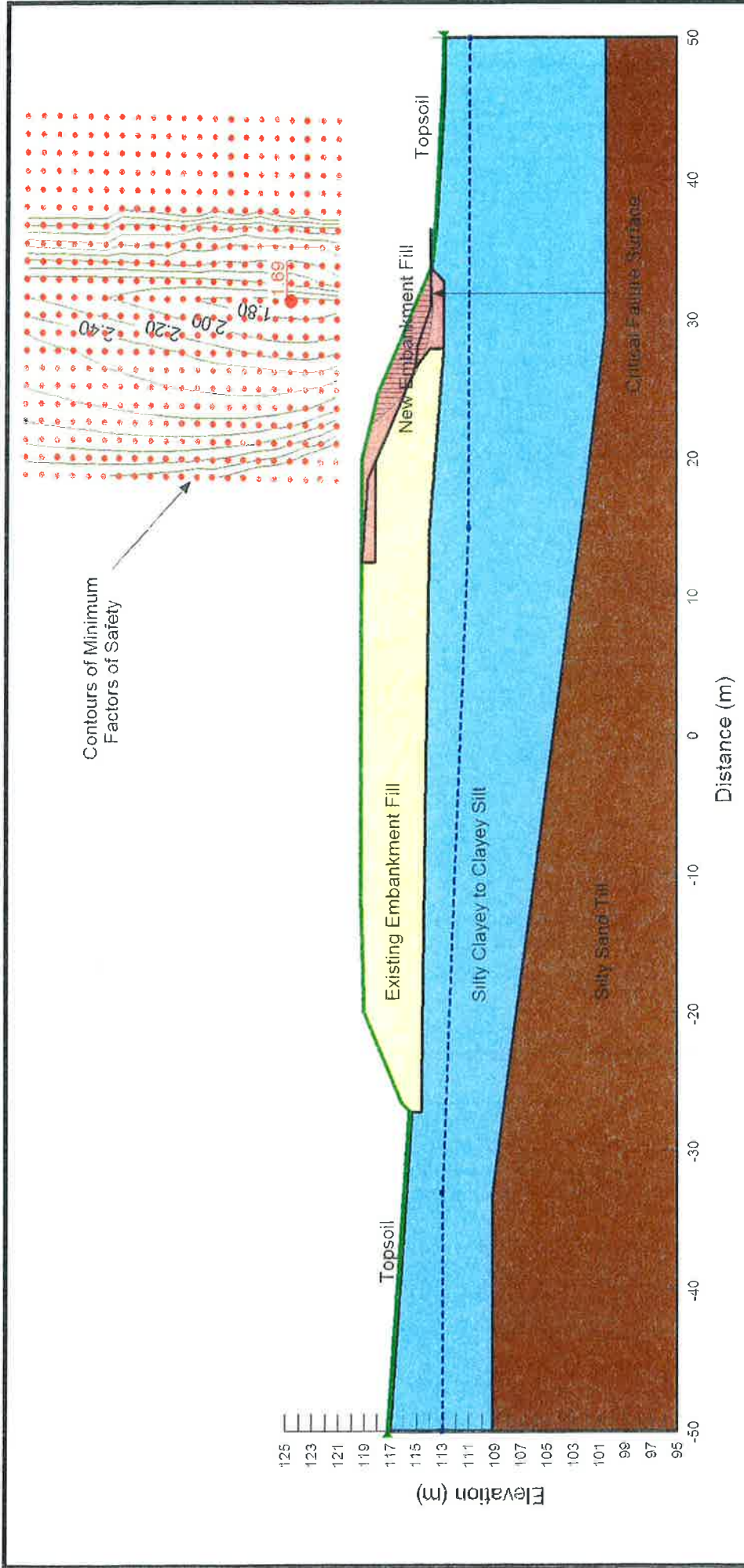
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 Condition : Drained
 Method : Morgenstern - Price

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New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS
 Embankment Fill Area 1

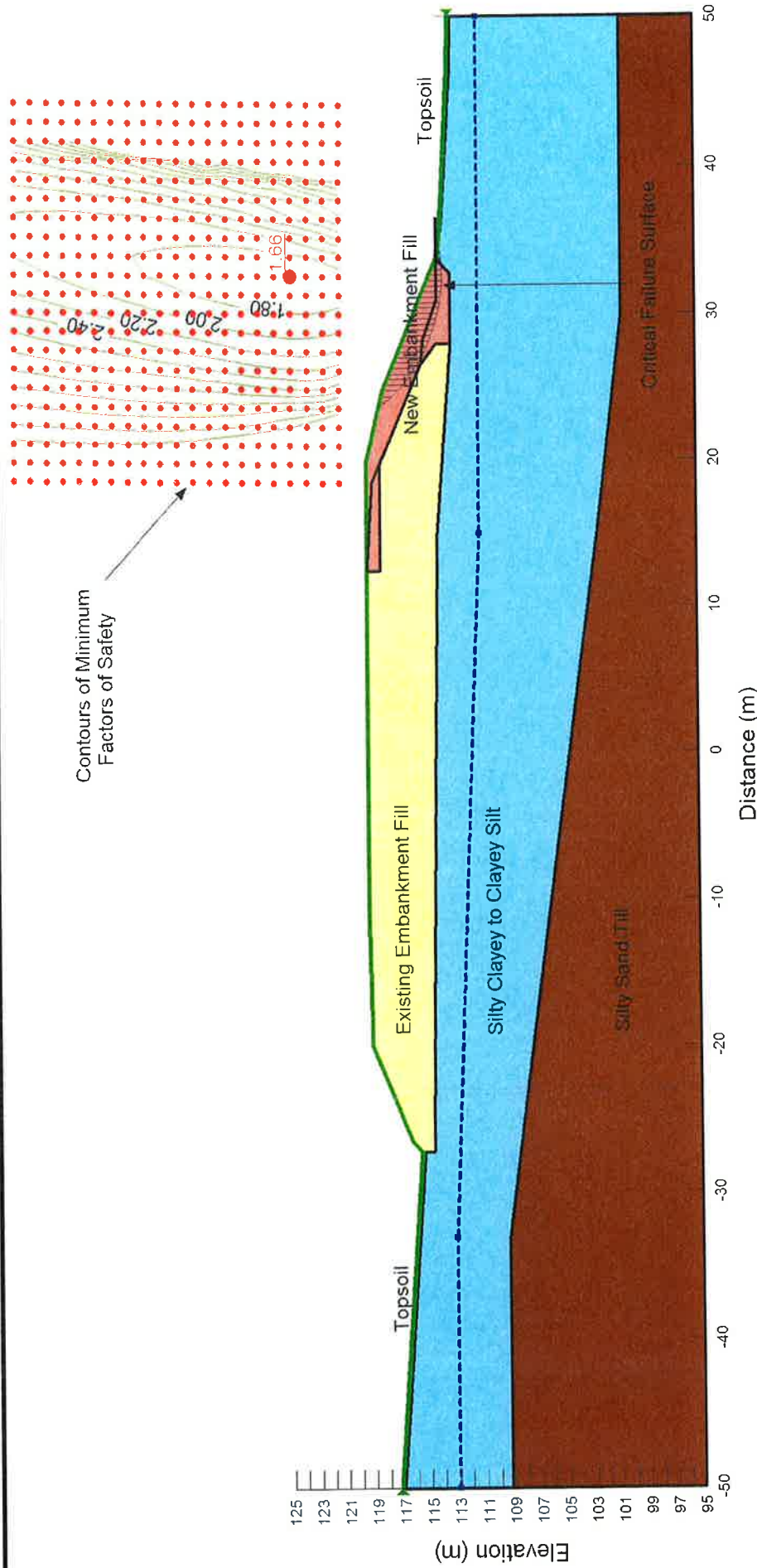
SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012	FIGURE G1-2
DESIGN:	HW	REVIEW:	ZO	
Highway 401 Expansion				



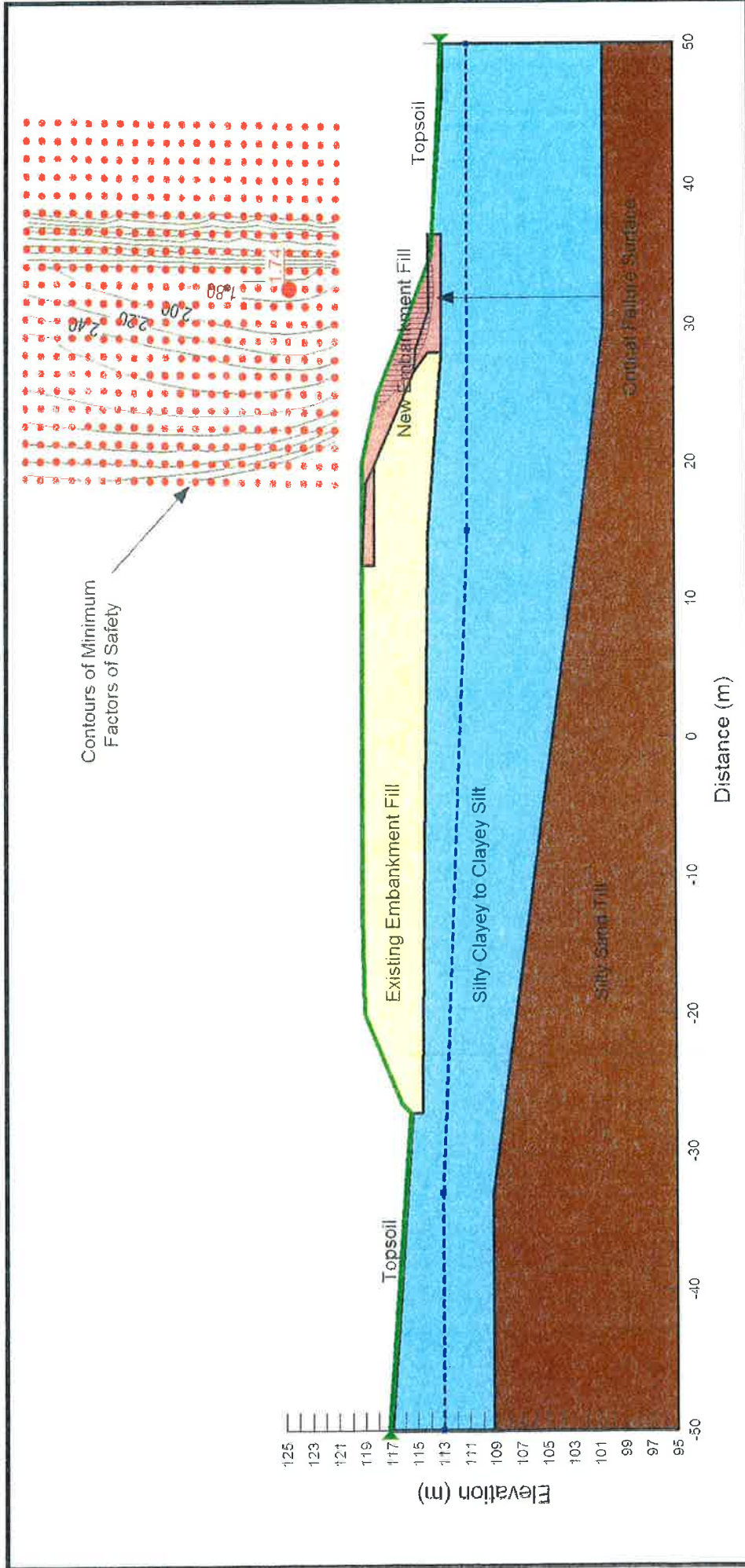
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 Slope : 2.25H:1V
 Condition : Undrained
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Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	20 - 50	0
Silty Sand Till	22.0	0	34



Section : Sta. 20+200 EB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
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Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	34

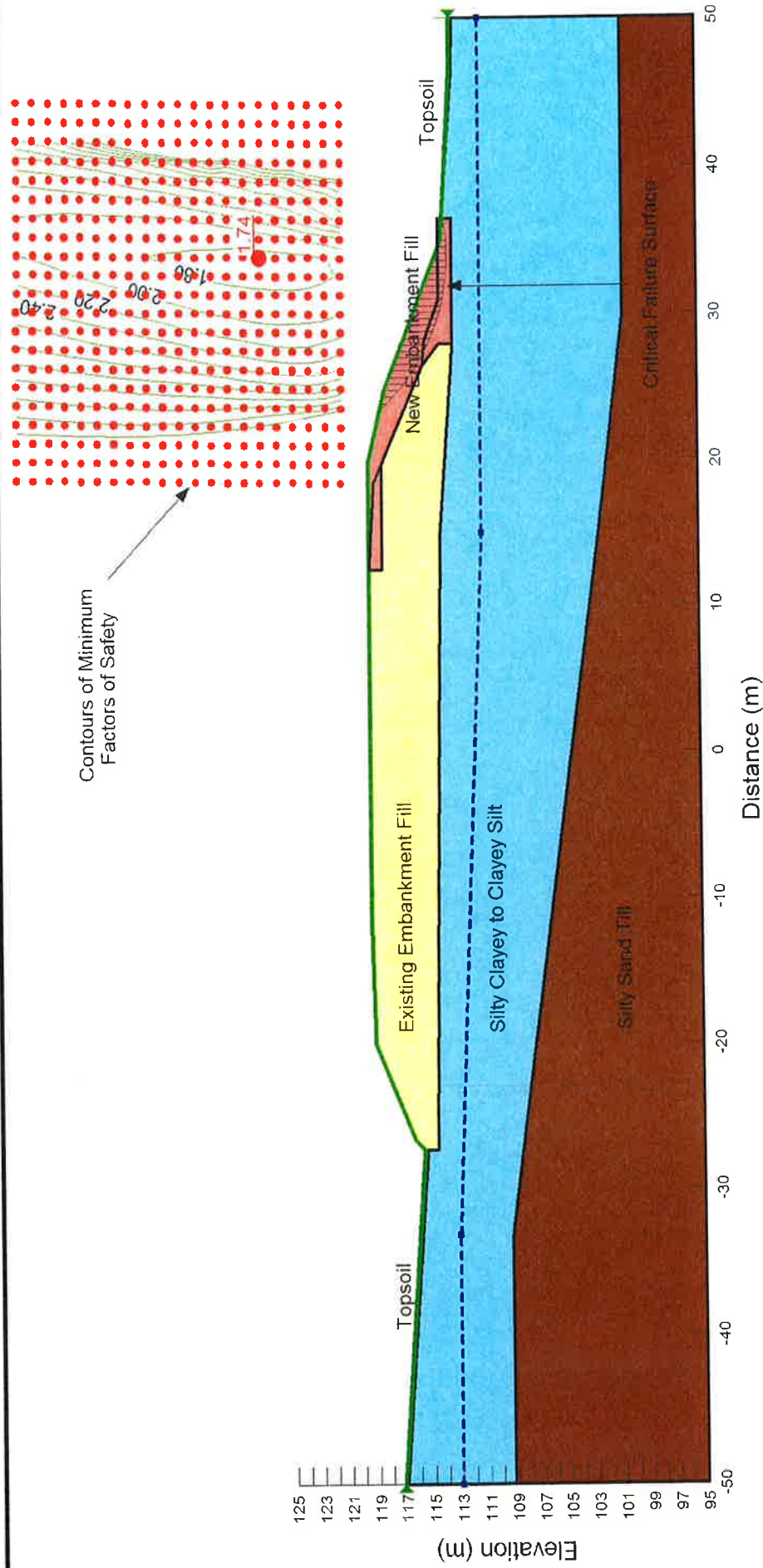


Section : Sta. 20+200 EB
 Slope : 3.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

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Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	20 - 50	0
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 1



Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
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Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	34

Section : Sta. 20+200 EB
 Slope : 3.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

STATIC SLOPE STABILITY ANALYSIS

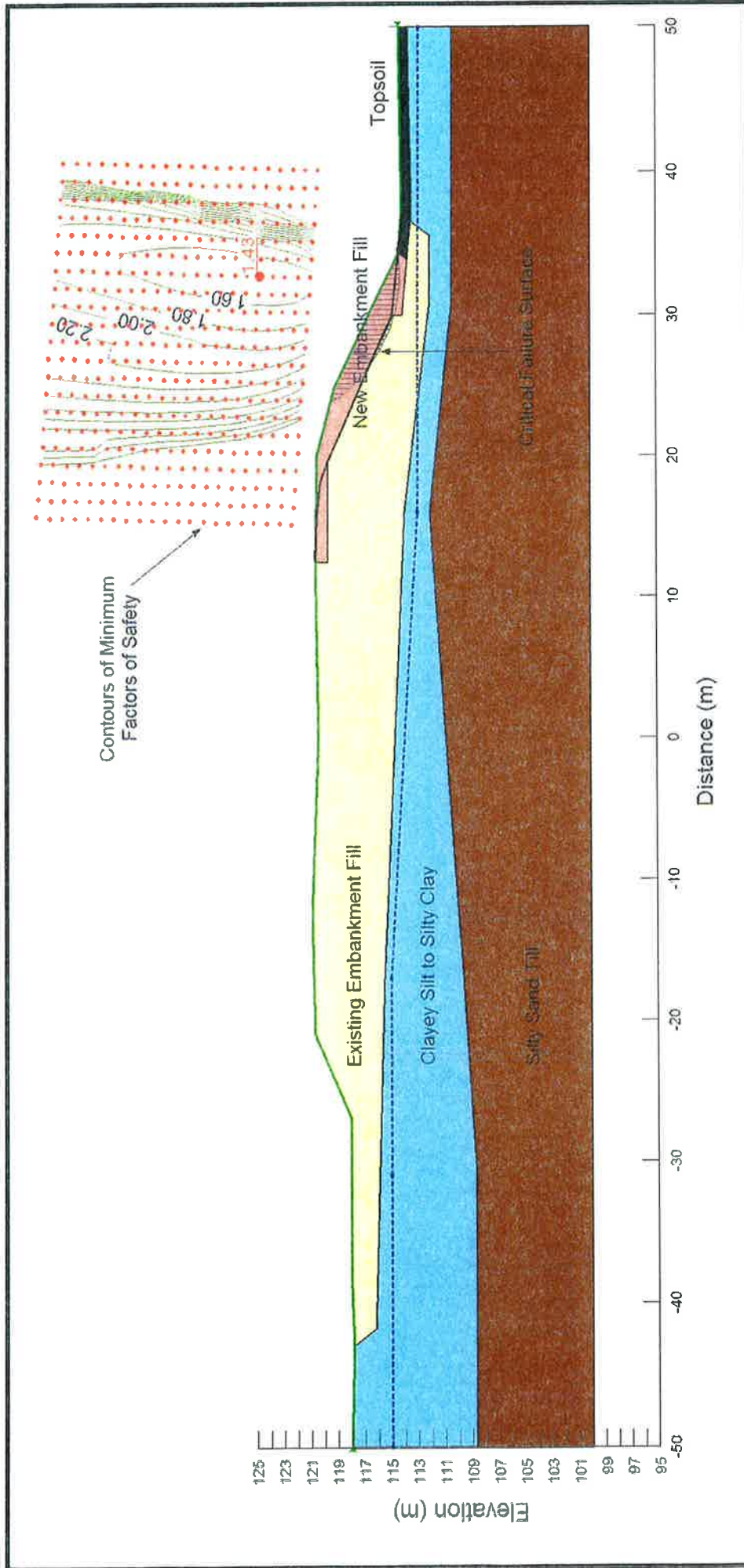
Embankment Fill Area 1

coffey geotechnics
 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G1-6

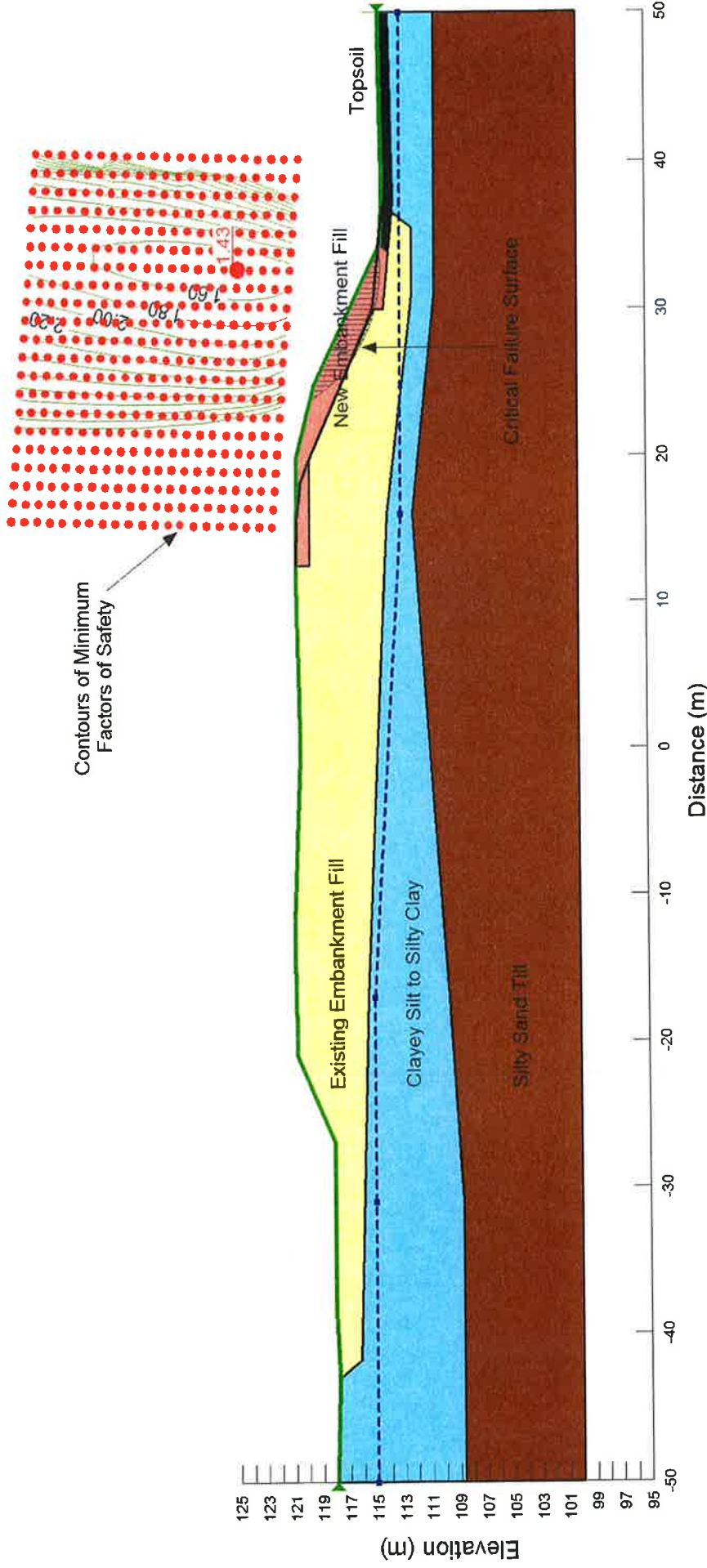


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Existing Embankment Fill	20.0	0	30
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Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 1

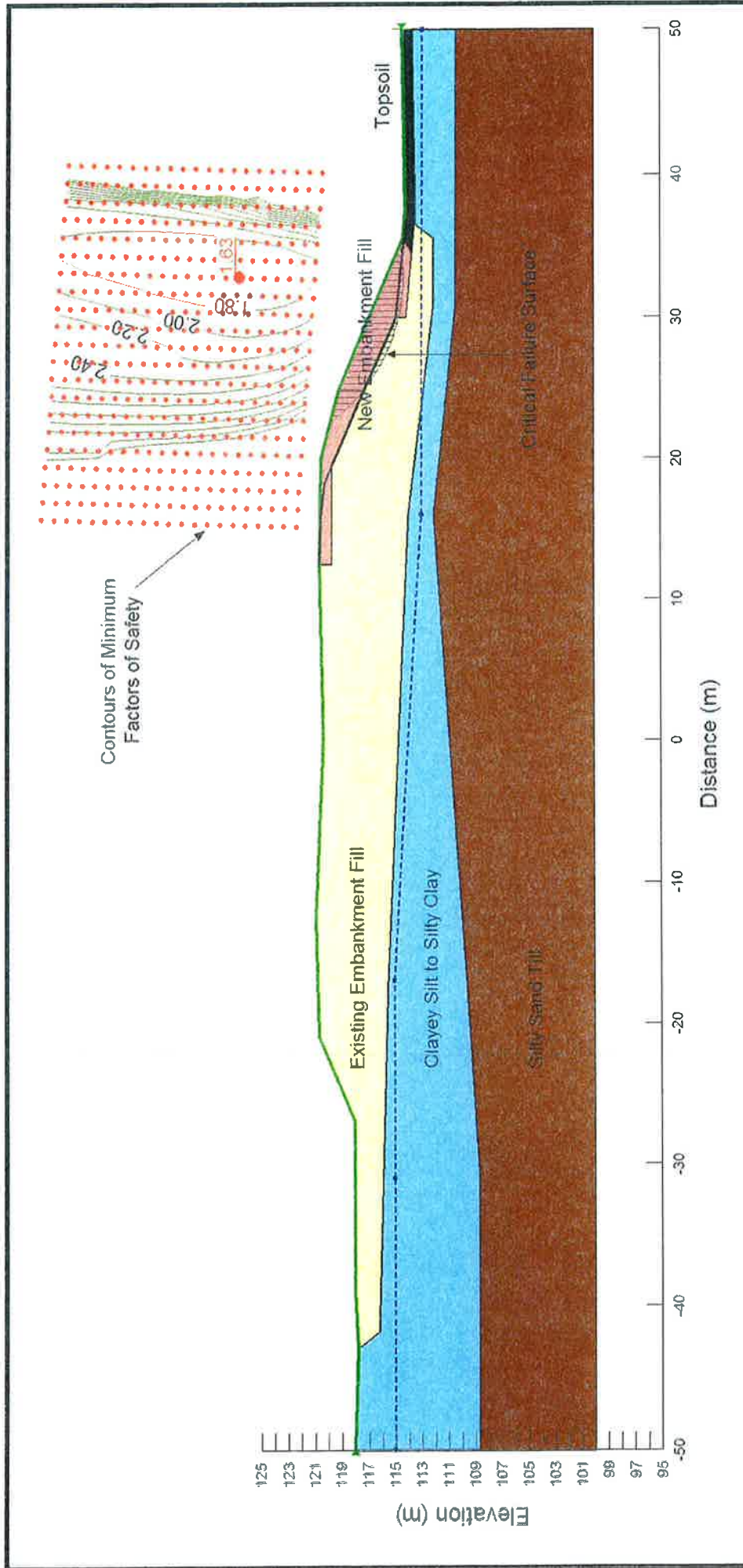


Section : Sta. 20+300 EB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

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Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 1

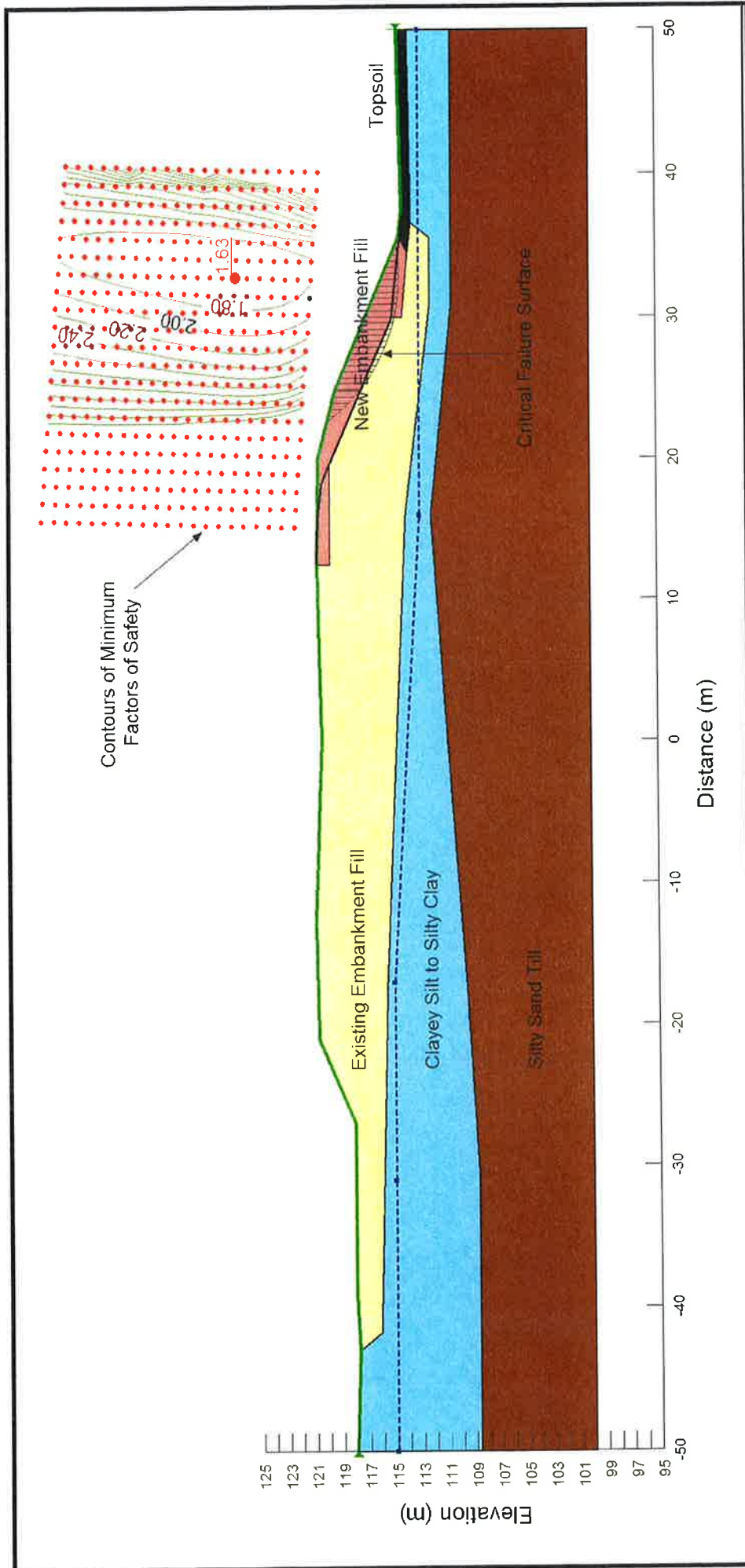


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 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

