Appendix B: Temporary Construction Access Road – Geotechnical and Slope Stability Assessment (Thurber Engineering 2014) – See compact disc

THURBER ENGINEERING LTD.

October 9, 2014 File: 19-5438-102

AECOM
#1200, 10235 - 101 Street
Edmonton, AB, T5J 3E9

Attention: Mr. Josh Jones, PMP

EDMONTON LIGHT RAIL TRANSIT – VALLEY LINE STAGE 1
SHORT TERM CONSTRUCTION ACCESS ROAD ON NORTH RIVERBANK
PRELIMINARY GEOTECHNICAL INVESTIGATION AND SLOPE ASSESSMENT

Dear Sir,

This letter presents the results of a geotechnical investigation and a preliminary slope assessment for the proposed construction access road along the north riverbank that is being considered to facilitate the erection of Stage 1 of the Valley Line of Edmonton's Light Rail Transit system (LRT- VL).

The geotechnical investigation and the slope stability assessment presented herein were carried out in general accordance with our proposal letter to AECOM dated February 7, 2014. Authorization to proceed with the study was given by Mr. Josh Jones of AECOM.

Use of this report is subject to the Statement of Limitations and Conditions which is included at the end of the text of this report. The reader's attention is specifically drawn to these conditions as it is considered essential that they be followed for the proper use and interpretation of this report.

1. BACKGROUND

As part of the LRT-VL development, the design includes a long term maintenance and emergency access road to the north riverbank portal via Cameron Avenue. To minimize the impact of construction on the residential neighbourhood along Cameron Avenue, a separate, short term construction access road from the west through Louise McKinney Park is being considered. In November 2013, three alternate alignments of the construction access road were proposed by the design team. A high level, multi-disciplinary review of the three options (including a geotechnical review by Thurber) concluded that a west access from the Grierson Hill Road past the Riverfront Plaza along the existing southern Shared Use Path (SUP) seemed to be the least disruptive alternative. The findings of the review were presented to the City of Edmonton (the City) in a memorandum by ConnectEd Transit Partnership on December 19, 2013. In early 2014, the City requested ConnectEd to carry out a preliminary geotechnical investigation to evaluate the impact of the preferred construction access road on the overall stability of the north river valley slope in the project area.

Drawing No. 19-5438-102-1AR in Appendix A shows the preferred alignment of the construction access road. The topographic contours of the valley slope in the project area are also shown on the drawing. As discussed, upgrading of the existing SUP (both in terms of geometry and pavement structure) could be required to accommodate the anticipated construction traffic. No vertical alignment of the proposed construction access road was available at the time of this report. It is our understanding, however, that only minor grading works may be required to upgrade the access road to the required geometry.

From a geotechnical perspective, the temporary access road runs across the Grierson Hill slide which is only marginally stable. Depending on the extent of the required grading works and associated slope disturbances, construction of the access road could potentially impact the stability of the north river valley slope. An assessment of the potential impacts of the access road on the stability of the river valley slope is presented in this report.

As discussed in previous Thurber reports, the Grierson Hill slope was used as a waste dump for the City in the early 1900's and random thick fills mixed with various municipal waste materials were encountered near the ground surface. As such, the condition of subgrade soils may be poor. Preliminary recommendations for a pavement structure more suited to supporting construction traffic on the access road are also provided.

2. SCOPE OF WORK

Given the objectives of the study (outlined earlier), our scope of work consisted of the following:

- Compile and review existing geological and geotechnical information pertaining to the Grierson Hill slide.
- Undertake a field drilling program to identify the subsurface conditions along the proposed access road alignment.
- Install geotechnical instruments to monitor slope movement and pore water pressure conditions.
- Undertake geotechnical assessment of the impact of the proposed access road on the overall stability of the north valley slope and provide preliminary recommendations on access road development.
- Carry out preliminary design for a pavement structure suitable for supporting anticipated construction traffic.

It should be mentioned that environmental assessments pertaining to the impacts of the proposed road on the Louise McKinney Park and the historic waste dump were not part of our scope of work.

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3. AVAILABLE INFORMATION

The following documents were obtained and reviewed as part of this study:

- EBA Engineering Consultants Ltd., and Norbert R. Morgenstern Consultants Ltd., 1978. Edmonton Convention Centre geotechnical evaluation. Report submitted to the City of Edmonton, Department of Real Estate and Housing.

- EBA Engineering Consultants Ltd., 1981. Grierson Hill stabilization study. Report submitted to the City of Edmonton, Engineering Department/Parks and Recreation.

- EBA Engineering Consultants Ltd., 1989. Riverbank slope protection measures, Grierson Hill, Edmonton. Report submitted to the City of Edmonton Transportation Department.

- City of Edmonton, 2000. Slope indicator installation, Grierson Hill Road bike path.

- Hardy, R.M. & Associates Ltd. 1961. Third Report Re Grierson Hill, City of Edmonton, Alberta. Report submitted to the City of Edmonton.

- Martin, R.L., Williams, D.R., Balanko, L.A., and Morgenstern, N.R. 1984. The Grierson Hill slide, Edmonton, Alberta. Proceedings, 4th International Symposium on Landslides, Toronto, Canada Day Volume, pp. 125-133.

- Martin, R.L., Lewycky, D.M., and Ruban A.F., 1998. Long term movement rates in a large translational landslide. Proceedings, 51th Canadian Geotechnical Conference, Edmonton. Volume 1, pp. 23-30.

- Thurber Engineering Ltd., 2005. Louise McKinney park Riverfront Plaza - geotechnical investigation. Report submitted to the City of Edmonton. Project No. 14-31-212.

- Thurber Engineering Ltd., 2010. SE LRT expansion, North Saskatchewan river valley crossing, geotechnical data gathering. Report submitted to the City of Edmonton. Project No. 14-31-303.

- Thurber Engineering Ltd., 2011. Louise McKinney park Millennium Plaza phase 1 - geotechnical investigation. Report submitted to the City of Edmonton. Project No. 14-31-203A.

- Thurber Engineering Ltd., 2012. Edmonton southeast LRT extension Quarters to Connors road - an overall appraisal of geotechnical conditions along the LRT alignment. Report submitted to AECOM. Project No. 19-5438-68.

- Thurber Engineering Ltd., 2012. Edmonton southeast LRT transit expansion: preliminary study of the stability of the north valley slope – Grierson Hill slide area. Report submitted to AECOM. Project No. 19-5438-68C.

- Thurber Engineering Ltd., 2012. Edmonton's southeast light rail transit – Quarters to Cloverdale: preliminary assessment of stabilization piles for the north valley slope. Report submitted to AECOM. Project No. 19-5438-68C.

4. GEOLOGIC SETTING

The geologic conditions underlying the project area have been established based on published studies (Kathol and McPherson, 1975; Andriashek, 1988) and the results of recent and previous geotechnical investigations. The subsurface conditions along the alignment of the proposed access road are expected to consist of fill and colluvium material, overlying bedrock. The man-made fills at surface were associated with the waste disposal activities in the area up until about 1940, the grading works related to the development of Louise McKinney Park in the seventies, and the stabilization of the valley slope in the eighties. The underlying colluvium material consists of a mixture of till, clay, silt, sand, and gravel that were displaced and re-located downslope by the Grierson Hill Slide. The bottom horizons of the colluvium comprise, generally, bedrock that has been disturbed and weakened by the slide. The combined thickness of fill and colluvium in the Grierson Hill area varied significantly from one location to the other, and was up to about 23 m in one test hole.

The undisturbed bedrock underlying the project area is of the Upper Cretaceous Edmonton Formation, which consists of interbedded layers of clay shale, sandstone, and siltstone. Coal layers and bentonite seams of variable thickness are frequently encountered throughout the bedrock. The bentonite seams represent weak layers along which sliding of the valley slopes has occurred. The Grierson Hill slide is a result of sliding along some of these bentonite seams. Coal layers within the bedrock were mined extensively in the Grierson Hill area. Disturbance caused by mining activities has also contributed to weakening of the river valley slopes.

5. GRIERSON HILL LANDSLIDE

The proposed access road is located near the toe of the Grierson Hill Slide; a major deep-seated landslide that encompassed the north slope of the North Saskatchewan River valley. The slide has been the subject of several studies (e.g. Hardy & Associates, 1961; EBA, 1981; EBA, 1989; Martin et al, 1984; and Martin et al, 1998). A brief description of the slide and its history is presented below as it could impact the proposed development.

The Grierson Hill slide first occurred in 1901 and was reportedly attributed to toe erosion from river action, weakening of the bedrock in the backslope area caused by coal mining activities, and a prolonged period of precipitation. The landslide measures about 600 m east-west along the riverbank and has a total slope height of about 55 m, with an average slope angle of 11 degrees. It extends from the Shaw Convention Centre at the west end to the Cloverdale pedestrian bridge at the east end; and from Grierson Hill Road at the north end to the river's edge at the south end (see Drawing 19-5438-102-1AR).

The slide mechanism was translational, with the failure mass sliding towards the river on planar near-horizontal shear surfaces that developed along distinct bentonite seams within the bedrock. A schematic diagram of the slide mechanism is shown on Drawing No. 19-5438-102-2AR. Since 1901, the slide scarp has retrogressed more than 35 m and the toe has moved out some 120 m into the river from its original pre-slide location (refer to Drawing 19-5438-102-1AR).

Since the initial failure in 1901, the Grierson Hill slope has been modified by extensive dumping and backfilling, mainly on the upper portions of the slope. Between 1911 and 1940, the graben feature created by the slide was used as a waste dump for the City of Edmonton. Between 1950 and 1961, nearly 50,000 m^3 of fill were placed in the graben area for the construction of the Grierson Hill Road. In 1978, the Grierson Hill slope was graded and landscaped into a city park; the Louise McKinney Park. Construction of the Shaw Convention Centre at the west end of the slide was undertaken in the early 1980's, and a portion of the Grierson Hill Road was relocated slightly to the north in the late 1980's.

Monitoring the movement of the valley slope in the area dates back to the early 1950's during the initial attempts to construct the Grierson Hill Road. Since then, slope movements have occurred periodically, sometimes at rates as fast as several meters per year in the central portion of the slide. It has been observed that the movement rates were very sensitive to changes in slope condition (e.g. grading works, toe erosion, precipitation, etc.). Over the years, various stabilization measures have been implemented to slow the slope movement. In the late 1950's and early 1960's, dewatering wells and drainage galleries were installed to drain the coal seams and abandoned mine openings. In 1987, a toe berm was constructed to improve the stability of the slope after a major flood removed up to 8 m of the river bank in 1986. In 1991, a 4 m wide outer berm of concrete rubble and rock riprap was installed along the north bank of the river channel. The outer berm was deemed necessary following a rapid drawdown failure of a 50 m long section of the riverbank in July of 1990.

The stabilization measures noted above have considerably improved the overall slope stability. Two slope inclinometers were installed in March 2000 by the City of Edmonton along the Grierson Hill Road. Available readings of these slope inclinometers (between April and June, 2000) did not indicate any significant slope movements. Four additional slope inclinometers were installed in 2010 and 2011 at the eastern flank of the slide near the LRT-VL alignment. The instruments have been monitored regularly since November, 2010. No noticeable slope movements have been detected to date.

6. GEOTECHNICAL INVESTIGATION

6.1 Field Drilling Program

Six test holes (TH14-1 to TH14-6) were drilled along the preferred road alignment to depths ranging between 6 and 10 m below existing ground surface. Upon the completion of drilling, 25 mm diameter standpipe piezometers were installed in all six holes for future monitoring of groundwater levels.

Two deep test holes, SI14-1 and SI14-2, were also drilled upslope of the road alignment to depths of 45.6 and 33.3 m, respectively, for the installation of geotechnical instruments. A total of 2 slope inclinometers and 5 pneumatic piezometers were installed in these two holes.

Five test holes (TH14-7 to TH14-11) were drilled to depths ranging from 5.2 m to 11.9 m below existing ground near the eastern end of the road alignment. These test holes were part of a different study aimed at characterizing the thickness of waste material within the anticipated LRT-VL construction zone (Thurber report dated July 23, 2014).

The locations of recent and previous test holes advanced in the project area are presented on Drawing No. 19-5438-102-1AR in Appendix A.

The current field program was conducted between March 17 to 24, 2014, using two different drill rigs; a small auger rig and a large rig with both auger and wet rotary/coring capabilities. The shallow holes and overburden soils in the two deeper holes were drilled using solid stem augers while continuous coring was used in the bedrock. Both rigs were owned and operated by Mobile Augers and Research Ltd. of Edmonton, Alberta. The field work was conducted under the supervision of Thurber personnel. The test hole locations were surveyed by Opus Stewart Weir after the drilling program was completed.

For overburden soils, disturbed soil samples were obtained from the auger flights and Standard Penetration Tests (SPTs) were carried out at selected depths. The undrained shear strength (Cpen value) of cohesive samples was estimated using a pocket penetrometer. For bedrock, continuous core samples were recovered.

Water and slough levels were noted during and immediately after the completion of drilling, before backfilling the test holes.

The results of the drilling, field observations, and the details of the installed instruments are summarized on the test hole logs in Appendix B.

6.2 Laboratory Testing

Laboratory testing included visual classification and the determination of the natural moisture content of all soil samples. Bedrock core samples were also logged in the laboratory and the percent recovery and the Rock Quality Designation (RQD) were recorded. The moisture content of select bedrock specimens were determined. Atterberg Limits tests were carried out on selected representative soil and bedrock samples.

The results of laboratory testing are summarized on the test hole logs in Appendix B. An explanation of the symbols and terms used to describe observations on the test hole logs and the Modified Unified Soil Classification System are also provided in Appendix B.

7. SUBSURFACE CONDITIONS

7.1 Soil Conditions

7.1.1 General

The subsurface conditions encountered in test holes drilled along the proposed road alignment comprised, in descending order, topsoil, fills of varying composition and thickness, overlying colluvium (lacustrine clay, clay till and sand). In TH14-5 and TH14-6 at the east end of the alignment (which coincides with the eastern flank of the Grierson Hill slide), clay shale and sandstone bedrock were encountered directly beneath the topsoil or below a limited thickness of fill.

Similar stratigraphy was observed at the locations of the two deep test holes drilled upslope of the road alignment. The primary difference was that the fill soils were much thicker.

Brief descriptions of the main soil layers are provided in the following sections. Detailed soil descriptions are presented on the test hole logs attached in Appendix B.

7.1.2 Topsoil

Topsoil was encountered in all test holes. The topsoil extended to depths ranging from about 0.15 m to 0.3 m below existing ground surface. It should be noted that the thickness of topsoil could vary between test holes and it may be thicker or thinner at other locations along the road alignment.

7.1.3 Fill

Fill soils were encountered in all test holes except TH14-6. The fill ranged from 1.6 to 2.9 m in thickness at the western and eastern ends of the road alignment which coincide with the flanks of the Grierson Hill Slide. Along the central part of alignment, the fill extended to the termination depths of test holes TH14-2 through TH14-4 at 5.8 m below ground surface. At the locations of SI14-1 and SI14-2, the fill was 12.8 and 10.2 m thick, respectively.

The fill comprised clay or clay shale with intermittent gravelly and sandy horizons. Coal, peat, organic soils, brick fragments, pieces of glass, and wood were encountered within the fill.

The moisture contents of fill samples varied widely, ranging from 4 percent up to about 60 percent. The lower values were associated with sand and gravel fills near the ground surface whereas the higher values were characteristic of peat layers. SPT ‘N’ values in the fill ranged generally from 2 to 17 blows per 300 mm penetration indicating soft to very stiff consistencies. The results of four Atterberg Limits tests conducted on samples of the clay and clay shale fills indicated plastic limits between 17 and 27 percent and liquid limits between 44 and 72 percent. The results indicate that fill soils were generally of medium to high plasticity.

7.1.4 Clay (Possible Colluvium)

A clay layer was encountered beneath the clay fill in TH14-1 at a depth of about 1.5 m below ground surface and had a thickness of about 2.3 m. The clay was brown, silty, contained trace oxides and was classified as high plastic. The natural moisture content of clay samples ranged from 28 to 43 percent. One SPT 'N' value of 7 blows per 300 mm penetration was recorded in the clay, indicating firm consistency.

7.1.5 Clay Till (Possible Colluvium)

Layers of clay till were encountered beneath the clay in TH14-1 and beneath the fill in SI14-1. The thickness of till layers varied from 0.8 to 2.3 m. The clay till was medium plastic, silty, sandy, and contained traces of gravel, coal, and occasional sand lenses. The natural moisture content of clay till samples varied between 17 and 22 percent. The clay till was of very stiff consistency with SPT 'N' values between 18 and 29 blows per 300 mm of spoon penetration.

7.1.6 Bedrock

Bedrock consisting of interbedded layers of clay shale and sandstone was encountered in test holes TH14-5, TH14-6, SI14-1 and SI14-2. Coal seams, 0.2 to 0.5 m thick, and thin layers of siltstone, 0.1 to 0.2 m thick, were encountered within the bedrock. The elevation of top of bedrock varied between 623.3 and 633.1 m, depending on the test hole location on the valley slope. The corresponding depth to top of bedrock below existing ground ranged between 0.3 m (TH14-6) and 13.6 m (SI14-1).

The moisture content of bedrock samples ranged generally from 15 to 30 percent. Higher moisture contents, up to 60 percent, were recorded at a few locations and were typically associated with bentonitic horizons or coal seams within the bedrock. SPT 'N' values in the bedrock ranged from 14 to over 100 blows per 300 mm penetration, indicating a stiff to hard consistency in soil mechanics terminology. The results of one Atterberg Limits test conducted on a clay shale sample indicated high plastic material with a liquid limit of 63 percent and a plastic limit of 27 percent.

7.2 Groundwater Conditions

Groundwater measurements taken in the standpipe piezometers installed in test holes advanced along the road alignment are presented in Table 7.1. A summary of the groundwater levels recorded in the pneumatic piezometers installed in SI14-1 and SI14-2 is presented in Table 7.2.

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TABLE 7.1
SHORT TERM GROUNDWATER OBSERVATIONS AND SLOUGHING CONDITIONS

TEST HOLE	DRILL DEPTH B.G.S. [1] (m)	DEPTH OF STANDPIPE PIEZOMETER B.G.S. [1] (m)	LEVEL BELOW GROUND SURFACE AT END OF DRILLING [2] (m)		WATER LEVEL IN STANDPIPE PIEZOMETER B.G.S. [1] (m)	
			SLOUGH LEVEL	WATER LEVEL	June 11, 2014	July 31, 2014
TH14-1	6.1	6.1	none	none	4.6	4.6
TH14-2	5.8	5.6	5.5	5.3	5.4	5.1
TH14-3	5.8	5.8	none	none	Dry	Dry
TH14-4	5.8	5.8	none	none	Dry	Dry
TH14-5	10.1	9.6	9.7	none	8.1	8.2
TH14-6	10.4	10.2	9.9	9.7	6.7	6.6

[1] Below ground surface.
[2] Test holes were drilled on March 24, 2014.

TABLE 7.2
SHORT TERM GROUNDWATER LEVELS IN PNEUMATIC PIEZOMETERS

TEST HOLE	TIP OF PNEUMATIC PIEZOMETER		GROUNDWATER LEVEL ON			
			11-JUN-2014		20-AUG-2014	
	DEPTH [1] (m)	ELEVATION (m)	DEPTH [1] (m)	ELEVATION (m)	DEPTH [1] (m)	ELEVATION (m)
SI14-1	12.0	632.5	3.50	641.0	3.1	641.4
	21.6	622.9	16.2	628.3	17.7	626.9
	35.3	609.2	27.3	617.2	27.1	617.4
SI14-2	5.8	627.7	5.1	628.4	4.2	629.3
	27.3	606.2	19.0	614.5	19.2	614.3

[1] Below ground surface.

It should be noted that the water level measurements taken during this field investigation program are short term levels and may not represent the stabilized long term groundwater conditions. In addition, groundwater levels may vary between test hole locations. Groundwater levels are also expected to vary in response to seasonal factors and precipitation. Hence, the actual groundwater conditions at the time of construction could vary from those recorded during this investigation.

8. SLOPE MOVEMENT MONITORING

As noted earlier, slope inclinometers SI14-1 and SI14-2 were installed during the current investigation (refer to Drawing 19-5438-102-1AR) to monitor the movement of the Grierson Hill slide. Previously, four slope inclinometers were installed at the eastern end of the proposed construction access road as part of the geotechnical investigation for the LRT-VL project.

All instruments have been monitored a number times each year since they were installed. The monitoring results, in terms of the observed cumulative and incremental slope movements, are presented on the attached plots in Appendix C. As shown on the plots, the slope inclinometer data did not indicate any noticeable slope movements.

It should be noted, however, that the monitoring period, 2011 to 2014, is relatively short and may not necessarily reflect the long term performance of the slope, particularly if changes to the slope conditions (e.g. caused by construction) were to occur.

9. PRELIMINARY GEOTECHNICAL SITE EVALUATION

9.1 General

As discussed earlier, the preferred alignment of the construction access road runs along the toe of the Grierson Hill slide. It is our understanding that construction of the access road will involve minor grading works. For the purposes of this assessment, it was assumed that fills up to 1 m high may be placed for road construction. It was also assumed that the width of the road will be in the order of 8 m to accommodate two way traffic.

Because of disturbances caused by the Grierson Hill slide and subsequent grading works, the subsurface conditions in the project area are complex. The stratigraphy, characteristics of fill and colluvium materials, and groundwater conditions vary significantly from one location to the other. Considering the uncertainty in subsurface conditions, the intent of the stability analyses presented herein was not to estimate the absolute values of the factor of safety, but rather to quantify the change in the slope factor of safety as a result of access road construction. On that basis, slope stability analyses were carried out for four different cross-sections (Sections A-A′, B-B’, C-C’ and D-D’ shown on Drawing No. 19-5438-102-1AR) to assess the impact of road construction on the factor of safety of the existing valley slopes. Deep-seated translational failure modes along weak bentonite seems within the bedrock were considered in the analyses. Both large scale failures encompassing the majority of the valley slope and small failures encompassing the 10 m high bank along the river channel were investigated. Potential rotational failures of the latter shallow bank were also analyzed. They were found less critical and the results of these stability analyses are not reported herein.

9.2 Assessment of Slope Stability

9.2.1 Stratigraphy and Soil and Groundwater Parameters

The soil/bedrock stratigraphy used in the stability analyses was inferred from available test hole information from both the current and previous geotechnical investigations (Appendix B). The slope profiles along cross-sections A-A′, B-B’, C-C’ and D-D’ were estimated from the survey data provided by AECOM.

Soil and bedrock strength parameters used in the stability analyses were estimated from the results of various geotechnical studies and are presented in Table 9.1. They are also shown on the figures of slope stability analyses in Appendix D.

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TABLE 9.1
SOIL AND BEDROCK STRENGTH PARAMETERS
USED IN STABILITY ANALYSES

SOIL TYPE	UNIT WEIGHT (kN/m^3)	EFFECTIVE FRICTION ANGLE ϕ' (°)	EFFECTIVE COHESION c' (kPa)
Colluvium and Fill	18	23	2
Clay Till (Weathered)	18	25	5
Clay Till	18	25	20
Previous Slip Zone (Bentonite seams at residual strength)	20	9	0
Potential Slip Zone (Bentonite seams at peak strength)	20	14	0
Bedrock Units A and B	20	25	80
Bedrock Unit C	20	25	60
Bedrock Units D and E	20	25	50
Disturbed Bedrock	20	25	15 - 30

From a slope stability perspective, the shear strength of bentonite seams within the bedrock is a governing factor in the global stability assessment of the Grierson Hill slope. In the analyses, the peak strength parameters (ϕ' = 14°, c = 0) were used along the relatively undisturbed sections of the bentonite layers behind (i.e. north of) the old scarp area. The residual strength parameters (ϕ' = 9°, c = 0) were assigned to the disturbed sections of the bentonite seams near the slope toe, where significant slope movements have occurred in the past.

The shear strength of the disturbed horizons of bedrock was varied between cross-sections. For Sections A-A', B-B' and C-C', ϕ' = 25° and c = 15 kPa were used in the analyses. For Section D-D' near the eastern flank of the slide where slope movement and ground disturbance would have been less severe, higher shear strength parameters (ϕ' = 25°, c = 30 kPa) were used.

The groundwater levels used in the stability analyses were primarily based on historic and some recent groundwater monitoring data. They varied from elevations of about 654 m below the crest of the valley slope to 614 m at the toe of the slope near the North Saskatchewan River.

9.2.2 Analysis Results

The slope stability analyses were performed using the SLOPE/W software, based on the method of limit equilibrium. Stability analyses were first performed for the existing slope condition prior to access road construction. The slope profiles were modified to approximate possible changes in ground surface topography associated with road construction (i.e. possible fills and cuts). A surcharge pressure of 16 kPa was applied on the road surface to account for loading induced by construction traffic. The stability analyses were then repeated to assess the

change in the slope factor of safety as a result of road construction. The results of the stability analyses are presented on Figures D1 through D24 in Appendix D, and are also summarized in Table 9.2.

TABLE 9.2
SUMMARY OF RESULTS OF SLOPE STABILITY ANALYSES

CROSS SECTION [1]	SLOPE FACTOR OF SAFETY					
	BENTONITE SEAM 'A' [2]		BENTONITE SEAM 'B' [2]		RIVERBANK [3]	
	EXISTING CONDITION	ACCESS ROAD [4]	EXISTING CONDITION	ACCESS ROAD [4]	EXISTING CONDITION	ACCESS ROAD [4]
A – A'	1.33	1.34	1.23	1.24	1.23	1.23
B – B'	1.31	1.31	1.20	1.21	1.24	1.22
C – C'	1.30	1.30	1.24	1.25	1.15	1.07
D – D'	1.23	1.23	1.23	1.23	1.20	1.17

1 Refer to Drawing 19-5438-102-1AR for cross-section locations.
2 Refer to the slope stability figures in Appendix D for soil/bedrock stratigraphy, including the depth of bentonite seams.
3 Factor of safety of the ~10 m high bank along the river channel.
4 Factor of safety following construction of the access road in accordance with the approximate geometry shown on the stability figures in Appendix D.

As shown on the stability figures in Appendix D, possible translational failures along bentonite Seams 'A' and 'B' are large slides that encompass the majority of the valley slope. For the deep Bentonite Seam 'A' below riverbed, the pre-construction factor of safety ranged between 1.2 and 1.3. Construction of the access road had practically no effect on the slope factor of safety. For Bentonite Seam 'B' above the elevation of the riverbed, the preconstruction factor of safety was in the order of 1.2. Similarly, construction of the access road had practically no impact on the slope factor of safety. These findings are attributed to the minute size of road fill, 1 m high embankments, compared to the volume of the slide mass (refer to Figures D2 and D4, for example).

For potential failures encompassing the riverbank (i.e. the shallow bank along river channel), the preconstruction factor of safety was estimated to be in the range of 1.15 to 1.25. The placement of access road fill, albeit very limited, could potentially result in a 2 to 7 percent reduction in the slope factor of safety. While the percent reduction in the factor of safety is not large, it reduces the already low factors of safety even further to a 1.1 to 1.2 range. As noted in Section 5, a 50 m long section of the riverbank failed in July 1990 following a rapid drawdown of the river level. A 4 m wide outer berm of concrete rubble and riprap was constructed in 1991 (EBA, 1989; and Martin et al, 1998) to improve the marginal stability of the riverbank.

9.2.3 Conclusions and Recommendations

The proposed alignment of the temporary construction access road runs along the toe of the valley slope. It was assumed that road construction could involve the placement of up to 1 m high fills. Limited cuts could also be required to accommodate an 8 m wide road for two-way traffic.

The analysis results in Section 9.2.2 suggest that road construction will have minimal impact on the stability of the overall valley slope. It could, however, adversely affect the stability of the shallow bank along the river channel. Although any such failure would impact a limited portion of the valley slope, instabilities along the toe of the sensitive Grierson Hill slide may trigger slope movements on a wider scale, if not repaired on a timely basis. As such, it is recommended that the placement of additional fill be avoided during construction of the temporary access road. The footprint of the access road (to accommodate an 8 m wide road) should be kept as far north as practical from the crest of the riverbank. Limited cuts may be used to achieve the required road width. To limit the extent of excavations, cuts could be supported using temporary retaining systems (e.g. lock-block walls).

A number of slope inclinometers should be installed along the alignment of the access road and monitored on a regular basis to help detect and assess any slope movements. Visual inspections of the river valley slope in the general area of the access road should also be carried out regularly during road and LRT-VL construction to identify any signs of ground movement (e.g. cracks, bulging, tilted trees or posts, etc.). Should the slope monitoring or visual inspections indicate any ground movement, a review of the slope condition should be carried out immediately and measures to arrest the movement should be implemented as soon as possible.

9.3 Subgrade Assessment and Pavement Design

The evaluation and recommendations provided in the following sub-sections were based on limited information and concept level drawings provided by AECOM. They are considered preliminary and should be reviewed by the contractor's geotechnical engineer based on actual design and construction requirements.

9.3.1 General

The design grades of the temporary construction access road through Louis McKinney Park were unknown at the time of preparation of this report. However, it is understood that the road grades will follow the existing grades with possibly some minor cuts and fills.

Based on available test hole information, it is expected that the subgrade conditions would vary along the alignment of the subject access road. In some areas, the subgrade conditions would be adequate while in others poor unsuitable fills would be present at the subgrade level. The removal and replacement of unsuitable soils will be required in such areas and remedial measures will need to be determined at the time of construction on a case by case basis.

Recommendations for site grading and subgrade preparation are provided in Section 9.3.2. Preliminary design recommendations for alternate pavement structures are provided in Section 9.3.3.

9.3.2 Grading and subgrade preparation

All topsoil/peat, organics, and fill soils containing significant organic content or municipal waste materials should be removed from the proposed roadway areas. The thickness of topsoil at the test hole locations ranged from 0.15 m to 0.3 m below existing ground surface, however stripping requirements will be largely governed by the presence of organic/waste materials and the overall stability of existing fill soils that form the majority of the near-surface stratigraphy.

The exposed surface (after stripping) should be proof rolled and inspected by qualified geotechnical personnel to identify weak areas and to confirm that all deleterious material has been removed. Weak zones or pockets of deleterious material at surface should be locally removed and replaced with suitable fill compacted to at least 97 percent of Standard Proctor Maximum Dry Density (SPMDD).

Where the pavement subgrade will be located in cut or in fill of less than 150 mm, the finished subgrade should be subcut to a depth of 300 mm. The removed material (if suitable) should be reworked, then placed in lifts and compacted to 100 percent of the SPMDD.

The natural water content of existing fill soils varied widely ranging from 4 to 60 percent. It is, therefore, expected that poor subgrade conditions will be encountered in areas where the moisture contents of in-situ soils are significantly higher than the Optimum Moisture Content (OMC). In such areas, moisture conditioning will be required in order to meet the subgrade compaction requirements. Depending on the weather at the time of construction, it may be preferable to modify wet subgrades using cement. The use of cement modification offers improved field workability, quicker drying, and the formation of a working platform suitable for placing and compacting the pavement materials. A minimum application rate of 10 kg/m^2 of cement would be required per 150 mm lift of soil. Additional cement to deeper depths may be required if weaker soils are encountered.

The following additional recommendations also apply:

- Subgrade areas that become softened as a result of construction traffic or weather conditions should also be subexcavated and replaced with low to medium plastic clay or clean granular fill prior to the installation of pavement structure.

- Fill soils required to achieve the design subgrade level should consist of inorganic low to medium plastic clay placed in 150 mm thick lifts (compacted thickness) and compacted to at least 97 percent of the SPMDD at placement moisture contents within ±2 percent of the OMC. The upper 300 mm of subgrade should be compacted to 100 percent of the SPMDD.

- Uniformity of compaction is essential to reduce the potential for differential settlement. It is recommended that fill placement be inspected and tested by qualified geotechnical personnel to ensure adequate compaction.

Permanent site drainage should be developed at early stages of construction in order to improve site trafficability and reduce future frost effects in the subgrade. It is recommended that the finished subgrade surface be sloped at a minimum of 2 percent towards side ditches. The purpose of this is to drain surface water from the subgrade and thereby prevent ponding of water which could result in swelling, softening, and/or possible frost heave of the subgrade. The final compacted subgrade surface should be proof-rolled to confirm that surface deflections are minimal under the influence of construction traffic.

9.3.3 Pavement Structure

It is understood that the temporary construction access road will be required to accommodate wheel loads from typical construction equipment such as; dump trucks, concrete trucks, tracked equipment, and trailers. Although the expected number of trips per day is not available, we understand that the traffic through the construction access road is expected to be typical for a project of this scope with large quantities of earth moving expected. We further understand that the subject access road could either be asphalt concrete pavement (ACP) or gravel surfaced and would be in use for about 4 years.

Due to the frequent use of the construction access road by heavy trucks and construction equipment, and the relatively short service life, it is recommended that consideration be given to construction of a gravel pavement structure as opposed to an ACP pavement structure.

The design of pavement thickness will depend on the magnitude, frequency, and distribution of traffic loading anticipated on the access road. In the absence of this information, one of the preliminary pavement sections presented in Table 9.1 below may be considered for the design and construction of the subject temporary access road. Once the actual construction traffic loads and frequencies are known, the contractor's pavement engineer should review and confirm the adequacy of these proposed pavement sections.

The pavement design has been based on an assumed subgrade CBR value of 3 and a design period of 4 years.

TABLE 9.3
ALTERNATE PAVEMENT STRUCTURES (GRAVEL PAVEMENTS)

UNREINFORCED STRUCTURE	REINFORCED STRUCTURE
550 mm Crushed Granular Base over Woven geotextile (Nilex 2004) over 300 mm of prepared subgrade	350 mm Crushed Granular Base over Geogrid (Tensar TX 160 or equivalent) over Non-Woven geotextile (Nilex 4551) over 300 mm prepared subgrade

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On-going grading and maintenance of the roadway gravel surface should be anticipated, particularly where vehicles are turning and braking. In addition, some maintenance may also be required to repair localized structurally damaged areas and/or to fill and level rutted areas. Additional gravel may be required to restore the gravel section at damaged or rutted areas. Prior to placing the gravel, any surficial contamination or loosed material should be removed. The replacement gravel should comprise suitable crushed gravel compacted to the specified compaction level.

Pavement materials should be supplied and constructed in accordance with the latest edition of the City of Edmonton Design Standards and Construction Specifications.

10. CLOSURE

We trust the above provides the information you require at this time. If you have any questions regarding the contents of this report, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.
Robin Tweedie, M.Sc., P. Eng
Review Principal

PERMIT TO PRACTICE
THURBER ENGINEERING LTD.
Signature H. El Ramly
Date 9 Oct. 2014
PERMIT NUMBER: P 5186
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PROFESSIONAL ENGINEER ALBERTA HASSAN EL-RAMLY
Oct. 9, 2014

Hassan El-Ramly, Ph.D., P. Eng
Senior Project Engineer

PROFESSIONAL ENGINEER ALBERTA Donald W. Stefanyk
October 9, 2014

Don Stefanyk, P.Eng.
Senior Pavement Engineer
/lg

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Attachments

- Appendix A
  - Drawing No. 19-5438-102-1AR – Site Plan Showing the Alignment of the Proposed Construction Access Road and Approximate Test Hole Locations
  - Drawing No. 19-5438-102-2AR – Schematic Diagram of Failure Mechanism of Grierson Hill Slide

- Appendix B
  - Modified Unified Soils Classification System
  - Symbols and Terms Used on the Test Hole Logs
  - Test hole Logs

- Appendix C
  - Plots of Slope Inclinometer Readings

- Appendix D
  - Figures of Slope Stability Analyses

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering or environmental consulting practices in this area. No other warranty, expressed or implied, is made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document, subject to the limitations provided herein, are only valid to the extent that this Report expressly addresses proposed development, design objectives and purposes, and then only to the extent there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation or to consider such representations, information and instructions.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS WE MAY EXPRESSLY APPROVE. The contents of the Report remain our copyright property. The Client may not give, lend or, sell the Report, or otherwise make the Report, or any portion thereof, available to any person without our prior written permission. Any use which a third party makes of the Report, are the sole responsibility of such third parties. Unless expressly permitted by us, no person other than the Client is entitled to rely on this Report. We accept no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without our express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and this report is delivered on the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by us. We are entitled to rely on such representations, information and instructions and are not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

(see over …)

INTERPRETATION OF THE REPORT *(continued. . .)*

c) Design Services: The Report may form part of the design and construction documents for information purposes even though it may have been issued prior to the final design being completed. We should be retained to review the final design, project plans and documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the report recommendations and the final design detailed in the contract documents should be reported to us immediately so that we can address potential conflicts.

d) Construction Services: During construction we must be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RISK LIMITATION

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause an accidental release of those substances. In consideration of the provision of the services by us, which are for the Client's benefit, the Client agrees to hold harmless and to indemnify and defend us and our directors, officers, servants, agents, employees, workmen and contractors (hereinafter referred to as the "Company") from and against any and all claims, losses, damages, demands, disputes, liability and legal investigative costs of defence, whether for personal injury including death, or any other loss whatsoever, regardless of any action or omission on the part of the Company, that result from an accidental release of pollutants or hazardous substances occurring as a result of carrying out this Project. This indemnification shall extend to all Claims brought or threatened against the Company under any federal or provincial statute as a result of conducting work on this Project. In addition to the above indemnification, the Client further agrees not to bring any claims against the Company in connection with any of the aforementioned causes.

7. SERVICES OF SUBCONSULTANTS AND CONTRACTORS

The conduct of engineering and environmental studies frequently requires hiring the services of individuals and companies with special expertise and/or services which we do not provide. We may arrange the hiring of these services as a convenience to our Clients. As these services are for the Client's benefit, the Client agrees to hold the Company harmless and to indemnify and defend us from and against all claims arising through such hirings to the extent that the Client would incur had he hired those services directly. This includes responsibility for payment for services rendered and pursuit of damages for errors, omissions or negligence by those parties in carrying out their work. In particular, these conditions apply to the use of drilling, excavation and laboratory testing services.

8. CONTROL OF WORK AND JOBSITE SAFETY

We are responsible only for the activities of our employees on the jobsite. The presence of our personnel on the site shall not be construed in any way to relieve the Client or any contractors on site from their responsibilities for site safety. The Client acknowledges that he, his representatives, contractors or others retain control of the site and that we never occupy a position of control of the site. The Client undertakes to inform us of all hazardous conditions, or other relevant conditions of which the Client is aware. The Client also recognizes that our activities may uncover previously unknown hazardous conditions or materials and that such a discovery may result in the necessity to undertake emergency procedures to protect our employees as well as the public at large and the environment in general. These procedures may well involve additional costs outside of any budgets previously agreed to. The Client agrees to pay us for any expenses incurred as the result of such discoveries and to compensate us through payment of additional fees and expenses for time spent by us to deal with the consequences of such discoveries. The Client also acknowledges that in some cases the discovery of hazardous conditions and materials will require that certain regulatory bodies be informed and the Client agrees that notification to such bodies by us will not be a cause of action or dispute.

9. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on our interpretation of conditions revealed through limited investigation conducted within a defined scope of services. We cannot accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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APPENDIX A

Drawing No. 19-5438-102-1AR – Site Plan Showing the Alignment of the Proposed Construction Access Road and Approximate Test Hole Locations

Drawing No. 19-5438-102-2AR – Schematic Diagram of Failure Mechanism of Grierson Hill Slide

Z:\19\19-5438-102\for tme\19-5438-102-1AR.dwg - 1AR - Oct. 09, 2014

N
W
E
S

97 STREET
101A AVENUE
JASPER AVENUE
95A STREET
101 AVENUE
GRIERSON HILL ROAD
ROWLAND RD.
100A AVENUE
CAMERON AVENUE

A
B
C
D

660
655
650
645
640
635
630
625
620
615

TH11-21
TH11-20
TH11-19A
TH11-18A/18
TH11-26
TH10-6
SI10-6
TH10-5
SI10-5
TH14-7
TH14-9
TH14-10
SI11-17 / TH11-17
TH14-5
TH14-6
SI10-4
TH14-8
TH14-11
TH10-4
TH14-4
TH10-2
TH10-1
SI14-2
EBA 80-14
SI14-1
EBA 80-13
EBA 80-12
EBA 80-11A/11B
EBA 80-15
EBA 80-9
EBA 80-10
EBA 80-8
EBA 80-5
EBA 80-6
EBA 80-7
EBA 80-1
EBA 80-3
EBA 80-4
EBA 80-2
TH14-1
TH14-2
TH14-3
PROPOSED LONG TERM MAINTENANCE AND EMERGENCY ACCESS ROUTE
PROPOSED TEMPORARY CONSTRUCTION ACCESS ROAD

BASE PLAN PROVIDED BY CH2M HILL CANADA LTD.

LEGEND

- TEST HOLE LOCATION BY THURBER
- PREVIOUS TEST HOLE LOCATION BY OTHERS
- TEST HOLE LOCATION WITH EXISTING SLOPE INCLINOMETER BY THURBER
- CURRENT SLOPE CREST / SCARP (APPROXIMATE)
- APPROXIMATE SLOPE CREST IN 1887 (BEFORE FAILURE)
- APPROXIMATE TOE OF RIVERBANK IN 1887 (BEFORE FAILURE)
- PROPOSED LRT ALIGNMENT

0 20 40 60 80 100 120m
SCALE 1:2000

AECOM

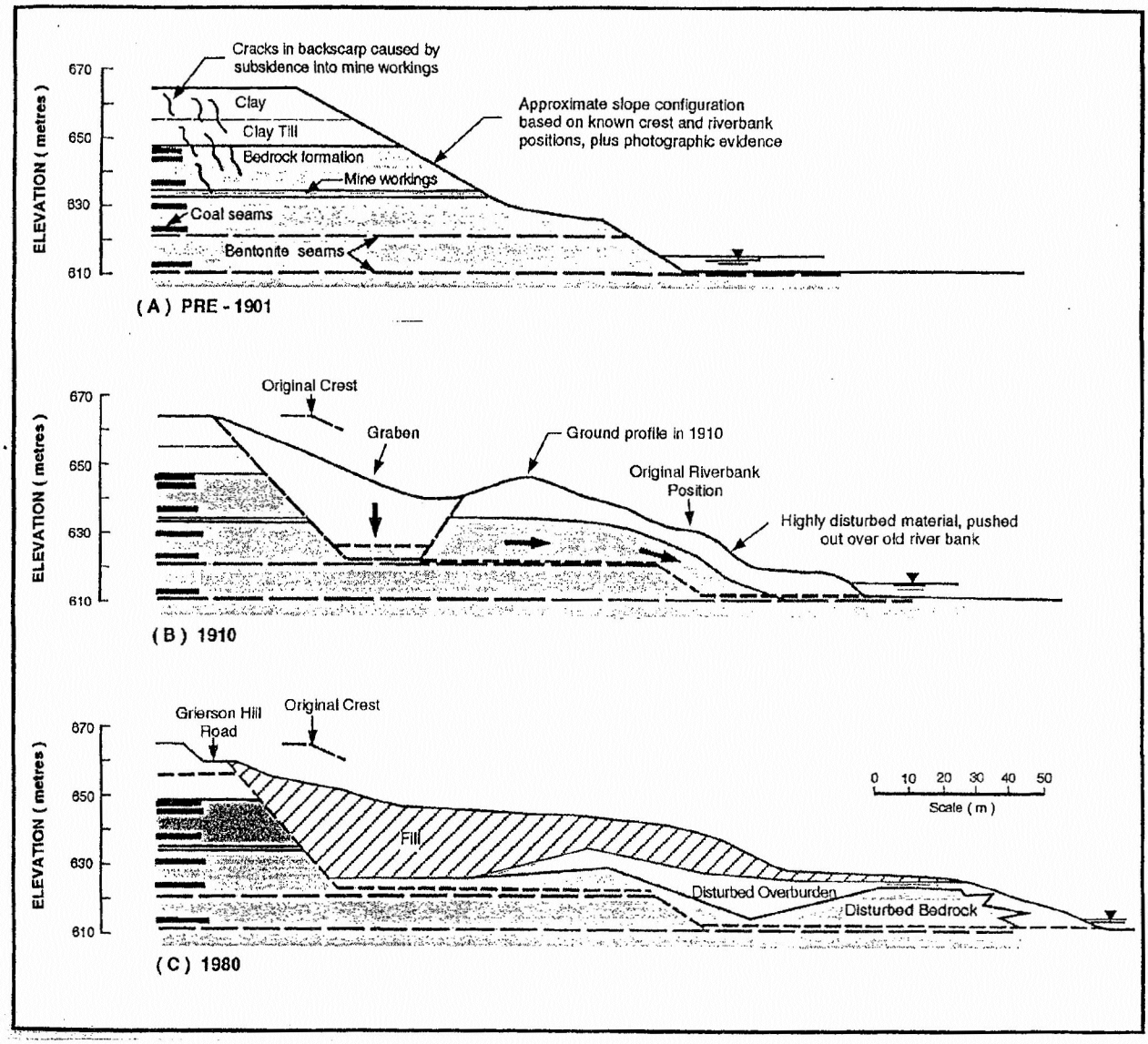
PROPOSED NORTH BANK ACCESS ROAD PRELIMINARY GEOTECHNICAL INVESTIGATION AND ASSESSMENT

SITE PLAN SHOWING THE ALIGNMENT OF THE PROPOSED CONSTRUCTION ACCESS ROAD AND APPROXIMATE TEST HOLE LOCATIONS

DWG No. 19-5438-102-1AR

DRAWN BY	ML
DESIGNED BY	TME
APPROVED BY	HER
SCALE	1:2000
DATE	OCTOBER 2014
FILE No.	19-5438-102

THURBER ENGINEERING LTD.