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New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
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Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 1



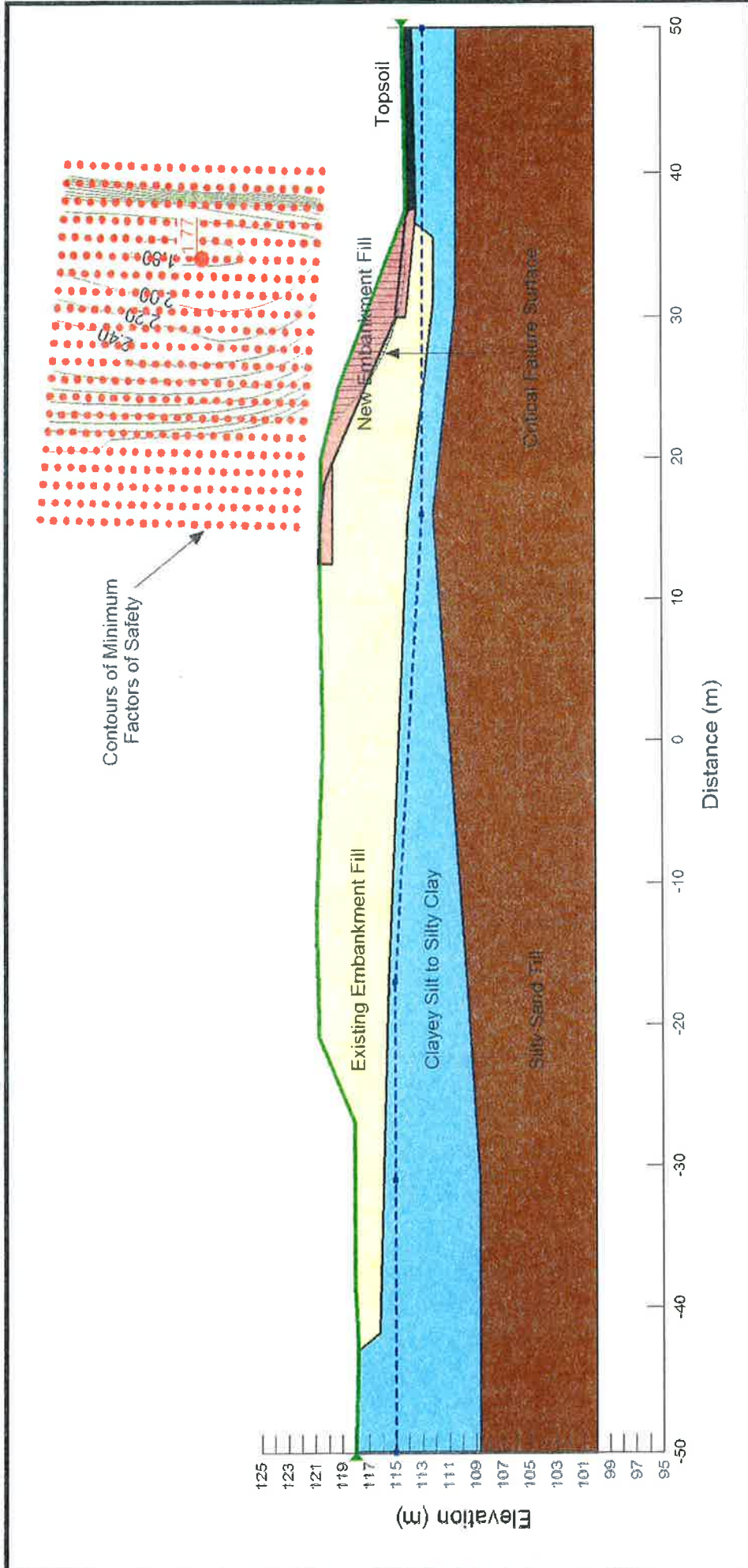
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Existing Embankment Fill	20.0	0	30
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Silty Sand Till	22.0	0	34

Section : Sta. 20+300 EB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 1

SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO
Highway 401 Expansion			FIGURE G1-10

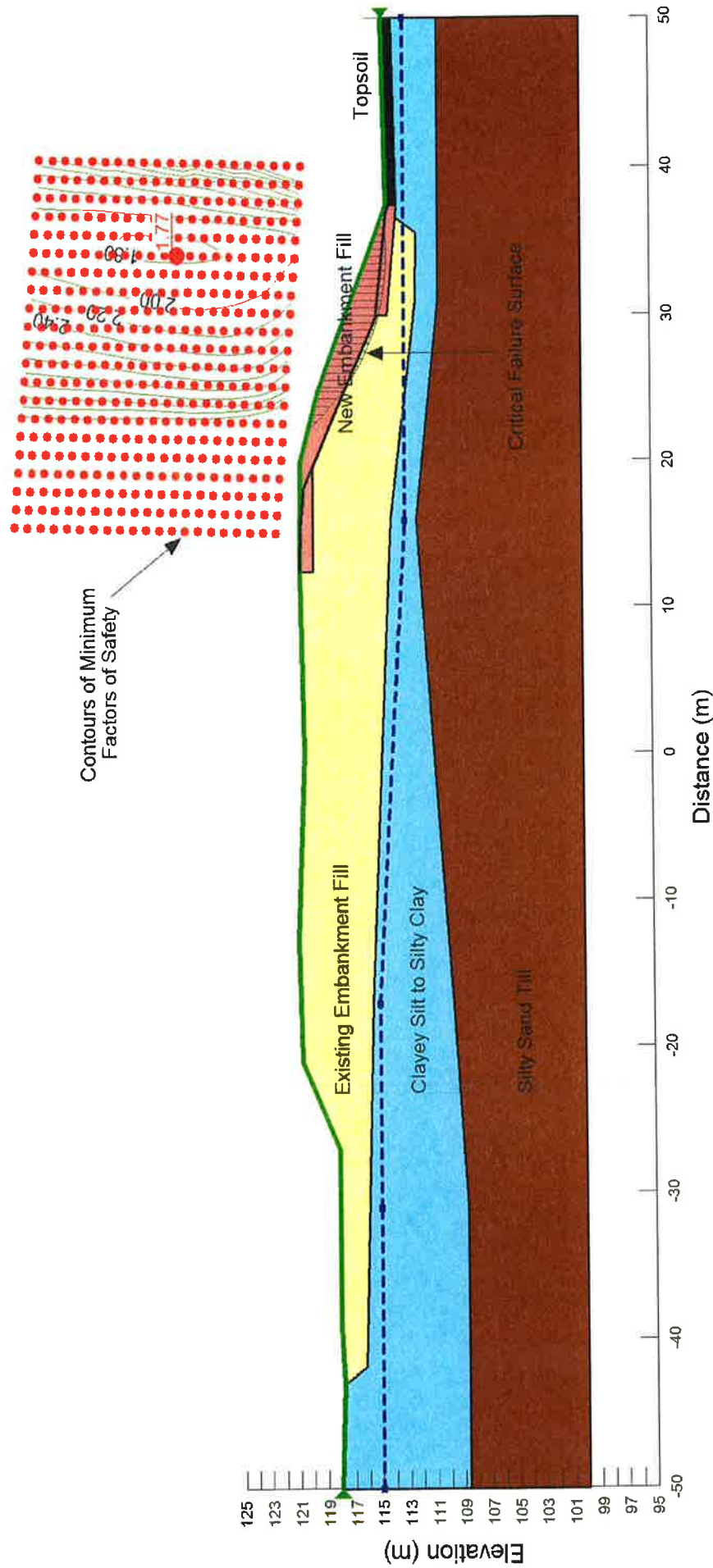


Section : Sta. 20+300 EB
 Slope : 2.5H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	20 - 50	0
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 1





Section : Sta. 20+300 EB
 Slope : 2.5H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

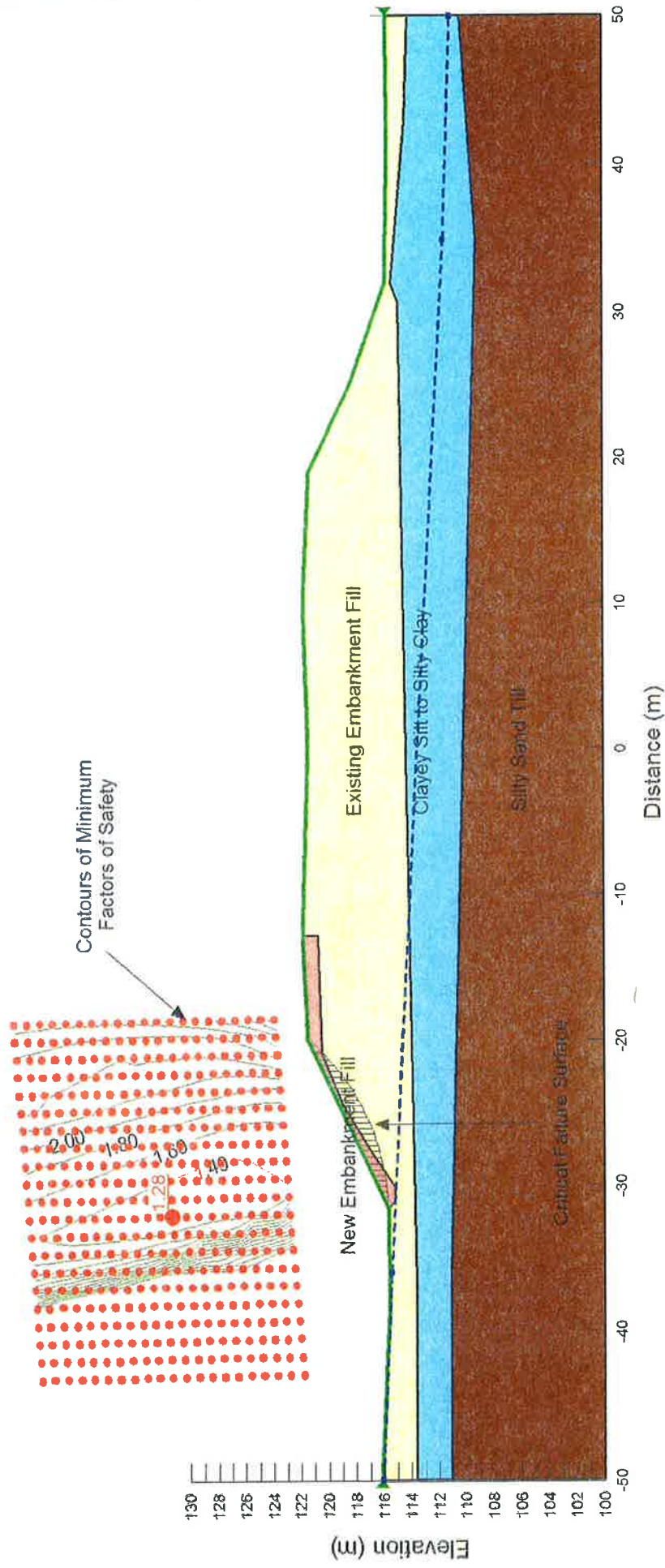
Embankment Fill Area 1

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G1-12



Section : Sta. 20+350 WB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	40 - 50	0
Silty Sand Till	22.0	0	31

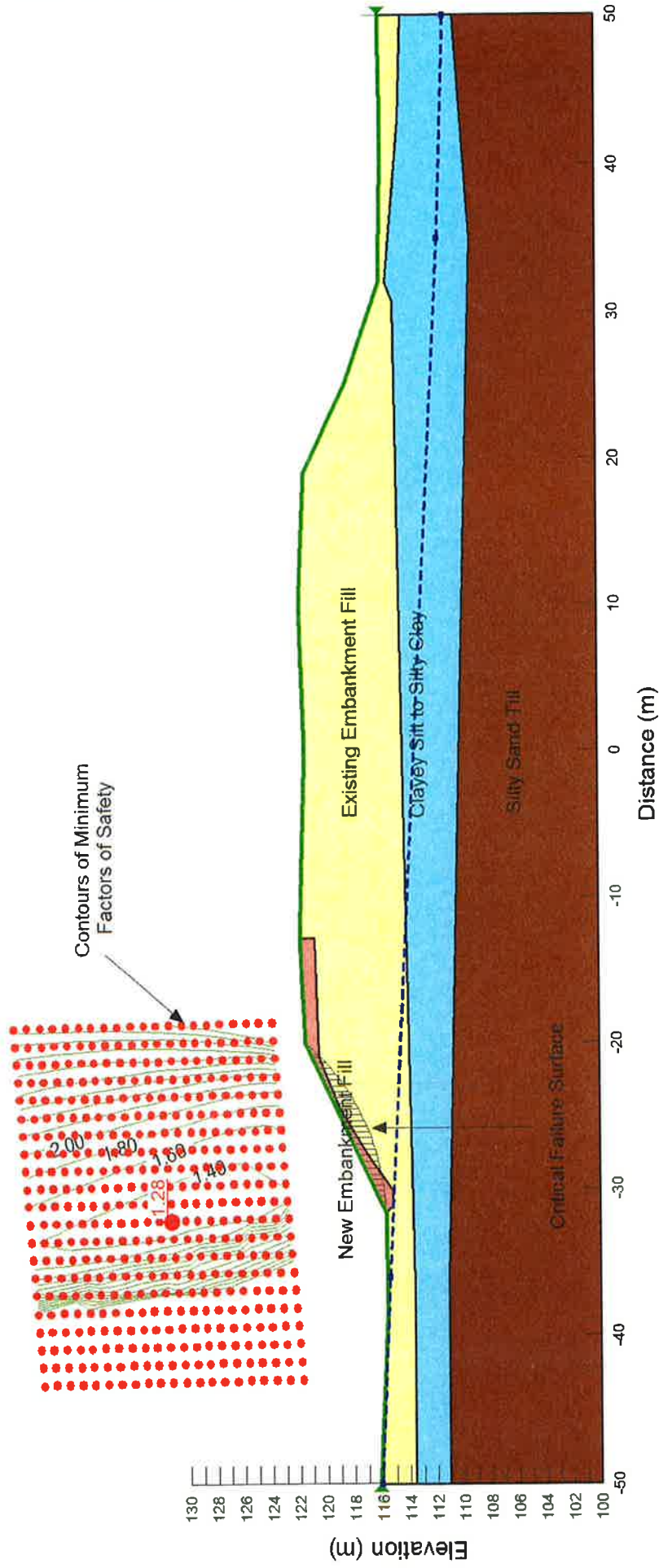
STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 2

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETO10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

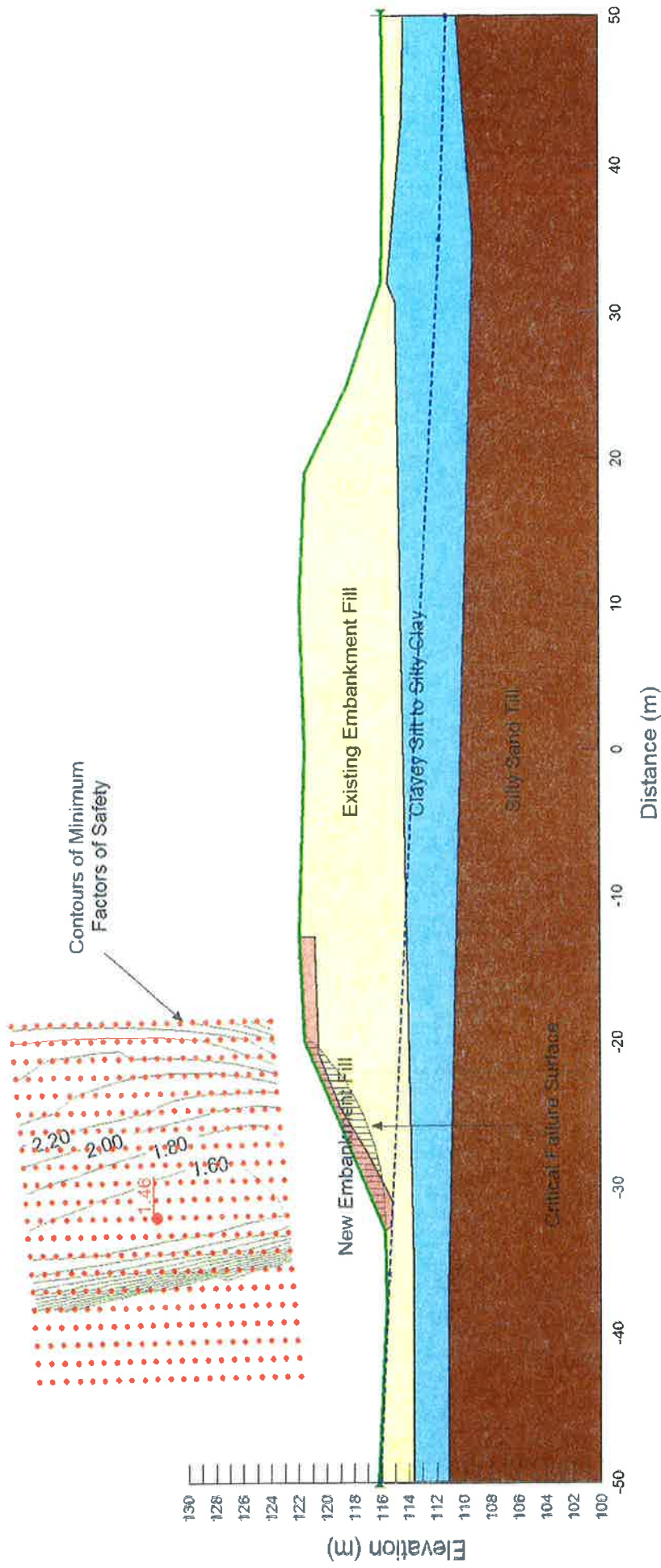
Highway 401 Expansion

FIGURE G2-1



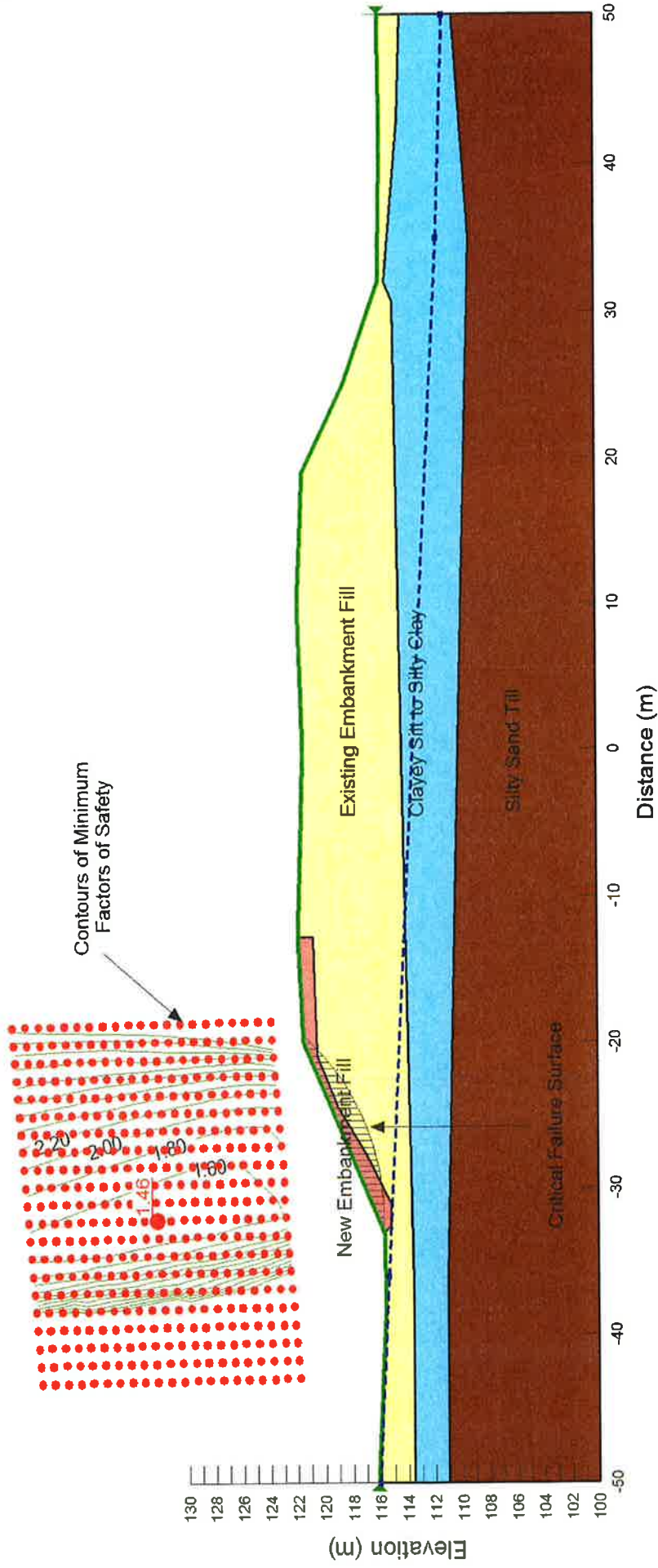
Section : Sta. 20+350 WB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	31



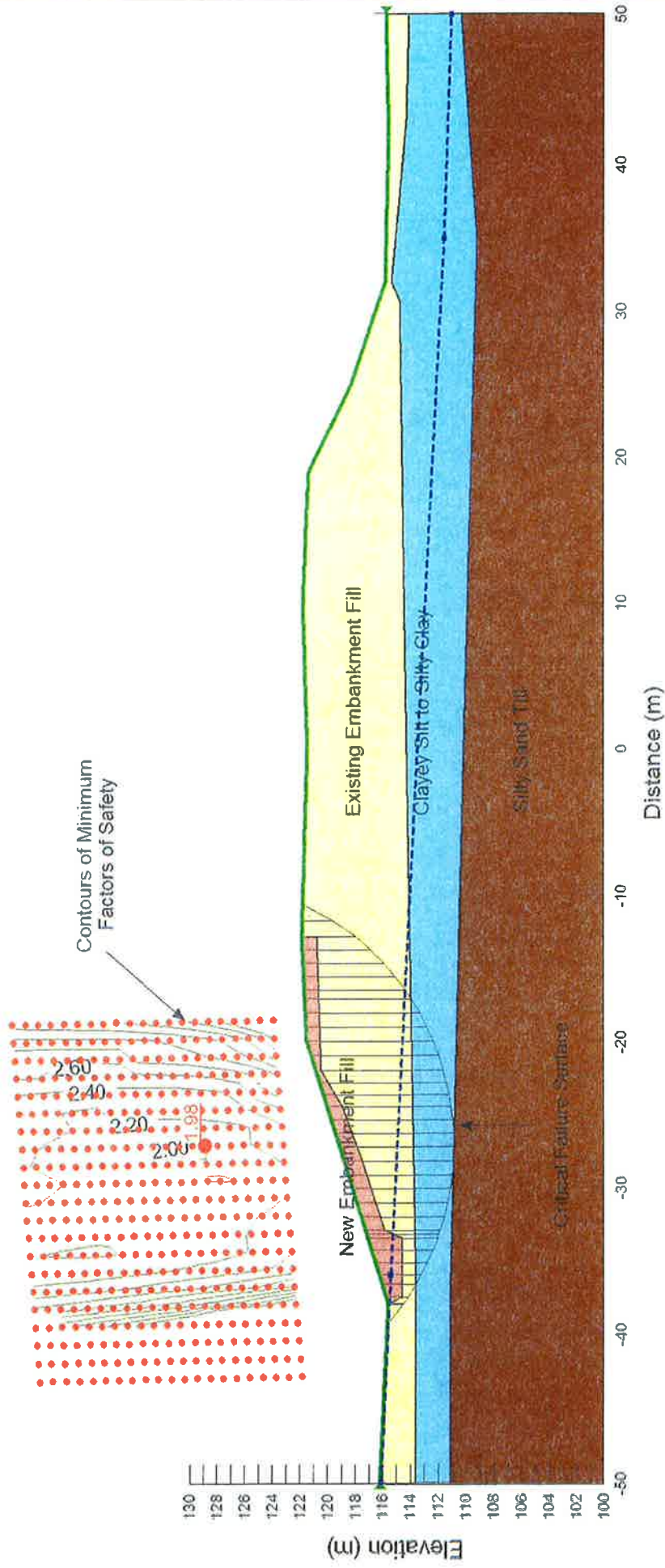
Section : Sta. 20+350 WB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	40 - 50	0
Silty Sand Till	22.0	0	31



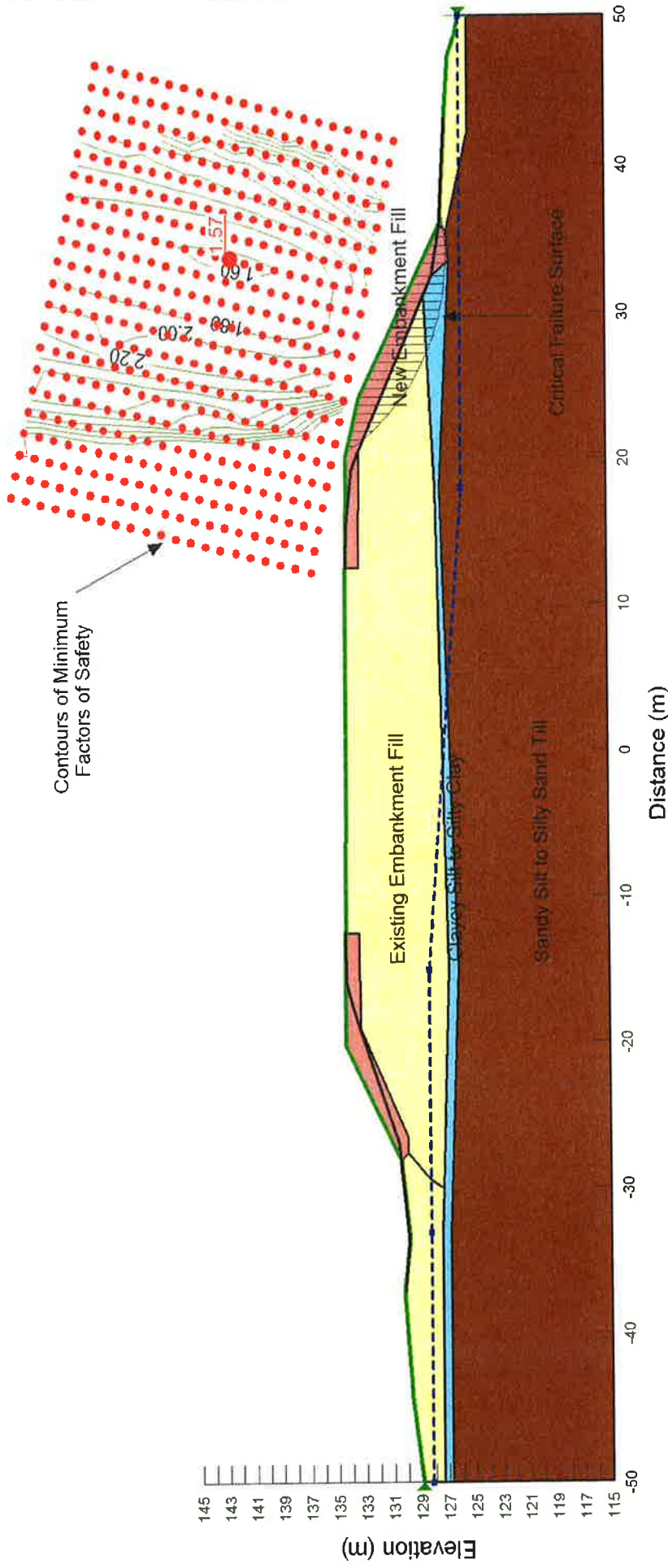
Section : Sta. 20+350 WB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	31



Section : Sta. 20+350 WB
 Slope : 3.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	40 - 50	0
Silty Sand Till	22.0	0	31