FROM MARTIN et. al., 1998

CROSS-SECTION SHOWING SLIDE DEVELOPMENT

PROPOSED NORTH BANK ACCESS ROAD
GEOTECHNICAL INVESTIGATION AND ASSESSMENT

SCHEMATIC DIAGRAM OF FAILURE MECHANISM OF GRIERSON HILL SLIDE

DWG No. 19-5438-102-2AR

AECOM

DRAWN BY	ML
DESIGNED BY	TME
APPROVED BY	HER
SCALE	N.T.S.
DATE	OCTOBER 2014
FILE No.	19-5438-102

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APPENDIX B

Test hole Logs

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Test Holes by Thurber (2014)

SYMBOLS AND TERMS USED ON TEST HOLE LOGS

1. VISUAL TEXTURAL CLASSIFICATION OF MINERAL SOILS

CLASSIFICATION	APPARENT PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200 mm	Greater than 200 mm
Cobbles	75 mm to 200 mm	75 mm to 200 mm
Gravel	4.75 mm to 75 mm	5 mm to 75 mm
Sand	0.075 mm to 4.75 mm	Visible particles to 5 mm
Silt	0.002 mm to 0.075 mm	Non-Plastic particles, not visible to the naked eye
Clay	Less than 0.002 mm	Plastic particles, not visible to the naked eye

2. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	APPROXIMATE UNDRAINED SHEAR STRENGTH		APPROXIMATE SPT * 'N' VALUE
Very Soft	Less than 10 kPa		Less than 2
Soft	10 - 25 kPa		2 to 4
Firm	25 - 50 kPa		4 to 8
Stiff	50 - 100 kPa		8 to 15
Very Stiff	100 - 200 kPa	Modified from	15 to 30
Hard	200 - 300 kPa	National Building	Greater than 30
Very Hard	Greater than 300 kPa	Code	

* SPT 'N' Value Standard Penetration Test 'N' Value - refers to the number of blows from a 63.5 kg hammer free falling a height of 0.76m to advance a standard 50mm outside diameter split spoon sampler for 0.3m depth into the undrilled portion of the test hole.

3. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	STANDARD PENETRATION TEST (SPT) (Number of Blows per 300 mm)	
Very Loose	0 - 4	
Loose	4 - 10	
Compact	10 - 30	Modified from
Dense	30 - 50	National Building
Very Dense	Over 50	Code

4. LEGEND FOR TEST HOLE LOGS

SYMBOL FOR SAMPLE TYPE

■	Shelby Tube	▤	A-Casing
⊘	SPT	▥	Grab
⊠	No Recovery	◧	Core

SYMBOLS USED FOR TEST HOLE LOGS

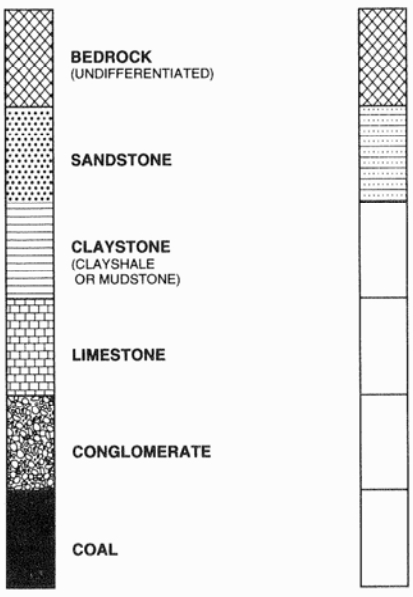
●	MC - Moisture Content (% by weight) of soil sample
▼	Water Level
■ SPT	Standard Penetration Test 'N' Value (Blows/300mm)
▲ CPen	Shear Strength determined by pocket penetrometer
CVane	Shear Strength determined by pocket vane
Cu	Undrained Shear Strength determined by unconfined compression test
SO_4%	Percent (%) of water soluble sulphate ions

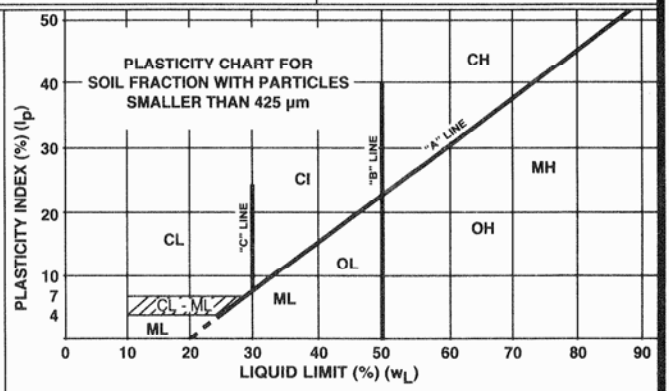
THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

MAJOR DIVISION			GROUP SYMBOL	THURBER LOG SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75µm)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES	Determine percentages of gravel and sand from grain size curve. Depending on percentages of fines (fraction smaller than 75µm) coarse grained soils are classified as follows: Less than 5% GW, GP, SW, SP; More than 12% GM, GC, SM, SC; 5% to 12% Borderline cases requiring use of dual symbols. $C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR GW
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7 — Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
	SANDS MORE THAN HALF COARSE GRAINS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
		SAND WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE I_p LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE I_p MORE THAN 7 — Above "A" line with I_p between 4 and 7 are borderline cases requiring use of dual symbols
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 50\%$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)
		$w_L > 50\%$	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	$w_L < 30\%$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	
		$30\% < w_L < 50\%$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS	
		$w_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	$w_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY	
		$w_L > 50\%$	OH		ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS	
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE

SPECIAL SYMBOLS





THURBER ENGINEERING LTD.

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS
(MODIFIED BY PFRA, 1985)

ROCK MATERIAL DESCRIPTION

Descriptions should follow the form "Colour, grain size, textural fabric, weathering, alteration, strength, type". Example: Dark bluish grey, fine-grained, crystalline, slightly weathered, moderately strong basalt.

COLOUR

Shade	Primary	Secondary	
light		pinkish	pink
dark		reddish	red
		yellowish	yellow
		brownish	brown
		olive	olive
		greenish	green
		bluish	blue
			white
		greyish	grey
			black

GRAIN SIZE

Term	Particle Size	Retained on Sieve Size	Equivalent Soil Grade
Very coarse-grained	>60 mm	2 inch	Coarse gravel, cobbles, boulders
Coarse-grained	2 - 60 mm	No. 8	Gravel
Medium-grained	60 microns - 2 mm	No. 200	Sand
Fine-grained	2 - 60 microns		Silt
Very fine-grained	<2 microns		Clay

Note: grains >60 microns are visible to the naked eye.

TEXTURE/ FABRIC

crystalline
granular
glassy

WEATHERING / ALTERATION

Term	Description
Fresh	No visible sign of rock material weathering.
Faintly weathered	Discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker than in its fresh conditon.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a continuous framework or as corestones.
Highly weathered	More than half the rock material is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

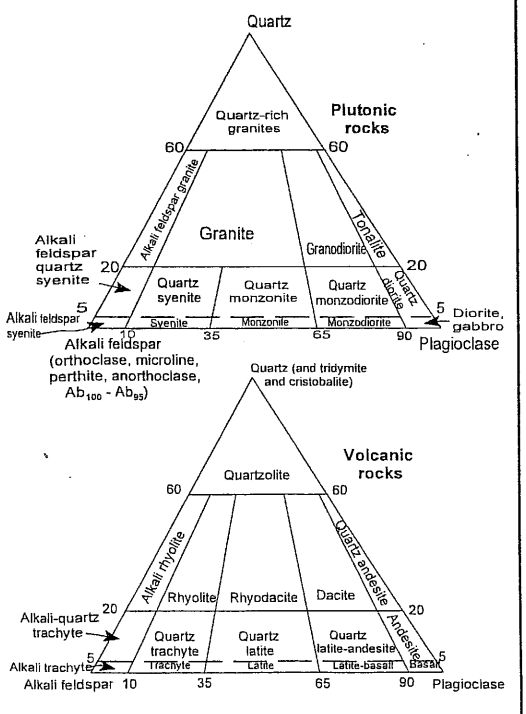
ROCK STRENGTH

Term	Grade	Unconfined compressive strength (MPa)	Unconfined compressive strength (psi)	Field estimation of strength
Extremely strong rock	R6	>250	>36,000	Specimen can only be chipped with a geological hammer.
Very strong rock	R5	100 - 250	15,000 - 36,000	Specimen requires many blows of a geological hammer to fracture it.
Strong rock	R4	50 - 100	7,500 - 15,000	Specimen requires more than one blow of geological hammer to fracture it.
Medium strong rock	R3	25 - 50	3,500 - 7,500	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.
Weak rock	R2	5 - 25	750 - 3,500	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.
Very weak rock	R1	1 - 5	150 - 750	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.
Extremely weak rock	R0	.25 - 1	35 - 150	Indented by thumbnail.
Hard clay[1]	S6	>.50	>70	Indented with difficulty by thumbnail.
Very stiff clay[1]	S5	0.25 - 0.50	35 - 70	Readily indented by thumbnail.
Stiff clay[1]	S4	0.10 - 0.25	15 - 35	Readily indented by thumb but penetrated only with great effort.
Firm clay[1]	S3	0.05 - 0.10	7 - 15	Can be penetrated several inches by thumb with moderate effort.
Soft clay[1]	S2	0.025 - 0.05	4 - 7	Easily penetrated several inches by thumb.
Very soft clay[1]	S1	<0.025	<4	Easily penetrated several inches by fist.

[1]These soil strengths are as recommended by ISRM but should only be used to describe highly weathered rock, residual soils or rock discontinuity filling; they do not correspond to ASTM D2488 consistency criteria.

ROCK TYPE

Genetic group			*Detrital sedimentary*			*Pyroclastic*	*Chemical organic*	*Metamorphic*		*Igneous*
Usual Structure			BEDDED			BEDDED		FOLIATED	MASSIVE	MASSIVE
COMPOSITION			Grains of rock, quartz, feldspar and minerals	At least 50% of grains are of carbonate		At least 50% of grains are of fine-grained volcanic rock		Quartz, feldspars, micas, acicular dark minerals		
	Grain size (mm)									
Very coarse grained	60	RUDACEOUS	Grains are of rock fragments Rounded grains: CONGLOMERATE Angular grains: BRECCIA	LIMESTONE (undifferentiated)	CALCI-RUDITE	Rounded grains AGGLOMERATE Angular grains VOLCANIC BRECCIA	SALINE ROCKS Halite Anhydrite Gypsum	MIGMATITE	HORNFELS	
Coarse grained	2							GNEISS	MARBLE	
Medium grained	0.06	ARENACEOUS	SANDSTONE Grains are mainly mineral fragments QUARTZ SANDSTONE: 95% quartz, voids empty or cemented ARKOSE: 75% quartz, up to 25% feldspar: voids empty or cemented ARGILLACEOUS SANDSTONE: 75% quartz, 15% + fine detrital material		CALC-ARENITE	TUFF		Alternate layers of granular and flakey minerals SCHIST	GRANULITE QUARTZITE	
Fine grained	0.002	ARGILLACEOUS or LUTACEOUS	MUDSTONE SHALE: fissile mudstone SILTSTONE: 50% fine-grained particles CLAYSTONE: 50% very fine-grained particles CALCAREOUS MUDSTONE		CALCI-SILTITE	Fine-grained TUFF	CHERT	SLATE	AMPHIBOLITE	
Very fine grained						Very fine-grained TUFF	FLINT COAL	MYLONITE		
GLASSY					CALCI-LUTITE		OTHERS			



References:

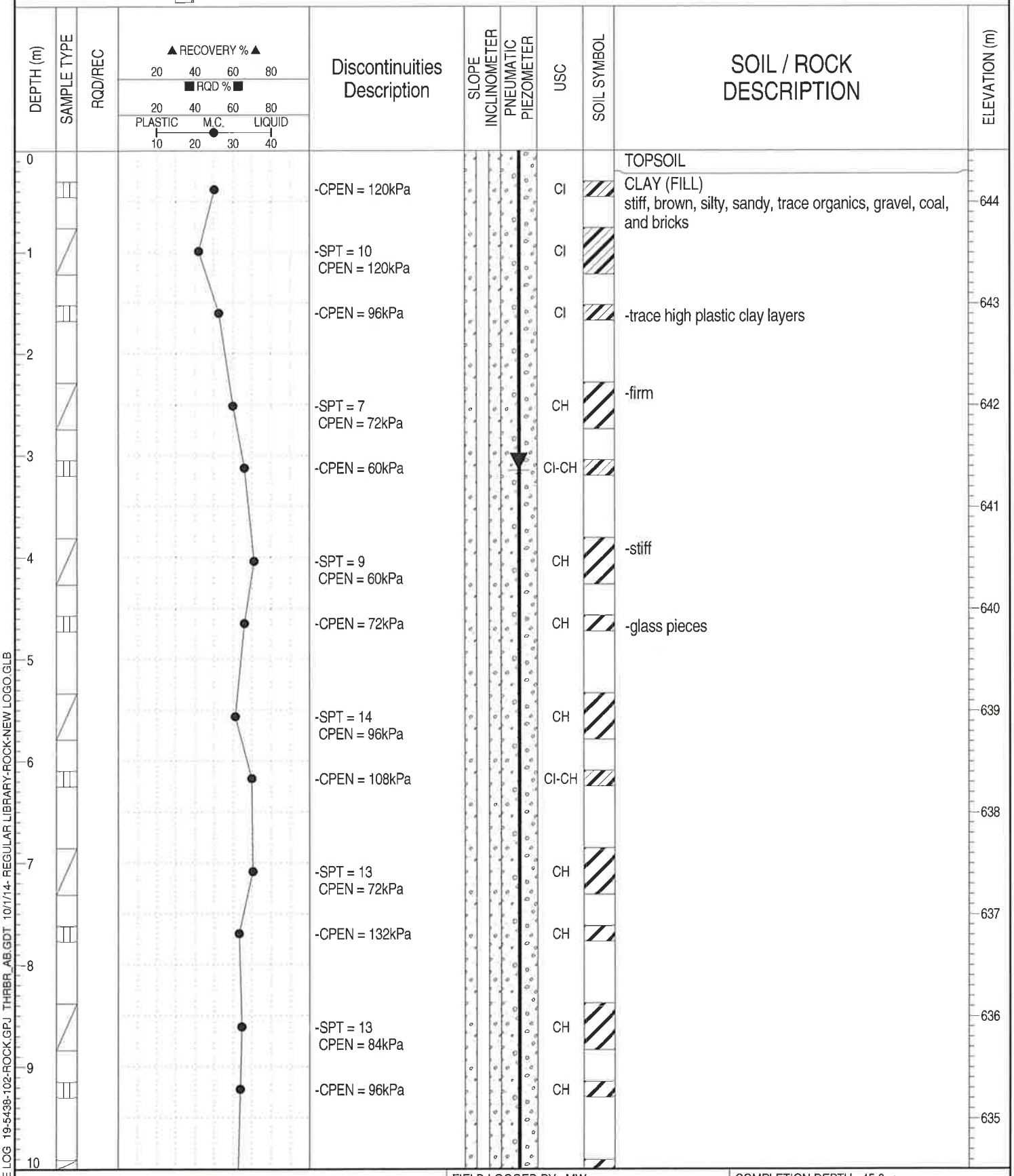
Geological Society Engineering Group Working Party (1977), The Description of Rock Masses For Engineering Purposes, Quaterly Journal of Engineering Geology, Vol. 10; Rock Chracterization Testing and Monitoring, ISRM Suggested Methods, E. Brown, Pergamon Press; Manual of Mineralogy, 20th Edition, C. Klein and C. Hurlbut, Wiley; Canadian Foundation Engineering Manual, 2nd Edition, 1985, Canadian Geotechnical Society; Foundations on Rock, D. Wyllie, E & FN Spon.

THURBER

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: GROUT



FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	Page 1 of 5

THURBER ENGINEERING LTD.

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲RECOVERY %▲ 20 40 60 80 / ■RQD %■ 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Discontinuities Description	SLOPE INCLINOMETER / PNEUMATIC PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
10				-SPT = 13 CPEN = 96kPa		CH			634
				-CPEN = 120kPa		CH			
11									
				-SPT = 17 CPEN = 132kPa **-P/N35450**		CH		-very stiff	633
12				-CPEN = 48kPa		CI		-some sand lenses	
									632
13				-SPT = 29 CPEN = 204kPa		CI		CLAY (TILL) very stiff, grey, silty, sandy, trace gravel, coal, and oxides, occasional clay shale nodules and silt lenses	
				-CPEN = 156kPa		CI-SC		SANDSTONE dense, bluish grey, bentonitic, trace coal, occasional clay lenses	631
14									630
				-SPT = 38 -CPEN > 215kPa		CI-CH			
15				-CPEN = 168kPa		CI-SC			629
16				-SPT = 55 -CPEN > 215kPa -Start coring at 16.46m		CI-SC		-very dense	
								SANDSTONE extremely weak, fresh, light grey, fine grained, bentonitic, silty	628
17				-Possible joint at 16.96m at 70° TCA, curved, rough					
		45/66		-Possible joint at 17.12m at 70° TCA, undulating, rough				-clay shale laminations from 17.46 - 17.52m, silty -clay shale laminations from 17.60 - 17.66m, silty	627
18				-Joint at 17.44m at 70° TCA, undulating, rough					
									626
19				-Possible joint at 18.75m at 60° TCA, undulating, rough -Joint at 19.04m at 70° TCA, undulating, smooth					
		33/37							625
20									

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FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
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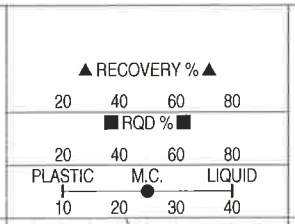
BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: GROUT



DEPTH (m)	SAMPLE TYPE	RQD/REC	Discontinuities Description	SLOPE INCLINOMETER / PNEUMATIC PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
20							-trace coal inclusions	
		41/75	-Rubbled / disturbed from 20.47 - 20.62m				CLAY SHALE extremely weak, fresh, dark brown, carbonaceous, trace coal	624
21			-Joint at 20.84m at 80° TCA, undulating, smooth, rough -Rubbled from 21.34 - 21.68m with clay infilling -**P/N35121**				-trace coal inclusions	
							Coal, very weak, fresh	623
22		0/99	-Rubbled from 21.94 - 22.28m with clay infilling					
			-Rubbled / disturbed from 22.55 - 23.13m					622
23							-extremely weak to very weak, brown, silty	
		0/99	-Joint at 23.28m at 70° TCA, undulating, smooth, rough -Joint at 23.47m at 70° TCA, irregular, rough -Rubbled / disturbed from 23.50 - 23.84m and 23.93 - 24.14m -Joint at 24.14m at 80° TCA, undulating, rough -Joint at 24.19m at 50° TCA, closed				-extremely weak -sandstone laminations from 23.28 - 23.37m	621
24							-siltstone laminations from 24.16 - 24.28m -very weak, trace siltstone inclusions	620
25		8/98						
			-Fractured / rubbled from 24.28 - 24.36m -Possible joints from 24.38 - 24.63m at 5° TCA, undulating, closed -Rubbled / disturbed from 24.63 - 24.77m with clay infilling -Joint at 24.80m at 40° TCA, undulating, smooth					619
26								
		27/81					Sandstone, extremely weak, fresh, light grey, fine grained, slightly bentonitic, silty, trace thin clay shale laminations at 80° TCA	618
27			-Fractured / rubbled from 24.98 - 25.04m and 25.12 - 25.22m -Rubbled / disturbed from 25.51 - 25.75m				Sandstone, extremely weak, fresh, light grey, medium to fine grained, bentonitic	617
28			-Joint at 26.57m at 80° TCA, undulating, rough -Joint at 26.88m at 40° TCA, curved, rough				SANDSTONE, extremely weak, fresh, medium to fine grained, bentonitic, silty, trace coal and siltstone inclusions	
		19/76	-Fractured from 28.05 - 28.11m -Joint at 28.12m at 60° TCA, undulating, smooth -Joint at 28.15m at 80° TCA, undulating, rough -Rubbled / disturbed from 28.15 - 28.45m with clay infilling				CLAY SHALE extremely weak to very weak, fresh, slightly carbonaceous -very weak to weak -very weak, trace coal inclusions	616
29								615
30							Siltstone, very weak, fresh, trace coal inclusions	

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
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BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲RECOVERY %▲ 20 40 60 80 / ■RQD %■ 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Discontinuities Description	SLOPE INCLINOMETER / PNEUMATIC PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
30		49/100		-Joints at 28.45m and 28.54m at 70° TCA, undulating, smooth -Fractured / disturbed from 28.70 - 28.90m, trace clay infilling -Rubbled / disturbed from 30.60 - 30.75m -Rubbled / disturbed from 30.94 - 31.14m and 31.09 - 31.24m with clay infilling -Joint at 31.70m at 60° TCA, closed				-fine sandstone laminations from 30.23 - 30.30m SILTSTONE, very weak, fresh, thin clay shale and coal laminations at 85° TCA	614
31								CLAY SHALE, very weak, fresh, silty, trace coal inclusions SILTSTONE, very weak, fresh, some clay shale laminations	613
32		26/72						-sandstone laminations from 30.79 - 30.87m, trace coal inclusions CLAY SHALE, very weak, fresh, silty SILTSTONE, medium strong, fresh, cemented, trace calcite stringers, calcareous	612
33		25/98		-Joint at 32.74m at 70° TCA, undulating, rough -Joint at 33.07m at 70° TCA, curved, smooth -Joint at 33.26m at 60° TCA, undulating, rough -Joint at 33.40m at 70° TCA -Fractured from 33.84 - 34.02m and 34.19 - 34.50m with clay infilling				CLAY SHALE, very weak to weak, fresh, brown, silty -extremely weak, bentonitic, trace coal inclusions from 31.70 - 31.83m -highly carbonaceous from 31.88 - 31.98m Coal, very weak, fresh	611
34		0/96						-very weak, trace coal inclusions, siltstone laminations from 32.64 - 32.86m -weak to very weak	610
35		36/100		-Fractured / disturbed from 34.57 - 34.64m -Joint at 34.72m at 85° TCA, undulating, smooth -Rubble from 34.72 - 34.75m with clay infilling **-P/N35105**				Siltstone, weak, fresh, cemented -carbonaceous -extremely weak, green, bentonitic from 35.31 - 35.55m -weak	609
36				-Joint at 34.75m at 80° TCA, curved, smooth -Joint at 34.81m at 80° TCA, undulating, smooth -Joint at 35.13m at 80° TCA, undulating, smooth -Joint at 35.89m at 70° TCA, curved, smooth					608
37		72/100		-Rubble from 35.93 - 35.96m with clay infilling -Joints from 36.04 - 36.33m at 5° TCA, closed				SANDSTONE, weak, fresh, some clay shale laminations -very weak, fine grained, silty CLAY SHALE weak, fresh, brown, silty	607
38		0/91		-Disturbed / closed jointed from 36.70 - 36.92m -Possible joint at 37.12m at 80° TCA, curved, smooth				very weak, carbonaceous, trace coal inclusions -extremely weak -very weak, highly carbonaceous from 38.44 - 38.60m	606
39		26/89		-Possible joint at 37.13m at 40° TCA, closed -Joint at 37.76m at 70° TCA, undulating, rough				COAL, very weak, fresh, black CLAY SHALE, extremely weak to very weak, fresh, carbonaceous, trace coal inclusions	605
40				-Joint at 37.80m at 70° TCA, undulating, rough -Joint at 37.83m at 80° TCA, undulating, smooth				SANDSTONE, very weak, fresh, fine grained, silty, bentonitic, trace clay shale laminations	

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FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
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BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 19, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934499.95, E34488.92	ELEVATION: 644.51 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲ RECOVERY % ▲ 20 40 60 80 ■ RQD % ■ 20 40 60 80 PLASTIC M.C. LIQUID 10 20 30 40	Discontinuities Description	SLOPE INCLINOMETER	PNEUMATIC PIEZOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
40				-Fractured from 37.93 - 37.97m -Joint at 38.08m at 40° TCA, planar, smooth -Joint at 38.30m at 60° TCA, undulating, rough -Joints from 38.68 - 38.83m at 10° TCA, planar, rough, fractured -Fractured / jointed from 38.83 - 39.16m with clay infilling -Joint at 39.95m at 70° TCA, undulating, smooth -Joint at 40.07m at 80° TCA, undulating, smooth -Joint at 40.43m at 80° TCA, undulating, smooth -Joint at 40.78m at 85° TCA, undulating, smooth -Possible joint at 41.48m at 80° TCA -Joint at 41.89m at 80° TCA, planar, smooth -Joint at 42.09m at 40° TCA, curved, rough -Joint at 42.47m at 80° TCA, planar, rough -Joint at 42.94m at 80° TCA, curved, rough -Joint at 43.32m at 85° TCA, undulating, smooth -Joint at 43.35m at 80° TCA, undulating, rough -Fractured from 43.38 - 43.59m -Possible joints at 43.87m and 43.89m at 80° TCA, undulating, rough -Joint at 44.15m at 80° TCA, curved, smooth -Joint at 44.41m at 70° TCA, curved, rough -Joint at 44.80m at 70° TCA, planar, smooth -Joint at 45.11m at 70° TCA, curved, smooth -Joint at 45.21m at 85° TCA, undulating, rough -Rubble from 45.36 - 45.38m					-medium to fine grained -some clay shale laminations from 40.14 - 40.43m	604
41										
42		72/91							-fine grained, slightly bentonitic, trace coal inclusions	603
43		85/98								602
44		30/100							-trace cemented siltstone clasts CLAY SHALE extremely weak, fresh, brown, silty -medium strong, calcareous, cemented siltstone from 43.30 - 43.59m SANDSTONE, extremely weak, fresh, fine grained, bentonitic, trace coal inclusions -weak, silty, slightly cemented, calcareous	601 600
45		75/98							CLAY SHALE, very weak, fresh, carbonaceous, trace coal inclusions	599
46									END OF TEST HOLE AT 45.6m UPON COMPLETION: Slope indicator (casing at 45.5m) installed Three pneumatic piezometers installed (P/N35450, P/N35121, and P/N35105) WATER LEVEL BELOW GROUND SURFACE: P/N35450: -July 9, 2014 = 3.1m -July 31, 2014 = 3.4m -September 29, 2014 = 3.1m P/N35121: -July 9, 2014 = 16.8m -July 31, 2014 = 17.1m -September 29, 2014 = 18.0m P/N35105: -July 9, 2014 = 26.9m -July 31, 2014 = 26.4m -September 29, 2014 = 27.2m	598
47										597
48										
49										596
50										595

THURBER ENGINEERING LTD.

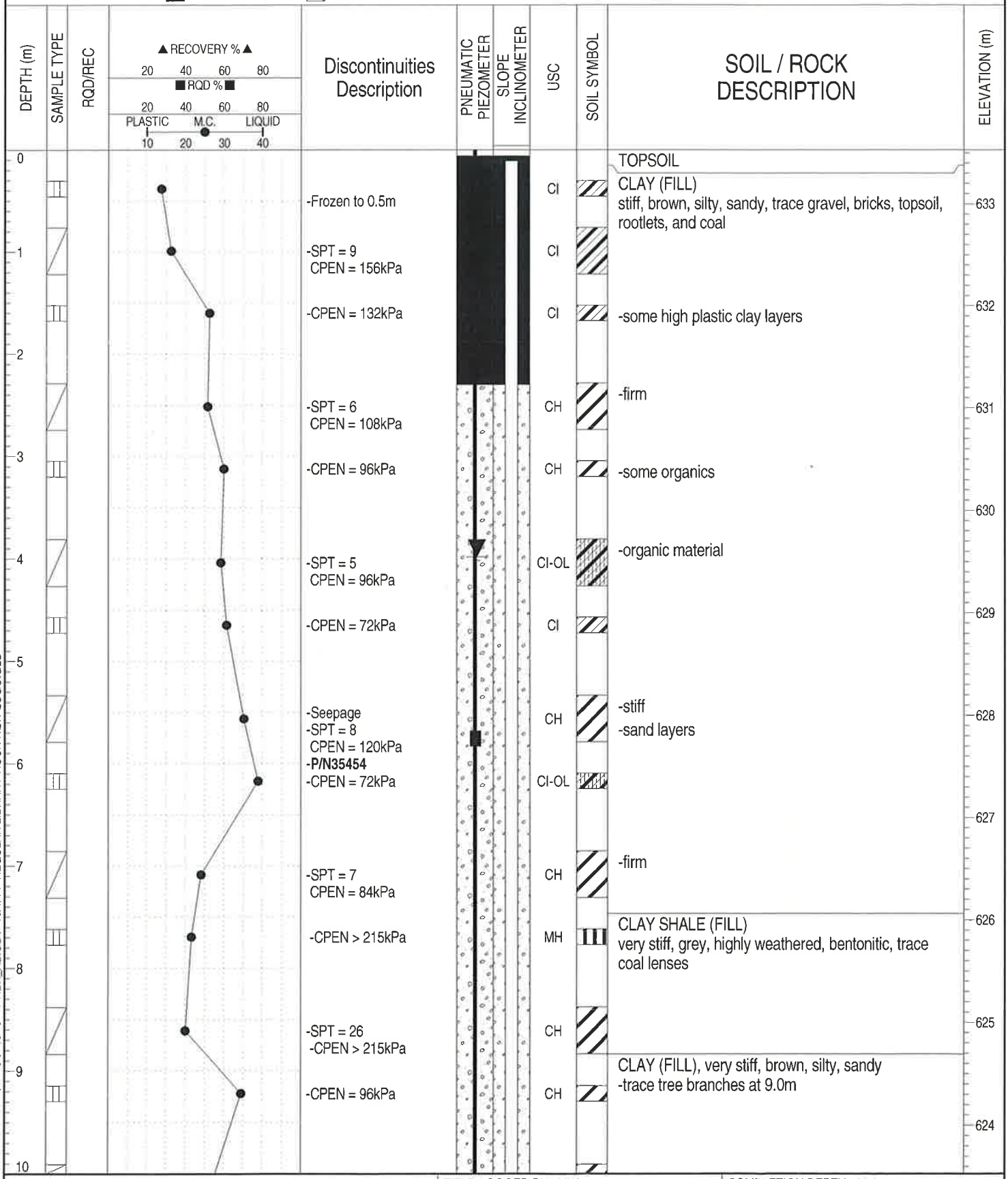
FIELD LOGGED BY: MW	COMPLETION DEPTH: 45.6 m
PREPARED BY: XW	COMPLETION DATE: 3/19/14
REVIEWED BY:	Page 5 of 5

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: BENTONITE | GROUT



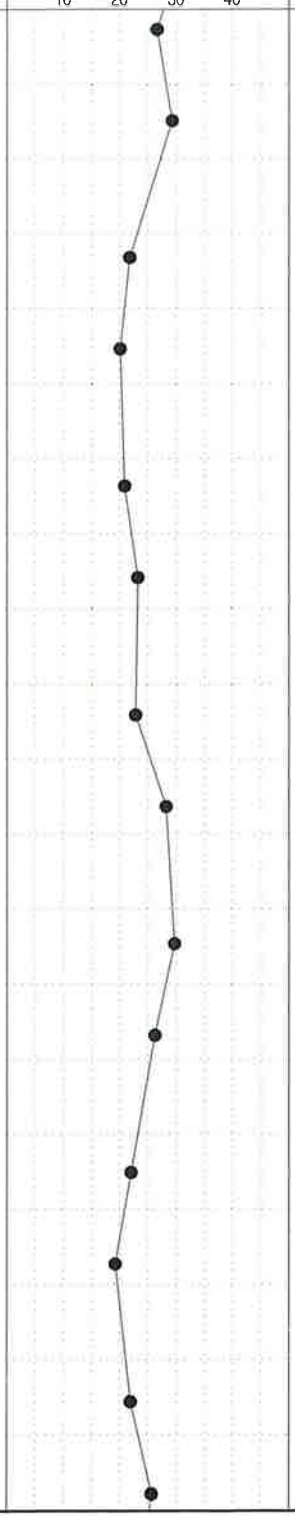
THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
	PREPARED BY: XW	COMPLETION DATE: 3/17/14
	REVIEWED BY:	Page 1 of 4

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: BENTONITE | GROUT



DEPTH (m)	Discontinuities Description	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
10	-SPT = 17 CPEN = 60kPa -Seepage	CH			
	-CPEN = 168kPa	CH		CLAY SHALE grey, silty, weathered, trace oxides	623
11					
	-SPT = 25 -CPEN > 215kPa	SC		SANDSTONE compact, bluish grey, bentonitic	622
12	-CPEN = 132kPa	SC			
					621
13	-SPT = 21 CPEN = 120kPa	SC		-occasional clay shale lenses	
	-CPEN > 215kPa	CH		CLAY SHALE hard, grey, weathered, trace oxides, occasional siltstone	620
14					
	-SPT = 38 -CPEN > 215kPa	CH			619
15	-CPEN = 132kPa	CH			
					618
16	-SPT = 35 -CPEN > 215kPa	CH		-coal layer	
	-CPEN > 215kPa	CH			617
17					
	-SPT = 28 CPEN = 156kPa	SC		SANDSTONE compact, bentonitic	616
18	-CPEN = 180kPa	SC		CLAY SHALE very stiff	
					615
19	-SPT = 26 CPEN = 156kPa	CH		SANDSTONE	
					614
20	-CPEN > 215kPa	CH		CLAY SHALE	

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FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
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BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: BENTONITE | GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲RECOVERY % ▲ 20 40 60 80 / ■RQD % ■ 20 40 60 80 / PLASTIC M.C. LIQUID 10 20 30 40	Discontinuities Description	PNEUMATIC PIEZOMETER	SLOPE INCLINOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
20									hard, occasional sandstone lenses and coal	
										613
21				-SPT = 39 -CPEN > 215kPa			SC			
		50/100		-Start coring at 21.03m -Fractured / rubbled from 21.23 - 21.46m					CLAY SHALE, extremely weak, fresh, dark grey, silty	
									SILTSTONE, extremely weak, fresh, grey, some clay shale inclusions	612
		30/51							CLAY SHALE, very weak, fresh, dark brown - black, highly carbonaceous, some coal inclusions	
22									-greyish brown, silty	
				-Rubbled from 22.45 - 23.15m with clay infilling					SANDSTONE extremely weak, fresh, light grey, bentonitic, silty, some grey clay shale inclusions	611
23									CLAY SHALE, very weak, fresh, dark brown, carbonaceous, trace coal inclusions	
		0/99		-Joint at 23.12m at 80° TCA, undulating, smooth -Joint at 23.31m at 80° TCA, irregular, rough, rubble infill -Joint at 23.36m at 40° TCA, curved, smooth, rubble infill -Joint at 23.49m at 60° TCA					-extremely weak, grey, silty	610
24									-brown	
										609
		49/87		-Fractured / rubbled from 23.60 - 23.74m -Rubble from 23.98 - 24.12m with clay infilling -Possible joint at 24.21m at 70° TCA, closed					Siltstone, medium strong, fresh -extremely weak to very weak, siltstone clasts	
25										608
									Coal, extremely weak, fresh, black -highly carbonaceous from 25.69 - 25.79m	
26				-Joint at 24.34m at 75° TCA, slightly undulating, smooth						
		0/68		-Joint at 24.53m at 60° TCA, stepped, smooth -Joints at 24.68m, 24.75m, 24.82m, and 24.89m at 50 - 70° TCA, undulating, smooth **-P/N35447**					-highly carbonaceous from 26.55 - 26.68m, trace amber inclusions	607
27										
				-Joints at 24.98m and 25.33m at 75 - 80° TCA, curved, smooth						606
28		35/100		-Joints from 25.50 - 25.59m at 5° TCA, planar, rough -Fractured / rubbled from 25.59 - 25.62m -Joint at 25.90m at 80° TCA, planar, smooth					SILTSTONE, extremely weak to very weak, fresh, grey, fine sandy	
									SANDSTONE very weak, fresh, fine grained, silty, trace coal inclusions	605
29				-Joints from 25.90 - 26.09m at 5° TCA, planar, smooth, rough, fractured					SILTSTONE, very weak, fresh	
									CLAY SHALE, extremely weak, fresh, brown, silty	
		56/82		-Joint at 26.22m at 70°					SANDSTONE very weak, fresh, grey, fine grained, silty	604
30										

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FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
REVIEWED BY:	Page 3 of 4

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **SI14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 17, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: Core Truck / Solid Stem Augers	LOCATION: N5934403.87, E34520.25	ELEVATION: 633.53 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | CORE

BACKFILL TYPE: BENTONITE | GROUT

DEPTH (m)	SAMPLE TYPE	RQD/REC	▲ RECOVERY % ▲ (20 40 60 80) ■ RQD % ■ (20 40 60 80) PLASTIC M.C. LIQUID (10 20 30 40)	Discontinuities Description	PNEUMATIC PIEZOMETER	SLOPE INCLINOMETER	USC	SOIL SYMBOL	SOIL / ROCK DESCRIPTION	ELEVATION (m)
30				TCA, undulating, rough -Joint at 26.27m at 40° TCA, curved, smooth -Joint at 26.28m at 80° TCA, planar, smooth -Joint at 26.32m at 70° TCA, undulating, rough -Fractured / rubbled from 26.55 - 26.68m and 27.23 - 27.98m -Joint at 29.06m at 50° TCA, curved, smooth, rough -Joint at 29.45m at 40° TCA, curved, rough -Joint at 29.56m at 30° TCA, undulating, smooth -Joint at 29.74m at 80° TCA, irregular, smooth -Joints at 29.89m and 30.04m at 70 - 80° TCA, undulating, smooth -Joint at 30.72m at 60° TCA, curved, rough -Joint at 30.77m at 40° TCA, undulating, rough -Joint at 32.54m at 60° TCA, undulating, rough -Fractured from 32.54 - 33.29m					CLAY SHALE, extremely weak, fresh, brown, silty -sandstone laminations from 29.49 - 29.51m SILTSTONE, extremely weak, fresh, light grey, trace clay shale laminations / inclusions	
31		54/99							SANDSTONE extremely weak, fresh, fine grained, silty	603
32									-light grey, slightly bentonitic, trace siltstone inclusions	602
33		46/95							-trace thin coal laminations -highly carbonaceous clay shale laminations from 32.44 - 32.51m SILTSTONE, extremely weak to very weak, fresh SANDSTONE, very weak, fresh, trace siltstone laminations CLAY SHALE, very weak, fresh, highly carbonaceous SILTSTONE, medium strong, fresh, cemented CLAY SHALE, very weak, fresh	601 600
34									END OF TEST HOLE AT 33.3m UPON COMPLETION: Slope indicator (casing at 33.3m) installed Two pneumatic piezometers installed (P/N35454and P/N35447) WATER LEVEL BELOW GROUND SURFACE: P/N35454: -July 9, 2014 = 4.8m -July 31, 2014 = 4.5m -September 29, 2014 = 4.0m P/N35447: -July 9, 2014 = 19.1m -July 31, 2014 = 19.3m -September 29, 2014 = 19.3m	599
35										598
36										597
37										596
38										595
39										594
40										

THURBER ENGINEERING LTD.

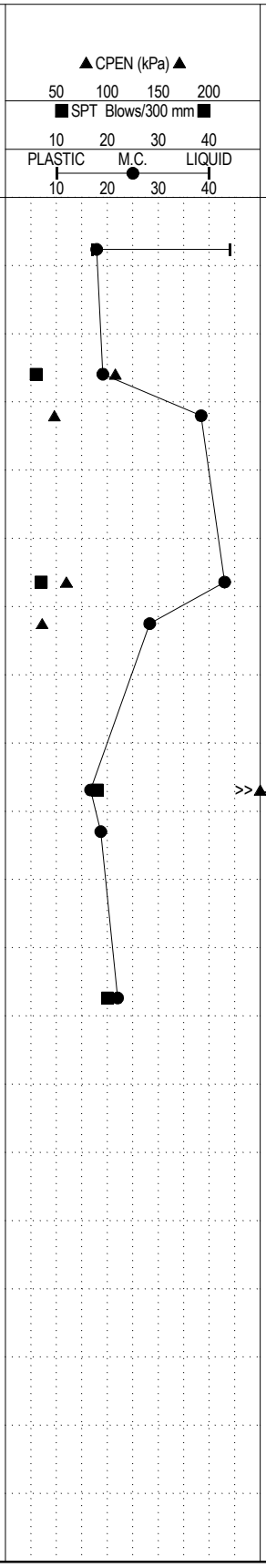
FIELD LOGGED BY: MW	COMPLETION DEPTH: 33.3 m
PREPARED BY: XW	COMPLETION DATE: 3/17/14
REVIEWED BY:	Page 4 of 4

BOREHOLE LOG 19-5438-102-ROCK.GPJ THRBR_AB.GDT 10/1/14- REGULAR LIBRARY-ROCK-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-1**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934370.75, E34212.54 3TM	ELEVATION: 634.19 (m)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS



DEPTH (m)	SAMPLE TYPE	SPT (N)	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0							TOPSOIL	634
					CI		CLAY (FILL) brown, silty, sandy, trace gravel, coal, roots, and bricks, occasional sand lenses	
1		6			CI		-firm	633
					CH		CLAY firm, brown, silty, trace oxides	
2								632
		7			CH			
3					CH			631
4		18	>>▲Cpen > 215kPa		CI		CLAY (TILL) very stiff, brown - grey, silty, sandy, trace gravel, coal, and oxides, occasional sand lenses	630
5					CI			629
6		20			CI		END OF TEST HOLE AT 6.1m UPON COMPLETION: -No slough -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2014 = 4.6m -July 9, 2014 = 4.7m -July 31, 2014 = 4.6m -September 29, 2014 = 4.8m	628
7								627
8								626
9								625
10								

THURBER ENGINEERING LTD.