Section : Sta. 21+700 EB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32

STATIC SLOPE STABILITY ANALYSIS

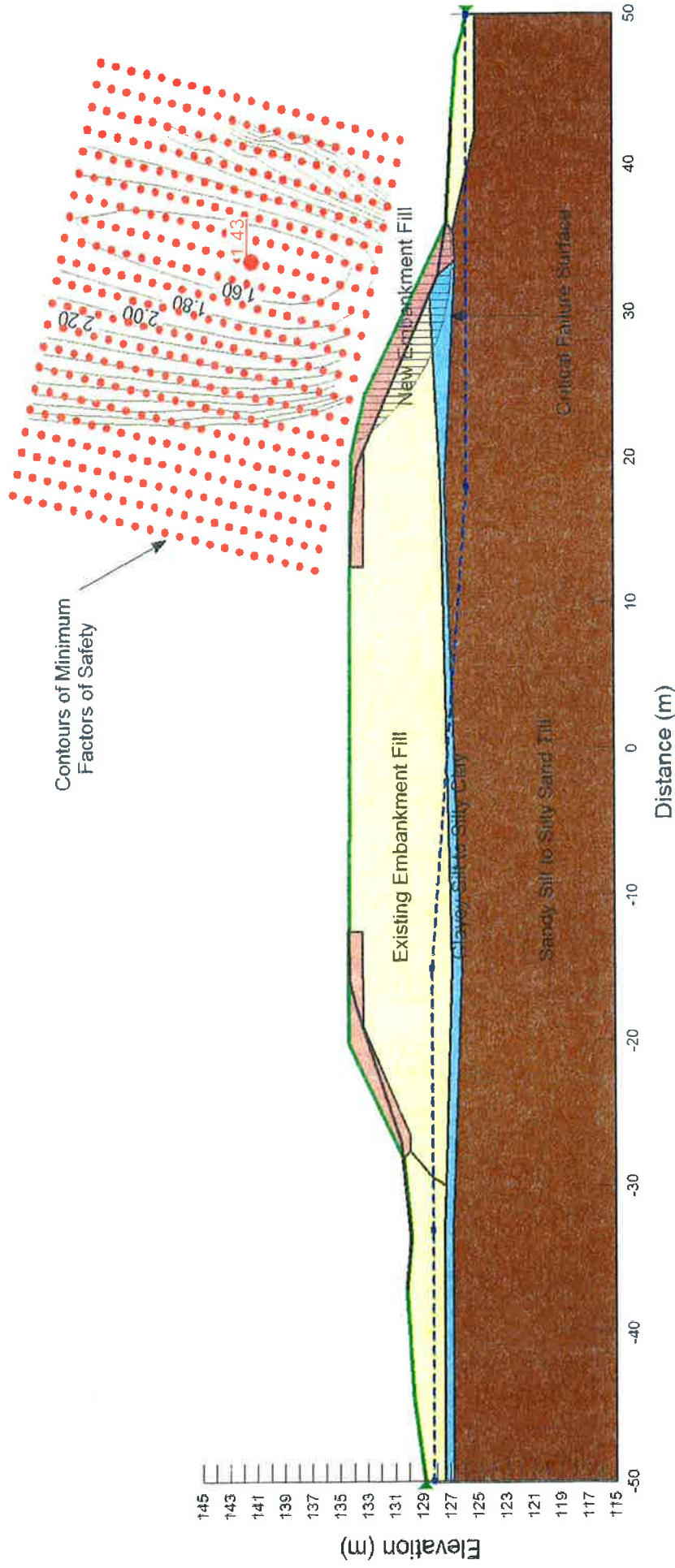
Embankment Fill Area 3

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

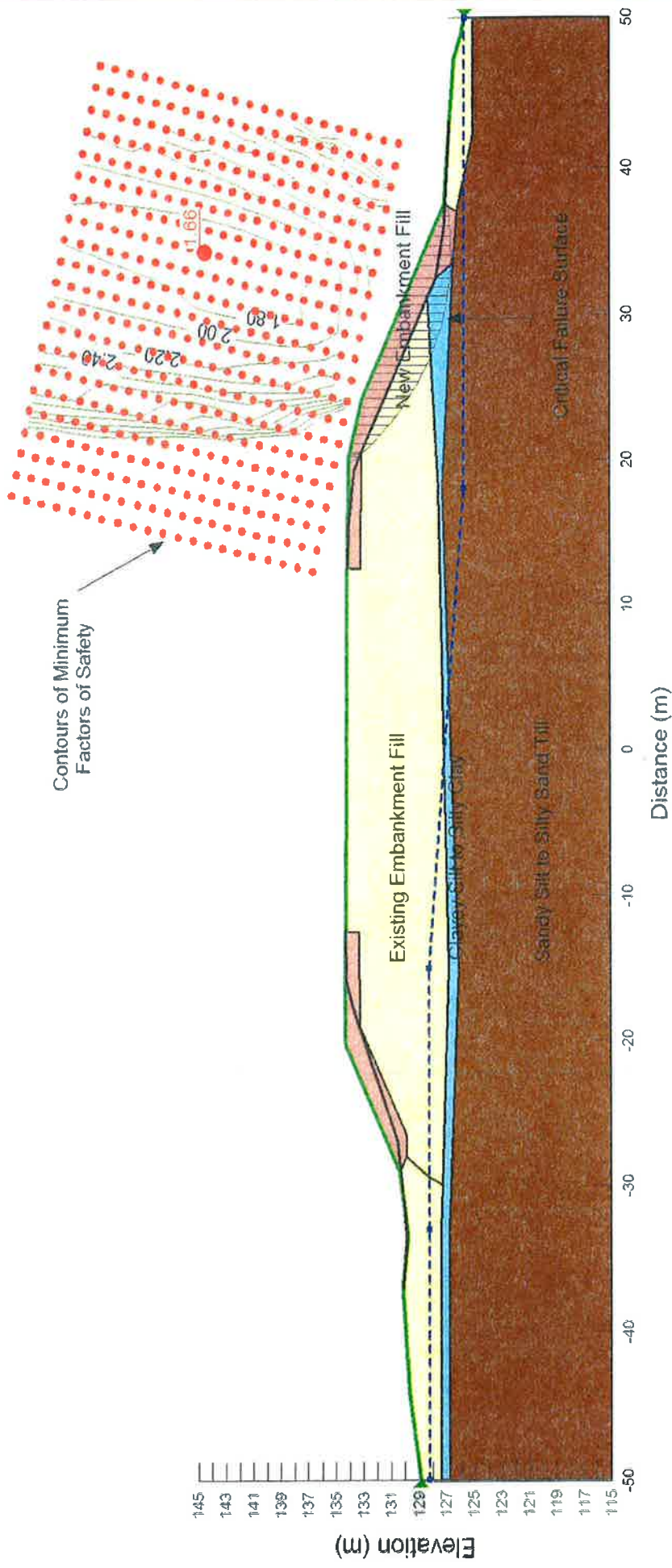
Highway 401 Expansion

FIGURE G3-1



Section : Sta. 21+700 EB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32

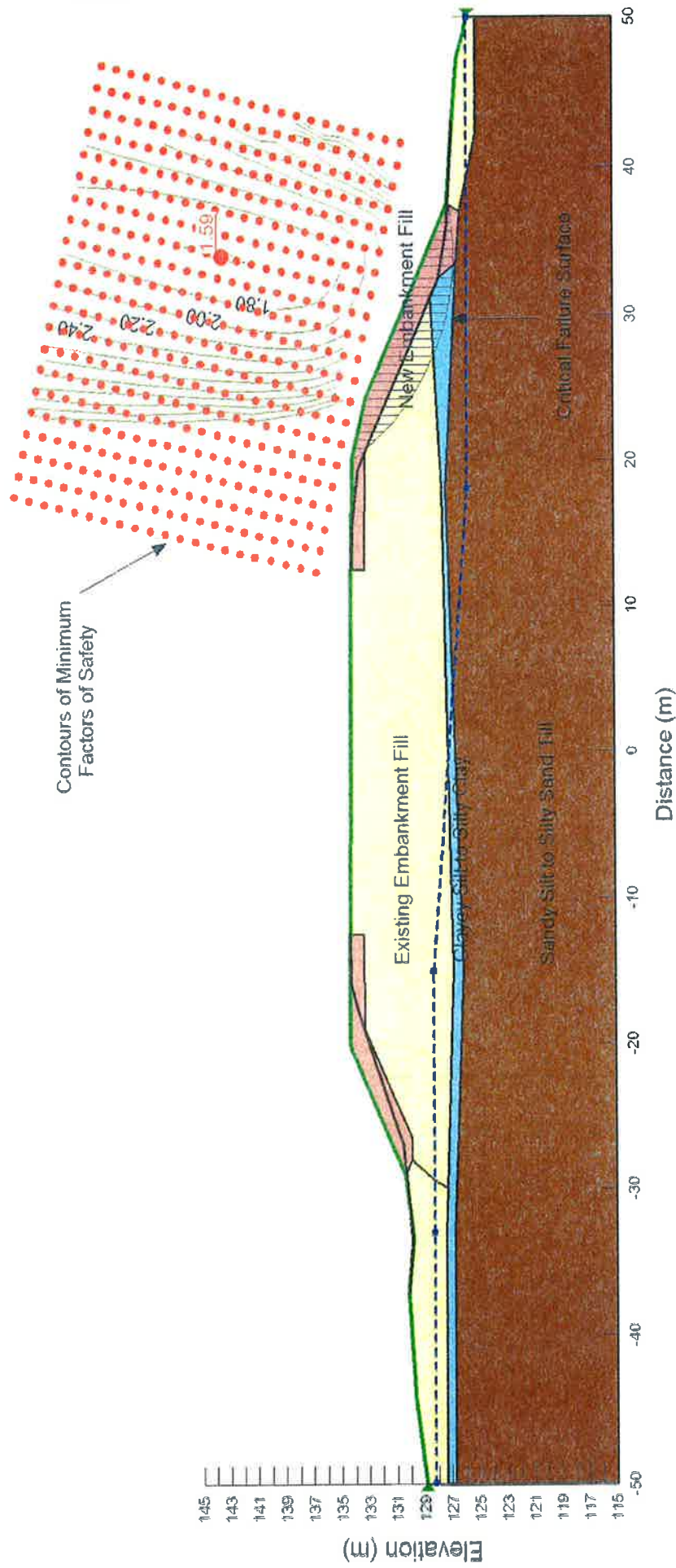


Section : Sta. 21+700 EB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32

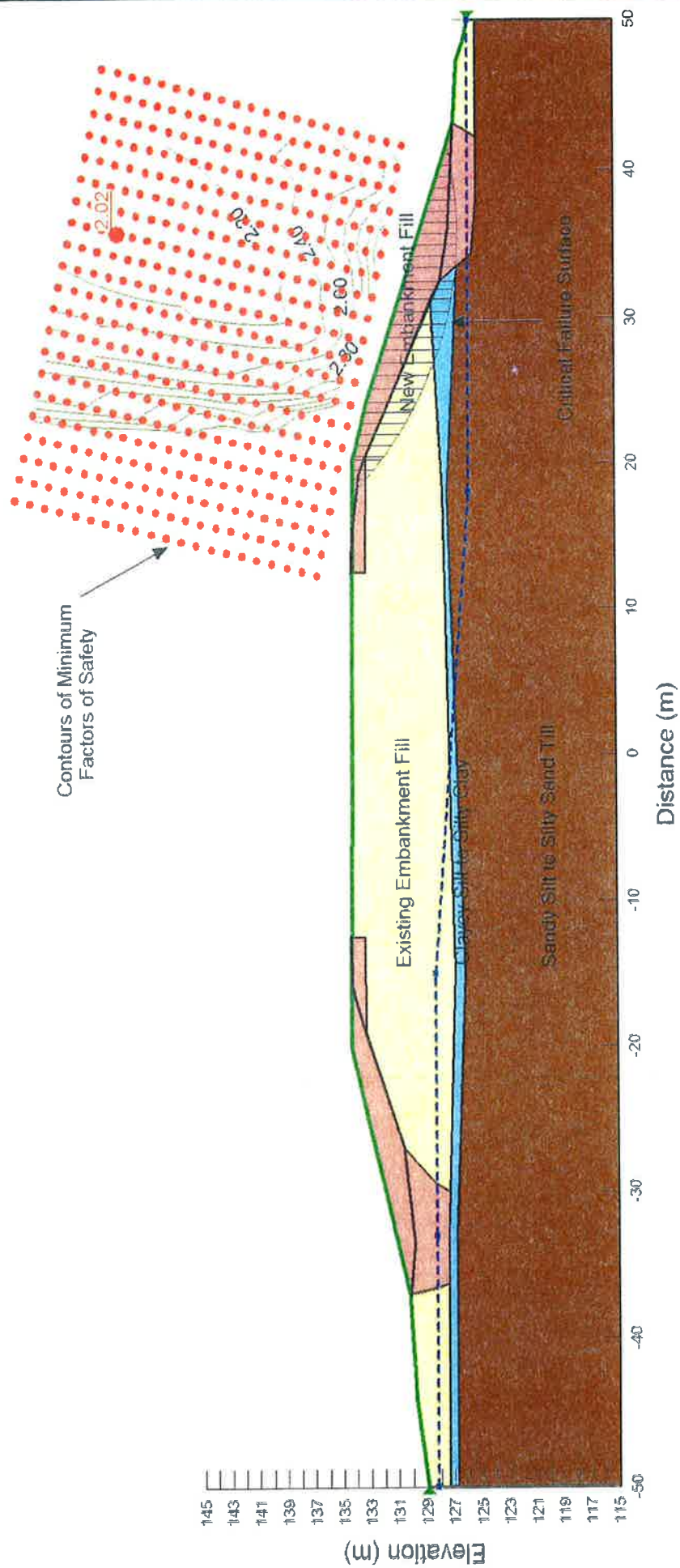
STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 3



Section : Sta. 21+700 EB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32

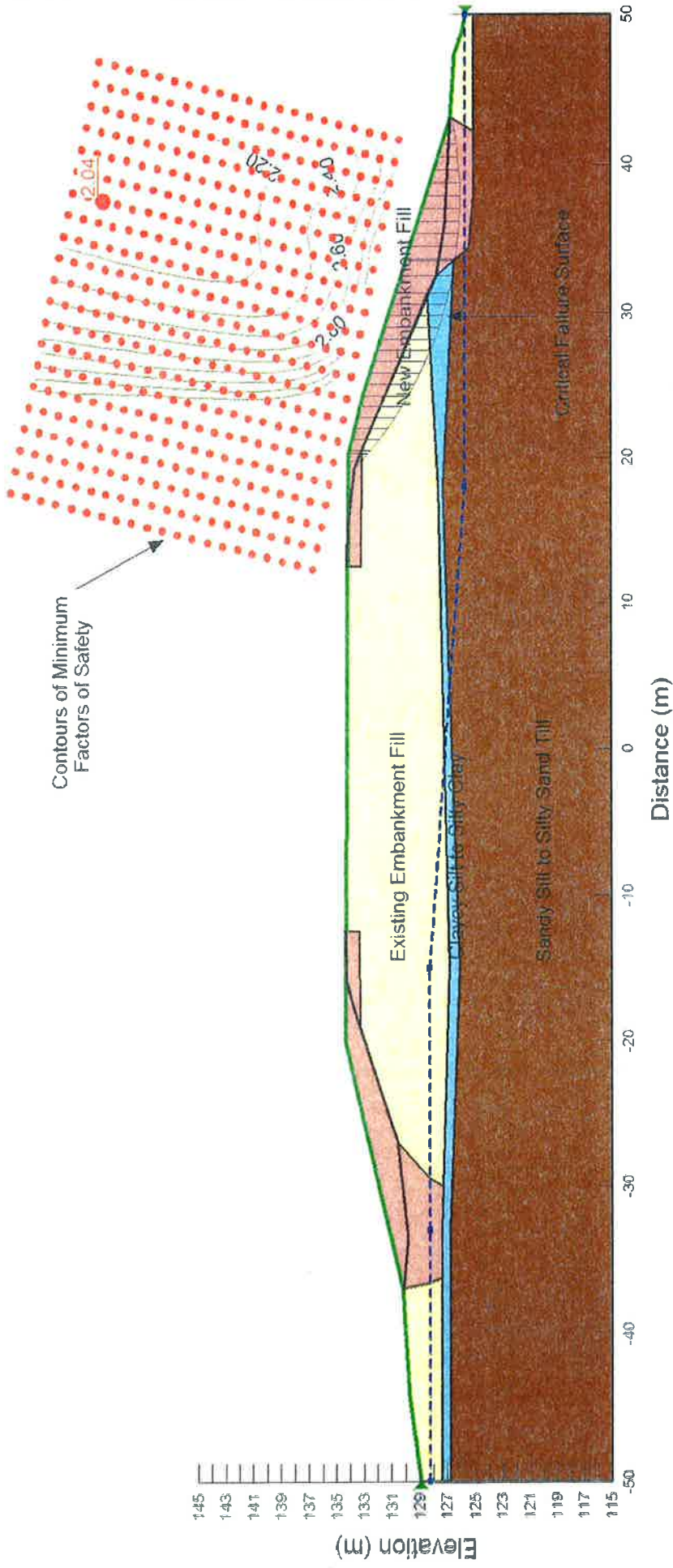


Section : Sta. 21+700 EB
 Slope : 2.5H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32

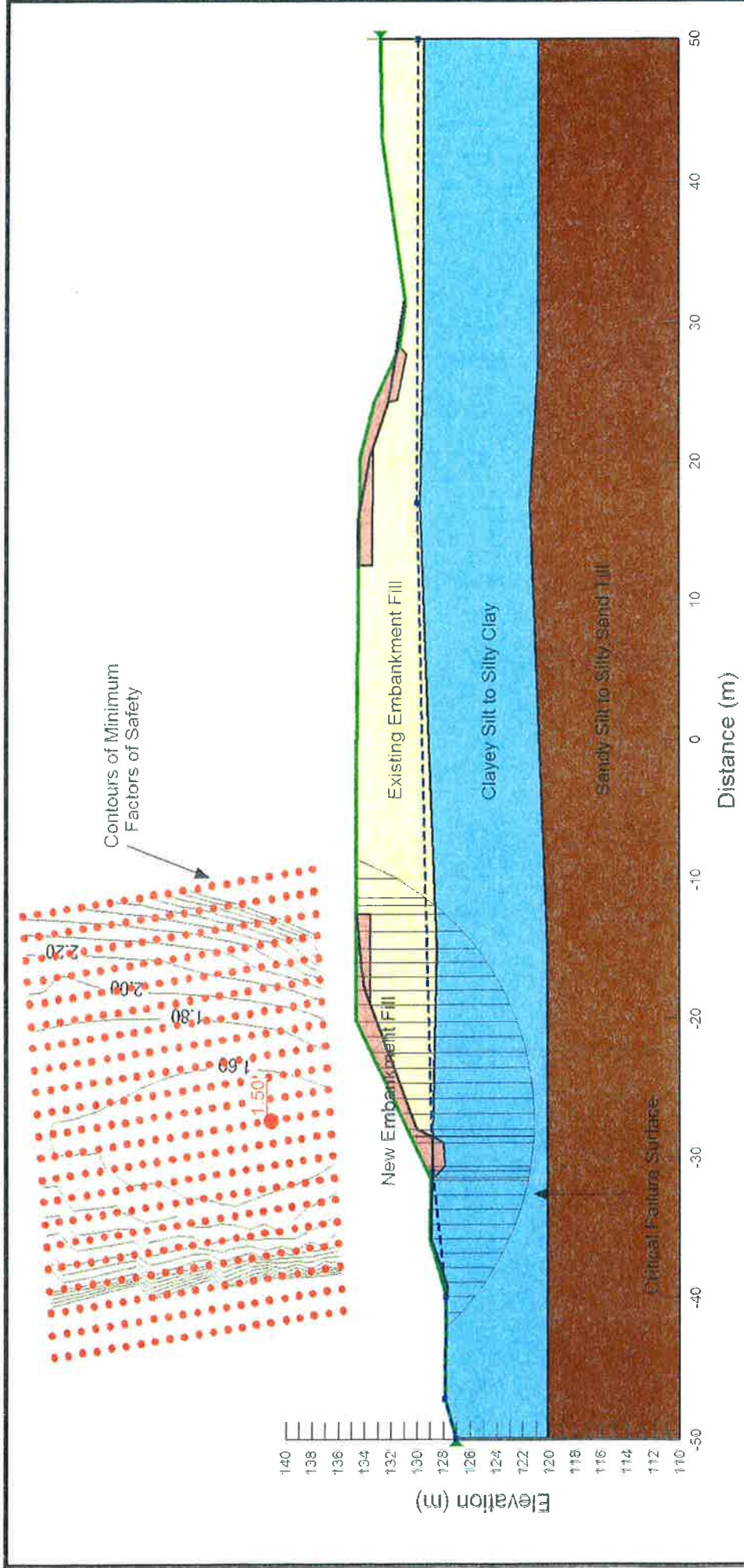
STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 3



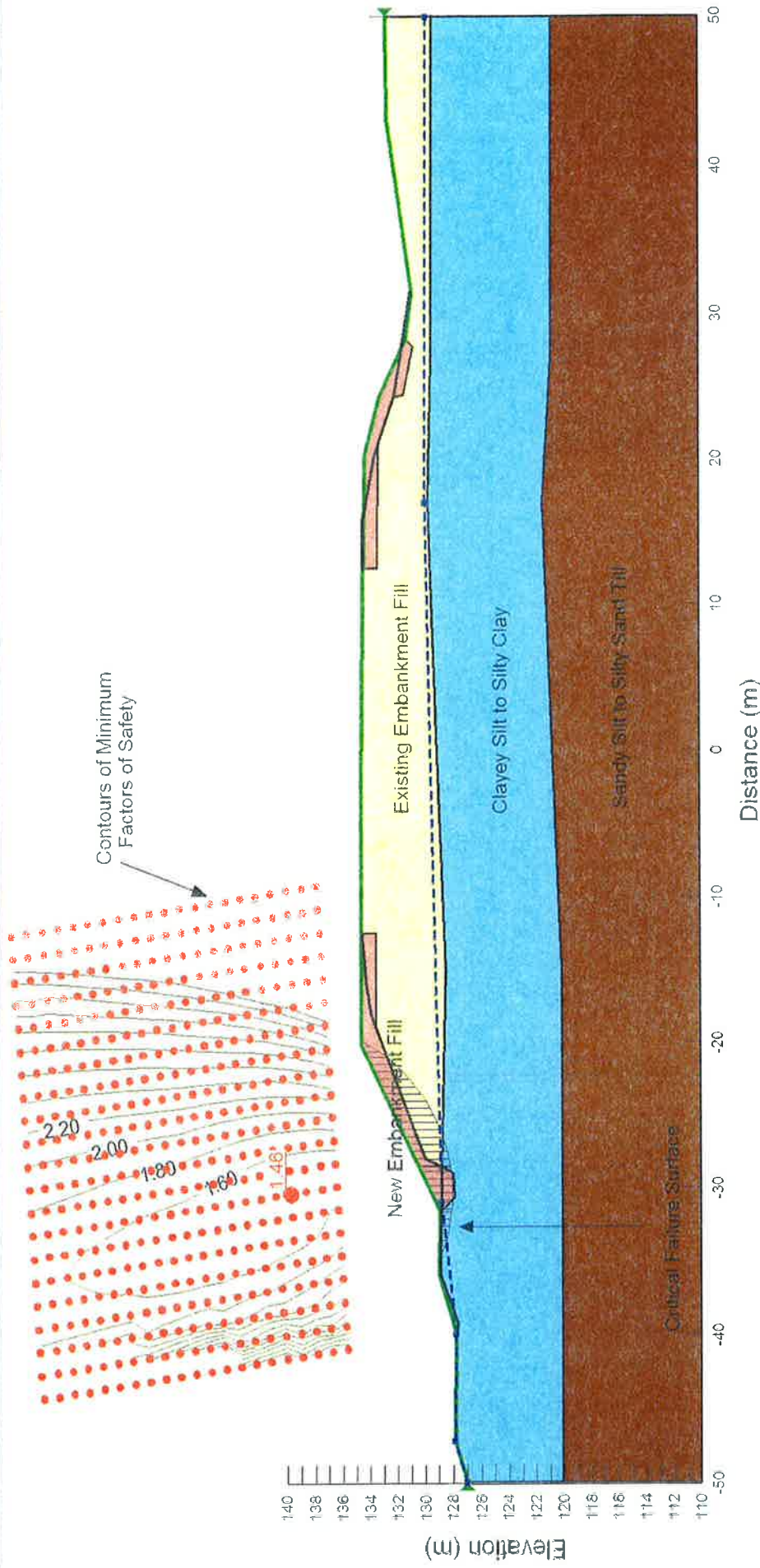
Section : Sta. 21+700 EB
 Slope : 2.5H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32



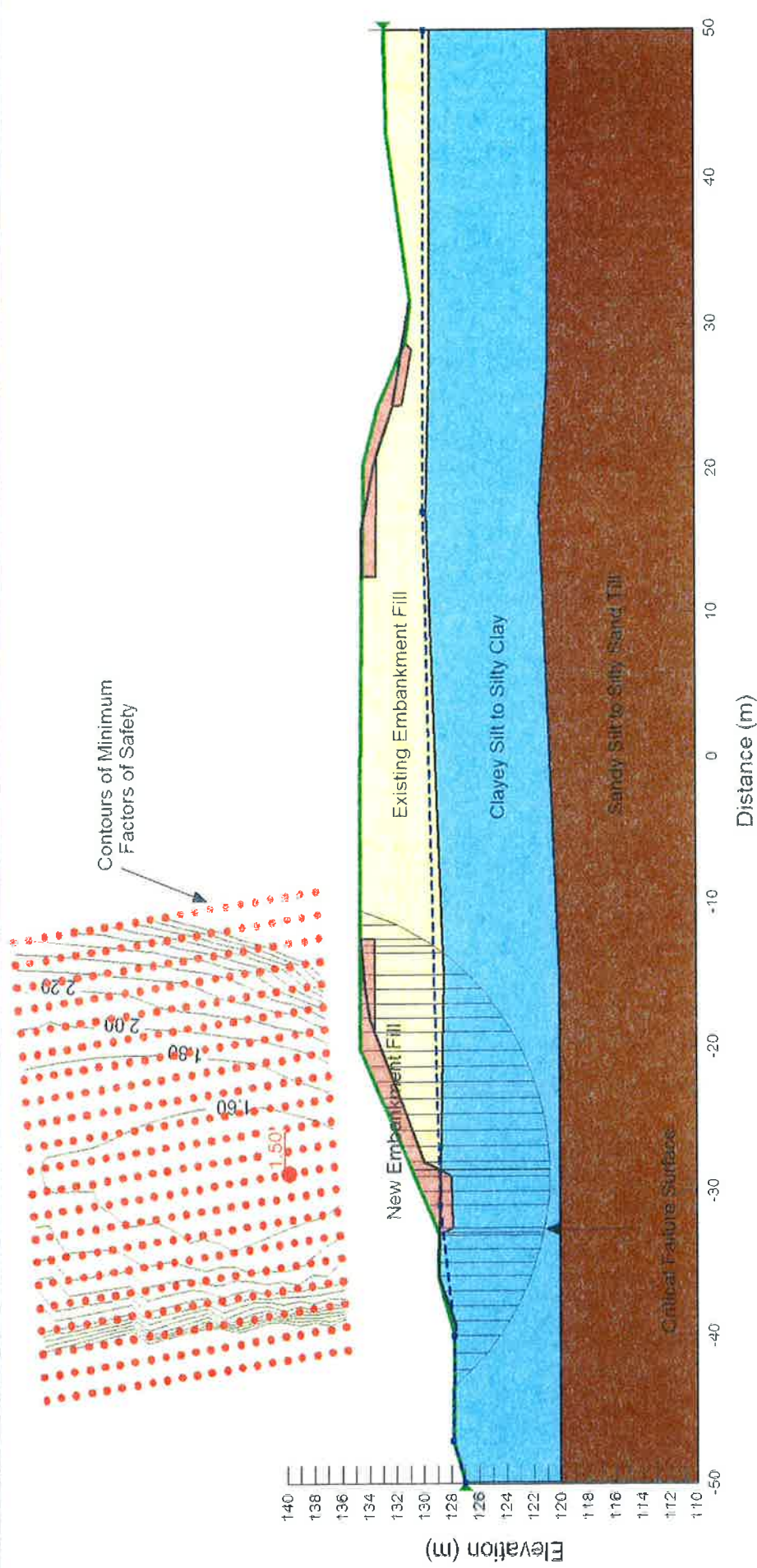
Section : Sta. 21+750 EB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32



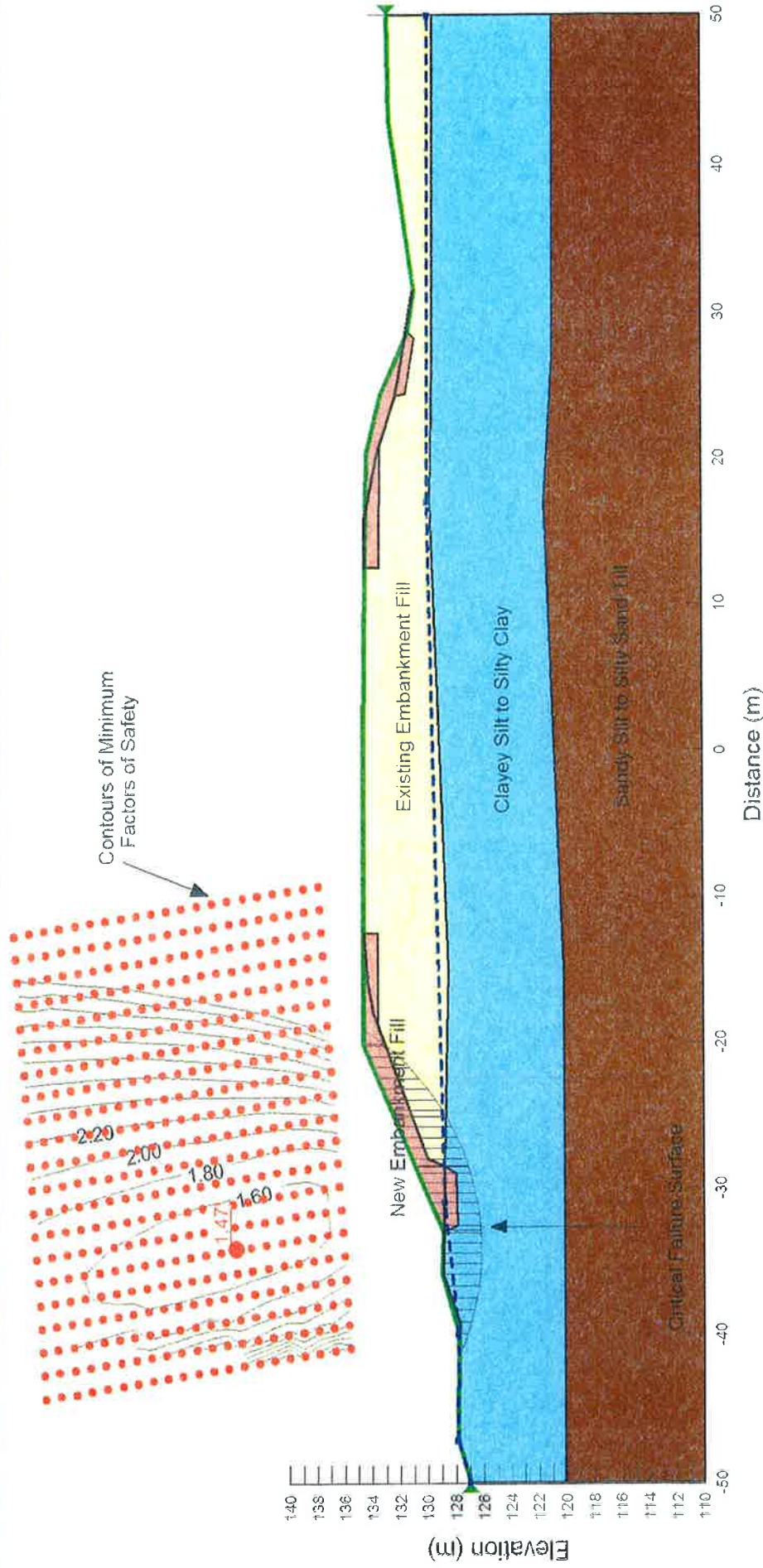
Section : Sta. 21+750 EB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32