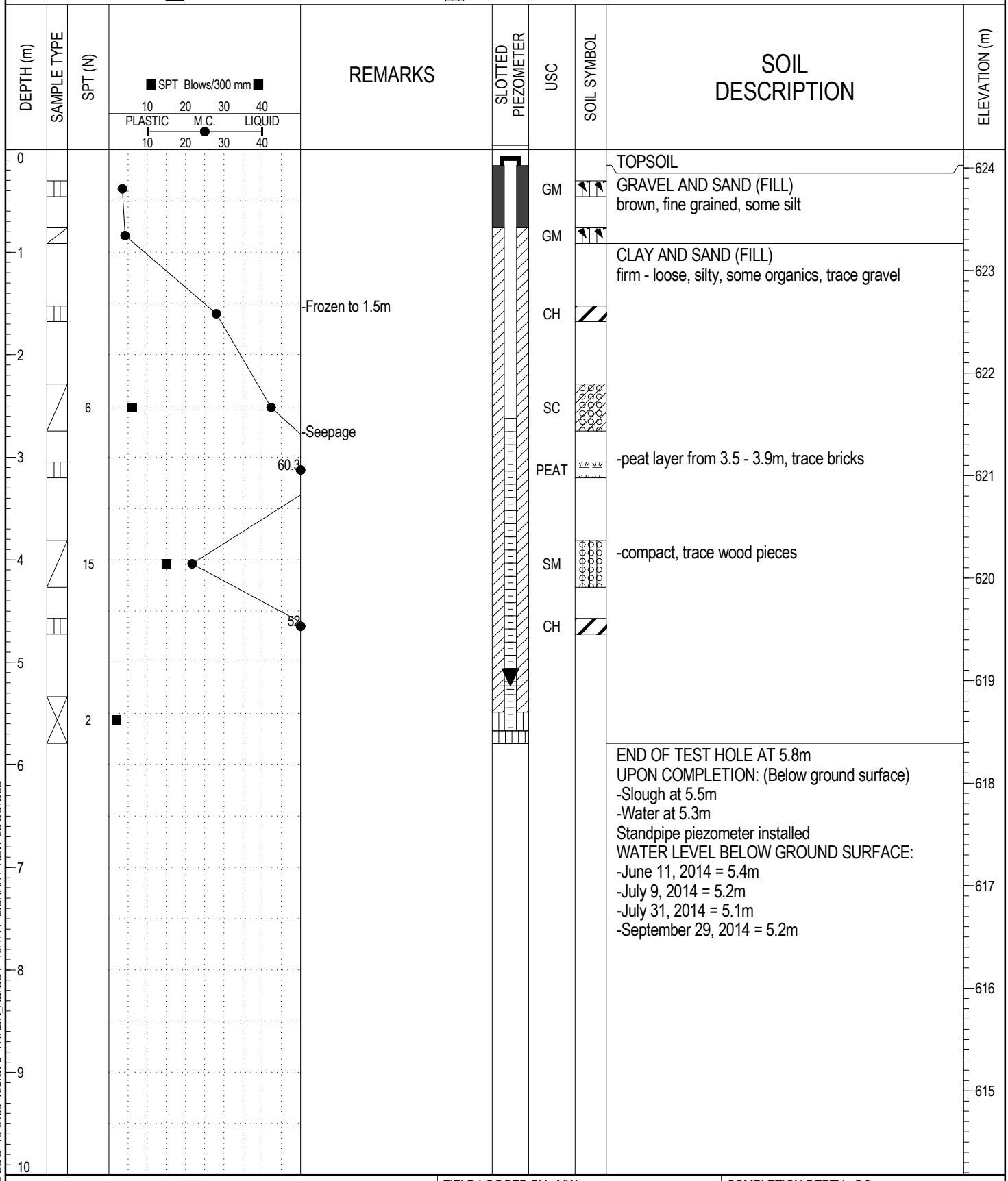
FIELD LOGGED BY: MW	COMPLETION DEPTH: 6.1 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 1

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-2**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934322.72, E34321.18 3TM	ELEVATION: 624.18 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | NO RECOVERY

BACKFILL TYPE: BENTONITE | DRILL CUTTINGS | SLOUGH



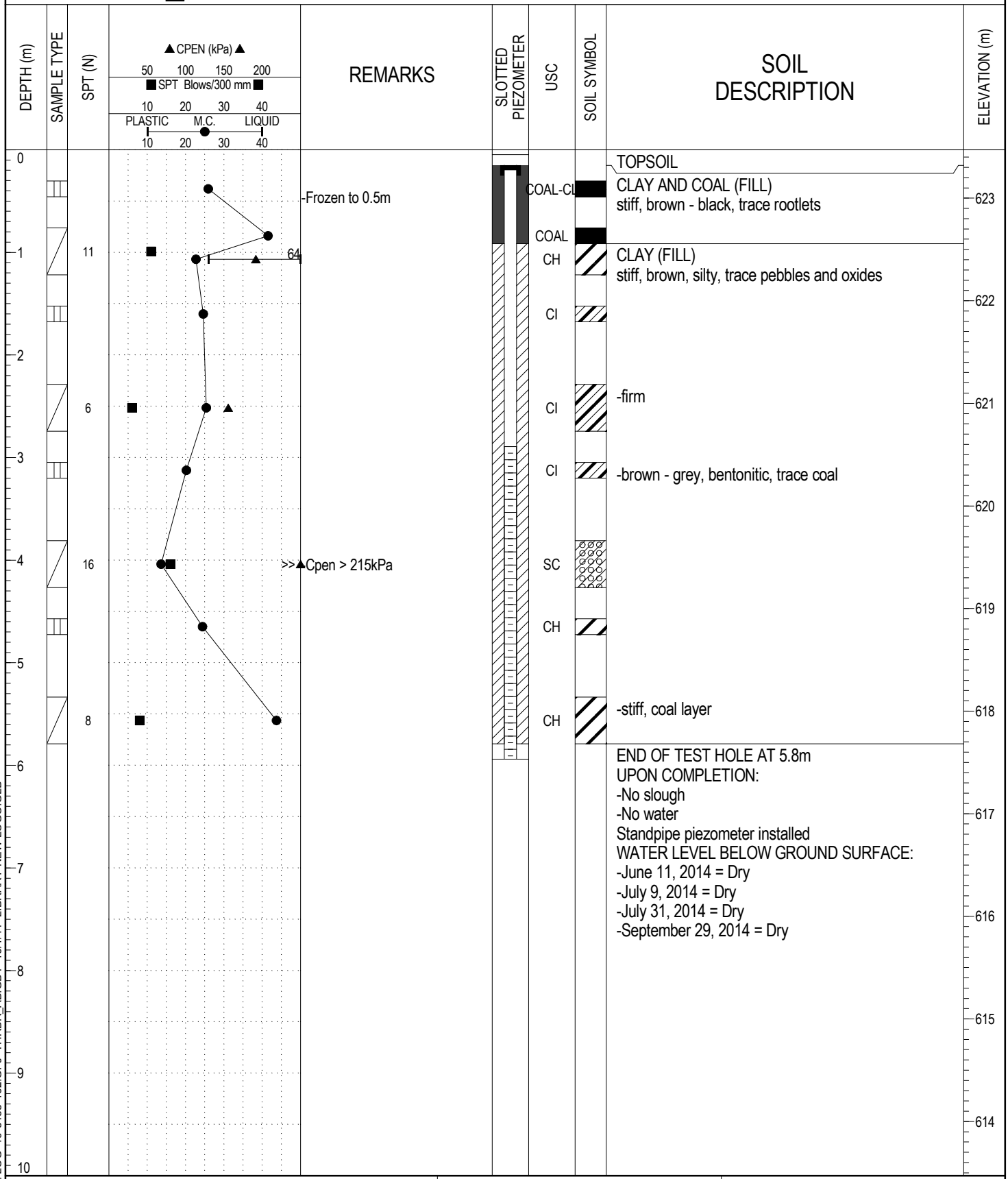
THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
	PREPARED BY: TME	COMPLETION DATE: 3/24/14
	REVIEWED BY:	Page 1 of 1

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-3**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934342.67, E34469.76 3TM	ELEVATION: 623.47 (m)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS



THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
	PREPARED BY: TME	COMPLETION DATE: 3/24/14
	REVIEWED BY:	Page 1 of 1

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-4**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934376.95, E34599.26 3TM	ELEVATION: 628.02 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200; ■SPT Blows/300 mm■ 10 20 30 40; PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
0								TOPSOIL	
						CL-OL		CLAY (FILL) brown - grey, silty, trace organics, gravel, oxides, and bricks	
1				-Frozen to 1.2m		CL-OL			627
						CI		-brown, sandy	
2									626
		7				CI		-firm	
3						CH		-some sand lenses	625
								CLAY SHALE (FILL) stiff, grey, silty, weathered, trace debris	
4		11				CH			624
						CH			
5									623
		7				CH		-firm	
6								END OF TEST HOLE AT 5.8m UPON COMPLETION: -No slough -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2014 = Dry -July 9, 2014 = 5.6m -July 31, 2014 = Dry -September 29, 2014 = 5.6m	622
7									621
8									620
9									619
10									

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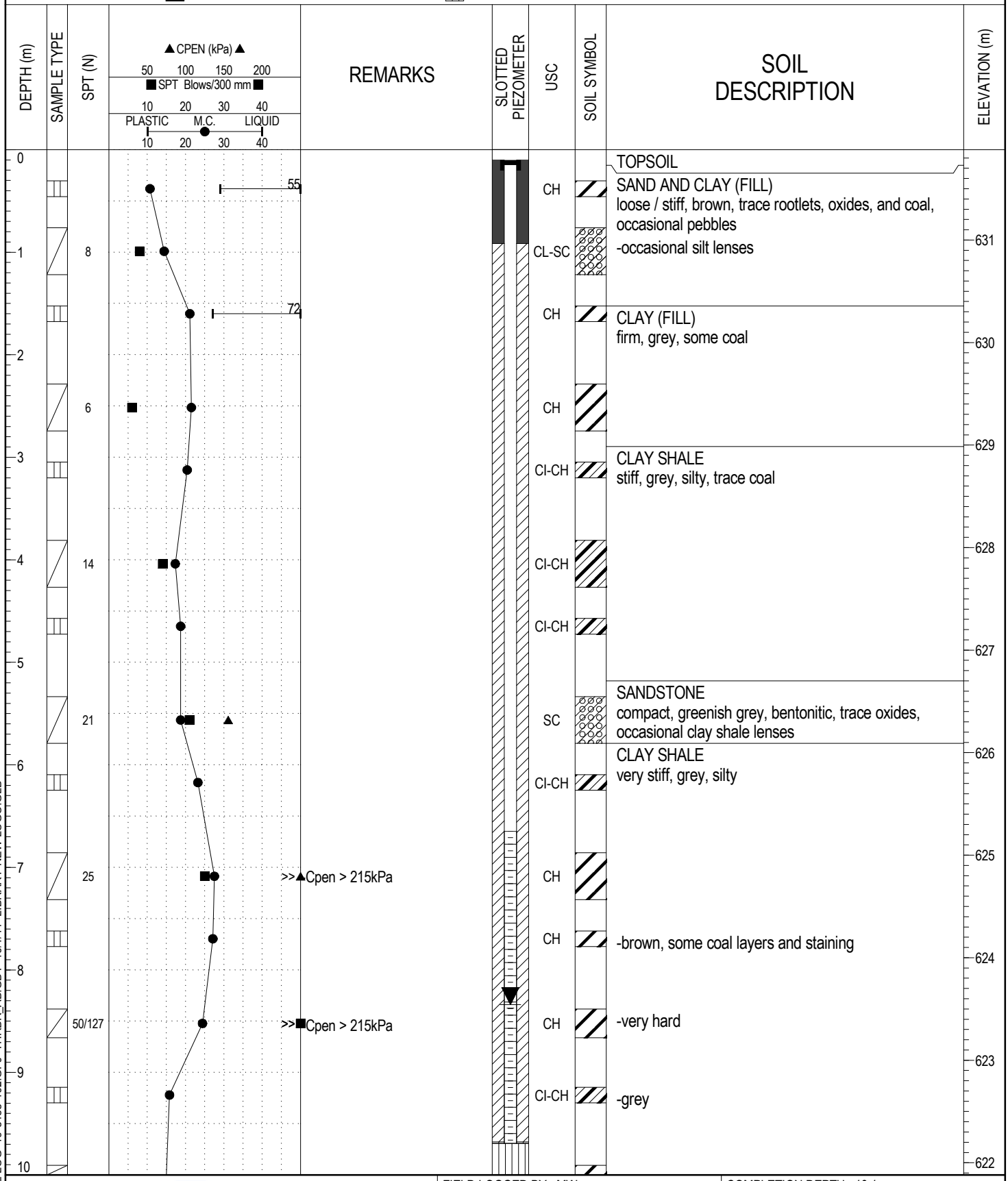
FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.8 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 1

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-5**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934394.61, E34775.98 3TM	ELEVATION: 631.88 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS; SLOUGH



THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.1 m
	PREPARED BY: TME	COMPLETION DATE: 3/24/14
	REVIEWED BY:	Page 1 of 2

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-5**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934394.61, E34775.98 3TM	ELEVATION: 631.88 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS; SLOUGH

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10		50/51	>>	Cpen > 215kPa		CH		CLAY SHALE - CONTINUED	
								END OF TEST HOLE AT 10.1m UPON COMPLETION: (Below ground surface) -Slough at 9.7m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2014 = 8.1m -July 9, 2014 = 8.2m -July 31, 2014 = 8.2m -September 29, 2014 = 8.3m	
11									621
12									620
13									619
14									618
15									617
16									616
17									615
18									614
19									613
20									612

THURBER ENGINEERING LTD.

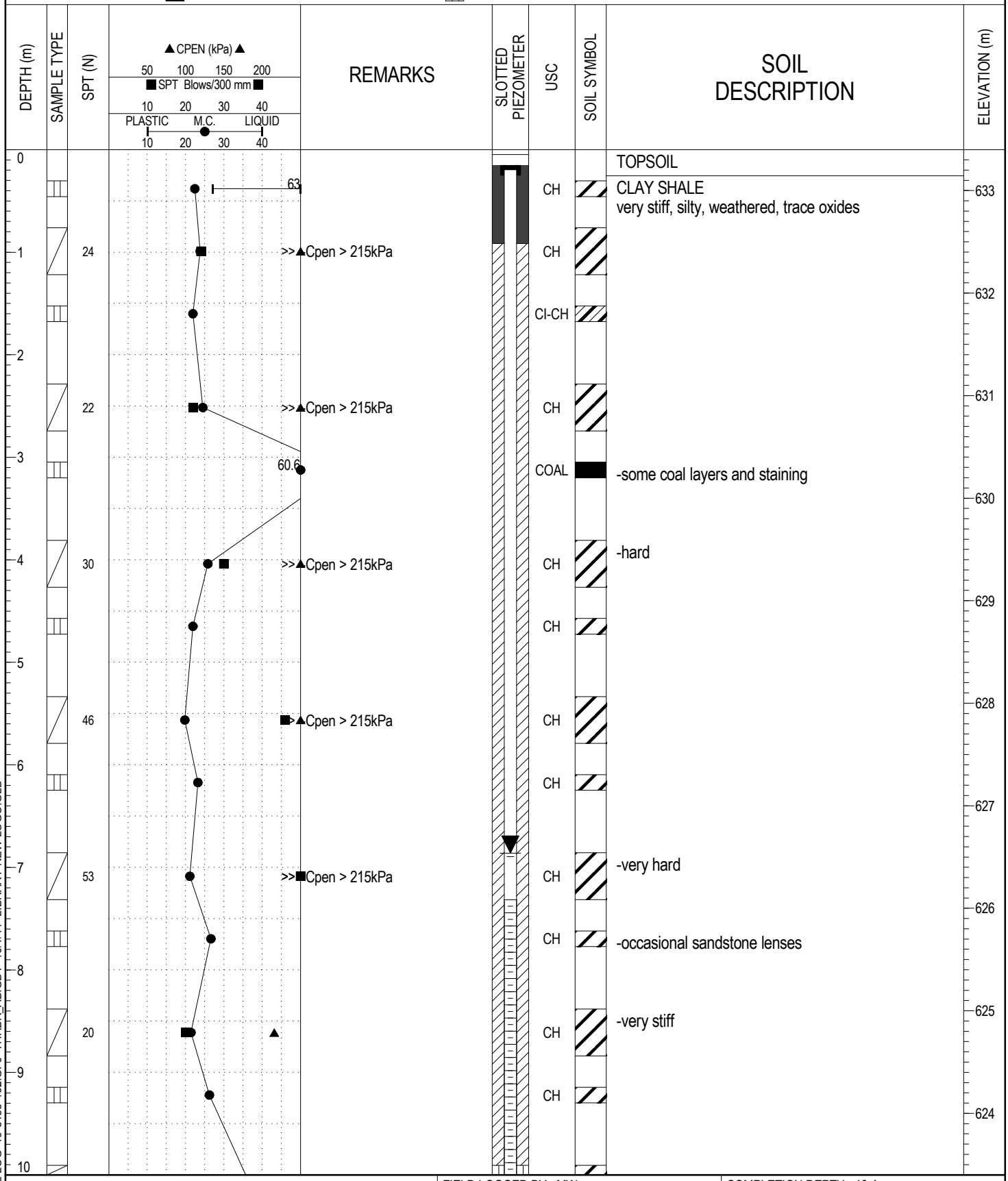
FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.1 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 2 of 2

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-6**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934388.42, E34840.38 3TM	ELEVATION: 633.40 (m)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS, SLOUGH



FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 1 of 2

THURBER ENGINEERING LTD.

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-6**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 24, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934388.42, E34840.38 3TM	ELEVATION: 633.40 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS; SLOUGH

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10		32	■ ● ▲			CH		CLAY SHALE - CONTINUED -hard -coal layers	623
11								END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -Slough at 9.9m -Water at 9.7m Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -June 11, 2014 = 6.7m -July 9, 2014 = 6.8m -July 31, 2014 = 6.6m -September 29, 2014 = 6.9m	622
12									621
13									620
14									619
15									618
16									617
17									616
18									615
19									614
20									

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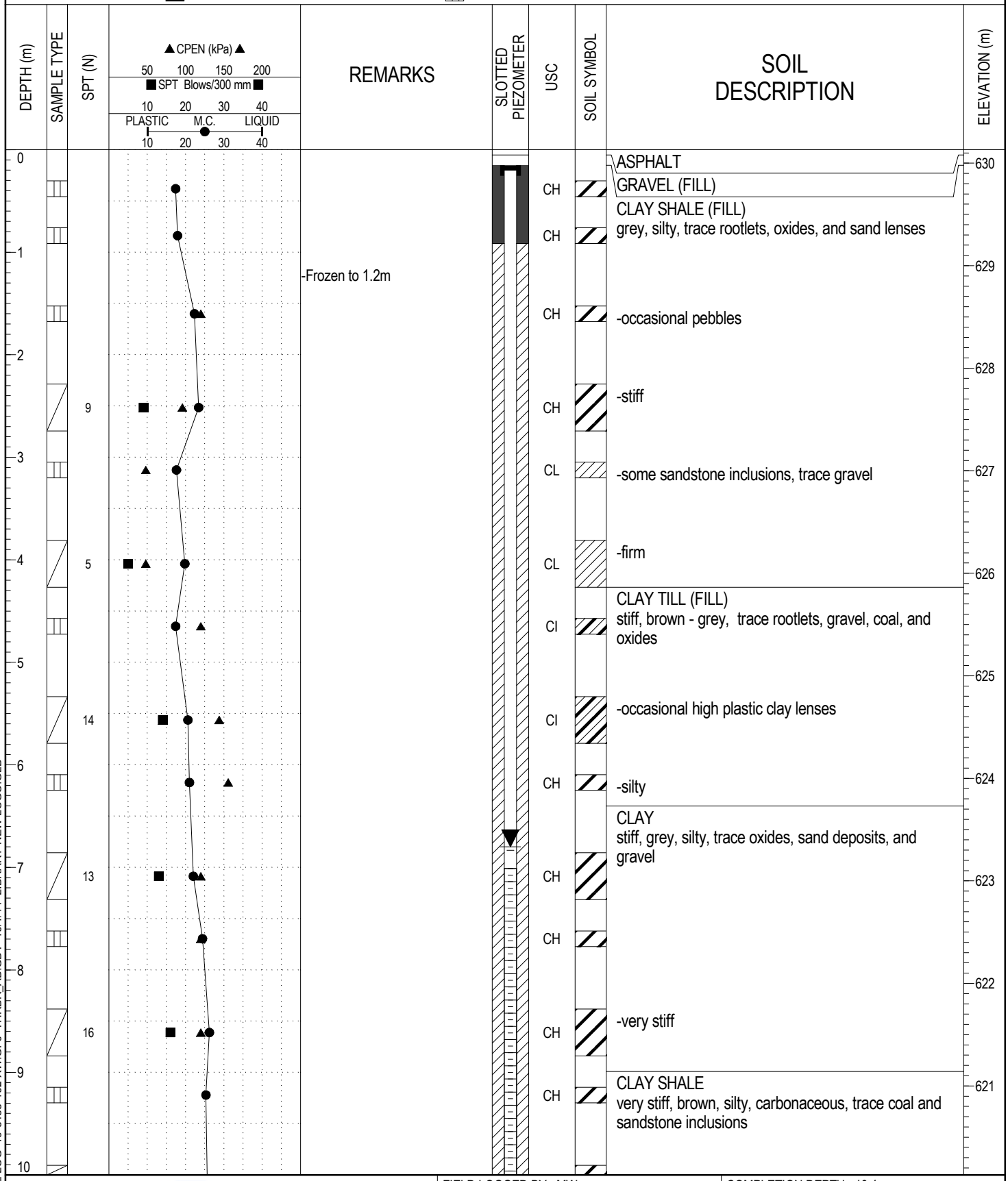
FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: TME	COMPLETION DATE: 3/24/14
REVIEWED BY:	Page 2 of 2

BOREHOLE LOG 19-5438-102.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-7**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934401.22, E34639.49 3TM	ELEVATION: 630.13 (m)

SAMPLE TYPE: GRAB SAMPLE, SPT

BACKFILL TYPE: BENTONITE, DRILL CUTTINGS, SLOUGH



FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 1 of 2

THURBER ENGINEERING LTD.

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-7**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934401.22, E34639.49 3TM	ELEVATION: 630.13 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS; SLOUGH

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 ■SPT Blows/300 mm■ 10 20 30 40 PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	SLOTTED PIEZOMETER	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10		20				CH		CLAY SHALE - CONTINUED -trace siltstone inclusions	620
								END OF TEST HOLE AT 10.4m UPON COMPLETION: (Below ground surface) -Slough at 10.1m -No water Standpipe piezometer installed WATER LEVEL BELOW GROUND SURFACE: -May 5, 2014 = 7.0m -July 9, 2014 = 6.8m -July 31, 2014 = 6.8m -September 29, 2014 = 6.8m	
11									619
12									618
13									617
14									616
15									615
16									614
17									613
18									612
19									611
20									

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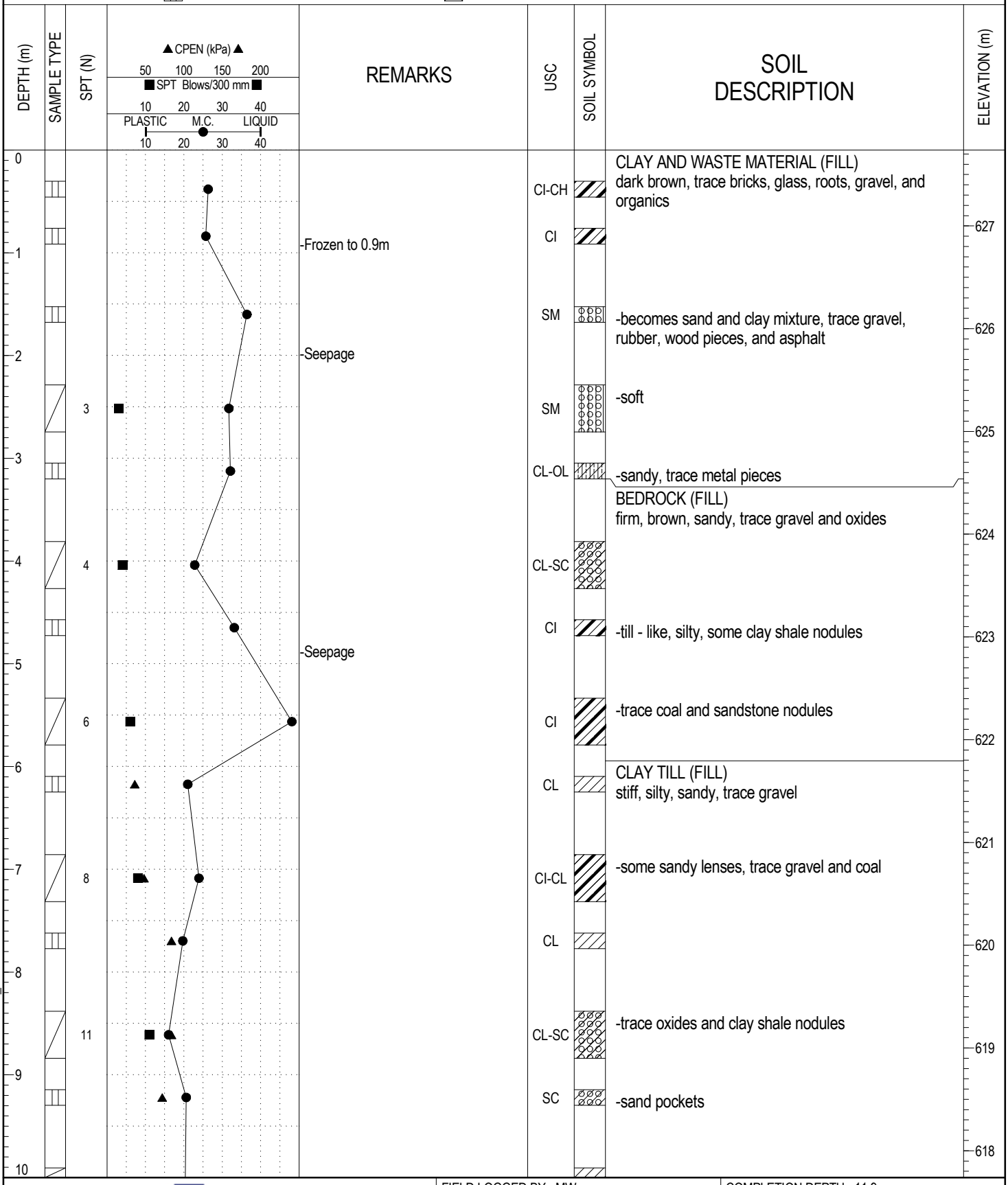
FIELD LOGGED BY: MW	COMPLETION DEPTH: 10.4 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 2 of 2

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-8**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934381.75, E34667.58 3TM	ELEVATION: 627.74 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | NO RECOVERY



THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 11.9 m
	PREPARED BY: XW	COMPLETION DATE: 3/25/14
	REVIEWED BY: HER	Page 1 of 2

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-8**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934381.75, E34667.58 3TM	ELEVATION: 627.74 (m)

SAMPLE TYPE: GRAB SAMPLE | SPT | NO RECOVERY

DEPTH (m)	SAMPLE TYPE	SPT (N)	▲CPEN (kPa)▲ 50 100 150 200 / ■SPT Blows/300 mm■ 10 20 30 40 / PLASTIC M.C. LIQUID 10 20 30 40	REMARKS	USC	SOIL SYMBOL	SOIL DESCRIPTION	ELEVATION (m)
10		9			CL		CLAY TILL (FILL) - CONTINUED	
					CH		CLAY grey, silty, trace oxides	617
11								
		12						616
12							END OF TEST HOLE AT 11.8m UPON COMPLETION: (Below ground surface) -Slough at 2.4m -No water Backfilled with drill cuttings and bentonite chips at surface	
13								615
14								614
15								613
16								612
17								611
18								610
19								609
20								608

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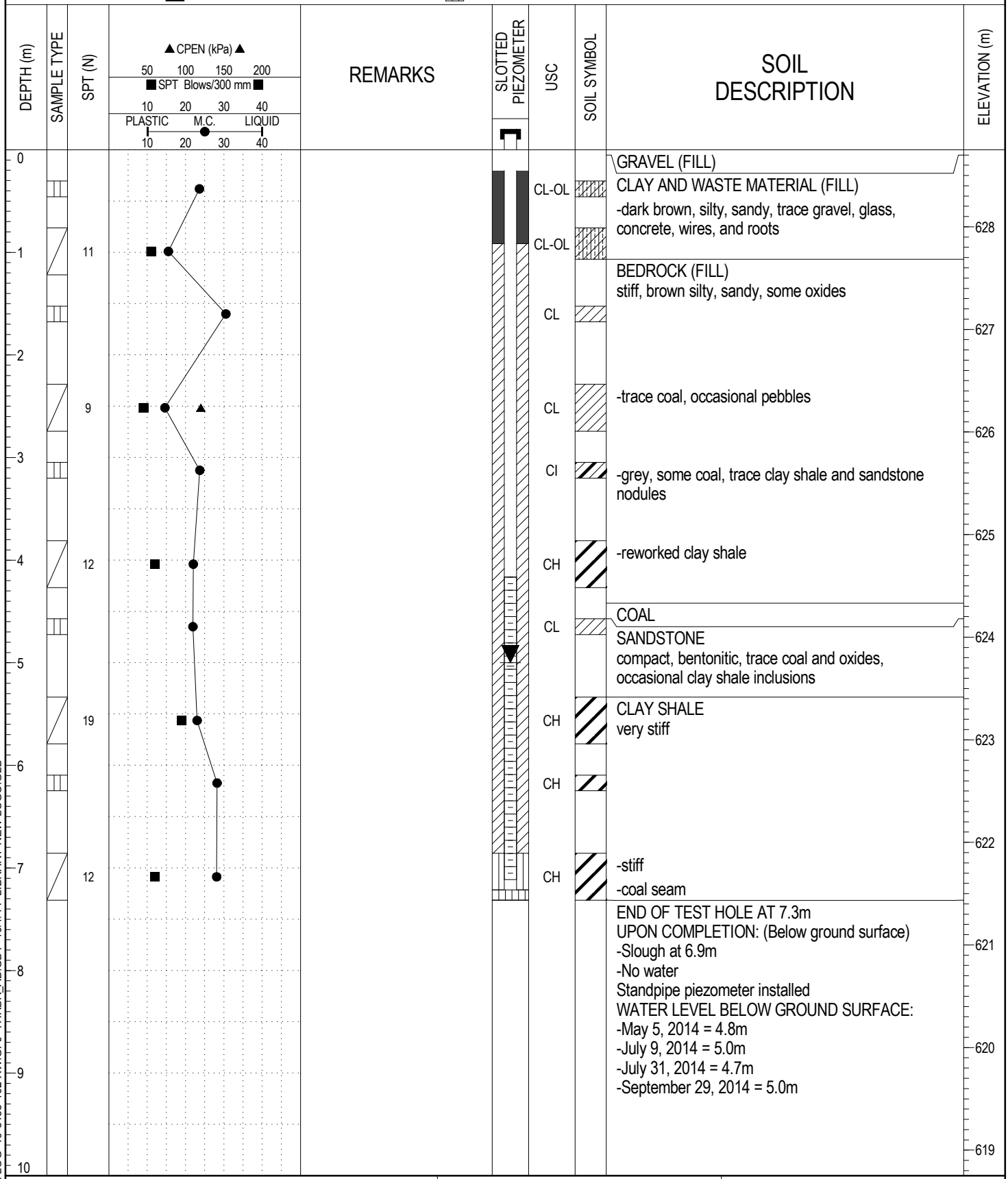
FIELD LOGGED BY: MW	COMPLETION DEPTH: 11.9 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 2 of 2

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-9**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: N5934403.58, E34676.13 3TM	ELEVATION: 628.75 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS; SLOUGH



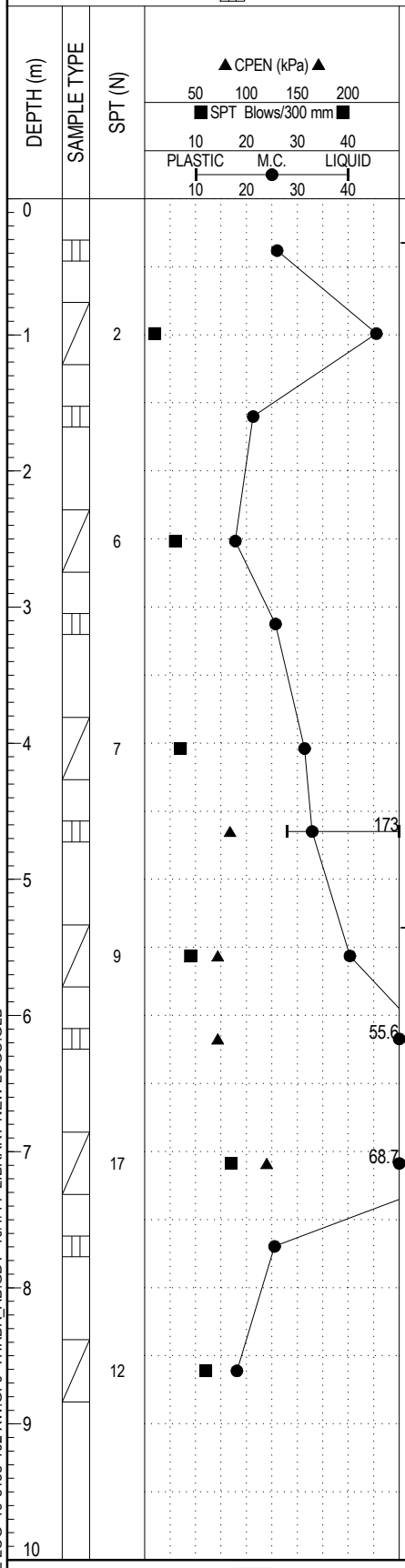
FIELD LOGGED BY: MW	COMPLETION DEPTH: 7.3 m
PREPARED BY: XW	COMPLETION DATE: 3/25/14
REVIEWED BY: HER	Page 1 of 1

THURBER ENGINEERING LTD.

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-10**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 25, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Truck / Solid Stem Augers	LOCATION: N5934399.65, E34689.76 3TM	ELEVATION: 628.75 (m)

SAMPLE TYPE ▯ GRAB SAMPLE ▨ SPT



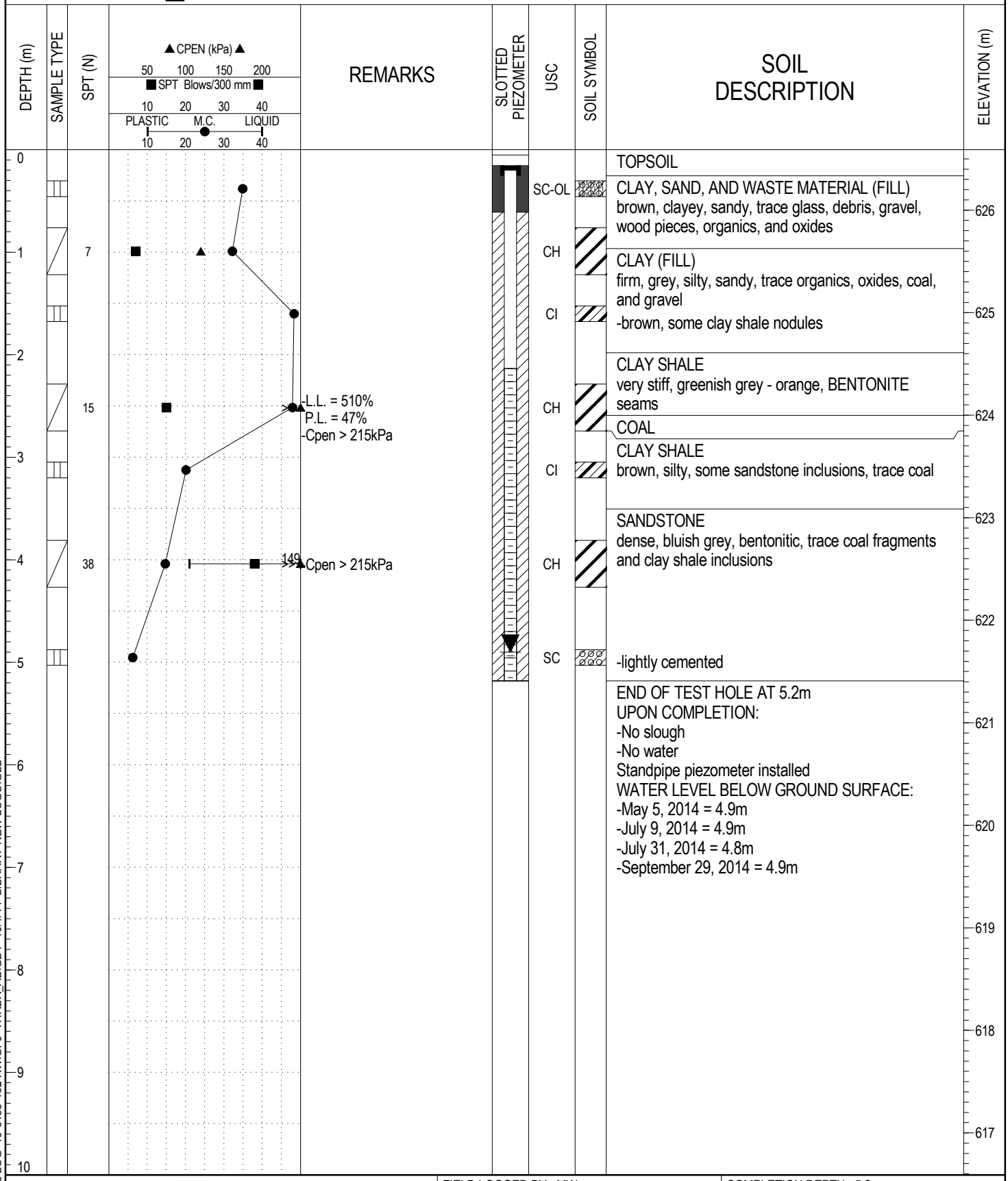
THURBER ENGINEERING LTD.	FIELD LOGGED BY: MW	COMPLETION DEPTH: 8.8 m
	PREPARED BY: XW	COMPLETION DATE: 3/25/14
	REVIEWED BY: HER	Page 1 of 1

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

CLIENT: AECOM	PROJECT: EDMONTON SE LRT EXTENTION	BOREHOLE NO: **TH14-11**
DRILLING COMPANY: Mobile Augers & Research Ltd.	DATE DRILLED: March 26, 2014	PROJECT NO: 19-5438-102
DRILL/METHOD: M5 Track / Solid Stem Augers	LOCATION: N5934377.92, E34685.20 3TM	ELEVATION: 626.59 (m)

SAMPLE TYPE: GRAB SAMPLE; SPT

BACKFILL TYPE: BENTONITE; DRILL CUTTINGS



TOPSOIL

CLAY, SAND, AND WASTE MATERIAL (FILL)
brown, clayey, sandy, trace glass, debris, gravel, wood pieces, organics, and oxides

CLAY (FILL)
firm, grey, silty, sandy, trace organics, oxides, coal, and gravel

-brown, some clay shale nodules

CLAY SHALE
very stiff, greenish grey - orange, BENTONITE seams

COAL

CLAY SHALE
brown, silty, some sandstone inclusions, trace coal

SANDSTONE
dense, bluish grey, bentonitic, trace coal fragments and clay shale inclusions

-lightly cemented

END OF TEST HOLE AT 5.2m
UPON COMPLETION:
-No slough
-No water
Standpipe piezometer installed
WATER LEVEL BELOW GROUND SURFACE:
-May 5, 2014 = 4.9m
-July 9, 2014 = 4.9m
-July 31, 2014 = 4.8m
-September 29, 2014 = 4.9m

THURBER ENGINEERING LTD.

FIELD LOGGED BY: MW	COMPLETION DEPTH: 5.2 m
PREPARED BY: XW	COMPLETION DATE: 3/26/14
REVIEWED BY: HER	Page 1 of 1

BOREHOLE LOG 19-5438-102-XW.GPJ THRBR_AB.GDT 10/1/14- LIBRARY-NEW LOGO.GLB

Previous Test Holes (by others)

Project: GRIERSON HILL STABILIZATION STUDY
Location: EDMONTON, ALBERTA
Project Number: 106-2672

Hole No. 80-1 | Log Type: Overburden/Rock Core
Surface Elevation: 639.2 m (CITY) | Core Size: 50 mm
Completion Depth: 23.0 m | Drilling Contractor: Mobile Augers
Date Drilled: July 22, 1980 | Drilling Method: Hollow Stem Auger/ Wireline Coring
Logged By: RRH (field); _____ (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1–3	1	CLAY (FILL)	- medium to dark grey, silty CLAY, hard, dry							
4–6	2		- medium to dark brown, silty CLAY, hard lumps, loosely compacted, some sand, pebbles to 100 mm, coal particles, moist - some cinders, pieces of glass and coal			7	17.5 28.3		500 400	
7–9	3						34.1			
10–12			- medium to dark brown, silty CLAY, stiff, some sand, pebbles, coal particles, moist			12	28.9			
13–15	4	ORGANIC FILL	- black, very organic, silty, soft, some fibres, wood, cardboard, moist to wet, strong odour			N/A	40.9			
16–18	5		- very wet				184.1			
19–22	6					10	142.9			
23–24	7		- pieces of glass				85.1			
25		SILT	- medium brown/grey, sandy, trace of clay, stiff, organic pockets, rootlets, moist			13	27.4			
26–28	8	CLAY	- brown-grey, mottled, silty, stiff, pebbles to 15 mm oxide stains, trace of organics, moist							
29	9						25.6			

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Drawing No. B-2

Sheet 1 of 3

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON, ALBERTA
Project Number 106-2672

Hole No. 80-1 Log Type Overburden/Rock Core
Surface Elevation 639.2 m (CITY) Core Size 50 mm
Completion Depth 23.0 m Drilling Contractor Mobile Augers
Date Drilled July 22, 1980 Drilling Method Hollow Stem Auger/ Wireline Coring
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY	- brown-grey, mottled, silty, very stiff, pebbles to 15 mm, coal particles, moist			17	21.0			
31										
32	10									
33							20.6		250	
34			- moist sand pockets							
35		CLAY (TILL)	- grey brown, silty, very stiff, sand lenses, carbonaceous zones, pebbles to 10 mm, damp			25	22.4			
36	11									
37		CLAY SHALE	- dark brown to black, softened, K1 hardness, carbonaceous, damp							
38			- grey silt lenses							
39	12						25.7		350	
40			- medium grey			25	25.5			
41										
42	13	SANDSTONE								
43			- light grey, silty, fine-grained, uniform, K1 hardness, some coal particles, damp, compact to dense				21.3		300	
44										
45			- compact			31	23.0			
46	14									
47										
48			- light grey with light brown clay shale (K3 hardness) lenses				20.4			
49	15									
50						36	22.6			
51										
52	16	CLAY SHALE								
53			- dark brown, silty, carbonaceous, K1 to K3 hardness, fissile fabric, dry				16.7			
54										
55						37 (150mm)	18.3			
56	17		START ROCK CORING							

EBA Engineering Consultants Ltd.

Drawing No. B-2

Sheet 2 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-1	17.0-23.0m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE	- light to medium grey, silty, K3 hardness, brittle, dry	- fine horizontal bedding, slightly fractured (horizontal)	16.4			
57		SANDSTONE	- light to medium grey, silty, fine grained, uniform, K2 to K3 hardness, shale lenses (5 to 10mm)	- horizontal bedding, massive	18.8	95	100	85
58			- coal stringers			1065		
59	18	CLAY SHALE	- light to medium grey, silty, K3 to K4 hardness, brittle, dry	- slightly factured (horizontal), homogeneous fabric		90		
60						35	100	66
61			- K4 hardness, well indurated, trace of coal particles			105		
62	19					55		
63			- medium grey, bentonitic inclusions	- fractured (horizontal), blocky microstructure (15 mm)	15.6	110		
64						195		
65	20		- dark brown, carbonaceous, fragmented, K2 to K3 hardness	- extremely fractured, blocky (10 mm)	16.4	250		
66		COAL	- black, brittle	- slightly factured, fissile fabric		60		
67						90		
68			- SHALE seam (75 mm)		34.9	25		
69	21	BENTONITE	- 50mm thick, green, soft, moist	- homogeneous, non slickensided	34.6 40.6	80		
70		CLAY SHALE	- dark brown, silty, K2 to K3 hardness, coal specks and stringers	- fractured (horizontal)		225	81	56
71			- medium to dark grey, sandstone pockets	- massive		45		
72	22					185		
73			- medium grey SANDSTONE layer (350 mm), silty, fine grained, uniform, dry, some clay	- massive		65		
74						350		
75	23		- bentonite pockets			80		
76			END OF BOREHOLE (23.0 metres)			65		
						90		
						70	34	12
						40		
						35		
						110		
						55		
						1420	100	100

EBA Engineering Consultants Ltd.	Drawing No. B-2	Sheet 3 of 3

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-2
Surface Elevation 637.2 m (CITY)
Completion Depth 13.6 m
Date Drilled July 23, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden
Core Size _____
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1–3	1	SAND (FILL)	- medium grey-brown, silty, fine to coarse grained, some clay pockets, pebbles to 25 mm, organic pockets, carbonaceous inclusions, damp				21.8			
4–6	2		- dark brown to black, loose, dry			5	12.4			
7–9	3		- medium grey-brown - medium brown, medium grained				14.7			
9–10		CLAY (FILL)	- grey-brown, silty, firm, trace of organics, pebbles, some coal, moist			7	28.6			
10–12	4		- pieces of brick and glass							
13–14			- grey-brown, silty, organic pockets, damp				21.3			
14–16	5		- stiff, moist			10	27.7			
17–19	6	CLAY (TILL)	- medium brown-grey, silty, trace of sand, numerous coal particles, damp				30.2			
20–22	7		- very stiff, oxide stains			18	25.3			
23–24		COAL	- black, powdery, moist, fractured				25.8			
24–25		CLAY	- medium grey, silty, sandy, stiff, organic pockets, damp							
25–26	8		- traces of organic material			16	22.0			
27–28			- medium brown, silty, pebbles to 10 mm, damp							
29	9	SILT					23.0			

EBA Engineering Consultants Ltd.

Drawing No. B-3

Sheet 1 of 2

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-2 Log Type Overburden
Surface Elevation 637.2 m (CITY) Core Size
Completion Depth 13.6 m Drilling Contractor Mobile Augers
Date Drilled July 23, 1980 Drilling Method Hollow Stem Auger
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SILT	- medium brown, sandy, very stiff, some oxide stains, damp to moist			19	23.6			
31										
32	10	CLAY (TILL)	- grey with brown silt lenses, very stiff, pebbles to 25 mm, coal particles, damp							
33										
34			- medium brown SAND lens (150 mm thickness) well graded, moist				15.6			
35	11		- medium brown SAND pocket, well graded			27	16.7			
36										
37										
38		CLAY SHALE	- medium grey, silty, K1 hardness, blocky, micro-structure, damp				31.9			
39	12	COAL	- black, hard, brittle, highly fractured, powdery lens (75 mm thickness) at 12.1 m			22	37.6			
40										
41		CLAY SHALE	- dark brown, silty, K1 hardness, carbonaceous, damp							
42	13									
43			- medium to dark grey, extremely fractured, angular fragments to 10 mm, K4 to K5 hardness, moist to wet				33.0			
44			- grey-brown, K1 to K2 hardness, dry			56 (150mm)	25.6			
45	14		END OF BOREHOLE (13.6 metres)							

EBA Engineering Consultants Ltd.

Drawing No. B-3

Sheet 2 of 2

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-3
Surface Elevation 638.8 m (CITY)
Completion Depth 24.7 m
Date Drilled July 23, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1–3	1	SAND (FILL)	- sandy - black-brown, sandy, loose, some organic material, slightly carbonaceous, traces of white salts, brick, cinders, pebbles to 25 mm, dry				8.5			
4–6	2					15	15.2			
7–9	3		- light to medium brown, moist				36.4			
10–12	4		- dark grey, silty sand, fine-grained, some clay pockets, traces of coal - dark brown, silty sand, loose, some clay, rock fragments, moist			5	31.1			
13–16	5					18	29.1			
17–18	6		- medium to dark brown, silty clay, some sand, organic material, rock fragments, coal							
19		CLAY (TILL)	- medium to dark grey-brown, silty, some coal particles and pebbles, traces of brown oxides				30.8			
20–22	7	CLAY SHALE	- medium grey, softened (very stiff soil), highly fractured			24	24.8			
23–24			- medium brown and grey, silty, stiff to very stiff, coal particles, moist, some hard inclusions at 7.4 m				29.6			
25–26	8	COAL	- black, brittle, highly fractured			17	38.3			
27–29	9	CLAY SHALE	- medium brown-grey, silty, K1 to K3 hardness, damp				25.7			

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-3
Surface Elevation 638.8 m (CITY)
Completion Depth 24.7 m
Date Drilled July 23, 1980
Logged By RRH (field); (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method Hollow Stem Auger/

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		COAL	- black, brittle, highly fractured, wet			27	28.6			
31										
32	10	CLAY SHALE	- medium grey, silty, K1 hardness, some sandstone pockets, damp							
33			- COAL lens (25 mm thickness), black, brittle, wet				13.9			
34			- SANDSTONE layer (300 mm thickness), light to medium grey, fine-grained, uniform, compact, damp, some coal stringers			17	26.0			
35	11									
36										
37										
38			- SANDSTONE layer (150 mm thickness), light to medium grey, fine grained, compact, damp				27.9			
39	12		- COAL lens (50 mm thickness), black, brittle, highly fractured			16	26.4			
40										
41										
42	13									
43			- SILT lens (120 mm thickness), medium grey, non-indurated, trace of sand, damp to moist				28.7			
44			- SANDSTONE layer (75 mm thickness), light grey with brown patches			18 (no recovery)				
45	14									
46										
47										
48			- light to medium brown CLAY SHALE, light grey sandstone inclusions of K3 hardness, massive				28.7			
49	15									
50			- dark grey, K1 to K2 hardness			18	29.2			
51										
52	16									
53			- finely layered				31.5			
54		COAL	- black, brittle, highly fractured			57	21.1			
			START ROCK CORING			(150mm)				

EBA Engineering Consultants Ltd.