Section : Sta. 21+750 EB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32



Section : Sta. 21+750 EB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32



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STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 3

PROJECT:

TRANETO810434AA

DATE:

Jan-2012

DESIGN:

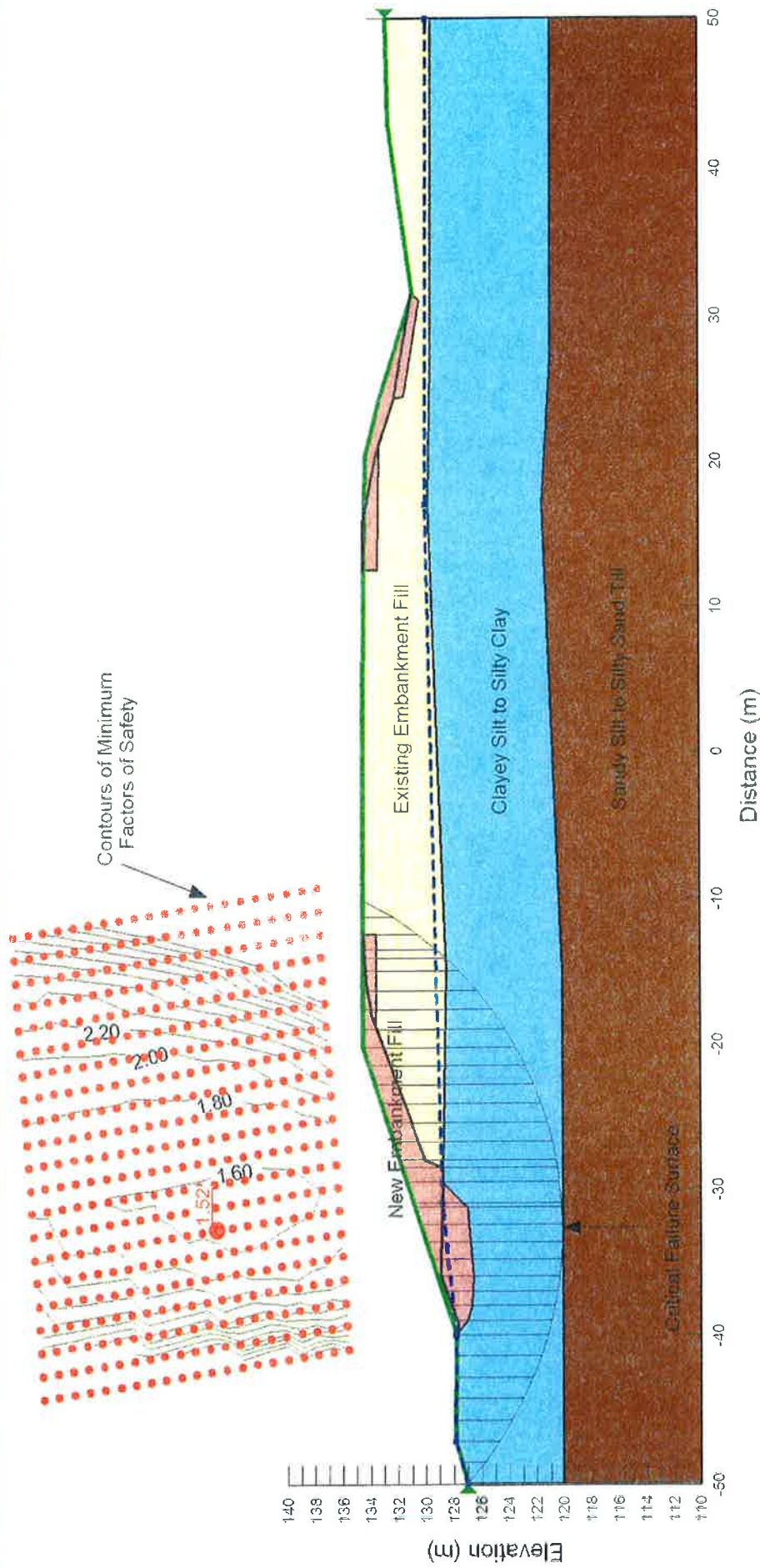
HW

REVIEW:

ZO

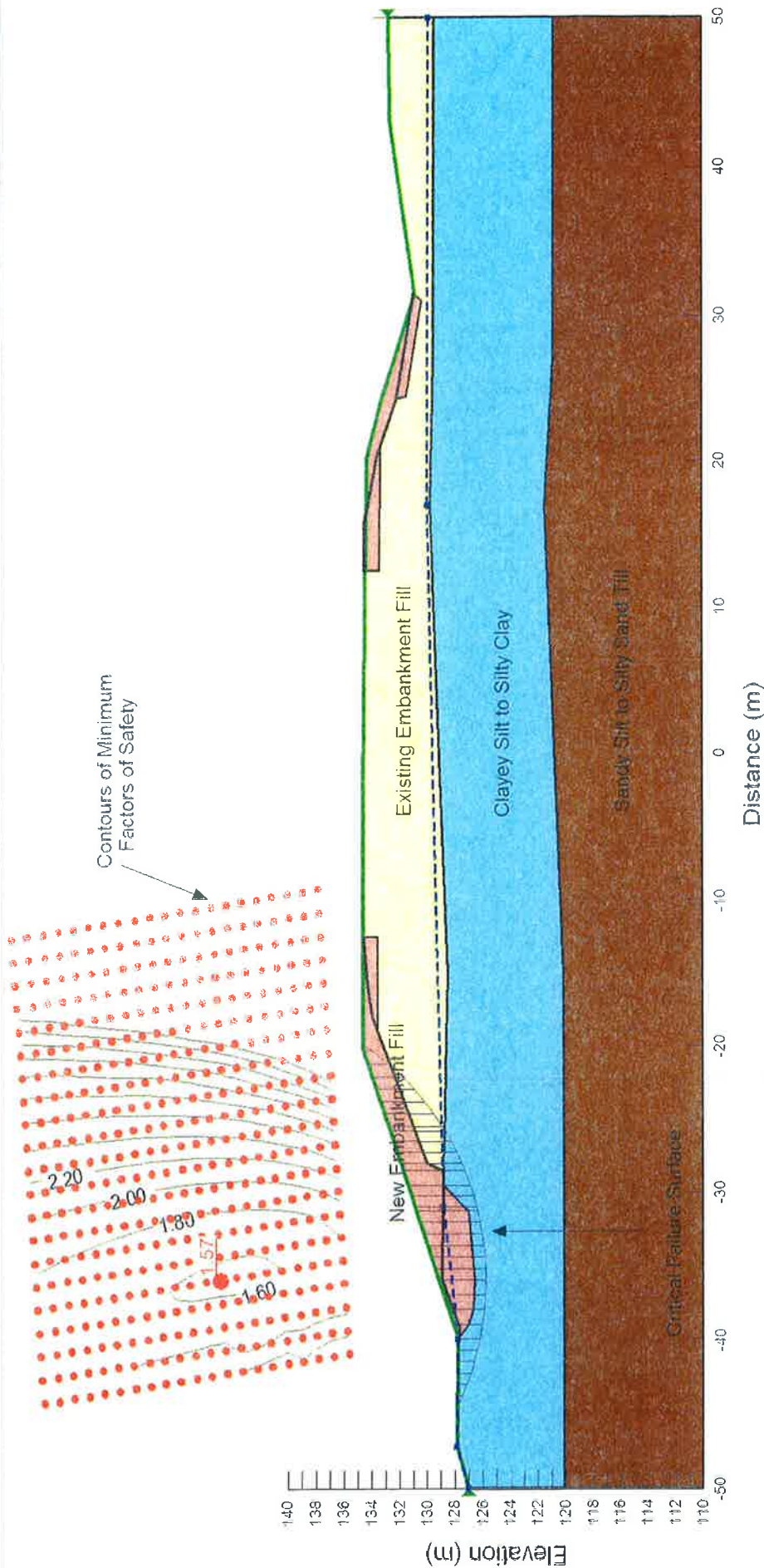
Highway 401 Expansion

FIGURE G3-10



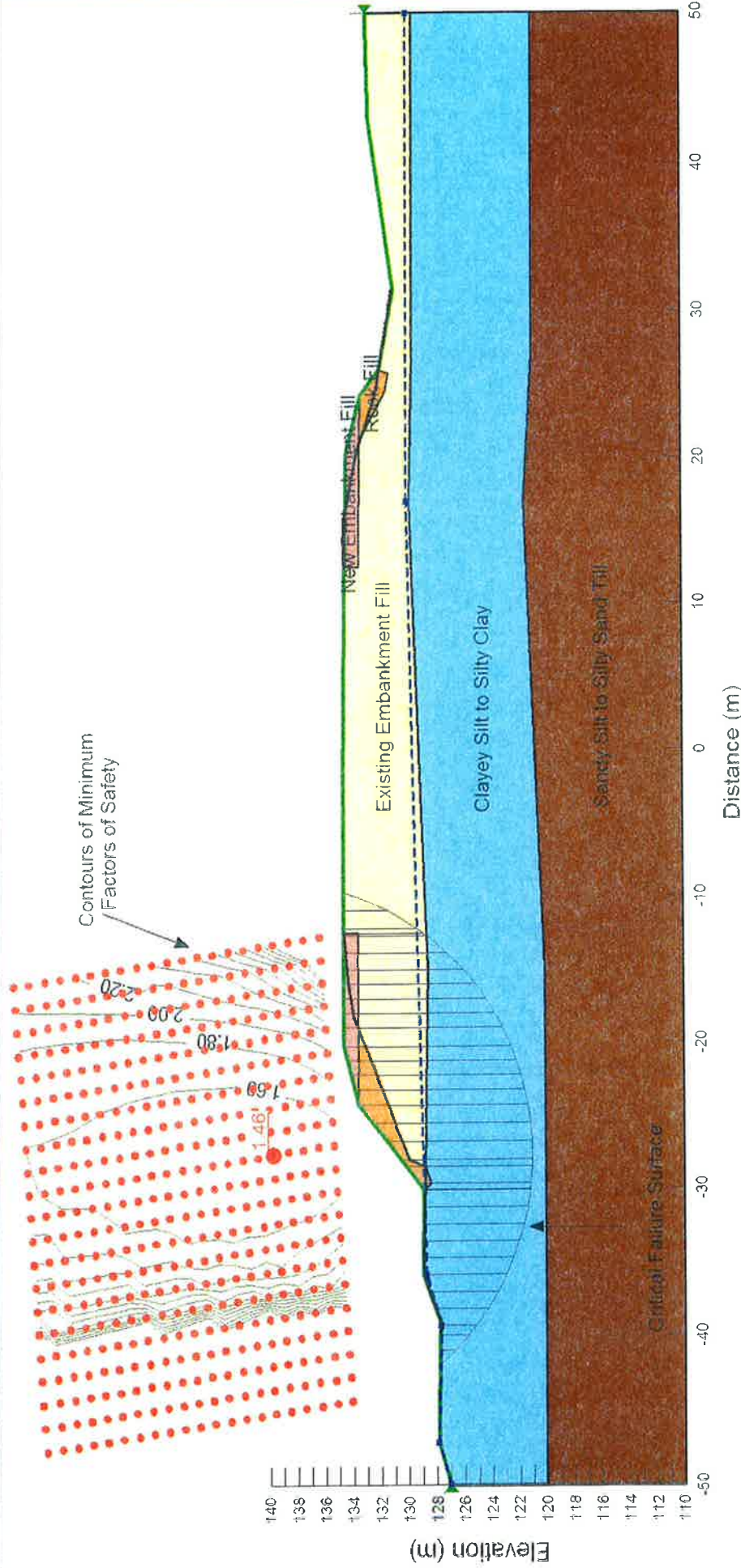
Section : Sta. 21+750 EB
 Slope : 3.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32



Section : Sta. 21+750 EB
 Slope : 3.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32

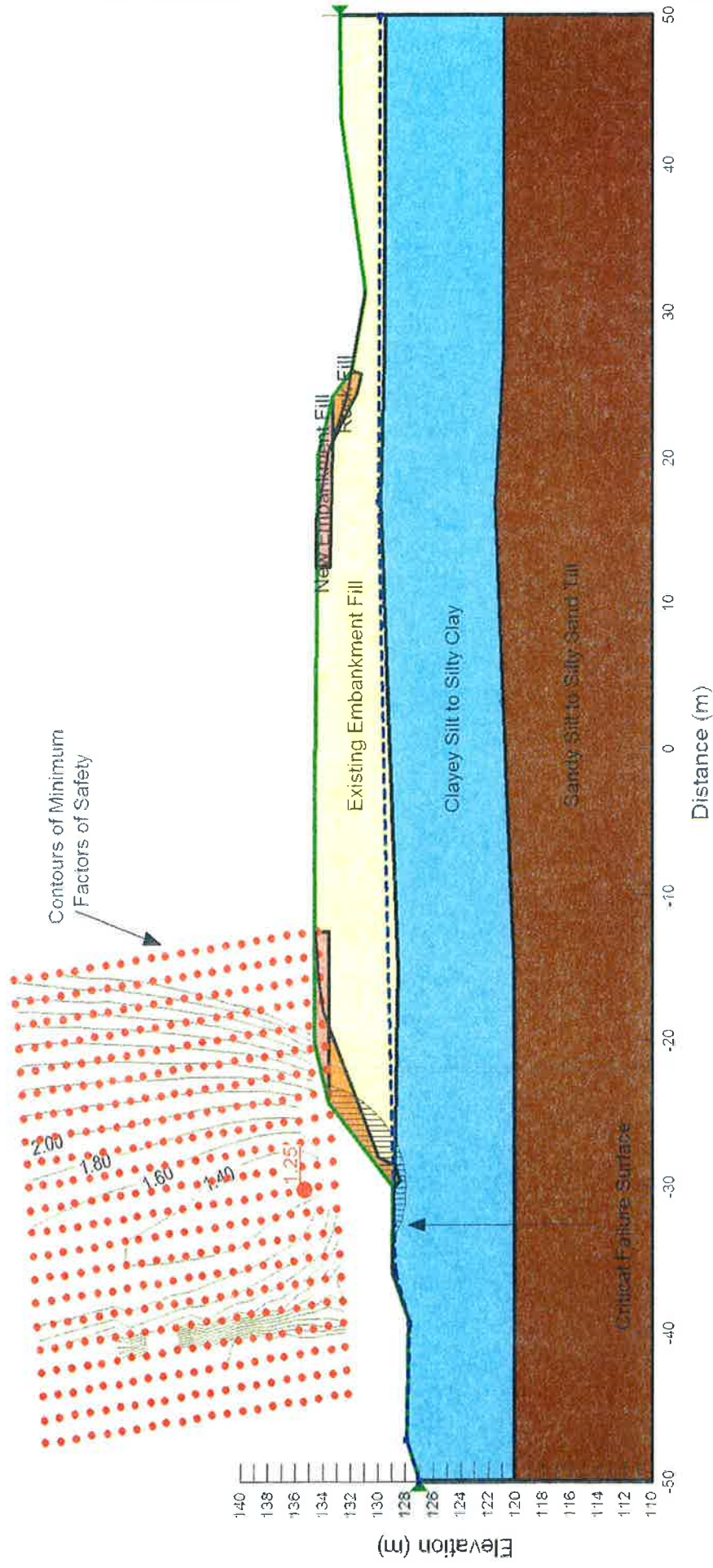


Section : Sta. 21+750 EB
 Slope : 1.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Rock Fill	19.0	0	45
Clayey Silt to Silty Clay	18.0	35	0
Silty Sand Till	22.0	0	32

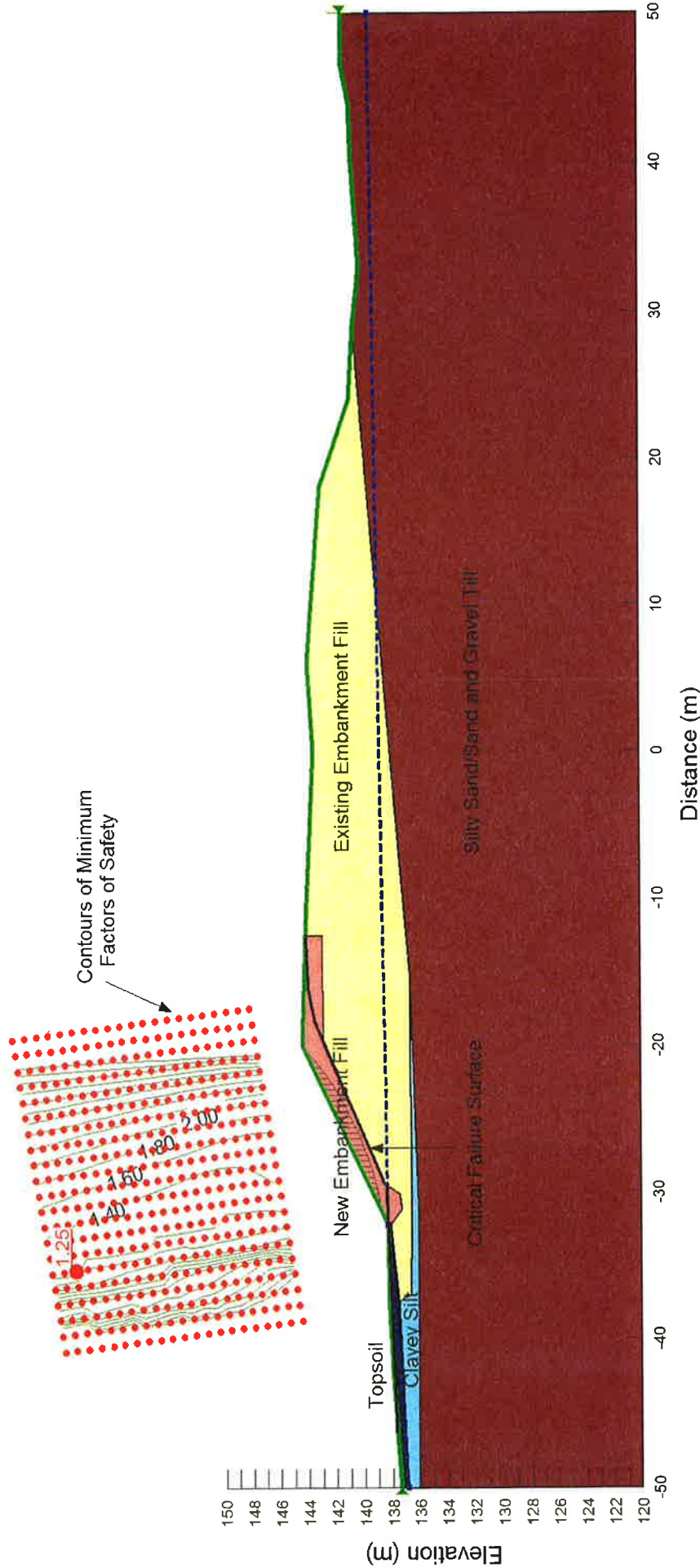
STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 3



Section : Sta. 21+750 EB
 Slope : 1.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Rock Fill	19.0	0	45
Clayey Silt to Silty Clay	18.0	3	25
Silty Sand Till	22.0	0	32



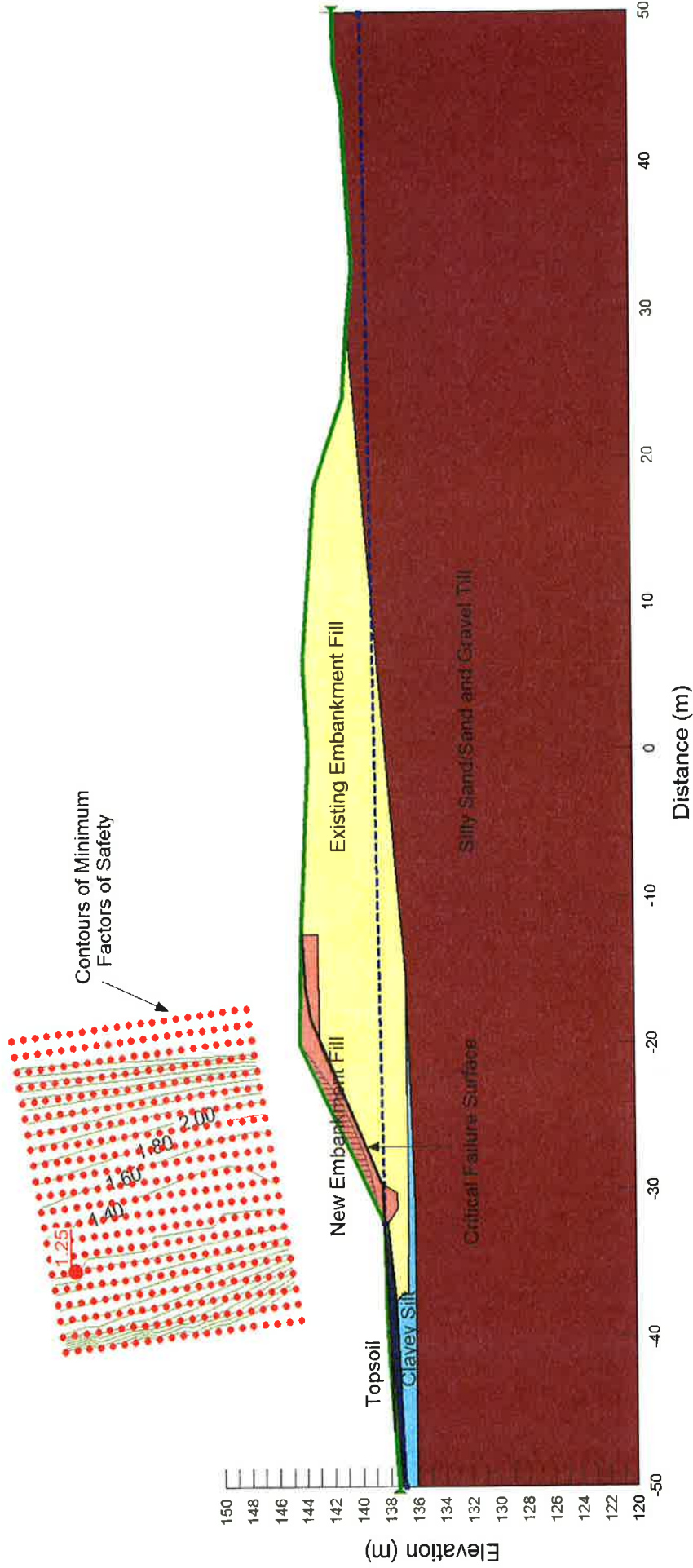
Section : Sta. 22+300 WB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS
 Embankment Fill Area 4



PROJECT:	TRANETOB10434AA	DATE:	Jan-2012	Highway 401 Expansion	FIGURE G4-1
DESIGN:	HW	REVIEW:	ZO		



Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33

Section : Sta. 22+300 WB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

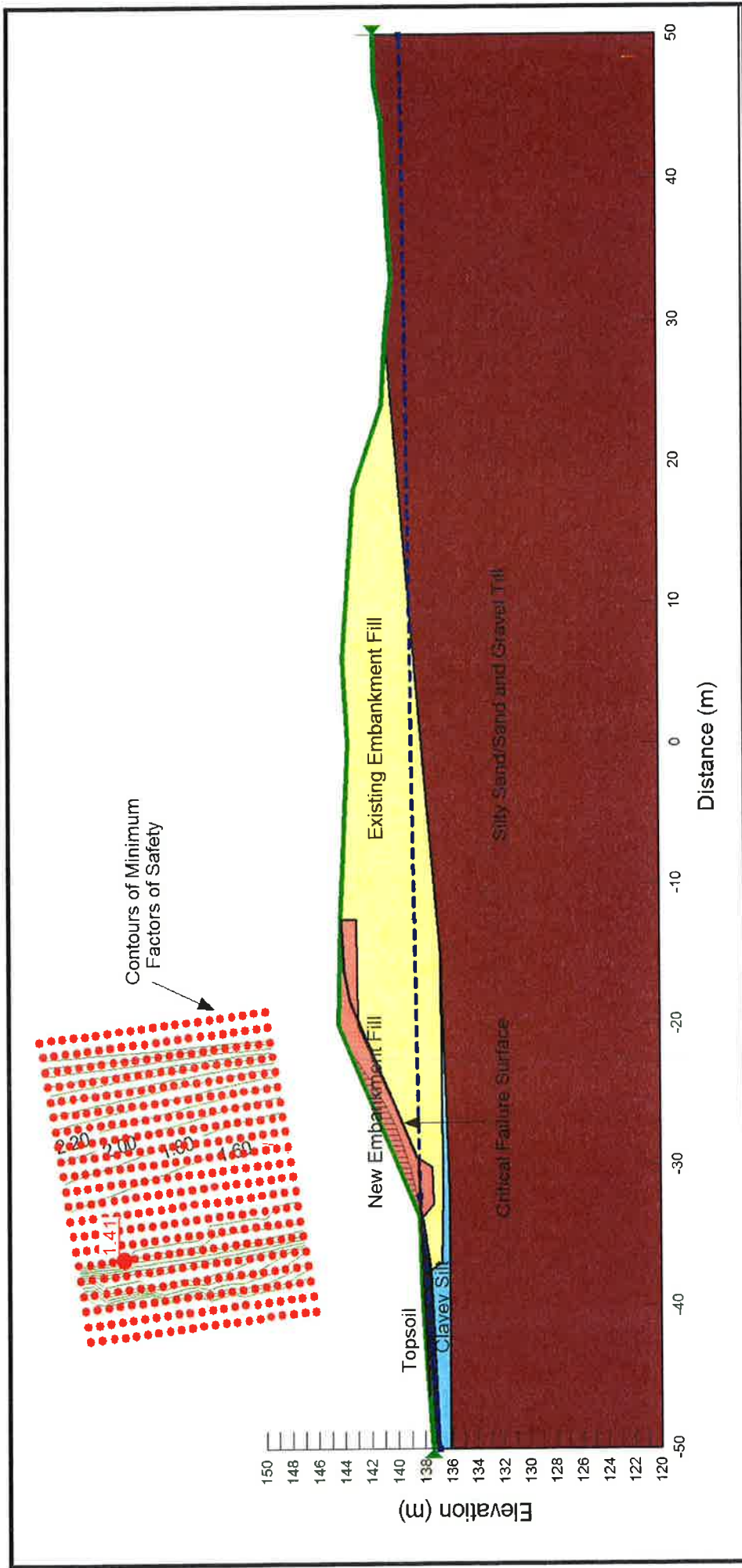
STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 4




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PROJECT:	TRANETOBT0434AA	DATE:	Jan-2012	FIGURE G4-2
DESIGN:	HW	REVIEW:	ZO	

Highway 401 Expansion



Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

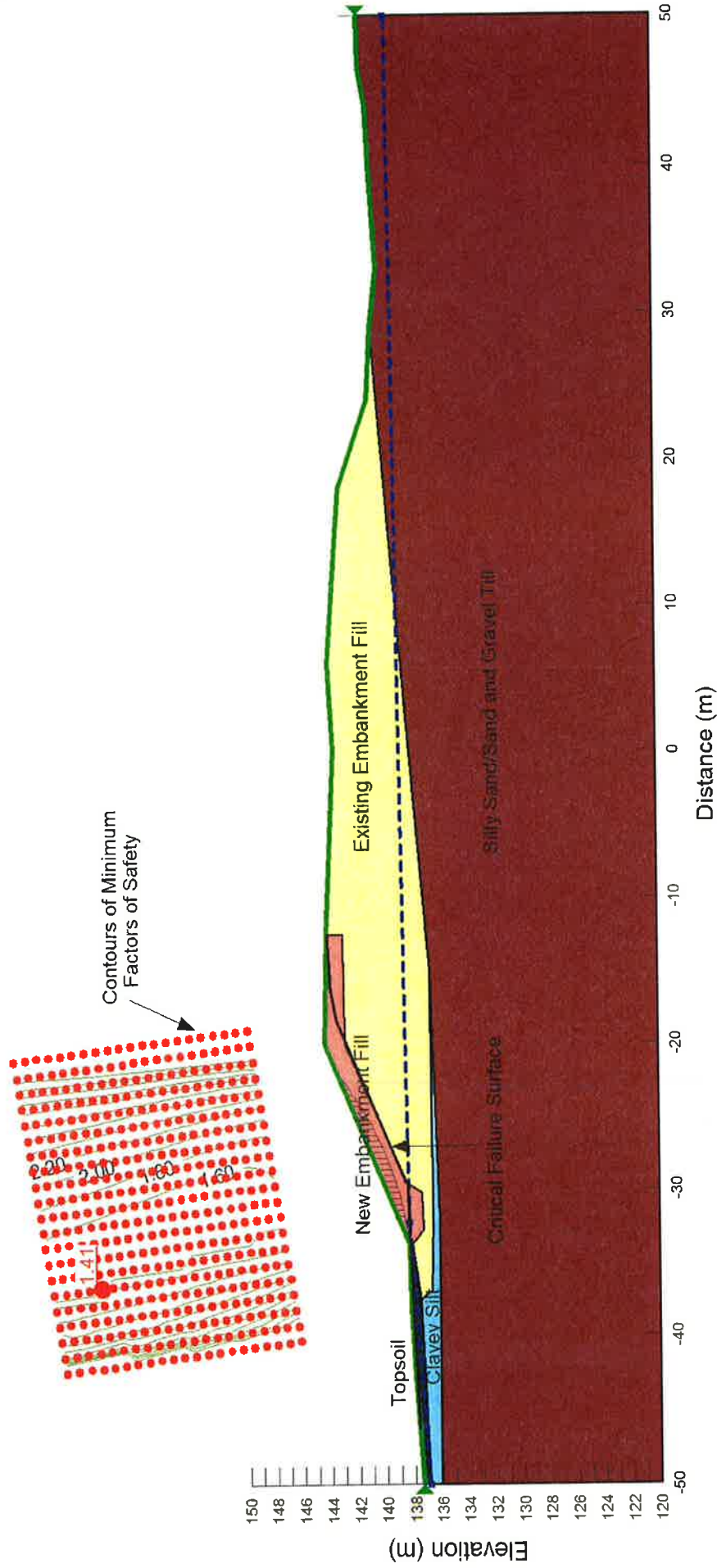
Section : Sta. 22+300 WB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4