Drawing No. B-4

Sheet 2 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-3	16.2m-24.7m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
53			START ROCK CORING					
54		CLAY SHALE	- medium grey, silty, K4 hardness, thin coal stringers, dry	- massive, horizontal bedding				
55								
	17					865	98	94
56						180		
						245		
57			- thin siltstone lens, light grey			55		
58					17.8			
59	18			- slightly fractured (horizontal)				
60						400	100	88
						190		
61						306		
				- brecciated zone (25 mm)		80		
62	19		- medium to dark grey		14.8	140		
						175		
63				- brecciated zone		75		
64			- dark grey, K4 to K5 hardness, traces of coal particles		15.5			
				- massive to slightly fractured, horizontal bedding		370	87	78
65						50		
	20		- SILTSTONE layer (200 mm thickness), light to medium grey, well indurated, K7 hardness	- homogeneous fabric		65		
66			- dark grey-brown K3 to K4 hardness			570		
67			- carbonaceous, K2 hardness		33.4			
		COAL	- black, brittle, K6 hardness	- blocky microstructure, massive				
68						60		
					23.9		78	56
69	21					35		
						55		
70		CLAY SHALE	- dark brown, silty, carbonaceous	- massive, homogeneous, non-slickensided		100		
		BENTONITE	- green, K1 hardness, traces of coal particles, dry to damp	- homogeneous fabric		100		
71						25		
		CLAY SHALE	- medium grey, silty, K1 to K2 hardness, coal particles, bentonitic	- massive, homogeneous fabric		65		
72	22					20		
						70		
73			- medium to dark grey, K2 to K3 hardness		28.6	480		
			- soft CLAY lens (50 mm thickness)			285	97	97
74			- SILTSTONE layer (400 mm thickness), light grey, indurated, K3 to K4 hardness			970		
75	23			- massive, blocky microstructure (10 mm blocks)	14.5			
76								
77			- light to medium grey siltstone and sandstone laminations		14.4			
		SANDSTONE	- light grey, fine grained, uniform, K2 to K3 hardness, cemented, thin medium grey silty laminations (20 mm thick), dry	- massive, laminated microstructure		1300	95	95
78								
	24							
79								
80			- finer grained, K3 to K4 hardness	- homogeneous fabric				
81			- traces of coal particles	- laminated microstructure				
			END OF BOREHOLE (24.7 metres)					
	25							

EBA Engineering Consultants Ltd.	Drawing No.	Sheet
	B-4	3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-4
Surface Elevation 638.3 m (City)
Completion Depth 15.6 m
Date Drilled July 28, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden
Core Size _____
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1–3	1	CLAY (FILL)	- dark brown, silty, sandy, pebbles to 20 mm, organic pockets, damp							
3–6	2		- dark brown to black, cinders, damp				13.8			
			- medium brown, silty, trace of organic material, moist			12	27.0			
6–9	2–3	ORGANIC FILL	- black, clayey, carbonaceous, pebbles to 25 mm				32.5			
			- wood chips, cinders			15	24.6			
9–13	3–4									
13–14	4		- extremely organic, pieces of cardboard, moist to wet				43.6			
14–16	4–5	CLAY SHALE	- medium grey, silty, slightly organic, wood fibres, damp - light grey and brown sandstone pockets, thin coal lenses			22	24.9			
16–19	5–6		- dark grey, silty, K1 hardness with some K2 inclusions, blocky microstructure, damp				37.6			
19–20	6	COAL	- black, brittle, fractured, blocky							
20–22	6–7					23	54.1			
22–23	7	SANDSTONE	- light grey, silty, fine grained, K1 hardness, coal particles, clay shale inclusions, damp							
23–24	7						39.1			
24–26	7–8	COAL	- black, K6 to K7 hardness, fractured, blocky, moist to wet			16	53.1			
26–27	8									
27–29	8–9	CLAY SHALE	- dark brown to black, K2 hardness, carbonaceous, damp - greenish-grey, silty, K1 hardness, slightly bentonitic				29.8			

EBA Engineering Consultants Ltd.

Drawing No. B-5

Sheet 1 of 2

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-4 Log Type Overburden
Surface Elevation 638.3 m (City) Core Size
Completion Depth 15.6 m Drilling Contractor Mobile Augers
Date Drilled July 28, 1980 Drilling Method B61 Hollow Stem
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY SHALE	- medium grey, K3 hardness, dry to damp			37	24.3			
31										
32	10									
33			- medium brown-grey, K1 hardness, blocky microstructure, damp				30.7			
34			- CLAY SHALE layer (150 mm) dark brown to black, carbonaceous, K2 hardness							
35			- silty, K2 hardness, coal particles			18	28.8			
36	11									
37		SILTSTONE								
38			- medium grey/brown, clayey, K2 hardness, damp				29.5			
39	12									
40		CLAY SHALE	- dark brown-grey, silty, K3 hardness, blocky microstructure, dry, light grey sandstone lenses			27	32.0			
41										
42	13									
43			- dark brown, carbonaceous, K2 hardness, damp							
44		BENTONITE	- green-grey, K1 hardness, damp, (75 mm)				34.7			
		CLAY SHALE	- medium to dark brown-grey, K3 to K4 hardness, damp							
45		SANDSTONE	- medium brown-grey, fine grained, uniform, softened, clay shale inclusions			43 (150mm)	31.2			
46	14									
47		CLAY SHALE								
48			- dark brown to black, carbonaceous, K2 to K3 hardness, blocky microstructure				24.5			
49	15		- COAL layer (50 mm) fractured, K6 hardness							
50			- dark grey-brown, K3 hardness, coal particles, dry			78	24.3			
51			END OF BOREHOLE (15.6 metres)							
			Water level: 5.2 m on completion Slough level: 9.8 m on completion							

EBA Engineering Consultants Ltd.

Drawing No. B-5

Sheet 2 of 2

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-5
Surface Elevation 639.2 m (CITY)
Completion Depth 21.7 m
Date Drilled July 24-25, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		SAND (FILL)								
2										
3	1		- dark brown, clayey, loose, some cinders, pieces of coal, brick and glass, pebbles to 10 mm, traces of red oxides, traces of organic material, dry to damp				31.1			
4										
5			- moist			3	45.2			
6	2									
7		CLAY								
8			- medium grey-brown, silty, firm, some oxides, traces of organic material, damp				36.8		100	
9	3		- coal pocket							
10						8	31.4			
11										
12										
13	4									
14			- firm, soft grey inclusions - coal particles, dry				29.9		175	
15		COAL	- black, extremely fractured, wet			12	50.8			
16	5		- CLAY SHALE, brown-black, stiff, carbonaceous, damp							
17		INTERBEDDED CLAY SHALE AND SANDSTONE								
18			- medium to dark grey, silty, stiff, blocky - softened shale layer (150 mm thickness), clay-like, medium grey-brown, silty, stiff, some coal particles				21.9			
19										
20	6		- softened shale layer (150 mm thickness) - medium grey, silty, stiff, very fine coal stringers, traces of brown oxides, dry, blocky micro-structure			18	23.7			
21										
22										
23	7		- SANDSTONE layer (300 mm thickness), light grey, silty, medium grained, compact, K1 hardness				21.0			
24										
25			- CLAY SHALE, dark grey, silty, hard, extremely fractured - dark brown, carbonaceous			40	25.8			
26	8		- COAL layer							
27			- CLAY SHALE, dark brown, silty, K4 hardness, damp - COAL layer (10 mm thickness) - SANDSTONE layer (75 mm thickness), light to medium grey, fine-grained, uniform, K1 hardness, damp							
28										
29	9						20.1			

EBA Engineering Consultants Ltd.

Drawing No. B-6

Sheet 1 of 3

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-5 Log Type Overburden/Rock Core
Surface Elevation 639.2 m (CITY) Core Size 50 mm
Completion Depth 21.7 m Drilling Contractor Mobile Augers
Date Drilled July 24-25, 1980 Drilling Method B61 Hollow Stem/ Wireline Coring
Logged By RRH (field); _____ (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		INTERBEDDED CLAY SHALE AND SANDSTONE	- CLAY SHALE, brown-grey, silty, K1 to K2 hardness, some coal particles, damp, blocky micro-structure			34	21.3			
31										
32	10									
33			- SANDSTONE, light to medium grey, silty, fine grained, K1 to K2 hardness, laminated, coal stringers, damp				21.1			
34			- CLAY SHALE layer (150 mm thickness), medium to dark grey, silty, K2 to K3 hardness, dry							
35						42	18.9			
36	11									
37										
38			- laminated SANDSTONE/CLAY SHALE							
39							27.5			
40	12	COAL	- black, hard, brittle, highly fractured, moist to wet			24	49.3			
41		CLAY SHALE	- medium grey, silty, K1 to K2 hardness, homogeneous fabric, damp							
42										
43	13									
44							26.7			
45			- SANDSTONE pocket, light grey, fine grained			22	29.6			
46	14									
47										
48			- dark brown, silty, K2 hardness, carbonaceous, dry							
49	15		- medium to dark grey, K3 hardness, coal particles,				24.6			
50			blocky microstructure, dry START ROCK CORING			46 (150mm)	19.6			

ft.	m.	Depth	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
51			CLAY SHALE	- medium to dark brown, silty, K2 hardness, dry to damp	- massive, homogeneous fabric	18.3	1170 80	100	94
52	16			- SANDSTONE layer (500 mm) light to medium grey, fine grained, uniform, K2 hardness, coal particles, fine clay shale laminations (5 to 10 mm), damp	- fine horizontal bedding	17.7			
53									
54				- medium greenish grey, CLAY SHALE, bentonitic, silty, K3 hardness, dry	- fine horizontal bedding				
55	17								

ROCK CORE LOG

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-5	17.0-21.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE	- medium grey, silty, K3 to K4 hardness, slightly bentonitic, coal particles, siltstone pocket at 17.1 m	- massive, blocky microstructure	16.7	960 150 100	100	100
57								
58			- dark brown-grey					
59	18			- massive, blocky microstructure		115 315	109	81
60			- dark brown to black, carbonaceous, K4 to K5 hardness, brittle	- fractured	16.7	20 80 65 250		
61				- slightly fractured		95 190		
62	19		- K3 hardness			120 85		
63		COAL	- black, brittle, K6 hardness	- fractured, blocky microstructure		80 50 20 120 30 50	83	55
64			- CLAY SHALE lens (300 mm), black, carbonaceous					
65		BENTONITE	- greenish grey, K1 hardness, high plasticity (50 mm)	- homogeneous fabric		10 100		
	20	CLAY SHALE	- dark brown, silty, K3 to K4 hardness, coal particles, dry to damp	- fractured, blocky, microstructure	15.2	25 205 240 80		
66								
67				- massive, blocky microstructure	13.9	1190 140 40	100	97
68		INTERBEDDED CLAY SHALE AND SANDSTONE	- light to medium grey SANDSTONE, K3 hardness, some coal particles, slightly bentonitic, dark grey-brown CLAY SHALE laminations (5 to 10 mm)		14.4			
	21		- CLAY shale lens (100 mm)					
69								
70								
71			- siltstone pocket	- slightly fractured				
			END OF BOREHOLE (21.7 metres)					
72	22							
73								
74								
75								

EBA Engineering Consultants Ltd.	Drawing No.	Sheet
	B-6	3 of 3

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-6
Surface Elevation 640.3 m (CITY)
Completion Depth 21.4 m
Date Drilled July 28, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		TOPSOIL	- black, organic							
		CLAY (FILL)	- dark brown, silty, some rootlets, dry							
3	1		- SAND layer (75 mm), orange-brown, silty, damp							
4			- some organic material				25.7			
5		SAND (FILL)	- medium brown, calcareous, some organic material			8	22.5			
6	2									
7		CLAY SHALE	- dark brown, silty, K1 hardness, coal stringers, some inclusions of K3 hardness, damp							
8			- dark brown to black, carbonaceous							
9		COAL	- black, brittle, K6 hardness, highly fractured, blocky				26.9			
10	3		- powdery, dry			13	37.1			
12		INTERBEDDED CLAY SHALE AND SANDSTONE	- CLAY SHALE, medium grey-brown, silty, K2 to K3 hardness, coal particles, blocky microstructure							
13	4						19.7			
14			- fine sandstone laminations							
15			- SANDSTONE, medium grey, fine grained, softened, K1 hardness, damp			17	22.5			
16	5									
17			- alternating layers of CLAY SHALE, dark brown-grey, and SANDSTONE, medium grey (75-200 mm thickness), coal particles							
19							19.3			
20	6					26	19.5			
21		CLAY SHALE	- dark brown-grey, silty, K2 to K3 hardness, damp							
23	7									
24			- damp to moist							
			- green-grey, bentonitic, coal particles				23.7			
25		COAL	- black, brittle, K6 hardness, highly fractured, blocky			65	32.8			
26	8									
28										
		CLAY SHALE	- dark brown-black, carbonaceous							
29	9	SILTSTONE	- medium grey-brown, K3 to K4 hardness				17.8			

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Drawing No. B-7

Sheet 1 of 3

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-6
Surface Elevation 640.3 m (CITY)
Completion Depth 21.4 m
Date Drilled July 28, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wirline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SANDSTONE	- light to medium grey, fine grained, uniform, softened, K1 to K2 hardness, damp			53	17.5			
31										
32	10									
33			- K2 hardness, coal particles, horizontal bedding				15.8			
34										
35			- K2 to K3 hardness			53	16.7			
36	11									
37		CLAY SHALE	- dark brown-grey, silty, K3 hardness, dry, blocky							
38							18.5			
39	12	SANDSTONE	- light to medium grey, silty, fine grained, K2 to K3			31 (150mm)	19.2			
40			hardness, fine shale laminations, horizontal bedding							
41										
42		CLAY SHALE	- dark brown-grey, silty, K3 hardness, some green-grey bentonite pockets, dry to damp							
43	13									
44			- SANDSTONE layer (100 mm), damp				23.3			
45						60	21.1			
46	14	CLAY SHALE	- medium to dark grey, silty, K3 to K4 hardness, coal particles, dry		- fractured, blocky microstructure			40 155 610	59	56
47			- dark grey-brown, K2 to K3 hardness, slightly carbonaceous, dry to damp		- massive, blocky microstructure		14.8			
48										
49	15									
50		COAL	- black, brittle, K6 hardness		- highly fractured, blocky		19.7	25	85	73
51		CLAY SHALE	- dark brown to black, silty, K2 to K3 hardness, carbonaceous, siltstone seam (50 mm)		- fractured, blocky microstructure			60 190		
52	16		- slightly bentonitic		- massive		15.5	80 750		
53			- medium to dark grey, K3 hardness, coal stringers, trace of sandstone							
54			- siltstone inclusions		- massive, blocky microstructure		18.9	475 685	100	100
55	17		- slightly bentonitic							

ROCK CORE LOG

ft. / m. Depth	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)

EBA Engineering Consultants Ltd.

Drawing No. B-7

Sheet 2 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-6	17.0-21.4 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE						
57			- dark brown-grey, silty, K3 to K4 hardness, coal particles, lenses of softened material	- massive, block microstructure				
58			- SILTSTONE layer (100 mm) K7 hardness, indurated	- factured		110 70	81	75
59	18				15.2	615 190		
60			- K4 hardness	- extremely fractured zone, slickensided fracture surfaces				
61			- some softened zones					
62	19				17.5	710	95	84
63			- dark brown to black, carbonaceous	- massive		50 85		
64		COAL	- black, brittle, K6 hardness	- fractured, blocky microstructure	17.8	150 165		
65	20	CLAY SHALE	- dark brown, carbonaceous, K2 to K3 hardness, dry to damp	- massive				
66		BENTONITE	- grey-green, damp, coal stringers, (130 mm)	- homogenous		1470	107	107
67		SANDSTONE	- light grey, medium grained, uniform, K4 hardness, coal stringers, siltstone laminations	- massive, horizontal bedding	13.5			
68								
69	21				12.5			
70			END OF BOREHOLE (21.4 metres)					

EBA Engineering Consultants Ltd.	Drawing No.	Sheet
	B-7	3 of 3

Project GRIERSON HILL STABILIZATION STUDY	**Hole No.** 80-7
Location EDMONTON ALBERTA	**Surface Elevation** 637.8 m (City)
Project Number 106-2672	**Completion Depth** 22.0 m
	Date Drilled July 31, 1980
	Logged By RRH (field); _____ (lab)
	Log Type Overburden/Rock Core
	Core Size 50 mm
	Drilling Contractor Mobile Augers
	Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
0		TOP SOIL	- dark brown to black, organic, damp, rootlets							
1		CLAY (FILL)	- dark brown, silty, pebbles, dry to damp							
3	1		- rootlets, pieces of brick							
4			- wood fibres, some sand, organic pockets, soft, moist				40.6		480	
5						3	47.7			
6	2									
7		SILT (FILL)								
8			- dark brown, some clay and sand, firm, black organic pockets, pieces of glass, rust-coloured pockets, wood fibres				41.0		90	
9	3		- dark grey/black, firm, very organic, moist			5	30.9			
10										
12	4									
13										
14			- brown/grey, firm, some sand, coal lenses, organic pockets				31.1		110	
15						8	30.1			
16	5		- dark brown to black, clay shale inclusions, coal particles, moist							
17		CLAY SHALE								
18			- medium grey-brown, silty, K1 hardness with K3 inclusions, blocky microstructure (1 mm), organic pockets, light grey sandstone inclusions				28.1		100	
19	6									
20			- coal particles			10	28.8			
22	7									
23		COAL	- black, brittle, extremely fractured, blocky (2 to 3 mm), wet				61.7			
25		SANDSTONE	- light grey, silty, fine grained, K1 hardness, damp, some medium grey soft siltstone laminations			16	25.8			
26	8									
27		CLAY SHALE	- medium to dark brown/grey, silty, K1 hardness with K3 inclusions, coal particles, damp, brecciated							
28										
29	9	COAL	- black, K6 hardness, extremely fractured, blocky (5mm), wet				38.8			

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-7 Log Type Overburden/Rock Core
Surface Elevation 637.8 m (CITY) Core Size 50 mm
Completion Depth 22.0 m Drilling Contractor Mobile Augers
Date Drilled July 31, 1980 Drilling Method B61 Hollow Stem/ Wireline Coring
Logged By RRH (field); _____ (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		COAL								
31		CLAY SHALE	- dark brown/black, silty, carbonaceous, K1 hardness, damp			15	48.7			
32	10									
33			- grey/rust-brown, silty, K1 to K2 hardness, brecciated, blocky, coal particles, damp				32.8			
34			- brownish grey with rust-brown pockets							
35						30	26.5			
36	11									
37		COAL	- black, K6 hardness, extremely fractured, wet							
38										
39	12	CLAY SHALE	- dark brown/black, K2 hardness, carbonaceous, bentonite pockets				35.9			
40			- medium brown-grey, bentonitic							
41			- dark brown			30	28.1			
42	13									
43			- silty, coal particles, light grey bentonitic sandstone lenses							
44		SANDSTONE	- medium grey-brown, fine grained, uniform, softened, K1 hardness, bentonite seams, coal particles				28.8			
45			START ROCK CORING			69	19.1			

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
46	14	CLAY SHALE	- medium to dark grey, silty, K3 hardness, coal particles	- massive, horizontal layering	19.0			
47			- interbedded SANDSTONE and SILTSTONE layers (75 to 200 mm), coal particles		17.3	1365	100	100
48			- medium to dark grey, silty, K3 hardness	- some fractures				
49	15							
50			- dark brown-grey, silty, K3 to K4 hardness		15.3	570	92	69
51						375		
52	16		- coal particles	- fractured, slickensided fracture surfaces	24.8	55 65 25		
53		COAL	- black, brittle, K6 hardness	- highly fractured, blocky		80 85		
54		CLAY SHALE	- dark brown to black, carbonaceous, K2 hardness, coal particles	- massive	18.7			
55	17		- green-grey, slightly bentonitic	- blocky microstructure (5to10mm)				

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Drawing No. B-8

Sheet 2 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-7	17.0-22.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		CLAY SHALE	- medium to dark grey, silty K3 to K4 hardness, coal particles angular fragments (3 mm)	- massive, blocky microstructure		1155	84	84
57								
58		INTERBEDDED SANDSTONE AND SILTSTONE	- SILTSTONE, medium to dark grey, K4 to K5 hardness, coal particles	- massive, homogeneous, fabric	14.4			
59	18		SANDSTONE, light to medium grey, K3 hardness	- slickensided fractures	15.4	1375	100	100
60			- softened CLAY SHALE lens (15 mm)	- horizontal bedding				
61			- interbedded SILTSTONE and SANDSTONE					
62	19							
63					14.3			
64			- SANDSTONE, medium grained, uniform, K4 hardness		16.0	1330	97	97
65	20				14.0			
66			- coal laminations					
67			- K5 hardness	- bedding planes dip at 30°, fissile fabric				
68			- K6 hardness, indurated, slightly bentonitic			130	90	77
69	21				8.6	120		
70						70		
71			- SILTSTONE layer (50 mm), K3 to K4 hardness, coal particles			95		
72	22					810		
			END OF BOREHOLE (22.0 metres)					

EBA Engineering Consultants Ltd.	Drawing No. B-8	Sheet 3 of 3

Project GRIERSON HILL
STABILIZATION STUDY
Location EDMONTON
ALBERTA
Project Number 106-2672

Hole No. 80-8
Surface Elevation 645.0 m (CITY)
Completion Depth 22.7 m
Date Drilled August 1, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
0		TOPSOIL	- black, organic, damp							
1		SILT (FILL)	- medium brown, clay pockets, some sand, pieces of glass, coal particles, damp, powdery, cohesionless							
3	1	CLAY (FILL)	- medium to dark brown, silty, hard, pebbles to 30 mm, pieces of glass, coal particles, damp, cohesive				17.3		500	
5			- wood fibres, golf ball, traces of oxides			24	11.7			
6	2									
7		SAND	- olive-brown, silty, fine-grained, grey clay lenses, damp, mainly cohesionless				14.6			
10	3					15	15.9			
11		CLAY	- grey and brown, silty, stiff, trace of sand, oxide stains, coal particles, damp, cohesive							
13	4		- fine sand lenses, damp to moist, fairly cohesive				27.5		150	
14		COAL	- black, brittle, K5 to K6 hardness, highly fractured, blocky (15 mm)							
15		CLAY SHALE	- dark brown to black, silty, K2 hardness, carbonaceous, dry to damp, massive			22	25.8			
16	5									
18			- medium brown-grey, K2 to K3 hardness, damp, fractured, blocky microstructure				20.5		>500	
20	6									
20		SANDSTONE	- light grey, fine-grained, uniform, K1 to K2 hardness, medium grey silt laminations, coal particles, damp, homogeneous fabric			24	21.9			
23	7									
24		CLAY SHALE	- medium to dark brown-grey, silty, K3 hardness, fractured, block microstructure (5 mm), some slickensided				16.8		>500	
25		COAL	- black, K6 hardness, highly fractured, (10 mm) free water			30 (75mm)	45.2			
26	8									
27		CLAY SHALE	- dark brown, silty, K3 hardness, coal particles, damp, blocky microstructure							
28			- grey-brown, K3 to K4 hardness, coal stringers				24.3			
29	9									

EBA Engineering Consultants Ltd.

Drawing No. B-9

Sheet 1 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-8	9.0-19.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
30		CLAY SHALE	START ROCK CORING					
31		INTERBEDDED CLAY SHALE AND SANDSTONE	- SANDSTONE, light grey, silty, fine grained, K3 hardness, coal particles, light brown streaks, dry to damp	- slightly fractured, homogeneous fabric	11.5	100 1285	100	100
32	10		- CLAY SHALE, dark brown-grey, silty, K3 hardness, oxides, coal stringers, dry to damp	- massive, blocky microstructure				
33			- SANDSTONE	- horizontal bedding				
34			- CLAY SHALE, DRY		15.2			
35			- fine SANDSTONE laminations					
36	11		- softened, clay-like, damp - brown-black, carbonaceous, black			535 130 280	69	69
37		COAL	brittle, poor recovery	- extremely fractured (5 mm)				
38		CLAY SHALE	- dark brown-grey, silty, K3 hardness - SILTSTONE layer, K6 to K7 hardness, indurated	- slightly fractured - highly fractured	18.6			
39	12		- rust stains on fracture surfaces					
40		COAL	- black, brittle, K6 hardness	- extremely fractured (5 mm), blocky	25.2	460	34	34
41								
42	13			- massive to slightly fractured, fissile fabric				
43								
44		INTERBEDDED CLAY SHALE, SILTSTONE AND SANDSTONE	- CLAY SHALE, dark brown-black, silty, K3 hardness, carbonaceous	- slightly fractured, fine horizontal bedding	18.0	170 1075	91	91
45	14							
46					16.5			
47			- SANDSTONE, light grey, light brown, streaks, K3 hardness, coal particles, damp	- massive, homogeneous fabric				
48					16.3			
49	15		- SILTSTONE layer (150 mm), light grey, K5 hardness, dry to damp, indurated	- homogeneous fabric		1265	92	92
50			- SANDSTONE		17.1			
51								
52	16		- CLAY SHALE, dark brown-grey, silty, K3 hardness, coal streaks, dry to damp					
53			- carbonaceous layer (25 mm)	- fractured, blocky microstructure (5 mm)	23.2	60 1215	93	89
54			- fine light grey SANDSTONE/dark CLAY SHALE laminations, slightly bentonitic, K2 to K3 hardness, dry to damp	- inclined bedding (15°)				
55	17							
56					22.3			
57			- SILTSTONE, dark grey, very fine grained, K2 to K3 hardness, some clay, dry	- massive, fissile fabric	21.9	40 700	54	51
58								
59	18		- SANDSTONE layer (150 mm)					
60			- SILTSTONE - CLAY SHALE, dark grey, K3 hardness	- slightly fractured, blocky microstructure				
61					18.6			
62	19			- extremely fractured, angular	22.1			

EBA Engineering Consultants Ltd.	Drawing No.	Sheet
	B-9	2 of 3

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-8	19.0-22.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
63		INTERBEDDED CLAY SHALE, SILTSTONE AND SANDSTONE	- CLAY SHALE, dark brown-grey, K3 hardness, coal particles, siltstone inclusions	- slightly fractured, blocky microstructure (5 mm)	19.0	210 310 115 155 165	70	70
64								
65	20		- SILTSTONE, medium brown-grey, K5 hardness, indurated - CLAY SHALE	- extremely fractured, angular (10 mm)				
66		COAL	- black, brittle, bentonite inclusions	- fractured (poor recovery) blocky (10 mm)	16.8	50 290	25	21
67								
68		CLAY SHALE	- dark brown to black, K2 hardness, carbonaceous	- massive				
	21		- BENTONITE layer (100 mm)					
69			- K3 hardness		13.9			
70								
71			- SILTSTONE layer (200 mm), medium grey, K4 to K5 hardness, indurated	- massive				
72	22		- dark grey, K4 hardness, coal particles, slightly bentonitic	- massive, blocky microstructure (5 mm)	15.2	380 865	102	102
73								
74			- dark brown to black, carbonaceous	- blocky microstructure (3 mm)				
75	23		END OF BOREHOLE (22.7 metres)					

EBA Engineering Consultants Ltd.	Drawing No. B-9	Sheet 3 of 3

Project: GRIERSON HILL STABILIZATION STUDY	Hole No.: 80-9
Location: EDMONTON ALBERTA	Surface Elevation: 652.7 m (CITY)
Project Number: 106-2672	Completion Depth: 28.5 m
	Date Drilled: August 5, 1980
	Logged By: RRH (field); _____ (lab)
	Log Type: Overburden/Rock Core
	Core Size: 50 mm
	Drilling Contractor: Mobile Augers
	Drilling Method: B61 Hollow Stem/ Wire line, coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
0	0	TOP SOIL	- black, organic, rootlets, damp							
1		CLAY	- medium brown, silty, stiff, trace of rootlets, grey streaks, moist, cohesive						190	
2		SAND	- medium brown and grey, silty, fine grained, damp, cohesionless							
3									450	
4		CLAY	- medium to dark brown, silty, very stiff, some sand, pebbles to 20 mm, coal particles, damp, cohesive, impermeable				14.1		330	
5										
6			- dark grey			13	16.0			
7										
8			- damp to moist, stiff				18.3		160	
9									180	
10										
11		SAND	- medium brown, silty, compact, fine to medium grained, trace of clay, damp, cohesionless			15	21.3			
12										
13		CLAY (TILL)	- dark grey-brown, silty, very stiff, coal particles, pebbles, damp to moist, cohesive, impermeable				18.0		270	
14										
15						15	18.5			
16										
17			- dark grey, more silty							
18							17.6		300	
19										
20		CLAY SHALE	- dark brown to black, silty, K1 hardness, coal particles, damp, fissile fabric			23	21.5			
21		COAL	- black, brittle, K5 hardness, highly fractured, blocky (10 mm)							
22										
23		CLAY SHALE	- medium grey, silty, K2 hardness, coal pockets, dry to damp, brecciated				15.8		>500	
24										
25			- light grey sandstone and siltstone inclusions, K2 hardness, brecciated			42	14.6			
26										
27		COAL								
28			- black, highly fractured (10 mm), powdery				17.5			
29										

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-9
Surface Elevation 652.7 m (CITY)
Completion Depth 28.5 m
Date Drilled August 5, 1980
Logged By RRH (field); _____ (lab)

Log Type Overburden/Rock core
Core Size 50 mm
Drilling Contractor Mobile Auger
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		COAL	- black, highly fractured (10 mm), powdery			37	23.3			
31										
32	10									
33		SANDSTONE	- light grey, fine grained, uniform, K1 hardness, coal particles, brown vertical streaks, damp, homogeneous fabric			28	19.0			
34										
35										
36	11		- (high resistance to drilling)							
37		CLAY SHALE								
38			- dark grey, silty, <K1 hardness, clay-like, damp, pieces of timber			16	26.1			
39	12									
40		COAL	- black, K5 to K6 hardness, wet, fractured, blocky							
41										
42	13									
43			- dark brown, silty, K2 hardness, fine horizontal bedding, occasional sandstone and softened shale (clay-like) layers				30.3		>500	
44			- light grey-green BENTONITE layer (50mm), soft, damp			38 (100mm)	29.6			
45			- K3 hardness, coal stringers START ROCK CORING							

ft.	m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
45	14	COAL	- black, K6 hardness	- fissile fabric		135	93	71
46		CLAY SHALE	- dark brown to black, silty, K3 hardness, carbonaceous, dry to damp	- fractured, fine horizontal bedding	21.0	70		
47			- dark grey-brown	- slightly fractured, fine horizontal bedding		30 215		
48			- SILTSTONE layer (300mm), light grey, K7 hardness, indurated	- fractured		280 345 50		
49	15				1.1	50		
			- dark grey-brown, K3 hardness			95		
50		SANDSTONE	- light to medium grey, silty, fine grained, K3 hardness, coal stringers, occasional SILTSTONE layers (100 to 300mm), fine CLAY SHALE laminations, dry to damp	- slightly fractured to massive, homogeneous fabric	9.7	210 1025 55	100	90
52	16				11.3	80		
53			- CLAY SHALE layer (300 mm), dark brown-grey, silty, K3 hardness, dry	- fractured, fine horizontal bedding				
54						1220	99	99
55	17		- SANDSTONE, K3 to K4 hardness	- massive, homogeneous fabric		130		

ROCK CORE LOG

EBA Engineering Consultants Ltd.

Drawing No. B-10

Sheet 2 of 4

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-9	17.0-27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-56			- medium to fine grained, K3 hardness, coal particles	- slightly fractured, homogeneous fabric				
-57			- light grey, K6 hardness, indurated, dry		11.3			
-58								
-59	18					330	97	92
						140		
-60			- K3 hardness, light brown horizontal lenses, damp	- slightly fractured to massive, horizontal bedding		690		
						100		
-61						65		
					12.5			
-62	19		- medium to fine grained, K4 hardness, coal stringers					
-63			- light grey, medium grained, dark brown-grey clay shale laminations	- massive, horizontal bedding		1280	93	93
-64								
-65	20		- light brown siltstone pocket, K4 to K5 hardness, indurated					
-66			- light grey, medium to fine grained, K3 hardness, damp		11.6			
-67								
-68								
	21		- medium grey	- massive		645	103	94
-69						512		
-70			- medium brown siltstone layer, (50mm), K6 to K7 hardness, indurated		12.2	125		
-71			- fine to medium grained, K3 hardness	- fractured		95		
						40		
-72	22							
-73			- CLAY SHALE, dark brown to black, K3 to K5 hardness, carbonaceous, with layers of COAL, black, highly fractured, (5mm) and SILTSTONE, medium grey, silty, indurated	- fractured, block microstructure, 100 to 200 mm layers	11.8	95	103	80
-74						20		
						45		
-75	23		- light grey, silty, fine grained, K4 to K5 hardness	- massive, homogeneous fabric	11.3	90		
						70		
-76			- CLAY SHALE lens (10mm)			785		
						305		
-77			- coal stringers			1075	94	86
						105		
-78	24				14.9	70		
						35		
-79			- dark brown-grey, silty, K3 to K4 hardness, coal particles, dry	- fractured, blocky microstructure (5mm)	11.7			
-80								
-81			- dark brown to black, K5 hardness, carbonaceous, dry					
	25				13.7	25	89	72
-82								
			- black, K6 hardness	- fissile fabric (10mm layers)	13.2	40		
-83			- dark brown to black, carbonaceous	- massive, fine horizontal bedding		80		
						150		
-84			- COAL lens (25mm)			100		
			- medium to dark grey, K3 hardness slightly bentonitic		16.9	90		
-85	26				22.0	735		
-86			- coal stringers	- massive		970	79	71
			- SILTSTONE layer (100mm)			65		
-87			- dark brown-grey, silty, K3 to K4 hardness		19.0	40		
-88	27				18.5			

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-9	27.0-28.5 m

ROCK CORE LOG

Depth ft.	Depth m	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-89		CLAY SHALE	- light grey siltstone laminations - SILTSTONE layer (150 mm), K7 hardness, indurated	- fractured, horizontal bedding				
-90				- extremely fractured (very poor recovery)		-	0	
-91	28							
-92			- dark brownish grey, K3 to K4 hardness - SILTSTONE inclusions	- extremely fractured (very poor recovery)	33.1			
-93						-	0	
-94			END OF BOREHOLE (28.5 metres)					
-95	29							

EBA Engineering Consultants Ltd.	Drawing No.	Sheet
	B-10	4 of 4

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON
Project Number 106-2672

Hole No. 80-10
Surface Elevation 653.1 m (City)
Completion Depth 29.0 m
Date Drilled August 9, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow stem/ Wireline coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		TOP SOIL	- dark brown to black, clay pockets, damp, rootlets							
2		CLAY (FILL)	- dark brown, silty, some sand, stiff, pebbles to 20 mm, pieces of brick and coal, organics, damp, cohesive						160	
3	1		- black organic layers, piece of wire, damp to moist							
4							21.7		140	
5									190	
6	2		- extremely organic silt layers - moist, firm, cohesionless			5	23.1			
7										
8		SILT (FILL)	- medium brown, sandy, organic pockets, firm to stiff, piece of glass, damp to moist, mainly cohesive				28.5		100	
9	3	SAND (TILL)	- medium to dark brown, silty, some clay, fine to							
10			medium grained, compact, trace of pebbles and organics, damp, mainly cohesionless			11	15.8			
11										
12										
13	4		- medium brown, moist to wet, cohesionless							
14							16.5		110	
15										
16		CLAY (TILL)	- dark brownish grey, silty, some sand, stiff, pebbles and coal specks, damp, cohesive			14	16.0			
17	5									
18										
19			- CLAY SHALE, grey and brown, silty, K1 hardness, weathered, horizontal bedding, coal specks, damp(150mm)				17.2		300	
20	6		- very stiff							
21		CLAY SHALE	- medium grey and brown, silty, K1 hardness, massive, damp, horizontal bedding			29	22.3			
22			- SANDSTONE, light grey, fine grained, damp (150 mm)							
23	7									
24			- dark grey, K1 to K3 hardness, brecciated, blocky fragments (5-10 mm)				23.8			
25			- medium brown layers			22	21.2			
26	8		- coal lenses							
27										
28		SANDSTONE	- light grey, silty, fine grained, uniform, K1 to K2 hardness, medium grey clay laminations, brown iron streaks, damp, massive, homogeneous fabric				17.0	D	>500	
29	9									

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-10 Log Type Overburden/Rock Core
Surface Elevation 653.1 m (CITY) Core Size 50 mm
Completion Depth 29.0 m Drilling Contractor Mobile Augers
Date Drilled August 9, 1980 Drilling Method B61 Hollow Stem/
Logged By RRH (field); _____ (lab) Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SANDSTONE	- dry to damp, K2 hardness			40	19.0			
31										
32	10									
33			- light grey and brown, thin medium grey clay laminations, slightly fractured, homogeneous fabric with faint horizontal bedding				16.8		>500	
34										
35			- K3 hardness, dry			32 (150mm)	16.9			
36	11									
37										
38			- K1 to K2 hardness, dry to damp				15.2			
39	12									
40			- thin medium grey clay shale lens (25 mm) START ROCK CORING			55	16.6			

ft.	m	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
41			- light grey, silty, fine grained, uniform, coal, damp	- slightly fractured, homogeneous fabric, coal stringers and clay shale lenses @ horizontal and inclined @ 30°	17.6			
42	13		- loss of water pressure and poor recovery	- massive, homogenous fabric				
43					13.2	70 80 95 790	76	58
44								
45								
46	14							
47		CLAY SHALE	- medium to dark grey, silty, K2 hardness, subangular fragements dry to damp	- slightly fractured, blocky microstructure (2 to 5 mm)	16.6		35	35
48						480		
49	15		- dark brown to black, carbonaceous, coal particles, dry to damp	- fractured, fissile fabric				
50		COAL	- black, fragmented, K6 hardness,	- highly fractured, blocky (20mm)	17.1			
51		CLAY SHALE	- medium grey, silty, K1 to K3 hardness, coal particles, damp	- brecciated fabric			37	37
52	16		- SANDSTONE (100mm), light grey, fine grained, K1 to K2 hardness					
53			- dark brownish grey, K3 hardness thin siltstone lenses, dry to damp	- fine horizontal bedding		110 400		
54		COAL	- black, fragmented, K6 hardness					
55	17	CLAY SHALE	- dark brownish grey, silty, K2 hardness, coal particles, damp	- fractured, brecciated - slightly fractured, blocky				

ROCK CORE LOG

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-10	17.0- 27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56			- light grey sandstone pockets				12	12
57								
58						170		
	18		- dark brown to black, carbonaceous, K1 hardness, damp to moist	- slightly fractured, brecciated				
59		CLAY SHALE	- med.green-grey, slightly bentonitic, layer (50 mm thick), K3 hardness	- fractured, fissile & blocky (20 mm)	31.2			
60			- dark brown to black, carbonaceous			90		
61		COAL	- black, brittle, subangular fragments, K6 hardness, wet	- fractured, blocky microstructure (5 mm)	28.6	415 65 40	53	30
62	19				23.1	50 70		
63								
64		CLAY SHALE	- dark brown to black, carbonaceous, K2 hardness, coal stringers, dry	- massive, fissile fabric				
65	20		- dark brownish grey, silty, K3 hardness, coal specks, dry	- massive, some horizontal fissures			100	99
66				- slickensided fracture plane at 45° to horizontal	20.1	20 1350		
67			- K3 to K4 hardness, siltstone inclusions	- highly fractured, 25 mm sub-angular fragments (loss of water pressure)				
68	21				12.9			
69		INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- light grey sandstone/med. grey siltstone, K3 to K4 hardness, dry	- massive, horizontal bedding				
70			- medium brown siltstone bonds, K6 hardness		14.2	115 75 50 65 1060	100	86
71			- dark brownish grey, silty, K3 to K4 hardness					
72	22							
73			- numerous light grey sandstone lenses & pockets	- massive, blocky with fine horizontal bedding	15.1			
74					15.0		100	100
75	23							
76			- some sandstone & siltstone laminations, K4 hardness	- fine horizontal bedding - slickensided fracture planes		1375		
77								
78	24			- fractured	15.6			
79			- SILTSTONE layer (75 mm), K7 hardness, indurated			40	33	24
80			- SANDSTONE layer (800 mm), light grey, silty, uniform, some coal specks, K5 hardness, dry, medium to dark grey clay shale laminations	- massive, homogeneous fabric		10 75 330		
81								
82	25				14.7			
83				- massive, homogeneous fabric, some vertical fissures			100	100
84				- blocky microstructure (25 mm)	14.5			
85	26		- dark brown to black, carbonaceous, K4 hardness			1370		
86								
87		COAL	- black, K6 hardness (poor recovery)	- highly fractured, blocky		80 130	46	29
88	27	SANDSTONE	- light to medium grey, silty, uniform, K4 hardness, some clay shale laminations	- massive, homogeneous fabric	13.1		100	100

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2682	80-10	27.0 - 29.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
89		SANDSTONE	- medium grained, K3 hardness, coal specks	- massive, homogeneous fabric	9.8	1360	100	100
90								
91	28							
92		CLAY SHALE	- dark brown-grey, silty, K4 to K5 hardness, coal specks, siltstone inclusions	- fractured to massive	12.6	195 225 85	68	57
93								
94			- dark brown to black, carbonaceous		12.3	65 135 230		
	29							
95			END OF BOREHOLE (29.0 metres)					
96								

EBA Engineering Consultants Ltd.	Drawing No. B-11	Sheet 4 of 4

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-11A
Surface Elevation 656.5 m (City)
Completion Depth 20.7 m
Date Drilled August 27, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		GRAVEL	- dark brown, sandy, silty, pebbles to 35 mm, damp to moist, cohesionless							
2		CLAY (FILL)	- medium brown, black organic pockets, silty, very stiff, trace of rootlets, medium plasticity, damp, cohesive						200	
3	1									
4		CLAY (FILL) TILL	- dark brown-grey, silty, hard, sand pockets, pebbles, coal specks, oxide stains, damp, cohesive				13.3		480	
5			- pieces of brick, firm			5	14.6			
6	2									
7			- SILT, (600 mm thick), medium brown-black, some clay and sand, very stiff, organics, trace of pebbles, damp, mainly cohesive				19.4		280	
9	3									
10			- dark greyish brown, stiff, some organics, rootlets, damp cohesive			8	18.1			
12			- black organic seams, pebbles to 10 mm							
13	4		- SILT, (75mm thick), brown, very fine grained, damp, mainly cohesionless				28.0		180	
14		CLAY (FILL)	- medium greyish brown, silty, stiff, high plasticity, moist				25.7		110	
15			- brown-grey, mottled, stiff, medium to high plasticity, damp to moist			10	33.7			
16	5									
17										
18			- medium to dark brown, very silty, sandy, stiff, pieces of shells and glass, organics, damp to moist, mainly cohesive				22.3		170	
19							19.9		230	
20	6									
21			- brown and grey, black organic silt pockets			24	19.6			
22										
23	7									
24			- grey and black, silty, sandy, very stiff, pieces of coal, glass and bricks, calcareous, damp, mainly cohesive				21.1		320	
25		CLAY (TILL)	- dark brownish grey, silty, hard, sand pockets, trace of pebbles and coal particles, damp, cohesive			33	20.7			
26	8									
27										
28		COAL	- black, brittle, highly fractured, K6 hardness, powdery, to blocky, (100 mm)				28.0			
29	9									

Project: GRIERSON HILL STABILIZATION STUDY	Hole No.: 80-11A
Location: EDMONTON, ALBERTA	Surface Elevation: 656.5 m (CITY)
Project Number: 106-2672	Completion Depth: 20.7 m
	Date Drilled: August 27, 1980
	Logged By: RRH (field); _____ (lab)
	Log Type: Overburden/Rock Core
	Core Size: 50 mm
	Drilling Contractor: Mobile Augers
	Drilling Method: B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY SHALE	- thin dark brown carbonaceous layer (75 mm) - medium to dark grey, silty, K3 hardness, massive, homogeneous fabric, dry			60 (225mm)	17.5			
31										
32	10									
33			- coal stringers, some brecciated zones - 25 mm thick, K1 to K3 hardness			50 (100mm)	15.2			
34										
35										
36	11									
37		COAL								
38			- black, brittle, highly fractured, K6 hardness, powdery to blocky, (max 10mm)							
39	12					54	44.5			
40										
41		CLAY SHALE								
42	13		- medium to dark grey, silty, K1 to K3 hardness, massive, brecciated, damp to moist							
43										
44		SANDSTONE	- SANDSTONE, light grey, silty, fine grained, friable, coal stringers, massive, homogeneous fabric (150 mm)				21.3			
45			- light grey, silty, K2 hardness, clay shale laminations				18.6			

START ROCK CORING

ft.	m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
46	14		- K1 to K2 hardness, coal particles - coal seams and clay shale laminations	- massive, homogeneous fabric, horizontal bedding	9.7			
47							77	72
48		CLAY SHALE	- dark grey, silty, K3 hardness, coal specks, dry	- massive, irregular to blocky microstructure (5 to 10 mm)	18.8	980		
49	15		- dark brownish grey, K1 to K3 hardness, damp	- slightly fractured, brecciated		80		
50			- SANDSTONE, light grey, silty, K3 hardness, siltstone seams (75mm)		17.6	75 150	82	58
51			- dark grey, K3 hardness, coal stringers, horizontal siltstone laminations	- massive, homogeneous fabric, slickensided fracture planes		30 135 160 70		
52	16		- SILTSTONE, light brown, K7 hardness (50 mm)	fractured				
53			(No recovery - 16.35 to 16.65 m lost all water pressured and no resistance to coring - possible void, mine working?)				0	0
54								
55	17							