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PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO
Highway 401 Expansion			FIGURE G4-3



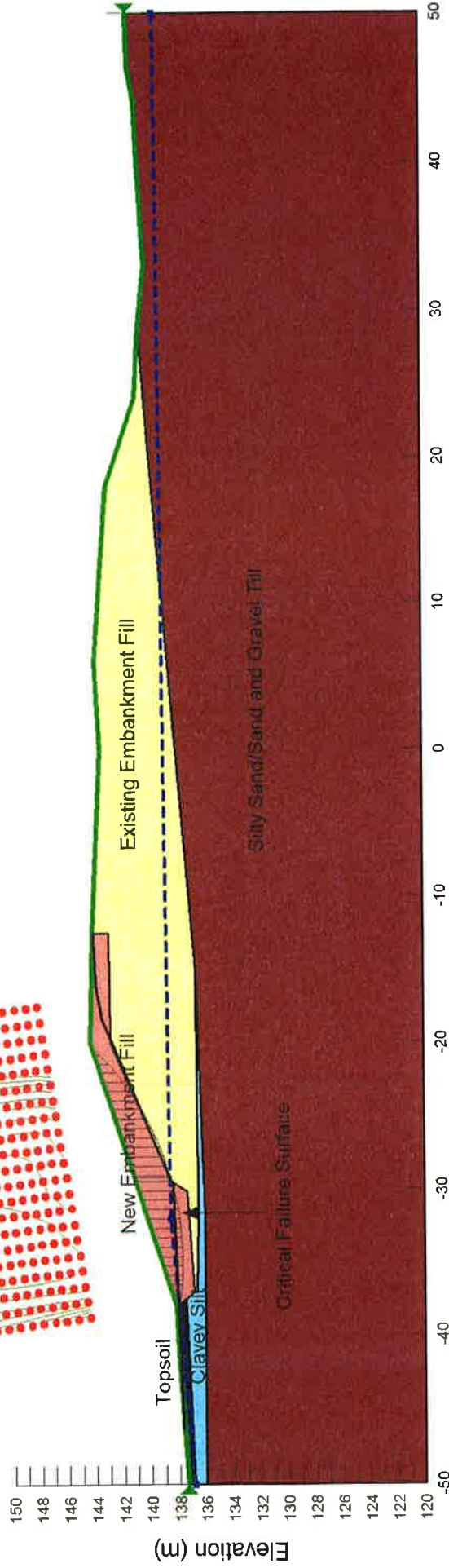
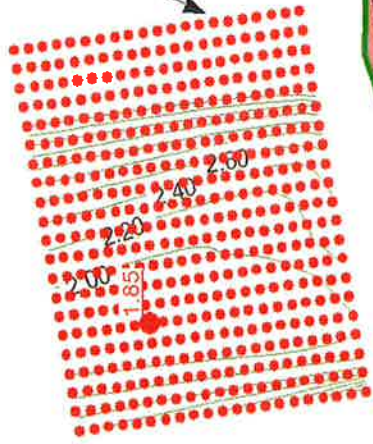
Section : Sta. 22+300 WB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4

Contours of Minimum Factors of Safety



Section : Sta. 22+300 WB
 Slope : 3.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

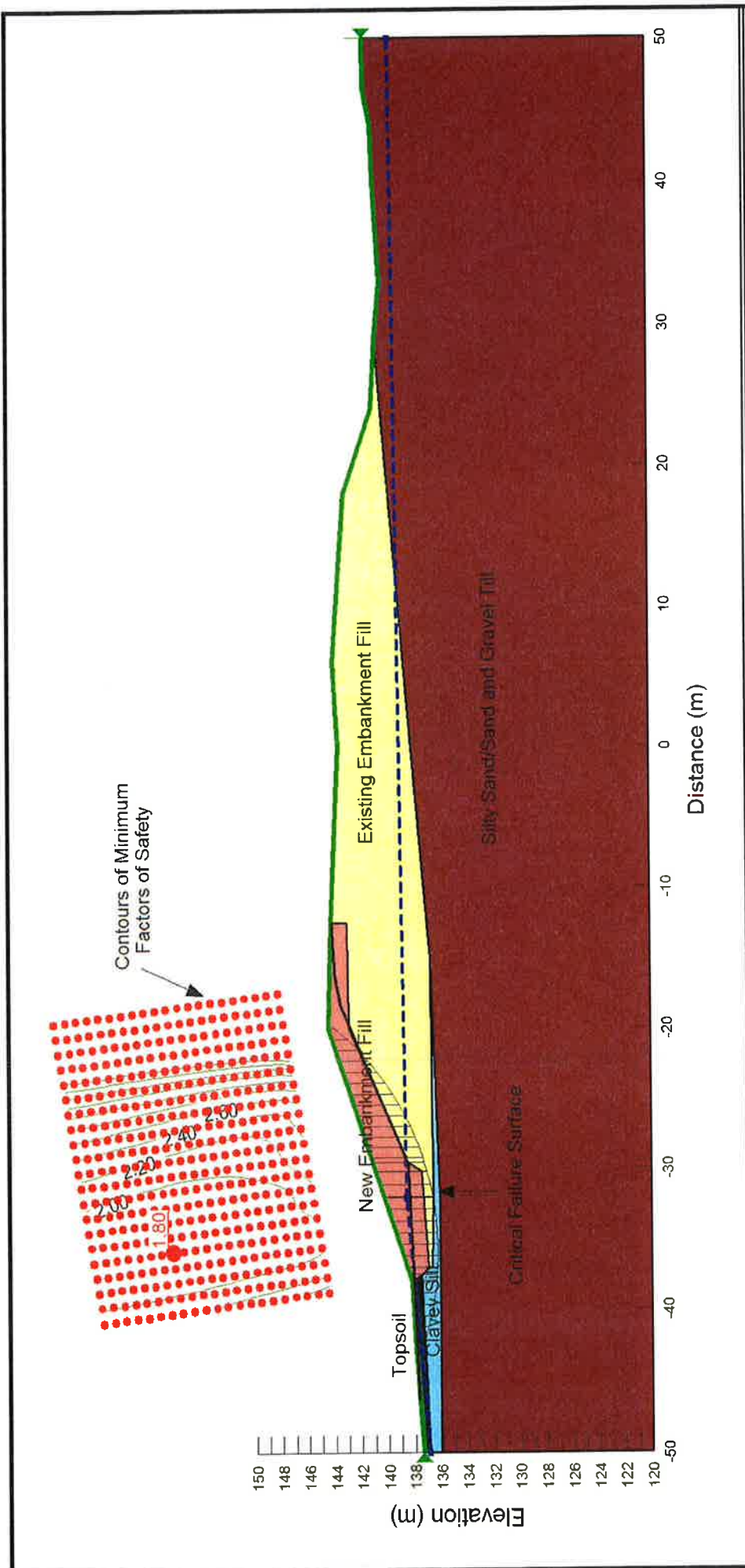
STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETO10434AA	DATE:	Jan-2012	FIGURE G4-5
DESIGN:	HW	REVIEW:	ZO	

Highway 401 Expansion



Section : Sta. 22+300 WB
 Slope : 3.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

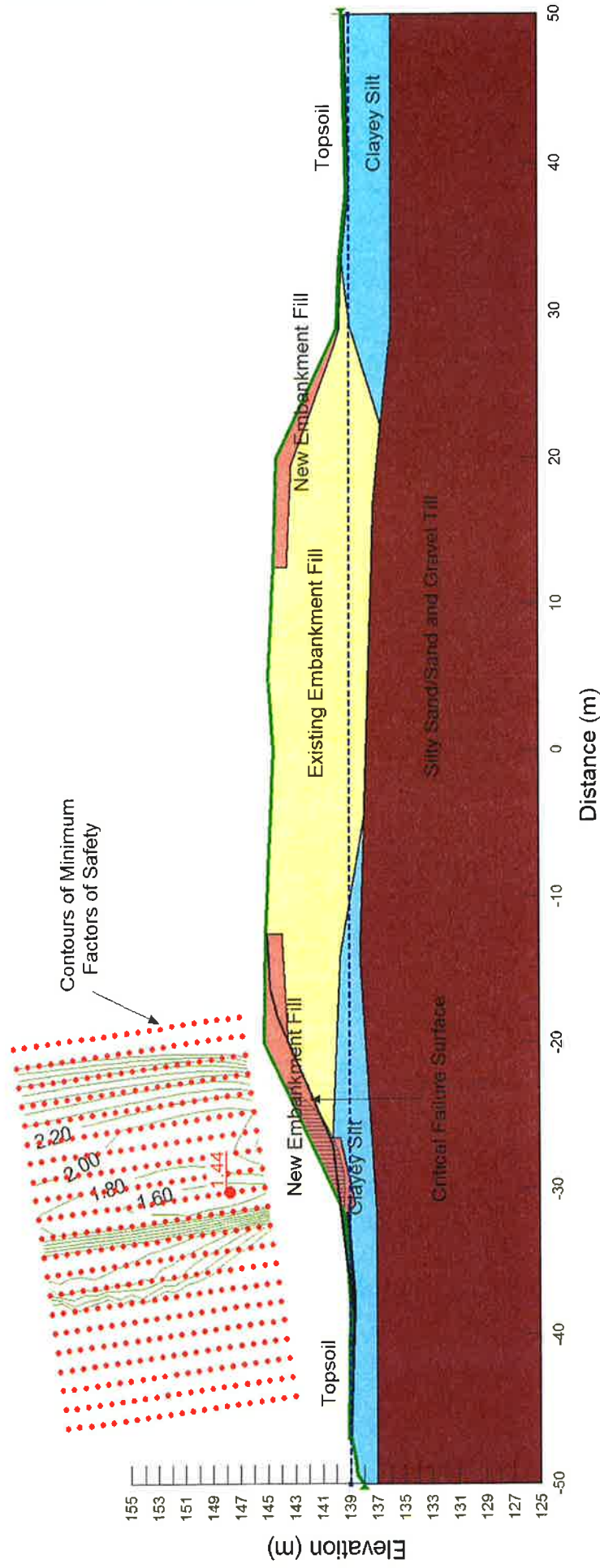
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4

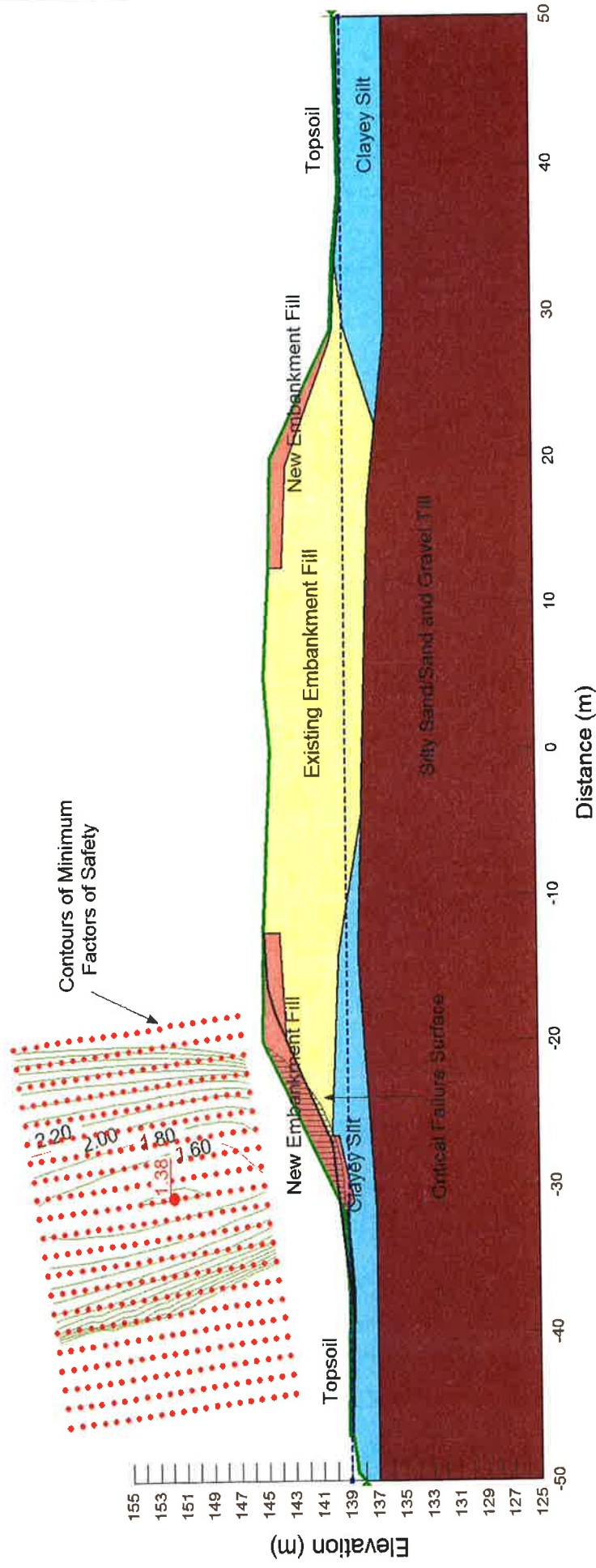


PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO
Highway 401 Expansion			FIGURE G4-6



Section : Sta. 22+350 WB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

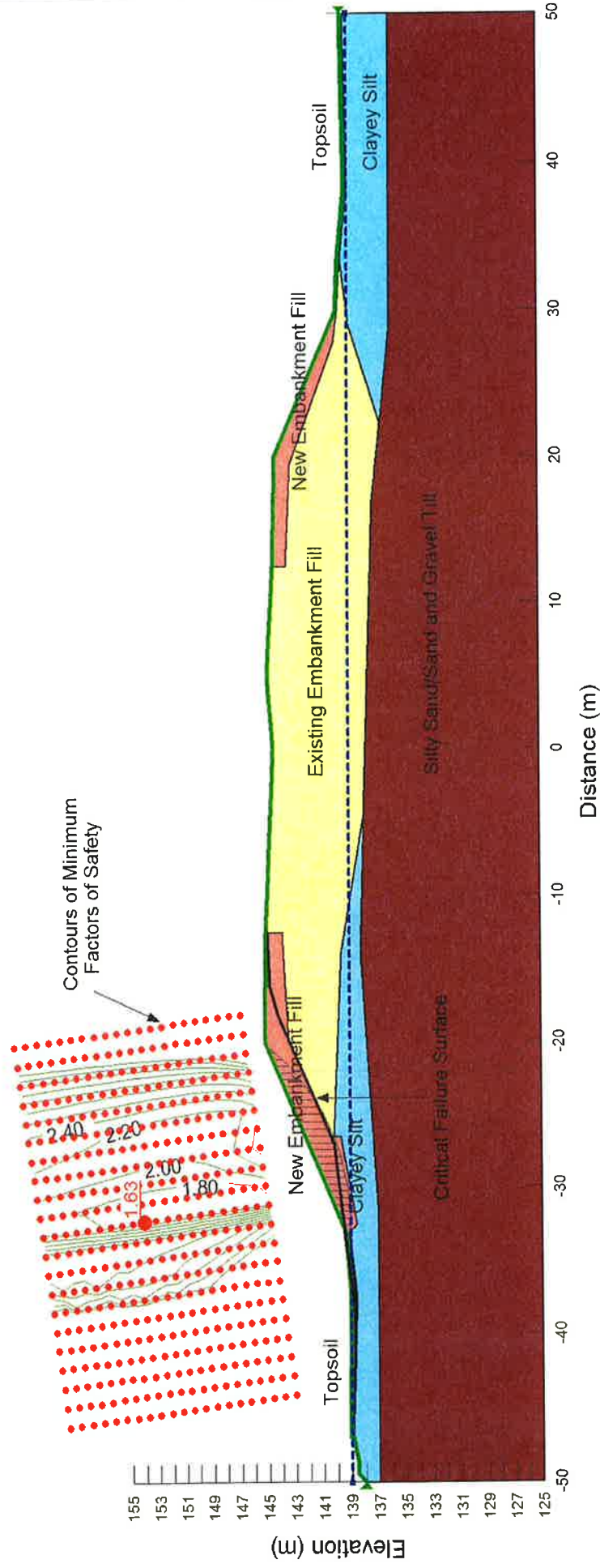


Section : Sta. 22+350 WB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4

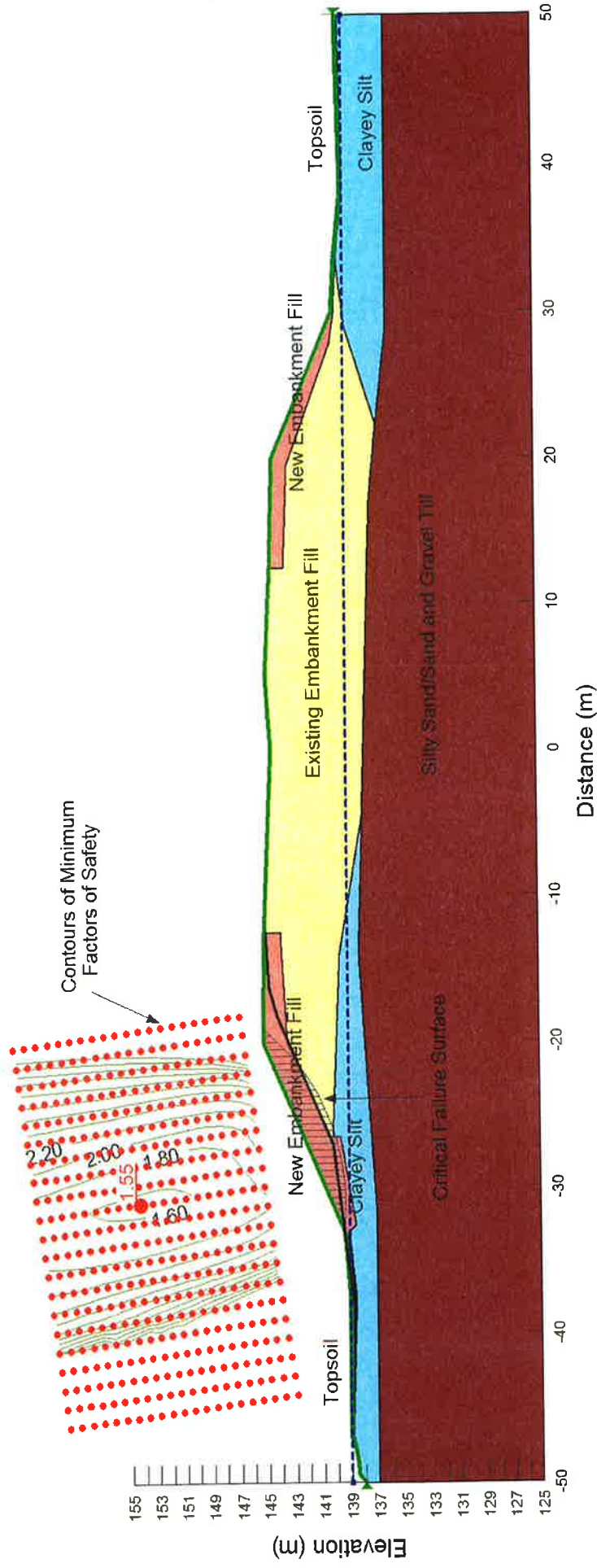


Section : Sta. 22+350 WB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 4



Section : Sta. 22+350 WB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS

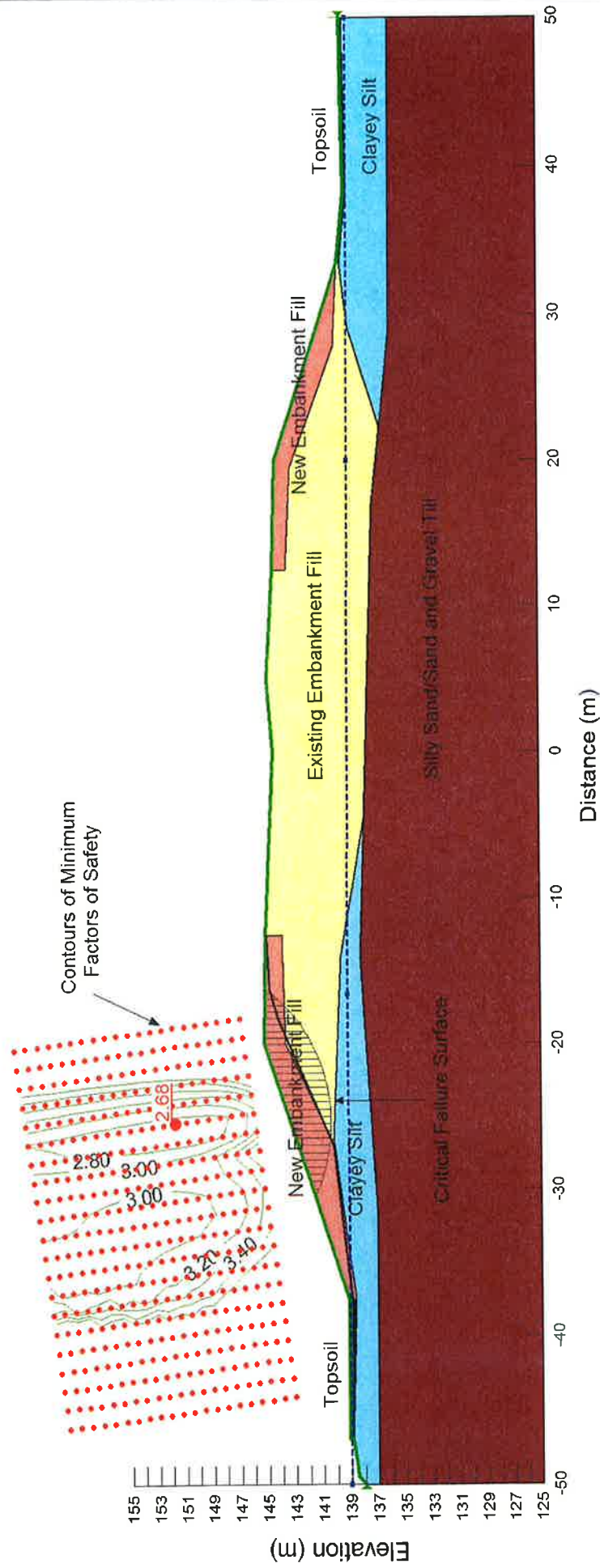
Embankment Fill Area 4

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FIGURE G4-10

Highway 401 Expansion

PROJECT: TRANETO10434AA DATE: Jan-2012
 DESIGN: HW REVIEW: ZO



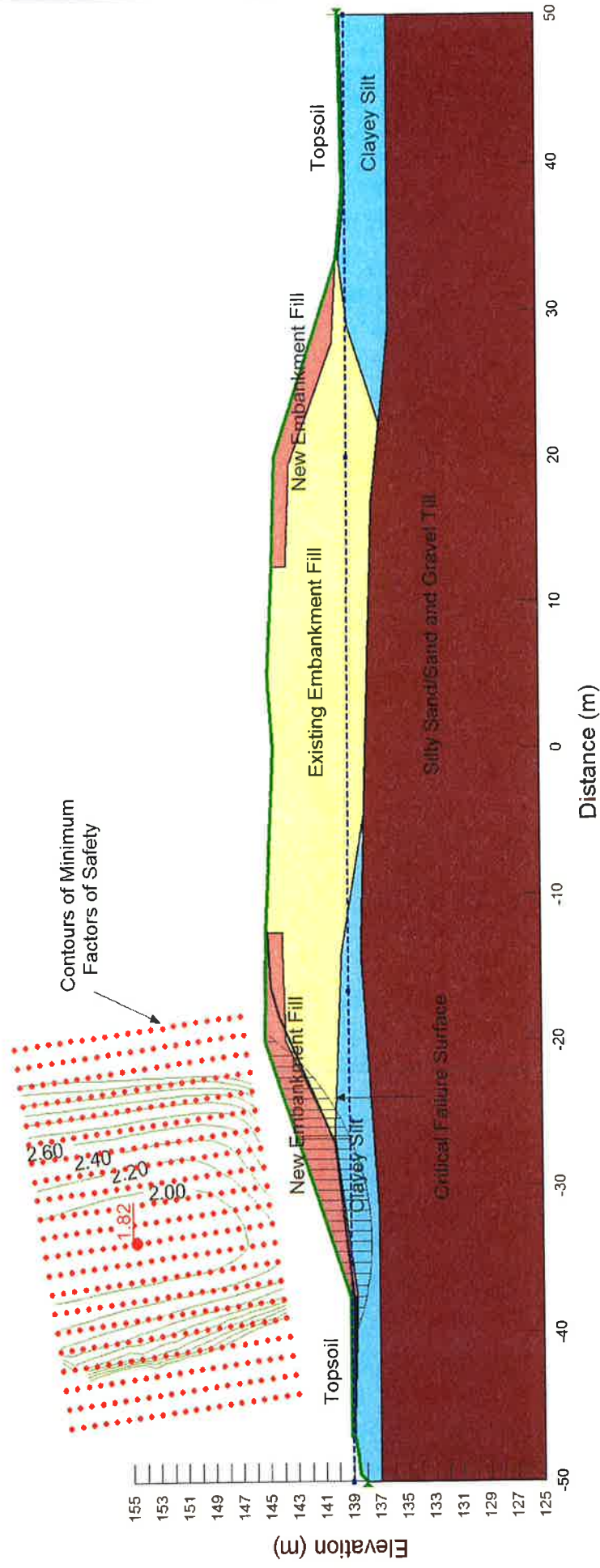
Section : Sta. 22+350 WB
 Slope : 3.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	80	0
Silty Sand Till	22.0	0	33

STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 4

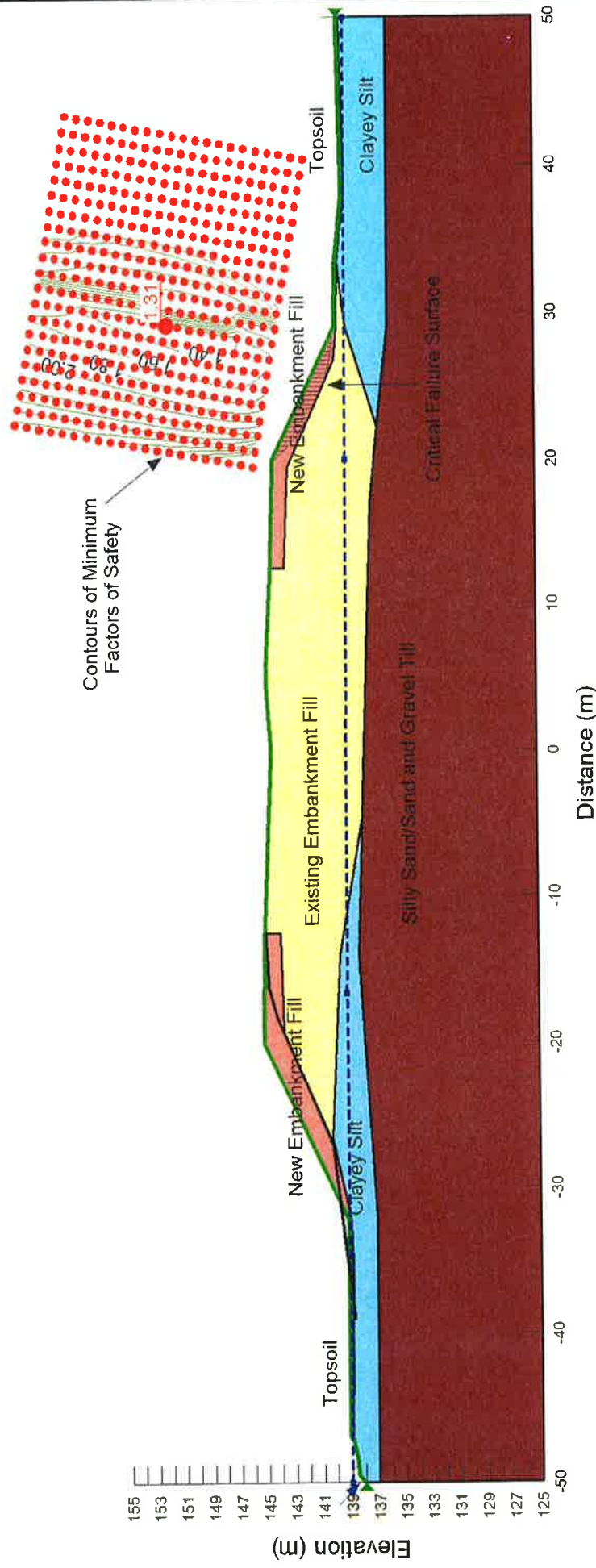


PROJECT:	TRANETOB10434AA	DATE:	Jan-2012	Highway 401 Expansion	FIGURE G4-11
DESIGN:	HW	REVIEW:	ZO		



Section : Sta. 22+350 WB
 Slope : 3.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	33



Section : Sta. 22+350 EB
 Slope : 2.0H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	50	0
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

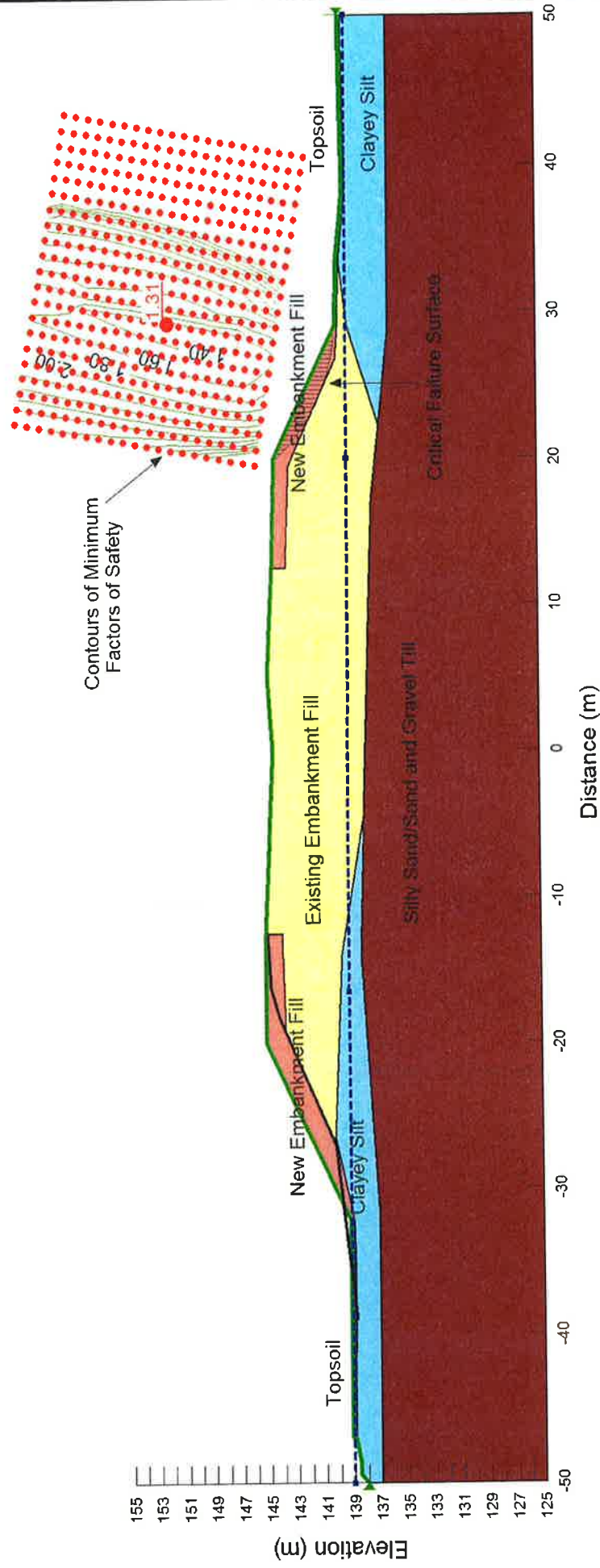
Embankment Fill Area 5

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PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G5-1

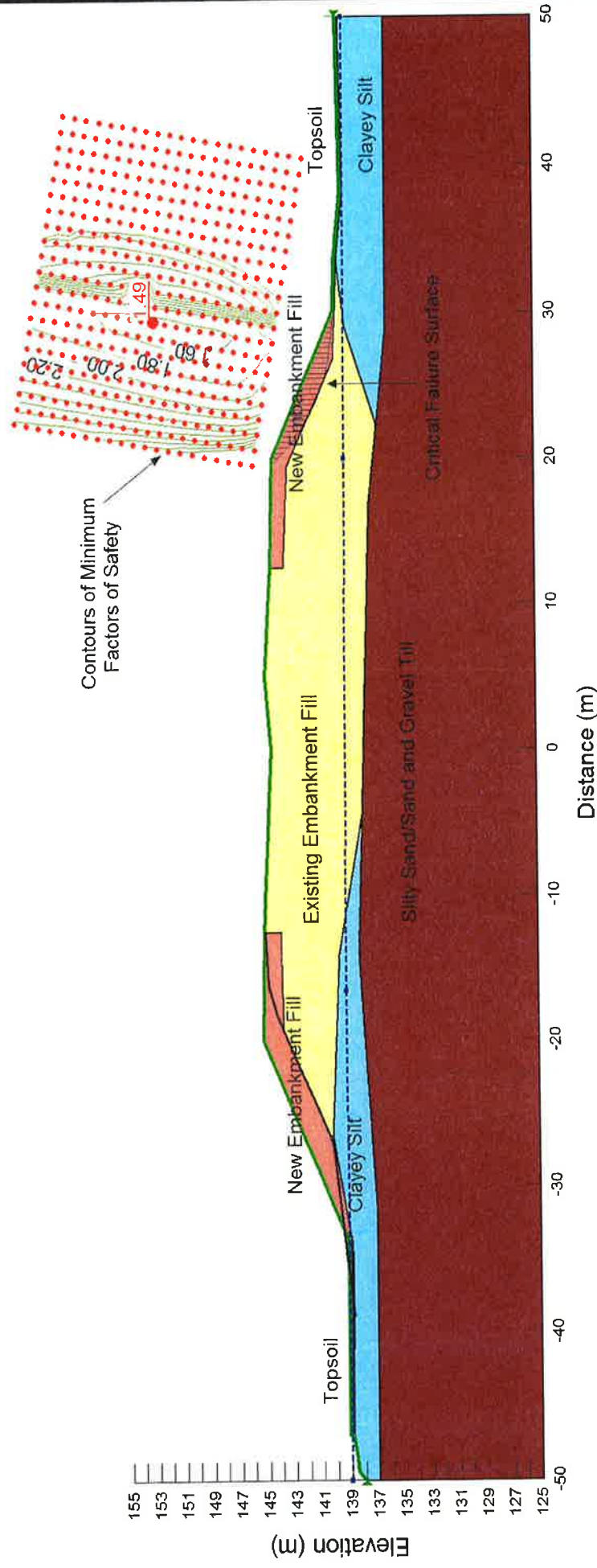


Section : Sta. 22+350 EB
 Slope : 2.0H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS

Embankment Fill Area 5



Section : Sta. 22+350 EB
 Slope : 2.25H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	50	0
Silty Sand Till	22.0	0	34

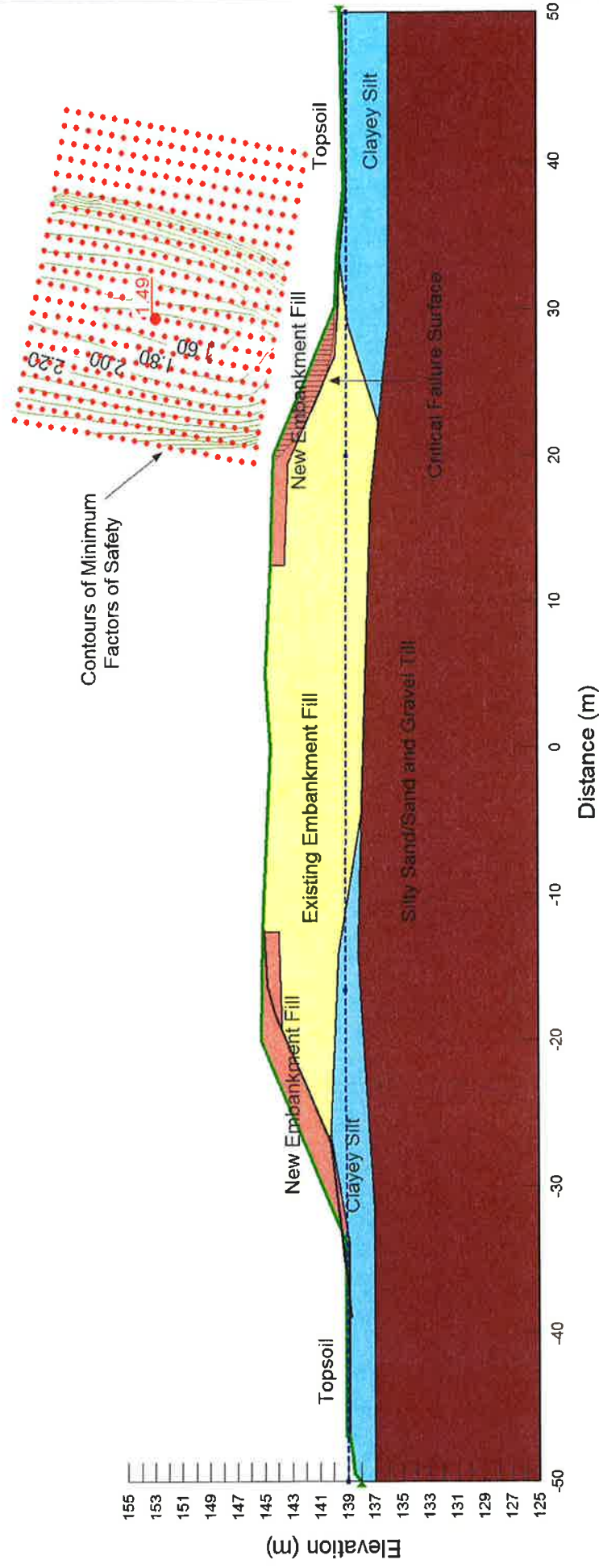
STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 5

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

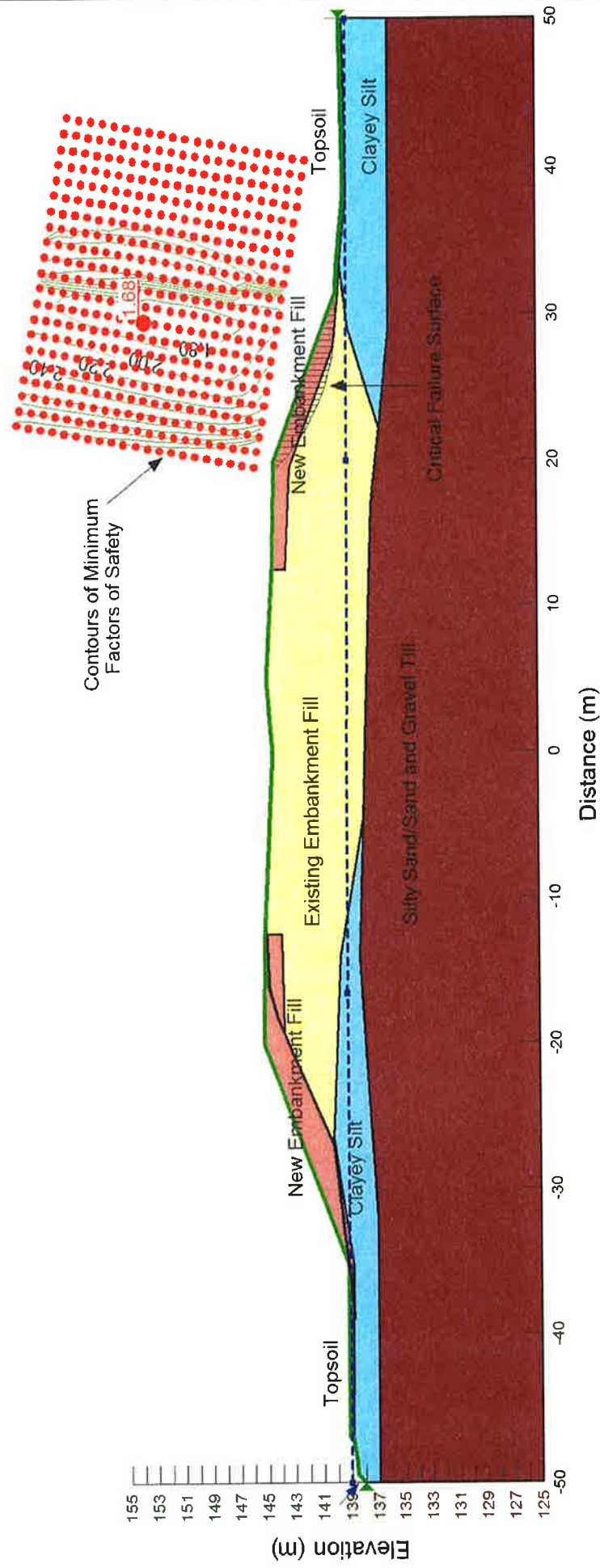
Highway 401 Expansion

FIGURE G5-3



Section : Sta. 22+350 EB
 Slope : 2.25H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	34



Section : Sta. 22+350 EB
 Slope : 2.5H:1V
 Condition : Undrained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	50	0
Silty Sand Till	22.0	0	34



SPECIALISTS MANAGING THE EARTH

STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 5

PROJECT: TRANETOB10434AA

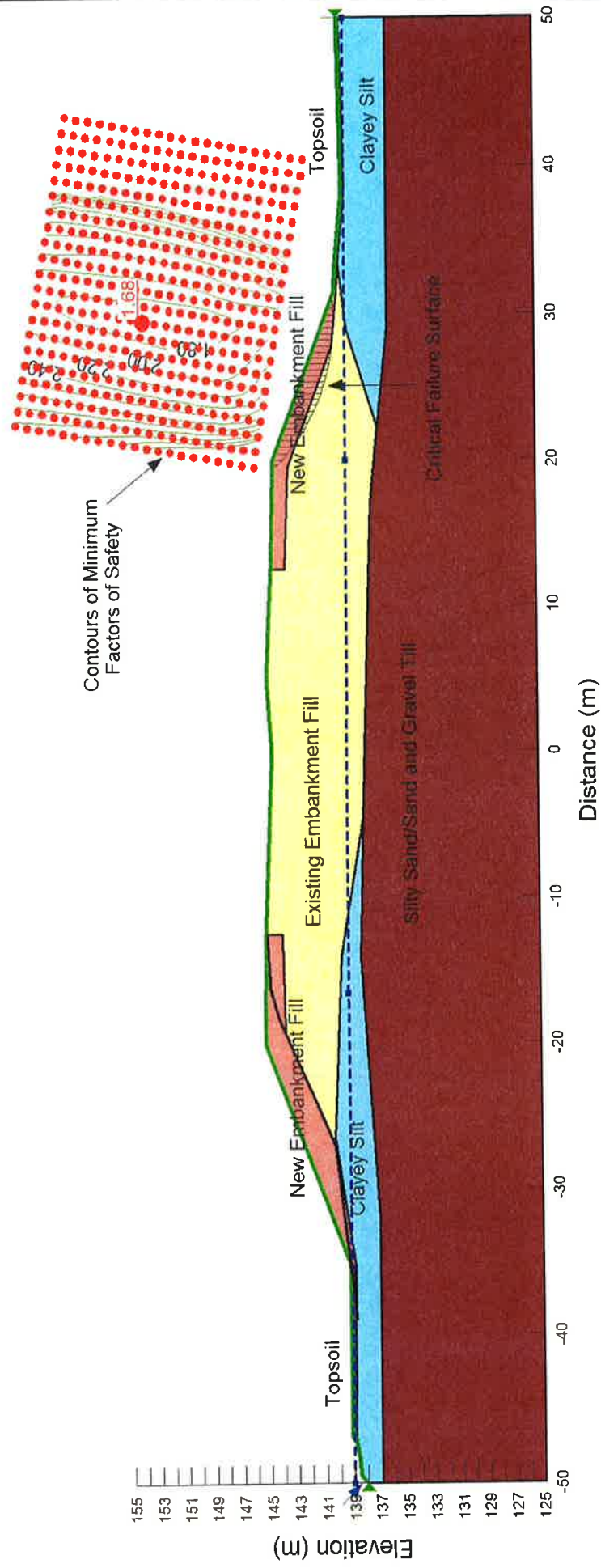
DATE: Jan-2012

DESIGN: HW

REVIEW: ZO

Highway 401 Expansion

FIGURE G5-5

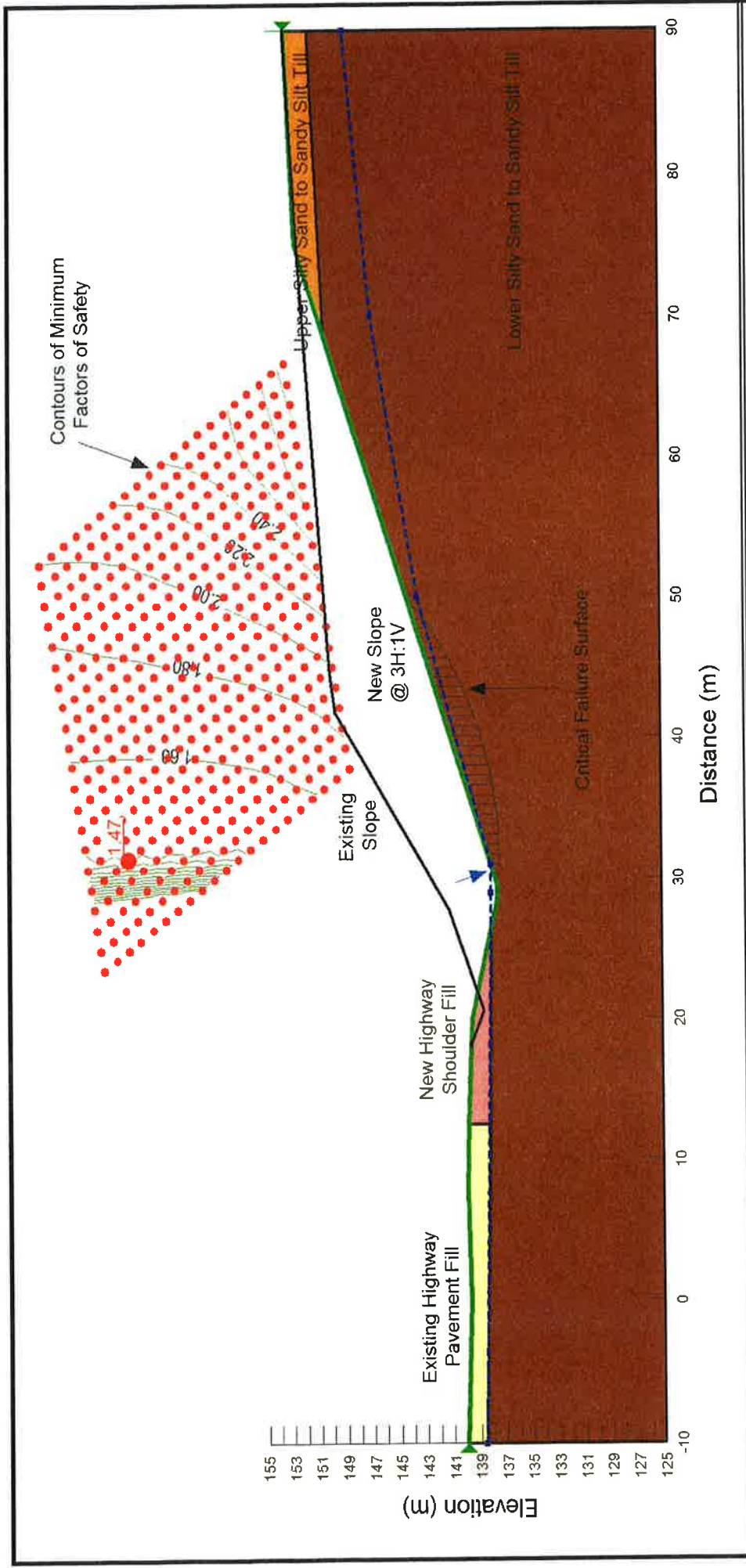


Section : Sta. 22+350 EB
 Slope : 2.5H:1V
 Condition : Drained
 Method : Morgenstern - Price

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Embankment Fill	20.5	0	31
Existing Embankment Fill	20.0	0	30
Clayey Silt to Silty Clay	18.5	5	25
Silty Sand Till	22.0	0	34

STATIC SLOPE STABILITY ANALYSIS Embankment Fill Area 5

PROJECT:	TRANETO10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO



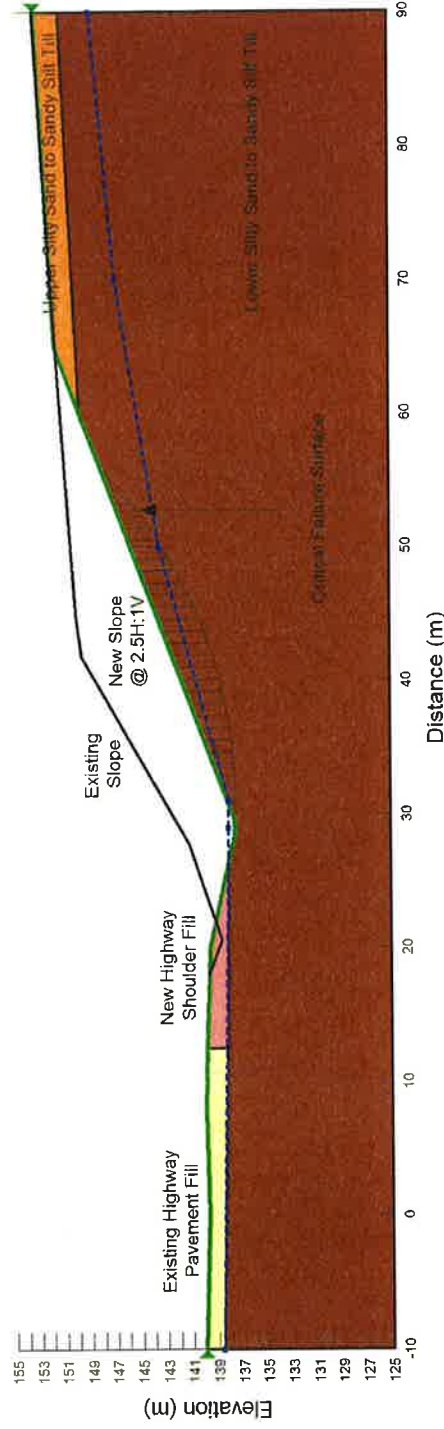
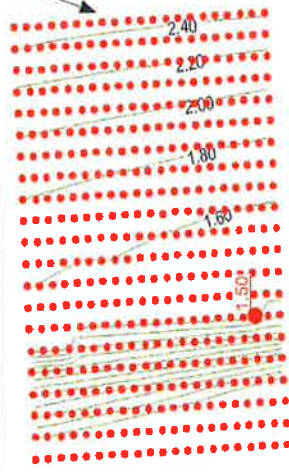
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

Section : Sta. 22+050 EB
 Slope : 3.0H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : No berm

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1

Contours of Minimum Factors of Safety



Section : Sta. 22+050 EB
 Slope : 2.5H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : No berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

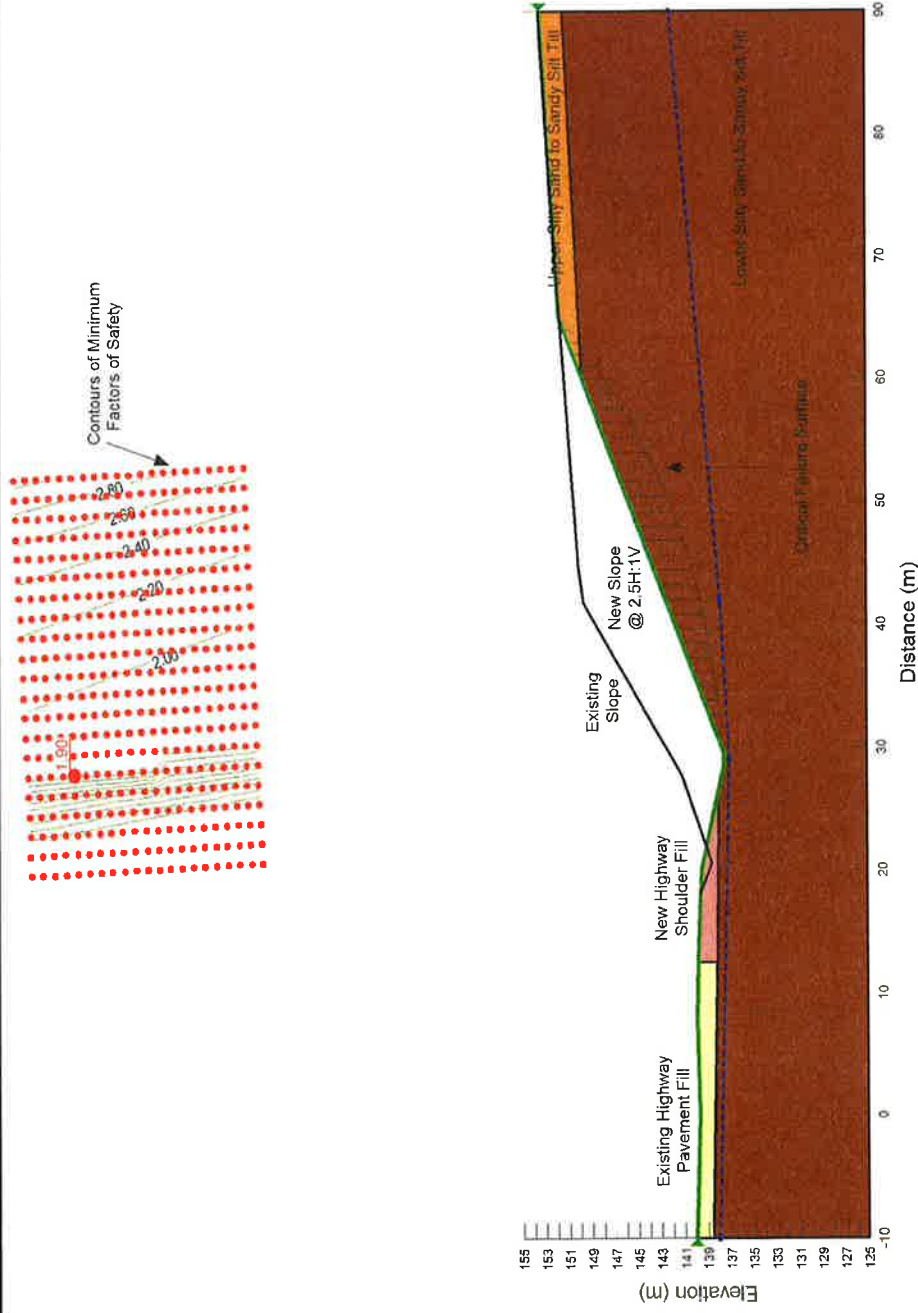
Excavation Cut Area 1

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DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G6-3



Section : Sta. 22+050 EB
 Slope : 2.5H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : No berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

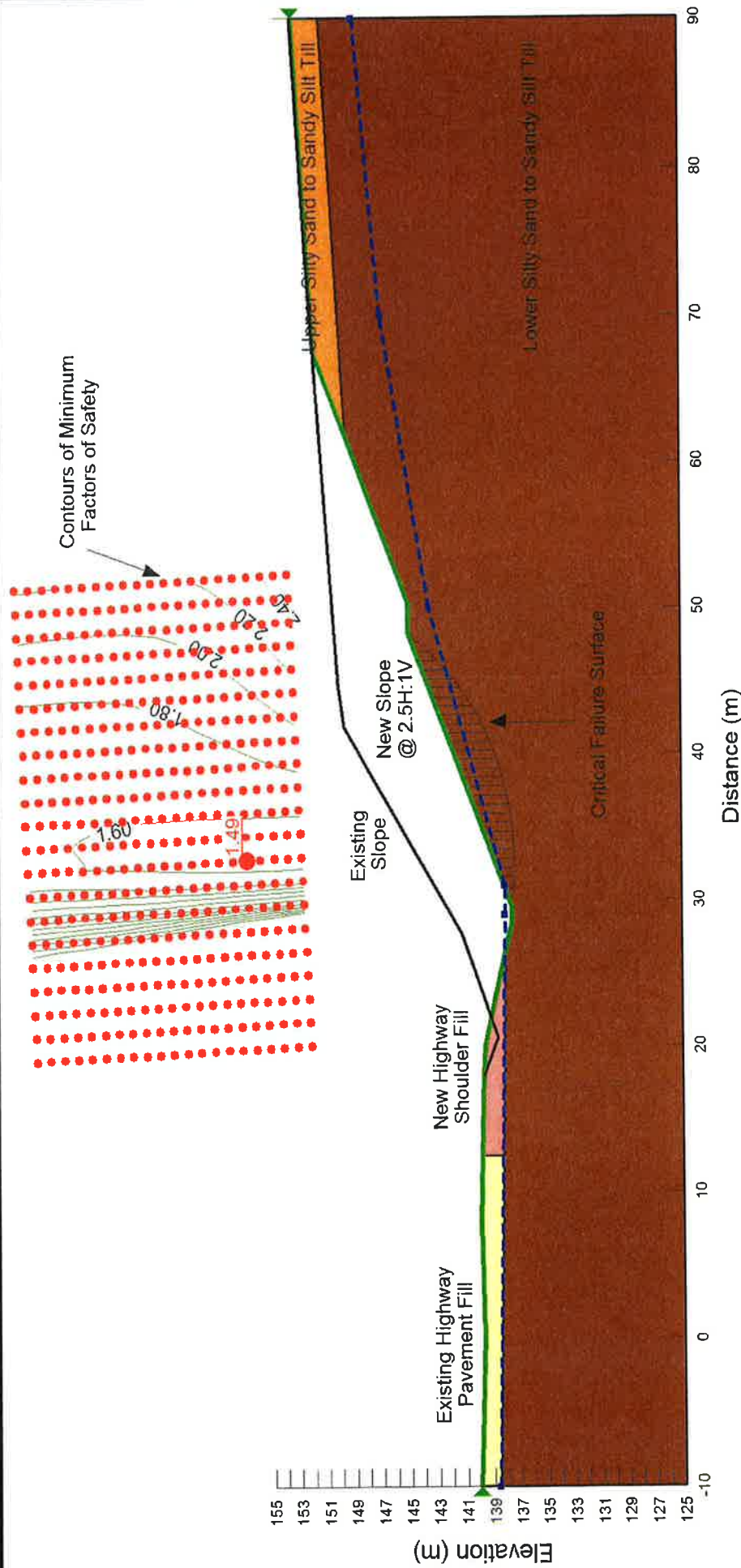
Excavation Cut Area 1

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PROJECT:	TRANETO810434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G6-4