ROCK CORE LOG

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-11A	17.0-20.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-56								
-57							28	20
-58			- dark brown to black, silty, carbonaceous, K5 hardness, coal lenses	- fractured, homogeneous to fissile fabric		50 60 100 170		
	18				15.9			
-59			- dark grey, K1 to K3 hardness - K3 hardness, siltstone laminations	- brecciated zone (50 mm) - slightly fractured, fine horizontal bedding				
-60			- fractured zone	- extremely fractured, angular and subangular fragments (2 to 5mm), brecciated material			72	70
-61			- K3 hardness	- brecciated zone (50 mm)		30 160		
	19			- slickensided along fracture planes				
-62			- dark brown to black, silty, K3 to K4 hardness, carbonaceous		19.2	135 205		
-63			- COAL, poor recovery - dark grey, silty, K3 to K4 hardness	- massive, irregular blocky microstructure (2 to 5 mm)		275 185		
-64			- dark brownish grey, coal streaks					
-65	20		- SILTSTONE, medium grey, K3 hardness, clay shale laminations, coal streaks (400 mm)				77	74
-66				- massive, homogeneous with fine horizontal bedding	17.7			
-67			- dark brownish grey, K3 to K4 hardness - thin light grey sandstone lenses	- massive, blocky microstructure (5 to 10mm), fine horizontal bedding		40 325 695		
-68	21		END OF BOREHOLE (20.7 metres)					
-69								
-70								
-71								
-72								
-73								
-74								
-75								

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-11B
Surface Elevation	656.5 m
Completion Depth	34.7 m
Date Drilled	September 10, 1980
Logged By	RRH (field); (lab)
Log Type	Rock Core
Core Size	75 mm
Drilling Contractor	Garrity & Baker
Drilling Method	Cyclone - Wireline

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-57			0 - 20.0 metres - This portion of Borehole 80-11B not logged. - See Borehole 80-11A					
-58								
-59	18							
-60								
-61								
-62	19							
-63								
-64								
-65	20							
-66		CLAY SHALE	- dark grey, silty, K1 to K3 hardness, damp to moist	- slightly factured				
-67			- dark brownish grey, K3 hardness, light grey, sandstone pockets, siltstone bands	- massive, some slickensided fracture planes at various angles		100	55	51
-68						400		
-69	21					50		
-70						200		
-71		BENTONITE	- (100mm), light greyish green, K1 hardness, coal streaks					
		CLAY SHALE	- dark brown to black, carbonaceous, K3toK4 hardness, coal lenses	- massive, homogeneous to fissile fabric				
-72	22	COAL	- (225mm), black, fractured, K6 hardness	- fractured, blocky (≈25mm)				
-73		CLAY SHALE	- thin carbonaceous zone - greenish grey, bentonitic, K3 to K4 hardness	- massive, homogeneous fabric		610 90	97	81
-74			- SILTSTONE, (300mm), medium grey, clayey, K4 to K5 hardness, coal specks	- massive, blocky microstructure		50 260		
-75	23		- SANDSTONE (450mm), light grey, silty, fine grained, K4 hardness	- massive, homogeneous fabric		45 70		
-76			- dark brownish grey, silty, K4 to K5 hardness, thin coal lenses	- massive, blocky microstructure		60 40 50		
-77						270		
-78	24		- dark grey, light grey sandstone laminations	- horizontal bedding		700 110 160		
-79								
-80			- K1 to K3 hardness	- brecciated zone (150 mm)				
-81				- fractured, blocky microstructure, slickensided fracture			100	98
-82	25		- SILTSTONE, (225mm), dark greyish brown, K5 to K6 hardness	- massive, homogeneous fabric				
-83			- SANDSTONE, (75 mm), light grey, silty, fine grained	- homogeneous fabric		70 115		
-84			- dark brownish grey, K4 to K5 hardness	- massive, homogeneous fabric, fissures at various angles		245 1320 585		
-85	26		- K1 to K3 hardness, siltstone inclusions	- brecciated zone		130		

Project	Project No.	Hole No.	Depth Interval
FESTIVAL PARK	106-2672	80-11B	26.0-34.7 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-86			- sandstone lenses, fine grained	- horizontal bedding				
			- slickensided fracture planes at 45° to horizontal					
-87		SANDSTONE	- light grey, silty, K4 hardness, fine grained, siltstone bands, coal streaks	- massive, homogeneous fabric				
-88	27							
-89								
-90							73	65
-91			- SILTSTONE, dark brown, clayey, K4 to K5 hardness, carbonaceous, coal particles (300mm)	- massive, homogeneous fabric		75		
						1070		
-92	28	INTERBEDDED CLAY, SHALE AND SANDSTONE	- dark brown, slightly carbonaceous clay shale, K4 to K5 hardness			70		
						120		
-93			- light grey sandstone, K4 hardness					
-94			- dark grey clay shale, K4 hardness - light grey sandstone					
-95	29		- dark brown clay shale - light grey sandstone	- slightly brecciated		145	100	90
						40		
-96						100		
						40		
-97						55		
			- dark brownish grey, K4 to K5 hardness	- fractured, homogeneous, slightly blocky microstructure		105		
-98	30					185		
						60		
						1115		
-99								
-100								
-101								
	31		- SILTSTONE, (75mm), light brown, K6 hardness, well indurated	- fractured			77	65
-102		CLAY SHALE	- dark brown, slightly carbonaceous			110		
			- greenish brown, slightly bentonitic, thin bentonite seams (2to5mm)	- massive, irregular, blocky		90		
-103		COAL	- black, brittle, K6 hardness	- fractured, blocky		140		
						185		
-104		CLAY SHALE	- medium to dark grey, silty, K4 to K5 hardness, coal specks	- fractured, blocky microstructure (5 to 15mm)		55		
-105	32					100		
						215		
			- SILTSTONE, (150mm), light brown, K6 hardness	- fractured, irregular		60		
-106			- SANDSTONE, (450mm), light grey, K4 hardness, fine to medium grained, coal stringers			95		
				- massive, homogeneous fabric		185		
-107						230		
			- medium to dark grey, silty, K4 to K5 hardness			525		
-108	33			- massive, irregular, blocky microstructure				
-109			- thin light grey sandstone lenses, coal stringers	- massive, blocky microstructure (10-20mm) with horizontal bedding				
-110								
-111			- medium grey, slightly bentonitic, K3 hardness, sandstone seams (100mm)					
	34						94	94
-112			- medium to dark grey, K4 to K5 hardness, coal pockets					
			- thin light brown siltstone lens, K7 hardness, calcareous			1595		
-113			- dark grey, silty, K5 hardness, coal specks	- massive, blocky, microstructure		415		
-114			END OF BOREHOLE (34.7 metres)					
	35							
-115								
	36							

EBA Engineering Consultants Ltd.	Drawing No. B-12(b)	Sheet 2 of 2

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-12 Log Type Overburden/Rock Core
Surface Elevation 658.2 m (City) Core Size 50 mm
Completion Depth 37.0 m Drilling Contractor Mobile Augers
Date Drilled August 25, 1980 Drilling Method B61 Hollow Stem/ Wireline Coring
Logged By RRH (field); (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		GRAVEL	- dark brown, silty, sandy, pebbles, wet, cohesionless, permeable							
1		CLAY (FILL)	- medium to dark brown, silty, organic pockets, stiff, pebbles, pieces of brick, cohesive						180	
2		SAND (FILL)	- medium brown, silty, clay pockets, fine grained, organic streaks, mainly cohesionless, permeable							
3	1						16.3			
4										
5		CLAY (FILL)	- brown-grey, silty, clay shale inclusions, firm, thin bentonite seams, sand pockets, damp to moist, mainly cohesive			7	27.9			
6	2									
7										
8			- dark brown, silt pockets, stiff, pebbles to 20 mm, coal particles, wood fibres, organic seams, damp				24.2		240	
9	3						24.1		110	
10										
11			- medium brown, stiff, high plasticity, moist, cohesive			8	33.1			
12										
13	4		- ~~medium brown, grey coarse grained sand lenses~~, pebbles to 10mm, rootlets, mainly cohesive				35.8		120	
14										
15										
16	5					8	28.4			
17										
18		CLAY TILL (FILL)	- medium brown and grey, very sandy, silty, very stiff, pebbles, coal particles, damp, mainly cohesive				27.3		210	
19			- black, organic silt lens (75 mm), piece of leather, damp							
20	6									
21		CLAY (FILL)	- medium brown with grey streaks, silty, stiff, high plasticity, moist, cohesive			11	31.7			
22										
23	7									
24			- siltier, very stiff, oxide stains, damp to moist				31.2		240	
25			- thin medium brown silt lenses (50 mm), damp to moist, mainly cohesionless			13	25.3			
26	8									
27										
28			- SAND TILL (300 mm), medium brown, silty, fine grained pebbles and coal specks, damp, cohesionless - CLAY TILL, dark greyish brown, silty, hard, damp				11.3		480	
29	9									

EBA Engineering Consultants Ltd.

Drawing No. B-13

Sheet 1 of 5

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-12
Surface Elevation 658.2 m
Completion Depth 37.0 m
Date Drilled August 25, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY SHALE	- brown-grey, mottled, silty, very stiff, coal particles, sand pockets, medium plasticity, moist, cohesive			18	28.6			
31										
32	10									
33			- SILT (200 mm), black, extremely organic, trace of pebbles, damp, mainly cohesive				24.0		260	
34			- medium brown, damp to moist							
35			- medium grey with brown streaks, very stiff			21	25.7			
36	11									
37		CLAY TILL (FILL)								
38			- medium greyish brown, silty, some sand, very stiff, pebbles to 15 mm, coal particles, damp, cohesive				29.7		360	
39	12	CINDERS (FILL)	- brown and black, some clay and silt, compact, coal particles, pieces of wood, calcareous, wet, cohesionless, permeable			16	34.3			
40			- free water in borehole at 12.0 m							
41										
42	13									
43			- pieces of bricks and concrete, coal particles				25.7			
44										
45			- rock fragments, pieces of ceramics			13	30.8			
46	14	CLAY (TILL)	- medium brown with grey streaks, silty, stiff, medium to high plasticity, coal pockets, moist, cohesive							
47										
48			(no recovery 14.0 - 16.0 m)							
49	15									
50										
51										
52	16									
53			- medium brown-grey, mottled, silty, very stiff, moist, cohesive				27.6		230	
54			- thin wet sand pocket (25 mm)							
55			- SILT (300 mm), grey and black, siltstone inclusions, stiff, moist, mainly cohesive			11	27.1			
56	17		- organic pockets, wood fibres							
57										
58										
59	18		- SILT, dark brown, very sandy, pieces of glass, wood and ceramics, wet cohesionless				45.4			

Project GRIERSON HILL STABILIZATION STUDY
Location EDMONTON ALBERTA
Project Number 106-2672

Hole No. 80-12
Surface Elevation 658.2 m (City)
Completion Depth 37.0 m
Date Drilled August 25, 1980
Logged By RRH (field); _____ (lab)
Log Type Overburden/Rock Core
Core Size 50 mm
Drilling Contractor Mobile Augers
Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
-60			- dark brown, black peat seams, pieces of wood and bricks			15	46.8			
-61										
-62	19									
-63			- (No recovery - 18.6 m to 21.2 m)							
-64										
-65	20									
-66										
-67										
		CLAY								
-68	21									
-69			- medium brown and grey, silty, very stiff, some sand pockets, trace of pebbles, damp, cohesive			23	23.1			
-70										
-71			- moist, high plasticity							
-72	22									
-73			- light and medium brown, silty, very stiff, high plasticity, moist, cohesive				38.5		250	
-74		CLAY SHALE	- dark greyish brown, silty, thin bentonite seams, K1 to K2 hardness, massive, brecciated, moist			40	52.6			
-75	23	COAL	- black, brittle, highly fractured, blocky (1-10 mm), wet							
-76										
		CLAY SHALE								
-77										
-78			- medium grey, silty, K3 hardness, coal specks, massive, homogeneous fabric, dry to damp			50	(150 mm)			
-79	24						23.8			
-80			START ROCK CORING							

ROCK CORE LOG

ft.	m.	Depth	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-81				- medium to dark grey, silty, K3 hardness, coal specks, dry	- massive, fissile fabric				
	25			- K3 to K4 hardness, coal stringers	- massive, homogeneous fabric			62	62
-82									
-83				- light brown siltstone inclusions - K6 hardness		15.1	560 200		
-84									
-85	26								

EBA Engineering Consultants Ltd.

Drawing No. B-13

Sheet 3 of 5

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-12	27.0-36.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
86			- dark brownish grey, silty, K3 to K4 hardness, light brown siltstone inclusions	- massive, homogeneous fabric	18.1			
87						365	27	27
88	27		- SANDSTONE, light grey, silty, fine grained, K3 hardness, dry	- massive, homogeneous fabric				
89		SILTSTONE	- light brownish grey, K7 hardness fractured zone (75mm) at 27.1m, lost water pressure	- highly fractured, homogeneous fabric				
90					13.1			
91			- medium to dark grey, K4 hardness, sandstone pockets, dry	- massive, homogeneous fabric			30	15
92	28					80 50 70 210		
93								
94		SANDSTONE	- light grey, silty, K3 to K4 hardness, fine grained, horizontal clay laminations, coal stringers, dry	- massive, homogeneous fabric	13.3			
95	29		- fine to medium grained					
96		CLAY SHALE	- dark brownish grey, silty, K4 hardness, subangular fragments (≈10mm), siltstone inclusions, dry	- massive, blocky microstructure		950	69	69
97			- K4 to K5 hardness		14.8			
98	30							
99			(No Recovery in core barrel - full run of core was left in the bottom of the borehole. Attempted to recover by overcoring but core was washed away).				0	0
100								
101	31							
102			- dark brown, silty, K3 hardness, carbonaceous, coal particles, dry	- slightly fractured, homogeneous fabric				
103			- medium to dark grey, K3 to K4 hardness, slightly bentonitic, siltstone inclusions	- massive, homogeneous fabric	13.3	90 30 205 100	85	71
104								
105	32							
106			- dark brownish grey, K4 hardness			310 105		
107					15.3	90 205 160		
108	33		- dark brown to black, silty, K5 hardness, carbonaceous	- massive, homogeneous to fissile fabric				
109						40 60	42	27
110		BENTONITE	- greyish green, coal stringers, high plasticity		15.6	65		
111		CLAY SHALE	- medium grey, silty, K3 to K4 hardness, slightly bentonitic, coal stringers, dry	- massive, homogeneous fabric		195 40 180		
112	34							
113			- SANDSTONE (150mm), light grey, silty, K3 hardness, fine grained, dry	- massive, homogeneous fabric	19.1			
114			- dark grey, coal patches, siltstone pockets - SILTSTONE, (50mm), light greyish brown, K7 hardness, calcareous stains	- slightly fractured, horizontal bedding		505 90	100	90
115	35		- dark grey, very silty, K3 to K4 hardness, dry		15.4	320		
116			- dark brownish grey, K4 hardness		17.1	75 40 40 95		
117			- SILTSTONE, (150mm), light greyish brown, K7 hardness, coal particles	- slightly fractured, some fissures	18.0	60 85		
118	36	BENTONITE	- light greyish green, clay lenses, K1 hardness, high plasticity, damp		35.3			

EBA Engineering Consultants Ltd.	Drawing No. B-13	Sheet 4 of 5

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-12	

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
		BENTONITE	- as above			105		
-119-		CLAY SHALE	- dark brown to black, silty, K4 to K5 hardness, carbonaceous, coal lenses	- massive, homogeneous to fissile fabric		50 290 160	97	83
-120-						20 45		
			- dark brownish grey, silty, K5 hardness, coal specks		10.8	120 140		
	37			- massive, homogeneous fabric		30 70		
			END OF BOREHOLE (37.0 metres)			455		

EBA Engineering Consultants Ltd.

Drawing No. B-13

Sheet 5 of 5

Project GRIERSON HILL STABILIZATION STUDY	**Hole No.** 80-13
Location EDMONTON ALBERTA	**Surface Elevation** 659.0 (CITY)
Project Number 106-2672	**Completion Depth** 33.7 m
	Date Drilled August 14-16, 1980
	Logged By RRH (field); _____ (lab)
	Log Type Overburden/Rock Core
	Core Size 50 mm
	Drilling Contractor Mobile Augers
	Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
1		TOP SOIL	- dark brown to black, organic, damp, rootlets							
		SILT (FILL)	- dark brown, clay pockets, trace of sand, rootlets, organic streaks, damp to moist, mainly cohesionless							
2										
3	1	CLAY TILL (FILL)	- medium and dark brown, silty, some sand, hard, pebbles to 25 mm, pieces of brick, organic seams, rootlets, damp, cohesive							
4							21.1		>500	
5			- medium brown, light grey sand pockets, very stiff, coal pieces, damp						>500	
6	2					21	16.9			
7										
8			- dark brown, black organic bands, numerous pebbles, damp				26.3		210	
9										
	3	CLAY (FILL)	- medium brown, black organic silt pockets, very stiff, damp to moist, cohesive						200	
10										
11						22	26.2			
12										
13	4		- medium brown-grey, mottled, very silty, stiff, trace of sand, damp to moist, cohesive				28.9		190	
14									160	
15			- very stiff, coal particles, sand pockets, some pebbles							
16	5					15	27.0			
17										
		CLAY (FILL) TILL	- dark greyish brown, black organic silt seams, very stiff, calcareous, pebbles and coal specks, damp, cohesive							
18										
19	6						18.2		250	
20			- very silty, very stiff, pebbles to 25 mm, organics, mainly cohesive			25				
21										
22										
23	7									
24			- dark greyish brown, black organic seams, silty, stiff, piece of concrete, nail, damp				18.3		300	
25			- very stiff, pebbles to 25 mm			19	14.5			
26	8									
27										
28			- sand pockets, organic layers, very stiff, cohesive							
29	9	SILT (FILL)	- black, extremely organic, wood fibres, damp, mainly cohesionless				20.9		200	

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-13
Surface Elevation	659.0 m
Completion Depth	33.7 m
Date Drilled	August 14-16, 1980
Logged By	RRH (field); (lab)
Log Type	Overburden/Rock Core
Core Size	50 mm
Drilling Contractor	Mobile Augers
Drilling Method	B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		SILT (FILL)	- coal particles, cinders, damp, cohesionless - pieces of brick			33	32.3			
31										
32	10									
33			- CINDERS, medium and dark brown, silty, angular fragments, piece of plastic, wet, cohesionless, free water in borehole at 10.0 m				36.5			
34										
35		CLAY (FILL)	- medium brown, black organic silt pockets, very stiff, wood fibres, damp to moist, mainly cohesive			16	30.6			
36	11									
37		CLAY (FILL)	- medium to dark greyish brown, silty, very stiff, trace of pebbles and coal specks, wood fibres, some organics, damp, cohesive							
38			- medium brown and grey, mottled, very silty, high plasticity, calcareous pockets, moist, cohesive				34.5		2.7	
39	12									
40			- thin organic seams, pieces of weathered concrete			19	30.7			
41										
42	13									
43			- trace of pebbles, damp to moist - SILT, (200mm), black, organic, pieces of wood and brick, moist, mainly cohesionless				27.7		3.1	
44										
45			- medium brown and grey, very silty, very stiff, silt lenses, pebbles to 25 mm			19	31.2			
46	14									
47			- SILT, (600mm), dark grey to black, clayey, very stiff, organics, wood fibres, damp, mainly cohesive				28.0		2.9	
48										
49	15									
50			- medium brown and grey, mottled, very silty, very stiff, some organics, damp, cohesive			21	27.2			
51										
52	16									
53			- CLAY TILL, (200mm), medium to dark grey and brown, silty, some sand, very stiff, piece of weathered concrete, organic streaks, pebbles to 25 mm, damp, cohesive				21.4		2.9	
54										
55	17					23	27.8			
56										
57			- SILT, (200mm), light to medium grey, some sand, stiff, damp to moist, mainly cohesionless						1.9	
58	18									

Project: GRIERSON HILL STABILIZATION STUDY
Location: EDMONTON ALBERTA
Project Number: 106-2672

Hole No. 80-13 | Log Type: Overburden/Rock Core
Surface Elevation: 659.0 m (CITY) | Core Size: 50 mm
Completion Depth: 33.7 m | Drilling Contractor: Mobile Augers
Date Drilled: August 14-16, 1980 | Drilling Method: B61 Hollow Stem/ Wireline Coring
Logged By: RRH (field); _____ (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
-60		CLAY	- SILT, (300mm), grey and black, extremely organic, damp, mainly cohesionless						2.7	
-61			- medium brown, silty, very stiff, high plasticity, moist, cohesive			20	20.7			
-62	19									
-63			- SILT, (100mm), medium grey, some sand, very stiff, trace of organics, damp to moist, mainly cohesionless				25.9		2.7	
-64										
-65	20		- SILT, (250mm), medium grey, black organic bands, hard, damp, cohesive			31	23.1			
-66			- medium brown - as above							
-67										
-68			- medium brown, grey silt lenses, very stiff, sand pockets, damp, cohesive				26.1		3.7	
-69	21									
-70			- dark grey and black, very stiff, extremely organic lenses, pieces of wood, rootlets, damp							
-71			- dark grey and black horizontal bedding, damp, cohesive			24	24.1			
-72	22									
-73			- PEAT, dark brown, silty, clayey, extremely organic, very stiff, wood fibres and rootlets, damp				32.0		3.0	
-74										
-75	23		- SAND, light to medium brown, very silty, dense, fine grained, damp, cohesionless			42	19.4			
-76		CLAY SHALE	- dark brown to black, silty, carbonaceous, K3 hardness, slightly fractured, fissile fabric, dry to damp							
-77										
-78		COAL	- black, highly fractured, K5 hardness, blocky (5mm)							
	24		- dark brown - as above			42 (150mm)				
-79		CLAY SHALE	- dark brownish grey, silty, K3 hardness, slightly fractured START ROCK CORING				23.6			
-80										

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-81		CLAY SHALE	- dark brownish grey, silty, K3 to K4 hardness, coal stringers, dry	- massive, homogeneous fabric				
-82	25				18.7			
-83							49	49
-84			- medium to dark grey, K4 hardness, slickensided fracture planes at 80° to horizontal	- massive, homogeneous fabric, slightly fissured		670		
-85	26							

EBA Engineering Consultants Ltd.

Drawing No. B-14

Project	Project No. 106-2672	Hole No. 80-13	Depth Interval

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
86			- light brown siltstone pocket		13.5			
			- SANDSTONE (300mm), light grey, very silty, fine grained, K3 hardness, dry to damp	- massive, homogeneous fabric	13.1			
87							100	100
			- medium to dark grey, silty, K4 hardness	- massive, blocky		975		
88	27		- SILTSTONE (200mm), light brownish grey, K6 hardness, coal stringers	- massive, homogeneous microstructure with some fissures		395		
89								
90								
91							38	38
	28		- medium to dark grey, silty, K3 to K4 hardness, coal pockets	- massive, blocky microstructure (10-15mm)	15.8			
92		SANDSTONE	- light grey, silty, fine to medium grained, K5 hardness, grey clay shale laminations	- massive, homogeneous fabric with horizontal shale laminations				
93					7.2	520		
94			- coal stringers			300	100	100
	29				11.8			
95								
96								
97		CLAY SHALE	- dark grey, silty, K4 hardness, coal particles	- massive, homogeneous fabric		95	71	64
98	30				15.0	170 605		
99			- dark brownish grey, K1 to K3 hardness, angular fragments, damp	- fractured, brecciated	14.1			
100			- K3 to K4 hardness - dark brown to black, K4 to K5 hardness, carbonaceous, coal particles	- massive, blocky microstructure (≈10mm)				
101	31	SANDSTONE	- light grey, very silty, K3 hardness, fine grained, grey clay shale laminations	- massive, homogeneous fabric, faint horizontal bedding			100	100
102					10.3	1370		
103			- K5 hardness, fine to medium grained, coal specks	- homogeneous fabric				
104	32				10.3		66	66
105						475		
106			- SILTSTONE, medium grey with light grey streaks, very fine grained, K3 to K4 hardness, dry (100mm)	- fractured, horizontal bedding		120		
107								
108	33		- K3 to K4 hardness, fine grained		11.5	25	71	67
109		COAL	- black, brittle, fragmented, K6 hardness, some gold streaks, wet	- highly fractured, blocky microstructure (25mm) to fissile		30 280		
110		CLAY SHALE	- dark brown to black, K4 to K5 hardness, carbonaceous, coal lenses	- massive, homogeneous to fissile fabric	23.6	135 240 260		
111	34		END OF BOREHOLE (33.7 metres)					
	35							
	36							

EBA Engineering Consultants Ltd.	Drawing No. B-14	Sheet 4 of 4

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672

Hole No.	80-14
Surface Elevation	659.0 m (CITY)
Completion Depth	35.1 m
Date Drilled	August 6, 1980
Logged By	RRH (field); (lab)
Log Type	Overburden/Rock Core
Core Size	50 mm
Drilling Contractor	Mobile Augers
Drilling Method	B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- black, organic, rootlets, damp							
1		SILT (FILL)	- medium to dark brown, some clay and sand, pieces of glass, coal particles, rootlets, damp, mainly cohesionless							
2										
3	1	CLAY (FILL)	- medium to dark brown, silty, sandy, hard, pebbles to 20 mm, pieces of brick, damp, cohesive							
4							15.0		>500	
5		CLAY TILL (FILL)	- medium to dark brown, silty, sand pockets, hard, pebbles to 25 mm, damp, cohesive						>500	
6	2		- medium brown, stiff, medium plasticity, damp, cohesive			11	19.6			
7										
8			- dark greyish brown, stiff, low to medium plasticity, pieces of brick, calcareous, damp to moist, cohesive				24.6		180	
9	3		- sand and silt pockets, pieces of concrete						210	
10			- organic, piece of coal to 30 mm			11	25.2			
11										
12										
13	4	CLAY	- light to dark brown, sand lenses, stiff, medium to high plasticity, piece of steel, rootlets, moist, cohesive				27.2		290	
14										
15						12	28.7			
16	5									
17										
18			- light to medium brown, very silty, sand pockets, firm, organic silt pockets, moist, cohesive				32.6		80	
19										
20	6					11	32.0			
21										
22										
23	7									
24			- medium brown, very silty, sandy clay pockets, stiff, trace of pebbles, piece of asphalt, moist, cohesive				31.5		160	
25						13	33.5			
26	8									
27										
28			- light to medium brown, silty, stiff, pebbles to 5 mm, trace of organics, moist, cohesive				30.3		180	
29	9									

Project GRIERSON HILL STABILIZATION STUDY	**Hole No.** 80-14
Location EDMONTON ALBERTA	**Surface Elevation** 659.0 m (CITY)
Project Number 106-2672	**Completion Depth** 35.1 m
	Date Drilled August 6, 1980
	Logged By RRH (field); _____ (lab)
	Log Type Overburden/Rock Core
	Core Size 50 mm
	Drilling Contractor Mobile Augers
	Drilling Method B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m^3)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30		CLAY	- light to medium brown, silty, very stiff, organic pockets			19	28.8			
31										
32	10									
33			- medium brown, trace of organics, damp to moist, cohesive							
34		SILT	- dark grey to black, clayey, some sand, very stiff, organic, damp, mainly cohesive				27.6		200	
35			- black, sandy, clay pockets, trace of pebbles, damp			27	31.5			
36	11									
37		CLAY	- medium to dark grey, silty, hard, pebbles to 25 mm, damp, cohesive						410	
38			- light to medium brown, grey sand pockets, very stiff, damp, cohesive				24.8		280	
39	12									
40			- light brown, silty clay pockets, very stiff, damp, cohesive			19	24.1			
41			- greyish brown, black organic silt layers, cohesive							
42	13	CLAY (TILL)	- medium to dark brown, sandy, silty, very stiff,							
43			pebbles to 20 mm, pieces of coal, low to medium plasticity, damp, cohesive				20.3		310	
44										
45			- pebbles to 15 mm, low plasticity			37	14.6			
46	14									
47		CLAY SHALE	- dark brownish grey, silty, K1 to K3 hardness, brecciated, damp							
48										
49	15		- dark grey to black, carbonaceous, K3 hardness, blocky				25.7			
50						40	21.8			
51										
52	16									
53			- dark grey, silty, K3 hardness, grey sandstone pockets, faint horizontal bedding				24.1		>500	
54										
55		SANDSTONE	- light grey, silty, K3 hardness, fine grained, homogeneous			52	16.0			
56	17		START ROCK CORING							
	18									

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-14	17.0-27.0 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
56		SANDSTONE	- light grey, silty, K2 hardness, fine grained, grey clay pockets	- massive, homogeneous fabric				
57			- medium brown soft silt lens, rootlets, moist			75	67	57
58						180		
59	18					45		
						180		
60			- K2 hardness, grey clay laminations	- massive, homogeneous fabric with some horizontal bedding				
61			- light brown iron stains				100	100
62	19		- K4 to K5 hardness, coal stringers	- massive, horizontal bedding				
63						895		
64			- SILTSTONE, light brownish grey, K2 hardness, very fine grained, coal stringers			325		
65	20		- light grey, very silty, K2 hardness, fine grained, coal stringers, clay laminations, siltstone inclusions	- massive, homogeneous fabric with bedding planes at 20° to horizontal		555	91	91
66								
67							0	0
68	21							
69			- light grey, K1 to K2 hardness, friable, fine grained, clay laminations	- massive				
70			- CLAY SHALE (100mm), brownish grey, K2 to K3 hardness	- massive, blocky microstructure (3-5 mm)		70	87	80
71						730		
72	22							
73							26	26
74		CLAY SHALE	- dark brownish grey, silty, K3 hardness	- massive, blocky microstructure (3-5 mm)		130		
75	23							
76				- brecciated zone (100 mm)		190		
77		COAL	- black, brittle, K6 hardness, wet fracture planes	- fractured, blocky (<10mm)			87	85
78		CLAY SHALE	- dark brownish grey, silty, K3 to K4 hardness, coal particles	- massive, homogeneous fabric with faint horizontal bedding		120 635 155		
79	24		- medium to dark grey, K4 hardness, slightly bentonitic, high plasticity	- massive, blocky microstructure		15		
80			- SILTSTONE, (150mm), light brownish grey, K7 hardness	- fractured irregular				
81			- siltstone bands	- faint horizontal bedding			22	17
82	25							
83						230		
84			- dark grey, silty, K3 to K4 hardness, siltstone inclusions	- massive, horizontal to slightly inclined bedding		75		
85	26							
86			- SILTSTONE, (150mm), medium grey, some clay and sand, K3 hardness coal stringers	- massive, horizontal bedding				
87			- K4 to K5 hardness, coal lenses			810	100	100
88			- thin coal lens (25mm), blocky to powdery	- massive, homogeneous fabric with fine horizontal bedding		275 285		
	27							

EBA Engineering Consultants Ltd.	Drawing No. B-15	Sheet 3 of 4

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-14	

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
89		INTERBEDDED SANDSTONE AND SILTSTONE	- light grey sandstone, silty, K4 hardness/medium grey siltstone K4 to K5 hardness	- massive, horizontal bedding			100	100
91	28					1370		
92			- dark grey to black, carbonaceous zone (75 mm)					
93			- CLAY SHALE, (150mm), brownish grey, K4 to K5 hardness					
94							101	101
95	29		- thin coal lens					
96		CLAY SHALE	- dark brownish grey, silty, K4 to K5 hardness, trace of bentonite	- massive, homogeneous fabric				
97						1380		
98	30			- some slickensided fracture planes				
99						225		
100			- SILTSTONE, (75mm), medium brown, K6 hardness			160 75	94	82
		SANDSTONE	- light grey, silty, K5 hardness, fine grained, coal lenses	- massive, homogeneous fabric		125		
101	31		- fine to medium grained			80		
102						620		
103								
104							0	
105	32		(no recovery below 31.1 m)					
106							0	
107								
108	33							
109								
110								
111	34						0	
112								
113								
114								
115	35							
			END OF BOREHOLE (35.1 metres)					

EBA Engineering Consultants Ltd.	Drawing No. B-15	Sheet 4 of 4

Project	GRIERSON HILL STABILIZATION STUDY
Location	EDMONTON ALBERTA
Project Number	106-2672
Hole No.	80-15
Surface Elevation	656.3 m (CITY)
Completion Depth	32.3 m
Date Drilled	August 12-13, 1980
Logged By	RRH (field); _____ (lab)
Log Type	Overburden/Rock Core
Core Size	50 mm
Drilling Contractor	Mobile Augers
Drilling Method	B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
		TOP SOIL	- dark brown to black, organic, rootlets, dry to damp							
1		SILT (FILL)	- dark brown, some clay and sand, piece of glass, trace of rootlets, damp, mainly cohesionless							
2										
3	1		- piece of wood				18.0		>500	
4			- CLAY, (100mm), medium brown-grey, silty, hard, pieces of coal and bricks, rootlets, dry to damp							
5			- SAND, (375mm), light brown, silty, pieces of coal and brick, rootlets, dry, cohesionless				8.3			
6	2	CLAY (FILL)	- medium brown, silty, firm, pebbles to 5 mm, pieces of glass, rootlets, dry to damp, cohesive			6				
7										
8			- medium to dark brown, silty, sandy, very stiff				21.8		260	
9	3								250	
10			- SAND, (450mm), dark brown, silty, some clay, pieces of coal, steel and wood, trace of pebbles, dry to damp, cohesionless			4	22.0			
11										
12										
13	4									
14		SAND (FILL)	- dark brown, silty, fine grained, pieces of glass and coal, pebbles, dry to damp, cohesionless				15.7			
15										
16	5		- loose			6	23.0			
17										
18		CLAY (FILL)	- SILT, (450mm), dark brown to black, organic, stiff, pieces of brick, damp, mainly cohesionless							
19	6		- dark brown to black, silty, sandy, stiff, organics, trace of rootlets				48.5		160	
20						9	36.8			
21										
22	7									
23			- grey pockets, very stiff, pieces of ceramics, moist, cohesive							
24							28.3		240	
25			- brownish grey, very sandy, stiff, slightly organic, piece of brick			7				
26	8									
27										
28			- stiff, pieces of wood and glass, trace of rootlets				36.9		180	
29	9		- large pieces of brick							

Project: GRIERSON HILL STABILIZATION STUDY	Hole No.: 80-15
Location: EDMONTON, ALBERTA	Surface Elevation: 656.3 m (CITY)
Project Number: 106-2672	Completion Depth: 32.3 m
	Date Drilled: August 12-13, 1980
	Logged By: RRH (field); (lab)
	Log Type: Overburden/Rock Core
	Core Size: 50 mm
	Drilling Contractor: Mobile Augers
	Drilling Method: B61 Hollow Stem/ Wireline Coring

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
30			- wet cinders, pieces of coal, cohesionless - grey, stiff, medium plasticity, slightly organic, damp to moist, cohesive			10	35.4			
31										
32	10									
33			- SILT, (50mm), black, extremely organic, rootlets, pieces of brick and wood, damp to moist							
34		CLAY	- medium greyish brown, silty, very stiff, pieces of coal, medium to high plasticity, moist				32.7		210	
35						16	28.1			
36	11									
37										
38			- high plasticity - brownish grey, sandy, stiff, trace of pebbles, wet				29.0		180	
39	12		- ~~SAND, (125mm), brownsih grey, silty, clayey, medium grained, wet~~							
40			- brownish grey, clayey sand pockets, very stiff, medium plasticity, moist, mainly cohesive			22	18.6			
41										
42	13									
43			- SILT, medium grey, sand lenses, stiff, wet, mainly cohesive						160	
44			- silty, very stiff, low to medium plasticity, pebbles to 5mm, damp to moist, cohesive				19.3		270	
45						16				
46	14									
47		CLAY (TILL)	- dark grey and brown, silty, very stiff, pebbles to 5mm, low to medium plasticity, damp							
48							18.2		230	
49	15									
50			- dark brownish grey, pebbles to 2 mm							
51			- numerous coal lenses			21	22.3			
52	16									
53			- dark grey, silt and sand lenses, very stiff, pebbles to 25 mm, low to medium plasticity, damp to moist, cohesive				18.0		230	
54										
55	17					27				
56										
57										
58			- dark brownish grey, silty, hard, shale inclusions, damp				25.1		400	
	18	COAL	- black, highly fractured, blocky fragments(1mm), powdery, wet							

Project GRIERSON HILL STABILIZATION STUDY	**Hole No.** 80-15 **Log Type** Overburden/Rock Core
Location EDMONTON ALBERTA	**Surface Elevation** 656.3 m (CITY) **Core Size** 50 mm
Project Number 106-2672	**Completion Depth** 32.3 m **Drilling Contractor** Mobile Augers
	Date Drilled August 12-13, 1980 **Drilling Method** B61 Hollow Stem/ Wireline Coring
	Logged By RRH (field); _____ (lab)

OVERBURDEN SAMPLING LOG

Depth ft.	Depth m.	Lithologic Units	Soil Description	Unified Soil Classification	Sample Type	SPT N Value (blows/foot)	Moisture Content (%)	Wet Unit Weight (KN/m³)	Pocket Pen. Strength (KPa)	Undrained Compressive Strength (KPa)
-60		CLAY SHALE	- medium to dark grey, silty, K1 to K2 hardness, coal particles, massive, brecciated			41	21.8			
-61										
-62	19									
-63			- interbedded sandstone layers, thin organic seams, massive, horizontal bedding				21.3			
-64										
-65	20	SANDSTONE	- light grey, silty, K1 hardness, fine to medium grained, massive, homogeneous			33	19.8			
-66										
-67		CLAY SHALE	- medium to dark grey, silty, K1 to K2 hardness							
-68	21		- dark brown to black, K1 to K2 hardness, carbonaceous, coal lenses, fissile				30.6			
-69		COAL	- black, highly fractured, blocky fragments (2-5mm), K6 hardness, wet			40 (100mm)	56.4			
-70		CLAY SHALE								
-71										
-72	22									
-73			- medium grey, silty, K1 to K2 hardness, fractured, brecciated, dry			75 (125mm)	17.3			
-74			START ROCK CORING							

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-75	23	INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- CLAY SHALE, medium to dark grey, K1 to K2 hardness, damp to moist	- massive, brecciated				
-76			- SANDSTONE, light grey, silty, K3 hardness, fine grained	- massive, homogeneous fabric	13.6		99	99
-77			- CLAY SHALE, dark grey, K3 hardness		17.5	900		
-78	24		- SILTSTONE, medium grey, K3 hardness			460		
			- thin slickensided clay shale lens	- massive, fractured				
-79			- light grey sandstone lenses					
-80			- CLAY SHALE, dark brownish grey, silty, K3 to K4 hardness	- massive, blocky microstructure			101	101
-81					14.8			
-82	25					1380		
-83			- thin beds of siltstone and sandstone, K3 hardness		13.4			
-84			- SILTSTONE, medium grey, K3 hardness, coal stringers		14.0			
-85	26		- CLAY SHALE, dark grey, K3toK4 hardness	- massive, irregular				

Project	Project No.	Hole No.	Depth Interval
GRIERSON HILL STABILIZATION STUDY	106-2672	80-15	26.0-32.3 m

ROCK CORE LOG

Depth ft.	Depth m.	Lithologic Units	Description	Structural Features	Moisture Content (%)	Core Length (mm)	Recovery (%)	RQD (%)
-86		INTERBEDDED CLAY SHALE SANDSTONE AND SILTSTONE	- thin beds of siltstone and sandstone, K3 to K4 hardness, coal stringers	- massive, horizontal bedding	14.5	1355	99	99
-87			- SANDSTONE, light grey, K4 hardness, medium grained, clay laminations	- massive, homogeneous fabric	13.2			
-88	27							
-89		CLAY SHALE	- dark grey, silty, K3 to K4 hardness, coal specks	- massive, homogeneous fabric with some slickensided fracture planes	14.3	90 35	97	84
-90						540		
-91			- dark brown to black, silty, K5 hardness, carbonaceous, coal lenses	- irregular, blocky microstructure, massive, homogeneous		210		
-92	28				15.1	55		
		SANDSTONE	- medium greyish brown, silty, K5 hardness, fine grained, coal streaks	- massive, faint horizontal bedding	12.6	400		
-93			- light grey, K3 to K4 hardness, fine to medium grained					
-94								
-95	29						91	91
-96					10.4	1240		
-97			- numerous coal laminations					
-98	30		- SILTSTONE, medium grey, K4 hardness - CLAY SHALE, dark brown to black, K4 to K5 hardness, carbonaceous, coal lenses	- massive, horizontal bedding	15.5			
-99				- massive, fissile fabric		510	95	82
		COAL	- black, brittle, K6 hardness, subangular fragments	- highly fractured, blocky (5 to 10 mm)		85 90		
-100					22.8	140		
-101		CLAY SHALE	- dark brown, carbonaceous zone - dark greenish brown bentonitic, K3 to K4 hardness	- massive, blocky microstructure		475		
	31	BENTONITE	- greenish grey, K2 hardness, coal stringers					
-102		INTERBEDDED CLAY SHALE SANDSTONE ANDSILTSTONE	- SILTSTONE, dark brownish grey, K3 to K4 hardness - SANDSTONE, light grey, K3 hardness, fine grained, bentonite bands - CLAY SHALE, dark brownish grey, silty, K4 hardness, coal particles	- massive, homogeneous fabric with horizontal bedding	21.1		100	97
-103						1155		
-104	32			- massive, homogeneous fabric	20.6	40		
-105			- siltstone inclusions, K6 hardness, calcareous stains			175		
-106			END OF BOREHOLE (32.3 metres)					

EBA Engineering Consultants Ltd.	Drawing No. B-16	Sheet 4 of 4

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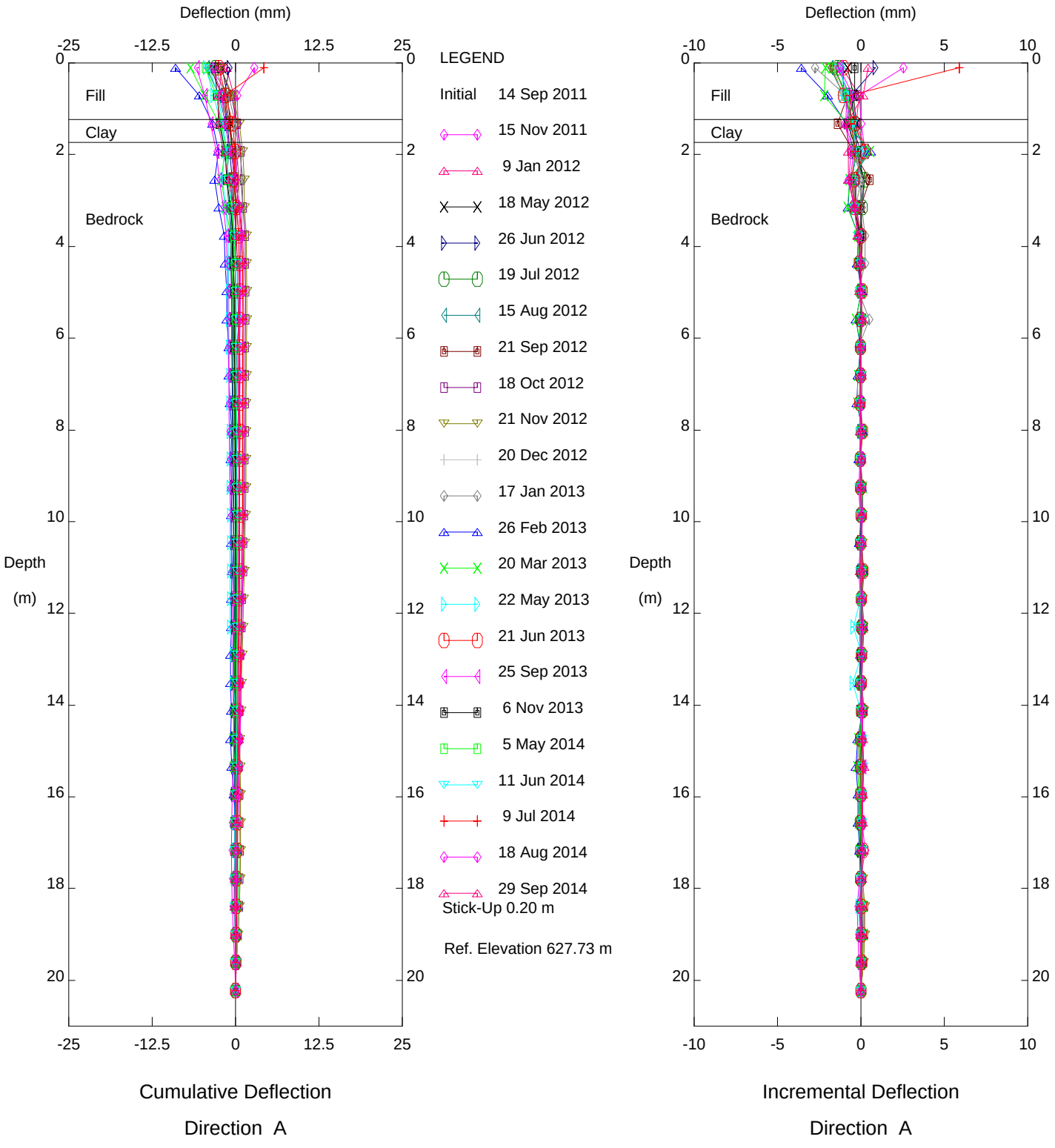
APPENDIX C

Plots of Slope Inclinometer Readings

Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI10-4

N5934378.81 E34644.45

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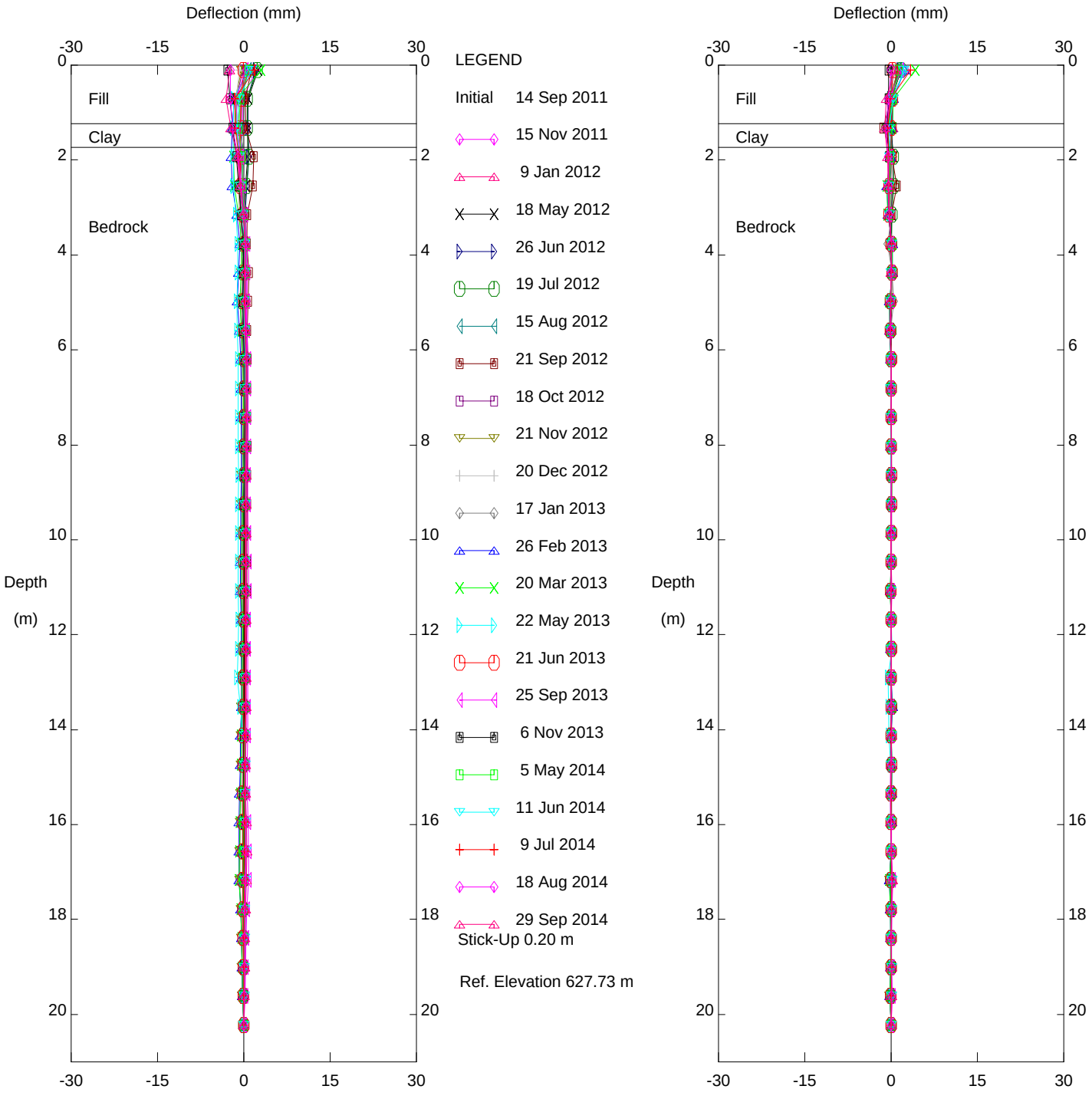
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SE LRT Extension, Inclinometer SI10-4

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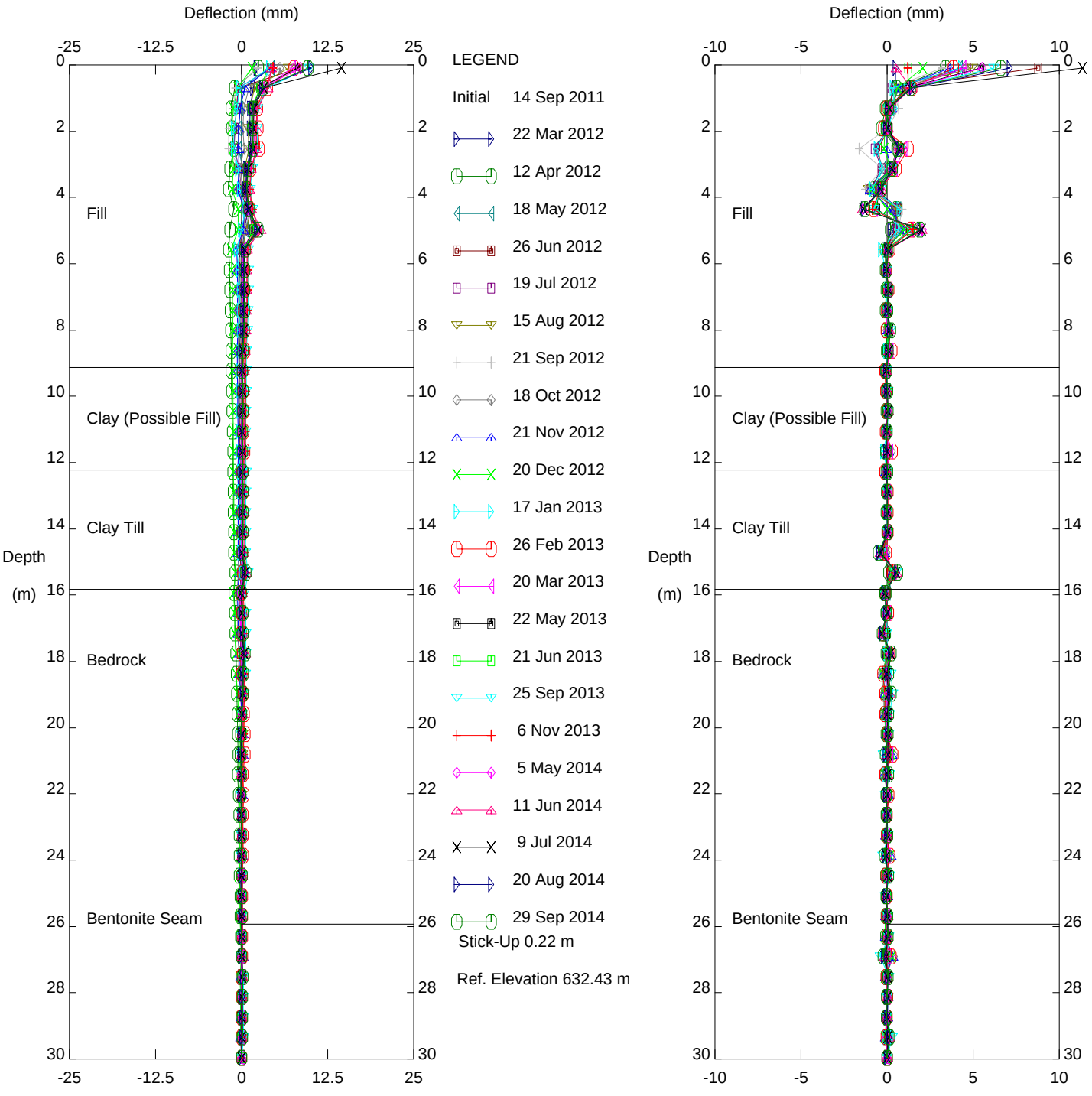

Cumulative Deflection

Direction A

Incremental Deflection

Direction A

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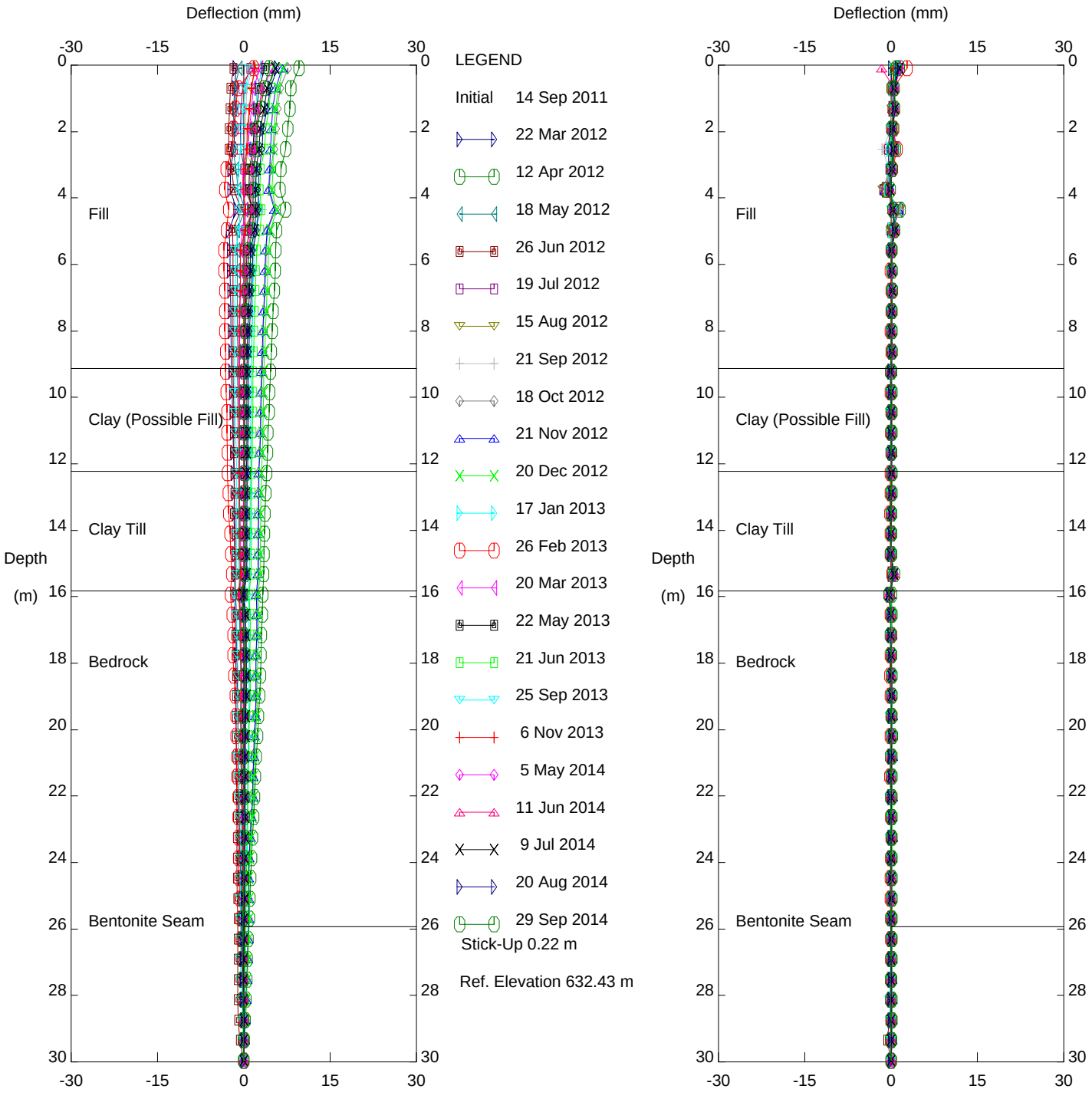

Cumulative Deflection

Direction B

Incremental Deflection

Direction B

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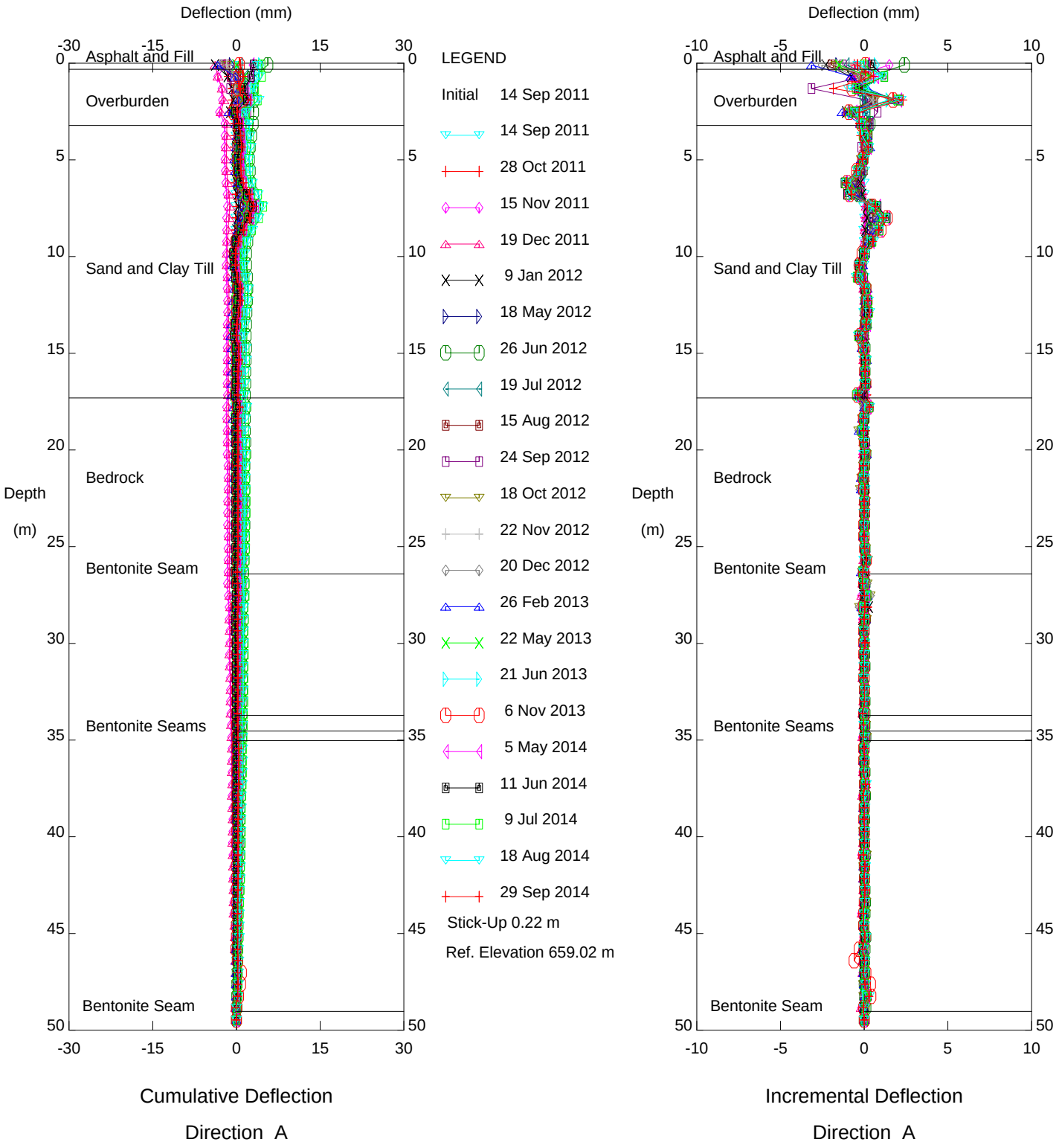

Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI 10-6

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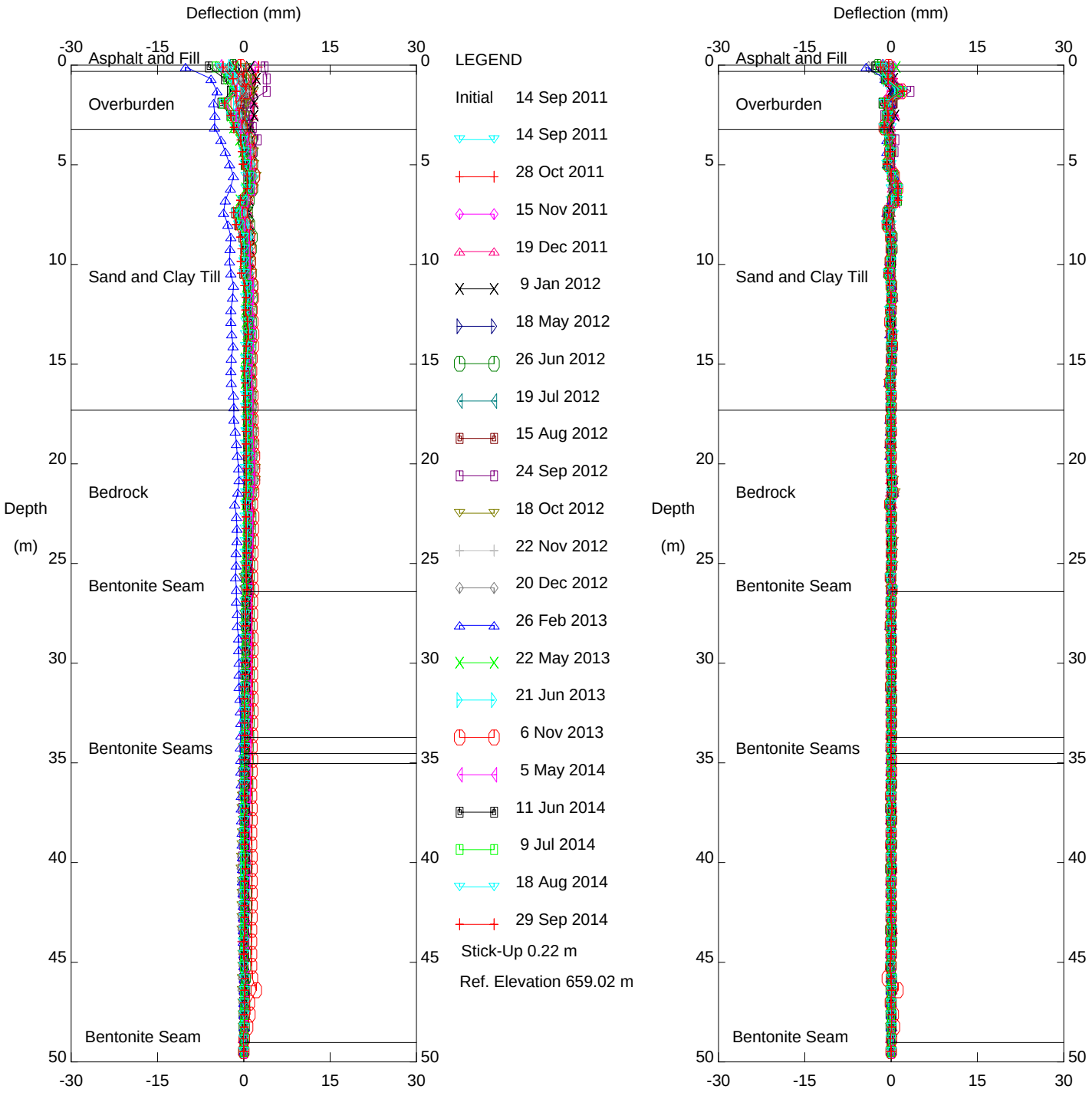
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SE LRT Extension, Inclinometer SI 10-6

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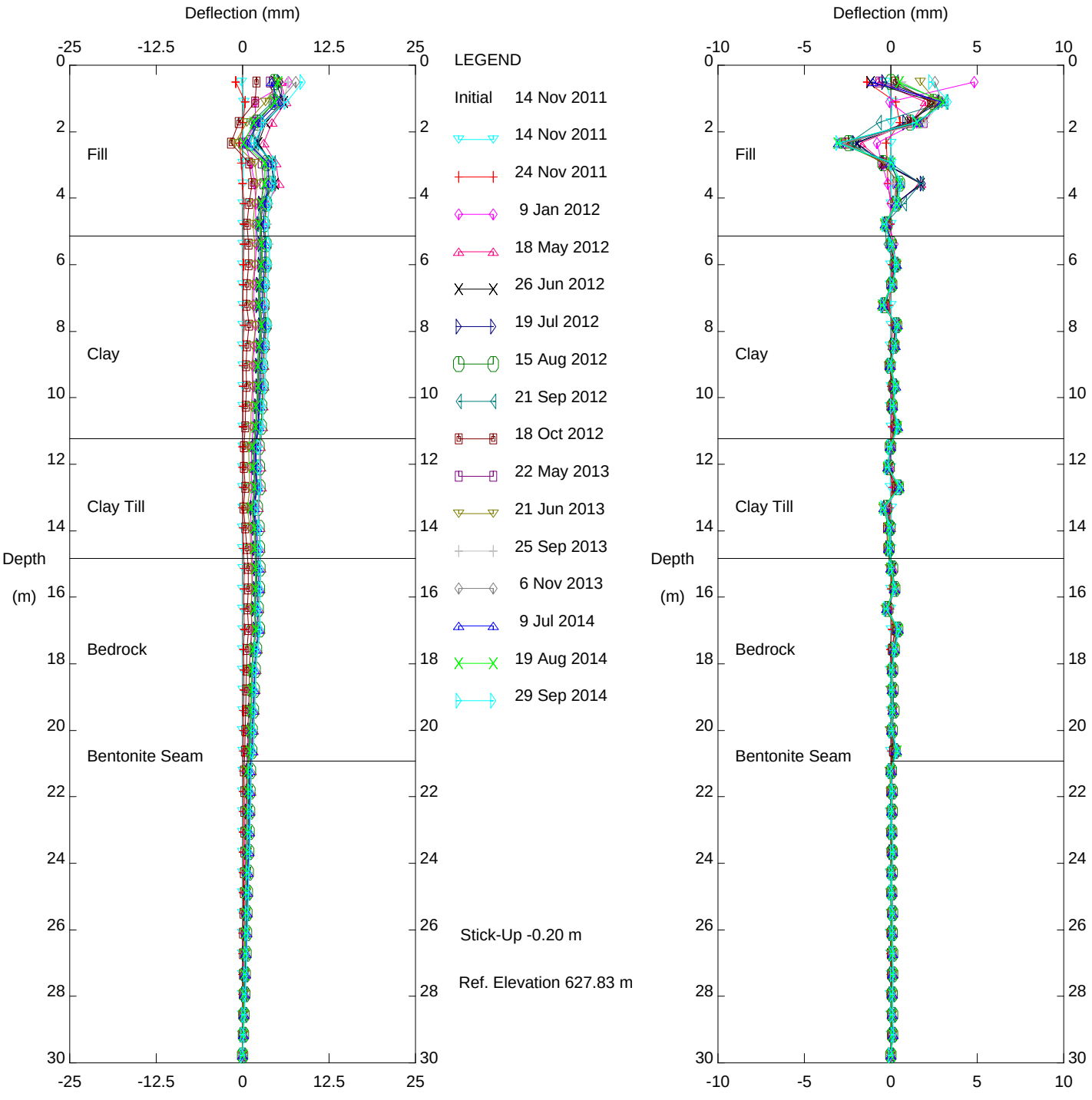

Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SE LRT Extension, Inclinometer SI 11-17

N5934386.82 E34678.91

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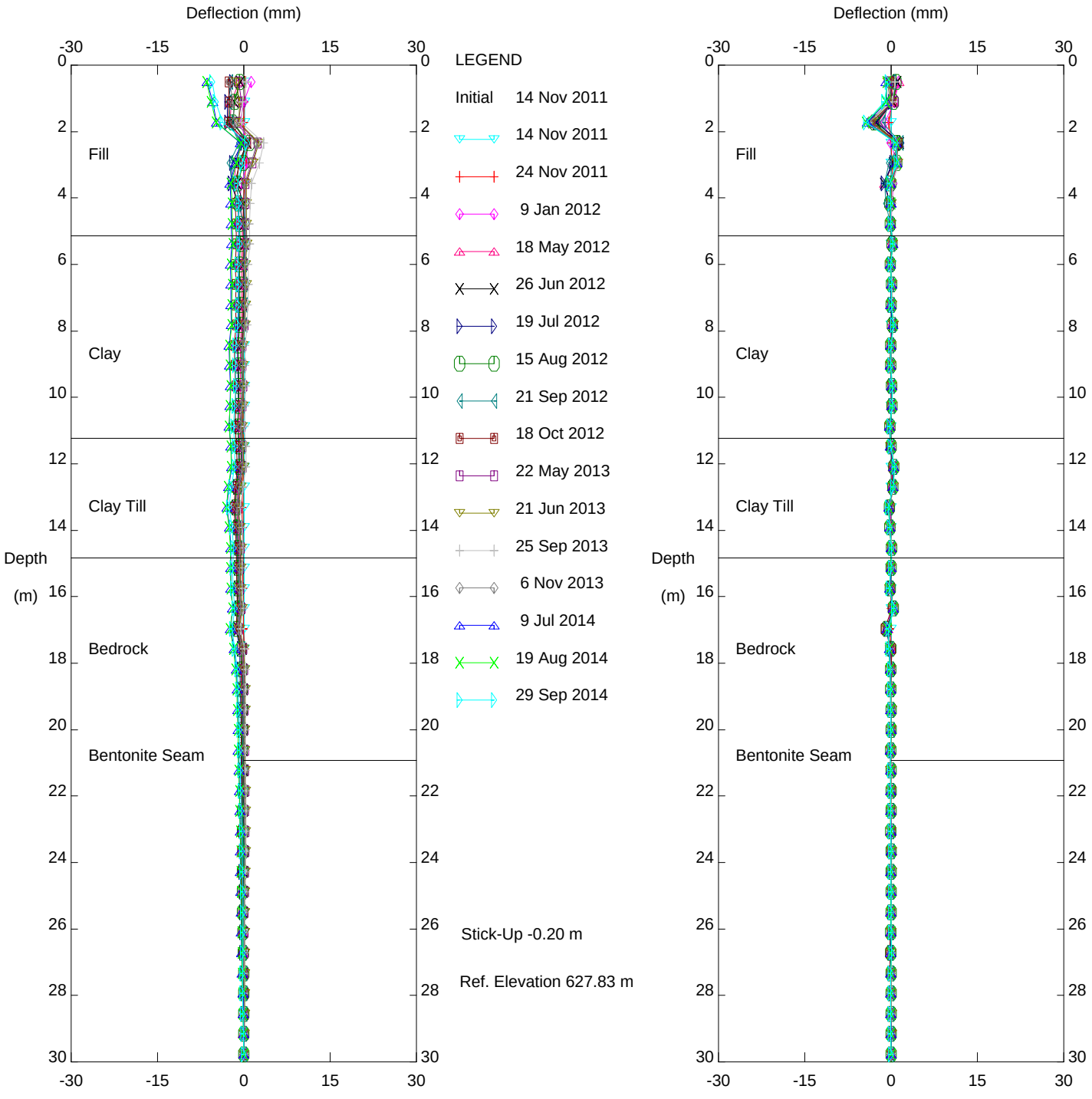
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

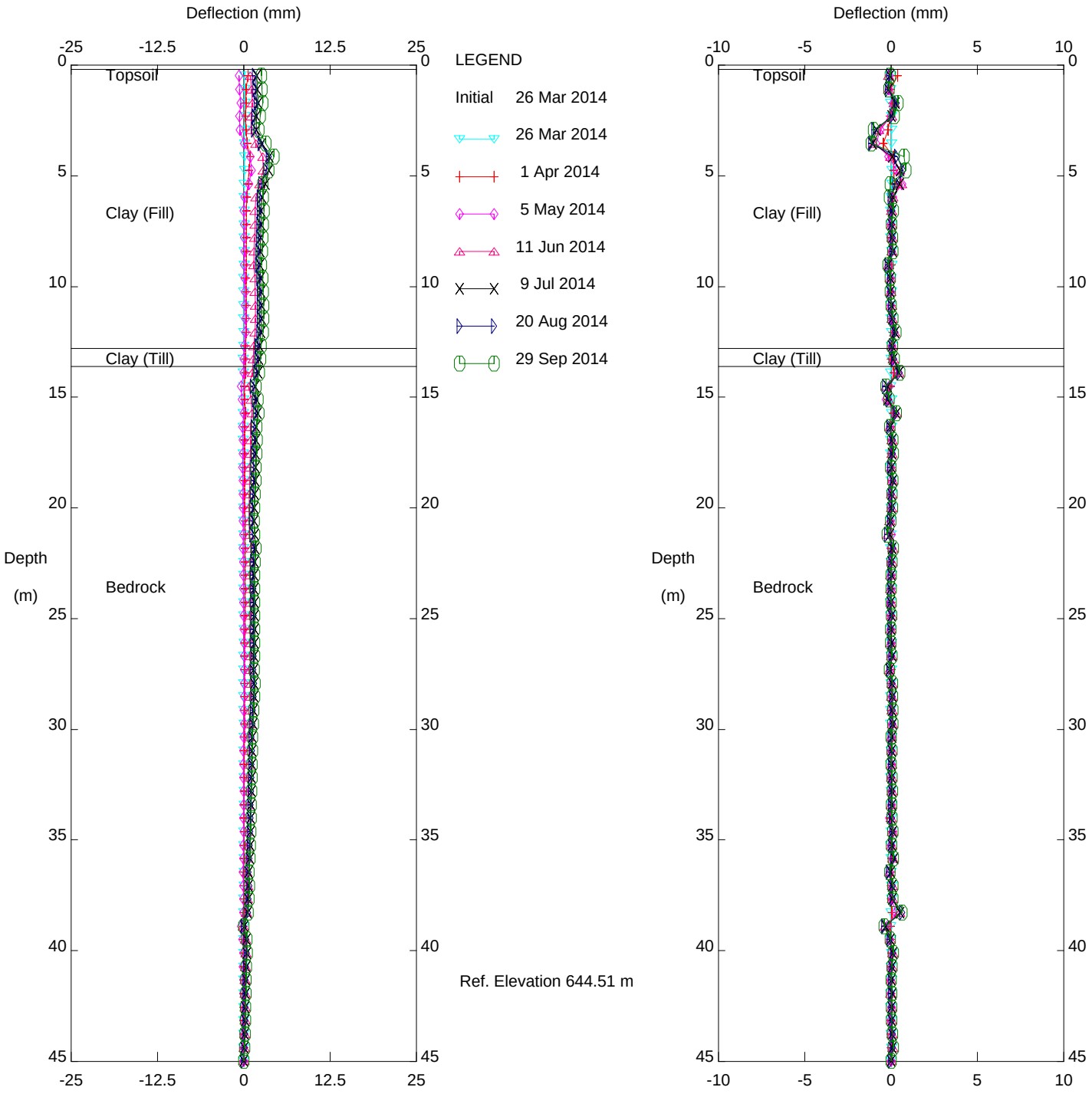
Incremental Deflection

Direction B

SE LRT Extension, Inclinometer SI 11-17

N5934386.82 E34678.91

Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SELRT, Inclinometer SI14-1

AECOM

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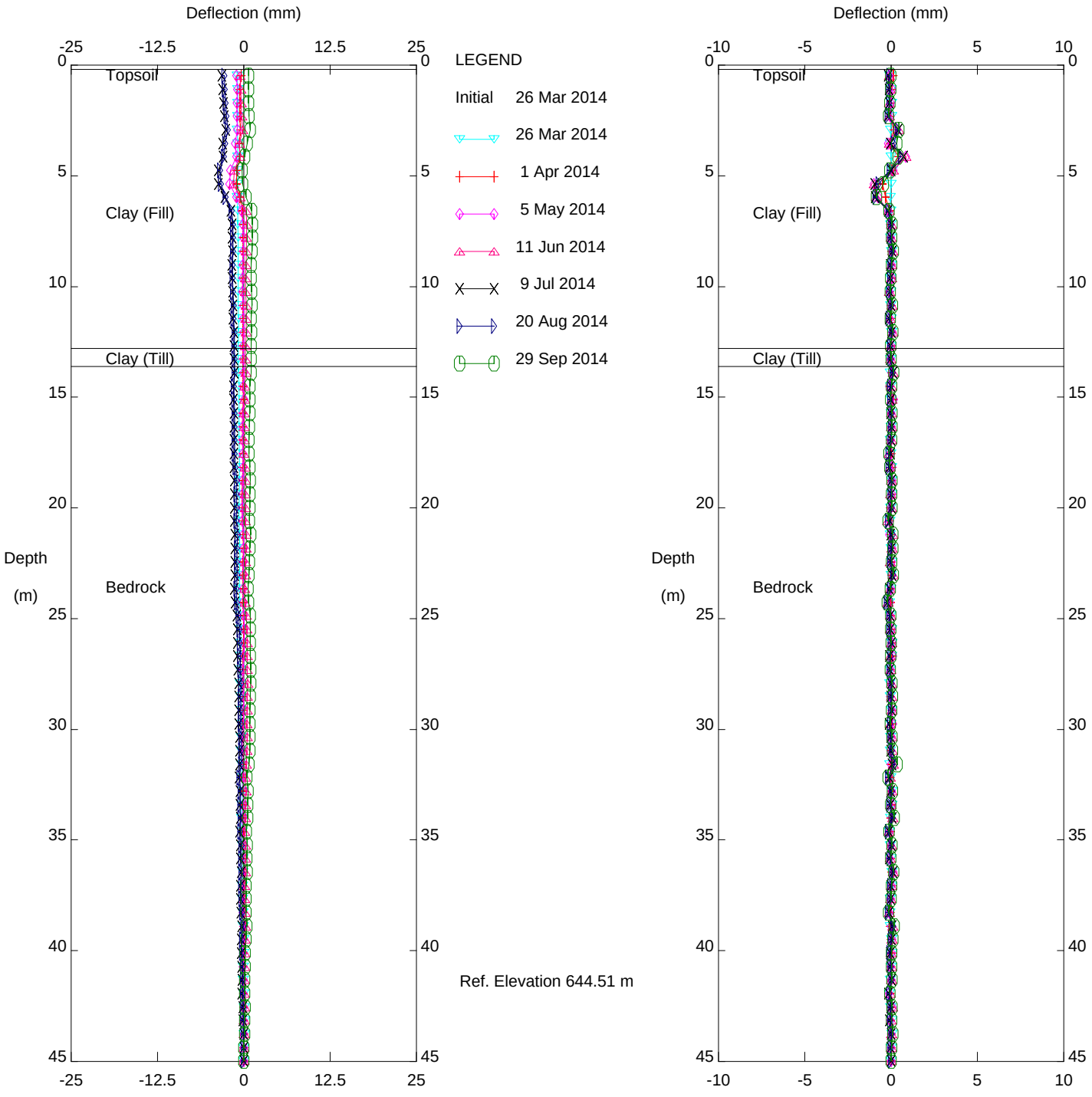
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SELRT, Inclinometer SI14-1

AECOM

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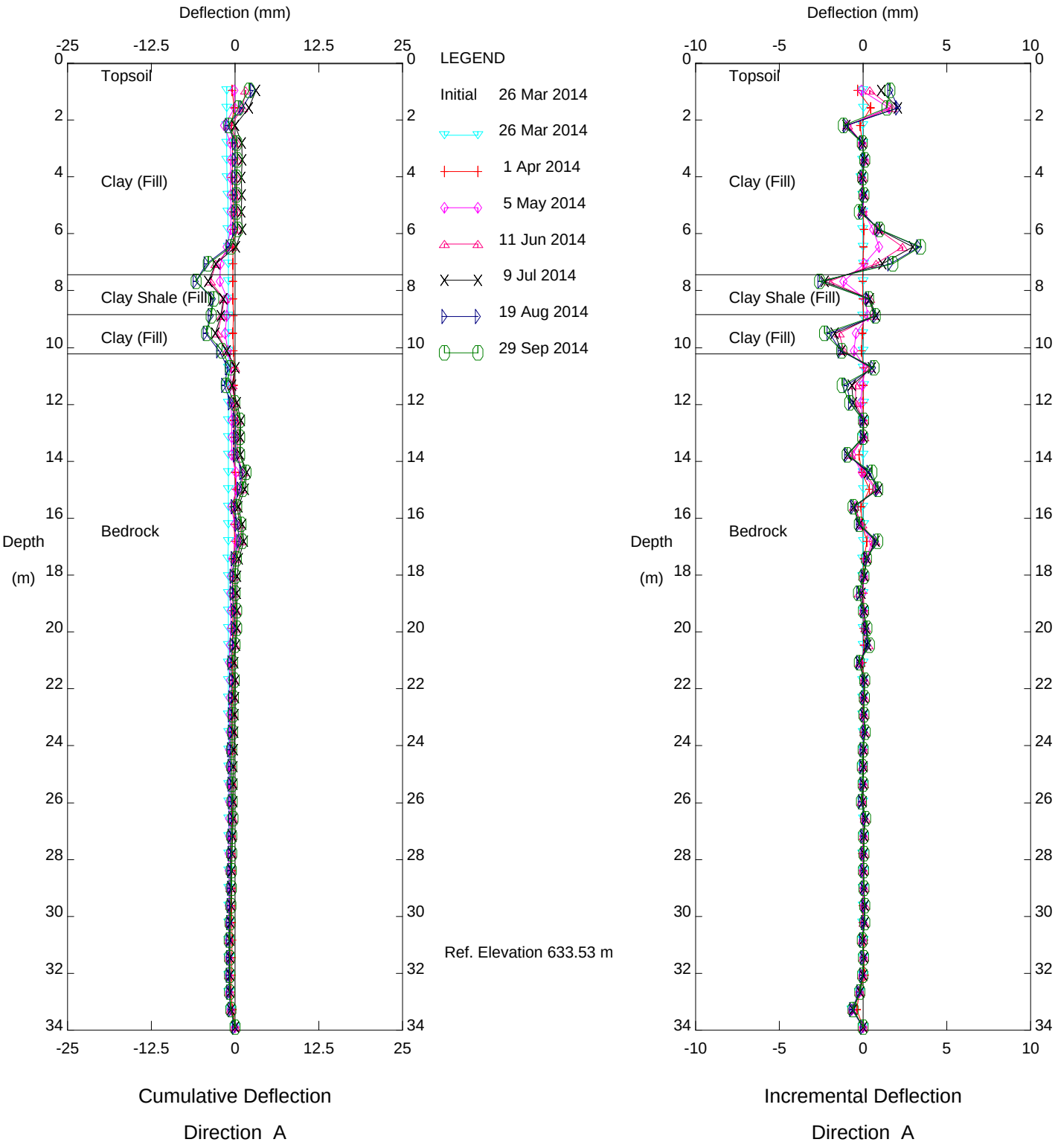
Thurber Engineering Ltd.



Cumulative Deflection

Direction A

Incremental Deflection

Direction A

SELRT, Inclinometer SI14-2

AECOM

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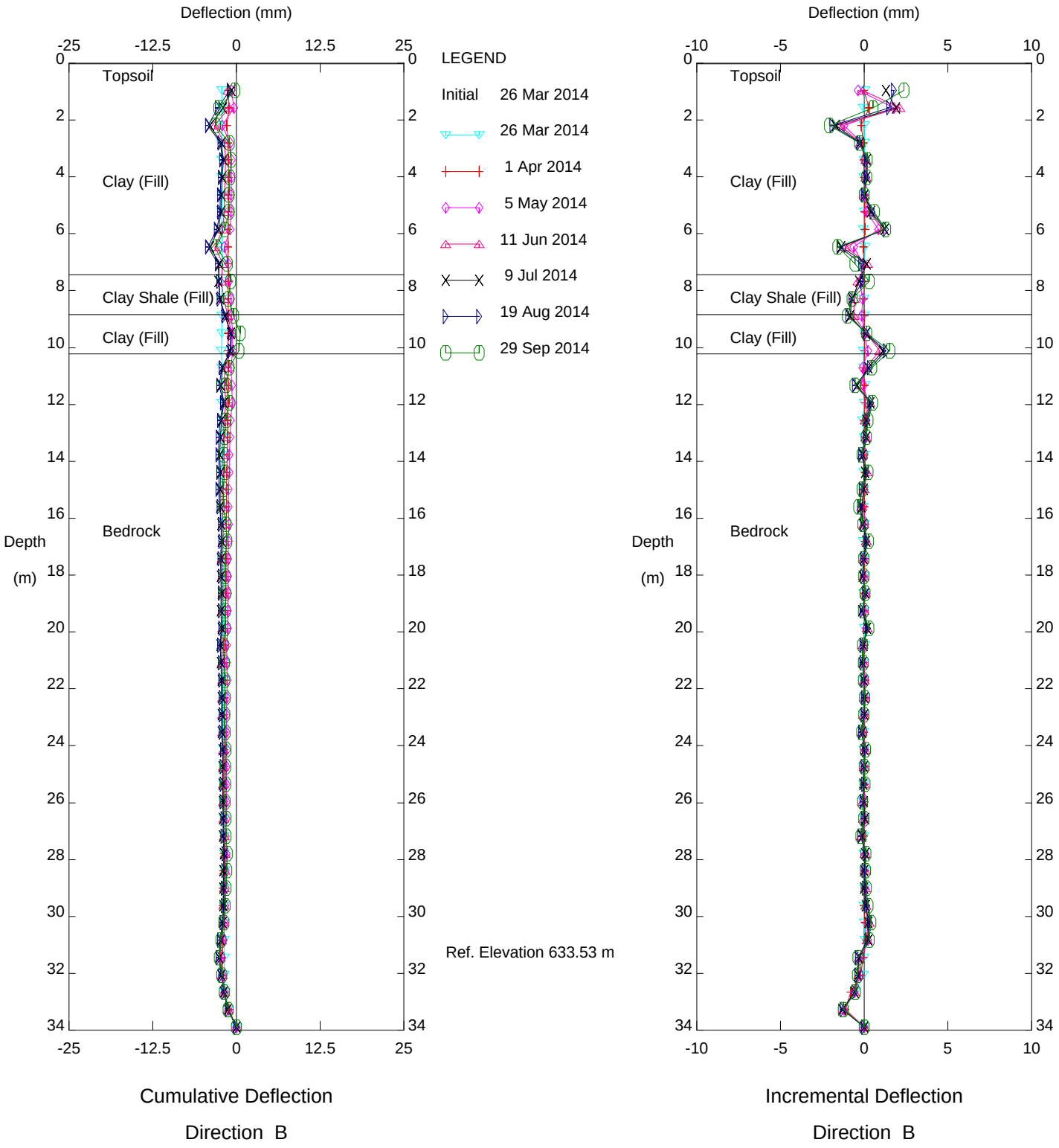
Thurber Engineering Ltd.