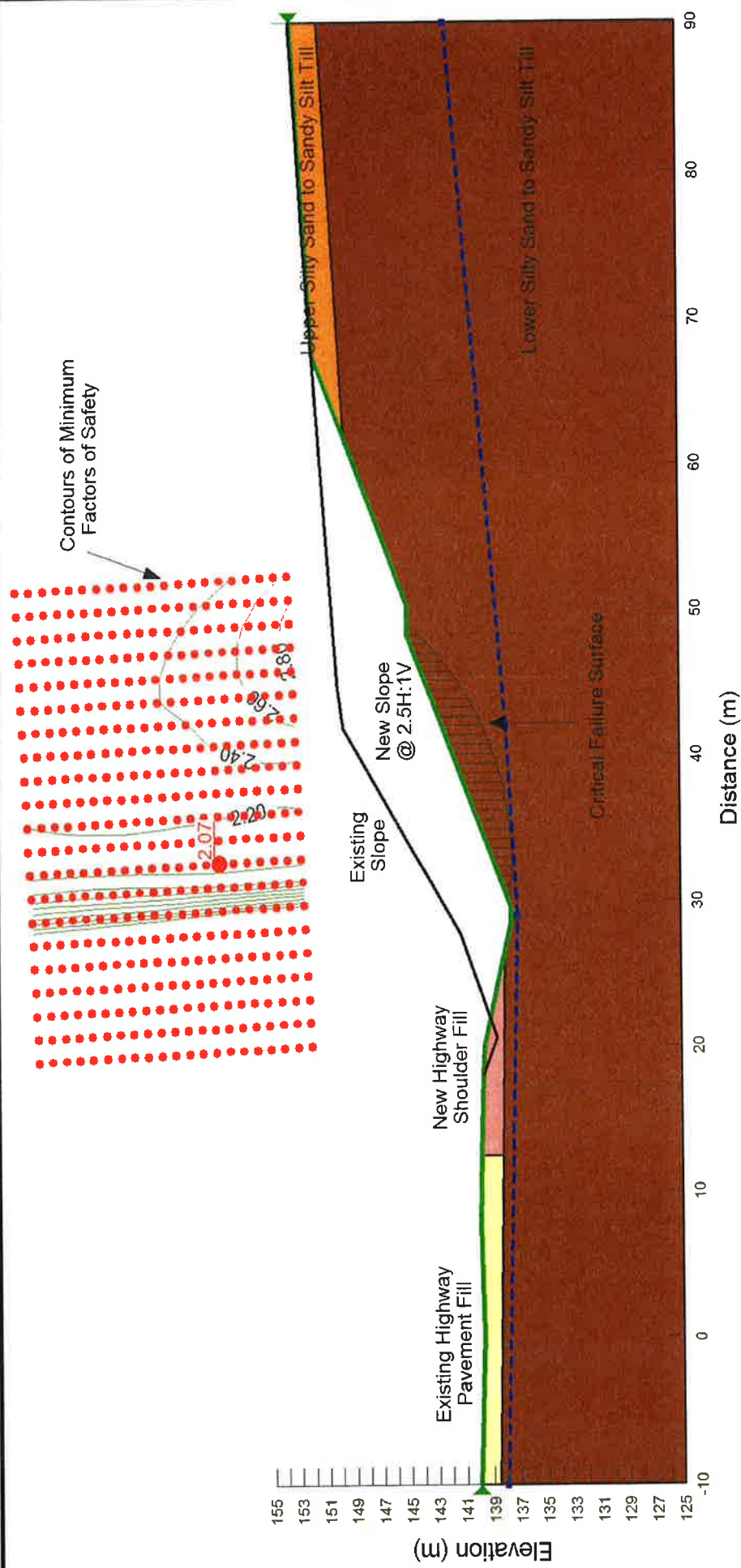
Section : Sta. 22+050 EB
 Slope : 2.5H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : One berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS
 Excavation Cut Area 1



PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO



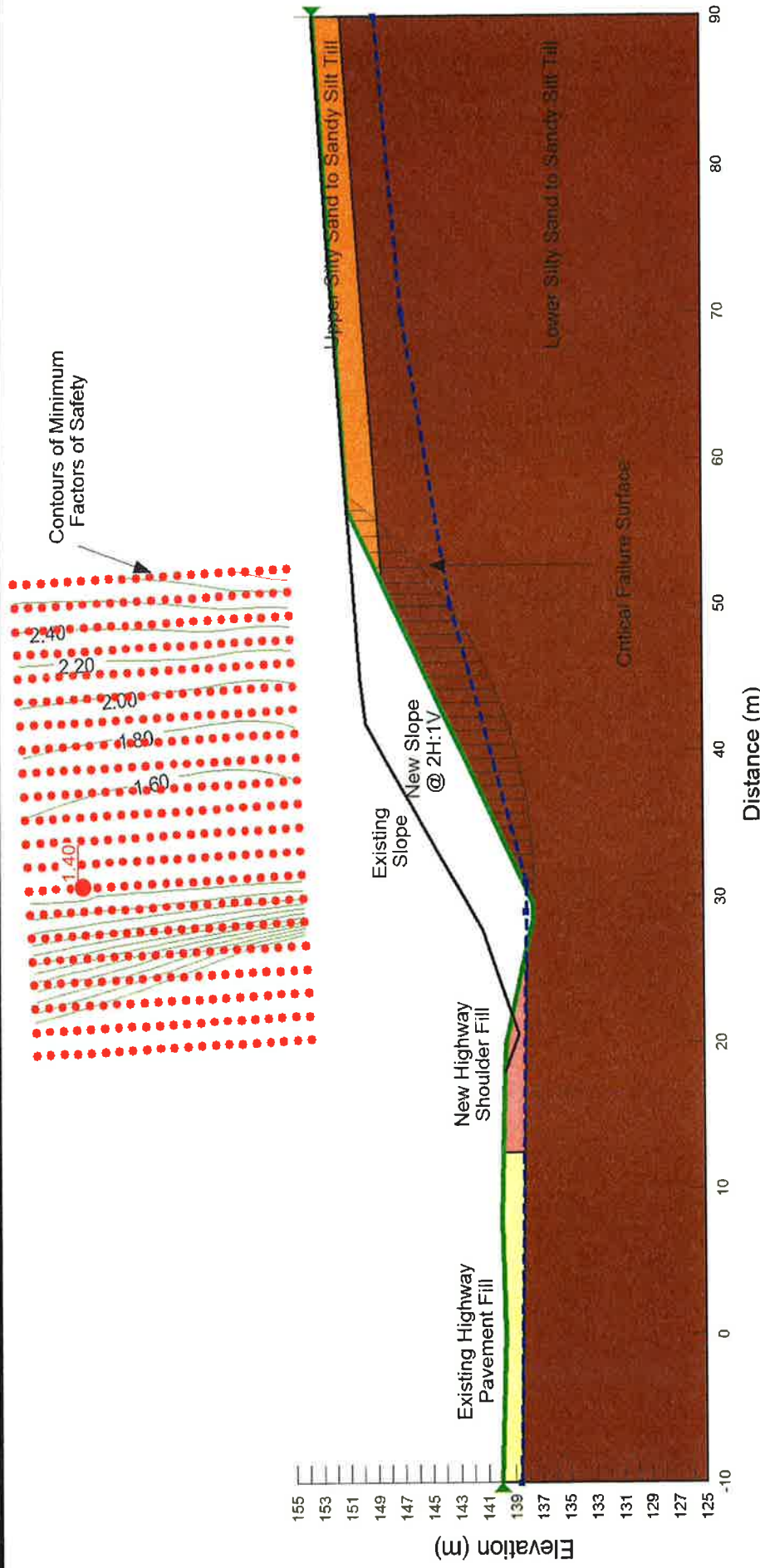
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

Section : Sta. 22+050 EB
 Slope : 2.5H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : One berm

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1





Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : No berm

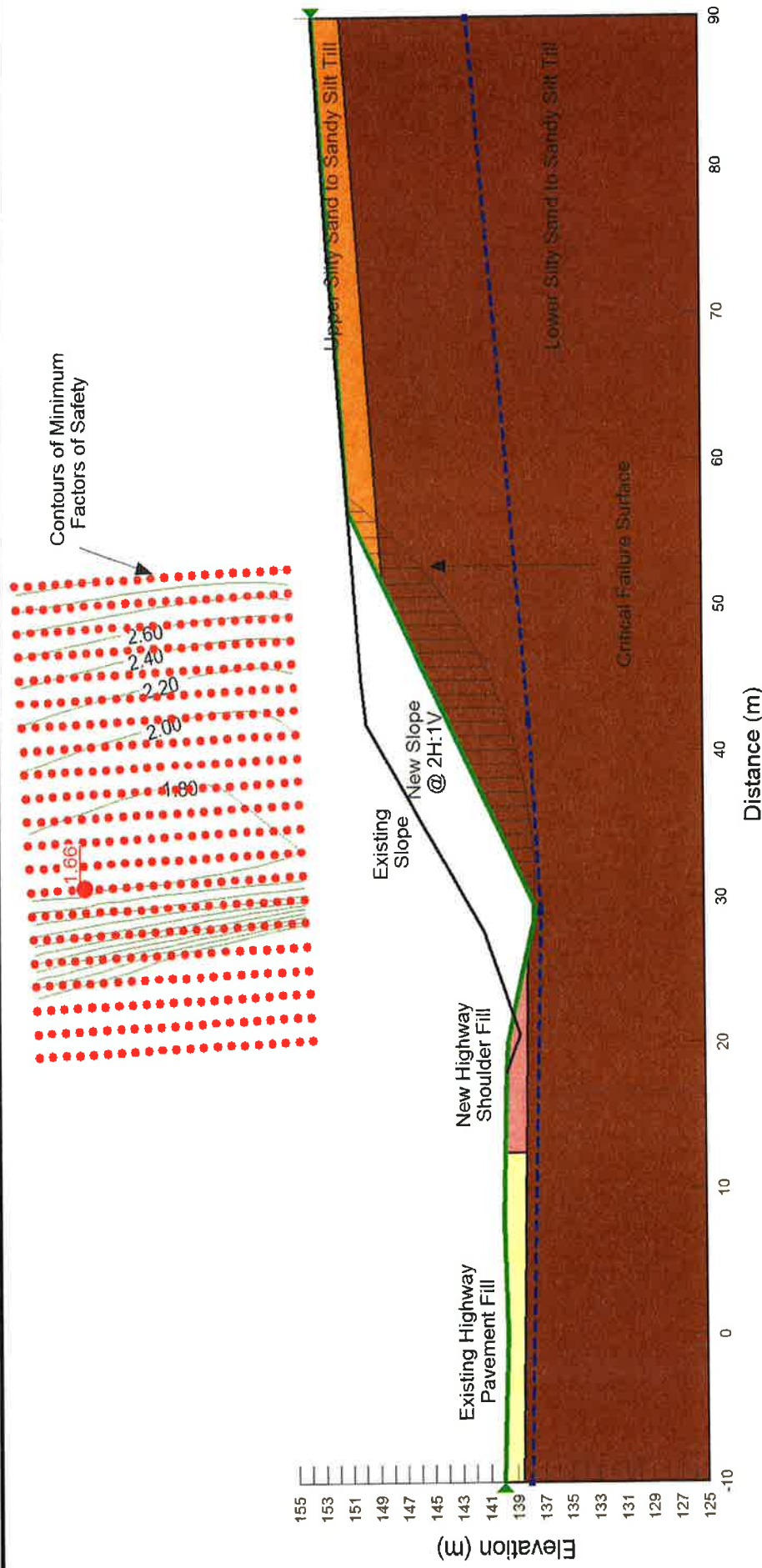
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1

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PROJECT:	TRANETOB10434AA	DATE:	Jan-2012	Highway 401 Expansion	FIGURE G6-7
DESIGN:	HW	REVIEW:	ZO		

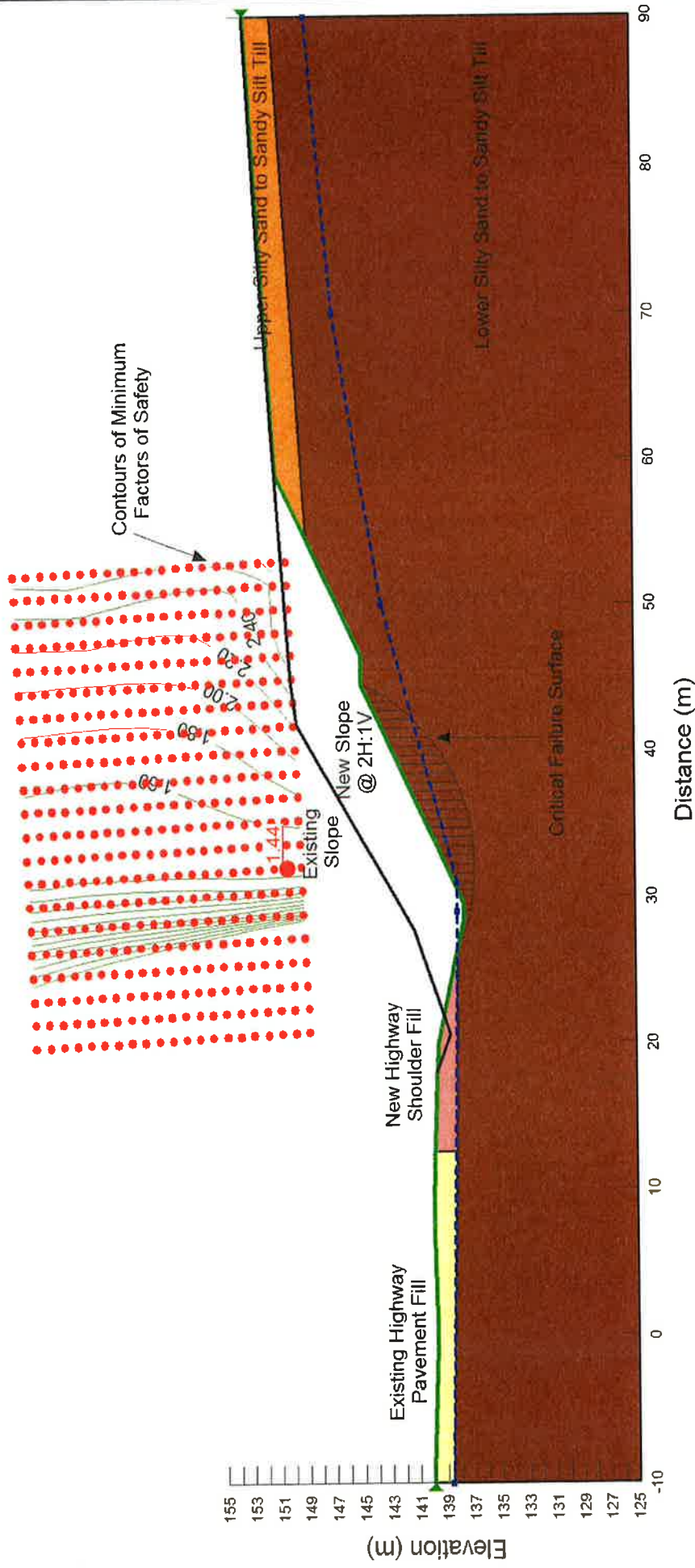


Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : No berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1



Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : One berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

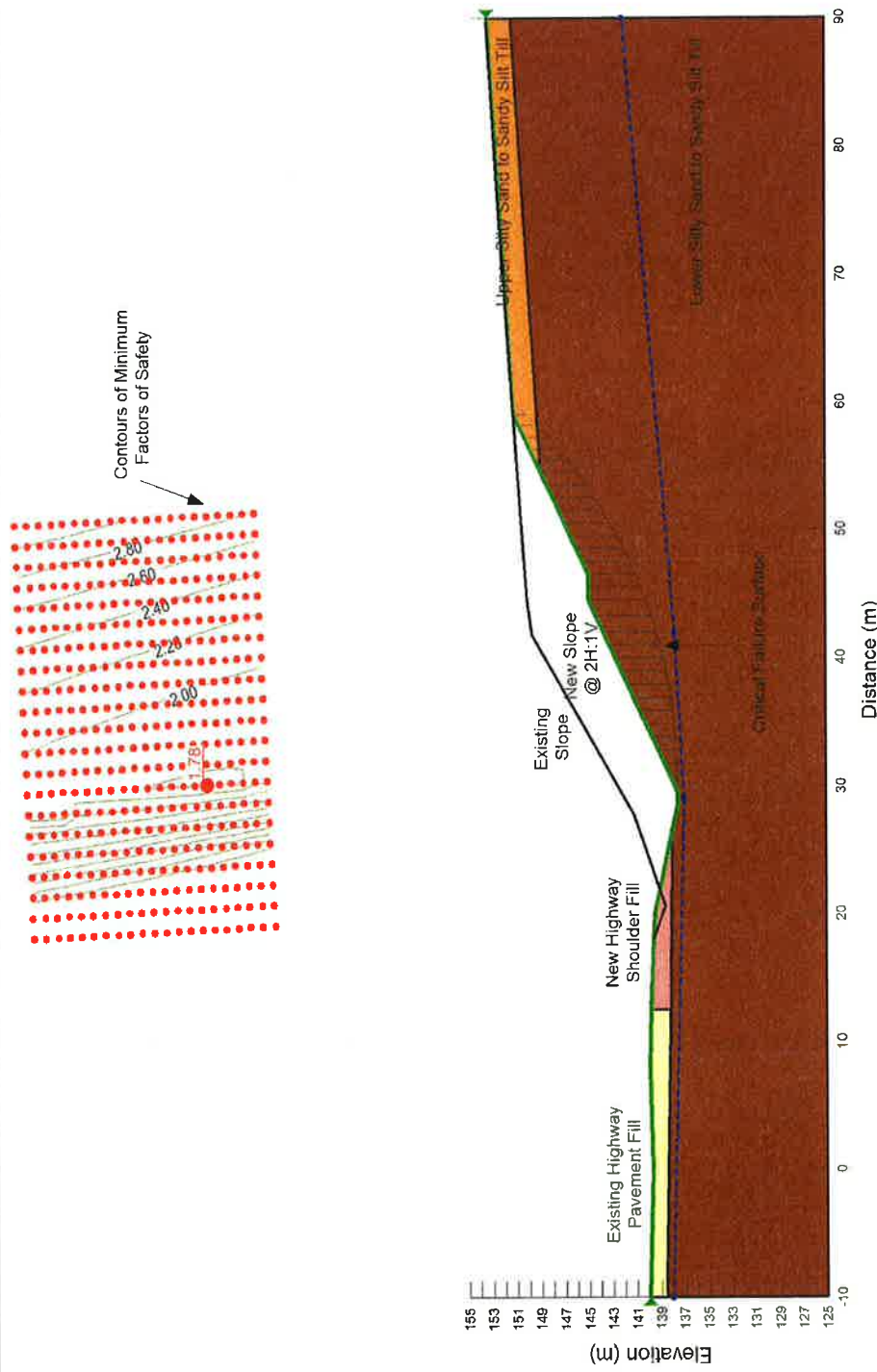
Excavation Cut Area 1

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PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G6-9



Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : One berm

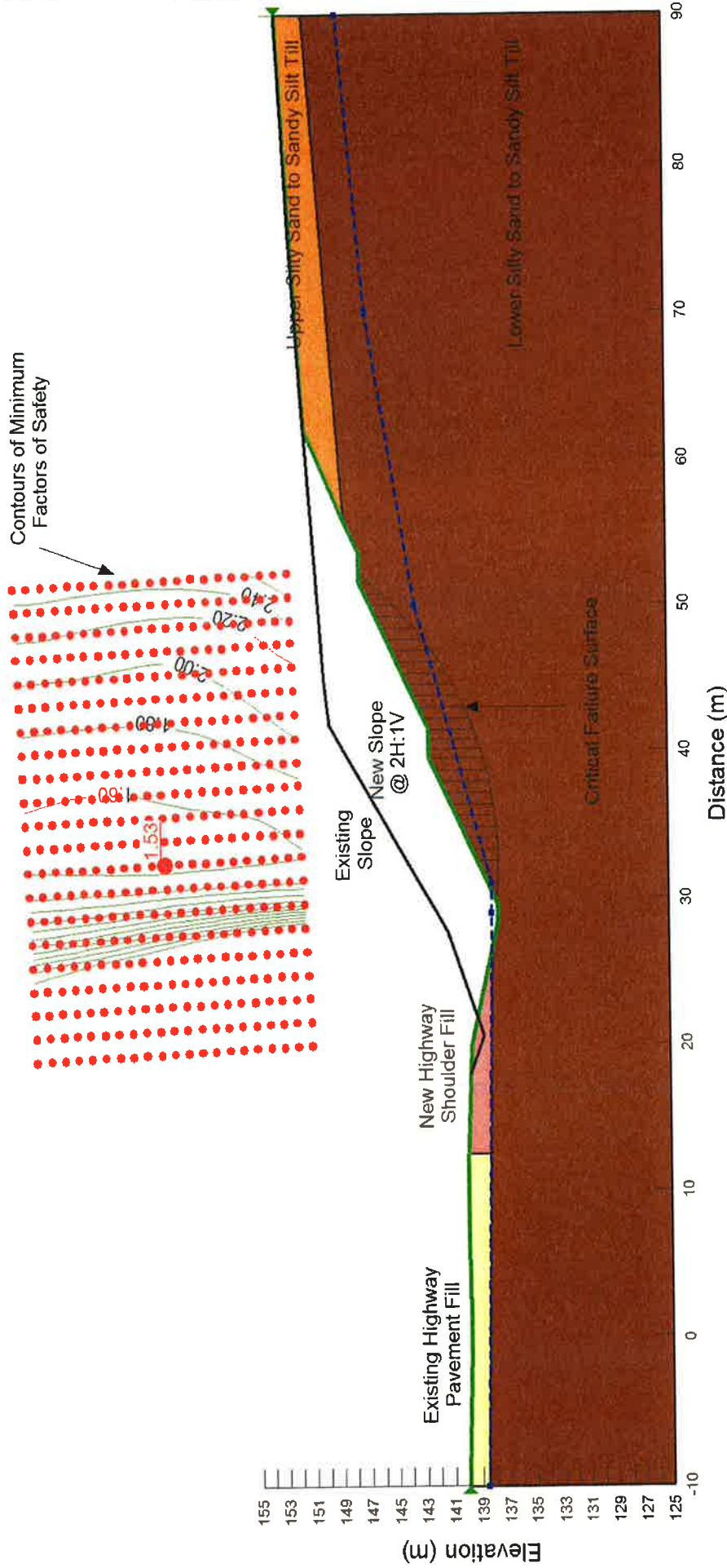
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1



PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO
Highway 401 Expansion		FIGURE G6-10	



Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : Two berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

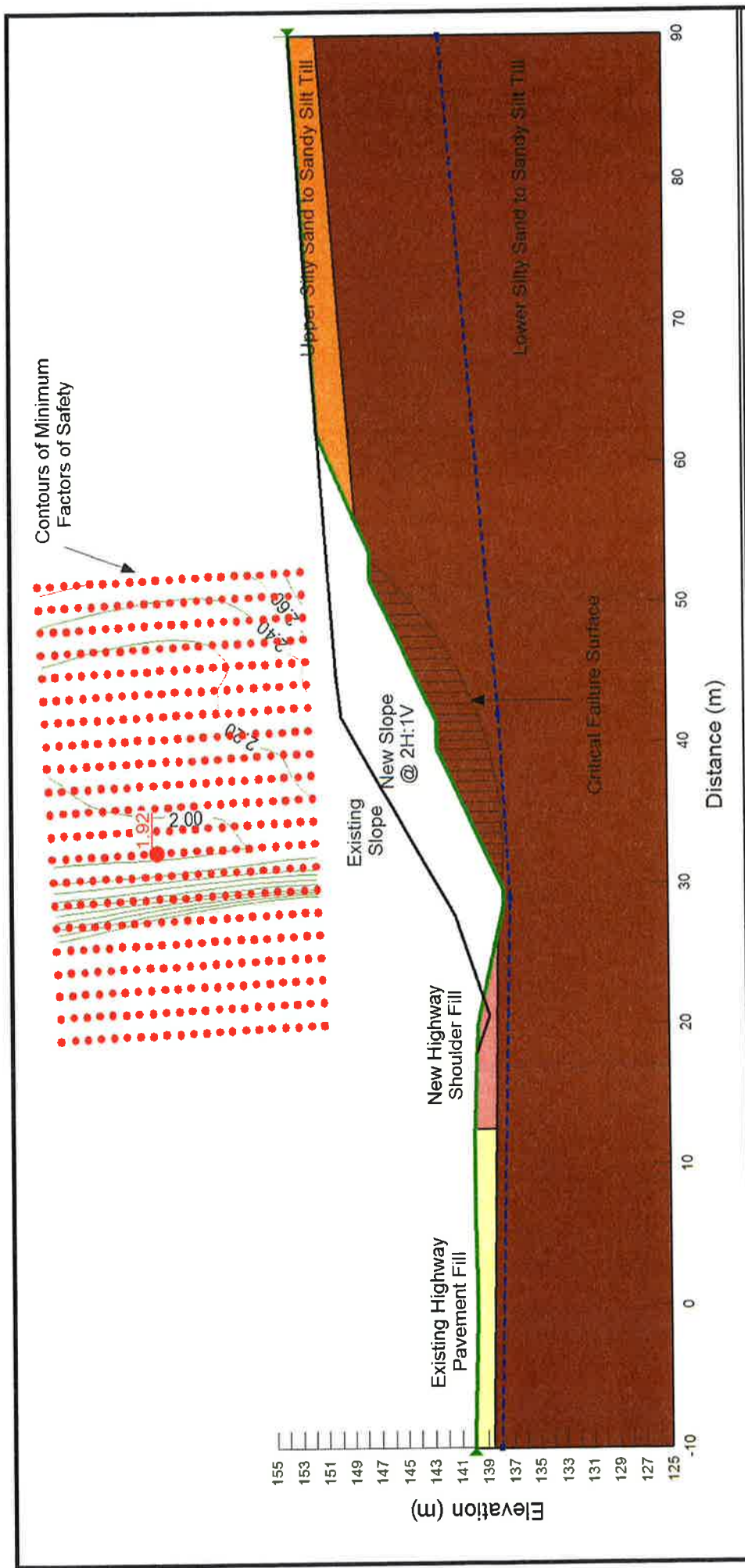
Excavation Cut Area 1

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 SPECIALISTS MANAGING THE EARTH

PROJECT:	TRANETO10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO

Highway 401 Expansion

FIGURE G6-11



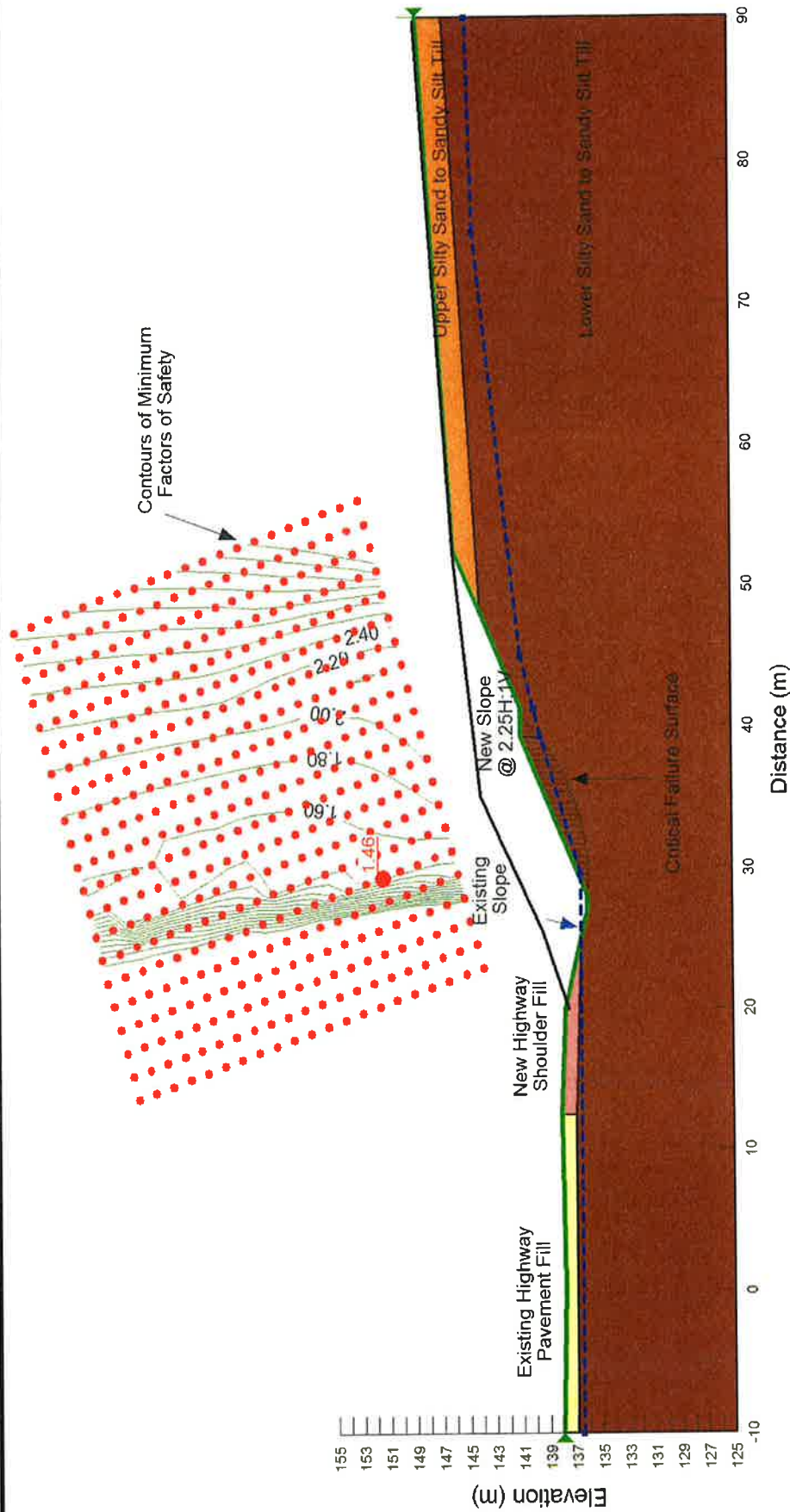
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

Section : Sta. 22+050 EB
 Slope : 2.0H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : Two berm

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1

PROJECT:	TRANETOB10434AA	DATE:	Jan-2012
DESIGN:	HW	REVIEW:	ZO
Highway 401 Expansion			FIGURE G6-12