Cumulative Deflection

Direction B

Incremental Deflection

Direction B

SELRT, Inclinometer SI14-2

AECOM

H:\19\5438-68C Edm. SE LRT Extension - Geotech. Inv. - Slope\Instrument Readings\SI14-2.gtl

THURBER

APPENDIX D

Figures of Slope Stability Analyses

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

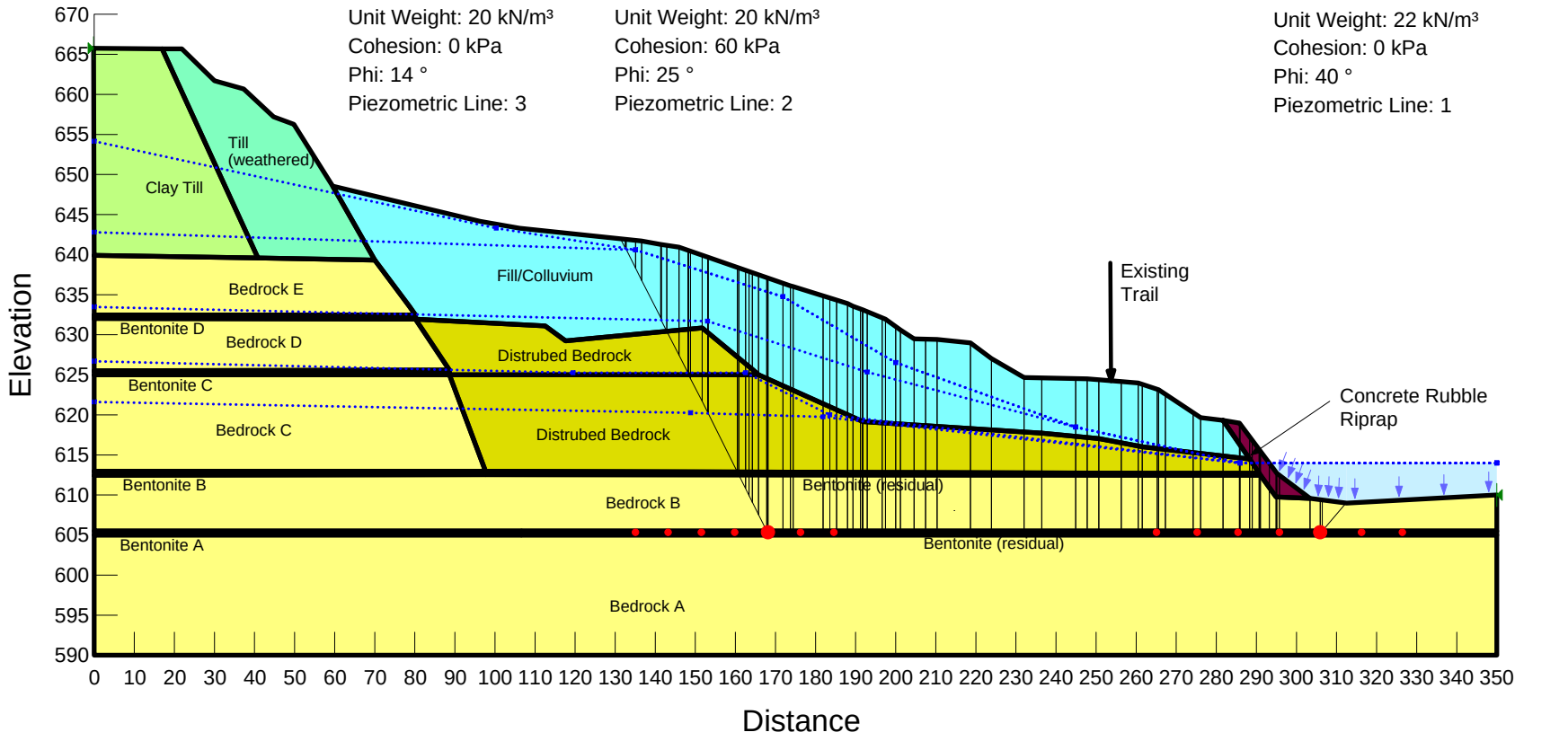
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D1

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

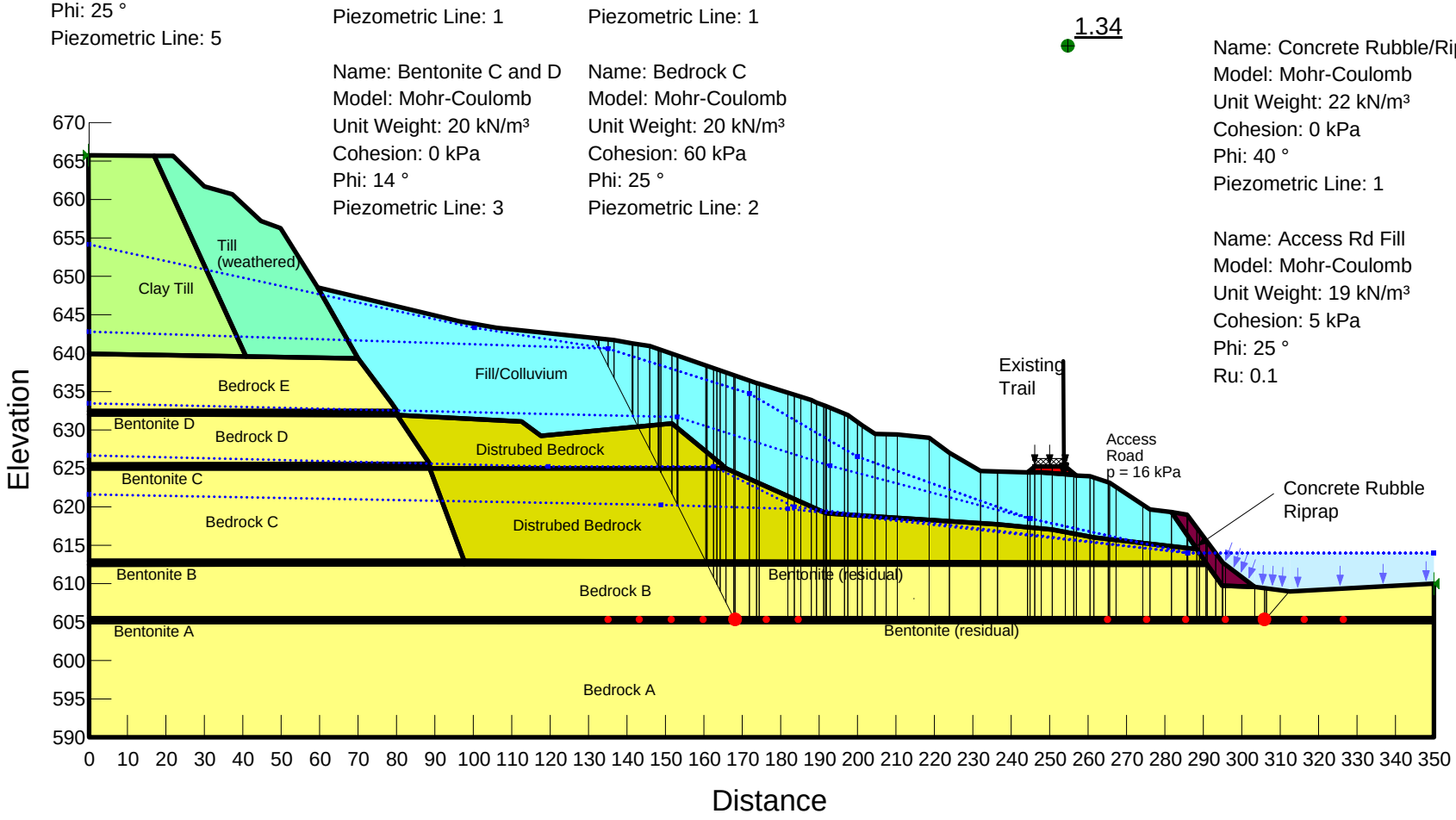
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:16:09 AM

SECTION A-A - FIGURE D2

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

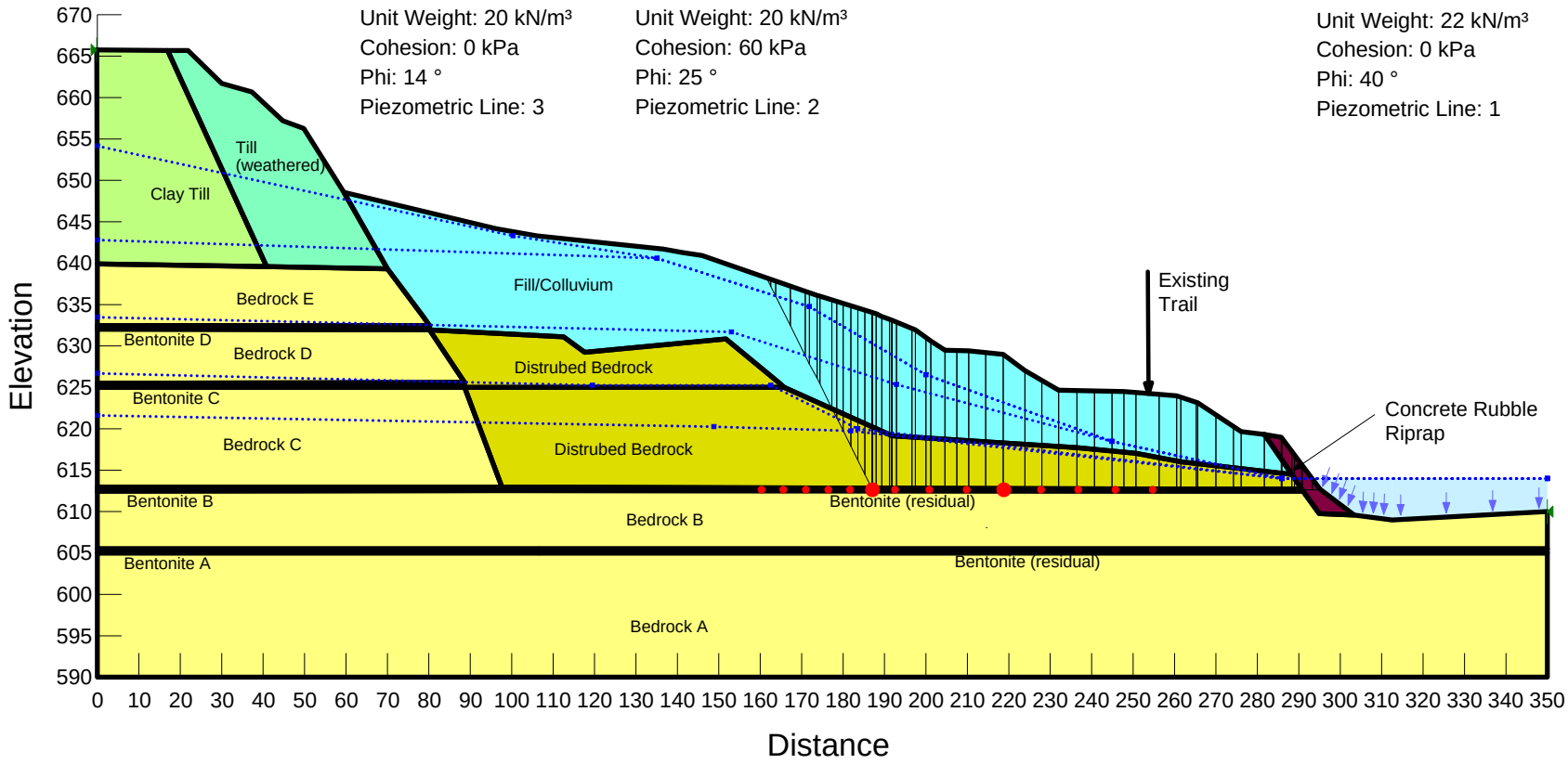
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

1.23

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D3

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

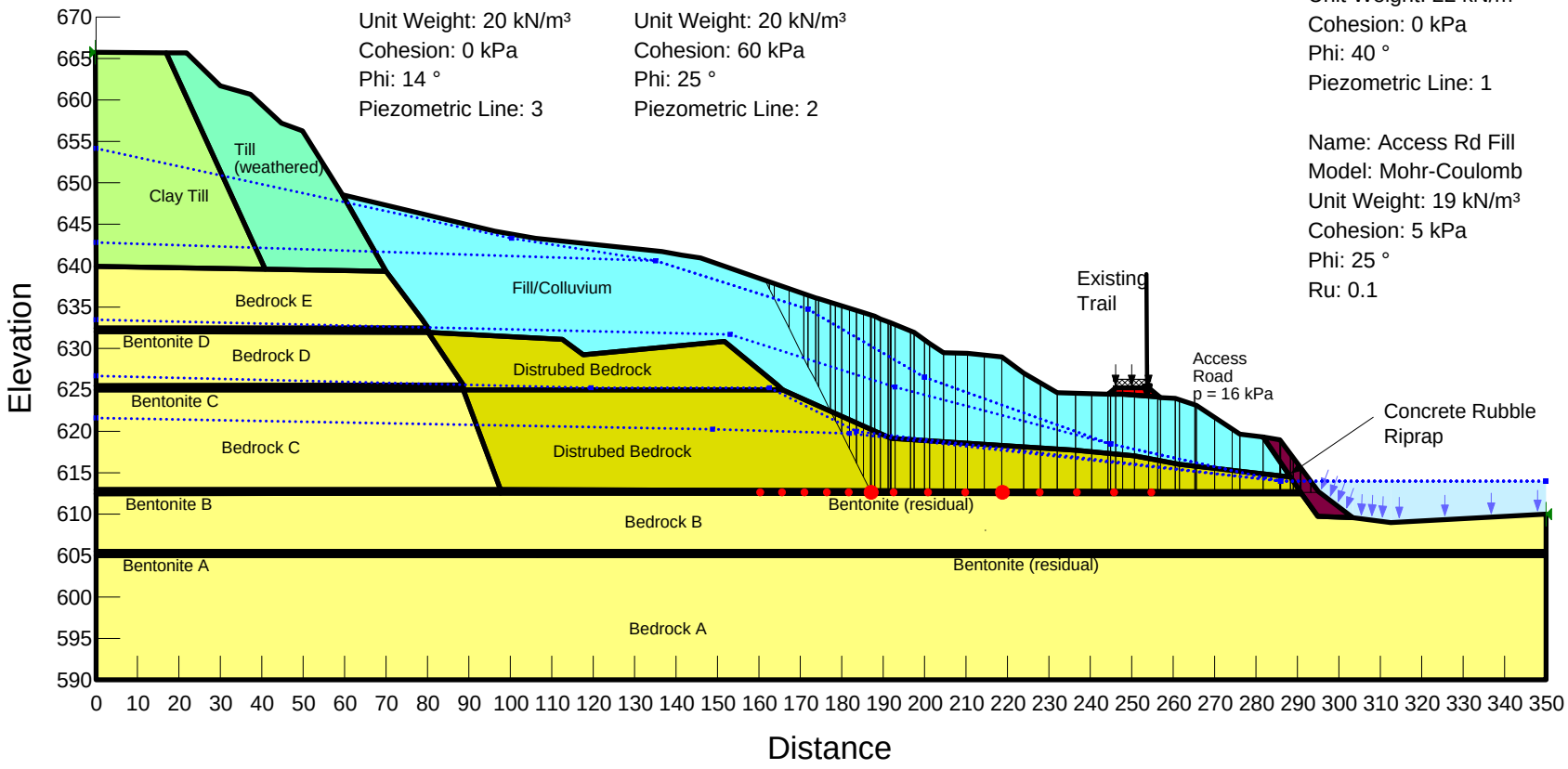
1.24

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:16:09 AM

SECTION A-A - FIGURE D4

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

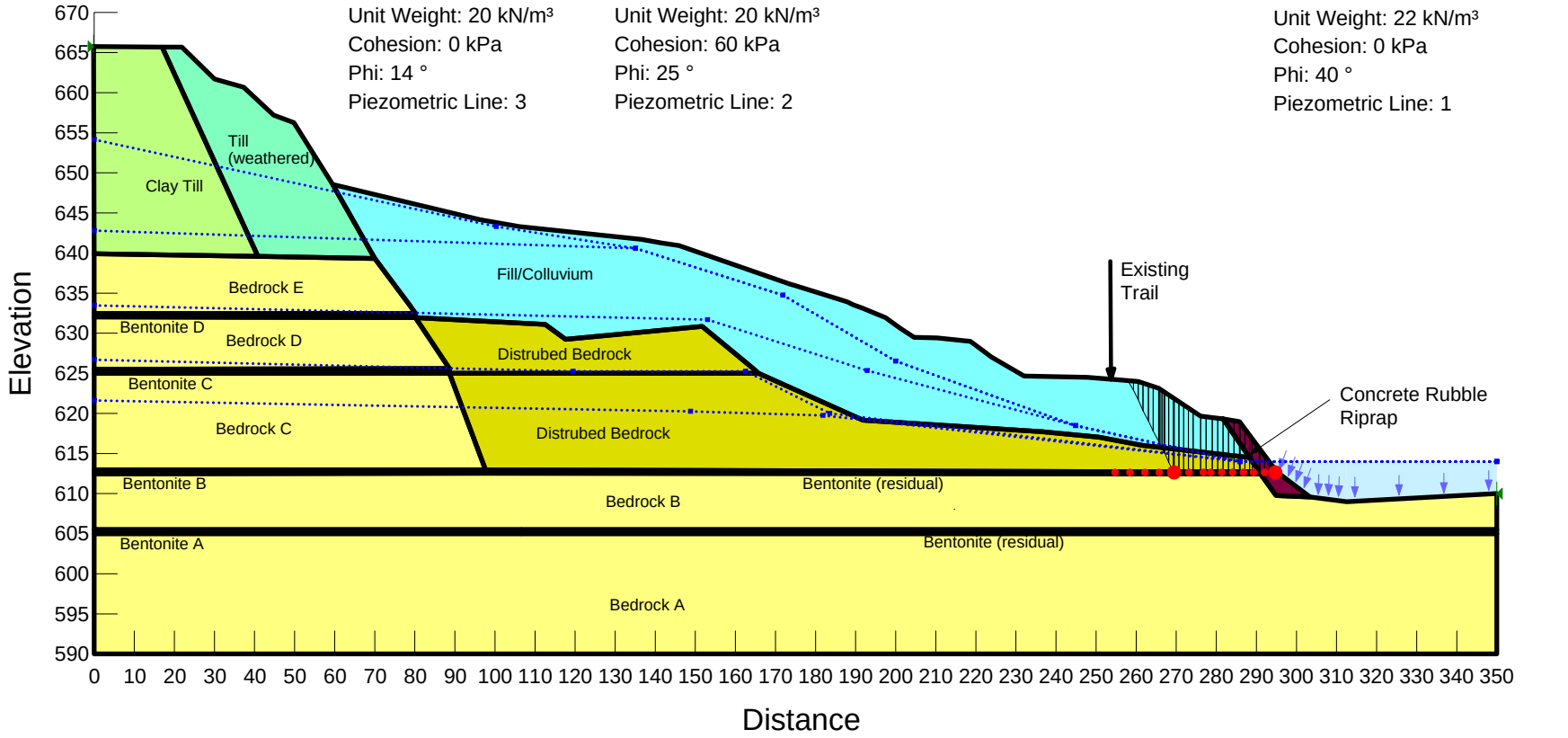
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.23

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section A-A_Current Conditions_Rev2_HER.gsz
Date: 9/6/2014 Time: 12:04:24 AM

SECTION A-A - FIGURE D5

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

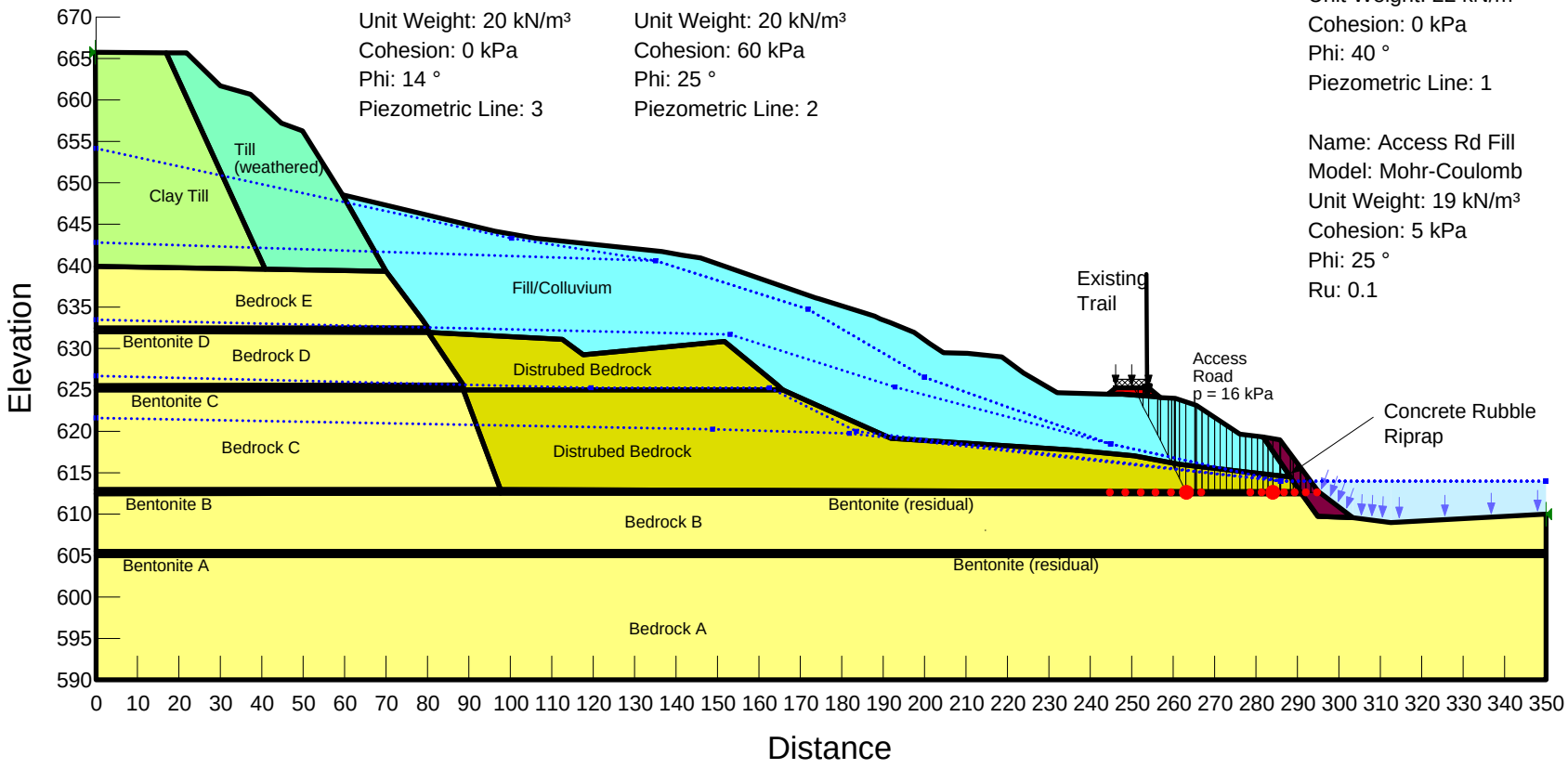
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.23

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section A-A_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/6/2014 Time: 12:25:11 AM

SECTION A-A - FIGURE D6

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

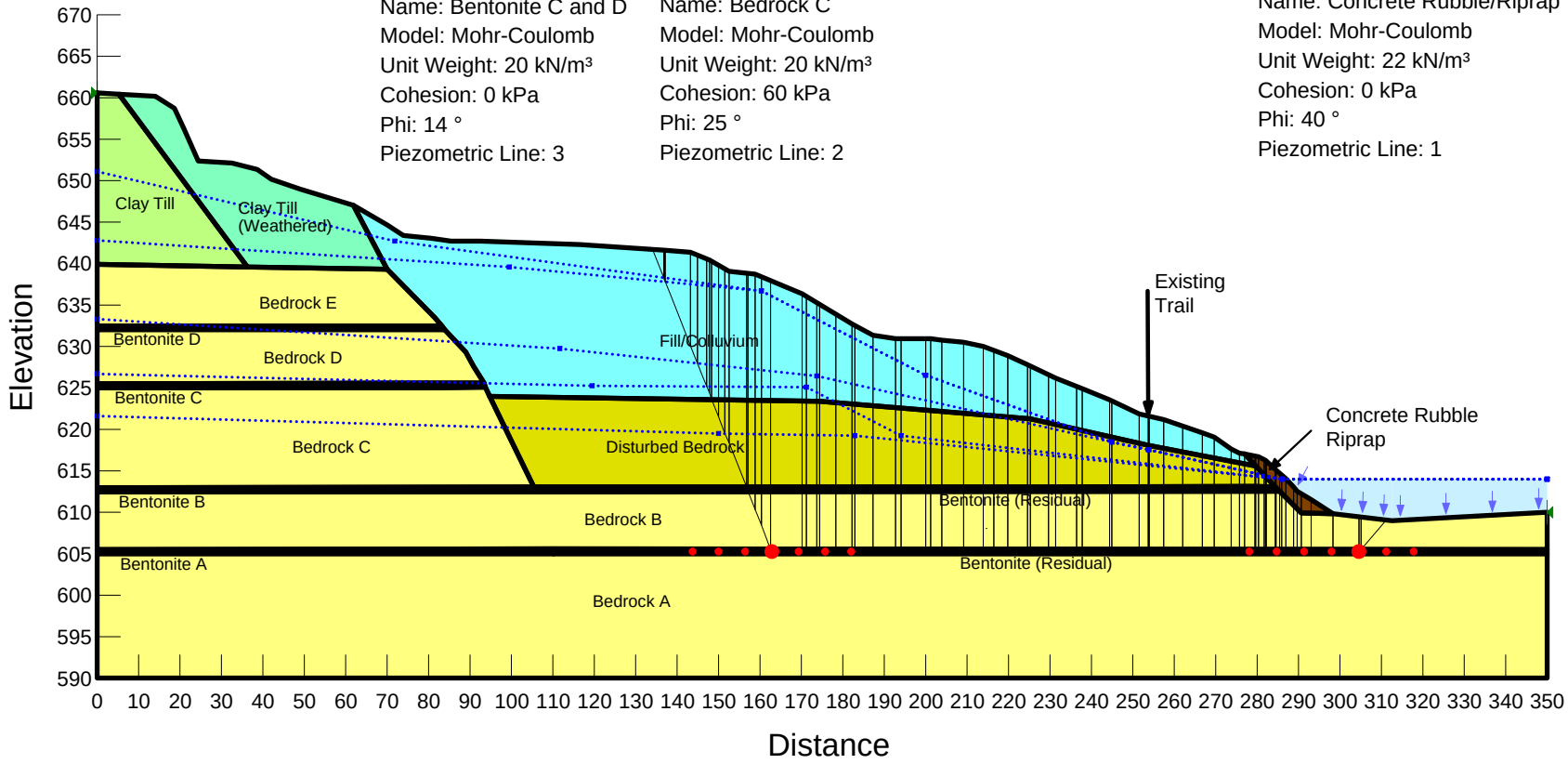
Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section B-B_Current Conditions_Rev2_HER.gsz
Date: 9/5/2014 Time: 11:30:49 PM

SECTION B-B - FIGURE D7

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

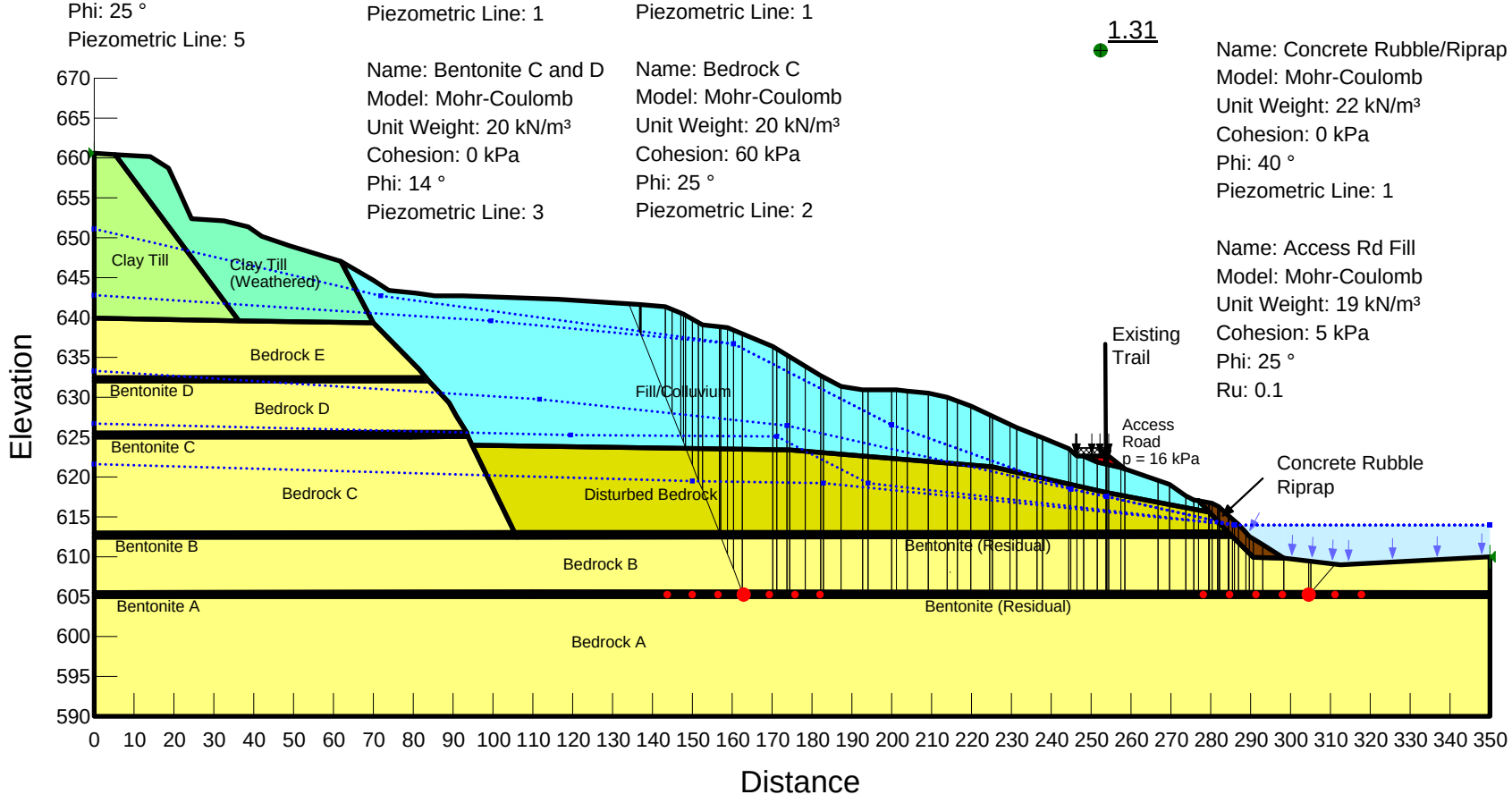
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



Directory: H:\19\5438-102 Edmonton SE LRT Extention (Valley Line) - Procurement Stage\North Bank Access Road\Slope Stability Analysis\New Analysis_HER\Revision 2\
File Name: Section B-B_After Road Construction_1m Fill_Rev 2_HER.gsz
Date: 9/5/2014 Time: 11:37:02 PM

SECTION B-B - FIGURE D8

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

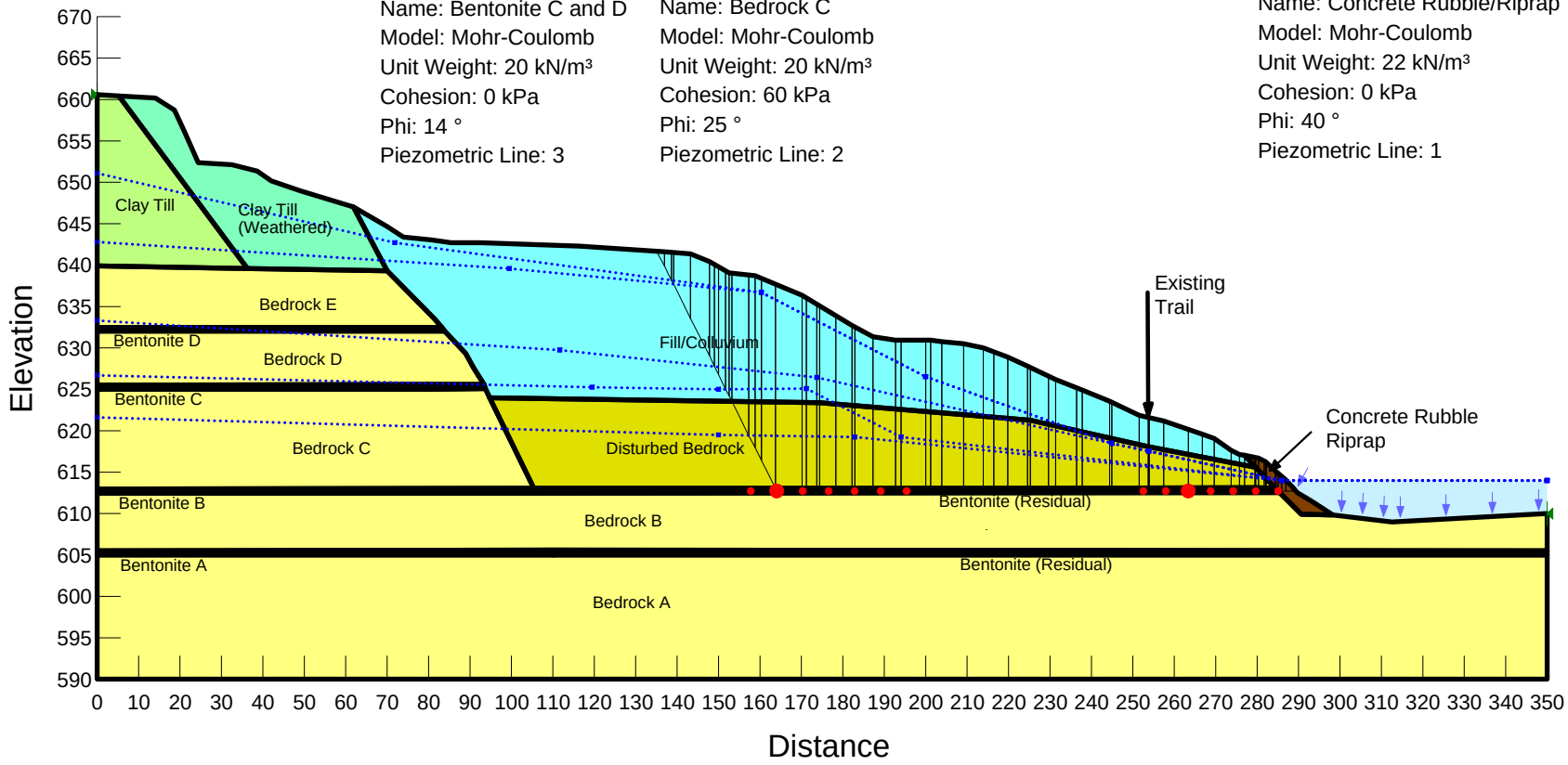
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

1.20



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File Name: Section B-B_Current Conditions_Rev2_HER.gsz
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SECTION B-B - FIGURE D9

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

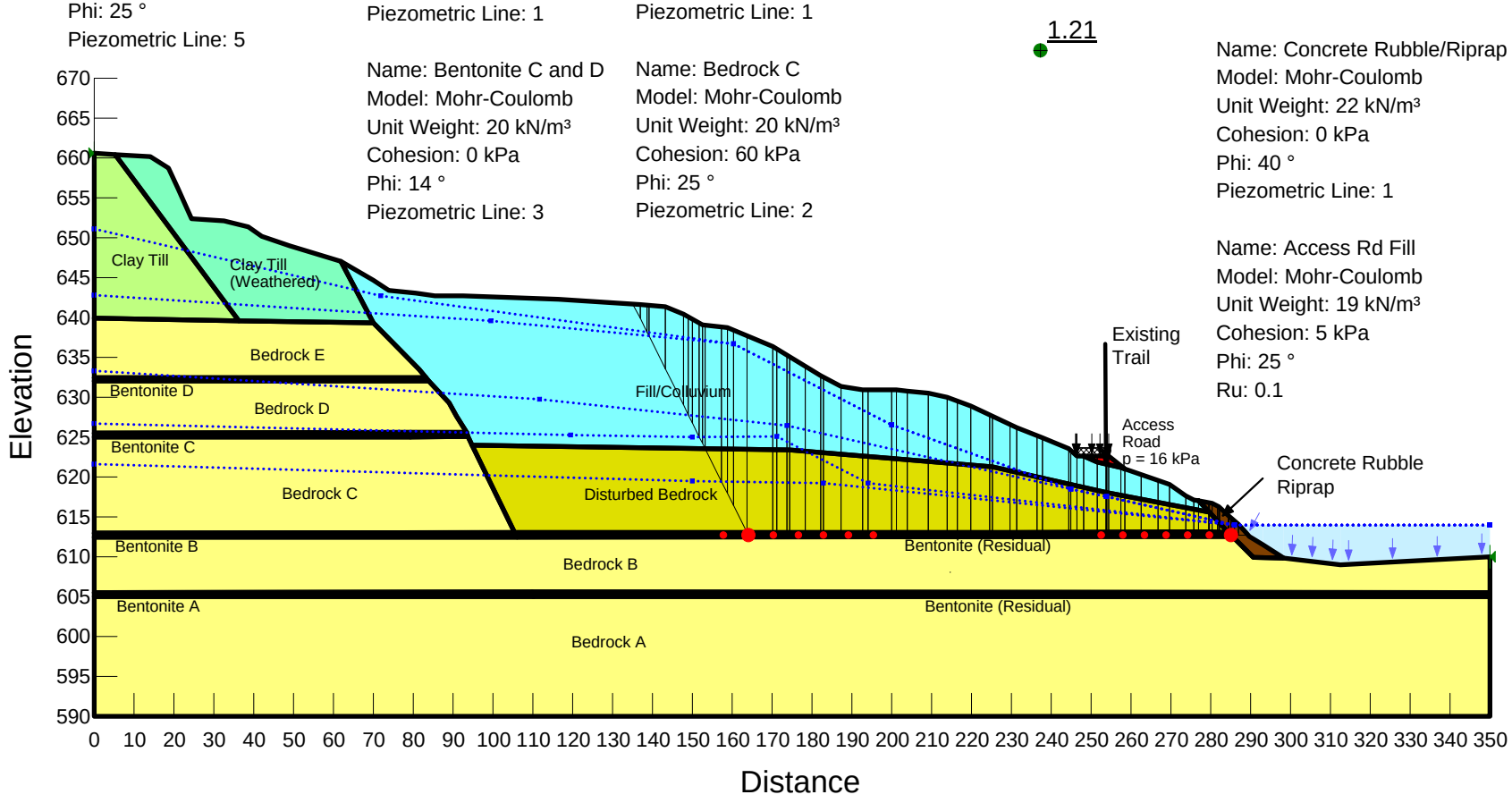
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section B-B_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION B-B - FIGURE D10

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

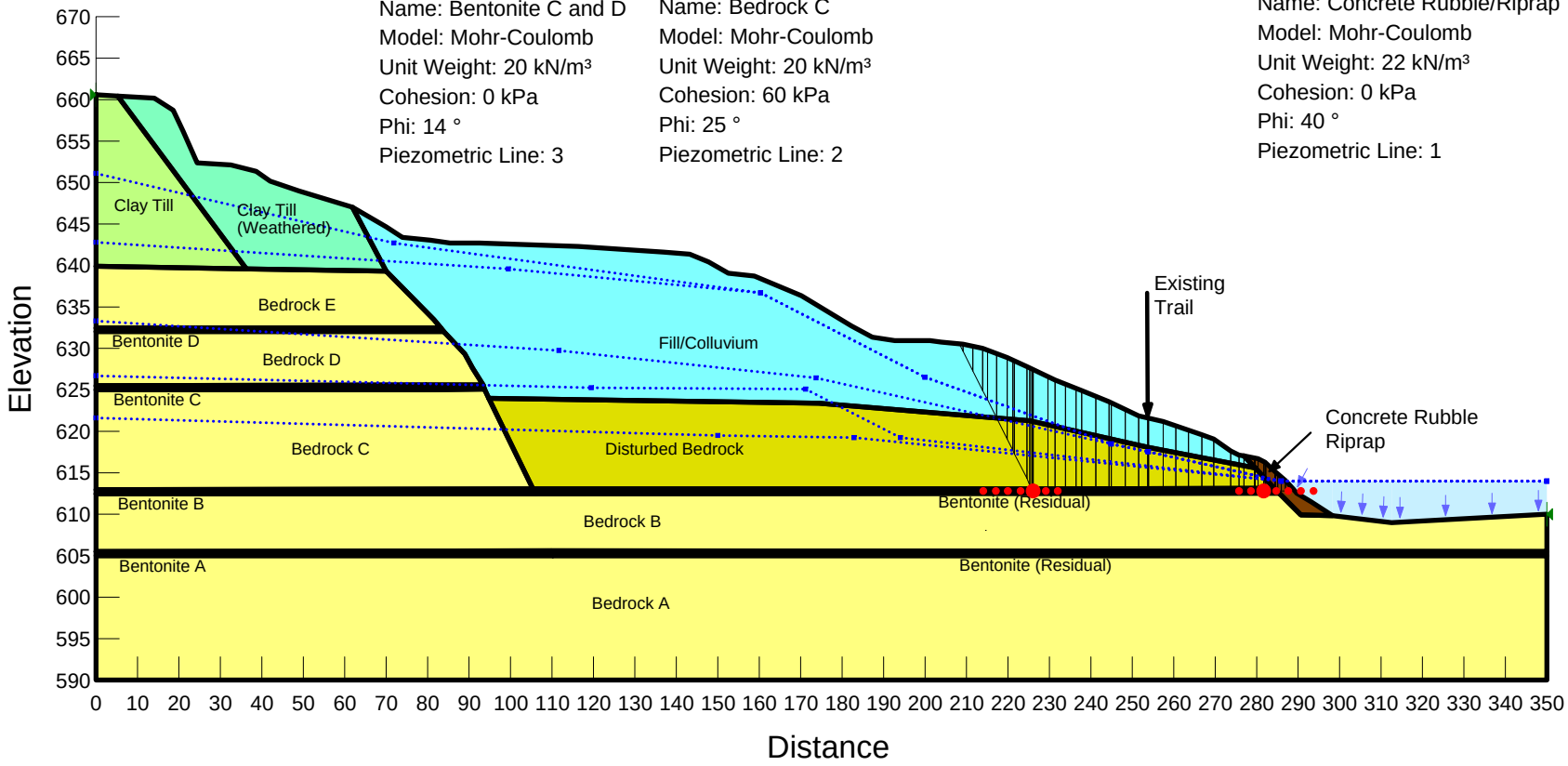
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.24

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section B-B_Current Conditions_Rev2_HER.gsz
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SECTION B-B - FIGURE D11

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

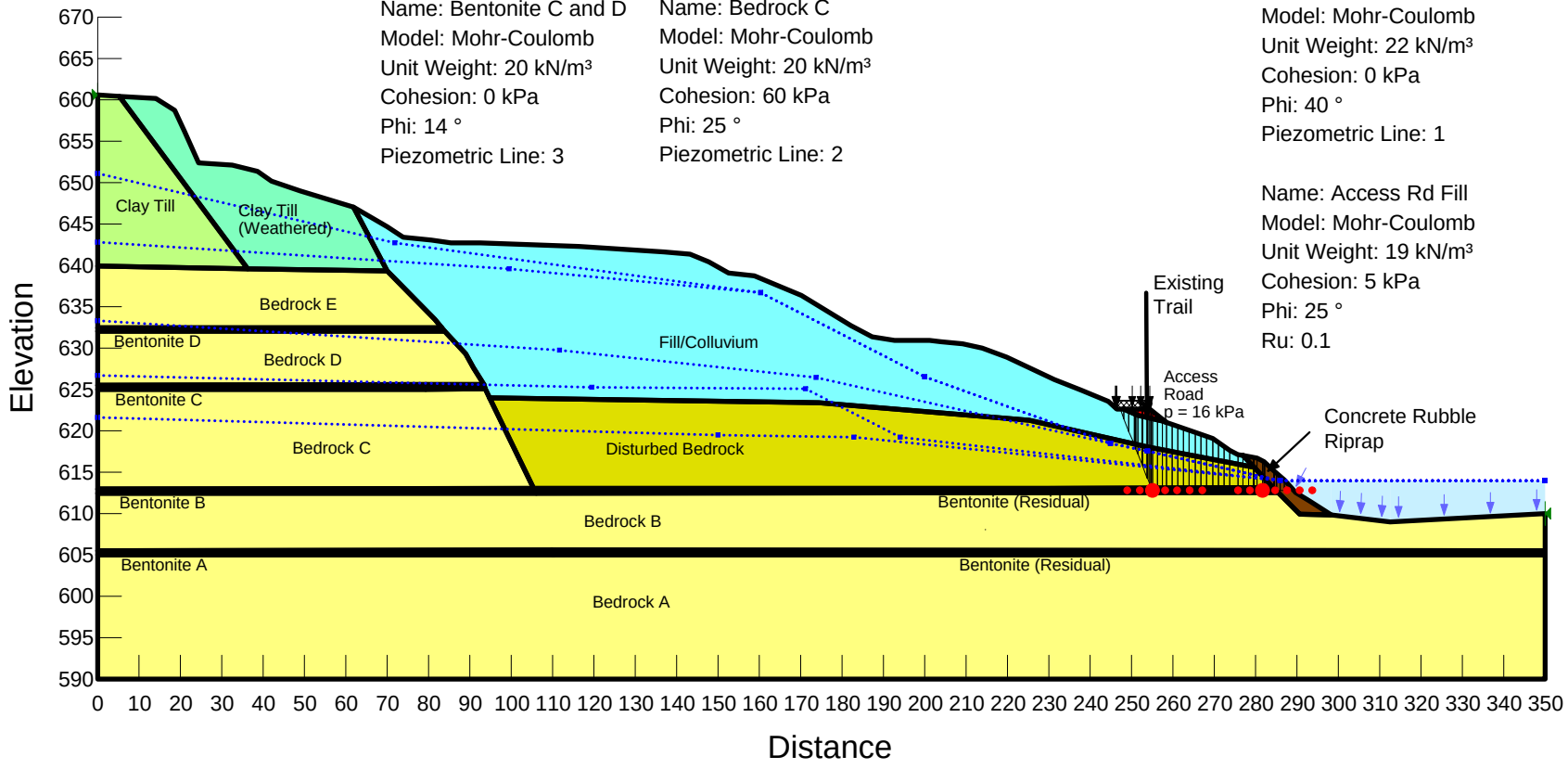
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.22

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section B-B_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION B-B - FIGURE D12

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

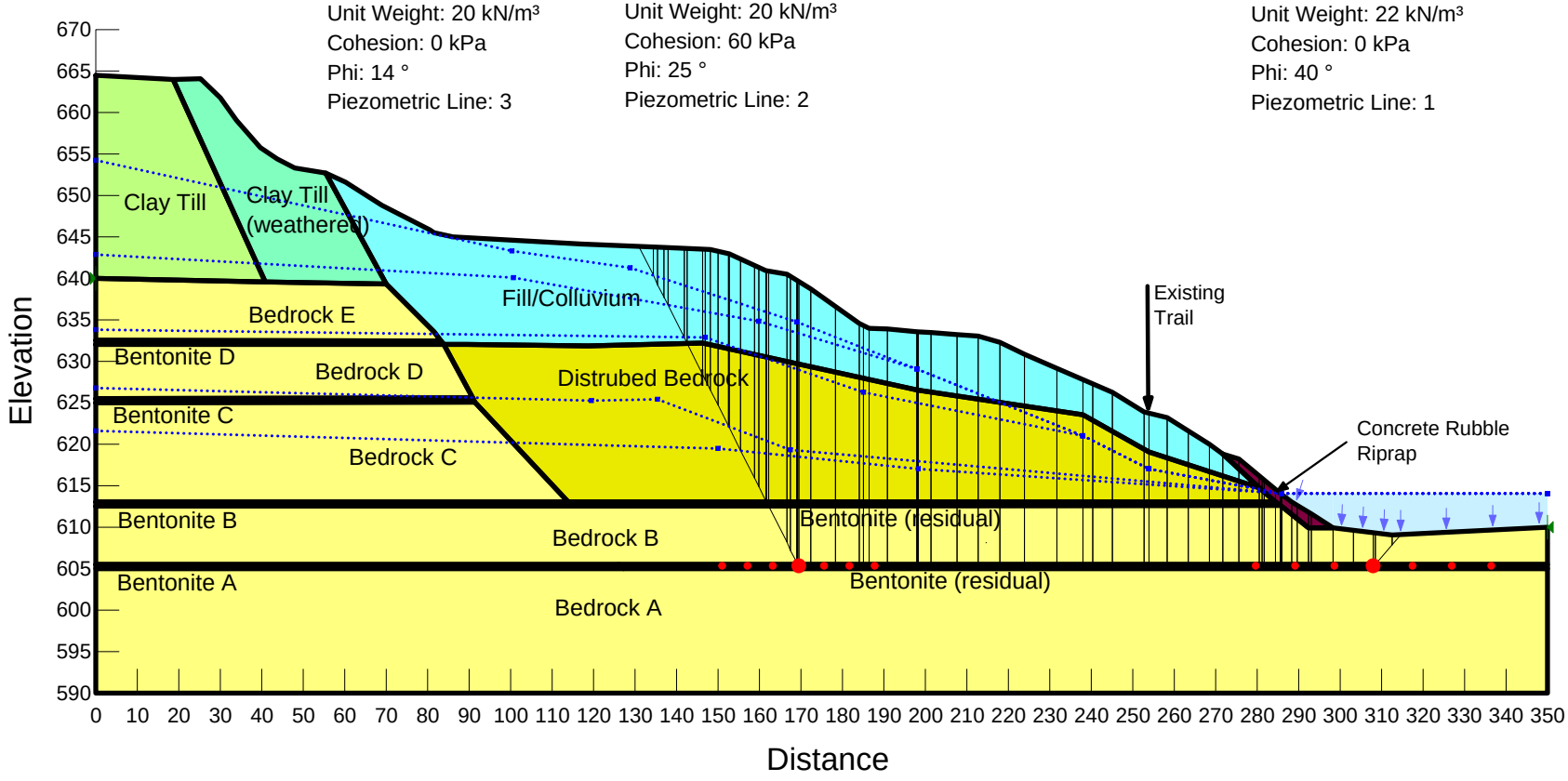
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.30