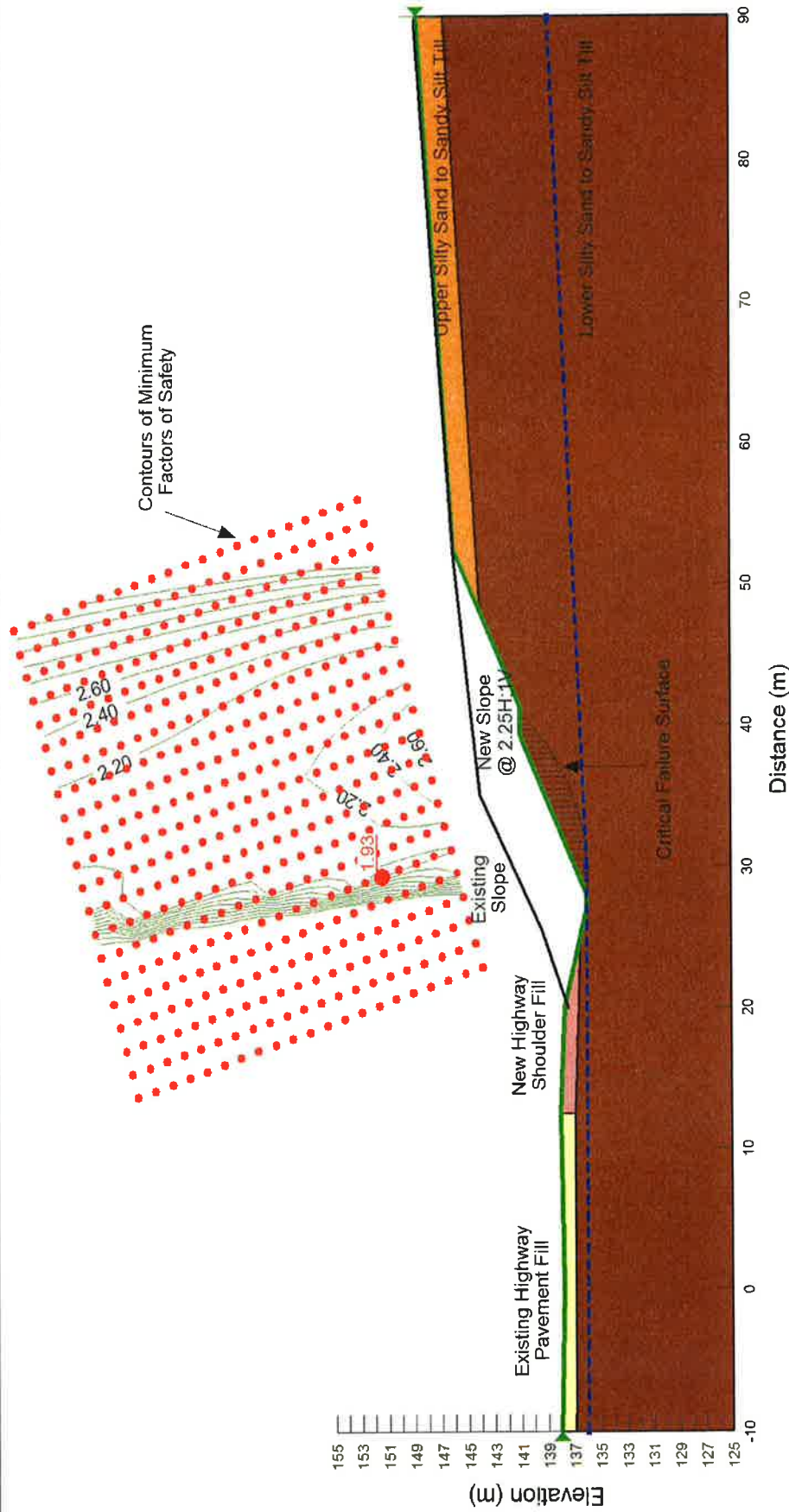


Section : Sta. 21+950 EB
 Slope : 2.25H:1V
 Condition : Drained
 High water table
 Method : Morgenstern - Price
 Berm : One berm

Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

Excavation Cut Area 1



Section : Sta. 21+950 EB
 Slope : 2.25H:1V
 Condition : Drained
 Low water table
 Method : Morgenstern - Price
 Berm : One berm

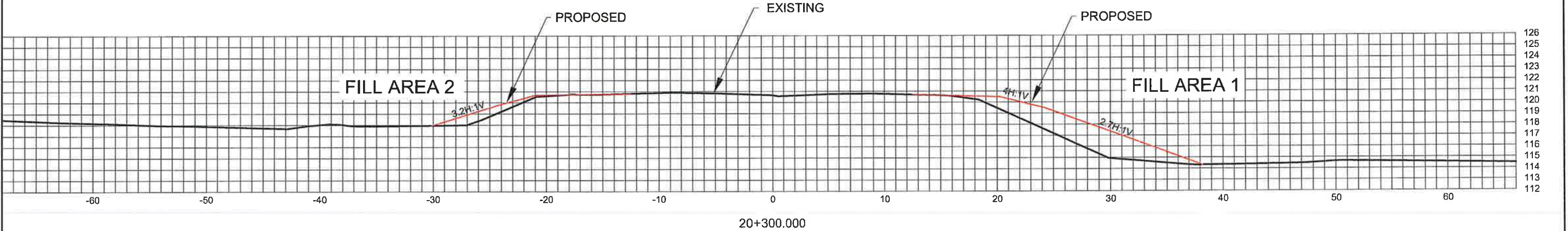
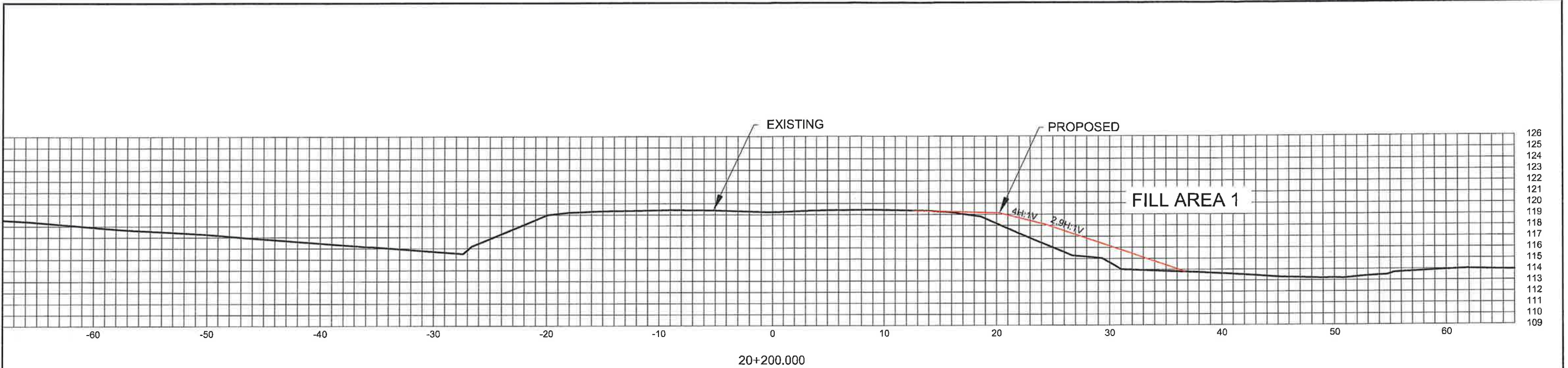
Stratum	γ (kN/m ³)	c (kPa)	ϕ (°)
New Highway Shoulder Fill	20.5	0	31
Existing Highway Pavement Fill	20.0	0	30
Upper Silty Sand to Sandy Silt Till	21.5	0	34
Lower Silty Sand to Sandy Silt Till	22.0	0	36

STATIC SLOPE STABILITY ANALYSIS

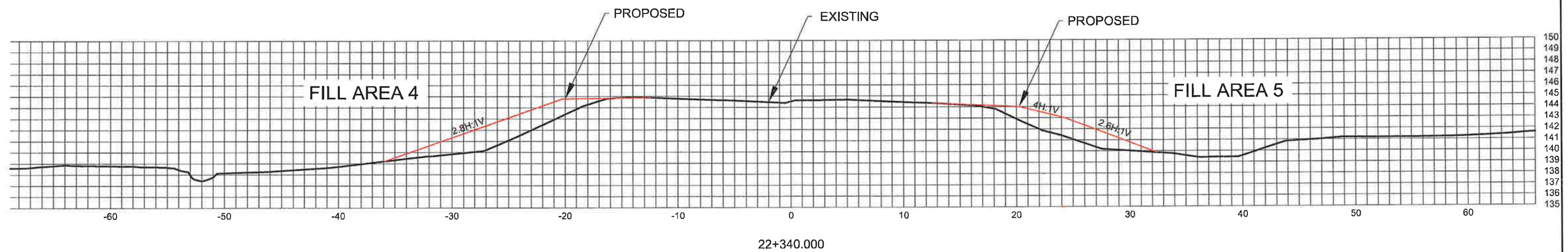
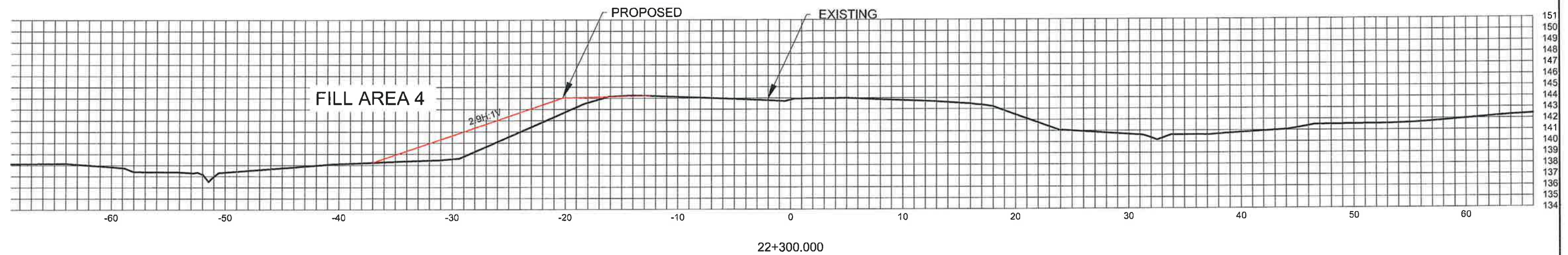
Excavation Cut Area 1

Appendix H

Cross Sections Used for Settlement Calculations



drawn	SH	<div>coffey</div> <div>geotechnics</div> <div>SPECIALISTS MANAGING THE EARTH</div>	client:	AECOM	
approved	DS		project:	HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT	
date	Aug. 2011		title:	EXISTING AND PROPOSED CROSS SECTIONS 1 OF 4	
scale	AS SHOWN		project no:	TRANETOB10434AA	FIGURE no:
original size	Tabloid				H1

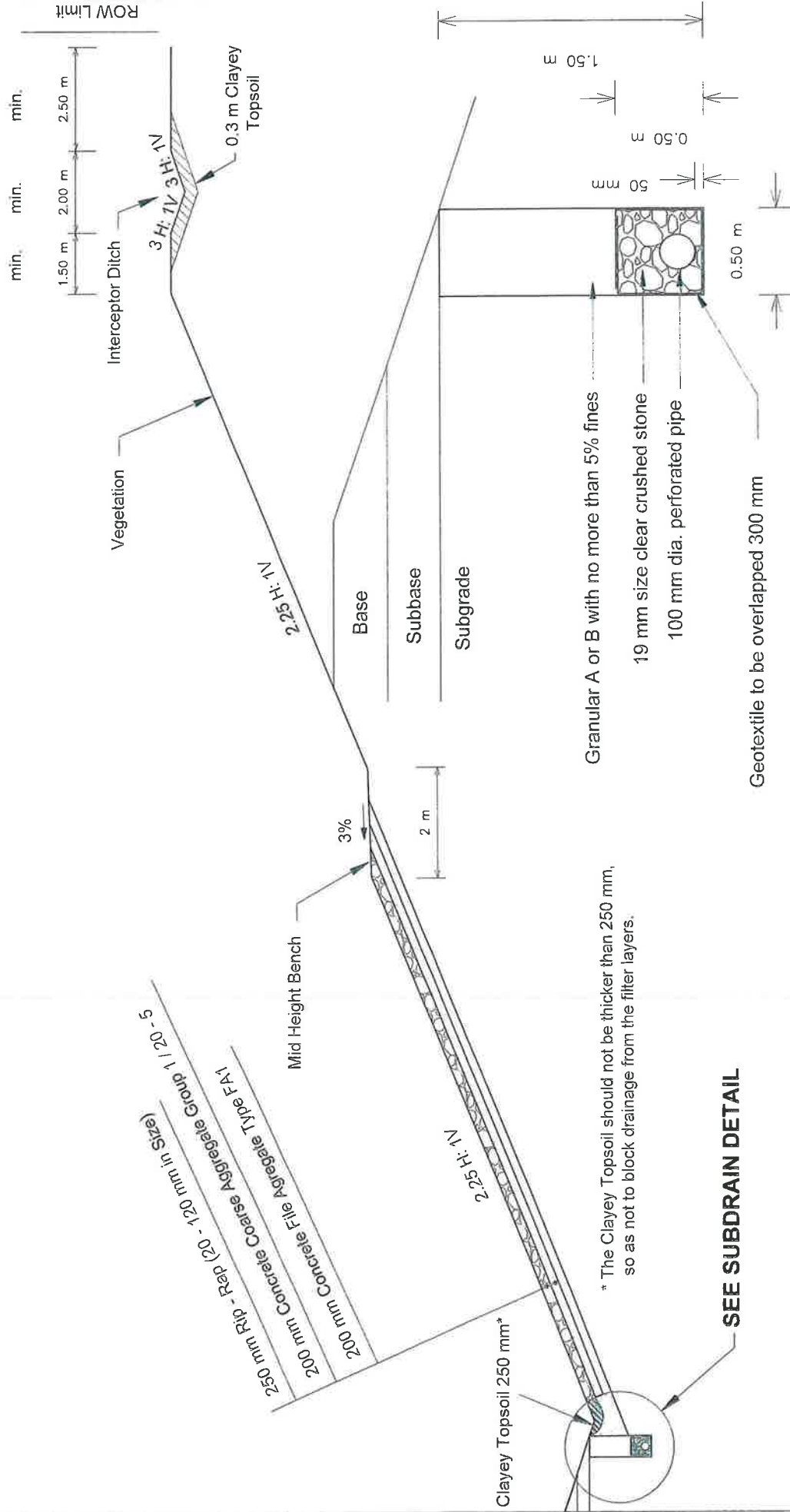


drawn	SH	<div>coffey</div> <div>geotechnics</div> <div>SPECIALISTS MANAGING THE EARTH</div>	client:	AECOM	
approved	DS		project:	HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT	
date	Aug. 2011		title:	EXISTING AND PROPOSED CROSS SECTIONS 4 OF 4	
scale	AS SHOWN		project no:	TRANETOB10434AA	FIGURE no:
original size	Tabloid				H4

Appendix I

Recommended Slope Protection Measures for Cut Area 1

RECOMMENDED SLOPE FOR PROTECTION MEASURES FOR CUT AREA 1 SLOPES BETWEEN 7.0 AND 12.0 m IN HEIGHT



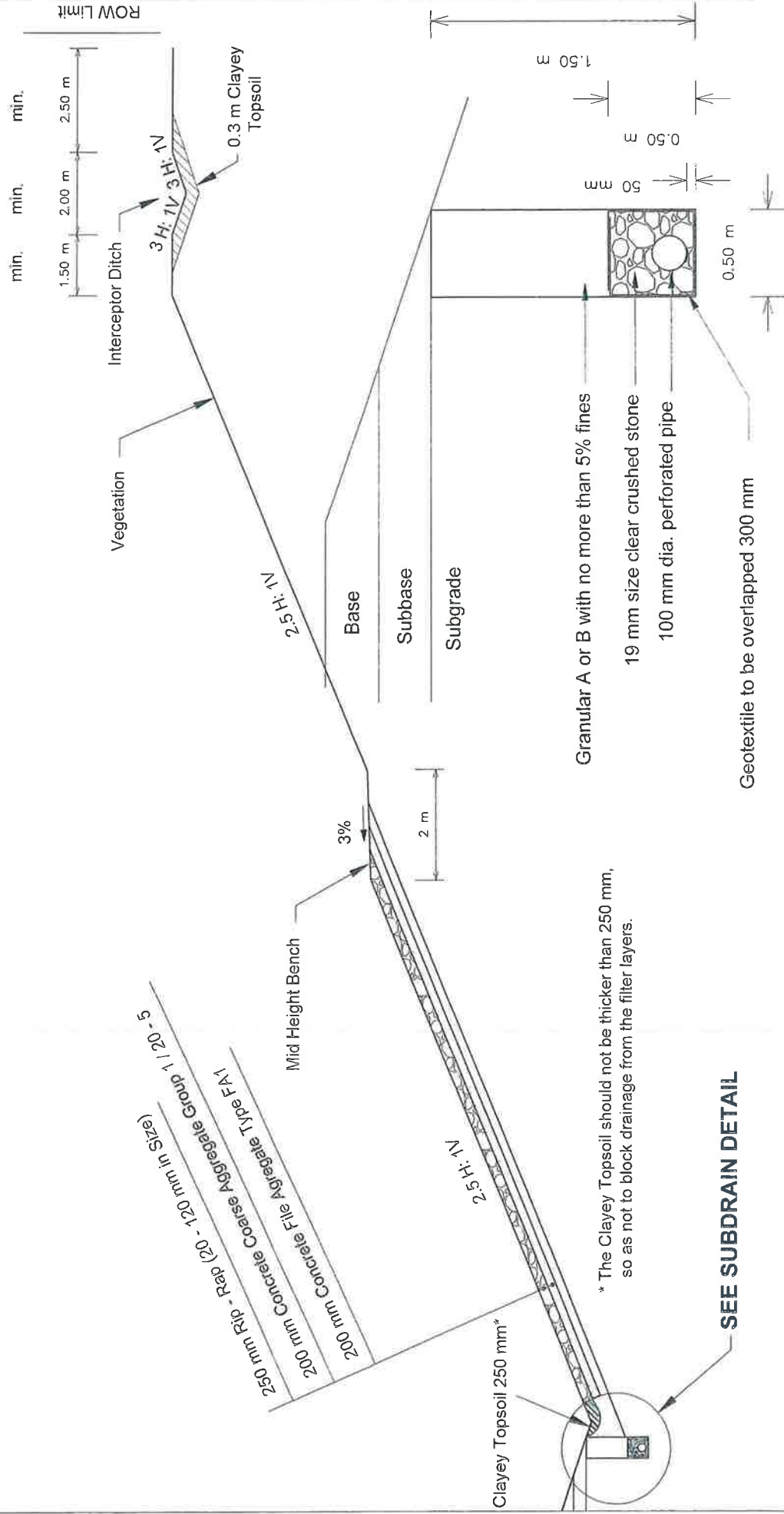
SUBDRAIN DETAIL

client: AECOM		HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT			
project:		RECOMMENDED SLOPE PROTECTION MEASURES FOR CUT 1			
title:		TRANETOB10434AA			
project no:		FIGURE no: I - 1			
drawn	S.H.				
approved	DS	SPECIALISTS MANAGING THE EARTH			
date	January, 2012				
scale	Not to scale				
original size	Letter				

Note:

This drawing should be read in conjunction with the accompanying report.

RECOMMENDED SLOPE FOR PROTECTION MEASURES FOR CUT AREA 1 SLOPES BETWEEN 12.0 AND 14.5 m IN HEIGHT



SUBDRAIN DETAIL

client:		AECOM	
project:		HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT	
title:		RECOMMENDED SLOPE PROTECTION MEASURES FOR CUT 1	
project no:		TRANETOB10434AA	
figure no:		I - 2	

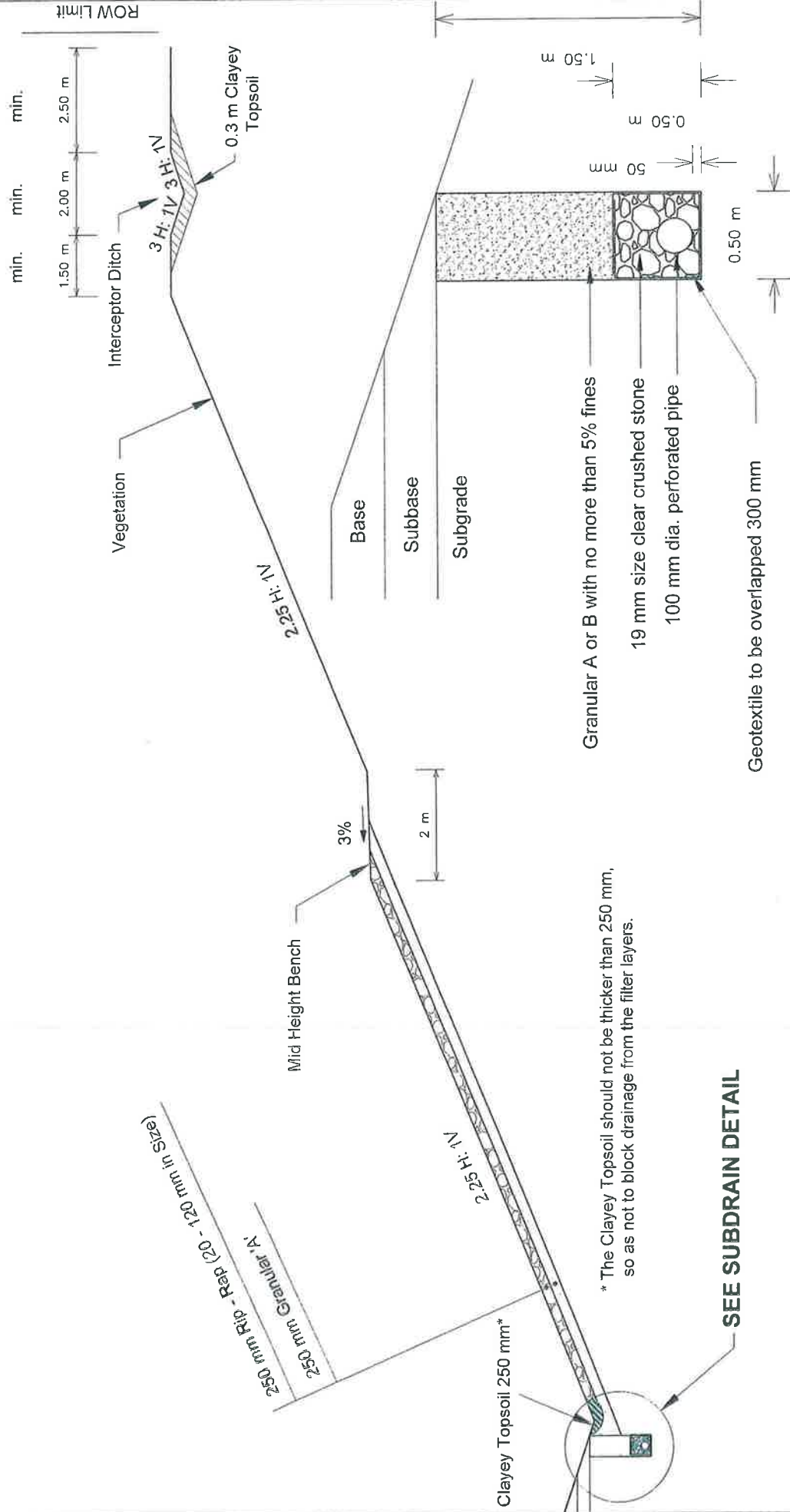
drawn	S.H.
approved	DS
date	January, 2012
scale	Not to scale
original size	Letter

Note:

This drawing should be read in conjunction with the accompanying report.

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geotechnics
SPECIALISTS MANAGING
THE EARTH


RECOMMENDED SLOPE FOR PROTECTION MEASURES FOR CUTS SLOPES BETWEEN 7.0 AND 12.0 m IN HEIGHT



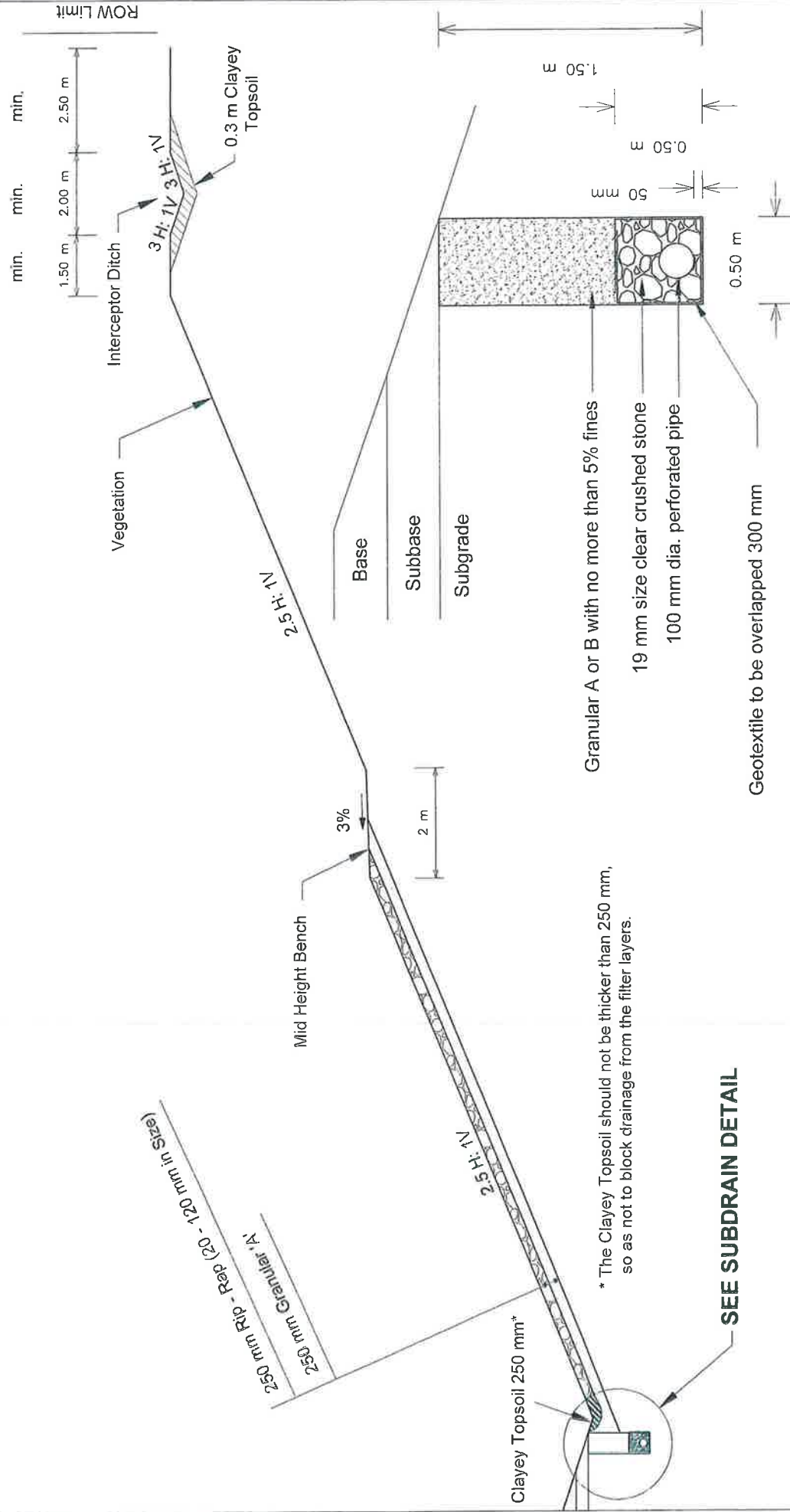
SUBDRAIN DETAIL

Note:

This drawing should be read in conjunction with the accompanying report.

drawn	SH	 <p>coffey geotechnics SPECIALISTS MANAGING THE EARTH</p>	client:	AECOM
approved	DS		project:	HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT
date	January, 2012		title:	RECOMMENDED SLOPE PROTECTION MEASURES FOR CUT 1
scale	Not to scale		project no:	TRANETOB10434AA
original size	Letter		figure no:	1 - 3


RECOMMENDED SLOPE FOR PROTECTION MEASURES FOR CUTS SLOPES BETWEEN 12.0 AND 14.5 m IN HEIGHT



SUBDRAIN DETAIL

Note:

This drawing should be read in conjunction with the accompanying report.

drawn	SH	 SPECIALISTS MANAGING THE EARTH	client:	AECOM
approved	DS		project:	HIGHWAY 401 EXPANSION EMBANKMENT FILLS AND EXCAVATION CUT
date	January, 2012		title:	RECOMMENDED SLOPE PROTECTION MEASURES FOR CUT 1
scale	Not to scale		project no:	TRANETOB10434AA
original size	Letter		figure no:	I-4

Appendix J

List of SP, OPSSs and OPSDs

List of SPs, OPSSs and OPSDs referenced in the report

SP 206S03 Grading, Earth and Rock Excavation, Excavation for Pavement Widening

OPSS 206 Construction Specification for Grading

OPSS 212 Construction Specification for Borrow

OPSS 501 Construction Specification for Compaction

OPSS 571 Construction Specification for Sodding

OPSS 572 Construction Specification for Seed and Cover

OPSS 1010 Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

OPSD 208.010 Benching of Earth Slopes

OPSD 210.070 Granular Sealing

Appendix K

Suggested Nssp Wording

Suggested NSSP Wording – Time of Paving

Paving of the road should be implemented no sooner than four weeks after the completion of the embankment widening to its substantial fill height.

Suggested NSSP Wording - QVE

All organic and unsuitable soils (e.g. very loose to loose/very soft to soft materials) shall be removed from all portions of the work area during the widening process. The replacement of the removed materials should be in accordance with convention of MTO practice. A qualified geotechnical engineer appointed by the Quality Verification Engineer (QVE) should be employed to inspect the exposed subgrade of the proposed embankment widening.

Suggested NSSP Wording – Excavation and Backfilling

If excavations deeper than 0.4 m are required (i.e. thick topsoil/organic soils are encountered) from the bottom of embankment, then the excavation and backfilling will need to be carried out in narrow sections (e.g. 3 to 4 m wide sections perpendicular to embankment), and backfilling will be carried out immediately to prevent embankment instability. All of these works shall be carried out under the direction and supervision of the QVE.

Suggested NSSP Wording – Slope Stability during Construction

To maintain the stability of cut slope during construction, additional loading such as stockpile, heavy machinery or any surcharge loads should not be present within a horizontal distance from the crest of the slope equal to the vertical height of the cut, during construction.

Appendix L

Limitations of Report

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to Coffey Geotechnics Inc. (Coffey) at the time of preparation. Unless otherwise agreed in writing by Coffey, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

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

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

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