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section C-C_Current Conditions_Rev2_HER.gsz
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SECTION C-C - FIGURE D13

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

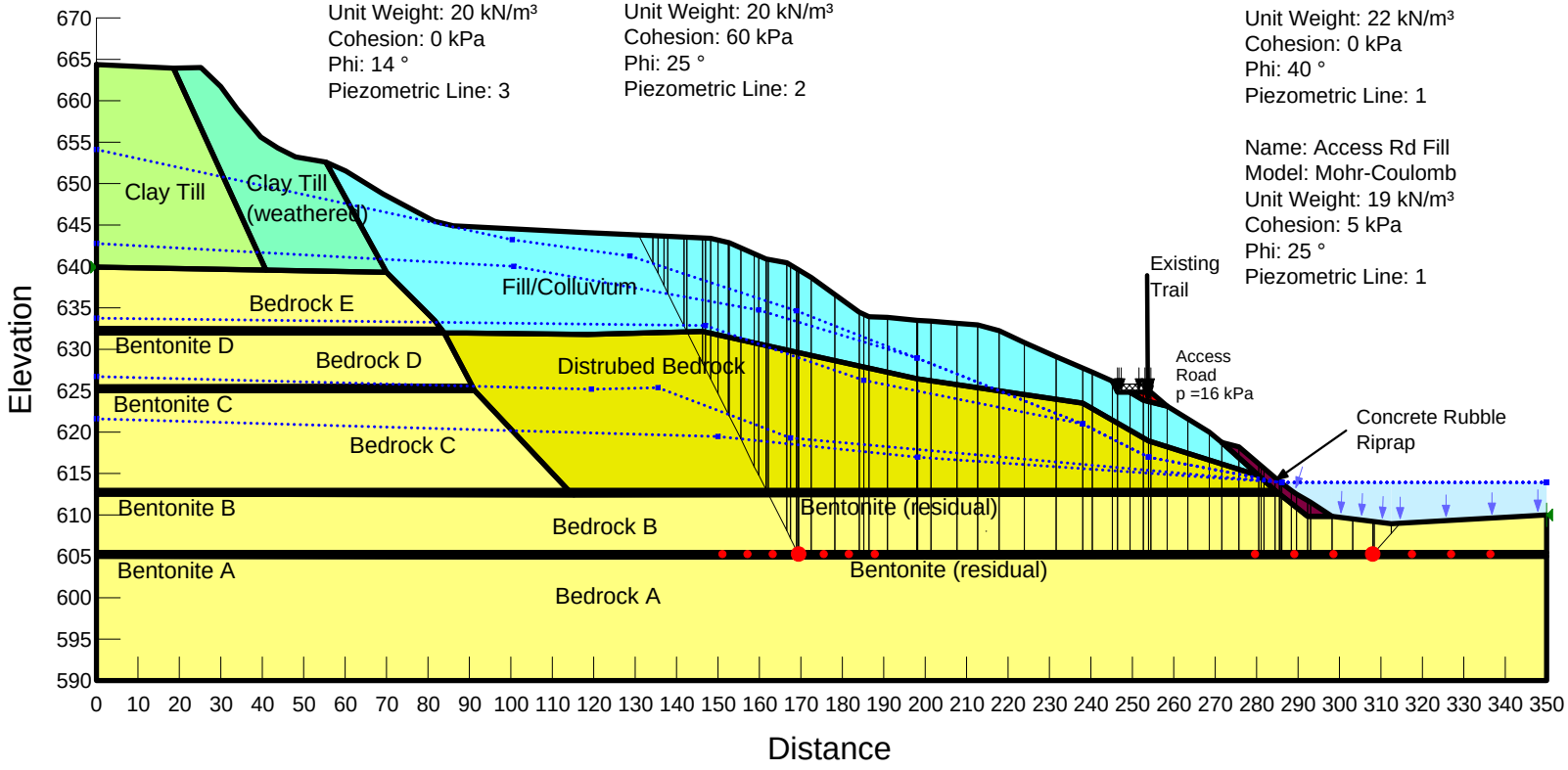
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.30

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION C-C - FIGURE D14

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

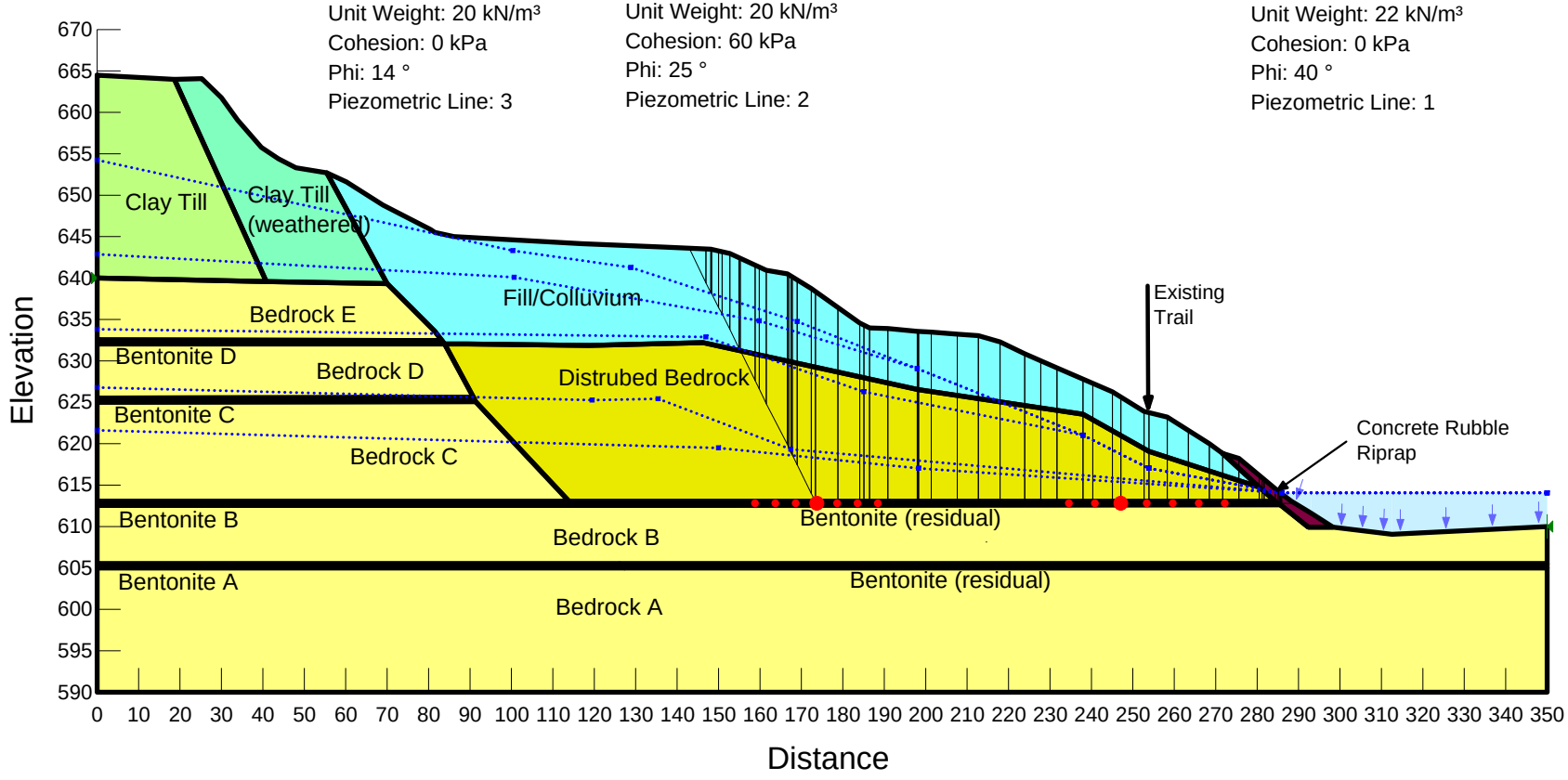
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

1.24



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File Name: Section C-C_Current Conditions_Rev2_HER.gsz
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SECTION C-C - FIGURE D15

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

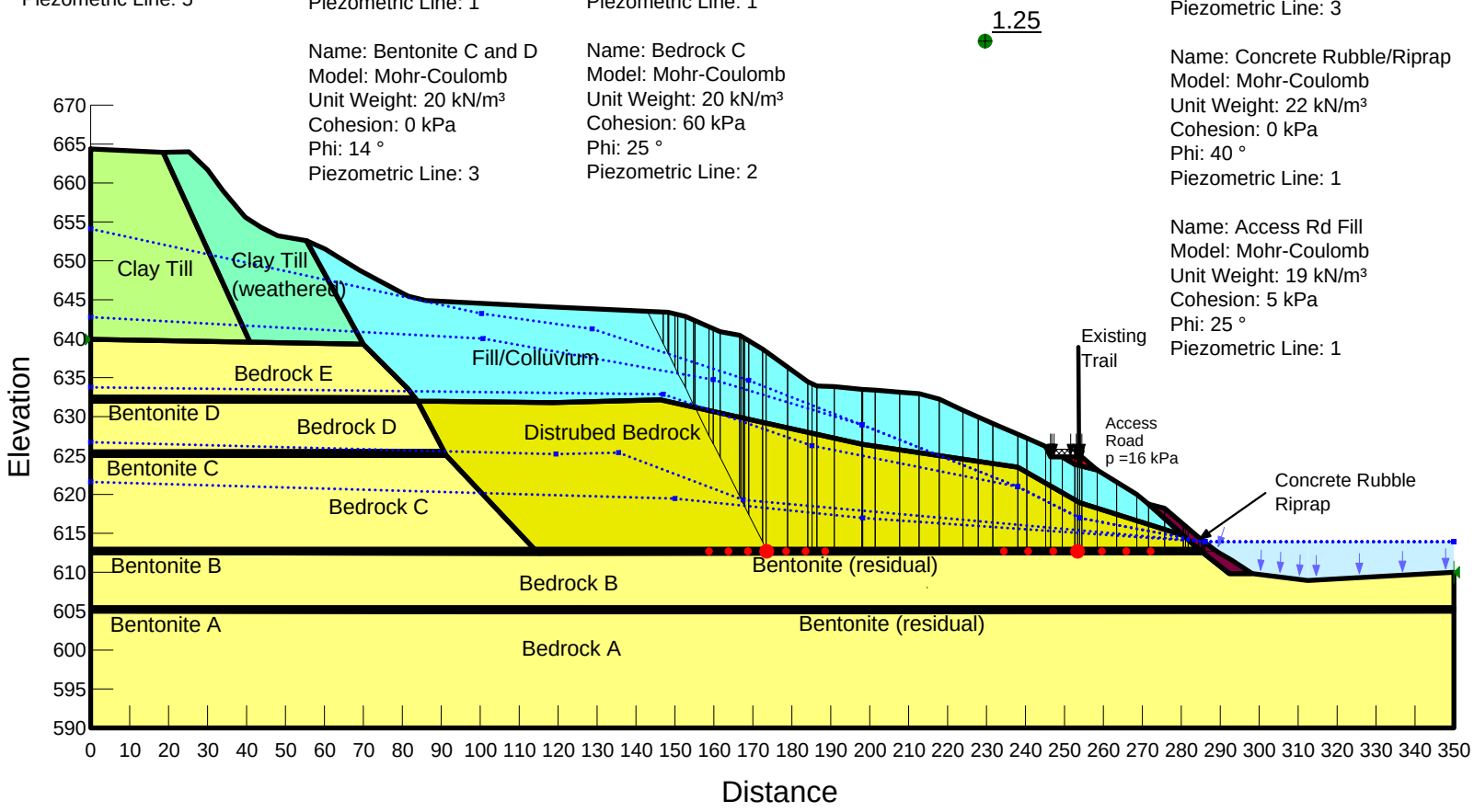
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION C-C - FIGURE D16

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

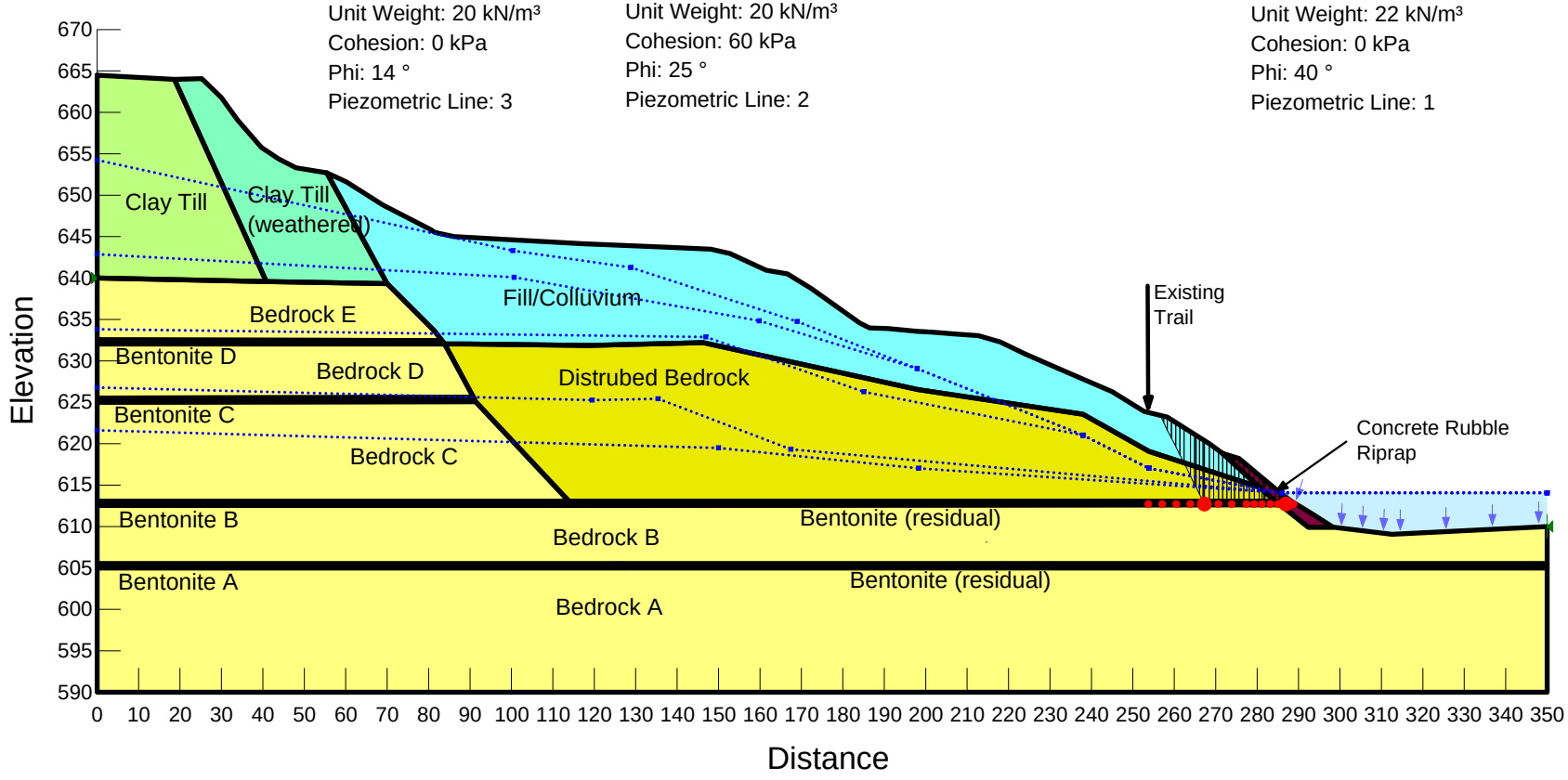
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.15

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section C-C_Current Conditions_Rev2_HER.gsz
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SECTION C-C - FIGURE D17

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

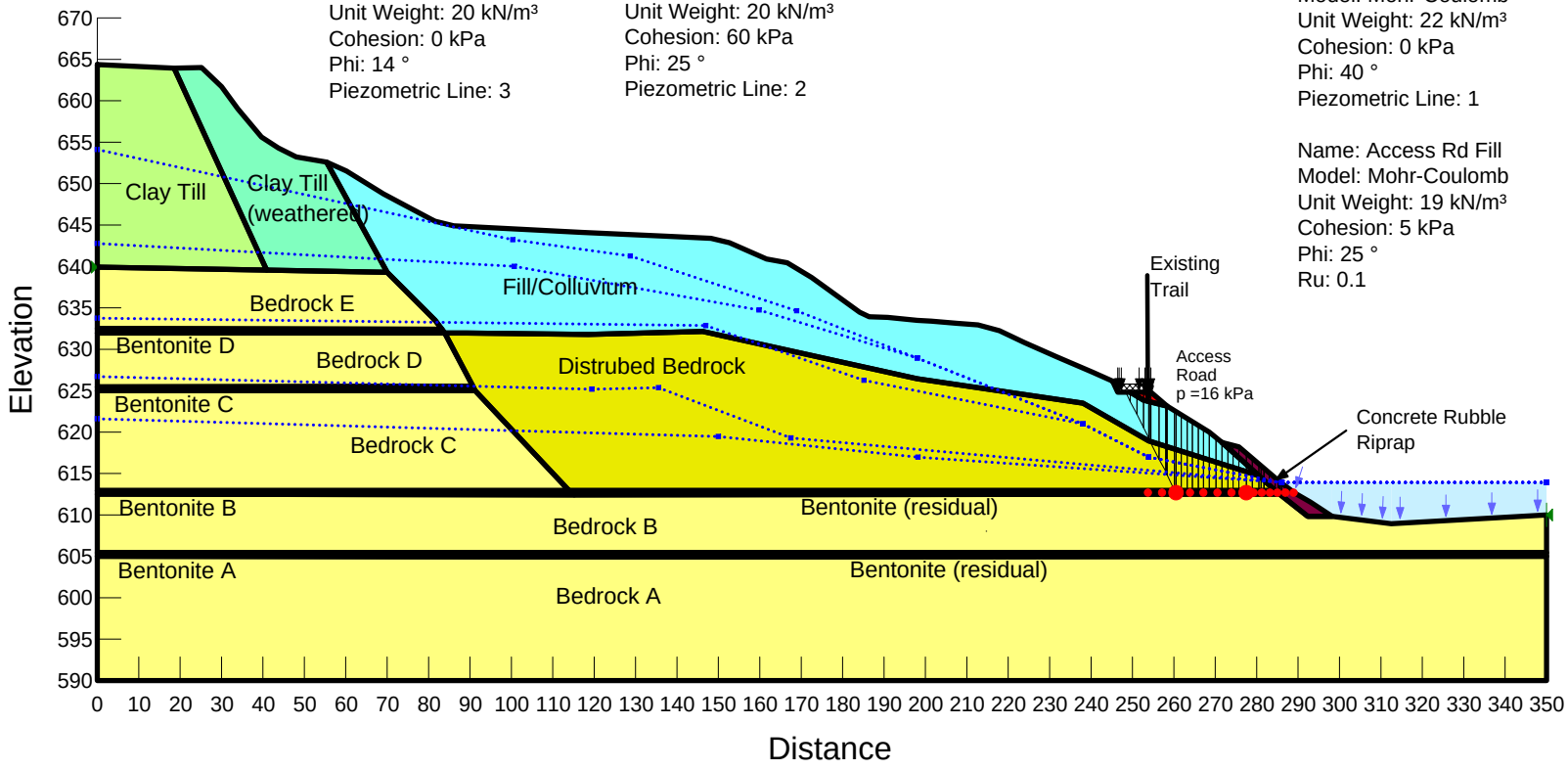
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 15 kPa
Phi: 25 °
Piezometric Line: 3

1.07

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1



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File Name: Section C-C_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION C-C - FIGURE D18

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

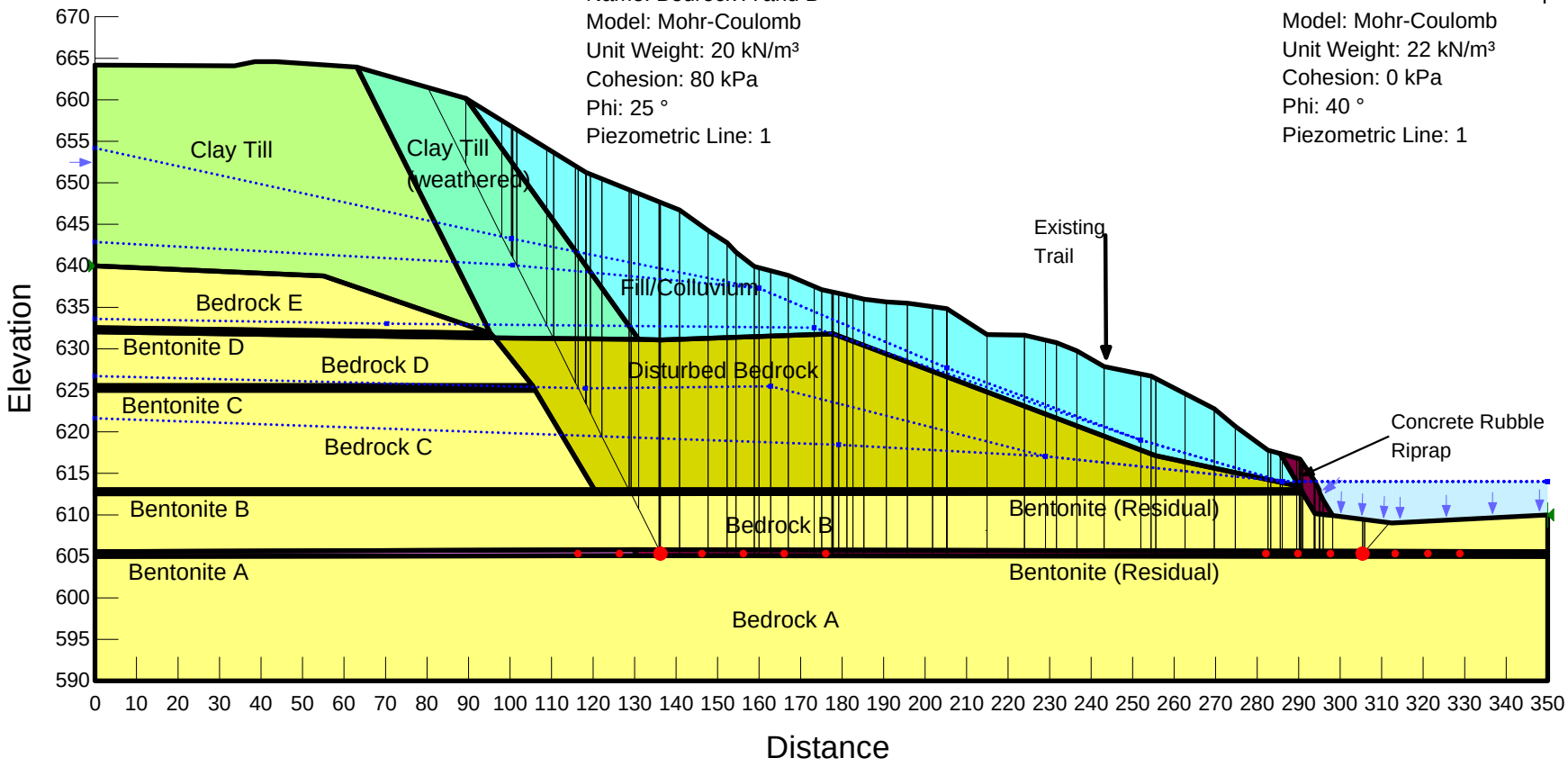
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

1.23

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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SECTION D-D - FIGURE D19

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

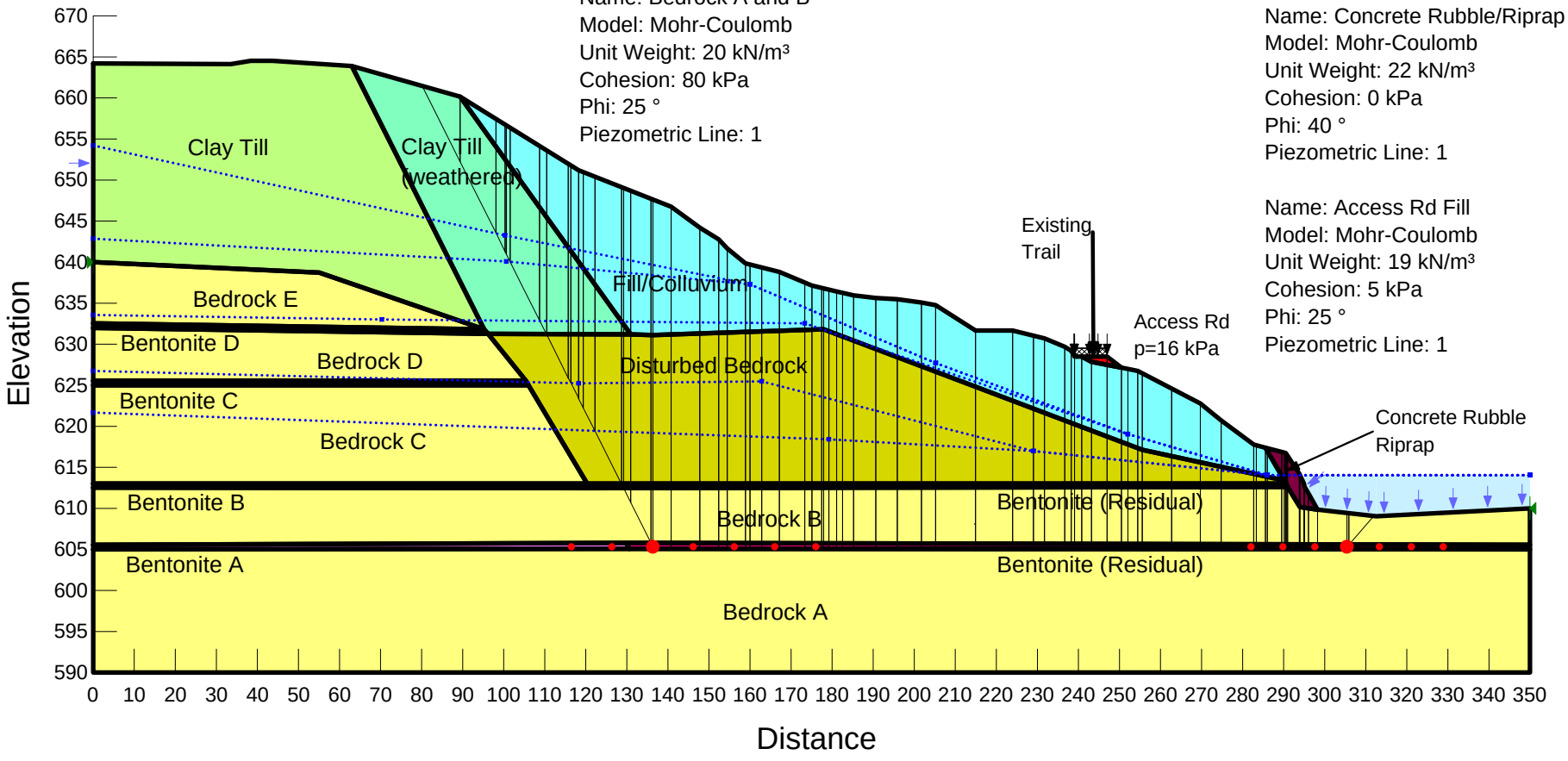
1.23

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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SECTION D-D - FIGURE D20

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

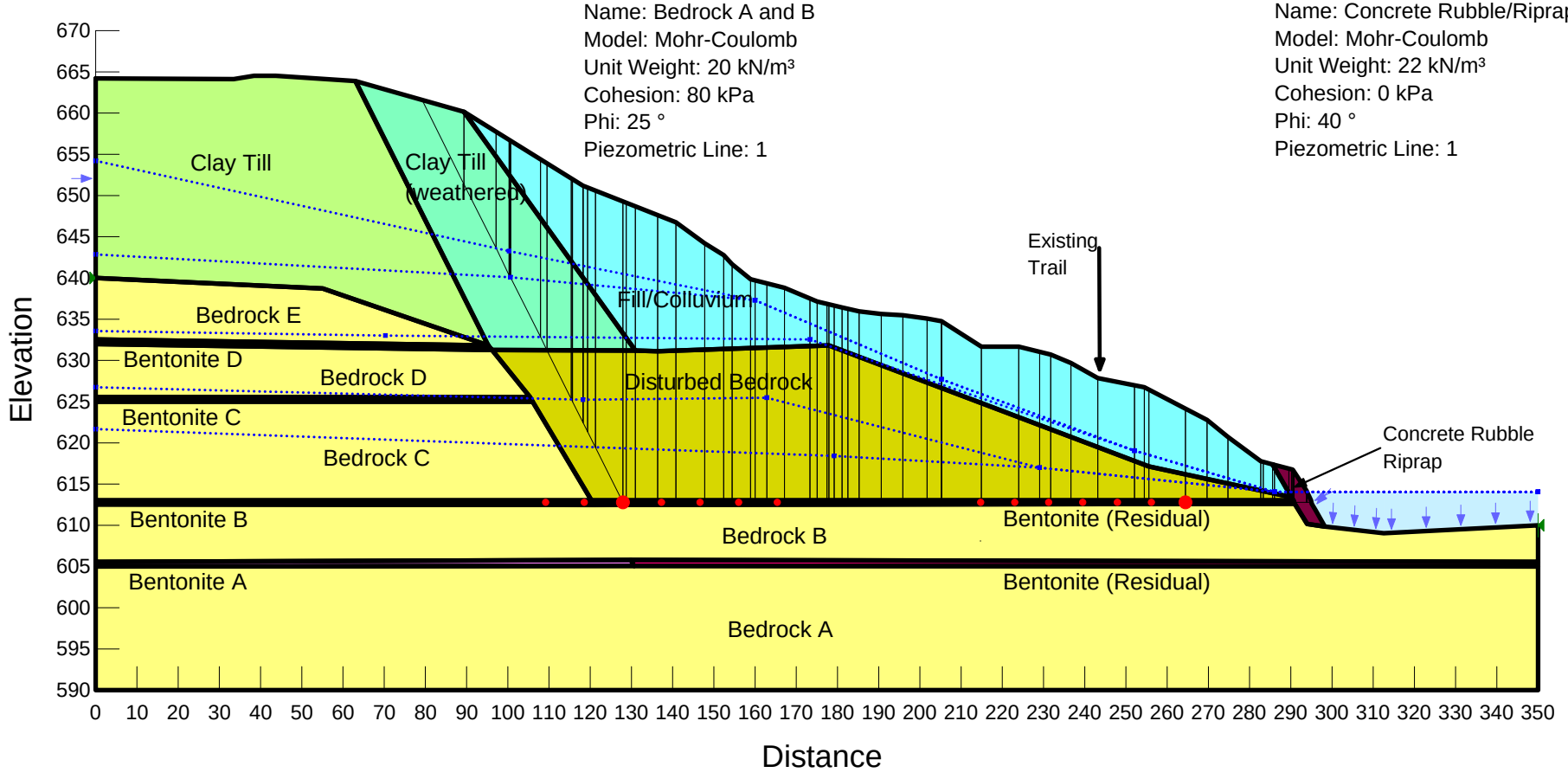
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

1.23



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SECTION D-D - FIGURE D21

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

1.23

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

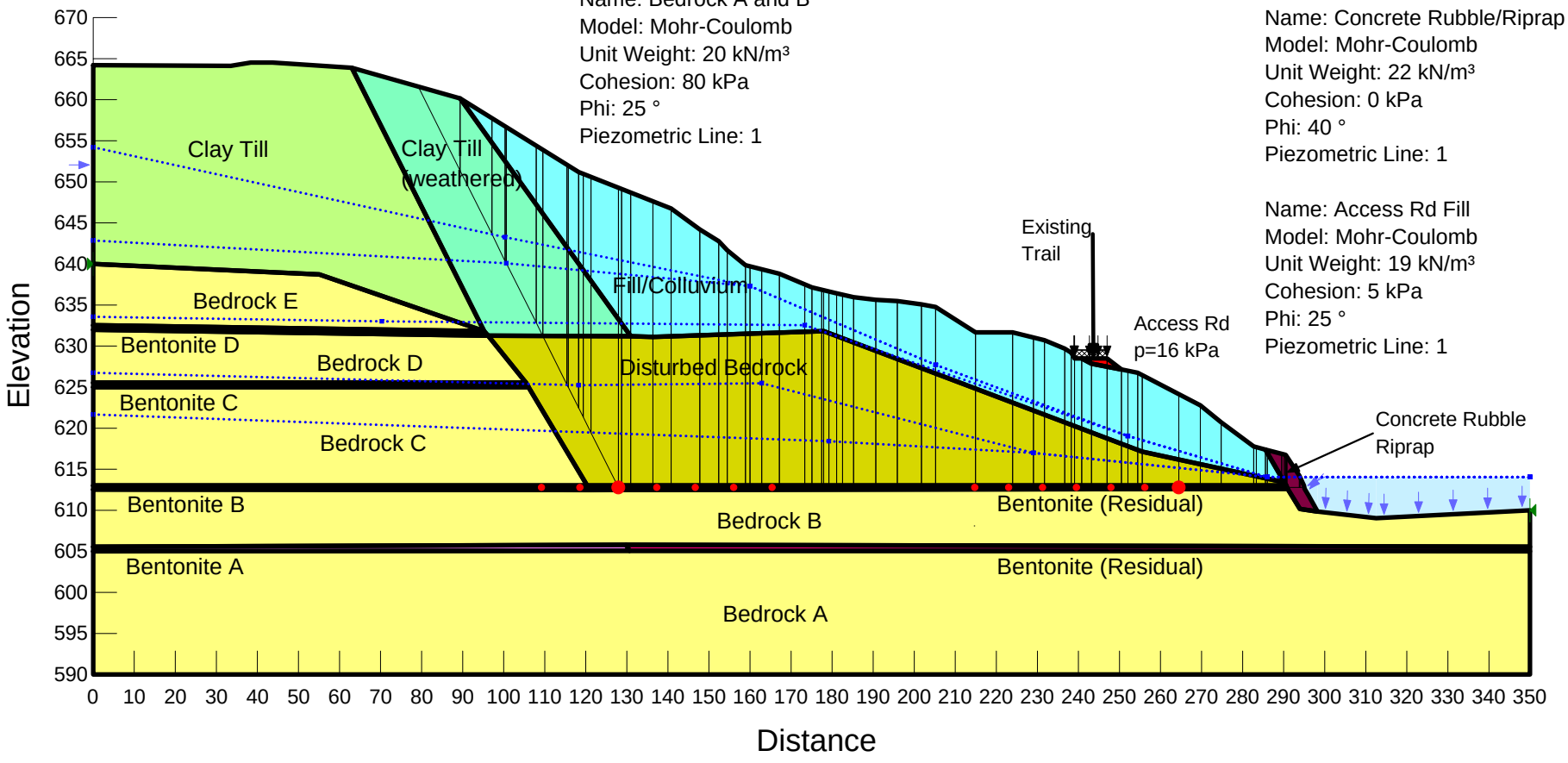
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 1



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File Name: Section D-D_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION D-D - FIGURE D22

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

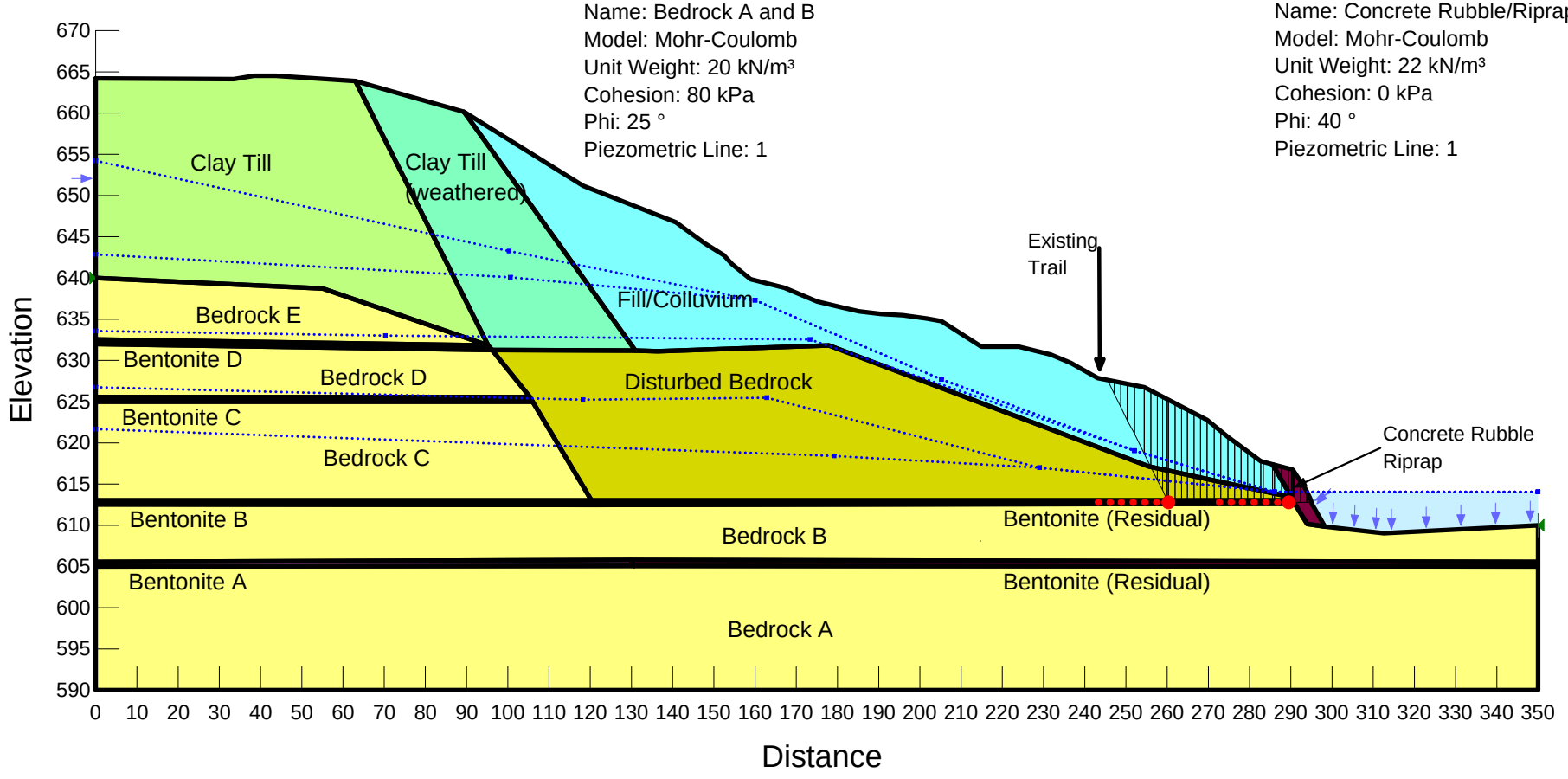
Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

1.20

Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1



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File Name: Section D-D_Current Conditions_Rev2_HER.gsz
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SECTION D-D - FIGURE D23

Name: Clay Till
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 20 kPa
Phi: 25 °
Piezometric Line: 5

Name: Fill and Colluvium
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 2 kPa
Phi: 23 °
Piezometric Line: 5

Name: Clay Till (Weathered)
Model: Mohr-Coulomb
Unit Weight: 18 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Piezometric Line: 5

Name: Bentonite A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 1

Name: Bentonite C and D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 14 °
Piezometric Line: 3

Name: Bentonite Seam (Residual)
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 0 kPa
Phi: 9 °
Piezometric Line: 1

Name: Bedrock A and B
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 80 kPa
Phi: 25 °
Piezometric Line: 1

Name: Bedrock C
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 60 kPa
Phi: 25 °
Piezometric Line: 2

Name: Bedrock D
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 3

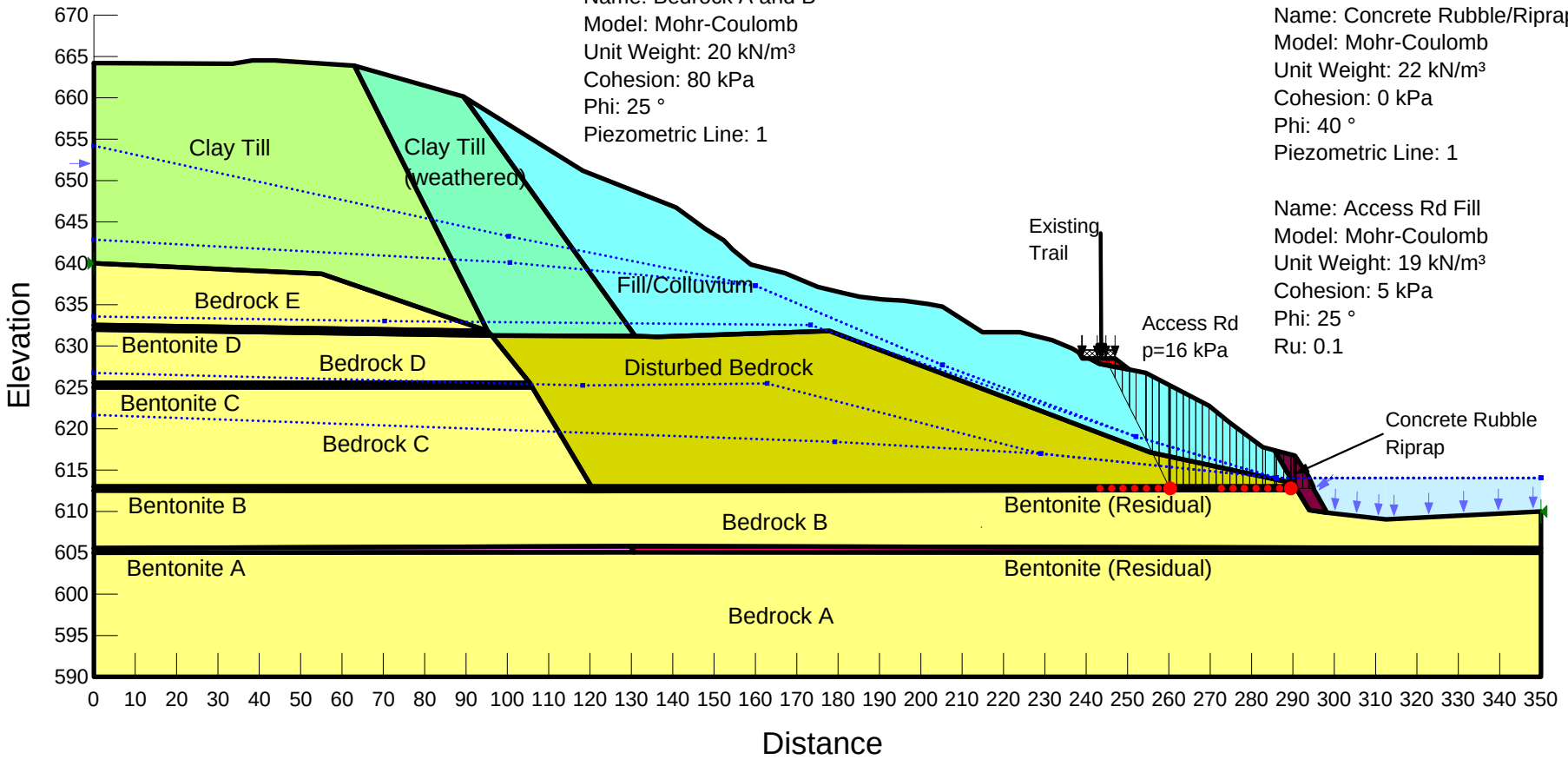
Name: Bedrock E
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 50 kPa
Phi: 25 °
Piezometric Line: 4

Name: Disturbed Bedrock
Model: Mohr-Coulomb
Unit Weight: 20 kN/m³
Cohesion: 30 kPa
Phi: 25 °
Piezometric Line: 3

Name: Concrete Rubble/Riprap
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 40 °
Piezometric Line: 1

Name: Access Rd Fill
Model: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 5 kPa
Phi: 25 °
Ru: 0.1

1.17



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File Name: Section D-D_After Road Construction_1m Fill_Rev 2_HER.gsz
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SECTION D-D - FIGURE D24